

Sir Alister Hardy Foundation for Ocean Science

Monitoring the health of the oceans since 1931



Refrigerated cargo ship **BENGUELA STREAM**

Owners: Seatrade Groningen NV, Netherlands.
 Charterer: Geest Bananas UK Ltd
 B route: Mid Atlantic to Portsmouth, UK
 From January 2008



Containership **REYKJAFOSS**

Charterer: Eimskip, Reykjavik , Iceland
 Owners: Reidar Shipping BV, Netherlands
 Zc, Zb and Z Routes
 Newfoundland to Iceland, From June 2008



Fishery Protection Vessel **PHAROS SG**

Charterer: Government of South Georgia
 Owner: Byron Marin, Stanley, Falklands
 SF route: Falklands to South Georgia. From: March 2011



Passenger Ro-Ro ferry **ARMORIQUE**

Brittany Ferries, Roscoff, France
 PR route: Plymouth to Roscoff
 From March 2009



Containership **S. RAFAEL**

Charterer: Eimskip, Reykjavik
 Owners: Briese Schiffahrts, Leer, Germany
 NI route, Mosjoen, Norway to Reydarfjordur, Iceland. From Sep 2010



Cargo-Supply ship **GREEN FROST**

Charterer: Zahl Transport A/S,
 Bodo, Norway
 Owners: Green Reefers A/S
 Bergen
 ST route: Svalbard to Tromso.
 From November 2008



Ro-Ro **MORNING CEDAR**

Charterer: Seaboard
 International Shipping Company
 North Vancouver, Canada
 Owners: Eukor Pte Ltd,
 Singapore
 VJ Route:- Vancouver to Japan.
 From April 2011



Containership **HORIZON KODIAK** **Horizon Lines LLC, U.S.A.**

AT route: N.E. Pacific: Tacoma, Washington State, USA to
 Anchorage, Alaska. From March 2004



Ro-Ro **TOR DANIA**

Charterer: DFDS Seaways, Copenhagen, Denmark
 Owners: Imperial Shipping AB, Gothenburg, Sweden
 HE Route: Elbe to the Humber. From October 2005 to April 2012



Ro-Ro/Containership **ATLANTIC COMPANION**

Owners: Atlantic Container Line,
 Skarhamn, Sweden
 E route: New York to Halifax, Nova
 Scotia and 52°W
 D & W routes: 33°W to 7° West and
 Liverpool
 From May 2008



Ro-Ro **FICARIA SEAWAYS**

DFDS Seaways,
 Copenhagen
 C route: Humber to
 Hanstholm Lighthouse,
 NW Denmark, then to
 Gothenburg. From July
 2006

Containership **SOPHIA**

Charterer: MacAndrews Ltd,
 London
 Owners: Draxl Schiffahrt,
 Haren Ems, Germany
 IB and SB routes
 Lisbon, Leixoes, 46°N, 53°N
 and Dublin. From December
 2011



Annual Report 2011

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Directors Review of the year

Welcome to our 2011 Annual Report and to another multi-decadal milestone in the history of the Continuous Plankton Recorder (CPR) survey. From humble beginnings on a cold January day in the southern North Sea in 1931, when the CPR was first towed, the survey has since grown truly global in scope, operating across both hemispheres from the Arctic to Antarctica. The 80th year of the CPR survey was suitably celebrated by hosting an international Symposium 'Plankton 2011' in Plymouth which brought together 180 scientists from 21 countries. The Symposium focused on understanding the causes and consequences of long-term plankton changes in both marine and freshwater systems. Engineered and orchestrated with great enthusiasm by Professor Peter Burkill the Symposium was a resounding success.

Another highlight of our 80th year was the establishment of a global network of CPR surveys which has long been a vision of the Sir Alister Hardy Foundation for Ocean Science. The concept of 'going global' was also held by the heads of other regional surveys operating independently in oceans around the globe. This shared enthusiasm for a global network culminated in the formation of the Global Alliance of CPR Surveys (GACS) in September 2011. GACS lists developing a shared global network for plankton data and facilitating new surveys by developing capacity building procedures as some of its many aims. By pooling the expertise of over 50 marine scientists from 12 different organisations and involving over 50 vessels from 40 shipping companies, GACS will ultimately lead us to a better understanding of marine biodiversity changes at the global scale.

After 5 successful years at the helm Professor Peter Burkill retired from the position of Director in autumn 2011. Peter was instrumental in setting up the global network of CPR surveys as well as forging good relationships between the three laboratories in Plymouth which culminated in the signing of a new Memorandum of Understanding (MoU) between SAHFOS, Plymouth Marine Laboratory and the Marine Biological Association in 2011. All the staff wish him good luck and a happy, fulfilling retirement. Professor Peter Liss from the University of East Anglia took up the presidency of SAHFOS from Professor Patrick Holligan in 2011. Patrick remains on the

SAHFOS board of Trustees. SAHFOS staff also saw a number of changes in 2011 with the retirement of one of our most experienced analysts (Paul Tranter) to the welcome addition of a number of new staff (Jennifer Skinner, Delphine Nicolas, Jess Haapkyla and Mike Flavell) who came in to strengthen our analysis team, work on new research contracts and to develop the new global CPR database.

Along with achieving Living with Environmental Change (LWEC) accreditation SAHFOS was also recognised by an Investors in People (IIP) silver award in 2011. These awards and accreditations are a testament to the staff's dedication and commitment to SAHFOS whom are instrumental in helping us maintain our position as an international centre of excellence in plankton ecology.

All in all 2011 was another successful year for SAHFOS, 80 years since the first CPR tow and 6 million towed nautical miles later, we continue to find ourselves in exciting times with a buoyant future. We will leave you with some of the highlights and new developments achieved in 2011.



Martin Edwards

Acting Director

Sampling and observation: Over the last year, SAHFOS sampled on average 10,000 nautical miles per month in the North Atlantic, North Pacific and Arctic. This was accomplished using ~ 50 vessels from about 40 shipping companies. The CPR survey data, being a key component to the Global Ocean Observing System (GOOS) and GEO-BON (the biological component of GEOSS) were used by marine biologists, scientific institutes and in environmental change studies around the world. The CPR routes in the western North Atlantic form part of the Canadian Atlantic Zone Monitoring Program (AZMP); new CPR routes in South Africa and Namibia contribute to the Benguela Current Commission (BCC) State of the Environment Information System; and routes in Australia form part of the Australian Integrated Marine Observing System (IMOS).

New technologies: SAHFOS now has a water sampler housed onboard certain CPRs to provide additional data and sample the whole size-spectrum of plankton from bacteria and viruses to flagellates and other taxa not normally identified using standard CPR analysis. We also aim to provide additional chemical and physical analysis of the water samples and plan to instrument all CPRs to collect additional physical measurements. New molecular methods are being used to analyse CPR samples as a standard form of analysis and on the CPR sample archive dating back to the 1960s. New molecular microarrays are being developed for monitoring Harmful Algal Blooms.

New database on physical variables: Physical data (predominately temperature, salinity and florescence) has been collected on many CPR routes dating back to the early 1990s. This data is now being collated into a new physical database to be released to the scientific community.

New fish larvae database: SAHFOS has completed retrospectively analysing fish larvae from the CPR sample archive in the NE Atlantic. This unique fish larvae database contains information on over 60 species for the last 50 years. It is being used to test stock recruitment models for a number of commercially important species.

Near-real time sampling: SAHFOS is currently piloting on certain routes near-real time monitoring and releasing data within 2 weeks. This includes standard CPR data (~500 species identified), physical data, flow cytometry data and molecular data as standard. It is envisioned that data could then be released to the scientific community via a web interface in the near future.





CPR Survey Operations

Tow logistics and operations

In September 2011, the Foundation celebrated 80 years of the Continuous Plankton Recorder (CPR) being towed each month by merchant ships on selected routes. The first CPR was towed by the cargo ship *Albatross* of Bremen, Germany on 15 September 1931. A total of 5,961,198 nautical miles have been towed to 31 December 2011 and by the 300 ships since September 1931. Since then the Survey routes have expanded from the southern North Sea to the North Atlantic and world-wide. The physical operation of the expanding Continuous Plankton Recorder Survey over the past 80 years would not have been economically possible without the generous support of ships, owners, managers, charterers, port operatives and agents. The consistent monthly tows plus assistance from the agents and port operatives in transporting the recorders to and from the vessels are a fine testament to the shipping industry. The international marine scientific, fisheries, meteorological and oceanographic communities are greatly indebted to them.

Ships and companies participating during 2011 are shown in Appendix B and photographs of the ships are inside the covers. During 2011 the 24 tow ships logged 129,192 nautical miles on 23 routes world-wide. There were 113,445 analysable nautical miles (nm). The near 90% sampling success rate in 2011 illustrates the conscientious, consistently professional work of the CPR workshop team. The team comprises Lance Gregory, Roger Barnard, Chris Harris and Debbie Cracknell.

Six changes of ships occurred in 2011. February: *Pont Aven* on the SA route; March: *Oeland* on the IB and SB routes, April: *Morning Cedar* on the VJ route, September: *Horizon* on the CT route, November: *Bretagne* on the PR route. December: *Sophia* on the

IB and SB routes.

The tow equipment aboard the ships is subject to a planned maintenance and safety inspection regime complying with the international lifting equipment regulations and marine International Safety Management (ISM) code.

The following geographic areas were monitored by CPRs:

Arctic, North East Atlantic and Norwegian Sea

The ST route between the North Cape of Norway and Svalbard was towed monthly from June to December 2011 by the *Green Frost*. We are indebted to the owners Green Reefers of Bergen and charterers, Zahl Transport of Bodø, Norway. The NI route between Mosjøen, Norway and Reydarfjordur, Iceland was towed by the containership *S. Rafael* each month in 2011 except for September and December due to customs clearance delays. This east-west route across the Norwegian Sea is very important for monitoring species migration.

Iceland to North America and Europe

We are very grateful to Reider Shipping BV, Netherlands for allowing their ship, the *Reykjafoss* to tow the Z route from Newfoundland to Reykjavik from January to April and September to December 2011. Due to problems no tows were possible from May to August. The superb professionalism of the crew in towing CPRs sometimes in very bad NW Atlantic winter weather is noted. Eimskip Shipping Company of Reykjavik has steadfastly supported the CPR survey since 1933. They have allowed successive ships to tow CPRs from the east coast of the USA to Nova Scotia, Newfoundland and Iceland (E and Z) routes, (*Godafoss*, *Skogafoss* etc.), and presently, the chartered *Reykjafoss*.

They also allow the Foundation to tow CPRs on the Immingham to SE Iceland (LR and V) routes from the *Selfoss*. The Foundation is also indebted to the Hafrannsóknastofnunin (Marine Research Institute) of Reykjavik for the continuous logistical support to the Survey. Teresa da Silva, Hildur Petursdottir and Dr Astthor Gislason organise the transfer of the CPRs to and from the Z route ship, *Reykjafoss* at Reykjavik.

East Coast of North America

Towed by the ro-ro/containership *Atlantic Companion* between New York, Halifax, Nova Scotia and south of Cape Race, Newfoundland (E route) throughout 2011. We are very grateful to the ship and Atlantic Container Line of Sweden for their professional assistance. The route has been run at five weekly intervals despite the busy operational schedule of the ship and often poor weather.

North Atlantic

The *Atlantic Companion* also towed the DA and D routes every five weeks between 33°W and 7°15'W to the north or south of Ireland en route to Liverpool depending on the prevailing North Atlantic weather. B route: *Benguela Stream*, a fast refrigerated cargo ship completed four consecutive tows every 28 days from 40° West to Portsmouth, UK.

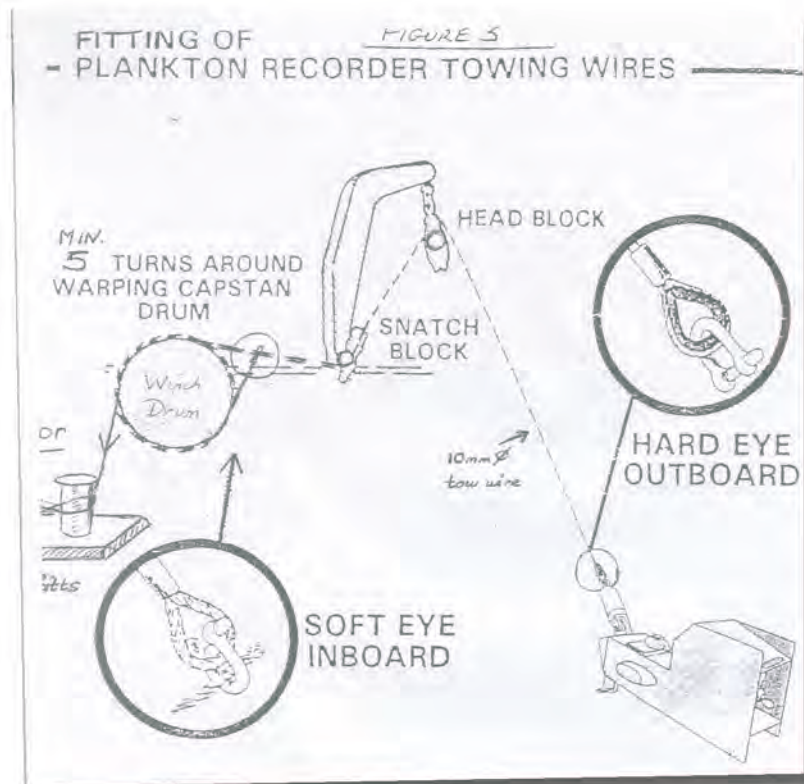
Thirteen sets of 4 tows totalling 22,582 nm were completed in 2011. We are much indebted to the ship for handling the plankton recorders sometimes in arduous weather conditions and at night. We gratefully acknowledge the kind permission from the ship's managers, Seatrade NV, Groningen, and the charterers, Geest Line Ltd, Fareham and also MMD Shipping Services, Portsmouth for their logistical support.

North Pacific

The AT route is towed between Tacoma, Washington State and Anchorage, Alaska from April to September. We are very grateful to Horizon Lines LLC and their containership, *Horizon Kodiak*, for their continued professional

support for this route since 2004. Eighteen individual tows were completed to September, with 7501 nm logged. Two technicians, Mark Savoie and Gary Lawley from Kinnetic Laboratories, Anchorage, Alaska, were trained in April 2011 at the Foundation in Plymouth to look after the CPRs. They unloaded, serviced and reloaded the CPRs at Anchorage achieving with the crew of the *Horizon Kodiak* a creditable 94.8% plankton sampling success rate. Horizon Lines Tacoma container terminal shore gang handled the CPRs to the ship. Thanks are due to the Ship's Superintendent, Danny Ellis, Horizon Lines shore gang plus Ken Clinton and Vern Poulsen.

VJ route: During April, June and August, the new ship, *Morning Cedar*, owned by Eukor of Singapore and chartered by Seaboard International Shipping Company of Vancouver completed three westbound sets of seven 500 nm tows. 10,971 nm were logged over the 21 tows giving 10,392 analysable nm. This gave a 98.8% sampling success rate attributable to the care taken by the *Morning Cedar* crew, Doug Moore, Sonia Batten and team on Vancouver Island. A Brancker XR620 CTD + F unit was successfully run on the three sets of VJ route tows.



North Sea

The C, HE and LG routes have been consistently monitored each month by ships of DFDS Seaways (formerly DFDS Tor Line) fleet over many decades. The Survey is much indebted for permission from DFDS Seaways, Copenhagen and for the logistical help from their port operatives at Immingham and Gothenburg. *Tor Dania* chartered from Imperial Shipping Gothenburg towed the HE route monthly throughout 2011. DFDS Seaways *Ficaria Seaways* and *Petunia Seaways* towed on the C and LG routes. *Flandria Seaways* (ex *Maersk Flanders*) has towed the R route monthly between the Shipwash Bank and Hook of Holland since July 2000. The continued permission from the owners and managers plus logistical support from DFDS Seaways at Dooley Terminal, Felixstowe are much appreciated. The M route, between Aberdeen and Tananger, has been towed consistently each month by the freight ro-ro *S. C. Aberdeen* of Sea Cargo A/S, Bergen. We gratefully acknowledge the kind permissions from Sea Cargo of Bergen and Aberdeen and their ships over many years. The A route between Lerwick and Aberdeen was towed monthly in 2011 by the freight ro-ro *Hildasay* chartered by NorthLink Ferries Ltd from Seatruck Ferries, Heysham. We are very grateful for their permission and professional assistance to the Survey.

Irish Sea

IB route: (46°North in Biscay to 53°North, off Dublin) was towed by the containership *Helgaland* from February 2010 to January 2011. MacAndrews Ltd of London then chartered the *Oeland* (owners M/S Frisia Schiffahrts-GmbH / DT-Bereederungs GmbH Burg/Dithmar Germany) which towed on the route from March to October 2011. The *Sophia* (chartered from Mar Trust ship No. 2/ Peter Döhle Schiffahrts, Haren-Ems, Germany), resumed the route from December 2011. We are grateful to the crews, charterers, owners and

managers for their professional assistance and permission.

IN route: The *Norbay* of P&O Ferries Irish Sea Ltd, Larne, Northern Ireland, consistently monitors the plankton each month between the Liverpool Bar light buoy and Dublin. We are grateful to the ship and P&O Ferries at Gladstone Dock, Liverpool, for their professional assistance.

Portuguese and North Spanish coasts, Bay of Biscay and the Channel.

SB route: This was towed in 2011 by the same ships chartered by MacAndrews as on the IB route above. The SB route is from Cabo da Roca (38°50'N 9°53'West) to Leixoes (41°15'N, 8°58'W). The recorder bodies with the same filter cassette inside were then re launched off Leixoes and towed to 46°North in Biscay. SA Route: Brittany Ferries, Roscoff, kindly gave permission for their *Cap Finistère* to tow plankton recorder on this route from October 2010 to November 2011. The ship had to stop tows in November 2011 due to track changes to the more restricted shallower inshore route between Ushant and the Breton coast. A new ship is being sought for the route. PR route: No ship on the route in January. Brittany Ferries' *Armorique* towed each month to October. *Bretagne* towed in November and the *Armorique* in December. We are much indebted to Brittany Ferries for their kind permission and professional assistance.

Southern Africa: Luanda, Angola to Durban, South Africa

This new route was set up for the Benguela Current Commission (BCC) in July and August 2011. The project leader for BCC is Dr Hans Verheye at Cape Town. On 1 July 2011, Shanghai Costamare Ship Management and the charterers Ocean Africa Container Line, Durban of the containership *MV Horizon* kindly gave permission to tow plankton recorders between Luanda and Durban.



Peter Pritchard organised the tow point fitting at Durban on 29 August which was attended by Hans Verheye and Marco Worship. The Chinese crew were instructed in deploying the CPR and changing the filter cassettes. Five consecutive, successful CPR tows were completed between 22 September and 1 October.

South Atlantic: Falkland Islands to South Georgia

From June 2010 Dr Peter Ward of the British Antarctic Survey (BAS), Cambridge put forward a plan to tow CPRs on alternate months between Stanley, Falkland Islands and South Georgia. This was agreed and CPR 184 was sent to Stanley in September 2010 on the *James Clark Ross*. Dr Martin Collins, the Director of Fisheries, Government of South Georgia agreed to their chartered fisheries protection vessel, *Pharos SG* towing the CPRs. Mr David Allan the technical director of Byron Marine Ltd of Southampton (the ship managers) very kindly organised the new tow point for the CPR on the ship's stern. The first two tows were completed from 5 to 9 March. Two CPRs covered the 720nm. These were followed by tows in May, July, September, early November and late December. 4313nm were towed in 2011. Judith Brown at Stanley and Katie Brigden on South Georgia unloaded, serviced and reloaded the plankton recorders. We are very grateful to the crew of the *Pharos SG* and the se above mentioned for the successful tows.

CPR Workshop

There were no losses of CPRs during 2011. Jan 2011: CPR 188 and three cassettes sold to Aus CPR. May 2011: CPR 185 with three cassettes sold to Aus CPR. September 2011: New CPR 192 with one cassette received for SAHFOS use. November 2011: CPR 193 with five cassettes was sold to Aus CPR. December 2011: CPRs 194 and 195 with five cassettes prepared for delivery to Aus CPR in January 2012. SAHFOS workshop staff and outside contractors have worked hard to prepare old and new CPRs for use and sale abroad. At 31 December 2011 there were 51 bodies and 106 cassettes operational. There were 346 whole filter silk meshes used in 2011 (including the 10 second part tows on the SB route).

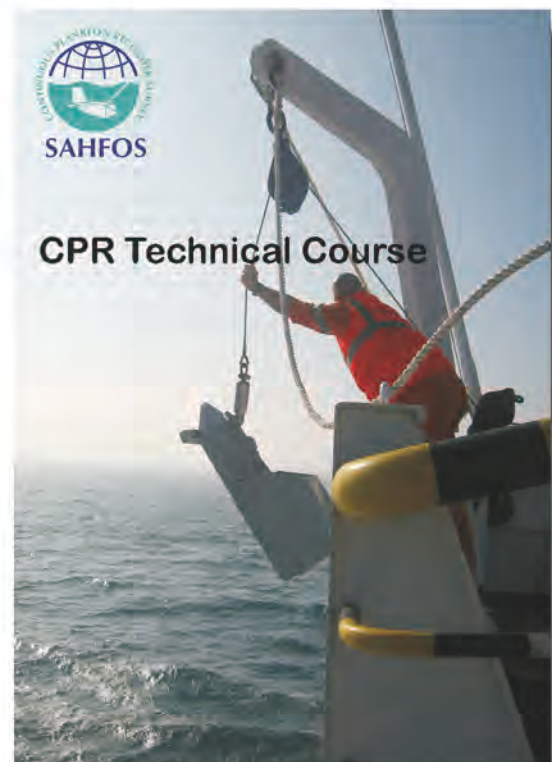
673 square metres of Shanghai woven silk were used to produce 33,096 two-inch divisions of filter and cover mesh (1681.3 metres each of filter and cover silks).

Instrumentation

SAHFOS used temperature loggers and CTD units to measure sea surface temperature and salinity on several CPR routes in 2011. We measure temperature on 2 trans-Atlantic routes (BB/BA and DA/D-), 2 routes across the Bay of Biscay (IB and SA) and on the Plymouth to Roscoff route (PR). We collected temperature and salinity on the CPR tow from Immingham to Iceland (LR/V-) and 2 routes in the Norwegian Sea from Norway to Iceland (NI) and from Norway to Svalbard (ST). The records are assigned a position by interpolation from the log sheet information and are posted on the SAHFOS web site within a month.

In addition temperature and salinity were measured on the 3 trans-Pacific CPR routes (VJ) and temperature on the Canadian west-coast tow (AT). We are indebted to Mark Savoie and Gary Lawley of Kinetic Labs for assuming responsibility for the AT measurements.

SAHFOS has measured temperature and salinity on the V route from Orkney to Iceland since May 2011 (7 tows).





Plankton Analysis

Since 1931, the CPR analysis team has analysed more than 245,000 samples from regular monitoring in the North Atlantic, North Sea, Norwegian Sea, North Pacific and Scotia Sea. In 2011, eighteen analysts were working at the Plymouth laboratory, two in Canada (Sonia Batten and Doug Moore) and three in Japan (Sanae Chiba, Tomoko Yoshiki and Yuka Sasaki). This year in Plymouth, Paul Tranter retired, Astrid Fischer took maternity leave, Milly Hatton-Brown left to train as a teacher and Priscilla Licandro ceased analysing because of the pressure of other SAHFOS work. We were pleased that Alistair Lindley, a former CPR analyst, kindly agreed to work for a few months as a contractor in the latter part of the year. We welcomed Jennifer Skinner as a trainee analyst in November. CPRs sampled 112,593 nautical miles in 2011 (Figure 1). Tows from the North Sea, North and South Atlantic and Pacific Oceans resulted, to date, in 4851 samples for analysis (Figure 2), though we still await the return of some South Atlantic silks. At the start of 2011 we anticipated that we would analyse about 6,400 samples—but the actual number was smaller because ships were not always available for monthly tows, particularly on the Z route (Table 1).

The analysis of Pacific tows is now shared between laboratories in Vancouver, Yokohama and Plymouth. During 2011, CPRs sampled 17,499 nautical miles in the Pacific; the Canadian and UK laboratories analysed 433 of the samples collected. The transfer of samples between laboratories is working well but increasing regulations and security issues can make the process quite complicated and time-consuming. The South Georgia fishery patrol vessel *MV Pharos* started bi-monthly CPR tows between the Falkland Islands and South Georgia in March 2011. The CPRs are serviced by technicians on the islands. Sample silks collected will be returned to us every six months. We have recently received the silks for March, May and July and eagerly anticipate the analysis of these first-ever regular tows in the region. Towards the end of 2011, we decided to instigate an Analyst of the Month award for high scores in regular quizzes and tests, quality of analysis and maintenance of a low backlog of samples awaiting analysis. Our first two winners were Claire Taylor and Usha Jha.

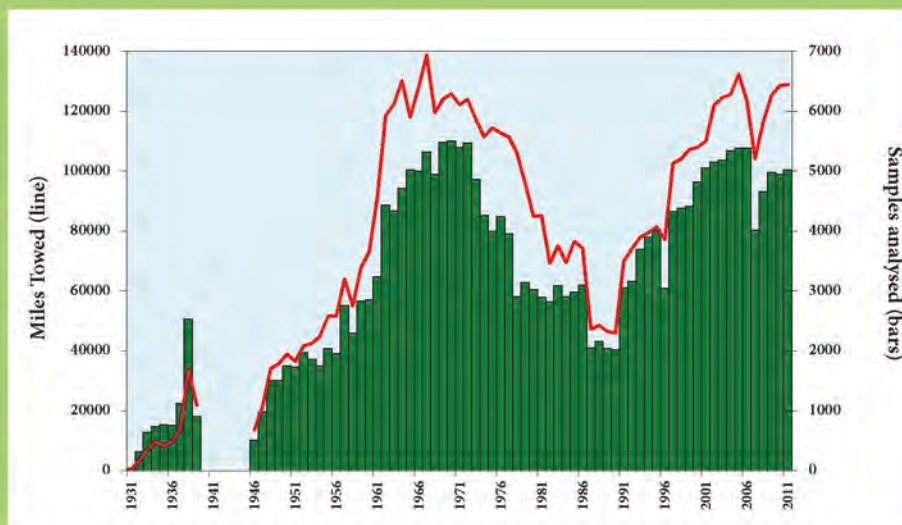


Figure 1. Miles towed and samples analysed to 2011

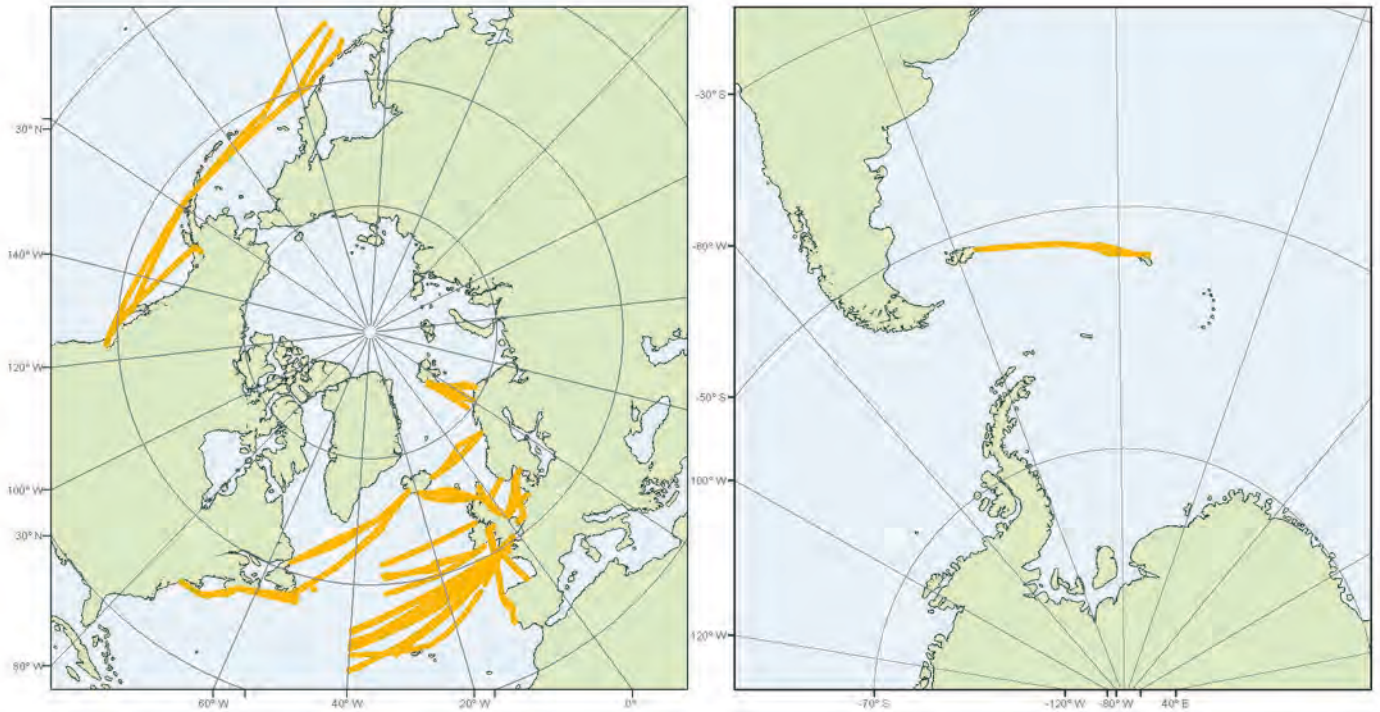


Figure 2. CPR 2011 samples map

Table 1: Monthly breakdown of all CPR sampling in 2011

Month	Tows Made ¹	Tows for analysis ²	Samples for analysis ³	Miles sampled
January	25	20	367	7517.85
February	20	18	304	5870.49
March	28	26	415	9433.3
April	36	32	525	13271.92
May	28	22	379	9060.15
June	33	31	456	12396.6
July	34	28	470	11240.16
August	32	28	419	11200.42
September	34	25	430	9832.3
October	22	20	330	6815.7
November	27	25	425	9105.67
December	24	20	331	6848.46
Totals	343	295	4851	112593.02

1. Includes all failed and as yet non-analysed tows.

2. Includes only those tows that have been processed for analysis.

3. At 29 February 2012, 591 allocated samples from 2011 are still awaiting analysis.

Training

Training sessions were held regularly from mid March onwards. We started with a session on Pacific copepods taken by Tomoko Yoshiki from Japan. In April, Graham Hosie instructed us in identification of Antarctic euphausiids. Gemma Brice, Maria Campbell and Milly Hatton-Brown expanded their knowledge and learnt to identify Pacific plankton. Other training for all analysts covered the identification of Ostracoda, *Candacia* spp., small difficult to identify copepods and also the use of microscope cameras. Clare Buckland attended a course on zooplankton taxonomy and ecology in Maine, USA. Jennifer Skinner started to train as a CPR analyst in November.

Console and data availability

Since 2008, Console has been the user interface for data entry to the CPR database. More information is stored and much can be accessed more readily, although the functionality still needs improvement—a necessity not only for those based at SAHFOS but also for our partners in the Global Alliance of CPR Surveys (GACS). Mike Flavell joined us in June as a Database Developer and has already enhanced Console.

Up until this year, we always have tried to make each year's quality-controlled North Atlantic data available by the end of the following September. In 2011 we were pleased that the 2010 data was available by mid August – our earliest ever.

New laboratory facilities and equipment

In November 2010, the SAHFOS Council agreed to a major refurbishment of the analysis laboratory and associated offices. Having cleared the old laboratory for the refurbishment, the MBA kindly loaned us the use of a small temporary analysis laboratory in their main building. The majority of the SAHFOS laboratory and workshop building was stripped out. The rebuilding provided a new analysis laboratory, a formalin extraction system, an additional 'cutting' and unloading room, vented storage facilities for sample boxes and six new offices for analysts and tech-

nicians. Sanber, the designers and building contractors, were efficient and completed the task according to schedule. We were able to commission and move into the new laboratory facilities in early March. The purpose-built laboratory has been a great boost to the analysts, workshop staff and visitors alike and will fit SAHFOS for the years ahead.

Information Technology

Darren Stevens and Mike Flavell

Staff were surveyed to find out what they considered their data storage requirements would be over the next 12, 24, and 60 months. This allowed the IT team to plan and invest in suitable back office hardware in order to meet the needs of SAHFOS going forward, particularly planning for molecular and image data, which has the potential to accumulate, in terms of gigabytes, faster than the CPR dataset. In connection with the image library project we have invested in a further ESX server (for creating further virtual servers), 8TB of SAN (Storage Area Network) storage, and a LTO5 backup tape drive and library. This should meet the storage needs of SAHFOS for the next 3-5 years, equivalent to the expected lifetime of the hardware.

The SAHFOS image library has been launched (internally) using the open source software Resourcespace (<http://www.resourcespace.org>). Once the system has sufficient content it will be opened on the web for users to have access to SAHFOS images and copyright-free material. The software has made the sharing of images within SAHFOS much easier, with improved accompanying metadata and search



facilities. Linux training has allowed us to revisit the issues we had been experiencing using the Global Biodiversity Information Facility Integrated Publishing Toolkit (GBIF IPT). The system was much easier to implement using Linux and an updated release of IPT. This is now our primary way of supplying data to EurOBIS, iOBIS, GBIF, and for sending data to DFO Canada.

Following the recommendations from the Database Working Group we went through a rewarding recruitment process for a new Database Manager to take over the development of the CPR console and lead on the Global CPR database.

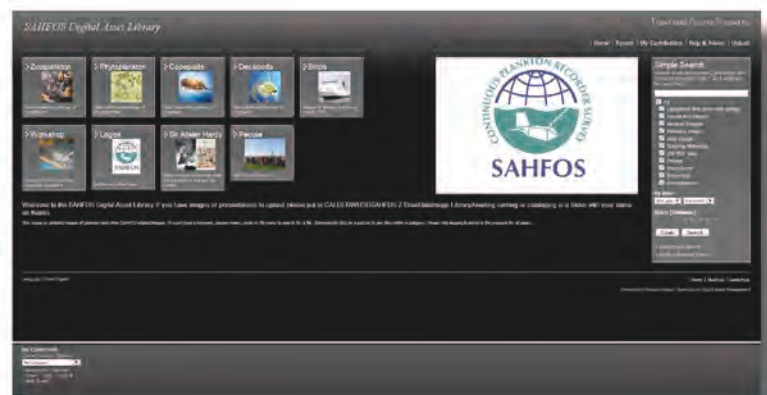
Database, In-House Software, and Websites

On the 1st June 2011, Mike Flavell joined SAHFOS in the position of Database Manager. Mike's initial task was to familiarise himself with the CPR Console, software that is used extensively throughout SAHFOS for the input and quality control of CPR Survey data. A number of behind the scenes changes have since been made to the CPR Console software with the intention of making a large proportion of the existing source code re-usable should different types of user interfaces (such as an internet browser on a PC, or mobile devices such as iPhones, BlackBerrys etc.) need to be developed for the CPR database in the future. Fifteen issues and improvements to the Console Software have been worked on to date and a new version of the CPR Console will be released in the near future.

Attention has also focussed on the systems and processes in place for the ongoing development of desktop software (e.g. CPR Console) and websites (e.g. www.sahfos.ac.uk and www.globalcpr.org) within SAHFOS. All source code for the CPR Console and GACS website has been placed into a 'Version Control System' that enables us to monitor and manage all changes. This Version Control System has been integrated with an Issue and Project Management tool named "JIRA" that allows us to record any problems with the software, and any requests for new features to be added. We are now able to plan which items will be included in future iterations of software development, and view the source code changes that have been made to address those items. We are also better able to timetable the release of new versions of software or websites.

In addition to the above, a new wiki-based system for storing our documentation has been set up, as has a system for automatically building and unit-testing any changes to our software and web sites. The introduction of all these systems will enable us to better plan and document our software, rapidly respond to any need to make changes, and enable future versions of the software to be released more regularly. We acknowledge the generous donation of a "community licence" by the company Atlassian (www.atlassian.com) for their suite of products.

Late September saw the first GACS Workshop. IT was significantly involved with both Darren and Mike giving presentations to the international panel of GACS Partners. The workshop was a great success and sufficient feedback was obtained to enable us to commence development of the GACS website. Mike and Alec worked solidly on its creation from November and the website went live on 8 February 2012. Developing the GACS website has involved the integration of two freely available (open source) systems: a content management system named 'Umbraco' for entering and managing the update of web site content, and a geospatial software stack named 'OpenGeo Geostack' that will enable us to provide map-based products from the combined data of each GACS Partner survey via the internet. The geospatial data system has been successfully piloted internally using some SAHFOS test data, and future work will focus on combining data from the GACS partners and making products from this data available on the GACS website.



Global CPR Network

SCAR Southern Ocean CPR survey

Graham Hosie, Director of the SCAR SO-CPR survey, Australian Antarctic Division (AAD)

It has been a year of highlights for the SO-CPR Survey, starting with the celebration of 20 years of the Survey, then participating in the celebration of 80 years of the North Sea CPR Survey during Plankton 2011, then working with the other regional CPR surveys to create the Global Alliance of CPR Surveys (GACS).

Duarte, Cebrian and Marba (1992, *Nature* 356, p 190) said that “long-term monitoring programs are, paradoxically, among the shortest projects in marine science: many are initiated but few survive a decade”. This is despite the continuing need of such programs to understand human impacts on marine ecosystems, by providing essential baseline information on biodiversity and helping distinguish man-made and natural changes, at local or on broad scales. It was some degree of both joy and relief that we started the 2010/11 Antarctic season with the celebration of 20 years of CPR tows in Southern Ocean and Antarctic waters. After some test tows around Heard Island during the winter (June) of 1990, the Southern Ocean CPR Survey officially commenced with Tow 1 on 12 January 1991 deployed from the RSV *Aurora Australis* on route between Mawson and Hobart. The corresponding tow at close to the same time in 2011 was Tow 572 on 15 January in the Ross Sea by the *San Aotea II* on route back to New Zealand. During the twenty years the SO-CPR Survey has grown from a one-man, one-ship survey, to a survey involving more than a dozen countries and 15 Antarctic vessels from Australia, Japan, New Zealand, Germany, USA, Russia, Brazil, and Chile. This covers about 70% of the region around Antarctica and complements the tows conducted in the southern Atlantic/South Georgia area conducted by UK (SAHFOS and the British Antarctic Survey). The 20th Anniversary received a lot of publicity in the Australian media, highlighting the need for sustained long-term monitoring, and included a high profile report on the web page of Australia’s Chief Scientist: www.chiefscientist.gov.au/2010/12/mapping-plankton-pathways-in-the-southern-ocean.

Field work

The Southern Ocean CPR Survey completed 48 tows from four vessels during the 2010-11 season, October to March. Australia completed 22 tows south and west of Australia from the Australian icebreaker RSV *Aurora Australis*. Japan supplemented this with another seven tows in the same region from their new icebreaker *Shirase* and a further nine tows from the TRV *Umitaka Maru*. New Zealand completed ten tows between New Zealand and the Ross Sea from the *San Aotea II*. Tows were planned to be conducted across Drake Passage, but due to operational reasons these tows could not proceed. This was a little disappointing as this is a region of high abundance of Antarctic krill and fishing for krill. In total 2,901 samples were collected and processed by SO-CPR during the 2010/11 Antarctic season. The 2011/12 season is expected to produce a similar number of tows. The addition of the 2010/11 samples increases the data set to 33,635 samples for approximately 230 zooplankton taxa coupled with environmental data.

Noctiluca moving into the Southern Ocean (David McLeod, AusCPR & SO-CPR)

A significant result of the 2010/11 was finding the red-tide forming, heterotrophic dinoflagellate *Noctiluca scintillans* in the Southern Ocean well south of Tasmania in December 2010. It was first detected 200 km south of Tasmania during a CPR transect conducted between Tasmania and Antarctica as part of the Southern Ocean CPR (SO-CPR) and Australian CPR (AusCPR) Surveys. The ‘bloom’ of *Noctiluca* then extended over 242 km further south. This record of *Noctiluca* is the most southerly, oceanic record globally and can be linked to the intensification of the East Australian Current (EAC), a situation apparently caused by altered circulation patterns associated with global warming. On present evidence, the current observation of *Noctiluca* in the Southern Ocean is an extension of coastal Tasmanian populations. Sea surface height and sea surface temperature data at the time indicated that a warm-water eddy of the East Australian Current (EAC) extended along the east coast of Tasmania and beyond, which provided a potential vector for the transport of *Noctiluca* offshore into a cool, oceanic environment not generally associated with this organism. *Noctiluca* is thought to be a neritic species with oceanic occurrences uncommon.

The *Noctiluca* cells found in this study appeared 'healthy' and 'well-fed', seemingly full of mainly diatom prey. This indicates that despite their apparent unplanned venture into the oceanic environment they were able to feed on Southern Ocean productivity. Data from the same CPR transect showed that copepod abundance was apparently limited by the presence of the *Noctiluca* indicating potential competition for food. If viable populations of *Noctiluca* become established in the Southern Ocean in the future, there is likely to be additional competition with copepod grazers for phytoplankton, with unknown effects for the food web. Given predictions that the EAC is likely to continue to strengthen and transport more warm water and eddies further south there may be more frequent seeding of *Noctiluca* into cooler waters in the future and *Noctiluca* could well become resident in the Southern Ocean. The results of this finding have recently been published online in the Journal of Plankton Research (McLeod et al. 2012, Journal of Plankton Research, doi:10.1093/plankt/fbr112).

Data Analyses and Workshops

Time-series analyses of the CPR dataset has continued using both observed data and modelled patterns to understand the variability and trends being observed in zooplankton distributions, abundances and composition in relation to various environmental variables such as temperature, salinity, chlorophyll, sea-ice. This work is a major contribution to a joint Australia-Japan collaboration funded by both governments to establish a benchmark on plankton biodiversity, distribution and abundance in order to study future climate change impacts. Spatial analysis on the Southern Ocean data set has also continued throughout the year as a major contribution on plankton for the SCAR Southern Ocean Biogeographic Synthesis Atlas. The new atlas is expected to be a major tool for future Antarctic research, conservation and management of the region. The focus of the analysis to date has been developing predictive models of the distribution patterns of whole zooplankton assemblages around Antarctica, by month and season, using Generalised Dissimilarity Modelling. Follow up analyses will include more specific predictive spatial models of individual species using the same Boosted Regression Tree method used to model the circum-Antarctic distribution patterns of the copepod *Oithona similis* (Pinkerton et al., 2010, Deep-Sea Research 57, 469–485).

The results of both the temporal and spatial analyses were presented at a number of workshops and symposiums during the year including:

- The JST-DIISR Project Final Symposium "Establishing a benchmark to assess climate change impact in the eastern Antarctic Marine System", Hobart, Australia, February 2011.
- Presentation to UN Ambassadors, Australian Antarctic Division, March 2011.
- Second SCAR Biogeographic Synthesis Atlas Workshop, Brest, France, May 2011
- 2011 Annual Conference of The Australian Marine Sciences Association. Fremantle, Australia, July 2011.
- Plankton 2011: Biodiversity & Global Change, Plymouth, U.K., September 2011.
- XXXIII Symposium on Polar Biology, National Institute of Polar Research, Tokyo, November 2011.
- New Zealand-Australia Symposium in Ocean Observing and Data Management. University of Tasmania, December 2011.

As noted previously, one of the highlights of the year was the Plankton 2011 Symposium in Plymouth where a number of members of the SO-CPR team from Australia, Japan and New Zealand presented results. It was also an opportunity to hold another standards workshop with the SAHFOS and SO-CPR analysts to ensure our taxonomic accuracy was being maintained between laboratories. The previous Southern Ocean standards workshop was held in Tokyo, November 2010, and attended by both SO-CPR and SAHFOS analysts. The Tokyo workshop focussed on zooplankton. The Plymouth workshop focussed on the taxonomy of Southern Ocean phytoplankton and protists. It was also an opportunity for the Southern Ocean analysts to hone their phytoplankton counting and Phytoplankton Colour Index (PCI) assessment techniques with the help of the SAHFOS team. We plan to continue holding the standards workshops annually, which will not only benefit analysts working on Southern Ocean plankton but also maintain standards and foster exchanges within the spirit of GACS.

The United States West Atlantic (US-CPR) CPR Survey

Chris Melrose, NOAA/NMFS/NEFSC, Narragansett, USA

The U.S. National Oceanic and Atmospheric Administration's (NOAA) Northeast Fisheries Science Center (NEFSC) Oceanography Branch maintains two CPR surveys: one crossing the Gulf of Maine from Boston to Nova Scotia and one from New York to Bermuda across the Mid-Atlantic Bight (Figure 3). A third CPR route in Narragansett Bay, Rhode Island was discontinued in 2010 due to a loss of funding. Both the Gulf of Maine and Mid-Atlantic Bight CPR routes include concurrent expendable bathythermograph (XBT) and thermosalinograph (TSG) sampling in partnership with NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML). Additionally, the Gulf of Maine route includes pCO₂ measurements in partnership with AOML, and the Mid-Atlantic Bight route includes Acoustic Doppler Current Profiler (ADCP) measurements in partnership with the University of Rhode Island and Stony Brook University.

NOAA's CPR program underwent several important changes in 2011. The biggest change was that Jack Jossi retired in April, 2011 after a long and successful career. Jack had been with NOAA since the agency's formation and began working on NOAA's CPR program in 1973. Jack is a great colleague and friend. He will be missed but his retirement is well earned. Jack kicked off his retirement in adventurous fashion by taking a motorcycle trip from Oregon to Alaska. We wish Jack a long and happy retirement!

In January 2011, I, Chris Melrose, joined the program and began to assume Jack's day-to-day duties. I had previously worked on NOAA's Narragansett Bay monitoring program, which had included a CPR component. It has been a pleasure joining the program and I look forward to working on NOAA's CPR survey for many years to come.

In October 2011 NEFSC signed the Memorandum of Understanding to join the Global Alliance of Continuous Plankton Recorder Surveys

(GACS). We believe GACS will help to tighten the bonds of cooperation and collaboration in the global CPR community and we welcome expanded cooperation with our global partners.

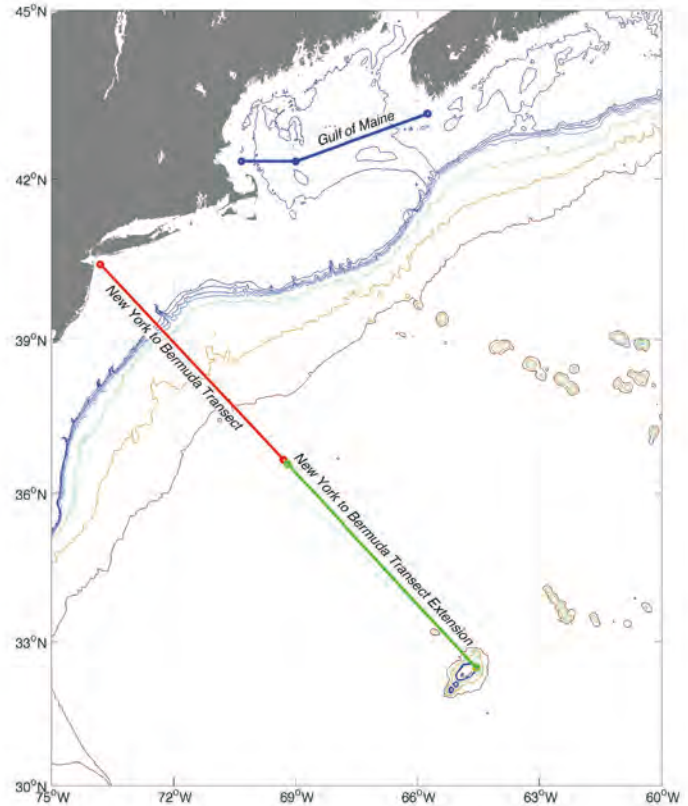


Figure 3. US-CPR routes



There were also changes to our sampling programs during the past year. We extended our existing New York to Bermuda CPR line aboard *M/V Oleander*, a container vessel operated by Bermuda Container Line. Prior to October 2011 a single CPR was towed up to 350 nautical miles from New York toward Bermuda. Starting in October we added a second CPR deployment on each trip to extend the line the remaining distance across the Sargasso Sea to Bermuda. We plan to continue sampling on the extended line through at least the end of 2012.

The *Oleander* underwent a major refit between January and April 2011 and as a result, we missed 4 months of sampling. During the remainder of the year we conducted 8 successful CPR tows on the original New York to Bermuda route and an additional 3 tows on the new extended line across the Sargasso Sea.

During one trip in November 2011 the crew of *Oleander* rescued 4 sailors from the sailboat *Elle* after the vessel was disabled by a storm in the Sargasso Sea. I was aboard during that trip as a scientific observer and witnessed the skillful rescue by the crew of the *Oleander* in difficult conditions.

CPR operations on the Gulf of Maine route aboard *M/V Reykjafoss*, a contracted container vessel operating on behalf of EIMSKIP, continued in 2011 with 7 successful CPR tows. Due to dry dock repairs to the *Reykjafoss* there was a gap in our Gulf of Maine sampling between May and September of 2011. We wish to thank Bermuda Container Line, EIMSKIP and the crews of the *Oleander* and *Reykjafoss* for their continued cooperation without which these surveys would not be possible. I'd also like to mention that 2012 is Daniel Smith's 40th year working on NOAA's CPR program. Dan handles our ship visits, CPR maintenance, and sample preparation. In the past Dan has also analyzed samples so he has been involved in all aspects of CPR operations through his career.

Pacific CPR operations

Sonia Batten

The east-west (VJ) transect was sampled by a new ship in 2011, the *Morning Cedar*, which replaced the *Skaubryn* that had towed the route for 10 years. The switch went very well with excellent cooperation from the new owners, officers and crew. The *Morning Cedar* is slightly faster than the *Skaubryn*, and given that some regions of the North Pacific are only sampled with this one transect we looked more closely at the speed and depth of tow data (Fig 4). Mean speed for the three 2011 east-west transects with the new ship are compared to 2009 and 2010 data from the *Skaubryn* and also the *Horizon Kodiak* which tows the north-south (AT) transect. The *Morning Cedar* is significantly faster than the *Skaubryn*, though not by much, and significantly slower than the *Horizon Kodiak*. Speed is one factor which influences depth of tow. The east-west transect has depth recorded via the Brancker CTD in the tail section and the right hand panel of Fig 5 compares mean sampling depth from the three 2011 tows with the three 2010 tows collected by the *Skaubryn*. Depth does vary within a tow, and between seasons with the same ship, but it appears that depth of tow was comparable in 2011 to 2010 and we would not expect any changes in the plankton sampled.

Two new technicians from Anchorage took over the servicing of the north-south transect in 2011. Mark Savoie and Gary Lawley of Kinnetic Labs spent two weeks at SAHFOS in spring, learning the ins and outs of CPRs and returned to Alaska in time to meet the first ship. Everything went smoothly through the sampling season, with a high success rate and good communication between Alaska and BC. They were also able to install and download a minilogger on each transect so that we have temperature data for each Pacific tow in 2011.

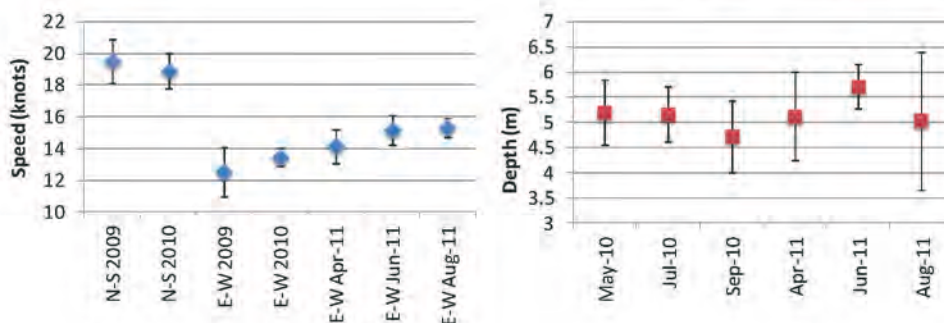


Figure 4 Left panel - mean speed of both transects in 2009 and 2010 compared with the mean speed of each east-west transect in 2011. Right panel - mean depth of tow of east-west transects in 2010 and 2011. Error bars are standard deviations.

Global Alliance of CPR Surveys

Graham Hosie

The establishment of a global network of CPR surveys has long been a vision of SAHFOS. Previous Directors Dr Chris Reid and Prof. Peter Burkill actively promoted the need for such a network. Eventually, Prof. Burkill and the SAHFOS team were successful in obtaining establishment funding for the 'Going Global' initiative. Going Global was also a vision shared by the heads of other regional surveys, who enthusiastically agreed to form the Global Alliance of CPR Surveys (GACS). It seemed appropriate then, during the celebrations in Plymouth UK in September 2011 that marked the 80th Anniversary of the start of the North Sea CPR tows, the heads of the nine regional CPR surveys should meet to discuss the formation of GACS. Joining us were a number of representatives from the Global Ocean Observing System (GOOS) programme of the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the Partnership for the Observation of the Global Oceans (POGO) and the North Pacific Marine Science Organisation known as PICES. They provided invaluable advice to help set up GACS and also witnessed the signing of the Memorandum of Understanding by the founding GACS partners.

The general goal of GACS is to understand changes in plankton biodiversity at ocean basin scales through a global alliance of CPR surveys. By "understand" we mean characterise, analyse and interpret. GACS has a number of specific aims which include:

- development of a global CPR database
- production of a regular Ecological Status Report for global plankton biodiversity
- ensuring common standards and methodologies are maintained
- providing an interface for plankton biodiversity with other global ocean observation programmes
- to set up and maintain a website for publicity and data access
- to facilitate new surveys and develop capacity building procedures
- to facilitate secondments of CPR scientists between GACS institutions



GACS brings together the expertise of approximately 50 plankton specialists, scientists, technicians and administrators from 12 laboratories around the world, towing a common and consistent sampling tool, the CPR, from about 50 vessels. Working together, pooling our data and resources, was considered essential in order to understand the effects of environmental changes on plankton biodiversity at a global level. Numerous local and regional monitoring and observational programmes have been established in the past, but to date we have lacked a holistic perspective on plankton biodiversity in response to global events such as global warming and ocean acidification. GACS will provide that perspective using CPR data, a well recognised and standardised methodology. It will also allow us to assess changes and events at a local or regional level in a world-wide context. At the heart of GACS is the development of the global database of CPR data that will allow us to make such assessments of local, regional and global changes. Subsequently, an important product of GACS will be the production of a regular Ecological Status Report for global plankton biodiversity.



Working groups are being developed and will address the formation of the global CPR database, and maintaining standards and methodologies. Supporting all this are also a number of SAHFOS staff involved with secretariat support, database development, collaboration, training and publicity.

In order to keep scientists, governments and the public informed of GACS activities the GACS website has been established at www.globalcpr.org, which provides information about GACS, the member surveys and news of events. Regular newsletters will be produced and the first newsletter has already been distributed. It is exciting times ahead for GACS and for studying and monitoring plankton biodiversity at a global scale.

CPR surveys are now well established in the North Sea, North Atlantic, North Pacific and Southern Ocean. New Surveys are underway in Australian, New Zealand, Japanese and South African waters with a Brazilian survey under development. These surveys provide coverage of much of the world's oceans. However, there are still vast areas of the mid-Atlantic, Pacific and Indian Oceans where there are no sustained plankton monitoring. One of the long-term challenges will be filling these gaps.

A Board of Governance has been established, comprising the regional heads of CPR Surveys:

- Dr Graham Hosie, SCAR Southern Ocean CPR Survey (Chair)
- Dr Sonia Batten, North Pacific CPR (Vice-Chair)
- Dr Sanae Chiba, Japan JAMSTEC CPR
- Dr Martin Edwards, Deputy-Director SAHFOS
- Prof. Mitsuo Fukuchi, Japan NIPR CPR
- Dr Julie Hall, New Zealand CPR
- Assoc. Prof. Anthony Richardson, Australian CPR (AusCPR)
- Dr Chris Melrose, Narrangansett USA CPR
- Prof. Erik Muxagata, Brazil
- Dr Hans Verheye, South Africa CPR
- Prof. Peter Burkill, ex officio



POOLING DATA: From left are Staffan Dunbar, Marco Wernitz, Chris Harris, workshop engineer Roger Burdard and workshop manager Lance Guppy.

Ocean research goes global in 80th year

A UNIQUE Plymouth science project, which provides vital data on the health of the oceans, is marking 80 years of survey work to plankton.

The Sir Alister Hardy Foundation for Ocean Science (SAHFOS) is training technicians from other countries to set up similar surveys around the world.

SAHFOS has monitored plankton across 5.5 million miles of the North Atlantic, North Pacific and North Sea since 1931.

That is the legacy of a long investigation in the world into the microscopic plants and animals that are key indicators of ocean health. The data is also used to assess fish stocks and climate change. The vital work is done at minimal cost by using merchant vessels on commercial routes to tow the continuous Plankton Recorder (CPR) sampling device. These ships of opportunity do the work without charge.

Now the pioneering work done by SAHFOS is expanding to cover the seas around the Falklands in the South Atlantic, in the Southern Ocean, around Australia and east of South Africa.

Two technicians from Namibia

and South Africa are being trained in CPR operation at the SAHFOS base on the Eze, Western Coast of the Ministry of Fisheries and Marine Resources, Namibia, and Marco Wernitz, who works for the Department of Environmental Affairs.

Mr Wernitz said: "Plymouth is the only place in the world that we can learn about this CPR. It's fish stocks and the plankton they feed on move about in the seas of different countries and we need to know as much as we can about them."

"Even one survey trip would cost hundreds of thousands of pounds. This method using commercial ships costs a fraction of that."

Among the international operators who tow the CPR plankton sampler without charge are Plymouth-based Brittany Ferries who trail them mostly on the routes from the city to Roscoff in France and Portsmouth-Spain.

Dr Martin Edwards, deputy director of the Plymouth Foundation said: "SAHFOS is becoming

a global hub for a 'venerable' of CPR surveys but this would not be possible without the support of 'ships of opportunity'."

In 2006, 24 merchant ships covered 120,000 miles of ocean taking samples for SAHFOS.

"A couple of weeks' towing on a scientific research vessel would take up our whole budget for the year," said Dr Edwards.

As well as being the back-bone source sustaining all research in the oceans, plankton are essential to life on land. They provide half of the world's oxygen and absorb vast quantities of the greenhouse gas, carbon dioxide, reducing atmospheric global warming.

The survey was started by former Plymouth Marine Laboratory (PML) scientist Sir Alister Hardy, who by 1930 was working as a fisheries biologist in Brixham.

The base moved to Plymouth at the PML site in 1976. In 1990 the survey became an independent organisation and a charitable foundation.

See the Big Road, Pages 16-17

Coverage of the GACS event and training in a local newspaper



CPR Water Sampler

Anthony Walne and Rowena Stern

In 2011 a new one year trial of the Water and Microplankton Sampler (WaMS) started. The WaMS is an autonomous water collecting device that fits into a CPR and collects water at timed intervals. This device should complement the CPR survey to provide data on the smaller and more delicate planktonic taxa normally lost or destroyed in CPR silk. CPRs were towed in 11 months on the Plymouth to Roscoff (PR) route in 2011. The WaMS was used on each tow with samples being successfully collected on 9 tows. The CPR was always towed north and launched at about 3.95°W 48.7°N and recovered at 4.18°W 50.3°N. The tow depth was recorded with Star Oddi depth loggers on 8 tows and the average tow depth varied between 2.9 m and 8.3 m. Temperature was measured on 10 tows using Star Oddi and Vemco loggers. The coldest water was about 8.3 °C off the English coast in February and the warmest about 17 °C in mid-Channel in August.

The CPR was delivered by SAHFOS personnel and samples processed immediately. With a tow duration of typically 5-6 hours, the samples were processed for further analysis 2 hours after being taken. The colour of the CPR filtering mesh can be assessed rapidly and is related to phytoplankton abundance. The Phytoplankton Colour Index (PCI) is assigned per sample and in examining the results it would appear that the PR route can be divided into 3 regions: French Coastal, mid-Channel and UK Coastal with the highest phytoplankton abundance being observed in the mid-Channel region.

After initial investigation into WaMS samples to identify such organisms, analysis was performed to identify major planktonic components of these samples. In the first 4 months, results of these analyses revealed 9220 different recognised DNA sequence types (operational taxonomic units) from 87167 sequences (Figure 5).

This year saw the successful application of next-generation sequencing to archived CPR samples, in addition to samples from the water sampler. We are finalising a study on *Dinophysis* molecular identification and are due to analyse and report on molecular identification of *Pseudo-nitzschia* in the English Channel. Molecular identification and flow cytometry results from the first 4 months of the WaMS trial showed large levels of known (and unknown) diversity over all eukaryotic kingdoms and this trial will conclude in February 2012. A small trial survey of next-generation sequencing on CPR archive material from July 2003 was successful. 3000 partial small ribosomal subunit sequences were identified from the North Sea CPR samples, that mostly identified jellyfish zooplankton from Rathkeidae family. The phytoplankton component was dominated by the harmful algal genus *Dinophysis*, a major contributor to economic loss through aquaculture closure in NE Scotland. Currently we are finalising a study to create a molecular marker database of single cells from UK waters with the help of Eileen Bresnan from Marine Scotland in Aberdeen and Station Biologique, Roscoff. In this way we have been able to better categorise *Dinophysis* species from CPR samples.

Identifying taxa across spatial scales for April from 25,582 filtered sequences, for example, revealed very different taxon assemblages (see Figure 6), including 64 new taxa not formerly recognised by the CPR survey. The marker can identify a large range of eukaryotes with very few contaminating human sequences. These include members of chlorophyta which contain some of the smallest size class of photosynthetic algae, and their identification can be used to better assess PCI. In common with a molecular study of marine fungi (Richards et al. 2012) we found Pezizomycotina ascomycetes fungi dominated our samples and many of our identified sequences overlapped with theirs and are also common to those found in low oxygen, deep sea environments, some of which

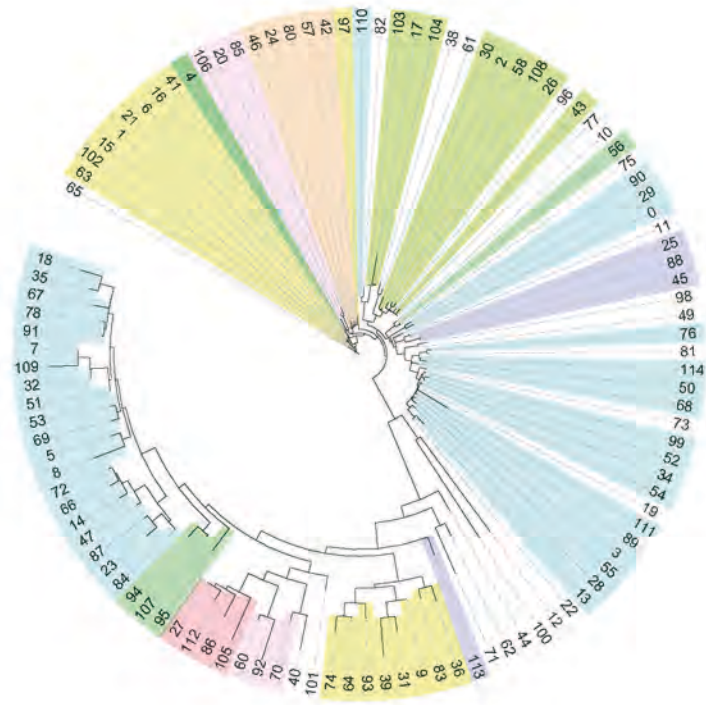
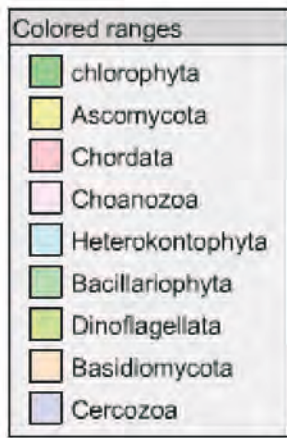
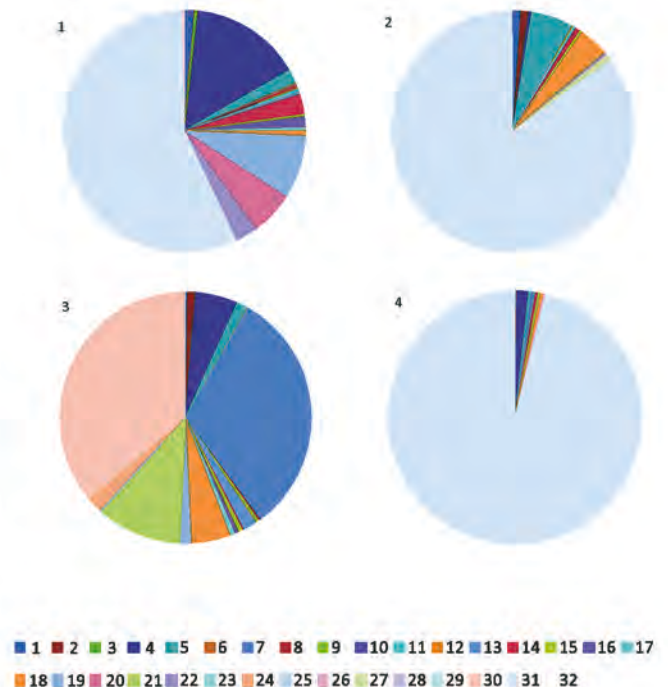
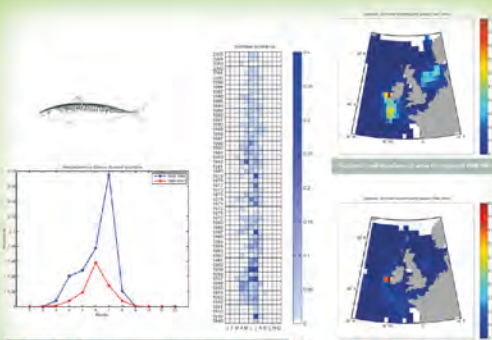


Figure 5 (above) Neighbour joining phylogenetic tree of unique sequences from all WaMS samples (February-May, 2011) at least 97% similarity to those in genetic databases.

may be disease-forming in bivalves. Our samples also contained a large number of unknown Dikarya fungi that suggest a larger diversity than presently known. Also of importance to the Marine Strategy Framework Directive (MSFD) are the identification of potential pathogens such as the human pathogen *Acanthamoeba* and various apicomplexan parasites of algae, invertebrates and fish. Of interest is the large proportion of unknown eukaryotes found and it is our aim to find markers that can better identify these organisms to understand their role in the marine ecosystem.

Figure 6 (right) Eukaryotic Taxon composition at phylum level using partial SSU on route 346PR route (English Channel), 6 April 2011. 1= French coast (-3.96, 48.81), 2= Mid-channel (-4.01, 49.09), 3= Mid- Channel (-4.05, 49.38), 4= English coast (-4.17, 49.99). 1=Ciliophora; 2= Dinophyceae; 3= Apuzomondadae; 4= Ascomycetes; 5= Haptophyceae; 6= Ichthyosporae; 7=Arthropoda (Crustacea); 8= Chordata (Tunicata); 9=Cnidaria; 10=Rotifera; 11=Cercozoa; 12= Rhodophyta (Floridiophyceae); 13=Bacillariophyta (Bacillariophyceae); 14= Bacillariophyta (Coscinodiscophyceae); 15= Bacillariophyta (Mediophyceae); 16=Bolidophyceae; 17=Pelagophyceae; 18=Synurophyceae; 19=Chlorophyta (Mamiellophyceae); 20= Chlorophyta (Prasinophyceae); 21=Chlorophyta (Trebouxiophyceae); 22=Embryophyta (all phyla); 23=Acanthamoebidae; 24=Cryptophyta (all phyla); 25= Echinodermata; 26/27=Amoebozoa; 28= Bicosoecia (Cafeteriaceae); 29=Chrysophyceae; 30=Arthropoda (Hexapoda); 31= Environmental eukaryote; 32= Human (contamination).





CPR Research Highlights

A new historical plankton database provides 100 years of plankton indicators

Abigail McQuatters-Gollop

Historical datasets help us to understand past biological conditions and assess changes that have taken place over time. SAHFOS has recently completed the digitization of seven historic volumes of ICES plankton surveys, covering the period 1901–1912. The dataset includes approximately 13,000 plankton samples and around 2000 taxa, many identified to species level. The observations are geographically distributed over the Northeast Atlantic, the North Sea, the Irish Sea, the Baltic Sea, and the Arctic Sea. SAHFOS worked closely with Plymouth University on this project which took three years to complete. First, the data from the historic ICES volumes were digitized and quality-checked for technical accuracy by the University. The spatial accuracy of each historic sample was then resolved through both a mapping exercise and literature review. As many samples were referenced in the volumes by only a station name and did not include lat-long coordinates, it was often necessary to search through century-old literature to find precise station locations. Ascertaining the taxonomic integrity of each taxon identified was a major challenge as taxonomic knowledge has developed considerably in the last 100 years. Each taxon was resolved to its current accepted taxonomic name, a process which involved extensive literature research and which also took advantage of the planktonic taxonomic expertise available at SAHFOS. As data was supplied by multiple countries, sampling methodologies varied widely between research cruises. Therefore, it may be difficult to use this data quantitatively. Caution must be used when analysing the data due to the range of sampling and enumeration techniques used in the historical dataset. However, many possibilities for analysis exist for this specific dataset, using semi-quantitative techniques, including for example exploration of changes in range, distribution

and frequency of occurrence. The digitization of the historic ICES plankton data has temporally extended our knowledge of the marine ecosystem by providing information on the comparatively less-impacted historic plankton communities of the North Atlantic, North Sea, Baltic and Arctic Ocean. In conjunction with the CPR, we now have the data to explore 100 years of plankton change in these regions. Not only is this database exciting from a research perspective, but the implications for policy are significant, particularly when it comes to selecting reference conditions and setting baselines.

Standard Areas Revisited

Pierre Helaouet

In 1957, plankton results were compared to sea surface temperature and salinity values averaged ICES rectangles (1° latitude x 2° longitude). The observed distributions of plankton were related to the distribution of water masses in the Northeast Atlantic and coastal waters of the British Isles. Colebrook showed in 1963 that it was possible to use even larger rectangles called Standard Areas to investigate seasonal and interannual variability over the northern North Atlantic Ocean. Standard Areas have been used in a great number of studies since then. The fact that SAHFOS celebrated its 80th Anniversary this year is a good opportunity to provide an update of the information on those areas. We started by extracting all the samples from the CPR database from January 1958 to December 2010 (250,813 entries). We then cleaned the dataset by focusing on an area ranging from 35 to 70°N of latitude and -80 to 20°E of longitude (218,619 entries) and then each sample, characterised by its longitude and latitude, is attributed to a Standard Area. For each area we obtained a table representing the number of samples found as a function of months and years (12 by 53). For each standard area, the maximum value of the table is identified and used to standardise the table.

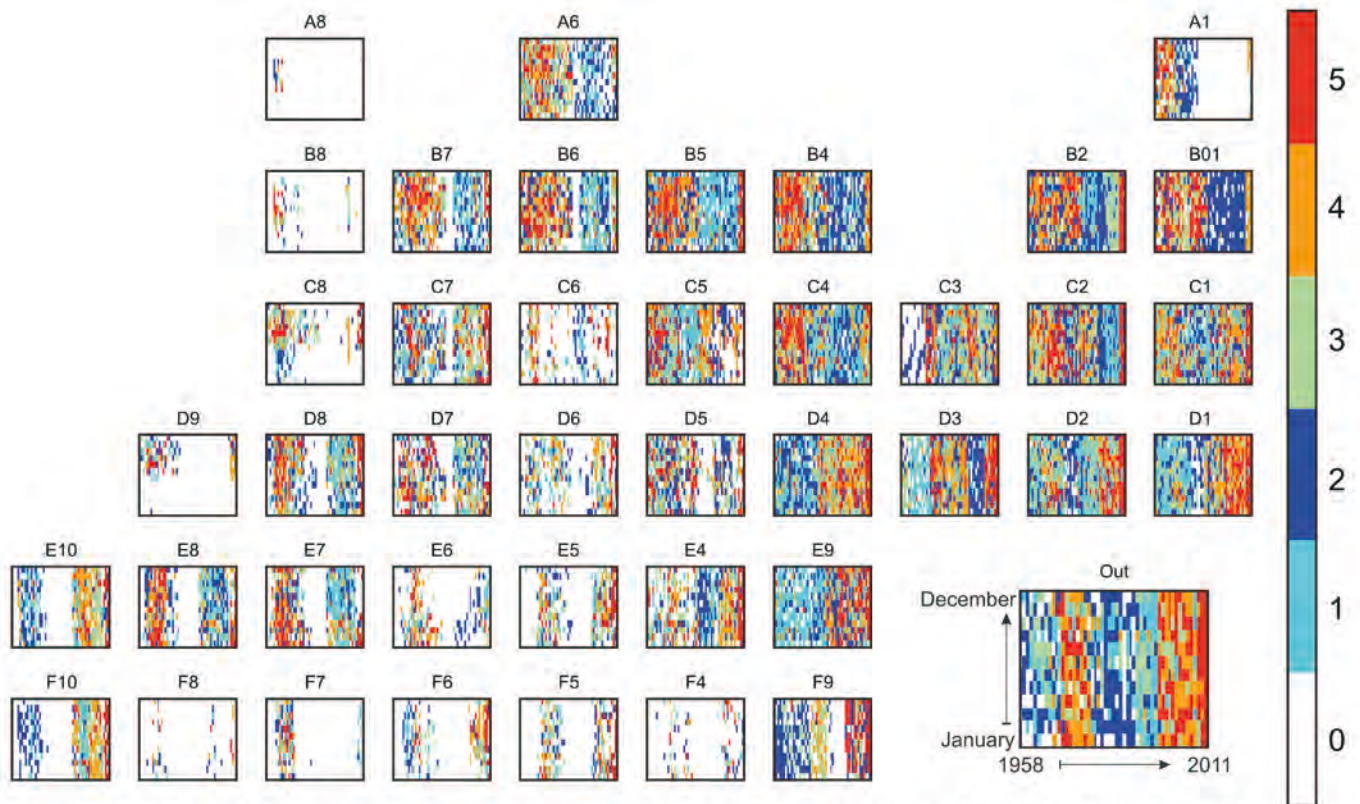


Figure 7: Traffic lights diagrams representing the number of samples for each standard area as a function of month (y axis) and year (x axis). The number of samples has been categorised from 0 (no sampling) to 5 (abundant sampling).

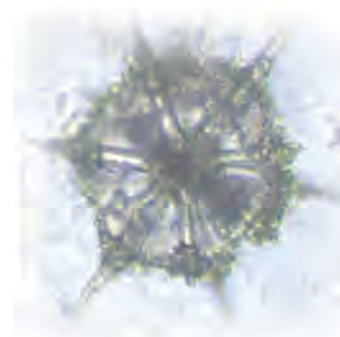
6 categories of abundance of samples were created: 1 is no samples, 2 is less than 20% of the maximum number of samples found, 3 between 2 and 40%, 4 between 41 and 60%, 5 between 61 and 60%, and 6 above 81%. Despite some funding problems in the early 90s (especially in the west of the North Atlantic Ocean), results show (Fig 7) that overall SAHFOS succeeds in its principal assignment: maintain a comparable and consistent survey in the North Atlantic Ocean. This method of data extraction can also be used for abundance data, providing monthly and annual means per Standard Area.

Investigating Acantharia

Johan Decelle, Station Biologique Roscoff

In the ocean, Acantharia are widely distributed and commonly outnumber their rhizarian counterparts (e.g. Foraminifera, Polycystinea) in surface waters. Acantharia significantly participate in the carbon and strontium biogeochemical cycles as well as primary production through endosymbiotic relationships with microalgae. This association can account up to 20% or more of the carbon fixation in the upper euphotic zone. However, there is a huge knowledge gap on the biology and biogeography of Acantharia. Analysis of the 7 year SAHFOS dataset of acantha-

ria, zooplankton and phytoplankton will provide a unique opportunity to study the distribution and the seasonal abundance of Acantharia in the North Atlantic and English Channel. For instance, how they correlate with physical-chemical parameters and any trophic association they may have with potential prey. Statistical analyses will be carried out to highlight any correlations between these factors (e.g. heat maps). In this way, SAHFOS data could greatly improve our understanding of Acantharian ecology. In addition, we are carrying out a trial to obtain genetic sequence (18S and 28S rDNA) information from single cells picked from CPR material. If successful these sequences can be compared to our reference genetic dataset (containing more than 100 sequences from isolated specimens) and may provide at least genus-level identification of Acantharia from CPR material.



NE Pacific 2011 indicators

Sonia Batten

The NE Pacific is one region of the world's ocean where temperatures have been cooler than average during the last few years. La Niña conditions persisted through 2011, and in fact were strong at the end of the year. At the time of writing, sample analysis is complete for the first two sampled months of 2011; April and May and for the north-south June transect. Data for the east-west June transect and July to September described here are based on the samples analysed in BC, Canada – about 25% of the eventual number to be analysed.

The region considered here is the offshore region adjacent to British Columbia, out to -145°W near the Alaska Gyre. Both transects cross this region which therefore has the greatest sampling coverage. The seasonal cycle of mesozooplankton biomass showed a flatter, more extended spring peak (Fig 8), which has been noted before in cool years, and biomass for the year showed a small positive anomaly. This is in contrast to 2010 when biomass was the lowest seen in the time series. The phenology of *Neocalanus plumchrus* suggested that the timing of the midpoint of the season, and the length of the season, were within the range seen in previous years. The timing of the midpoint of the season is significantly negatively correlated with the mean annual Pacific Decadal Oscillation index for the time series as a whole and we might have expected a later peak in 2011 based on this relationship, however, the most negative PDO values were towards the end of the year, after *N. plumchrus* had descended in diapause. Conditions are set for it to remain cold into spring 2012.

It was noticed during analysis that 2010 abundances of *Pseudocalanus* were unusually high over quite a wide area. Fig 9 shows the mean spring anomalies (since spring 2011 data are virtually complete) for several of the most common taxa that cover a range of plankton groups. The *Pseudocalanus* peak in 2010 is clearly evident but 2011 abundances were close to average. *Acartia longiremis* showed its most positive anomaly in 2011. A predominantly shelf species, this may indicate more offshore transport has occurred.

Chaetognaths, Euphausiids and *Metridia pacifica* are showing a declining trend in recent years, from

positive anomalies early in the time series. The small pteropods, *Limacina*, have been more abundant recently and have shown periods of high and low abundance. While these patterns may be no more than interannual variability, the length of the time series now gives us more confidence in identifying anomalous events or trends.

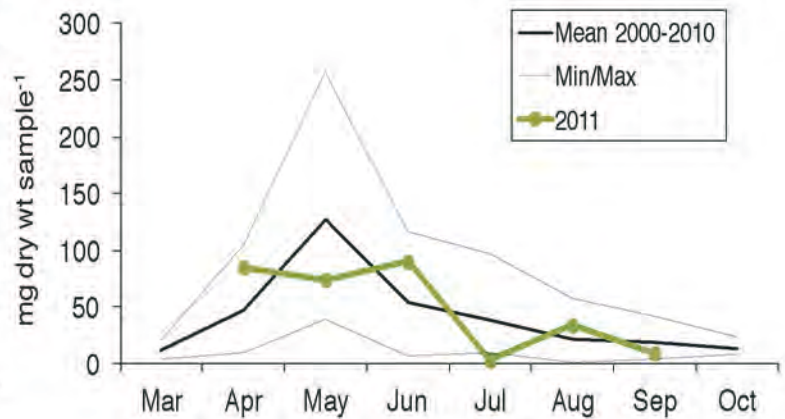


Figure 8. Mean monthly mesozooplankton biomass for 2011 together with the time series mean, minimum and maximum values. Note that data for June onwards are not yet complete.

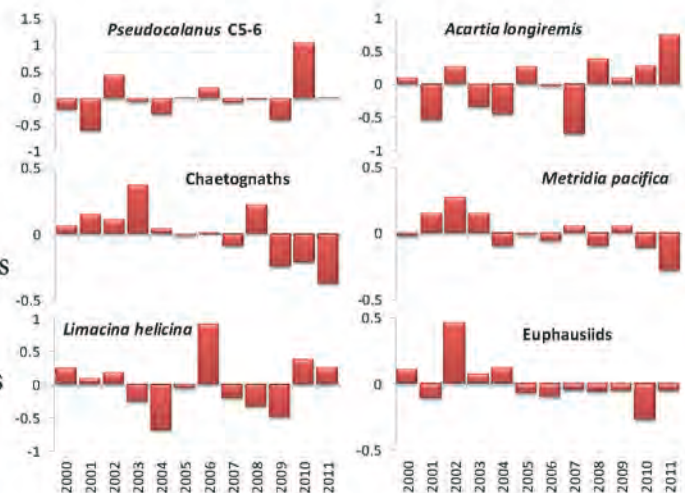


Figure 9. Annual spring (April-June) abundance anomalies (log₁₀) for 6 of the most frequently occurring taxa in Pacific CPR samples.

Parasitic fungi in marine systems

Kristina Hamilton and Bryony Williams, University of Exeter

Virtually no research has been performed on parasitic fungi in marine systems, yet these organisms are widespread in these systems: fungi as important contributors in biogeochemical cycles and Microsporidia as serious pathogens of fish and planktonic fish larvae, of commercially valuable crustaceans, and of copepods. Microsporidia is a widespread fungal pathogen, infecting large number of hosts, although its host range in marine waters remains unknown. Preliminary data from first water sample from the English Channel has already revealed high levels of unidentifiable fungi and Microsporidia. We aim to address the paucity in our knowledge of fungi and Microsporidian genetic diversity in plankton by examining historically and geographically diverse CPR samples from the North Atlantic, especially in fishing areas that may allow us to determine the extent of parasitism in zooplankton, which may affect higher trophic levels. This research would use previously tested molecular probes specific to the small sub-unit (SSU) of the rRNA gene of Microsporidia and basal fungi (Zygomycetes) to search for DNA of these organisms in CPR samples. The resulting data will add to our understanding of marine ecosystem biodiversity and processes. Additionally, it will form a basis to explore changes to ecosystem functionality (i.e. Microsporidia as potentially invasive species) and will highlight putative environmental health and aquaculture hazards.

HABs in the Pacific Northwest

Stephanie Moore (NOAA), Vera Trainer (University of Washington), Sonia Batten, Abigail McQuatters-Gollop and Rowena Stern

Harmful algal blooms (HABs) have been monitored off the Washington coast of the USA for over 10 years as part of the Olympic Region Harmful Algal Bloom Monitoring Program (ORHAB, <http://www.orhab.org/>). This project uses the ORHAB time-series to link HAB occurrences with climate changes. In the last decade there has been a shift from a diatom-dominated phytoplankton community to that of a flagellate-dominated one. Combining ORHAB data with that of the Pacific Northwest CPR survey has identified climatologically anomalous years showing corresponding variability in the phytoplankton community. In order to better identify how these changes affect the HAB genus *Pseudo-nitzschia*, genetic identification of the phytoplankton community in archived CPR samples is being performed in coastal and open ocean areas.

Identifying *Pseudo-nitzschia*

Naomi Downes-Tettmar, PML

The marine diatom *Pseudo-nitzschia* is a common contributor to coastal phytoplankton communities world wide, including the English Channel, and plays an important role in the marine food web. This genus has attracted much attention in the last two decades since the discovery that it produces the potent neurotoxin domoic acid. Domoic acid can accumulate through the food chain impacting on aquaculture industries, marine mammals, seabirds, and human health. Both the L4 time series (off Plymouth) and CPR survey record *Pseudo-nitzschia* but this genus is notoriously difficult to identify to species-level by light microscopy. Genetic analysis has confirmed *Pseudo-nitzschia* is in fact a species-complex consisting of species with overlapping morphological features. Of the 37 known *Pseudo-nitzschia* species only 12 have been found to produce domoic acid, so identification to species level is vitally important. I am a PhD student at Plymouth Marine Laboratory studying *Pseudo-nitzschia* species and domoic acid production at L4. I have examined the seasonal variation of this genus and explored the environmental factors that influence its occurrence and toxin production in this region. Using molecular techniques, I aimed to genetically identify the *Pseudo-nitzschia* to species level in samples that tested positive for domoic acid and those that did not. These results will be combined with toxicity data, and detailed morphological examination by electron microscopy, to identify potentially toxic species and look at the seasonal composition of *Pseudo-nitzschia* in the English Channel. To date, I have successfully identified the presence of *Pseudo-nitzschia* in L4 samples from 2009 using the *rbcl* DNA marker, that encodes for RUBISCO- a gene involved in photosynthesis in diatoms. I am now awaiting results of more detailed genetic tests. The results of this study will provide a genetic database of *Pseudo-nitzschia* species that can be applied when testing CPR archive samples in the same area to examine past temporal and spatial ranges of this genus.

Plankton Taxonomy: SAHFOS Guide to North Atlantic Plankton

Marianne Wotton and Claudia Castellani

As part of its mission as a Centre of Excellence in plankton ecology and taxonomy SAHFOS staff are preparing a guide on marine plankton.

This timely book would be the first of its kind for many decades on the ecology and taxonomy of North Atlantic plankton. The book aims to provide students and professionals with an authoritative overview of the ecological importance of plankton, their taxonomic identification, collection in the field and handling in the laboratory. Its main focus will be on the taxonomic identification of the mesozooplankton, but there will be sections dealing succinctly with the most important representatives of the phytoplankton and the microzooplankton. The book will mainly describe species occurring between the sub-arctic and the sub-tropical biomes, although some of the most abundant warm water (tropical) species and invasive taxa will also be included. We have already made good progress on the taxonomic sections of the book and have recruited eminent plankton scientists who will contribute to the ecological and methodological sections.

What is new in this book compared to published plankton taxonomy guides? We have created a key-map which will aid navigation throughout the taxonomic section, to enable the initial broad identification of the taxa and direct the reader to the chapter where the specimen can be further identified. Each chapter will include examples of the life cycle and information on systematics, general morphology and ecology of the taxa. The text for taxonomic identification will be reduced to a minimum and will be next to the taxa figure; line drawings of each taxa will be fully annotated to highlight key morphological features which facilitate identification. Wherever possible we will include a representative photograph of the taxa. We are also planning to have distribution maps for most of the species described, so that readers can appreciate differences in species spatial distribution. Technical terms in the text will be in bold and defined in the glossary. Whilst collating the taxonomic information together for this guide we have uncovered and ad-

ressed many issues concerned with the perpetuation of errors, and misinterpretations, from old published works into more modern guides. This will be the most comprehensive guide to North Atlantic plankton ever produced in a single work.

On the importance of deriving adequate measurements of zooplankton standing stock indices for model validation

Priscilla Licandro

A novel index of zooplankton standing stock was derived from North Atlantic Continuous Plankton Recorder (CPR) records. This was obtained by multiplying the taxa-specific dry weights (DW) and densities of all the main zooplankton categories routinely sampled by the CPR (108 species, 67 genera, 23 groups). As zooplankton encompass organisms characterized by a large variety of shapes and by very different stoichiometries, for a same size the biomass of a zooplankton individual can be very dissimilar according to different taxa, genera or species of the same genus (Figure 10).

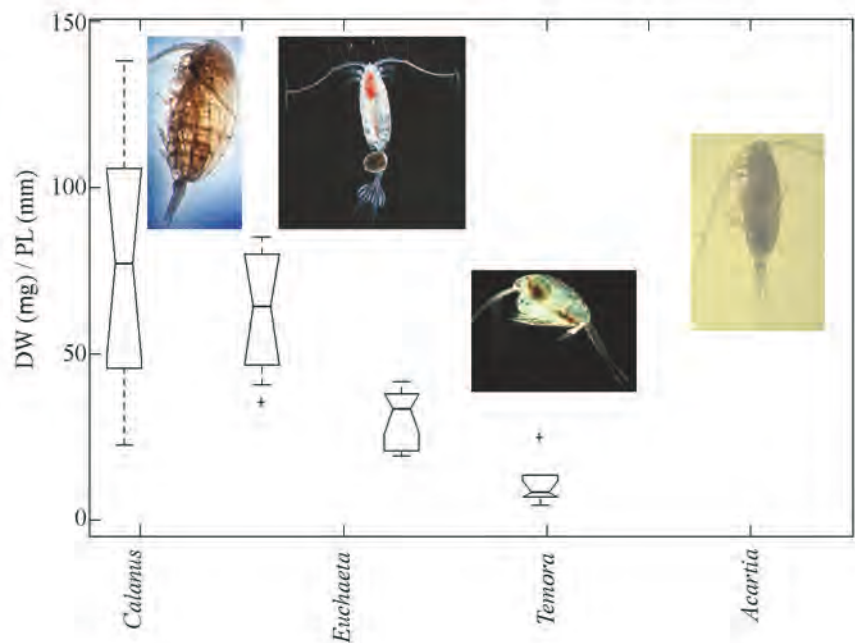


Figure 10. Mass (dry weight) per prosome unit length (mm) for different genera of dominant copepods

For instance the biomass of the copepods *Calanus finmarchicus* and *C. helgolandicus*, that appear identical and can only be distinguished by very subtle morphological differences in the 5th leg, differs of about 60% as average dry weight per unit length. We stress therefore the importance when deriving zooplankton biomass from density data of taking into account not only the size but also the composition of the zooplankton community. This is particularly important when those data are utilized for the parameterization of modern ecosystem models that are intended to be used for the management of marine environments at local and regional scales.

A new fish larval database for the NE Atlantic

Martin Edwards

The CPR survey records over 500 taxonomic entities and although the number of fish larvae on each sample is counted, they are not routinely identified to species or taxonomic group. The fish larvae project was an ambitious study to identify the fish larvae and transfer the results to a database incorporating the data from an earlier CPR Fish Atlas (from 1980). This required re-analysing over 10,000 archived CPR samples and recording over 32,000 identified specimens. The project has resulted in the creation of a unique fish larvae database of the NE Atlantic, North Sea and adjacent areas from 1948-2005. Young fish are some of the largest organisms sampled by the CPR survey, typically ranging from 2 mm to 50 mm (mean size ~12mm), with the CPR (although selective) sampling a comparable part of each population from year to year. Due to the size of the fish larvae and the sampling method, they can often be damaged and identification to species level is not always possible using traditional microscopic methods (which was the method used in this project). However, advances in molecular analysis of CPR archived

material now allow molecular identification of fish larvae. In terms of diversity, the CPR fish larvae database consists of 75 taxonomic groups or species including many species of commercial value. In the example shown we have looked at some results concerning mackerel larvae in the NE Atlantic.

Results from the CPR survey (Figure 11) show the two separate spawning stocks of mackerel, these being in the central North Sea and to the west and south-west of the British Isles. In the North Sea mackerel larvae are caught predominately between June and August with highest numbers occurring in July (for the first period 1948-1985) and in June for the second period (1986-2005). In the Celtic Sea mackerel spawn earlier, from March to July with highest numbers occurring in April and May. Observing the overall trend, mackerel larvae have declined substantially over the last few decades reflecting the decline of first the North Sea stock and subsequently the western population.

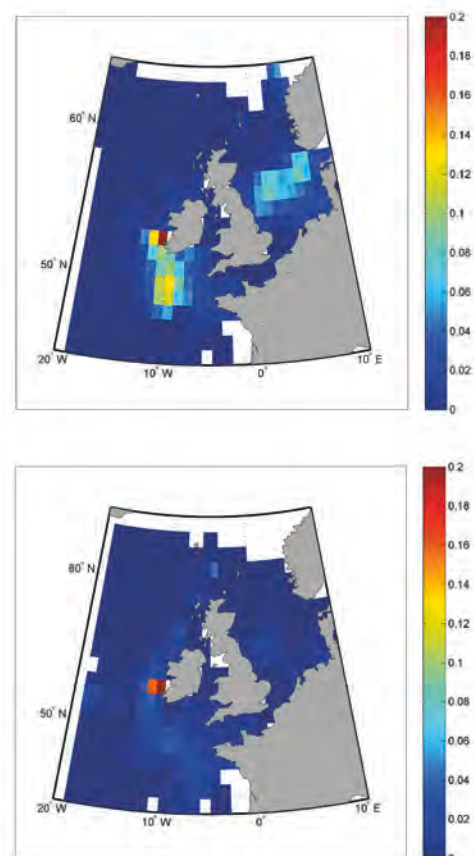


Figure 11. Distribution and abundance of mackerel larvae (top 1948-1985, bottom 1986-2005)





Plankton 2011 - September 2011 Plymouth

On 22-23 September 2011 the Sir Alister Hardy Foundation for Ocean Science hosted 'Plankton 2011' at the Plymouth Guildhall. This international Symposium focused on understanding the causes and consequences of long-term plankton change in fresh and marine waters, based on remote as well as in-situ approaches. It brought together 180 scientists from 21 countries to celebrate 80 years of the Continuous Plankton Recorder (CPR) Survey, and also pay homage to Sir Alister Hardy, his vision and the colossal contribution he made to plankton studies.

The Symposium began with an enlightening journey through the life of the Survey since 1931. Hardy, the man, his beliefs and his motivations were captured by the first keynote, John Spicer of Plymouth University. He also discussed how Hardy's achievements could guide us scientifically in the 21st century. This was followed by Chris Reid of SAHFOS celebrating past successes of the Survey and the personalities behind them, recent scientific breakthroughs that have opened up new research avenues for CPR data and the formation of extant sister Surveys and future globalisation. Session two, focusing on change in plankton communities was opened by Trevor Platt of Plymouth Marine Laboratory and Dalhousie University and detailed remote sensing of ocean colour and the use of the CPR as complementary sources of information. A selection of presentations from Sargasso Sea dynamics, to Baltic Sea plankton com-

munities, to zooplankton of Japanese waters and developments in long-term phytoplankton series in other oceans continued into the afternoon.

Session three, highlighting the drivers of change in ecosystems and their consequences began with the keynote speech delivered by Stephen Maberly of the Centre for Ecology and Hydrology, Lancaster Environment Centre. A comprehensive look at the dynamics of freshwater lakes, long-term plankton data, monitoring, mechanisms and models to comprehend the past and forecast the future opened up the floor to a selection of presentations on climate forcing of zooplankton communities, and various multi-decadal scale changes in plankton communities in Europe, North Pacific and North Atlantic.

One of the major highlights of the Symposium was a panel debate during the final session of day one, focusing on large-scale changes in ocean phytoplankton. This was an invited public session bringing together scientists and interested members of the public.





This panel debate was fuelled by a SAHFOS rebuttal written in response to a Nature publication on 'global phytoplankton trends' by Boris Worm et al, of Dalhousie University. It was chaired by Emeritus Professor John G Field, Director of the Marine Research Institute University of Cape Town and former Trustee and advisor to Plymouth Marine Laboratory, who had also previously given the 25th Annual Plymouth Marine Science Lecture on projecting ecosystem change under scenarios of global change. The panel consisted of a SAHFOS representative, Abigail McQuatters-Gollop, Boris Worm, and Marcel Wernard of the Royal Netherlands Institute for Sea Research. A stimulating and thought provoking debate ensued and one that highlighted the need for improved global collaboration among institutions.

At the close of day one, Deputy Lord Mayor of Plymouth, Edward Delbridge, welcomed delegates to Plymouth with a wine reception and a specially commissioned CPR cake, the cutting of which commemorated 80 years of the CPR survey.

The Symposium dinner was then held at the National Marine Aquarium, Plymouth. This venue is one of the institutions alongside SAHFOS within the Plymouth Marine Sciences Partnership. Delegates had the pleasure of enjoying not only a three course dinner set against a

most impressive backdrop of the Atlantic Reef tank, but also a tour of the entire Aquarium.

Day two opened with the first session documenting plankton communities from algae to larval fish and included an invited talk by Graham Hosie, of the Southern Ocean CPR Survey detailing changes in Antarctic krill and future implications of this change. This session also covered presentations on primary production changes using satellite data, extensions of warm water copepods in the North-East Pacific, community shifts and phenological change in various time series. The final session 'looking over the horizon at the future' detailed future applications of molecular techniques, archival samples from our own CPR Survey and automated flow cytometry and cell imaging. The powerful final keynote provided by Dave Checkley of Scripps Institution of Oceanography, aptly entitled 'the future of plankton observing' highlighted the development of a framework for global observing, the continuation of key existing time-series and increased support of research and development in order to better inform decision makers in management and policy. Past research has shown that the willingness of public society to engage depends on their understanding and appreciation of issues that we as scientists consider being of global concern, and this was one of Dave's final points. Part of the future of plankton observing is finding ways of increasing the level of public education so that they can understand the need for future observing and monitoring.



This in turn, opened up the floor during the closing session for a delegate debate on the 'where next for long term plankton monitoring?'. Conclusions reached emphasised the need for stronger collaborations among the scientific community, data being freely available and the benefit of meetings with wide and varied topics.

The world has recognised that Hardy was not only a great scientist, but also an accomplished artist; hence the Symposium celebrated art alongside the science in the form of an art exhibition and an art competition sponsored by Brittany Ferries.

Local artists submitted their interpretations for the exhibit; this included an 8 foot metal sculpture inspired by the CPR, a series of plankton metal works created by SAHFOS's marine technician Roger Barnard, and prints obtained from copper etchings by Debbie Mason, a local artist who has had work commissioned by Defra. Local schools were involved and their artwork included a giant jellyfish hanging and twinkling as it swayed as delegates moved past.

The art competition had 34 entries and Symposium delegates voted on their winners for each category. These were All Saints Primary School in the under 5-10 year olds, Dan Douglas for the 11-18 year olds and Wendy Wates, the wife of retired SAHFOS Treasurer Anthony Wates, for the Over 19 year olds. Wendy Wates also won the overall prize for best artwork.

Alongside scientists the Symposium also drew media interest including The Times ocean correspondent Frank Pope and a Canadian media company involved in producing the film 'The Cove'. Social media played a key part of communication with delegates using Twitter to both follow and pass on outcomes of the symposium.

Complementing the Symposium was the first meeting of the SAHFOS Alumni Association. The Association is intended for those who have an interest in plankton and marine biology as well as those who have worked for the CPR Survey and have an interest in its future to be kept aware, receive special event invitations and more. Members joined SAHFOS staff at Citadel Hill to a complementary inaugural lunch. It was an opportunity to meet old colleagues and to have a tour of SAHFOS which now enjoys a greatly expanded new laboratory space and workshop.

The Sir Alister Hardy Foundation for Ocean Science has amassed an impressive research résumé during its 80 years of operation, and the aim of this Symposium was to bring together the imagination, foresight, design and technical skills of some of the greatest minds in plankton research today, in order to secure the continuation of plankton observing and monitoring for the next 80 years and beyond.



'Diverse Catch' by Sam White



Knowledge Exchange

Education and Outreach activities

Clare Buckland

The education activities in 2011 were broad ranging and inspiring to students, school children and the general public. National Science and Engineering (NSE) week activities were held at Plymouth City Museum and Art Gallery. This collaborative event with Plymouth Marine Laboratory and Plymouth University was a repeat of our successful 'Change: for better or worse?' and was designed to promote awareness to the changes in the environment and to organisms. The event was a great success and attracted approximately 600 new visitors throughout the week. In addition to our activities in the Museum, Gemma Brice attended Paignton Zoo during NSE week to run a series of Powerful Plankton workshops. It involved fifteen primary and secondary schools from the surrounding area, who took part in activities such as an 'Amazing Facts' Plankton Quiz, a 'catch your own plankton', an 'ID under the microscope', and a 'design your own plankton' craft-making activity.

SAHFOS continued with 'You're Hired' challenges during 2011, setting school challenges to design a suitable sampling device. These were held at Marine Academy Plymouth and Notre Dame School in Plymouth. The city-wide final competition was held at the end of June at the Plymouth University, SAHFOS received media coverage and publicity for the event.

School workshops and presentations to Year 10/11 students were carried out during the spring and summer at Ridgeway School and Plymstock School about the importance of plankton and the work of the CPR survey. Students enjoyed seeing how biology and science are used in the workplace and many were

enthused to see marine science in action in Plymouth.

In June SAHFOS took part in the Plymouth Marine Science Partnership event to celebrate World Oceans Day in Plymouth City Centre. The event included live displays, activities and presentations from scientists across Plymouth's marine science sector and was an effective method for showcasing the important research carried out by Plymouth scientists.

SAHFOS and the MBA carried out a plankton safari day for the general public as well in June, which included sampling and examining organisms through the microscope. In July Clare Buckland carried out an Introduction to Marine Zooplankton Identification course at the MBA for undergraduate students and other interested adults. The course was well attended by students from the Plymouth University and other scientists with no or little experience of identifying zooplankton. The aim of this one day course was to encourage identification skills in young scientists and give students experience of examining specimens. It was a great success and many of the students expressed a desire to repeat the course in 2012.

Lectures were also given to the Plymouth University's MRes students to support the MBA teaching programme. Clare Buckland gave a presentation about phenological studies using plankton indicators and Priscilla Licandro gave a presentation about analysis of ecological time series. In August SAHFOS was host to two work experience personal: Georgina Greenhalgh and Emma Gavan joined us for two weeks and carried out important tasks for the Survey.

SAHFOS took part in BIOBLITZ at Mount Edgumbe County Park, Cornwall, at the end of September which was well attended by school groups and the general public. BIOBLITZ is an interactive biological sampling event with the aim of producing a full inventory of species from a certain area in a 24 hour period. Fair weather meant that many of the biological surveys were very successful and our plankton sampling discovered a new recorded species of Harpacticoid in Plymouth Sound. In total around 800 species were recorded and many were identified by members of the public.



The Plankton 2011 Symposium was held in September at The Guildhall, Plymouth to mark the 80th Anniversary of the CPR survey and to bring together plankton scientists from around the world. It was during the Symposium that we premiered our new animation *The Power of Plankton* and it was very well received by all the delegates. The animation demonstrates how important plankton are to the marine environment and charts the sampling carried out by the CPR survey, plus the research achieved by SAHFOS. The animation is now available on DVD and via the SAHFOS website.

Science and Policy Update

Abigail McQuatters-Gollop

Policy drivers influence research at SAHFOS and an important aim of the organisation is to use CPR data and the expertise of SAHFOS scientists to deliver evidence-based advice to policy makers and ecosystem managers. SAHFOS continues to hold a place on the UK Marine Monitoring and Assessment Strategy (UKMMAS) Healthy and Biologically Diverse Seas Evidence Group (HBDSEG). In addition to its

involvement in HBDSEG, SAHFOS remains active in the Cefas/Defra-funded Marine Ecosystem Health Working Group and multiple ICES and SCOR Working Groups.

In 2011 SAHFOS expertise and CPR data also contributed to policy-relevant products for the following UK, European and international bodies: Defra, Scottish Natural Heritage, OSPAR, the European Environment Agency, the European Marine Observation and Data Network (EMODNET), ICES, WWF, the American National Science Foundation, and the Canadian Department of Fisheries and Oceans.

SAHFOS science is directly influencing UK marine policy. SAHFOS is currently leading pelagic indicator and target development for the UK's implementation of the EU Marine Strategy Framework Directive (MSFD), a project overseen by HBDSEG. This is a high profile project, the results of which will be legally binding for the UK. In 2011, Dr Abigail McQuatters-Gollop was invited to speak about the MSFD indicator and target development process and the CPR's use as a policy tool to the UK Marine Management Organization, the Challenger Society for Marine Science, and the NERC Oceans 2025 consortium. Assessments and talks such as these provide a mechanism to transfer scientific information to decision makers and facilitate the evidence-based development of monitoring programmes and policy measures.

During 2011 SAHFOS continued to excel at translating scientific research into an accessible policy-relevant format. SAHFOS research and CPR science contributed to the UK's National Ecosystem Assessment, the first ever analysis of the UK's natural environment in terms of societal and economic benefits. This assessment is essentially a monetary valuation of the UK's environment and is therefore politically influential. SAHFOS recently published "Climate Change and European Marine Ecosystem Research", an issue-based book exploring key areas of marine research and the policy and societal implications associated with them. The book is targeted at policy makers and the public and can be downloaded from the SAHFOS website. This publication was funded by FP7 CLAMER (www.clamer.eu).

Publications using CPR data

SAHFOS staff in **bold**

*Associated Researchers/Research Fellow/ PhD students (current and previous)

Refereed publications

Batten, S.D. and **Walne, A.W.**, 2011. Variability in northwards extension of warm water copepods in the NE Pacific. *Journal of Plankton Research*, 33: 1643–1653.

*Bicknell, A. W. J., **Campbell M.**, Knight M. E., Bilton D. T., Newton J. and Votier S. C., 2011. Effects of formalin preservation on stable carbon and nitrogen isotope signatures in Calanoid copepods: implications for the use of Continuous Plankton Recorder Survey samples in stable isotope analyses. *Rapid Communications in Mass Spectrometry*, 25: 1794–1800.

Bond, A.L., Jones, I.L., Williams, J.C. and Byrd, V., 2011. Diet of auklet chicks in the Aleutian Islands, Alaska: similarity among islands, interspecies overlap, and relationships to ocean climate. *Journal of Ornithology*, 153: 115–129.

Brewin, R.J.W., Hardman-Mountford, N.J., Lavender, S.J., *Raitsos, D.E., Hirata, T., Uitz, J., Devred, E., Bricaud, A., Ciotti, A. and Gentili, B., 2011. An intercomparison of bio-optical techniques for detecting dominant phytoplankton size class from satellite remote sensing. *Remote Sensing of Environment*, 115: 325–339.

Castellani, C., **Lindley, J.A.**, **Wootton, M.** and Kirby, R.R., 2011. Morphological and genetic variation in the north Atlantic copepod, *Centropages typicus*. *Journal of the Marine Biological Association of the UK*, 92.1

Edwards, M., 2011. Biodiversity and ecosystems: Change at the community level. *Nature Climate Change*, 1: 398–399.

Fauchald, P., Skov, H., Skern-Mauritzen, M., **Johns, D.G.** and Tveraa, T., 2011. Wasp-Waist Interactions in the North Sea Ecosystem. *PLOS-one*, 6: e22729.

Fauchald, P., Skov, H., Skern-Mauritzen, M., **Johns, D.G.** and Tveraa, T., 2011. Scale-dependent response diversity of seabirds to prey in the North Sea. *Ecology*, 92: 228–239.

Frank, K.T., Petrie, B., Fisher, J.A.D. and Leggett, W.C., 2011. Transient dynamics of an altered large marine ecosystem. *Nature*, 477: 86–89.

*Fredericksen, M., Elston, D.A., **Edwards, M.**, Mann, A.D. and Wanless, S., 2011. Mechanisms of

long-term decline in size of lesser sandeels in the North Sea explored using a growth and phenology model. *Marine Ecology Progress Series*, 432: 137–147.

Harrison, P.J., Furuya, K., Glibert, P.M., Xu, J., Liu, H.B., Yin, K., WLee, J.H., Lliu, H., Gowan, R., Al-Azri, A.R., Ho, A.Y.T. and Anderson, D.M., 2011. Geographical distribution of red and green *Noctiluca scintillans*. *Chinese Journal of Oceanology and Limnology*, Vol. 29: 807–831.

Hartmann, M., Grob, C., Scanlan, D.J., Martin, A.P., **Burkill, P.H.** and Zubkov, M.V., 2011. Comparison of phosphate uptake rates by the smallest plastidic and aplastidic protists in the North Atlantic subtropical gyre. *FEMS Microbiology Ecology*, 78 327–335.

Helaouët, P., *Beaugrand, G. and **Reid, P.C.**, 2011. Macrophysiology of *Calanus finmarchicus* in the North Atlantic Ocean. *Progress in Oceanography*, 91: 217–228.

*Hinder, S.L., Hays, G.C., Brooks, C.J., Davies, A.P., **Edwards, M.**, **Walne, A.W.** and Gravenor, M.B., 2011. Toxic marine microalgae and shellfish poisoning in the British isles: history, review of epidemiology, and future implications. *Environmental Health*, 10: 54

Jansen, T. and Gislason, H., 2011. Temperature affects the timing of spawning and migration of North Sea mackerel. *Continental Shelf Research*, 31: 63–72.

Licandro, P., Souissi, S., Ibanez, F., Carré, C. 2011. Long-term variability and environmental preferences of calycophoran siphonophores in the Bay of Villefranche (North-Western Mediterranean). *Progress in Oceanography* (<http://dx.doi.org/10.1016/j.pocean.2011.11.004>).

*Llope, M., **Licandro, P.**, Chan, K.-S., Stenseth, N.C. 2011. Spatial variability of the plankton trophic interaction in the North Sea: a new feature after the early 1970s. *Global Change Biology*, doi: 10.1111/j.1365-2486.2011.02492.x. (<http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2011.02492.x/pdf>).

Luczak, C., *Beaugrand, G., Jaffre, M. and Lenoir, S., 2011. Climate change impact on Balearic shearwater through a trophic cascade. *Biology Letters*, 7(5): 702–5.

Mazzocchi, M.G., **Licandro, P.**, Dubroca, L., Di Capua, I. and Saggiomo, V., 2011. Zooplankton associations in a Mediterranean long-term time-series. *Journal of Plankton Research*, 8: 1163–1181.

*McGinty, N., Power, A.M. and Johnson, M.P., 2011. Variation among northeast Atlantic regions in the responses of zooplankton to climate change: Not all areas follow the same path. *Journal of Experimental Marine Biology and Ecology*, 400: 120-131.

McQuatters-Gollop, A., Reid, P.C., Edwards, M., Burkill, P., Castellani, C., Batten, S., Gieskes, W., Beare, D., Bidigare, R., Head, E., Johnson, R., Kahru, M., Koslow, J. and Pena, M., 2011. Is there a decline in marine phytoplankton? *Nature*, 472: E6-E7.

McQuatters-Gollop, A. and Vermaat, J.E., 2011. Covariance among North Sea ecosystem state indicators during the past 50 years - contrasts between coastal and open waters. *Journal of Sea Research*, 65: 294-292.

Mollmann, C., Conversi, A. and **Edwards, M.**, 2011. Comparative analysis European wide marine ecosystem shifts - a large scale approach for developing the basis for ecosystem-based management. *Biology Letters*, 7: 484-486

Perrings, C., Naeem, S., Ahrestani, F.S., Bunker, D.E., **Burkill, P.**, Canziani, G., Elmqvist, T., Fuhrman, J.A., Jaksic, F.M., Kawabata, Z.I., Kinzig, A., Mace, G.M., Mooney, H., Prieur-Richard, A.-H., Tschirhart, J. and Weisser, W., 2011. Ecosystem services, targets, and indicators for the conservation and sustainable use of biodiversity. *Frontiers in Ecology and the Environment*, 9: 512-520.

Philippart, C.J.M., Anadon, R., Danovaro, R., Dippner, J.W., Drinkwater, K.F., Hawkins, S.J., T. oGuz, O'Sullivan, G. and **Reid, P.C.**, 2011. Impacts of Climate Change on European Marine Ecosystems: Observations, Expectations and Indicators. *Journal of Experimental Marine Biology and Ecology*, 400: 52-69.

*Raitsos, D.E., Lavender, S.J., Maravelias, C.D., Haralabous, J., **McQuatters-Gollop, A., Edwards, M. and Reid, P.C.**, 2011. Macroscale factors affecting diatom abundance: a synergistic use of Continuous Plankton Recorder and satellite remote sensing data. *International Journal of Remote Sensing*, 32: 2081-2094.

Stern, R.F., Andersen, R.A., Jameson, I., Küpper, F.C., Coffroth, M.A., Vaultot, D., Le Gall, F., Véron, B., Brand, J.J., Skelton, H., Kasai, F., Lilly, E.L. and Keeling, P.J., 2011. Evaluating The Ribosomal Internal Transcribed Spacer (ITS) as a Candidate Dinoflagellate Barcode Marker. *PLOS-one*.

Vezzulli, L., Brettar, I., Pezzati, E., **Reid, P.C.**, Colwell, R.R., Höfle, M.G. and Pruzzo, C., 2011. Long-term effects of ocean warming on the prokaryotic community: evidence from the vibrios. *The ISME Journal: Multidisciplinary Journal of Microbial Ecology*, 6: 21-30.

Policy reports and documents

Amaral-Zettler, L., Duffy, J.E., Fautin, D., Paulay, G., Rynearson, T., Sosik, H. and Stachowicz, J., 2011. Attaining an Operational Marine Biodiversity Observation Network (BON) Synthesis Report. National Oceanographic Partnership Program, 36.

Austen, M.C., Malcolm, S.J., Frost, M., Hattam, C., Mangi, S., Stentiford, G., Benjamins, S., Burrows, M., Butenschön, M., Duck, C., **Johns, D.G.**, Merino, G., Mieszkowska, N., Miles, A., Mitchell, I., Pimm, E. and Smyth, T., 2011. Chapter 12: Marine, The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment. UNEP-WCMC, Cambridge.

Byrne, C. and **McQuatters-Gollop, A.**, 2011. A new addition to the online offering: ICES Historical Plankton Dataset, ICES Inside Out vol 5. ICES, Copenhagen, pp.

Edwards, M., *Beaugrand, G., Johns, D.G., Helaouet, P., Licandro, P., McQuatters-Gollop, A. and Wootton M., 2011. Ecological Status Report: results from the CPR survey 2009/2010. SAHFOS Technical Report, 8: 1-8 1744-0750.

Edwards, M., Helaouet, P., Halliday, N., *Beaugrand, G., Fox, C., Johns, D.G., Licandro, P., Lynam, C., Pitois, S., Stevens, D., and Coombs, S. 2011. Fish Larvae Atlas of the NE Atlantic. Results from the Continuous Plankton Recorder survey 1948-2005. Sir Alister Hardy Foundation for Ocean Science. 22p. Plymouth, U.K. ISBN No: 978-0-9566301-2-7

Johns, D.G. and McQuatters-Gollop, A., 2011. Natural Heritage Trends – Plankton in the seas around Scotland – update, 5pp.

Licandro, P., Head, E., Gislason, A., Benfield, M.C., Harvey, M., Margonski, P. and Silke, J., 2011. Overview of Trends in Plankton Communities. ICES Coop. Res. Rep, 310: 103-122.

Moffat, C., Aish, A., Hawkridge, J.M., Miles, H., Mitchell, P. I., **McQuatters-Gollop, A.**, Frost, M., Greenstreet, S., Pinn, E., Proudfoot, R., Sanderson, W. G., & Tasker, M. L., 2011. Advice on United Kingdom biodiversity indicators and targets for the Marine Strategy Framework Directive. Healthy and Biologically Diverse Seas Evidence Group, Report to the Department for Environment, Food and Rural Affairs, 207pp.

Reid, P.C. and Valdes, L., 2011. ICES status report on climate change in the North Atlantic. ICES Cooperative Research Report.

Tarran, G., Guilloux, L., Rigaut-Jalabert, F., Simon, N., **Stern, R., Walne, A.** and Widdicombe, C., 2011. Joining Forces to Create a Cross-Channel Time-Series Observatory within the EU Interreg project, Marinexus. Station Biologique Roscoff, Roscoff, France.

Papers accepted for publication

Batistić, M., Lučić, D., Carić, M., Garić, R., **Licandro, P.** and Jasprica, N., in press. First record of the calycophorae *Muggiaea atlantica* Cunningham 1892 in the marine lakes of Mljet Island (Croatia): Is the native congener *M. kochi* being displaced? *Hydrobiologia*.

Bode, A., Alvarez-Ossorio, M.T., Miranda, A., López-Urrutia, A. and Valdés, L., in press. Comparing copepod time-series in the north of Spain: spatial autocorrelation of community composition. *Progress in Oceanography*. online.

Burthe, S., Daunt F.H.J., Butler A., Elston, D., *Frederiksen, M., **Johns, D.G.**, Thackeray S.J. and Wanless, S. in press. Phenological trends and trophic mismatch across multiple levels of a North Sea pelagic food web. *Marine Ecology Progress Series*.

Scheef, L.P., Pendleton, D.E., Hampton, S.E., Katz, S.L., Holmes, E.E., Scheuerell, M.D. and **Johns, D.G.**, in press. Assessing marine plankton community structure from long-term monitoring data with multivariate autoregressive (MAR) models: a comparison of fixed station vs. spatially distributed sampling data. *L&O Methods*.

Vofß, M., Baker, A., Bange, H., Conley, D., Deutsch, B., Engel, A., Heiskanen, A.S., Jickells, T., Lancelot, C., **McQuatters-Gollop, A.**, Middelburg, J., Schiedek, D. and Slomp, C., in press. Chapter 7: Nitrogen turnover processes and effects in coastal and marine ecosystems, *European Nitrogen Assessment*.

Non-refereed, non- CPR publications or unpublished reports/abstracts

Bode, A., Álvarez-Ossorio M. T. and Miranda A., 2011. Variabilidade e tendencias interanuais do zooplâncto galego. In: Xunta de Galicia. Conselleria de Medio Ambiente e Desenvolvemento Sostible (Editor), *Evidencias e Impactos do Cambio Climático en Galicia*. Santiago de Compostela. Xunta de Galicia, pp. 341-354.

Bresnan, E., **Edwards, M., Stern, R.,** Hughes, S., Fraser, S., **Johns, D.G.** and Lacaze, J.P., 2011. Changes in the diversity of the dinoflagellate genus *Dinophysis* (Ehrenberg) in the northwest North Sea,

World Conference of Marine Biodiversity, Aberdeen, Scotland, pp. 39.

Buckland, C., 2011. *The Power of Plankton*, DVD animation. Plymouth, UK.

Burkill, P., 2011. 80 years - a testament to a good idea. *The Marine Scientist*: 11-15.

***Buttino, I.**, Cruscanti, M., Pellegrini, D., **Wootton, M.** and **Licandro, P.**, 2011. Application of confocal microscopy for the taxonomic identification of CPR copepods, *Plankton 2011*, Plymouth, UK.

Gilbert, A., Langmead, O., **McQuatters-Gollop, A.**, Mee, L.D. and Vermaat, J.E., 2011. Trade-offs for Good Environmental Status, *KnowSeas 3rd Scientific Workshop*, Helsinki, Finland.

McQuatters-Gollop, A., Johns, D.G., Dowland, P., **Edwards, M.**, 2011. Digitization, analysis and interpretation of plankton data for pre-1914 ICES sampling in the North Sea and adjacent waters: final report April 2011. SAHFOS, Plymouth, 20 pp.

McQuatters-Gollop, A., 2011. Is there a decline in the marine phytoplankton? *Plankton 2011*, Plymouth, UK, September 2011.

McQuatters-Gollop, A., Gilbert, A.J., Mee, L.D. and Vermaat, J.E., 2011. How well do ecosystem indicators communicate the effects of anthropogenic eutrophication? *Plankton 2011*, Plymouth, UK, September 2011.

McQuatters-Gollop, A., 2011. Challenges for managing our seas in a climate of macroecological change: messages from the plankton Prospectus for UK Marine Science for the next 20 years: A Joint Project by The Challenger Society for Marine Science and the UK Scientific Committee on Oceanic Research, Royal Society, London, UK. September 2011.

McQuatters-Gollop, A., 2011. Implications of large-scale ecological change for managing UK seas, How can we manage our seas in the real world? Organized by Plymouth Marine Sciences Partnership in collaboration with the Marine Management Organisation, Plymouth, UK. September 2011.

McQuatters-Gollop, A. and Gilbert, A., 2011. Why is it so hard to set MSFD indicators and targets? Messages from the plankton, *KnowSeas 3rd Scientific Workshop*, Helsinki, Finland. November 2011.

Reid, P.C., Gorick, G. and **Edwards, M.**, 2011. Climate change and European Marine Ecosystem Research. Sir Alister Hardy Foundation for Ocean Science, Plymouth, UK, 53p.

Wootton, M. and **Burkill, P.**, 2011. Going Global: planning the next 80 years of the Continuous Plankton Recorder Survey. World Conference on Marine Biodiversity 2011, Aberdeen.

Stern, R.F., Bresnan, E. and **Edwards, M.,** 2011. Molecular investigation of Phytoplankton and Pseudo-nitzschia species over 10 years in Atlantic using archival samples from the Continuous Plankton Recorder, Plankton 2011, Plymouth, pp. F4.

Stern, R.F., Keeling, P.J. and **Edwards, M.,** 2011. Making sense of Dinoflagellate diversity using DNA barcoding, Fifth European Congress of Phycology, Rhodes, Greece, pp. 30.

Data requests

For 2011 there were 69 specific data requests, not including WinCPR downloads or standard updates.

Data requests came from Canada, Denmark, France, Ghana, Iceland, Ireland, Italy, Netherlands, Norway, Saudi Arabia, Switzerland, UK and USA.

January – Victoria Harris (UCL, UK), Stephanie Hinder (University of Swansea, UK), Trevor Platt (PML, UK), Alessandra Conversi (CNR-ISMAR, Italy).

February – Niall McGinty (Galway, Ireland), Ed Westwood (NOC, UK).

March - Anna Krystalli (University of Sheffield, UK), Patrick Martin (NOC, UK), Rebecca James (SNH, UK).

April - Alex Shakespeare (University of Southampton, UK), Stephanie Hinder (University of Swansea, UK), Dave Conway (MBA, UK).

May –Santi Alvarez Fernandez (IMARES, WUR, Netherlands), Chelsea Bradbury (University of Aberdeen, UK), Sean Anderson (Simon Fraser University, Canada), Severine Alvain (CNRS, France), Andrew Mogg (SAMS, UK), Dionysios Raitzos (RSR, Saudi Arabia), Manal Al-Kandari (MBA, UK).

June – Jim Aiken / Bob Brewin (PML, UK), Kirsteen Mackenzie (NOC, UK), Mikael Van Deurs (DTU Aqua, Denmark), Dionysios Raitzos (RSR, Saudi Arabia), Ewan Wakefield / Matt Witt (University of Leeds, University of Exeter, UK), Ross Griffin (Sea Survey, UK), Annette Samuelsen (Mohn-Sverdrup Centre, Bergen, Norway).

July –Corrine Pebody (NOC, UK), Ross Griffin (Sea Survey, UK), Jules Lovail (University of Swansea, UK), Johann Decelle (Roscoff, France),

Bryony Williams (University of Exeter, UK), Andrew Griffiths (MBA, UK), Lavinia Suberg (NOC, UK), Clara Mackenzie (University of Bangor, UK).

August – Chris Clements (University of Sheffield, UK), Louis Peperzak (NIOZ, Netherlands), Laura Harris (DSTL Porton Down, UK), Clara Mackenzie (University of Bangor, UK), Doug Beare (IMARES, Netherlands).

September - Stephanie Hinder (University of Swansea, UK), Eileen Bresnan (MARLAB, UK), Declan Schroeder (MBA, UK), Marie-Fanny Racault (PML, UK), Samir Suweis (ISTE, Switzerland), Dionysios Raitzos (RSR, Saudi Arabia).

October – ECOSCENARIOS group, Saeed Sadri (University of Plymouth, UK), Hawa Bint (Marine Fisheries Research Team, Ghana), Samir Suweis (ISTE, Switzerland), Dave Mills (CEFAS, UK), Jennifer Riley (University of Southampton, UK), Teresa Silva (Marine Institute, Ireland), Manal Al-Kandari (MBA, UK), Sofia Pilitz (University of Oxford, UK), Catherine McClellan (University of Exeter, UK).

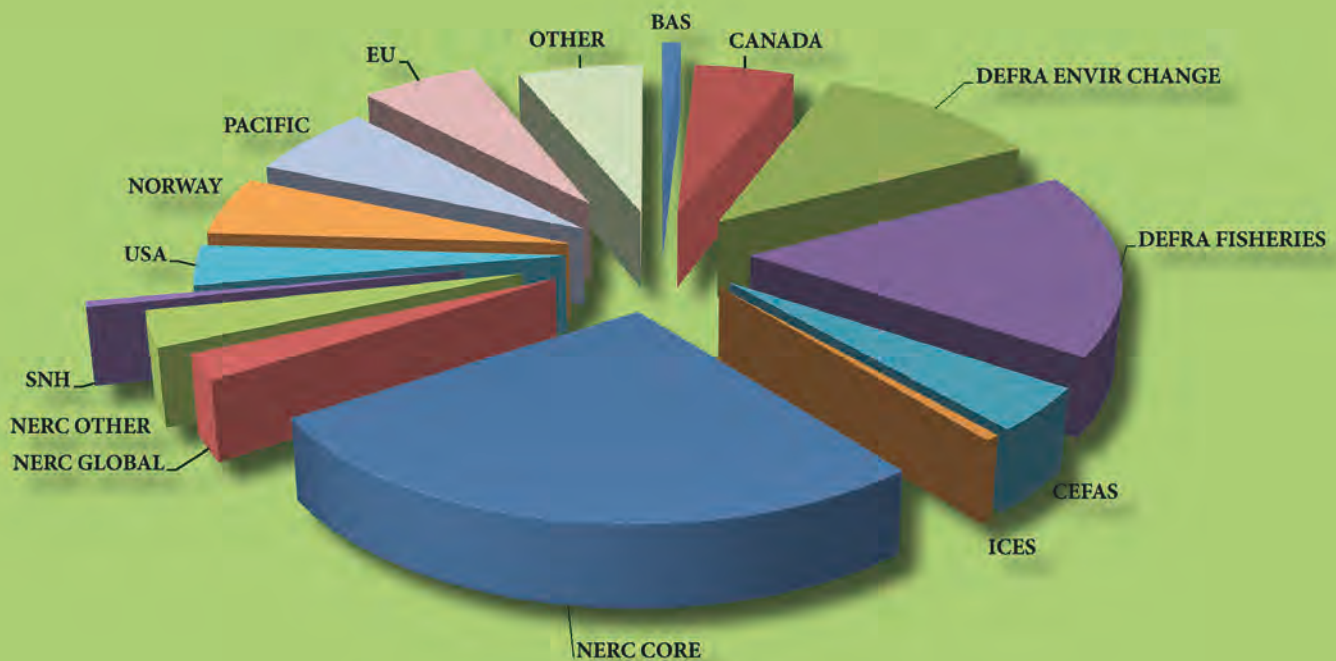
November – Julie Coad (DTU Aqua, Denmark), Renee Lee (University of Oxford, UK), Stephanie Henson (NOC, UK), Joanne Ziemann (University of Plymouth, UK), Katie St. John Glew (University of Southampton, UK), Valentina Lauria (University of Plymouth, UK), Lauren Timpson (University of Reading, UK), Clare Ostle (UEA, UK).

December – Chris Melrose (NOAA, USA), Kathryn Hughes (NUI, Galway), Mark Jessop (CMRC, Ireland).



Appendix A. Financial Summary 2011

The principal sources of funding for 2011 are broadly derived from grants and contract income from core funding organisations and research & academic organisations. Core funding organisations provide support funding to enable the general operation of the CPR Survey. In 2011 these were: UK Natural Environment Research Council (NERC), UK Department of Environment, Food and Rural Affairs (DEFRA) & National Oceanic and Atmospheric Administration (NOAA). Research and academic organisations commission SAHFOS to undertake research, or tow specific routes. SAHFOS may also collaborate with other research groups, sometimes under the umbrella of international organisations. In 2011 these were Exxon Valdez Oilspill Trust (EVOS), the North Pacific Research Board (NPRB), Dept of Fisheries & Oceans Canada (DFO), British Antarctic Survey (BAS), European Union FP7 (EU), CEFAS, ICES, Institute of Marine Research Norway (IMR), and others.



Total incoming resources for 2011 have reduced during the year and together with other income from charitable activities, are reported at £1,589,267 (2010 £1,809,677). Total resources expended for 2011 have increased during the year with the result of an overall movement in funds of -£221,558 (2010 £191,041).

The Foundation 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.

Appendix B. Shipping companies assisting the CPR survey in 2011

Routes	Towing Vessels	Shipping Company
A-	<i>Hildasay</i>	Chartered by NorthLink Orkney & Shetland Ferries Ltd., Stromness, Orkney. Owners: Seatruck Ferries of Warrenpoint and Heynsham
AT	<i>Horizon Kodiak</i>	Horizon Lines LLC, Charlotte, North Carolina, USA and Tacoma, WA, USA
BA, BB, BC & BD	<i>Benguela Stream</i>	Seatrade NV, Groningen, Netherlands. Charterers: Geest Line Ltd., Fareham, England
C-	<i>Ficaria Seaways</i>	DFDS Seaways, Copenhagen, Denmark
CT	<i>Horizon</i>	Chartered by Ocean Africa Container Line, Durban, South Africa from Shanghai Costamere Ship Management, China. Towed in Sept 2011
DA, D-, EA & EB	<i>Atlantic Companion</i>	Atlantic Container Line, Gothenburg, Sweden
HE	<i>Tor Dania</i>	Chartered by DFDS Seaways, Copenhagen from Imperial Shipping AB, Gothenburg, Sweden
IB & SB	<i>Helgaland</i>	Owners: MS Helga GmbH & Co, Jork, Germany. Charterers: MacAndrews Ltd, London. To January 2011
	<i>Sophia</i>	Chartered by MacAndrews Ltd, London from Peter Doehle Schiffahrts KG, Haren/Ems, Germany. From December 2011
IN	<i>Norbay</i>	P&O Ferries (Irish Sea) Ltd, Larne, Northern Ireland
LG	<i>Petunia Seaways</i>	DFDS Seaways AB, Copenhagen, Denmark
LR & V	<i>Selfoss</i>	Eimskipfelag, Reykjavik, Iceland
M-	<i>S C Aberdeen</i>	Sea Cargo A/S Bergen, Norway
NI	<i>S. Rafael</i>	Chartered by Eimskip, Reykjavik, Iceland from Briese Schiffahrts, GmbH, Leer, Germany
PR	<i>Armorique, Bretagne, Pont Aven</i>	Brittany Ferries, Roscoff, France
R-	<i>Flandria Seaways</i>	DFDS Seaways, Copenhagen, Denmark
SA	<i>Cap Finistère, Pont Aven</i>	Brittany Ferries, Roscoff, France. To November 2011
SF	<i>Pharos SG</i>	Owners: Byron Marine Ltd, Southampton, England. Charterers: Government of South Georgia & South Sandwich Islands, Stanley, Falkland Islands
ST	<i>Green Frost</i>	Green Reefers AS, Bergen, Norway
VJ	<i>Morning Cedar</i>	Owners: Eukor Car Carriers, Singapore. Charterers: Seaboard International Shopping Company, North Vancouver, British Columbia, Canada
Z-, ZB & ZC	<i>Reykjafoss</i>	Chartered by Eimskipafelag, Reykjavik, Iceland from Reider Shipping BV, Winschoten, Netherlands



Ro-Ro NORBAY

P&O Ferries (Irish Sea) Ltd., UK
IN Route - Dublin to Liverpool
Mid Irish Sea. From May 2004



Containership SELFOSS

Eimskip, Reykjavik, Iceland
LR and V routes: Immingham to Sule Skerry (NW Scotland) and SE
Iceland. From September 2000



Ro-Ro PETUNIA SEAWAYS

DFDS Seaways, Copenhagen,
Denmark
LG Route: Humber to Gothenburg
From August 2006



Passenger Ro-Ro ferry BRETAGNE

Brittany Ferries, Roscoff,
France
PR route: Roscoff to Plymouth
November 2011



Ro-Ro HILDASAY

Charterer: NorthLink Orkney & Shetland Ferries Ltd
Owners: Seatruck Ferries Ltd, Heysham, England
A route: Lerwick Shetland to Aberdeen. From March 2010



Ro-Ro S.C. ABERDEEN

Sea Cargo A/S, Bergen and Stavanger, Norway
M Route: Aberdeen to off Stavanger and Tananger, Norway
Northern North Sea.
From September 2001



Containership mv HORIZON

Charterer: Ocean Africa
Container Line, Durban
Manager: Shanghai Costamare
Ltd, China
CT Route: Luanda, Angola to
Durban, South Africa
From September 2011



Ro-Ro FLANDRIA SEAWAYS

DFDS Seaways, Copenhagen
R Route: Hook of Holland to the Shipwash Bank, off Suffolk en route to
Felixstowe, England.
From July 2000.

Containership HELGALAND

Charterers: MacAndrews &
Co Ltd, CMA CGM London
Owners: M/S Helga GmbH
Co. Jork, Germany
IB and SB routes: Lisbon to
Porto and 46°N then Dublin
From Feb 2010 to Jan 2011



Passenger Ro-Ro ferry CAP FINISTÈRE

Brittany Ferries, Roscoff, France
SA route, Bilbao to Portsmouth
Oct 2010 to Nov 2011



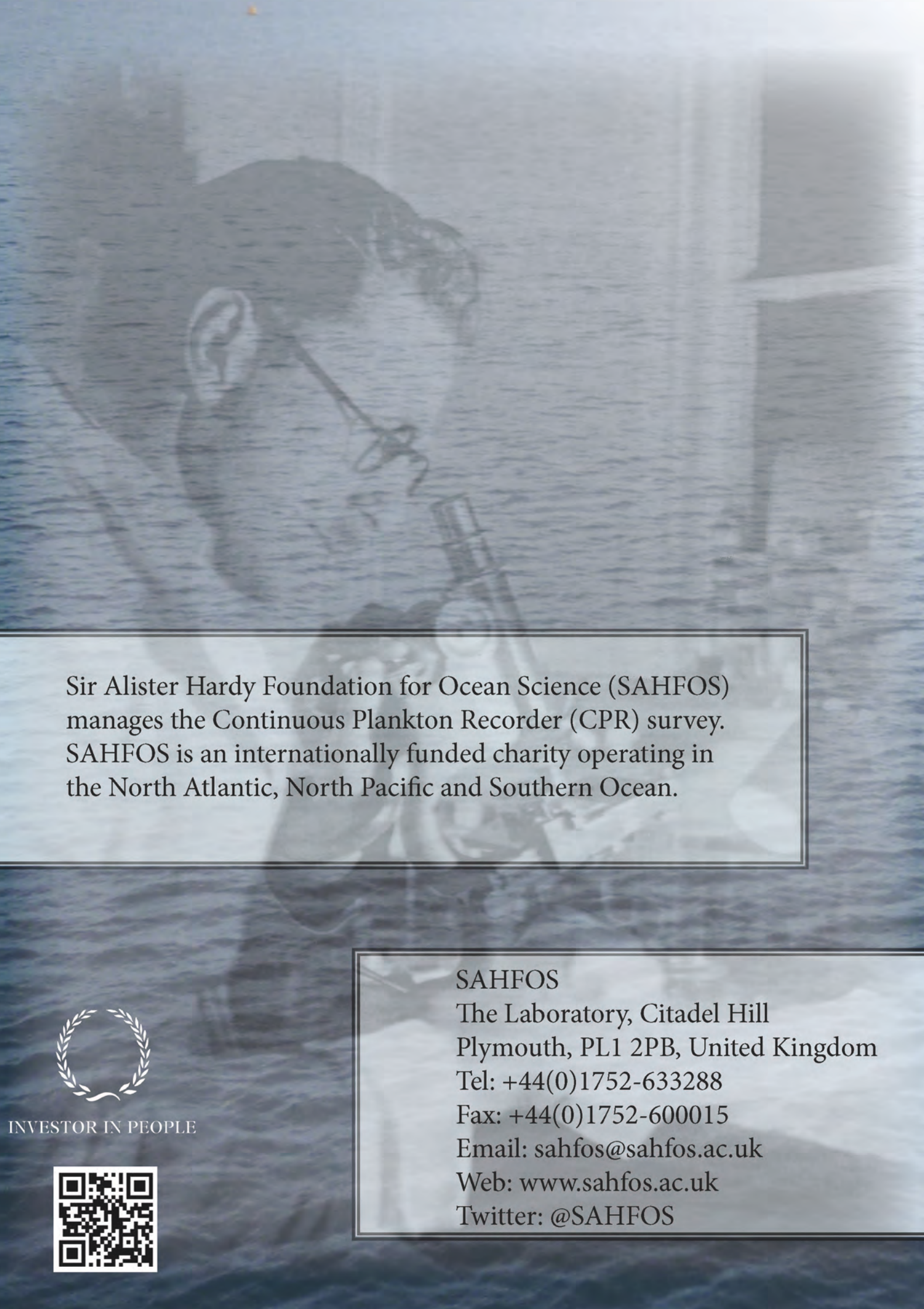
Containership OELAND

Charterer: MaAcAndrews &
Co Ltd, London
Managers: DT Bereederungs,
Burg, Dithmar, Germany
IB and SB Routes: Lisbon,
Leixoes, 46°N, 53°N and
Dublin
March to October 2011



Ro-Ro Passenger Ferry PONT AVEN

Brittany Ferries, Roscoff, France
SA Route: Santander to Portsmouth. Feb to April 2011



Sir Alister Hardy Foundation for Ocean Science (SAHFOS) manages the Continuous Plankton Recorder (CPR) survey. SAHFOS is an internationally funded charity operating in the North Atlantic, North Pacific and Southern Ocean.



INVESTOR IN PEOPLE



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