Science in the Public Interest

D.W. Schindler

Slide 1

In this day when the Canadian government is muzzling its scientists, and industry and provincial governments are heavily propagandizing major industrial developments, it is particularly important that scientists devote at least some of their research to issues of public interest, and communicate their findings to the voting public. Quite simply, participatory democracy cannot flourish in an absence of knowledge, and expect that rational decisions will be made. Here I describe my own path to realizing the importance of this, and some of the occasions where my science has played an influential role in making sound public decisions.

Slide 2

My first experience with scientists who address such problems was as a graduate student with Charles Elton, the British scientist who devoted much of his professional career to investigating public problems, as exemplified by the book that introduced me to ecology as an undergraduate, *"The Ecology of Invasions by Animals and Plants."* In it, Elton described how species of animals and plants were moved between countries and continents by travellers and commerce, usually unwittingly, often changing the nature of ecosystems as they invaded. He speculated on the end result of "homogenizing the earth's fauna and flora." His book *"Voles Mice and Lemmings"* described the results of his efforts to protect British grain reserves from rodents during World War II. Other research of note included his analysis of the Hudson's Bay Company's fur records, from which he deduced the now familiar cycles of snowshoe hares and predators in the Canadian boreal region. Clearly, much of what we know about ecology came from studies designed to investigate and solve societal problems.

After finishing graduate school, I took a position as Assistant Professor of Biology at Trent University. I became interested in the scourge of the day in the Great Lakes, the burgeoning blooms of algae that were said by reporters to be causing Lake Erie's death. The problem was called *eutrophication* by limnologists (the freshwater equivalent of oceanographers). I decided to attend a symposium on the problem held in Madison Wisconsin, sponsored by the US National Academy of Sciences (Slides 3 and 4). Almost every element in the Periodic Table seemed to be thought to play a role in promoting algal blooms! The resulting volume of papers reached no concensus on how to attack or solve the eutrophication issue.

Fortunately, I met three other participants at the symposium who would be important to my science. Wally Johnson was the new director of the Fisheries Research Board of Canada's Freshwater Institute, to be built in Winnipeg. He was at the meeting to recruit scientists. Richard Vollenweider from Switzerland had just spent several years synthesizing the problem of eutrophication in Europe, in a 300 page document that later became the "bible" of how to solve eutrophication. He was recruited by

Johnson to head the new division to be based on the Great Lakes. Jack Vallentyne, a professor at Cornell, had also been recruited by Johnson to head the new Eutrophication Section. Vallentyne (Slide 5, in his "Johnny Biosphere" costume, in which he visited schools to promote ecological literacy) invited me to visit their new lab, first in January of 2007, then again in January 2008. Both times he tried to recruit me, and the latter time he succeeded.

My job was to head one of the FWI's major approaches, whole lake experiments to determine solutions to eutrophication. Johnson was convinced that to get policy makers to form sound environmental policy, it was necessary to have whole ecosystem studies to guide decisions, rather than the usual bench-scale experiments. My directions for the first summer were formidable: I was charged with finding a remote area where we could have sole control of a number of small lakes that were suitable for performing various nutrient additions to entire lakes, to provide sound basis for management policy. I was to locate a site for a laboratory in the area, lay out a route for a road, select some lakes for the first experiments, collect appropriate background data, and propose some key experiments to inform eutrophication policy. A tall order for a summer for someone just 2 years beyond a PhD! We selected an area in northwestern Ontario, south of the Transcanada Highway between Kenora and Vermilion Bay, and east of Highway 71, where hundreds of small lakes were dotted among larger ones (Slides 6 -8). The area was almost unroaded and still largely unlogged. Two small companies had cutting rights to the area, but much of the work was still done with chainsaws and horses. Control of the watersheds of 56 small lakes was negotiated with the Ontario government, and I, assisted by 6 university students, portaged or helicoptered into the lakes to collect background data. By December, 1968, we had a trailer camp in the heart of the area (Slide 9), connected to Highway 71 by extending an existing logging road by an additional several miles.

The people that social scientists Oreskes and Conroy would later politely call "Merchants of Doubt" were already flourishing in those days. Vollenweider and Vallentyne had proposed to the International Joint Commission (IJC) that phosphorus control would be a key requirement of solving eutrophication in the Great Lakes. The detergent industry, which based most of its detergent formulations on compounds high in phosphorus, was opposed. Based on three small scale experiments, they published a volume of papers in Canadian Research and Development (Slide 10) that criticized the phosphorus theory and claimed the IJC was acting prematurely in proposing to regulate phosphorus. Their theory was that carbon was the element that must be controlled. Phosphorus in detergents contributed up to 50% of the input of the element to the lower Great Lakes, so stakes for them were high.

In our first summer's surveys of the new Experimental Lakes Area (ELA), we found that all of the lakes had very low contents of dissolved inorganic carbon, much lower than in the Great Lakes. We decided to test the detergent industry's theory by adding nitrogen and phosphorus to Lake 227, the ELA lake with the lowest carbon concentration. Low carbon did not hinder algal development, the lake turned green with algae in weeks (Slide 11). Thus, with one experiment, we destroyed the industry's theory that carbon control was the key to preventing eutrophication. We published our results in *Science.*

Industry then tried to divert the attention of the IJC to nitrogen, claiming that phosphorus was recycled so fast that it could never be controlled well enough. We tested that theory in a double basin lake, Lake 226, with the basins separated at the narrows with a heavy nylon curtain. We added nitrogen and carbon to both basins, but phosphorus to only one. Only the basin receiving phosphorus developed an algal bloom (Slide 12). The resulting picture, published in Science in 1974, was instrumental in getting various US states in the Great Lakes watershed to control discharge of phosphorus to the Great Lakes. The picture has been reprinted hundreds of times in textbooks, and three times in Science alone. Prof. Jim Elser of the University of Arizona has referred to it as "the most powerful picture in the history of limnology."

At that point, the IJC was convinced, and recommended phosphorus control. Canadian policy makers quickly passed phosphorus control legislation for the Great Lakes. Convincing Canadian policy makers was largely Vallentyne's doing, I just supplied the research. We were very proud of having solving a mysterious problem in only 4 years. But there was still the USA to convince (Slide 13). The USEPA had just been formed and was still in disarray. It was decided that individual states would make their own decisions. Hearings, some quasi-judicial and some informal, were held in all states. The Soap and Detergent companies would always appear with a very polished "travelling circus" of people who would challenge banning phosphate detergents, for a variety of exaggerated reasons, such as high cost, being a health hazard, poor cleaning ability, etc. None of these turned out to be true.

Vollenweider received the Tyler Prize for Environmental Achievement, and Vallentyne the Rachel Carson Award for their roles in solving the problem. Canadian policy was copied by many countries, and today we have a long-list of well-documented lake recoveries as the result of phosphorus control policies (Slide 14).

Before the USA had developed phosphorus control policies, Vallentyne decided to resign as Section Head, as the result of the forced assimilation of the Fisheries Research Board of Canada by the Canadian Civil Service. He told me that I must see that the U.S . circuit of state hearings was aware of our experiments. It was my first exposure to policy makers, who were generally not very science-literate. But the picture of Lake 226 could be understood by all, and always prevailed over industry's claims. The picture was worth a million words!

The takeover of the FRBC, first by Environment Canada, then DFO after it was split off, was one of the most tragic moves in Canadian environmental science. The FRBC was governed by a board of experienced scientists, who allocated money on the basis of merit, and the importance of aquatic problems. Administrators were few, and leaders at all levels of the organization were scientists. With the transfer to the civil service, bureaucrats, red tape, and many layers of non-scientist upper managers cut the efficiency and effectiveness of environmental research. There were too many layers of non-scientists in the DFO bureaucracy, who were incapable of understanding the most rudimentary science (Slide 15). Money went to protect the images of politicians and bureaucrats, not to provide science to underpin sound policy. FR Hayes, the last chair of the FRBC, likened the takeover to "The Chaining of Prometheus" in a book by that name (Slide 16).

The new fisheries bureaucracy was largely focused on political marine problems such as the collapsing cod and salmon stocks. Political pressure on ministers was the main driver of science. They began calling ELA a “sunset” program, meaning that it would soon be closed. In their view, we had solved the eutrophication problem and it was time to put funding to more pressing problems. I argued that there were many other freshwater problems requiring whole-lake approaches. One was acid rain, which was already known to be affecting lakes and streams in Scandinavia, and in lakes near Sudbury. It was viewed by Canadian bureaucrats as a small, localized problem. I argued that we had hundreds of thousands of lakes in Canada that were as vulnerable as those of Scandinavia due to their geological setting, and that they were exposed to a huge source of sulphuric acid as prevailing winds blew from the US Midwest to eastern Canada, causing acid rain (Slide 17). At first Fisheries bureaucrats accused me of exaggerating the acid rain problem. We received no funding. We turned to the Alberta Oil Sands, via its new AOSERP research fund. They funded the first three years of our first whole-lake experiment, in Lake 223 (Slide 18). By then, international pressure had caused the federal government to recognize acid rain as a problem and fund our research. Naturally, Fisheries bureaucrats were happy to claim that they had been foresighted by beginning research three years earlier!

Lake 223 was the smallest lake trout at ELA. Most of the science of acid rain at that time had been crude laboratory toxicological experiments, exposing organisms to acidic water for 96 hours, then counting the percentage that died during the experiment. These acute toxicology experiments revealed that fish only became susceptible to acidification at pH 5 and lower. There were almost no tests on other aquatic species. We decided to concentrate our experiment on what happened at pH above 5, in the early stages of acidification. We acidified the lake slowly, at a rate of about 0.25 pH units a year (Slide 19). We soon found that some species were much more vulnerable than had been realized. Opossum shrimp (Mysis) and fathead minnows (slides 20 and 21) quit reproducing at pH 6, ten times less acidic than had been regarded as detrimental! This also meant that many lakes of eastern Canada were vulnerable to acid rain.

As a result of the early loss of their main prey species, lake trout starved, becoming so emaciated that they stopped reproducing, at pH values well above their lethal pH of 5 (Slide 22). Lack of reproduction would eventually have the same result as acute toxicity for the lake trout population, it would cease to exist.

By the time we had titrated the lake slowly to pH 5, where acid rain damage had previously been believed to start, roughly 50% of the original species were lost from Lake 223. A few of those lost were replaced by acid-tolerant species that had not been recorded in the lake before, but even when they were accounted for, biodiversity declined by about 1/3 (Slide 23). Clearly, acid rain’s damage to lakes began much earlier than had previously been believed by policy makers.

One rather amusing part of the acid rain story is that industry responded by reducing sulphur oxide emissions much more rapidly than regulation required in Canada (Slide 24). This is rarely the case, but the power and smelting industries clearly saw that there were good reasons to reduce emissions, and that it was economically possible to do so. Unfortunately, in most cases, industry procrastinates until forced by regulators to make changes.

Reducing acid rain in the USA took longer. To protect its coal-fired electricity industry, targets for reduction were set that allowed several years to reach compliance. Nevertheless, acid rain was greatly reduced within several years (Slide 25). Unfortunately, acid rain has dropped off the public and media radar completely, and today we still have considerable damage from acid rain, to forest soils and very sensitive lakes. Nitrogen oxides are a major culprit, and emissions still need to be reduced.

Today's federal ministers act as though environmental science contributes nothing to an economy. In fact, by regulating the acid rain problem before it became more serious, billions of dollars worth of resources were saved (Slide 26). The same might be said of regulations to control eutrophication. Obviously, policy makers must learn to analyze both sides of their ledger. Clearly, preventing costly problems is as good for the economy as producing more widgets to sell! But one would never know this from recent changes to the deployment of research funds in Canada.

ELA continued to struggle along after acid rain. It did experiments on greenhouse emissions from reservoirs, on the effects of endocrine disruptors, on mercury, and responses of lakes to climate change, among other things. But federal funding was meagre. I decided in 1989 that it was time for a life-change, in part so that my wife, also a professional aquatic scientist, could find employment. In 1989, we moved to the University of Alberta.

Alberta was like a different planet. Instead of policy makers and industries who were responsive to sound science to underpin policy, the attitude was clearly that politicians should make decisions behind closed doors, and the public that had elected it should trust them to do the right thing. Scientists should stay in their laboratories and write papers for other scientists to read. Messengers who questioned whether policies were scientifically sound were received with hostility.

I found this out the hard way. As we were beginning to move, I was invited to be a federal member of a federal- provincial panel to hear public concerns about a proposed new pulp mill to be built near the town of Athabasca (Slide 27). I accepted, thinking it might provide an opportunity to find out what sort of environmental problems the province faced. I had no teaching commitments for the first term, so it seemed ideal. I was rather horrified by the first meeting of the panel. Some of the members were very close to provincial officials, and no one else had any aquatic science background. The attitude seemed to be that we would visit a few communities to listen sympathetically to people, then approve the mill. We were also restricted to considering the question, will the river be adversely affected by the pulp mill?, without being allowed to consider the effects of forest cutting. However, on reading about contemporary pulping processes, consulting scientists familiar with them, and comparing results to the mill's descriptions, I found that there would be some dioxin production. The proponents stated that it would be the cleanest bleached kraft pulp mill anywhere in the world, but simple calculations showed that the dioxin concentrations would be similar to those in the much larger Fraser River, where three large pulp mills were releasing enough dioxin to be affecting reproduction in downstream colonies of fish-eating birds. I convinced the panel to hear some of my previous colleagues from DFO, who specialized in dioxins and similar compounds, and studied their effects. Dioxin was measured in fish from the Athabasca and Peace rivers. Results showed that releases from existing

Alberta pulp mills already required advisories to restrict human consumption of several species for hundreds of miles of rivers. Other members of the review committee and the public were horrified.

After many more hearings than were originally planned, the panel unanimously recommended against building the mill, at least until more thorough studies of the river were completed and a dioxin-free pulping process was available. Politicians were shocked. They had been so confident that we would favour the mill that they had already invested heavily in building railroads to the proposed mill site and other actions to speed construction. At first, they said they accepted the panel's recommendation. A week later, the Premier pronounced our report as flawed, and announced that he was hiring Finnish pulp and paper giant Jaakko Pöyry to critique our report. The Finnish team visited us. They were delighted to find that I had a preliminary draft copy of our report where I had inserted all of the scientific references used to justify our decision. These had been removed in the final report to support the panel's majority view that it made the report look too technically imposing. The Jaakko Pöyry team pronounced that our report was sound and went home. But the government continued to press for the mill. For the next several months, I engaged in a battle in the press with then Minister of Environment Klein, who seemed to regard the panel's decision as all my fault. Then the proponents of the mill put forward a new proposal, proposing a new pulping process that they said would not produce any dioxins. It had only been tested at bench scale, in my view not sufficient. But the Premier quickly appointed a new panel, all civil servants on very short leashes. They said yes, the process would work.

The Premier proclaimed that now the pulp mill could proceed. As a sop to us (now called the environmental panel, the more recent one the technical panel), the provincial and federal governments approved funds to study the river for 5 years. No matter that the mill would be operating before the baseline studies were complete! But the technical committee was right, more from luck than for any other reason. The process that ALPAC developed was then forced upon other pulp mills. Dioxins and related compounds in fish declined. Today, the only remaining consumption advisory is to restrict eating the livers of burbot, which are notorious for biomagnifying concentrations of many contaminants, but considered a delicacy by indigenous people.

It was rumored that aides to the Premier had pressured University of Alberta officials to silence or fire me. If this is true, I have nothing but praise for the U of Alberta administration, they solidly backed me on this, and on many subsequent run-ins with government. I learned that tenure did indeed have some value.

A few years later, on October 16, 1996, there was an accidental release of toxic gases, including PCBs, dioxins and furans, from the Swan Hills toxic waste treatment facility, following a malfunction in a transformer. My group had just developed methods for measuring such compounds, to study the deposition of organic toxins in snow of the Rocky Mountains. A few phone calls and I had two post-docs in the field, guided by a local trapper in the Swan Hills area, to collect snow samples. We found that snow was contaminated for a 20 km radius around the facility. Alberta Health made measurements of fish and game, which also showed widespread contamination. They appointed me to their advisory panel, along with a number of international health experts specializing in such compounds. We recommended a consumption advisory for a 20 km radius around the facility. Sadly, it is still in place

today, and the most recent analyses reveal few, if any decreases in contaminants. Once again, Alberta politicians stated that I was interfering in their business, which was clearly to promote corporate welfare.

My next run-in was over government ads, paid for with taxpayers' dollars, stating that climate change was a hoax, a conspiracy developed by scientists to squeeze research money from governments. Unfortunately, Alberta is a hotbed of climate deniers (Slide 28). Many have little knowledge of how science works, and are unwilling to believe anything that threatens their libertarian views. I persuaded over 80 earth scientists from Alberta universities to co-sign a letter telling then- Premier Klein that greenhouse warming was real, and well-supported by science. I sent a copy to the press. Put on the spot, Klein arranged for me to meet with his Minister of Environment Lorne Taylor. I was accompanied by Martin Sharp, a senior glaciologist at the University. We spent a genial few hours, not agreeing with Taylor on everything, but on many consequences of climate change. No more anti-climate change ads appeared in the papers. Taylor developed the *Water for Life* strategy, still the province's centerpiece for water protection. Lorne and I developed a good working relationship, which led to his asking me to chair a review of problems with Lake Wabamun, a heavily-used lake near Edmonton, which supported both several enormous coal-fired power plants and large numbers of well-heeled and vociferous cottagers, many of them key contributors to the PC party.

In the eyes of cottagers, the power plants were ruining the lake. We found that the biggest damage to the lake was done by cottagers, in their cavalier treatment of shorelines and water levels. Many thought nothing of removing all of the aquatic vegetation, keeping water levels stable to enjoy easy access to their boat docks, or dumping several truckloads of sand along their waterfront to have a perfect beach! While the power plants had caused a number of problems, the company had responded quickly to fix them once they were discovered. I presented our report at two public hearings, which Environment officials predicted would be hostile. They were not. For a change, I had done something right in the eyes of politicians! I submitted the final report in January of 2005. Taylor left politics shortly after. His successor was Guy Boutilier, whom I knew from the Northern River Basins Studies days, when he was mayor of Fort McMurray. He had often participated in the "celebrity race" at the Fort McMurray winter carnival, where we had participated in the professional sled dog races. We always lent Guy our dogs, and he always won!

On August 3 of that year, I received a call from Boutilier. He sounded desperate. A train had just derailed that morning, spilling 8 tankers of bunker C oil into Lake Wabamun. He requested my help. I agreed to meet him at the lake. But his advisors cautioned him not to go, because they believed cottagers would be hostile. They were already blocking the tracks to prevent trains from passing! I assured Guy that we would be safe. I was right. Residents seemed surprised to see a minister personally visit the lake, and some hugged him with tears in their eyes. I was appointed to an advisory committee to help supervise the cleanup of the lake. It turned out that CN had not had the correct booms to contain the oil, and their staff made no effort to deploy them! It would have been no more difficult than separating the basins of Lake 226 at ELA for the experiment that I showed earlier ….. a few students and a rowboat would have been able to do it! Subsequently, I served on committees to advise on mitigation of the effects of the spill, then on a commission to make recommendations for environmental

protection from industrial disasters. By now, I was considered by many politicians to be one of the good guys! Alas, it was not to last, due to my involvement with the tar sands in the last decade (Figure 29).

Until the late 1990s, the tar sands industry floundered (I do not consider tar sands to be a derogatory term, but a realistic one. I have visited Bitumount, the original site of tar sands research in the area, in the heat of summer, and found my shoes sticking to the black, asphalt-like ooze around the site). But when the price of oil began to skyrocket, the industry suddenly took off. Both industry and the government promoted the oil sands shamelessly, claiming that the development was "world class," releasing nothing harmful to the environment (Figures 30 and 31), and that all pollutants in the river were from natural sources. Indeed, exposed strata of tar sands were undoubtedly contributing to the contaminants in the river system (Figure 32). Shoddy environmental impact assessments were rubber stamped, despite the objections of indigenous people and scientists from both university and government. However, monitoring, which had been cut throughout the 1980s and 1990s, was not increased or improved in proportion to the accelerating development. Much of it was done by consultants working for industry, via its RAMP (Regional Aquatic Monitoring Program). I was a small part of a 2004 scientific review of RAMP by an independent federal panel. The review was probably the most excoriating I have ever seen, yet few changes were made to RAMP.

Upgraders in the oil sands burned fossil fuels to extract bitumen. The high upgrader temperatures meant that volatile contaminants of several sorts would be released from upgrader stacks. I noticed that the National Pollutant Release Inventory was showing increasing emissions of a number of toxic metals and organic compounds (Figure 33). In winter, snow had visible dark layers near the industry. Finally, huge areas of the watersheds draining to the Athabasca River and its tributaries were being cleared and mined. Water use by the industry was also increasing to where it was consuming several percent of river flows during low-flow periods in winter. The industry and Alberta Government claims that the industry was emitting nothing to the environment seemed about as likely as an Immaculate Conception!

In 2007, I had lunch with the provincial Minister of Environment to discuss my concerns. He brought along two of his tar sands officials. I was assured that everything was under control, they had 4 million data points to show that the industry contributed nothing to the river! But the data were not accessible to scrutinize. With the approval of indigenous leaders, I proposed to plan an independent study. Tides Canada and the Gordon Foundation funded it. I recruited two people with whom I had worked on the Wabamun oil spill problem. Jeff Short was the chemist from the US NOAA who had done much of the chemistry following the Exxon Valdez disaster in Alaska. Peter Hodson was a toxicologist from Queen's University who had done much of the toxicological work on tar sands. The study would be executed by a former PhD student of mine, Erin Kelly, who was experienced at working on contaminants in remote areas. We hired two indigenous boatmen from the area to serve as guides and assistants. We did two surveys, in winter and summer of 2008. We mapped the extent of the McMurray Formation, where tar sands mining was concentrated, and planned our river sampling from that (Figure 34).

When we melted snow near the oil sands upgraders and filtered the meltwater, filters changed from white to black because of the high particulate load (Figure 35). Filtrate had visible scums of oil in

top, and left a black residue coating our stainless steel melting pots (Figure 36). We found that polycyclic aromatic hydrocarbons (PAHs) and numerous toxic trace metals in snow were elevated near the upgraders, and detectable for a radius of about 50 km. Most of the contamination was in particulate matter, although some was also dissolved (Figure 37). We published two papers in the Proceedings of the US National Academy of Sciences (Figure 38). They attracted considerable interest from the popular media, which in turn elicited denials from federal and provincial ministers of environment and the Canadian Association of Petroleum Producers. We responded by holding a public display of malformed fish caught by indigenous people in the lower river during our study period (Figure 39).

Fortunately, two public officials took the high road. Premier Ed Stelmach said publicly that he thought our results should not be dismissed out of hand. Federal Minister of Environment Jim Prentice flew to Edmonton to go through the results with us. Both started more intensive examinations, by panels of recognized experts. Over the next few years, there would be several expert panels examining our results and RAMP's. We showed them how some of RAMP's methods were inadequate to assess the problem. All panels concluded that past monitoring had been poor, and needed improvement. The federal response was very rapid. They assembled a national group of experts to devise a new monitoring program (I was a member of the group). They started the new program the following spring. The Provincial Minister of Environment's response was slower. He appointed a final panel, to advise him on how to create a "world class" monitoring program. They reported that governments had lost the public trust by shamelessly promoting the industry, and recommended that monitoring be put under the supervision of an independent agency. All of this was closely followed by the press, to the embarrassment of ministers. The result was AEMERA, the Alberta Environmental Monitoring, Evaluation and Reporting Agency. It remains to be seen whether AEMERA can produce the "spin free" results that are so desperately needed for the Lower Athabasca. Alberta must follow the standards of other countries, where good and transparent science is viewed as a vital underpinning of environmental policy (Slide 40). It is unrealistic to think that policy makers will obtain the science that they need from reading obscure journals in ivory tower libraries.

Today, we have a bizarre situation in Canada. We have a federal government that appears to believe that it can form sound environmental policy without science! This never used to be the case federally, and one can only assume that the infusion of Alberta-like attitudes came with the Harper Government. Federal environmental scientists have been muzzled, and their numbers and finding cut.

Canada's current international image on environmental matters is as some sort of third-world thug, the subject of international ridicule (Slide 41). Our Minister of Natural Resources recently pronounced that environmentalists are terrorists paid to hinder Canadian economic development. Federal scientists going to international science meetings have been monitored by "handlers" whose responsibility is to see that they say nothing that would disagree with official Canadian policy. In the days of the Soviet Union, KGB agents played a similar role at scientific meetings. Key research stations like the Experimental Lakes Area have been de-funded, and science libraries have been closed, under the guise of "cost cutting." Altogether, the government's treatment of science inspired the "Death of Evidence" march by scientists on Parliament Hill three years ago, protesting many changes, such as the closure of the Experimental Lakes Area (Slides 42 and 43). In fact, the savings from the destructive changes to science are very small when compared to our Prime Minister's G20 and arctic photo-ops.

Federal officials involved in international affairs shamelessly substitute “green posturing” for solid environmental action. Apparently, they are so naïve that they think foreign officials can be fooled into believing unsupported propaganda. Chris Turner’s book *The War on Science* accurately describes what has happened.

It is clear that in this age of multiple, complex environmental problems, our need for environmental policy that is grounded in sound science is the greatest it has ever been. We, the citizens of Canada, must insist that our politicians consider environmental integrity as more important than the economy. The future of our grandchildren depends on it. To expedite science-grounded policy, scientists, government agencies and universities must all change their behaviour. Participation in sound public decisions is certainly as worthy of reward as another paper in an obscure academic journal. Government scientists should be expected to report to us, the taxpayers who find their salaries and their research, not to politicians and their spin-doctors. We must teach public participation as part of our graduate education, and to participate more fully in public life. We must keep our eyes open for ways to communicate with the public about important scientific findings. Both Canadian democracy and a sound Canadian ecosystem for our descendants depend on scientifically sound policies.