Innovations and Sustainability

Part 3

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This Discussion Paper is intended to spark discussion and debate. Please use it but ensure that the ideas presented within are appropriately attributed to the author. Correspondence about the project as a whole can be directed to Dr. Robert Gibson at rbgibson@uwaterloo.ca or Dr. Maureen Reed at m.reed@usask.ca

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3. Synoptic overviews of strategies and programs in Canada related to Eco-Innovations. Three parallel themes, each with several "discursive domains", are unfolding. Some main issues raised by each are noted and a number of examples are described.

Introductory Comments.

The first discussion paper in this set, *Innovations and Sustainability – 1*, briefly noted the concepts and strategies for Eco-Innovations being followed within the OECD and the EU, and issues being discussed in various circles that relate to these endeavours. It notes that much the same discourses are underway in Canada. The present discussion paper examines these topics in somewhat more detail. Three concurrent and largely parallel themes are discernable, each of which has a history and at least three "discursive domains". The "domains" are defined by people and organizations in them and may be modified over time. They can be differentiated by the framing of issues that the domains are most, or sometimes exclusively interested in as well as the intellectual boundaries used to identify the scope and/or scales of the complex social-ecological systems in which the domains are embedded. The three main themes (that were discernable after the first drafts of the discussion paper) were completed are:

1. Clean and Green Technologies. There are three subset domains named by the proponents as "eco-efficiency"; "industrial ecology" associated with "eco-industrial parks"; and "eco-business zones".

2. Sustainable Communities. There are domains at different scales that are partially linked together as different versions of local scale sustainability identifiable by 23 labels about "community"; different kinds of networks of cooperation and information exchange that extend horizontally across Canada, and often to similar local efforts in other countries; and the emergence of the "Green Economy" as a global ideal celebrated at the Rio+20 Conference in June 2012.

3. Focus on Ecosystems. The Rio + 20 Conference and associated other meetings noted ample reasons for devoting much more attention to the ecosystems in social-ecological systems at all scales. There are at least three subsets domains that address

issues (across different spatial and to some extent time scales); “parks and protected areas” for conservation and protection for ecosystems that seem relatively undisturbed by human impact; “restoration ecology” for impacted areas at local scales and increasingly at much larger spatial scales; and the design of “novel ecosystems” to restore “natural capital” and the kinds of ecological goods and services provided by such capital.

These three varieties of Eco-Innovation are NOT sequences in which one replaces the other. Rather, they are three distinctive sets of perspectives each having discursive domains and their own “epistemic community” of leaders.

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1. Clean and Green Technologies.

There is a very large literature that has summarized and analyzed ideas and events associated with the evolution of Eco-innovation concepts of clean technologies in most of the industrial countries of Europe and North America in particular. Examples include Könnölä and others 2008; Kemp 2009 a; b; Cooke 2011, and for Canada, Fan Shu-Yang and others 2004; Côté 2010. One can trace back the recent and current concerns about environmental sustainability to the 1960s when public concerns in the developed industrialized countries arose over problems of pollution from industries.

Starting in the mid-1960s, pollution was both emblematic of, and a synonym for “environment”. The eventual response was to introduce technical devices in discharge outlets (“end-of-the-pipe” add-on) to capture some of the pollutants, including toxic substances, for diversion into waste treatment facilities before they too were discharged into the air, water, or landfills. Technical considerations for plant operations began then to look for ways of reducing wastes at their source by reducing the volumes of materials and energy being consumed during the production processes. This reduced costs of production while also producing less pollution. This was seen as a win-win strategy, and was called *“eco-efficiency”* by the World Business Council for Sustainable Development in the early 1990s. There was some debate about whether or not industries should be recognized for environmental stewardship if it was just an accidental positive externality rather than an integral part of some conscious technical design process that included possible environmental impacts. Either way, it became increasingly acceptable to develop and apply technological solutions to deal with the entire production process from

the time of creation and sale of the product to the end of its useful life and subsequent disposal viewed as a “closed loop” (or “cradle to grave”) technical design process. These were also recognized as incremental sub-system changes that were positive as far as they went. One difficulty was that these improvements and efficiencies could lead to more consumption of the products with the result that there was either no net gain, or possibly a greater loss of environmental quality because of these over-all impacts.

Public environmental awareness was also being enhanced by publicity given to ecology and to the concept of “ecosystem”. The rather standard view in the 1960s and 1970s was that of delicately balanced natural systems with their own flows of nutrients and energy through different trophic layers both at larger and smaller scales than those more readily seen at the human scale. Nevertheless, this concept of ecosystems was widely adopted as a metaphor for how eco-efficiencies should work such as recycling from one industrial operation to another. This led to the concept of *“industrial ecosystems”* as open cycles so that “cradle to grave” closed cycles would be replaced by “cradle to cradle” new beginnings when items salvaged or recycled from one operation became raw materials for some other. It was a question of how to perceive or define the relevant inter-related production systems in the industrial manufacturing sectors to recognize how they have become “eco-effective” by this use of materials and energy among them. Gradually, at this point in the early 2000s, “*industrial ecology”* became mainly a pragmatic, technological and technique set of enterprises dominated by practitioners.

Most municipalities in Canada (and elsewhere) have zoning regulations that separate different major urban or rural land uses from direct mutual interferences with one another. Hence, the idea of an “industrial park” was widespread. Many local governments designed them as “full service sites” having water and sewerage, electrical and/or other sources of energy, and roads and parking lots available for easy access and use. The purpose was to attract businesses and jobs into the municipality. If the businesses were “clean and green” but not related to one another, this was quite acceptable.

However, there were some situations where certain kinds of businesses had already started to come together, especially around outlying areas that had municipal or private “junk yards” for salvaging and recycling operations. They were not likely to be attractive

but they were serving vital functions. As urban regions grew out towards them, their importance became more widely evident especially as old landfills had to be closed, and creating new ones located further away became an almost politically impossible task in many cases. “Industrial ecology” often became associated with these as working examples of the concept in practice. Côté (2003) provides several examples. Information about these business opportunities was generally provided through websites maintained by the owners of the sites, or portions of them, as well as by contractor services, and planning and/or engineering consulting firms. The fewer but more academic discussions tended to focus on questions such as cluster developments for such sites, network links among companies in the same industry but more widely dispersed geographically, and on how the system might be expanded beyond individual companies, or for the design of special “eco-buildings” with retrofits and other resource conserving features. The challenge was to embrace at much larger scales urban forms and infrastructures. Meanwhile the metaphors in the discourse began to include notions of “industrial symbioses” and “by-product synergies”.

“Industrial ecology” appears to have become institutionalized around its various professional and technical publications, professional specialties, various business associations and some “environmental technologies”. The latter can also ground it within national or regional innovation systems being constructed, but with more awareness that environmental issues can go well beyond what the innovation systems usually focus upon.

Some eco-innovation discourses now underway are moving beyond the innovation technologies as the major focus by adopting “sustainable development” as an orienting framework. This concept is now used by many organizations, especially following the main reports from Brundtland (1987) and the MEA (2005). Sustainability also originated as a concern in the 1960s and 1970s, but it has always included “environment” as an integral part of economic and social development. It also interprets “environment” to mean the biosphere life support systems, a growing number of which are now recognized to be imperiled.

Working definitions of “eco-innovation” include:

European Union 2011. Eco-innovation Action Plan.

> **"Eco-Innovation** is any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources". Brussels: COM (2011) Final , p. 2 .

OECD 2010. Eco-Innovation in Industry: Enabling Green Growth.

> "Many companies and a few governments have started to use the term eco-innovation to describe the contributions of business to sustainable development while improving competitiveness. Eco-innovation can be generally defined as innovation that results in a reduction of environmental impact, no matter whether or not that effect is intended. Various eco-innovation activities can be analyzed along three dimensions:
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> • targets (the focus areas of eco-innovation: products, processes, marketing methods, organisations and institutions);
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> • mechanisms (the ways in which changes are made in the targets: modification, redesign, alternatives and creation); and
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> • impacts (effects of eco-innovation on the environment).
>
> "Innovation plays a key role in moving manufacturing industries towards sustainable production, and the evolution of sustainable manufacturing initiatives has been facilitated by eco-innovation. As those initiatives advance, the process of their implementation becomes increasingly complex and industries need to adopt an approach that can integrate the various elements of eco-innovation to leverage the maximum environmental benefits. Such advanced, multi-level eco-innovation processes are often referred to as system innovation – innovation characterised by shifts in how society functions and how its needs are met, often complemented by non-technological changes. (pp.15-16, Executive Summary).

The United Nations Environment Program (UNEP) defines eco-innovations as:

> **Eco-innovations** (EIs) [are defined] as "product, process or organizational innovations that contribute to the economic, environmental and social pillars of sustainability. EI are building blocks for sustainable development. They add market value and also increase environmental and social acceptance.
>
> "Today, much emphasis is placed on the environmental and economic pillars of EI. We believe that the EIs social pillar (e.g., social acceptance, ownership, learning) represents a major bottleneck to sustainable development. Indeed, many potential eco-innovations, albeit technically feasible, are not yet implemented because of social, institutional, and cognitive barriers".

While the concept of industrial ecosystems was promoted by a number of local, provincial, and national organizations especially interested in technological research, industrial applications and trade, "eco-innovations" oriented by concepts of sustainable development spurred further refinements by new groups (such as "The Interuniversity Research Centre for the Life Cycle of Products, Processes & Services, CIRAIG" that

was formed in 2001 by Quebec-based universities, and the Canada Green Building Council formed in 2002 representing the building industries). Their focus remained one of developing clusters of interacting organizations that remained devoted to eco-industrial goals of energy conservation, pollution prevention, switching to more benign fuel sources, recovering materials from waste streams, and promoting the recycling and use of waste materials. Municipal industrial parks have set a variety of standards and expectations, and so did some of the newly created local or regional clusters that were developing in various parts of Canada. From about the mid-1990s on, many of these were called *"eco-industrial parks"* that can include some industrial ecology inspired tenants, but also can set requirements for "green" infrastructures and "green" businesses to qualify for location in the parks.

It is not easy to get a sense of the current status of these initiatives across Canada, partly because they seem to be evolving quite quickly. Much depends on the criteria adopted by governments, industry associations, and non-governmental organizations for identifying different examples. Independent observers have encountered reluctance of site owners to give out information about their tenants to third parties for various business or proprietary reasons. Thus, information can best be gleaned from a number of websites maintained by consultancies to identify sites they had worked on in order to advertise their own expertise, or by trade magazines and/or business associations to promote their views on issues they think should be of wider public interest.

But to indicate the variety of initiatives underway in Canada, the following is noted from various sources with apologies to whoever was inadvertently overlooked, and to those for which the information noted here might be very incomplete.

a) *District Heating Initiatives*: Waste heat from thermal power plants (fossil fuel or nuclear) is distributed for space heating of other buildings and for the associated business or other activities in the buildings. The Canadian District Energy Association undertook a national survey in 2008 and reported 118 such energy projects in Canada. One that has been identified in a number of eco-industry tallies is the *Bruce Energy Centre*, in Tiverton ON, where steam generated by the Bruce nuclear power complex is fed into at least five other buildings nearby and is used to produce greenhouse

vegetables, fruit and vegetable concentrates, domestic animal feed, commercial ethanol, and specialized plastic films.

b) *Towards provincial networks of industrial parks: Nova Scotia as an example*. The Burnside Industrial Park in Dartmouth, Nova Scotia, is one of the largest in Canada. It has developed over the last 40+ years from its origins as the City of Dartmouth Industrial Park. In the earlier years it was apparently a location for the disposal and treatment of solid wastes from various sources with businesses that included salvaging useful components, recycling and re-using some materials, and repairing other items for re-sale. When the MacKay Bridge to Halifax was opened in 1970, this gave direct access to Halifax and the port of Halifax while also connecting the Halifax Regional Municipality directly with the Halifax international airport. The Burnside facilities then expanded rapidly. The 1,200 ha site now has about 1,500 business enterprises on it that employ about 17,000 people. It has become a transportation and warehousing centre with most long haul trucking firms located there as well as rail access. There is a large concentration of suburban offices with sales and services and over 100 manufacturers and 100 retail outlets. Some recent buildings have LEED certifications.

Raymond Côté and his colleagues at Dalhousie University conducted detailed collaborative (multi-disciplinary and multi-institutional) studies of this location from industrial ecosystem perspectives over a six-year period beginning in about 1990. They included documentation of material flows, energy audits, waste and materials exchanges, retrofitting possibilities, recyclers and waste managers information exchanges (e.g. for the Cleaner Production Centre Business leaders), surveys of institutional policies and management capabilities and concerns, and disseminating information in newspaper columns. They also oversaw an Eco-Efficiency Centre in the complex that helped with retrofitting to improve the environmental performance of many of the activities and help transform them into an industrial ecosystem. The outcomes of all this is that Burnside is now well-known and often cited in trade and professional publications as well as academic writings (e.g. Côté 1997).

More recently, Dalhousie (c 2008) reported out studies they had fostered to explore networking among about seven industrial park operations in Nova Scotia under the general theme of “industrial symbiosis”. These included industrial parks in Cornwallis,

Truro, and Hantsport, as well as interesting start-ups at Wolfville, Mulgrave, and Port Williams. Student teams under Côté's direction explored possibilities for the Canso region in southern Cape Breton (Ayisi-Boateng and others, 2006).

c). *Eco-Innovation Industrial Parks* that serve particular local industries or local interests and opportunities. This need not be an either/or division because over time any given site can grow and add new partnerships. One example of start-ups that serve particular industries is the *TaigaNova Eco-Industrial Park* in Fort McMurray, AB. This is a 51.3 ha site seven km north of the town centre along the main highway that connects the major oil sands operations (24 km) to the north, with the City of Edmonton (~400km) to the south. Its 24 industrial lots incorporated water conservation and other "green" designs partly as demonstration sites for the local service industries and all were sold by January 2011. Another example is the *Innovista Eco-Industrial Park* at Hinton AB, a 44 ha site on the Yellowhead Highway 29 km from Jasper National Park. It is located at the edge of town between the highway and the main transcontinental (Canadian National) rail line. The Hinton region has a natural resource based economy that includes the Elk Valley (Ltd.) coal mine, the Hinton Division of West Fraser Mills' pulp and sawmills, and various oil and gas operations. It was also headquarters for the former Foothills Model Forest (1992-2006). The eco-industrial park was being developed in three phases and in conformance with a 2005 land use zoning by-law and development guidelines that emphasize ecological design, green infrastructure investment energy and water conservation, and conversion of wastes and byproducts into useable resources.

Other eco-innovation industrial parks grew slowly over a number of years. An example is the *Ross Eco-Industrial Park* in Regina. It has been the main industrial area in Regina since 1962, located close to the Trans-Canada highway, the transcontinental (Canadian Pacific) rail line, and to the Regina airport. The site has grown considerably over the years to some 730 ha, with 35 km of roads and about 500 businesses on site. A Regina Eco-Industrial Networking Association was created in the early 2000s to help transform this industrial district into a high performance eco-industrial park. An opportunities assessment report was completed in 2003 followed by a detailed resource baseline analysis of the park compiled as a customized GIS database. Through consultations with property owners on the site and other partners, the Association and its consultants are designing "green buildings" and installing technology retrofits for energy conservation

and wastewater re-use. They are also exploring more use of rail access for shipping, improved municipal transportation access to the site, and possibilities for shared shipping and receiving facilities (Regina 2009).

d) *University Science Parks* link science and applied science research undertaken at a university or other post-secondary institution (such as teaching hospitals, and some colleges) with financial and mentoring support for the early stages of commercializing some of the research results to the point that start-up companies are launched. This approach can be viewed as the "supply side" trying to connect with the "demand-side" from interested on-going businesses. They generally fit well with the "Canadian Innovation System" initiatives, with each science park specializing in one or a few technological domains, at least in the earlier years.

The Canadian Association of University Research Parks (AURP Canada) was formed in 2007 as the Canadian Chapter of the (US) Association of University Research Parks. It publishes an on-line magazine "Canada NOW" that celebrates the work of 27 member science parks. There are one or more members from ten provinces so far, with 11 in Quebec and eight in Ontario. The David Johnston Research+Technology Park at the University of Waterloo is treated somewhat as a model for what is possible, in part because it has received considerable funding from the Research in Motion (Blackberry) Corporation, itself a model of what the Canadian Innovation System is intended to promote. Now as Governor-General, David Johnston promotes excellence in innovation regularly in his statements and appearances across Canada. Bramwell and others (2004) traced the cultural history of the Waterloo cluster over the past 50 years noting the main events that laid the basis for the current ICT developments in software design and informatics.

Not surprisingly, most science parks have a distinctive history, including informal cooperation among different post-secondary institutions. In Vancouver, *The Great Northern Way Campus* was initiated in 2001 by a donation of a 7.5 ha property from a private owner to four universities, University of British Columbia, Simon Fraser University, the BC Institute of Technology, and the Emily Carr Institute of Art and Design. It was a part of a much larger 125 ha former industrial area along the south edge of the False Creek Flats in downtown Vancouver. Since then, the universities, local and regional government and private sector have been developing the larger site to become

a collaborative mixed use commercial and residential area with the property leased back to academic institutions. As of 2010, the Emily Carr Institute was planning to move its entire campus to this area along with their New Centre for Digital Media. The BCIT has its Centre for the Advancement of Green Roof Technology there and offers trade and apprenticeship courses. SFU has a downtown centre nearby, and UBC in 2011 opened its $ 37m Centre for the Interactive Research on Sustainability (CIRS) in a four-story "living laboratory" building that exceeds the LEED Platinum and Living Standards. It is located on its main campus, but with expectations that inter-university cooperation will develop in the years ahead.

e) *Eco-Business Zones* constitute a scaling up of the eco-innovation industrial parks concept. The main example of this is the Pearson Eco-Business Zone that encompasses 12,000 ha of industrial and commercial land surrounding the Toronto Pearson International Airport. This zone includes an estimated 12,500 businesses employing about 355,000 people. The area is a heavy user of water, electricity and natural gas. It also produces an estimated 1.7 million tons of greenhouse gas emissions annually. The zone is located in four municipal jurisdictions, City of Toronto, City of Brampton, City of Mississauga, and the Region of Peel. It is also part of the Toronto and Region Conservation Authority (TRCA), a watershed organization that was dealing with severe water pollution and related land use issues in the Greater Toronto Region. Since the late 1990s, TRCA had been working with the Greater Toronto Airports Authority (GTAA) on some of these issues.

In 2008, the TRCA and GTAA launched a *Partners in Green* initiative headed up by a business-led steering committee. They took an eco-industrial approach whereby they identified the best green technologies to reduce waste and improve their own efficiencies and fostered business-to-business networks to work together on these issues. By 2009, the Partners had produced a detailed strategy document that included an eco-efficiency program, green building retrofit program, sustainable transportation initiatives, shared green purchasing arrangements, and by-product exchanges. Implementation of these entails shared activities such as efficiency audits, waste-recovery projects, creation of a district-wide energy system, networks of vegetated watercourses and storm water retention ponds, and biogas feasibility studies (using wastes from over 200 food

processors in the area). To promote these initiatives, the Partners give recognition awards to various businesses and organize tours of various facilities.

"Alberta's Industrial Heartland" is a 582 km^2 region in five municipalities northeast of Edmonton immediately adjacent to the chemical and petrochemical complex on the east side of Edmonton. The heartland region includes the 49 km^2 Horsehills Energy and Technology Park in Edmonton itself, along with industrial lands in Fort Saskatchewan ("up-grader alley") and other sites in Strathcona, Lamont and Sturgeon Counties to the northeast. There are about 50 companies associated with the oil and gas industries in the area. They have an "eco-industry" orientation and have invested an estimated $25 billion in facilities and infrastructure; they also expect to invest that much again in the next 10-25 years.

The municipalities formed an " Alberta Industrial Heartlands Association" in 1998 to deal with issues such as locations for infrastructure and services, other land uses, emergency preparedness, air and water quality monitoring and abatement measures, all associated with the industrial chemical complexes. This also entailed re-zoning of some 194 km^2 of existing rural industrial, agricultural, and residential properties, a process that generated considerable controversy (Masuda and others 2008). In addition, the "Northeast Capital Industrial Association" maintains a "Life in the Heartland" information portal for different aspects of "sustainable development operations". There are also four Community Advisory Panels. As of 2012, there were several major projects underway. The largest was the "Northeast Expansion", a proposed 297 km 42" pipeline from Conklin AB to a Sturgeon County terminal dedicated to carry 350,000 barrels of blended bitumen/day. It is going through regulatory processes, and plans to open by 2014. Different companies are developing their own facilities for bitumen up-grading, including off-gas processing for hydrogen, ethane, propane, and sulphur extraction, and a gas-fired 190 MW thermal power plant (in Lamont County). Some other proposals for up-grade projects have been deferred or cancelled, depending on business circumstances of the company or companies involved.

2. Sustainable Communities.

Local initiatives at local scales have proliferated in Canada over the past two or three decades to the point that "micro-localization" is sometimes portrayed as a major weakness. But a recurring observation by people who take these local steps has been that as local people there is not much they can do on their own about climate change or global manifestations of non-sustainability, exemplified for example by the crucial and increasingly vulnerable dependencies on fossil fuels. But they can at least begin to ameliorate these where they live while there is still time to experiment locally, and learn from different ways of adapting to change while enhancing greater self-reliance.

A somewhat cursory examination indicates that, while there are many similarities and overlaps in these initiatives, each has or had its own rationale at the time. Some have since developed to the point that they are now much broader multi-sector initiatives, and/or they were able to have some of their endeavours "scaled up" so that government departments in at least one (if not all three) jurisdictional levels have now taken on the funding and administration of them as part of their regular programs. More recent innovations are exploring how to launch "social enterprises" at the community scale to help fund this kind of work.

One can sense the range of these local initiatives by noting the adjectival labels that have been adopted by their proponents, i.e. The x City (or Community). In Canada over the last 25-30 years or so the adjective (x) in alphabetical order has included: Age-friendly; Biosphere; Bluegreen; Compassionate; Creative; Eco; Fire-smart; Forest; Green; Healthy; Human Rights; Inclusive; Intelligent; Learning; Livable; Resilient; Safe; Smart Growth; Strengthened; Sustainable; Transition; Vibrant; Youth-Friendly. Brief summaries of all of these are given in *Innovations and Sustainability – 6*. One main example that has been underway for more than 25 years is sketched below to illustrate the variety in some local sustainability initiatives.

Example: *Healthy Communities:* There is a long history of concern about the health and living conditions of people in industrial eras that dates back to the early years of industrialization. In Canada, similar concerns were the subject of several investigations by the Commission on Conservation Canada (1906-1921) who had documented severe public health issues including some traced to polluted water supplies and serious coal-fired air pollution. There were also reports on improved town

planning modeled on the English Garden City ideals, and land use plans using these perspectives were proposed for a number of Canadian cities in c1915-1920.

Much more recently, an international health conference was co-sponsored by the Canadian Public Health Association, Health and Welfare Canada, and the World Health Organization (WHO) in Ottawa in 1986. This gathering tabled and discussed a set of principles for the promotion of health, and the resulting “Ottawa Charter” became widely known for its declaration that “health” refers to “a state of complete physical, mental and social wellbeing and not merely to the absence of disease or infirmity” (WHO 1986). This Charter became the basis for the creation of a WHO healthy cities program that within a decade had been adopted by a large number of cities or other communities, (e.g. Hancock n.d., based on his 1993 publication). As of 2012, WHO had designated 830 “collaborative centres” of expertise in a range of medical and public health issues in the six main regions of the world that altogether advised cities or other communities in 195 countries. Canada has 25 of these “collaborative centres”.

Adoption of the Charter also led to commentaries about its implications and issues that require further clarification. Green and Raeburn (1988) for example, noted that the statement was very Euro-centric in its assumptions about medical infrastructures, and about what statements such as health promotion being “the process of enabling people to increase control over, and to improve, their health” meant to people in poorer countries and other cultures, or for communities in developed countries where health promotion activities were already organized by different agencies than medical and health services. Were resources to be turned over to communities for their direct use?

Compared to medicine that has a strong and continually increasing body of evidence-based theory to guides its practices, the public health promotion was a pragmatic framework of general guidelines that seemed quite sensible, but had no strong theory to substantiate them. A medical sociologist proposed, and then strenuously advocated for adoption of his conceptual foundation called a “salutogenic model”, meaning the origins of health (Antonovsky 1996). He also proposed a set of hypothesis to pursue based on 29 criteria and indicators that together would constitute an “orientation to life” that would be based on an emergent “sense of coherence” (SOC) by which individuals made sense of their world in terms of experiencing it as “comprehensible, manageable and

meaningful". Eriksson and Lindström (2008), looking back over the previous 20 years concluded that this was a valid, reliable and cross-culturally applicable instrument for judging SOC, but the salutogenesis concept was much broader and more holistic. They did not discuss the governance implications of this observation.

Health promotion is still conducted primarily at the municipal and non-governmental community levels in Canada. Federal government involvement at the time of the Ottawa Charter ended with severe budget cuts in 1991-1992, and currently, only the Quebec, Ontario, and British Columbia provincial governments offer various kinds of provincial support, much of it from their public health agencies. (e.g. ONCC 2011). Hancock (2009) documented the development of health promotion initiatives in Canada in a large compendium kind of statement for a Senate sub-committee in Ottawa.

In the meantime, however, much work has gone into identifying and quantifying social determinants of health in Canada and elsewhere in the world as part of the WHO Commission on Social Determinants of Health. Fourteen broad factors have been identified and all can interact in various ways, sometimes negatively as exemplified by continuing problems experienced by people in poverty. For a recent Canadian summary of social determinants in Canada see Mikkonem and Raphael (2011). A conceptually related, but seemingly quite independent approach to social determinants, has been taken by social workers and nurses for dealing with people at risk. The Resilience Research Centre based at the School of Social Work in Dalhousie University, Halifax, examines how children and their families can become competent and caring contributors to their communities despite risks, adversity, and personal traumas some have experienced (see for example, Ungar 2005). The Dalhousie Centre has an extensive research network including people in other countries that share cross-cultural insights into these phenomena. This can be particularly helpful for assisting new immigrants in Canada. The Faculty of Nursing, University of Alberta, has also adopted resilience perspectives that underlie their teaching and research (see Marck and others 2007). It can be noted in passing that this use of the term "resilience" is quite different from the ecological version adopted by the Resilience Alliance network of ecologists who examine community-based resource management issues.

In addition, it can be noted that the UN Human Development Reports have been published since 1980 with the theme “people are the real wealth of a nation”. The reports use a wider range of indicators of wellbeing to qualify the widespread conventional reliance only on economic indicators of production and productivity. In Canada, several major initiatives have been taken to develop more comprehensive and transparent sets of criteria and indicators for documenting social conditions and/or “genuine progress”. These include the Canadian Sustainability Indicators Network (CSIN), the Pembina Institute’s economic, social and environmental indicators for green economies, piloted by applying 51 such indicators to Alberta for the years 1961 through 2005 (Anielski 2007) to exemplify Genuine Progress Indicators (GPI). Other GPIs were developed for the Atlantic Canada region, applied initially to Nova Scotia. The GPI have been further refined by the Atkinson Charitable Foundation (Toronto) and its Partners and is now the Canadian Index of Wellbeing. As of 2011, these indices are maintained and refined further through research networks based in the Faculty of Applied Health Studies at the University of Waterloo.

It seems clear that the healthy communities commitments are alive and well, and have either been scaled up and/or coordinated more strongly among different institutions and their practices. It still leaves opportunities for volunteers in different communities to mobilize local initiatives to promote improvements in hygiene, nutrition, fitness, and poverty alleviation. Burris and others (2007) noted the need to think about “healthy urban governance” in order to deal with these issues. While the concepts might best be applied quite locally, the cross-scale implications (that become evident with the adoption of complex socio-ecological systems as the appropriate perspectives) are, ultimately, global. This is also the message from UNEP (2011), Webb and Esakin (2011) following their consultations across Canada, and the Rio+20 Conference (United Nations 2012).

The Future We Want, UN Conference on Sustainable Development (RIO + 20) June 2012

This UN Conference along with about 6,000 other events, seminars and at least 500 somewhat official meetings occurred in Rio de Janeiro from June 13-22, 2012. An estimated 40-50,000 people participated in some way. Senior officials from most of the UN Specialized Agencies held meetings and informal discussions. Over 12,000 accredited representatives from 191 Member States and international governmental

organizations (and NGOs) participated in these various sessions. As of 30 June 2012, 715 volunteer commitments for sustainable development were registered with the UN by governments, business and civil society organizations. They included US $513 billion in commitments to various sectors of the global "green economy".

The "Future We Want" was the title of the official "Outcome Document" that was accepted by the main Conference delegates on the final day (United Nations 2012). It had been formulated by several preparatory conferences prior to the Rio gatherings. It was a very comprehensive statement in 'UN-ese' that included references to numerous UN declarations, treaties and conventions, and major programs of the UN Specialized Agencies. The purpose of the Conference was best summarized in the Section 5 Framework for Action and Follow-up:

> "We recognize that in order to achieve the objective of the Conference, namely to secure renewed political commitment for sustainable development, as well as to address themes of a green economy in the context of sustainable development and poverty eradication and the institutional framework for sustainable development, we commit to addressing remaining gaps in the implementation of the outcomes of the major summits on sustainable development, to address new and emerging challenges and to seize new opportunities through the actions enumerated below in this framework for action, supported as appropriate through provision of means of implementation. We recognize that goals, targets and indicators, including where appropriate gender-sensitive indicators, are valuable in measuring and accelerating progress…" (para. 104, pp. 20-21).

The document serves to endorse institutional modifications in the UN system that reaffirms the central role of the UN General Assembly as the "chief deliberative policy-making and representative" body (para. 81, p. 15), the Economic and Social Council (ECOSOC) as "a principal body for policy review, policy dialogue and recommendations on issues of economic and social development and for the follow-up to the Millennium Development Goals…" (para. 82, p. 15). It also notes a UN commitment to major strengthening of the United Nations Environment Programme (UNEP) to become a full equivalent to a UN Specialized Agency with a "universal membership" in its Governing Council and with increased funding (para. 88, p. 17). As for statements about the "green economy" itself:

> "We affirm that there are different approaches, visions, models and tools available to each country, in accordance with its national circumstances and priorities, to achieve sustainable development in its three dimensions which is our overarching goal. In this regard, we consider green economy in the context of sustainable development and poverty eradication as one of the important tools available for achieving sustainable development and that it could provide options for policymaking but should not be a rigid set of rules. We emphasize that it

> should contribute to eradicating poverty as well as sustained economic growth, enhancing social inclusions, improving human welfare and creating opportunities for employment and decent work for all, while maintaining the healthy functioning of the Earth's ecosystems. (para 56, p. 9).

Much of the criticisms of the Outcome Statement from NGOs, and especially participants in the various associated events at Rio+20 was that the statement didn't directly re-affirm "binding commitments" on governments with targets and dates to achieve them, especially ones recommended by a number of groups who proposed them at Rio.

The various associated meetings with Rio + 20 were the occasions to discuss other international and/or multi-lateral programs that are to help implement or supplement the green economy agenda for a sustainable world. The main ones are:* The *Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)* that is sponsored by UNEP, UNESCO, UNDP, and FAO in association with ICSU and IUCN; the *Program on Ecosystem Change and Society (PECS)* sponsored by ICSU in association with the UNU and the Stockholm Resilience Centre; and "*Future Earth" - Research for Global Sustainability*, an Earth System Science Partnership that coordinates the follow-up from the former International Geosphere-Biosphere Program (IGBP), the International Program on Biological Science (DIVERSITAS), the World Climate Research Program (WCRP), and the International Human Dimensions Program on Global Environmental change (IHDP).

> [* ICSU (International Council of Scientific Unions) now called the International Council for Science, Paris; IUCN (The International Union for the Conservation of Nature and Natural Resources) now the World Conservation Union), Geneva; FAO The UN Food and Agriculture Organization, Rome; UNDP, the UN Development Program, New York; UNESCO, the UN Educational, Scientific and Cultural Organization, Paris; UNEP, the UN Environment Program, Nairobi; and UNU United Nations University, Tokyo].

The Rio+20 Outcome Statement notes only "We take note of the establishment of the (IPBES) and invite an early commencement of its work, in order to provide the best available policy-relevant information on biodiversity to assist decision makers" (para. 204, p. 39). There is wide recognition and acceptance that these programs are dealing with complex social-ecological systems that are inherently cross-scale in their manifestations, and that the main challenges are to develop effective trans-or cross-disciplinary research teams that are capable of dealing with both the range of natural sciences and social sciences in policy-relevant contexts. It also implies that effective working relationships can be established with other international organizations that

operate almost entirely at other scales. A major example would be ICLEI (International Council for Local Environmental Initiatives) now called simply *Local Governments for Sustainability*. ICLEI was conceived in 1989. Its founding conference was at the UN in New York in 1991 where some 200 local government representatives from 43 countries agreed to take an active role in the 1992 UNCED Conference in Rio and its follow-up. ICLEI's Secretariat was first set up In Toronto in 1991. ICLEA now has some 1,200 cities, towns and counties as members, including 29 municipal government members in Canada (from eight provinces/territories with 11 of them in Ontario). Its World Secretariat is now in Bonn, Germany (since 2009). ICLEI took a lead for the Agenda 21 outcome from Rio '92 and has given priority to promoting and helping to implement local actions for climate change adaptations in urban areas.

3. Focus on Ecosystems.

As noted above, ecological metaphors have been in use for the past several decades for various interpretations of Eco-Innovation. Ecological knowledge itself has been developed into a mix of multi-disciplinary and integrated complex systems perspectives. With the Rio + 20 conference, the launch of the IPBES platform for biodiversity and ecosystems services, the PECS program on ecosystem change and society, and Future Earth, the complex social-ecological systems perspectives have come to the forefront with a sense of urgency. "Navigating the Anthropocene" calls for major transformations in global governance (see Biermann and others 2012) that would be a new "constitutional moment" similar to the transformative shift in governance that occurred after 1945 with the establishment of the UN system itself. For summaries of the thinking that has led up to this point, see Carpenter and others, 2009; 2012; Rockström and others 2009; Schellnhuber and others 2004: and Walker and others 1999.

It was not always like this. Ecology had first to become defined, then developed into a substantive discipline. While concepts similar in ways to modern ecology can be traced back at least to the 18th century, it is convenient to go back only to the 1930s starting with Sir Arthur Tansley, an Oxford botanist who studied plant succession and the influence that soil characteristics, moisture regimes and other land uses had on vegetation. In 1935, he invented the term "ecosystem" to emphasize his belief that vegetation and the biophysical environment where it was growing had to be viewed as

an integrated system of biotic with abiotic components through which energy and nutrients flowed. Similar ideas were emerging about aquatic systems through work underway in Europe and the US in the new science of limnology, and notably in the long-term scientific studies conducted at the University of Wisconsin, Madison, of the relatively shallow inland lakes nearby. Ecology came in to its own during the decade of the International Biological Program IBP) starting in the mid-1960s that initiated collaborative work to analyze the structures and functions of different ecosystems and refining methods for doing this including some of the first attempts at computer modeling of ecosystems. IBP was also a direct outcome of the growing public concerns about environment and the effects of pollution and resource misuse that arose in Europe and North America during the 1960s. For accounts of this history of ecology, mainly in the US, see Golley (1993) and Egan and others (2011). For more recent accounts mainly in North America, see Allen and Hoekstra (1992); Woodley, Kay and Francis (1993); Kay and others (1999); and Gunderson and Holling (2002).

Parks and Protected Areas:

The protection of nature has a much longer and varied history. The subject matter entails issues of the relationships between Culture and Nature that are as old as humanity itself. For humans everywhere, 'Nature' in their traditional lands is both nourishing and threatening and the powers of the non-human forces had to be respected and obeyed. Priests, shamans, elders and other people with magical powers or knowledge help tribes to reconcile conflicting forces. Part of this was to identify special places that were deemed to be sacred. These sites could be as small as a grove of trees, a cave, a water source, or an unusual rock outcrop, and as large as mountains and entire rivers. In Canada, First Nations everywhere retain this traditional knowledge despite attempts by the settler society to ignore and belittle it while also despoiling areas in their traditional lands by "development". The dominant Euro-Canadian settler society brings what it believes is much superior scientific knowledge to issues of culture and nature, with conservation described in terms of sustainable resource use, protection of ecological integrity, and conservation of biodiversity. There is a long history to this.

The European age of exploration followed by trade, settlement, and empire over at least three centuries brought Europeans into contact with lands, natures and cultures they never knew existed. The European version of this history is full of courage, adventure,

and heroic exploits. But, as was well documented by Grove (1995) there is also a convincing narrative to present under the theme of “green imperialisms”. The more reflective of European explorers did re-think their acquired views of the world and all that is in it, and wonderment about how it all happened. Charles Darwin is one of the most well known, but certainly not the only one as Grove notes. These cultural imperialism assumptions are discernable in the parks and protected areas movement that in North America got underway in the late 19th century.

It is worth recalling that in Canada, the first national parks, i.e. Banff in 1885 followed by four others in the Rocky Mountains by 1911 when the Dominion Parks Service was formed, were valued for their scenery and some large mammals that could easily be seen. The Duke of Connaught was appointed as the 10th Governor General in 1911 and in a talk he gave in Ottawa about national parks in 1913, he observed:

> “I do not think that Canada realizes what an asset the nation possess in the parks. These areas have been preserved from the vandal hand of the builder for the use and enjoyment of the public, who may take their holidays there and keep close to nature under the most comfortable conditions, amassing a store of health which will make them better able to cope with the strenuous life to which they return after their vacation” (Hewitt, 1921: 243).

How most Canadians would get there was obviously a question. The wealthy could afford the luxury of train travel to the Rockies and the first class railway-owned hotels, some with access to hot springs and golf courses. The appeal was scenery, spectacle and aesthetics. However, about 50 years later, with the automobile age well underway, mass tourism did catch up to the point that the resulting impacts from outdoor campgrounds, hiking trails, and visitors attending conferences held in the main hotels have kept controversies about management practices for Banff (and other destination sites) a regular news item for years. It could be added, that the fortunate few who did visit the mountain parks in the Duke’s days could and did write of their visits in terms of experiencing the majestic, scenic, picturesque and the sublime. Similar accounts came from people who were wealthy enough to take steamboat cruises to exclusive fishing lodges or private summer homes in the Great Lakes region.

This vocabulary about what protected areas are meant to do, has now been replaced by rationales based in ecological science, notably maintenance of ecological integrity and conservation of biodiversity. People can still enjoy scenery and sunsets and

anthropomorphic interpretations about animals, but that's not what protected areas are really all about. As noted earlier, ecology had to come of age first.

"Ecosystem integrity" was a metaphorical concept that implied an ethic, and in North America it emerged in the 1970s. It appears to have arisen first in the context of US-Canadian commitments to rehabilitate aquatic ecosystems in the Great Lakes. Edwards and Regier (1990) reviewed the origins and background of the concept that arose from the US Federal Water Pollution Control Act Amendments of 1972. The goal of the amendments was stated to be the restoration and maintenance of "the natural, chemical, physical, and biological integrity of the nation's waters" by 1985. This wording was also used in the 1978 revision of the Great Lakes Water Quality Agreement between the US and Canada where the "Great Lakes Ecosystem" was defined to be "the interacting components of air, land, water, and living organisms including man (*sic*) within the drainage basin of the St Lawrence River upstream from the point where this would become the international boundary"… and the purpose is "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem". This opened up much discussion among scientists, other academics and resource managers about what this "ecosystem approach" entailed, including different concepts of ecosystems and of biotic integrity. (See for example, Francis and others 1979; Caldwell 1988).

The phrase "biological diversity" was introduced in 1980 by Thomas Lovejoy, then a Director of the US World Wildlife Fund, and was soon adopted by other NGOs as justifications for their conservation programs. It was also used in the first World Conservation Strategy document in 1980 produced by the *World Conservation Union* (WCU/IUCN), UNEP and UNESCO. The WCU was created in 1948 by 18 governments, 7 international, and 107 national nature conservation organizations, meeting in France by the invitation of Sir Julian Huxley, the first Director-General of UNESCO, who wanted a new environmental institution UNESCO could draw upon for scientific advise.

As of 2012, the IUCN (the former acronym the WCU uses along with its new name) had 1,205 members world-wide from over 160 countries (including 87 States, 120 government agencies, and 853 national NGOs), over 60 regional and national committees, 11,000+ voluntary experts organized into six Commissions (thematic

groups), and 1,000 staff for global thematic and 9 regional programs. It has consolidated its programs into three interrelated programs for which IUCN has had considerable experience over the years. These are: valuing and conserving Nature; effective and equitable governance of Nature's use; and deploying Nature-based solutions to issues of climate change, food security, and economic and social development (IUCN 2012).

IUCN collaborates with parks and protected areas organizations all over the world. Parks Canada and other federal civil servants have had a long and continuing involvement, including leadership roles within IUCN on several occasions. IUCN is also quite involved with other international bodies notably the Secretariat for the Convention on Biological Diversity, 1992 (that is based in Montreal), its Strategic Plan for Biodiversity (2010-2020), the UN Decade for Biodiversity (2011-2020), and the Convention's Protocol on Access and Benefits Sharing (use of biodiversity); the new IPBES and especially UNESCO's DIVERSITAS portion of it. It also has links with a number of international treaty or convention bodies, from the World Heritage Convention (1972); the UN Framework Convention on Climate Change (1992); the Ramsar Convention on Wetlands (1971) and the UN Forum on Forests. It has been an influential body on policy formation in a number of countries. While it is aware of cross-cultural differences on approaches to conservation, it nevertheless articulates its programs in a dominant Eurocentric way. Sacred sites are just another way to conserve some biodiversity (e.g. Lee and Schaaf 2003).

The World Association of Zoos and Aquariums (WAZA) is, since 2000, the new name for a predecessor organization that was a founding member of the IUCN in 1948. WAZA membership now includes about 250 zoos and aquaria from a large number of countries along with some affiliated organizations and corporate partners. Some of the members also have links with regional or national zoos and aquaria; these secondary affiliates are estimated to be about 1,300. The *Canadian Association of Zoological Parks and Aquaria* (CAZA) was founded in 1975. As of 2011, CAZA had 27 accredited members, seven of whom are also members of WAZA. The vision of WAZA is to realize the full potential of these kinds of organizations to contribute to species and habitats conservation and sustainability. That entails maintaining the highest standards of animal welfare and husbandry and providing *ex-situ* (in zoos) maintenance of endangered species of

animals with the hope that some can eventually become “founder populations” in suitable restored habitat.

A major sub-set of these organizations supports the *Conservation Breeding Specialists Group* (CBSG) associated with the IUCN Species Survival Commission. CBSG is based in the Minneapolis Zoo. It has a network of 550 volunteer professionals, assisted by six FTE staff and nine Regional and National networks on five continents. It began as a liaison between the IUCN and zoos, and developed expertise for managing captive populations. It also began to recognize the similar need to address issues of managing small populations in the wild and to link *in-situ* (in the wild) to *ex-situ* scientific expertise.

Over the years the CBSG has developed and refined models for population and habitat viability analyses (PHVA) that can be applied to individual populations of species or sub-species in particular locations anywhere in the world. They conduct workshops only in response to host country invitations to do so, and confirmation that the hosts will participate in them. These analyses include computer simulations of the possible futures of a given population in terms of their inherent demographic stability and major habitat and other environmental conditions that influence the survival of populations. These simulations represent interactive bio-complexity. The computer programs are called “Vortex”, named after the image of populations being trapped in a downward spiral towards local extirpation and possibly extinction if they are the last of their kind. Vortex is the centre piece of elaborate PHVA workshop processes over about three days in which population biologists who know the species well meet with resource managers from management agencies responsible for habitat protection and use. In 1997, they also began to include social scientists in the workshop processes. Westley and Miller (2003) have described the PHVA models and processes in considerable detail. They include six case studies as examples. Three are from Canada, relating to Peary and Arctic Island caribou in the western Arctic based on considerable work by the Canadian Wildlife Service; grizzly bear populations in the Rocky Mountains, based on field studies in the Banff area conducted by people in the University of Calgary; and the Algonquin wolf in eastern-central Ontario, based on field work by people in the University of Waterloo.

Canada has a highly developed set of agencies and NGOs engaged in parks and protected areas. Parks Canada is the best funded one by far, compared to National

Wildlife Areas, Migratory Bird Sanctuaries and provincial parks and reserves. In 1970, Parks Canada developed its first National Park Systems Plan in which 39 natural regions were identified by their physical, geographic and biological features and the long range goal was to select one site in each so that a national park there would "represent" the entire region. It was thought that having a clear end goal in mind would be politically astute in getting the funding needed to establish each park since it requires that the land base for it must be entirely owned by Parks Canada. In 2002, the parks system plan was extended to include 29 marine regions (including the Great Lakes as one of them) with marine conservation areas established under a new statute passed that year.

In 1979, a revised parks policy introduced the notion of ecological integrity as a guiding principle for park management and this was formally recognized in the 1988 amendments to the National Park Act. Following a detailed review by an expert Panel on the Ecological Integrity in Canada's National Parks (Canada Parks Agency 2000), the legal definition of ecological integrity was:

> "....'ecosystem integrity' means, with respect to a park, a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change, and supporting processes." A state of EI implies that both abiotic and biotic processes of park ecosystems are functioning properly, and that they support, and will continue to support, viable populations of the suite of organisms representative of the natural area the park was established to represent.

The challenge since then has been to develop a workable set of indicators for each park, establish baseline conditions through field studies over several years of measurement, and then monitor them at appropriate intervals to report on whether things are improving, deteriorating or staying much the same.

The *Canadian Council on Ecological Areas* (CCEA) was created in 1982 following a long delayed organizational follow-up to the Canadian participants' work in the International Biological Program from 1964 to about 1975. Groups in each province inventoried suitable sites for continuing field research and to encourage conservation measures for the sites where interesting work could be done. But the IBP program, sponsored by ICSU, and thus by the National Research Council in Canada, had no provisions whatever to follow-up. What had to be done next was well outside of the NRC's mandate. Some provinces had established "ecological reserves", usually rather small but relatively undisturbed sites, so the original idea for the CCEA was that it would help

further the work of the ecological reserve programs and extend them to all provinces if it could.

In due course, the CCEA became a major forum for representatives of federal, provincial, and territorial programs that also included some academics involved in protected areas work, and their ecological reserves programs or their equivalents were folded into provincial parks systems where they became the “nature reserve” category of parks (most provinces have classified provincial parks by the major purpose they serve, i.e. historic sites, outdoor recreation areas, and so on). The CCEA’s role is “to facilitate and assist Canadians with the establishment and management of a comprehensive network of protected areas representative of Canada’s terrestrial and aquatic ecological natural diversity”. It became a charitable organization in 1995 based on its educational role. It has created and helped maintain a Canadian Conservation Areas Database (for all categories of protected areas); published annual jurisdictional reports on main accomplishments during the past year; co-sponsored conferences and workshops on topical issues; published proceedings, occasional papers, and fact sheets, and given out Gold Leaf Awards annually to recognize the work of organizations and individuals (CCEA n.d. c 2009).

Mention should also be made of the non-governmental organizations that lobby for or otherwise support protected area work. The *Canadian Parks and Wilderness Society* (CPAWS) is “the Canadian Voice for Wilderness”. As of 2012, it was a national charity with 13 chapters across Canada, 40,000 supporters, hundreds of volunteers, and an annual budget of about $3.6 million. It provides help and educational materials for its supporters to engage in political advocacy for the protection of parks and wilderness lands, and for ending logging, mining, and other resource extraction actions in otherwise relatively intact natural areas, and in cooperation with First Nations, wilderness outfitters and guides who agree that this should be done. *The Nature Conservancy of Canada* was created in 1962 in Toronto to acquire conservation property from willing sellers or donors. Over the years it has gradually expanded operations all across Canada, so that by 2012 they have protected though donations, conservation easements or outright purchase some 1 million ha of lands in all provinces. Its mission is “to lead, innovate, and use creativity in the conservation of Canada’s natural heritage”. It has about 200 staff at Headquarters in Toronto and seven regional offices, some 1,200 volunteers, and

a Board composed of business people and some conservation scientists. It has created conservation databases in all regions, based on the model developed by The (US) Nature Conservancy, that ranks natural communities and plant and animal species status by degrees of endangerment ranging from rare or endangered through to common and not threatened.

The NCC also worked with the federal government during the 1990s to make tax changes that enabled landowners to benefit from donations of lands suitable for conservation without triggering punitive capital gains taxes and allowing tax credits for donations to charities. Under these changes, made in 1995, Environment Canada administers an “Ecogifts” program by approving organizations that are eligible to receive them. As of 2012, about 180 organizations across Canada are eligible receivers, and 941 gifts valued at over $583 million protect some 142,000 ha of “wildlife habitat”. This also stimulated the formation of community-based land trusts all across Canada. They have been able to raise endowment funds for individual properties and/or go on acquisition campaigns of their own.

NCC often works closely with other trusts to advise or help with acquisitions that the trust can then place under long- term care and suitable management, Currently in Ontario, for example, the Ontario Land trust Alliance has 32 community trust members who have protected some 36,000 ha of wildlands, agricultural lands and other lands or waters that have natural, cultural or heritage significance. The Alliance itself provides administrative and professional support for its member groups. A Canadian Land Trust Alliance has also formed with cooperation especially from the Ontario, Alberta and British Columbia provincial alliances. Hanson and Filax (2009) reviewed critiques of land trusts in Canada noting that most are situated in the context of local social economies. Some people complain that trusts are just ‘privatizing Nature’ to conform with neo-liberal doctrines and privileges, or that while trusts may seem to be successful, they are not responsive to other community values such as holding community consultations before business transactions are negotiated, or accommodating public access for purposes other than nature conservation.

Climate change is having a de-stabilizing effect on biodiversity, and by implication, the conservation of park and protected areas that had implicitly assumed that the

"naturalness" of landscapes could be assured indefinitely by just leaving them alone. The situation in Canada was reviewed during a major workshop in Toronto (Munn 1996), and globally by a special report prepared by the Intergovernmental Panel on Climate Change for the UN Convention on Biological Diversity (Gitay and others 2002). Marris (2011) described the situation facing some well-known US National Parks.

Lemieux and Scott (2005) used outputs from two equilibrium vegetation models forced with six climate change scenarios to explore potential terrestrial biome-type changes in Canada's protected areas network (2,979 federal and provincial parks, ecological reserves, wildlife areas and other designations such as biosphere reserves and Ramsar sites). The vegetation modeling results indicated that 37%-48% could experience a change in vegetation type (most would lose one or more types and a few might gain one or more) under a doubling of atmospheric CO_2. They noted that there might well be a number of other ecological or land use factors that will determine how these changes could occur on individual sites, and that the full impacts might not occur for several decades. However, the goals for protected area management of maintaining the "representativeness" of present biological and geographical conditions needs re-thinking. See also Scott and others (2002) and Scott and Lemieux (2005).

People involved with protected area stewardship and with ecological restoration in North America have suggested that a mix of guiding concepts (other than naturalness) could be used such as the principles associated with the maintenance of historical fidelity, resilience in social-ecological systems, ecological integrity and biodiversity conservation (Cole and others 2008; Hobbs and others 2010). But it does become a matter of scale for both groups. The main challenges, especially as the areas to be protected or restored become quite large, is who actually decides what is to be done, on what basis, and how?

It is necessary to recognize an important distinction between "restoration ecology" as the set of scientific and other methods that can be used, and "ecological restoration" as the implementation of some program using the methods available to do this; these two terms are often treated as synonyms. Ecological restoration has many other factors to consider in order for it to be feasible and durable. They include the level of support from local communities, supportive policies, legislation, and long-term funding, and an ability to

reconcile quite different beliefs and values associated with culture and nature. Ethical issues are the central ones to address (e.g. Higgs 2005). Minteer and Collins (2008) argue that the prevailing environmental ethics is insufficient as a basis for a practical ethics suitable for guiding restoration decisions. Much of it, including "intrinsic values" favour population, species or ecosystem considerations over animal ethics, while the latter often includes only sentient creatures, unless some management-oriented research requires their sacrifice too.

Given the influence of climate change, the global transport of biotic propagules of what might become an "invasive or alien species", and other human impacts on ecosystems, all ecosystems are becoming "novel ecosystems", especially if they are viewed in the appropriate temporal contexts. So how should they be managed? Which versions of their history should be chosen? Otherwise, just recognize that they are all to some extent "novel ecosystems" or hybrids between what they once were and what they are now becoming (e.g. Hobbs and others 2009). The proper perspective is to adopt a "new paradigm: ecology as if people matter; economics as if nature matters" (Aronson and others 2006:261).

Tomblin (2009) argues that the ecological restoration movement must engage with diverse cultures in different places. He distinguished three types: "holistic restoration" that seeks out areas deemed to be wilderness that can have therapeutic values for those who engage in its protection and various kinds of vigorous recreational practices in them; "indigenous peoples restoration cultures" that have become evident in the (US) Northern Great Plains; and "environmental justice restoration" that needs more recognition so that disadvantaged people can also benefit from environmental improvements and not be just ignored in what might only be some "gentrification" scheme for well-off people. O'Brien (2006) noted his growing concern about the rhetoric of "alien, foreign, introduced, and invasive" species that need to be controlled or eradicated to restore some putative "ecological integrity". This vocabulary resonates too closely with discriminatory language towards people other than a dominant ethnic or class already settled into some place they consider theirs only. He suggested one could start with a different metaphor such as "recombinant ecology".

Ecological Restoration and New Designs for Natural Capital:

“Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” (SER 2004). “Restoration” usually means returning a site or larger ecosystem to what it otherwise would be like if it had not been impacted, and could thereby return to its historical development trajectory. “Rehabilitation” and “reclamation” means repairing ecosystem processes, productivity, and ecological services, but not the original biotic composition of the ecosystem aside from some preferred fish or wildlife species, or the removal of unwanted invasive species. “Ecological engineering” is the creation of novel ecosystems with different natural materials, physical & chemical environments, and living organisms to solve technical problems and/or meet human goals. It does not rely only on steel and concrete substrates that civil engineers would more likely choose. As new constructed ecosystems they can provide a range of ecosystem goods and services.

Many of these kinds of restoration activities have been going on at the small site level by land and water conservation agencies, fish and wildlife management agencies, and volunteers from outdoor clubs, naturalists groups, youth groups and so on. Some of this is also guided by landscape ecology that seeks greater connectivity of otherwise scattered remnant patches of the original landscape cover in order to enhance the range of biodiversity and biological survival of small populations of some plants and animals (especially ones considered to be endangered or threatened) that are surviving in the small “islands of green” patches. Restoration activities at local levels have been going on for years in Canada and elsewhere. For example, the first tree nursery for reforestation in Canada (St. Williams, Norfolk County, ON) celebrated its centennial year in 2008.

Greater Sudbury Land Reclamation:

By far the largest land reclamation project in Canada has been in the Sudbury region in northern Ontario, a well-known and long established mining and smelting area, primarily for nickel and copper. The deposits, formed by a meteorite strike some 1.8 billion years ago created a basin over an area of some 1,800 km^2 and up to 15 km deep in some places. Earlier resource extraction practices from about 1888 to 1927, and following the clear-cut logging for railroads and lumber exports to Britain and the US, included the process of smelting sulfide ores on “roast beds” of cordwood in open air at temperatures

that oxidized the sulphur and burned it off as sulphur dioxide (SO_2). When the ore itself started to burn it was then transferred to furnaces for smelting that also produced SO_2 as well as copper, nickel, and other metal particles. The results of this began to be documented in 1942-1943 when the smelters were in high production during World War II. The impacts had sterilized some 17,000 ha of land and lakes in zones closest to the smelters. This was after about a century of increased logging, wild fires, SO_2 fumigation, metal deposition, water and soil erosion and enhanced frost action on bare ground such that only stones and large boulders remained on the low hills and valleys (Winterhalder 1995; Little 2012) and it left another 65,000 ha in a semi-barrens state.

The Regional Municipality of Sudbury was formed in 1973, and people from the Ontario Ministry of Natural Resources and Laurentian University began to experiment on small plots of bare ground by liming, fertilizing and then seeding them with hardy grasses and legumes. Concerns about long-ranged air pollution from Sudbury resulted in the industry (International Nickel Company, Inco, at the time) building a large 380 metre tall "superstack" at its Copper Cliff smelter in 1972 to discharge wastes. While the wastes dispersed over a much larger region than Sudbury itself, they also became recognized as the largest point source of "acid rain" in Ontario. Recent and current owners (Vale Inco and Xstrata Nickel) have since reduced air-borne emissions from their smelters by about 90% since the 1970s.

In 1978, a regional "greening program" was started based on recommendations from people doing the smaller experiments of liming and seeding. As of 2011, some 3,435 ha of barren land had been limed, 3,217 ha fertilized, and 3,145 ha seeded. About 9.3 million trees and over 80,000 shrubs have been planted, all at a total cost of $26.8 million (1978-2011). A number of sites are monitored each year. Many school children and other volunteers from 14 local groups are engaged in this work. The main mining companies (now Vale Inco and Xstrata Nickel) contribute funding, and one grows seedlings in an underground nursery year-round. Other seedlings came from the Nickel District Conservation Authority, a watershed organization, and from Tree Canada (an NGO engaged mainly in urban forestry). Other local companies and businesses lend or donate equipment and other items.

From 2001-2009, an exhaustive “Sudbury Soils Study” was conducted over 40,000 km^2 to determine whether the levels of metals of concern in the study area (arsenic, cadmium, cobalt, copper, lead, nickel, and selenium) pose a risk to humans, plants and animals. Plant communities continue to be affected by these chemicals in the soil and other factors such as soil erosion, low nutrient levels, lack of organic matter and low soil pH, and may also indirectly affect wildlife living in these vegetation conditions. Generally there are no direct human health effects from this or from current smelter emissions (Summary 2009; Living Landscape 2012). Almost all of the trees and shrubs planted have been local native species, but a few exotics were used because they adapt well to the harsh growing conditions. Now that small stands are becoming established, a more strategic policy to enhance biodiversity has been adopted (in 2009) that includes planting a few species of trees a little north of their current range in Ontario to see whether they can help with an “assisted migration” of others as climate change stimulates range changes. Work on developing different local seed banks for selected species is being coordinated by the Collége Borèal in Sudbury (Regreening 2011).

In 2001, the City of Greater Sudbury was formed by amalgamation of the Regional Municipality and seven adjacent municipalities. The Greater Sudbury covers 3,410 km^2 and has a population of 160,770 (2011). The mines and smelters came under complete foreign ownership in 2012 through a $90 billion global merger between Xstrata and Glencore Financial (Switzerland). Local work will be coordinated by their wholly-owned Canadian subsidiaries. Greater Sudbury had embarked upon a Regional Eco-Industrial Strategy that would create eco-industrial networking to produce ‘synergy’ and co-ordinate “green technology adoption” (Greater Sudbury 2007). McKinley (2008) noted that the previous Falconbridge-Noranda smelters were practicing ‘industrial ecology’. They were major recyclers of electronic wastes, batteries and copper, and had developed recycling partnerships with companies that bought their primary outputs. The current problem for Greater Sudbury is that the amalgamation also brought four proposed industrial parks all of which needed more infrastructure investments, including extension of water, sewage services, and power lines out to their locations as well as development of the sites themselves.

Restoration to what?

If *restoration* means going back to some historical period, then how is that chosen? In North America, it sometimes means the time before the European settler communities took over. In the US this has often been dated at the time of Columbus (1492) hence some pre-Columbian conditions are considered the ideal for restoration work. In Canada, the time of settlement varied considerably from the Atlantic region to the Pacific. What the landscape was like in the early 17th century in the east can only be interpreted from fragmented information, such as palynological studies of pollens in bogs sediments, correspondence or other writings by some of the early settlers, and accounts from First Nations elders. In Upper Canada (southern Ontario) there have been descriptions from the records kept by the first land surveyors who methodically laid out the grid of roads and settlement lots and noted the kinds of vegetation cover they cut trails through to do this. Further west there are some of the first photographs from surveyors and early settlers.

In Europe, this is not an option, since their tribal roots go back millennia. Drenthen (2009) notes that in Europe a cultural history approach to landscape (rather than a functional ecological interpretation) is much more realistic. Cultural heritage is valued highly by people living in a region, because their ancestors had been there for several generations, and there is a strong attachment to place. Cultural artifacts, such as old ruins of former structures, and restoration of old buildings exhibiting the folk architecture of the time are highly valued. Europeans often value the concept of “harmonious landscapes”, and these cultural artifacts in their place serve to remind them of who they are and re-enforces their sense of place. Each item is subject to a folk history or legend. One can sense analogies with First Nations in Canada. Dufour and Piégay (2009) go further and urge abandonment of any myth of a lost past and focus on the human benefits of whatever needs to be done now.

Many conservation and restoration programs have been influenced by the principles of “island biogeography” and “landscape ecology” that views the main issues to be addressed as ones at much larger spatial scales than just local efforts. The best example of this in North America is the *Wildlands Network*, formed in Florida in 1991, to identify continental ”wildways”. Since 2000, conservation organizations that form the network and biologists associated with them have mapped four major wildland network designs based on existing protected areas and possible wildlife corridors that connect

these areas that large “keystone” animals would need to survive. They are now mobilizing interest and support from interested groups in these areas.

The “wildways” include: (a) the Rocky Mountains as the “Spine of the Continent” from Mexico to Alaska (and through Alberta and British Columbia); (b) the “Pacific Wildway” extending from Baja California north along the US west coast through coastal British Columbia to Alaska; (c) an “Eastern Wildway” along the Appalachian Mountains from Florida to to Maine and then through New Brunswick to eastern Quebec (Gaspé region) then across to Port-aux Basque, Newfoundland, and north along the west coast to the tip, then across the straight of Belle Isle to Labrador. As of 2012, new chapters for these trail groups have been added in Greenland, Iceland, and the several northern European countries; and (c) the Canadian Boreal Forest across the north from a section of the Rocky Mountains through to Quebec and Newfoundland.

Local organizations along the wildways sometimes adopt smaller sections of these continental scale corridors to help things out. In Canada, examples would be the Crown of the Continent section of the Rockies more recently enlarged by the from Yellowstone to the Yukon (Y2Y) concept (see for example Heuer 2002); the Canadian Boreal Forest initiative (that is recognized by the network as the lead for this continental corridor); the Algonquin to the Adirondacks (A2A) in eastern Ontario, a side link to the Appalachians from a boreal mixed forest to the north; and Canadian participants in the northern Appalachian trail. The *International Society for Ecological Restoration* (SER) was formed in the US in 1989 but now has a Canadian chapter and chapters in other countries. The SER is much more focused on strategies and techniques to implement these kinds of grand visions at multiple spatial scales.

The “Buffalo Commons”:

Of considerable interest is an on-going rewilding program for the northern plains of the US and southern Canada based on the restoration of native bison. Bison survived the megafauna extinctions, but were deliberately wiped out in the US in the 19th century to subdue tribal lands and cultures dependent upon bison. The systematic slaughter in the US began in the 1830s and continued until about 1890 by which time their range had diminished greatly and only small remnant herds survived in remote or almost

inaccessible pockets, including a few in the southern prairie provinces. This was before the building of the transcontinental railways in Canada that brought a similar influx of European settlers into western Canada, and where the “Grand Treaties” in early Confederation were meant to smooth the way with First Nations. The story about how various groups of bison were bought and sold and protected to a varying extent in early national parks or reserve lands that no longer exist is both a detailed and fragmented one (see for example Ogilvie 1979).

Popper and Popper (1999) have written extensively about the regional boom and busts over the huge Great Plains Region extending from Texas and New Mexico north to Montana and North Dakota (and extending into MN, SK, and AB). In 1999, they proposed the concept of *“The Buffalo Commons”* as a metaphor for a large-scale, long-term ecological-economic restoration program, and they spoke out in favour of it at many meetings while also following how various organizations and individual people began to interpret it. There was a wide range of viewpoints but all were “captured first by the metaphor”, and the latter served “as a method to describe and navigate regional change”. The process however, “is deeply paradoxical”.

Truett and others (2001) provide an overview of the Great Plains Ecosystems and the ecological functions that bison, as the largest keystone herbivore, perform in these ecosystems. McDonald (2001) describes management issues that have been defined by different resource management agencies and collaborative networks of people and organizations that have formed to deal with issues as well as conflicting beliefs and values underlying them. Some of the main initiatives are:

- The US Wildlife Conservation Society (WCI) revitalized the American Bison Society for the purpose of restoring bison to their historical range. WCI hired a consulting firm to prepare an Atlas of Bison Conservation (Headwaters Economics 2008). Sanderson and others (2008) elaborated this program in much more detail.

- Montana Big Open Inc. This is a particularly arid zone of about 3.5 million ha in east central Montana that is considered to be the largest restorable land mass in the lower 48 States. Most of it has never been plowed, yet many of the ~3,000 people cannot make a living on raising wheat and cattle. There is a movement supported by about 20 organizations (the Northern Plains Conservation Network) to organized much of this area into a co-operative set of ownerships to begin restoration of native grasslands that would become the basis for a wildlife-based economy with hunting, eco-tourism and other outdoors recreational pursuits.

- The Inter-Tribal Buffalo Council (ITBC) was formed in 1991 at a gathering in the Sacred Black Hills in South Dakota, and incorporated in 1992 to restore bison to

Indian nations in the manner that is compatible with their spiritual and cultural beliefs and practices. The ITBC now has 52 tribes in 19 States with a collective herd of ~15,000 bison.

- The US World Wildlife Fund (WWF) Northern Great Plains Project is fostering the formation of collaborative networks to promote strategies for creating new conservation areas as well as encouraging biodiversity-friendly farming and grazing practices, and eco-tourism. They are also promoting re-introductions of key prairie fauna such as plains bison, prairie dogs (a ground squirrel that lives in burrows), black-footed ferrets (a weasel), pronghorn antelopes and sage grouse.

- Some Canadian organizations are participating in some of these initiatives. They include (in alphabetical order) the Alberta Wilderness Association; the Bison Producers of Alberta; the Nature Conservancy of Canada; the Sierra Club Canada; and the World Wildlife Fund (Canada).

- Some of the re-introduced plains bison have come from the disease-free herd in Elk Island National Park (a major "core area" for the proposed Beaver Hills Biosphere Reserve). The Parks Canada Agency has overseen introductions of plains bison, swift fox, and black-footed ferrets into Grasslands National Park along the Saskatchewan-Montana border. The 5,300 ha "Old Man on His Back Prairie and Heritage Preserve" was created in 1996. It is based on a major donation of property from the Butala family to the Nature Conservancy of Canada (NCC). This ranch had been in the family for several generations and most of it was never plowed. It is now co-managed through a long-term agreement between two Saskatchewan Ministries and the NCC. A few bison were introduced in 2003, and as of 2012 there were 128 bison including 40 calves and 30 yearlings.

For an informative recent up-date of this situation, written in the style of literary non-fiction, see Hylton (2012).

Continuing with grandiose visions, some scientists associated with the re-wilding believe the scale question has to go back in time as well. There have been debates for a number of years about the causes of the mass extinction of North American mega-fauna some 13,000 years ago. The debate for a long while was between anthropologists who attributed it to post-glacial climate change, and biologists who blamed it much more on mortality through over-killing by the first humans to have arrived on the continent. These issues have been explored in detail by Martin (2005) who concluded, on balance, that these extinctions were caused by humans over a period of centuries. More recent work based on more refined techniques or dating residual materials tend to support and better document this conclusion (e.g. Burney and Flannery 2005; Gillespie 2008).

Coward and Grove (2011) review on-going work in paleo-anthropology that goes well beyond earlier views that innovation by "hominin" (human-like) groups was some combination of the evolution of neural capacity ("encephalization") and use of material

artifacts (simple tools). Human evolution had much more to do with innovations within groups and social organization that produced cultural learning and transmission of it among and between groups of related hominin to the point of life-long learning and deliberate teaching of their young. Compared with other species, including apes, hominin have a relatively long period of biological development of their cognitive and motor systems after birth. Thus, there are many complex factors in play that affect human evolution than had been assumed. Incidentally, this may also support interpretations of human-caused extinctions of other creatures over many millenia.

In the early 2000's, proposals were raised about creating "Pleistocene Parks" that would, with due care, introduce current relatives of the ancient mega-fauna in habitats thought to be similar to the ones they were once in, and at some point experiment with possible restoration of hybrids bearing some genetic material from fossil sources (Foreman 2004; Donland 2005; Donland and others 2006). This touched off a debate about both desirability and feasibility (e.g. Rubenstein and others 2006). Participants in these discussions all seem to agree that the proposal is wonderfully innovative, but as the innovation literature would observe, the "proof of the concept" has much work to do despite the existence of some quite large 'safari parks' in the US that have species of animals related to the ancient mega-fauna, and would not require importing some from Asia or Africa where they still exist in dwindling numbers.

It remains to be seen where this will end up. But conceptually, it could be considered a major Eco-Innovation at an impressively large spatial and temporal scale.

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