2. SUMMARY OF FINDINGS

2.1 Summary of Current Biological Assessment Programs and Biocriteria Development

This report summarizes the national breadth of biological monitoring and assessment in stream and wadeable river management programs based on 2001 program information (Table 1). Since this summary pertains to more than just "states," the term "entity" is used to refer to the combination of states, tribes, territories, and interstate commissions. Survey responses were received from 65 entities (50 states, District of Columbia, four territories, six tribes, and four interstate commissions – see Appendix A for a complete list).

Although ranging across a wide spectrum – from initial pilot studies to comprehensive assessment – 57 of the 65 entities have bioassessment programs for streams and wadeable rivers, and two (Puerto Rico and the Nez Perce Tribe) have programs under development. Nearly 440,000 river and stream miles nationwide are assessed using biological data (see Figure 1a for state-by-state percentages). More importantly, as shown in Table 1, 40 entities use bioassessment to help determine aquatic life use support (ALUS) for their 305(b) reporting (Figure 1b), and six states (AK, CA, HI, MT, NV, OK) are developing processes for using biological data to interpret ALU. Thirteen entities, including seven states (AZ, AR, CO, DE, LA, SD, UT) either don't have *comprehensive* statewide bioassessment programs in place, or they don't yet use bioassessment data to determine the condition of their waters.

A total of 29 entities have incorporated narrative biocriteria into their WQS (Figure 2a). The 11 entities (AZ, CO, HI, IL, IN, IA, MD, MT, NV, WA, Pyramid Lake Paiute Tribe) in a developmental phase of adopting narrative biocriteria into their WQS are at various stages in this process. While some may have already developed biocriteria and are working on promulgating the statements into their WQS, others are awaiting state or federal approval, or are in the earlier stages of developing narrative biocriteria to be submitted for review. Although 20 entities do not have narrative biocriteria in their WQS, several of these have incorporated general aquatic life statements. The following five entities – ICPRB, SRBC, Nez Perce Tribe, Oneida Nation of Wisconsin and Passamaquoddy Tribe - Pleasant Point Reservation – do not have federally approved WQS and are not currently working toward that end. Therefore, these entities are not included in any biocriteria counts.[1]

Of the 29 entities with narrative biocriteria incorporated into their WQS, 22 have also developed quantitative implementation procedures or translators, and eight are working to develop them (Figure 2b). These procedures can be found in various documents including WQS, SOPs, 305(b) guidelines, and other agency documents. While numeric procedures are not numeric *biocriteria* per se, they do provide a quantitative basis for assessing attainment of specific designated aquatic life uses and are an important step in biocriteria development.

[1] While the Oneida Nation does not have federally approved water quality standards, the Tribe is currently using bioassessments to implement their water quality program under tribal law. Inclusion of narrative and numeric biocriteria into the Tribe's WQS is under development.

Table 1. National summary of bioassessment programs for streams and wadeable rivers in 2001

PROGRAMMATIC ELEMENT	NUMBER OF ENTITIES			
	In-place	Under development	None	Not applicable
Use of Bioassessments				
Water resource management	57	2	6	0
Interpret aquatic life use attainment	40	6	13	6[2]
Narrative biocriteria in WQS	29	11	20	5[3]
Narrative biocriteria in WQS with quantitative implementation procedures or translators	22	8	30	5[4]
Numeric biocriteria in WQS	4	11	45	5[4]
Assemblage Used				
Fish	41	0	16	8[4]
Benthic macroinvertebrates	56	1	0	8[5]
Algae (periphyton, diatoms)	20	5	32	8[5]
More than one assemblage	45	5	7	8[5]
Reference Conditions				
Ecoregional	42	2	12	9[5]
Site-specific	19	1	37	8[6]
State-wide or basin-specific	7	1	46	11[6]
Analysis				
Biological metrics	54	1	1	9[7]
Multivariate	22	2	32	9[8]
Assessment				
Multimetric index	41	3	12	9[8]
Habitat assessment	57	0	0	8[3]

[2] DRBC and ICPRB are not regulatory authorities. Nez Perce Tribe, Oneida Nation of Wisconsin, Passamaquoddy Tribe - Pleasant Point Reservation, and Pyramid Lake Paiute Tribe do not have federally approved WQS.

[3] ICPRB, SRBC, Nez Perce Tribe, Oneida Nation of Wisconsin and Passamaquoddy Tribe - Pleasant Point Reservation do not have federally approved WQS and are not currently working toward that end.

[4] The following entities do not use biological assessment methods as a means to assess stream and river water quality: American Samoa (AS), Puerto Rico (PR), U.S. Virgin Islands (USVI), Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida. The Commonwealth of Northern Mariana Islands (CNMI) has a bioassessment program for marine systems only; bioassessment for freshwater is not applicable.

[5] Virginia did not provide complete reference condition information. American Samoa, CNMI, Puerto Rico, U.S. Virgin Islands, Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida do not have bioassessment programs.

[6] AS, CNMI, PR, USVI, Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida do not have bioassessment programs.

[7] Pyramid Lake Paiute Tribe has not yet analyzed or evaluated their biological data. AS, CNMI, PR, USVI, Confederated Tribes of the Colville Reservation, Nez Perce Tribe, Passamaquoddy Tribe - Pleasant Point Reservation, and Seminole Tribe of Florida do not have bioassessment programs.

Four entities (FL, OH, OK, DRBC) have numeric biocriteria incorporated into their WQS (Figure 2c).[8] And of the 11 entities for which numeric biocriteria is categorized as "under development," Maine and Wyoming have developed and incorporated numeric biocriteria into other program documents, such as SOPs and monitoring guidance manuals, and have been using the numeric limits to maintain designated uses.

The three major groups of biological organisms or assemblages monitored as part of comprehensive biological assessment programs are fish, benthic macroinvertebrates, and algae (periphyton). Macroinvertebrates are the most common indicator assemblage used by state water quality agencies and are a part of all but Hawai`i's bioassessment program, where it is currently under development (Figure 3a). The second most common assemblage monitored is fish, followed by periphyton (Figures 3b and 3c). Forty-five entities monitor for at least two assemblages, and another five (AK, HI, NV, UT, WY) currently use one, but are developing the capability of using a second (Figure 3d).

One of the key elements in bioassessment programs is the establishment of reference conditions to help discern human impacts from natural variation. The two types of reference conditions currently used in biological surveys are regional and site-specific. The Ecoregion Concept, a common regionalization approach, recognizes geographic patterns of similarity among ecosystems and the subsequent distribution of biological communities grouped on the basis of environmental variables such as climate, soil type, physiography, and vegetation. Forty-two entities have adopted this method of stream stratification/ characterization in developing reference conditions (Figure 4). Site-specific reference conditions typically consist of condition measurements taken upstream of a point source discharge or from a "paired" watershed. However, their usefulness is limited since they have only site-specific value (USEPA 1999). Only nine entities primarily use this approach to determine reference conditions.

Biological metrics and multivariate analysis are two types of data analysis tools/methods used to reduce a wealth of raw data into workable indicators of biological condition. Nearly all of the entities with bioassessment programs have developed biological metrics. In addition, just under half use multivariate analysis (techniques that look at the pattern of relationships among several variables simultaneously, such as principal components analysis (PCA) and non-metric multidimensional scaling (NMS)). Of the 54 entities that select and calculate biological metrics, 41 aggregate these metrics into a multimetric index (such as fish or macroinvertebrate IBIs) to assess biological condition and water quality, and to discriminate between impaired and unimpaired conditions (Figure 5). Finally, all entities with bioassessment programs also assess the physical habitat quality at their sample sites, usually employing visual based methods (such as QHEI and RBPs) in combination with other measurements.

2.2 Bioassessment Program Success from 1989 to 2001

In 1989, when developing the *Rapid Bioassessment Protocols for Use in Streams and Rivers*, USEPA summarized the bioassessment and biomonitoring capabilities in state regulatory programs (USEPA 1989). While the 1989 summary did not determine the actual use of the bioassessment data for all states, it did provide an estimate based upon past knowledge of state programs and on the documentation gathered during its development.

The *Summary of State Biological Assessment Programs for Streams and Rivers,* based on 1995 data, compiled a more comprehensive assessment of state uses of bioassessments and biocriteria in water management programs (USEPA 1996). The document serves as the baseline for determining changes and improvements in bioassessment capabilities over the past six years. Table 2 presents a summary of the 1989 and 1995 results alongside the 2001 data from Table 1. The incremental change (from 1989 to

---

[8] Florida has made substantial progress in developing new multimetric indices for streams (Stream Condition Index and BioRecon), lakes (Lake Condition Index), and wetlands for eventual inclusion in the Florida Administrative Code. When the new indices are adopted as water quality standards, the role of Shannon-Weaver diversity as a numeric standard will be re-evaluated.

Macroinvertebrate biocriteria were developed for DRBC's Special Protection Waters rules issued in 1990, but the criteria were later found to be based upon inconsistent and non-representative methods and have not been used as envisioned during development of the Commission's antidegradation policies. Program redesign recommendations were recently made to improve effectiveness and applicability of the criteria.

1995, and 1995 to 2001) appears in parentheses, and an additional column indicates the net change from 1989 to 2001. For the purposes of comparison, Table 2 only contains program information from the original 52 entities surveyed in 1989 and 1996 (50 states, the District of Columbia, and ORSANCO). Refer to Table 1, Chapter 3, and Appendix A for programmatic information on the additional entities surveyed for this document.

There has been extensive progress in the development and use of biological assessments and criteria as revealed by virtually all measures of the survey as shown in Table 2. All 52 entities contained in this table have incorporated bioassessment in their water resource management programs. This is up over 20% from a count of 41 in 1989. Although the number of states that used bioassessments to determine aquatic life use attainment in 1989 is unknown, these numbers did increase noticeably from 1995 to 2001. And despite the fact that the number of entities with numeric biocriteria in their WQS has only increased by two over the past 12 years, 18 entities have developed and implemented quantitative procedures or translators for use in their water quality management programs (Figure 2b), and sixteen are in the process of developing narrative and/or numeric biocriteria for their standards.

Since 1989, the number of entities sampling at least one of the three major assemblages has steadily grown. Almost every entity surveyed in 1995 now conducts benthic macroinvertebrate assessments (Figure 3a). Even periphyton sampling, which declined from 1989 to 1995, rose sharply from 1995 to 2001. Studies have found that assessing only one assemblage can only achieve roughly 80 to 85% effectiveness at identifying aquatic life use attainment or nonattainment. Thus, since 1995, USEPA has recommended the use of multiple assemblages, especially in larger streams (USEPA 1996). The number of entities using more than one assemblage in 2001 reached 41 (an increase of 15 in just five years); and 20 of these 41 entities sample for at least three, and even four, assemblages, such as phytoplankton, macrophytes and zooplankton (Figure 3d).

One of the major advancements since 1989, and especially since 1995, has been the increased use of regional reference conditions as a basis for making comparisons and detecting use impairment. Only four states were actively using ecoregional reference conditions in 1989, and still only 15 in 1995. However, by 2001, 39 entities characterized reference conditions using a composite or aggregation of least or minimally impaired sites within distinct ecoregions (Figure 4). And conversely, 11 fewer entities used a site-specific approach alone to determine reference conditions.

The number of entities using biological metrics for data analysis increased by eight in 2001, in step with a sharp increase of 39 between 1989 and 1995. Today, all but two of the surveyed entities contained in Table 2 have developed biological metrics.

Finally, for the 2001 survey, we narrowed the definition of what constitutes narrative biocriteria in WQS to exclude general aquatic life statements. We adhered to the definition of narrative biocriteria as “narrative expressions that describe biological integrity of aquatic communities inhabiting waters of a given classification or designated aquatic life use.” We also required entities to clarify how the criteria were operationally defined in their WQS. This examination yielded a count of 28 entities with narrative biocriteria in their WQS, one entity less than was reported in 1995. However, had we used the 1995 definition of narrative biocriteria, these 28 entities would grow to 40, resulting in an increase of 11 between 1995 and 2001.

Refer to Appendix A for a summary of pertinent information for each entity surveyed. This information is captured in greater detail and clarity in the individual program summaries found in Chapter 3.

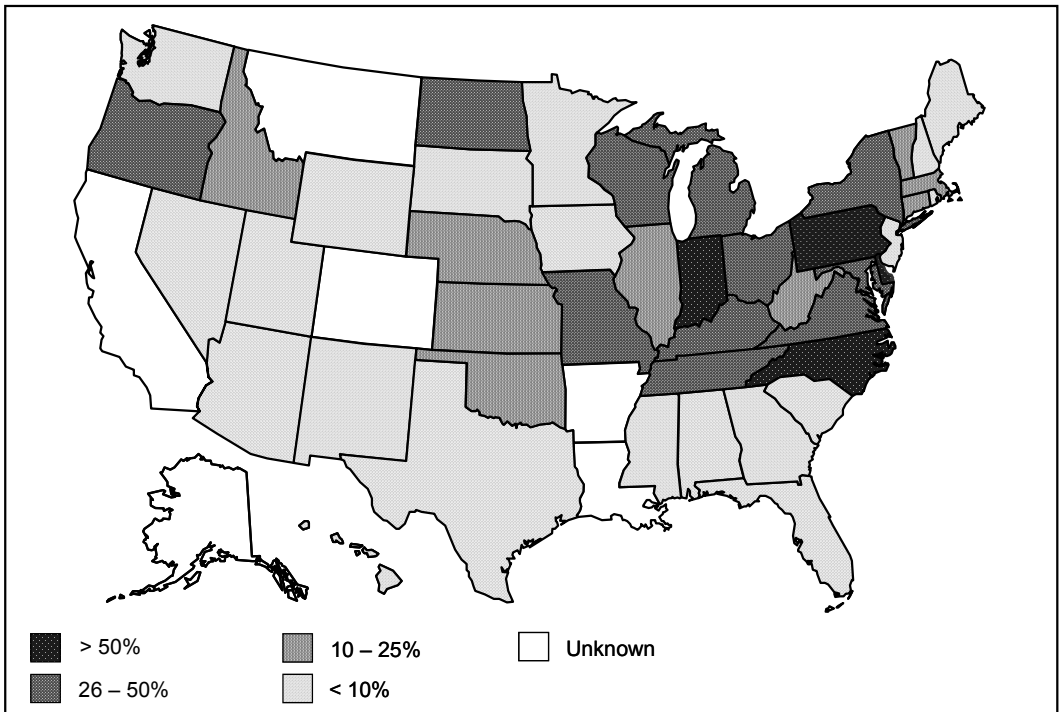
Table 2. National summary of bioassessment programs for streams and wadeable rivers in 1989, 1995, 2001 and the interim change [9]

PROGRAMMATIC ELEMENT	NUMBER OF ENTITIES (see note below)											
	In-place				Under Development				None			
	1989	1995	2001	net change	1989	1995	2001	net change	1989	1995	2001	net change
Use of Bioassessments												
Water resource management	41	41 (+0)	52 (+11)	+11	3	8 (+5)	0(-8)	-3	8	3 (-5)	0(-3)	-8
Interpret aquatic life use attainment	unk	31	39 (+8)	+8	unk	8	6 (-2)	-2	unk	13	7 (-6)	-6
Narrative water quality standard	unk	29	28 (-1)	-1	unk	11	10 (-1)	-1	unk	12	14 (+2)	+2
Numeric water quality standard	1	2 (+1)	3 (+1)	+2	unk	15	10 (-5)	-7	49	35 (-14)	39 (+4)	-8
Organism Group Used												
Fish	22	29 (+7)	37 (+8)	+15	1	5 (+4)	0 (-5)	-1	28	18 (-10)	15 (-3)	-13
Benthic macroinvertebrates	39	44 (+5)	51 (+7)	+12	3	5 (+2)	1 (-4)	-2	10	3 (-7)	0 (-3)	-10
Algae (periphyton, diatoms)	7	4 (-3)	19 (+15)	+12	0	3 (+3)	5 (+2)	+5	44	45 (+1)	28 (-17)	-16
More than one assemblage	24	26 (+2)	41 (+15)	+17	4	10 (+6)	5 (-5)	+1	26	16 (-10)	6 (-10)	-20
Reference Conditions												
Ecoregional	4	15 (+11)	39 (+24)	+35	2	26 (+24)	2 (-24)	0	44	11 (-33)	11[10] (0)	-33
Site-specific	unk	31	19 (-12)	-12	unk	0	1 (+1)	+1	unk	21	32[10] (+11)	+11
State-wide or basin-specific	unk	6	6 (0)	0	unk	0	0	0	unk	46	46[10] (0)	0
Multiple Metrics for Data Analysis												
Biology	3	42 (+39)	50 (+8)	+47	11	6 (-5)	1 (-5)	-10	35	4 (-31)	1 (-3)	-34

NOTE: The same 52 entities were used for each of the years for the most accurate comparison of changes over time.

[9] The incremental change (from 1989 to 1995, and 1995 to 2001) appears in parentheses, and the "net change" column indicates the total change from 1989 to 2001, or 1995 to 2001 where 1989 data is unknown.

[10] The *Ecoregional* and *State-wide or basin-specific* elements are not applicable to New York and Virginia's programs (Virginia did not complete this section). The *Site-specific* element is not applicable to Utah's program. For the purposes of comparison, each has been counted as *None* in this table.



*The use of various monitoring designs, i.e. targeted vs. probabilistic, influences the derivation of these numbers.

Figure 1a. Percent of total stream/river miles assessed in each state using bioassessments

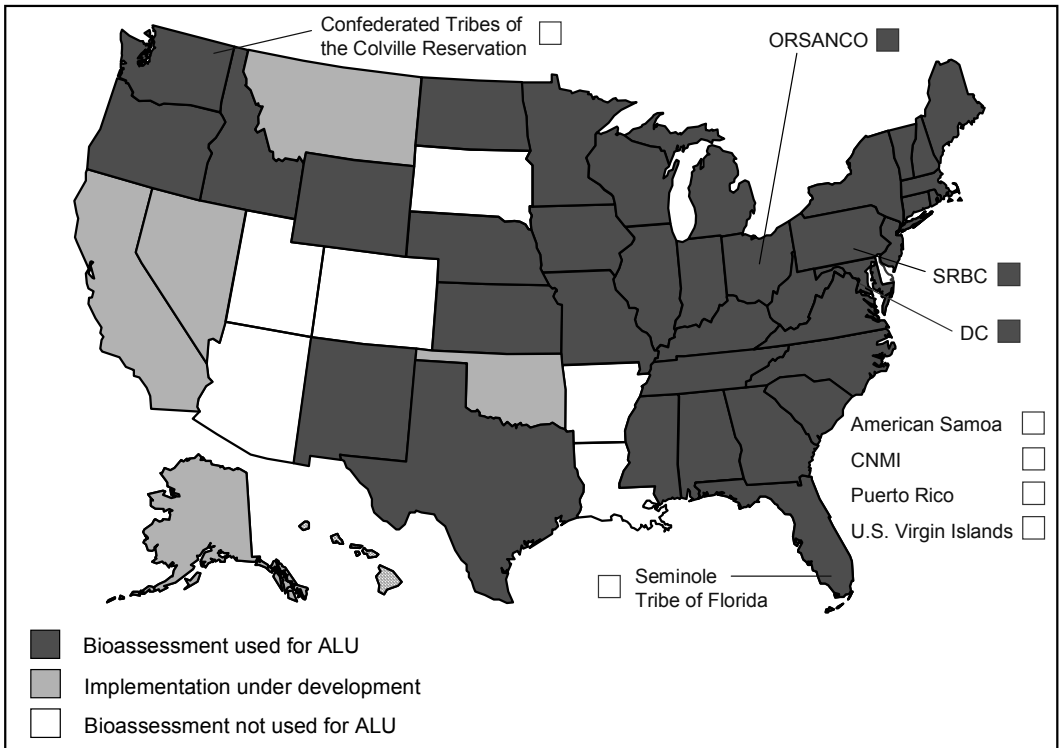


Figure 1b. Use of bioassessment to determine aquatic life use (ALU) for 305(b) reporting

Figure 1. Use of bioassessments to assess water quality

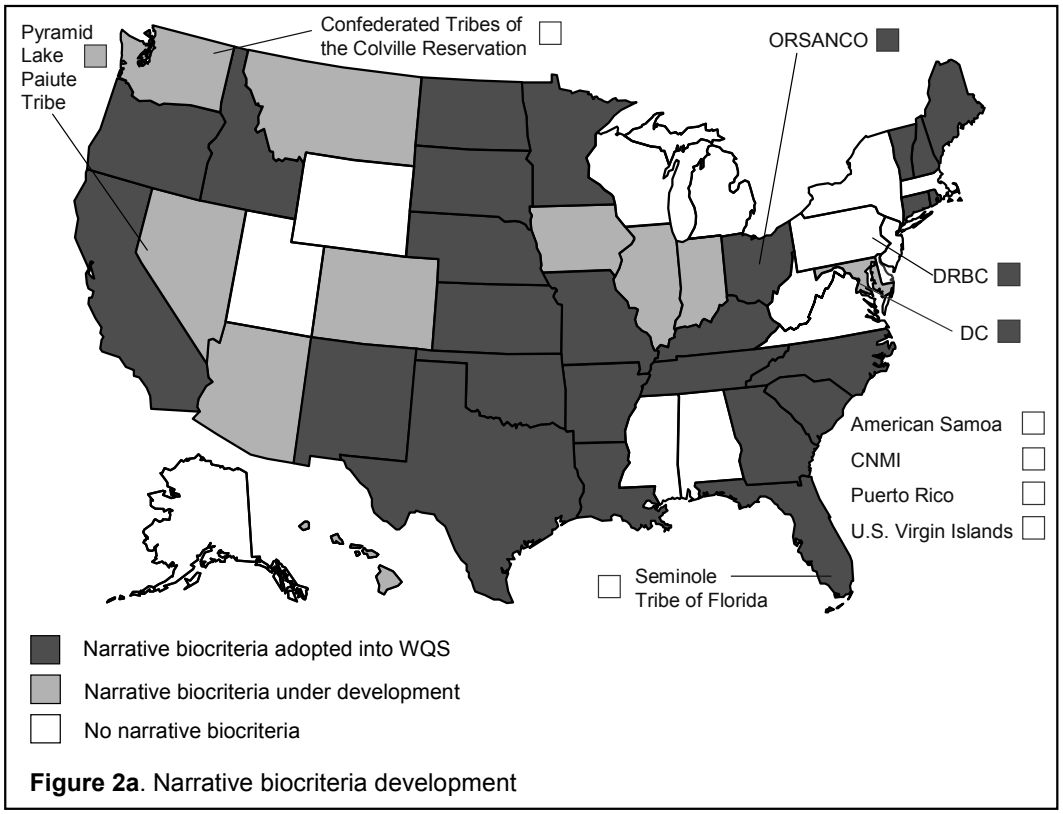


Figure 2a. Narrative biocriteria development

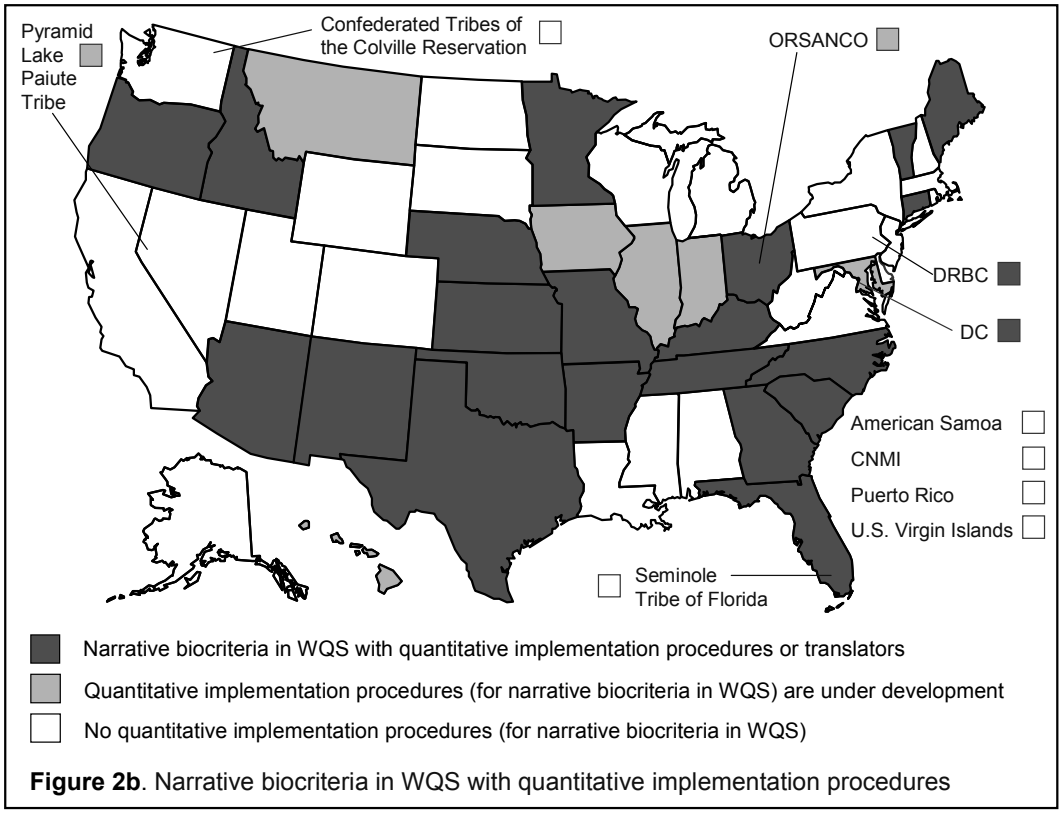


Figure 2b. Narrative biocriteria in WQS with quantitative implementation procedures

Figure 2. Biocriteria development

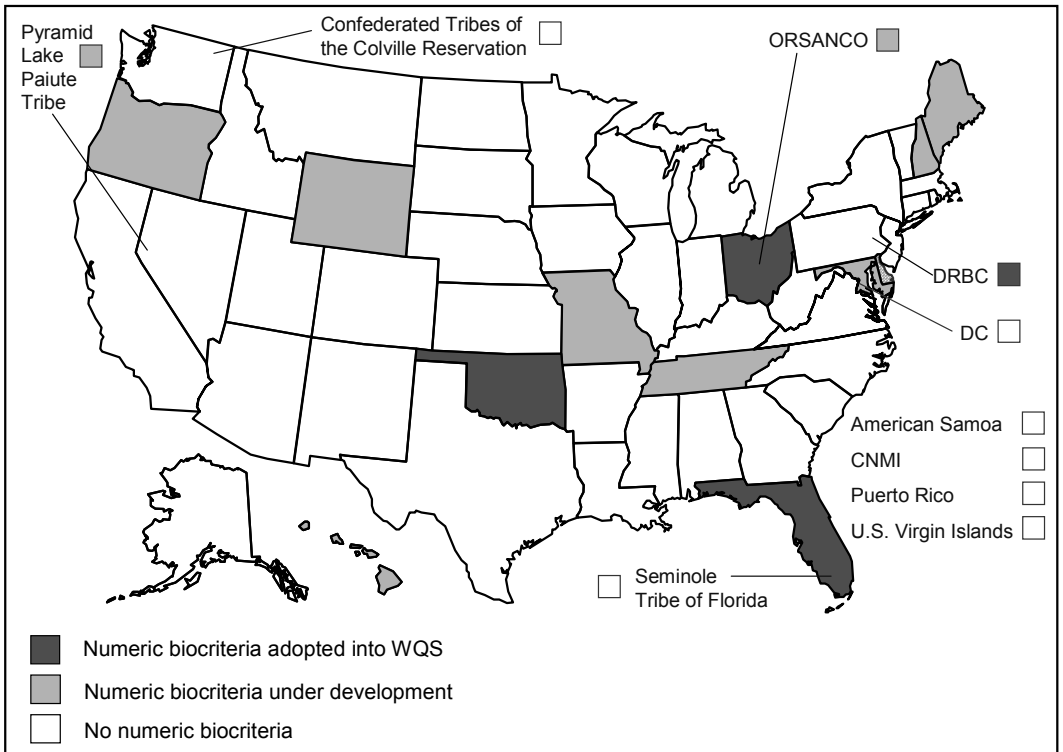


Figure 2c. Numeric biocriteria development

Figure 2 (cont). Biocriteria development

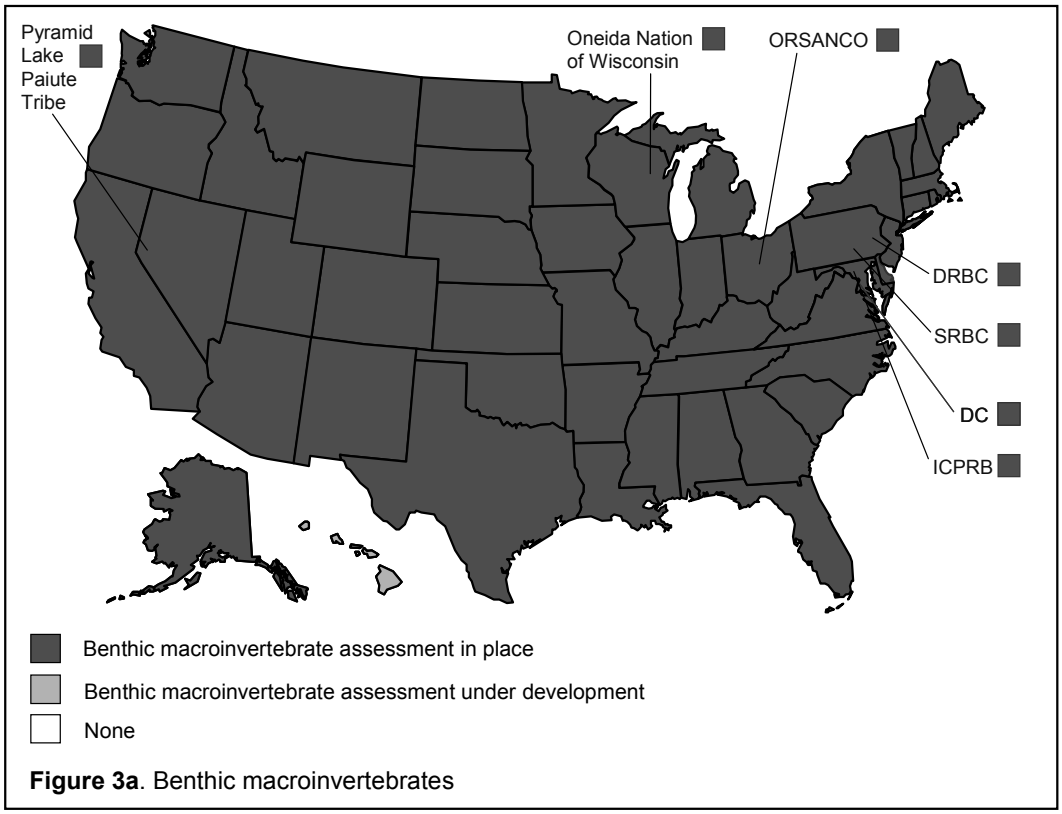


Figure 3a. Benthic macroinvertebrates

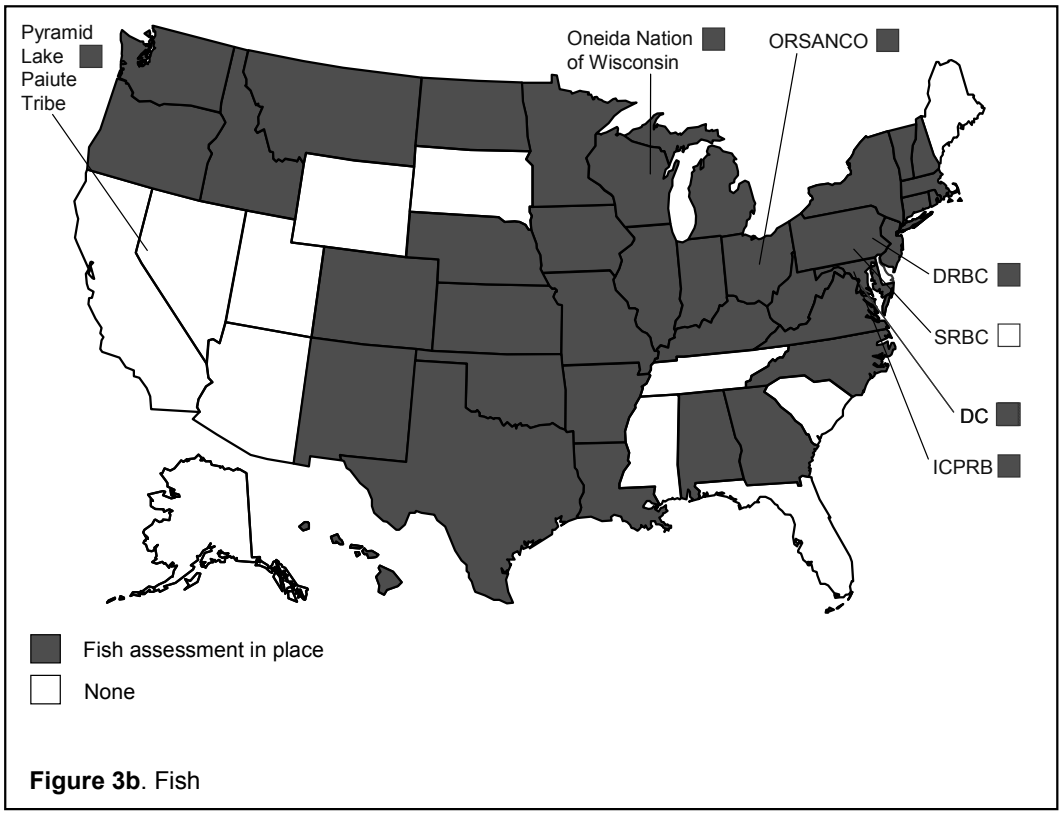


Figure 3b. Fish

Figure 3. Assemblages assessed

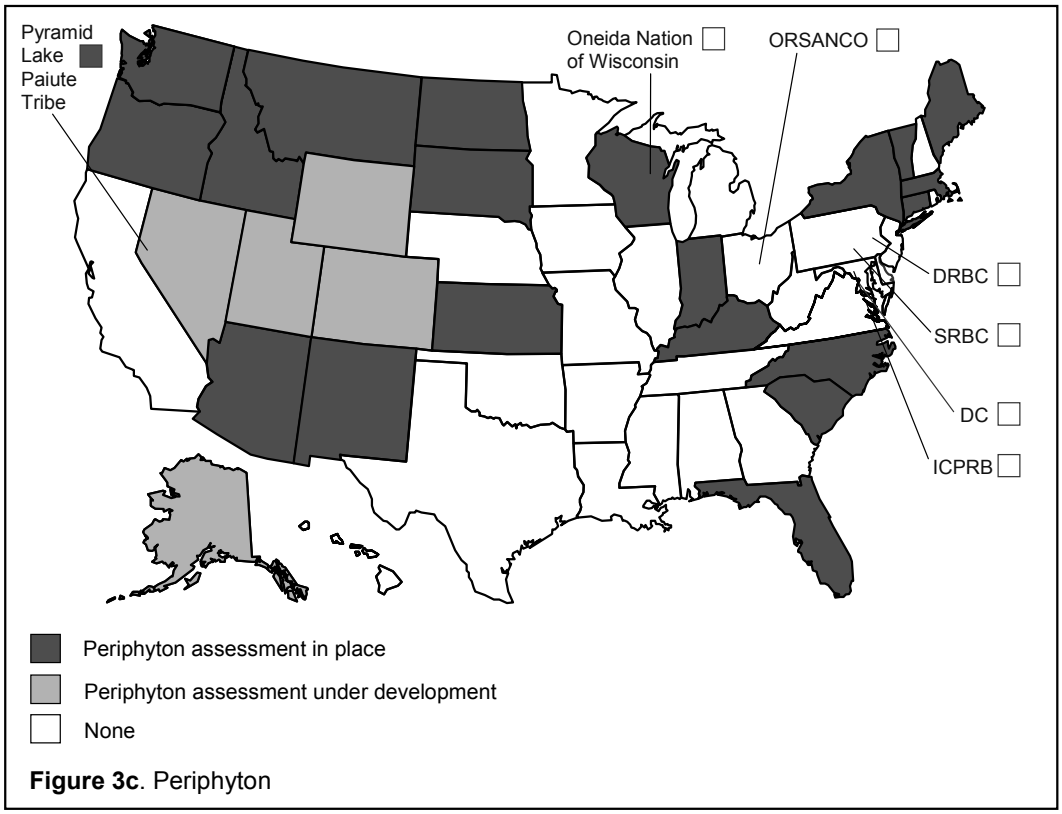


Figure 3c. Periphyton

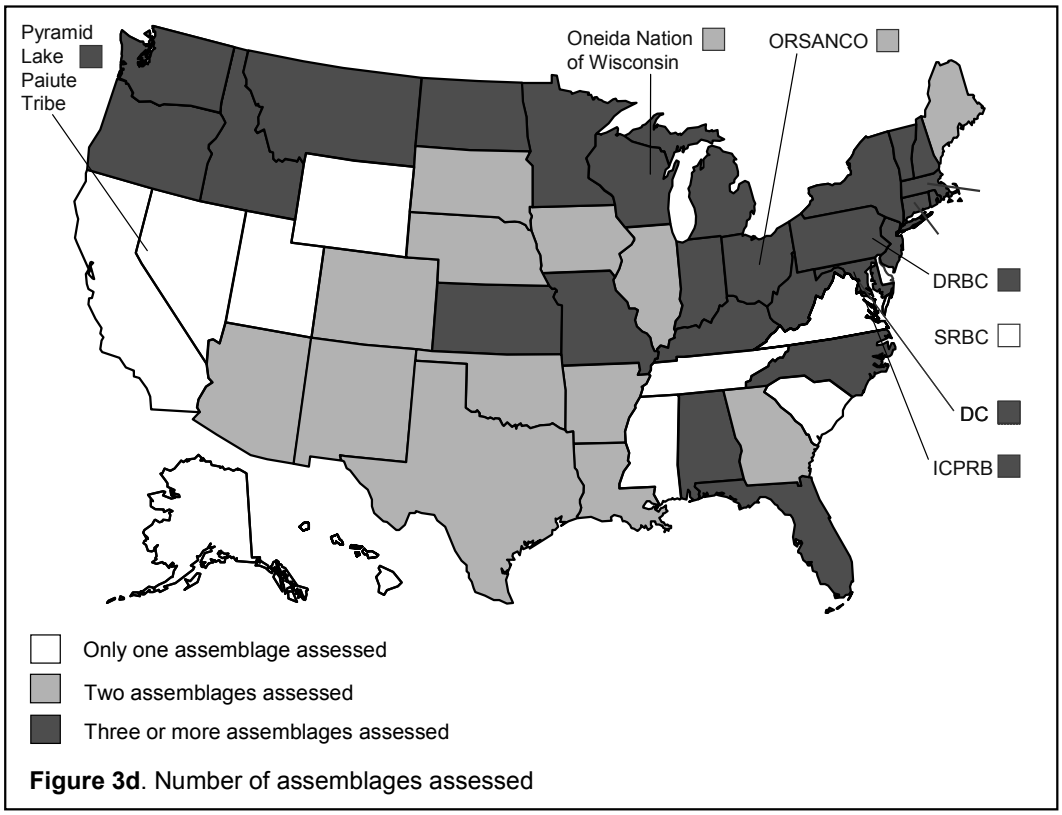


Figure 3d. Number of assemblages assessed

Figure 3 (cont). Assemblages assessed

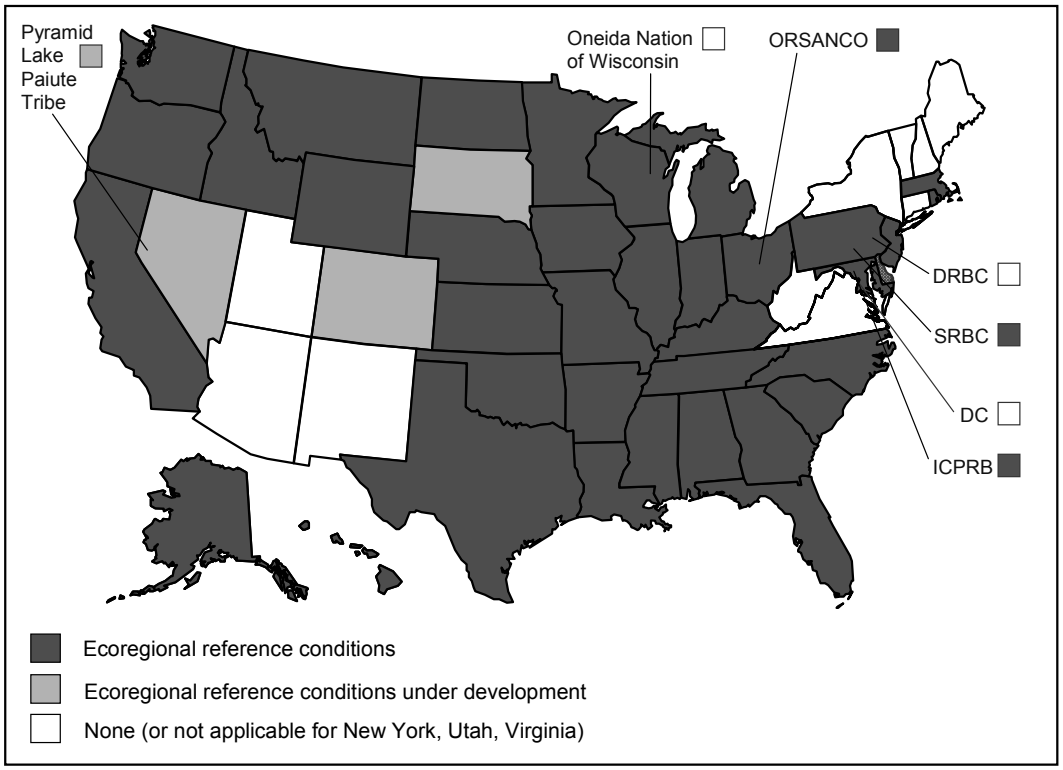


Figure 4. Use of ecoregional reference conditions

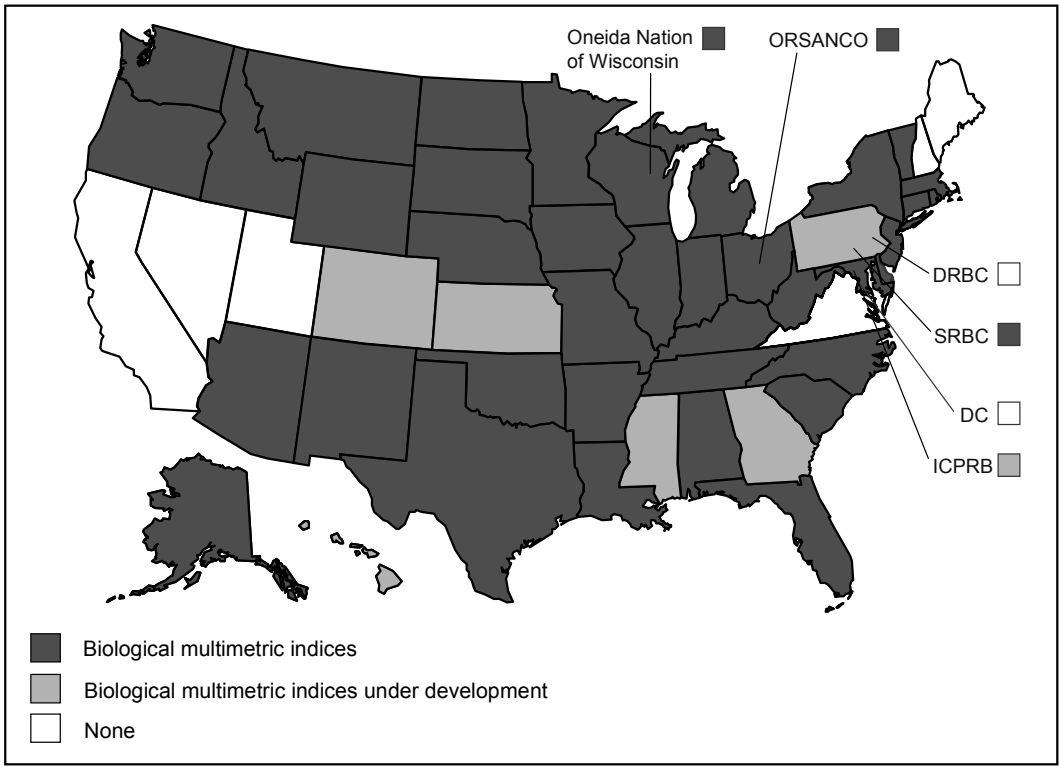


Figure 5. Development of biological multimetric indices

THIS PAGE INTENTIONALLY LEFT BLANK