



Newsletter / Bulletin

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Date of Issue - **June 2006**

Cover Photo: Top three photos of Lorelei Benoit, sampling benthic invertebrates (left side) and filtering water for chlorophyll analyses (right side); sampling conducted with Dr. Suzanne McGowan at Attenborough Ponds in Nottingham, UK. Photo (bottom) by Carol Churchward DFO, participants in a bioengineering/stream stabilization workshop on the Pembina River near Hinton Alberta.

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CSEB NEWSLETTER 2006

Vol. 63, Number 2 Summer 2006

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:** Sean Sharpe, Editor, PO Box 962, Station F, Toronto ON; e-mail: Sean.Sharpe@gems9.gov.bc.ca

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LE BULLETIN de la SCBE 2006

Vol. 63, Numbre 2 Été 2006

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 diversifié d'environmentalistes 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 correspondance 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:** Sean Sharpe, Editor, PO Box 962, Station F, Toronto ON; e-mail: Sean.Sharpe@gems9.gov.bc.ca

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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 conserve les ressources naturelles candiennes.
- 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.

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NATIONAL

President's Report

I am pleased to announce that we have decided on a date and a topic for this year's National Meeting. Doug Ramsey will be hosting the meeting to be held in Manitoba on October 26th and 27th, with the possibility of a field trip on October 28. The topic for the conference will be "Habitat and Development" and will hopefully incorporate a broad range of issues including climate change, habitat fragmentation, and impacts on terrestrial and aquatic environments. Details on the venue and a Call for Papers will be available on the website in early July and an announcement will be sent out on the mailing list (listerv) when more information is available.

Earlier in the spring, I met with Brian Free (1st Vice-President) and Gary Ash (Membership Secretary) in Edmonton to discuss how best to involve CSEB members in the society. We would like to see CSEB take on more issues of national importance to biologists and to present our views to government. We will be working to establish how these issues can be handled, starting with a task force to determine how and when it is appropriate for CSEB to support various issues. Volunteers for the task force would be appreciated.

Another important aspect we covered is, with a few exceptions, the inactivity of our regional chapters. I know that many people have the best of intentions in becoming involved and I would like to hear from anyone who would be willing to set up a meeting in their local area and start an active chapter. As well-informed professionals, we have a lot to offer society, and I hope we can focus our attention and address some of the important issues facing us.

Please feel free to call or email me any time if you have thoughts or suggestions for improving the CSEB, I would be more than happy to hear from you and consider your ideas. ■

Shawn Martin, President (2006-2007)
Canadian Society of Environmental Biologists

Wanted: Regional Newsletter Contributors

CSEB needs to set up a network of regional newsletter contributors to gather newsworthy information and solicit regional based articles for inclusion in the quarterly CSEB Newsletter/Bulletin. If you are interested, please contact Gary Ash at gash@golder.com.

Atlantic News

Submitted by: Patrick Ryan, CSEB Past President

Cod Fishery Allowed on Northeast Coast of Newfoundland and Labrador

The federal government is opening up more of the cod fish stocks, both from a commercial and recreational perspective. Fisheries Minister Loyola Hearn made the announcement in Petty Harbour during a news conference on June 8th.

There will be an expanded food fishery with a daily bag limit of five fish per person and a boat limit of 15 in area 2J3KL. The season will open August 1st and close September 4th, and licences and tags are no longer required. Hearn says people can go out and fish on any day during the five-week period.

On the commercial side, there will be a limited experimental fishery in 2J3KL, which takes in the northeast coast. Some 2300 fishermen in the province licensed with a boat under 45 feet will be able to participate in a "bay stock" fishery of 3,000 pounds each. But that's limited to each fishermen sticking to their own bay.

The total catch for the southern Gulf cod fishery hasn't changed - still 4,000 tonnes, while the northern Gulf fishery has increased slightly to 6,000 tonnes.

Source by VOCM Radio, St. John's, June 9, 2006 ■

Quebec News

Submitted by Claude Delisle, CSEB Regional Director

In Quebec, there is an important "battle" between the Charest Government and a public group called SOS Park Orford, due to the privatisation of an important surface of land in the National Park of Orford in the Eastern Township area near Sherbrooke and Magog. Major environmental groups across Quebec have united under a single banner called SOS Park Orford to save 650 hectares of land in the Mont Orford Park. The government said it will pass a special law and open the Park law to exclude the ski centre and the golf course from the Park, and also to allow the construction of 1000 condominiums. This is now a question of principle. The Park law should not be touched!

Only 3.4% of Quebec's territory is protected. This is the lowest percentage in Canada. Even if Quebec Government purchases proximate lands to enlarge the Park, they should do it without touching the actual surface. This ecosystem should be preserved in its integrity.

The environmental battle concerning the National Orford Park is still going on. This is now a real political issue. After a Parliament Commission on the subject at the end of May, SOS Parc Orford decided to protest against the Charest "one track mind" and they organized a "sit in" in Quebec City on June 4. Following is information on SOS PARC Orford:

SOS Parc Orford is a grass roots organization, which was created following Quebec Government's decision to sell 649 hectares of public land from the Orford National Park.

Mission

SOS PARC ORFORD's mission is to convince the government of Quebec to :

- Not to sell a part of Mount Orford National Park
- Not pass a special bill in order to allow this sale; it's contrary to the intent of Quebec Loi sur les parcs
- Instead facilitate finding of solutions that allow for conservation and development of environmentally-respectful usage of Orford National Park

For information on how to get involved with SOS PARC ORFORD, check out their website at <http://sosparcorford.org>

Ontario News

The Times They Are A-Changin'

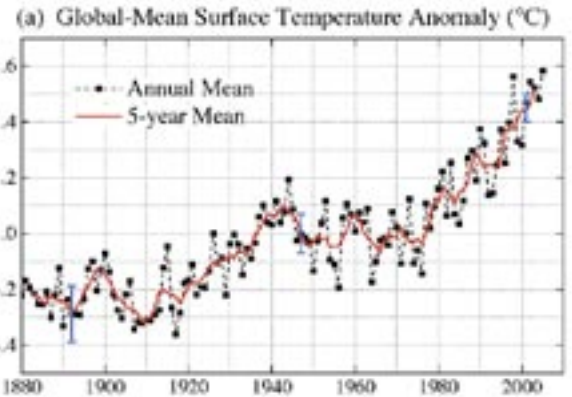
By Natalie Helferty, CSEB 2nd Vice-President

Come gather 'round people
Wherever you roam
And admit that the waters
Around you have grown
And accept it that soon
You'll be drenched to the bone.
If your time to you
Is worth savin'
Then you better start swimmin'
Or you'll sink like a stone
For the times they are a-changin'.

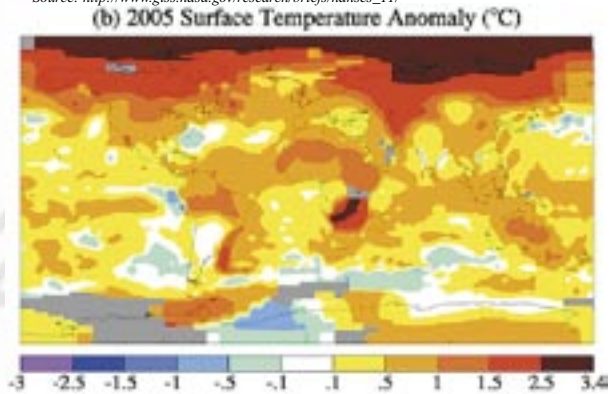
Bob Dylan's song is a testimony of the changes of the 1960s. Today in 2006 we are undergoing a surging wave of change in Ontario soon to break its crest upon our shores.

Climate change scientist James Hansen of NASA's Goddard Space Institute at Columbia University predicted 2005 to be the hottest year on record. He was right. The arctic in particular concentrates all atmospheric pollutants, including greenhouse gases. The temperature increase in the arctic in particular was over 2.5 °C above normal for 2005. Compare that to the 'global average' rise in temperature over the last 100 years of 0.6 °C. (See table from NASA <http://data.giss.nasa.gov/gistemp/2005/>)

He now predicts that within 25 years the oceans will be rising 6m above their present level. This predicted extremely rapid increase in sea level changes by Dr. Hansen is not without much controversy. With the melting of glaciers historically raising sea levels on the order of 20 m over 400 years, on average due to natural rapid melting and 'calving' of ice sheets to spread these ice bergs into the sea quickly, we can expect rapid rises in sea level. How fast is likely a best guess, but one thing is clear, ice melts at 0°C and the arctic is getting warmer with the winter season shortening and permafrost melting.



Source: http://www.giss.nasa.gov/research/briefs/hansen_11/



Historically, abrupt changes in climate were not unknown, with changes in the order of 16°C within a decade showing in ice core sampling from 12,000 years ago. A multi-decadal drought brought on the collapse of the Mayan civilization, a more advanced civilization than either the Greeks or Romans in terms of their understanding of astronomy and mathematics. And these events occurred without the advent of the automobile and industrial civilization.

Carbon dioxide levels are now at 375 ppm in the atmosphere, compared to the maximum level over the past 400,000 years taken from ice core samples of no more than 300 ppm. And methane levels are even more dramatically of the charts at 1756 ppb compared to maximums from these same ice core samples of 800 ppb! Methane absorbs heat in the atmosphere 21 times more effectively than carbon dioxide even though it is a smaller composition of the atmosphere.

Carbon dioxide emissions are literally only half the problem. Methane release and nitrous oxides from decomposition and burning of fossil fuels also contribute vastly to the warming. As northern permafrost melts further, this formerly frozen plant material will off-gas methane and carbon dioxide from the re-activation of decomposition processes, adding more greenhouse gases to the atmosphere quickly. This is a positive feedback loop.

The stress on nature is a reality that Canada faces due to the climatic responses of more severe and frequent weather events from droughts and forest fires to hurricanes and floods. With continued increased burning of a fast-shrinking global oil reserve (predicted at current rates of extraction to last less than 20 years) we can only logically expect resultant accelerated warming and extreme responses in the climate from that increase in atmospheric and oceanic warming. The responses from Nature herself will form positive feedback loops.

For example, eutrophication could occur due to the die-off of oceanic life as warm currents cause sea floor expansion of tectonic plates and off-gassing of methane and carbon dioxide; this would also accelerate atmospheric greenhouse gas build-up and ocean warming. Eutrophication is a positive feedback loop in that die-off causes excessive nutrients in the water and toxic 'red' algae blooms. Bacteria also decompose dying algae and plants, which forms more carbon dioxide and methane. The impacts on natural ecosystem processes needs to be understood before we continue on our merry way trying to solve an 'energy crisis' here in Canada.

The Alberta Oil Sands extraction is just starting to get geared up, despite the fact that Canada will soon become the Number 1 contributor to greenhouse gas emissions worldwide. The Oil Sands are second to only Saudi Arabia in terms of volume of fossil fuel abundance, but the energy required to melt bitumen is enormous. Diversion of Mackenzie Pipeline natural gas to extraction processes will eat up a large chunk of remaining natural gas reserves, which peaked in 2001-2002. That also ignores the greenhouse gases given off from the processing itself, let alone the end-use of the oil in vehicles for industrial purposes.

Geologically, to form this oil, it took 23 tonnes of plant matter to decompose for every 1 Litre of oil we burn today. This means every year, we burn 400 years worth of plant matter! This was calculated by Jeffrey Dukes of the Carnegie Institute of Washington based on 1997 numbers (published in *Burning Buried Sunshine: Human Consumption of Ancient Solar Energy*. 2003. *Climate Change*, 61(1):31-44). He calculates that switching to biomass at expected increased rates of consumption would require 22% of the Earth's terrestrial net primary production, which is about 50% more than what we are using now of the Earth's vegetated resources. That would have an enormous impact on the existing terrestrial biodiversity and ecosystem function considering the harvest rate required to meet annual biomass demands.

What is not being considered is what we do when the Earth's resources and carrying capacity for such intense energy demand can no longer provide this to us humans. That is not something that politicians want to address. Anything but collapse as a future scenario is being proposed in Ontario, from 'conservation' to 'renewables' to 'replacement' to deal with Ontario's growing energy demand and lack of capacity to meet 'peaking demand', during those hot summer days (caused by climate changes). A 'Conservation Challenge' of 10% reduction in energy use by Ontarians by 2007 was issued by Peter Love, the head of Ontario Power Authority's Conservation Bureau. By comparison, California which has 25% privately-owned energy supply companies under contract with the State, is expected to have demand-side reduction in the order of 500 MW per year. Ontario is trying to grow capacity more than reduce demand. Aggressive conservation is needed, by preventing further increases by eliminating new additions.

Some progress is being made with Standard Offer Contracts to suppliers of 'renewable' energy, such as wind, micro-hydro, solar and some biomass for projects generating up to 10 MW now being offered by the Ontario government, with payments of 11 cents per KWh, with a bonus of 3.52 cents per KWh for supplying during peak hours. Wind farms are also now popping up, along with the perpetual houses in the Greater Golden Horseshoe, with a target of 5% of energy to come from 'renewables' by 2007 and 10% by 2010.

And so, with so little in the form of 'renewables', we are left with 'replacement' of old nuclear facilities as the other option on the table that the Province is seriously considering to supply energy demands in future. The existing nuclear plants in Ontario have been a 'white elephant' since their construction in the 1970s, with every Ontarian now paying 0.7 cents per KWh as a 'nuclear debt retirement' charge on their monthly bill to pay off the roughly \$15 billion in unfunded nuclear related debt generated by the Crown Corporation, Ontario Power Generation. Ontario Power Authority is recommending the Province build 24 new nuclear plants in Ontario. The cost of building replacement nuclear plants of course is also far greater in terms of the atomic waste generated that has a half-life of 24,110 years. Future generations will need more than money to deal with the repercussions of failing nuclear plants, declining 'yellow cake' uranium reserves (a finite resource) and disintegrating copper and tin or concrete containers holding this waste. Putting the money into fuel and energy efficiency and better urban form and practices through 'localization' and self-sufficiency to reduce transportation use itself is not on the agenda, although the technology and desire is out there to achieve this. Our assumption of growth at any cost is also being questioned.

So we face the reality that the carbon released into the atmosphere cannot hope to be absorbed by remaining vegetation or the oceans as they currently exist. We have overwhelmed the carrying capacity of our planet to 'sink' this excess carbon back into the soils anytime soon, let alone by 2012, which is the deadline to meet our Kyoto Accord commitments or whatever program the Federal government hopes to achieve. Kudos go to the Feds for addressing air quality with the proposed Clean Air Act; that will help a lot in addressing efficiency and climate change as well.

Ontario is undergoing many policy changes of late including the passing of the Greenbelt Act and Plan (2005) and the Places to Grow Act (2005) with a Proposed Growth Plan still in draft form undergoing some 'rethink'. And that is a good thing. The Neptis Foundation, a planning research think tank group, has criticized the Proposed Growth Plan as being "not enough", even with 40% redevelopment targets. The off-setting of all this redevelopment, though, in cities needs to come with a caveat that open land is needed for infiltration to prevent floods, and greenspace to provide habitat, trees for shade and shelter from urban heat, and for aesthetic and recreation and spiritual needs to connect with nature. Despite good intentions to curb 'urban sprawl', the liveability of urban and suburban areas needs to be acknowledged. 'Mixed use' still has no target in this first draft, despite zoning being anathema to past good planning practices and current liveability principles that engender community living and walkable neighbourhoods.

As Toronto faced a major severe downburst last August 19, 2005, brought on by the extreme climate of the 2005 heat wave and the 'urban heat island effect', more land for nature in cities will be needed to absorb excess rainwater to prevent future flood damage. This event was larger than Hurricane Hazel in 1953 that spawned the growth of new Conservation Authorities in southern Ontario to prevent flooding and manage watersheds. The original impetus was the 'dirty 30s' droughts that occurred with massive deforestation and farming of the sandy soils of the Oak Ridges Moraine. Desert formation was occurring back then. If not for lobbying by farmers to reforest the land, hiring returning WWII soldiers in 1945, southern Ontario would likely be a dust bowl by now.

Of course paving is our new solution to blowing sands it seems with 60% as 'greenfield' development under the Proposed Growth Plan. The Neptis Foundation derides this policy, given our current limits in rural aquifer water capacity and need to protect headwater zones for flood mitigation and water quality. The Province has simultaneously launched the Sourcewater Protection Act, which hopefully will address water quality to some extent, but upon closer inspection, this will only ensure that contaminants from industrial activity do not enter municipal drinking water supplies. This Act was a response to the Walkerton tragedy where seven people died of water contamination.

Water quantity still needs to be addressed, particularly in the face of climate change and anticipated prolonged droughts and lowered winter snowpack levels. One Conservation Authority did a calculation of 'Water Taking Permits' issued by the Province for their watershed. If all permits issued were to reach their maximum allowable, there would be no water left in their river system!

So, change is inevitable, and Ontario is trying to move to improve the environment with a new way of doing business, compromising all the way. Ultimately though, the problem may only be addressed by acknowledging that 'business' is not always the way to improve the environment—society needs to think about nature and our role in the ecosystem, and whether economics needs to continue to override eco-logics. That may be the only way to 'save the earth' before we all drown in the flood of growth, pollution...and water. ■

Source: http://www.giss.nasa.gov/research/briefs/hansen_11/



Photos: August 19, 2005 flooding of Black Creek in Toronto

Manitoba News

Chapter News

On May 31, 2006 a workshop was held at the Freshwater Institute, University of Manitoba Campus entitled

"Setting of Long-Term Ecologically-Relevant Nutrient Objectives for Lake Winnipeg"

Submitted by Dr. Bill Paton, CSEB Regional Director

Some of our CSEB members were in attendance. The workshop objectives were

- (1) To gather feedback on the "draft principles needed to establish long-term, ecologically-relevant water quality objectives for nutrients for Lake Winnipeg, its contributing basin, and its downstream environment. No small order!!
- (2) To discuss the literature review prepared by North South Consultants for its completeness and accuracy. This document can be located on the Lake Winnipeg Stewardship's Board's web-site.
- (3) To identify key themes and approaches that should be used to develop long-term, ecologically-relevant water quality objectives for nutrients and development of subsequent nutrient management reduction strategies for Lake Winnipeg.

The Draft Principles were:

That water quality objectives for nutrients in Lake Winnipeg should:

1. preserve or restore the important ratio between nitrogen and phosphorus, and reflect both in-lake concentrations and watershed loadings.
2. consider historical concentrations of nitrogen and phosphorus in Lake Winnipeg.
3. ensure the healthy functioning of the Lake Winnipeg ecosystem.
4. minimize the duration, frequency, and intensity of blue-green cyanobacterial blooms including the need to minimize the production of cyanobacterial toxins harmful to aquatic life, recreation and drinking water.
5. minimize the duration, frequency, and intensity of blooms of other forms of algae including those leading to fouling of commercial and subsistence fishing nets or that otherwise interfere with successful harvest of fish.
6. ensure that an optimum balance is achieved between nutrient enrichment, productivity of the commercial and subsistence fishery, and subsequent economic return to communities, while protecting the lake's ecosystem health and recreational uses.
7. protect the downstream environment in the Nelson River and Hudson Bay.
8. recognize water quality objectives established for the contributing watersheds, and that water quality objectives for nutrients established in the contributing watersheds need to recognize Lake Winnipeg.

9. consider the social and economic implications of implementation and compliance.

Any advice, comments etc. from readers would be most appreciated. We are particularly interested in other situations with large relatively shallow eutropic lakes around the world. ■

Other Manitoba News

*Submitted by Doug Ramsey, M.Sc., R.P.Bio.
CSEB Manitoba Director*

The following was compiled by Alison Reineke, B.Sc. of Wardrop Engineering Inc., Winnipeg.

International Institute for Sustainable Development and the Government of Manitoba

Manitoba's world-class climate-change and wetlands research, environmental education and best practices planning will continue under a five-year agreement signed with the International Institute for Sustainable Development (IISD). This internationally-recognized organization can assist decision-makers around the world through its research and recommendations. The IISD focuses on international trade and investment, economic policy, climate change, measurement and assessment, natural resources management and makes recommendations to governments, business and non-government organizations.

Over the next year, projects will focus on climate change, education for sustainable development, best practices in government planning and reporting systems, Netley-Libau wetlands research, world heritage site recognition for the area east of Lake Winnipeg and a number of others.

Source: Manitoba Environmental Industries Association Inc., June 2006 (<http://www.meia.mb.ca/WeeklyFYIforJune52006.html>) ■

Problem Beaver Management Program

Beaver can inflict considerable damage to private and municipal property in Manitoba. The Problem Beaver Management Program, initiated in 1993 by Manitoba Conservation, has evolved into a comprehensive management program to continue to help reduce losses to private property and public infrastructure. The program provides monetary incentives to Manitoba trappers to encourage the harvest of over-abundant beaver in designated problem areas. In some areas, pond levelers may also be made available as a non-lethal method of preventing beaver damage.

During a recent review of this program, municipal officials, landowners and trappers agreed to end the break between the summer removal and the winter subsidy time frames. Municipalities can now continue their removal efforts and maximize the trapping opportunities when pelts are worth more commercially.

Source: Wildlife and Ecosystem Protection Branch, Manitoba Conservation, June 2006 (http://www.gov.mb.ca/conservation/wildlife/news/news_releases.html) ■

Bear Smart

A new education and awareness initiative called Bear Smart will help the public to stay safe and keep black bears in nature and out of harm's way. The Bear Smart initiative will help to safeguard humans; minimize property, crop and livestock damage; and maintain a healthy bear population.

Bear Smart will include roadside signs, brochures and fact sheets, an information campaign and free community workshops presented by the government.

Source: Wildlife and Ecosystem Protection Branch, Manitoba Conservation, June 2006 (http://www.gov.mb.ca/conservation/wildlife/news/news_releases.html) ■

Boreal Woodland Caribou

Protecting at-risk boreal woodland caribou populations in Manitoba and working to recover their habitats is the focus of a strategy document released in April 2006. The strategy is based on scientific research, knowledge and experience gained from co-operative partnerships between individuals and groups over the past three decades. The Conservation and Recovery Strategy for Boreal Woodland Caribou outlines goals, objectives and guiding principles to help ensure effective management of habitat and action plans that will sustain boreal woodland caribou. The province will develop and implement action plans based on this strategy, which will continue to evolve with ongoing research.

Source: Wildlife and Ecosystem Protection Branch, Manitoba Conservation, June 2006 (http://www.gov.mb.ca/conservation/wildlife/news/news_releases.html) ■

Saskatchewan News

Aerial Spraying to Combat Spruce Budworm

Submitted by Art Jones, Saskatchewan Environment

June 1, 2006

In late May and early June this year, Saskatchewan Environment will use aerial spraying to treat about 25,000 hectares of forested land in the Deschambault Lake and Amisk Lake areas for spruce budworm. The biological pesticide, *Bacillus thuringiensis* var. *kurstaki* (Btk), a naturally occurring soil bacterium known to kill certain types of caterpillars, will be used.

Btk has been safely used around the world for nearly 40 years. It is not harmful to other insects such as bees, or fish, birds or wildlife and poses no human health hazard. Btk does not build up in the environment and if the target insect, the budworm, does not eat it, Btk will only survive for a few days after application.

"Spruce budworm is a natural part of our forest ecosystem but high populations can pose a threat to valuable timber resources," says Saskatchewan Environment entomologist, Rory McIntosh, "The

objective of our budworm management program is to protect these resources by managing heavy infestations in selected areas while allowing the insect to play its natural role in the ecosystem in most other areas.”

Spruce budworm larvae are small, only 18 to 24 millimetres long. They are greenish-brown with two rows of whitish spots along the back. However, the impact they have on the forests can be enormous.

In late June or July, the adult moth lays clusters of eggs on the needles of balsam fir, white spruce and black spruce. The eggs hatch in 10 days. The larvae find a protected spot on the tree and soon begin to spin a shelter of silk where they will spend the winter. In spring, the larvae emerge and feed on old needles, unopened buds or male flowers eventually making their way into the growing shoots. They pupate in June and the cycle begins again.

“One of the reasons for concern is the budworm’s messy eating habits,” says Environment’s McIntosh “They use their silk webbing to tie two or three shoots together to form a feeding tube. Then they bite needles off at the base. The needles dry out, leaving masses of silk and dried red-brown needles hanging from the trees. Repeated defoliation during a heavy infestation of budworms can eventually kill a tree or make it so weak it dies.”

Areas are selected for treatment with the objective of keeping economically valuable trees green so that they can be harvested. A computer model is used to analyze tree growth, defoliation and population data to help forest managers make the best choices. “We use all the available data to make sure that our spraying efforts are directed where they will be most effective,” says Environment’s McIntosh. “We also direct harvesting operations into severely defoliated areas whenever possible, making use of the trees while removing the budworm’s habitat and food source.”

The Provincial Spruce Budworm Management Program has been operating since 1992. Results of the program are monitored and reported. Ongoing surveys reveal that defoliation in areas treated with the biological pesticide, Btk, has been reduced by as much as 60 per cent when compared to areas that have not been sprayed.

For more information contact:

Rory McIntosh Provincial Forest Entomologist Saskatchewan Environment (306) 953-3617 rmcintosh@serm.gov.sk.ca	Or	Art Jones Communications Consultant Saskatchewan Environment (306) 787-5796 (306) 536-8452 (cell) ajones@serm.gov.sk.ca
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(Permission is given to reprint or broadcast all or parts of this article. Previous “Environment Newline” articles are available at www.se.gov.sk.ca/media/) ■

Alberta News

Prepared by: Brian Free, CSEB Regional Director

For the Birds....

Fond of flycatchers? Hooked on herons? Smitten by sparrows?

The Federation of Alberta Naturalists is compiling a second edition of the Alberta Breeding Bird Atlas. And they need photos!

They are seeking high quality colour photos. Traditional film photos will be scanned and are preferred, but they will also accept digital versions (jpeg or tiff, 5”x7” at 300 dpi, 1500 x 2100 pixels)

Contact Philip Penner at philipp@fanweb.ca
or (780) 427-8124

Or visit the website of the Federation of Alberta Naturalists at http://www.fanweb.ca/projects/bird_atlas/intro.htm

And to see some live specimens...

Why not visit the new Boreal Centre for Bird Conservation? This new station has recently been completed as an Alberta Centennial project. It is located in Lesser Slave Lake Provincial Park, which is in the migratory path of many neotropical songbirds that nest in the boreal forest. The park is about a 2 ½ hours drive northwest of Edmonton.

Furthermore, this new interpretive centre was built to LEED standards (Leadership in Energy and Environmental Design). This means that it had minimum impact on its surroundings and has many leading-edge features related to energy efficiency and other environmental aspects. Check it out!
<http://www.borealbirdcentre.ca/>

But on a more serious note...

Three Alberta men were convicted recently of trafficking in birds of prey. They were fined a total of \$44,000. for killing and selling eagles, hawks and owls. There apparently is quite a black market for eagle talons, feathers and other parts for First Nations’ ceremonial gear and medicines. As well, private and commercial collectors and hobbyists will pay a high price for these items. Shame! ■

Oil Sands Consultation – New and Improved?

Several months ago, the Alberta Government announced a draft Mineable Oil Sands Strategy (MOSS) and proposed a few public meetings in northern Alberta to solicit input. There was an outcry that this limited consultation fell far short of the mark for such a significant issue. The Alberta government took a step back and set up a special Oil Sands Consultation Group to recommend a more suitable consultation process. That group of five included a provincial politician, and representatives of the regions’ First Nations, environmental organizations, the industry and a public member.

This Group has issued its report and the Alberta Government has accepted all of its nine recommendations.

A multi-stakeholder committee will oversee the consultations and a panel will collect the public input. Public sessions will be held in the oil sands region as well as in Edmonton and Calgary. Input via the Internet will also be considered. This consultation will likely begin in September 2006 and run until next June. Details are yet to come, but are there any CSEB members interested in exploring this issue and perhaps helping to prepare a CSEB submission? Contact Sheri Dalton at sdalton@concordia.ab.ca.

The Oil Sands Consultation Group's report is available via Alberta Environment's website at www.environment.gov.ab.ca under "What's New"? ■

Oil Sands Fever: The Environmental Implications of Canada's Oil Sands Rush

Presented by Simon Dyer, Senior Policy Analyst with the Pembina Institute

The ASPB Calgary Professional Development Committee

Presentations

Oil Sands Fever: The Environmental Implications of Canada's Oil Sands Rush

"Ambitions of producing one million barrels per day of oil from the oil sands by 2020 have been greatly exceeded: this goal was surpassed in 2004. This intense rate of development is being driven by a steadily rising market price for crude oil, growing uncertainty about the global supply of oil and rapidly growing demand from the United States and Asia. Canada's so-called "black gold," now regarded as an abundant, secure and affordable source of crude oil, is the focus of international attention. Managing the environmental impacts arising from this pace and scale of development is a considerable challenge that must be urgently addressed, particularly in light of the new goal of producing five million barrels per day by 2030. As Alberta's northern boreal forest is torn up for oil sands development, the environmental impacts to air, land and water in Alberta are increasing rapidly. Not surprisingly, Alberta is now Canada's pollution capital for industrial air pollutants. And the oil sands are the single largest contributor to greenhouse gas emissions growth in Canada." - *Oil Sands Fever*, report published by the Pembina Institute, November 2005. ■

Wanted: Regional Newsletter Contributors

CSEB needs to set up a network of regional newsletter contributors to gather newsworthy information and solicit regional based articles for inclusion in the quarterly CSEB Newsletter/Bulletin. If you are interested, please contact Gary Ash at gash@golder.com.

British Columbia News

Submitted by Gary Ash, CSEB

Lower Fraser Sturgeon Listing Under SARA Uncertain

5 April 2006 - White sturgeon in the lower Fraser River may escape listing under the federal Species At Risk Act (SARA) because of the potential socio-economic impact on the lucrative sport fishery here and on gravel mining operations that generate revenue and aid flood protection.

Dan Sneed, federal co-chair of the national recovery team for white sturgeon, says there is no disagreement on a "purely scientific basis" that all six white sturgeon populations in the province are at risk of extinction.

But he says the federal cabinet can opt to exempt the lower Fraser population, which has been on the rebound due to recovery efforts by sport and native fishermen, because of the socio-economic impact of a listing on the \$6.4-million guided sport fishery in the Fraser Valley.

The fishery and gravel mining could be banned altogether or curtailed under SARA, as well as the upstream activities of BC Hydro and Alcan, if the lower Fraser population is listed, he says.

Unlike the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which listed all six populations as endangered species based on a scientific analysis, the federal cabinet may consider the socio-economic impacts in its decision.

Sneed says that decision is not expected until August. Although he would not release the team's recommendation to cabinet, reached after extensive public consultations last year, he expects it will be posted in the Canada Gazette in April or May.

"It's hard to say whether cabinet will accept" the team's recommendation, he says, but the fact that the lower Fraser catch-and-release fishery on white sturgeon is a guided one was "front and centre in our deliberations" and he believes it will also be a major factor in cabinet's decision.

He says the cabinet could also decide to send the issue back to COSEWIC, if it believes that body's information was flawed or incorrect, but he does not expect that will happen.

Fraser River white sturgeon, which survived two ice ages and once numbered in the millions, were driven to near extinction in B.C. by an aggressive commercial fishery a hundred years ago. Although the commercial fishery was halted and sports anglers limited to a catch-and-release fishery, the remaining Fraser River population has been fighting to survive the effect of urbanization. However, under an on-going tagging project by the Fraser River Sturgeon Conservation Society, the lower Fraser population has rebounded to about 60,000.

Article continued on next page ➤

Society president Rick Hansen told The Progress last year that the next critical steps for the stock's recovery are identification and protection of habitat, mortality reduction in both gillnet and catch-and-release fisheries, and continued monitoring of populations. "We have a long way to go before these fish are out of the woods," he said. ■

Source: Reprinted from *Agassiz Observer*

Costal Marine Environment Report Sets Data Baseline

Submitted by Gary Ash, CSEB

8 June 2006, VICTORIA – Six reports on the coastal environment of British Columbia produced through interagency collaboration were released today by the Ministry of Environment. The release of these reports on World Oceans Day reflects the importance of the coastal and ocean environment to the province.

The studies provide decision-makers with baseline scientific information about the state of the province's environment, from the Coast Mountains to Canada's 200-mile offshore limit. The topics of the six in-depth technical reports are: Population and Economic Activity, Industrial Contaminants, Climate Change, Fisheries, Biodiversity and Ecosystem Protection.

In addition, the project website www.env.gov.bc.ca/soe/bcce/ was launched. All results, including the full text of the reports and the data sets underlying the graphs, are available to the public on the website. The website also provides summaries of key information and links to other information sites for further reference.

An educational poster about protecting the coastal environment was also released. The poster and a CD-ROM containing the reports will be sent to all libraries and schools in the province.

British Columbia's Ministry of Environment worked on the project in partnership with Fisheries and Oceans Canada, the University of British Columbia Fisheries Centre and the University of Victoria Geography Department. Environment Canada was also a key contributor. All agencies contributed funding or made in-kind contributions to the project. Ministry of Environment staff provided overall project management.

The B.C. Coastal Environment Project is a successful example of interagency collaboration that enabled partners to pool their resources to achieve a more comprehensive result than would have been possible separately. It also provides a strong foundation for collaboration on future studies.

The project consulted experts widely, with more than 140 people from 30 agencies and organizations contributing data and technical expertise, as well as reviewing the science in the reports. ■

Source: *BC Environment Website*

Territories News

Submitted by Anne Wilson, CSEB Director

Folks working in the biological disciplines in the north could be said to fall into two broad categories: those who gather and report on information, and those of us who are (sadly!) what I think of as "desk" biologists. We look jealously at those who are braving insects, bears, weather, high/low water, logistical minefields, and huge expenses to collect data on the natural conditions. We think back to our previous days of field work, as, surrounded by reports and beset by review deadlines and endless meetings, the open water calls.

Summer solstice approaches, and maximum advantage is being taken of the extra-long days north of sixty. Existing projects are proceeding at top speed with construction, summer exploration activity is underway, and field crews are geared up for summer sampling programs. This summer there are many projects which have fairly intensive environmental monitoring programs. These range from resource extraction or pipeline prospects collecting baseline data as they prepare for environmental assessments, to operating mines, to contaminated sites such as abandoned mines. All the disciplines are well represented, with intensive work being done on caribou and other wildlife, birds, species at risk, vegetation, water quality, and aquatic biota.

Several things are driving the ongoing environmental work in the NWT and Nunavut. Environmental assessments will tend to include reports and/or project certificates which carry monitoring conditions. Where regulatory instruments fail to require environmental monitoring programs, environmental agreements have been implemented which require wildlife, air quality, and aquatic monitoring. Under CEAA, follow-up work is required on major projects, and under the Metal Mining Effluent Regulations, rigorous environmental effects monitoring must be done. And, of course, research continues on many fronts, through various universities and institutions. Study design is always the subject of extended discussion between proponents, regulators, and other stakeholders. We never know what we don't know (and should have been looking for!) until we have the benefit of hindsight, and we have learned much from the last decade of intensive monitoring programs in the NWT, that we can apply to new projects coming up.

Upcoming major projects in the NWT and NU include the Mackenzie Gas Project, which is mid-way through the public hearings stage, the Gahcho Kue Diamond Project, which has been referred to an Environmental Impact Review (panel hearings). In addition, gold and base metal projects have been proposed in both Territories, and a hydroelectric development in the NWT. The Deh Cho bridge across the Mackenzie River has been stalled by high steel prices, and needs further financing to proceed. Remediation of the Giant and Colomac mine sites continues, along with the other 19 sites in the NWT and 18 NU sites.

This field season looks to be very busy all around, and hopefully we deskbound types can count on at least a few site visits! ■

Comparison of Two Benthic Invertebrate Sampling and Analysis Methods for Streams in Greater Vancouver

Submitted by: Jim Armstrong, B.Sc. and Ken Ashley, Ph.D., Utility Analysis and Environmental Management Division, Policy and Planning Department, Greater Vancouver Regional District (GVRD)

Introduction

GVRD recently funded a study comparing two techniques for collecting and analyzing benthic invertebrate data: B-IBI (Benthic Index of Biological Integrity) and CABIN (Canadian Aquatic Biomonitoring Network). Two key questions were identified in this study:



1. *Are the estimates of richness and abundance of benthic invertebrate taxa collected by the Surber sampler and kicknet sampling methods statistically equal?*

2. *Do the analysis methods differ in their assessment of biological condition?*

Data were collected from eight streams in North Vancouver from September-October 2003, and from 11 streams located throughout the Greater Vancouver area in September, 2004.

The study concluded that although the two sampling and analytical methods differ in field methodology, lab processing and data analysis, both methods are valuable tools in assessing the taxa richness and abundance of the benthic invertebrate communities. However, the methods are significantly different in their methodology and should not be used interchangeably for stream assessment in Greater Vancouver.

Sampling Methodology

B-IBI (benthic index of biological integrity) is used by the majority of organizations, including the US Environmental Protection Agency (EPA) and Washington State Department of Ecology to assess and monitor the biological conditions of streams and rivers. B-IBI is a method that uses predictable changes in the benthic invertebrate community along with a defined gradient of anthropogenic stressors to assess the biological condition of the stream. Using an index of scoring metrics from values observed for the invertebrate communities in undisturbed streams, a biological assessment of a disturbed stream can be valued. In this study, the standard 10-metric scoring system was used to compare benthic invertebrate values to the RCA-Cabin method.

The RCA-CABIN (Reference Condition Approach – Canadian Aquatic Biomonitoring Network) has been developed by Environment Canada to compare the observed benthic invertebrate

community structure to a regional reference condition as defined by specific reference sites. Specific examples where this method has been used are the Great Lakes and the Fraser River Basin. Unlike the B-IBI method, RCA-Cabin uses predictive models that have been derived from the covariation of environmental and biological data to predict what the benthic community should be at a particular site within a stream. This method uses natural variation of reference sites to present the assessment of the specific site with probabilities of stress.

Sampling Protocols

While each method can assess the benthic invertebrate community of a stream or small river, the sampling method of each significantly differs from the other. B-IBI uses the Surber sampling method and RCA-Cabin employs the kicknet sampling method. Using the Surber method requires that four composite samples be collected over a 500m reach in each stream. Each of the four composites requires that three individual samples be collected from one riffle. The kicknet method only requires one or two samples being collected from a stream using a three-minute travelling transect. The protocol for comparison of the methods in this study had the kicknet method being used only in the general vicinity of the most downstream Surber sampling site to avoid sampling recently disturbed sites.

In addition, the intervals between sampling using the noted methods varied between the two sampling years; 2003 – between 14-42 (average 30) days elapsed between Surber and kicknet sampling; 2004- <12 hours elapsed between the two sample collections. Although the 2003 sample protocol reflected the recommended periods for sample collection for each method (i.e. Surber – August 1-September 30; kicknet – September 15 – October 25), the results may not be reflective of the benthic invertebrate community for the overall sampling period of August 1 to October 30.

Other notable differences in the field sampling between B-IBI and RCA-Cabin protocols are outlined in the study report. The mesh size used in each method reflects the abundance of benthic invertebrates captured by the Surber and kicknet sampling. More organisms should have been captured using the kicknet sampler due to the finer mesh size. However, the results indicate that a single three-minute kicknet transect collected approximately the same number of organisms as seven Surber placements.

Analytical Protocol

For a complete understanding of the two sampling methods, the study used three analyses to compare the differences in the assessment of the biological condition of the individual stream:

- B-IBI values for kicknet samples and mean B-IBI values for Surber samples using paired t-tests

- Correlation between B-IBI calculated from Surber & kicknet samples was tested.
- Qualitatively compared the assessment of biological condition provided by B-IBI & RCA-CABIN methods.

(a) Paired T-test values:

Paired T-tests were used to statistical analyze the comparability of the two sampling methods. The T-tests indicated that the coefficient of variation (CV) showed similar variability for many of the attributes measured. One important finding of the study was that the total number of invertebrate taxa was significantly higher in the Surber samples (mean of 20.3 vs. 18.5; $p=0.0105$). This discrepancy between sampling methods may be accounted for in the type of habitat sampled or the larger number of organisms collected by the Surber sampling method. Neither the EPT (Ephemeroptera/Plecoptera/Trichoptera) taxa richness nor the percentage of EPT organisms was significantly different between the two sampling methods.

The paired t-test analysis indicated that there were no significant differences between the two sampling methods. This conclusion was supported through the B-IBI values, which were significantly higher in the kicknet samples. The Surber samples had higher taxa richness but the B-IBI values were higher in the kicknet samples, mainly due to the higher number of mayfly (Ephemeroptera) and clinger taxa. However, since the sampling for 2003 was conducted at different times (average 30 days apart), the values for mayfly and clinger taxa may have affected the overall taxa numbers. The assessment should have only included the 2004 sample results to ensure a more appropriate level of confidence in the B-IBI values.

(b) Correlation: Total and EPT taxa richness in Surber and Kicknet samples

The report indicates that there a high level of correlation between the two sampling methods in regards to total number of taxa and number of EPT taxa. The nonmetric multidimensional scaling (NMDS) ordination analysis showed that there was a greater similarity between the Surber and kicknet samples of the same stream than between the Surber samples of the same stream. However, since the Surber samples of the same stream reach were taken over a 500m

range, there was a high probability that there would be differences within the same reach. The comparison of the Surber & kicknet sample results of the same stream should indicate a high probability that they are similar due to the fact that they are taken within the same riffle area of the stream reach.

(c) Differences in Biological Condition Assessment: B-IBI and RCA-CABIN

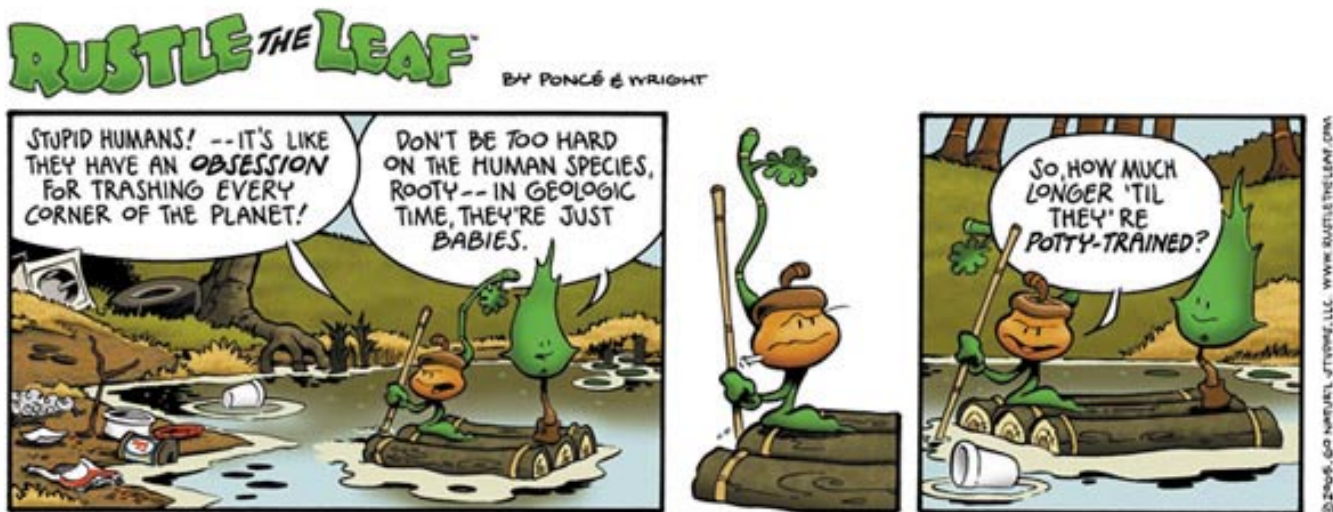
Although the two assessment processes are different, there was good comparison in determining the anthropogenic stress on the stream communities. B-IBI uses the multi-metric approach while RCA-CABIN employs a multi-variant approach. The level of stress (based on sampling data) that each value indicated good comparison although the degree might vary. The B-IBI assessment values generally indicated a higher level of stress than the RCA-CABIN values.

Discussion

Although the majority of study conclusions are defensible, a more detailed study should be undertaken before the hypothesis that both methods are interchangeable can be supported. For example, data collected in 2003 should be discarded due to the different sampling periods, use of the kicknet method only at the most downstream area of the Surber sampling and the minimum number of samples taken.

The sampling data from 2004 are more of an indicator of the benthic invertebrate community but additional sampling should have been done using the kicknet method. Concerns remain about the reliability of data due to the different mesh sizes used by the Surber (500 micron) and kicknet (400 micron) samplers.

The analytical assessment of both methods supports the conclusions that each sampling method has value in determining the anthropogenic stress level of a stream or small river. If the additional sampling study is undertaken, using more stringent criteria, it is possible that one of the conclusions will be that the sampling methods are interchangeable, as each closely reflects the biological condition of the stream using either the B-IBI multi-metric or RCA-CABIN multi-variant approach. ■



Trial of the Century: Co-Conspirators Convicted

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The views expressed in this article are those of the author, and not necessarily those of the CSEB or our membership.

People can be convicted of murder on the basis of overwhelming circumstantial evidence, as the public has been reminded recently. The same is true of three odious, though not odorous, “greenhouse gases”, which have been observed lurking in the Earth’s atmosphere.

The ring-leader, code-named “see-oh-two”, or CO₂ (carbon dioxide), is the boisterous one who demands attention, but two taciturn sidekicks, code-named CH₄ (methane) and N₂O (nitrous oxide), were also accused. Expert testimony revealed that the wispy CH₄ had been almost as brutal as rotund CO₂ in toying with planet Earth’s climate. Reliable intelligence revealed that the three defendants were conspiring for a spectacular final attack on planet Earth, with heat and pestilence, ferocious storms, and rising seas to overwhelm coastal areas.

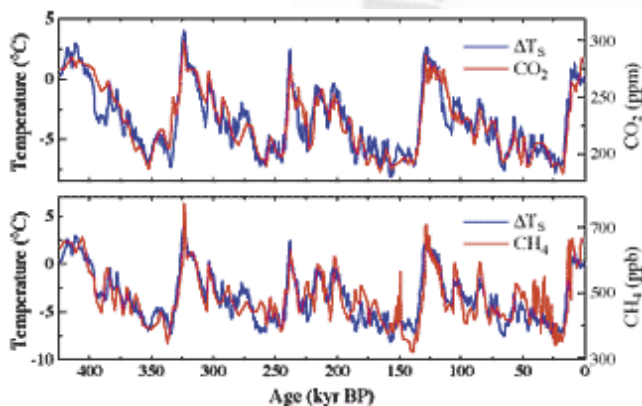


Figure 1: Antarctic (Vostok) ice core records of temperature, CO₂ (upper) and CH₄ (lower) including time-scale adjustment to account for ice-age age difference associated with the time for air bubbles to be sealed (Petit et al. 1999) and corrected for variations of climate in the water vapor source regions (Vimeux et al. 2002) as described in Supporting Text of Hansen and Sato (2004). (View as large GIF or PDF)

Evidence was shown during the trial (Fig. 1) that the Earth’s temperature had tracked closely the presence of the accused for hundreds of thousands of years. Confronted with this circumstantial evidence, a composed CO₂ responded calmly “this evidence is misleading. It is the baryon planets, Jupiter and Saturn, who are to blame for tugging at Earth and changing its orbit.” He even accused saintly Venus of skirting close by Earth, like a siren, inducing the spinning Earth to tilt its axis.

However, the prosecution showed that the Earth’s orbital twitches were only guiding pacemakers, their message carried by sunbeams to all regions of the Earth in different seasons. The three culprits had willingly followed the sunbeams’ cue, sometimes seeping together from the soil and seas into the air, and other times diving back into subterranean lairs, almost always traveling together so as to wreak the greatest possible havoc upon the Earth’s climate.

Hammered not only with this circumstantial evidence, but also with the common knowledge of their force in blocking heat radiation, CH₄ cracked. “Why blame us? H₂O is a bigger culprit in the long run, snowing and glaciating the way he does, ever so slowly making himself into huge ice sheets. H₂O is the problem! When we came out again, he started melting and dripping and sliding, and all of a sudden, boom, he collapsed! He caused the flooding!”

H₂O testified that it was true, but he was powerless to stop the effects of their heat on him. “And I have always tried hard to deliver clean fresh drinking water to everyone, and I want to do so in the future!”

CO₂, sensing empathy for H₂O, rose lawyer-like to object. “Let not chameleon H₂O fool you. Experts have shown that he, coating the ground with snow and ice, is the greater force in changing climate (Fig. 2)!”

The revered long-lived yodyte was called on. “Aye, in days of yore they worked in concert, CO₂ and CH₄ stealing away to withdraw their heat, H₂O falling as gentle snowflakes, building mile-thick ice sheets over millennia. As CO₂ and CH₄ returned, the ice was dripping, sliding, and boom, floods and warming climate, in the twinkling of a century or so!”

“And now?”

“Now,” the yodyte continued, “CO₂ and CH₄ from the dark side are joining their brethren. Their numbers, more than 375 for CO₂ and 1750 for CH₄ are off the scale of Fig. 2. Such heating has never been experienced in the age of humanoids.”

“What does it mean?” The yodyte paused and bowed his head. “I feel a force, a long struggle. The feeble pull of the planets is now fruitless. Alien CO₂ and CH₄ are a much more dominant force. H₂O, as always, must follow. The future is murky, still in the making.”

H₂O was acquitted. CO₂, CH₄, and N₂O were convicted. However, their devilish plot to terrorize the modern world, as they had the ancient worlds, was already far advanced. The planet was now populated by humanoids, a remarkably resourceful species — perhaps growing a bit flaccid as they indulged in the pleasures of their inventions — but they were basically peaceable, and trusting, perhaps even gullible!

A gleam entered the beady eyes of plump self-confident CO₂. Their conviction need not foil their plot if they were not bottled up in jail; perhaps the judge would parole them! CO₂ was articulate, trained in

the sciences at MIT, he could debate with the best, and his message fell on welcoming ears. He knew that humanoid leaders would be reluctant to act on the scientific verdict. It was easier to deny it. Many leaders and their financial supporters had vested interests in the status quo. They could find a way for CO₂ to keep his freedom, at least for long enough to get that traitor H₂O sweating and weakened beyond recovery! Oh, what sweet revenge!

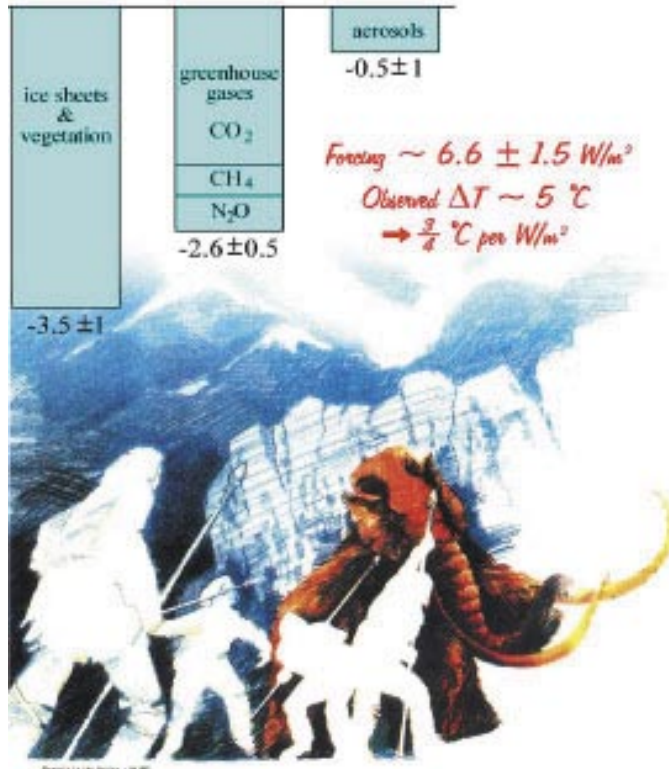


Figure 2. The Earth must be in radiative (energy) balance within a very small fraction of 1 W/m² averaged over the current interglacial period as well as during the peak of the last ice age 20,000 years ago. The changes in atmospheric composition and surface properties, indicated here, which maintained a global temperature difference of 5±1°C between the ice age and the interglacial period, are known accurately. They imply that climate sensitivity is 3/4°C per W/m², which corresponds to 3±1°C for a doubled CO₂ forcing of 4 W/m² (Hansen et al. 1993). (View as large GIF or PDF)

Hansen and Sato (2004) dispassionately examined the status of this melodrama by going beyond the circumstantial data, finding a discouraging, but not hopeless situation. CO₂ has craftily avoided attempts to bottle it up. It has now reached a level of 378 ppm. More important, it has increased its underlying growth rate to 1.9 ppm per year. Given the inertia in the world's energy infrastructure and growing global economies, it now seems impractical to avoid reaching a level of at least 440 ppm.

The CO₂ amount of 440 ppm is a critical threshold. Other things being "normal", it is the peak CO₂ amount in a scenario (1) that would keep additional global warming from exceeding 1°C (1.8°F). Based on the history of the Earth, it is estimated that warming greater than 1°C above today's level would weaken the ice sheets that cover Greenland and Antarctica, causing eventual rise of sea level by several meters.

On the bright side, Hansen and Sato showed that if CH₄ emissions decreased substantially, rather than continued to increase, it would allow the critical threshold of CO₂ to be higher. Some CH₄ emissions are easier to deal with than CO₂. A concentrated global effort to reduce CH₄ and other trace gas emissions may allow the CO₂ amount to be as great as 520 ppm without spelling doom for the ice sheets. Reducing N₂O emissions, for example via more carefully measured application of nitrogen fertilizers, would also help.

A program to reverse CH₄ growth would require global cooperation, but it could be a positive, enabling experience, analogous to the global program to control chlorofluorocarbons. However, the benefits from CH₄ reduction would be wiped out if at least the beginning steps to limit CO₂ were not initiated at the same time.

The possibility of finding a practical, beneficial way out of the Earth's climate predicament, by dealing with the entire group of causative agents, is a hopeful vision. This climatic melodrama will be playing longer than any soap opera. Stay tuned for the next episode.

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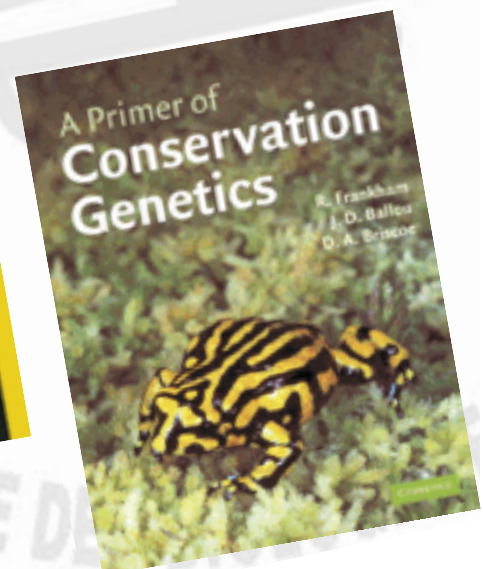
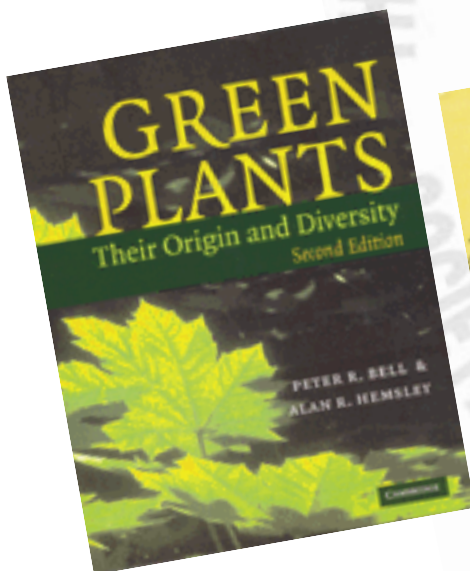
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