

## “Oroville”: A Relevant Measure of Current Environmental Paralysis

On the West Coast, what happens in California is a reliable foreshadowing of things to come at home. Geologically, the 1000km Cascadian Subduction zone and the terrains associated with it link us to Northern California, whose flora and fauna extends well north of the 49<sup>th</sup> parallel. Most of BC’s residents live in the southern edge which is a climatic extension of the Sonoran desert and Northern Californian ecosystems. Every year, the weather systems that first show up in California make themselves felt along southern BC’s coast. When California suffers an extreme drought, BC may not experience the same duration, but it too experiences at least prolonged droughts of three months or more, as we did over the past years. The general consensus is that Canadian weather is shifting to extremes.<sup>1</sup> Over the past decade BC has experienced with unprecedented frequency “pineapple expresses”, high winter temperatures and high southern winds that come with record precipitation, which are atmospheric rivers.<sup>2</sup>

Just how much California’s predicament is similar to ours has been brought home by a report prepared by the Pacific Climate Impacts Consortium for Metro Vancouver (*Climate Projections for Metro Vancouver*.)<sup>3</sup> Based on the “business-as-usual” scenario, which is very likely given the inability of various levels of government to take meaningful action, projections indicate that the Lower Mainland is on track to have weather similar to San Diego’s current weather by 2050.<sup>4</sup> While this might sound appealing, this in fact points to a major dislocation of regional ecosystems and the services they currently provide, with disastrous consequences for both water quality and quantity, and the infrastructure associated with water supplies.

The recent dam failure at Oroville California, brings to public attention the implications of our changing climate, in a way that scientific research and numerous publications over the past 3 decades have been unable to do. It is a demonstration, not just that North-American infrastructure is ageing and has often reached or exceeded its lifespan, but that the technology, the climate assumptions on which it was based, and the economic assumptions associated with these structures, are no longer viable. As a recent report indicates, about 70% of dams in the USA are over 50 years old, with many reaching their lifespan.<sup>5</sup> Few, if any, of these dams were designed with the challenges in mind that the projected climate extremes are now likely to pose:

*“That is a national concern for us,” said Lori Spragens, the executive director of the Association of State Dam Safety Officials. “Most dams are almost 50 years old. Many of them are very behind in their rehabilitation and they need to be upgraded to current standards. It’s the lack of money. The whole concern with infrastructure is just not there, as we know.”*

*Climate change adds to the challenges. Scientists have said for years that a warming atmosphere should lead to more intense and frequent storms in many regions. In California, where precipitation in the Sierra Nevada is the source of much of the state’s water, warming also means that more of the moisture in a given storm falls as water and less as snow, adding to the immediate burden on downstream reservoirs.<sup>6</sup>*

In brief, the system of dams developed largely by Governor Edmund Brown in the late fifties, which is the pillar of California’s economic prosperity, is now proving to be largely unsustainable. The Californian dam system and building enthusiasm of Governor Brown served as a model for many of

B.C.'s dam projects built in the same period of time under W.A.C. Bennett. It is not just the built infrastructure that is no longer up to the challenges posed by climate change, so is the social and intellectual infrastructure that has come out of this prosperity.

There is a growing weariness in the scientific community at the apparent inability or refusal of politicians and the electorate to come to terms with the unsustainability of current practices and the economic model that drives environmental impacts. While the technical capacity to understand and measure these impacts continues to be refined, buzzwords and cosmetic planning programs are constantly elaborated and multiplied to give the appearance that action is being taken. This public relations effort is substantially vacuous, and should only be measured by the outcomes. Those outcomes are the dam failure at Oroville, and the *Biological Extinction Conference* which tells us that 50% of species will face extinction this century.<sup>7</sup> Those are the only real measures of "sustainability."

The sense of a pervasive lack of effective progress grows. As recently pointed out by Harvard's Aaron Ellison with regards to the development of a new metric to measure the rate of deforestation:

*"I don't think we need another metric," said [Aaron Ellison](#), a researcher at the [Harvard Forest](#), adding that measures of other processes like fragmentation — the breaking of large forests into smaller, disconnected forests — already provide a nuanced picture of deforestation. Decades of scientific knowledge about forest management have not managed to halt clear-cutting and unsustainable development, Dr. Ellison said. To him, the challenge is much larger, and involves altering people's demands for short-term economic gains.*

*"No metric, no matter how opaque or how clear, has made a difference in that discussion during my lifetime," he said.<sup>8</sup>*

The only real no-news in the development of a "forest attrition metric" is that deforestation across the USA is proceeding at unsustainable rates, as it is across all of the planet.

Over the last 3 months British Columbia has been treated to a succession of environmental reports and events that should give rise to a similar unease at the general paralysis and insensitivity in the face of a rapidly developing crisis. At a time when British Columbians, like many Canadians across the country are expressing their lack of confidence in the objectivity of national and provincial institutions charged with carrying out environmental assessments, such as the National Energy Board whose entire structure and operating procedures are currently undergoing a review,<sup>9</sup> the viability of the provincial environmental assessment process has been cast into doubt by the scandal surrounding the Shawnigan Lake contaminated soil site.<sup>10</sup> The judgement recently rendered in BC Supreme Court by Justice Sewell, (January 24), revealed the extent to which the process and the BC environmental assessment appeal board's handling thereof, had been extensively corrupted. Justice Sewell determined that: *"the board appears to have applied different standards for the admission of opinion evidence from the Shawnigan Residents Association than it applied to evidence from government staff."*<sup>11</sup> The three-year old decision by BC's Minister of Environment, Mary Polak, to allow Cobble Hill Development to create and maintain a lucrative holding facility for contaminated soils in the Shawnigan Lake watershed, never received social license and was decried repeatedly by independent environmental scientists and residents alike. Justice

Sewell's judgment found that the engineering firm which prepared the environmental reports for environmental assessments had proprietary interests in the project, and was therefore in a clear conflict of interest. Justice Sewell's conclusion is that the case has brought the integrity of the environmental assessment board and its process into question.

In the wake of Justice Sewell's judgement, the minister has been left with no choice but to pull Cobble Hill Development's license, and is now calling for a clean-up of the site.<sup>12</sup> It is, of course, now unclear where the contaminated soils currently on site are to be safely removed, and where those that were expected to be delivered are now to be safely moved to.

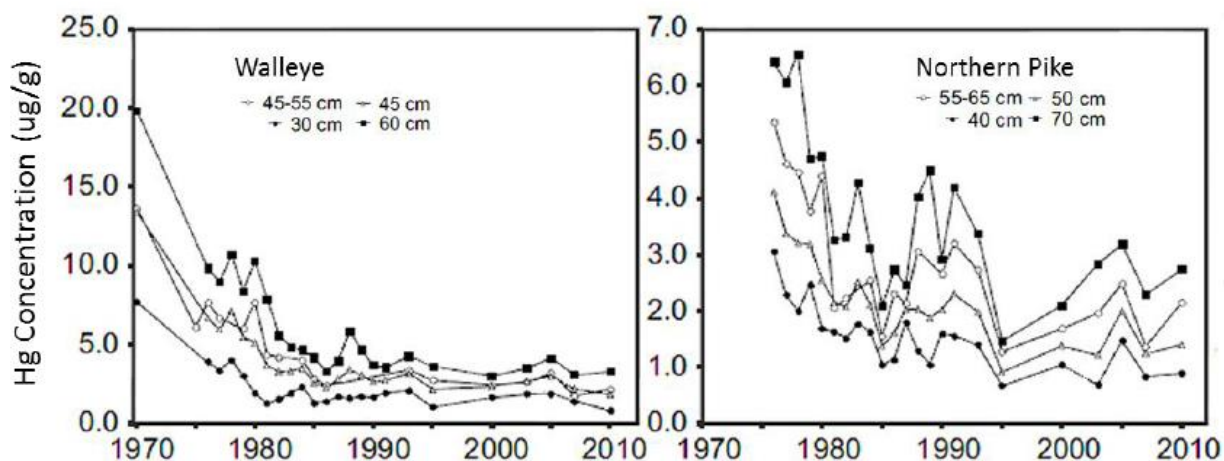
Contamination and the resulting pollution appear to be a perennial intractable problem in BC, as it appears to be in the rest of Canada. This week, just as Canadians were reminded that the Grassy Narrows contamination dating back to 1970, was back in the limelight, thanks to the work of David Suzuki and John Rudd, a number of events, including the Vancouver Aquarium's "Ocean Watch" report on Howe Sound, brought back to our consciousness the actual lack of progress in either our ability or our will to remediate these two contaminated sites. These two notorious sites which dominated environmental news in the early 1970's, "Britannia Beach" and "Grassy Narrows" might best be referred to as two zones of "national sacrifice,"<sup>13</sup> a term developed to designate areas that are so contaminated with at least tacit government approval, that there can be no hope of returning them to pre-industrial conditions. Areas of national sacrifice are not only irrecoverable, they are also excluded from the national consciousness. They are the inconvenient reality of our real impacts on the planet that polite people keep out of national conversations, preferring to treat them as exceptions, rather than the norm. In this case they may well be models for a future norm.

Over the past 50 years, these sites have largely receded from our consciousness. It is remarkable to consider that 50 years on the problems posed remain largely unresolved, and have been largely absent from the public eye and public discussion. Occasional well-timed public announcements of minor environmental successes, such as returning salmon sightings in contaminated waters, or initial rapid declines in metal concentrations following the covering or removal of a source, or the construction of treatment plants, have largely masked the reality that these sites continue to be regional sources of contamination and remain monuments to our provincial and national disgrace. That they are now returning to public attention may be timely, and inevitable. They are both precursors at a very local scale of the kind of global problems that are emerging from anthropogenic climate change scenarios. As does the Oroville disaster, they point to the limits of our capacity to address the environmental consequences of anthropogenic climate change.

In terms of Grassy Narrows, the chlor-alkali facility was closed in 1970 and the source of mercury was largely decommissioned and "cleaned up" in part by the installation of a water treatment plant to control effluent quality into the river. Following a dilution model, no remediation was undertaken in the sediments downstream. This reasoning was based on the false assumption that the mercury would somehow be absorbed downstream and eventually equilibrate with the Canadian Shield's natural background levels of mercury. As the data in Figure 1 show, although the closing of the facility resulted in an initial rapid decline in mercury concentrations in the Wabigoon watershed in the first decade,

methyl mercury concentrations in game fish levelled out and remain above acceptable levels. 90% of Grassy Narrows current population continues to show the effects of mercury contamination. As a result, levels of contamination continue to exceed by 2 to 6 times the accepted guideline of 0.5ppm mercury concentrations in walleye and northern pike. Although the “clean-up” initially resulted in a rapid decline in mercury concentration in the first decade, concentrations have not declined appreciably over the subsequent 4 decades.

To a large extent, a lack of follow-up after 1980 appears to be related to a neglect to continue monitoring as rigorously as one might have felt compelled to do, had Grassy Narrows remained a national concern in the public eye. The final report presented by John Rudd and associates (*Advice on Mercury Remediation Options for the Wabigoon-English River Systems, March 21 2016*) indicates that the problem can be remediated by either armored capping or hydraulic dredging of large parts of the river bed and Clay Lake, or testing novel technologies, at a cost between \$945 million and \$1.5 billion. While the authors of the report are optimistic that “remediation of at least some parts of the mercury-contaminated Wabigoon River is feasible,” they offer no guarantees that the system can be fully returned to its pre-industrial state, and include as a caveat that their modelling does not include potential climate change considerations.



**Figure 1:** John Rudd et al. (March 21 2016) *Advice on Mercury Remediation Options for the Wabigoon-English River Systems*. Figure 2: Mercury concentrations in walleye and northern pike of different sizes in Clay Lake, 1970-2010. Modified from Neff et al. (2012)

The situation regarding Howe Sound and Britannia Mines in BC is remarkably similar. The attitude towards it differs only inasmuch as Howe Sound is in a remarkably scenic corridor between Vancouver and Whistler, which has become part of the population density and housing relief zone in the wake of the 2010 Olympics. During the pre-Olympic period, pink salmon were observed in one of the local streams and endangered species, such as pacific tailed frogs (*Ascaphus truei*) and northern red-legged frogs (*Rana aurora*) were also observed. In fact the “miracle recovery” of Britannia Mines seems to have coincided with the development of that area during the pre-Olympic development boom, in part

because of the intensive monitoring that took place during the planning and building phase of the “Sea-to-Sky” highway.

Contrary to the somewhat rosy picture presented by some local newspapers, whose real estate advertisers depend on selling the image of a “pristine natural environment”, the recent report by Ocean Watch (The Vancouver Aquarium’s Coastal Ocean Research Institute) found that the majority of species and habitats in the sound are still “in trouble.” Nearly half are in critical danger, while the rest show very low numbers. Of greatest interest is the work done by Golders and Associates indicating that porewater contamination processes continue to be poorly understood and that heavy metal concentrations of iron, copper, zinc and cadmium often exceed WQGs between 100 and 125 times.<sup>14,15</sup> Thus while:

*“...the waters are no longer lethal to fish. The source(s) of recurring high metal concentrations in porewater and intertidal water at some locations near the mine is under investigation, as is the feasibility of future remediation options. It is unlikely that the area around Britannia Mine will ever be returned to its pre-mine state, copper levels may never consistently meet WQG, and risk assessment will be used as a tool to determine what an acceptable end state will be. Even when closure is achieved for the Britannia Remediation Project through a closure plan, there will be ongoing risk management obligations, for example the continued operation of the Water Treatment Plant.”<sup>15</sup>*

In both instances, Grassy Narrows and Britannia Mine, researchers explicitly noted that they excluded consideration of the potential effects of climate change on the remediation efforts. It may be worth bearing in mind that much of the remediation efforts are guided by standard engineering considerations. These assumptions represent a mindset somewhat similar to that which has guided both the construction in 1960 and the maintenance procedures at the Oroville Dam up to now. It may in fact be worth considering what some recent climate change research suggests: the new extremes which we are increasingly experiencing is the reality that will constrain everything we do in this century. The new reality of extreme climate change must be incorporated in all infrastructure and environmental restoration assumptions.

The climate events that we have witnessed over the last decade indicate that we are entering into a period extended droughts followed by extreme precipitation. As research shows throughout this decade the Pacific coast has experienced increased tree mortality which has come in a variety of forms such as the insect infestations of pine beetle, and the fungal outbreak of *Phytophthora infestans* which has killed about 10 million trees on the coast.<sup>16</sup> Throughout that period, climate models indicate that within the coming decades we will likely witness a shift in tree species distributions. Until recently the driving mechanism for this shift had been unclear. Recent research indicates that most trees can survive short periods of extreme moisture and of heat and cold. What they cannot survive is prolonged periods of drought, of three months or more, such as we have been experiencing over the past decade.<sup>17</sup> Not only does lower precipitation result in lower photosynthesis, it ultimately causes vascular problems leading to mortality. Ecologically, tree mortality increases litter, and ultimately this increases carbon loading in aquatic systems.

Vancouver Island, as much of the coast is already experiencing the consequences of climate extremes. Areas like the Comox Valley which depend on a relatively low-elevation mountain reservoir which rarely freezes over, are experiencing increasingly frequent boil water advisories. The rapid and unseasonal influx of cold mountain water associated with extreme rain and snow events, which is no longer retained in the ice caps in the winter period, but enters into relatively warmer reservoirs is causing unseasonal lake turnovers which result in abnormal periods of water turbidity. While these turnovers are a nuisance to taxpayers which can easily be addressed by water treatment, the phenomenon resulting from the shift from extreme drought to extreme precipitation is a much greater ecological concern, because it is related to the natural production of methyl mercury which enters in food chains.

Conditions which combine an increase in carbon coupled with a decrease in oxygen and increased temperature are the hallmark conditions for methyl mercury production. The development of such conditions in estuaries is yet again a reminder that we live in an ocean planet. The small percentage of total planet waters represented by our freshwaters (3%, of which our lakes and rivers are only 0.3%), is just an infinitesimal distillation of our oceans which always returns to our oceans. The quality of our freshwaters has to be a concern not just as a source of drinking water, but for the productivity of our oceans, particularly so for the most productive fisheries zone which is the brackish zone of estuaries and coastlines.

The flux of extreme weather, which challenged all the engineering assumptions behind the Oroville dam, also challenges food production associated with our estuaries. Weather extremes increase the number of annual fluxes and the volume of carbon that flows into our estuaries. Recent work shows that at a global scale under the projected climate changes natural organic matter run-off is likely to increase 10-50%. At a conservative increase of terrestrial carbon of 15-30% in our estuaries, under current ocean conditions, MeHg would increase in zooplankton by a factor of 3 to 6.<sup>18</sup> Bearing in mind that Health Canada recommendations for safe fish consumption are currently limited to 150 grams a week for an adult, and once a month for children and pregnant persons, an increase of 3 to 6 times would theoretically place MeHg in coastal fisheries within the current range of fish at Grassy Narrows.

This scenario becomes particularly important to consider since increasingly the data show that the oceans are warming and that oxygen levels are dropping significantly (2C over 50 years), to the point of threatening the viability of top fish species and “sustainable” fisheries.<sup>19</sup> The message seems to be that the shift in climate and weather is a radical shift in biogeochemistry and ecological function, for which we have not planned.

It is the measure used: “over 50 years” that really draws our attention. For over 50 years environmental science has grown, but it has been unable to meaningfully change the conversation. The decline in the sustainability of everything from our fisheries to our infrastructure that has happened in the 50 intervening years since Grassy Narrows and Britannia Mine should give a very clear indication of where we were headed. Grassy Narrows and Britannia Mine should have been meta-lessons, in 1970. It is a situation that has evolved as we superficially “moved on” beyond the reality of those very significant events that now come back to haunt us. It is as though we have never learnt from these lessons, because we chose not to pay attention to them, and continued to operate in a reality which shifted very

quickly while we stayed stuck in the misleading assumptions of an obsolete paradigm dominated by economic objectives rather than developing ecological realities.

In BC it is the economic concern of everything that draws our attention. If the public is truly shocked to learn that 26 First Nations communities in BC have been facing water advisories for over 10 years, although their water sources come from “remote pristine sources,”<sup>20</sup> then the public should really be asking some pointed questions about the reality of that “pristine” environment, in “Supernatural BC.” It should also consider the effectiveness of the agencies charged to protect the environment, like the NEB, and the Federal and Provincial Environmental Assessment Authorities. And it should consider how much longer we should listen to the hype about sustainability within an unsustainable paradigm, before we are brutally forced to become truly sustainable by facing reality.

To the great concern of our oyster farmers we continue to produce oysters which the Chinese market rejects because of high cadmium levels, and which Health Canada cannot understand why they are contaminated with norovirus.<sup>21</sup> When the federal government takes belated steps to protect rare glass sponge reefs off Haida Gwaii, the Fish Harvester’s Federation cries foul at an infringement of its “sustainable” economy.<sup>22</sup> There is still no real climate change plan in BC, and, as Justice Sewell’s judgement at Shawnigan Lake shows, assessments don’t really need to consider whether the paradigms they operate from match anything beyond their clients’ sense of reality.

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