

# THE LAW AND ECONOMICS OF ENVIRONMENTAL HARM: A PRIMER AND UPDATE FOR ENVIRONMENTAL SENTENCING (PARTS III, IV & V)

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### **PART III: BASIC CONCEPTS, PRINCIPLES AND TOOLS FOR ENVIRONMENTAL VALUATION**

The field of environmental valuation, a sub discipline of environmental economics, has emerged in response to the need to develop monetary measures of changes in the provision of environmental goods and services. Although one cannot downplay the importance that damage assessment has played in the development of valuation methods, the field started as a need to develop monetized measures of environmental services for inclusion in formal cost benefit analyses (CBA). The issue was that many resource development projects would impact many environmental services that were not traded in formal economic markets. Hence attempting to estimate the economic values of these services would allow a more complete analysis of the benefits and costs arising from development or management changes of resources.

The concept of compensation for harm or damage to the environment, which in theory is a good that is “owned” by the collective or state, suggests that the responsible party should provide compensation equal to the damage in order to make the public “whole”. While this appears to be a simple concept, in reality assessing environmental damages and determining appropriate levels of compensation is difficult. One reason is that economists view the environment as a resource or entity that provides a bundle of services to society. Relating the harm to physical changes in these service flows is a major challenge in determining compensation. The types of services can vary from place to place or ecosystem to ecosystem; the levels of use or enjoyment of the services can vary both spatially or temporally; and physical measurement of the service levels either before or after harm has occurred can be absent or expensive to implement. In addition, in many cases the environmental service flows may be beneficial to humans well away from the site or area damaged. Thus, the first challenge involves understanding the biophysical dimensions of changes in environmental quality caused by the harm.

The next set of challenges relate to translating the biophysical changes in goods and services affected by damages to measures of the value associated with these changes. This typically means that one needs to define the condition and value of the “base case”, or in other words the condition of the environmental asset prior to the harm or damage taking place. This is needed to determine the situation before and after the environmental harm has taken place. In situations where this knowledge exists, economists have derived a number of approaches to develop monetary values of associated changes in service flows. Essentially what one needs are measures of the changes in human welfare (typically in monetary terms) arising from changes in environmental conditions. This can be straightforward to determine for environmental goods and services that are traded in markets (e.g. minerals, tourism, etc.). For example, one can assess changes in market values arising from changes in industrial production or costs resulting from environmental changes. If an environmental change impacts an industry or firm, changes in output levels resulting in lost profits, or input levels resulting in rising costs of

production, can be directly assessed. However, many aspects of environment harm or damage involve changes in goods and services that are not traded in formal markets. Examples provided in the previous discussion (Part I) involve such things as migratory birds, marine mammals etc.

Environmental valuation basically involves two approaches: 1) identifying linkages between market goods and environmental goods and using these links to assess welfare changes associated with changes in environmental conditions; and 2) developing/creating hypothetical markets that incorporate environmental conditions and evaluating welfare changes using these hypothetical markets. Applying specific methodological approaches from these two categories always involves the assessment of a change in the “state of the world” which encompasses a change in environmental quality. Values expressed through market or near market behaviour can include the purchase of individual or bundles of goods that are jointly related to the environmental change. These types of goods are referred to as “use” values and the valuation methods employed to measure the values in an environmental context are called “revealed preference” methods since a “user” reveals their environmental preferences through their market behaviour or choices. The most common methods include a group of methods that have been applied to recreational use of the environment.

The first valuation approach, briefly referred to in Part I, is called the travel cost method which involves revealing the value of recreation sites to visitors through the costs they pay travelling to sites. Since values of accessing sites are not revealed through entrance or access fees (which can be absent for many recreational areas) the total costs of access (both travel and entrance fees) approximate the “true price” of a visit. These methods would relate environmental quality changes to the responses recreationists by examining changes in their levels of visitation. For example, given that X trips are made by recreationists to a park in a pristine state, damages to park quality would reduce the number of these trips to Y and hence damages would be assessed through this reduction in visitation expressed using per trip economic values.

Recent developments in the travel cost method, however, involve the construction of choice models in which the actual attributes of recreation sites (including elements of environmental quality) in addition to travel costs explain demand for the sites. These attributes can include man-made features such as campsites and roads, as well as environmental attributes such as forest conditions (species, age of trees etc.), water clarity, etc.<sup>1</sup> Here an analyst develops a model that assesses the probability of visiting a particular site among a complex of sites as a function of these characteristics and travel costs. This allows assessment of changes in visitation as one or more attributes change at sites and the model predicts where in the complex of sites a recreationist would go in

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<sup>1</sup> An example for Canadian wilderness recreation is: PC Boxall, DO Watson & J Englin, “Backcountry recreationists’ valuation of forest and park management features in wilderness parks of the western Canadian Shield” (1996) 26:6 Can J For Res 982 at 990.

response to the change. Thus this method allows a formal consideration of substitutes that could be used if an individual site is damaged. By relating changes in trip behaviour to travel costs, economic values can be estimated due to changes in one or more attributes across the complex of recreation sites as visitors pay more to access higher quality sites further from their homes to avoid the change in conditions.<sup>2</sup>

Another revealed preference approach involves statistical or econometric assessments of the variation in prices of properties in residential markets to evaluate changes in environmental quality. Since property prices are a function of the attributes associated with those properties, including environmental characteristics of the property or surrounding areas, the procedure “backs out” the value of the environmental asset by determining if its availability affects the sales price of an individual property. This approach, called the “hedonic price method,” has been used to examine the values of positive or negative environmental amenities associated with properties.<sup>3</sup> In essence this intuition can be applied to most forms of economic transactions where attributes of the object purchased vary. For example this includes hotel and tourism package prices. The method can also be used to examine the sensitivity of wage rates to changes in environmental or health related characteristics.

In many cases, however, there is no observable behaviour that arises in response to an environmental quality change. For example a local forest may support the existence of a rare and endangered species. Individuals may be concerned about the viability of this species, but there is no mechanism available through which they can pay for or vote to be taxed for actions to ensure its survival. This type of value is referred to as an “existence value” because while individuals may not go and view the species, or have any intention of “using” it, they nevertheless value its existence. Economists have broadened this concept to “passive use” value which also includes possible future use and bequeathing use to future generations [passive use values are also considered non-use values in this case].

In cases where values associated with an environmental good or service are not associated with market purchases or behavioural trails, “stated preference” approaches are used to estimate passive use values. These methods utilize questionnaire surveys in which conversations with respondents are employed to estimate standard metrics of economic value — the “willingness to pay” (WTP) or to willingness to accept

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<sup>2</sup> Peter Boxall et al provide an example for the vandalism of Canadian aboriginal rock paintings which were modelled as a recreation attribute (see “Valuing aboriginal artifacts: A combined revealed-stated preference approach” (2003) 45:2 *J Environ Econ Manage* 213 at 230).

<sup>3</sup> For example Peter Boxall et al find that the presence of energy infrastructure developments within 4 km of a given country residential properties depress their sales price in Alberta (see “The impact of oil and natural gas facilities on rural residential property values: A spatial hedonic analysis” (2005) 27:3 *Res Energy Econ* 248 at 269); J Loomis and M Feldman uncover positive economic benefits for stabilizing lake levels of nearby properties in the U.S. (see “Estimating the benefits of maintaining adequate lake levels to homeowners using the hedonic property method” (2003) 39:9 *Water Res Research WES* 2-1 at WES 2-6).

compensation (WTAC) in response to changes in environmental conditions. The most well-known of these methods is “contingent valuation” in which a hypothetical referendum is introduced in the survey and respondents vote on accepting an environmental improvement in exchange for an increase in tax payments (hence an assessment of WTP). As noted in Part I, this method has a long history in the valuation of environmental harm stemming from the 1989 Exxon Valdez oil spill in Alaska.<sup>4</sup>

The method has also been extended to include various attributes in a choice modelling framework as mentioned above. Here various “states of the world” are defined based on changing levels in a set of attributes, formed into sets of choices, and respondents are asked to choose among them. The attribute bundles include tax or income changes and environmental quality changes are portrayed using adjustments in the attribute levels. The results permit a much richer understanding of preferences for environmental quality changes. The major difference between contingent valuation and the attribute based choice modelling is that contingent valuation tends to focus largely on monetary factors.

Since actual environmental damages involve a change in conditions, determining the extent of economic harm also must involve assessing a change. Hence total values for some feature of the environment are not useful in the actual damage assessment context. Rather, one must use marginal economic values directly associated with the environmental quality change. This usually means that one must understand the before-the-damage conditions and compare this with the after-the-damage condition. Thus, utilizing the methods described above, for example in a recreation context, one must understand levels of visitation prior to the environmental damage. If one can forecast or determine a decrease in visitation levels, then this quantity decrease must be multiplied by the per trip economic value to assess the levels of damages. Alternatively, if a recreation choice model has been developed then one can measure the damages by changing the attributes at the damaged site, estimate the changes in visitation patterns, and calculate economic measures of damages based on these changes in trip patterns among the complex of substitute sites. Note that these procedures require prior knowledge of values or model development prior to the environmental harm taking place.

With respect to potential harm (risk of damage), economic damage assessments methods may not be directly useful in determining the level of compensation. Environmental valuation, however, is typically used to examine the benefits provided by environmental assets, not specifically the economic assessment of damages. So these values could provide information to the judiciary on the magnitudes of undamaged environmental assets which might be useful in understanding the magnitudes of reductions in the value of services provided by damaged environmental assets. There is a growing literature that deals with transferring such estimates from one site to another; or from one type of use to another. The procedures for doing this are called “benefits transfer” and involve the direct

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<sup>4</sup> See Carson et al, “Contingent valuation and lost passive use: Damages from the Exxon Valdez oil spill” (2003) 25:3 *Env Res Econ* 257 at 286.

transfer of a specific economic estimate (called a “unit value transfer”) such as \$/day. A more complicated transfer, called a “function transfer”, can be performed by using the specific mathematical function developed for the original site or study. For example in study A an equation was developed that provided a benefit (damage) estimate — by using specific information available for study site B the values of the arguments of that equation that relate to site B are used in the equation for developing the new estimate.

Assuming there are a number of valuation projects undertaken that the judiciary can examine, it would be possible for potential damages to be assessed based on previous more formal damage assessments. A major issue, however, is that such a bank of specifically Canadian studies does not exist, nor have there been enough studies conducted in the country that would make such a bank worthwhile. Thus, one might have to turn to studies conducted in other parts of the world in order to learn something about potential damages in a Canadian context. One such database is the Environmental Valuation Resource Inventory (EVRI),<sup>5</sup> a database hosted and run by Environment Canada and which contains a multitude of environmental valuation studies. The use of this database in a “damage transfer” process would mimic the benefits transfer approach.

#### **PART IV: A CASE STUDY — USE AND NON-USE VALUES ASSOCIATED WITH THE WILMOT RIVER, PEI**

As noted in the introduction to this paper, an environmental valuation approach to quantifying harm has never been successfully carried out in the Canadian sentencing context. This is not to say, however, that such an approach has never been attempted. In this part, we consider one such attempt and then set out the kind of evidence that could have been introduced.

##### ***A. R. v. George M. Caseley & Sons Inc. (2004)***<sup>6</sup>

The facts in this case are relatively straightforward. The accused, a potato producer, plead guilty to permitting a deleterious substance to enter waters frequented by fish, contrary to s. 36(3) of the *Fisheries Act*,<sup>7</sup> following an incident whereby a rain squall caused runoff from two of his fields to reach the upper reaches of the Wilmot River. These fields had been sprayed the previous day with Azinphos-methyl, a pesticide that is extremely toxic to fish and other wildlife, which reached the Wilmot because the accused failed to ensure

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<sup>5</sup> See online: <<https://www.evri.ca/Global/Splash.aspx>>.

<sup>6</sup> 10 CELR (3d) 178, 241 Nfld & PEIR 194 [*Caseley & Sons*].

<sup>7</sup> RSC 1985, c F-14.

a sufficient buffer zone.<sup>8</sup> Subsequently, a total of 4500 dead trout were collected from the Wilmot River.

In what appears to be the only reported case of its kind, the Crown called evidence in an attempt to show the “overall economic consequences of the offence,” as follows:

Lisa DeBaie, who is employed by the Federal Government with Environment Canada to study the economic impact of environmental issues, prepared a damage evaluation in relation to this matter. Ms. DeBaie’s report was filed as an exhibit on the sentencing hearing and Ms. DeBaie testified that the cost of the fish required to restock the Wilmot River is approximately \$3,100. The cost of monitoring the recovery of the river is approximately \$9,700 for a total of \$12,800. The reliability of those figures is not in issue.

Ms. DeBaie then went on to attempt to quantify the more intangible losses which economists apparently believe occur from these kinds of events. Ms. DeBaie assigned a dollar value to the time spent by volunteers although they were unpaid. She assigned a dollar value to the work of government employees although no additional staff were hired as a result of this offence. She assigned a dollar value to the recreational enjoyment of individual fishers and multiplied it by the projected numbers of fishers who might be expected to use the Wilmot River, and multiplied that by the number of days that those individuals might have fished. This analysis of course assumes that none of those recreational fishers decided to fish elsewhere in Prince Edward Island. She estimated that total loss at up to \$286,300.

Ms. DeBaie then attempted to quantify the total overall economic impact of resident, visiting non-resident Canadian, and visiting non-Canadian fishers not fishing on Prince Edward Island and in the case of non-residents, apparently not even visiting Prince Edward Island because of the closure of the Wilmot River to recreational fishing. Ms. DeBaie estimates that the total impact could be as high as \$690,000 per year while the river remains closed.<sup>9</sup>

The Court, however, rejected this evidence:

The difficulty which the Court has with Ms. DeBaie’s evidence is that it is for the most part not based on empirically grounded data. *There is no evidence of how many people fished the Wilmot River, on average, before its closure. There is no evidence that even one fisher stopped fishing in east Prince County because of the closure. There is no evidence that even one visitor failed to come to Prince Edward Island and fish because of the closure.*

It may well be that the Province has suffered and will continue to suffer economic loss because of the closure of the Wilmot River and the impact on environmental tourism generally from pesticide-laced runoff and fish kills. *However, without evidence based on hard data*, in the Court’s view, Ms. DeBaie’s conclusion must be regarded as speculation ...

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<sup>8</sup> Readers may be interested to know that, subsequent to this case (2002), Azinphos-methyl’s use has been slated for being phased out; see *Re-evaluation Decision Document*, RRD2004-05 (Ottawa: PMRA, 2004), online: <<http://publications.gc.ca/site/eng/247893/publication.html>>.

<sup>9</sup> *Caseley & Sons*, *supra* note 6 at paras 9-11.

I therefore find the proven losses in this matter to be \$12,800 for re-stocking and monitoring of the river's recovery.<sup>10</sup>

## **B. Quantifying Damages: Actual and Potential (Specific and General)**

### *i) Actual Damages*

This case highlights the importance of understanding baseline conditions prior to damages taking place, as well as having data on conditions following the incident. In particular, an analyst assessing damages would want information about the levels of use of the fishery as well as the condition of the fish populations prior to the incident taking place. Armed with this initial data, assessments of use levels following the damage would allow some understanding of the impacts of the damage on the use of the fishery. At the very least being able to determine the level of reduction in fishing trips caused by the loss of trout, and using estimates from other fisheries of the economic value of a fishing trip through benefits transfer (perhaps using travel cost models), the analyst could develop *annual* estimates of the economic loss. Of course how long the damage to the fishery would last, and how quickly it would take fishers to return to former levels of use, would remain an open but important question in determining the total damage estimate over time.<sup>11</sup> These temporal considerations require reconnaissance of fisher efforts as well a biological knowledge on recovery.

In many cases there is existing data on use levels that has been collected for some other purpose. In the case of fisheries for example, there are typically periodic creel surveys which are designed to estimate the annual levels of fish harvest. These surveys are designed and conducted by biologists who visit fishers on-site and the information collected is specifically used for biological purposes rather than determining use levels and associated economic values. This unfortunate but common situation requires intervention such that data collection efforts with a few modifications could be designed to serve multiple purposes; one of which could be developing estimates of the levels of use and the collection of information which might allow the development of travel cost models.

In addition to adjustments to systematic biological data collection, it is also possible to adjust other systems that collect data for the primary purpose of tracking revenues from users for auditing systems. These include park and campsite registrations as well as hunting and fishing licenses. There has been research examining the utility of such systems for examining levels of use, determining where visitors come from, and for

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<sup>10</sup> *Ibid* at paras 12-14.

<sup>11</sup> This is a case of determining the “interim loss” which would involve the loss from the time of the incident to full recovery of the damages. This is discussed in some depth in CA Jones & KA Pease, “Restoration-based compensation measures in natural resource liability statutes” (1997) XV Contemp Econ Policy 111 at 122.

estimating travel costs with no or minor impact on their original intended purpose.<sup>12</sup> However, provincial and federal government agencies have not heeded calls by researchers to adjust such systems to incorporate these additional needs. It is also difficult to access such data under access to information legislation.

The comments above relate to “use values” which are easier to understand and estimate given sufficient data. However, significant challenges arise in determining the non-use values associated with some damage incident. Ideally an independent study of these values would be necessary, but this is difficult to see happening for two reasons. First any study would have to be conducted *ex post* of the incident and the results of such efforts could be influenced by knowledge of the incident. Thus, an *ex ante* study would be preferable, but it is difficult to predict where such studies would have to take place before damages occur. Second, estimating non-use values requires the use of stated preference methods as described in Part III above and these are typically expensive to conduct.<sup>13</sup>

Despite considerable investments by Canadian resource management agencies in collecting biological data of relevance to environmental management, they have been reluctant to make similar investments in data collection efforts that could generate useful inventories of the use of environmental resources and to develop economic valuation information. This reluctance comes despite the need for this information in cost benefit analyses of regulatory changes and in assessing environment harm and damage. These authors are amazed at the myriad of requests for proposals that arise from government agencies to gather data on use and values despite the fact that this information simply does not exist in many cases. Funds for such contracts would be better spent in developing data collection systems and generating empirical economic valuation estimates.

#### *ii) Risk of Damage (Specific)*

Recalling the discussion in Part II, the focus of the inquiry here is to determine whether there was a real potential for greater environmental damage than actually occurred (e.g.

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<sup>12</sup> Such research has been conducted in Alberta for camping areas in the Rocky Mountain Foothills managed by the provincial government (see PC Boxall, BL McFarlane & M Gartrell, “An aggregate travel cost approach to valuing forest recreation at managed sites” (1996) 72:6 Forestry Chronicle 615 at 621). A similar report to Parks Canada pointed out the potential use of their registration systems for similar purposes (see BF McFarlane, D Watson & PC Boxall, “Getting more from what we have: The case of backcountry permits” (2001) 9:3 Research Links 5 at 7).

<sup>13</sup> It is estimated that the contingent valuation survey conducted to estimate the damages of the 1989 Exxon Valdez oil spill cost \$3 million to implement. GC Harrison & JC Leahy, “Must Contingent Valuation Surveys Cost So Much?” (1996) 31 J Env Econ Mgmt 79 at 95 discuss this and provide an alternative cheaper method. One would need to recognize that the survey expenditure level was high due to the fact the results were to be used in litigation around the damage assessment estimates. Stated preference surveys conducted by Boxall and colleagues typically cost in the range of \$120,000-\$150,000 each.

the 4,500 dead trout). This analysis will be context specific; as in *Terroco, supra*, the nature of the product (here a toxic insecticide that has since been slated for phase out by the federal Pesticide Management Regulatory Agency)<sup>14</sup> as well as the sensitivity of the receiving environment, here the Wilmot River, will be especially relevant.

For example, the Wilmot River is also salmon-bearing, at least at the juvenile stage and if only barely.<sup>15</sup> Consequently, the damage could have been greater if the event had occurred while salmon were spawning or juveniles were otherwise present. To determine the probability of such damage (*P*), it would be necessary to know the timing of spawning or juvenile presence generally and whether it could have overlapped with the timing of pesticide application in the potato growing context. The magnitude (*M*) of the potential damage could be based on the number of salmon juveniles expected to be found in the Wilmot River at such a time.

A damage transfer approach would take estimates from a pollutant spill somewhere else in Canada (or North America or even possibly from around the world) that affected a recreational fishery and apply the findings to the Wilmot River case. Obviously finding a fishery pollution impact case that can represent the Wilmot River situation as closely as possible would be preferable. So learning from cases where pollution impacts were known and assessed in economic terms would provide valuable information to the judiciary in understanding something about the potential risk of damage.

Alternatively, or at least in the meantime, environmental valuation could tell the Court something about the value of Atlantic salmon generally against which to “benchmark” the risk of damage. For example, simply assessing the market value of fish filets killed in the Wilmot case would provide one simple measurable component of the overall impact of the pollution event. Other values of these fish and their use, however, would be much larger than this market food value — one recent study for example estimated that there is “over \$105 million in public non-use value associated with wild salmon.”<sup>16</sup> While the Wilmot River would represent only a tiny fraction of this value, it would nevertheless provide the Court with some kind of benchmark for the purposes of quantifying this component of the risk of damage. It must also be recalled that potential harm to salmon is

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<sup>14</sup> *Supra* note 8: “Based on a review of the available information, the PMRA has concluded that the use of azinphos-methyl and its associated end-use products in accordance with the current label directions entails an unacceptable risk of harm to agricultural workers pursuant to Section 20 of the PCP Regulations. Environmental concerns have also been identified ....”

<sup>15</sup> DFO, *Stock Status of Atlantic Salmon (Salmo Salar) in DFO Gulf Region (Salmon Fishing Areas 15 to 18)*, Canadian Science Advisory Secretariat Science Advisory Report 2012/040 (Ottawa: DFO, 2012), online: <[http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2012/2012\\_040-eng.pdf](http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2012/2012_040-eng.pdf)>.

<sup>16</sup> Gardner Pinfold, *Economic Value of Wild Atlantic Salmon* (Halifax: Atlantic Salmon Federation, September 2011), online: <[http://0101.nccdn.net/1\\_5/13f/2a0/0fe/value-wild-salmon-final.pdf](http://0101.nccdn.net/1_5/13f/2a0/0fe/value-wild-salmon-final.pdf)>.

but one example and one component of the potential harm or risk of damage.<sup>17</sup>

### *iii) Risk of Damage (General)*

The focus of this inquiry is on the regulated community. Although this could be defined as broadly as all those persons or entities that are subject to the subsection 36(3) prohibition, a more useful category may be all PEI farmers who use pesticides on their crops, or perhaps all such farmers in the Maritimes. Framed this way, the risk of general damage could be a function of the number of farmers and the amount of pesticides that they use on an annual basis. And while the probability of all such farmers ignoring appropriate buffers would be low, it does appear to be the case that fish kills like this one are actually not uncommon in PEI; according to one source found by the authors, there have been roughly fifty such fish kills in PEI in the past 50 years, or one per year.<sup>18</sup>

Here, again, in the absence of a damages transfer database, environmental valuation could tell the Court something about the value of the environment or ecosystem asset at stake against which to benchmark the risk. Returning to the example of Atlantic salmon, even if the general risk of damage was deemed to be to only a fraction of a percent of the Atlantic salmon population (e.g. 0.1%), that still represents \$105,000 in non-use values.

What this case study makes clear is that the risk of damage analysis, whether specific or general, is not limited the same way as the actual damage assessment analysis is, which is to say by the need for baseline information *prior to the incident*. The “risk of damage” assessment is hypothetical and, in the general risk context especially, is likely to take into account a considerably higher level of harm than the specific offence, such that the latter is not likely to affect the results of the former. Simply put, the absence of a baseline would not seem as problematic to this exercise as it is for actual damages. Thus, where the Crown deems it sufficiently important, it could elect to carry out a valuation study after the offence for the purposes of informing the general risk of harm analysis.

## **PART V: PROSPECTS FOR ENVIRONMENTAL VALUATION IN ENVIRONMENTAL SENTENCING**

It has now been a decade since the Supreme Court of Canada’s decision in *Canfor* and almost five years since the passage of the *EEA*, and there has yet to be a Canadian

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<sup>17</sup> Revealing the numerous other benefits conferred on society by functioning ecosystems is the goal of the ecosystem services framework; for more on the potential to apply an ecosystem services framework to sentencing, see Martin Olszynski, “Environmental Damages after the Federal *Environmental Enforcement Act*: Bringing Ecosystem Services to Canadian Environmental Law?” (2012) 50:1 Osgoode Hall LJ 129.

<sup>18</sup> *A Compiled History of PEI Fish kills 1962-2011* (Belfast, PE: Macphail Woods Ecological Forestry Project, 14 February 2013), online: <<http://www.macphailwoods.org/wp-content/uploads/2013/02/History-of-Fish-Kills-PEI-.pdf>>.

judgment — whether in the civil or regulatory context — that has seriously considered the loss of use and non-use values in the context of environmental damages.

It is clear that further development in this area, which the authors regard as necessary for the full consideration of environmental harm, will require considerable work and effort on the part of researchers, government agencies and Crown prosecutors. The needed economic valuation information can only be provided from banks of sufficient data which currently do not exist. Such data will need to be generated through developing new data collection efforts as well as adjusting existing data collection systems. Since sufficiently trained staff will be required to analyze and interpret this new data, regulatory agencies will need to add expertise beyond their traditionally trained environmental science staff.

Should agencies finally undertake expanding their expertise in this area, Canada's judiciary will also be challenged when it comes time to considering such evidence, although its existing track record for digesting complex scientific evidence suggests that it is entirely up to the task. Until then, it is apparent that the Canadian judges will have to continue to call on the Crown to collect and submit the necessary expert evidence, as was done in *R. v. United Keno Hill Mines*,<sup>19</sup> *R. v. Carriere*<sup>20</sup> and numerous other cases, albeit it now with a shift towards economic quantification.

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<sup>19</sup> [1980] 1 YJ 299 at para 16.

<sup>20</sup> 2005 SKPC 84, 272 Sask R 13 at para 27.