Chapter 4

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Summary and Next Steps

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Summary

The United States covers an enormous and diverse landscape, and not surprisingly, the biological condition of the nation's streams varies widely geographically. Overall, 42% percent of the nation's stream length is in poor biological condition compared to least-disturbed reference condition in each of the WSA ecoregions. The Eastern Highlands region has the largest proportion of streams in poor biological condition (52%), whereas the West has the lowest proportion (27%). In the Plains and Lowlands region, 40% of stream length is in poor biological condition.

Stream miles, represented as stream length, are not evenly distributed across the country. The densest coverage of perennial streams in the lower 48 states is in the Eastern Highlands region, which has approximately 276,362 miles of perennial streams and the smallest land area of the three major regions. The Plains and Lowlands region, which covers the largest portion of the United States, has 242,264 miles of perennial streams. The West has 152,425 miles of streams. It is important to evaluate the survey results in terms of both stream length percentages and absolute stream miles in each condition class. For example, the percentage of stream length in good condition varies dramatically between the West (45%) and Plains and Lowlands regions (29%); however, if these percentages are converted to stream miles, the West has 68,672 miles in good condition, whereas the Plains and Lowlands region has 70,257 miles in good condition.

The WSA finds that the most widespread or common stressors are elevated levels of the nutrients nitrogen and phosphorus, riparian disturbance, and excess streambed sediments. Nationally, 32% of stream length (213,394 miles) has high concentrations of nitrogen compared to least-disturbed reference conditions, and 31% (207,355 miles) has high concentrations of phosphorus. Twenty-six percent of the nation's stream length (171,118 miles) has high levels of riparian disturbance (e.g., human influence along the riparian zone), and 25% (167,092 miles) has streambed sediment characteristics in poor condition. Analysis of the association between stressors and biological condition finds that high levels of nutrients and excess streambed sedimentation more than double the risk of poor biological condition.

The WSA provides the first nationally consistent baseline of the condition of the nation's streams. This baseline will be used in future assessments to evaluate changes in conditions and to provide insights as to the effectiveness of water resource management actions. *Highlight: Acidification Trends and the Clean Air Act* illustrates how this type of survey can be used to evaluate the effectiveness of management actions on improving water quality. States, EPA, and other partners plan to use this approach to implement large-scale assessments of lakes in 2007 and similar assessments of rivers, wetlands, and coastal waters in future years.

Highlight

Acidification Trends and the Clean Air Act

Although this WSA provides a snapshot of the current conditions in the nation's streams, future surveys will allow us to detect trends in stream conditions and in the stressors that affect them. One example in which probability-based survey designs were implemented repeatedly over the course of 10 years has been the evaluation of the responsiveness of acid-sensitive lakes and streams to changes in policy and management actions. Title IV of the 1990 Clean Air Act Amendments (CAAA) set target reductions for sulfur and nitrogen emissions from industrial sources as a means of reducing the acidity in deposition. One of the intended effects of the reductions was to decrease the acidity of low-alkalinity waters. A 2003 EPA report by Stoddard et al., assessed recent changes in surface water chemistry in the northern and eastern United States to evaluate the effectiveness of the CAAA. At the core of the monitoring, known as the Temporally Integrated Monitoring of Ecosystems (TIME) project, was the concept of a probability survey, where a set of sampling sites was chosen to be statistically representative of a target population. In the Northeast (New England and Adirondacks), this target population consists of lakes likely to be responsive to changes in rates of acidic deposition. In the Mid-Atlantic, the target population is upland streams with a high probability of responding to changes in acidic deposition. Repeated surveys of this population allowed an assessment of trends and changes in the number of acidic systems during the past decade. The trends reported in the following table are for recovery from chronic acidification. The analysis found that during the 1990s, the amount of acidic waters in the target population declined. The number of acidic lakes in the Adirondacks dropped by 38%, and the number of acidic lakes in New England dropped by 2%. The length of acidic streams declined by 28% in the Mid-Atlantic area.

Estimates of change in number and proportion of acidic surface waters in acid-sensitive regions of the northern and eastern United States. Estimates are based on applying current rates of change in Gran ANC[a] to past estimates of population characteristics from probability surveys.

Region	Number of Lakes	Number Acidic[b]	% Acidic[c]	Time Period of Estimate	Current Rate of ANC Change[d]	Estimated Number Currently Acidic[e]	Current % Acidic	% Change in Number of Acidic Systems
New England	6,834 lakes	386 lakes	5.6%	1991–1994	+0.3	374 lakes	5.5%	-2%
Adirondacks	1,830 lakes	238 lakes	13.0%	1991–1994	+0.8	149 lakes	8.1%	-38%
Mid-Atlantic	42,426 km	5,014 km	11.8%	1993–1994	+0.7	3,600 km	8.5%	-28%

[a] For both Northeast lakes and Mid-Atlantic streams, waterbodies with ANC (using the analytical technique of Gran titration, with the result known as "Gran ANC") of < 100 µeq/L are particularly vulnerable.
[b] Number of lakes/streams with Gran ANC < 0 in past probability survey (data collected at "Time Period of Estimate" in column 5).
[c] Percent of population (from Column 2) with Gran ANC < 0 in past probability survey (data collected at "Time Period of Estimate" in column 5).
[d] Based on regional trends in µeq/L/year.
[e] Based on trends from repeated surveys through 2001.

Next Steps

In addition to characterizing the biological condition of the nation's stream resources, the WSA provides a rich data set that has sparked interest in many additional areas of investigation. These include the following:

- **Support Protection and Restoration Actions** – The WSA finds that between 25 and 32% of stream length is rated poor due to high levels of nutrients or excess streambed sedimentation. These streams are two times more likely to score poor for biological condition than streams with low levels of these parameters. This national-scale finding reinforces reports from states and the USGS on specific watersheds and stream segments that identify nutrients and streambed sedimentation as leading water quality stressors. EPA is pursuing opportunities to use the WSA data in combination with other data to inform decision-makers responsible for water resource protection and restoration actions. Specific actions in the short term include analyzing the WSA dataset to determine associations between watershed characteristics (e.g., size, slope, and soil type) to help target where improvements are needed; using these characteristics in conjunction with information on the effectiveness of best management practices (BMPs) to help identify successful non-point source pollution controls; and supporting states' development of water quality standards for nutrients and sediments.

- **Future Designs** – It is clear that future surveys will continue to be based on sample survey designs and that the detection of changes and trends will be of greater interest; therefore, future survey designs will include provision for estimating both current status and future trends. This will require a determination of the number of sites that are revisited versus new sites. Current analyses of variance components suggest that in future surveys, a substantial percentage of the sites (possibly 20–50%) should be replaced with new sites and that this replacement should continue with each new survey. This replacement will help detect change; incorporating new sites will improve future status assessments and reduce the likelihood that bias will be introduced by repeated sampling of the same locations. As individual states and tribes begin adopting sample survey designs into their programs, the results from their efforts can be incorporated into the national assessments.

- **Indicators** – This initial assessment was unable to incorporate a large set of biological and stressor indicators because of a short planning timeline. In future national stream surveys, the WSA will consider including fish assemblages, algal assemblages (e.g., periphyton in streams), fish tissue contamination by metals and organics, and/or sediment contamination assessed through either sediment metal and organic chemistry or sediment toxicity tests. It will also be possible to add emerging stressor indicators of concern. This will allow for a more comprehensive assessment of both the conditions in wadeable streams and the stressors potentially affecting them.

- **Field Protocols** – The field protocols used for the WSA are widely used and were well tested across the country. These protocols have demonstrated a strong ability to detect environmental signals against the background of natural variability. For this initial assessment of wadeable streams, using the same protocols across the country reduced the complexity of interpreting the results; however, for future national stream surveys, the use of different yet comparable methods will be evaluated for different types of streams (e.g., low gradient vs. high gradient). EPA and the states will also explore integrating and sharing data from multiple sources, as well as options to improve sample collection methods.

- **Reference Conditions** – Stream ecologists and state and federal managers agree that they should be able to describe least-disturbed reference condition at a more refined spatial scale than that of the nine regions presented in the WSA. To do so will require substantial coordinated efforts among state, tribal, and federal partners. There are also likely to be some regions of the country in which land-use changes have been so dramatic that even the "best" streams may have experienced substantial chemical, physical, and biological degradation. Additional research will be required to provide a better solution to setting expected conditions for those regions of the country.

- **Stressor Ranking** – The presentation on stressors in the WSA showed both their extent (i.e., the percent of stream length with excessive levels of the stressors) and relative risk (i.e., the increased chance of finding poor biological condition). To make the best use of this information, the WSA must look for stressors that have both high relative risk and large extent. The human health assessment community combines these two sets of information into a single number called the "population attributable relative risk." If, during investigation, this summary number proves reliable for ecological studies, it will simplify the ranking of stressors in future assessments. However, use of more than one biological assemblage in future assessments will result in multiple relative risk values, one for each biological indicator. It would

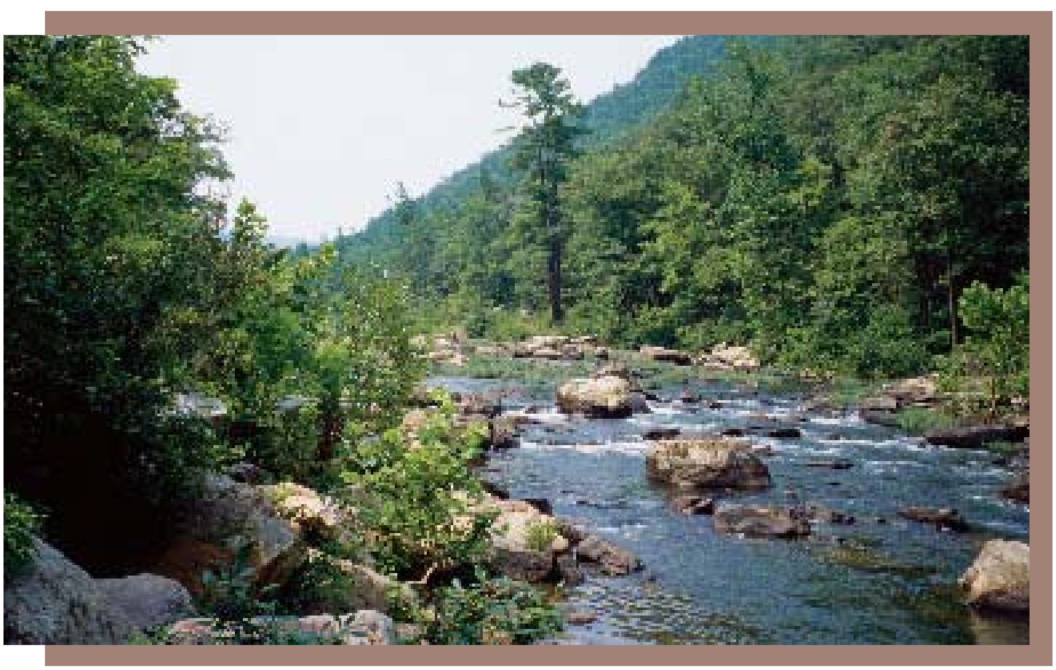

Photo courtesy of Michael L. Smith, FWS

not be surprising if EPA and its partners find that the relative risk posed by each stressor depends on the biological community being evaluated. Although these added numbers may complicate the ranking of stressors, they will also aid in understanding which component of the stream biota is sensitive to each stressor and will provide additional options for management.

- **Future National Assessments** – EPA and its state, tribal, and federal partners will produce national assessments of waterbody types on a yearly cycle. For lakes and reservoirs, a field survey will occur in 2007 with a national assessment report of the results in 2009. Rivers will be surveyed in 2008, and a national assessment report will follow in 2010. Wadeable streams will be surveyed again in 2009, and the assessment report that follows in 2011 will include all flowing waters – both rivers and streams. That report will also evaluate any changes in biological condition that occurred in streams. An NCCR assessment will be repeated in 2012, with the results of the field survey from 2010. Wetlands will be surveyed during the 2011 sampling season, followed by a national assessment report in 2013. From that point on, the surveys and national assessment reports will be repeated in sequence, with changes and trends becoming a greater focus for each resource survey.

The continued utility of these national surveys and their assessment reports requires continued consistency in design, as well as in field, lab, and assessment methods from assessment to assessment; however, the surveys must also provide flexibility that allows the science of monitoring to improve over time. Maintaining consistency while allowing flexibility and growth will be one of the many challenges facing the national assessment program in coming years.

This national survey would not have been possible without the involvement of hundreds of dedicated scientists working for state, tribal, and federal agencies and universities across the United States. Future surveys will rely on this continued close collaboration, a free exchange of knowledge, and a deep well of energy and enthusiasm. It is EPA's goal that participants translate the expertise they gained through these national surveys to studies of their own waters and use this substantial and growing baseline of information to evaluate the success of efforts to protect and restore the quality of the nation's waters.

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