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THE CANADIAN SOCIETY OF ENVIRONMENTAL BIOLOGISTS Newsletter / Bulletin

In this Issue:

CSEB Newsletter Bulletin SCBE

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In this issue

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CSEB NEWSLETTER 2011

Vol. 68, Number 1 Spring 2011

The Canadian Society of Environmental Biologists Newsletter is a quarterly publication. The Newsletter keeps members informed of the Society's activities and updates members on the current affairs and advances in the field of environmental biology. This publication draws together the widely diverse group of Canadian environmental biologists through a national exchange of ideas. Members are invited to contribute papers, photos or announcements that are of a national biological and environmental interest. Letters to the editor are welcome. This is a volunteer non-profit organization and we rely on your participation to make the newsletter a productive forum for ideas and discussion.

All business correspondence, changes of address, undeliverable copies and membership applications should be sent to: CSEB National Office, P.O. Box 962, Station F, Toronto, ON., M4Y 2N9. **Editorial correspondence: Gary Ash, Editor, e-mail:** gash@golder.com

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LE BULLETIN de la SCBE 2011

Vol. 68, Numéro 1 Printemps 2011

Le Bulletin de la SCBE est une publication trimestriel de la Société Canadienne des Biologistes de l'Environnement. Le Bulletin informe les membres des activité de la Société sur événements courant ainsi que les progrès qui font en sciences de l'environnement. Par un échange d'idées au niveau national, cette publication intéresse un groupe très diverssifié d'environnementalistes Canadien. Les membres sont invités a contribuer des articles, photos (noir et blanc) ou des messages qui sont d'intérêt nationale en sciences biologiques et environnementales. Les lettres à l'editeur sont bienvenues.

Tout la correspondence d'affaires, y compris les abonnements, les changements d'adresse, les exemplaires retournés et les formulaires: CSEB National Office, P.O.Box 962, Station F, Toronto, ON, M4Y 2N9. **Les lettres à l'editeur: Gary Ash, Editor, courriel:** gash@golder.com

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The Canadian Society of Environmental Biologists

CSEB OBJECTIVES

The Canadian Society of Environmental Biologists (CSEB) is a national non-profit organization. Its primary objectives are:

- to further the conservation of Canadian natural resources.
- to ensure the prudent management of these resources so as to minimize environmental effects.
- to maintain high professional standards in education, research and management related to natural resources and the environment.

OBJECTIFS de la SOCIÉTÉ

La Société Canadienne des Biologistes de l'Environnement (SCBE) est une organisation nationale sans but lucratif. Ses objectifs premiers sont:

- de conserver les ressources naturelles canadiennes.
- d'assurer l'aménagement rationnel de ces ressources tout en minimisant les effets sur l'environnement.
- de maintenir des normes professionnels élevés en enseignement, recherche, et aménagement en relation avec la notion de durabilité des ressources naturelles et de l'environnement, et cela pour le bénéfice de la communauté.

PRESIDENT'S Report

Greetings!

As I step into my new role as president of the CSEB organization, I think about the work that my predecessors undertook, not only as biologists and environmentalists, but as executive officers of our organization. Not only have they dedicated their skills to their work, whether it be in academia, consulting or government, but they have also brought their skills to our organization with enthusiasm.

I hope I can bring this same enthusiasm to my new role.

In my view, I believe that one of the original mandates of the CSEB was to inspire up and coming young biologists, whether they be starting out in their careers, or fast approaching their goal of becoming a biologist in their latter years of university. We did this by sharing our knowledge and experiences with them, through this newsletter and employing them as young graduates, or summer students. As a summer student some few decades ago, I soon realized that all the schooling I had received sitting in classrooms and labs through university would not ready me for work as a biologist, or someone devoted to work in the environmental field. My work as a summer student working as a field technician in the Muskoka and Kawartha lakes, steered me in the direction of phytoplankton ecology and lake eutrophication. The other permanent field technicians and biologists inspired me, by sharing their practical knowledge and skills; in other words, what I really needed to know; beyond that of a textbook and classroom. My professional career took place over a period of 38 years, and those early learned skills served me well.

I think it behooves all of us in this organization, to not only share our credentials of knowledge and skills with younger professionals, recent graduates, or students entering their final years in academia, but to also recruit those same individuals into what is the lifeblood of our organization; our membership. I encourage you to seek them out; seek their views; and most importantly, share with them the importance of seasoned peers through the Canadian Society of Environmental Biologists, so as to be able share their skills and knowledge in years to come.

Robert Stedwill
President
rjstedwill@live.ca

NATIONAL News

Summary of CSEB/RCEN Activities

Submitted by Joseph M. Hnatiuk, CSEB Saskatchewan Regional Director

In the last several months The Canadian Environmental Network (RCEN) Environmental and Assessment Caucus (I am the CSEB representative on the EPA caucus) has been monitoring the status of the 7- Year review of the *Canadian Environmental Assessment Act* (CEAA), administered by Environment Canada. Until the recent call of the Federal election, the EPA caucus was waiting for the formal review request by Government for RCEN to participate in the CEAA review. Several schedules were proposed and the most recent one was to begin during the spring of 2011; the election call, however, resulted in the indefinite postponement of the review. The most recent information regarding the review is that regardless of who forms the next Government, the review will proceed as soon as possible. The likely outcome is that the review will begin in September 2011 when the new Government officially begins the formal governing process. When the official review begins, I will be requesting CSEB members for their suggestions so that your views can be passed on to the RCEN EPA caucus for their consideration and submission to Government.

The CSEB is also involved in the RCEN Biodiversity Caucus whose mandate is to move society, by enhancing interested member' groups capacity, to inform, promote and advocate on:

1. The conservation, promotion and equitable sharing of genetic, species and ecosystem biodiversity and function;
2. the conservation, and improvement of conditions that support biodiversity; and
3. the importance of biodiversity as a primary determinant of a sustainable biosphere in Canada and aboard.

With that regard, in the past several months, the caucus prepared a 2011-12 work plan that focused on four strategic objectives. These are:

- Communicating information to various audiences, both within RCEN, Civil Society and the Canadian public, on biodiversity, the provisions of the Convention on Biodiversity and the need for its implementation both domestically and internationally;
- To strengthen the governance and funding of the biodiversity caucus;
- Working to establish a viable Friends' of the Convention on Biodiversity in Canada; and
- Continue to provide support to federal government departments, on a contract basis (primarily, but not limited to Environment Canada), in consulting on biodiversity matters with both ENGO's and Civil Society.

More detail regarding past and current activities can be found at http://www.cen-rce.org/eng/caucuses/biodiversity/index.html

NATIONAL News

CSEB 2011 AGM & CONFERENCE ANNOUNCEMENT

Important Role of Provincial & National Parks

Submitted by Bill Paton, CSEB 2nd Vice-President

The 2011 Annual General Meeting of the Canadian Society of Environmental Biologists will be held at Onanole/Wasagaming and Riding Mountain National Park, Manitoba. This year Parks Canada celebrates 100 years. Today Parks Canada boasts 42 national parks from coast to coast to coast, covering more than 300,000 square kilometres. Parks Canada was officially established in 1911 and was the first national park service in the world. For a history and interesting articles, look at the April issue of Canadian Geographic Magazine entitled "National Parks. The Future of our Natural Wonders." We will be part of the celebrations at Riding Mountain National Park.

Last year was also a special year for Manitoba Parks, since 2010 was the 50th anniversary of The Provincial Parks Act. First passed in 1960, the Act continues to preserve and protect our natural areas today.

The origins of Manitoba parks go back to the early 1900s when a number of forest reserves were established in Manitoba by the federal government. These were Duck Mountain, Porcupine Mountain, Riding Mountain, Turtle Mountain and Spruce Woods. These protected areas would eventually form the core of today's parks system. The Manitoba government has been regularly adding new parks to the system.

The Workshop portion of the AGM will highlight the important role of our federal and provincial parks as valuable sites for research in ecology and conservation. Riding Mountain National Park has some unique issues to deal with like T.B. in elk and minimizing contacts with cattle operations on the park periphery: why Clear Lake is so oligotrophic in a province with largely highly eutrophic lakes; reintroduction of pine martens, etc. It also is a major summer tourist location with all the challenges that presents for a National Park. The Parks also provide an excellent venue for education of all ages and a marvelous opportunity for everyone to enjoy the great outdoors. We would like to highlight innovative new techniques or equipment that environmental biologists and others can use in their professional setting. Many universities across Canada have been able to use federal and provincial parks as sites for research and student field experiences and we encourage graduate and honours students who have experiences to share to join us in this celebration and support for these areas of preserved biodiversity.

The dates chosen for the AGM and Workshop are September 29-30 and October 1, 2011 as this will allow those members wishing to attend The Aquatic Toxicity Workshop in Winnipeg, which runs from October 2-5, 2011. Please watch our web-page for accommodation details, travel arrangements, paper/poster submissions, sponsorship opportunities, etc.

UPCOMING SYMPOSIA/ WORKSHOPS

38th Aquatic Toxicity Workshop

Watershed: Environmental Integration on a Landscape Scale. October 2-5, 2011 Winnipeg Manitoba.

Proposed Sessions

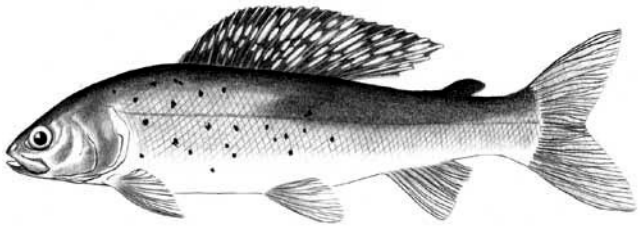
- Remediation of degraded lakes * NEW
- Emerging contaminants
- Omics (genomics, proteomics, metabolomics)
- Environmental effects monitoring
- Endocrine disrupting compounds
- Amphibians and wildlife toxicology
- Pesticides
- Toxicity mechanisms
- Toxicity testing - methods development
- Biomarkers
- Nanotoxicology
- Routes of metal exposure - water versus diet versus sediment
- Groundwater and aquatic toxicology
- Toxicology and reclamation
- Climate change and toxicology

For info and details : www.atw.ca

UPCOMING SYMPOSIA / WORKSHOPS

Arctic Grayling Symposium and Workshop 2011: Our Conservation Challenges and Opportunities

June 7-9, 2011. Grande Prairie Regional College, Grande Prairie, Alberta.



For registration, go to
www.tucanada.org/ARGR2011/index.html

KEYNOTE SPEAKERS

Dr. J. D (Don) McPHAIL
Professor Emeritus, Native Fish Research Group, University of British Columbia

Topic: Conservation Changes and Challenges for Northern Fishes

Dr. E.B. (Rick) TAYLOR
Director of Fish Collection, Beaty Biodiversity Museum and Professor of Zoology, University of British Columbia and Co-Chair, Freshwater Fishes Specialist Sub-Committee, COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

Topic: From Siberia to Swan Hills: Evolutionary Genetics of Arctic Grayling with Relevance to the COSEWIC Process and Species-at-Risk Assessment and Listing in Canada

Dr. MICHAEL SULLIVAN
Fisheries Scientist, Alberta Fish and Wildlife Division

Topic: Death by a Thousand Cuts; Cumulative Effects and the Loss of Alberta's Small Rivers

Dr. DANA M. INFANTE
Department of Fisheries and Wildlife, Michigan State University

Topic: Managing River Systems with a Landscape Approach: Improving the Odds for Conserving Arctic Grayling

Trout Unlimited Canada, Golder Associates, and Alberta Sustainable Resource Development (Fish & Wildlife), in association with Fisheries and Oceans Canada, Department of Renewable Resources (University of Alberta), Alberta Conservation Association and the American Fisheries Society (Mid-Canada Chapter), will be hosting a two day symposium & workshop on the Conservation of Arctic Grayling. The event will be held in Grande Prairie, Alberta, June 7-9, 2011.

Since the earlier workshops in Prince George, B.C (January 2000), and Jackson, Montana (August 2005), additional knowledge on grayling biology and conservation approaches has been made available, numerous case-histories of grayling loss and recovery have been documented, and concerns have been heightened around consequences of development, cumulative effects and climate change.

Arctic grayling are truly a special fish, but in much of the southern portion of their range, their vulnerability to development, harvest, and changing landscapes have rendered their populations fragile and in need of special care. Our symposium will address the following questions:

- How have we met the challenges of maintaining grayling populations and their habitats?
- What sampling and restoration techniques have proven useful, or have been shown to fail?
- What seem to be the most fruitful areas of research and most effective management approaches?

A portion of funds collected above workshop cost recovery will be donated to Trout Unlimited Canada. This matching fund donation will be used to support a study of the genetic biodiversity of Arctic Grayling in northwestern North America.

TECHNICAL PROGRAM

The two-day symposium will be composed of a series of 20 minute presentations and a field visit to nearby grayling streams. Participants will travel to sites along the nearby Beaverlodge River. The grayling population in this notable grayling stream was extirpated during the 1990s because of unplanned land use and subsequent stream fragmentation and degradation of water quality. Group transportation will be provided.

Presentations will be organized into four sessions, each focussing on a primary theme.

- Biology and Natural History
- Monitoring Approaches
- Threats to Conservation
- Management Strategies

For further information, please contact JPONeil@golder.com.

REGIONAL News

ALBERTA News

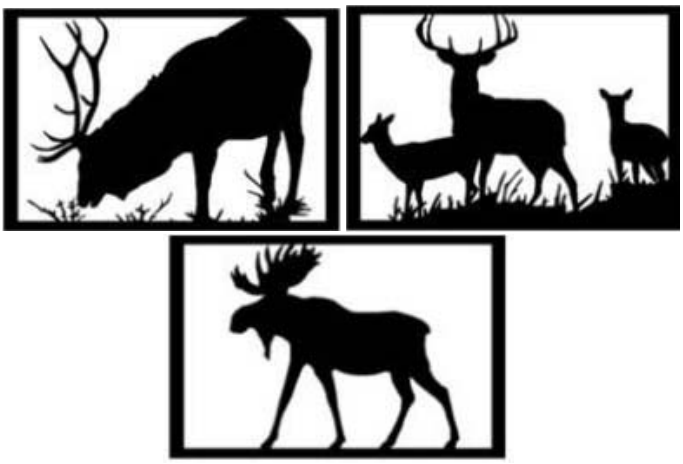
Submitted by Brian Free, CSEB Past President

More bad publicity haunts the oil industry with a major leak from an oil pipeline 100 km northeast of the Town of Peace River. This time it was sweet, light crude, not the heavy crude produced in the oil sands area. An estimated 28,000 barrels of the oil leaked from a ruptured pipeline. Some nearby First Nations communities have complained about illness related to the oil spill. Fortunately, the pipeline has been repaired and the spill has been contained. Clean-up will be completed before the pipeline resumes operation.

And this comes at a time when the Alberta Government is hoping for prompt approval of the proposed Keystone pipeline that will carry Alberta crude oil to American refineries. Some American communities along the proposed pipeline route have been fighting this project, so this latest accident will not help.

More details have been released regarding the monitoring program for chronic wasting disease. This is a serious disease affecting native deer, elk and moose. Chronic wasting disease has been spreading from the central USA into Canada, and was first detected in Alberta in 2005. Almost one hundred cases have been confirmed since then, based on testing of hunter-killed deer and road kills. Since last September, 19 more cases have been identified, including 17 mule deer and 2 white-tails.

The most western cases were found along the Red Deer River near Drumheller. One other case suggests the disease has reached the North Saskatchewan River valley. Increasing the hunter harvest in affected areas is the main control strategy.



SASKATCHEWAN News

The Bakken Oil Field in Saskatchewan

Submitted by Robert Stedwill, CSEB President

As this newsletter goes to press, the Saskatchewan's natural resources continue to draw people to the Province from far and wide. When you think about this province's resources and recent announcements in the media—potash, uranium, heavy oil and deep bedded tar sands—one resource not mentioned frequently, but which has the potential to significantly impact the Province's environment and labour force, namely the Bakken Oil field in Saskatchewan's southeast.

Bruce Johnstone of Saskatchewan News Network indicates that "Saskatchewan could be sitting on 25 billion to 100 billion barrels of sweet, light crude oil". Comparing this to the heavy oil resource in the west central portion of the province – it has the potential to be four times in size. Needless to say, this is likely the biggest oil find in Saskatchewan since the 1950s.

"The sheer magnitude of the Bakken formation, which is found in the Williston Basin underlying much of North Dakota, eastern Montana, southeastern Saskatchewan and southwestern Manitoba, has government agencies responsible for resource exploitation excited to say the least.

"The Bakken is a geological formation of siltstone and sandstone about 300 metres below the Mississippian formation, where most Saskatchewan light oil production comes from. Bakken wells tend to be highly productive (200 barrels a day or more), producing sweet, light crude oil with 41 degree gravity, basically the highest grade of crude oil you can find anywhere. While relatively new in Canada, Bakken exploration has been underway in the U.S. since 2000 and has increased dramatically in recent years. According to the U.S. Geological Survey, the Bakken formation could contain a mind-boggling 413 billion barrels of oil in place."

A study done in 1991 estimated the US reserves in excess of one hundred billion barrels in place. One of the authors of that study said the prevailing view in the geoscience community at the time was "the potential of the Bakken was immense, but the price of oil in 1991 was not such that people wanted to risk (exploration and development dollars)." In addition to the price of oil, the ability to access the oil utilizing horizontal drilling and hydraulic fracturing has greatly increased the percentage of recoverable oil. Roughly 25 per cent of the Williston Basin, which covers some 200,000 square miles (518,000 square kilometres) is located in Saskatchewan. Based on that simple arithmetic, the estimate of Bakken oil in the province could range anywhere from 25 billion barrels to 100 billion barrels of oil in place. Hence, Johnstone's conclusion as stated at the outset.

Of concern of course, based on my observations of the oilfield activity in North Dakota, as recently as the third weekend in March, is the number of erected pumpjacks, access roads and oil storage batteries, and their related incremental accumulated environmental disturbances. Added to this are the societal issues of increases in oilfield workers, support services, housing units, utilities, impacts to existing infrastructure and the building of new infrastructure. And as the price of oil increases, so too will be the fervor to extract the oil from the ground.

I hope the environmental/societal impacts lessons learned in Alberta will serve Saskatchewan well.

MANITOBA News

Submitted by Dr. William Paton, CSEB 2nd Vice-President

Greetings from the land of flooded landscape and swollen rivers. Field work for Manitoba biologists who work in the riparian river valleys or agricultural areas alongside the major streams and rivers will be very late this season. Pelicans, geese and ducks are making great use of our flooded parks in Brandon. We expect all the flood waters to recede well before our planned Annual General Meeting and Science Workshop in late fall at Riding Mountain National Park. This is a particularly beautiful time of year in the Park, the summer tourists have all gone home and yet all the major facilities remain open until Thanksgiving weekend. Please consider visiting us.

Research Centre Cutbacks

Many environmental and other biologists have had the pleasure of field experience and research in the many Research Stations run by our Canadian Universities. Unfortunately, we are learning of cutbacks for these facilities and in some cases closure or threatened closures. Here in Manitoba, the Delta Marsh Research Station has been impacted and the Boreal Forest Research Station set up the late Dr. Pruitt appears to have been abandoned, despite the fact that it resides inside the proposed Boreal Forest reserve. As an alumnus of Queens', I understand that Lake Opinicon is also threatened. This is an area of concern I believe for our Society. I would appreciate hearing from other regions of Canada if this is also a concern. The Churchill Northern Research Centre is still operating but of course it is government funded directly.

ATLANTIC News

Submitted by Patrick Stewart, CSEB Atlantic Regional Director

The Atlantic Region continues to solicit interested individuals to serve as Directors for CSEB. We have a large region with diverse interests, and could benefit from increased representation from Newfoundland and Labrador, Prince Edward Island, New Brunswick and Nova Scotia.

We still intend to hold a local get together in the Halifax area in the near future, and would like one of the local members to step up and take the reins. We have a potential speaker but other suggestions or offers to give a talk would be appreciated.

Lower Churchill Hydroelectric Generation Project

Environmental assessment hearings into the development of the $6.2 billion, 824 megawatt project at Muskrat Falls in Southeastern Labrador near Goose Bay recently ended, having begun in early March. The project generated public opposition from Labradorians concerning the loss of land to the reservoir, and the lack of substantial benefit to them—the power being exported to insular Newfoundland and to Nova Scotia. The area is largely wilderness rich in wildlife including Caribou, Moose, Black Bear, Marten, as well as birds and other species, many of which will lose a proportion of their habitat because of the reservoir.

Location of Muskrat Falls

The public hearing for the Joint CEAA Panel reviewing the proposed Lower Churchill Hydroelectric Generation project ended on April 15, 2011. The Panel is now reviewing all the information gathered during the review process, and is preparing its report for submission to the federal Minister of the Environment, the provincial Minister of Environment and Conservation, and the responsible authorities (Fisheries and Oceans Canada, and Transport Canada) no later than July 14, 2011. All the information relating to this review is available online on the Canadian Environmental Assessment Registry, registry number 07-05-26178, at the following link: www.ceaa-acee.gc.ca/default.asp?lang=En&n=D75FB358-1

Satellite image showing existing Muskrat Falls

TERRITORIES News

Submitted by Anne Wilson, CSEB 1st Vice President

Greetings from Iqaluit and Yellowknife!

Winter has wound up, and spring may be almost here. In the NWT we had much lower than usual snowfall, with the consequence that ice thicknesses are greater, so it will be a slow melt given our below-normal spring temperatures. Those of us bound to desks are busily reading the multitude of reports presenting 2010's monitoring results for the mines, and the field folks are assembling gear, arranging logistics, and waiting for the ice to melt.

Meanwhile, it is hard not to feel cheerful with the lengthening days and bright sunshine, low temperatures notwithstanding. I think of it as a welcome delay to bug season!

Nunavut Regional Update

(the snow buntings are back!!!)

Mining news:

- Baffinland's Mary River Project (iron ore) continues through the environmental assessment process with their submitted Draft Environmental Impact Statement in review with the Nunavut Impact Review Board and distributed to government regulators and interveners. Baffinland has recently responded to the over 600 Information Requests made by regulators and interveners after an initial review of the document. The NIRB is currently hosting community information meetings through May in 11 potentially affected communities. Based on Baffinland's anticipated timelines, they are estimating construction to commence on the project in 2013 with the first commercial shipment of ore to occur in 2016. The estimated capital cost of the project is $4.1 B.

- Agnico-Eagle's Meliadine Project (gold) is picking up speed with a planned 27-km all-weather road proposed to be constructed between 2011 and 2012 to support a bulk sample program. The proposal for the road is currently being screened by the Nunavut Impact Review Board.

- AREVA's Kiggavik Project (uranium) and the Nunavut Impact Review Board continue their consultation on the project and to develop the Environmental Impact Statement Guidelines. An EIS development workshop was held in Baker Lake in late March. Related to the continued interest in uranium in Nunavut, the Government of Nunavut recently held public meetings on uranium in three communities (Iqaluit, Baker Lake, and Cambridge Bay) to develop a position and polity on uranium in the territory.

Overall, it appears that 2011 will be another busy year for exploration in Nunavut. Numerous companies have obtained, or continue to work under existing land use permits and water licenses to support exploration drilling for commodities such as gold, diamonds, iron and uranium.

Municipal news:
After lots of media attention in recent months about the state of landfills throughout Nunavut, it will be interesting to see what happens with the Iqaluit municipal water license as it is coming up for renewal this year. With the problems of what to do with waste and limited recycling options in the North, Iqaluit city council recently held public meetings to discuss solid waste management in the city. With a population of over 6,000, the City of Iqaluit's dump, despite a fire last year, is beyond capacity and a contract has been awarded to design a new solid waste facility.

Science news:
Lancaster Sound remains in the news with a proposal by Oceans North to study marine mammals and birds going to the Nunavut Impact Review Board in late April. Oceans North, an Arctic waters environmental group, has worked with the Qikiqtani Inuit Association in the past to protect Lancaster Sound.

Nuclear issues are in the news in the North but this time for a different reason. With the increased cost of fossil fuels and the North's reliance on aging diesel-powered generating plants, the Quilliq Energy Corp. is considering a nuclear solution. Micro-nuclear plants have been on QEC's radar for a while due to the lower cost than proposed hydroelectric projects.
www.cbc.ca/news/canada/story/2011/04/12/f-power-nunavut-nuclear.html

NWT Regional Update

Mining news:

- The Prairie Creek Mine Project environmental assessment continues with the analysis of the Developer's Assessment Report (DAR) and supplementary information submitted by Canadian Zinc Corp. The main issues of concern include effluent and water quality, spill prevention and preparedness for the access road through the Nahanni National Park, and wildlife protection.

- Court has wrapped up hearings on the Fortune Minerals NICO project environmental assessment. The cobalt-gold-bismuth-copper project has been caught in land tenure wrangling and jurisdictional challenges around inclusion of the access road in the environmental assessment. There will be a wait of several months before we hear the ruling of the Supreme Court of the NWT on the Tlicho government's challenge of the Review Board's decision to allow the Environmental Assessment to proceed.

- The Giant Mine Remediation Project environmental assessment has been delayed by 3 months, as a result of late release of intervener funding. The project includes the containment of 237,000 tonnes of arsenic trioxide dust currently stored underground, generated over 6 decades of mine production. The first test thermosyphons have been installed and are in the process of freezing the first arsenic vault into a massive ice cube. Public hearings will likely be held in late-August.

- In late December, De Beers and Mountain Province released the Environmental Impact Statement for the Gahcho Kue Diamond Project. The conformity check by the Mackenzie Valley Environmental Impact Review Board identified several areas requiring further work, with responses to be submitted by May 2nd and will revise the workplan after information is received. This project has some interesting aspects around partially dewatering a lake, mining the ore beneath it, then backfilling two of the three pits and rewatering the lake at closure. In addition to the water management concerns, there are issues with the disposal of mining wastes that must be resolved.

- Avalon Rare Metals Inc. will be submitting their Developer's Assessment Report to the Board by late May, for their Thor Lake Rare Earth Elements Project. The proposed rare earth and metals project is located just north of the Hearne Channel of Great Slave Lake. An underground operation is proposed, along with a processing plant and tailings management area near Thor Lake. A hydrometallurgical processing plant is proposed to be located at the old Pine Point Mine site. Extraction of rare earths from the ore is complex, with extensive steps using various reagents and processes. As China stockpiles rare earth elements, and restricts exports, there is a lot of impetus for REE exploration and development across Canada.

Information on current projects undergoing assessment is available from the Mackenzie Valley Environmental Impact Review Board site at http://www.mveirb.nt.ca/.

- The three active diamond mines (Ekati, Diavik, and Snap Lake) in the NWT continue operations, and have submitted monitoring and annual reports for 2010. Each mine has a comprehensive environmental monitoring program, and reports are available on the land and water boards' public registries at http://www.mvlwb.ca/default.aspx.

- Debeers is working on their Snap Lake Interim Mine Closure and Reclamation Plan, and on the Snap Lake aquatic effects monitoring program. The company's water licence expires Apr. 14, 2012 and a renewal application is expected soon.

- North American Tungsten continues production at the CanTung Mine. The mine has been continuing its environmental monitoring under the Metal Mining Effluent Regulations, as have several closed mines (Lupin Gold Mine, Giant Mine, and the Con Mine).

Information on projects in the Mackenzie Valley jurisdiction of the NWT can be found at http://www.mvlwb.ca/default.aspx.

Hydroelectric:

- Taltson Hydro Expansion: The Mackenzie Valley Environmental Impact Review Board released the Report of Environmental Review with their decision that the project could proceed subject to certain measures, and subject to the transmission line route being negotiated with the Lutsel K'e Dene First Nation. Given their adamant rejection of the transmission line going through their territory, it appears unlikely this development can proceed. The federal Minister of INAC referred the report back to the Board for further consideration as being incomplete without the transmission line assessment.

- The Northwest Territories Power Corporation was recently issued a licence for their Bluefish Hydro facility, to construct a new dam. Mercury associated with a new impoundment area was raised as an issue, and the Board has required monitoring and management plans to address concerns.

Oil & Gas:

- Paramount Resources continues production in the Cameron Hills area of the NWT, southwest of Hay River, with applications for land use permit renewals in process.
- The Mackenzie Gas Project received final approval early this year, with the caveat of no federal subsidies. This may mean the project is no longer economic, at a cost of $16B, and with lower natural gas prices than when first proposed. Other energy sources such as shale gas may be more attractive to oil companies. The NEB has issued the Certificate of Public Convenience and Necessity, and numerous other permits and authorization would be needed if Imperial was to proceed. The investment partners have until 2013 to make an investment decision, and construction must start by 2015 for the approval to remain valid.

Municipal:

Municipal field work is again planned at several communities across the North, to do comprehensive characterization of representative Northern systems in order to evaluate performance, as well as collection of sampling data from a number of other systems to round out the community data inventory. While the draft Wastewater System Effluent Regulations will not apply to the North until after 2014, it is necessary to collect information to determine what reasonable and appropriate performance standards might be for effluent from Northern systems. The regulations have not been brought into force yet; that is anticipated to happen in late 2011. Further information on the regulations is available at www.gazette.gc.ca/news-nouvelles/news-nouvelles-2010-11-02-eng

There are two "Type A" municipal water licence renewals coming up in the north: Iqaluit's licence expires May 15, 2011 and Fort Smith's licence expires Oct. 31st. These will involve a comprehensive review of the sewage and solid waste disposal practices, and future requirements.

Are you doing work in the North that you'd like to let others know about? Got an idea for a training course the CSEB could help organize? Please feel free to contact us, or to draft an article for the newsletter. The CSEB provides a valuable networking and communication forum! There is also the option of instigating other CSEB activities – both of the fun and/or of the educational variety - with colleagues in the north. Please email your thoughts to anne.wilson@ec.gc.ca or paula.c.smith@ec.gc.ca.

2011 Arctic Ungulate Conference

Challenges of Managing Northern Ungulates

2011 Arctic Ungulate Conference
August 22 to 26, 2011
Yellowknife, Northwest Territories

The 13th Arctic Ungulate Conference will address the difficulties of managing ungulate populations faced with the unpredictable effects of climate change, an ever-increasing human presence on the land and the challenges of developing recovery actions for declining caribou and reindeer populations, which are an integral part of Aboriginal cultures and ways of life.

The conference provides an excellent opportunity for biologists, managers, Aboriginal groups, co-management boards, researchers, students and resource users to discuss northern ungulate research and management with their circumpolar peers.

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Long-term Vertical Distribution and Abundance of the Phytoplankton Community of Meromictic Mahoney Lake in South-Central British Columbia, with Some Recent Coverage on Nearby Blue Lake

Submitted by T.G Northcote & K.J. Hall

Introduction

Saline lakes have long fascinated naturalists, biologists, and limnologists studying them over the world. In the late 1830s Charles Darwin in his first book - "Journals of Researches into the Natural History and Geology of the Countries Visited During the Voyage of H.M.S. Beagle Round the World", noted their special features and importance. See especially the two page section covered from it by Grady (2007) who noted that Darwin's discovery of organisms living in the highly saline waters of the Argentinian Lake Salina convinced him of the tenacity of life and the wonders of adaptation. This focus led later to outstanding developments in the field of evolutionary science.

But many saline lakes are shallow, often mixing from top to bottom at least seasonally, so they may not develop markedly different limnological conditions in their lower layers. Such was not the case over the several decades period (1960s to 2010s) that we have studied Mahoney Lake, and later Blue Lake (see relevant references in Northcote and Hall 2010), both being meromictic over much of our study period on them. See especially Wetzel (2001) pages 83-86 for a general discussion of meromictic lakes and their various types as well as terminologies used since it was first introduced by Findenegg (1937).

That Mahoney Lake (see Fig. 1A, B and C herein, as well as in Northcote and Halsy (1969)), can be meromictic was first discovered in June 1961 and its limnological conditions have been followed since then, often seasonally, up until early autumn 2010. Nevertheless at times over this five decal period Mahoney Lake has verged on being unimeromictic. Some general information on its holocene or near-holocene phytoplanktonic community has been published elsewhere (Overmann et al. 1993, Lowe et al. 1997, Heinrichs et al. 1997, Lowe et al. 1998, Hall and Northcote 2000), but here we give more detailed coverage of its phytoplankton community and vertical distribution. The purple sulphur bacterium (*Amoebobacter purpureus*) production in Mahoney Lake mixlimnion exceeded concomitant primary production by a factor of 7 (Overmann et al. 1999a). For nearby Blue Lake (see Fig. 1A, C), and also Northcote and Hall 2006, found it to be meromictic in mid September 2000, Phytoplankton production and biomass are given for both Mahoney and Blue lakes for 2001 (May to October) and 2003 (May to August); see Table 2 in Northcote and Hall (2010).

All phytoplankton samples have been stored since collection and preservation (Lugol solution) in glass vials at cool temperature in complete darkness. We summarize the phytoplanktonic information herein and note additional sampling periods and collections that have been made for Mahoney Lake, adding in recent work on Blue Lake.

The 50th edition of The Freshwater Biological Association Newsletter, Summer 2010, included a series of articles on the importance of collecting long term data, its use, and how crucial it is to continue such work. See especially McCullough and Sandelands (2010). Furthermore Gleich et al. (2010) outline fundamental conclusions about climate change effects, relevant to Mahoney and Blue lakes, that could have major effects on their overall limnology and especially on their phytoplankton communities: (1) world warming results from greater heat-trapping gases in its atmosphere; (2) much of their increase during the last century is caused by human activities; (3) natural causes are now overwhelmed by human-induced changes; these will threaten marine and inland water ecosystems, forests, and mountain environments. See also the relevant situation facing outskirt residences of Lima, Peru (Vince 2010), and also in parts of the U.S.A. (Gibbons 2010). Elsewhere studies with an experimental approach (Greig 2010) are being continued. Of direct relevance to Mahoney Lake studies is that of Lowe et al. (1998). Heinrichs et al. (1997) provided diatom-based paleosalinity reconstructions from the early postglacial to the mid and late Holocene (the past 11,000 years).

Further climate changes in western North America will cause a much drier climate there (Overpeck and Udall 2010) which may already have major effects on meromictic Mahoney Lake showing recent decline in surface water level of up to 5 m or more (Fig. 2A, B). 108 Mile Lake to the northwest has dropped over 2 m in recent years and is causing much local concern (Winter and Swan 2011). A large-scale and long-term experimental study on climate change effects and related stressors is being conducted in artificial ponds on the UBC campus to examine cumulative effects of warmer temperatures, nutrient manipulations, and changes in top predators over the past two years; contact: kratina@zoology.ubc.ca.

Methods

All phytoplankton samples have been stored since collections (mainly by a battery driven pump with 25 mm internal diameter plastic hose fitted with 4 bottom horizontal tubes 15 mm diameter, and preservation (Lugol solution) in glass vials at cool temperature in darkness. Phytoplankton present in Clarke - Bumpus samples from Mahoney Lake, 14 September 1966 were counted for three depths above the purple sulphur bacterial plate (2, 5.25, 6.5 m) with none present at 8.75 and 9.5 m except for *Oedogonium* sp. filaments at 9.5 m probably being dead because no light or oxygen occurred below the overlying purple sulphur plate (Northcote and Halsey 1969). Northcote and Hall (1983) give

more phytoplankton and enumeration methodology in late April 1982 samples, as well as Northcote and Hall (1990) for those of 22 May 1983 sampling, which provided vertical abundance data for chlorophytes, the most abundant major group, which exceeded 700 cells per mL between 3.5 and 4 m, followed by diatoms maximal at 4 m, and cyanophytes maximal at 1.5 m.

Detailed analysis to common genera and many to species is given herein in previously unpublished data of TGN for cyanophytes, diatoms, and chlorophytes, and other less abundant groups (chrysophytes, cryptophytes, and dinophytes) for months from May to December 1983, and February, March, April and May 1984.

Hall and Northcote (1990) cover further detailed phytoplankton primary production methodology from mid October 1983 through to October 1987. See Overmann et al. (1993) for paleolimnological methodologies they used to go back in time some 11,000 years for Mahoney Lake, as well as Overmann et al. (1999a,b) for coverage of present phytoplanktonic biomass and primary production methodology. Those used in following millenial to centurial limnological changes in the lake are given by Hall and Northcote (2000), as are seasonal, annual and decadal ones in Northcote and Hall (2000). See Hall and Northcote (2002) for methodologies used to follow midsummer chlorophyll *a*, phytoplanktonic abundance and production in midsummer 2000. Chlorophyll *a*, biomass and primary production in Mahoney Lake from spring to late summer of 2001 and 2003 methodologies are provided by Northcote and Hall (2010).

Results and discussion synthesis

Two phytoplanktonic genera were common in the mid-September 1966 sampling (Northcote and Halsey 1969). The unbranched filamentous chlorophyte *Oedegonium* sp. reached peak abundance at 5.25 m depth (261 filaments / mL), decreased to 174 filaments / mL at 6.5 m, and none recorded at 8.5 m, with those at 9.5 m found below the zero oxygen level at 8 m and very low illumination, most probably dead filaments. The circular to subcircular celled diatom Campylodiscus sp. was low in abundance at 2 m, peaked at 5.25 m (800 cells/ mL), decreasing to 108 at 6.5 m with none recorded at 8.75 and 9.5 m depths.

The next sampling series with phytoplanktonic algal data available was made on 28 April 1982. Surprisingly no chlorophytes were recorded then in the Mahoney samples although such genera were present to common in nearby non-meromictic Green Lake (Northcote and Hall 1983). Two cyanophyte genera were common from the surface to 5 m, along with seven chrysophyte genera and one cryptophyte species (*Chroomonas acuta*) near the surface.

Starting on 22 May 1983, further sampling series for phytoplankton were made almost monthly until 8 December 1983 at a series of depths down to 8 or 9 m in Mahoney Lake, and carrying on monthly from 26 February until May 1984 with another series on 24 November 1984. Phytoplankton densities for chlorophytes, diatoms, cyanophytes, others, and totals are given for the 22 May 1983 series at depths from surface to 7 m (Northcote and Hall 1990) and at more dates and depths from the nearly monthly sampling series. Most of these data have not been previously published so are assembled herein; see Table 1.

The 22 May 1983 vertical sampling series clearly showed two peaks in vertical phytoplanktonic abundance, and upper one at 1.5 m depth and an even higher one at 4 m for chlorophytes, diatoms, and totals (Fig. 3), continued on there in the mid June and July series for 1983. Peaks in phytoplankton abundance at 2 - 4 m depths during the spring periods of April - May of 1983 and 1984 occurred when Mahoney Lake was bimeromictic with a secondary salinity stratification (Northcote and Hall 1990) and was probably related to nutrient regeneration in this stratified layer as detritus accumulated and decomposition released nutrients for phytoplankton uptake. Primary production was stimulated by nutrient addition experiments in this hardwater meromictic lake (Hall and Northcote 1990), and oxygen super-stratification occurred in these these stratified areas (Northcote and Hall 1990).

Thereafter in the nearly monthly vertical sampling series spaced at close vertical depth series, no consistent pattern for the major phytoplanktonic groups or overhall abundance seems clearly evident except for an overall decrease for several major contributor groups in the February and March 1984 vertical depth series (see Hall and Northcote 2000, Northcote and Hall 2000) for long and short term changes in limnological conditions in Mahoney Lake).

Surface and groundwater inflow in the mid 1980s and again at least from 1996 to 1997 added considerable amounts of phosphate and nitrate nutrients to Mahoney Lake, which promoted dense phytoplankton concentrations (mainly *Chaetocerus*) with chlorophyll a levels over 6 micrograms per litre (Northcote and Hall 2000, Overmann et al. 1999a, b); see also Hall and Northcote 1990, 2002; Overmann et al. 1993, 1999a,b. Spring (May) water quality and nutrient levels for Mahoney Lake in 2003 and 2007 are given by Northcote and Hall (2010), as are their primary production and chlorophyll a levels for 2001 and 2003.

Acknowledgements

We thank Moira Greaven for her untiring field assistance over the many years of this research, and Heather Northcote for helping us get water level readings on several occasions, as well as putting up with formalin and Lugols solution odours and stains in our within house "laboratory". Dr. Ann Chapman on sabbatical leave from New Zealand and Dr. Elizabeth Cornejo from Peru spent long hours helping TGN in a major way identifying and counting Mahoney Lake phytoplankton samples in his UBC laboratory. Dr.Janet Stein, Department of Botany, University of British Columbia, helped greatly in checking algal identification. Over several decades of interchange between British Columbia and New Zealand, Heather and Tom Northcote enjoyed the best of inland water appreciation in both countries with Ann Chapman. Together we dedicate this publication to her with thanks for so many strong memories.

References

Findenegg, I. 1937. Homomiktishe und meromiktishe Seen. Int. Rev. ges. Hydrobiol. 35: 586¬610.

Gibbons, A. 2010. Going back to the future to understand climate change. Meeting Briefs. Science. 29 October 2010, Volume 330: 582.

Gleick, P.H. plus 255 coauthors. 2010. Climate change and the integrity of science. Science, Volume 328, 7 May : 689-690.

Grady, W. 2007. Dark waters dancing to a breeze. Greystone Books. Pages 37-39. The Lake of Salt, a section from Charles Darwin (1839).

Greig, H. 2010. Understanding the effects of climate change on freshwater ecosystems. Pages 18-19. In: Branchlines. The university of British Columbia. Faculty of Forestry, Vancouver, B.C.

Hall, K.J. and T.G. Northcote. 1990. Production and decomposition processes in a saline meromictic lake. Hydrobiologia 197: 115-128.

Hall, K.J. and T.G. Northcote. 2000. Long-term (millenial, centurial) changes in the limnology of a saline meromictic lake : causes and consequences. Verh. Internat. Verein. Limnol. 27: 2628 -2632.

Hall, K.J. and T.G. Northcote. 2002. Bimeromixis sharply intensifies primary production processes in a normally unimeromictic small saline lake. Verh. Internat. Verein. Limnol. 28 : 1304 - 1310.

Heinrichs, M.L., S.E. Wilson, I.R. Walker, J.P. Smol, R.W. Mathews, and K.J. Hall. 1997. (7) Midge and diatom based paleosalinity reconstructions for Mahoney Lake, Okanagan Valley, British Columbia, Canada, International Journal of Salt Lake Research 6: 249-267.

Lowe, D.J., J.D. Green, T.G. Northcote, and K.J. Hall. 1997. Holocene fluctuations of a meromictic lake in southern British Columbia. Quarternary Research 48: 100-113.

Lowe, D.J., J.D. Green, T.G. Northcote, and K.J. Hall. 1998. Fluctuations of a meromictic lake, containing Mazama ash: evidence for holocene climatic flickering? Symposium Inter-INQUA et Inter-INQUA et Inter-UISPP Tephochronologie et coexistence Homme¬Volcans, Le Puy, France 24-29 August 1998. Four pages.

McCullough, J. and S. Sandelands. 2010. Changing weather? Shifting seasons? The importance of collecting long term data. The Freshwater Biological Association Newsletter No. 50: 06.

Northcote, T.G. and T.G. Halsey. 1969. Seasonal changes in the limnology of some meromictic lakes in southern British Columbia. J. Fish. Res. Bd. Canada 26 : 1732-1787.

Northcote, T.G. and K.J. Hall. 1983. Limnological contrasts and anomalies in two adjacent saline lakes. Hydrobiologia 105: 179-194.

Northcote, T.G. and K.J. Hall. 1990. Vernal microstratification patterns in a meromictic saline lake: their causes and biological significance. Hydrobiologia 197: 105-114.

Northcote, T.G. and K.J Hall. 2000. Short-term (decadal, annual, seasonal) changes in the limnology of a saline uni-bimeromictic lake : causes and consequences. Verh. Internat. Verein. Limnol. 27: 2652-2659

Northcote, T.G. and K.J. Hall. 2006. Effects of water level changes on morphometric production indicators in two meromictic lakes. Internat. Verein. Limnol. 29: 1492-1496.

Northcote, T.G. and K.J. Hall. 2010. Salinity regulation of zooplanktonic abundance and vertical distribution in two saline meromictic lakes in south central British Columbia. Hydrobiologia 638: 121-136.

Overmann, J., G. Sandmann, K.J. Hall and T.G. Northcote. 1993. Fossil carotenoids and paleolimnology of meromictic Mahoney Lake, British Columbia, Canada. Aquatic Sciences 55 (1): 31-39.

Overmann, J. Beatty, J.T., and Hall, K.J. 1994. Photosynthetic activity and population dynamics of *Amoebobacter purpureus* in a meromictic saline lake. FEMS Microbiol. Ecol. 15: 309-320.

Overmann, J., Beatty, J.T., and Hall, K.J. 1996a. Purple sulfur bacteria control the growth of aerobic heterotrophic bacterioplankton in a meromictic lake. Applied Environmental Microbiology 62: 3251-3258. (8)

Overmann, J., Beatty, J.T., Krouse, H.R., and Hall, K.J. 1996b. The sulfhur cycle in the chemocline of meromictic Mahoney Lake. Limnology and Oceanography 41: 147-156.

Overmann, J., K.J. Hall, T.G. Northcote, W. Ebenhoh, M.A. Chapman and T. Beatty. 1999a. Structure of the aerobic food chain in a meromictic lake dominated by purple sulphur bacteria. Arch. Hydrobiol. 144 (2): 127-156.

Overmann, J., K.J. Hall, T.G. Northcote and J.T. Beatty. 1999b. Grazing of the copepod *Diaptomus connexus* on purple sulphur bacteria in a meromictic salt lake. Environmental Microbiology 1 (3): 213-221.

Overpeck, J. and B. Udall. 2010. Dry times ahead. Science 328: 1642-1643.

Vince, G. 2010. Out of the mist. Hydrology Newsfocus, Science 330: 750-751.

Wetzel, R.G. 2001. Limnology. Lake and river Ecosystems. Third Edition. 1006 pages. Winter, B. and A. Swann. 2011. 108 Mile Lake : a cautionary tale. B.C. Lake Stewardship Society, Volume 14, Issue 1: 5-7.

Table 1. Phytoplankton genera and species identified in near monthly vertical sampling series from mid-Mahoney Lake station 1, (0 to 7-9 m depths), 22 May 1983 to 24 May 1984.

CYANOPHYTES

1. *Anabaena* sp.
2. *Aphanocapsa* sp.
3. *Aphanothece* sp.
4. *Arthrospira* sp.
5. *Gomphosphaeria lacustris*
6. *Merismopedia glauca*
7. *Microcystis* sp.
8. *Sphaerocystis schroeteri*

DIATOMS

1. *Achnanthes defleca*
2. *Achnanthes inflata*
3. *Achnanthes minutisma*
4. *Amphiprora alata*
5. *Amphora coffaeiformis*
6. *Asterionella formosa*
7. *Campylodiscus* sp.
8. *Ceratoneis arcus*
9. *Chaetocerus* sp.
10. *Cocconeis placentula*
11. *Cymbella* sp.
12. *Denticula elegans*
13. *Diatoma heimale*
14. *Diatoma tenue*
15. *Fragilaria crotonensis*
16. *Frustulia rhomboides*
17. *Mastogloia grevillei*
18. *Navicula* sp.
19. *Rhopalodia gibba*
20. *Rhopalodia gibberula*
21. *Surirella* sp.
22. *Synedra cyclopon*
23. *Tabellaria, fenestrata*
24. *Tabellaria floccosa*

CHLOROPHYTES

1. *Ankistrodesmus falcatus*
2. *Botryococcus braunii*
3. *Closterium* sp.
4. *Cosmarium granutum*
5. *Elakalothrix gelatinosa*
6. *Euastrum pectinatum*
7. *Gloeocystis* sp.
8. *Kirchneriella* sp.
9. *Mougeotia* sp.
10. *Oocystis borgei*
11. *Staurastrum quadricuspidatum*
12. *Tetraedron minimum*
13. *Ulothrix* sp.

CHRYSOPHYTES

1. *Chrysocapsa* sp.
2. *Dinobryon* sp.
3. *Ocromonas* sp.
4. *Synura uvella*

CRYPTOPHYTES

1. *Cryptomonas* sp.
2. *Rhodomonas* sp.

DINOPHYTES

1. *Ceratium hirundinium*
2. *Gymnodinium* sp.

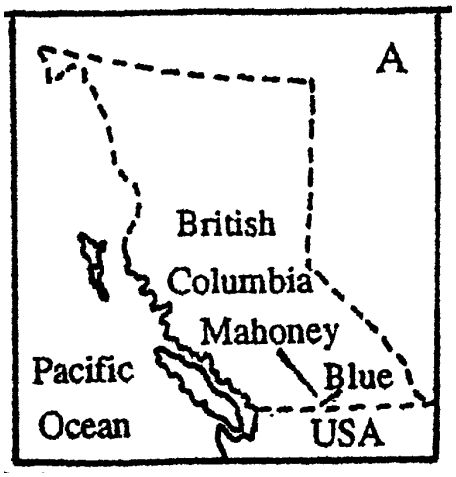


Figure 1A. General location of Mahoney and Blue lakes in south-central British Columbia.

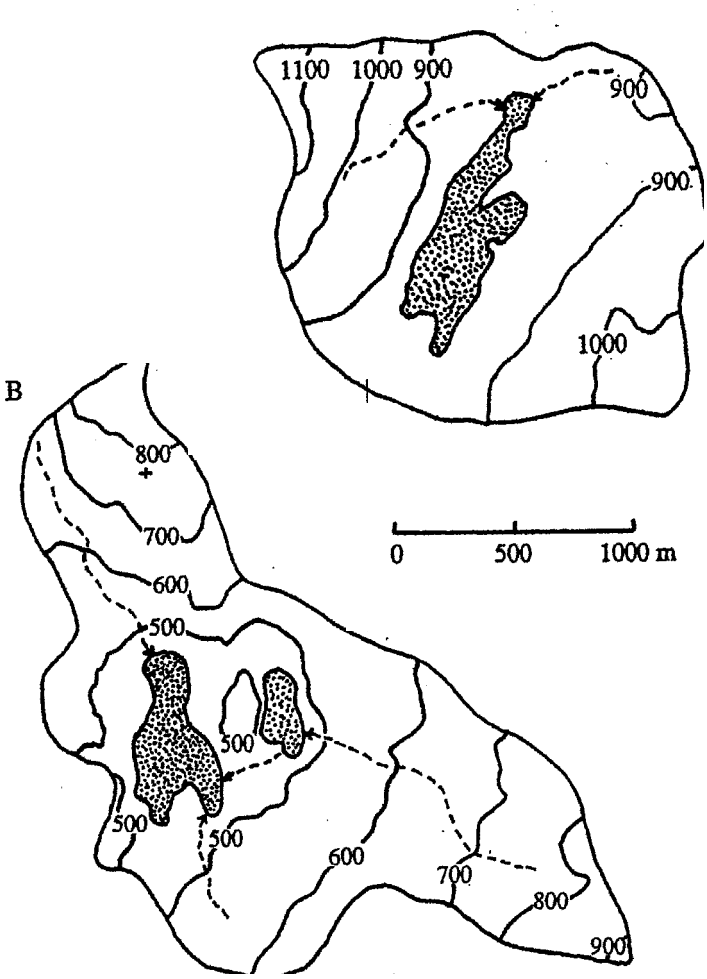
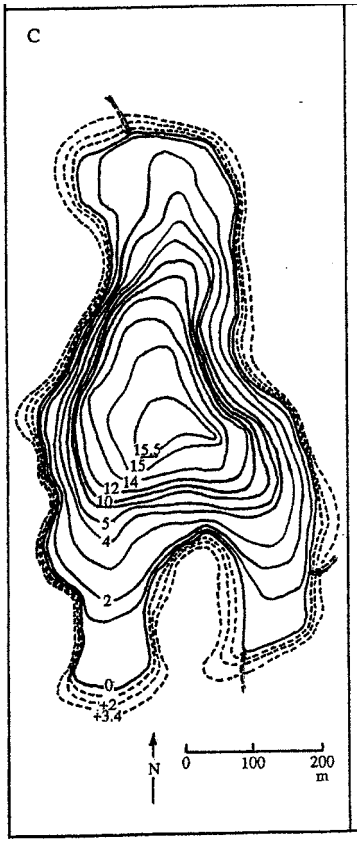
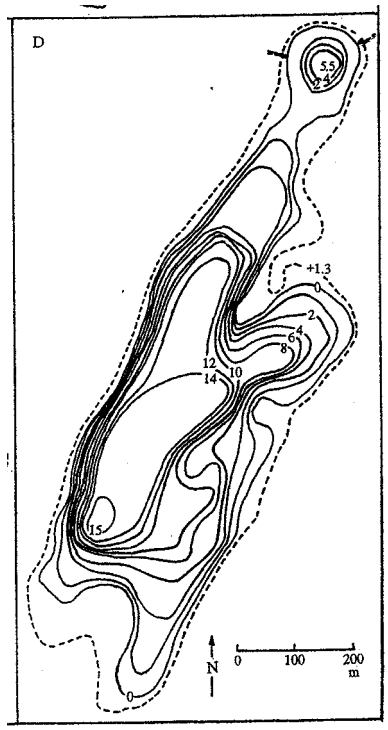


Figure 1B. Drainage basins of Mahoney Lake (bottom) and Blue Lake (top); elevations in metres.



MAHONEY LAKE



BLUE LAKE

Figure 1C & 1D. Depth contours of Mahoney Lake (top) and Blue Lake (bottom).

Figure 2A. MAHONEY LAKE, 4 October 2003, water level 472.15 m above sea level (Sleeping Water Lake, foreground).

Figure 2B. MAHONEY LAKE, northestern shoreline, 11 July 2004, water level 472.10 m. Dead standing tree above shoreline to left shows long-term saline highwater mark at 477.4 m above sea level on trunk (white), blackened above.

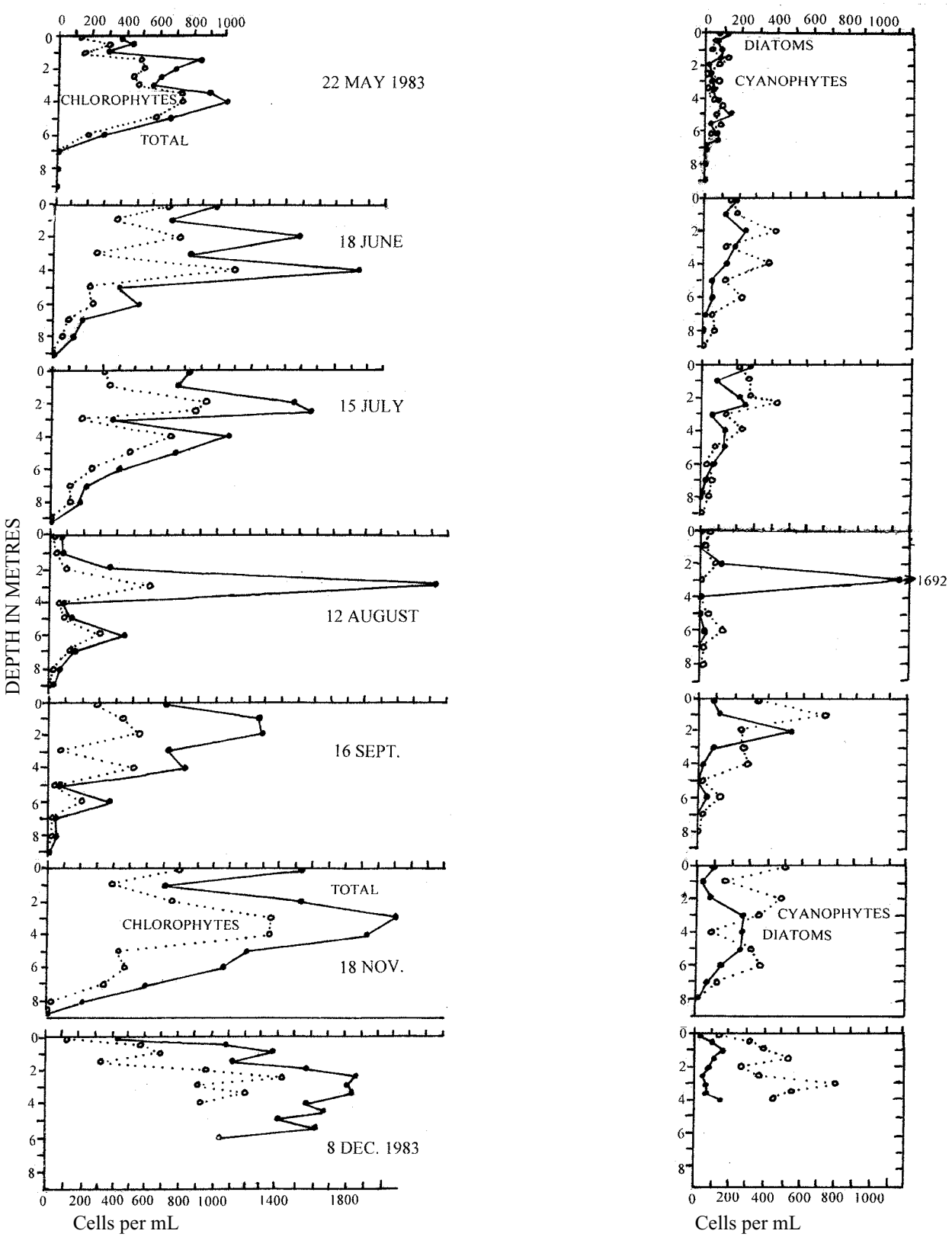


Figure 3A. Vertical distribution and abundance of major groups of phytoplankton in Mahoney L, central station 1, from 22 May to Dec. 1983.

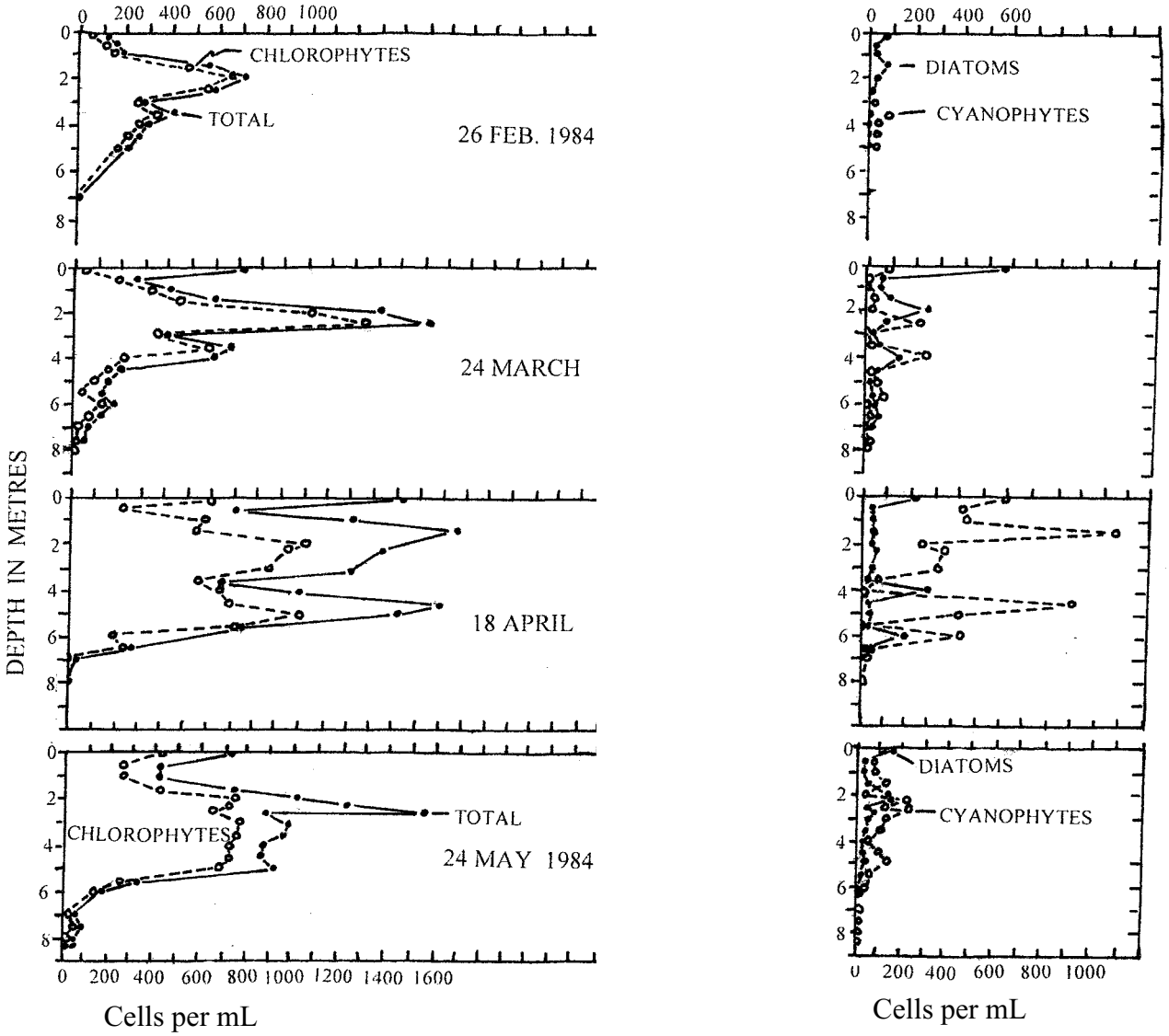


Figure 3B. Vertical distribution and abundance of major groups of phytoplankton in Mahoney L., central station 1 from 26 February to 24 May 1984.

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Monitoring the Health of the Bay of Fundy, Gulf of Maine[1]

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ABSTRACT:
The Bay of Fundy, its near-shore environments, its estuaries and watersheds currently face many pollution challenges, some new (e.g., plasticizers and some pesticides), some decades or even centuries old (e.g., pulp mill wastes, sewage). Amongst the pollutants are chemicals and nutrients from aquaculture, industrial chemicals and effluents, oil-derived hydrocarbons, metals and sediments from mining, and chemicals and pathogens from sewage. Non-point pollution and combined and cumulative effects of pollution are particular concerns. Although federal and provincial legislation, along with guidelines and regulations, has been in place for decades to control point-source industrial pollution (through the *Fisheries Act)*, and the introduction of "toxic chemicals" (through the *Canadian Environmental Protection Act*), the effectiveness of those regulations and guidelines demands considerable environmental monitoring by government agencies, researchers and community groups. Only with regular monitoring, reporting and follow-up action will there be assurance that the Bay's ecosystems are being adequately protected.

This paper briefly addresses monitoring the health of the Bay of Fundy – why we monitor, the challenges of multiple issues and the measurement of ecosystem health, a description of some of the monitoring programs (circa 2006) in the Bay, and new monitoring requirements to ensure protection of key species, ecosystems, and human health. This perspective is based in part on research on the concepts and key indicators of ocean health; work of the Gulf of Maine Council on the Marine Environment's Gulfwatch program (www.gulfofmaine.org); the inventory of coastal monitoring programs in Canada, including the Bay of Fundy, from the 2006 Ecological Monitoring and Assessment Program (EMAN) workshop; and BoFEP's contributions since 1995 (www.bofep.org).

Some needs for the Bay include: maintaining the longer-term monitoring of various waters, species and habitats; developing a more complete set of marine environmental quality guidelines to interpret monitoring data on water, sediments and biota; writing periodic State of the Bay of Fundy/Gulf of Maine reports, prepared with the involvement of a number of stakeholders; and re-engaging with the relevant policy and senior managers in government and industry responsible for preventing and controlling pollution, conducting key monitoring programs, and assessing and maintaining the health of the Bay's species and ecosystems.

1. INTRODUCTION

The Bay of Fundy, with its various near-shore environments, estuaries and watersheds, currently face many pollution challenges, some new (e.g. plasticizers, some pesticides, various endocrine disrupting chemicals in municipal effluents) and some decades old (e.g. pulp mill wastes, sewage, PCBs, DDT residues). Amongst the full range of pollutants are chemicals and nutrients from aquaculture, industrial chemicals and effluents, oil-derived hydrocarbons, metals and sediments from mining, and pathogens and chemicals from municipal effluents and raw sewage discharges (Wells et al. 1997; Percy 1996, 2004, 2006, 2008; amongst others). Non-point pollution is of particular concern, as many river basins such as that of the St. John River, discharge a mixture of sediments, nutrients, pesticides and many other toxic chemicals into the Bay on a continuous basis, and mercury largely from power plants continually enters from the atmosphere (see Harding et al. 2010). As shown by the *Gulf of Maine Council's Gulfwatch program* (Chase et al. 2001; Jones et al. 2001), intertidal organisms such as blue mussels in the Bay are being exposed temporally and spatially to a wide range of chemicals dissolved or dispersed in water, in and on sediment particles, and in the food chain. This is leading to concerns about which chemicals are solely contaminants (levels too low to cause measurable toxic effects), which are pollutants (levels are high enough for long enough time to cause measurable toxic effects), and which combine and last long enough to cause cumulative toxic effects directly on biota or their habitat quality. The Bay of Fundy is large (290 km long, 100 km wide at outer bay, approx. 16,000 km^2) and salt-water exchange is in the billions of tonnes, twice daily. However, as shown by monitoring programs, organism tissues and the marine sediments reflect chemical exposures in numerous settings, often with unknown biological consequences.

National and provincial legislation has been in place in Canada since the early 1970s to control point-source industrial pollution, such as that from food processing plants, fish plants, and oil refineries, e.g., the *Fisheries Act,* oil refinery regulations and guidelines. However, the effectiveness of such regulations and guidelines controlling toxic effluents and single chemicals under the different Acts (e.g., federally, *the Fisheries Act, Canadian Environmental Protection Act,* and *Pesticide Control Act*) demands considerable compliance monitoring (at the industrial source) and ambient environmental monitoring by government agencies, researchers, community groups, and the industries themselves (see Blaise et al. 1988; Day et al. 1988; Blaise 2003). Both types of monitoring are critical to ensure that accepted emission standards are being met and that the Bay's ecosystems and organisms are being adequately safeguarded.

This paper briefly introduced the topic for the benefit of the Fundy Pollution Workshop (Burt and Wells 2010) – why we monitor; the challenges of addressing multiple pollution issues; the measurement of ecosystem condition or health through use of common indicators; some of the current (circa 2006) monitoring programs in the Bay of Fundy and their results; and monitoring

needs to ensure protection of key species, habitats, ecosystems, and human health. This view of monitoring is based in part on a recent consideration of the concepts and key indicators of ocean health related to the bay (Percy and Wells 2002; Wells 2003, 2005; Wells et al. 2005); work of the Gulf of Maine Council on the Marine Environment's (GOMC) Gulfwatch program (www.gulfofmaine.org; Chase et al. 2001; Jones et al. 2001; Jones and Wells 2002; Pesch and Wells 2004), and the ESIP program (Ecosystem Indicators Program, C.Tilburg, pers. comm.); BoFEP's sponsored research and syntheses since 1995 (www.bofep.org); and the inventory of coastal monitoring programs in Canada, including the Bay of Fundy, from the 2006 Ecological Monitoring and Assessment Program (EMAN) workshop (Hazel et al. 2006). This work should also be considered within the broader overview of monitoring ocean health in Canada (see Strain and MacDonald 2002).

2. MONITORING THE BAY OF FUNDY – A SYNOPSIS

2.1 WHY DO WE MONITOR?

Through various programs, the Bay's ecosystems or their components are monitored to address specific questions – What is the present health or condition of the bay? Are conditions improving, deteriorating, or staying the same? Are there unsuspected environmental problems in the Bay? To answer these questions successfully, we need to monitor with indicators or measurements of various kinds that collectively can provide data on the Bay's health (Wells 2003, 2005; Wells et al. 2005) and analyse the data using the methods and models of ecological risk assessment. Because our suite of current techniques that can deployed across the Bay is limited (e.g. the ESIP-GOMC program identifies only three indicators for contaminants – coliform bacteria, chemical residues in mussels, and TRIAD data; see GOMC website), new and more sensitive monitoring methods are needed, using the knowledge and skills of chemistry, biochemistry, ecotoxicology, ecology and statistics. We also need to ensure that there is enough information to adequately answer the above questions and that this information is used to make the right decisions to protect the Bay (see the Fundy Information Collaboratory at www.bofep.org, and the Environmental Information: Use and Influence study at www.eiui.ca). Finally, adequate resources (e.g. institutional, financial, scientific, regulatory) to keep the monitoring programs operating in both the short and long term are fundamental to their success, a constant challenge and concern for those involved in monitoring.

2.2 WHAT ARE THE CHALLENGES OF MONITORING?

Monitoring faces at least three primary challenges in the Bay of Fundy. The first challenge is to sort out the number and complexity of the stresses confronting the Bay i.e. the issues, be they ones of resource extraction or environmental change, including contamination and pollution. The second challenge is the need to understand the dimensions of ecosystem health and to have appropriate and sensitive indicators of the Bay's health included in monitoring programs, paying particular attention to having enough statistical power with each indicator to detect significant change in the ecosystem, and to establish correlative and/or cause-effect relationships. The third challenge is to find funding for programs over the long term, to provide credible spatial and temporal data.

Thirty-eight issues were identified for the Bay at the 1996 Bay of Fundy workshop (Percy et al. 1997). At the 2007 Aquatic Toxicity Workshop in Halifax (www.atw.org), a wide range of water quality issues currently studied and in the media were reported (Wells 2008), including the following:

- pesticides (Minas Basin - freshwater quality was No 1 issue due to concerns about presence of pesticide residues in groundwater and well water);
- herbicide use - Vision, using glyphosate as active ingredient, over woodlots in Cumberland Co., NS; and past use , such as Agent Orange use in DND property at Camp Gagetown, NB., and persistent forest pesticides used since the 1940s;
- specific contaminants, e.g. oil pollution and wildlife, relative to both offshore oil spills and coastal oiling;
- chemical effects at aquaculture sites - heavy metals (e.g., Hg) and pesticides;
- contaminants in sediments from dredging operations in harbors;
- mercury, nitrogen and sewage, considered by the GOMC as the priority chemical stresses in the Gulf of Maine;
- effects of industrial and municipal operations e.g. impacts of fish plant effluents on coastal water quality;
- risks from LNG tankers in outer Bay of Fundy; and
- mining – potential impacts of sediment mineral extraction operations proposed for estuaries (e.g. Shubenacadie River, NS).

In a recent paper on emerging issues in the Gulf of Maine (Wells 2010), the list of current issues was long – they include (alphabetically) aquaculture impacts; coastal development and land use; hydrocarbon transport; coastal development in the GOM region; industrial chemicals and effluents; mining, including aggregate extraction from the bottom; nutrients, eutrophication, and algal toxins; sewage (organic loading, chemicals, pathogens); toxic chemicals, including pesticides; and the impacts of energy removal by tidal power projects. It is well known and documented that the Bay is exposed to a myriad of physical and chemical stressors on a daily basis (many refs, see the Fundy Information Collaboratory at www.bofep.org). Despite the large water and sediment volumes, and the twice daily flushing with large tides (up to 18m), the potential exists for effects caused by or related to these issues and other issues to occur, or for the contamination to become pollution. There is widespread industrial/toxic chemical contamination but relatively little evidence to date of pollution per se e.g. adverse toxic effects in the Bay (Wells et al. 1997). However, there are some cases of pollution; they include the benthic effects of dredging spoils at the ocean disposal site (outer Saint John Harbor) (Tay, Environment Canada, pers.comm.), historic impacts of pulp mill pollution on the L'Etang Estuary (Wildish, many papers), the widespread occurrence of imposex (a reproductive disorder) in marine gastropods (Prouse, unpubl. data), and the bioaccumulation of many compounds in mussels, marine mammals and likely other animals in the food webs, such as trace compounds in mussels (Chase et al. 2001), mercury in the pelagic food web (Harding et al. 2010) and pesticides in lobsters (Burt and Wells 2010).

A major challenge is determining what the criteria are for health and ecosystem health for the Bay, and ensuring that appropriate physico-chemical, biological and ecological indicators are monitored. In popular usage in the environmental context, health is a broad term referring to the state or condition of the oceans habitats and species, in this case the Bay of Fundy. The formal definition is freedom from or coping with disease, and having the capacity for maintaining organization or renewal, i.e. it is a measure of structure and functioning of the ecosystem under stress, in the short term (Wells 2003, 2005). If the Bay is healthy, species and ecological processes are present and functioning as expected e.g. fish are present, feeding, growing, developing and reproducing, and species generally resident in the NW Atlantic are present. But present ecological conditions may be much different from baseline, original or pristine conditions (pre-European settlement), the comparison having to be made over many years, and referred to as changes in environmental quality, ecosystem health and ecological integrity e.g. species diversity is diminished (e.g. some species are extinct or extirpated, such as sea lions), individuals are smaller (e.g. tuna, halibut), reproductive potential is diminished (e.g., smaller fish produce fewer eggs), and community structure is reduced, as has occurred on Georges Bank. The terminology and concepts were described by Wells (2003, 2005), among others, in an attempt to clarify the discussion of health and ecosystem health in the Bay of Fundy and Gulf of Maine.

One other useful model is that of health assessment, used by the medical fraternity and applicable to marine ecology and pollution studies. From medicine, the physician identifies symptoms; identifies and measures vital signs; makes a provisional diagnosis; conducts tests to verify diagnosis; makes a prognosis; and prescribes a treatment. In marine pollution studies, we make measurements in the field; identify unusual or unexpected conditions; monitor and investigate, including both laboratory and field approaches; interpret the data; and initiate management responses and additional monitoring. This approach is applicable to the Bay of Fundy and greater Gulf of Maine (Wells 2003, 2005).

Choosing appropriate indicators and conducting long-term monitoring programs plays a pivotal role in describing the health and ecosystem health of the Bay (Strain and MacDonald 2002; Wells et al. 2005; Tilburg, C., pers.comm.). This paper is a brief description of some of the ongoing monitoring programs, leaving out the complex discussion of deciding what to measure in the short term, what to measure over the longer term, and how to decipher the data relative to marine environmental guidelines, objectives, and standards.

2.3 WHAT ARE WE CURRENTLY MONITORING IN THE BAY OF FUNDY?

At the EMAN (Ecological Monitoring and Assessment Network) Workshop summary of February 2006, at least 30 programs were described for the Bay of Fundy, and some of these are mentioned below (see Hazel et al. 2006). On the current GOMC website, the GOM Monitoring Programs Summary lists 88 programs, run by government agencies and non-government groups. For the Bay of Fundy, both efforts supplement the summary made for the EMAN-BoFEP-Monitoring Workshop in November 1997 (Burt and Wells 1998).

The major programs circa 2006 include the following:

• Fisheries and Oceans (DFO)

- AZMP (Atlantic Zonal Monitoring Program)
- CHS (Canadian Hydrographic Service)
- Rockweed monitoring (mariculture)
- GoMOOS (Gulf of Maine Ocean Observing System)
- HAB (Harmful Algal Blooms)
- Benthic macrofaunal changes

• DFO/EC/Canadian Food Inspection Agency (CFIA)

- MSSP (Maritime Shellfish Sanitation Program)

• Environment Canada

- Chemical contaminants (Gulfwatch-mussels; seabirds).
- Air Quality.
- Canadian Wildlife Service wildlife programs.
- Disposal at sea site monitoring.
- Parks Canada Atlantic Coastal Monitoring programs.
- Seabird ecology and monitoring.

The Canadian Wildlife Service (EC) programs include the following:

• Habitat

- Coastal Habitat Distribution and Abundance - National Wetlands Inventory - Satellite Remote Sensing of Aquatic Vegetation (1985 -).
- Eelgrass Distribution and Abundance (1985 -).

• Birds

- Coastal Waterfowl Surveys (1960s -).
- Harlequin Duck surveys (1990's -).
- Phalarope Surveys and Plankton tows (2002 -).
- Salt Marsh Bird Surveys (2000-02).
- Tern and Gull surveys (1966 -).
- Eastern Waterfowl Survey (1988 -).
- Maritimes Shorebird Surveys (1974 -).
- Piping Plover banding (1990 -).
- Shorebird Banding (1981-2004).

The community led programs include the following:

- Atlantic Coastal Action Program (ACAP, developed in partnership with EC in all Atlantic Provinces) e.g., ACAP Saint John (NB), CARP (clean Annapolis Project).
- Ecology Action Center (EAC) Saltmarsh Restoration Study (NS).
- Bird Studies (Canada).
- Clean Nova Scotia.

An example of industry led monitoring is as follows:

• The Magaguadavic River Wild and Escaped Farmed Atlantic Salmon Monitoring Program

- runs from April to November each year.
- enumerates nos. of wild and escaped farmed salmon entering the rivers of western Fundy.
- screens fish for sea lice burden
- screens for viral and bacterial pathogens (DFO)
- operated by Atlantic Salmon Federation since 1992.
- also includes census of annual gaspereau run.

The data and information produced from these programs can be found with Google and WAVE searches e.g., Gulfwatch mussel data, 1993-2008, are on the Gulf of Maine Council's website www.gulfofmaine.org. There are dozens of programs, covering a range of species, habitats and biological processes. To date, there unfortunately has been no attempt to summarize the data on all of these programs and give a definitive, multi-parametric statement of the Bay's health. Rather, there have been exemplary individual efforts such as that of Hargrave et al (2005), to describe the environmental effects of the salmon aquaculture industry, and Harding et al. (2010) to describe mercury in the bay's food chain. More efforts such as these are needed.

2.4 WHAT DOES THIS MONITORING TELL US ABOUT THE HEALTH OF THE BAY OF FUNDY?

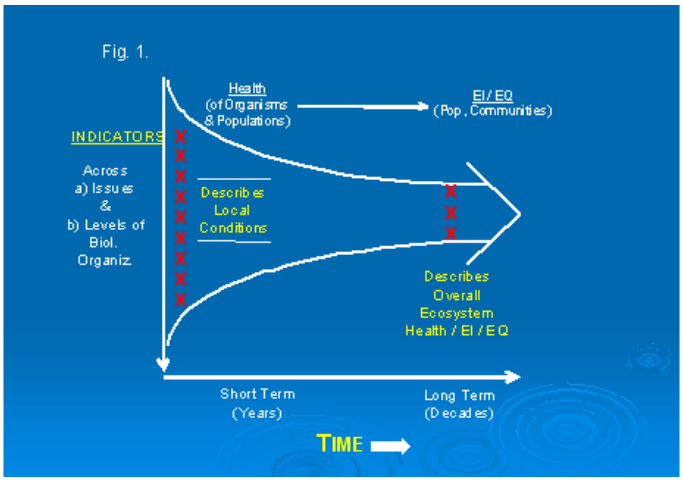
A number of messages are clear from the various monitoring programs underway. The linkages between land based activities and coastal health are "real" – we must monitor the watersheds and estuaries, as well as coastal waters. The Bay's ecosystem is functioning but its integrity has changed and declined, largely through the removal of species or species biomass, the transformation of most salt marshes to agricultural land, and the physical blocking of many water bodies with dams and other barriers (many refs). Biodiversity has been reduced; some species are at risk (e.g., Atlantic salmon, sturgeon, American shad, sea cucumbers, phalaropes). Some habitats have undergone marked changes and reduction (e.g., wetlands such as saltmarshes). The ecosystem is exposed to a wide range of chemicals, with some effects (e.g., imposex, bioaccumulation in tissues). Cumulative change of the whole ecosystem is not fully understood nor described comprehensively, a prerequisite to appropriate regulatory use of the monitoring data, and the deployment of precautionary measures to prevent further degradation.

3. WHAT ELSE IS NEEDED? – RECOMMENDATIONS.

Numerous monitoring needs remain for the Bay of Fundy. The established longer-term monitoring programs of various waters, species and habitats, such as Gulfwatch and others as above, need to be maintained and resourced. The longer term monitoring programs need to use a standard set of indicators for priority issues, achieved through consensus as in ESIP (Ecosystem Indicators Program) of the GOMC (C.Tilburg, pers.comm.). We need to progress from reporting on the status of multiple single indicators to reporting on the bay's health using one or more comprehensive indices (Figure 1), as with the stock market. A more complete set of marine environmental (water, sediment, tissue) quality guidelines to interpret monitoring data on water, sediments and biota is needed urgently, using mechanisms such as the CCME (Canada); this was strongly recommended by Arthur Hanson in his keynote talk at the 2004 BoFEP Bay of Fundy Science Workshop (Hanson 2005, in Percy et al. 2005).

A series of State of the Bay of Fundy/Gulf of Maine reports, prepared by a full range of stakeholders using current monitoring data, should get underway more quickly, as directed by the 2004 GOM Summit and 2009 RARGOM GOM Conferences. These have started as of June 2010 as theme papers under GOMC sponsorship, and are on the web (www.gulfofmaine.org); they may eventually contribute to a full synthesis report. Finally, following from the example of the UNH workshops in December 2002 and January 2004, monitoring specialists and environmental scientists should engage more frequently to exchange information and to have formal discussions with policy and decision makers in government and industry responsible for preventing and controlling pollution and maintaining the health of the Bay of Fundy and the greater Gulf of Maine.

Figure 1. A hypothetical view of what is required for monitoring the health and ecological integrity of the Bay of Fundy. The numbers of environmental indicators change with the monitoring objectives, and over time and space. For describing local conditions in the short term (months to years), many specific or unique measures of the ecosystem are required, obtained by monitoring individual organisms or their populations (as done by local community groups). In the longer term (years to decades), monitoring the greater Bay of Fundy requires a few key indicators (as resolved by the ESIP program and used by government agencies), preferably expressed collectively as one or more indices of the ecosystem health or ecological integrity of the entire bay. Some of the key indicators may be the same as used for shorter time monitoring, but institutionally will be deployed over long time periods to produce the data required to analyse for spatial and temporal trends.



4. REFERENCES

Blaise, C. 2003. Canadian application of bioassays for environmental management: a review. In M. Munawar. Ed. Sediment Quality Assessment and Management: Insight and Progress. Aquatic Ecosystem Health and Management Society, Burlington, ON, Canada. p. 39-58.

Blaise, C., G. Sergy, P.G. Wells, N. Bermingham, and R. VanCoillie. 1988. Biological testing – development, applications and trends in Canadian Environmental Protection laboratories. Toxicity Assessment 3:385-406.

Burt, M.D.B. and P.G.Wells. (Eds.). 1998. *Coastal Monitoring and the Bay of Fundy*. Proceedings of the Maritime Atlantic Ecozone Science Workshop (EMAN/BOFEP), St. Andrews, N.B. HMSC Technical Report, Huntsman Marine Science Centre, St. Andrews, N.B. 196p. ISBN 0-9692542-4-5.

Burt, M.D.B. and P.G.Wells. (Eds.). 2010. Proceedings of the BoFEP Fundy Pollution Workshop April 30th, 2010. www.bofep.org

Chase, M.E., S.H. Jones, P. Hennigar, J. Sowles, G.C.H. Harding, K. Freeman, P.G.Wells, C. Krahforst, K. Coombs, R. Crawford, J. Pederson and D. Taylor. 2001. Gulfwatch: Monitoring spatial and temporal patterns of trace metal and organic contaminants in the Gulf of Maine (1991-1997) with the blue mussel, *Mytilus edulis* L. Mar. Pollut. Bull. 42(6): 491-505.

Day, K.E., E.D. Ongley, R.P. Scroggins and H.R. Eisenhauer. (Eds). Biology in the New Regulatory Framework for Aquatic Protection. Proceedings of the Alliston Workshop, April 26-28, 1988. National Water Research Institute, Burlington, ON.

Hanson, A. 2005. The future: "Who should speak for the oceans? New and emerging ideas for ocean management". Pages 23-32 in Percy et al. (2005).

Harding, G.C.H., et al. 2010. The mercury flux in the Bay of Fundy, Gulf of Maine, and its bioaccumulation in the pelagic, demersal and benthic food webs. In Burt, M.D.B. and P.G.Wells. (Eds.). 2010. Proceedings of the BoFEP Fundy Pollution Workshop April 30th, 2010. (www.bofep.org)

Hargrave, B.T. (Ed.) 2005. Environmental Effects of Marine Fish Aquaculture. Springer-Verlag, Berlin, Heidelberg. 494p.

Hazel, F., M. Doyle, S. St. Jean, S. Courtenay, S. Kennedy and P.G.Wells (Editors and Contributors). 2006. Proceedings of the EMAN Near-shore Marine Ecological Monitoring Workshop, February, 2006, Bedford Institute of Oceanography, Dartmouth, NS. Ecological Monitoring and Assessment Network (EMAN), Environment Canada, Burlington, ON.

Jones, S.H., M. Chase, J. Sowles, P. Hennigar, N. Landry, P.G.Wells, G.C.H. Harding, C. Krahhforst, and G.L. Brun. 2001. Monitoring for toxic contaminants in *Mytilus edulis* from New Hampshire and the Gulf of Maine. J. Shellfish Res. 20(3):1203-1214.

Jones, S.H. and P.G. Wells. 2002. Gulf of Maine Environmental Quality Monitoring Workshop, Portsmouth, NH, April 30-May 1, 2001. Proceedings. Publication of the Gulf of Maine Council on the Marine Environment, Augusta, ME. November 2002. 37p.

Percy, J.A. 1996. Fundy's watery wastes? Pollution in the Bay of Fundy. BoFEP Fundy Issues No. 8, Autumn 1996. (www.bofep.org)

Percy, J.A. 2004. Contaminants concerns. Heavy metals and the Bay of Fundy. BoFEP Fundy Issues No. 25, Spring, 2004. (www.bofep.org)

Percy, J.A. 2006. Parlous POPs. Persistent organic pollutants in the Bay of Fundy. BoFEP Fundy Issues No. 27, Spring, 2006. (www.bofep.org)

Percy, J.A. 2008. Flushed with tide. Municipal effluents in the Bay of Fundy. BoFEP Fundy Issues No. 28. Autumn, 2008. (www.bofep.org)

Percy, J.A., and P.G.Wells. 2002. Taking Fundy' pulse. Monitoring the health of the Bay of Fundy. BoFEP Fundy Issues No. 22. Autumn, 2002. (www.bofep.org)

Percy, J.A., P.G.Wells and A. Evans. (Eds). 1997. *Bay of Fundy Issues: A Scientific Overview*. Workshop Proceedings, Wolfville, N.S., Jan. 29-Feb. 1, 1996. Environment Canada - Atlantic Region, Occasional Report No. 8, March 1997. Environment Canada, Dartmouth, N.S. and Sackville, N.B. 191p. ISBN 0-662-25570-4.

Percy, J.A., A.J. Evans, P.G. Wells and S.J. Rolston. (Eds.). 2005. *The Changing Bay of Fundy:* Beyond 400 Years. Proceedings of the 6th Bay of Fundy Workshop, Cornwallis, Nova Scotia, September 29th-October 2nd, 2004. Environment Canada-Atlantic Region, Occasional Report No. 23. March 2005. Environment Canada, Dartmouth, NS. 480 pages.

Pesch, G.G. and P.G.Wells. (Eds.). 2004. *Tides of Change Across the Gulf. An Environmental Report on the Gulf of Maine and Bay of Fundy.* Gulf of Maine Council on the Marine Environment, Augusta, ME. 81p. (plus appendices; also publ. as CD).

Strain, P.M. and R.W. MacDonald. 2002. Design and implementation of a program to monitor ocean health. Ocean and Coastal Management 45:325-355.

Wells, P.G. 2003. Assessing health of the Bay of Fundy – concepts and framework. Mar. Pollut. Bull. 46: 1059-1077.

Wells, P.G. 2005. Chapter 17. Assessing marine ecosystem health – concepts and indicators, with reference to the Bay of Fundy and Gulf of Maine, Northwest Atlantic. In Jorgensen, et al. *Handbook of Ecological Indicators*, Francis and Taylor/ CRC Press, Boca Raton, Fl., pages 395-430.

Wells, P.G. 2008. Navigating new waters in aquatic toxicology - the challenges of assessing and protecting the health of aquatic ecosystems in Canada. ATW 2007, Invited Plenary Paper. In the 34th Aquatic Toxicity Workshop, Halifax NS., Proceedings. (see www.atw.org).

Wells, P.G. 2010. *Emerging Issues*, Circa 2010. A GOMC State of the Gulf of Maine Theme Paper. Gulf of Maine Council on the Marine Environment. (www.gulfofmaine.org). June 2010. 20p.

Wells, P.G., P.D. Keizer, J.L Martin, P.A.Yeats, K.M.Ellis and D.W.Johnston. 1997. Chapter 3. The Chemical Environment of the Bay of Fundy. Pages 37-61 in Percy, J., P.G.Wells, and A.J. Evans. (Eds.) *Bay of FundyIssues: A Scientific Overview.* Environment Canada – Atlantic Region, Occasional Report No. 8. Environment Canada, Dartmouth, NS.

Wells, P.G., J. Harvey, J.A. Percy, G.R. Daborn, and S.J. Rolston. (Eds). 2005. *The Bay of Fundy Coastal Forum. Taking the Pulse of the Bay.* A GPAC-BoFEP Coastal Forum, held May 15-16th, 2002, as part of the 5th Bay of Fundy Science Workshop, Wolfville, Nova Scotia. Environment Canada-Atlantic Region, Occasional Report No. 25. March 2005. Environment Canada, Dartmouth, NS. 44 pages.

CSEB FINANCIAL REPORT FOR 2010

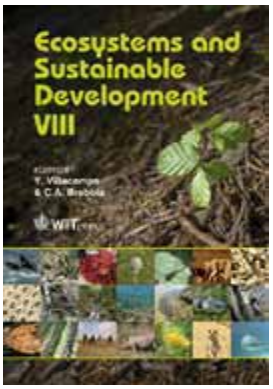
(by Karen March, CSEB Secretary - Treasurer - May 2011)

Cash in bank as of Dec. 31 2009 (from bank statement)*	$11,193.45
Receipts	
Membership Fees	
**(paypal of 558.38 not deposited til Jan.11)	$7,700.46
Including NRC Journals	
Publication Sales	$0.00
Bank Interest	$0.00
Contributions	$0.00
Total	$7,700.46
	Expenses
Newsletter Production	$4,669.23
V66.4wint09 – 1229.55	
V67.1spr10-1191.75	
V67.2sum-1105.13	
V67.3fall –1142.8**	
Newsletter Mailout	$1,344.31
V66.4-318.68	
V67.1-410.5	
V67.2-291.33	
V67.3-323.8**	
Membership Renewal (and cards)	$ 511.52
Administration (Board)	$0.00
Phone Conferencing	$ 584.49
To date – Dec. 2009 44.04,	
Feb. 54.22,	
May 142.30,	
Sept. 29.08	
Jan11 314.85**	
Mail Redirect and Mail Box (299.45+250)	$ 549.45
Journals	$ 1,029.00
Administration (CEN membership)	$ 30.00
Chapter Rebates	$0.00
Web Charges	$ 69.98
Bank Charges	$ 10.08
Society registration (federal	$ 30.00
Total	**$8,828.06**
Difference	- $1,1127.60
Cash in bank as of Dec. 29 2010 (from bank statement)	$11,750.09
GIC investment (value as of Dec. 31 2010)	$ 1,512.76

Bank balances are provided for information purposes.
*Dec. 2009 bank statement does not reflect 2009 expenses for fall v66 newsletter and mailsort $1428.79
**Dec. 2010 bank statement does not reflect 2010 expenses for fall newsletter and mailsort and fall phone conferencing ($1781.45) or paypal deposit of 558.38

BOOK REVIEW

Ecosystems and Sustainable Development VIII



Editor: Y. VILLACAMPA, Universidad de Alicante, Spain

C. A. BREBBIA, Wessex Institute of Technology, UK

The book *Ecosystems and Sustainable Development VIII* contains most of the papers presented at the Eighth International Conference on Ecosystems and Sustainable Development, held in Alicante, Spain, April 13-15, 2011. This biennial conference is the latest in a well established series that covers various aspects of ecosystems and sustainable development, including physical sciences and modelling. The book is dedicated to honor the memory of the late Professor Enzo Tiezzi, who died on 25th June 2010 and was to have been co-chairman of the conference.

The papers contained in the book are organized into sections on Ecosystems modeling, Natural resources management, Environmental indicators, Sustainable development studies, Data Mining applications, Energy and the environment, Soil contamination, Waste management, and Ecotoxicity.

Ecosystems and Sustainable Development VIII is Volume 144 in the **WIT Transactions on Ecology and the Environment**. Abstracts and Open Access papers (free) and full text ($30 per paper) of individual papers in the book are available through the electronic edition of the Transactions in the E-library section of our website.

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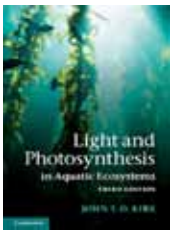
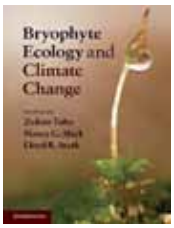


Kirk, J.T.O. 2011. *Light and Photosynthesis in Aquatic Ecosystems*. Cambridge University Press. Paperback, $90 US.

King, J. 2011. *Reaching for the Sun. How Plants Work.* Cambridge University Press. Paperback, $40.00 US



Tuba, Z, N.G. Slack, and L.R. Stark. 2011. *Bryophyte Ecology and Climate Change.* Cambridge University Press. Paperback, $60.00.

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