Canadian National Committee for SCOR
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Scientific Committee on Oceanic Research

CANADIAN OCEAN SCIENCE NEWSLETTER
LE BULLETIN CANADIEN DES SCIENCES DE L'OCÉAN

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OCEAN SCIENCE PROGRAMS

This section of your newsletter provides an opportunity to highlight your research programs to the Ocean Science Community.	Mettez en valeur vos programmes de recherche en publiant un article dans cette première section de votre bulletin.
Your are invited to send contributions to Michel Mitchell, michel.mitchell@dfo-mpo.gc.ca	Faites parvenir vos contributions à Michel Mitchell, michel.mitchell@dfo-mpo.gc.ca

Change in the Arctic Ocean – why we need a geochemical observing system

by R.W. Macdonald[1], Z.A. Kuzyk[2], and S.C. Johannessen[1]

[1] Institute of Ocean Sciences, Department of Fisheries and Oceans, Sidney, BC

[2] Earth Observation Science, Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba

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There is little doubt that the Arctic Ocean is losing sea-ice mass and areal coverage: you can see it from space. Beginning in the early 1990s, the polar science community recognized that something out of the ordinary was occurring in the Arctic Ocean (Macdonald, 1996). Since that time sea ice cover has riveted attention, partly because it is such a defining feature of polar oceans, and partly because the demise is so clear in satellite images. Satellite sensors have also informed us of climate-related trends in surface temperature, snow cover, glacier mass balances, permafrost temperature (Comiso and Hall, 2014), chlorophyll (Lowry et al., 2014), and colored dissolved organic matter (CDOM) (Matsuoka et al., 2015). As sea-ice cover shrank toward its historic minimum in late summer of 2012 and striking images of the decline, derived from satellite data, received wide circulation, the literature on Arctic sea ice increased exponentially. Unfortunately, literature describing accompanying changes occurring as a result of, or in addition to, sea-ice change that were not visible from space have not kept pace. One reason for this gap is that satellite proxy data inform us poorly, or not at all, about what is going on beneath the ocean-ice surface. A second reason is that Arctic field work is logistically difficult, especially in autumn and winter, which leads to gappy time-series data (Dickson, 1999). In our view, there have been two other shadow partners of change in the Arctic Ocean – fresh water and organic carbon. Although changes in both of these components relate in part to change in sea-ice cover, we do not understand them nearly as well. Fresh water and organic carbon present parallel challenges to observation in having marine and terrigenous components that are not necessarily in step with each other.

CNC-SCOR

The Canadian National Committee of the Scientific Committee for Oceanic Research (CNC-SCOR) fosters and facilitates international cooperation. It is a non-governmental body that reflects the multi-disciplinary nature of ocean science and marine technology.

Le Comité national canadien du Comité scientifique de la recherche océanographique (SCOR) favorise et facilite la coopération internationale. Il reflète la nature multidisciplinaire de la science océanique et de la technologie marine.

Fresh water has long been a topic of interest in its capacity to alter the Arctic Ocean's functioning; indeed, in 1985 Howard Cattle (1985) wrote an intriguing article on the potential of Soviet river diversion to affect the Arctic Ocean, concluding that major diversions might alter ice formation on the Siberian shelves but not have any great large-scale effect on circulation. Whether or not that conclusion was correct, later observations of a weakening of the cold halocline in the eastern Arctic Ocean were ascribed by Johnson and Polyakov (2001) to a 'natural' diversion of Soviet – now Russian – river water passing over these same shelves, caused not by humans but by wind regimes (i.e., the Arctic Oscillation). One consequence of this sort of freshwater diversion would be an altered storage of fresh water in the Beaufort Gyre of the Arctic Ocean (Proshutinsky et al., 2002), which then leads to altered ocean functioning within the Arctic, and an exportable mechanism of change (i.e., buoyancy) to the North Atlantic convection centres.

Sediment traps like the one shown in this photo from Beaufort Sea have been used to better understand the processes under the ice or beneath the surface, out of satellite's supervision

Unfortunately, we do not have time series appropriate to the questions we need to answer. We cannot see freshwater balances from space, and salinity fields by themselves do not inform us of how the sea-ice and runoff components interact. The importance of distinguishing between processes associated with these two components was pointed out by Ostlund (1982). Although there is evidence of a modest increase in river runoff over the past few decades (McClelland et al., 2006), and probably an increased moisture flux into the Arctic Ocean directly from precipitation, these changes seem much less important quantitatively than the capacity of the Arctic Ocean to store and release liquid freshwater at the decade or longer scale, which might amount to as much as 8000 km^3 (Rabe et al., 2011). To distinguish the seasonal role of sea ice in altering freshwater content of the upper ocean by freezing or melting from the roles of runoff and precipitation, we need to apply geochemical tracers, such as oxygen isotopic composition and alkalinity. Accordingly, we really need an Arctic Ocean wide network of sections to develop a time series of these tracers in the Arctic's upper ocean (0-1000 m). Indeed, we face the difficulty of having too many water sources and too few tracers in the Arctic, which demands the inclusion and/or development of even more geochemical measurements that have the potential to distinguish among freshwater sources (e.g., Alkire et al., 2015; Guay et al., 2001; Jones et al., 2003).

A typical Arctic River poised for change in its hydrology and geochemistry

Organic carbon (OC) also has two dominant sources in the Arctic Ocean, one imported from land (OC_{terr}) and another made in the ocean (OC_{mar}). These two forms of OC are not affected in the same way by climate change, and although we can glimpse components of each from satellites (e.g., chlorophyll blooms at the surface, coloured dissolved organic matter emanating from river water), we cannot quantify the processes affecting these OC components in time and space. Budgets show that OC supplied to the Arctic Ocean from land (~13 Mt yr^{-1}) is much less than that produced in the ocean (~300 Mt yr^{-1}). On the other hand, the burial of particulate carbon in the Arctic Ocean sediments favours OC_{terr} (4.4 Mt yr^{-1})

over that of OC_{mar} (2.2 Mt yr^{-1}) (Stein and Macdonald, 2004a). According to biomarker and isotopic evidence from sediments ($\delta^{13}C$, $\delta^{15}N$), the OC_{mar} is far more digestible than OC_{terr} , and we thus see a very strong recycling engine for the marine carbon, and a strong paleo-recording engine for the terrigenous carbon. But both of these OC engines are undergoing change: in the terrigenous system it is the demise of permafrost and change in vegetation and moisture balance; in the marine system it is the change in sea-ice cover and type of sea ice (first year vs. multiyear), which then produces changes in mixing, nutrient supply, and light climate. How, quantitatively, are these two loci of change going to alter the balance of organic carbon in the Arctic Ocean? Again, this question cannot be answered from space. As in the case of freshwater, this question requires a coherent attack using biogeochemical time series over a wide network of sections. We can immediately define two first-order questions that need answers. First, the OC_{terr} budget proposed above may be in error or the supply of OC_{terr} may already have started to change substantively. In a recent examination of the Siberian Shelf, Vonk et al.(2012) proposed that 44 Mt yr^{-1} of OC_{terr} was being released as part of the demise of ice complexes at the coast, two thirds being metabolized and the remainder buried. This supply is about three times that estimated earlier for the entire Arctic Ocean. Second, Boetius et al. (2013) recently measured a large flux of algal mat material to a depth of 4000 m in the central Arctic basins. How long has this flux been going on? Is this large flux a manifestation of the shift from multi-year ice to first year ice, producing a better habitat for ice algae, which then sloughs off each year? The Boetius et al. estimate of 9 g OC m^{-2} yr^{-1} at 400 m is enormous compared to the traditional view of an impoverished <0.1 g OC m^{-2} yr^{-1} to the basins in the Arctic Ocean (e.g., Honjo et al., 2010; Stein and Macdonald, 2004b). If this large flux is something recent, then we can expect change to occur in the benthic systems of the deep basins, and potentially a change in the rate of drawdown of dissolved oxygen in basin water, which is sluggishly replaced in the Canada Basin. But we run into a problem of sustainability. To supply this flux of OC to the basins, the surface layer must export at least an equivalent amount of OC, and probably quite a bit more to account for metabolism on the way to the bottom. The problem is that this algal flux implies an accompanying flux of nutrients that would be equivalent to a drawdown of over 2 mmol m^{-3} N and 0.1 mmol m^{-3} of P from the top 50 m or so. If this is a new export flux of OC from a surface ocean thought to be already starved of nutrients, how does the system sustain it? Is there now a more substantial supply of new nutrients? Intuitively, the addition of more fresh water would seem to mitigate against nutrient supply by strengthening stratification. Again, we need a network of sustained measurements of the OC system in the Arctic Ocean. These measurements would have to include a measure of particle flux out of the surface layer and into the basin, as well as the biogeochemical composition of such flux.

Over the centuries, lots of people dreamed about reaching the poles. Here is one of the lucky ones, our own Arctic oceanographer, Robie Macdonald, skating around at the North Pole

Importantly, the above two components of change, freshwater and OC cycling, impinge directly on the Arctic Ocean's sensitivity to ocean acidification. Changes in the storage of freshwater, which is poorly buffered, already drive large areas of surface water below solubility thresholds for aragonite on a seasonal basis (Yamamoto- Kawai et al., 2011). At the same time, an increased flux of OC to bottom waters becomes, when metabolized, a strong supply of CO_2, every bit as potent as anthropogenic CO_2 added to the surface ocean. Thus the Arctic Ocean's surface and bottom waters are both likely to be in the vanguard of effects from ocean acidification.

The task of providing a sufficient network of observatories to monitor the changes occurring in the Arctic Ocean's freshwater and organic carbon cycles is beyond one country's capacity, considering the financial, logistical and political hurdles. But it seems a very doable project if the major Arctic countries collaborate by producing a set of data in their respective sectors using common methods in station organization (distribution and depths), target analytes, and sampling/analytical methods. Interpreting these data will, of course, require simultaneous time-series for sea-ice cover, but the latter will never supplant the need for the geochemical section data. Without such data we will not understand what climate change actually means for the greater Arctic Ocean.

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PERSONEL

Dr. Philip Boyd: 2015 A. G. Huntsman Award Recipient

The A.G. Huntsman Foundation is pleased to announce that the **2015 A.G. Huntsman Award** will be presented to **Dr. Philip Boyd** of the University of Tasmania. The award ceremony will take place at 2PM on Friday 11 December 2015 at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. Following the ceremony, Dr. Boyd will present a distinguished lecture entitled "Ocean Global Change Biology – unravelling a Gordian Knot".

The **Royal Society of Canada** (www.rsc.ca) will present the 2015 A.G. Huntsman Award to Dr. Boyd to recognize his research contributions to marine science, which include his remarkable ability to conceive and lead trans-disciplinary projects that that have resulted in a more realistic understanding of a wide range of inextricably linked ocean processes. Dr. Boyd is a leading world expert on a range of topics including: iron biogeochemistry and ocean iron fertilization; the ocean biological pump and organic matter export; and climate change impacts on ocean planktonic ecosystems.

The **A.G. Huntsman Award** (http://www.HuntsmanAward.org) was established by the Bedford Institute of Oceanography in 1980 to recognize excellence of research in, and outstanding contribution to, the marine sciences. The award honours those men and women, of any nationality, who have had, and continue to have, a significant influence on the course of marine scientific thought. The award was created to honour the memory of Archibald Gowanlock Huntsman (1883–1972), pioneer Canadian oceanographer and fishery biologist.

MEETINGS

MTS/IEEE Oceans'15, 19-22 October 2015, Washington, DC

The Oceans'15 conference sponsored by the Marine Technology Society and the IEEE Oceanic Engineering Society will be held at the Gaylord National Resort and Convention Center. The conference offers technical presentations, tutorials, workshops, networking opportunities and an exhibition highlighting state-of-the-art developments in technologies related to exploring, monitoring, protecting, and wisely using the world's ocean resources. Over 2,500 attendees, with a broad international representation, are expected. Visit the conference web site for more details.

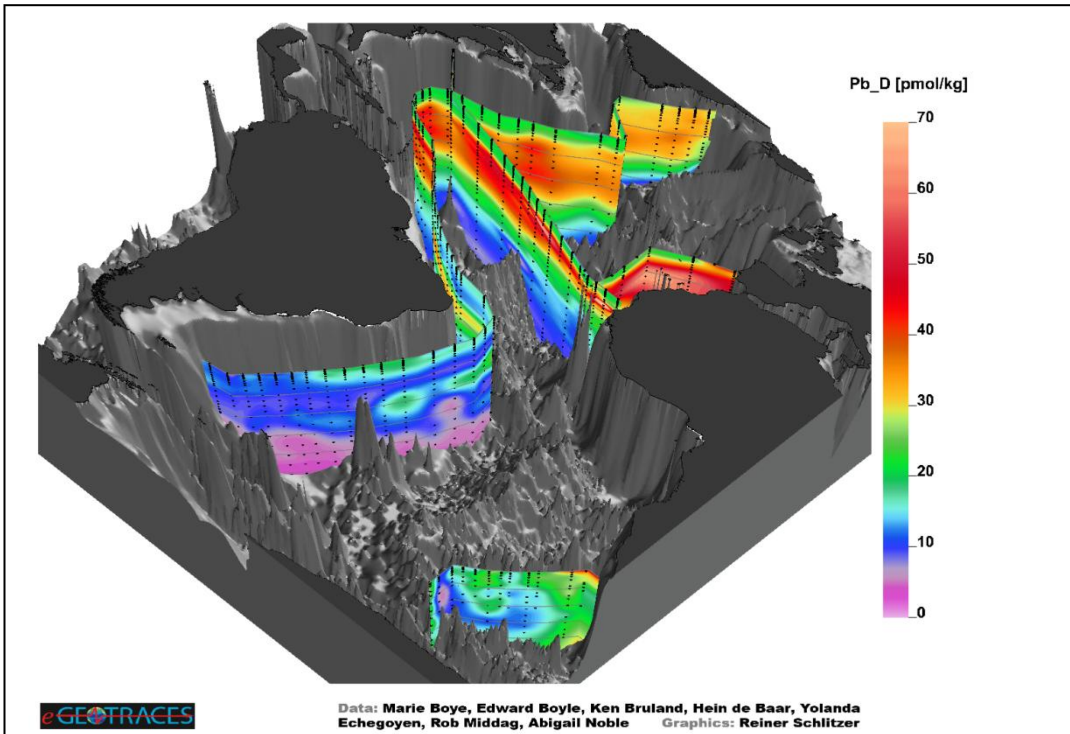
AGU Fall Meeting, 14-18 Dec 2015, San Francisco

Discover the latest Earth and space science news at the 48th annual AGU Fall Meeting this December, when about 24,000 attendees from around the globe are expected to assemble for the largest worldwide conference in the Earth and space sciences. This year, the meeting runs from Monday through Friday, Dec. 14-18, at the Moscone Center, 747 Howard St., San Francisco, Click here for more details.

GEOTRACES Scientific Steering Committee and Data Management Committee Meetings

The GEOTRACES Scientific Steering Committee and Data Management Committee meetings were held at UBC from 13-17 July, and were hosted by Maite Maldonado. These meetings were sponsored by the U.S. National Science Foundation through international SCOR (http://www.scor-int.org/), MEOPAR (http://meopar.ca/), as well as the Canadian National Committee for SCOR (CNC/SCOR, http://cncscor.ca/). GEOTRACES (www.geotraces.org) is an international study of the marine biogeochemical cycles of trace elements and their isotopes. Scientists from 35 nations have been involved in the programme, designed to study all major ocean basins over the next decade. So far, 747 stations have been sampled during 52 cruises resulting in more than 1000 data sets of hydrographical and geochemical data. To facilitate access to these data, the first GEOTRACES Intermediate Data Product is freely available on-line (www.bodc.ac.uk/geotraces/data/idp2014/). Digital data is accompanied by an electronic atlas (www.egeotraces.org) that provides 2D and 3D images of the ocean distribution of many of the parameters (see figure below).

GEOTRACES SSC Group picture: July 16th, 2015 @ Locarno Beach



3D scene showing the distribution of dissolved lead (Pb) in the Atlantic. This tracer is of anthropogenic origin. The dominant input into the North Atlantic and spreading with the main deep water masses are clearly visible on this 3D view.
** Colour code: warm colours (red, orange, etc.) indicate high concentrations.*

CANADIAN JOBS and TRAINING

Tenure-track Faculty Position in Physical Oceanography

The Department of Atmospheric and Oceanic Sciences (www.mcgill.ca/meteo) at McGill University is seeking outstanding applicants for a tenure-track Assistant Professor position to strengthen its component in physical oceanography. The successful applicant will be expected to develop an active research program, supervise graduate students, and teach a variety of undergraduate and graduate courses. A Ph. D. in physical oceanography or a closely related field is required.

Applications can be sent via email in pdf format to ocean@meteo.mcgill.ca or by post to Dr. John R. Gyakum, Chair, Department of Atmospheric and Oceanic Sciences, McGill University, 805 Sherbrooke Street West, Montreal, QC H3A 0B9, Canada (Telephone: 514-398-3760; fax: 514-398-6115). The preferred starting date for this position is September 1, 2016. Review of the applications will begin on December 15, 2015, and continue until the position is filled. For more information click here (pdf file).

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GENERAL

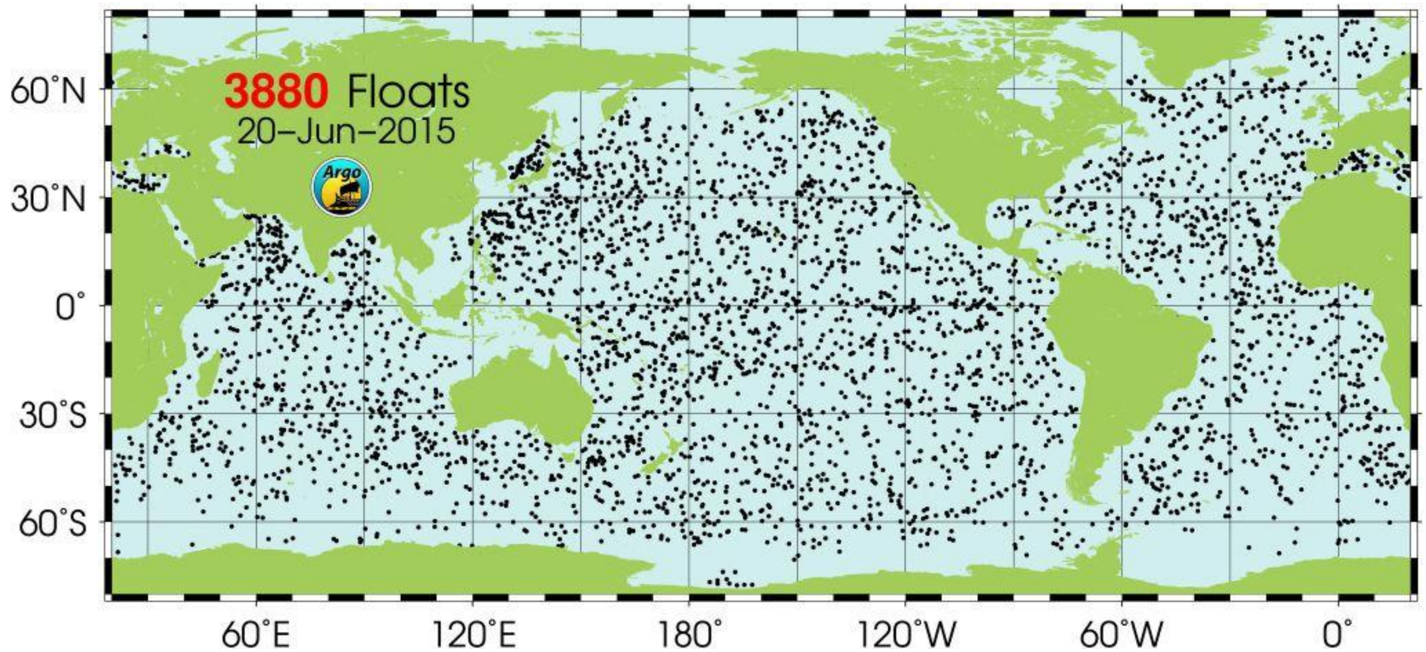
Argo Canada

Submitted by Blair Greenan, Scientific Director, Canadian Argo, Bedford Institute of Oceanography
From CMOS Bulletin SCMO, June 2015, Vol. 43, No. 4, page 128

On April 1st 2015, Argo Canada underwent a transition in leadership with Denis Gilbert (Institut Maurice-Lamontagne) being replaced by Blair Greenan (Bedford Institute of Oceanography) as Scientific Director. Argo Canada is a national program supported by DFO (Department of Fisheries and Oceans) headquarters staff as well as regional team members on both the Atlantic and Pacific coasts.

www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/argo/index-eng.html

The program has been a success because of the contributions of numerous individuals since its inception more than a decade ago. The international Argo program vastly improved open ocean sampling through the deployment of over 3880 robotic profiling floats in world oceans. These freely drifting floats take profiles of temperature and salinity every ten days from 2000 m depth to the surface. They provide oceanographers and meteorologists with real-time temperature and salinity data year-round and typically last four to five years. We are working hard to ensure program stability with the support of senior DFO management. [See Argo array status graph as of 20 June 2015 below].



International Argo Program Floats Status / État des flotteurs-profileurs du programme international Argo (courtesy of University of California San Diego [http://www.argo.ucsd.edu/statusbig.gif])

Argo Canada contributes to the International Argo Program (www.argo.ucsd.edu), which is guided by the Argo Steering Team (AST). The AST meets annually to provide scientific leadership and oversee the development and implementation of the global array; meeting reports are available at www.argo.ucsd.edu/Meeting_reports.html. Dr. Greenan is a member of the AST, as is DFO Emeritus Scientist Howard Freeland who is currently the Argo Director for the international program.

In addition to ensuring a stable core Argo program, the international community is undertaking new initiatives which include the development of deep Argo floats having the capability to profile to depths as great as 6000 m. There is also significant effort underway to implement a global strategy for the inclusion of biogeochemical sensors on the Argo platform (Bio-Argo). In September 2015, a science conference will take place in Galway, Ireland to address sustained ocean observing for the next decade (www.gaic2015.org); this meeting will bring together scientists from the GO-SHIP (Global Ocean Ship-based Hydrographic Investigations Program), Argo, and IOCCP (International Ocean Carbon Coordination Project) programs to discuss synergies, and to promote and coordinate sustained observations of the water column to reveal the changing physics, chemistry, and biology of the ocean.

OBIS: Legacy of Census of Marine Life

Submitted by Savithri Narayanan (Co-Editor, CMOS Bulletin SCMO; formerly Dominion Hydrographer of Canada, and Director General of Ocean Sciences and Canadian Hydrographic Service of Department of Fisheries and Oceans)

From CMOS Bulletin SCMO, June 2015, Vol. 43, No. 3, pages 100-101

The *Census of Marine Life* was an international program spanning ten years that recorded the diversity, distribution, and abundance of life in the ocean. With a participation of more than 2,700 scientists from 670 institutions spread over 80 nations, it was one of the largest scientific collaborations ever conducted, that comprised of a major thrust on investigating what now lives in the world's oceans through sampling important kinds of biota in each of the six realms of the global oceans (Human Edges, Hidden Boundaries, Central Waters, Active Geology, Ice Oceans, and Microbe) using a range of technologies. Recognizing the importance of responsible management of the resulting data and information to achieve the overall program objectives, the scientific framework of the program included the establishment of a distributed Ocean Biogeographic Information System (OBIS) assimilating data and information from its own field projects as well as all available historical databases.

OBIS was the result of a vision to create a strategic alliance of people and organizations to make marine biogeographic data, from all over the world, easily and freely available through internet, at a time when a standard system for the retrieval, exchange, and integration of ocean biological data did not exist. Thus OBIS was established as the central access point for the distributed ever-expanding network of portals and databases on marine biodiversity, providing expert geo-referenced data on marine species along with user-friendly spatial/temporal query visualization and data extraction tools. The OBIS portal was widely accepted by the scientific community, particularly as the ownership of the data in the nodes remained within their host institutions, without requiring them to make ongoing transfers of their collections to a central data base. Consequently, many scientists placed their data sets under the OBIS umbrella allowing access by the wider community to a more comprehensive distributed data and information base that can be seamlessly searched by species names, higher taxonomic level, geographic area, depth, and time, and associated environmental data related to the locations.

As the Census of Marine Life Program came to an end and many of the researchers moved on to other projects, the scientific community became concerned about the future of the OBIS, and the fate of many of its nodes. It became clear that there is a real danger of OBIS stagnating or falling apart without stability in funding and international collaboration to keep it alive, growing and adapting to technological advancement. A few countries including Canada proposed that the Intergovernmental Oceanographic Commission (IOC) adopt OBIS as one of its activities under the International Oceanographic Data and Information Exchange (IODE) programme, which was accepted by IOC in 2009. With IOC's allocation of a dedicated staff officer for OBIS and funding support from Member States, OBIS has now been transitioned to an intergovernmental activity under the IOC, managed by a Steering Group composed of the managers of the OBIS nodes, and conforming to its own vision and that of the IOC of open access and data sharing.

In spite of the intergovernmental status of OBIS, any organization, consortium, project or individual may contribute to OBIS and in return benefit from this invaluable global biodiversity data portal. Consequently, many new nodes are linked to the portal each year.

The user community of OBIS is also expanding as a result of the growing awareness of biodiversity issues and because of the strong support from the OBIS secretariat, including the OBIS training modules under the OceanTeacher program of IODE.

Canada has played a leading role in the establishment of OBIS as a program of the Census of Marine Life and through the OBIS Canada, established as a regional OBIS Node hosted partly at the Bedford Institute of Oceanography, has been a major contributor to the global biodiversity database. Canada continues to support the program by adding biodiversity data to its node as and when they become available. The latest Canadian contribution to OBIS is the addition of the Ocean Tracking Network database to the OBIS system of nodes. OBIS Canada is hosted by:

- Centre for Marine Biodiversity (http://obiscanada.marinebiodiversity.ca/)
- Bedford Institute of Oceanography
- Dalhousie University

For additional information on OBIS, please contact the IOC's IODE office at:
OBIS Secretariat
UNESCO-IOC Project Office for IODE
Wandelaarkaai 7/61, 8400 Oostende,
Belgium Project Manager: Mr. Ward Appeltans
Email: w.appeltans@unesco.org
http://www.iobis.org/

ASLO Awards

ASLO awards (aslo.org/awards/index.html) provide opportunities to recognize outstanding individual performance and to highlight accomplishments of the aquatic science research community. Award nominations can be submitted year-round, but must be received by **15 October** to be considered in the fall evaluation. Awards may be submitted via the online forms available on the web site (click here).

CANADIAN OCEAN SCIENCE NEWSLETTER
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Newsletter #85 will be distributed in November 2015.
Please send contributions to Michel Mitchell,
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Veuillez faire parvenir vos contributions à Michel Mitchell,
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