Environment Canada Environnement Canada

STATUS REPORT on the *Pulp and Paper Effluent Regulations*

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Forest Products and Fisheries Act Division
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REVIEW NOTICE

The information used in this report was submitted to Environment Canada by regulated pulp and paper mills and off-site treatment facilities as required under section 7 of the *Pulp and Paper Effluent Regulations* (PPER) pursuant to the *Fisheries Act*.

Environment Canada compiled this report to inform the regulated community, other stakeholders and the interested public on the PPER, for informational purposes only. For all purposes of interpreting and applying the law, users should consult the PPER, as registered by the Clerk of the Privy Council and published in Part II of the *Canada Gazette*.

ABSTRACT

The *Pulp and Paper Effluent Regulations* (PPER) pursuant to the *Fisheries Act* govern the discharge of deleterious substances into waters frequented by fish. The PPER have the overall objective of protecting water quality that sustains fish, fish habitat and the use of fisheries resources. The purpose of the *Status Report on the Pulp and Paper Effluent Regulations* is to present a brief history of the PPER since its inception, provide an overview of the main requirements of the Regulations, and summarize the results achieved under the Regulations.
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EXECUTIVE SUMMARY

Significant improvements in pulp and paper mill effluent quality have been achieved since the *Pulp and Paper Effluent Regulations* (PPER) were first published in 1971. Over the years, amendments to the regulations, additional federal regulations for the sector, cooperative work between federal and provincial governments, and feedback from industry, academia, and non-profit research and environmental groups contributed to enhanced protection of the aquatic environment. Building on this record of improvement, the Government of Canada continues to strive for the most effective and efficient regulatory framework.

History of the PPER

The PPER govern the discharge of deleterious substances from pulp and paper mills into water frequented by fish, with the overall objective of water quality that sustains fish, fish habit and the use of fisheries resources.

In 1971, pulp and paper became the first regulated sector under the *Fisheries Act*. The 1971 PPER were intended to control discharges of deleterious substances and reduce the effects on fish and fish habitat that had been observed at mills across Canada at that time. Problems were linked to deposits of effluents containing large quantities of suspended and dissolved solids. The solids settled on the beds of water bodies, forming decomposing fibre mats, destroying spawning beds and essential organisms on which fish feed. Dissolved materials served as food for natural micro-organisms and, in turn, their growth and proliferation depleted dissolved oxygen vital to aquatic life. In addition, concentrations of many substances in mill effluents were toxic to fish and other aquatic life.

The 1971 PPER set limits on the amounts of total suspended solids (TSS) and biochemical oxygen demanding (BOD) matter, and prohibited deposits of effluents that displayed acute lethality to fish. The limits applied to mills commencing operation after the coming into force period of the Regulations, and served as non-enforceable guidelines for mills already in operation.

By the late 1980s, Environment Canada had determined that the 1971 Regulations had not yielded all of the desired effluent quality improvements. The Government amended the PPER in 1992 to introduce: enforceable effluent quality standards for all mills based on standards achievable using secondary wastewater treatment; a requirement for all mills and off-site treatment facilities (OSTFs) to produce effluents that are not acutely lethal to Rainbow Trout; and a requirement for all mills and OSTFs to conduct comprehensive Environmental effects monitoring (EEM) studies.

Further amendments in the 2000s clarified and streamlined monitoring and reporting requirements, and added EEM requirements to investigate the cause(s) of and solution(s) to adverse environmental effects associated with pulp and paper effluents.

Effluent Quality and Compliance

Discharges to water and the rate of compliance with the Regulations have improved considerably since the 1970s. Comparing data from 1970 and 2008, total discharges of

TSS and BOD matter decreased by approximately 90% and 97%, respectively. Compliance also showed marked improvements for acute lethality testing, increasing from a pass rate on the order of 25% in 1985, to a 78% pass rate in 1996, and a 97.4% pass rate by 2008. Early improvements to effluent quality came largely from the addition of primary effluent treatment systems, such as clarifiers and settling basins, at most mills across Canada. To comply with the 1992 PPER, most mills also found it necessary to implement secondary biological treatment, which contributed to further reductions, especially for BOD matter.

Environmental Effects Monitoring

EEM is a science-based performance measurement tool used to collect information to be used in assessing the effectiveness of the PPER in achieving its objective of protecting water quality that sustains fish, fish habitat, and the use of fisheries resources. The EEM requirements in the PPER consist of sublethal toxicity testing of mill effluent, biological monitoring studies conducted in the receiving environment, and investigations of the cause(s) of and solution(s) for environmental effects associated with mill effluent. Ongoing analysis of EEM data has led to continuous improvements in the EEM requirements, both through policy decisions and periodic amendments to the Regulations.

Biological monitoring studies are conducted to assess and investigate effects in three components: fish health, fish habitat and human usability of fisheries resources. In general terms, if biological monitoring data collected in an area exposed to mill effluent are statistically different from data collected in a similar area not exposed to mill effluent, the mill's effluent has an effect on fish health and/or habitat. For human usability of fisheries resources, fish tissue data from the exposure area are assessed against an established threshold for chlorinated dioxins and furans.

Data from four cycles of EEM have been analyzed to discern national patterns. The data show that although there is little to no impact on the use of fisheries resources, some effluents appear to continue to cause effects on fish and/or fish habitat. On a national basis, the prevalent effect on fish is associated with nutrient enrichment (of the receiving environment), sometimes combined with reduced fish gonad size (with possible disruption to reproduction). For benthic invertebrate communities, the prevalent effect is associated with eutrophication from nutrient enrichment.

Moving Forward

Mills with confirmed effects are currently conducting investigations to determine causes and identify possible solutions to eliminate the adverse effects associated with their effluent. Completion of these studies will represent a major milestone in the history of the PPER. The results, along with social, economic, and other technical information, will be taken into consideration by Environment Canada as part of next steps.

1.0 INTRODUCTION

The *Fisheries Act* provides the primary legislative authority for federal water pollution control programs in Canada, with subsection 36(3) prohibiting the deposit of deleterious substances[1] into waters frequented by fish, unless authorized by regulations. The pulp and paper sector was the first industry regulated under the Act through the promulgation of the *Pulp and Paper Effluent Regulations* (PPER) in 1971.

In its 40-year history, the PPER have led to significant effluent quality improvements. The 1971 PPER established the first effluent limits and guidelines for pulp and paper effluent deposits, and major amendments over the years, starting in 1992, led to important changes within the sector, such as the adoption of enhanced wastewater treatment technologies and improved management and operational practices. These changes contributed to reductions in deposits of the prescribed deleterious substances. Furthermore, the environmental effects monitoring (EEM) requirements introduced in 1992 provided a science-based approach to collect information to be used in assessing the effectiveness of the PPER in achieving its objective of protecting water quality that sustains fish, fish habitat, and the use of fisheries resources. The addition of EEM requirements to investigate causes (added in 2004) and solutions (added in 2008) for environmental impacts associated with mill effluents has provided, and will continue to provide, additional useful information to help improve the protection of aquatic receiving environments.

This report presents a brief history of the PPER, an overview of the main requirements under the Regulations, and the results of effluent quality testing and EEM findings over time.

[1] Deleterious as defined in the *Fisheries Ac*t in subsection 34(1).

2.0 EVOLUTION OF THE PPER

2.1 1971 *Pulp and Paper Effluent Regulations*

Efforts to address pulp and paper mill effluents in North America and Scandinavia were initiated in the 1960s as a result of concerns related to effluent quality and impacts on the environment. At the same time, in the United States the Environmental Protection Agency passed guidelines for biochemical oxygen demand (BOD) and total suspended solids (TSS) based on median performance of secondary wastewater treatment systems. Those guidelines were incorporated as limits in mill permits.

In Canada, the *Fisheries Act* was revised in 1970 to allow for national regulations to control discharges to the environment. In 1971, pulp and paper became the first regulated industrial sector, upon promulgation of the PPER.

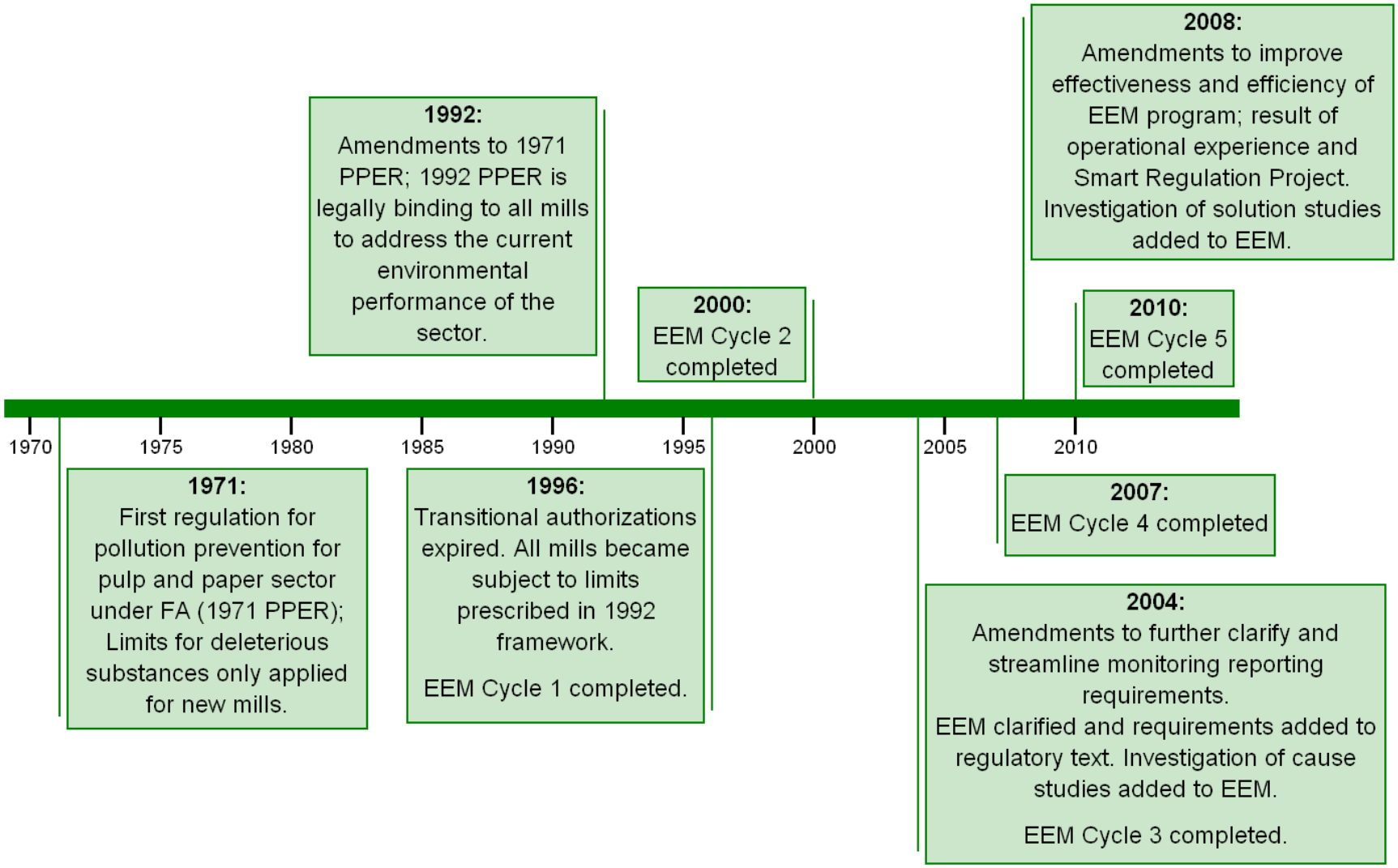
Pre-1971 data revealed that mill effluents contained many substances able to cause deleterious effects in receiving waters. Effects at individual sites varied according to the quantity and quality of the discharges, and the dilution capacity (i.e., flow, size) of the receiving waters. Problems seen at some sites included large areas of decomposing fibre mats, large expanses of water with little or no dissolved oxygen, and concentrations of effluent constituents toxic to fish, even after dilution.

To manage these problems, the 1971 PPER set mass-based limits for deposits of TSS and BOD matter, and prohibited the release of effluents that were acutely lethal to fish. The Regulations were designed to encourage mills to modify their processes in order to improve water quality and protect fish, fish habitat and the use of fisheries resources.

The 1971 PPER differentiated between new, expanded, altered and existing mills. New, expanded and/or altered mills were subject to the prescribed limits. For mills already in operation, the limits served as non-enforceable guidelines. This distinction was included because new mills could cost-effectively incorporate modern pollution prevention-based production technologies and effluent treatment systems, at the design stage, whereas most existing mills faced high costs to install effluent treatment systems.

Figure 2.1 provides an historical timeline of the evolution of the PPER, highlighting key points in its development. The sections that follow provide further details.

Figure 2.1: Evolution of the *Pulp and Paper Effluent Regulations*



2.2 1980 to 1990 – A New Regulatory Framework Was Required

In the late 1980s, the pulp and paper industry was still facing environmental scrutiny as a result of its effluent releases. Canada, along with the United States and other countries, began updating its respective regulatory regimes. Environment Canada analyzed the impacts of the 1971 PPER, and determined that the Regulations had not yielded the desired level of effluent quality improvements.

In 1985, about 25% of mills were meeting the requirement for effluents to be non-acutely lethal to Rainbow Trout.[2] These mills included mostly new and expanded mills, as designated under the Regulations, and a small proportion of the older and unregulated mills. In addition, about 60% of mills were in compliance with the prescribed limits for TSS and 68% for BOD.[3]

The 1971 PPER were legally binding only for new, expanded and altered mills, which was a key limiting factor to achieving improved effluent quality across the sector. New mills accounted for only approximately 10% of all operating mills at that time. The applicability of the 1971 PPER to expanded or altered mills was difficult, as it was unclear if the Regulations applied only to the expanded or altered portion of the facility or to the whole mill. The absence of mandatory requirements for existing mills and the lack of clarity for expanded and altered mills had led to disappointing levels of effluent quality improvement by that portion of the sector. Furthermore, the BOD limits set out in the 1971 PPER were high when compared to what was possible with enhanced wastewater treatment systems. Thus, there was a need to amend the 1971 PPER to drive further effluent quality improvements.

2.3 1992 PPER

In 1992, after extensive consultations, a new federal framework for pulp and paper effluents was completed. The 1992 PPER were registered on 7 May 1992. Among the many improvements, the 1992 PPER introduced the following:

- Enforceable effluent quality standards for all mills and off-site treatment facilities (OSTFs) based on standards achievable using secondary wastewater treatment
- A requirement for all mills and OSTFs to produce effluents that are not acutely lethal to Rainbow Trout
- A requirement for all mills and OSTFs to comply with comprehensive EEM requirements

In 1998, the United States Environmental Protection Agency (EPA) passed rules for water and air quality for the pulp and paper sector that were implemented through permits and which reshaped the existing instrument, as the 1992 PPER did in Canada.

2.4 Expiration of Transitional Authorizations (TAs) in 1996

For most of the mills commissioned before 1971, major upgrades to manufacturing processes and effluent treatment systems were required in order to achieve compliance with the 1992 PPER. Mills required time to design and install the necessary equipment to

[2] Rainbow Trout is the fish species used to test for acute lethality in Environment Canada's standard test method.
[3] BOD limits in the 1971 PPER only applied to mills with chemical pulping processing (i.e., 64% of mills operating in 1985).

meet the new regulatory requirements. Therefore, the 1992 PPER included a system of transitional authorizations (TAs) that set interim limits and binding construction milestones on a site-specific basis. The conditions and duration of TAs were based on evaluations of the abatement plans that mills were required to submit. Individual TAs expired by December 31, 1995 or earlier, and on January 1, 1996 all mills in Canada became subject to the new limits. The use of TAs in the 1992 PPER was a novel concept at the time, and allowed for incremental progress toward achieving the ultimate regulatory limits.

2.5 Amendments in 2004

The 2004 PPER amendments were the result of a review of the 1992 PPER, including EEM requirements, conducted by Environment Canada in consultation with Fisheries and Oceans Canada as well as stakeholders. The 2004 PPER amendments were aimed at streamlining and improving the clarity of the Regulations to make compliance and enforcement more practical. The amendments focused mainly on monitoring and reporting requirements under the EEM program, but did not change the fundamental requirements of the Regulations. Changes included the following:

- Less prescriptive requirements for how EEM studies were to be conducted
- A requirement that EEM studies be performed and reported in accordance with "generally accepted standards of good scientific practice"
- Additional EEM requirements for mills to investigate the cause(s) of environmental effects associated with their effluents

2.6 Amendments in 2008

The 2008 PPER amendments also focused on the EEM requirements and were the result of operational experience gained through implementing those requirements, as well as feedback from the Smart Regulation Project (for further information, refer to Section 5.2.3). The amendments were designed to improve the effectiveness and efficiency of the EEM requirements. The significant changes included the following:

- An additional EEM requirement for mills to investigate solutions to eliminate environmental effects associated with their effluents
- Suspension of EEM at mills that have ceased production for at least eight consecutive months
- Streamlining of requirements for sublethal toxicity testing, biological monitoring studies, and assessments of the magnitude and extent of observed effects

3.0 OVERVIEW OF REQUIREMENTS UNDER THE PPER

Overview of the *Pulp and Paper Effluent Regulations*		
Application	• **All "mills" in Canada** – a factory (or complex of factories) that is designed or used to produce pulp or paper products. • **Off-site treatment facilities** – facilities that treat wastewater from a mill but are neither owned nor operated by the owner of a mill, and where a threshold for BOD loading is met.	
Prescribed Deleterious Substances	BOD matter Suspended solids (measured as TSS)	For both BOD matter and TSS: • Maximum daily and monthly limits for a facility discharging directly to water (quantities from each outfall structure[4] are summed) • Limits are based on a calculation using the mill's "reference production rate" • Mills may apply to exceed these limits in certain circumstances and must provide Environment Canada with specific additional information
	Acutely lethal effluent	• Acute lethality tests must be conducted using Rainbow Trout • Effluent must not be acutely lethal to Rainbow Trout for a facility discharging effluent directly to water
Production and Effluent Monitoring		
Production and Reference Production Rate	• Mills must report the quantity of finished product produced each daily period • Reference Production Rate (RPR) – used in the calculation to determine the maximum quantities of BOD matter and TSS that may be discharged. RPR is the highest value of the 90th percentile of daily production for the previous 3 years. Mills must provide their RPR to Environment Canada.	
BOD and TSS Monitoring	• BOD tests – at least three times a week for each outfall structure discharging directly to the environment • TSS tests – every day for each outfall structure discharging directly to the environment • Effluent concentrations are multiplied by effluent flow rate to determine quantities deposited • Exceedances of maximum limits must be reported to Environment Canada without delay • Reduced monitoring – testing at a reduced frequency of once per month for an effluent that is not acutely lethal and has BOD and TSS concentrations below certain levels or an effluent that is solely composed of non-contact cooling water	
Acute Lethality Testing	**Rainbow Trout** • Acute lethality testing – once a month for each outfall structure discharging directly to water using Environment Canada's Reference Method EPS 1/RM/13	

[4] An "outfall structure" is a conduit or other structure (such as a pipe) through which effluent is conveyed to the location where it is deposited.

	• Test Failures: o Failures must be reported to Environment Canada without delay o Facility must increase testing frequency to once a week o Monthly testing resumes once effluent passes three consecutive weekly tests
Effect on *Daphnia magna*	• Effect on *Daphnia magna* tests – once per week for each outfall structure discharging directly to the environment using Environment Canada's Reference Method EPS 1/RM/14 • Test Failures: o Failures must be reported to Environment Canada without delay o Facility is required to conduct an acute lethality test on Rainbow Trout unless the sample in question was already tested o If the acute lethality test using Rainbow Trout demonstrates the sample is non-acutely lethal, no further testing is required o If, on the other hand, the sample proves to be acutely lethal to Rainbow Trout, Rainbow Trout acute lethality testing must be carried out weekly until three consecutive weekly tests are passed as described above
Flow and Loading	• Installing, maintaining and calibrating monitoring equipment • Submit information on outfall structures and deposit effluent only through those outfall structures • Volume of effluent from each outfall structure must be measured each day • Flow measurements and BOD and TSS concentrations are used to calculate daily mass loadings from each outfall structure • Results for each outfall structure are summed to calculate total daily and monthly mass loadings of BOD matter and TSS • Mills cannot combine: o Any treated effluent with water before the treated effluent is deposited o Any treated effluent with any other effluent unless both effluents are not acutely lethal, or if the mill is given an authorization to combine effluents
Preparation of Plans	• Preparing and updating annually a remedial plan describing the measures to be taken by the operator to eliminate unauthorized deposits of deleterious substances in the case where effluent fails an acute lethality test • Preparing an emergency response plan and making it readily available on-site to persons who are to implement the plan
Reporting	• Monthly reports or annual reports (depending on the point of deposit) must be submitted to the Authorization Officer[5]. The report includes monitoring results and production information. • Reports are submitted in written or electronic format, depending on the province
Compliance and Enforcement	• Enforced by Environment Canada in accordance with the *Fisheries Act* and Environment Canada's Compliance and Enforcement Policy for Habitat Protection[6] • Inspectors abide by the requirements of the PPER and Compliance and Enforcement Policy, which sets a range of possible responses to offenses, including warnings, inspector's directions, ticketing, ministerial orders, injunctions, prosecution and civil suits by the Crown for the recovery of costs

[5] The "Authorization Officer" is the designated official listed in Schedule V, Column II of the PPER, and is responsible for various tasks necessary for the implementation of the Regulations. These responsibilities are clearly indicated throughout the Regulations and include issuing authorizations, receiving regulatory information and monthly monitoring reports.
[6] Environment Canada's *Compliance and Enforcement Policy for Habitat Protection*: http://www.ec.gc.ca/alef-ewe/default.asp?lang=en&n=D6B74D58-1

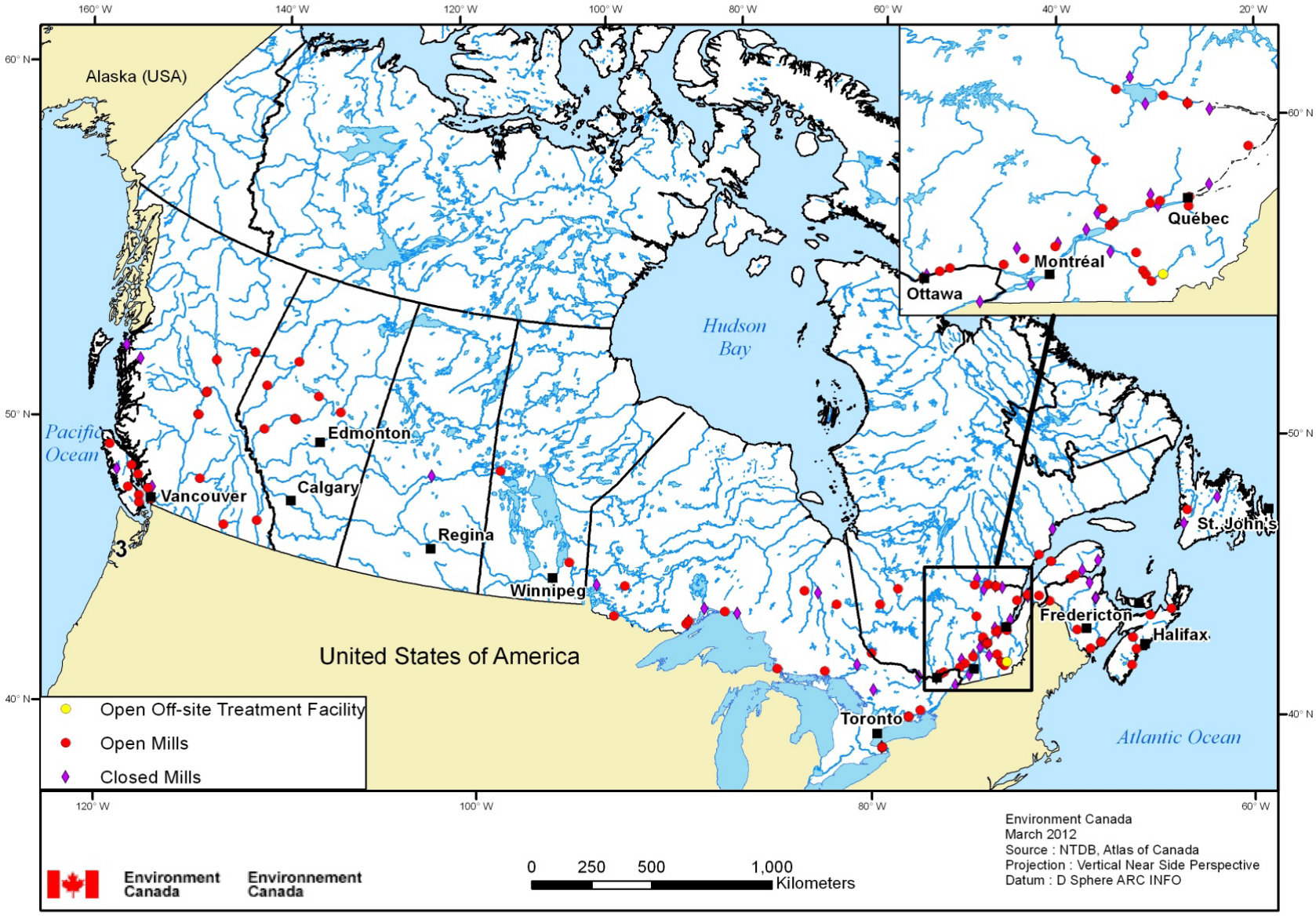
Environmental Effects Monitoring Requirements	
Overview	• EEM includes sublethal toxicity testing of effluent, and biological monitoring studies • EEM consists of cyclical monitoring and interpretation phases designed to assess and investigate the impacts on the same parameters and locations. In this way, both a spatial characterization of potential effects and a record through time to assess changes in receiving environments are obtained
Sublethal Toxicity Testing	• Conducted twice a year using effluent from the outfall structure that is anticipated to have the most adverse environmental impact • The tests measure survival, growth and/or reproduction endpoints in marine or freshwater plant and invertebrate organisms in a controlled laboratory environment
Biological Monitoring Studies	• Studies are conducted in three or six-year cycles • Requirements for each study depend on results from the previous cycle • Fish population and benthic invertebrate community studies are completed in exposure and reference areas. Fish tissue studies are done in exposure areas. • To assess and confirm effects, studies are conducted on three components: o Fish population to assess effects on fish health o Benthic invertebrate community to assess effects on fish habitat o Fish tissue (dioxins and furans) to assess the human usability of fisheries resources • To investigate effects, studies are conducted to: o Describe the magnitude and geographic extent of effects o Determine the causes of effects o Identify possible solutions to eliminate effects
Defining and Confirming Effects	• The PPER defines an effect for indicators in each of the three components (fish, benthos, fish tissue) and prescribes the data assessment required for specific indicators • To establish if there are effects, data collected on specific effect endpoints are assessed for statistical differences between exposure and reference areas • To confirm that an observed effect is in fact mill-related, studies are repeated in subsequent cycles. If the same effect is observed in consecutive cycles, the effect is considered “confirmed” o If a lack of effects is confirmed, mill proceeds to a reduced monitoring schedule o If effects are confirmed, mill proceeds to investigate effects in subsequent cycles
Magnitude and Geographical Extent of Effects	• A description of the magnitude and geographic extent of the effect is required for confirmed effects • Additional monitoring may be required if data from previous studies are insufficient
Investigation of Cause (IOC)	• If the most recent study indicates the magnitude and geographic extent of a confirmed effect, and the cause of the effect has not yet been identified, an IOC study is required • Goal – to understand the cause of the confirmed effect(s) and progress to investigating possible solutions
Investigation of Solution (IOS)	If the most recent study indicates the cause of the effect, and a possible solution(s) has not yet been identified, an IOS study is required

4.0 NATIONAL PERFORMANCE SUMMARY

This section provides a national-level summary of performance under the PPER since its inception. Data from the years 1970, 1987, 1996, 2003 and 2008 are included to represent effluent quality at key points in the evolution of the Regulations. Section 4.1 examines reductions in total discharges of TSS and BOD matter to water over time. Section 4.2 discusses regulatory performance in the context of total and individual mill discharges of TSS, BOD matter and acute lethality testing.

Figure 4.1 shows the locations of all pulp and paper mills and OSTFs in Canada that are or have been subject to the PPER since 1971, and that deposit effluent directly into water. In 1970 there were 119 mills in operation for which Environment Canada has historical data. In 2008, 103 mills and 1 OSTF were subject to the Regulations and were depositing effluent directly to water.

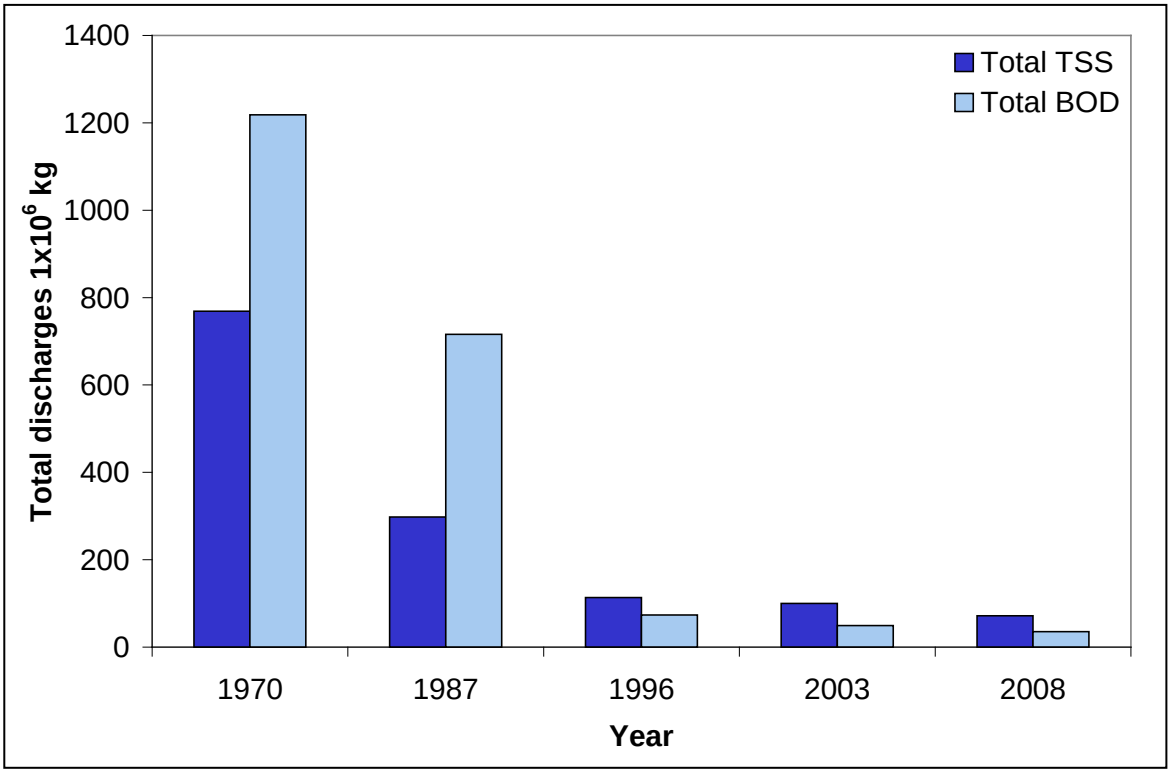
Figure 4.1: Pulp and Paper Mills in Canada, as of 2011



4.1 Total TSS and BOD Matter Discharges to Water

Figure 4.2 depicts the estimated total annual quantities of TSS and BOD matter deposited into the environment (total discharges) for the years 1970, 1987, 1996, 2003 and 2008, on a nationwide basis.[7]

Figure 4.2: Total Annual Discharges of TSS and BOD Matter ($1x10^6$ kg/year)[8]



The data from 1970 illustrate conditions prior to the promulgation of the 1971 PPER. Between 1970 and 1987, the total discharges of TSS and BOD matter decreased by approximately 60% and 40%, respectively. These improvements came largely from the addition of primary effluent treatment systems, such as clarifiers and settling basins, at most mills across Canada. In-plant pollution prevention measures, such as replacement of wet debarking by dry processes and the use of in-plant screening to recover fibre losses, also helped and improved mill economics at the same time.

Discharge data from 1987 illustrate conditions prior to implementation of the current regulatory limits (i.e., the 1992 PPER). By 1996, all mills in Canada were subject to the limits of the 1992 PPER, as all TAs had expired. Between 1987 and 1996, total discharges of TSS and BOD matter to water decreased by approximately 60% and 90%, respectively. The improvements are directly linked to the fact that most mills

[7] For 1970 and 1987, available data records are limited to "average daily discharge." As such, total annual discharges were estimated assuming that mills were discharging 365 days of the year.

[8] In figures 4.2 – 4.5 the data represent 119 mills in 1970, 122 mills in 1987, 128 mills and 2 OSTFs in 1996, 115 mills and 2 OSTFs in 2003, and 103 mills and 1 OSTF in 2008.

implemented secondary biological treatment systems in order to meet the requirements of the 1992 PPER; this was the key factor for effluent quality improvements in this time period, especially for BOD matter discharges.[9]

Between 1996 and 2008, total TSS and BOD discharges to water remained relatively stable, as mills had already undertaken the major capital investments needed to meet the 1992 PPER.

4.2 Compliance with PPER Limits

During the life of the 1971 PPER (i.e., 1971 to 1992), a number of periodic conformance assessments were conducted. A 1985 Environment Canada survey showed only modest improvements in effluent quality, with about 25% of the mills meeting the provisions for non–lethal effluent, 68% for BOD matter and 60% for TSS. The survey also revealed that the use of secondary biological treatment was common at mills that met the requirements for all three parameters. These findings influenced the design of the 1992 PPER.

Compliance results subsequent to 1996 show marked improvements from the earlier regime, as illustrated in Table 4.1. For example, in 2008 the industry achieved compliance rates of 97.4% for acute lethality tests and 99.9% for BOD and TSS tests across Canada.

Table 4.1: PPER Compliance – Percentage of Passed Tests[10]

Test	1996	1998	2000	2002	2003	2008
Non-acute lethality	78.0%	90.4%	94.9%	95.9%	96.4%	97.4%
BOD	97.8%	99.7%	99.8%	99.9%	99.9%	99.9%
TSS	99.7%	99.9%	99.8%	99.9%	99.9%	99.9%

Figures 4.3 and 4.4 depict the average daily TSS and BOD matter discharges per tonne of mill production for the years 1970, 1987, 2003, 1996 and 2008, on a facility-by-facility basis (i.e., each X depicts a facility in operation at that time). The maximum monthly average limits for TSS and BOD matter (starting in 1992) are 11.25 kg/tonne of production and 7.5 kg/tonne of production, respectively.[11] Note the decreasing spread between individual mills over time as compliance was achieved.

[9] Secondary biological treatment uses micro organisms to breakdown dissolved solids and toxic components by converting them into fine biosolids.

[10] Percent compliance was calculated by taking the total number of tests passed for all mills divided by the total number of tests conducted for all mills multiplied by 100%.

[11] Note that some mills have authorizations to exceed the maximum loading limits under certain conditions as described in the Regulations.

Figure 4.3: Average TSS Discharges per Tonne of Production

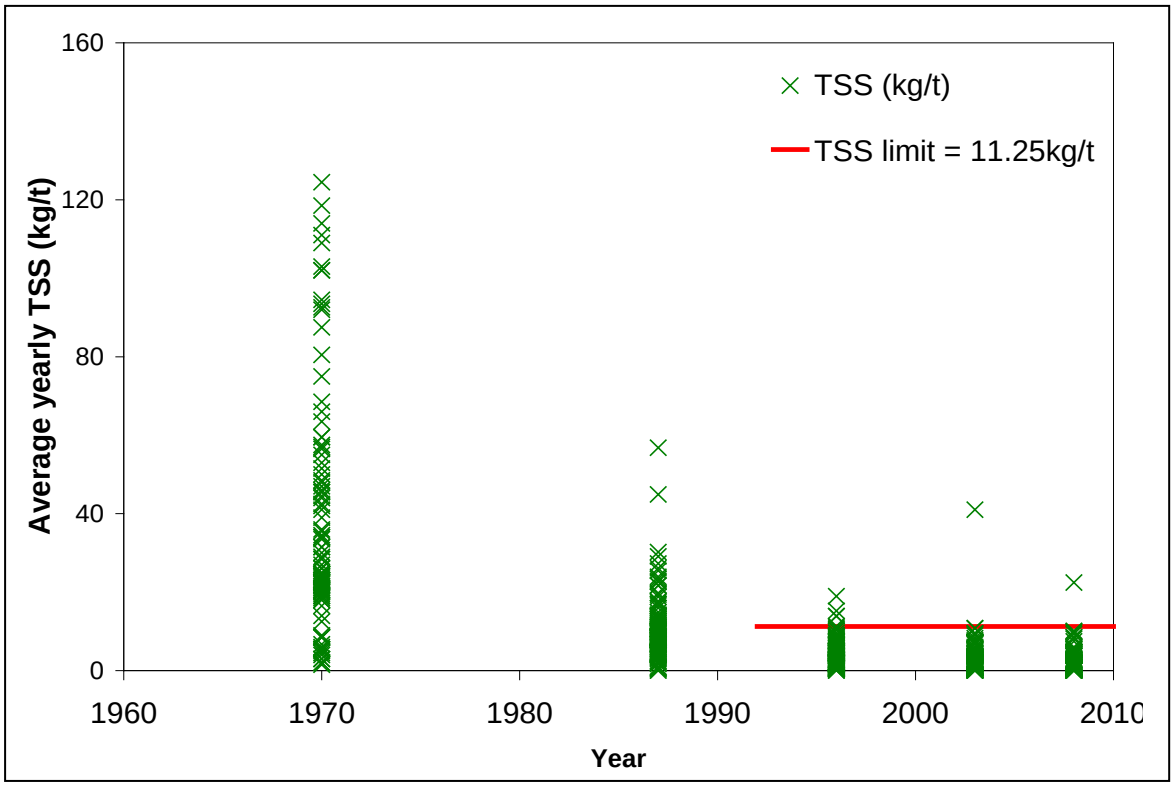


Figure 4.4: Average BOD Matter Discharges per Tonne of Production

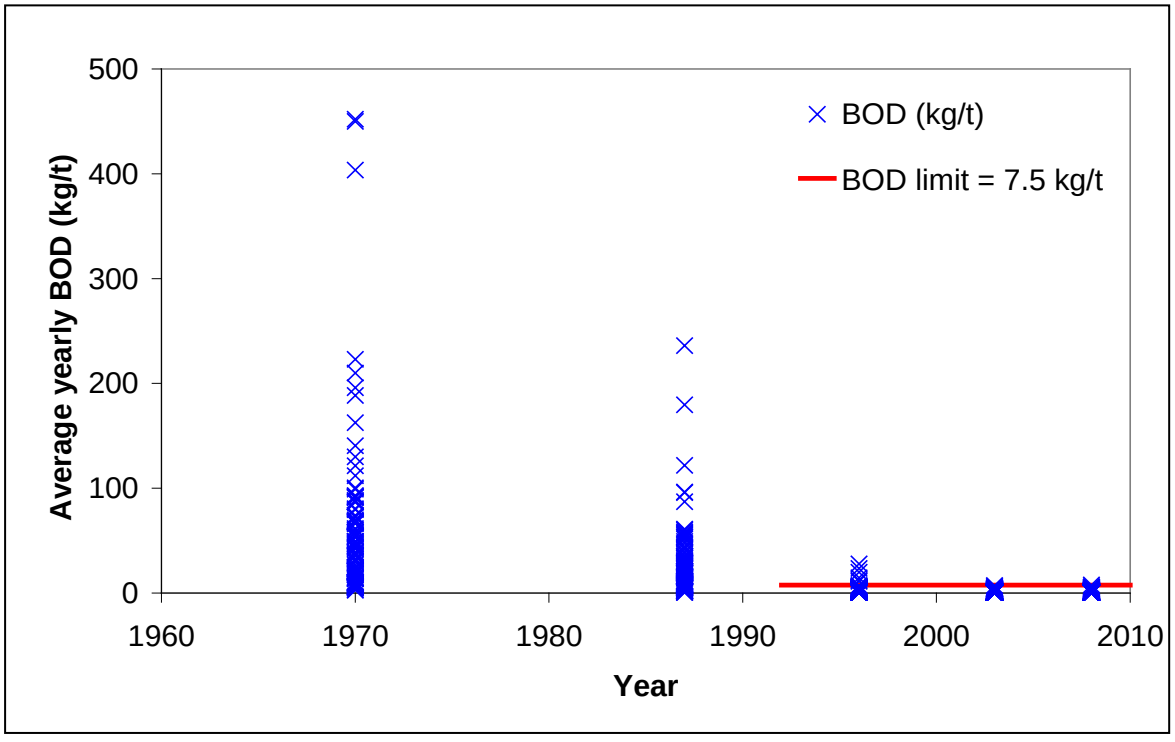
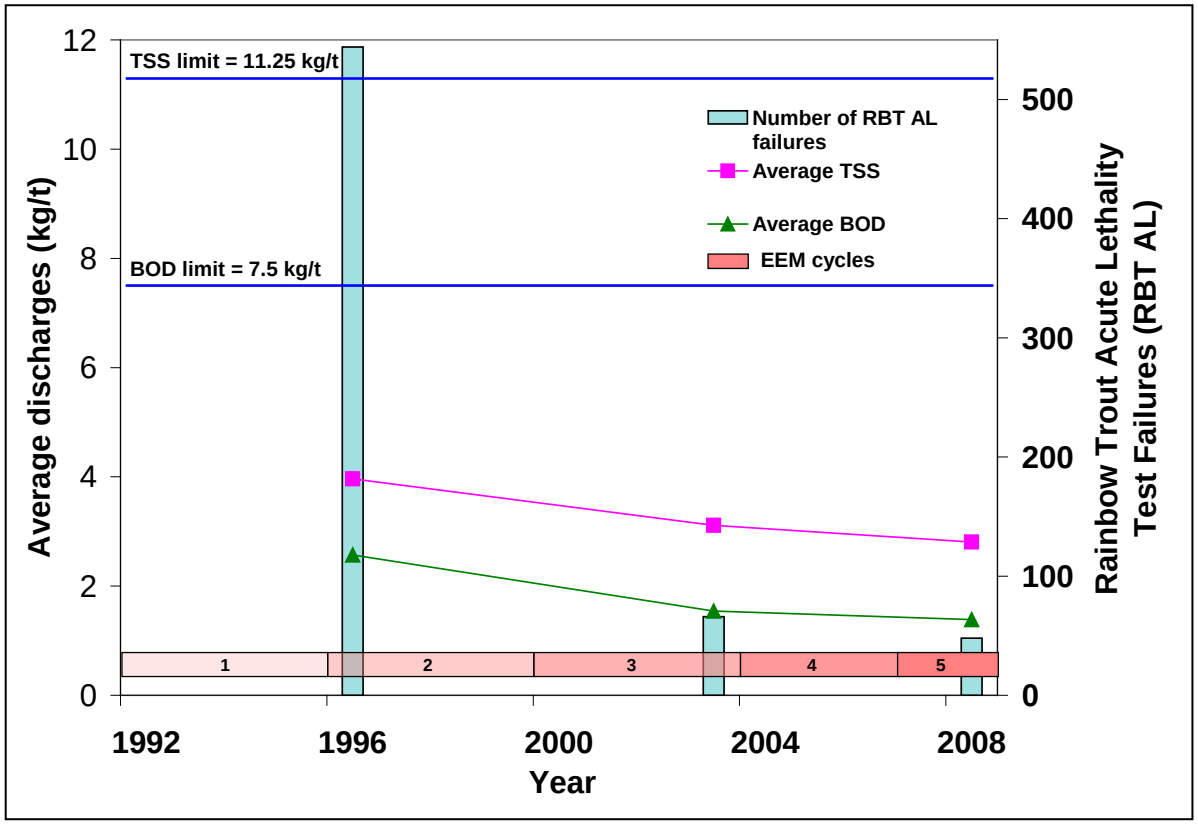


Figure 4.5 further illustrates effluent quality after the 1992 PPER were fully implemented, including total TSS and BOD matter discharges, as well as failures of the acute lethality test. Note the significant increase in compliance with the non-acutely lethal effluent requirement. Timelines for the EEM study periods (cycles) are plotted to show when, according to sublethal toxicity testing results, mill effluent had become less toxic. A substantial reduction in mill effluent toxicity occurred between Cycle 1 and the end of Cycle 2 (see Figure 5.4)

Figure 4.5: Effluent Quality Post-Implementation of the 1992 PPER



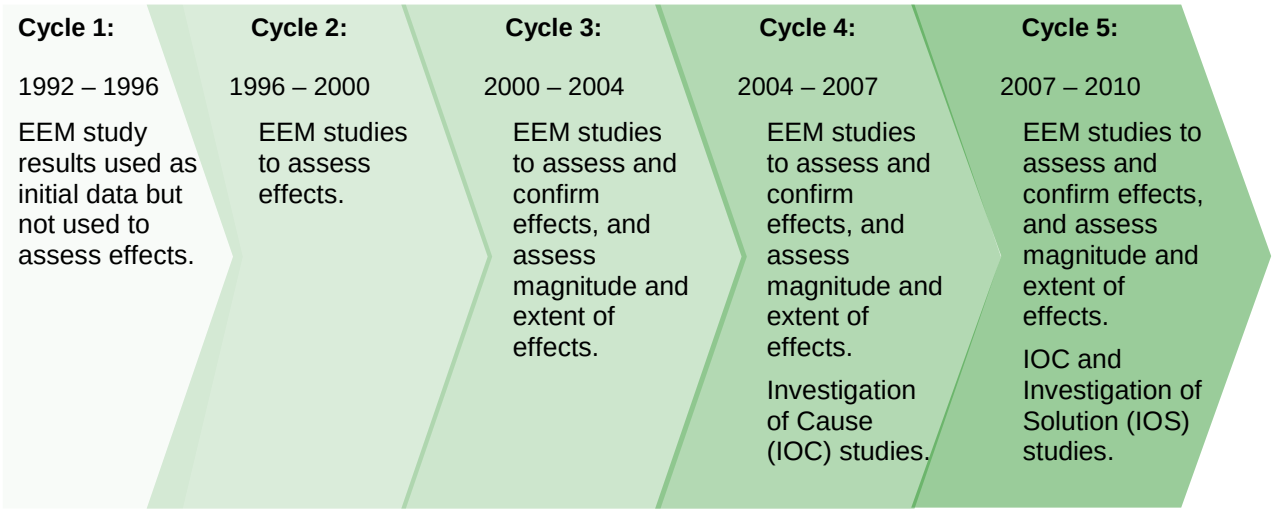
5.0 NATIONAL EEM SUMMARY

Four cycles of EEM studies have been analyzed to discern national patterns. The national analysis of Cycle 5 studies is anticipated to be completed in 2012.[12]

5.1 Summary of Environmental Effects Monitoring Activities

Figure 5.1 summarizes EEM monitoring activities, which are described in the paragraphs below.

Figure 5.1: Summary of Environmental Effects Monitoring Activities



Starting in Cycle 1, sublethal toxicity testing has been conducted twice a year by all mills in production or once a year if the mill deposited effluent on fewer than 120 days in a calendar year. Reports on sublethal toxicity tests are submitted to Environment Canada within three months of the completion of the tests.

Biological monitoring studies are conducted once per cycle[13] by all mills in production with a concentration of effluent greater than 1% in the area located beyond 100 m[14] of a point of deposit of the effluent.[15] The studies conducted in Cycle 1 were not sufficiently comprehensive to assess effects, but were used to establish initial results and develop monitoring guidance to improve future studies. Studies conducted in cycles 2 and 3 were used to assess and confirm effects identified previously. In Cycle 4, the majority of mills continued to conduct biological monitoring to assess and confirm effects, while mills that had confirmed effects in the previous cycle conducted studies to determine the

[12] EEM National Assessment Reports can be found at: http://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=2E689B7B-.

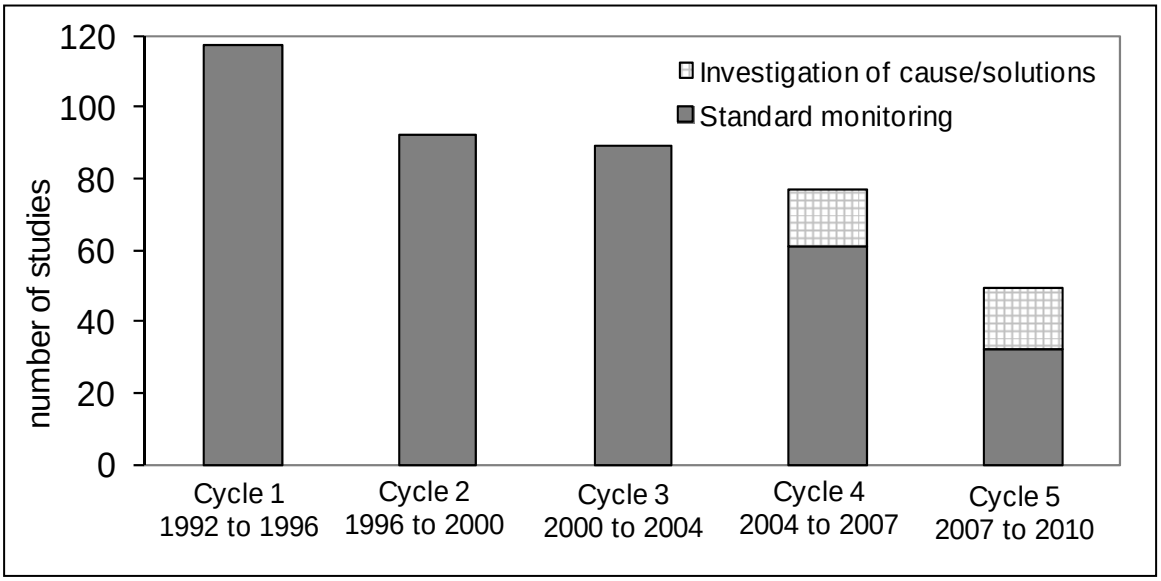
[13] The EEM monitoring period for cycles 1, 2 and 3 were extended from 3 to 4 years to allow industry and government more time to assess study results and design future monitoring studies.

[14] Prior to the 2008 amendment all mills in production conducted benthic biological monitoring surveys, and those mills with a concentration of effluent greater than 1% in the area located beyond 250 m of a point of deposit of effluent also conducted fish biological monitoring studies.

[15] A small number of mills were exempted from this requirement due to hazardous conditions in the effluent receiving environment that prevented sampling.

magnitude and the extent of confirmed effects, and a number of mills conducted biological monitoring studies to investigate the causes of the effects. In Cycle 5, a number of mills continued to conduct biological monitoring studies to assess and confirm effects, others continued to investigate causes, and a few mills, having determined the causes of confirmed effects in Cycle 4, conducted investigations to identify solutions to eliminate those effects. In some situations, two mills conducted one study jointly. The National Investigation Study into the causes of reduced fish gonad size involved eight mills. As well, a number of mills ceased production during cycles 4 and 5, thereby reducing the number of mills required to conduct EEM studies. Figure 5.2 shows biological monitoring activities per cycle.

Figure 5.2: Number of Biological Monitoring Studies Conducted per Cycle

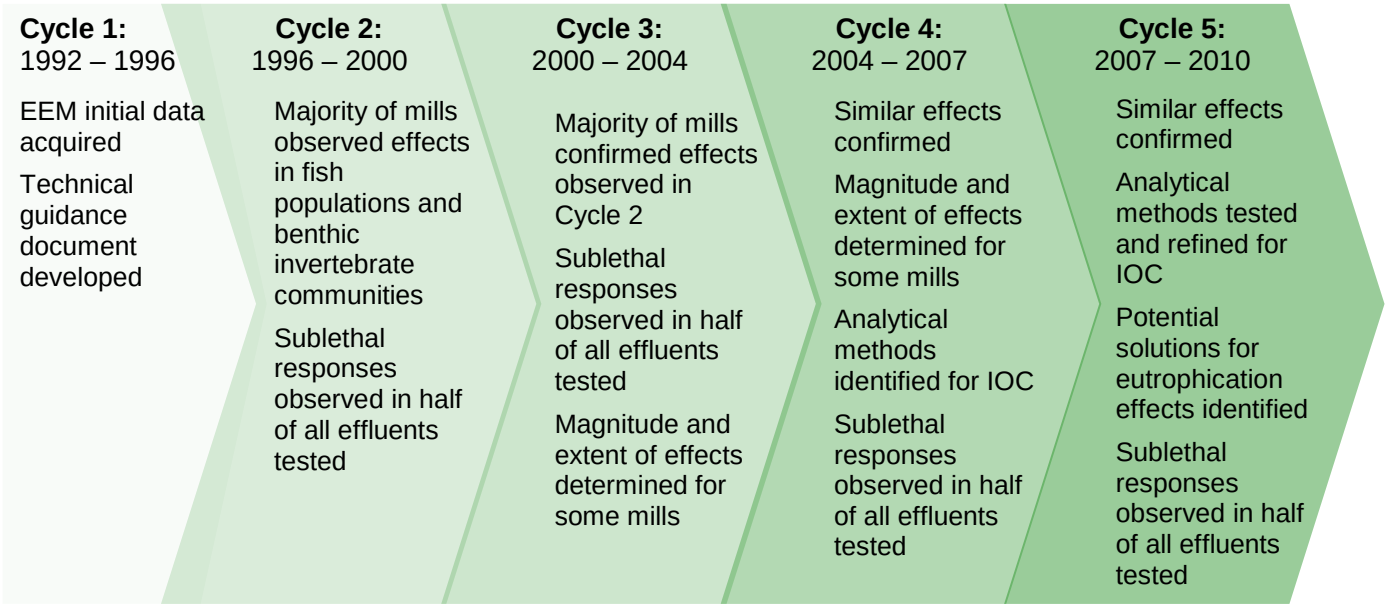


As mills have progressed through the cycles, EEM activities have become more focused on investigating the causes and solutions for confirmed effects.

5.2 Summary of National Environmental Effects Monitoring Results

Figure 5.3 summarizes the major EEM findings per cycle.

Figure 5.3: National EEM Results per Cycle



Sublethal toxicity test data collected from all mills in production are analyzed to assess overall quality of effluents. The biological monitoring study data collected from receiving and reference environments are analyzed to determine the types and magnitude of effects of mill effluents on adult fish, fisheries resources and benthic invertebrate communities. Two complementary quantitative approaches are used to synthesize the large number of studies into a national overview of the effects of pulp and paper mill effluents: 1) tabulation of the results of individual mill comparisons; and 2) meta-analyses. The tabulations are useful to illustrate the main findings of the analyses, and the meta-analysis is used to statistically examine the magnitude and direction of effects. The direction of the effects indicates whether endpoint measurements were less than or greater than levels observed in the reference fish (e.g., smaller gonads and/or larger livers relative to fish from reference area).

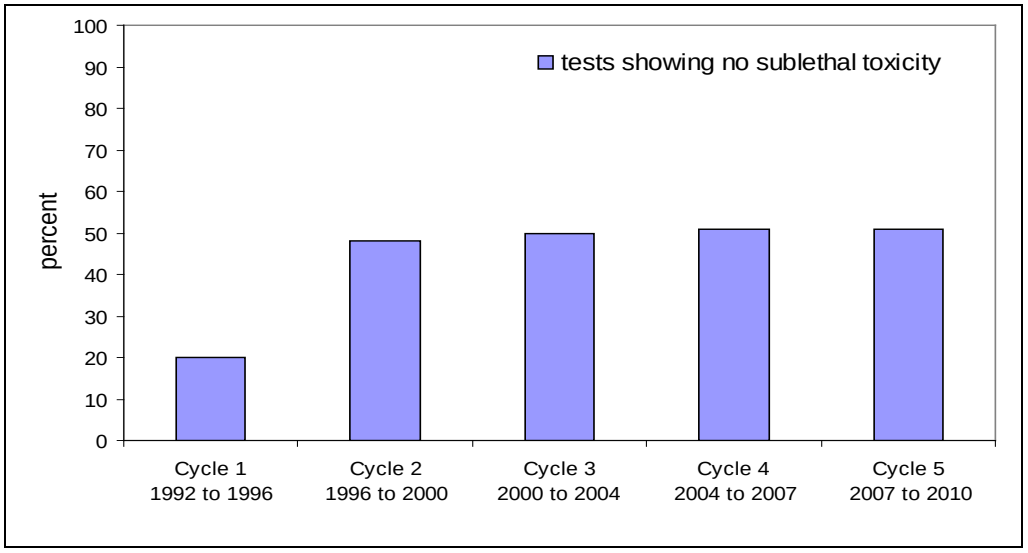
5.2.1 Results from EEM Sublethal Toxicity Testing

The sublethal toxicity tests required under the PPER provide an estimate of the potential effects of effluent on biological components (phytoplankton, zooplankton, benthic invertebrates, fish, macrophytes) in the exposure area. For national assessment purposes, the results are used to assess changes in effluent quality over time (i.e., an increase in toxicity could indicate a potential decrease in effluent quality and vice versa). On a site-specific basis, sublethal toxicity data can be used to estimate the relative contribution to overall effluent impacts of each outfall structure from a mill in multiple discharge situations, and to better understand effects observed in the receiving environment.

Each mill is required to measure the sublethal toxicity of its final effluent discharge. Mills conduct sublethal toxicity testing twice each calendar year (summer and winter). Testing includes: 1) reproduction of an invertebrate; and 2) algal growth inhibition or reproduction. The endpoint that is used to measure effluent quality is the *inhibiting concentration that produces a 25% effect (IC25)*, i.e., that effluent concentration causing a reduction in performance (e.g., lower growth or reproduction) of 25% relative to levels for the control organisms. If a full-strength effluent does not cause at least a 25% inhibition, the effluent is reported as eliciting no sublethal toxicity response for that endpoint.

Sublethal toxicity testing results from cycles 1 and 2 showed that mill effluent toxicity decreased between 1992 and 1996 (the time when full compliance with the PPER limits was required). On a national basis, mill effluent sublethal toxicity has generally remained constant since the industry reached full compliance. The improvement in effluent quality following Cycle 1 has been attributed to upgrades in effluent treatment in response to the 1992 PPER. Mill effluents continue to elicit sublethal toxicity responses in half of all effluent tests. Figure 5.4 depicts the percentage of sublethal toxicity tests showing no toxicity, per cycle.

Figure 5.4: Percentage of Sublethal Toxicity Tests[16] Showing No Toxicity at 100 percent Effluent Concentration in Cycles 1 through 5



5.2.2 Results from EEM Biological Monitoring Studies

National analyses of EEM biological monitoring studies showed that some mill effluents were causing effects on fish and fish habitat, and very rarely on the use of fisheries resources (determined by elevated levels of dioxins and furans in fish tissue).

The study results from the first cycle of monitoring were used for technical guidance development only, and were not interpreted to determine national average response patterns. In Cycle 2, the national average response pattern for fish was typical of those

[16] Represents all sublethal toxicity testing conducted on phytoplankton, zooplankton, benthic invertebrates, fish and macrophytes.

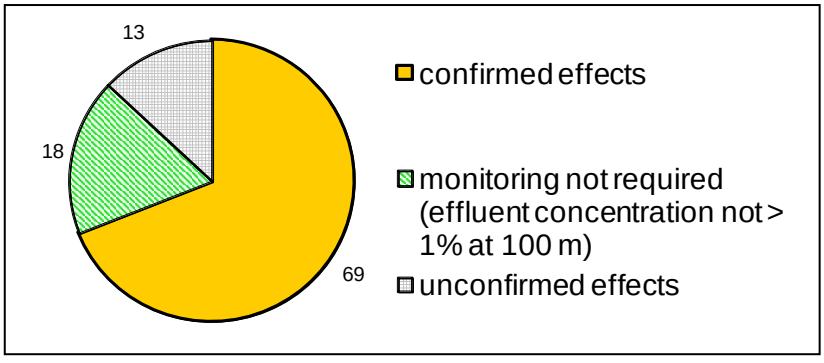
conditions related to nutrient enrichment, co-occurring with metabolic disruption. Specifically, predominant effects were fatter and faster-growing fish with increased relative liver size, together with decreased relative gonad size. The national average response pattern for benthic invertebrate communities (fish habitat) in this cycle was typical of various degrees of eutrophication (i.e., nutrient enrichment conditions). Specifically, predominant effects were increased invertebrate density and changes in community structure and taxon richness (i.e., species diversity or number of species).

National average response patterns observed for fish and benthic invertebrate communities during Cycle 3 were similar to those observed during Cycle 2. In addition, approximately 70% of the mills confirmed an effect for at least one of the effect indicators,[17] with approximately 45% of mills confirming effects relating to eutrophication and 20% confirming a reduced gonad size effect.

In Cycle 4, national average response patterns observed for fish and benthic invertebrate communities were similar to those observed during cycles 2 and 3. Results from studies investigating the causes of confirmed effects indicated that investigation methods needed to be refined and tested in a variety of mills. Review and assessment of Cycle 5 data is anticipated to be completed in 2012.

Figure 5.5 shows the effects categories for mills still active in Cycle 4. When effects on the fish population, use of fisheries resources and benthic invertebrate communities are considered together, 69% of the mills still in production in Cycle 4 reported a confirmed effect in at least one of the EEM effect indicators. When the concentration of mill effluent in the receiving environment is below the criterion[18] set out in the PPER, mills are not required to conduct biological monitoring studies. Of the mills still in production in Cycle 4, 18% were not required to conduct biological monitoring studies for fish and/or benthic invertebrate communities. One mill confirmed through biological monitoring studies that its effluent was having no effect on fish populations and benthic invertebrate communities, but confirmed a fish tissue effect. Of the mills still in production in Cycle 4, 13% had unconfirmed effects (the same effects or absence of effects were not observed in consecutive cycles).

Figure 5.5: Effect Categories for Mills in Production in Cycle 4 (Percent)



[17] Effect indicators for fish include: age (survival); size-at-age (body weight against age) (energy use – growth); relative gonad size (gonad weight against body weight) (energy use – reproduction); condition (body weight against length) (energy storage – condition); and relative liver size (liver weight against body weight) (energy storage – condition). Effect indicators for benthic invertebrates include: density; taxa richness; the evenness index (Simpson's evenness); and the similarity index (Bray-Curtis index).

[18] The criterion is: a concentration of effluent in the exposure area greater than 1% in the area located within 100 m of a point of deposit of the effluent in water.

5.2.3 Magnitude of Effects Observed in Biological Monitoring Studies

The concept of critical effect size (CES) was introduced to assist in identifying the effects of most concern after national analyses of EEM study results showed that the majority of mills had observed effects in the receiving environment. A CES is a threshold based on the magnitude of an effect that indicates whether an effect may be of high risk. Of the 69% of mills reporting at least one confirmed effect, 58% reported confirmed effects with a magnitude in excess of the CES for a particular endpoint. Starting in Cycle 4 (2004 to 2007), mills confirming effects of a magnitude above CESs associated with nutrient enrichment conducted IOC studies.

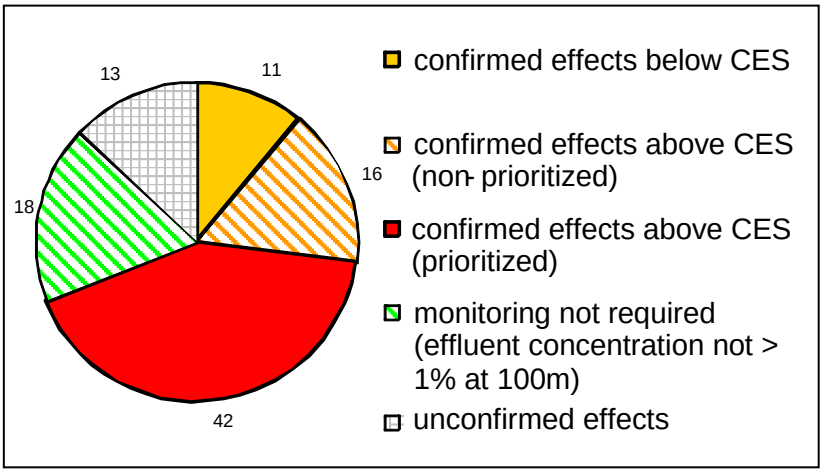
In January 2005, Environment Canada launched the Smart Regulation Initiative Project on Improving the Effectiveness and Efficiency of Pulp and Paper Environmental Effects Monitoring. The project was in response to stakeholder feedback on the EEM requirements. Industry representatives had expressed an interest in improving the effectiveness and efficiency of the EEM requirements to allow them to focus monitoring efforts and resources where they were needed most. Environmental and Aboriginal groups had expressed concern that while the EEM requirements included continued monitoring or IOC when an effect was observed, there were no requirements to address the effect. The Smart Regulation Project therefore brought together policy experts from the federal government, industry, and the Aboriginal and environmental communities. The group submitted a report[19] to Environment Canada, which included eight recommendations. Some of those recommendations were implemented through the 2008 PPER amendments, and the remainder were addressed through other actions.

In response to the recommendation that priority be given to the investigation of two predominant responses, eutrophication (nutrient enrichment) and reduced fish gonad size, a national investigation study into the causes of reduced fish gonad size was initiated in Cycle 4. Eight of the mills that had confirmed an effect of reduced fish gonad size participated in the initial national study. In addition, the Forest Products Association of Canada developed a best management practices guide for nutrient management in effluent treatment to assist mills in reducing eutrophication effects.[20]

In response to the recommendation that overall action toward causes and solutions be accelerated, a risk-based approach for the investigation of all confirmed effects was developed during Cycle 5 (2007 to 2010). This approach uses CES values to identify large (above CES) priority effects (associated with eutrophication or reduced fish gonad size) considered to be of highest risk. Action toward the determination of causes and identification of solutions for all confirmed effects is expected to be accelerated in Cycle 6 (2010 to 2013) by applying the level of effort commensurate with the level of risk.

[19] The Smart Regulation Initiative for Environmental Effects Monitoring report and Environment Canada's response to the reports is available from this website http://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=890E0366-1 .
[20] Forest Products Association of Canada, 2008 Best Management Practices Guide for Nutrient Management in Effluent Treatment: http://www.fpac.ca/index.php/en/publications-viewer/488/

Figure 5.6: Effect Categories, Including CES and Effect Prioritization for Mills in Production in Cycle 4 (Percent)



6.0 SUMMARY AND CONCLUSIONS

The PPER were created with the overall objective of water quality that sustains and protects fish, fish habit and the use of fisheries resources. Since promulgation of the Regulations in 1971, there have been significant effluent quality improvements. Between 1970 and 2008, total discharges of TSS and BOD matter from pulp and paper mills in Canada decreased by approximately 90% and 97%, respectively. Compliance also showed marked improvement for acute lethality testing, increasing from a 78% pass rate in 1996 to 97.4%[21] pass rate in 2008. This improvement in effluent quality has been attributed mostly to upgrades in effluent treatment completed in response to various iterations of the Regulations.

Despite these significant reductions in deleterious substances, EEM biological monitoring studies show that some mill effluents are causing effects on fish and fish habitat, and, in rare cases, on the use of fisheries resources. Government, industry and academia are investigating the effects associated with mill effluents to determine the causes and identify possible solutions, with a focus on the effects of most concern. It is expected that the results from EEM Cycle 6 (2010–2013) will provide significant additional information about causes and possible solutions.

Completion of the IOS studies by most mills will represent a major milestone in the history of the PPER. The results, along with social, economic, and other technical information, will be taken into consideration by Environment Canada as part of next steps.

[21] Percent compliance was calculated by taking the total number of tests passed for all mills divided by the total number of tests conducted for all mills multiplied by 100%.

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LIST OF ACRONYMS AND ABBREVIATIONS

BOD	biochemical oxygen demand
CES	critical effect size
EEM	environmental effects monitoring
IOC	investigation of cause
IOS	investigation of solution
kg/t	kilogram(s) per tonne
OSTF	off-site treatment facility
PPER	*Pulp and Paper Effluent Regulations*
TA	transitional authorization
TSS	total suspended solids

www.**ec.gc.ca**

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