Submission to the Expert Panel for the Review of Environmental Assessment Processes

Title: The Effective Use of Science in Environmental Assessment
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SUBMITTED ON LINE

This submission focuses on the role of scientific information and expertise in environmental assessment (EA), in an effort to address the provision in the EA Expert Review Panel's terms of reference that it "provide recommendations on how to ensure environmental decisions are based on science, fact and evidence". In keeping with the mandates of a number of federal government departments involved in EA, the current federal EA review emphasizes the need for relevant and effective science to inform decisions.

I submit these remarks in my capacity as a conservation biologist and wildlife ecologist who is actively engaged in conservation science and related policy in species at risk conservation and conservation planning, including EA, in northern Canada. I am President of Wildlife Conservation Society Canada, a conservation science NGO that has been incorporated in Canada since 2004. Our mission is to save wildlife and wild places in Canada through science, conservation action, and inspiring people to value nature. Our trademark is "muddy boots" biology, which we do by getting in the field and conducting the necessary research to fill key information gaps on Canada's fish, wildlife, and ecosystems. We then use relevant information and our expertise, working with Government and regulatory agencies, conservation groups, indigenous communities and industry, to resolve key conservation issues.

I provide these comments from the perspective of one who has reviewed numerous environmental impact statements and associated scientific products, especially baseline studies, as an independent outsider or to support directly-affected First Nations, and testified before one review panel. I also have considerable experience in the practice of applying scientific and technical information to decision making, having served on a number of government advisory panels, and as a co-chair of the terrestrial mammals subcommittee of COSEWIC, the Committee on the Status of Endangered Wildlife in Canada since 2009.

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My remarks serve as a companion to that of my colleague Dr. Cheryl Chetkiewicz, the leader of our northern Ontario program, who has prepared a separate submission to the Panel organized around addressing one of the Panel's suggested themes, specifically "Planning Environmental Assessment", and the five questions therein. Based on our experience in the Far North, where there is a flurry of activity associated with development of the Ring of Fire, we see significant gaps inherent CEAA 2012 when it comes to addressing modern-day environmental threats and impacts, particularly those that are cumulative in nature. We are particularly concerned about the process and outcomes of EA in the context of the myriad challenges of welcoming new development, e.g., major mines and associated infrastructure, into remote, intact regions in the north where the majority of the population are Indigenous with Aboriginal and/or Treaty rights under the Canadian Constitution. WCS Canada is also part of the Environmental Planning and Assessment Caucus of the Canadian Environmental Network (EPA Caucus), and I was a co-author on their submission to the Panel.

1. Background

1.1 The problem

Any EA places heavy reliance on scientific input and/or expertise in almost all stages of the process. Scientific expertise is necessary for both proponents and decision makers (Appendix 1). From formulating the project description to the ultimate approval (or denial) of a project, virtually every step or activity requires scientific expertise related to myriad activities that include: gathering and reviewing existing experience and insights, assembling new information, data analysis, making predictions, undertaking risk assessments, acknowledging and addressing uncertainties, undertaking expert review, designing and evaluating monitoring frameworks, and analyzing trade-offs of any decisions that have to be made.

Even if we can all agree that strong scientific input is important for EA outcomes that enjoy public confidence, the conversation frequently stops at statements intended to provide public assurances that EA decisions will be or have been scientifically based[1]. Yet, questions keep arising in many sectors about the quality of science underpinning development decisions that have been subjected to EAs.

[1] Examples: 1. "The decision will be based on the best available science and on real and meaningful consultations with Canadians, including indigenous communities." Minister of Environment and Climate Change Catherine McKenna (April 10, 2016) in reference to the then-forthcoming decision on Pacific NorthWest LNG project. 2. "We're satisfied that the scientific evidence that was available to the government in advance of this decision was good evidence and sufficient to make a good judgment." Minister of Natural Resources Jim Carr (November 29, 2016) in reference to the Kinder Morgan pipeline decision. 3. "This is a decision based on rigorous debate on science and evidence." Prime Minister Justin Trudeau (November 29, 2016) in reference to the Kinder Morgan pipeline decision.

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The issue of how to improve the scientific basis of environmental impact assessment in Canada is far from new. In the 1980s, the Federal Environmental Assessment Review Office (predecessor to the Canadian Environmental Assessment Agency) commissioned a major review on this subject, resulting in a comprehensive report and multiple recommendations for implementing stronger "ecological science" in the EA process (Beanlands & Duinker 1983). As Greig & Duinker (2011) pointed out more recently, however, even while the 1983 report and its findings continue to be widely cited, the issues and concerns that it raised still persist. Although perceptions vary among engaged actors (e.g., between those who conduct EAs and those who are affected by development: Hegmann 2013; Leung et al. 2016), significant doubts about the veracity of the scientific basis of EA decisions, and scientific quality of EA products continue to be voiced in Canada. For example, Weber (2016) and De Souza (2016) raised concerns about the recent approval of the Kinder Morgan pipeline expansion to coastal southwest British Columbia, which the Prime Minister cited as environmentally 'safe', despite an absence of scientific information about the biological effects of diluted bitumen products on marine life in the event of a spill (Green et al. 2016).

1.2 Key questions for the current review

Given this context, two key questions inherent in this federal review are:

1) How can EA law and practice in Canada best ensure that individual assessment decisions, whether they are conducted at the project level or in the context of strategic or regional EAs, are based on the best available science? .

2) How do existing legal and institutional structures control the quality and effectiveness of scientific underpinnings of EA and where are the procedural checks and balances?

While there is broad recognition that science does not ultimately dictate EA decisions, an EA should be derived from a process that is strongly based on accepted scientific principles and procedures if it is to be perceived as credible (Cashmore 2004). Tackling these questions therefore requires examining barriers and disincentives to producing, synthesizing, and considering science in the EA process.

Broadly speaking, how science is brought into the EA process (i.e. through generating scientifically-robust EA products), and how this science is used for making regulatory decisions are two different things entirely. Bringing science into the EA process currently entails the proponent generating and analysing information in accordance with directions set by the responsible authority (RA). In this stage, high-quality information and scientific expertise is imperative but can be limited by various factors, particularly if data are collected anew in areas that have been subjected to minimal prior study. How science is used in regulatory decisions concerns the process by which information is received and interpreted for the purposes of decision making, alongside other non-scientific considerations for undertaking the project. Decision making also requires an ability of key actors to absorb and evaluate scientific

information, which can be affected by the limited capacity of elected officials and civil servants to remain current with the latest scientific information and developments (Roach and Worbets 2012).

2. Purpose of this submission

This submission highlights five key aspects of EA where the science contribution requires strengthening:

1) Language in the legislation (CEAA 2012)
2) Scientific capacity throughout the EA process: "inside" and "outside" actors
3) Development of EA products
4) EA decisions
5) Monitoring and adaptive management

For each aspect, I briefly characterize the problems I have witnessed (i.e. what isn't working) and offer recommendations for change to legislation, associated policy guidance, and/or the practice and culture of EA to improve the production, synthesis, interpretation and use of science in decision making. Although this discussion will bring up CEA 2012 in particular where relevant, the perspectives offered here relate to more generalized EA processes and can be adapted for regional and strategic assesssments. My submission serves to raise attention to the relevant issues for the Panel, but does not constitute a complete review. This will be the subject of a longer paper that I am preparing with colleagues for publication in early 2017.

At the request of the Panel members, following my Nov. 16 presentation to them in Winnipeg, this submission incorporates three pieces of "homework" I was given:

1) Stages in the EA process where science is needed (Appendix 1);
2) Structural implications for the federal agency *vis-à-vis* a "science unit" (s. 5); and
3) How science is brought into decision making and enforcement, especially uncertainty and monitoring and follow-up (s. 3.4.2 and s. 3.5).

2.1 Definitions and scope

This submission takes a purposely broad view of the definition of science, i.e., one that also includes the social sciences and indigenous science (commonly referred to federally as "aboriginal traditional knowledge" and as "traditional knowledge" under the United Nations Convention on Biological Diversity), and should be interpreted as such. I should, however, note that my own experience emphasizes bio-physical science, and so my observations are not likely sufficient in and of themselves to address all dimensions of "science" as I intend.

My perspective offered here on what is and is not working is largely derived from project-specific assessments, which has been the standard to date in Canada. However, concepts and recommendations for the "next generation EA" being contemplated by the Panel can and must be adapted to fit circumstances of strategic or regional assessments, which cover a wider range of activities and/or over a broader area than project-level EAs. My recommendations keep such a transition in mind.

3. Five fundamental weaknesses in EA law and practice that reduce the scientific quality of assessments

3.1 Language in the legislation

A statute's language and architecture are essential for establishing the role of science in the assessment process, in decision making, and in the respective mandates of those responsible for the statute's delivery.

In CEAA 2012, the word "scien[ce][tific]" is not mentioned anywhere in the Act, and other terms, such as "knowledge", "information" or "expert[ise]" are mentioned only in five sections (Appendix 2). The words are largely limited to descriptions of various parties involved in the process, including an "interested party" or those under the "federal authority" involved in the process. The latter in particular serves to constrain guidance that has been formulated under CEAA 2012. For example, on the matter of "scientific advice", "Guidelines for the Preparation of an Environmental Impact Statement" under CEAA 2012 for a number of projects available on the CEAA website speak to the requirement under s. 20 of CEAA 2012 to interact with a "federal authority with specialist or expert information or knowledge", but mention no other expertise that may be available and relevant. Similarly, the guidance on incorporation of aboriginal and community knowledge is offered only because s. 19(3) of CEAA 2012 states that "the environmental assessment of a designated project *may* take into account community knowledge and Aboriginal traditional knowledge".

The federal Species at Risk Act (SARA; 2002) provides a sharp contrast to CEAA 2012 in this respect, in that not only are these terms frequently mentioned ("scien[ce][tific]" appears 7 times, and "knowledge", "information" or "expert[ise]" in 12 sections of the Act; Appendix 2), but SARA explicitly distinguishes between products, decisions, and roles that consider scientific information alone and those that include socio-economic considerations. For example, "aboriginal traditional knowledge" (ATK) is mentioned 9 times in SARA and is explicitly considered as included in the requirement to use the "best available information", along with "scientific" and "community" knowledge. In CEAA 2012, mention of ATK appears once, and only with respect to its role in informing the scope of the EA.

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In practice, the wording in SARA has provided helpful focus to implementation of this complex law. For example, as a result of my personal experience as a member of COSEWIC, I can attest to the fact that the clear articulation in the Act of COSEWIC's role and responsibility has allowed this body to conduct its work with minimal political interference, ensuring a clear distinction between scientific assessments and listing decisions by the Minister that come later and bring in socio-economic considerations. SARA's language has been instrumental in a number of court decisions over the past decade. For example, in the Nooksack dace case regarding critical habitat identification under SARA (*Environmental Defence Canada et al.* v. *Minister of Fisheries and Oceans*, 2009 FC 878 (CanLII), the court ruled that the Minister of Fisheries and Oceans had failed to meet the requirement under SARA to identify critical habitat in the recovery strategy, to the extent possible, based on the best available information, thereby confirming the purely scientific nature of this documentation. A similar decision was rendered for the greater sage-grouse (Alberta Wilderness Association v. Canada (Environment), 2009 FC 710 (CanLII)).

There is, by contrast, no direction in CEAA 2012 articulating how scientific information must support EA products or decision making. Clarifying the role of science in the EA framework through specific language in CEAA is essential for meeting 1) the government's commitment that EAs have a strong scientific basis, 2) expectations for how scientific information will inform ultimate decisions, and 3) necessitating that the various actors in the process have sufficient scientific expertise.

3.2 Scientific capacity throughout the EA process: "inside and outside actors"

Most actors engaged in EA must have scientific training themselves or at least a clear understanding of scientific principles (Appendix 1). For example, science is a necessary foundation for project description, and producing environmental impact statements (EIS) and other materials delivered by the proponent (usually through consulting bodies) to the responsible authority (RA). For the RA, scientific expertise is necessary for reviews of these EA materials and for producing the Guidelines (TOR) and EA Report. Expertise is also required of government scientists in other agencies who will be engaged to conduct any scientific reviews of the materials. I will address decision making in the next section.

Such actors are all "inside" the EA regulatory process. It is becoming increasingly evident that federal government agencies lack the capacity to make sufficient contributions to robust data sources, analyses, and expertise that can inform EA. This shortfall has limited the capacity of RAs to conduct thorough reviews of EA materials and provide sufficiently detailed guidance on additional information needed, the best ways to obtain it, and necessary standards for documentation. In particular, (i) budget cuts have negatively affected government science capacities (e.g., in establishing ecological and socio-economic baselines) without evident efforts to build replacement capacity elsewhere; and (ii) the incentives for government reviewers (and their home agencies) to participate effectively in EA deliberations have diminished. Critical steps in EA deliberations that require agency experts include the provision of early guidance for

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and critical reviews of submitted assessments, reviews of EA documents, and subsequent effects monitoring. From an outside-of-government perspective, it is not possible to fully interpret the quality and comprehensiveness of scientific reviews of EAs materials, or how these have informed any decisions, because any documentation of this kind does not tend to be made available to outsiders.

Much scientific expertise and many science products generated by "outside" actors (e.g., universities and NGOs) has the potential to be highly relevant to EAs, yet is generally conceived and executed independent of any EA processes. As convincingly argued by Greig and Duinker (2011), there is a lot to be gained by deliberately integrating "outside" scientists into EA processes "to create, test, and refine robust models for predicting ecological effects of development." Without deliberate integration of outside actors in EA processes, advances in basic science that could have major practical implications for EA will continue to evolve in silos (Schindler & Donahue 2006).

More effort could be made to bring in outside scientists with expertise in particular relevant subjects to conduct independent reviews of EA products and/or pertinent analyses. Yet currently, RAs do not tend to solicit such reviews, instead relying on the interest of science experts outside the government to engage in passive public participation windows in the EA process. Most outside scientists who would be well qualified to participate in review of EAs, have no idea that any particular EA is proceeding, let alone that they have expertise that would be relevant for informing decisions. Careful attention should be dedicated to breaking down procedural barriers that may stand in the way of enabling and encouraging RAs to identify and request the participation of outside experts in EA product review under contract.

One exception to the tendency not to seek outside support in the CEAA 2012 context is reference of an EA to a review panel composed of individuals external to the process. However, there is currently no direction in the Act regarding the necessary scientific qualifications for review panel members who are appointed to hold hearings and prepare EA reports, and in practice panels are often composed of individuals without science backgrounds. In order to ensure that science is considered appropriately in this form of the EA process, at least some members of the review panel must have sufficient understanding of and training in scientific principles to evaluate scientific materials presented to them.

3.3 Development of EA products

The scientific information and analyses that are incorporated at various stages of the EA process to a) seek approval for a specific project and b) monitor while operations are underway, tend to be produced almost exclusively by consultants who are hired by the development proponent, and cannot generally be considered to be independent. There is little room for innovation in the preparation of EA reports for scientific consultants hired by clients that are seeking approval for a development project.

Grieg and Duinker (2011) point to scope of project-specific data collection, timelines, and motivation as key barriers to strong and innovative science occurring in current EA practice. For example, comprehensive literature reviews, related analyses, comparison and learning from the impacts and successes/failures of mitigation actions with other similar undertakings and other dimensions of scientific inquiry, rarely appear in template-driven EA reports. Reporting timelines tend to be too narrow to rigorously test hypotheses regarding cause and effect. Scientific rigour in this fashion is rarely encouraged by proponents, and the time and financial means are lacking for intervenors and public/indigenous participants to make up for this lack of quality in the overall EA. This is exacerbated by a tendency for the production of voluminous reports that follow templates whereby the most meaningful content tends to be limited and difficult to find.

There is a growing body of literature that outlines new data analyses and synthesis techniques that, if applied in EA practice, could potentially increase the rigour of scientific analyses that informs EA decisions. These include: standardized systematic reviews to bring together best available evidence and identify gaps (Cooke et al. 2016); frameworks for identifying and explicitly characterizing sources of uncertainty along the impact assessment process (Refsgaard et al. 2007; Cardenas & Halman 2016); analytical technique for synthesizing, weighting and evaluating causal relationship from existing studies of an effect (Norris et al. 2012); interpretation techniques for increasing the relevance of environmental modeling output to decision making (van Voorn et al. 2016). While Noble (2015) points out (in reference to cumulative effects assessment) that researchers have provided much more criticism of practice than guidance on how to improve practice within the constraints of the regulatory system, the regulatory process itself also requires modification to test new methodologies that improve science rigour (e.g. those listed above) with an eye towards adopting these into regular practice, while remaining within the "pragmatic limits of the possible" (*sensu* Hegmann 2013), given the reality of data and knowledge limitations.

3.4 Science informing EA Decisions

There are currently no criteria, guidance or constraints on the Governor in Council's decision as to whether significant adverse effects are "justified in the circumstances" (CEAA 2012, s. 31(1)). This lack of specificity creates the potential to undermine public trust in decisions and weaken the link between science and decision-making. The simultaneous consideration of both environmental and economic goals at this final point in the EA process inevitably invites polarization, particularly with increasing complexity of environmental impacts that exists today. In current practice, decision makers who seek to "balance" these competing goals fail to engage in honest and transparent discussions of inevitable trade-offs between such competing goals (Roach & Worbets 2012).

There are at least three key elements that EA decision making requires if decisions are to inspire public confidence that scientific information and expertise have received appropriate

consideration: 1) clear policy direction at the outset, 2) contending with uncertainty, and 3) transparency.

3.4.1 Policy direction

The vast majority of EA decisions are made at the project level in a framework of "balancing" competing interests or claims as to the public interest. This tends to occur in a "policy fog", absent clear policy direction at the outset that articulates "the overriding objectives of their respective government's environmental and natural resource policies, the implied trade-offs and how conflict will be addressed (i.e., what takes precedence in what circumstances)" (Roach & Worbets 2012). This matters from a scientific perspective, because it is otherwise impossible to reconcile claims by politicians that decisions will be made "based on science" with the obvious necessity of incorporating other socio-economic considerations into the ultimate decision. Despite some political statements to the contrary, it is almost always impossible to do both. A promising solution to this issues is the implementation of regional and strategic assessments that would proceed and inform project-level EAs and serve to set policy direction (Jones 2016; Sutherland et al. 2016). It is beyond the scope of this submission to address regional/strategic EAs in full, but see submissions by C. Chetkiewicz (WCS Canada) and the EPA Caucus.

3.4.2 Uncertainty

By the time a project EA reaches the final stage, a decision maker is confronted with compounded uncertainty that stems from various stages of the process, including:

- Incomplete or limited portrayal of baseline conditions in the EIS due, for example, to lack of available information collected and published by others prior to EA and inadequate time and scale of inquiry for proponent studies that serve as input into the EIS;
- Uncertainty of potential impacts and mitigation tools due, for example, to inadequate understanding of baseline conditions and lack of monitoring on similar projects that might enable learning opportunities and transfer of knowledge;
- Insufficient reporting by the proponent of the full breadth of uncertainty of information, analysis, and conclusions that appear in the EIS; lack of disclosure of data gaps, and overconfidence in predictions;
- Loss of full information that does appear in the EIS, including statements of uncertainty, on the way up the ladder to the decision-making point stage.
- Lack of capacity by decision makers to make full use of scientific information that does reach them.

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Tennøy et al. (2006) pointed out that grappling with uncertainty in EAs not only concerns the inadequacy of predictions in the EA reports, but also the inadequacy of fundamental aspects of communication throughout the decision-making process. By examining 22 cases in Europe, they found that EA documentation rarely discussed or even mentioned uncertainty. Where information on uncertainty had been gathered, it hadn't reach decision makers. Leung et al. (2016) confirmed this in Canada by means of a comprehensive survey of EA practitioners, regulators, and interest groups, where 85% of respondents indicated that uncertainties are insufficiently acknowledged in practice and, when disclosed, are not considered by decision makers. A key result was overconfidence in impact predictions and mitigation measures. Not accounting for uncertainty increases the chance that decisions will be made based on erroneous information, and increases the potential for unwanted, significant environmental consequences.

Uncertainty can and should be minimized by increasing the accuracy and objectivity of predictions that are presented in EIS and other EA products. However, at least as much focus must be placed on better communication regarding uncertainties where they persist and more transparency in the prediction and decision making processes.

3.4.3. Transparency

Much has been written about the need for transparency in decision making, especially with respect to how science has been considered and weighted (e.g., Kontic 2000; Morrison-Saunders & Bailey 2000; Tennøy et al. 2006; Roach & Worbets 2012; Science Integrity Project 2015), and this is central to both aspects of decision making already discussed above. Kontic (2000) defines transparency in the context of EA as: a) complete and clear recording of expert reasoning, judgements and decisions in the evaluation process; b) a clear indication of unknowns; the rationale for the methods used to address variability and uncertainty; where hypotheses and/or speculations have been adopted; and the appraisal of values.

3.5 Monitoring and Adaptive Management

EA is essentially a hypothesis framework, with approval resting on the assumption that the project will incur no significant adverse environmental impacts once mitigation measures have been deployed. This is a hypothesis that needs testing, and monitoring is a critical means to test this hypothesis. Once a project is approved and gets underway, monitoring is absolutely necessary to enable the learning needed to test and improve impact predictions, success of mitigation options, and most importantly, to enable learning between projects that are similar in nature (e.g., similar type of development or undertaking and/or impacts) or in the same general geography.

Once project approval has been achieved after an often-lengthy EA process, attention can dissipate. Given the added expense of monitoring, the incentive to minimize this aspect of project implementation can grow, particularly when proponents are aware that RAs have

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limited capacity to follow up on monitoring activities. Yet monitoring design and robust sampling is fundamental to generating confidence that proponents will be able to detect change, which may point to unwanted impacts, and to differentiate this kind of change from what might arise from natural variability or other noise.

Information derived from monitoring at the project level can have little meaning in the absence of contextual information that is beyond the proponent's responsibility. However, provincial and federal monitoring programs are being increasingly cut from budgets, even though the data they provide are vital to learning and adaptation. This increases the importance of coordinated monitoring programs between multiple projects in a region, as well as the role of citizen science and community-based monitoring to scale up monitoring (Conrad & Hilchey 2011).

Similar to EA documentation, monitoring reports require scientific review by experts with adequate knowledge that goes beyond checking compliance. Among other things, these individuals must be able to evaluate the robustness of the monitoring design, data gaps, and the veracity of the conclusions, based on available information. Monitoring data and reports generated by proponents are not, however, generally available or accessible, and gaps in capacity and expertise to allow for robust review of monitoring are often evident.

4. Recommendations

I offer 8 recommendation to the Expert Panel that directly address the significant shortcomings discussed above with respect to five aspects of EA regarding the fundamental role of science:

1) Make expectations for the relative strength and role of science in all stages of the EA process explicit within the language in the CEAA legislation -- from the initial project description to the EA decision and follow-up monitoring and enforcement. This necessitates adding the terms like 'science' and 'information' in relevant sections of the Act. Acts such as SARA provide a rough model for this action.

2) Mandate increased time and financial support by RAs to obtain reviews from scientists outside of the federal government of: 1) EA documents (e.g., project descriptions, EIS, and monitoring reports) submitted by development proponents and/or 2) ancillary technical analyses and/or advice that fill gaps in EA science delivered by the development proponent. Such outside participation should be required by the RA at multiple stages of the EA process (see Appendix 1), as one means among many of increasing integration of "outside" scientists, e.g., through development of research programs needed to provide the necessary models for impact assessment.

3) Review Panel members must include people with scientific training and expertise, and terms of reference must indicate how science is to be considered in panel deliberations. Direction for both should be explicit in the legislation. Review Panel members must be enabled to solicit specific outside expertise to fill perceived gaps.

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4) Clear and detailed guidelines on expectations of scientific quality of materials (e.g., project descriptions, EIS, etc.) must be developed to ensure delivery of the most meaningful and relevant information for decisions. Guidelines should go beyond listing the components of an EIS, but should provide clearly articulated expectations regarding quantity and quality of information that is expected. In addition, practitioners must be provided explicit guidance on what to do and how to report and interpret uncertainty within the context of the multiple facets of information gathering and reporting. These guidelines should be created with input from an expert working group composed of scientists from across sectors (i.e. inside and outside of federal government) (see EPA Caucus submission, Theme 2).

5) Reduce the potential for conflict of interest between the production of EA materials and the outcome of project decisions. This could be accomplished by re-routing oversight of scientists who are conducting EA from proponents to the RA, or by adopting a co-management approach where proponents and the RA jointly commission EA materials.

6) Develop clear decision-making criteria and trade-off rules to guide decisions and incentivize decision making based on the information and analysis considered during EA reviews (see EPA Caucus submission). These criteria and associated procedures should be developed with the objectives of 1) providing clear policy direction at the outset of the decision, 2) contending with uncertainty, and 3) ensuring transparency.

7) Require continuous oversight by RAs from the beginning stages when guidelines (TORs) are devised. RAs must invest in regional monitoring programs and establish clear guidance and criteria to define appropriate mitigation and require it to be specifically proposed during the conduct of an EA and its concrete, applicable details described in approval conditions. Monitoring requirements must be specifically designed to test the efficacy of mitigation measures for projects that are approved, with adequate statistical power to detect change where possible.

8) Federal government budgets must recognize the critical need for internal scientific capacity, expertise, and data collection to support the RA role in EA processes. This includes coordinated and strategic investments in regional monitoring programs ahead of project approvals, even in areas where industrial development is currently limited, such that the science is available when needed and information generated at the project level can be considered in its appropriate context.

5. Structural Considerations

This discussion has implications for considering how the assessment authority (RA) might be structured following a reformed EA where science is elevated in importance from current practice. Of particular interest is the distribution of scientific expertise inside the Agency (RA). It

might be tempting to create a consolidated scientific unit as a means to house RA scientists participating in EAs. However, I would have significant concerns that such a model would serve to isolate scientists and inadvertently provide support to the notion that they should be uninvolved at the key stages of the process, including the final decision where understanding of the environmental, social, and economic trade-offs associated with approval/non-approval would be highly beneficial.

A key take-home message of my submission is how scientific considerations permeate the EA process from top to bottom (Appendix 1), underscoring the need for scientific capacity at virtually all stages of the process. Moreover, much attention needs to be devoted to the communication to decision makers of scientific aspects of the impact assessment that stand to influence the approval decision. This must include a full and transparent accounting of uncertainty and unknowns associated with conclusions about potential impacts and mitigation.

In addition to increasing internal scientific capacity within government for EAs, I have made the argument here for more deliberate integration of outside scientific expertise into the process, even beyond review panels. I point to the EPA Caucus submission for some preliminary ideas we offered for an institutional model that could help fulfil the requirements of next-generation EA, taking into account the increasing imperative for strategic, regional, and cumulative effects assessments. With respect to how scientific capacity is integrated within this scheme, my recommendation is to focus on how to ensure the most robust engagement by scientific experts in each of the main stages of the EA process.

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Appendix 1. The incorporation of scientific information and expertise into EA stages (emphasis is on project-level assessments).

General Stage of EA	Activity	Why or How Scientific Information and Expertise is Required	Responsibility (under CEAA 2012)
Screening	Preparing the project description (PD)[1]	Information and analysis of the potential environmental and socio-economic impacts of the project, including waste emissions	Proponent
	Determining whether an EA is required	Sufficient understanding of 1) whether the information provided by the PD is complete and accurate and 2) the potential severity of impacts	Responsible Authority (RA)[2]
Scoping	Determining what to include and exclude from the assessment and the geographic scope	Knowledge and understanding of which ecosystem and socio-ecological components are likely to be adversely affected by the project in that location and context and the plausible relevant geographic scale. Knowledge must include potential for cumulative impacts in the region (e.g., other projects in the region) and climate change considerations	RA
	Establishing the terms of reference for the project (Environmental Impact Statement [EIS][1] Guidelines)	Knowledge and understanding of the nature, scope and extent of the information, (including gaps), that would provide a sufficiently strong base for the preparation of an EIS	RA
	Referral to Review Panel	Evaluation of the potential severity of all aspects of environmental[3] and socio-economic impacts	RA[2]
Impact analysis and mitigation (EIS)[1]	Establishing the environmental and/or socio-economic baseline, including identification of key issues or trends in valued components	Review of available relevant information, design and implementation of new studies, data analysis and understanding of uncertainties	Proponent

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General Stage of EA	Activity	Why or How Scientific Information and Expertise is Required	Responsibility (under CEAA 2012)
		and unknowns	
	Generating predictions about potential direct, indirect, and cumulative effects (scope, severity, probability, etc.) of the project and alternatives to the project and approaches to carrying out the project (e.g., scenarios)	Identify the types of impact; infer or predict the magnitude, the probability of occurrence, and the extent of the impact; assess the significance of impacts; and identify sources of uncertainty and unknowns	Proponent
	Identifying or designing proposed impact management or mitigation measures to manage or reduce potential adverse and cumulative impacts for all alternatives	Review efficacy of mitigation options from previous experience and documentation elsewhere; design mitigation measures to learn from success/failure; sufficient understanding of impacts to design potential solutions	Proponent
Review	Determining the acceptability of the EIS[1] and proposed project	Sufficient understanding of 1) whether the information provided by the EIS is complete and accurate and 2) the potential severity of impacts of all alternatives means of carrying out the project in consideration of the context	RA[2]
	Concluding whether the potential adverse effects of the project, the mitigation measures that were taken into account and the significance of the remaining adverse environmental effects as well as follow-up program requirements (EA Report[1])	Sufficient understanding of 1) whether the information provided by the EIS is complete and accurate; 2) whether there is available information elsewhere that might contradict findings and 3) the potential severity of impacts in full consideration of the context	RA or Review Panel[2]
EA Decision	Determining whether significant adverse environmental effects*** are "justified" (CEAA 2012 s. 31)	Understanding of trade-offs and risks resulting from various choices, i.e., "predicted damages and risks are accepted as the price to	Minister

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General Stage of EA	Activity	Why or How Scientific Information and Expertise is Required	Responsibility (under CEAA 2012)
		pay for what expected benefits" (Gibson 2013) and associated uncertainties and unknowns	
	Approving or not approving the project and establishing conditions	Evaluate aspects of the socio-ecological environment that are most likely to change and require monitoring; full awareness of uncertainties and unknowns; disclosure of assumptions	Minister
Follow-up and adaptive management	Designing and implementing monitoring to verify impact predictions and effectiveness of mitigation actions	Understanding potential impacts, data gaps, and sufficiency of sampling scheme to detect change	Proponent
	Enforcing conditions	Understanding the basis for monitoring requirements and what constitutes a sufficient change to require management shifts	RA[2]

[1]Documentation currently required under CEAA 2012 for this stage/activity; [2]Stages/activities where engagement of external scientists with appropriate expertise, either for review of products or for undertaking new work, would be most beneficial; [3] his would not be limited to "environmental effects" as defined by CEAA 2012, rather "environment" means the components of the Earth, and includes (a) land, water and air, including all layers of the atmosphere; (b) all organic and inorganic matter and living organisms; and (c) the interacting natural systems that include components referred to in paragraphs (a) and (b).

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Appendix 2. Scien[ce,tific], knowledge, information, technical, expert/expertise, biolog[ical], ecolog[ical] in CEAA 2012 and SARA.

CEAA 2012	SARA
[Preamble]	**[Preamble]** community knowledge and interests, including socio-economic interests, should be considered in developing and implementing recovery measures, the traditional knowledge of the aboriginal peoples of Canada should be considered in the assessment of which species may be at risk and in developing and implementing recovery measures, knowledge of wildlife species and ecosystems is critical to their conservation,
[Purpose]	**[Purpose]** wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons, the Government of Canada is committed to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to a wildlife species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty,
[Definitions – interested party] **2.** (2) One of the following entities determines, with respect to a designated project, that a person is an interested party if, in its opinion, the person is directly affected by the carrying out of the designated project or if, in its opinion, the person has relevant information or expertise: (a) in the case of a designated project for which the responsible authority is referred to in paragraph 15(*b*), that responsible authority; or (*b*) in the case of a designated project in	**[Interpretations-definitions]** **2.** "status report" means a report, prepared in accordance with the requirements of regulations made under subsection 21(2), that contains a summary of the best available information on the status of a wildlife species, including scientific knowledge, community knowledge and aboriginal traditional knowledge.

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CEAA 2012	SARA
relation to which the environmental assessment has been referred to a review panel under section 38, that review panel.	
[Federal authority's obligation] **11.** Every federal authority that is in possession of specialist or expert information or knowledge with respect to a designated project that is subject to a screening must, on request, make that information or knowledge available to the Agency within the specified period.	**[Stewardship Action Plan contents]** **10.2** (*c*) methods for sharing information about species at risk, including community and aboriginal traditional knowledge, that respect, preserve and maintain knowledge and promote their wider application with the approval of the holders of such knowledge, with other governments and persons; (*f*) provide information relating to the technical and scientific support available to persons engaged in stewardship activities.
[Factors to be considered] **19.** (1) (*d*) mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project; (*g*) alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means; (3) The environmental assessment of a designated project may take into account community knowledge and Aboriginal traditional knowledge.	**[COSEWIC]** **14.** (2) COSEWIC must carry out its functions on the basis of the best available information on the biological status of a species, including scientific knowledge, community knowledge and aboriginal traditional knowledge. **16.** (1) COSEWIC is to be composed of members appointed by the Minister after consultation with the Canadian Endangered Species Conservation Council and with any experts and expert bodies, such as the Royal Society of Canada, that the Minister considers to have relevant expertise. (2) Each member must have expertise drawn from a discipline such as conservation biology, population dynamics, taxonomy, systematics or genetics or from community knowledge or aboriginal traditional knowledge of the conservation of wildlife species. **18.** (1) COSEWIC must establish subcommittees of specialists to assist in the preparation and review of status reports on wildlife species

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CEAA 2012	SARA
	considered to be at risk, including subcommittees specializing in groups of wildlife species and a subcommittee specializing in aboriginal traditional knowledge, and it may establish other subcommittees to advise it or to exercise or perform any of its functions. (3) Subject to subsection (2), the chairperson and members of the aboriginal traditional knowledge subcommittee must be appointed by the Minister after consultation with any aboriginal organization he or she considers appropriate. **20.** The Minister must provide COSEWIC with any professional, technical, secretarial, clerical and other assistance, and any facilities and supplies, that, in his or her opinion, are necessary to carry out its functions.
[Federal authority's obligation] **20.** Every federal authority that is in possession of specialist or expert information or knowledge with respect to a designated project that is subject to an environmental assessment must, on request, make that information or knowledge available, within the specified period, to (*a*) the responsible authority; (*b*) the review panel; (*c*) a government, an agency or body, or a jurisdiction that conducts an assessment of the designated project under a substituted process authorized by section 32; and (*d*) a jurisdiction that conducts an assessment, in the case of a designated project that is exempted under subsection 37(1).	**[Recovery Strategy]** **38.** In preparing a recovery strategy, action plan or management plan, the competent minister must consider the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed wildlife species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty.
[TOR/appointment of members of Review Panel] **42.** (1) Subject to subsection (2), if the environmental assessment of a designated project is referred to a review panel, the Minister must	**[Determination of Feasibility]** **40.** In preparing the recovery strategy, the competent minister must determine whether the recovery of the listed wildlife species is technically and biologically feasible. The determination

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CEAA 2012	SARA
establish the panel's terms of reference and appoint as a member one or more persons who are unbiased and free from any conflict of interest relative to the designated project and who have knowledge or experience relevant to its anticipated environmental effects. (2)(*d*) the members of the panel are to be unbiased and free from any conflict of interest relative to the designated project and are to have knowledge or experience relevant to its anticipated environmental effects.	must be based on the best available information, including information provided by COSEWIC.
	[Monitoring and reporting] **55.** The competent minister must monitor the implementation of an action plan and the progress towards meeting its objectives and assess and report on its implementation and its ecological and socio-economic impacts five years after the plan comes into effect. A copy of the report must be included in the public registry.
	[Filing in court for the purposes of public access **111.** (3) Subject to subsection (4), if any of the following information is to be part of the agreement or the report, it must be set out in a schedule to the agreement or to the report: (*a*) trade secrets of any person; (*b*) financial, commercial, scientific or technical information that is confidential information and is treated consistently in a confidential manner by any person;

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