

Chapter 8

Summary and Recommendations

8.1 Summary

This report recommends and evaluates numerical sediment quality assessment guidelines (SQAGs) for priority substances in Florida coastal waters. An approach was selected that would respond to Florida's management requirements. Following refinement of this approach, numerical SQAGs were derived for 34 substances or groups of substances. These SQAGs were subsequently evaluated to determine their comparability, reliability, and predictability. Volume 2, *Applications of the Sediment Quality Assessment Guidelines*, provides guidance on the intended uses of the SQAGs. Volumes 3 and 4, *Supporting Documentation - Biological Effects Database for Sediments* and *Supporting Documentation - Regional Biological Effects Database for Sediments*, summarize the data that were used to develop the SQAGs.

In Florida, conservation and protection of natural resources is a high priority environmental management goal. Achieving this goal requires protection of living resources and their habitats in estuarine, nearshore, and marine ecosystems. In the last decade, there has been a significant increase in the level of understanding (and public recognition) of the role sediments play in coastal ecosystem functions. Sediments are particularly important in determining the fate and effects of environmental contaminants.

Recent monitoring data indicate that concentrations of various contaminants are elevated at numerous locations in Florida coastal sediments. The SQAGs are needed to evaluate the potential for biological effects associated with these contaminants and to provide assistance in managing coastal resources. In this respect, SQAGs provide useful tools for focusing limited resources on the highest management priorities.

To identify an appropriate procedure for deriving SQAGs, the major approaches used in other jurisdictions to derive numerical SQAGs were evaluated in the context of Florida's requirements for sediment quality assessment values. The results of this analysis indicated that a weight of evidence approach (WEA) used by the NOAA National Status and Trends Program (Long and Morgan 1990) would respond most directly to Florida's requirements. Therefore, a strategy that relied on a refined version of the WEA was recommended to derive numerical SQAGs for near-term use in addressing sediment quality concerns.

Sediment quality assessment guidelines have been developed for 34 priority contaminants and groups of contaminants in Florida coastal waters. However, insufficient data were available to derive guidelines for another 20 substances that are known or are suspected to contaminate Florida coastal sediments. The numerical SQAGs were used to define three ranges of concentrations for each of the 34 contaminants: a probable effects range; a possible effects range; and, a minimal effects range.

A preliminary evaluation of the recommended SQAGs was conducted to determine their potential applicability in Florida coastal waters and other areas in the United States. The results of this evaluation indicate that most of the SQAGs can be used with a high or moderate degree of confidence to conduct sediment quality assessments. The SQAGs for 18 to 20 substances were comparable to similar guidelines developed by other investigators using different approaches and procedures. In addition, the SQAGs for 28 substances had a moderate or high degree of reliability, as indicated by analysis of the incidence of adverse effects in the expanded NSTP database. Furthermore, the SQAGs for 34 substances compared to field-collected data, were found to provide predictive tools for classifying sediments in terms of their potential for being associated with adverse biological effects. Therefore, the results of all three evaluations indicated that the SQAGs are likely to be appropriate for use in a variety of applications in Florida and elsewhere in the United States.

The recommended SQAGs support the identification of contaminated sites and priority chemicals of concern in Florida coastal waters. As such, the guidelines can contribute to the design, implementation, and evaluation of local and state sediment quality monitoring programs. In addition, the guidelines may be used in a variety of environmental management applications, including identifying the need for further testing to support regulatory decisions and evaluating the need for remedial actions. Furthermore, SQAGs provide a common basis for reaching agreements on sediment quality.

The preliminary guidelines were established to provide a yardstick for evaluating sediment quality in Florida. As such, these guidelines may be used to screen sediment chemistry data and establish priorities with respect to sediment quality management. They should not be used in lieu of water quality criteria, nor should they be used as sediment quality criteria. Ambient environmental conditions may influence the applicability of these guidelines at specific locations.

8.2 Recommendations

The following recommendations will strengthen the identification and management of contaminated sediments. While several tasks might appear onerous, most will not require significant resources to complete. Importantly, FDEP has forged partnerships with key investigators in this field, including the National Atmospheric and Oceanic Administration,

National Biological Survey, U.S. Environmental Protection Agency, California State Water Resources Board, and Environment Canada. Activities which are being conducted or planned by these and other agencies will provide products which can be used directly to implement the recommendations. The Department is encouraged to strengthen these relationships and develop a plan of action for addressing sediment contamination.

8.2.1 Conduct Further Screening and Expansion of the NSTP Database

An expanded NSTP database was used to support the derivation of numerical SQAGs for Florida coastal waters. This database should be updated and expanded as new information on the biological effects of sediment-associated contaminants becomes available (see discussion in Section 4.3). Specifically, the database should be expanded to include the results of high quality coastal studies that have recently been conducted in Florida (e.g., Pensacola Bay, St. Andrews Bay), the southeast (e.g., Savannah, GA; Charleston, SC), and elsewhere in the United States (e.g., San Pedro Bay and San Diego Harbor, CA; Boston Harbor, MA). The database should also be improved by further screening the data to identify the highest quality data; additional procedures for screening data were recently proposed by the Science Advisory Group on the Assessment of Sediment Quality.

8.2.2 Strengthen and Add Sediment Quality Assessment Guidelines

An updated and further expanded NSTP database should be used to strengthen the SQAGs recommended in this document and to derive guidelines for additional priority substances (for which insufficient data were available for developing this report) identified in Florida coastal sediments. Numerical SQAGs or refined SQAGs are required for the following substances and groups of substances:

- Metals (specifically, mercury and nickel);
- Organotins;
- Polychlorinated biphenyls (PCBs);
 - Pesticides (specifically, azinphos-methyl, chlordane, chlorothalonil, chlorpyrifos, DDTs, disulfoton, endosulfan, endrin, heptachlor, heptachlor epoxide, endrin, lindane, phorate, toxaphene, and trifluralin);
- Polychlorinated dibenzo-*p*-dioxins (PCDDs);
- Polychlorinated dibenzofurans (PCDFs);
- Pentachlorophenol; and,
- Phthalate esters (specifically, dimethyl phthalate and di-n-butyl phthalate).

8.2.3 Further Evaluate the Sediment Quality Assessment Guidelines

In Chapter 7, the SQAGs were evaluated to determine their applicability in Florida coastal waters. This evaluation focused on the comparability, reliability, and predictability of the SQAGs. However, this evaluation was preliminary and additional data from field surveys and laboratory studies are required to further evaluate the SQAGs.

Many types of sediments occur in Florida coastal ecosystems, ranging from terrigenous sediments in the northern portion of the Gulf coast to carbonate sediments in some areas of south Florida. There is significant potential for differences in the bioavailability (and hence the toxicity) of contaminants in different sediment types. Although the information used to derive the SQAGs includes data from a wide variety of sites in North America, it is possible that these data do not adequately represent the range of conditions in Florida. Further biological testing and benthic invertebrate community evaluations should be conducted in various Florida sediments to determine the applicability of SQAGs. These locations should be selected to encompass a wide range of sediment types and should include contaminated sites and uncontaminated "reference" locations.

The recommended guidelines are based on dry weight-normalized contaminant concentrations. The preliminary evaluation of these SQAGs indicated that they were both reliable and predictive. Nonetheless, the results of several studies suggest that certain variables (such as total organic carbon and acid volatile sulfide) could influence the bioavailability of sediment-associated contaminants. Data from other studies have not confirmed these relationships. Therefore, additional data is needed to define the conditions governing the bioavailability of individual contaminants in Florida coastal sediments. The guidelines should be refined appropriately when these relationships become more clearly established.

8.2.4 Determine the Sensitivities of Selected Florida Estuarine Invertebrate Species

The relative sensitivity of species that occur in Florida is a central consideration for further evaluating the applicability of the SQAGs. The SQAGs recommended for assessing the potential for biological effects of sediment-associated contaminants in Florida were developed using data on a wide variety of species that occur in North America. However, biological effects data on aquatic organisms from the southeastern portion of the United States are limited. Therefore, it is difficult to determine if the recommended SQAGs would adequately protect aquatic organisms that occur in Florida coastal waters. Additional biological testing and benthic invertebrate community evaluations should be undertaken to determine if aquatic organisms that occur in Florida have sensitivity ranges similar to organisms occurring in other parts of North America.

8.2.5 Develop Bioaccumulation-Based Sediment Quality Assessment Guidelines

The numerical SQAGs recommended in this study were primarily developed from information on the effects of sediment-associated contaminants on sediment-resident organisms. However, these SQAGs do not consider the potential for bioaccumulation of persistent substances in the tissues of aquatic organisms nor the potential for adverse effects on the human and non-human consumers (wildlife) of these aquatic organisms. Therefore, bioaccumulation-based SQAGs should be developed for the most persistent and bioaccumulative substances that occur in Florida coastal sediments and used with the effects-based SQAGs that were derived in this study. The tissue residue approach may provide appropriate procedures for developing the required SQAGs (see Section 3.4).

8.2.6 Develop Sediment Quality Assessment Guidelines for Freshwater Ecosystems

The SQAGs developed in the present study and the Department's metals interpretive approach are tools for evaluating coastal sediment quality conditions. No such tools exist for use in Florida's freshwater ecosystems. Effects-based SQAGs should be developed to evaluate the biological significance of contaminated sediments in freshwater systems. In the past year, Environment Canada has made progress in developing a biological effects database for freshwater sediments. Upon completion, the information contained in this database could be used to derive numerical SQAGs for freshwater ecosystems. Hence, the FDEP is encouraged to cooperate with this agency to take advantage of the considerable cost-savings and head-start in developing freshwater SQAGs.

In addition to effects-based SQAGs, a companion tool is required to identify metals contamination in freshwater sediments. Therefore, it is recommended that the Department's metals interpretive tool and similar procedures for identifying anthropogenic enrichment of sediment-associated metals be evaluated for application in Florida freshwater sediments.

8.2.7 Improve Survey Procedures

In the past, several sampling, chemical analytical, and biological testing procedures have been used in sediment toxic effects studies (e.g., dredged material disposal, etc.) conducted in Florida coastal waters. Often, the procedures have limited the applicability of the studies and hindered their use in broader ecological investigations. Routine practices should be re-evaluated in light of recent information and procedures refined as appropriate.

Standard procedures for collecting, storing, characterizing, and manipulating sediments that are to be used in toxicological testing have been established by the ASTM (1994) and should be followed. The results of the assessment of the SQAGs indicate that aquatic organisms exhibit a range of sensitivities to sediment-associated contaminants. Therefore, there is a need to ensure that biological investigations of sediment quality employ a battery of tests, with a focus on sensitive species and sensitive endpoints. For example, the results of the sea urchin fertilization test (using porewater) was highly correlated with sediment chemistry in Tampa Bay and Pensacola Bay (Long *et al.* 1994; Long Unpublished data). In contrast, the results of short-term toxicity tests which measure the survival of adult sand worms, bivalves, or shrimp provide little information for assessing sediment quality. Standard methods for conducting biological tests with a range of species (e.g., amphipods and polychaetes; ASTM 1993) have been developed to provide guidance to practitioners in this field and adherence to these protocols will improve the quality of data that are generated in Florida.

8.2.8 Increase Coordination with Federal Agencies on Contaminated Sediment Management

In the southeastern United States, there are a relatively large number of independent and loosely-related initiatives involved in evaluating and managing contaminated sediments. Development of a regional intergovernmental strategy for contaminated sediment assessment and management would improve the effectiveness of state and federal programs, encourage greater local support in preventing sediment contamination and restoring sediment quality, and reduce unnecessary regulatory delays. For example, the FDEP coastal contaminants database is used in a variety of applications, including wetland permitting and restoration, contaminated site clean up, and identifying stormwater management priorities. The consolidation of this data with comparable sediment quality data from other programs, such as the EPA Environmental Monitoring and Assessment Program (EMAP), would be of considerable benefit to both the responsible agencies and the regulated entities.

A cooperative effort should be pursued by the National Oceanic and Atmospheric Administration, National Biological Survey, United States Fish and Wildlife Service, United States Environmental Protection Agency, United States Army Corps of Engineers, United States Geological Survey, Florida Department of Environmental Protection, and other affected agencies to identify priority sediment management, monitoring, and regulatory objectives, and to develop an interagency strategy for achieving them.