Improving the Effectiveness and Efficiency of Pulp and Paper Environmental Effects Monitoring: A Smart Regulation Opportunity

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Table of Contents

Foreword

In January 2005, Environment Canada launched the Smart Regulation Project on Improving the Effectiveness and Efficiency of Pulp and Paper Environmental Effects Monitoring. Canada is a pioneer in the area of environmental effects monitoring (EEM) and unique in requiring pulp and paper mills to conduct an EEM program under regulation at a national scale to determine if our regulations provide adequate protection for all receiving environments. Since the EEM program began, there has been a process of continuous learning and improvement based on evolving science and stakeholder input. The Smart Regulation recommendations in this report build on the success of the national EEM program, which has provided the information needed to progressively focus and refine efforts to assess and manage environmental risks associated with pulp and paper mill effluent.

The Smart Regulation project brought together a group of policy experts from the federal government, industry, and the Aboriginal and environmental communities to think creatively about common concerns and innovative solutions. The group saw this as an opportunity for everyone to achieve benefits through more efficient, targeted monitoring and actions to address environmental effects where they have been identified. This was a highly rewarding dialogue, and I would like to thank the following individuals for their expert advice:

Bruce Boles, Privy Council Office

William Borland, JD Irving Limited

Bob Christie, Pictou Harbour Environmental Protection Project

Barry Firth, Weyerhaeuser

Nuzrat Khan, Department of Fisheries and Oceans

Beatrice Olivastri, Friends of the Earth

Jacques Rocray, Tembec

Michael Sherry, Chiefs of Ontario

Christian Turpin, Abitibi-Consolidated

A special note of thanks goes to the Forest Products Association of Canada for its leadership and early commitment to this project and, in particular, to Roger Cook for his technical support and broader industry perspectives on the EEM program.

I am grateful to the Environment Canada Regional Directors for Environmental Protection and the National EEM Team for their insights and advice to the Smart Regulation group. Their input to this process and their experience have been invaluable. In particular, Connie Gaudet of the National EEM Office provided valuable scientific and technical advice throughout the project, with strong support from Rick Lowell, Bonna Ring, and Georgine Pastershank, who provided information and data to the process under very tight time frames and with considerable effort.

Colleagues from the Saskatchewan and Alberta governments were consulted during the course of this project, based on their formal role as authorization officers under the *Pulp and Paper Effluent Regulations*. I would like to thank them for their involvement. It is clear that provincial governments will be an important part of broader consultations on any future changes to the EEM program.

Finally, special thanks are due to Environment Canada's project management team — Victoria Rowbotham and Linda Maddison — for bringing a strong expert team together and moving us towards a product that we are confident will lead to continued improvement in the EEM program.

Environment Canada, through its Competitiveness and Environmental Sustainability Framework, has a strong commitment to finding innovative ways to improve the environment and enhance industry competitiveness at the same time. A key collaborative mechanism to deliver on this commitment is the Forest Sector Sustainability Table. This Smart Regulation report is an example of the kind of collaborative initiative that I believe will be of interest to the Forest Sector Sustainability Table in setting its agenda for the-future.

On behalf of this expert group, I respectfully submit this report to the Deputy Minister of Environment Canada for his consideration.

Dr. John Carey
Smart Regulation Project Team Chairman
Environment Canada

Executive Summary

In January 2005, Environment Canada launched the Smart Regulation Project on Improving the Effectiveness and Efficiency of Pulp and Paper Environmental Effects Monitoring. The Environmental Effects Monitoring (EEM) program was introduced in 1992 as a component of the *Pulp and Paper Effluent Regulations* (PPER) to provide Environment Canada with information to help assess the adequacy of the PPER in protecting fish, fish habitat, and the use of fisheries resources. EEM provides information on the potential effects of effluent on fish populations, fish tissue, and benthic invertebrate communities. Canada is unique in requiring pulp and paper mills to conduct an EEM program under regulation at a national scale to determine if our regulations provide adequate protection for all receiving environments. The EEM program has undergone continuous improvement since it began.

The Smart Regulation project was launched in response to stakeholder feedback on the EEM program. Industry expressed interest in improving the effectiveness and efficiency of the EEM program to allow it to focus monitoring efforts and resources where they are needed most. Environmental and Aboriginal groups expressed concern that the EEM program only has a requirement for continued monitoring or investigation of cause when an effect is observed, but no requirement to actually address the effect. This project was recognized as an opportunity for an environment–economy win–win situation by achieving benefits through more efficient, targeted monitoring and actions to address effects where they have been identified. This Smart Regulation project brings together policy experts from the federal government (Environment Canada, Department of Fisheries and Oceans, and Privy Council Office), industry, and the Aboriginal and environmental communities. Project team members were asked to come with an open mind and think creatively about common concerns and innovative solutions.

The Smart Regulation group members were presented with a review of the national assessment of the recent EEM data (Lowell et al., 2005). The group reviewed the key outcomes of the national assessment to understand what effects had been observed in pulp and paper mill receiving environments. Based on its observations on the results of the fish and benthic surveys, the Smart Regulation group believes that there is an opportunity to expand beyond monitoring and move towards solutions in two priority areas — decreases in fish gonad size and eutrophication. To enable the shift to a solution-oriented agenda, it will be important that the EEM program encourages creative study designs and collaborative efforts to identify causes and solutions.

The group has discussed opportunities to improve the efficiency of the EEM program and has made a number of recommendations for changes to the structure of the EEM program. These recommendations focus on targeting resources towards areas of greatest environmental risk, as evidenced by observed effects on fish and benthos.

1. Introduction

In 1992, the federal government passed an updated regulatory framework for pulp and paper mill effluent. The framework set stringent discharge limits for mills across Canada and included an Environmental Effects Monitoring (EEM) program as a component of the *Pulp and Paper Effluent Regulations* (PPER) under the *Fisheries Act*. The EEM program provides Environment Canada with information to help assess the adequacy of the PPER in protecting fish, fish habitat, and the use of fisheries resources. EEM provides information on the potential effects of effluent on fish populations, fish tissue, and benthic invertebrate communities. The adequacy of the regulations can be assessed by evaluating the information provided by the EEM program along with information about other ecological, technical, social, and economic factors. Through technical multistakeholder working groups, regulatory amendments, and updated technical guidance, the EEM program has been continuously reviewed and has evolved significantly since it began.

In May 2004, Environment Canada published amendments to the PPER and the EEM program. In preparing those amendments, Environment Canada consulted broadly with industry, the provinces, Aboriginal groups, municipalities, federal departments, and environmental groups on the proposed changes to the regulations. In the fall of 2004, Environment Canada held information sessions across Canada to explain the amendments to the PPER and the EEM program. During the information sessions, the department heard two major policy messages:

- Industry expressed interest in improving the effectiveness and efficiency of the EEM program to allow it to focus monitoring efforts and resources where they are needed most.
- Environmental and Aboriginal groups expressed concern that the EEM program only has a requirement for continued monitoring or investigation of cause when an effect is observed, but no requirement to actually address the effect.

During 2004, the External Advisory Committee on Smart Regulation (2004) made a strong recommendation to the federal government for a regulatory strategy for Canada to make regulations as effective as possible, no more complicated or costly than needed, and able to keep up with developments in science, technology, and global markets.

Environment Canada and the Forest Products Association of Canada released a Smart Regulation report in September 2004 exploring innovative ways to manage air emissions from pulp and paper mills (Forest Products Association of Canada and Environment Canada, 2004). That report was based on the work of a group of policy experts from government, industry, and environmental and Aboriginal communities and has led to the creation of a high-level Pulp and Paper Air Quality Forum tasked with developing a 10-year agenda to reduce pulp and paper air emissions.

The Forest Products Association of Canada proposed the EEM program as a candidate for a second Smart Regulation project to bring together similar policy experts for an open and frank exchange of ideas on ways to improve the effectiveness (i.e. does the program lead

"As Canadians, we generally tend to downplay and understate our successes and our achievements. The EEM program is one accomplishment all Canadians should take great pride in and continue to develop it to be both cost-effective and performance-effective. As an environmentalist who has been a participant in the program's development and evolution for well over a decade, I take great pride in its effectiveness at monitoring environmental effects."

Bob Christie
Pictou Harbour
Environmental Protection Project

to solutions where effects have been identified?) and efficiency (i.e. are monitoring efforts and resources focused where they have most value?) of the EEM program. Environment Canada committed to review the EEM program following each cycle to ensure that the program continues to provide valuable information (Government of Canada, 2004). The most extensive review occurred in 1996–97 following Cycle 1, after which regulatory changes introduced decision trees and design changes to strengthen the program. After two complete cycles of high-quality data, the recent national assessment of the Cycle 2 and Cycle 3 data, and the policy messages noted above, the department felt this to be an opportune time to review the program and identify opportunities for further improvement.

Environment Canada launched the Smart Regulation Project on Improving the Effectiveness and Efficiency of Pulp and Paper Environmental Effects Monitoring in January 2005, bringing together policy experts from the federal government (Environment Canada, Department of Fisheries and Oceans, and Privy Council Office), industry, and the Aboriginal and environmental communities. Project team members were asked to come with an open mind and think creatively about common concerns and innovative solutions.

The mandate of the group was to review the key scientific findings and operational experience gained to date through implementation of the program and work collaboratively to develop ways to improve the future effectiveness and efficiency of the program and to address effects where they have been identified. The group was tasked with providing Environment Canada with external advice that will inform discussions within the federal government and consultations with interested parties on future proposals to improve the EEM program. Early on in its deliberations, the group recognized the links between the federal EEM program and the provincial management systems for pulp and paper mills and noted the importance of engaging provincial governments in future discussions.

This report is structured as follows: Section 2 provides an overview of the current regulatory structure, with a focus on the history and development of the EEM program. Section 3 examines the response to the regulatory requirements and describes the major improvements in effluent quality over the past decade. Section 4 provides a description of the high-level review of the national EEM data by the Smart Regulation group and its observations and discussions based on those data. Section 5 describes the opportunities identified to improve the effectiveness and efficiency of the EEM program. Section 6 describes the considerations for changes to the regulatory requirements and their impacts on the suggested timelines for the group's recommendations. Section 7 provides the group's recommendations.

2. Overview of Current Regulatory Structure

In Canada, the control of effluent discharges from pulp and paper mills is a shared authority between the federal and provincial governments. In the early 1990s, the federal and provincial governments worked jointly to develop a national regulatory framework under the Canadian Council of Ministers of the Environment (CCME) to improve pulp and paper mill effluent quality. It was agreed that the federal regulatory limits would serve as national baseline standards and that provinces could adopt these or enact stricter limits as required.

"When a multistakeholder group with as divergent a list of interests comes to consensus on the issue of EEM, it is a true indication of the importance of the issue."

William Borland
JD Irving Limited

In 1992, the federal government passed an updated regulatory framework for pulp and paper mill effluent. This framework includes the PPER under the *Fisheries Act* to improve effluent quality and two regulations under the *Canadian Environmental Protection Act* to prevent the formation of and to control the release of chlorinated dioxins and furans.

Under the *Canadian Environmental Protection Act, the Pulp and Paper Mill Defoamer and Wood Chip Regulations* set quantitative limits on the amounts of unchlorinated dioxins and furans allowed in defoamers used at mills with a chlorine bleaching process. As well, these regulations ban pulp mills from using wood chips derived from lumber treated with pentachlorophenol. The *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* prohibit the release of measurable concentrations of 2,3,7,8-tetrachlorodibenzo-para-dioxin and 2,3,7,8-tetrachlorodibenzofuran in effluent from mills that use chlorine or chlorine dioxide to bleach pulp. These two regulations minimized the entry of dioxin/furan precursors into the pulping process and induced major reductions in the amounts of gaseous chlorine that could be used in the bleaching process.

Under the *Fisheries Act*, the PPER set discharge limits for biochemical oxygen demand matter (BOD) and total suspended solids (TSS). As well, the PPER prohibit the discharge of effluents that are acutely lethal to rainbow trout at 100% effluent concentration and require mills to conduct EEM studies to assess the effects of mill effluent on fish, fish habitat, and the use of fisheries resources.

EEM was included as a component of the PPER because of uncertainty that uniform discharge standards would protect all receiving environments. EEM studies are intended to identify effects from pulp and paper effluent, not evaluate cumulative effects resulting from other sources. EEM has provided the science-based feedback loop to assess the effectiveness of the national discharge limits in protecting the fisheries resource. Canada is unique in requiring pulp and paper mills to conduct an EEM program under regulation at a national scale to determine if our regulations provide adequate protection for all receiving environments.

The EEM program is carried out in three-year cycles and consists of a biological monitoring study and sublethal toxicity testing of effluent, including supporting information to aid with the interpretation of the monitoring results. Recent changes to the regulations introduced tiered monitoring, which reduces the frequency of biological testing to every six years where mills show no effects and increases efforts where more significant effects are observed.

The biological monitoring study may consist of a fish survey, a benthic invertebrate community survey, and a fish tissue survey. These components of the EEM program were selected based on the goals of the *Fisheries Act* to protect fish, fish habitat, and the use of fisheries resources. Potential effects of effluent on fish are assessed by comparing fish exposed to effluent with unexposed fish. Effects on fish habitat are assessed through comparing benthic invertebrate communities from areas exposed and unexposed to effluent. Effects on the use of fisheries resources are assessed through measurements of dioxins and furans in fish tissue. Gradient designs may be used to assess effects on fish and fish habitat along a gradient of decreasing effluent concentration in place of the standard control/impact design. The areas farther from the mill become the reference.

The fish survey statistically compares indicators of reproduction, condition, growth, and survival of two species of fish exposed to effluent with the same indicators in unexposed fish collected from a reference area (Table 1). Mills that have an effluent concentration of less than 1% within 250 m of the point of effluent deposit are exempt from conducting a fish survey.

Table 1: Core Indicators for the Fish Survey

Measurement	Indicator
Gonad weight relative to body weight	Reproduction
Body weight relative to body length	Condition
Liver weight relative to body weight	Energy storage
Body weight relative to age	Growth
Age structure	Survival

Statistical differences in four core indicators between exposure and reference areas are used to quantify effects on the benthic invertebrate community (Table 2).

Table 2: Core Indicators for the Benthic Invertebrate Community Survey

Measurement	Indicator
Total abundance	Number of animals
Taxon richness	Number of taxa or kinds of animals
Simpson's evenness	Measure of how evenly the animals are distributed among the taxa
Bray-Curtis index	Measure of overall community composition

It is recognized that not all statistically significant differences are necessarily considered serious. Therefore, Environment Canada has adopted "critical effect sizes" (CES) to identify differences that could be important. These are shown in Table 3.

Table 3: Critical Effect Sizes for EEM for Pulp and Paper Mills

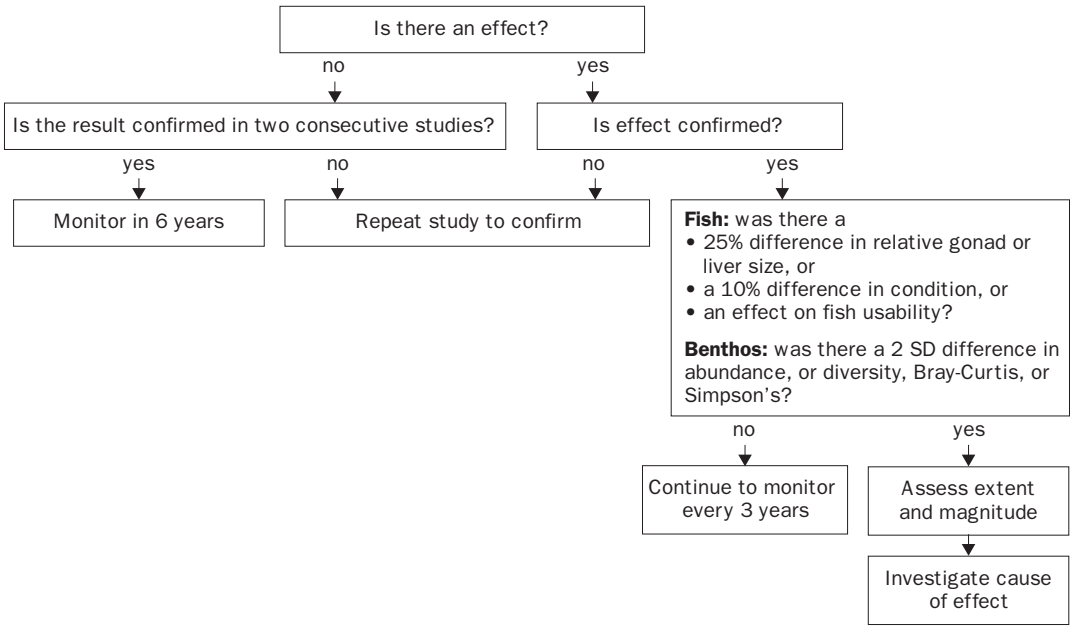
Parameter	Difference from reference	Parameter	Difference from reference
Fish populations		**Benthic communities**	
Relative gonad size	±25%	Total abundance	±2 SD
Relative liver size	±25%	Taxon richness	±2 SD
Condition	±10%	Simpson's evenness	±2 SD
		Bray-Curtis index	±2 SD

Note: Differences in fish population studies are expressed as a percentage (%) of the reference mean, whereas differences in benthic community surveys are expressed as multiples of within-reference-areastandard deviations (SDs).

The CES in Table 3 were developed after Cycle 2 data showed that most mills reported statistically significant effects in at least one of the core indicators. For fish, the CES were based on 1) the magnitude of observed pulp and paper mill effluent effects that were previously demonstrated in Canada and Sweden, 2) natural variations typically observed, and 3) the magnitude of effects observed in Cycle 2. For benthic invertebrate communities, the CES were also based on the magnitude of effects measured during Cycle 2, as well as the concept that effects exceeding the "normal range" of variability in reference areas are important (Lowell et al., 2005). The CES were developed to ensure that more extensive monitoring efforts are undertaken at the mills with the largest effects.

Figure 1 illustrates the sequence of events in the current pulp and paper EEM program and-includes the use of CES when determining the type and frequency of the biological monitoring studies.

Figure 1: Sequence of Events in Current Pulp and Paper EEM



Another requirement of the EEM program is for mills to conduct sublethal toxicity testing on their effluent twice per year. Sublethal toxicity tests measure the sublethal effects of pulp mill effluents on freshwater and marine organisms under controlled laboratory conditions. The sublethal toxicity testing evaluates the early life stage development of a fish, reproduction of an invertebrate, and algal growth inhibition and reproduction. The sublethal toxicity testing identifies the IC_{25}, which is the concentration of effluent that produces a response in the exposed organisms that is 25% inferior to that of the control organisms.

The EEM program has evolved since it was introduced in 1992 in response to experience by regulators and feedback from industry and other interested stakeholders. Through technical multistakeholder working groups, regulatory amendments, and updated technical guidance, the EEM program has been continuously reviewed and has evolved significantly since it began. The most extensive review occurred in 1996–97 following Cycle 1, and regulatory changes introduced decision trees and design changes to strengthen the program.

In parallel with the federal government initiatives, the provinces of British Columbia, Ontario, and Quebec passed new regulations dealing with pulp and paper mills. The province of Alberta also implemented new regulations affecting the permitting of mills, including application of best available technology. Under the provincial regimes, similar limits were set for dioxins, furans, BOD, TSS, and acute lethality. In some cases, provincial limits were more stringent than the federal limits. Some jurisdictions also included other parameters, such as adsorbable organic halides (AOX), in their regulations that were not part of the federal regulations. There are no equivalent provincial EEM programs; however, some provinces use the EEM information to inform permitting and other regulatory approaches, and many participate in an advisory role in the program.

3. Overview of Response to Regulatory Requirements

To comply with the federal and provincial requirements, most mills installed major pollution prevention measures and introduced secondary biological treatment. Chlorine bleaching mills also substituted chlorine dioxide for elemental chlorine to control chlorinated dioxin and furan releases.

The new regulations and permitting have led to vast improvements in effluent quality at pulp and paper mills. Despite tough economic challenges, the pulp and paper industry has made significant investments in pollution prevention and control equipment to meet the 1992 regulations. It was estimated that Canadian mills invested over $2.3 billion (1990$) in pollution prevention and control equipment in the period between 1992 and 1995. (Government of Canada, 2004)

As demonstrated in figures 2 and 3, releases of BOD, TSS, AOX, and chlorinated dioxins and furans have been significantly reduced compared with pre-regulatory levels.

Figure 2: Discharge Trend of BOD and TSS (1987–2003)

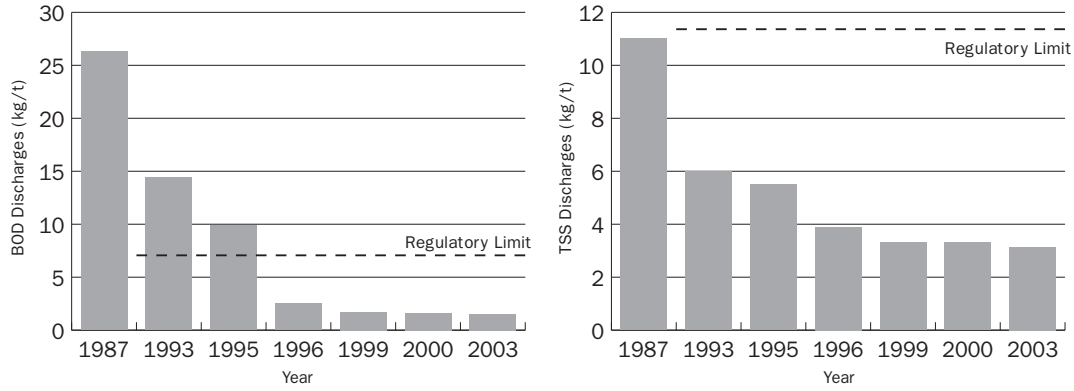
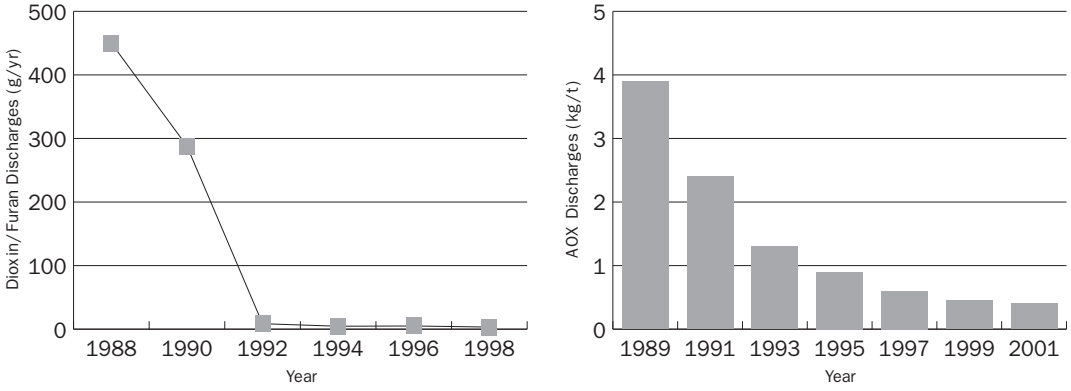


Figure 3: Discharge Trend of Dioxins/Furans (1988–1997) and AOX (1989–2001) (AOX data supplied by the Forest Products Association of Canada)



The PPER requirement that effluents not be acutely lethal to rainbow trout also showed significant improvement. Prior to the 1992 PPER, less than one-third of the discharged effluents tested in a year could meet this standard. By 2003, this had improved to 96% of the effluents tested.

Industry has now completed three full cycles of EEM monitoring. The cost of conducting the EEM studies is approximately $50 000–$200 000 per cycle per mill, or approximately $40 million to date. Cycle 1 studies were conducted, in some instances, while treatment systems were being constructed. During this construction period, some mills were granted authorizations that established interim, less stringent discharge limits and also set milestone dates for the completion of the mills' plans to achieve compliance with the full regulatory limits. These authorizations all expired on December 31, 1995. Therefore, Cycle 2 and Cycle 3 data are considered to reflect the effects observed in the receiving environment when the industry is in general compliance with the regulations.

4. Review of EEM Results

The Smart Regulation group members were not tasked with conducting an assessment of the EEM data. The group was presented with a review of the national assessment of the Cycle 2 and Cycle 3 EEM data (Lowell et al., 2005), which had recently been produced by the National EEM Office of Environment Canada. This national assessment provided the foundation for the group's discussions. The group reviewed the key outcomes of the national assessment to understand what effects had been observed in Cycle 2 and Cycle 3.

The analysis of the EEM data has provided a fairly robust picture of the effects of pulp and paper mill effluent on Canadian receiving waters. As described by Lowell et al. (2005), while the quality of effluent has dramatically improved, biological monitoring studies demonstrate that a number of mills continue to have some effect on their receiving environment. These effects were not always consistent from one cycle to the next for individual sites. Broadly speaking, the response measured for fish in both Cycles 2 and 3 in mills demonstrating effects were suggestive of nutrient enrichment and metabolic disruption. That is, exposed fish at some sites demonstrated evidence of increased food availability or food absorption (fatter, faster growing, with larger livers) but fewer resources allocated to reproduction (smaller gonads), in comparison with reference area fish (Lowell et al., 2005).

The response for benthic invertebrate communities in both Cycles 2 and 3 for mills demonstrating effects was generally indicative of eutrophication that ranged from mild to pronounced, depending, in part, on habitat type. More specifically, benthic invertebrate communities exposed to pulp mill effluent have commonly exhibited increases in abundance, together with some combination of increases, decreases, or no change in taxon richness, depending on the degree of eutrophication. Other observed benthic invertebrate responses suggested toxicity or smothering effects and were more frequently observed in marine environments.

Sublethal toxicity tests conducted under EEM showed clear improvements in effluent quality from Cycle 1 to Cycle 2, with, for the most part, no further changes in effluent quality in Cycle 3. These results are consistent with the results of BOD, TSS, and dioxin and furan levels in effluents presented above. While sublethal toxicity tests, like chemical analysis of the effluents, do provide information on effluent quality, the tests used are not intended to detect the most common effects observed through the EEM program, specifically effects of nutrient enrichment or decreases in fish gonad size in the receiving environment.

The Smart Regulation group members made a number of observations about the EEM program and its results based on their discussions of the general trends identified in the EEM Cycle 2 and Cycle 3 national assessment. These are described in Figure 4.

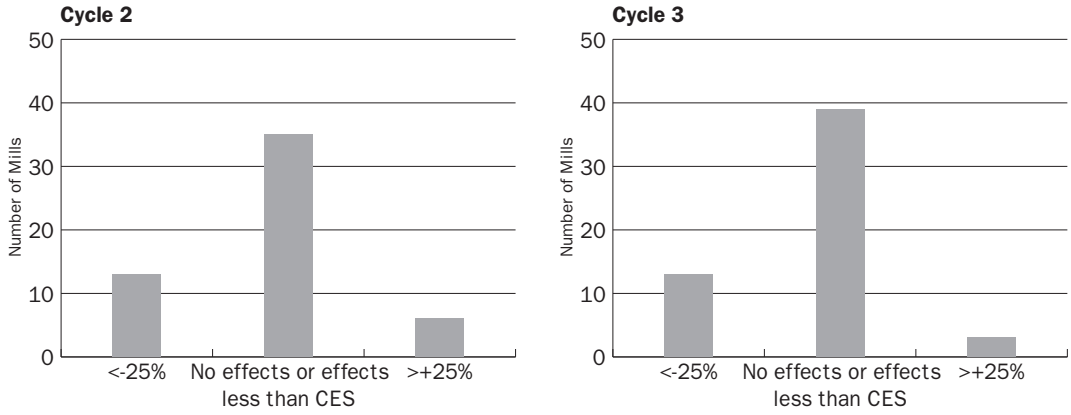
4.1 Fish Survey Observations

The group reviewed the data on condition factor, liver weight, and gonad size. While there were observed effects in all of these endpoints, the group felt that the priority focus should be on reduced gonad size. Reduced gonad size has been demonstrated to be a useful indicator of impaired fish reproduction in a variety of research studies on the environmental effects of pulp and paper mill effluents, which have been recently summarized by McMaster et al. (2003). Increases in fish condition were assumed to be related to nutrient enrichment, which is also assessed through benthic community monitoring. It was felt that addressing the observed effects in gonads and in the benthic invertebrate community may have multiple benefits and could address some of the observed effects in condition and, potentially, liver weight.

Figure 4 shows the number of mills that have demonstrated effects that exceed the CES for gonads, condition factor, and liver weight.

Figure 4: Mills Exceeding the CES for (a) Relative Gonad Size, (b) Condition Factor, and (c) Relative Liver Weight

(a) Relative gonad size



(b) Condition factor

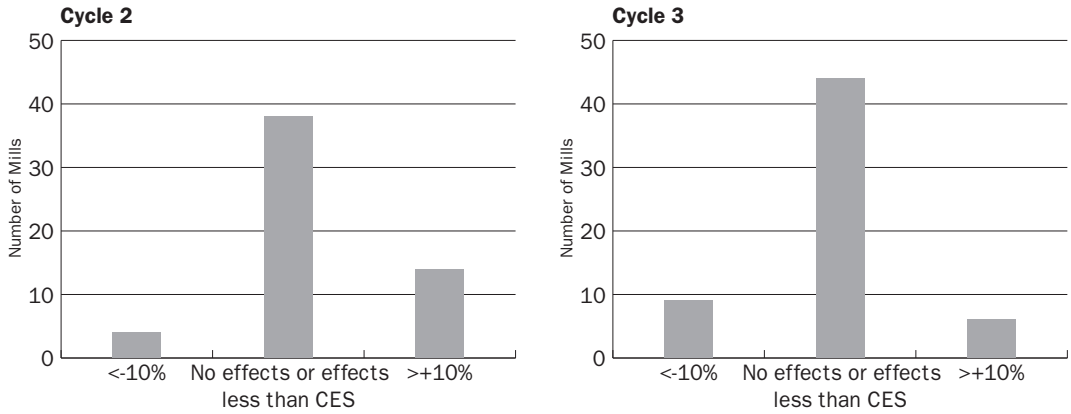
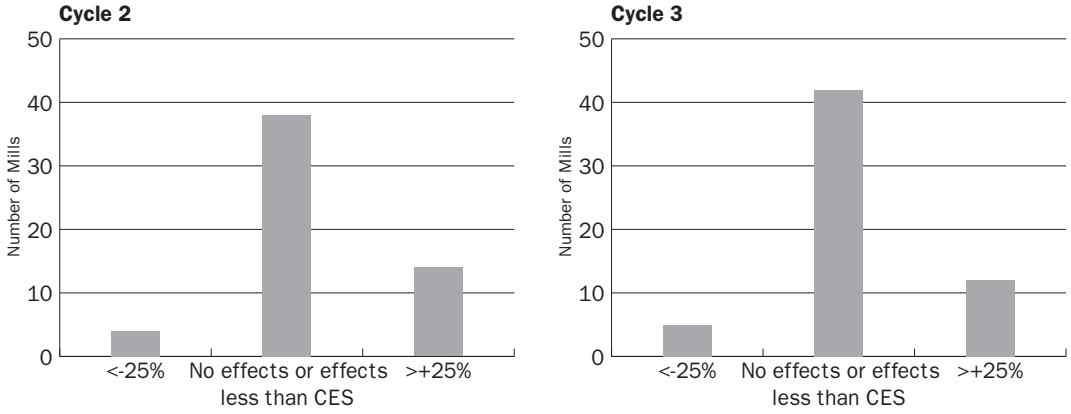


Figure 4: Mills Exceeding the CES for (a) Relative Gonad Size, (b) Condition Factor, and (c) Relative Liver Weight (continued)

(c) Relative liver weight



The Cycle 2 and Cycle 3 results demonstrated the presence of effects on fish reproduction based on the indicator of reduced gonad size (i.e. exceedance of the current 25% CES) in fish exposed to mill effluent at some sites. While the majority of mills in Cycle 2 and Cycle 3 did not exceed the 25% CES, the group observed that had the CES been 15%, many more mills would have demonstrated an effect that exceeded the CES.

The group did not review the data for the fish tissue analysis component of the biological monitoring studies. That component of EEM is targeted at a small number of mills in British Columbia, and there did not appear to be any broader issues related to improved effectiveness or efficiency questions.

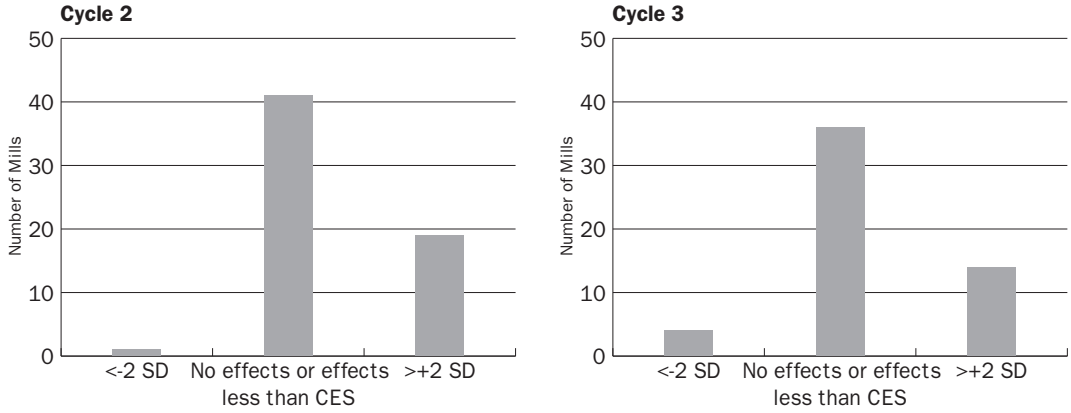
4.2 Benthic Survey Observations

The group reviewed the data on abundance and taxon richness. These two indicators of changes in invertebrate community structure and composition were examined in the national assessments by Environment Canada (2003) and Lowell et al. (2005). Total abundance is the total number of individuals of all taxonomic categories collected at a sampling station, expressed per unit area. Taxon richness is the total number of different taxonomic categories collected at a sampling station. The group did not review the data on Simpson's evenness or the Bray-Curtis index. To date, mills have not been required to submit these data, and these values have been calculated by Environment Canada. Starting in Cycle 4, mills will be required to report these parameters; however, they will not be used to direct mills to more focused monitoring (i.e. magnitude and extent and investigation of cause) until Cycle 6, after two consecutive cycles of use.

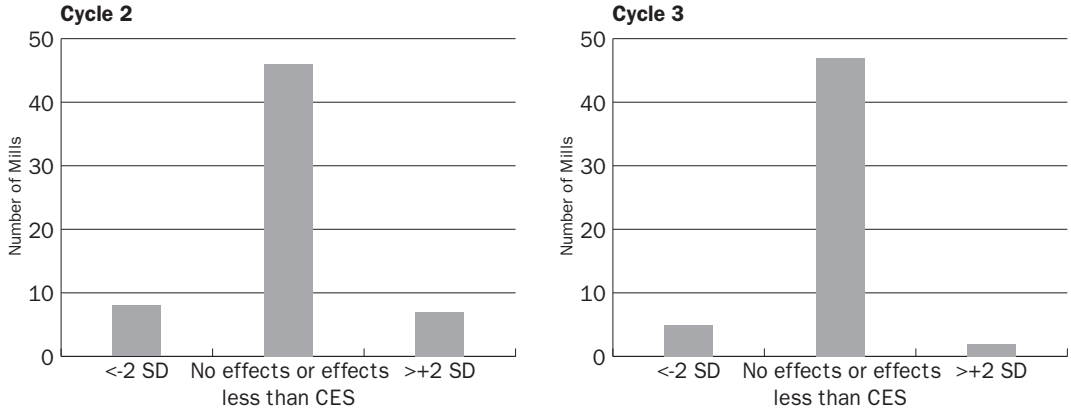
While the majority of mills showed either no effect or effects that were less than the CES for abundance and taxon richness, there were also many mills that demonstrated changes exceeding the CES, as shown in Figure 5.

Figure 5: Mills Exceeding the Critical Effect Size (CES) for (a) Abundance and (b) Taxon Richness

(a) Abundance



(b) Taxon richness



The Cycle 2 and Cycle 3 results of benthic abundance and taxon richness demonstrated eutrophication. Eutrophication is the process of over fertilization of a body of water by nutrients, which often results in excessive production of organic biomass and is typified by large numbers of benthic organisms and, when pronounced, few species. More pronounced eutrophication is commonly associated with decreases in taxon richness, even while abundance is still greater than that found in reference areas (Lowell et al., 2005). Eutrophication can be a natural process or it can be accelerated by an increase of nutrient loading to a water body by human activity.

The group observed that the causes of eutrophication are reasonably well understood. However, determining the significance of the observed effects and how best to mitigate them requires very site-specific analysis.

The group discussed the issue of differentiating between “pronounced” eutrophication and “moderate” or “mild” eutrophication. There was a general sense that mitigative action should be taken to address pronounced eutrophication, monitoring of the benthic community should continue for moderate eutrophication, and monitoring should be reduced

for cases of mild eutrophication. Although the group noted that it does not have the technical and scientific expertise to provide detailed recommendations on this, it did feel that the issue should be explored in the context of improving the effectiveness and efficiency of the program. Revisiting the CES could be a first step in this exploration.

*"One of the most important and interesting outcomes of the EEM Smart Regulations process that I foresee is the **cooperation** and **dialogue** between the different parties involved (federal and provincial governments, industry, ENGOs, First Nations and research institutes) in finding solutions to reduce the potential impact associated with liquid discharge into receiving water."*

Christian Turpin
Manager, Environment

5. Opportunities for Improvement

To the best of our knowledge, the EEM program was the first such program to be incorporated into a regulation anywhere in the world. There were very few precedents upon which the program could be designed. This has meant that there has been continuous learning and improvement of the program with each cycle.

5.1 Effectiveness

While it is clear that the program is effective in identifying effects in the receiving environment, which was its original intent, it is also clear from the comments received from Aboriginal and environmental groups that a redesign of the program could make it more effective in ensuring that the effects observed are addressed.

Based on its observations with respect to the results of the fish and benthic surveys, the Smart Regulation group believes that there is an opportunity to expand beyond monitoring and move towards solutions in two priority areas — small fish gonads and eutrophication. The group believes that:

- the occurrence of gonad effects observed in the EEM data for Cycles 2 and 3, in addition to the research conducted by the National Water Research Institute, industry, and academia, is sufficient to focus on a solution-oriented agenda to address decreases in gonad size;
- the industry can move towards solutions where monitoring indicates pronounced eutrophication; and
- to enable the shift to a solution-oriented agenda, it will be important that the EEM program encourages creative study designs and collaborative efforts to identify causes and solutions.

There is a major opportunity for pulp and paper mills to build on water quality performance improvements and to be proactive in addressing these two priority areas. These are anticipated to have multiple benefits and could help to mitigate observed effects on other EEM endpoints.

5.2 Efficiency

Based on its review of the EEM program and its results, the group has discussed opportunities to improve the program's efficiency by targeting resources towards areas of greatest environmental risk, as evidenced by observed effects on fish and benthos.

An important issue for the group was the pros and cons of comprehensive versus targeted monitoring. The current structure of the EEM program requires that mills need to show no statistical difference in all biological monitoring components (fish and benthos) in order to reduce the frequency of monitoring from every three years to every six years. The group observed that there were a number of mills showing no effects in one component of the biological monitoring study. These mills were required to continue to monitor all study components, even if effects had never been observed, rather than targeting resources where effects had been observed.

While this comprehensive monitoring strategy was useful in earlier stages of the EEM program, the group felt that it did not use resources efficiently, by not targeting resources towards effects that had been observed and confirmed. A key area of discussion was the opportunity to modify the EEM program decision tree to allow each of the biological monitoring components to be evaluated separately, or to "decouple" the fish and benthic surveys. On balance, the group felt that by evaluating these components separately, the program would be more efficient, as it would allow mills to target resources where they are needed to further explore an identified effect.

There was some concern expressed about whether the decoupling of benthic and fish components would lead to the loss of important information about the aquatic environment. This led to a broader discussion about the importance of developing "triggers" for mills with reduced monitoring requirements. These "triggers" would provide a less onerous but effective way to detect changes that could signal a problem in the aquatic environment and the need for a resumption of field monitoring.

The group also acknowledged the importance of CES in identifying important effects warranting more targeted investigation. Under the current structure, the CES are used to identify mills that require more focused study (i.e. magnitude and extent or investigation of cause), whereas mills that do not exceed the CES are assumed to continue routine monitoring. The group identified an opportunity to allow mills that are showing a statistical effect that is smaller than the CES to move to less frequent monitoring, while mills with effects greater than the CES would continue to move to more focused monitoring. However, the group also felt that further refinement of the currently recommended CES was needed for this process to be effective in targeting areas of highest potential risk. While there was recognition that the CES currently in use appear to be effective at detecting eutrophication-type responses, it was felt that the current CES of 25% for reduced gonad size may not be adequately capturing the range of mills with fish reproduction effects.

It was also felt that if mills showing effects less than the CES were allowed to reduce field monitoring, two conditions were necessary: 1) a set of relevant triggers needed to be developed to determine if a mill needed to resume field monitoring; and 2) a quality assurance and quality control (QA/QC) mechanism needs to be in place to ensure that data are adequate to assess the CES (e.g. some studies showing large effects that are not statistically significant due to small sample size and/or lack of reproducibility of results with same sex/species). This is in addition to the QA/QC mechanisms for study design and sample collection already present in the EEM program.

The group identified an important opportunity to improve efficiency by removing the current sublethal toxicity testing requirements. The group noted that the EEM program is designed to measure effects in fish, fish tissue, and the benthic invertebrate community, and, as such, only the results of the studies in the receiving environment are used to determine the next steps in the program. The current suite of tests has not been demonstrated to be predictive of the effects in the receiving water. Therefore, the results of the sublethal toxicity tests have been used primarily to assess effluent quality. While sublethal toxicity test results showed improvements in effluent quality between Cycles 1 and 2 in response to the regulatory amendment, no further change was seen between Cycles 2 and 3. Furthermore, there is no reason to expect any substantial changes in the results of sublethal toxicity tests in the future. In addition, it was noted that information on effluent quality is also available through other sources, specifically compliance effluent quality monitoring. As a result, the group felt that sublethal toxicity tests are not providing "value-added" information for decision-making *at this stage* in the EEM program and should be removed. However, the group also noted that a refined suite of tests may be useful in the future as a trigger for returning a mill to receiving environment monitoring, provided it could be demonstrated that the results of these tests are directly correlated to effects observed in the receiving environment.

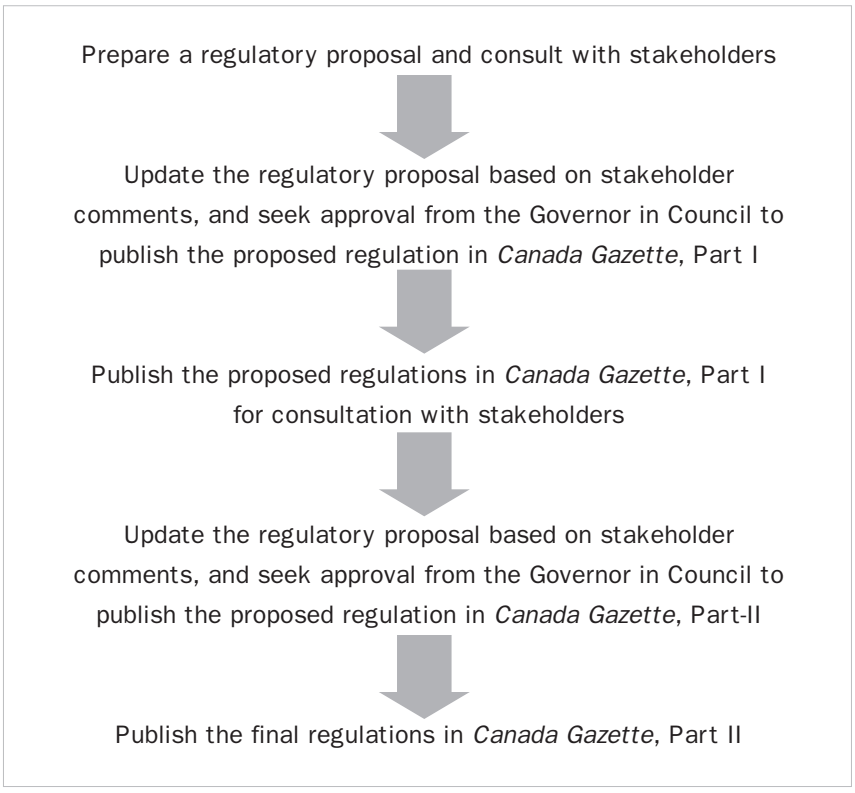
The group recognized a need to address as soon as possible the requirement for closed mills to conduct an EEM study. There was consensus within the group that conducting an EEM study at a permanently closed mill is not an efficient use of resources.

The group also identified that Environment Canada should provide more timely feedback on studies to mills before their design phase for the next cycle begins. A lack of timely feedback to the mills impacts the efficient and effective functioning of the EEM program. This may entail modifications to Environment Canada's review process if necessary to ensure that mills receive feedback on EEM reports in time to be of use in designing the next cycle.

6. Considerations for Changes to Regulatory Requirements

Given that the Smart Regulation group has identified a number of opportunities for improvements to the efficiency and effectiveness of the EEM program, the group has also considered the time constraints that will affect their implementation. The EEM requirements are contained in the PPER, and therefore many of the recommendations may require regulatory amendments. This process for making new regulations or for amending existing regulations has a number of steps, which are broadly outlined in Figure 6. Depending upon the complexity of the proposed changes to the regulations, the time required to complete a regulatory amendment can vary considerably (e.g. ranging from one to three years). A key element of the regulatory process is stakeholder consultation. While this adds considerable time to the regulatory process, the benefits of public engagement and feedback improve the quality of regulations. The timelines identified in the recommendations in this report reflect the mandate schedule associated with the regulatory process.

Figure 6: Broad Description of the Steps Involved in the Regulatory Process



7. Recommendations

"The recommendations developed through the smart regulation process will streamline the EEM requirements, and ensure the mill studies and Environment Canada research is focused on identifying and eliminating receiving water impacts."

Barry K. Firth
Weyerhaeuser

The following eight recommendations were developed to improve collaborative efforts to:

- address problems and track progress;
- improve the effectiveness of the EEM program by enabling mills to move more expeditiously to solutions where effects have been identified;
- improve the efficiency of the program by ensuring that monitoring effort is focused where it has most value, while maintaining confidence that aquatic environments remain protected; and
- ensure that the science and technology continue to advance in order to support solutions.

Recommendation #1

Environment Canada should establish a collaborative, open, and transparent mechanism whereby industry, federal and provincial governments, and non-governmental stakeholders work together to achieve continuous improvement of water quality where it is affected by pulp and paper mill activities. One task for this new mechanism will be to track implementation of the recommendations in this report.

Recommendation #2

Addressing the effects will require the development of new technology and approaches that do not currently exist. Environment Canada should show leadership in bringing together industry, academia, and other research interests to develop these technologies and approaches.

Recommendation #3

Environment Canada should take appropriate steps to enable maximum flexibility with respect to the design of investigation of cause studies and encourage cooperation across mills to generate the critical mass necessary for more effective studies and to reduce duplication of effort. Where regulatory changes are necessary to effect this, these should be completed by 2007 in advance of the Cycle 5 EEM studies.

Recommendation #4

Environment Canada should modify the EEM program to incorporate a new component, investigation of solutions, to enable mills that understand the cause of their effects to formally accelerate actions towards solutions. This should be completed by 2007 in advance of the Cycle 5 EEM studies.

Recommendation #5

Government and industry should work collaboratively and transparently to identify the cause of effluent effects on fish gonads and to find and implement solutions to address the cause:

- Government and industry should submit a public report in 2007 describing actions taken and money spent to identify the cause of decreased gonad size and explore solutions and to identify milestones for transparent tracking of this research.
- Industry should submit implementation schedules to address gonad effects by 2012.

Recommendation #6

Mills showing pronounced eutrophication (where the cause is already understood) must adopt best management practices as soon as possible — by 2010 at the latest. Industry should develop a "best practices" guide, track effectiveness in reducing eutrophication, and report on progress in 2007 and 2010. Environment Canada should recommend criteria and guidance for identifying areas of pronounced eutrophication.

Recommendation #7

Environment Canada should initiate a regulatory amendment process to amend the EEM program in advance of Cycle 5 EEM (2007) studies to address the following issues:

- decouple the benthic and fish surveys;
- remove the sublethal toxicity testing;
- ensure that closed mills are not required to undertake continued monitoring; and
- include provisions for a QA/QC mechanism on field monitoring studies to ensure that data are adequate to assess the CES.

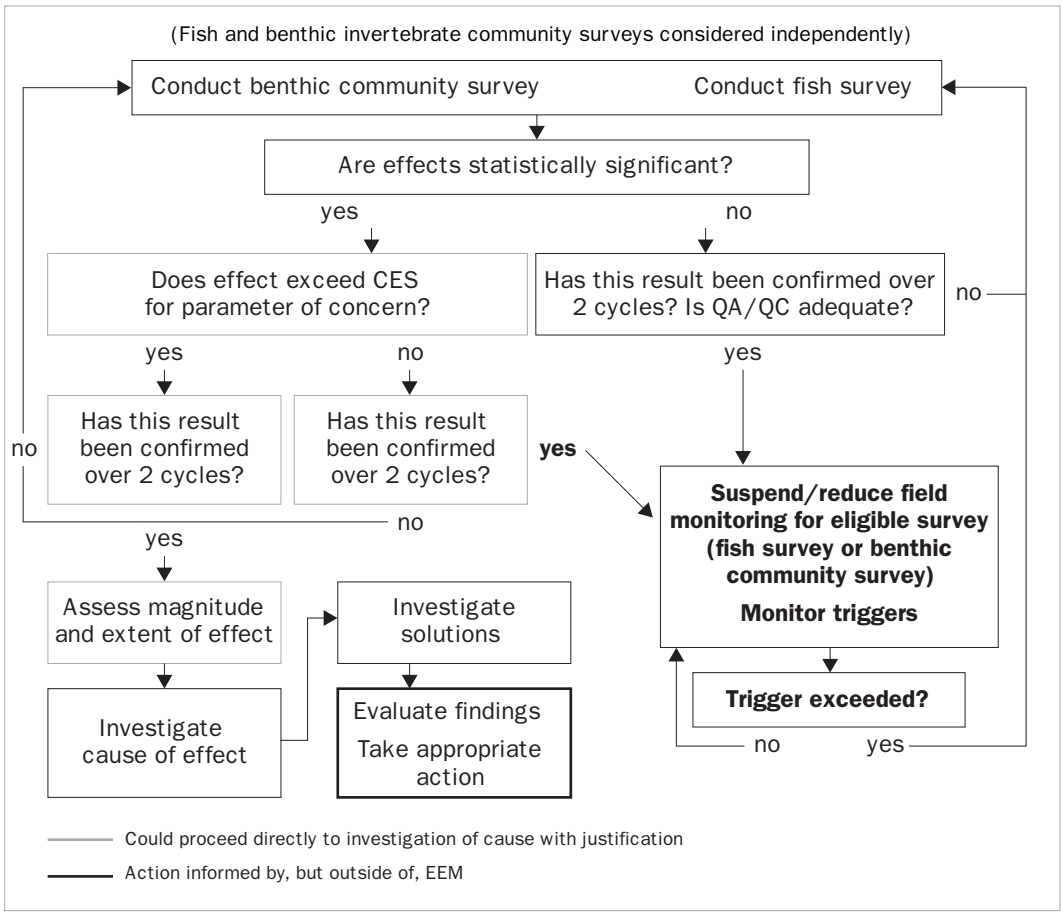
Recommendation #8

Environment Canada should initiate discussions now to explore more complex issues that could lead to regulatory amendments in advance of the Cycle 6 EEM studies. These include:

- strengthening the role of Critical Effect Size (CES) in focusing and accelerating action towards identification of cause and solutions and in improving efficient targeting of resources by identifying mills that could reduce monitoring frequency. This would include the following specific actions:
    - Review and update currently recommended CES to ensure adequacy in identifying effects/mills of most importance by 2006.
    - Develop provisions to allow mills to assess performance against updated CES and, in particular, to allow mills showing no effects or effects less than the updated CES to withdraw from field monitoring, conditional upon incorporation of “triggers” by 2007.
- developing a robust set of “triggers” by 2007 to incorporate into the EEM program to return mills to field monitoring.

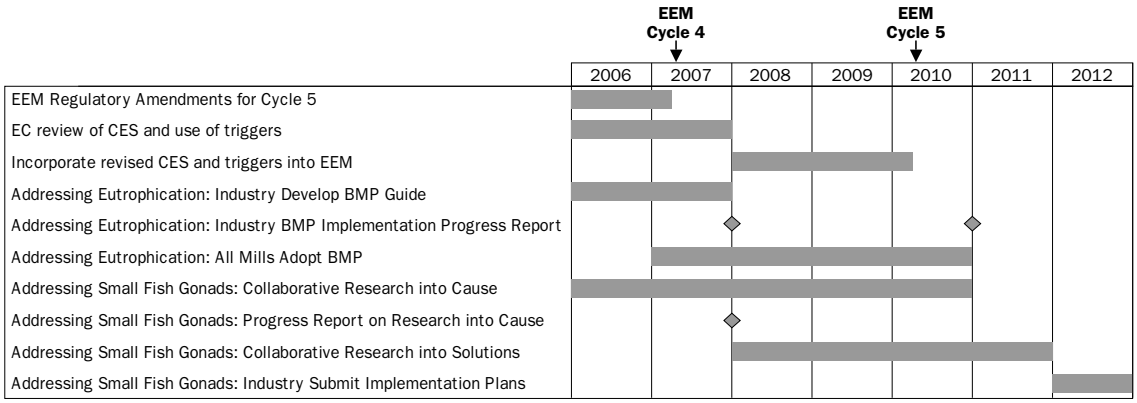
The group discussed the implications of the recommendations on the sequence of events in the EEM program. To illustrate what the program could look like if the recommendations were implemented, the group developed the decision tree in Figure 7 to reflect how a revised EEM program could function.

Figure 7: Illustrative Sequence of Events for Pulp and Paper Environmental Effects Monitoring (EEM) that Could Result from the Implementation of Recommendations



More generally, the group discussed the overall timeline associated with the recommendations. The chart below illustrates this timeline.

Figure 8: Illustrative timeline for report recommendations



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