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Science-Based Solutions
Solutions fondées sur la science

Development of this series of factsheets was coordinated by the National Guidelines and Standards Office of Environment Canada to consolidate information on the variety of existing approaches to the assessment of sediment quality in Canada and to highlight sediment assessment programs developed by Environment Canada. Additional factsheets will be added to the series as new sediment assessment tools or programs are developed to highlight significant work across the Federal government.

SEDIMENT ASSESSMENT SERIES

Basic Concepts and Program Highlights

Factsheet 1

Sediments: Sink and Source — Putting the Problem in Perspective

An increasing amount of chemicals or substances are being released into the environment, and sites contaminated with nutrients, metals, organics and oxygen-demanding substances are widely reported from freshwater and marine ecosystems. Although some of these contaminants may occur in elevated concentrations due to natural processes, most increases are directly related to anthropogenic activities. In aquatic environments, contaminants not only cause ecological impairment, but they also have the potential to cause severe economic damage. Monitoring and assessment of sediment contamination is both complex and potentially expensive, and remains one of the greatest challenges in environmental management today.

Sediments act as a **sink** for some contaminants entering aquatic ecosystems, where they can accumulate over long periods of time. Importantly, contaminated sediments may also serve as a continued **source** of contamination to other components of the environment and as a route of entry of contaminants into the food web. Not only do contaminated sediments directly affect benthic organisms, such as insects, worms, molluscs and bottom-dwelling fish that spend a large portion of their life cycle in or on sediments, they can also indirectly affect other life forms that feed on benthic organisms.

There is little question as to the significance of sediment quality in maintaining the overall health of the aquatic ecosystem. However, remediating and managing contaminated sediments is both economically and technologically demanding. Because of this, the scientific community has been developing science-based tools to identify sediments that are impaired and, ultimately, to support effective management decisions and priorities for dealing with contaminated sediments. These tools vary, but have a common objective of assessing sediment quality based on its ability to support and sustain a healthy aquatic community. In Canada, assessment of sediment quality is needed to support a broad range

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of programs ranging from the determination of the effectiveness of regulations in protecting the environment, the mapping of the extent of historic contamination, the remediation of contaminated sites, to the control of ocean disposal of dredged material.

Over the past decade, a powerful suite of science-based sediment quality assessment approaches has been developed. There is no single “best” approach to assessing sediment quality, and the most appropriate method or combination of methods will be dictated not only by science, but by time constraints, costs, program needs and the type of management decision needed.

A distinction should be made between sediment assessment and sediment management. A sediment assessment is conducted to determine the extent or severity of contamination at a site and its potential for causing adverse effects. The choice of which assessment tools to use should be guided by considerations of time and cost concerns, suitability and accuracy of the various assessment tools, and potential risks associated with assessment errors. Sediment management involves making decisions that are based on the sediment assessment results, but take into consideration political and socioeconomic factors. Sediment management also includes the development and evaluation of risk reduction measures (e.g., remediation), planning and maintenance of "ongoing" control measures, monitoring and communication to stakeholders of the risks associated with particular sediments.

This factsheet consolidates information on the major sediment assessment approaches, provides a conceptual approach and advice for the application of major methods (emphasizing their complementary nature), and highlights research and development in sediment assessment programs under way at Environment Canada. Issues pertaining to sediment management are not the focus of this document.

The Pillars of Sediment Assessment

Even within a single site, sediments can vary in structure, composition and biological diversity. The physicochemical differences in sediment characteristics such as particle size and shape, or organic content can profoundly influence the bioavailability and degree of toxicity of sediment-associated contaminants. In addition, the ecology of benthic organisms varies greatly such that feeding habits, habitat requirements and physiology all influence contaminant exposure and uptake among benthos. Consequently, there is a need for a variety of sediment assessment tools that can adequately address the dynamic physical, chemical and biological characteristics of contaminated sediment and their influence on the resident biota.

There are three main approaches (i.e., lines of evidence) for assessing sediment quality:

- chemical-specific sediment quality guidelines (CCME 1999)
- biological guidelines or community assessments (Reynoldson and Day 1998)
- toxicity tests (Environment Canada 1999; Bombardier and Blaise 2000)

Each of these approaches has inherent strengths and limitations (Table 1), and a comprehensive sediment assessment approach will integrate evidence from each of these approaches to support scientifically-sound management decisions and action (Chapman et al. 1992; Ingersoll et al. 1997). In addition to these approaches, the potential to bioaccumulate is a key component of sediment assessment. An examination of bioaccumulation may identify potential adverse impacts on higher trophic levels due to biomagnification, even if effects are not detected by the other approaches (Chapman et al. 1997). Although not discussed separately, physical assessment of sediment (e.g., grain size, redox potential and transport of sediment) is routinely considered in chemical, biological and toxicological sediment assessment approaches.

> "Toxicity testing cannot substitute for chemical measurements, or for surveys of communities of organisms. On the contrary, the strengths of toxicity testing are best realized in conjunction with chemical and biological field measurements." (Environment Canada 1999)

> "The best approach to the assessment of sediment quality is still an integrative approach wherein more than one generic tool, such as a battery of toxicity tests, is combined with chemical analyses and an evaluation of the structure of the benthic communities." (Bombardier and Blaise 2000)

Table 1: Summary of the Approaches, Outcomes, Strengths, Limitations and General Use of the Sediment Assessment Methods

Approach	Description	Outcome	Strengths	Limitations	General Use
Chemical-specific guidelines (e.g., Canadian Sediment Quality Guidelines)	Compare sediment chemistry with chemical-specific guidelines Could also involve comparing tissue chemistry of sediment-dwelling biota with body burden guidelines	Classify sediments in terms of whether they are expected to be: not associated with biological effects; occasionally associated with adverse effects; or frequently associated with biological effects	Simple, consistent method for evaluating chemical contamination Linked directly to stressors of concern or can be combined into an index of general sediment quality Use can result in both preventative and restorative action Status and trend results are easily communicated Although most existing guidelines are based on a co-occurrence approach, other approaches may also be used (e.g., spiked-sediment toxicity, equilibrium partitioning) Option to generate site-specific guidelines	Information limited to chemical stressors Guidelines for many chemicals have not been developed Guidelines are set to protect sensitive uses, and exceeding a guideline does not automatically indicate a detrimental effect (e.g., sites where contaminants are not bioavailable or sensitive species are not present) Unknown or unmeasured contaminants may be present Direct cause-and-effect relationships generally cannot be inferred from the co-occurrence data used to develop the guidelines; co-occurrence data can only establish associations between chemical concentrations in sediments and adverse biological effects	Screening levels, benchmarks to aid in management of contaminated sediments

Table 1. Continued

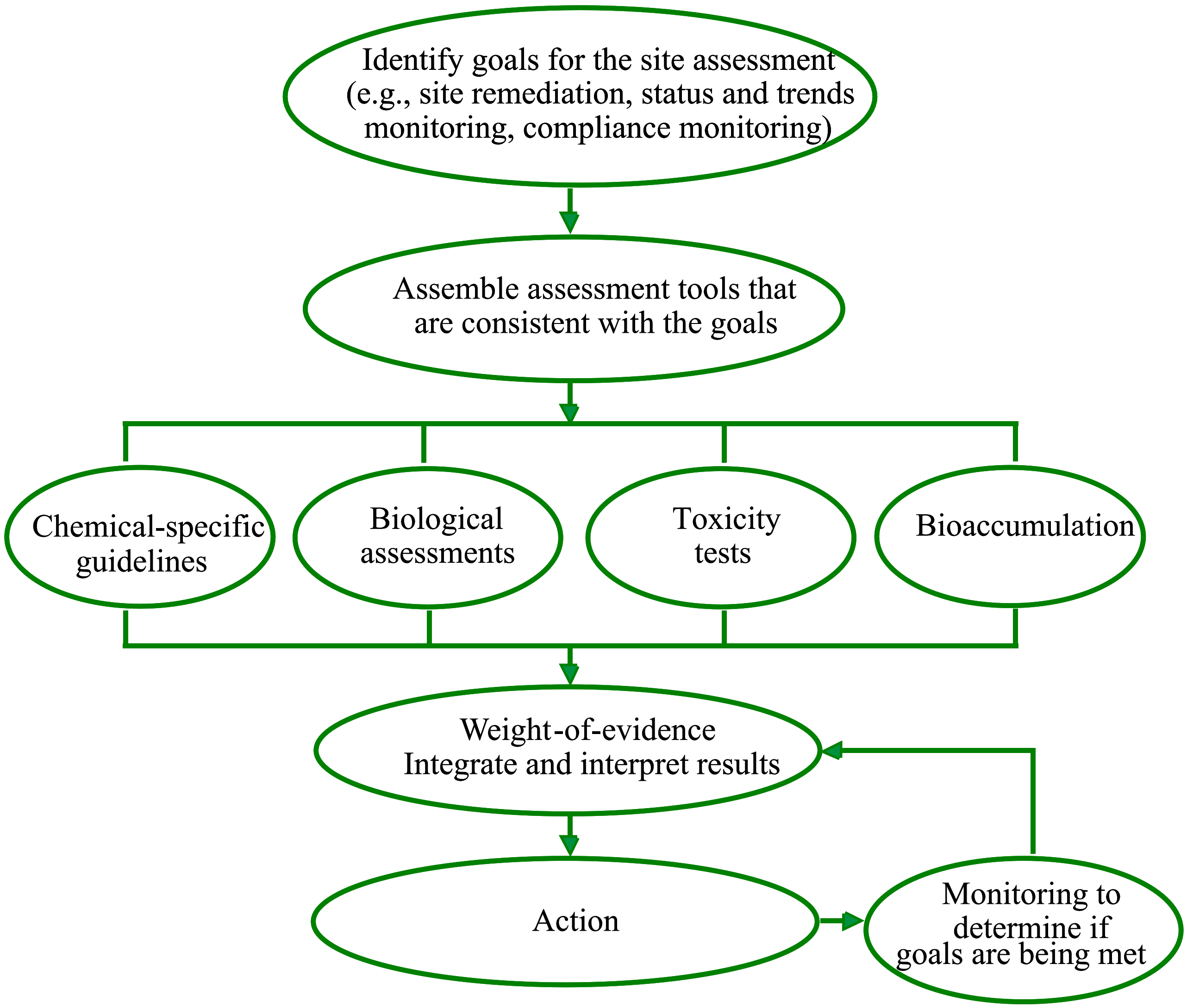
Approach	Description	Outcome	Strengths	Limitations	General Use
Biological assessments (benthic community)	Compare differences between predicted community assemblages (based on a reference condition) and functional responses with site-specific benthic communities and responses	Characterize benthic community structure as unstressed, potentially stressed, stressed or severely stressed, relative to the reference condition	Direct measure of the health of benthic communities Ecologically relevant Assess the effects of non-chemical impacts (e.g., habitat degradation) Measure status and trends over time	Difficult to detect changes related to contaminants as compared to other environmental stressors, like physical characteristics Difficult to identify the impact of specific chemicals Time and resources required to generate status and trend data are high Cannot predict the likelihood of adverse effects, can only identify where adverse effects have already occurred Bioaccumulation, or the potential for biomagnification, is not addressed	Used to assess the integrated response to stressors at the community level

Table 1. Continued

Approach	Description	Outcome	Strengths	Limitations	General Use
Toxicity testing	Compares the response of benthic organisms exposed to field-collected sediments (e.g., bulk sediment, sub-fractions, pore water, elutriate, etc.) to responses in control or reference samples; tests are generally conducted in the laboratory according to defined test methodologies	Results indicate the degree of toxicity of a sediment sample or sub-fraction to test organisms or indigenous organisms collected from the field	Assesses toxicity of mixtures of contaminants (assuming well matched control samples) Assesses toxicity of chemicals for which no guidelines exist Good predictor of impacts on benthic communities	Could be difficult to detect toxicity related to a specific contaminant in a mixture Limited to organisms and test conditions for which standard protocols have been developed Predictions from toxicity tests are limited when test and field conditions are not similar Manipulation of sediment may cause toxicity in the lab (artifact)	Indicates likelihood of a given sediment producing measurable effects
Bioaccumulation	Biological uptake of a chemical from food and the surrounding media (water and sediment)	Biota-sediment accumulation factors (BSAFs) describe the accumulation of contaminants in biota to assist in determining the potential for biomagnification	Can indicate valid cause for concern to higher trophic levels when other methods show negative results Can identify the cause of toxicity when compared to critical body burdens previously shown to be toxic	Accumulation factors assume a steady-state condition Significance of bioaccumulation can be difficult to interpret if information on critical body burdens does not exist	Assists in establishing benchmarks or reference points to help interpret biological monitoring data

Adapted from: Chapman et al. 1997; Federal Register 1998; and Borgmann et al. 2001.

Conceptual Approach to the Assessment of Sediment Quality*



* The assessment approaches are presented with equal importance. All approaches might not necessarily be used in every situation; for example, certain assessments might only require the use of chemical-specific guidelines (e.g., Canadian Sediment Quality Guidelines) and the evaluation of the potential to bioaccumulate. Factors such as time constraints, costs, program needs and management goals will dictate the best weight-of-evidence approach. Sediment management programs usually benefit from a tiered approach that makes the most efficient use of available tools.

Chemical-specific guidelines are currently used across Canada to evaluate sediment quality, alone or in combination with other assessment tools. These guidelines recommend limits for individual contaminants of concern based on the effects of these substances on sediment-associated biota in the field. They are predictive in nature and provide rapid screening tools to identify areas of potential concern where chemical characterization of a site has been conducted. Use of sediment quality guidelines is more diagnostic than chemical characterization alone, which indicates only what contaminants are present. Screening chemical concentrations against recommended guideline concentrations adds additional information on the potential risk posed by the measured levels of contaminants.

Biological assessments of benthic communities focus on the cumulative effects of multiple stressors, and establish normal or acceptable conditions or characteristics for sediment biota — from the individual to the community level. When the conditions or characteristics of an *in situ* community vary significantly from the reference conditions or characteristics, it is considered to be impaired. Establishing the reference condition for a site is key to the application of this approach. Though highly diagnostic in identifying actual rather than predicted impairment of a site, the causes of the impairment may not be clear.

Toxicity tests focus on responses of individual organisms exposed to field-collected sediments, usually under standardized conditions, and are used to help establish a relationship between contamination at a site and biological effects. Organisms and endpoints that are known to be sensitive or ecologically relevant indicators are usually chosen, and a suite or battery of tests may be used to provide evidence of toxicity. Toxicity indices may also be used to express the results from several different toxicity tests as a single number that rates the toxicity of the sample (Environment Canada 1999).

In combination, these three approaches provide complementary evidence for sediment quality impairment that can focus the need for further action. Where all lines of evidence point to a biological effect, there is strong evidence for impairment caused by known contaminants. Where only one or two lines of evidence support a decision of impairment, interpretation becomes difficult. The Sediment Quality Triad of Chapman et al. (1992) provides eight scenarios indicating the possible conclusions when the three lines of evidence (sediment quality guidelines, biological assessments and toxicity tests) appear contradictory. It is important to note that combining the evidence of the three approaches does not identify which chemicals bioaccumulate. Even though results from these three lines of evidence may indicate no degradation or toxicity of the sediments, if significant bioaccumulation occurs then there is also the potential for biomagnification. Therefore, in addition to the three key approaches to sediment assessment, the incorporation of the **potential for chemicals to bioaccumulate** in the conceptual approach to sediment assessment is essential. Table 2 (adapted from Grapentine et al. (2002)) also considers biomagnification, and includes 16 possible scenarios.

For substances that are known to bioaccumulate and biomagnify, such as PCBs and toxaphene, and for which aquatic food sources are the main route of exposure for wildlife, additional tools are available to assess the presence of these substances in sediments and their effect on ecosystem health. These include biota-sediment accumulation factors (BSAFs) and national tissue residue guidelines (TRGs) for the protection of wildlife consumers of aquatic biota. TRGs refer to the maximum concentration of a chemical substance in the tissue of aquatic biota that is not expected to result in adverse effects in wildlife (CCME 1999). TRGs have been developed for DDT, PCBs, toxaphene, PCDD/Fs and mercury, and together with other environmental quality guidelines, provide benchmarks or reference points to help interpret biological monitoring data.

Together with data from sediment chemistry, biological assessments and toxicity tests, bioaccumulation data can also assist in determining the cause of sediment toxicity. By comparing measurements of bioaccumulation with critical body burdens that have been shown to cause toxicity, it is possible to quantify the bioavailability of contaminants and identify those which are most likely the cause of the sediment toxicity (Chapman 1997; Borgmann et al. 2001). Further refinement is possible when this approach is supplemented with measurements of contaminant levels in overlying water during toxicity tests (Borgmann et al. 2001).

Table 2: Interpretation of Effects When Three Approaches of Sediment Assessment and Biomagnification are Combined*

Sediment quality guidelines	Biological assessments	Toxicity tests	Biomagnification	Possible Conclusions
-	-	-	-	Sediments do not present a risk.
+	-	-	-	Contaminants do not present a risk.
-	+	-	-	Potential for adverse effects. Consider comprehensive analyses of contaminants in lab and field biota for evidence of contaminant exposure and uptake.
-	-	+	-	Sediments currently do not present a risk. Identify cause of impairment in invertebrate community. Consider unmeasured contaminants.
-	-	-	+	Biomagnification risk. Conduct an assessment to verify lack of contaminant availability from the sediment, and identify source and implications. Investigate potential shift in food web dynamics (e.g., due to *Dreissena* invasion).
+	+	-	-	Potential for adverse effects. Consider potential effects to unadapted communities in far field based on severity of the toxicity and assessment of site stability.
-	+	+	-	Adverse biological effects occurring.
-	-	+	+	Sediments currently may not pose a risk, but biomagnification is occurring. Examine sources and pathways of contaminant of concern. Investigate potential shift in food web dynamics (e.g., due to *Dreissena* invasion). Must confirm that sediment is not the source of contamination.
+	-	+	-	Adverse effects occurring but cause(s) unknown.
+	-	-	+	Unacceptable risk of biomagnification. Conduct an assessment. Verify biomagnification from the sediment, and potential effects to receptor species in the upper food chain.
-	+	-	+	Potential for adverse effects to benthos; unacceptable risk of biomagnification.
+	+	+	-	Sufficient evidence for unacceptable risk from sediment contamination.
+	+	-	+	Potential for adverse effects to benthos; unacceptable risk of biomagnification. Results indicate that contaminants are bioavailable but mechanism may be long term, or uptake from sediment is indirect.
+	-	+	+	Adverse effects to benthos; unacceptable risk of biomagnification.
-	+	+	+	Adverse effects to benthos; unacceptable risk of biomagnification. Investigate potential shift in food web dynamics (e.g., due to *Dreissena* invasion).
+	+	+	+	Sufficient evidence for unacceptable risk from sediment contamination.

*An effect significantly different from the condition at the reference site is shown as positive while a negative indicates no difference. Biomagnification is recognized as the result of the process of bioaccumulation where the concentration of the contaminant increases as it is transferred through two or more trophic levels.

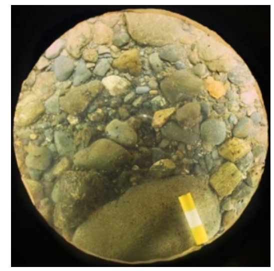
Adapted from: Grapentine et al. 2002.

Additional Information

In addition to the sediment assessment approaches described above, additional information on sediment quality may be available for use in a weight-of-evidence approach for sediment assessment.

Sediment toxicity identification evaluation (TIE) is a method that can relate the toxicity of effluent, water or sediment samples containing complex mixtures of chemicals to single compounds or classes of contaminants. As toxicity tests of contaminated sediments by themselves cannot identify the chemicals causing the observed toxicity, TIE uses toxicity-based procedures to characterize, identify and confirm the identity of compounds responsible for the toxic effects. TIE methods are currently based on pore water, but the application of these methods to whole sediments is an area of research (Swartz and Di Toro 1997).

Physical/chemical characteristics of sediments include physical descriptors of sediment type (e.g., grain size), sediment transport, overlying water chemistry, and pore-water chemistry. These types of data can be used to clarify, for example, background levels of contamination, expected bioavailability and mobility of contaminants.



An Overview of Environment Canada Tools and Programs

Environment Canada has played an important scientific role in the development of sediment quality assessment tools and approaches that encompass the "pillars" of sediment assessment (chemical-specific guidelines, biological assessments and toxicity tests). Some of the major tools include:

- Canadian Sediment Quality Guidelines (CSQGs)
- BEnthic Assessment of SedimenT (BEAST)
- Sediment-Toxicity (SED-TOX) Index
- Environment Canada's Biological Test Methods

Chemical-Specific Sediment Quality Guidelines

Canadian Sediment Quality Guidelines (CSQGs) are nationally endorsed, science-based goals for the quality of aquatic systems. They are developed under the auspices of the Water Quality Task Group of the Canadian Council of Ministers of the Environment (CCME), for which the National Guidelines and Standards Office of Environment Canada is the technical secretariat. CSQGs represent concentrations of individual chemicals below which adverse biological effects are not expected (CCME 1999), and are derived from the available toxicological information according to the procedures published by the CCME (1995). When data permits, two assessment values are generated: the Threshold Effect Level (TEL) which represents the concentration below which adverse biological effects are expected to occur rarely; and the Probable Effect Level (PEL) which defines the level above which adverse effects are expected to occur frequently. To date, over 60 freshwater and marine CSQGs have been developed for a number of substances including metals, organic pesticides, PCDD/Fs, PAHs, and PCBs. All of the CSQGs developed to date have an interim status.

Despite a variety of potential uses (e.g., to evaluate potential impacts of developmental activities), sediment quality guidelines are most likely to be routinely applied as screening tools in the site-specific assessment of the potential risk of exposure to chemicals in sediment and in formulating initial management decisions, such as acceptability for open-water disposal, determining whether remediation is required, further site investigation and prioritization of sites. Further descriptions of chemical-specific sediment quality guidelines are discussed in *Science-Based Solutions Sediment Assessment Series Factsheet #2*, "Chemical-Specific Sediment Quality Guidelines."

Biological Guidelines for the Assessment of Sediment Quality in the Laurentian Great Lakes

Environment Canada (National Water Research Institute and Ontario Region) has developed an approach to assess freshwater sediments in the near-shore areas of the Great Lakes. A key element of this approach is the BEnthic Assessment of SedimenT (BEAST) (Reynoldson et al. 1995), which is a tool for evaluating the health of benthic invertebrate communities by using predictive models that relate site habitat attributes to an expected community, commonly referred to as a reference condition. The approach also involves sediment toxicity tests, and has been used to assess community structure and sediment contamination at various Areas of Concern in the Great Lakes (Reynoldson and Day 1998; IJC 1999) and other freshwater systems in Canada, such as the Fraser River (Reynoldson and Rosenberg 1999).

As an assessment tool, the community-based biological approach uses ecological information that links habitat quality to the expected community structure. The approach is highly diagnostic in confirming that sediment-associated biota are being affected by conditions at that site. However, as the invertebrate community integrates effects from many sources, the cause of the impairment may not be clear; therefore, toxicity tests are incorporated in the BEAST approach to provide confirmation of the relationship between contamination at a site and its effects. Details of these guidelines are discussed in *Science-Based Solutions Sediment Assessment Series Factsheet #3*, "Biological Guidelines for the Assessment of Sediment Quality in the Laurentian Great Lakes."

Toxicity Tests and Indices

Standardized Biological Test Methods

The existing test methods for single species in sediments are cost-effective tools for determining whether contaminants in sediment are harmful to benthic or epibenthic organisms, as well as those frequenting the overlying water column. The procedures described here have been developed to balance scientific, practical and cost considerations, and to ensure that the results will be sufficiently precise for the majority of situations in which they will be applied.

Environment Canada's Environmental Technology Centre has developed biological test methods in sediments for freshwater and marine/estuarine sediment-dwelling organisms (Environment Canada 1992a; 1997a; 1997b; 2001). For marine and estuarine habitats, a 10-d test measures the mortality of amphipods (Environment Canada 1992a), and a 14-d test evaluates the survival and growth of polychaete worms (Environment Canada 2001). Using sediment pore water, Environment Canada has developed a test method for examining fertilization success of two echinoids, sea urchins and sand dollars (Environment Canada 1992b). In freshwater, a 14-d exposure is used to evaluate mortality and growth of the freshwater amphipod *Hyalella azteca* (Environment Canada 1997a); while a 10-d test is used to evaluate mortality and growth of the midge larvae (Environment Canada 1997b). In addition, a new type of sediment toxicity testing developed by Environment Canada's National Water Research Institute involves using large water-sediment ratios to circumvent the problem of deteriorating overlying water quality during sediment toxicity tests with benthic invertebrates (Borgmann and Norwood 1999). Chronic sediment toxicity tests of 10-d to 28-d have been successfully conducted with a variety of benthic invertebrates (Borgmann and Norwood 1999). Other test methods that are used by Environment Canada in both regulatory and monitoring programs include the microtox solid phase test with the luminescent bacteria *Photobacterium phosphoreum* (Environment Canada 1992c) and a 28-day bioaccumulation test using the bivalve *Macoma* sp. (USEPA 1993).

The biological test methods for sediment can be used for various purposes; in fact they have been applied in the data generation stages of both the numerical and biological guidelines, as described above (Environment Canada 1999). In general, whole sediment toxicity tests are commonly used for assessing the quality of field-collected sediment. Sediment toxicity testing methods have been applied in a regulatory context according to the *Disposal at Sea Regulations* under Part 7 of the *Canadian Environmental Protection Act* (CEPA). The regulations explain the use of toxicity tests for the assessment of sediments for disposal at sea (Environment Canada 1995).

Sediment-Toxicity (SED-TOX) Index

The St. Lawrence Centre of Environment Canada has a developed a tool, the Sediment-Toxicity (SED-TOX) Index, for the assessment of sediment quality that: 1) integrates the various parameters of effects on an assortment of aquatic species of several trophic positions; and 2) distinguishes between degraded and non-degraded areas (Bombardier and Bermingham 1999; Bombardier and Blaise 2000). The SED-TOX Index generates a single value (SED-TOX score) that represents all the results of the different sediment toxicity tests on a common, easily interpreted scale. This score can be used to rank a wide range of sites based on their potential toxicity to various test species and to make comparisons between present and future conditions in a given area (Bombardier and Blaise 2000). A summary of the approach of the SED-TOX Index model and its application are discussed in the *Science-Based Solutions Sediment Assessment Series Factsheet #4*, "The Sediment-Toxicity (SED-TOX) Index."

National Environmental Effects Monitoring Program

Environment Canada's National Environmental Effects Monitoring (EEM) Office manages and coordinates the EEM Program, which is used to determine if pulp and paper mill and metal mining effluents adversely affect fish health, fish habitat and the human use of fisheries resources. The National EEM Program for pulp and paper mill and metal mining effluents are regulated under the *Pulp and Paper Effluent Regulations* (PPER) and the *Metal Mining Effluent Regulations* (MMER), respectively — both under the *Fisheries Act*. The PPER require that all pulp and paper mills in Canada conduct EEM; while the MMER require that all metal mines in Canada conduct EEM.

In addition to environmental effects monitoring being conducted nationally as required by *Fisheries Act* regulations, other sectors such as oil and gas are also conducting environmental effects monitoring programs to assess the effects of their activities.

A variety of sediment assessment tools, including benthic community surveys (biological assessments), whole sediment chemistry (compared to sediment quality guidelines) and whole sediment toxicity tests, are recommended for the monitoring of environmental effects of metal mining and pulp and paper mill effluents. At the end of each EEM cycle, individual mines and mills are required to submit an "interpretive report" summarizing the monitoring results to Environment Canada. Examples of EEM in metal mining and pulp and paper mill regulations are given in the *Science-Based Solutions Sediment Assessment Series Factsheet #5*, "Environmental Effects Monitoring (EEM): Metal Mining and Pulp and Paper Mill Effluent Regulations."

Disposal at Sea Program

Since 1976, Environment Canada has been assessing sediments in a regulatory context under a national permitting system that controls disposal of wastes at sea. A formal sediment assessment framework appears in the *Canadian Environmental Protection Act* (CEPA) and in the international 1996 Protocol to the *London Convention on Disposal of Wastes at Sea*. The framework requires Environment Canada to assess the physical, chemical and biological properties of the sediment and to set limits above which disposal at sea will not be allowed without the use of management techniques or processes. To that end, the framework has established a tiered testing regime with lower, middle and upper levels. Canada has defined how it will apply these levels in the *Disposal at Sea Regulations*, with chemical guidelines used at the lower level and a battery of toxicity and bioaccumulation testing used to determine the middle and upper levels. The framework also requires the selection of a suitable disposal site, the construction of formal impact hypotheses and follow-up monitoring to ensure that decisions were correct and adequate to protect the marine environment. To monitor the disposal sites, Environment Canada has developed a set of National Monitoring Guidelines which also use both chemical and biological tools in a tiered fashion to help with cumulative assessment and site management. Reports are published annually.

Future Directions

There are currently a number of initiatives under way in Canada and in other countries around the world by research scientists, government and industry to further advance the current understanding of existing tools for the assessment of contaminated sediment. Some areas for future development include evaluation and improvement of the existing tools. One novel idea being explored is the development of a sediment quality index based on chemical-specific guidelines. There have been some pilot efforts in the Ontario Region of Environment Canada based on a CCME Water Quality Index model that integrates chemical data into a sediment quality index — potentially the subject of an upcoming factsheet. A variation on this approach, also currently being developed, is called “consensus-based sediment quality guidelines.” The strength of these types of indices is that they increase the predictive ability of numerical guidelines by applying them collectively (for more information, see Long et al. 1998; Ingersoll et al. 2000; MacDonald et al. 2000).

Approaches such as Environment Canada's BEAST are being applied to regions outside the Great Lakes, although expansion is limited to some extent by data requirements to establish reference conditions for a site or region. Notwithstanding, this is a powerful tool in a sediment assessment framework that could have application across Canada, including the marine environment.

WANT MORE INFORMATION?

Website: www.ec.gc.ca/ceqg-rcqe/

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