Chapter 4

A Recommended Approach for Deriving and Validating Effects-Based Sediment Quality Assessment Guidelines in Florida

4.0 Introduction

This chapter completes the evaluation of approaches for developing SQAGs conducted in Chapter 3 and provides an overview of, and rationale for, the recommended strategy for deriving and validating numerical SQAGs for Florida coastal waters. As indicated in Chapter 3, no effects-based SQAGs exist which apply directly to conditions in Florida. While effects-based SQAGs have been developed for specific parts of the country (e.g., in Puget Sound using apparent effects threshold approach; AETA), the EPA Science Advisory Board (SAB) has cautioned against using these guidelines outside the areas for which they were developed (Sediment Criteria Subcommittee 1989). The SAB has also questioned the validity of the sediment quality criteria that are currently under development by EPA (i.e., using the equilibrium partitioning approach; EqPA), although a more recent review is less critical (Sediment Quality Subcommittee 1992). These evaluations by the SAB suggest that the SQAGs that are under development in other jurisdictions are not likely to address Florida's immediate requirements for sediment assessment tools.

4.1 Considerations for Recommending a Strategy for Deriving Sediment Quality Assessment Guidelines for Florida Coastal Waters

A total of eight approaches for deriving numerical SQAGs were identified and reviewed in Chapter 3. However, selection of an appropriate procedure for deriving guidelines for Florida coastal waters necessitates further evaluation of each of the approaches in light of the state's specific needs. In this chapter, criteria are provided to evaluate candidate approaches and select a relevant strategy for deriving guidelines (Table 2). The primary considerations in the selection of the recommended strategy were related to practicality, cost-effectiveness, scientific defensibility, and broad applicability to the assessment of sediment quality. Each of these factors are discussed below.

Table 2. Evaluation of approaches for deriving sediment quality assessment guidelines.

Evaluation Criteria	SBA	SSTA	EqPA	TRA	SLCA	SQTA	AETA	WEA
Practicality								
Supports development of numerical SQA(	Y	Y	Y	Y	Y	Y	Y	Y
Feasible to implement in the near term?	Y	N	Y/N	Y/N	Y/N	N	N	Y
Cost Effectiveness								
Expensive to implement?	N	Y	N	Y	Y	Y	Y	N
Requires generation of new data?	N	Y	N	Y	Y	Y	Y	N
Scientific Defensibility								
Considers bioavailability?	N	Y	Y	Y	N	N	Y/N	Y/N
Provides cause and effect relationships?	N	Y	Y	N	Y/N	Y/N	Y/N	Y/N
Based on biological effects data?	N	Y	Y	Y	Y	Y	Y	Y
Considers data from South East?	Y	N	N	N	N	N	N	Y
Provides weight of evidence?	N	N	N	N	N	Y	Y	Y
Support definition of ranges of concentrations rather than absolute assessment values	N	N	Y/N	N	N	N	N	Y
Considers mixtures of contaminants?	N	N	N	N	Y	Y	Y	Y
Requires field validation?	Y	Y	Y	Y	Y	Y	Y	Y
Considers site-specific conditions?	Y	Y/N	Y/N	N	N	Y	Y	N
Applicable to all classes of chemicals?	Y	N	Y/N	Y	Y	Y	Y	Y
Applicability								
Supports monitoring programs?	Y/N	Y	Y	Y	Y	Y	Y	Y
Supports problem identification?	Y/N	Y	Y	Y/N	Y	Y	Y	Y
Supports regulatory programs?	N	Y	Y/N	N	Y/N	Y/N	Y	Y/N
Overall assessment	*	***	***	**	**	***	***	****

* = poor; ** = fair; *** = good; **** = excellent

Practicality is one of the central considerations with respect to the development of SQAGs. Numerical SQAGs must be functional (i.e., easy to use) and understandable if they are to be useful for assessing environmental quality. In addition, the immediate need for these assessment tools necessitates selection of an approach that can be implemented in the near term.

In Florida, limited agency resources make collection of a significant quantity of additional data improbable. Therefore, the approach that is recommended must support the development of numerical SQAGs with data that are currently available. In addition, it must be amenable to re-evaluation of the SQAGs as new data become available.

For SQAGs to be effective in Florida, they must be effects-based (i.e., consider biological effects) and scientifically defensible. Key evaluation criteria for assessing the various approaches include their potential to consider the factors that control the bioavailability of sediment-associated contaminants, to establish cause and effect relationships, and to apply to priority classes of chemicals and mixtures of contaminants that are expected to occur in Florida. They must be compatible with other interpretive tools, such as the metals interpretive tool that has already been developed by the Florida Department of Environmental Protection (FDEP). Furthermore, it is desirable for candidate approaches to be able to explicitly consider data from Florida and elsewhere in the southeastern United States and provide a means of accounting for site-specific environmental conditions.

Due to the uncertainty associated with the candidate approaches, it would be advantageous if the guidelines supported the identification of ranges of contaminant concentrations which are predicted to be associated with specific biological effects (as was recommended by the SAB; Sediment Quality Subcommittee 1992). That is, the guidelines should identify ranges of contaminant concentrations that have high, moderate, and low probabilities of being associated with adverse biological effects. The guidelines should also be supported by a weight of evidence provided by the available data.

To be applicable to Florida, SQAGs must address the needs of the agencies that are charged with managing environmental quality. For example, SQAGs should be relevant to designing, implementing, and evaluating environmental monitoring programs by helping identify contaminants that are likely to be associated with adverse biological effects. This would help determine the need for further investigations at sites with concentrations of specific contaminants that exceed the SQAGs. Guidelines should also support the identification of areas that are most in need of remediation; however, they would not necessarily be used to establish clean-up levels. Furthermore, guidelines should contribute to regulatory programs by helping to evaluate source control measures and the need for further biological and chemical testing to support regulatory decisions.

4.2 Recommended Strategy for Deriving Numerical Sediment Quality Assessment Guidelines for Florida Coastal Waters

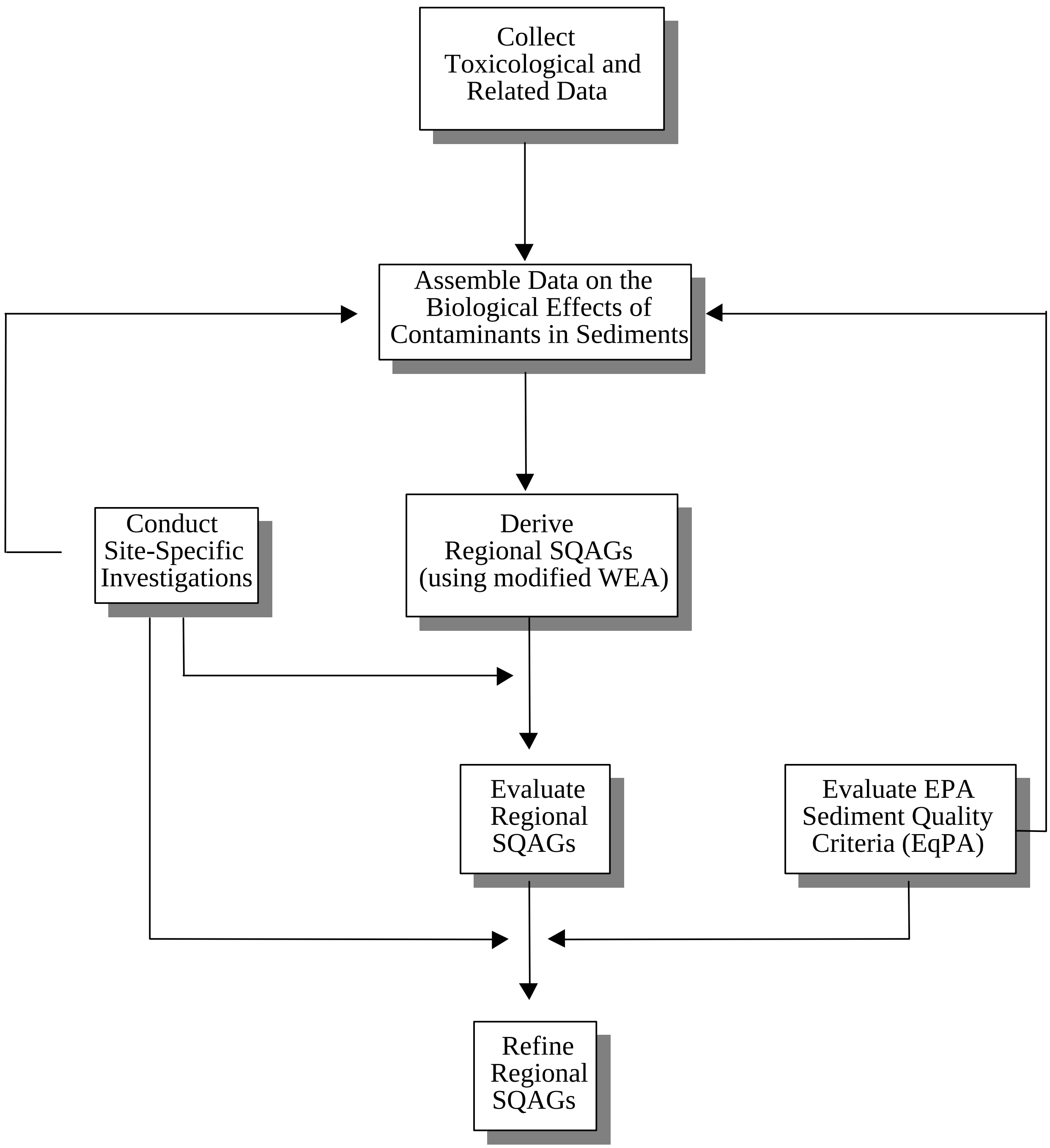
Ideally, SQAGs should be developed from detailed dose-response data which describe the acute and chronic toxicity of individual contaminants and chemical mixtures to sensitive life stages of resident species of aquatic organisms. These data should be generated in controlled laboratory studies, in which the influences of important environmental variables (such as TOC, AVS, salinity, and others) are identified and quantified and compared to the values predicted by appropriate models (e.g., EqP models). Finally, the results of these studies should be validated in field trials to ensure that any guidelines derived from these data are applicable to a broad range of locations.

Unfortunately, insufficient data are available to support deriving numerical SQAGs using the ideal approach. Currently, only a limited number of controlled laboratory studies (i.e., spiked-sediment bioassays) have been conducted to assess the effects of sediment-associated contaminants on estuarine and marine organisms (Long and Morgan 1990). However, in spite of this limitation, other types of data are routinely collected which contribute to our understanding of the toxic effects of these contaminants. Specifically, whole sediment toxicity tests have been conducted to assess the biological significance of concentrations of contaminants in sediments collected from numerous geographic locations. These toxicity tests include those performed on benthic organisms (bivalve mollusks, shrimp, amphipods, polychaetes, nematodes, chironomids and other arthropods, etc.) and on pelagic organisms [*Daphnia*, oyster larvae, luminescent bacteria (Microtox), etc.]. Furthermore, numerous field studies have been conducted to assess the diversity and abundance of benthic infaunal species (bivalve mollusks, arthropods, amphipods, etc.) and epibenthic organisms (echinoderms, crustaceans, etc.). For many of these studies, matching data on the concentrations of contaminants in these sediments have been collected. Studies which report matching sediment chemistry and biological effects data are highly relevant to the SQAGs derivation process.

In recommending a suitable strategy for deriving SQAGs, it is important to recognize the limitations of the existing information for evaluating the potential biological effects of sediment-associated contaminants. In addition, the strategy must address the immediate requirement for defensible SQAGs and the long-term requirement for increased reliability and applicability of these guidelines (i.e., guidelines that account for the environmental characteristics influencing the bioavailability of sediment-associated contaminants).

Evaluation of each of the approaches for deriving SQAGs in the context of the requirements for Florida (as expressed in Section 4.1) indicates that no single approach is likely to satisfy all of the immediate and long-term requirements for SQAGs (Table 2). For this reason, a strategy is recommended that places a priority on the immediate need for defensible SQAGs, while providing a framework for the revision or refinement of these values as data become available (Figure 1).

Figure 1. An overview of the recommended process for deriving numerical sediment quality assessment guidelines in Florida.



The weight of evidence approach (WEA; Long and Morgan 1990; Long 1992) provides a pragmatic means of generating scientifically defensible guidelines using data which are currently available. As such, this approach facilitates the immediate generation of SQAGs. However, several modifications (described in Chapter 5) to this approach are recommended to increase the applicability of the WEA to Florida. These modifications increase the quantity and suitability of data used to evaluate the biological significance of sediment-associated contaminants (i.e., to incorporate data from Florida, other southeastern areas, and elsewhere in North America). In addition, the arithmetic procedure for deriving the guidelines has been refined to consider data from relatively uncontaminated areas. A detailed description and evaluation of the modified WEA for deriving SQAGs is provided in Chapter 5.