

'Voyage of Discovery' (VOD) Arrives



The editors of the *'Voyage of Discovery'* from the left, Donald Gordon, David Nettleship (Editor-in-Chief), Michel Latrermouille, and Michael Lewis.

The VOD has arrived. What a stupendous accomplishment for the BIO-Oceans Association and particularly for the four editors seen in the photograph above. VOD celebrates 50 years of scientific endeavour at the Bedford Institute of Oceanography. BIO science has been recognized world wide for its excellence. BIO science has contributed significantly to our understanding of the ocean and to important national initiatives. Trevor Swerdfager, DFO Assistant Deputy Minister - Ecosystems and Oceans Science in his letter of congratulations to the VOD's Editor-in-Chief, David Nettleship wrote "This book brings to life the research that has not only made Bedford Institute of Oceanography's national and international reputation, but has served Canadians so well over the years."

A major theme that permeates the book is the importance of partnership and team work. BIO has been and still is a partnership of federal departments, both formally and probably more significantly informally. Where other departments dwell in silos, at BIO, even with today's constraints on departmental mandates, staffs at BIO continue to find ways to work together. This teamwork is demonstrated in the book not only in the number of multi-authored chapters, but in VOD BOOK LAUNCH BIO in the Ford Auditorium on 20 November 2014 at 1000h

BUY *'VOYAGE OF DISCOVERY'* **TODAY!!!**

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Mike Hughes, President of BIO-OA, staffs the VOD distribution and sales table at the main entrance of BIO.

the list of contributors to the science mentioned in the acknowledgements in many chapters. One team that was critical to the development of the VOD is the team of editors assisted by Francis Kelly who executed the layout and design. Their professional and exceptional efforts have produced a book not only remarkable for its scientific and technical content but its attractiveness as a publication. Page after page is beautifully illustrated with diagrams, maps, and pictures in a very readable style.

Some highlights from VOD for your editor include the international linkages from leading major international ocean circulation experiments like WOCE to collaboration with the Irish on research of the coast of Nova Scotia. The chapters on BIO's work in the Arctic were a highlight for me, sea-ice studies and ice-island experiments. The later being very challenging and potentially dangerous work. The boundary dispute and Law of the Sea projects contributed a legacy of extended sovereignty and resource potential to Canada. Than there was the work in our own backyard; St. Margaret's Bay, St. George's Bay, Canso Strait, the *Arrow* oil spill, the deep water corals, the Bay of Fundy just to name a few of the many projects that have contributed to our regions economic and environmental sustainability.

Needless to say the purchase of a copy of VOD is a must for anyone with an interest in the story of oceanog-raphy in Canada.

Applause from the ADM of Science DFO On the publication of 'Voyage of Discovery'

16 October 2014

Dear Dr. Nettleship:

It is my great pleasure to congratulate you and your colleagues on your achievement in assembling and publishing a "Voyage of Discovery: Fifty Years of Marine Research at Canada's Bedford Institute of Oceanography". This book brings to life the research that has not only made Bedford Institute of Oceanography's national and international reputation, but has served Canadians so well over the years. Both the breadth of contributions in the book and the depictions of major multidisciplinary investigations illustrate the strength of the Institute model where all major oceanographic disciplines are brought under one roof. The book also bears witness to the many contributions of DFO scientists at BIO to management and policy issues, notable among them being the delineation of the Gulf of Maine boundary in the 1980s and the more recent work on the extension of the Continental shelf under the Law of the Sea. These illustrate the importance of government science being hosted in Institutes like BIO for the wellbeing of Canadians. Overall, this impressive volume will stand as a durable homage to the first 50 years of research at this preeminent oceanographic institute in Canada and the world.

I cannot imagine the countless hours that went into the production of this book, from the writers penning the chapters, through the painstaking editorial work and to the graphics and layout work, along with finding a publisher and marketing this important volume to the world. That all this was done on a volunteer basis wonderfully illustrates how people pull together and give selflessly of their time for a worthy cause. You and the BIO-Oceans Association can be justly proud of the work you have accomplished. My office will purchase copies of the book for distribution to visiting officials and prestigious guests as testimony to the excellent science that the department has supported and will continue to support.

Thank you again.

Sincerely,

Trevor Swerdfager Assistant Deputy Minister Ecosystems and Oceans Science Sector Department of Fisheries and Oceans

Andy Sherin

AHOY THERE, Oceanographers and Marine Aficionados!

BIO-Oceans Association announces the publication of a major treatise reviewing the history and marine research accomplishments at Canada's Bedford Institute of Oceanography (BIO) over five decades primarily in the Atlantic and Arctic Oceans.

'Voyage of Discovery' (VOD), a massive hardcover volume comprising 460 pages printed on premium 8.5 x 11 inch Sterling 100-lb glossy paper with sewn binding, was released on 6 October 2014 with an official 'VOD Book Launch' scheduled at BIO in the Ford Auditorium on 20 November 2014 at 1000h (everyone is welcome to attend). The book's well-written text (almost half-million words) and illustrations (total of 566, mostly in colour) will appeal to a broad readership from professional oceanographers, environmental/ resource managers and decision-makers to marine science students and lay persons interested in the Atlantic and Arctic oceans. This publication is a 'must-have' book for any student of Canadian ocean science.

Voyage of Discovery' is available at BIO or by mail at \$35.00 per copy plus shipping (for mail orders). For prepaid mail-orders (by cheque, money order, credit card), contact BIO -OA for cost of shipping and/or credit card usage (902-826-2360 or 902-469-2798), and then send payment to: BIO-Oceans Association (VOD), c/o Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, NS, Canada B2Y 4A2.

VOYAGE OF DISCOVERY

Fifty Years of Marine Research at Canada's Bedford Institute of Oceanography

Edited by

D.N. Nettleship D.C. Gordon, C.F.M. Lewis and M.P. Latremouille



Bedford Institute of Oceanography Oceans Association

Once obtained, it's cast-off time into the '*Voyage of Discovery*' volume for exciting and stimulating reading of some extraordinary research findings derived from 50 years of study by BIO scientists and associates. Enjoy and discover a sample of the many special characteristics of the marine waters that surround us!

In Nemoriam

Richard (Mike) Michael Eaton, died 9 October 2014, "an innovative hydrographer, ... known as the father of the electronic chart."

Robert (Bob) Fitzgerald, died 29 September 2014, geochemist, GSC Atlantic.

Williamina (Wilma) (McLaren) Haworth, wife of Richard Haworth, research scientist, GSC Atlantic.

Jim Cuthbert, missing since 26 October 2014 and presumed dead, computer operations, BIO

Lin Yi-Chun, assistant engineer, Taiwan Ocean Research Institute and Hsu Shih-Chieh, a fellow with Academia Sinica in Taipei, died 10 October 2014 in the shipwreck of R/V *Ocean Researcher V*.

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FROM THE PRESIDENT

Another few months have drifted by since the last VoicePipe was published. The summer pot-luck BBQ held at Don and Joleen Gordon's was a great success with approximately fifty BIO-OA members and spouses attending. This is a good time for great food and socializing. Don has graciously volunteered to host this event again next year. Joleen's instructions in 'berry box lantern' making were again a big hit with many more now hanging in member's gardens.

The biggest news of the year is the arrival of 'The Voyage of Discovery'. This publication exceeds all expectations. The number of positive comments are beyond counting. Hats off to the editors. David Nettleship. Don Gordon, Mike Lewis and Mike Latremouille. A special thanks goes to Francis Kelly for the graphics and layout design of the book. Copies are 'flying off the shelf' so to say, and we are making strides towards the break-even point. If any members have not purchased a book, I strongly suggest they do so. This is a BIO-OA publication and your support is greatly appreciated to make it a successful project. Most of the pre-orders have been picked up or delivered with only a few of these remaining. The official book launch was held on 20 November 2014 in a full Ford Auditorium. Congratulatory messages were brought by several BIO Directors and a special address was given by Dr. Robert Fournier. Help make the book a success by spreading the word about VOD.

Our own events coordinator, Claudia Currie, returned home from the World Water Skiing Championships in Florida with a Gold Medal in Water Ski Tricks in the Plus Fifty category. Well done, Claudia!

On a sad note, Mike Eaton, the 'Father of Electronic Charts' passed away on 9 October 2014. A memorial service was held on 6 November at the Cole Harbour Meeting House with a number of old friends and colleagues in attendance.

Mike Hughes, President

The Bedford Car Pool by Jonathan Bujak

In sleepy silence four glum men Sit huddled, eyes fixed straight ahead. One sounds the horn, "Oh not again, I think John's still asleep in bed."

Out dashes John still getting dressed, His eyes quite wild, his hair all messed. A piece of toast stuck in his mouth, One shoe points north, the other south.

"I was early, you were late," Growls Willem, opening the debate. "Next time we'll leave you," then he smiles, "Perhaps you'd like to walk five miles."

Four tires squeal, five heads jerk back As Brian joins the Bedford race track, At sixty miles an hour and more, His foot pressed firmly to the floor.

Felix stirs, "I hear some banging, Not to mention clicks and clanging." Up jumps Willem with a shout, "I think the engine's fallen out."

Soon a fierce debate begins In Dutch and Flemish idioms. The English hear with bated breath This foreign battle to the death.

How many guilders in a cent? How far from Rotterdam to Ghent? Ford or Carter, who will win? Which is better, Scotch or gin?

In tones of gloomy prophesy Willem tells of things to be, Of giant cities ruled by cars Where no one sees the sun or stars.

Of massive freeways, concrete blocks, Of washing lines with smelly socks, Of politician's knobbly knees, Of Big Mack Hamburgers with cheese.

Of Plate tectonics, mountain chains, Subduction zones and dirty drains, Of things too horrible to tell That turn you into mush and gel.

So when at last they park the car And stagger out their mouths ajar To sit all day with gloomy thoughts Before the evening's motor sports.

The distinguished Bedford motor pool Convened to save precious fuel Will it ever be the same Willem in Utrecht again?

[Editor's note: 'The Bedford Car Pool' was written by Jon Bujak, formerly with the Atlantic Geoscience Centre at BIO. Jon recently asked me to send him a copy of his poem since he had lost his copy. It was originally published in Issue 13 of the BIO-Oceans Association Newsletter in October 2001. The car pool was a response to the 1973 oil crisis. "Giant cities ruled by cars" was Willem's prophecy, coming true with SUVs and pick up trucks being the most popular vehicles and a glut of oil and low gasoline prices.]

New Map Exposes Previously Unseen Details of Seafloor

A new seafloor map reveals new details on earthquakes (red dots), seafloor spreading ridges, and faults.

As though someone had pulled a plug in the oceans and drained them away, a sea-floor map has exposed thousands of never-before-seen underwater mountains and ridges. The map - generated by the highest-resolution gravity model ever made for the oceans - will guide deep-sea research for years to come.

Accessing two previously untapped streams of satellite data, scientists at Scripps Institution of Oceanography at University of California San Diego and their colleagues have created a new map of the world's seafloor, creating a much more vivid picture of the structures that make up the deepest, least-explored parts of the ocean. Thousands of previously uncharted mountains rising from the seafloor and new clues about the formation of the continents have emerged through the new map, which is twice as accurate as the previous version produced nearly 20 years ago.

Developed using a scientific model that captures gravity measurements of the ocean seafloor, the new map extracts data from the European Space Agency's (ESA) CryoSat-2 satellite, which primarily captures polar ice data but also operates continuously over the oceans, and Jason-1, NASA's satellite that was redirected to map the gravity field during the last year of its 12-year mission.

By measuring tiny changes in the surface level of the ocean, then subtracting the effect of temporary phenomena such as waves, the satellites mapped how the ocean responds to the gravitational pull of underwater features

such as mountain ranges. In essence, the probes map the sea surface as a proxy for the sea floor below.

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Combined with existing data and drastically improved remote sensing instruments, the new map, described recently in the journal *Science* (Vol. 346 no. 6205 pp. 65-67), has revealed details of thousands of undersea mountains, or seamounts, extending a kilometre or more from the ocean bottom. The new map also gives geophysicists new tools to investigate ocean spreading centres and little-studied remote ocean basins.

"The kinds of things you can see very clearly now are abyssal hills, which are the most common land form on the planet," said David Sandwell, lead scientist of the paper and a geophysics professor in the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics (IGPP) at Scripps.

The authors of the study say the map provides a new window into the tectonics of the deep oceans. Previously unseen features in the map include newly exposed continental connections across South America and Africa, and new evidence for seafloor spreading ridges at the Gulf of Mexico that were active 150 million years ago, now buried by mile-thick layers of sediment.

"One of the most important uses of this new marine gravity field will be to improve the estimates of seafloor depth in the 80 percent of the oceans that remains uncharted or is buried beneath thick sediment", the authors

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say in the report.

"Although CryoSat-2's primary mission is in the cryosphere, we knew as soon as we selected its orbit that it would be invaluable for marine geodesy, and this work proves the point," said Richard Francis, a co-author of the paper and project manager for the development of CryoSat-2 at the European Space Agency, and honorary professor in the Department of Earth Sciences at University College London, England.

The new map also provides the foundation for the upcoming new version of Google's ocean maps to fill large voids between shipboard depth profiles.

"The team has developed and proved a powerful new tool for high-resolution exploration of regional seafloor structure and geophysical processes," says Don Rice, program director in the National Science Foundation's (NSF) Division of Ocean Sciences. "This capability will allow us to revisit unsolved questions and to pinpoint where to focus future exploratory work."

Geologists around the world can use the map to reconstruct how oceanic crustal plates shifted, says Joanne Whittaker, a marine geoscientist at the University of Tasmania in Hobart, Australia. She studies the poorly mapped parts of the Indian and Southern Oceans between Antarctica and Australia, and relies on gravity maps to help plan her research voyages. Whittaker has an upcoming cruise aboard Australia's new research vessel, Investigator (see 'VoicePipe' # 60 for a picture of the *Investigator*), to study the underwater Gulden Draak Knoll, which may be a fragment of an ancient continent. Thanks to the gravity data, she says, "we will be able to plan our voyage with more confidence, and we may even try to adjust the voyage somewhat based on all the new information "

"The use of satellite altimeter data and Sandwell's improved data processing technique pro- A file picture of the survey ship Fugro Discovery, which docked in Westas," said Joan Cleveland, Office of Naval Research (ONR) deputy director, Ocean Sensing

and Systems Division. "Accurate bathymetry and identifying the location of seamounts are important to safe navigation for the U.S. Navy."

Oil and gas companies are also likely to make use of the map, says Sandwell. Among other things, it has revealed an extinct spreading ridge off the coast of Brazil, in an

area of intense petroleum exploration. U.S. energy company Conoco Phillips, based in Houston, Texas, was one of the early funders of Sandwell's research; other than such companies, he says, "almost nobody cares about the deep ocean any more".

But there is only so much that the gravity map can do. It can resolve sea-floor features to about five kilometres, which is enough to discover a seamount, but not enough to pinpoint smaller features, says Sandwell. Getting down to a resolution of about 100 metres will still require research ships pinging sonar to the seafloor. Even sharper detail - such as in the ongoing search for the Malaysia Airlines flight MH370 - requires the timeconsuming process of towing sonar apparatus behind a ship.

Parts of this article extracted under license from Nature News on 2 October 2014.



vides improved estimates of marine gravity and ern Australia's Port of Fremantle 5 October 2014 to be fitted with equipbathymetry worldwide, including in remote are- ment to restart the search for missing Malaysia Airlines Flight MH370. AFP PHOTO/FUGRO

Australian officials said they knew less about the area [in the Indian Ocean] they were exploring than is known about the surface of the moon. It's actually even worse than that. Surveys of Mars and Venus are considered around 250 times more accurate than existing maps of the underwater region where Flight 370 searchers are looking.



[Editor's Note 'Sherman Lagoon' comic strips published between 10–15 October 2014; used with permission of artist.]

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The Nearest Point of Land is Almost Always the Seabed¹

Today's navigators often venture where available hydrographic data do not meet the requirements of contemporary shipping. Member States of the International Hydrographic Organization (IHO) acknowledge this deficiency and are pledged to remedy it, but this will take time. The circumstances leading to past mishaps are therefore potentially present both now and in future. Although the charts in use in some of the cited casualties were compiled from lead-line surveys, they provided ample evidence that less water than charted might be expected. Accounts of accidents often reveal the vessel's speed to have been excessive in the circumstances.

The IHO defines inadequately surveyed areas as those where bathymetry is based on older lead-line surveys or other surveys which are either open in nature or not hydrographic surveys. International Maritime Organization (IMO) *Guidelines on Voyage Planning for Passenger Ships Operating in Remote Areas*, adopted in 2007, indicate that planning should take into account the source, date and quality of the hydrographic data of charts used. Navigators should remember that the nearest point of land is almost always the seabed, as the following case studies demonstrate:

Case 1 (Caribbean Calamity)

In January 1971, the former French passenger liner *Antilles* (loa, length over all = 183m, beam = 24.4m, draught = 8m) struck an uncharted reef off the northwest coast of Mustique in the Grenadine Islands. As the ship was proceeding at 16 knots, the impact caused her to break in two and catch fire.



The MV Antilles, photo from Wikipedia.

The passage being attempted was through apparently open water some 640m wide, with charted depths of 13 and 16 metres. It lay between two rock outcrops in a coral and reef-strewn area last surveyed in the 19th century. This followed a change to the planned route authorised by the master in order, as the subsequent legal proceedings revealed, "to provide his passengers with a better look at this enchanting isle and was consistent with his desire to implement the Owner's policy of making *Antilles*' cruises entertaining and unique".

Case 2 (Déja vu)

In April 2000, the 'Adventure' cruise ship *World Discoverer* (loa = 87m, beam = 15m, draught = 4.57m) grounded on an allegedly uncharted feature in Sandfly Passage, Solomon Islands. The ship was fatally holed



The wreck of the MV World Discoverer, photo from Wikipedia.

and the master beached her in Roderick Dhu Bay, where the hulk remains.

Neither the Australian Hydrographic Service nor the UK Hydrographic Office, the Primary Charting Authority, has any record of the incident. The stranded wreck of *World Discoverer* is clearly visible on *Google Earth*, but is not shown on the latest (2012) edition of chart *BA 1713*. The *Pacific Island Pilot*, current at the date of the incident, advises that "Deep-draught vessels should not attempt the passage owing to the reefs in the N entrance." The latest (2007) edition of the *Pilot* directs vessels west of Mid Reef, passing clear of the 9.1m patch. This remains the least depth shown in the passage other than the reef itself.

Case 3 (Uncharted but not Unexpected)

Such dangers also exist for large cargo vessels navigating in poorly charted waters. In 2010, the bulk carrier *Noble Hawk* (loa = 190m, beam = 33m, draught =

12.5m), outbound from Teluk Buli in Eastern Indonesia to China, grounded on an uncharted 5m shoal. Surrounding depths were 53 to 58m. Her course lay across a large bay encumbered with islets, reefs and shoals. The chart in use was compiled from 20th century lead-line surveys.

In 2012, the Indonesian Navy Hydrographic Service (DISHIDROS) carried out a survey of the grounding site and found a least depth of 3m and an adjacent depth of 15.3m in general depths of 50m. Mindful of the significant activity of large cruise ships and bulk carriers in these waters DISHIDROS recommended that the new shoal be marked.

Case 4 (Ennerdale Rocks)

In 1970, a Royal Fleet Auxiliary vessel the tanker *Ennerdale* (loa = 227m, beam = 30m, draught = 12m) struck a rock pinnacle about 8 miles NNE of Port Victoria in the Seychelles and sank. The pinnacle, which was charted at 9 ftm (16.5m), lay adjacent to a 10 ftm (18.3m) sounding in general depths of 13 to16 ftm (23.8 to 29.3m). The vessel, travelling at 12kts, was crossing a line of pinnacles and islet outcrops which extend northeastwards from the north tip of the Island of Mahé within the 20 fathom line.

The chart in use was compiled from a 19th century leadline survey, as stated in the title. The least depth of water over the pinnacle (subsequently established at 10.8m (35ft) was not shown on this chart. However, there was sufficient indication on the chart that shoaler water may well have existed in the vicinity. The previously unnamed feature is now charted as Ennerdale Rocks.

Cases 5 & 6 (Dangers of the Deep)

In 1973, the cargo ship *Muirfield*, drawing 16m, was on passage from the Cape of Good Hope to Selat Sunda. There was a 2-3m swell running when she struck the top of a seamount, 75 miles southwest of the Cocos Islands. A subsequent survey found a shoal with a least depth of 18m in charted depths of over 5,000m.

Submarine Surprised

More than 90% of all seamounts greater than 1km in height (estimated to be more than 100,000 in number) are unobserved by either ship soundings or satellite gravity (Sandwell and Wessel, 2010). This observation is consistent with the statement in IHO publication C-55 that renewed attention needs to be given to the disproving of vigias especially adjacent to the maritime shipping routes in the Pacific and adjacent seas. The danger to submarine navigation is self evident.



USS San Francisco underway on the surface, Photo from Wikipedia

In 2005 USS *San Francisco*, a nuclear powered submarine, collided with a seamount about 364 nautical miles southeast of Guam. The submarine was travelling at maximum speed at a depth of 160m. The seamount that she struck did not appear on the chart in use at the time of the accident. Other charts available showed an area of 'discoloured water', an indication of the probable presence of a seamount.

Subsequent investigation determined that information regarding the seamount should have been transferred to the charts in use, particularly given the relatively uncharted nature of the ocean area that was being transited.

Discussion

Despite a steady increase in the length of cruise ships, the draught of the current vessels in service has not increased proportionately and averages 8.4m. However, these ships are venturing into increasingly remote and poorly charted areas. Itineraries that seek to provide optimum passenger experience are potentially hazardous. Many of the smaller vessels (loa. <100m) that offer adventure cruises are fitted with forward looking sonar and can deploy portable echo sounders in their tenders. The report of an investigation into the incident in the Canadian Arctic highlights the necessity for such provision.

New Panamax vessels transiting the Caribbean may not be able to do so with the same confidence as their predecessors. Elsewhere ULCC and large bulk carriers are vulnerable to an encounter with an uncharted seamount rising close to the surface. In the deep areas of the ocean, most mariners consider that there is little chance of a vessel running aground on such a feature. Unfortunately, this is a misconception. Examples of navigation-

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ally significant seamounts include Vema Seamount limitations of available hydrographic data and act ac-(with a charted depth of 11 metres - about 1,000km WNW of Cape Town) and Walters Shoal Seamount (with a charted depth of 15 metres - about 400 nautical miles south of Madagascar). These seamounts rise up from ocean depths of about 4,000 and 2,000 metres, respectively. Cruise ships and deeper draught cargo vessels are unlikely to be surveyed to full modern standards in the foreseeable future. Navigators of these vessels therefore need to ensure that they fully appreciate the

cordingly. More owners should perhaps consider installing forward looking sonars for vessels operating in Polar Regions and away from recognised routes elsewhere. Such action might well have saved MV World Discoverer. It should also have prevented the damage to bulk carrier Noble Hawk, which incurred "significant salvage and repair costs as well as the associated loss of revenue".

Text (edited) from Hydro International 4 September 2014.

Phot Quiz: Guess who!









BIO-OA's Summer BBQ

Many BIO-OA members gathered at the home of Don and Joleen Gordon for a time of fellowship and good food on a beautiful sunny day on 13 August 2014.



Photos (clockwise from top left): host Don Gordon, welcomes guests to the BIO-OA BBQ; David Ross (left), former Director of the Atlantic Geoscience Centre with Mike Lewis (right) was the guest from farthest away, New Zealand; David Nettleship telling about the published *'Voyage of Discovery'*; and BIO-OA members in the garden of Gordon home.







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Editor's Keyboard: We apologize for the lateness of this issue of the *VoicePipe*, it has been a challenging time both at work and at home. This issue celebrates the arrival of the *'Voyage of Discovery'* (VOD). VOD is a remarkable accomplishment that puts the icing on the 50th BIO anniversary 'cake'. I would like to thank Don Gordon for sharing the photographs that appear on page 10. I challenge you, the reader, to identify who is in the pictures. Another look back is Jon Bujak's poem 'The Bedford Car Pool' (page 4) written to remember the car pool organized to respond to the 1973 oil crisis.

I asked Jon to write a new verse, but at press time I had not yet received it. I confess that I read the comic strips every day and 'Sherman's Lagoon' by Jim Toomey is one of my favourites. In October 2014 Toomey drew a series of strips on the topic of ocean acidification, (see page 7 for a few strips from this series): "What are we going to do about ocean acidification?" asks the crab. As we go to press, China and the United States have signed an agreement to cap and reduce carbon emissions. Maybe there is hope that something can be done. *Andy Sherin*



ABOUT THE BIO-OCEANS ASSOCIATION

The Bedford Institute of Oceanography Oceans Association (BIO-OA) was established in 1998 to foster the continued fellowship of its members; to help preserve, in cooperation with the Institute's managers and staff, BIO's history and spirit; and to support

efforts to increase public understanding of the oceans and ocean science. Membership is open to all those who share our objectives. Most current members are present or past employees of BIO or of the federal departments of Environment, Fisheries and Oceans, and Natural Resources (or their predecessors) located in the Halifax Regional Municipality, with other members spread out across Canada and the world. Membership is \$10.00 per year, \$40.00 for five years, or \$150.00 for a lifetime membership.

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Robert Reiniger (1998-2000), Dale Buckley (2000-02), David Nettleship (2002-04), Donald Peer (2004-06), Betty Sutherland (2006-08 and 2010-11), Bob O'Boyle (2008-10), Paul Keizer (2011-13)

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