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EPA

Watershed Protection: TMDL Note #2

Bioassessment and TMDLs

Background

Total Maximum Daily Loads (TMDLs) allocate allowable loads among different pollution sources so that appropriate control actions can be taken, water quality standards achieved, and human health and aquatic resources protected. To attain applicable water quality standards effectively, all sources of pollution to surface waters must be considered, including nonchemical stresses such as habitat alteration and hydromodification. This requires incorporating evaluations of the physical and biological components of aquatic ecosystems. Biological assessments (bioassessments) are well-suited to identifying aquatic life use impairments and evaluating their relative magnitude.

Bioassessment is the evaluation of ecosystem condition using integrated assessments of habitat and biological communities and comparing the results of the assessments to empirically defined reference conditions. Once an impairment is identified, other techniques, such as chemical sampling and toxicity testing might be needed to determine the cause(s) of impairment and sources of stress so that appropriate mitigation strategies can be designed and implemented. Bioassessments performed through time provide information about the ecological integrity (i.e., the condition of an unimpaired ecosystem as measured by combined chemical, physical, and biological attributes [Barbour et al., 1992]) of the waterbody and can indicate whether pollution control actions are achieving the biological endpoints that might be specified by a TMDL. They are particularly valuable for assessing the effects of physical habitat degradation on biological resources. Bioassessments can lead to substantially more accurate water resources assessments by explicitly linking biological and physical habitat evaluations with chemical water quality determinations.

Why is ecological regionalization important?

The TMDL process is a geographically-based approach to preparing load and wasteload allocations for sources of stress that might impair waterbody integrity. The geographic nature of this process can be complemented and enhanced by using ecological regionalization as part of bioassessment activities.

Ecosystems with similar spatial patterns can be grouped into ecoregions, which can be developed using mapped variables, such as hydrologic units, land-surface form, soil type, potential natural vegetation, and land use. Naturally occurring biotic assemblages would be expected to differ among ecoregions but to be relatively similar within a given region. One of the key tests for determining the validity of ecoregions is to establish that variability within regions is less than between regions. The ecoregion concept provides a geographic framework for more efficient aquatic resource management. A logical result of applying regionalization is that similar water quality standards, criteria, and monitoring strategies are likely to be valid throughout a particular ecoregion, but should be modified to accommodate differences between regions (Gallant et al., 1989). Ecoregionalization provides a means of identifying sites that represent valid reference conditions for an entire region for biosurveys and assessments. This

can obviate the need to identify site-specific reference (i.e., minimally impaired) locations. These might not exist in many watersheds affected by urbanization and agriculture.

How can bioassessment be used in the TMDL process?

1. Identification of Water Quality-Limited Waters that Require TMDLs

The first step in the water quality-based approach is to identify waterbodies that do not meet water quality standards after required controls have been installed. See Figure 1. This requires reviewing water quality standards, evaluating monitoring data, and determining whether adequate controls are in place. Biological community and habitat impairments are identified by comparing biological monitoring data from waters of concern against a reference condition (i.e.,"pristine" or minimally impaired waters) (Plafkin et al., 1989). The ability to complete bioassessments relatively rapidly enables states to meet the biennial reporting requirement for a list of waters still needing TMDLs and priority waterbodies.

2. Priority Ranking and Targeting Listed Waters

For the second step, a state prioritizes its list of waters needing TMDLs and targets those waters for development of TMDLs within a specified period. While individual states define their own ranking process, the Environmental Protection Agency (USEPA) has encouraged the adoption of ranking processes that integrate the pollution control activities in a state with other resource management programs and activities that directly or indirectly relate to water quality. Bioassessment data can be used in the ranking and targeting process to determine the relative vulnerability or fragility of particular waterbodies as aquatic habitat. USEPA guidance (1991) lists this as a factor states might consider.

Ecoregionalization in Ohio

Ecoregionalization has been effectively used in Ohio to increase the utility of bioassessments for reporting under Clean Water Act §305(b). The development of ecoregions has allowed Ohio to identify previously undetected water quality impairment using biocriteria and bioassessments. A comparison of the waterbody impairments identified using biocriteria with waterbody chemical exceedances based on the Ohio Water Quality Standards was performed as part of Ohio's 1990 305(b) reporting. It showed that biological impairment was evident in 49.8 percent of the waterbody segments where no ambient chemical water quality exceedances were observed (Yoder, 1991). Biological and chemical assessments both indicated impairment (or lack of impairment) in slightly greater than 47 percent of the waterbody segments. The development of ecoregions and subecoregions was fundamental to the ability of biological assessments, in concert with biocriteria, to generate these results (Yoder, 1991; Shepard, 1993).

3. TMDL Development

This third step of the TMDL process involves the compilation and analysis of all available data, as well as any modeling that might be needed to prepare a TMDL for the stressor of concern. TMDLs can and should be developed for nonchemical stressors that are identified through biosurveys and habitat assessments. For example, biosurveys and habitat assessments are excellent tools for identifying where damaged riparian zones should be repaired in order to reduce stream temperature and bank erosion in cool and cold-water streams. These techniques can be useful for indicating where sediment loadings should be reduced to reduce stream channel embeddedness in trout and salmon spawning reaches. They can also indicate the size of impacted habitat.

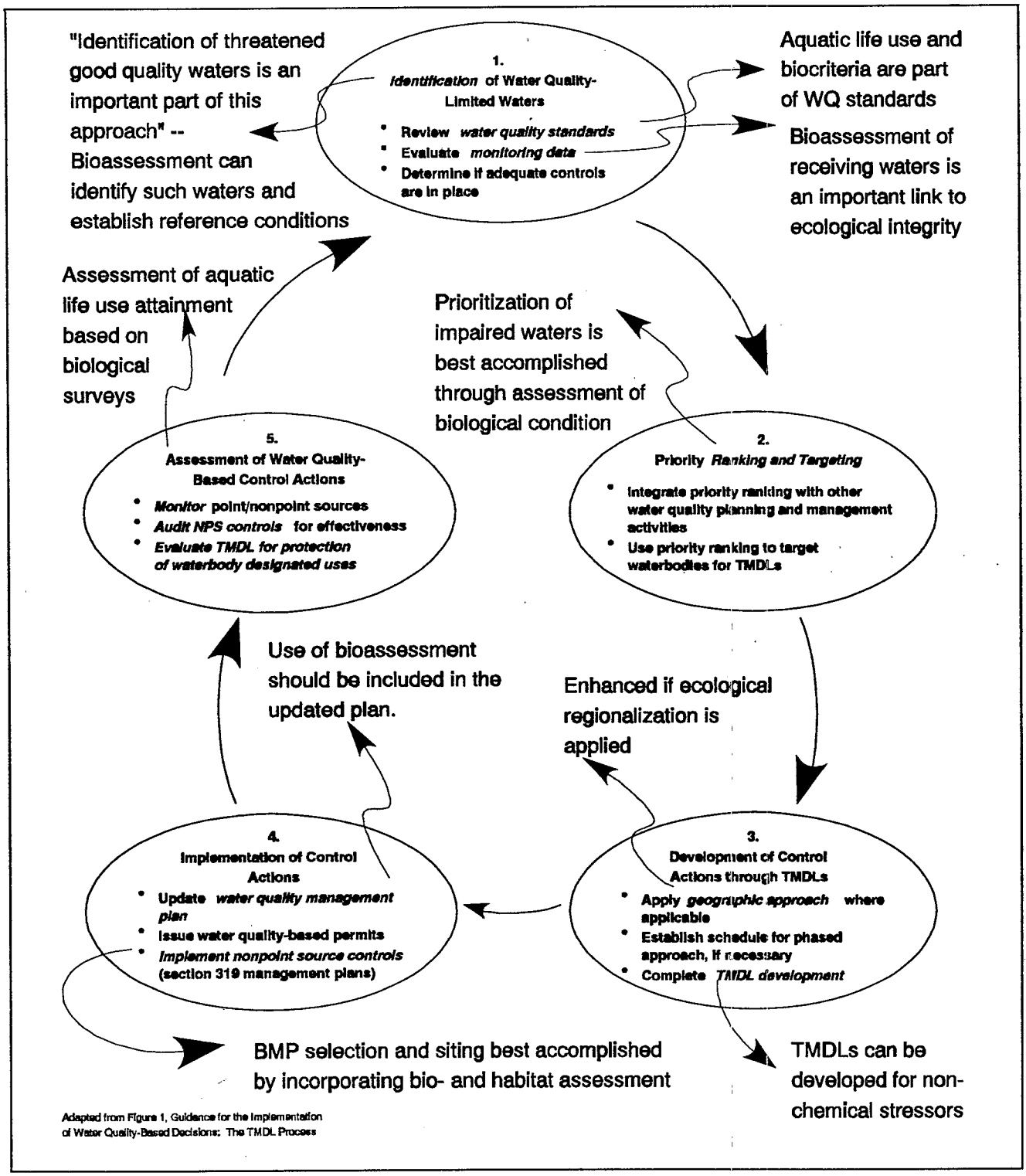

Figure 1. Using bioassessment in the TMDL process

4. Implementation of Control Actions

After TMDLs are developed, states must choose appropriate control actions, then site and implement them so that specific sources of stress can meet the allocations specified by the TMDL. Bioassessment and habitat data can be useful for selecting and siting required controls. For example, bioassessment and

habitat data might show that a particular stream reach is impaired due, in part, to poor habitat conditions and that those conditions are caused by sediment originating from streambank erosion upstream. Reestablishing vegetated riparian buffer zones would be a reasonable control action for this case, which would have the additional benefits of reducing stream temperature as the vegetation matured and increasing the food base for macroinvertebrates because allochthonous material would be added to the stream.

5. Assessment of Water Quality-Based Control Actions

Bioassessment can be used as one component of an integrated monitoring approach to measure pollutant inputs from point and nonpoint sources following implementation of control actions. For example, bioassessment can be used to determine the biological and habitat effects of a streambank fencing program to reduce streambank erosion in agricultural areas or the effects of controls applied to combined sewer overflows. Collection of monitoring data is essential for evaluating whether the TMDL that is developed for a waterbody is successful at protecting designated use(s).

References

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