Water Quality Today - Has the Clean Water Act Been a Success?

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I. INTRODUCTION

The nation recently celebrated the thirtieth anniversary of one of the most revolutionary statutes ever drafted—the Federal Water Pollution Control Act Amendments of 1972,[1] commonly referred to as the Clean Water Act ("CWA" or the "Act"). This first generation environmental statute nationalized the business of water pollution control in the United States, relegating the states, whose authority had long dominated the area, to a largely secondary, supporting role.[2] The Act utilized command-and-control regulatory techniques to implement a completely new, uniform system of technology-based effluent limitations.[3] The limitations applied to point source dischargers throughout the nation[4] and were enforced through a massive new permit program.[5] The Act's new strategy, however, was not entirely driven by national technology-based limits. Whenever necessary to meet water quality standards in a particular river or lake,[6] dischargers were expected to

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1. Pub. L. No. 92-500, 86 Stat. 816 (codified as amended at 33 U.S.C. §§ 1251-1376 (2000)).

2. *See* William L. Andreen, *The Evolution of Water Pollution Control in the United States—State, Local, and Federal Efforts, 1789-1972: Part II*, 22 STAN. ENVTL. L.J. 215, 286 (2003) [hereinafter Andreen, *Evolution of Water Pollution Control: Part II*].

3. Section 301(b) of the Act contemplates the promulgation of secondary treatment limitations for publicly-owned sewage treatment plants. Clean Water Act § 301(b)(1)(B), 33 U.S.C. § 1311(b)(1)(B). It also envisions the establishment of uniform, technology-based effluent limitations for existing industrial facilities, *id.* § 301(b)(1)(A), (b)(2), 33 U.S.C. § 1311(b)(1)(A), (b)(2), while section 306 directs the U.S. Environmental Protection Agency ("EPA") to set uniform performance standards for new industrial facilities. *Id.* § 306, 33 U.S.C. § 1316(b)(1)(B); *see* ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 619-24, 630-33 (4th ed. 2003); Oliver A. Houck, *Of BATs, Birds and BAT: The Convergent Evolution of Environmental Law*, 63 MISS. L.J. 403 (1994).

4. Point sources are defined as "any discernible, confined and discrete conveyance" such as pipes, ditches, channels, conduits, and the like "from which pollutants are or may be discharged." Clean Water Act § 502(14), 33 U.S.C. § 1362(14).

5. *Id.* § 402, 33 U.S.C. § 1342 (establishing the National Pollutant Discharge Elimination System ("NPDES")).

6. *Id.* § 303, 33 U.S.C. § 1313 (retaining and actually strengthening the water quality standards program that had been created by the Water Quality Act of 1965, Pub. L. No. 89-234, 79 Stat. 903 (1965) (superceded 1972)).

comply with more stringent, individually-crafted permit limitations.[7] The Act thus combined technology-based limits and environmental quality-based standards in an innovative attempt to fight the rising tide of water pollution.

The CWA was an extraordinary statute in other ways as well. It set the stage, for example, for a comprehensive new program to protect wetlands[8] and created an ambitious public works program to fund the construction of thousands of municipal wastewater treatment plants.[9] Congress was also wary of bureaucratic lethargy and concerned that future administrations might try to undermine the carefully articulated regulatory programs created by the Act. The statute, therefore, contained a long series of mandatory duties, regulatory schedules, and deadlines, as well as a citizen suit provision through which private citizens could seek to enforce these various duties and deadlines.[10]

The CWA and the regulatory programs it created have matured over the last thirty years. Today, the Act is increasingly acknowledged for its role in reducing the direct discharge of pollutants to the nation's waters, and as a result, water quality in many areas has improved significantly.[11] The Act,

7. Clean Water Act § 301(b)(1)(C), 33 U.S.C. § 1311(b)(1)(C); *see* Jeffrey M. Gaba, *Federal Supervision of State Water Quality Standards Under the Clean Water Act*, 36 VAND. L. REV. 1167, 1169-70 (1983).

8. Under section 404, the EPA and the U.S. Army Corps of Engineers are jointly responsible for the issuance and enforcement of permits to discharge dredged or fill material into waters of the United States. Clean Water Act § 404, 33 U.S.C. § 1344. Over the course of the last thirty years, the section 404 dredge and fill program had developed into a major tool to minimize the conversion of wetland habitat into dry land by farmers, developers, and timber interests, among others, due to the fact that wetlands are defined as any area—a bog, swamp, or prairie pothole—that is inundated or saturated at a frequency sufficient to support a prevalence of wetland vegetation. 40 C.F.R. § 122.2 (2003) (EPA definition); 33 C.F.R. § 328.3 (2003) (Army Corps of Engineers definition). In *Solid Waste Agency of Northern Cook County v. Army Corps of Engineers*, 531 U.S. 159 (2001), the Supreme Court narrowed the jurisdictional scope of the section 404 program by holding that isolated, non-navigable, intrastate waters that are used by migratory birds are excluded from the definition of a regulated water. *See* Robin Kundis Craig, *Beyond* SWANCC*: The New Federalism and Clean Water Act Jurisdiction*, 33 ENVTL. L. 113 (2003); William Funk, *The Court, the Clean Water Act, and the Constitution:* SWANCC *and Beyond*, 31 Envtl. L. Rep. (Envtl. L. Inst.) 10,741, 10,741-45 (2001); Robert R.M. Verchick, *Steinbeck's Holism: Science, Literature, and Environmental Law*, 22 STAN. ENVTL. L.J. 3, 48-52 (2003); Thomas L. Casey, III, Comment, *Reevaluating "Isolated Waters": Is Hydrologically Connected Groundwater "Navigable Water" Under the Clean Water Act?*, 54 ALA. L. REV. 159, 163-65 (2002).

9. *See* Clean Water Act §§ 201-19, 33 U.S.C. §§ 1281-99; *see also* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, PROGRESS IN WATER QUALITY: AN EVALUATION OF THE NATIONAL INVESTMENT IN MUNICIPAL WASTEWATER TREATMENT 2-63, 2-64 (2000) [hereinafter EPA, PROGRESS IN WATER QUALITY] (setting forth a brief history of the EPA's construction grants program).

10. *See* William L. Andreen, *The Evolving Law of Environmental Protection in the United States: 1970-1991*, 9 ENVTL. & PLAN. L.J. 96, 98-100 (1992).

11. *See, e.g.*, OLIVER A . HOUCK, THE CLEAN WATER ACT TMDL PROGRAM: LAW, POLICY, AND IMPLEMENTATION 3-4 (2d ed. 2002); JAMES OBERSTAR, THE CLEAN WATER ACT: 30 YEARS OF SUCCESS IN PERIL 1 (Oct. 18, 2002); Fran Dubrowski, *Crossing the Finish Line*, ENVTL. F., July-Aug. 1997, at 28; Robert W. Hahn, *United States Environmental Policy: Past, Present and Future*, 34 NAT. RES. J. 305, 306 (1994); Michael E. Kraft & Norman J. Vig, *Environmental Policy from the 1970s to the Twenty-First Century, in* ENVIRONMENTAL POLICY: NEW DIRECTIONS FOR THE TWENTY-FIRST CENTURY 1, 22 (Norman J. Vig & Michael E. Kraft eds., 2003) [hereinafter Kraft & Vig, *History of Environmental Policy*]; Paul R. Portney, *Environmental Problems and Policy: 2000-2050*, 14 J. ECON. PERSP. 199, 203 (2000).

however, is often maligned by commentators. Some contend that command-and-control approaches like the CWA are simply old-fashioned—expensive, inefficient, and rigid relics of the big-government past—and urge the adoption of more market-based instruments.[12] This kind of criticism often targets the Act's reliance upon technology-based standards because such a uniform approach to pollution control is said to impose "inordinate expense" and stifle "innovation and investment that would benefit both the environment and the economy."[13] Others criticize the expansive role given to the federal government under the Act and advocate some degree of devolution or transfer of regulatory authority to the state level.[14] Many of the Act's critics ad-

12. *See, e.g.,* Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1334-40 (1985); Eric W. Orts, *Reflexive Environmental Law*, 89 NW. U. L. REV. 1227, 1236-64 (1995); Cass R. Sunstein, *Paradoxes of the Regulatory State*, 57 U. CHI. L. REV. 407, 420-21 (1990); Barton H. Thompson, Jr., *Foreword: The Search for Regulatory Alternatives*, 15 STAN. ENVTL. L.J., at viii (1996).

13. Richard B. Stewart, *Economics, Environment, and the Limits of Legal Control*, 9 HARV. ENVTL. L. REV. 1, 9 (1985). It would be more efficient, the argument goes, to allow sources with low abatement costs to shoulder most of the responsibility for clean-up, rather than forcing all dischargers to meet the same technology-based, performance standard. *See id.* at 7. Technology-based standards, moreover, are said to discourage innovation because there is no incentive to go beyond the reference technology on which the EPA based the standard. *See id.* at 9.

Dischargers often claim that it would make more sense if limits were crafted according to the quality of the receiving water—rather than based, at least in part, upon uniform technology controls. Discharges thus would be cleaned up just to the extent necessary—not too much, not too little, but just right. *See* NOGA MORAG-LEVINE, CHASING THE WIND: REGULATING AIR POLLUTION IN THE COMMON LAW STATE 3 (2003) (characterizing the purported advantage of the means-end tailoring approach as "the avoidance of imposition of sacrifice on neighbors through underregulation, or on firms through overregulation"). This approach is appealing as a theoretical matter because it seems so logical and efficient. It also appeals to those who favor increased state control since the water quality standards program is a holdover from the days of greater state autonomy—with only a thin layer of federal authority, especially when it comes to setting total maximum daily loads ("TMDLs") to deal with water quality-impaired streams. *See* HOUCK, *supra* note 11, at 63.

The problem, however, is that the water quality standards approach has never worked. *Id* at 5. There has been too little stream quality data to support it, and too little political will. Although dischargers and many states have expressed their preference for the approach, they have never been eager to implement water quality standards through section 303(d) of the Act, 33 U.S.C. § 1313(d), the program for setting TMDLs. *See* HOUCK, *supra* note 11, at 5, 63; Linda A. Malone, *The Myths and Truths That Ended the 2000 TMDL Program*, 20 PACE ENVTL. L. REV. 63, 78-81 (2002). The TMDL program is necessary; it completes the regulatory approach envisioned by the CWA—limits based upon technology for point source discharges, supplemented where necessary by more stringent limits based upon water quality concerns. But the battle royale that the TMDL program has produced and the scant progress it has made to date, *see* HOUCK, *supra* note 11, at 5, together with the tactical advantage given to the regulated community when the points for decision are multiplied exponentially, seem to discredit arguments urging that technology-based limits be discarded in favor of a completely ambient-based approach. The cost of the program alone—setting TMDLs for up to 50,000 water quality impaired waters—might make technology standards "look like quite a bargain." *Id.* at 63. Moreover, these same kinds of problems would complicate, if not defeat, efforts to set up market-oriented trading or tax systems for the entire country, since such systems are based, in the first instance, upon calculations establishing maximum waste loads for every relevant pollutant in every stream segment in the country. *See, e.g.*, Ackerman & Stewart, *supra* note 12, at 1347.

14. *See, e.g.,* Jonathan H. Adler, *Let 50 Flowers Bloom: Transforming the States Into Laboratories of Environmental Policy*, 31 Envtl. L. Rep. (Envtl. L. Inst.) 11,284 (2001); Henry N. Butler & Jonathan R. Macey, *Externalities and the Matching Principle: The Case for Reallocating Environmental Regulatory Authority*, 14 YALE L. & POL'Y REV. 23 (1996); James E. Krier, *On the Topology of Uniform Environmental Standards in a Federal System—and Why It Matters*, 54 MD. L. REV. 1226 (1995); Richard L. Revesz, *Rehabilitating Interstate Competition: Rethinking the "Race to the Bottom" Rationale for Federal Environmental Regulation*, 67 N.Y.U. L. REV. 1210 (1992); Bruce Yandle, *Mr. Lomborg and the*

vocate a transition to a second-generation form of regulation.[15] In addition to ceding more responsibility to the state-level,[16] such reforms would include the use of more cost-benefit analysis, improved risk analysis, more agency flexibility in choosing regulatory priorities, and the use of market-oriented regulatory devices such as tradable permits and "green" taxes.[17] The critics would use these reforms not only to recast the existing regulatory system, but would actually "replace many uses of command instruments with alternatives."[18]

The debate between the critics and the Act's defenders has been going on for many years.[19] In large measure, it pits the environmental community and its advocates, many of whom are now graying just like the laws they

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Common Law, 53 CASE W. RES. L. REV. 285, 295 (2002). The dominant federal role is sometimes referred to pejoratively as "Soviet-style centralized planning." Stewart, *supra* note 13, at 6. *See also* Adler, *supra*, at 11,285 (criticizing the CWA as "excessively centralized" and thus exhibiting "most of the failings of Soviet-style command-and-control systems"). The state role in water pollution control, however, is not that insignificant. Most states administer the permitting system for water pollution discharges, *see infra* note 16, and these states enjoy quite a bit of autonomy given the EPA's relatively lax oversight of their programs. *See* Clifford Rechtschaffen, *Enforcing the Clean Water Act in the Twenty-First Century: Harnessing the Power of a Public Spotlight*, 55 ALA. L. REV. 775 (2004).

Moreover, no matter how appealing more local control may be in some sort of theoretical sense, one should remember the wise and colorful words of Oliver Houck:

> In most states . . . [local] needs are aligned with economic and development interests whose local influence—be it chickens in Arkansas, sugar in Florida, the timber industry in Idaho, wheat in Kansas, oil and gas in Louisiana, cattle in Nevada, coal in Wyoming, and real estate nearly everywhere—is magnified by being the dominant game in town. Trying to achieve a national interest in clean air or water through state and local governments . . . is like trying to encourage spaghetti through a keyhole.

HOUCK, *supra* note 11, at 195; s*ee also* William L. Andreen, *The Evolution of Water Pollution Control in the United States: State, Local, and Federal Efforts, 1789-1972: Part I*, 22 STAN. ENVTL. L.J. 145, 155 (2003) [hereinafter Andreen, *Evolution of Water Pollution Control: Part I*] (discussing some of the economic and political reasons why state water pollution control officials often prefer to rely upon persuasion, cooperation, and compromise, rather than stronger and more direct forms of enforcement); Malone, *supra* note 13, at 78 (concluding that "the states" have been "hesitant if not outright obstructionist toward the achievement of their own water quality standards"). For an economic analysis suggesting that state environmental standard setting would lead to inefficient regulatory competition, see Arik Levinson, *Environmental Regulatory Competition: A Status Report and Some New Evidence*, 56 NAT'L TAX J. 91 (2003).

15. *See, e.g.*, DEBRA S. KNOPMAN, PROGRESSIVE FOUNDATION'S CENTER FOR INNOVATION & THE ENVIRONMENT, SECOND GENERATION—A NEW STRATEGY FOR ENVIRONMENTAL PROTECTION (Apr. 1996), *available at* http://www.ppionline.org/ppi_ci.cfm?knlgArealD=116&subselD=150.

16. Under the CWA, states may choose to administer their own permit programs as long as they meet a number of federal requirements. *See* Clean Water Act § 402(b)-(c), 33 U.S.C. § 1342(b)-(c). Currently, forty-five states possess the authority to administer the NPDES program within their own jurisdiction, subject to EPA oversight. *See* U.S. Envtl. Prot. Agency, National Pollutant Discharge Elimination System, State Program Status, *available at* http://cfpub.epa.gov/npdes/statestats.cfm (last visited Dec. 2, 2003) [hereinafter EPA, NPDES State Program Status]. State programs are also responsible for the majority of enforcement actions under the Act. *See* Clifford Rechtschaffen & David L. Markell, *Improving State Environmental Enforcement Performance Through Enhanced Government Accountability and Other Strategies*, 33 Envtl. L. Rep. (Envtl. L. Inst.) 10,559, 10,559 (2003).

17. *See* Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 CAP. U. L. REV. 21, 21 (2001).

18. *Id.*

19. *Compare, e.g.*, Howard Latin, *Ideal Versus Real Regulatory Efficiency: Implementation of Uniform Standards and 'Fine-Tuning' Regulatory Reforms*, 37 STAN. L. REV. 1267 (1985) (defending command-and-control regimes like the CWA), *with* Ackerman & Stewart, *supra* note 12 (criticizing the present system).

promoted, against the desires of the regulated community. The defenders of the status quo have so far prevailed since Congress and the President, mired for years in gridlock between competing political parties and radically different perspectives on the public good, have been unable for nearly twenty years to enact any significant revisions to the Act.[20] Of course, a number of administrations, both Democratic and Republican, have used administrative techniques in an attempt to "reform" the existing system.[21] The Bush Administration, for instance, continues to pursue Clinton-era programs such as Project XL[22] and water quality trading,[23] initiatives that are aimed at injecting more flexibility into the existing permit system and thereby reducing the cost of complying with the CWA.[24] The basic design of the Act, however,

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20. *See* Michael E. Kraft, *Environmental Policy in Congress: From Consensus to Gridlock, in* ENVIRONMENTAL POLICY: NEW DIRECTIONS FOR THE TWENTY-FIRST CENTURY 127-28, 135-36 (Norman J. Vig & Michael E. Kraft eds., 2003). The same kind of policy gridlock has affected virtually all of the federal environmental statutes during the last ten years. *See id.* Environmental policy, therefore, appears to be "in 'equilibrium' at the moment with neither the right [the critics] nor the left [the defenders] able to vanquish the other side." Rena I. Steinzor, *Toward Better Bubbles and Future Lives: A Progressive Response to the Conservative Agenda for Reforming Environmental Law*, 32 Envt. L. Rep. (Envtl. L. Inst.) 11,421, 11,422 (2002) [hereinafter Steinzor, *A Progressive Response*].

21. One of the oldest approaches to "reforming" the existing regulatory system is by extending presidential supervision to the rulemaking process. President Reagan's Executive Order 12,291, 3 C.F.R. § 127 (1982), required executive branch agencies to submit major rules and regulatory impact analyses (emphasizing the costs and benefits of the agency's action) to the Office of Management and Budget ("OMB") for review. Although President Clinton modified Reagan's approach in order to make the process more transparent and less subject to influence from the regulated community and abuse by OMB, Clinton retained both OMB review and the emphasis upon cost-benefit analysis. Exec. Order No. 12,866, 3 C.F.R. § 638 (1993). President Bush has kept Clinton's order intact, although he did amend the order to eliminate the special role that the Vice President could play in resolving conflicts between OMB and an agency. Exec. Order No. 13,258, 67 Fed. Reg. 9385 (2002).

22. The Clinton Administration launched Project XL to give regulated entities the opportunity to develop alternative strategies for pollution control. Participants contract with the EPA on a site-specific basis promising to produce greater reductions of certain pollutants than currently required, while receiving a waiver from other standards. Regulatory Reinvention (XL) Pilot Projects, 60 Fed. Reg. 27,282, 27,282 (1995). Praised by some, *see e.g.,* Dennis D. Hirsch, *Project XL and the Special Case: The EPA's Untold Success Story*, 26 COLUM. J. ENVTL. L. 219 (2001), the project has been criticized by others. *See, e.g.,* Rena I. Steinzor, *Reinventing Environmental Regulation: The Dangerous Journey from Command to Self-Control*, 22 HARV. ENVTL. L. REV. 103 (1998). One of the most difficult problems facing such a project is that environmental groups simply do not have the resources to participate in the negotiation of dozens of site-specific regulatory agreements. *Id.* at 144. Nevertheless, only a few agreements have been signed, and efforts to conclude others have foundered due to various complexities, not least of which is the lack of statutory authority for granting the waivers. Sources, therefore, are rightfully concerned that they may still be the subject of enforcement actions brought either by citizens or perhaps even by government authorities. *See* Stewart, *supra* note 17, at 67.

23. The EPA began promoting watershed-based trading in response to President Clinton's reinvention initiative. OFFICE OF WATER, U.S. ENVTL PROT. AGENCY, DRAFT FRAMEWORK FOR WATERSHED-BASED TRADING, at ix (1996). Under this program, a municipal sewage plant, for instance, could obtain a credit for water quality related nutrient requirements in its permit by paying a farmer to change his cropping practices and planting shrubs or other vegetative cover along a stream. *See Current Developments*, 33 Env't Rep. (BNA) 1106 (2002). Critics worry about the real-world impact of trading. Nutrient reduction from a buffer strip or new cropping techniques is nearly impossible to quantify. *See Current Developments*, 34 Env't Rep. (BNA) 138 (2003). It is also difficult to judge the impact that a trading is having upon the ambient environment because of the dearth of adequate data about ambient water quality. Enforcers, therefore, would be hard pressed to gauge the adequacy of a trader's actions. *See* Steinzor, *A Progressive Response, supra* note 20, at 11,428-29. Trading could also lead to spikes in pollutant loadings in certain localized areas. *See id.* at 11,430.

24. *See* Andreen, *Evolution of Water Pollution Control: Part I, supra* note 14, at 150.

remains unchanged, although it appears increasingly vulnerable due to the rising tide of conservative political fortunes in Washington and around the country.

The Clean Water Act is at a critical juncture today. New policies, new approaches may soon be adopted before we have had an adequate opportunity to assess how well the "old" techniques have worked. We need to determine as accurately as possible what has worked and what has failed as we approach the question of change. And as the task of reform is undertaken, it is critical that we distinguish between "genuine efforts to reform environmental policies" and "actions that would compromise" our ability to protect the environment.[25] To do so is not necessarily easy. Political actors and policy advocates are quite capable of disguising their motives, as well as the likely real-world impact of complicated regulatory reforms.[26] Those who are genuinely concerned about making environmental progress therefore need to tread carefully amid the varying claims and countercharges.

Although the Act surely stands in need of revision to fill various gaps in coverage, the aspects of the Act that are prime candidates for reform are not the ones that the critics target. The CWA, in fact, has been remarkably successful in doing what it was designed to do. The implementation of technology-based limitations has produced substantial reductions in industrial pollution,[27] and the sums expended on the construction grants program have produced real dividends in terms of water quality.[28] Furthermore, the rate at which wetlands were being devoured has been cut dramatically,[29] although an increase in wetlands loss will undoubtedly follow in the wake of the Supreme Court's decision in *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* ("*SWANCC*").[30] All of this has been accom-

25. Kraft & Vig, *History of Environmental Policy*, *supra* note 11, at 2.

26. *See* William H. Rodgers, *The Lesson of the Owl and the Crows: The Role of Deception in the Evolution of the Environmental Statutes*, 4 J. LAND USE & ENVTL. L. 377, 378-81 (1989).

27. *See* PERCIVAL ET AL., *supra* note 3, at 571-72, 630-31.

28. *See id.* at 571-72, 632-33.

29. *See* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, NATIONAL WATER QUALITY INVENTORY, 2000 REPORT TO CONGRESS 45 (2002) [hereinafter 2000 NATIONAL WATER QUALITY INVENTORY].

30. 531 U.S. 159 (2001) (holding that the CWA did not extend the Corps' regulatory jurisdiction to cover isolated, non-navigable, intrastate wetlands used by migratory birds). Although the scope of the Court's ruling is not completely clear at present, it could affect up to 20% to 30% of the wetlands in the United States if it were to apply to all wetlands that lack a surface connection to another body of water. NAT'L WILDLIFE FED'N & NAT. RESOURCES DEF. COUNCIL, WETLANDS AT RISK: IMPERILED TREASURES 2 (July 2002). In January 2003, the EPA and the Corps solicited public comment on whether other isolated, non-navigable, intrastate wetlands—those that were, are, or could be used for interstate commerce in some other fashion (for example, for interstate or foreign visitors for recreation)—should continue to be covered by the CWA. Advance Notice of Proposed Rulemaking on the Clean Water Act Regulatory Definition of "Waters of the United States," 68 Fed. Reg. 1991 (Jan. 15, 2003). The issue is extremely controversial; over 133,000 comments were submitted to the agencies. Not surprisingly, the agencies spent months analyzing the comments, Lawrence Liebesman, *Judicial, Administrative, and Congressional Responses to* SWANCC, 33 Envtl. L. Rep. (Envtl. L. Rep.) 10,899, 10,906 (2003), and on December 16, 2003, EPA and Corps dropped the effort to issue a new rule. *See* U.S. ENVTL. PROT. AGENCY, *Press Release: EPA and Corps Issue Wetlands Decision*, *available at* http://www.yosemite/epa.gov/opa/admpress.nsf/blab9f485b0 (last visited Mar. 24, 2004). Additional commentaries dealing with *SWANCC* and its aftermath include Craig, *supra* note 8; Funk, *supra* note 8; Casey, *supra* note 8; David E. Kunz, *A River Runs Through It: An Analysis of the Implications of*

plished without causing any significant harm to the economy in terms of employment or growth or investment. It is an amazing success story—a tribute to a regulatory system, which, despite its blemishes, does not deserve all of the criticism that has been hurled in its direction.

More, of course, remains to be done. Permit compliance is too inconsistent;[31] too many industrial facilities that discharge toxics to municipal sewer systems fail to meet pretreatment standards;[32] too many municipal systems experience sewer overflows when it rains;[33] too many rivers suffer from altered flows;[34] and most municipal systems are aging and will soon need major renovation.[35] Too many rivers and other waters remain unable to meet water quality objectives largely because of various kinds of non-point source pollution—the indirect discharge of polluted runoff from fields and

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SWANCC *on the Clean Water Act and Federal Environmental Law*, 9 ENVTL. LAW. 463 (2003); John D. Ostergren, SWANCC *in Duck Country: Will Court-Ordered Devolution Fill the Prairie Potholes?*, 22 STAN. ENVTL. L.J. 381 (2003).

31. Between January 1, 2000 and March 31, 2001, nearly 30% of major dischargers—both industrial and municipal—were in significant non-compliance with the terms of their CWA permits. RICHARD CAPLAN, U.S. PUB. INT. RES. GROUP, PERMIT TO POLLUTE 6 (Aug. 2002). A discharger is deemed to be in "significant noncompliance" by the EPA whenever its discharge of toxic pollutants exceeds the average monthly permitted level by 20% or more in any two months of a six-month period or whenever its discharge of conventional pollutants exceeds its average monthly limit by 40% or more in any two months during a six-month period. U.S. GEN. ACCT. OFFICE, MANY VIOLATIONS HAVE NOT RECEIVED APPROPRIATE ENFORCEMENT ATTENTION 3 (1996) [hereinafter GAO, MANY VIOLATIONS HAVE NOT RECEIVED ATTENTION]. The rate of non-compliance with discharge limits rises to 81% if all violations, not just "significant" ones, are considered. U.S. PUB. INT. RES. GROUP, IN GROSS VIOLATION 9 (Oct. 2002) (examining the two-year period from January 1, 1999 to December 31, 2001).

32. *See* ROBERT W. ADLER ET AL., THE CLEAN WATER ACT: 20 YEARS LATER 147 (1993) [hereinafter ADLER ET AL., CLEAN WATER]; PERCIVAL ET AL., *supra* note 3, at 634. Pre-treatment standards are set to ensure that indirect discharges neither interfere with nor pass through municipal treatment facilities. Clean Water Act § 307(b), 33 U.S.C. § 1317(b). In addition to enforcement problems, the EPA fell behind in promulgating pre-treatment standards and thus thousands of indirect dischargers are not subject to pre-treatment standards even though they discharge toxics to public sewer systems. *See* ADLER ET AL., CLEAN WATER, *supra*.

33. Hundreds of sewage treatment systems suffer from sanitary sewer overflows in which raw sewage is released from the collection system before the waste reaches the treatment facility. The overflows often result from the infiltration and inflow of rainwater that simply overwhelms the capacity of the collection system, treatment facility, or both. *See* U.S. ENVTL. PROT. AGENCY, 1996 CLEAN WATER NEEDS SURVEY, REPORT TO CONGRESS 7 (1997) [hereinafter 1996 CLEAN WATER NEEDS SURVEY]; NAT. RESOURCES DEF. COUNCIL, SWIMMING IN SEWAGE: THE GROWING PROBLEM OF SEWAGE POLLUTION AND HOW THE BUSH ADMINISTRATION IS PUTTING OUR HEALTH AND ENVIRONMENT AT RISK 1 (Feb. 2004). Another problem, called combined sewer overflows, plagues 1100 older municipal systems, generally in the Midwest and Northeast, which collect both sanitary waste and stormwater runoff in a single collection system. *See* NAT. RESOURCES DEF. COUNCIL, WHEN IT RAINS . . . IT POLLUTES: A SURVEY OF RAW SEWAGE POLLUTION IN 14 U.S. CITIES (Apr. 1992).

34. Flows are regulated and modified by a number of hydrologic activities that include dredging, channelization, and the operation of dams. These activities often significantly degrade the quality of the aquatic environment. *See* 2000 NATIONAL WATER QUALITY INVENTORY, supra note 29, at 13-14. *See also* WILLIAM R. LOWRY, DAM POLITICS: RESTORING AMERICA'S RIVERS (2003) (exploring the problems caused by structural modifications to the nation's streams).

35. *See* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, THE CLEAN WATER AND DRINKING WATER INFRASTRUCTURE GAP ANALYSIS 14-15 (2002) [hereinafter EPA, GAP ANALYSIS]; OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, FINANCING AMERICA'S CLEAN WATER SINCE 1987: A REPORT OF PROGRESS AND INNOVATION 15 (2001); WATER INFRASTRUCTURE NETWORK, CLEAN SAFE WATER FOR THE 21ST CENTURY: A RENEWED NATIONAL COMMITMENT TO WATER AND WASTEWATER INFRASTRUCTURE, at ES-1 (2000).

roads, construction sites, and clear cuts.[36] And too many wetlands are still being destroyed or otherwise degraded.[37]

Enforcement of permits and pretreatment standards therefore needs to be strengthened and maintained at a consistently vigorous level,[38] but that is primarily an administrative and budgetary matter, not necessarily a matter of statutory design. The construction grants program needs to be invigorated with a new infusion of federal funding in order to build an adequate wastewater infrastructure for the twenty-first century,[39] but that is a question of renewing a statutory program which produced real results. Non-point source pollution needs to be addressed in some effective fashion,[40] but the failure

36. *See* 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at ES-3; U.S. ENVTL. PROT. AGENCY & U.S. DEP'T OF AGRIC., CLEAN WATER ACTION PLAN: RESTORING AND PROTECTING AMERICA'S WATERS 9 (1998), *available at* http://www.cleanwater.gov/action/toc.html [hereinafter CLEAN WATER ACTION PLAN]. Other sources of non-point source pollution include livestock production, parking lots, mining operations, seepage from septic tanks, and the airborne deposition of pollutants such as nitrogen and various heavy metals. *See* 1996 CLEAN WATER NEEDS SURVEY, *supra* note 33, at 27, 47. Non-point source pollution is, in fact, the largest source of water quality problems today. "It is the main reason that approximately 40% of surveyed rivers, lakes, and estuaries are not clean enough to meet basic uses such as fishing or swimming." OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, SECTION 319 SUCCESS STORIES VOLUME III, at 1 (2002) [hereinafter EPA, SECTION 319 SUCCESS STORIES]. *See also* Malone, *supra* note 13, at 76 (stating that non-point source pollution is "[t]he largest single source of contamination").

37. The net loss of wetlands between 1986 and 1997 was estimated at 58,500 acres per year. THOMAS E. DAHL, U.S. FISH & WILDLIFE SERV., STATUS AND TRENDS OF WETLANDS IN THE CONTERMINOUS UNITED STATES 1986 TO 1997, at 9 (2000). Even wetlands that escape filling are often victims of flow altering activities—such as canals, drainage ditches, and levees—and excessive amounts of nutrients and sedimentation. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 46-7.

38. For reports and commentaries dealing with deficiencies in federal and state enforcement of the CWA, see James R. May, *Now More Than Ever: Environmental Citizen Suit Trends*, 33 Envtl. L. Rep. (Envtl. L. Inst.) 10,704, 10,718 (2003) (reporting a 55% drop between 1997 and 2002 in the total number of EPA referrals for civil enforcement of the CWA—from 111 referrals in 1997 to 50 in 2002); Rechtschaffen & Markell, *supra* note 16, at 10,559 (stating that "the performance of many state enforcement programs falls substantially short of EPA's expectations"); CAPLAN, *supra* note 31; U.S. GEN. ACCT. OFFICE, EPA'S AND STATES' EFFORTS TO FOCUS STATE ENFORCEMENT PROGRAMS ON RESULTS (1998); Victor B. Flatt, *A Dirty River Runs Through It: The Failure of Enforcement in the Clean Water Act*, 25 B.C. ENVTL. AFF. L. REV. 1 (1997); GAO, MANY VIOLATIONS HAVE NOT RECEIVED ATTENTION, *supra* note 31; U.S. GEN. ACCT. OFFICE, WATER POLLUTION: OBSERVATIONS ON COMPLIANCE AND ENFORCEMENT ACTIVITIES UNDER THE CLEAN WATER ACT (1991). Controversy about appropriate levels of enforcement activity is not a new issue. *See*, *e.g.*, William L. Andreen, *Beyond Words of Exhortation: The Congressional Prescription for Vigorous Federal Enforcement of the Clean Water Act*, 55 N.C. L. REV. 202, 204-07 (detailing the precipitous drop in federal enforcement during the early years of the Reagan Administration).

Such a call for more vigorous enforcement accepts the value of "deterrence-based enforcement," the traditional way in which our society has dealt with legal infractions. Under this approach, if there are violations, they should be met with appropriate enforcement actions, at least insofar as available resources permit. *See* Clifford Rechtschaffen, *Deterrence vs. Cooperation and the Evolving Theory of Environmental Enforcement*, 71 S. CAL. L. REV. 1181, 1186-88 (1998). Of course, as Joel Mintz has pointed out, the provision of compliance assistance to small business and communities can be a useful supplement to a deterrence-based enforcement program. Joel A. Mintz, *Scrutinizing Environmental Enforcement: A Comment on a Recent Discussion at the AALS*, 30 Envtl. L. Rep. (Envtl. L. Inst.) 10,639, 10,646 (2000).

39. *See* WATER INFRASTRUCTURE NETWORK, *supra* note 35, at 5-1. According to the EPA, the gap between wastewater treatment capital spending needs and current spending levels (estimated at $10.4 billion per year) for the twenty-year period from 2000 to 2019 will range from $73 billion to $177 billion. EPA, GAP ANALYSIS, *supra* note 35, at 6.

40. *See* Dubrowski, *supra* note 11, at 37.

to adequately control non-point source pollution is not truly a failure of federal regulation since the CWA does not provide for any direct regulation of this pollution problem.[41] Congress basically left the problem—as politically and administratively difficult as it is to solve—to the states, and the states have not been equal to the challenge;[42] although, it is true that the EPA has not been willing to "play hardball" with them.[43] Finally, the continuing loss of wetlands—despite the existence of a no-net loss policy since 1988[44]—is due to a number of factors including shortcomings in the Corps' program to mitigate the authorized loss of wetlands,[45] less than aggressive enforce-

41. *See* PERCIVAL ET AL., *supra* note 3, at 695; Robert W. Adler, *The Two Lost Books in the Water Quality Trilogy: The Elusive Objectives of Physical and Biological Integrity*, 33 ENVTL. L. 29, 56 (2003) [hereinafter Adler, *The Water Quality Trilogy*].

42. Rather than directly regulate non-point source pollution, Congress originally relied upon a state-implemented planning process to deal with the problem. *See* Clean Water Act § 208, 33 U.S.C. § 1288. The section 208 program, however, proved ineffective, so Congress added a new provision in 1987. PERCIVAL ET AL., *supra* note 3, at 695-96. Section 319, 33 U.S.C. § 1329, called upon states to identify waters impaired due to non-point source pollution and to then develop management plans, subject to EPA review, that would remedy the problem. Unfortunately, Congress permitted states to use non-regulatory approaches—such as technical assistance, education, training, and demonstration projects—as an alternative to regulatory programs for the implementation of these management plans. *See* Clean Water Act § 319(b)(2)(B), 33 U.S.C. § 1329(b)(2)(B). As a result of that decision and other problems, including inadequate funding, the section 319 program "has not made great strides in controlling pollution from nonpoint sources." PERCIVAL ET AL., *supra* note 3, at 696. For some anecdotal evidence of success, however, see EPA, SECTION 319 SUCCESS STORIES, *supra* note 36.

43. Robert Adler, *Addressing Barriers to Watershed Protection*, 25 ENVTL. L. 973, 1045 n.427 (1995) (discussing the way in which the EPA approved state plans). For a slightly different view, see Dubrowski, *supra* note 11, at 32-3 (arguing that the EPA actually had little leverage over states since withholding approval of a state plan would merely deprive a state of a federal cost-share grant, which would preclude a state from making "what limited advances the state was willing to make"). In addition to section 319, the TMDL program could be used as a significant tool—a real regulatory stick, as opposed to the carrot of section 319—in the fight against non-point source pollution. However, even though the EPA has defined TMDLs as the sum total of point source and non-point source wasteloads under section 303(d), 33 U.S.C. § 1313(d), the agency has been reluctant to require state agencies to target non-point sources for specific reductions. *See* HOUCK, *supra* note 11, at 107-08.

44. In 1989, President Bush established a national goal of "no net loss" of wetlands. *See* Marged Harris, *Wetlands Management Under the Clean Water Act: Checking the Balances and Balancing the Checks*, 21 Env't Rep. (BNA) 828, 829 (1990). The Clinton Administration later expanded the goal to achieve a net increase in wetlands of 100,000 acres per year by the year 2005. CLEAN WATER ACTION PLAN, *supra* note 36, at 40-42. The administration of the younger President Bush has recently affirmed its commitment to "the goal of no net loss." DEP'T OF THE ARMY, U.S. ENVTL. PROT. AGENCY, U.S. DEP'T OF COMMERCE, DEP'T OF INTERIOR, U.S. DEP'T OF AGRIC. & U.S. DEP'T OF TRANSP., NATIONAL WETLANDS MITIGATION ACTION PLAN 1 (2002) (on file with author), *available at* http://www.epa.gov/owow/wetlands/NWMAP122402signed.pdf (last visited Feb. 6, 2004).

45. Each year between 1993 and 2000, the Corps permitted about 24,000 acres of wetlands to be filled and required 42,000 acres of compensatory mitigation (restored, created, enhanced, and sometimes merely preserved). NAT'L RES. COUNCIL, COMPENSATING FOR WETLAND LOSSES UNDER THE CLEAN WATER ACT 3, 20 (2001) [hereinafter NAT'L RES. COUNCIL, COMPENSATING FOR WETLAND LOSSES]. However, these mitigation projects have often not been carried out, even though required by a Corps permit, and compliance inspections have been rare. *Id.* at 101. Even when mitigation projects have been initiated, many mitigation sites are not performing as well as anticipated. *See id.* at 103. *See also* U.S. GEN. ACCT. OFFICE, WETLANDS PROTECTION: ASSESSMENTS NEEDED TO DETERMINE EFFECTIVENESS OF IN-LIEU MITIGATION (2001) (concluding that the effectiveness of in-lieu-fee mitigation is unclear).

The Corps and the EPA share administration of the section 404 permit program. Primary permitting authority is in the hands of the Corps, Clean Water Act § 404(a), 33 U.S.C. § 1344(a), while the EPA issues guidelines (in conjunction with the Corps) that the Corps must follow in administering the program, *id.* § 404(b), 33 U.S.C. § 1344(b), and has the power to review Corps-issued permits and veto those that "will have an unacceptable adverse effect on municipal water supplies, shellfish beds, . . .

ment,[46] and the problems of jurisdiction—the scope of the permit program—raised most recently and most seriously by the *SWANNC* decision.[47]

This Article, however, does not attempt to set forth a comprehensive critique of the CWA and its administration or to set forth a list of possible statutory and administrative responses. It is, instead, an attempt to examine the progress the CWA has produced in terms of water quality and to try to determine what has worked and what has not.

It is impossible to construct a fully comprehensive picture of water quality across the United States. We simply lack enough data for that. But we do have enough to draw some conclusions. Those conclusions are very telling about what has worked and what has not. The data reveals tremendous improvements in water quality below point source discharges, and the improvements were discerned not only in the immediate area of the discharge, but also dozens, even hundreds of miles downstream. This suggests, of course, that implementation of technology-based effluent limitations, combined with the municipal construction grant program, has worked and worked well. In fact, the urban waters that were most severely impacted by discharges from industrial and municipal point sources have enjoyed the most improvement. Setting aside the question of whether the use of technology-based limitations is the most efficient strategy in some theoretical sense, they have produced positive, tangible results when most of the other proposals have either never been tried in this country or have failed.

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fishery areas . . . , wildlife, or recreational areas." *Id.* § 404(c), 33 U.S.C. § 1344(c).

46. Enforcement authority for the section 404 program is divided between the Corps of Engineers and the EPA. The Corps is the lead agency in cases involving permit violations and most non-substantial unpermitted discharges. Meanwhile, the EPA has the lead for unpermitted discharges involving repeat violators, flagrant violations, cases where the EPA requests the lead, and instances where the Corps wants the EPA to take the lead. U.S. ENVTL. PROT. AGENCY & DEP'T OF THE ARMY, MEMORANDUM OF AGREEMENT BETWEEN THE DEPARTMENT OF THE ARMY AND THE ENVIRONMENTAL PROTECTION AGENCY CONCERNING FEDERAL ENFORCEMENT FOR THE SECTION 404 PROGRAM OF THE CLEAN WATER ACT 4 (1989) (on file with the author). *See* Robert W. Adler, *Fresh Water, in* STUMBLING TOWARD SUSTAINABILITY 197, 223 (John C. Dernbach ed., 2002); ROBERT W. ADLER ET AL., THE CLEAN WATER ACT: 20 YEARS LATER 215 (1993) [hereinafter ADLER ET AL., CLEAN WATER]; Ted Griswold, *Wetland Protection Under Section 404 of the Clean Water Act: An Enforcement Paradox*, 27 SAN DIEGO L. REV. 139, 151-52 (1990); U.S. GEN. ACCT. OFFICE, CORPS OF ENGINEERS' ADMINISTRATION OF SECTION 404 PROGRAM 55 (1988).

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47. *See supra* notes 8 and 30. In addition to the problems posed by the *SWANCC* decision, thousands of acres of wetlands are lost every year because the act of draining wetlands is not subject to CWA jurisdiction unless a discharge of dredged or fill materials is involved. *See* Save Our Cmty. v. EPA, 971 F.2d 1155, 1167 (5th Cir. 1992); WILLIAM L. WANT, LAW OF WETLANDS REGULATION 4-29 (2003). The Act also fails to regulate excavation activity in waters of the United States, where only incidental fallback of soil or other debris occurs. 33 C.F.R. § 323.2(ii) (2003) (rule resulting from the invalidation of the Tulloch Rule).

Before exploring the available data, however, the Article will deal with two preliminary matters. Since many readers may not be familiar with the legal or scientific dimensions of water pollution, the Article first sets forth a brief description of the CWA—its programs and regulatory scheme. It then examines the various components of water pollution and what sources are responsible for the problems. After thus setting the stage, the Article analyzes the available water quality data in an attempt to determine how well the regulatory structure of the CWA has worked. Much work remains to be done, but the Act has made a fine beginning.

II. A BRIEF SKETCH OF THE CLEAN WATER ACT

Although comprehensive federal efforts aimed at controlling water pollution date back to 1948,[48] it took two decades of cautious experimentation before an effective regulatory scheme would evolve. The Clean Water Act of 1972 completely revised the federal approach to water pollution control. The primary control strategy of the CWA is aimed at regulating point source discharges—pipes and other discernible conveyances through which pollutants are added to waters of the United States.[49] Such discharges are prohibited unless the discharger complies with a number of requirements under the Act.[50] In geographical terms, this prohibition extends beyond the traditional concept of navigability because Congress intended "waters of the United States" to be given the broadest possible application under the Commerce Clause of the Constitution,[51] although *SWANCC* certainly limited the breadth of that jurisdiction, at least in cases where the only link to interstate commerce involves migratory birds.[52]

48. For a discussion of the Federal Water Pollution Control Act of 1948, Pub. L. No. 80-845, 62 Stat. 1155 (1948), and the lengthy history leading up to its enactment, see Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 226-39; N. William Hines, *Nor Any Drop To Drink: Public Regulation of Water Quality Part III: The Federal Effort*, 52 IOWA L. REV. 799, 805-13 (1967). The passage of the 1948 Act actually represented a major defeat for the conservation community, who had for years advocated a much tougher approach. *See* Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 226-39. As Representative Karl Mundt said at the time: "[T]he polluters believe and I believe that this legislation will work to stop new attempts to write effective legislation . . . ." 94 CONG. REC. 8196-97 (1948).

49. *See supra* note 4.

50. Clean Water Act § 301(a), 33 U.S.C. § 1311(a) (2000) (forbidding "the discharge of any pollutant by any person" into waters of the United States).

51. S. REP. NO. 92-1236, at 144 (1972); *see also* United States v. Riverside Bayview Homes, Inc., 474 U.S. 121, 129-33 (1985) (stating that Congress exercised its power under the Commerce Clause to extend regulation to waters not deemed navigable under earlier notions of navigability—such as "wetlands adjacent to navigable or interstate waters and their tributaries").

52. *See supra* note 30 and accompanying text. According to joint guidance issued by the EPA and the Corps immediately after the decision was handed down, *SWANCC*'s holding was "narrowly limited" to waters that are "'nonnavigable, isolated, intrastate' waters whose regulation was based solely on the use of such waters by migratory birds." Memorandum from Gary Guzy, General Counsel, EPA, & Robert M. Andersen, Chief Counsel, U.S. Army Corps of Engineers, Supreme Court Ruling Concerning CWA Jurisdiction Over Isolated Waters 2 (Jan. 19, 2001). That position was affirmed in a more recent joint memorandum, which was issued by the Bush Administration and which superceded the earlier guidance. *See* 68 Fed. Reg. 1991, 1995 (Jan. 15, 2003). In the agencies' view, the Act still clearly applies to all waters that have been used, are currently used, or are susceptible to use in interstate commerce; all

Among the requirements that pertain to point source discharges are several that anticipate the promulgation of national effluent limitations that apply to all dischargers in particular industrial categories.[53] These limitations are generally based upon the application of specific kinds of control technology for particular waste streams: best conventional treatment for conventional pollutants such as organic waste;[54] best available technology for many toxics as well as non-toxic, non-conventional pollutants like ammonia;[55] and best available demonstrated technology for new facilities.[56] For sewage treatment plants, the CWA calls for the establishment of effluent limits upon secondary treatment levels,[57] a long-recognized and well-understood standard based upon reducing the oxygen demand of organic waste and total suspended solids by 85%.[58] Industrial polluters who discharge into a public sewage system—and hence are often referred to as indirect dischargers—must comply with pretreatment standards that apply to pollutants which may either interfere with the functioning of the sewage treatment facility or may pass through the facility without adequate treatment.[59] These standards often prescribe the same limits as would apply to a direct discharger.

The CWA also retained and expanded a system of state water quality standards.[60] Unlike the uniform, technology-based effluent limitations, water quality standards are tailored to the uses and values of specific waters. Under this program, all states are required, subject to federal approval, to zone their waters for specific uses—such as fish and wildlife protection and propagation or public water supply—and then set technical criteria—maximum levels of certain pollutants, minimum levels of dissolved oxygen, and perhaps a narrative description of the resulting ecosystem—that are designed to protect those uses.[61] So while the effluent limitations focus on the composition of the waste stream as it flows out of the discharge pipe, water quality standards focus on the overall quality of the receiving water. It

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interstate waters; all impoundments of such waters; all tributaries of such waters; the territorial seas; and all adjacent wetlands. *See id.* at 1995-97. However, due to uncertainties created by the Court's discussion in *SWANCC*, the assertion of jurisdiction over nonnavigable, isolated, intrastate waters that are or could be used by interstate or foreign travelers or from which fish or shellfish could be taken and sold in interstate commerce or which could be used by industries in interstate commerce will be considered on a case-by-case basis. *See id.* at 1996.

53. A powerful factor underlying Congress's adoption of effluent limitations was to provide "uniformity" among those federal and state jurisdictions enforcing the Act and "prevent the 'Tragedy of the Commons' that might result if jurisdictions can compete for industry and development by providing more liberal limitations than their neighboring states." NRDC v. Costle, 568 F.2d 1369, 1378 (D.C. Cir. 1977) (citing NRDC v. Train, 510 F.2d 692, 709 (D.C. Cir. 1975)).

54. Clean Water Act § 301(b)(2)(E), 33 U.S.C. § 1311(b)(2)(E) (2000).

55. *Id.* § 301(b)(2)(A), (C), (D), (F), 33 U.S.C. §1311(b)(2)(A), (C), (D), (F).

56. *Id.* § 306, 33 U.S.C. § 1316.

57. *Id.* § 301(b)(1)(B), 33 U.S.C. § 1311(b)(1)(B).

58. *See* 40 C.F.R. § 133.102(a)(3) (2002) (referring to biological oxygen demand ("BOD")).

59. Clean Water Act § 307(b), 33 U.S.C. § 1317(b) (2000). Most municipal treatment systems that receive pollutants from non-domestic sources must establish a pre-treatment program that enables the system to apply and enforce the applicable pre-treatment requirements. *See* 40 C.F.R. § 403 (2002).

60. Clean Water Act § 303, 33 U.S.C. § 1313 (2000).

61. *Id.* § 303(c), 33 U.S.C. § 1313(c).

is thus possible, especially for streams receiving discharges from many sources, for streams with relatively low flows, or for streams with very high uses, that compliance with effluent limitations alone will not necessarily ensure compliance with stream standards. For those streams still unable to meet water quality standards, the states are to set total maximum daily loads and allocate those loadings among the various sources of pollution.[62]

To implement and monitor compliance with these technology-based effluent limitations and any more stringent limits that may be necessary to meet water quality standards, every discharger must obtain a permit and comply with its terms.[63] These NPDES permits serve as a device for transforming general regulatory requirements into enforceable obligations of the individual discharger.[64] Although forty-five state programs have been granted authority to issue NPDES permits,[65] states must apply federal requirements[66] and are subject to an EPA veto should they fail to do so.[67] However, consistent with the preemption policy found in most federal environmental legislation, state-issued permits may require compliance with limitations or conditions which are more stringent than federal ones.[68]

The permit system greatly facilitated government enforcement efforts because NPDES permits normally contain precise numerical limits that define compliance for purposes of the Act. Congress also authorized EPA to impose substantial monitoring and reporting obligations upon the regulated community.[69] The EPA, in turn, has required each permittee to periodically file a discharge monitoring report ("DMR") that reveals the actual levels of pollutants found in the permittee's discharge.[70] The determination of a violation is thus a relatively simple process in most instances, involving a mere comparison of permit restrictions with the discharger's actual performance.[71]

The CWA also created a wide array of federal sanctions for violations of the Act. In doing so, Congress gave EPA enormous power to enforce the Act through the use of administrative compliance orders,[72] administrative

62. *See id.* § 303(d), 33 U.S.C. § 1313(d); *see also supra* text accompanying note 13.
63. Clean Water Act § 301(a), 33 U.S.C. § 1311(a) (2000).
64. *See* EPA v. California *ex rel.* State Water Res. Control Bd., 426 U.S. 200, 205 (1976).
65. *See* EPA, NPDES State Program Status, *supra* note 16.
66. Clean Water Act § 402(b), 33 U.S.C. § 1342(b) (2000).
67. *Id.* § 402(d), 33 U.S.C. § 1342(d).
68. *See id.* § 510, 33 U.S.C. § 1370. In order to give force to the principle that states may set more stringent conditions than federal law would require, section 401 requires—in cases where federal agencies are issuing permits—that applicants obtain a certificate from the state indicating that the discharge will comply with state water quality standards, as well as other pertinent requirements of state law and the CWA. *Id.* § 401, 33 U.S.C. § 1341.
69. *Id.* § 308(a), 33 U.S.C. § 1318(a).
70. 40 C.F.R. §§ 122.41(j)-(l), 122.44(i), 122.48 (1995) (imposed as a condition in each permit issued by the EPA or under an approved state program).
71. The EPA may, of course, conduct its own compliance inspections, Clean Water Act § 308(a)(B), 33 U.S.C. § 1318(a)(B) (2000), and states must have programs providing for periodic inspections, 40 C.F.R. § 123.26 (1995).
72. Clean Water Act § 309(a), 33 U.S.C. § 1319(a) (2000).

penalties,[73] civil suits for injunctive relief[74] and civil penalties,[75] and even criminal sanctions.[76] Every NPDES permit, furthermore, is subject to termination or modification in case of noncompliance.[77] In addition, state water pollution agencies were recognized as possessing concurrent power to enforce state-issued permits.[78] Finally, Congress included a citizen suit provision—modeled along the lines of the Clean Air Act provision[79]—to tap private resources and initiative in order to supplement and encourage government enforcement. Through this device, Congress empowered private citizens to sue those dischargers who are violating an "effluent standard or limitation" or an administrative order issued by either the EPA or a state.[80]

In addition to the NPDES permit system, the CWA contains four other vitally important programs. First, the Act prohibits the discharge of dredged or fill material into waters of the United States—including wetlands—without first obtaining a section 404 permit from the U.S. Army Corps of Engineers.[81] This program is not administered exclusively by the Corps. Dredge and fill permits are formulated pursuant to guidelines established by EPA,[82] and the permits themselves are subject to EPA review and possible veto.[83] While the dredging of navigable channels and disposal of the dredged materials often gives rise to controversy,[84] it is not the most controversial aspect of this program. That distinction is reserved for the disputes which arise out of the program's jurisdiction over the use and development of wetland areas, thousands of acres of which remain in private hands.[85]

The dredge and fill program is actually a special application of the Act's broad prohibition on discharging pollutants into waters of the United States from a point source. After all, a point source, in this context, could include a shovel or even a plow.[86] Another kind of point source discharge may be

73. *Id.* § 309(g), 33 U.S.C. § 1319(g).
74. *Id.* § 309(b), 33 U.S.C. § 1319(b).
75. *Id.* § 309(d), 33 U.S.C. § 1319(d).
76. *Id.* § 309(c), 33 U.S.C. § 1319(c). Any person who has been convicted of violating the CWA is barred from federal contracting until the EPA certifies that the violation has been corrected. *Id.* § 508(a), 33 U.S.C. § 1368(a).
77. 40 C.F.R. § 122.41(a) (2002).
78. Clean Water Act § 309(a)(1), (2), 33 U.S.C. § 1319(a)(1), (2) (2000).
79. Clean Air Act § 304, 42 U.S.C. § 7604 (1994) (originally enacted in 1970).
80. Clean Water Act § 505(a)(1), 33 U.S.C. § 1365(a)(1). "[E]ffluent standard or limitation" is defined to include NPDES permits, unpermitted discharges, state certifications under section 401, as well as effluent limitations, effluent standards, and pre-treatment standards. *Id.* § 505(f), 33 U.S.C. § 1365(f). As mentioned earlier, citizens may also sue the EPA for failures to perform any non-discretionary duties under the Act. *Id.* § 505(a)(2), 33 U.S.C. § 1365(a)(2).
81. *Id.* §§ 301(a), 404, 33 U.S.C. §§ 1311(a), 1344.
82. *Id.* § 404(b), 33 U.S.C. § 1344(b).
83. *Id.* § 404(c), 33 U.S.C. § 1344(c).
84. *See, e.g.*, GULF RESTORATION NETWORK & SIERRA CLUB LEGAL DEF. FUND, COSTLY CORPS: HOW THE U.S. ARMY CORPS OF ENGINEERS SPENDS YOUR TAX DOLLARS TO DESTROY AMERICA'S NATURAL RESOURCES 17 (1996).
85. Approximately 75% of wetlands in the lower forty-eight states are in private hands. ORG. ECON. CO-OPERATION & DEV., ENVIRONMENTAL PERFORMANCE REVIEWS: UNITED STATES 82 (1996) [hereinafter OECD, ENVIRONMENTAL PERFORMANCE REVIEW].
86. *See* Avoyelles Sportsmen's League, Inc. v. Marsh, 715 F.2d 897, 922 (5th Cir. 1983).

distinguished from those regulated by either the NPDES program or the section 404 program—unanticipated or accidental spills of oil or hazardous substances, events for which a permit system is unsuited.

To encourage spill prevention and to cope with spills once they occur, Congress refined and expanded a program whose origins date back to the Oil Pollution Act of 1924.[87] Section 311 of the CWA prohibits spills of oil and hazardous substances in harmful quantities and requires that the person in charge of the "leaking" vessel or facility give immediate notice to the government.[88] In addition to various penalties that may apply to the spill[89] and to any failure to give prompt notice,[90] section 311 created a system for cleaning up these spills—a response system which was strengthened considerably by the Oil Pollution Act of 1990.[91] The federal government must ensure the effective and immediate removal of any spill.[92] In most instances, this means that the government may choose to clean up the discharge itself using a dedicated trust fund, may direct those responsible for the spill to clean it up, or may monitor any private or public cleanup activities.[93] However, where a spill poses a substantial threat to public health or welfare, the United States must either perform or direct the response action.[94] In any case, the responsible party is strictly liable for the response costs incurred by the government and for damages to natural resources.[95]

Not all sources of water pollution involve a point source discharge. Most water pollution today, in fact, is caused by generalized runoff from fields and forests, parking lots, construction sites, and even from air pollution sources.[96] Recognizing this problem, Congress has twice attempted—albeit in half-hearted fashion—to craft programs to abate the most severe non-point source problems.[97] The current approach requires states to identify those waters that, without some action to control non-point sources, will not be able to comply with water quality standards.[98] The states are then called upon to develop management plans to reduce non-point source pollution along those water quality-stressed streams and lakes.[99]

The federal government began assisting local communities with the construction of sewage treatment plants during the New Deal.[100] Although

87. Pub. L. No. 68-288, 43 Stat. 604 (1924). For a brief review of the Act and its legislative history, see Andreen, *Evolution of Water Pollution Control: Part II*, *supra* note 2, at 223-25.
88. Clean Water Act § 311(b), 33 U.S.C. § 1321(b).
89. *Id.* § 311(b)(6), (b)(7)(A), 33 U.S.C. § 1321(b)(6), (b)(7)(A).
90. *Id.* § 311(b)(5), 33 U.S.C. § 1321(b)(5).
91. Pub. L. No. 101-380, 104 Stat. 486 (1990).
92. Clean Water Act § 311(c)(1)(A), 33 U.S.C. § 1321(c)(1)(A).
93. *Id.* § 311(c)(1)(B), (e), 33 U.S.C. § 1321(c)(1)(B), (e).
94. *Id.* § 311(c)(2), (e), 33 U.S.C. § 1321(c)(2), (e).
95. Oil Pollution Act ("OPA") § 1002, 33 U.S.C. § 2702 (1990). Certain limited defenses and limits on liability are set forth at sections 1003 and 1004 of the OPA, 33 U.S.C. § 2703, 2704.
96. *See supra* note 36 and accompanying text.
97. *See supra* notes 40-43 and accompanying text.
98. Clean Water Act § 319(a), 33 U.S.C. § 1329(a).
99. *Id.* § 319(b), 33 U.S.C. § 1329(b).
100. Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 226.

that assistance fell victim to the Second World War,[101] a modest amount of aid in the form of loans to local government was resumed in 1950.[102] In 1956, Congress started a more robust grant-in-aid program,[103] which grew substantially during the 1960s.[104] The municipal grants program fairly exploded with the passage of the CWA in 1972 due, in part, to long-deferred needs and because of the stringency of the effluent limitations that were soon to be imposed upon municipal dischargers.[105] Between 1970 and 1995, the federal government provided local governments with a total of $61.1 billion to build new treatment facilities and upgrade older ones,[106] and between 1988 and 1999, an additional $16.1 billion in federal aid was contributed to the State Revolving Fund Program.[107] This federal contribution, combined with state and local capital expenditures of approximately the same magnitude,[108] helped complete thousands of projects at thousands of municipal sewage plants. As a result, the number of municipal plants providing less than secondary treatment fell dramatically, from 2435 in 1968 (and 4278 in 1978) to less than 200 in 1996.[109] And the total number of people served by municipal plants with secondary or better treatment nearly doubled between 1968 and 1996 from 85.9 million to 164.8 million.[110]

III. WATER POLLUTION PROBLEMS

The surface water resources in the United States are immense. They consist of 3.5 million miles of rivers and streams[111]—enough, in fact, to extend from the Earth to the Moon more than twelve times. The five Great

101. *See* EARL FINBAR MURPHY, WATER PURITY: A STUDY IN LEGAL CONTROL OF NATURAL RESOURCES 89 (1961).

102. *See* Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 235-38.

103. *See id.* at 239-40.

104. *See id.* at 242, 252.

105. *See id.* at 284.

106. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2. By comparison, only $5.1 billion in federal aid was made available from 1957 to 1972. *Id.* at 2-63.

107. *Id.* Unlike the construction grants program, which provided funding directly to local government based on a state-established priority list, the State Revolving Fund Program provided federal funds to state governments, which could then provide assistance to local government in various ways including low-interest loans. *See* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, FINANCING AMERICA'S CLEAN WATER SINCE 1987: A REPORT OF PROGRESS AND INNOVATION 7 (2001), *available at* http://www.epa.gov/owm/finan.htm.

108. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-67.

109. *Id.* at 2. The total number of persons served by plants failing to meet secondary treatment fell from 140 million in 1968 to 17 million in 1996, and approximately one-third of these 17 million persons are currently served by plants that are not required to meet secondary treatment because they had received deep ocean discharge variances under section 301(h) of the Act, 33 U.S.C. § 1311(h). *See id.* at 3. As recently as 1988, there were 1789 municipal treatment facilities, serving over 26 million people, providing less than secondary treatment, and 118 facilities, serving 1.5 million persons, discharging raw sewage. *See* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, NATIONAL WATER QUALITY INVENTORY, 1988 REPORT TO CONGRESS 148 (1990).

110. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3.

111. *See* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, ENVIRONMENTAL INDICATORS OF WATER QUALITY IN THE UNITED STATES 2 (June 1996) [hereinafter EPA, ENVIRONMENTAL INDICATORS OF WATER QUALITY], *available at* http://www.epa.gov/OW/indic.

Lakes occupy 94,000 square miles, and there are another 100,000 lakes which exceed 100 acres in size excluding Alaska, which alone has several million such lakes.[112] We also enjoy 58,000 miles of ocean shoreline that is punctuated by magnificent estuaries such as San Francisco Bay, Puget Sound, Chesapeake Bay, Long Island Sound, Tampa Bay, and Mobile Bay. And between these open waters and dry land lies some 278 million acres of wetlands.[113]

This abundant resource has been an important factor in building and sustaining a healthy economy. Our surface waters provide drinking water for approximately half of the nation's population, and more than 13 trillion gallons of water are used every year to manufacture goods and process food in the United States.[114] The nation's beaches, lakes, and rivers are also the number one vacation destination for Americans who make an estimated 1.8 billion trips every year to swim or fish, boat, or simply relax around the water.[115] And the American fishing industry produces over 10 billion pounds of fish and shellfish each year, the current value of which is estimated at $3.4 billion, while irrigated agriculture produces about $70 billion of crops every year.[116] Clean and abundant supplies of water, however, should not be taken for granted.[117]

For as long as people have gathered together in towns and villages, there have been polluted waters. Many of the epidemics that periodically ravaged European cities and towns during the Middle Ages were caused by exposure to the waterborne viruses and pathogens that infected polluted waters.[118] In the United States, the industrialization and urbanization of the nineteenth century brought about a crisis in the quality of the nation's waters—a crisis largely caused by the discharge of untreated or inadequately treated human waste.[119] The industrial contribution to the problem, how-

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112. *See* OFFICE OF WATER REGULATIONS & STANDARDS, U.S. ENVTL. PROT. AGENCY, OUR NATION'S LAKES 2 (July 1980). The Great Lakes, in fact, constitute the largest fresh water system in the world—containing approximately 18% of the world's entire supply. *See* UNITED NATIONS ENV'T PROGRAMME, GLOBAL ENVIRONMENT OUTLOOK 99 (1997).

113. *See* OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, LIQUID ASSETS: A SUMMERTIME PERSPECTIVE ON THE IMPORTANCE OF CLEAN WATER TO THE NATION'S ECONOMY, at ii (May 1996) [hereinafter EPA, LIQUID ASSETS].

114. *See id.* at 10.

115. *See id.* at 3.

116. *See id.* at 6-7.

117. High-quality water is not just important for recreation and domestic uses; it is "critical" for most industrial uses as well. *See* KENNETH D. FREDERICK ET AL., ECONOMIC VALUES OF FRESHWATER IN THE UNITED STATES 3 (1996) (Resources for the Future Discussion Paper 97-03).

118. *See* J.N. HAYS, THE BURDENS OF DISEASE: EPIDEMICS AND HUMAN RESPONSE IN WESTERN HISTORY 35-36 (1998).

119. *See* Andreen, *Evolution of Water Pollution Control: Part I, supra* note 14, at 162-78. For excellent historical discussions of the sanitary problems of the nineteenth century and the governmental response to those problems, see JOHN DUFFY, THE SANITARIANS: A HISTORY OF AMERICAN PUBLIC HEALTH (1992); MARTIN MELOSI, THE SANITARY CITY: URBAN INFRASTRUCTURE IN AMERICA FROM COLONIAL TIMES TO THE PRESENT (2000); JOEL A. TARR, THE SEARCH FOR THE ULTIMATE SINK: URBAN POLLUTION IN HISTORICAL PERSPECTIVE (1996). For an exploration of the impact of industrial water pollution in the nineteenth century, see THEODORE STEINBERG, NATURE INCORPORATED: INDUSTRIALIZATION AND THE WATERS OF NEW ENGLAND (1991).

ever, continued to grow in magnitude. By the end of the Second World War, industrial waste effluents exceeded municipal sewage by a ratio of seven to six.[120] The Second World War, moreover, spawned a chemical revolution that increased the complexity and risk posed by industrial wastewater, which continued to be dumped—generally without treatment—into the nation's surface water either directly or indirectly through municipal sewers.[121] By the end of the 1960s, 80% of the pollution loading to U.S. waters was industrial in origin.[122] And of the 22 billion gallons of pollutants that U.S. industry discharged daily in 1970, only 29% received any treatment at all, regardless of whether the level of treatment was adequate or not.[123]

Over the past thirty years, significant progress has been made in reducing municipal and industrial point source discharges to our rivers and lakes. Although point sources continue to pose a number of problems—sanitary sewer overflows and combined sewer overflows, for instance, as well as the constant challenge of enforcing permit limitations—we have discovered that the causes of water quality impairment are quite varied and include many things, including air pollution, which the CWA was never designed to regulate.[124]

A. Pollutants and Processes that Harm Water Quality

Hundreds of different kinds of pollutants can harm or destroy aquatic life, threaten human health, or simply foul water to such an extent that recreation and aesthetic appreciation are impaired. Some of these pollutants have been studied for years and are well understood.[125] Conventional pollutants such as oxygen-depleting substances, suspended solids, fecal coliform (bacteria), pH (acids and alkalines), and oil and grease fit into this category.[126] Other pollutants have been designated as toxic because they can "cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations" in affected organisms.[127] Toxic pollutants include

120. *See* MURPHY, *supra* note 101, at 89; TARR, *supra* note 119, at 375.

121. *See* Andreen, *Evolution of Water Pollution Control: Part I*, *supra* note 14, at 188-89.

122. *See* AM. PUB. WORKS ASS'N, HISTORY OF PUBLIC WORKS IN THE UNITED STATES: 1776-1976, at 410 (Ellis L. Armstrong ed., 1976).

123. *See* William H. Rodgers, Jr., *Industrial Water Pollution and the Refuse Act: A Second Chance for Water Quality*, 119 U. PA. L. REV. 761, 764 (1971).

124. For over twenty-five years, the International Joint Commission has reported that the atmosphere was a "significant pathway" for the pollution of the Great Lakes. INT'L JOINT COMM'N, NINTH BIENNIAL REPORT ON GREAT LAKES WATER QUALITY 24 (1998). This pollution includes toxics such as mercury, lead, and PCBs, as well as the nutrient, nitrogen. Major sources include coal-fired electric-generating stations, incinerators, cars, trucks, and other transportation sources. *See id.*

125. *See* Donald W. Stever et al., *Water*, *in* 3 LAW OF ENVIRONMENTAL PROTECTION 13-94 (Sheldon M. Novick et al. eds., 2003) (stating that conventional pollutants are "those that have traditionally been regulated in discharges from municipal" wastewater treatment facilities).

126. *See* 40 C.F.R. § 401.16 (2003) (setting forth the list of conventional pollutants designated by the EPA under Clean Water Act § 304(a)(4), 33 U.S.C. § 1334(a)(4)).

127. Clean Water Act § 502(13), 33 U.S.C. § 1362(13). The original list of sixty-five toxic pollutants designated pursuant to § 307(a)(1), 33 U.S.C. § 1317(a)(1), is published at 40 C.F.R. § 401.15 (2003).

solvents, heavy metals, organic chemicals such as polychlorinated bipheyls (PCBs) and dioxins, and various pesticides.[128] Another group of pollutants—including such substances as ammonia, chlorides, nitrates, color, and iron—while not toxic, are not as well understood as the conventional pollutants and are therefore referred to as nonconventional pollutants (or gray-area pollutants) since they are neither toxic nor conventional.[129] They are subject to the same regulatory standards as apply to toxic pollutants unless it can be shown that such a stringent requirement is not necessary in a given case to satisfy water quality concerns.[130] There are also a number of activities like water diversions and dredging, and structures such as dams, which can adversely affect aquatic habitat and hydrology.[131]

1. Oxygen-Depleting Substances

The ability of a water body to support fish and higher forms of aquatic life depends upon adequate levels of dissolved oxygen. Most fish and beneficial aquatic insects need oxygen in order to survive. Although a few coarse species such as carp and catfish are adapted to life in oxygen-depleted water, most game fish (such as bass, trout, and salmon) will suffer if dissolved oxygen falls below 3.0-4.0 milligrams/liter (mg/L), which is the equivalent of three to four parts of oxygen per million parts of water.[132] Larvae and juvenile members of such species need even higher concentrations of oxygen, ranging from 5.0-8.0 mg/L.[133] Prolonged exposure to low levels of dissolved oxygen can suffocate mature fish, eggs, and larvae and can starve fish by killing insect larvae.[134]

Oxygen levels can fluctuate under natural conditions. Lengthy periods of hot, dry weather, for example, can depress in-stream oxygen levels, sometimes so severely that fish kills result.[135] More often, however, serious cases of oxygen depletion result from the discharge and subsequent decom-

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The list includes thirty-one chemical groups and thirty-eight individual substances. The EPA has since expanded the list to include 126 individual pollutants that are discharged by thirty-four industrial categories. These 126 toxics are commonly referred to as priority pollutants. *See* PERCIVAL ET AL., *supra* note 3, at 624.

128. *See* 40 C.F.R. § 401.15 (2003).

129. *See* Stever et al., *supra* note 125, at 12-81.

130. *See* Clean Water Act § 301(g), 33 U.S.C. § 1311(g).

131. *See* 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29; LOWRY, *supra* note 34; *see also infra* notes 169-71 and accompanying text.

132. *See* U.S. ENVTL. PROT. AGENCY, 1998 NATIONAL WATER QUALITY INVENTORY 18 (2000) [hereinafter 1998 NATIONAL WATER QUALITY INVENTORY]. A dissolved oxygen level of 4.0 mg/L is about the lowest that will support a varied fish population, and for a well-balanced population, the minimum concentration is 5.0 mg/L. *See* EPA, QUALITY CRITERIA FOR WATER 123, 125 (1976) [hereinafter EPA, RED BOOK]; *see also* EPA, QUALITY CRITERIA FOR WATER 209-19 (1986) [hereinafter EPA, GOLD BOOK] (containing updated water quality criteria for dissolved oxygen).

133. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 18; EPA, GOLD BOOK, *supra* note 132, at 211.

134. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132.

135. *See* THE ENCYCLOPEDIA OF THE ENVIRONMENT 143 (Ruth A. Eblen & William R. Eblen eds., 1994).

position of biodegradable organic material such as sewage, food processing wastes, discharges from pulp and paper facilities, and animal waste.[136] Although water quality standards refer to minimum levels of dissolved oxygen as necessary to meet particular use classifications, NPDES permits generally refer to biochemical oxygen demand ("BOD")—the measure of how much oxygen is consumed by the breakdown of organic material and the oxidation of some inorganic material.[137]

2. *Nutrients*

Nutrients such as nitrogen and phosphorus are essential ingredients for healthy and productive aquatic habitats.[138] Excessive amounts of these nutrients, however, can produce eutrophic conditions where the nutrients overstimulate the growth of algae and various aquatic weeds, which later decay causing a steep decline in the amount of oxygen available to fish and other life forms.[139] The most significant sources of waterborne nutrients are lawn and crop fertilizers containing phosphorus and nitrates that often run off into nearby waters, sewage, manure from fields and feedlots, and detergents that contain phosphorus.[140] The deposition of atmospheric nitrogen is another significant source of waterborne nitrogen.[141] Referred to as "atmospheric fallout" back in the 1970s,[142] this cross-media pollutant proves that what goes up does indeed come down. Airborne nitrogen is removed from the air by precipitation or when nitrogen particles settle out of the air and into water.[143] Air pollutants like nitrogen can also enter lakes and streams indirectly, by first being deposited on land, and then being flushed into a waterbody through stormwater runoff or blown into waters as dust. Studies suggest that 25% to 35% of the total loading of nitrogen in the Chesapeake Bay, which has suffered greatly from the effects of excessive nutrients,[144]

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136. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 18-19.

137. *See id.* at 18-19. For a more thorough discussion of BOD, see JOHN W. CLARK ET AL., WATER SUPPLY AND POLLUTION CONTROL 287-88 (3d ed. 1977).

138. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 19; U.S. DEP'T OF THE INTERIOR & U.S. GEOLOGICAL SURVEY, THE QUALITY OF OUR NATION'S WATERS: NUTRIENTS AND PESTICIDES 2 (Circular 1225, 1999).

139. U.S. ENVTL. PROT. AGENCY, DRAFT REPORT ON THE ENVIRONMENT 2003, at 2-6 (2003) [hereinafter EPA, DRAFT REPORT ON THE ENVIRONMENT]; Charles Driscoll et al., *Nitrogen Pollution: Sources and Consequences in the U.S. Northeast*, ENVT. 9, 16-18 (Sept. 2003). For a detailed discussion of eutrophication, see CLARK ET AL., *supra* note 137, at 275-86. An overabundance of algae can also produce what are known as "dead zones," such as the one that forms at the mouth of the Mississippi River every summer, where oxygen levels are so low that fish and shellfish cannot survive. *See* H. JOHN HEINZ III CTR. FOR SCI., ECON. & THE ENV'T, THE STATE OF THE NATION'S ECOSYSTEMS: MEASURING THE LANDS, WATERS, AND LIVING RESOURCES OF THE UNITED STATES 46 (2002) [hereinafter STATE OF THE NATION'S ECOSYSTEMS]; NANCY N. RABALAIS ET AL., NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, CHARACTERIZATION OF HYPOXIA, TOPIC #1, GULF OF MEXICO HYPOXIA ASSESSMENT (1999).

140. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 19.

141. STATE OF THE NATION'S ECOSYSTEMS, *supra* note 139, at 46.

142. *See* EPA, RED BOOK, *supra* note 132, at 107.

143. STATE OF THE NATION'S ECOSYSTEMS, *supra* note 139, at 46.

144. Excessive loadings of nitrogen are responsible for the eutrophic conditions that plague the Bay.

results from atmospheric deposition.[145] Common sources of airborne nitrogen include automobiles, coal-fired electric generating stations, steel and coke manufacturing facilities, and other combustion sources.[146]

3. Bacteria and Pathogens

A number of waterborne viruses, bacteria, and protozoa can cause infections and other illnesses in humans ranging from typhoid fever and dysentery to minor skin diseases and eye, ear, nose, and throat infections.[147] Waterborne microbes are responsible for over 900,000 infections in the United States every year.[148] These microbes originate in the excreta of warm-blooded animals and human beings and enter our waterways through inadequately treated sewage, septic tanks,[149] boats, stormwater discharges, and runoff from livestock feeding and grazing areas. Rather than sample for all of these pathogens, state and federal agencies measure particular indicator bacteria that are widely found in the intestines of animals and people. The presence of such bacteria—common indicator groups such as fecal coliform bacteria or Escherichia coli, for example—indicates that the lake or river is contaminated with untreated or inadequately treated human or animal waste and that there is a risk that other, more dangerous organisms, such as Sal-

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U.S. ENVTL. PROT. AGENCY, CHESAPEAKE BAY PROGRAM, ATMOSPHERIC NITROGEN DEPOSITION LOADINGS TO THE CHESAPEAKE BAY: AN INITIAL ANALYSIS OF THE COST EFFECTIVENESS OF CONTROL OPTIONS 1 (Nov. 1996) [hereinafter ATMOSPHERIC NITROGEN DEPOSITION LOADINGS TO THE CHESAPEAKE BAY].

It is probably no coincidence that the population of the toxic dinoflagellate *Pfiesteria piscida* exploded in the Chesapeake Bay during the 1990s since the microbe thrives in waters that are polluted with nutrients such as nitrogen and phosphorus. Researchers from Johns Hopkins and the University of Maryland have found evidence suggesting that persons exposed to *Pfiesteria*-contaminated fish or water may suffer symptoms such as fatigue, headaches, respiratory irritation, diarrhea, skin irritation, and memory loss. *See* AMERICAN RIVERS, AMERICA'S MOST ENDANGERED RIVERS OF 1998, at 10-11 (Apr. 1998).

145. *See* U.S. ENVTL. PROT. AGENCY, CHESAPEAKE BAY PROGRAM, CHESAPEAKE BAY ATMOSPHERIC DEPOSITION STUDY, PHASE II, FINAL REPORT 2 (July 1994) (relating results of three scientific studies). A recent EPA study concluded that 27% of the Bay's total nitrogen load stems from air pollution—10% deposited directly on the surface of the Bay and the tidal portion of its tributaries and 17% deposited elsewhere in the watershed that eventually runs into the tidal bay. ATMOSPHERIC NITROGEN DEPOSITION LOADINGS TO THE CHESAPEAKE BAY, *supra* note 144, at 1.

Studies also indicate that the atmospheric deposition of nitrogen oxide emissions is responsible for 20% of the nitrogen in Long Island Sound, 15% of the nitrogen in Delaware Bay, 44% of the nitrogen in North Carolina's Albemarle and Pamlico sounds, and 12% of the nitrogen in Narragansett Bay. *See Current Developments*, 27 Env't Rep. (BNA) 221-22 (1996).

146. *See* OFFICE OF AIR QUALITY PLANNING & STANDARDS, U.S. ENVTL. PROT. AGENCY, DEPOSITION OF AIR POLLUTANTS TO THE GREAT WATERS, FIRST REPORT TO CONGRESS 63 (May 1994).

147. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 20.

148. *See* David Pimentel et al., *Ecology of Increasing Disease: Population Growth and Environmental Degradation*, 48 BIOSCIENCE 817, 818 (1998) (resulting in approximately 900 deaths each year).

149. Most of the fifty million Americans who are not connected to a wastewater treatment system rely upon septic tanks for waste disposal. However, only about a third of the soils in the United States are suitable for absorbing septic tank effluent. Due to unsuitable soil conditions or improper installation, approximately 25% of all septic tanks malfunction periodically or continuously. In these circumstances, the effluent often migrates into surface or ground water supplies, producing bacterial or viral contamination. *See* DADE W. MOELLER, ENVIRONMENTAL HEALTH 151-52 (1997).

monella *typhi*, may infect humans who rely upon the waterbody for recreation or who consume drinking water or shellfish from it.[150]

4. Suspended and Settleable Solids

Suspended and settleable solids include a wide variety of pollutants that can adversely affect aquatic communities. These pollutants include eroded soil particles such as sand, gravel, clay, and silt—collectively referred to as sediment—and other solid particles that can be suspended in sewage and other liquid pollutants. The turbidity which results from sedimentation can clog or abrade fish gills, suffocate fish eggs and water insect larvae, damage invertebrate populations, and reduce the sunlight available to normal aquatic vegetation, thus lowering levels of dissolved oxygen. Turbid water conditions can also interfere with recreational activities due to the loss of water clarity, and suspended silt and sediment can clog mountain streams and choke impounded water bodies. Some solids—discharged, for example, through sewer overflows—may contain bacteria or toxics or oxygen-consuming nutrients. Even ordinary sediment may contain toxic and nutrient pollution since pesticides, other toxics, and nutrients like lawn or agricultural fertilizers may have adhered to or been absorbed by soil particles that are subsequently washed into a waterway.[151]

Approximately three billion tons of sediment are washed into our lakes and streams every year.[152] About half of this erosion is from agriculture where cultivated land is often left without a vegetative cover and is therefore extremely vulnerable to erosion. Significant amounts of erosion also occur at construction and logging sites,[153] in urban areas and from strip-mined lands, and as a result of removing vegetation from streambanks.[154] In 1998, the Ecological Risks Subcommittee of the EPA's Science Advisory Board ranked turbidity/sedimentation as a top ecological risk whose management is not being adequately addressed by any level of government.[155]

5. pH

"pH" is a measure of the acidity or alkalinity of a particular water. A low pH value (less than five) indicates acidic conditions whereas a high

150. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 20-21; EPA, RED BOOK, *supra* note 132, at 42-48.

151. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 20 (discussing sedimentation and siltation); EPA, RED BOOK, *supra* note 132, at 210-12; EPA, GOLD BOOK, *supra* note 132, at 262-66.

152. *See* OFFICE OF WATER REGULATIONS & STANDARDS, U.S.. PROT. AGENCY, OUR NATION'S LAKES 19 (July 1980) (citing a figure of four billion tons per year).

153. The timber-harvesting practices that lead to increased erosion include clear-cuts, the construction and use of logging trails, the use of fire to clear harvested areas of all vegetation before reforestation, and the removal of trees along streams. *See* U.S. GEN. ACCT. OFFICE, OREGON WATERSHEDS: MANY ACTIVITIES CONTRIBUTE TO INCREASED TURBIDITY DURING LARGE STORMS 22-24 (1988).

154. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 20.

155. *See Current Developments*, 28 Env't Rep. (BNA) 2743 (1998).

value (over nine) indicates alkaline conditions. A number of biological processes such as reproduction cannot function in either acidic or alkaline waters, and at extreme levels fish kills can occur.[156] Acidic water conditions can also aggravate toxic contamination because acidic conditions will release toxic materials that are present in stream or lake sediments. Mine acid drainage, runoff from mine tailings, and acid rain (resulting from the transformation of sulfur dioxide and nitrogen oxides into acids in the atmosphere) are among the primary sources of acidic water conditions.[157]

6. *Toxic Substances and Metals*

Conventional pollutants were the initial focus of most pollution control programs because they were so ubiquitous and because their effects were so obvious and immediate. Excessive amounts of bacteria could spread disease; excessive BOD would deplete oxygen levels and suffocate aquatic life; and excessive nitrogen or phosphorus could choke a lake with rotting masses of algae. Toxic pollutants, by contrast, often have a more obscure impact on human health and the environment. Although the impacts were often serious—causing, for example, cancerous tumors in fish and birth defects among predators like birds—cause and effect was not necessarily clear. Many toxics are dangerous at extremely low concentrations; others have long latency periods before they cause harm; and still others, those which bioaccumulate in the tissue of living organisms, pose the greatest danger to predators at the top of the food chain.[158] Determining whether a substance is toxic and, if so, at what concentration the substance poses risk, are often difficult, sometimes nearly impossible, questions to answer given the limited empirical data that is sometimes available.[159]

Toxic water pollutants include solvents such as toluene and benzene, pesticides such as DDT and chlordane, organic chemicals such as PCBs and dioxin, and metals such as lead and mercury. In most cases involving metals contamination, high concentrations tend to appear in fish tissue rather than the water column because heavy metals accumulate in the fatty tissue of organisms near the top of the food chain. A number of toxic organic chemicals—like PCBs, DDT, and dioxin—not only bioaccumulate in fatty tissue but persist and accumulate in the environment because they do not readily

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156. A pH range of 6.5 to 9.0 appears to provide adequate protection for freshwater fish and benthic organisms. *See* EPA, RED BOOK, *supra* note 132, at 180; EPA, GOLD BOOK, *supra* note 132, at 230 (stating that the toxicity of other poisons, however, may be affected by changes within this range).

157. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 21; COMM'N FOR ENVTL. COOPERATION, CONTINENTAL POLLUTANT PATHWAYS 8 (1997) [hereinafter CONTINENTAL POLLUTANT PATHWAYS]. Acid rain has been responsible for the decline and loss of fish resources in thousands of streams and lakes in eastern North America. *Id.* at 9.

158. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 21.

159. *See generally* CONSERVATION FOUND., STATE OF THE ENVIRONMENT: AN ASSESSMENT AT MID-DECADE 37-66 (1984) (discussing the impact of toxic substances on health and the environment) [hereinafter CONSERVATION FOUND., STATE OF THE ENVIRONMENT AT MID-DECADE].

degrade under normal circumstances.[160] The toxic substances and metals found in surface waters, fish tissue, shellfish, bottom sediments,[161] and sediment-dwelling organisms come primarily from industrial and municipal discharges,[162] agricultural runoff containing various pesticides,[163] spills,[164] and even air pollution.[165]

7. *Thermal Pollution*

Heat reduces the capacity of water to absorb oxygen, making it less efficient in assimilating oxygen-demanding materials and in supporting fish and aquatic life. A number of industries generate thermal pollution. The enormous quantities of hot water produced by a nuclear or coal-fired elec-

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160. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 21.

161. While fresh sediment may in some instances improve water quality by burying older, contaminated sediments, an EPA report has indicated that erosion may have caused some of the once-buried Hudson River PCBs to re-enter the river system. *See Current Developments*, 29 Env't Rep. (BNA) 693 (1998).

162. Some toxics continue to find their way into the nation's waters years after their discharge was prohibited. A study completed in 1998 found that wastewater treatment plants and various tributaries were still discharging significant amounts of PCBs to the Delaware River during wet weather. The plants were serving as conduits for PCBs associated with sediments that had settled out years before within the sewage collection systems, and the tributaries were transporting PCBs that had eroded from upland sites that had been contaminated for years. DEL. RIVER BASIN COMM'N, STUDY OF THE LOADINGS OF POLYCHLORINATED BIPHENYLS FROM TRIBUTARIES AND POINT SOURCES DISCHARGING TO THE TIDAL DELAWARE RIVER (June 1998). The study was prompted by concerns over elevated levels of PCBs that had been discovered in river sediments as well as the tissue of both resident and anadromous fish taken from the Delaware River and Bay. *Id.*

163. Runoff from irrigated agriculture can also contain salts and minerals that have leached out of irrigated soil and render the water unfit for use as drinking water or even irrigation. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 23. Irrigation water can also leach the toxic element selenium out of arid soil. Such leaching has led to the deaths of thousands of water birds at the Kesterson National Wildlife Refuge located in California's Central Valley. *See Current Developments*, 15 Env't Rep. (BNA) 2014 (1985).

164. *See* CONSERVATION FOUND., STATE OF THE ENVIRONMENT AT MID-DECADE, *supra* note 159, at 114-15.

165. High concentrations of mercury precipitation in the Lake Champlain basin, for instance, have been traced to mercury emissions originating in the Midwest and Ontario. The primary anthropogenic sources of mercury emissions are coal-fired electric-generating stations, waste incinerators, landfills, cement plants, and primary copper and lead smelters. *See* CONTINENTAL POLLUTANT PATHWAYS, *supra* note 157, at 9-11; s*ee also* OFFICE OF AIR QUALITY PLANNING & STANDARDS, U.S. ENVTL. PROT. AGENCY, DEPOSITION OF AIR POLLUTANTS TO THE GREAT WATERS, SECOND REPORT TO CONGRESS 91-100 (1997) [hereinafter EPA, DEPOSITION OF AIR POLLUTANTS TO THE GREAT WATERS] (referring to the following as air pollutants which enter the Great Lakes: mercury, lead, polycyclic aromatic hydrocarbons, DDT, lindane, PCBs, and toxaphene). The highest deposition rates for mercury are predicted to occur in the Ohio River valley, the southern Great Lakes, the Northeast, and scattered areas in the South. OFFICE OF AIR QUALITY PLANNING & STANDARDS & OFFICE OF RES. & DEV., U.S. ENVTL. PROT. AGENCY, MERCURY STUDY REPORT TO CONGRESS, VOLUME I: EXECUTIVE SUMMARY O-2 (1997) [hereinafter EPA, MERCURY STUDY REPORT].

Studies also suggest that a number of coastal waters suffer from significant loadings of toxic pollutants that result from atmospheric deposition. Air pollution, for example, is estimated to contribute 46% of the total annual load of cadmium to Tampa Bay, and from 17% to 31% of the total annual load of cadmium to Massachusetts Bay. *See* EPA, DEPOSITION OF AIR POLLUTION TO THE GREAT WATERS, *supra*, at 178. The highest deposition rates for mercury, moreover, are expected to occur in the Miami and Tampa areas. EPA, MERCURY STUDY REPORT, *supra*.

tric generating station, for example, can, unless cooled, seriously alter the ecology of a lake, a stream, or a coastal bay.[166]

8. Other Pollutants

Large amounts of oil can kill fish and other wildlife. Smaller, more persistent amounts, however, can decrease reaeration rates as well as damage the gills and exposed surface membranes of fish. Oil and grease problems normally result from spills associated with the operation or loading of oil tankers and barges and from pipeline breaks. Less dramatic problems can result from the improper disposal of used motor oil and generalized urban runoff.[167] A number of other pollutants can also cause serious harm to fish and aquatic life. Among these are two non-conventional, gray-area pollutants, ammonia and chlorine, both of which can be toxic to fish.[168]

9. Habitat and Hydrologic Modifications

Habitat modifications include a number of activities that can harm aquatic life. Such modifications include the removal of vegetation from stream banks, an operation that increases water temperature and causes erosion; the actual burying of streams; dredging; the filling and draining of wetlands; and other development and construction activities that change normal drainage patterns and increase the amount and intensity of storm water runoff. Hydrologic modifications like dams and channelization alter the flow of water, and in many instances, have adverse impacts on fish and wildlife.[169] Low instream flows below a dam, for instance, can jeopardize the health, even the existence, of downstream fisheries,[170] and many large hydroelectric impoundments discharge water that is low in dissolved oxygen and high in minerals and nutrients during the warm summer months.[171]

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166. *See* EPA, RED BOOK, *supra* note 132, at 218-29; CLARK ET AL., *supra* note 137, at 271. For a more up-to-date discussion of the EPA's water quality criteria for temperature, see EPA, GOLD BOOK, *supra* note 132, at 273-92.

167. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 22-23; EPA, RED BOOK, *supra* note 132, at 111-22.

168. *See* EPA, RED BOOK, *supra* note 132, at 10-13, 33-36.

169. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 22.

170. *See, e.g.,* PUD No. 1 of Jefferson County v. Wash. Dep't of Ecology, 511 U.S. 700 (1994) (upholding a state water quality certification that was conditioned upon the maintenance of minimum stream flows); DAVID M. GILLILAN & THOMAS C. BROWN, INSTREAM FLOW PROTECTION: SEEKING A BALANCE IN WESTERN WATER USE (1997). In estuarine environments the reduction of freshwater flows due to upstream dams or diversions may increase salinity levels, allowing predators of oysters, like the oyster drill, to colonize the oyster beds and other predators, such as snapper and grouper, to enter an estuary and prey upon shrimp and other species that use these areas as a safe refuge. *See* U.S. Army Corps of Eng'rs, Draft Environmental Impact Statement, Water Allocation for the Apalachicola-Chattahoochee-Flint (ACF) River Basin 4-172 to 4-174 (Sept. 1998).

171. *See* Nat'l Wildlife Fed'n v. Gorsuch, 693 F.2d 156 (D.C. Cir. 1982) (discussing dam-induced changes in water quality).

B. Sources of Water Pollution

The pollution control strategy of the Clean Water Act centers upon a simple but broad prohibition forbidding "the discharge of any pollutant by any person" to waters of the United States unless the discharger has obtained a permit and complies with its conditions, including restrictions on the amount or concentration of a pollutant that may be discharged.[172] While Congress could have defined a "discharge" to include generalized runoff as well as the more obvious sources of water pollution, such as those industries and publicly-owned treatment works that discharge wastewater through clearly identifiable structures, it chose to limit the permit program's application to the latter category.[173]

The reasons why Congress focused upon pollution emanating from point sources are not difficult to understand. The regulation of some 60,000 point sources—many of which were fairly notorious and easily targeted sources of pollution like industrial or municipal discharge pipes—was a much more manageable task than trying to regulate all sources of water pollution, including millions of persons and businesses who are responsible for causing non-point source pollution.[174] Not only would there be fewer and more obvious candidates for regulation, but point source discharges were amenable to end-of-pipe treatment, whereas the control of non-point source pollution was often thought impractical and not properly subject to federal direction.[175] What was the EPA supposed to do, tell farmers how to farm?[176] Although more is understood today about the way in which better farming techniques and improved land use management can reduce non-point source pollution, the imposition of such controls remains extremely controversial.[177]

Unlike point source discharges, non-point source pollution is diffuse in terms of its origin and the way in which it enters surface water. Non-point

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172. *See* Clean Water Act § 301(a), 33 U.S.C. § 1311(a) (requiring compliance with several statutory provisions, the most significant of which are the permit requirement (§ 402, 33 U.S.C. § 1342) and compliance with effluent limitations and water quality standards (§ 301(b), 33 U.S.C. § 1311(b))).

173. The Act defines a "discharge of a pollutant" to include "any addition of any pollutant to navigable waters from any *point source*" or "to the waters of the contiguous zone or the ocean from any *point source* other than a vessel or other floating craft." *Id.* § 502(12), 33 U.S.C. § 1362(12) (emphasis added).

174. The definition of a point source, however, is rather expansive and encompasses much more than just the typical industrial or municipal discharge pipe. Since it includes "any discernible, confined, and discrete conveyance," *id.* § 502(14), 33 U.S.C. § 1362(14), courts have found that backhoes and bulldozers that deposit fill material in wetlands are point sources, *see* Avoyelles Sportmen's League, Inc. v. Marsh, 715 F.2d 897, 922 (5th Cir. 1983), as well as drainage of contaminated runoff from strip mines, as long as the runoff had been first collected or channeled by the operator. *See* Sierra Club v. Abston Constr. Co., Inc., 620 F.2d 41, 45 (5th Cir. 1980). *See also* United States v. Earth Sciences, Inc., 599 F.2d 368, 374 (10th Cir. 1979) (involving a spill of cyanide from a sump located at a gold processing facility); *but see* United States v. Plaza Health Labs., 3 F.3d 643 (2d Cir. 1993) (holding that a person who personally placed a vial containing medical waste in the Hudson River was not a point source).

175. *See* S. REP. NO. 92-414 at 39, *reprinted in* 2 LEGISLATIVE HISTORY OF THE WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972, at 1457 (1973) (stating that "many nonpoint sources of pollution are beyond present technology of control").

176. *See* Nat. Res. Def. Council v. Cestle, 568 F.2d 1369, 1380 (D.C. Cir. 1977).

177. *See* PERCIVAL ET AL., *supra* note 3, at 695; Malone, *supra* note 13, at 76-78.

source pollution generally results from stormwater runoff from a wide variety of land use activities including farming, timber harvesting, mining, construction, and urban development.[178] However, other sources exist as well, such as seepage from septic tanks and abandoned mines, and the deposition of airborne pollutants like nitrogen and acid precipitation.[179] Unlike point source discharges, non-point source pollution does not typically enter a stream at a well-defined point, and, rather than being discharged at a predictable rate, non-point source pollution—as a result of its common association with precipitation—often occurs episodically and in large surges. These characteristics call for different kinds of pollution control strategies than are used for point sources,[180] but the regulation of non-point source pollution is not necessarily more difficult from a technological perspective than regulating point source pollution. As Professor Oliver Houck has written: "[T]he control technologies for nonpoint [source] pollution (e.g., shelter-belts, nutrient caps, retention ponds) are anything but unknown, complex, technologically difficult, or even very costly."[181]

The water quality problems posed by non-point sources are severe. Agricultural runoff, for example, often contains nutrients such as nitrogen and phosphorus from fertilizers, pesticides, bacteria and BOD from animal operations, soil erosion, and salts from irrigated fields. Silvicultural activities (such as timber harvesting, the construction of logging roads, and other forest management practices) typically produce sediment loadings as well as pesticides and organic materials, while mining not only adds sediment, but acid drainage at many abandoned locations.[182] Urban runoff, meanwhile, contains a veritable potpourri of pollutants including nutrients and pesticides from suburban lawns, siltation from land development projects, and oily residue and salt from city streets.[183] Rivers and streams can also be significantly affected by temperature stress caused by sprawling developments that remove streamside vegetation and by channelization and other hydrologic modifications.[184]

These problems have long been recognized. In a book published in 1968, for example, two engineering professors at the University of Washington wrote:

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178. *See* PERCIVAL ET AL., *supra* note 3, at 694.

179. *See* 1996 CLEAN WATER NEEDS SURVEY, *supra* note 33, at 27, 47; NANCY RICHARDSON HANSEN ET AL., CONTROLLING NONPOINT-SOURCE WATER POLLUTION 17 (1988).

180. *See* Robert Griffin, Jr., *Introducing NPS Water Pollution: We Can't Write Permits on Parking Lots*, EPA J., Nov.-Dec. 1991, at 6, 7.

181. HOUCK, *supra* note 11, at 87.

182. *See generally* EDWIN H. CLARK ET AL., ERODING SOILS: THE OFF FARM IMPACTS 8 (1985).

183. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 247; HANSEN ET AL., *supra* note 179, at 17-23. For other valuable references on the impacts of non-point source pollution, see CLARK ET AL., *supra* note 182; ENVIRONMENTAL IMPACT OF NONPOINT SOURCE POLLUTION (Michael R. Overcash & James M. Davidson eds., 1981); VLADIMIR NOVOTNY & GORDON CHESTERS, HANDBOOK OF NONPOINT POLLUTION: SOURCES AND MANAGEMENT (1981).

184. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 22.

> Water-quality control problems have generally been associated with municipal and industrial waste-water discharges. Land use is also becoming increasingly important in its relationship to water quality. In many instances, the effect on water quality caused by irrigation return flows, erosion, and diversion far transcend the effects of municipal and industrial waste water. A new philosophy of approach is needed for control of land use as it relates to water quality.[185]

Effective regulation, however, has remained elusive, "in part because [state and local] land use controls face fierce political resistance."[186]

Today, non-point source pollution, especially from agriculture,[187] is the chief impediment to achieving national water quality objectives.[188] The states, for example, reported in 2000 that 39% (269,258 miles) of the streams they had assessed and 45% (7.7 million acres) of the lakes they had assessed failed to meet at least one of their designated uses under the water quality standards program.[189] Agriculture was listed as the culprit responsible for 48% of the impaired stream miles, while hydrologic and habitat modifications were responsible for degrading an additional 34%.[190] Agriculture was also reported as responsible for 41% of the degraded lake acreage, while hydrologic modifications and urban runoff/storm sewers degraded an additional 36%.[191] In addition, many of our waterways suffer from the residue of prior industrial practice and misconduct—namely, sediments that are contaminated with heavy metals, PCBs, and pesticides.[192]

IV. WATER QUALITY TODAY—HAS THE CLEAN WATER ACT BEEN A SUCCESS?

A. *Long-Term Trends in Water Quality*

For years, various observers have tried to evaluate the efficacy of the regulatory system created by the CWA. The initial reports—those published

185. Robert O. Sylvester & Carl A. Rambow, *Methodology in Establishing Water-Quality Standards, in* WATER RESOURCES MANAGEMENT AND PUBLIC POLICY 111 (Thomas H. Campbell & Robert O. Sylvester eds., 1968).

186. PERCIVAL ET AL., *supra* note 3, at 695.

187. For an early discussion of the contribution of agriculture to water pollution, see N. William Hines, *Nor Any Drop To Drink: Public Regulation of Water Quality, Part I: State Pollution Control Programs*, 52 IOWA L. REV. 186, 193-94 (1966). An excellent contemporary treatment of the harms caused by agriculture and the safe harbors they enjoy is found in J.B. Ruhl, *Farms, Their Environmental Harms, and Environmental Law*, 27 ECOLOGY L.Q. 263 (2000).

188. CLEAN WATER ACTION PLAN, *supra* note 36, at 54.

189. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 13, 21. The state reports were based upon an evaluation or monitoring of 19% of river miles and 43% of total lake acres. *Id.*

190. *Id.* at 13-15. The states identified urban runoff, storm sewers, forestry, resource extraction, and municipal point sources as additional leading sources of river impairment. *Id.* at 14-15.

191. *Id.* at 22-23. Additional leading sources of lake impairment were atmospheric deposition, unspecified non-point sources, municipal point sources, and land disposal of wastes. *Id.*

192. *See* 1998 NATIONAL WATER QUALITY INVENTORY, *supra* note 132, at 219-21.

in the early 1980s—were disappointing.[193] On the one hand, they pointed to anecdotal information indicating that some of the most conspicuous and notorious examples of water pollution had been eliminated.[194] The Cuyahoga River, for instance, no longer caught on fire,[195] and Lake Erie was no longer choked with algae.[196] The Hudson River, which was proclaimed a dying river in 1966 due to discharges of raw sewage and toxic waste, no longer resembled an open sewer flowing to the sea.[197] Viewed in national terms, however, the most that could be said at the time was that water quality had not deteriorated since 1972.[198] That, of course, was some cause for celebration since the population was growing, industrial activity was expanding, and 57 million acres of new cropland was being farmed.[199] Nevertheless, water pollution was still widespread,[200] and the only early study that the General Accounting Office found to be based upon a statistically repre-

193. *See* COUNCIL ON ENVTL. QUALITY, ELEVENTH ANNUAL REPORT 100 (1980) [hereinafter CEQ, ELEVENTH ANNUAL REPORT]; CONSERVATION FOUND., STATE OF THE ENVIRONMENT 1982, at 97 (1982).

194. *See, e.g.,* CEQ, ELEVENTH ANNUAL REPORT, *supra* note 193, at 100 (concluding that "some localities" had witnessed "substantial improvement in water quality").

195. OFFICE OF PLANNING & MGMT., PROGRAM EVALUATION DIV., U.S. ENVTL. PROT. AGENCY, NATIONAL ACCOMPLISHMENTS IN POLLUTION CONTROL: 1970-1980, SOME CASE HISTORIES 33-34 (1980) [hereinafter EPA, NATIONAL ACCOMPLISHMENTS IN POLLUTION CONTROL]. The Cuyahoga River in central Cleveland ignited in a raging fire fed by oil and other industrial refuse on June 22, 1969. DAVID ZWICK & MARCY BENSTOCK, WATER WASTELAND 5 (1975). The specter of this burning river proved a powerful image in the marshaling of public and congressional support for the 1972 CWA. The Cuyahoga, of course, had burned periodically ever since John D. Rockefeller and others had built refineries along its banks in the 1860s to refine Pennsylvania crude oil. *See* RON CHERNOW, TITAN: THE LIFE OF JOHN D. ROCKEFELLER 101 (1998); Jonathan H. Adler, *Fables of the Cuyahoga: Reconstructing a History of Environmental Protection*, 14 FORDHAM ENVTL. L.J. 89, 99-104 (2002). Waterfront fires were not uncommon occurrences in the late nineteenth and early twentieth centuries. The Oil Pollution Act of 1924, in fact, was intended to combat such conflagrations in coastal waters. *See* Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 223-25.

196. EPA, NATIONAL ACCOMPLISHMENTS IN POLLUTION CONTROL, *supra* note 195, at 29-30. Sterling State Park, located between Toledo and Detroit along the western shore of Lake Erie, was opened to swimming again in 1978—after having been closed since 1961 due to high levels of bacteria from human waste. *See id.* at 33. For a fascinating account of how the closing of Sterling State Park galvanized local public opinion and led to a federal enforcement conference, see TERENCE KEHOE, CLEANING UP THE GREAT LAKES: FROM COOPERATION TO CONFRONTATION 56-59 (1997).

197. *See* KEHOE, *supra* note 196, at 16. Unfortunately, polychlorinated biphenyls ("PCBs"), which were manufactured in this country until 1978 and widely used through the 1980s, still lingered in the sediments of the Hudson and in the fatty tissue of fish like the striped bass. *See id.* at 16-17; COUNCIL ON ENVTL. QUALITY, 25TH ANNIVERSARY REPORT 226 (1997) [hereinafter CEQ, 25TH ANNIVERSARY REPORT]; William K. Stevens, *Shaking Off Man's Taint, Hudson Pulses with Life*, N.Y. TIMES, June 9, 1996, at 1.

For good news, the Conservation Foundation also pointed to the fact that salmon had reappeared in New England rivers such as the Connecticut and Penobscot, and that the ecological productivity of estuaries such as Pensacola Bay had returned to earlier levels. CONSERVATION FOUND., STATE OF THE ENVIRONMENT 1982, *supra* note 193, at 97.

198. *See* CEQ, ELEVENTH ANNUAL REPORT, *supra* note 193, at 100 (reporting that "the quality of surface waters nationally has not changed much in the last 5 years"); CONSERVATION FOUND., STATE OF THE ENVIRONMENT 1982, *supra* note 193, at 99 (stating that "in aggregate, there has been very little net change").

199. CONSERVATION FOUND., STATE OF THE ENVIRONMENT 1982, *supra* note 193, at 99; s*ee also* CEQ, ELEVENTH ANNUAL REPORT, *supra* note 193, at 100 (declaring that "[t]he fact that the nation's surface waters has not deteriorated despite a growing population and an increased gross national product is an accomplishment for control efforts").

200. *See* CEQ, ELEVENTH ANNUAL REPORT, *supra* note 193, at 100.

sentative sampling of river reaches[201] had concluded that the ability of waters to support game fish had "not changed appreciably during the last 5 years."[202]

It was too early in the life of the CWA, however, to render a definitive judgment about the Act's overall effectiveness.[203] Many effluent limitations were still being promulgated,[204] and thus tighter permit conditions had yet to be imposed in many instances, let alone enforced, and hundreds of publicly-owned sewage treatment plants were still in the process of being upgraded.[205] There was, moreover, a serious lack of coherent scientific data at the national level upon which to base any evaluation of the Act's effectiveness.[206]

A logical source of such evaluative data might have been the reports which Congress requires the EPA to submit to it every two years under section 305(b) of the Act.[207] Under section 305(b)(1), each state is required to prepare a report on the condition of its water quality and its progress towards achieving the goal of swimmable and fishable waters.[208] EPA, in turn, is directed to transmit these reports to Congress along with the agency's analysis of the state results.[209] While these reports could have yielded, in theory at least, significant data on overall trends, they have not. One reason is the lack of consistency in the waters that the states have chosen to assess every two years. Since financial and other resource constraints preclude an evaluation of 100% of a state's waters—the 1984 Report, for example, covered only 9% of the nation's rivers and streams,[210] whereas in 1996, 19% were surveyed[211]—the states must pick and choose which waters to evaluate. Unfortunately, the waters chosen do not form a stable group for purposes of comparison from year to year,[212] nor does anyone know how repre-

201. U.S. GEN. ACCT. OFFICE, THE NATION'S WATER: KEY UNANSWERED QUESTIONS ABOUT THE QUALITY OF RIVERS AND STREAMS 23 (1986).

202. U.S. FISH & WILDLIFE SERVICE & EPA, 1982 NATIONAL FISHERIES SURVEY, VOLUME I, TECHNICAL REPORT: INITIAL FINDINGS, at vii (1984).

203. As the CEQ wrote: "[C]leaning up the nation's water takes a long time. It is not surprising then, that vast improvements are not yet evident. The full effect of pollution control efforts will not be seen for a few more years." CEQ, ELEVENTH ANNUAL REPORT, *supra* note 193, at 100.

204. In 1987, in fact, Congress urged EPA to complete the task of promulgating BAT and BCT limits for unregulated categories as quickly as possible in order to give dischargers a reasonable time in which to come into compliance before the new deadline date of March 31, 1989. *See* H.R. CONF. REP. No. 99-1004, at 115 (1986), *reprinted in* 2 LEGISLATIVE HISTORY OF THE WATER QUALITY ACT OF 1987, at 804; s*ee also* Houck, *supra* note 3, at 457 (reporting on how Congress ordered "an obviously weary EPA to finish the job").

205. In 1982, for instance, there were still 3356 municipal facilities discharging at less than secondary treatment levels. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-32.

206. *See* ADLER ET AL., CLEAN WATER, *supra* note 46, at 129.

207. 33 U.S.C. § 1315(b) (2000).

208. *Id.* § 1315(b)(1).

209. Clean Water Act § 305(b)(2), 33 U.S.C. § 1315(b)(2). Pursuant to section 3003 of the Federal Reports Elimination and Sunset Act of 1995, Pub. L. 104-66, EPA's reports beginning with the 2000 edition are no longer considered Reports to Congress.

210. *See* OFFICE OF WATER REGULATIONS & STANDARDS, U.S. ENVTL. PROT. AGENCY, NATIONAL WATER QUALITY INVENTORY: 1984 REPORT TO CONGRESS 15 (1985).

211. *See* 1996 CLEAN WATER NEEDS SURVEY, *supra* note 33, at 32.

212. *See* J. CLARENCE DAVIES & JAN MAZUREK, POLLUTION CONTROL IN THE UNITED STATES:

sentative the assessed waters are.[213] EPA, therefore, advises caution when comparing information submitted from different reporting periods.[214]

In addition to being a moving target, the state section 305(b) surveys actually overstate our actual knowledge about water quality. While some of the state estimates are based upon actual monitoring data,[215] other estimates are subjective and based upon best professional judgments,[216] or as two recent observers have phrased it, "best guesses" as to water quality.[217] EPA has been working to improve the accuracy of the 305(b) process since 1990,[218] and the 305(b) reports, for all of their limitations, do provide a real service in identifying the leading causes of impairment in American waters. Nevertheless, it is impossible to compare the results from one biennial report to another in order to detect long-term trends.

The U.S. Geological Survey does maintain a long-term, nationally consistent network that monitors water quality at 420 stations all across the country.[219] The stations in the National Stream-Quality Accounting Network ("NASQAN"), however, are primarily located at the mouths of rivers in order to measure the quantity of the nation's surface water, not its quality.[220] In some cases, there may be pollution sources nearby; in other cases, there may be none—thus rendering NASQAN data as a whole less than optimal for gauging improvements in water quality.[221] NASQAN data, however, can be supplemented by additional water quality data that is available from other state, federal, and local sources. Much of this information is collected in EPA's STORET (STOrage and RETrieval) database and can be used for comparisons of pre-CWA conditions and post-CWA conditions.[222]

EVALUATING THE SYSTEM 68 (1998).

213. *See* Debra S. Knopman & Richard A. Smith, *20 Years of the Clean Water Act*, 35 ENV'T 16, 19-20 (1993).

214. U.S. ENVTL. PROT. AGENCY, NATIONAL WATER QUALITY INVENTORY, 1996 REPORT TO CONGRESS ES-2 (1998) [hereinafter 1996 NATIONAL WATER QUALITY INVENTORY].

215. Unfortunately, however, sampling techniques have sometimes differed from state to state. *See* EPA, DRAFT REPORT ON THE ENVIRONMENT, *supra* note 139, at 2-4.

216. *See* Dubrowski, *supra* note 11, at 30 (stating that much of the survey "consists of evaluative assessments (i.e., judgments based on land use or source location)"); Knopman & Smith, *supra* note 213, at 20.

217. DAVIES & MAZUREK, *supra* note 212, at 68.

218. EPA convened a 305(b) Consistency Workgroup in 1990 to address issues of consistency and to improve coverage and accuracy in the state assessment process. *See* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 374.

219. *See* Knopman & Smith, *supra* note 213, at 20. These stations monitor stream concentrations for dissolved oxygen, nutrients, fecal coliform bacteria, suspended solids, pH, and some metals. For years, Congress deprived the NASQAN program of adequate funding—during the 1980s, for example, funding remained at $5 million per year despite inflation. As a result, monitoring for several parameters was dropped and the frequency of sampling was reduced. *See id.* at 40 n.14.

220. U.S. GEN. ACCT. OFFICE, THE NATION'S WATER: KEY UNANSWERED QUESTIONS ABOUT THE QUALITY OF RIVERS AND STREAMS 26 (1986).

221. *Id.*

222. EPA's STORET database was first developed in 1964 and is one of the oldest environmental database systems still in use. Maintained by the agency's Office of Wetlands, Oceans, and Watersheds, STORET contains data from ambient water quality monitoring stations, from effluent monitoring, and from intensive surveys. Although STORET primarily focuses upon chemical and physical water quality monitoring data, the results of biological sampling are found in the associated BIOS (Biological System)

The STORET system holds a wealth of data—more than 150 million test results from over 735,000 sampling stations.[223] The problem of finding a reliable way of making a comprehensive assessment of national trends from this massive amount of data took some time to master.

In the meantime, a number of additional studies were published in the early 1990s that tried to evaluate the degree of success achieved by the Act. One indicated that dissolved oxygen ("DO") concentrations had improved substantially in the Delaware River, particularly since 1980,[224] and that fecal coliform counts had decreased greatly in the Neches Estuary in Texas.[225] Another linked improvements in dissolved oxygen levels in the White River in Indiana to upgrades in sewage treatment plants.[226] After examining these studies and others, Debra Knopman and Richard Smith concluded in 1993 that, while case studies had shown that dissolved oxygen had improved immediately downstream from many sewer outfalls, data from a broader network of sampling stations—the Geological Survey's NASQAN stations—suggested that the improvement had "been limited to a small percentage of the nation's total stream miles."[227] Based, in part, on similar NASQAN data, subsequent commentators also declared that although water quality had improved since 1972, especially in some previously heavily polluted areas, "[i]n terms of aggregate measures or national averages, the change has not been dramatic."[228] None of these studies, however, could be considered a comprehensive analysis of national progress under the CWA.[229]

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database, which is a component of STORET. A separately maintained, but linked, system is ODES (Ocean Data Evaluation System) that is designed to provide information on water quality and biological monitoring in marine and estuarine areas. *See* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 381. EPA has converted the National Fish Tissue Data Repository (NFTDR) to a STORET-based fish tissue database. *See id.* at 377.

223. *See* ANDREW STODDARD ET AL., MUNICIPAL WASTEWATER TREATMENT: EVALUATING IMPROVEMENTS IN NATIONAL WATER QUALITY 107 (2002).

224. RUTH PATRICK, SURFACE WATER QUALITY: HAVE THE LAWS BEEN SUCCESSFUL? 14 (1992).

225. *Id.* at 143.

226. Charles G. Crawford & David J. Wangsness, *Effects of Advanced Wastewater Treatment on the Quality of White River, Indiana*, 27 WATER RES. BULL. 769, 769, 771 (1991). Similar improvements were reported in the mid-1980s. WILLIAM M. LEO ET AL., U.S. ENVTL. PROT. AGENCY, BEFORE AND AFTER CASE STUDIES: COMPARISONS OF WATER QUALITY FOLLOWING MUNICIPAL TREATMENT PLANT IMPROVEMENTS, at ix (1984) (finding clear improvements in dissolved oxygen—from 0.8 mg/L to 6.1 mg/L—downstream from ten of thirteen upgraded sewage treatment plants).

227. Knopman & Smith, *supra* note 213, at 35. The NASQAN data, of course, probably reflected the fact that most of the sampling sites are "relatively removed from major point sources (factories or sewage plants)" and are thus unlikely "to reflect . . . reductions in industrial or sewage pollution." ADLER ET AL., CLEAN WATER, *supra* note 46, at 19.

228. A. Myrick Freeman III, *Water Pollution Policy*, *in* PUBLIC POLICIES FOR ENVIRONMENTAL PROTECTION 189 (Paul R. Portney & Robert N. Stavins eds., 2000). Elsewhere, Freeman characterized the available data as suggesting that "certain local areas that were quite bad in 1972 have been cleaned up dramatically." A. Myrick Freeman III, *Environmental Policy Since Earth Day I: What Have We Gained?*, 16 J. ECON. PERSP. 125, 137 (2000). Important to note, however, is the fact that Freeman gave the CWA high marks for its job in controlling point sources while doing little to control non-point sources. *Id.; see also* Robert W. Hahn, *United States Environmental Policy: Past, Present and Future*, 34 NAT. RES. J. 305, 313 (1994) (stating that "[t]here is no good overall measure of water quality, and the existing data provides a mixed picture about trends in water quality").

229. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-5.

In the mid-1990s, however, the EPA funded a study that evaluated progress under the Act in a more comprehensive fashion in an attempt to assess the long-term impact of point source regulation across the entire nation. It did so by examining the following: (1) national BOD loadings from sewage treatment plants before and after the enactment of the 1972 Act; (2) worst-case historical levels of DO in waterways downstream from point sources both before and after the Act; and (3) case study assessments comparing before and after conditions.[230] The results of this remarkable study were published in a peer-reviewed report issued by the EPA's Office of Water in June 2000.[231] It subsequently appeared in book form in 2002.[232]

With regard to BOD loadings[233] from municipal treatment facilities, the study found that considerable progress had been made due to the construction and renovation of thousands of municipally-owned sewage treatment plants and the imposition of secondary treatment requirements.[234] More specifically, the study reported that, despite the fact that loadings of BOD to municipal facilities had increased 35% between 1968 and 1996, these facilities actually discharged 45% less BOD in 1996 than they had in 1968.[235] During an even shorter period of time (1973 to 1987), the amount of BOD discharged from industrial point sources fell a whopping 93%.[236] By 1995, therefore, municipal and industrial point sources were responsible for only about 55% of total BOD loadings, while rural non-point sources accounted for 40% of the loadings.[237]

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230. *See* Andrew Stoddard et al., *Progress in Water Quality: An Evaluation of the Environmental and Economic Benefits of the 1972 Clean Water Act, in* PROCEEDINGS OF THE WATER ENVIRONMENT FEDERATION 83 (May 3-6, 1998, Denver).

231. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9.

232. *See* STODDARD ET AL., *supra* note 223.

233. BOD is the measurement that permits scientists to determine how much organic material is present in a stream. Since so much BOD-consuming material is discharged by sewage treatment facilities, it is an excellent way in which to test the efficacy of those treatment facilities. And, of course, the more efficient those facilities are, the less human health will be adversely affected by the discharge of raw or inadequately treated sewage. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-5; STODDARD ET AL., *supra* note 223, at 5.

234. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-5 to 1-6; STODDARD ET AL., *supra* note 223, at 5-6; *see also supra* text accompanying notes 108-09 (detailing the increases in the number of persons served by municipal treatment facilities since 1968, the precipitous drop in the total number of persons served by facilities utilizing less-than-secondary treatment technology, and the doubling of the persons served by facilities using secondary or better treatment).

235. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-43; STODDARD ET AL., *supra* note 223, at 61. The actual drop in effluent BOD loadings was from 6932 metric tons per day to 3812 metric tons per day. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-43; STODDARD ET AL., *supra* note 223, at 61.

236. *See* OFFICE OF POL'Y, PLAN., & EVALUATION, U.S. ENVTL. PROT. AGENCY, ENVIRONMENTAL INVESTMENTS: THE COST OF A CLEAN ENVIRONMENT: A SUMMARY 5-4 to 5-5 (Dec. 1990) [hereinafter THE COST OF A CLEAN ENVIRONMENT]. A significant portion of this decline was due to the fact that more industrial waste was being discharged to municipal treatment plants rather than being discharged directly into receiving waters. In fact, about 73% of industrially-generated BOD is sent to public treatment facilities. *See id.* The decline can also be credited to upgrades in industrial waste treatment capacity as required by the CWA, improved efficiency in the use of industrial process and cooling water, and the closure of obsolete industrial facilities in the Midwest and Northeast. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-63; STODDARD ET AL., *supra* note 223, at 85.

237. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-63; STODDARD ET AL., *supra* note 223,

Perhaps the most innovative aspect of the EPA's study was its approach to determining long-range nationwide trends in dissolved oxygen concentrations.[238] The study examined DO levels in rivers located downstream from point sources in a systematic way both before and after the enactment of the CWA. In doing so, the researchers identified water quality monitoring data that reflected the impact of point source discharges and isolated that data from the "noise" of millions of pieces of data stored in the STORET database.[239] To do so, the researchers evaluated changes in DO only for monitoring stations that were impacted by point sources[240] under worst-case, low-flow conditions. To isolate low-flow conditions,[241] the data was limited to the period of July to September, and to represent worst-case, low-flow conditions, two especially dry periods were chosen: 1961-1965 (representing pre-Act conditions) and 1986-1990 (representing post-Act conditions).[242] The study was also designed to go beyond earlier work, which was limited to an examination of local impacts,[243] and examine whether the CWA has produced broad-scale stream improvement.[244] Therefore, the researchers compared data at three spatial scales: river reaches (small scale);[245] catalog units (medium scale);[246] and major river basins (large scale).[247]

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at 85. Although urban stormwater runoff and combined sewer overflows are significant pollution sources in urban areas, they only contribute about 5% of the national loading of BOD. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-63; STODDARD ET AL., *supra* note 232, at 85.

238. Dissolved oxygen is the key parameter to focus on if one's interest is concentrated on protecting fish and other aquatic life. Fish kills are, for example, the most obvious symptom of low dissolved oxygen levels. *See supra* notes 132-37 and accompanying text; EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-6; STODDARD ET AL., *supra* note 232, at 6. Low dissolved oxygen levels can also produce partial mortality and retard the development of fish and other aquatic organisms. *See* EPA, RED BOOK, *supra* note 132, at 125-26.

239. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-5; STODDARD ET AL., *supra* note 232, at 107-08. The researchers tried to screen out hydrologic and other physical conditions that would interfere with the establishment of an accurate relationship between point source discharges and downstream DO concentrations. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-5; STODDARD ET AL., *supra* note 232, at 108.

240. Stations affected only by non-point sources were excluded from the analysis. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 9; STODDARD ET AL., *supra* note 232, at 122.

241. Using DO data from this period blocks noise caused by seasonal variations in precipitation, flow, and temperature. BOD loadings from non-point sources are also reduced during these periods due to lower levels of rain. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-13; STODDARD ET AL., *supra* note 232, at 120.

242. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-5 to 3-15; STODDARD ET AL., *supra* note 232, at 108-21. DO data selection was also limited to the top two meters of a water in order to screen out various physical, biological, and chemical processes occurring at the bottom of a stream and to create a level of comparability between shallow and deeper streams. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-14; STODDARD ET AL., *supra* note 232, at 120.

243. *See, e.g.*, Knopman & Smith, *supra* note 213, at 34-5 (finding that any improvement in DO levels are limited to reaches directly below pollutant discharges and thus impact only a small percentage of the nation's streams).

244. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-2; STODDARD ET AL., *supra* note 232, at 105.

245. River reaches are stream segments defined by the confluence of a tributary upstream and a tributary downstream. They average ten miles in length and drain an area of about 115 square- miles. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-8; STODDARD ET AL., *supra* note 232, at 7. Approximately 61,000 reaches exist within the lower forty-eight states. Stoddard et al., *supra* note 230,

The resulting study found significant improvement in summer DO conditions at all three scales.[248] As an example of this, the researchers presented the case of the Upper Mississippi River near Hastings, Minnesota, which is located about 30 miles downstream from Minneapolis. The data shows the greatest improvement in worst-case DO concentrations at the smallest scale—the reach level—where DO levels more than doubled, from an average of 2.5 mg/L before the enactment of the 1972 Act to an average of 6.0 mg/L after its enactment.[249] (Five mg/L is considered the dividing line between healthy and unhealthy levels of DO.)[250] At the larger scales, improvement occurred, but it was not as dramatic because the larger scales contain monitoring stations that are both close to and far from the point source discharges. Nevertheless, despite "the unavoidable introduction of data noise," the study revealed an increase of 1.7 mg/L in DO at the catalog unit scale and 1.5 mg/L at the major river basin scale.[251] In other words, average DO increased from 3.7 mg/L to 5.4 mg/L at the catalog unit scale, and from 3.8 mg/L to 5.3 mg/L at the major river basin level.[252] At all three spatial scales, therefore, DO improved from unhealthy levels below 4.0 mg/L to levels above the benchmark of 5.0 mg/L.

After looking at the relevant data for all of the watersheds examined by the study, the researchers found that 69% of the 311 reaches they evaluated (representing a disproportionately high level of urban/industrial areas) had improved levels of DO.[253] The number of reaches having worst-case DO levels above the benchmark of 5.0 mg/L also rose from 46% to 69%.[254] In addition, 68% of the 246 catalog units (largely dominated by urban/industrial areas having a population of nearly 62 million people) enjoyed higher levels of DO.[255] The greatest improvements were found in many streams in the urban/industrial midwest, upper midwest, and north-

at 86.

246. There are approximately 2111 hydraulic catalog units in the forty-eight contiguous states. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-9; STODDARD ET AL., *supra* note 232, at 10.

247. There are eighteen major river basins in the lower forty-eight states. They include, for example, the Ohio River basin and the Tennessee River basin. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-9; STODDARD ET AL., *supra* note 232, at 9.

248. STODDARD ET AL., *supra* note 232, at xvi.

249. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-11 to 1-12; STODDARD ET AL., *supra* note 232, at 11-12.

250. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-7; STODDARD ET AL., *supra* note 232, at 6.

251. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-12; STODDARD ET AL., *supra* note 232, at 12.

252. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 1-11; STODDARD ET AL., *supra* note 232, at 11.

253. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-45; STODDARD ET AL., *supra* note 232, at 175. The number of reaches that could be paired for before and after analysis was limited by the data available for the period of 1961 through 1965. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-45; STODDARD ET AL., *supra* note 232, at 175.

254. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-46; STODDARD ET AL., *supra* note 232, at 175.

255. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-46; STODDARD ET AL., *supra* note 232, at 175.

east—streams that had been known for serious pollution problems during the 1950s and 1960s. Among these streams were the Lower Susquehanna River, the Cuyahoga River, the Lower Fox River and Oconto River in Wisconsin, and the Lower Spokane River in Washington.[256]

Perhaps most surprisingly, eight of the eleven major river basins that were evaluated experienced "statistically significant improvement," while the other three—although failing to show significant improvement—did not suffer any significant degradation.[257] Given the large spatial scale of the major river basins in the United States, it was absolutely "remarkable" to detect such large improvements.[258]

The improvement in DO levels at all three spatial scales across the entire nation demonstrate the "tremendous progress" that has been achieved as a result of both CWA regulation and the municipal construction program.[259] Based upon the researchers' unique approach for identifying and evaluating DO improvements at a national scale since the 1960s, the study presents "*unambiguous evidence* that the technology- and water quality-based policies of the CWA for point source effluent controls were environmentally effective."[260] For the first time, therefore, there is clear proof that the point source program created by the CWA has worked—the basic framework of the Act appears sound[261]—although there is clearly much more to do.[262]

The researchers also conducted nine case studies in an attempt to answer a number of more specific questions, such as trends in the concentrations of other pollutants and the impact of any water quality improvement upon fisheries and recreational opportunities. Nine waterways were chosen for evaluation based upon the availability of historical data and the fact that the waters were notoriously dirty in the 1960s, are located in major urban/industrial areas, and receive substantial inflows from municipal treatment facilities.[263]

256. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-31; STODDARD ET AL., *supra* note 232, at 144.

257. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-46; STODDARD ET AL., *supra* note 232, at 176. Only eleven river basins had enough reach-aggregated data to do before-and-after comparisons. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-46; STODDARD ET AL., *supra* note 232, at 176.

258. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 3-47; STODDARD ET AL., *supra* note 232, at 176.

259. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-1; STODDARD ET AL., *supra* note 232, at 181.

260. Stoddard et al., *supra* note 230, at 87-88 (emphasis added).

261. According to the Organisation for Economic Co-Operation and Development, the Act "has been used *especially effective in reducing point* [source] *discharges*." OECD, ENVIRONMENTAL PERFORMANCE REVIEW, *supra* note 85, at 77.

262. *See, e.g.,* Dubrowski, *supra* note 11; Drew Caputo, *A Job Half Finished: The Clean Water Act After 25 Years*, 27 Envtl. L. Rep. (Envtl. L. Inst.) 10,574 (1997); OECD, ENVIRONMENTAL PERFORMANCE REVIEW, *supra* note 85, at 77.

263. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-4; STODDARD ET AL., *supra* note 232, at 183. The nine waterways were the Connecticut River, Hudson-Raritan estuary, Delaware estuary, Potomac estuary, James estuary, Chattahoochee River, Ohio River, Upper Mississippi River, and Willamette River. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-4; STODDARD ET AL., *supra* note 232, at 185.

The case studies also revealed "dramatic improvements" after the implementation of the CWA.[264] Between 1961 and 1970, worst-case DO levels in most of these waters ranged between 1.0 to 4.0 mg/L. Between 1986 and 1995, however, worst-case DO concentrations had risen to levels ranging from 5.0 to 8.0 mg/L.[265] Extraordinary progress, moreover, had been achieved in New York Harbor, the Delaware estuary, the Potomac estuary, and the Chattahoochee River.[266] Improvements also occurred with regard to other pollutants such as BOD, suspended solids, fecal coliform bacteria, nutrients, and heavy metals—and the study linked these reductions in many instances to improved discharges from industrial and municipal point sources.[267] Data from other sources, furthermore, demonstrate substantial declines in the last sixteen years in the discharge of toxic pollutants to the waters of the United States.[268] Finally, the study linked the progress made in restoring water quality to post-CWA restoration of fisheries and other biological resources and the expansion and creation of new recreational uses for these waters.[269] Although problems remain—especially those stemming from non-point source discharges,[270] contaminated sediments,[271] and combined sewer overflows[272]—"[t]he evidence is overwhelming" that the regulatory and policy design of the CWA has "achieved significant successes in many waterways."[273]

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264. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-6; STODDARD ET AL., *supra* note 232, at 184.

265. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-6; STODDARD ET AL., *supra* note 232, at 184. Worst-case concentrations of less than 2.0 mg/L of oxygen had improved to 5.0 mg/L or more after the implementation of the Act. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-6; STODDARD ET AL., *supra* note 232, at 184-85.

266. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-6; STODDARD ET AL., *supra* note 232, at 189.

267. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-6; STODDARD ET AL., *supra* note 232, at 189.

268. Direct industrial discharges of approximately 300 toxic water pollutants fell 72% between 1988 and 1996 from 164 million pounds per year to 45 million pounds per year, while—largely due to the pretreatment program established under the CWA—the amount discharged indirectly through sewage treatment plants dropped 44% from 254 million pounds annually to 141 million pounds. *See* OFFICE OF POLLUTION PREVENTION & TOXICS, U.S. ENVTL. PROT. AGENCY, 1996 TOXICS RELEASE INVENTORY: PUBLIC DATA RELEASE—10 YEARS OF RIGHT-TO-KNOW 95 (1998). Since the specific chemicals subject to the reporting requirement have changed over the life of the program, the year-to-year comparisons contained in the 1998 report were calculated from a consistent subset of chemicals. *See id.* at 28, 31. The decline in discharges reflected by the Toxic Release Inventory ("TRI") cannot be altogether attributed to CWA regulation since many of the toxics on the TRI list are not regulated under the Act. The TRI numbers underscore the need for the promulgation of additional water quality criteria—both chemical and narrative—dealing with toxics, *see* Dubrowski, *supra* note 11, at 31, and the considerable challenge that faces the pre-treatment program.

269. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-6, 4-10; STODDARD ET AL., *supra* note 232, at 189, 194.

270. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-60, 5-7, 10-7, 11-12; STODDARD ET AL., *supra* note 232, at 85, 206, 334, 358.

271. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 6-8 to 6-9, 6-16, 7-22; STODDARD ET AL., *supra* note 232, at 222-23, 235, 280.

272. *See* EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 2-58, 5-6, 6-13 to 6-14, 6-21, 10-7, 10-11, 11-12; STODDARD ET AL., *supra* note 232, at 84, 205-06, 237, 242, 334, 339-40, 358.

273. EPA, PROGRESS IN WATER QUALITY, *supra* note 9, at 4-11; STODDARD ET AL., *supra* note 232, at 195.

B. The Cost of Clean Water

Have these improvements been worth the cost? According to EPA, total annual costs associated with water pollution control increased from about $9.1 billion in 1972 to $34.4 billion in 1987,[274] and to approximately $39.4 billion in 1993.[275] Unfortunately, it is impossible to know what has been actually spent on water pollution control in the years since 1993 because the U.S. Department of Commerce discontinued the Bureau of Economic Analysis's comprehensive pollution abatement and control program in the mid-1990s,[276] and EPA's numbers were largely based upon these Commerce Department statistics.[277] In 1990, EPA projected that the total cost of water pollution control would rise to $57.5 billion by the year 2000.[278] However, that estimate may well have been on the high side;[279] at least that is what is suggested by figures provided by a Commerce Department program that tallied costs incurred by U.S. industry for water pollution abatement in 1994[280] and 1999.[281] According to those figures, the annual water

274. OFFICE OF POL'Y, PLAN., & EVALUATION, U.S. ENVTL. PROT. AGENCY, ENVIRONMENTAL INVESTMENT: THE COST OF A CLEAN ENVIRONMENT, A SUMMARY 3-3 (1990) [hereinafter EPA, THE COST OF A CLEAN ENVIRONMENT, A SUMMARY] (stated in 1986 dollars and representing annualized costs; not including the costs associated with the Safe Drinking Water Act). The EPA's numbers were based largely upon data provided by the U.S. Department of Commerce, Bureau of Economic Analysis, and published periodically in the *Survey of Current Business*. *Id.* at 1-6 to 1-7.

275. Christine R. Vogan, *Pollution Abatement and Control Expenditures, 1972-94*, SURV. CURRENT BUS. 48, 53 (1996) (representing actual costs). Preliminary estimates for 1994 were $43.4 billion. *Id.* at 63. The totals represent capital and operating expenditures by business, capital and operating expenses by public sewer authorities, the cost to government of regulatory and monitoring activities, and the cost of research and development. *See id.* at 54-55, 63. Vogan's article was compiled from data derived from various sources including two primary surveys conducted annually, at least at that time, by the Census Bureau—the Pollution Abatement Costs and Expenditures Survey and the Pollution Abatement Plant and Equipment Survey. *See id.* at 54.

276. *See id.* at 48.

277. *See supra* note 274.

278. EPA, THE COST OF A CLEAN ENVIRONMENT, A SUMMARY, *supra* note 274, at 3-3. This figure includes regulatory and monitoring expenditures by the EPA and state governments; expenditures by the EPA, state governments, and local governments for the construction and operation of municipal wastewater treatment facilities; expenditures by industry to comply with NPDES permits and pre-treatment requirements; federal, state, and local government expenditures for non-point source control, including the cost of reducing erosion during the construction of new highways; and private expenditures for non-point source pollution control. *See* OFFICE OF POL'Y, PLAN., & EVALUATION, U.S. ENVTL. PROT. AGENCY, ENVIRONMENTAL INVESTMENT: THE COST OF A CLEAN ENVIRONMENT 4-1 to 4-6, 4-13, 4-19 (1990) [hereinafter EPA, THE COST OF A CLEAN ENVIRONMENT, THE REPORT].

279. Economic analysts generally overstate the costs involved in complying with an environmental regulation because they routinely ignore the fact that regulation often fosters innovation—for example, pollution prevention techniques—which helps to cut costs. *See* Eban Goodstein & Hart Hodges, *Behind the Numbers: Polluted Data*, 35 THE AMERICAN PROSPECT 64, 67-69 (1997); DAVID M. DRIESEN, THE ECONOMIC DYNAMICS OF ENVIRONMENTAL LAW 22-23 (2003); s*ee also* OFFICE OF THE CHIEF FIN. OFFICER, U.S. ENVTL. PROT. AGENCY, EPA STRATEGIC PLAN 69 (1997) (stating that it is difficult to estimate and quantify "the ability of the regulated community to develop more cost-effective methods of meeting regulatory requirements"); William K. Reilly, *The EPA's Cost Underruns*, WASH. POST, Oct. 14, 2003, at A23 (concluding that the EPA has had a pattern of substantially overestimating the economic costs of regulation and underestimating the benefits of regulation).

280. U.S. DEP'T OF COMMERCE, BUREAU OF THE CENSUS, POLLUTION ABATEMENT COSTS AND EXPENDITURES: 1994 (1996) [hereinafter DEP'T OF COMMERCE, PACE SURVEY 1994].

281. U.S. DEP'T OF COMMERCE, BUREAU OF THE CENSUS, POLLUTION ABATEMENT COSTS AND

pollution abatement costs incurred by U.S. industry fell from $9.4 billion in 1994[282] to $6.3 billion in 1999[283]—a drop of $3.1 billion—whereas EPA had based its projections upon a rise to $13.4 billion in both 1999[284] and 2000.[285] Although it is not altogether clear what led to that decline, the drop certainly undermines to some extent EPA's annualized projection for the year 2000. Perhaps the most that can be said is that something in the range of $50 billion was spent in 2000 on water pollution control in the United States.

While it is difficult to accurately calculate the current cost of compliance, the benefits appear nearly impossible to quantify.[286] A few studies, however, have tried to do so. An early study, published in 1982, declared that it was likely that the cost-benefit relationship under the CWA was not favorable,[287] and a later, more narrowly focused study, based on a review of three major rulemakings promulgated between 1990 and 1995, concluded that the costs of those rules vastly outweighed their benefits.[288] Efficiency, however, was not the primary driving force behind the enactment of the Clean Water Act. Americans in 1971 and 1972 generally wanted strong action to curb water pollution.[289] "People wanted no more of fishkills, contaminated water, and stench-filled river valleys."[290] Their concerns and those of Congress appear to have been dominated by a sense of ethical obligation and esthetics, not by some over-riding concern for utility; and their goal was to find an effective way to protect public health and the environment.[291] It would thus be inappropriate to judge the success of the Act by

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EXPENDITURES: 1999 (2002) [hereinafter DEP'T OF COMMERCE, PACE SURVEY 1999]. The PACE Survey was discontinued after 1994 due to budget limitations, although it was re-instated in 1999 as a one-year pilot project. *See* U.S. DEP'T OF COMMERCE, CENSUS BUREAU, SURVEY OF POLLUTION ABATEMENT COSTS AND EXPENDITURES, *available at* http://www.census.gov/econ/www/mu1100.html (last visited Sept. 13, 2003).

282. *See* DEP'T OF COMMERCE, PACE SURVEY 1994, *supra* note 280, at 3 (attributing $2.4 billion to capital expenditures and $7 billion to operating costs).

283. *See* DEP'T OF COMMERCE, PACE SURVEY 1999, *supra* note 281, at v (attributing $1.8 billion to capital expenditures and $4.5 billion to operating costs).

284. *See* EPA, THE COST OF A CLEAN ENVIRONMENT, THE REPORT, *supra* note 278, at 4-13, 4-19 (reporting projected capital costs of $3.8 billion and operating costs of $9.6 billion for 1999).

285. *See id.* (reporting projected capital costs of $3.6 billion and operating costs of $9.8 billion for 2000).

286. *See* DRIESEN, *supra* note 279, at 21-22.

287. A. MYRICK FREEMAN III, AIR AND WATER POLLUTION CONTROL: A BENEFIT-COST ASSESSMENT 169-70 (1982) (concluding that benefits were most likely worth $9.4 billion a year in 1985 while costs would likely amount to between $15 and $20 billion—stated in 1978 dollars).

288. *See* Robert W. Hahn, *Regulatory Reform: What Do the Government's Numbers Tell Us?, in* RISK, COSTS AND LIVES SAVED: GETTING BETTER RESULTS FROM REGULATION 208, 222 (Robert W. Hahn ed., 1996) (citing costs of $6.7 billion and benefits of $0.5 billion).

289. *See* Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 260.

290. JOHN QUARLES, CLEANING UP AMERICA: AN INSIDER'S VIEW OF THE ENVIRONMENTAL PROTECTION AGENCY 146-47 (1976).

291. For example, the Act required dischargers to comply with technology-based effluent limitations regardless of whether such treatment was necessary to meet water quality standards. *See* Andreen, *Evolution of Water Pollution Control: Part II, supra* note 2, at 266. Moreover, no cost-benefit analysis was called for in setting effluent limitations based upon best available technology, *see* Clean Water Act § 304(b)(2)(B), 33 U.S.C. § 1314(b)(2)(B), and only a limited cost-benefit test was called for in establishing limits based upon best practicable technology. *See id.* § 304(b)(1)(B), 33 U.S.C. § 1314(b)(1)(B); *see*

strict reference to some sort of utilitarian formula since the Act was designed to serve and does serve other values as well. Nevertheless, cost-benefit analysis does provide a measure, albeit imprecise and not always very scientific, for assessing the performance of a regulatory statute. Therefore, it is fortunate today that we have a somewhat better, although still limited, grasp of the benefits produced by the Act.

During the late 1990s, EPA funded an elaborate study that explored some of the economic benefits produced by the CWA.[292] The study was only the first step in EPA's effort to produce a comprehensive assessment of those benefits. Thus, although the study was national in scale, it only produced partial results.[293] It focused, for instance, solely upon primary rivers and streams and thus did not include coastal waters, estuaries, the Great Lakes, other lakes, reservoirs, wetlands, and smaller streams.[294] It also looked only at the benefits derived from the Act's reduction of conventional pollutants and thus did not deal with the benefits gained by reducing the discharge of toxic and non-conventional pollutants.[295] The study also based its estimate of benefits upon improvements in some in-place services of water, such as recreational uses and aesthetic value for households residing close to the resource,[296] and did not attempt to value withdrawal services such as water for drinking, irrigation, or livestock purposes.[297] Even with all of those limitations—examining only a small subset of affected waters,[298] a

also E.I. du Pont de Nemours & Co. v. Train, 430 U.S. 112, 129-30 (1977) (quoting Senator Muskie as saying that "[t]he balancing test between total cost and effluent reduction benefits is intended to limit the application of technology only where the additional degree of effluent reduction is wholly out of proportion to the costs").

292. *See* OFFICE OF WATER & OFFICE OF POL'Y, ECON., & INNOVATION, U.S. ENVTL. PROT. AGENCY, A BENEFITS ASSESSMENT OF WATER POLLUTION CONTROL PROGRAMS SINCE 1972: PART I, THE BENEFITS OF POINT SOURCE CONTROLS FOR CONVENTIONAL POLLUTANTS IN RIVERS AND STREAMS, FINAL REPORT (2000) [hereinafter EPA, BENEFITS OF POINT SOURCE CONTROLS].

293. *Id.* at vii.

294. *Id.* at 4-3.

295. *Id.* at 4-2. The study used the National Water Pollution Control Assessment Model to characterize current water quality in terms of BOD, fecal coliform, and total suspended solids. These with CWA estimates were then contrasted with what current water quality would be without the Act. *See id.* at x-xi. Some of the reductions attributed to the CWA may, of course, be due to other reasons—such as some state program efforts unrelated to the Act—but since there is no method for estimating the impact of such efforts and because the CWA is generally considered the major force for producing reductions in pollutant loadings to our waters, the study attributed all of the reductions to the Act. *See id.* at 4-3 to 4-4.

296. *Id.* at xvi. Existence services—a value assigned to persons who, while not residing in the local area and not expected to use the resource, still experience an increased sense of wellbeing just knowing that the quality of the resource has improved—accounted for less than 15% of the benefits found by the study. *Id.*

297. *See id.* at 5-3. The measure used to determine the resulting benefits was based upon a survey that sought to uncover what households were willing to pay for the resulting improvements in water quality. *Id.* at 5-2.

298. While some 650,000 miles of rivers and streams were included in the assessment, *see id.* at x, there are 3.5 million miles of rivers and streams in the United States, *see supra* note 111 and accompanying text, of which about 1.2 million miles flow year round. *See* EPA, ENVIRONMENTAL INDICATORS OF WATER QUALITY, *supra* note 111, at 2. In many watersheds, the majority of pollutant loadings have been to small streams—streams whose condition may well have benefited a great deal from the Act but were not included in the benefits assessment. *See* Susan Bruninga, *Narrow Definition of Isolated Waters Needed to Protect Waters*, 34 Env't Rep. (BNA) 2031 (2003). There are also 58,000 miles of ocean shoreline, 34,000 acres of estuaries (excluding Alaska), 41 million acres of lakes, and 278 million acres

subset of regulated pollutants, and a subset of benefits—the study still found that the Act produces $11.1 billion worth of benefits annually.[299] If all the unaccounted for factors were assessed for all of the waters of the United States,[300] I would be more than surprised if one could not conclude that the costs of complying with the Act are at least roughly commensurate with its benefits.[301] Not only does the CWA appear to be more cost-effective than some have thought,[302] but it is important to note that there is no evidence indicating that our overall expenditure on environmental protection has adversely affected either the American economy or the nation's competitiveness.[303] In fact, an effort to cut regulatory costs through innovation can actually give companies that invest in more efficient plant and equipment a competitive advantage.[304] With regard to pollution control and expenditures in the developed world, a recent report from the Organisation for Economic Co-operation and Development ("OECD") indicates that the United States actually spends a smaller share of its gross domestic product on water pollution control than eleven of our trading partners: Germany, Austria, Denmark, Norway, France, Switzerland, Poland, Korea, the Netherlands, Belgium, and Finland.[305] This is a rather dramatic change from an OECD report

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of wetlands, EPA, LIQUID ASSETS, *supra* note 113, at 1, none of which were assessed by the study.

299. EPA, BENEFITS OF POINT SOURCE CONTROLS*, supra* note 292, at 5-9 (stated in 1997 dollars). This figure represents an average annual benefit of approximately $109 per household. *See id.* at 5-8.

300. The study urged that a more comprehensive assessment be undertaken that would address all of the pollutants regulated by the Act, all of the nation's surface waters, and all of the services that those waters provide. *Id.* at vii-viii.

301. Many of the researchers who produced the study concluded at an earlier stage of investigation that their findings suggested that "the national investment costs for municipal wastewater infrastructure improvement for inland rivers [were], in fact, commensurate with the estimated national economic benefits realized from water quality improvements." Stoddard et al., *supra* note 230, at 88.

302. *See* Stewart, *supra* note 17, at 33 (stating that the CWA "entail[s] costs that substantially exceed benefits").

303. OECD, ENVIRONMENTAL PERFORMANCE REVIEW, *supra* note 84, at 135. *See also* CONGRESSIONAL BUDGET OFFICE, U.S. CONGRESS, ENVIRONMENTAL REGULATION AND ECONOMIC EFFICIENCY 77 (1985) (concluding that "U.S. economic performance in general has not been reduced relative to other nations because of environmental regulation"). This conclusion appears consistent with a study that examined whether states with stronger environmental standards tend to lag economically behind those with lesser standards. According to this study, more rigorous state requirements "*have not limited the relative pace of economic growth and development among the states over the past twenty years.*" STEPHEN M. MEYER, ENVIRONMENTALISM AND ECONOMIC PROSPERITY: AN UPDATE 2 (Feb. 16, 1993) (The paper's author was the director of the MIT Project on Environmental Politics and Policy.). *See also* EBAN GOODSTEIN, THE TRADE-OFF MYTH: FACT AND FICTION ABOUT JOBS AND THE ENVIRONMENT 21 (1999) (stating that "the health of the macroeconomy . . . has not been impaired by environmental regulation").

304. *See* DAVIES & MAZUREK, *supra* note 212, at 143; OECD, ENVIRONMENTAL PERFORMANCE REVIEW, *supra* note 85, at 135 (concluding that "[w]henever new standards have been introduced at a pace at which industry can adjust, *environmental protection and competitive advantages have gone hand in hand*"). The demand for environmental goods and services also supports and nourishes a robust environmental industry. The value of products, services, and receipts for construction projects in the United States related to water wastewater treatment amounted to $31.1 billion in 1995. BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, SURVEY OF ENVIRONMENTAL PRODUCTS AND SERVICES 2 (1998).

305. *See* WORKING GROUP ON ENVTL. INFO. & OUTLOOKS, ORG. FOR ECON. CO-OPERATION & DEV., POLLUTION ABATEMENT AND CONTROL EXPENDITURE IN OECD COUNTRIES 39 (July 2003) (combining expenditures by the public sector, business sector, and specialized producers). The difference between Finland and the United States was so small that it may have resulted from inaccuracies in the data or from the efforts to put the numbers in comparable terms. *See id.*

issued in 1996, which concluded that only three countries—Germany, Austria, and the Netherlands—spent a larger share of gross domestic product on water pollution than the United States.[306]

C. More Specific Trends and Problems

1. Rivers and Streams

While the section 305(b) reports fail to provide a stable basis for documenting trends in water quality, they do provide an extremely useful, albeit somewhat limited, picture of what is happening in American waters.[307] For the EPA's 2000 report, the states surveyed 699,946 miles or 19% of the nation's rivers and streams—most of which were perennial waterbodies flowing year-round.[308] The states found that 53% of these waters fully support all uses, while 8% support their uses but are threatened and may become impaired unless some action is taken.[309] Some form of pollution, habitat modification or flow alteration prevented the other 39% from supporting one or more of their uses.[310] Bacteria was the most widespread pollutant on all streams and was deemed responsible, at least in part, for the poor conditions existing in 93,431 miles or 13% of assessed streams, and siltation was a close second, impairing 84,503 miles or 12% of assessed streams.[311] The other leading causes of impairment were habitat modifications, oxygen depleting substances, and nutrients, each affecting about 8% of assessed waters, as well as thermal modifications (affecting about 7%), metals (affecting about 6%), and flow alterations (affecting about 4%).[312]

As may be apparent from that litany of pollutants (siltation, nutrients, and bacteria), agriculture was by far the most significant source of pollution. According to the states, agricultural operations affected 18% of all surveyed streams and contributed to the water quality problems on 48% of the im-

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306. *See* ORG. FOR ECON. CO-OPERATION & DEV., POLLUTION ABATEMENT AND CONTROL EXPENDITURE IN OECD COUNTRIES 21 (1996).

307. The reports are not comprehensive, and, in many cases, waters are assessed not on the basis of actual monitoring data or a rigorous biological survey but on the basis of best professional judgment. *See supra* notes 215-17 and accompanying text.

308. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 9. Of the assessed miles, 46% had been monitored, 36% were merely evaluated, and 18% were assessed in some unspecified way. *Id.* at 11. Although the quality of the monitoring that the states are using may be improving to some degree, *see id.* at 9-10, the actual number of miles assessed using monitoring data was basically the same in 2000 as it was in 1996. *See* 1996 CLEAN WATER NEEDS SURVEY, *supra* note 33, at 27 (reporting on the quality of 693,905 miles of rivers and streams, 51% of which had been monitored).

309. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 10-11. While the states set their own use designations under the water quality standards program, the EPA asks states to assess how well their rivers and streams support six standard uses: aquatic life support, fish consumption, primary contact recreation (such as swimming), secondary contact recreation (such as boating), drinking water supply, and agricultural uses (irrigation and watering livestock). 1996 CLEAN WATER NEEDS SURVEY, *supra* note 33, at 30.

310. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 10-11.

311. *Id.* at 12-13.

312. *Id.* at 13. More than one pollutant or stressor may be responsible for impairing the water quality of a particular stream segment, which is why the percentages cited add up to more than 39%. *See id.*

paired waters.[313] Non-irrigated crop production was the leading source of agricultural pollution followed by animal feeding operations and irrigated crop production.[314] Various kinds of hydrologic and habitat modifications, such as dredging, channelization, the construction of dams, and destruction of stream bank vegetation, degraded 13% of the assessed streams and were responsible, at least in part, for 34% of the impaired streams.[315] Other sources of impairment were urban runoff and storm sewer systems (responsible for affecting 5% of the assessed mileage), as well as forestry operations, resource extraction (such as mining and oil production), and municipal sewage treatment (each of which was responsible for affecting about 4% of the assessed mileage).[316]

2. Lakes

Other than the Great Lakes, the states assessed over 17.3 million acres of lakes—43% of the nation's total—for the EPA's 2000 report.[317] Nearly half of this lake acreage (47%) supported all uses; 8%—while meeting all uses—were threatened; and 45% were impaired for one or more uses.[318] More lakes were impaired (22% of all lakes surveyed; 50% of all impaired acreage) by excess nutrients (primarily nitrogen and phosphorus) than any other substance.[319] Metals were the second most common pollutant causing impairment, primarily due to the detection of mercury in fish samples, followed by siltation, organic waste, excess algae, total dissolved solids, and pesticides.[320]

Once again, agriculture was the primary culprit—responsible for degrading 18% of all surveyed lakes and 41% of all impaired acreage.[321] Other

313. *Id.*
314. *Id.* at 13-14.
315. *See id.* at 14-15.
316. *Id.* Regional conditions vary. For example, the 1996 report indicated that although resource extraction contributes to the problems prevailing in 13% of impaired streams nationwide in that year's survey (about 5% of the total miles assessed), the impact of these activities (including mine acid drainage) was much more significant in the coal belt states of Pennsylvania, West Virginia, Ohio, Maryland, and Kentucky. *See* 1996 CLEAN WATER NEEDS SURVEY, *supra* note 33, at 32-33, 37-38. In those states, such extractive activities contributed to the degradation of 36% (6550 miles) of all impaired streams. *Id.* at 38. Similarly, the State of Washington identified forestry activities as responsible for 32% of impaired river miles, while nationally activities related to logging contributed to only 7% of degraded conditions. *Id.* at 38. Furthermore, California, Florida, Louisiana, Mississippi, Montana, and West Virginia reported that forestry activities had degraded over 1000 river miles in each state. *Id.*
317. *Id.* at 17. The states based 68% of their survey on monitoring data and "evaluated" 28% with quantitative information. *Id.* The states did not indicate whether 4% were monitored or evaluated. *Id.*
318. *Id.* at 18. The states were asked to rate their lakes according to the same six standard uses referenced *supra* note 309. *See id.* at 19.
319. *Id.* at 20.
320. *Id.* at 20-21. Metals were responsible for impairing 19% of the lake acreage (42% of the impaired acreage); siltation was responsible for impairing 9% of the lake acreage (21% of the impaired acreage); total dissolved solids were responsible for impairing 9% (19% of the impaired acreage); organic wastes were responsible for impairing 7% (15% of the impaired acreage); excess algae growth was responsible for impairing about 6% (about 12% of impaired acreage); and pesticides were responsible for impairing about 4% (about 8% of impaired acreage). *Id.*
321. *Id.* at 22.

than agriculture, the most significant sources of pollution were identified as hydrologic modifications and urban runoff/storm sewers, each of which was responsible for impairing 8% of the assessed lakes and 18% of the impaired lakes.[322] Other problems, in descending order of significance, were generalized non-point sources, atmospheric deposition, and municipal sewage plants.[323] The states also listed a number of sources that impacted several hundred thousand acres of lakes including habitat modifications, contaminated sediments, land disposal of wastes, mining, highway maintenance and runoff, and silvicultural activities.[324]

3. The Great Lakes

During the 1960s, Lake Erie was plagued by nutrient enrichment problems—algal blooms, fish kills, and a number of "dead zones" which contained little or no oxygen.[325] Although Lake Erie received most of the press attention, the other Great Lakes were not immune from excessive nutrient levels that resulted from fertilizer use, detergents, industrial discharges, and inadequately treated municipal sewage.[326] Over the course of the last thirty years, however, Canada and the United States have reduced the phosphorus load in the Great Lakes by 50% through controls on industrial dischargers, the construction and upgrading of municipal treatment facilities, restrictions on the use of phosphates in detergents, and reductions in agricultural runoff.[327] As an obvious problem like eutrophication has receded in importance, it has been replaced by less visible ones.

Although toxic discharges have declined in recent years, the lakes still suffer from the residue of past industrial practices. Many harbors contain contaminated sediment, and the water column still contains levels of PCBs and dieldrin that exceed some applicable water quality standards[328]—although the concentration of most organochlorine compounds has declined since the mid-1970s.[329] Since high levels of bioaccumulative pollutants are found in the tissue of certain fish, a number of Great Lakes states have issued fish advisories for a number of pollutants including chlordane, dioxins,

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322. *Id.* at 22-23.
323. *Id.*
324. *Id.* at 23. Atmospheric deposition is a significant source of mercury loadings in our lakes and estuaries as well. *See supra* note 165 and accompanying text.
325. *See* WILLIAM MCGUCKEN, LAKE ERIE REHABILITATED: CONTROLLING CULTURAL EUTROPHICATION, 1960S-1990S, at 4, 44-48 (2000); MARK SPROULE-JONES, RESTORATION OF THE GREAT LAKES: PROMISES, PRACTICES, PERFORMANCES 31-32 (2002).
326. *See* KEHOE, *supra* note 196, at 177.
327. *See* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 313; SPROULE-JONES, *supra* note 325, at 32, 34.
328. 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 313. For an excellent profile on the ecological conditions in the Great Lakes, see OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, NATIONAL COASTAL CONDITION REPORT 156-69 (2001) [hereinafter EPA, COASTAL CONDITION REPORT].
329. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 32.

mercury, PCBs, and toxaphene.[330] Nevertheless, due to longstanding federal bans on the use of DDT and the manufacture of PCBs,[331] the concentration of both chemicals in Lake Michigan lake trout has fallen about 90% since 1970.[332] The toxic problem in the Great Lakes, however, is not just a problem of old pollutants found in lake sediment. Atmospheric deposition is also a significant factor. The atmosphere is now the main way by which mercury (an estimated 15,000 pounds annually) reaches the Great Lakes.[333] In addition, a number of other airborne toxics—such as polycyclic aromatic hydrocarbons ("PAHs")—are being deposited in the lakes.[334]

As a result of the elevated levels of toxics found in fish tissue, the vast majority of Great Lakes shoreline failed to support at least one use, namely fish consumption.[335] More specifically, out of 5066 miles surveyed (92% of the total shoreline), 78% were impaired for one or more uses, and while the water quality along the remaining 22% was rated as good, even these shores were classified as threatened for one or more uses.[336] Nevertheless, the states reported that almost all of the assessed shoreline was safe for swimming, boating, and drinking water supply,[337] although some beaches are still closed at least once a year for health reasons.[338] The leading pollutants were, by far, toxic organic chemicals, followed by nutrients, bacteria, sedimentation, and organic wastes.[339] And the leading source of these pollutants was, by far, contaminated sediment, followed in importance by urban runoff/storm sewers, agriculture, atmospheric deposition, habitat modification, land disposal of wastes, and septic tanks.[340]

330. 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 313-14.

331. *See* EPA, DEPOSITION OF AIR POLLUTANTS TO THE GREAT WATERS, *supra* note 165, at 9. Some 282 million pounds of PCBs—20% of the PCBs which had been produced prior to the manufacturing ban—were still in service as of 1988. *Id.* at 95.

332. *See id.* at 91. *But see* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 314 (stating that, notwithstanding the improvement, the concentration of PCBs in these lake trout remains at about 180 times the target goal of 0.014 parts per million).

333. EPA, DEPOSITION OF AIR POLLUTANTS TO THE GREAT WATERS, *supra* note 165, at 99.

334. *See id.* at 95.

335. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 32-33.

336. *Id.* at 32. Of the surveyed shoreline, less than 1% was monitored, 75% was evaluated with qualitative information, and the states failed to indicate how the remaining 25% was assessed. *Id.* at 31.

337. *Id.* at 32-33. In some cases, however, states failed to report that any of their shoreline was unswimmable even though swimming was restricted at a number of their beaches due to serious water pollution. *See* ENVTL. INTEGRITY PROJECT, FLYING BLIND: WATER QUALITY MONITORING AND ASSESSMENT IN THE GREAT LAKES STATES 19, 26-27 (Mar. 2004).

338. *See* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 315-16, 320. These beach closings are generally due to overflows from combined sewer systems that follow heavy rainfall events. *Id.* at 315.

339. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 33-34. The significance of these results is limited, however, since only four of the eight Great Lakes states identified either the pollutants that were responsible for degrading water quality or their sources. *Id.* at 33.

340. *Id.* at 33, 35.

4. *Estuaries*

Estuaries provide a necessary habitat for most shellfish, including oysters, crabs, and shrimp, and for many commercially significant fish species, during some stage of their development.[341] Estuarine watersheds also provide tremendous amounts of drinking water—San Francisco Bay's watershed, for instance, supplies water to 20 million Californians.[342] Unfortunately, most estuaries are located near major urban areas.[343] As a result, industrial discharges, sewage, and coastal development as well as various non-point sources have sorely stressed these waters, leading to algal blooms, fish kills, contaminated shellfish beds, and the loss of wetlands.[344]

The states assessed 36% of their estuaries (31,072 square miles) for the EPA's 2000 section 305(b) report.[345] Of those estuaries, 45% supported all uses, 4% were threatened for one or more uses, and 51% were impaired for one or more uses.[346] More estuarine waters were degraded by metals, mainly mercury, than any other pollutant or stressor.[347] Excessive metals were found in 26% of all estuarine waters surveyed (8077 square miles) and contributed to the condition of 52% of the impaired estuarine waters.[348] The states also reported that pesticides were the second leading pollutant, found in 19% of the surveyed estuaries (5985 square miles) and causing, at least in part, the problems in 38% of the impaired estuaries.[349] Other significant pollutants and stressors were, in order of impact, organic materials, bacteria, toxics, PCBs, and total dissolved solids.[350]

The pollution patterns in our estuaries reflect the way in which industrial development and population growth have occurred along the coast.[351] According to the states, municipal sewage discharges were the leading source of pollution in the surveyed estuaries—adversely affecting 19% of all estuaries surveyed (5779 square miles) and contributing to the degraded

341. *Id.* at 25.

342. *See* Dawn M. Martin et al., Estuaries on the Edge: The Vital Link between Land and Sea 8 (1996).

343. *See id.* at 9.

344. *See id.* at 9-13.

345. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 25. Of those estuarine waters, 51% were actually monitored, while 32% were merely evaluated. The states did not indicate whether the survey results for 17% of their estuaries were based upon monitoring data or some sort of professional judgment. *Id.* For a thorough review of coastal conditions, including estuaries, see EPA, COASTAL CONDITION REPORT, *supra* note 328.

346. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 26.

347. *Id.* at 28.

348. *Id.*

349. *Id.*

350. *Id.* at 28-29. Organic materials degraded 17% of the assessed area (representing 34% of the impaired area); bacteria impaired 15% of the assessed estuarine area (30% of the impaired area); toxics impaired approximately 12% of the assessed area (23% of the impaired area); and PCBs contaminated approximately 8% of the assessed area (about 17% of the impaired area). *Id.*

351. Although the U.S. coastal zone only represents one-fourth of the country's total land area, 53% of its population (140 million in 1994) lives there. COUNCIL ON ENVTL. QUALITY: TWENTY-FIFTH ANNIVERSARY REPORT 247 (1996).

conditions in 37% of the impaired estuarine waters.[352] The states also reported that urban runoff and storm sewers were the second most widespread source of pollution, impacting some 16% of surveyed waters (32% of the impaired estuaries), followed, in order of magnitude, by industrial discharges, atmospheric deposition (a significant source of mercury and nitrogen), agriculture, hydrologic modifications, and resource extraction.[353]

5. *Wetlands*

When the first colonists settled along the banks of the James River in 1607, there were approximately 221 million acres of wetlands in the area that currently comprises the lower forty-eight states.[354] Since then, wetlands have been drained and filled and dredged in such remorseless fashion that less than half of that original acreage remains.[355] Today, only about 105 million acres of wetlands exist in the continental United States, of which 95% are inland freshwater wetlands while the remaining 5% are located in saltwater environments.[356] Six states—California, Ohio, Indiana, Illinois, Iowa, and Missouri—have lost 85% or more of their original wetlands while twenty-two other states—ranging from New York and Pennsylvania to Alabama and Idaho—have lost 50% or more.[357]

Due to prolific plant life, wetlands rank among the most productive ecosystems in the world. They produce massive amounts of vegetation that provide cover for fish and wildlife, nesting areas for birds, and nourishment for many aquatic invertebrates, shellfish, and forage fish, which, in turn,

352. 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 28-31.

353. *Id.* at 30-31. Industrial discharges polluted 13% of the assessed waters (representing 26% of the total impaired area); atmospheric deposition adversely affected 12% of the assessed area (representing 24% of the impaired area); agriculture adversely impacted about 9% of the assessed area (representing about 18% of the impaired area); hydrologic modifications degraded about 7% of the assessed waters (representing about 14% of the impaired area), and resource extraction polluted approximately 6% of the total estuarine area assessed (representing about 12% of the impaired area). *Id.* at 30-31.

354. *See* THOMAS E. DAHL, U.S. DEP'T OF THE INTERIOR, FISH & WILDLIFE SERV., WETLANDS LOSSES IN THE UNITED STATES 1780S TO 1980S, at 1 (1990), *available at* http://www.npwrc.usgs.gov/resource/othrdata/wetloss/wetloss.htm [hereinafter DAHL, WETLANDS LOSSES 1780S TO 1980S]. Alaska at that time had about 170 million acres of wetlands and Hawaii approximately 59,000 acres. *Id.*

355. *Id.* "On average, this means that the lower forty-eight states have lost over sixty acres of wetlands for every hour between the 1780s and the 1980s." *Id.* For most of the 400 years since the founding of Jamestown, Americans regarded wetlands as a nuisance. Wetlands were regarded as obstacles to development and transportation and were also considered to be unhealthy breeding grounds for insects and disease. *See id.* at 2; WILLIAM M. LEWIS, JR., WETLANDS EXPLAINED: WETLAND SCIENCE, POLICY, AND POLITICS IN AMERICA 5 (2001); Thomas E. Dahl & Gregory J. Allord, *History of Wetlands in the Conterminous United States, in* NATIONAL WATER SUMMARY ON WETLAND RESOURCES 20 (U.S. Geological Survey, 1996).

356. *See* THOMAS E. DAHL, U.S. DEP'T OF THE INTERIOR, FISH & WILDLIFE SERV., STATUS AND TRENDS OF WETLANDS IN THE CONTERMINOUS UNITED STATES 1986 TO 1997, at 9-10 (2000) [hereinafter DAHL, WETLANDS 1986 TO 1997]. The three-quarters of wetlands that are in private ownership are thought to be the most at risk from various development pressures. *See* OECD, ENVIRONMENTAL PERFORMANCE REVIEW, *supra* note 85, at 82.

357. Dahl & Allord, *supra* note 355, at 19. Florida has lost the most acreage, 9.3 million acres. DAHL, WETLANDS LOSSES 1780S TO 1980S, *supra* note 354, at 1.

provide food to larger fish including such game fish as striped bass and bluefish.[358] Wetlands provide a home for a wide array of rare plants and numerous endangered and threatened species.[359] Wetlands also serve to improve water quality by removing nutrients and trapping sediments before they flow into open waters.[360] In addition, wetlands provide flood protection by serving as storage basins during high water[361]—they also serve as a storm buffer along our coast absorbing wave action and reducing erosion.[362] Finally, wetlands serve as a natural recharge point for groundwater and help to even out stream flows.[363]

These values, however, were discerned rather late in the day. Throughout the nineteenth and the early twentieth centuries, the growth of agriculture and our westward expansion prompted the conversion of millions of acres of wetlands to croplands,[364] and the increased demand for wood products led to the loss of many forested wetlands.[365] The process of destruction intensified during the twentieth century as various water projects and flood control efforts became larger through the application of modern technology and as tractors made it easier for farmers to drain millions of acres of prairie potholes and other small wetlands.[366] From the mid-1950s through the mid-1970s, wetland losses in the United States averaged 550,000 acres per year—with agriculture responsible for more than 80% of those losses.[367]

With the enactment of section 404 of the CWA in 1972 and the implementation of the new permitting program during the mid-1970s, the rate of wetlands loss declined. From the mid-1970s to the mid-1980s, wetlands losses in the conterminous United States dropped to approximately 290,000 acres each year, about one-half of the average annual losses experienced during the previous twenty years.[368] Beginning in the mid-1980s, federal

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358. *See* U.S. CONGRESS, OFFICE OF TECH. ASSESSMENT, WETLANDS: THEIR USE AND REGULATION 52-60 (1984) [hereinafter OTA, WETLANDS]; U.S. DEP'T OF AGRIC. ET AL., OUR NATION'S WETLANDS: AN INTERAGENCY TASK FORCE REPORT 19-22 (1978).

359. An estimated 80% of the nation's coastal fisheries and about 33% of its endangered species depend upon wetlands for food sources, spawning purposes, and nursery areas. *See* EPA, ENVIRONMENTAL INDICATORS OF WATER QUALITY, *supra* note 111, at 11.

360. LEWIS, *supra* note 355, at 52-55; OTA, WETLANDS, *supra* note 358, at 48-51.

361. LEWIS, *supra* note 355, at 47-48; OTA, WETLANDS, *supra* note 358, at 43-46.

362. Virginia Carter, *Wetlands Hydrology, Water Quality, and Associated Functions*, *in* NATIONAL WATER SUMMARY ON WETLAND RESOURCES 46 (U.S. Geological Survey, 1996).

363. *See id.* at 43-44; 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 83-86.

364. Dahl & Allord, *supra* note 355, at 21-22. When drained, "many wetlands yielded rich soil capable of sustaining high yields of crops that tapped centuries of natural nutrient accumulation." LEWIS, *supra* note 355, at 5. We have transformed, therefore, some of the most magnificent wildlife habitats that ever existed into farmland. *See, e.g.*, MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER 346-47 (1986) (describing how the rivers and streams draining into California's Central Valley used to flood each winter creating a huge seasonal wetland that was populated by vast flocks of migratory birds).

365. Dahl & Allord, *supra* note 355, at 21-22.

366. *See id.* at 22-24.

367. *See id.* at 24.

368. THOMAS E. DAHL & CRAIG E. JOHNSON, U.S. DEP'T OF THE INTERIOR, FISH & WILDLIFE SERV., WETLANDS: STATUS AND TRENDS IN THE CONTERMINOUS UNITED STATES, MID-1970S TO MID-1980S, at 1 (1991).

efforts to protect wetlands intensified,[369] and as a result, annual wetlands losses fell to approximately 58,500 acres between 1986 and 1997.[370] Although annual losses are now some 85% below the peak levels of the 1950s and 1960s, there is still much to do—including limiting the damage that the *SWANCC* opinion[371] could cause—to reach the EPA's interim goal of no-net loss, let alone the agency's long-term goal of increasing both the quantity and quality of the nation's wetlands.[372] The improvement over the last twenty years, however, has been dramatic, and it may be attributed to a number of factors including more aggressive implementation of the section 404 program; enactment of the Swampbuster provisions in the 1985, 1990, and 1996 farm bills;[373] declining profits from converting wetlands into croplands; and growing public awareness and support for wetlands protection.[374]

According to the nine states that listed the sources of recent wetlands losses in their 2000 305(b) reports, the primary culprits were unspecified filling and draining, agriculture, residential development, and urban growth, followed by highway and bridge construction, dredging, resource extraction, and impoundments.[375] Actual wetland losses, however, are only part of the picture. Thousands of acres of wetlands are also being degraded or modified by human activities.[376] While only nine states reported in 2000 on the current quality of their wetlands, those states indicated that the primary causes of wetlands impairment were sedimentation, flow alterations, and nutrient pollution brought about by agriculture, construction, hydrologic modifications, urban runoff, forestry activities, and habitat modifications.[377]

369. Of course, these efforts are currently being undermined by the *SWANCC* decision, and if the broadest possible interpretation of *SWANCC* prevails, upwards of 20% to 30% of all wetlands in the country could lose their protected status under the CWA. *See supra* note 30 and accompanying text.

370. *See* DAHL, WETLANDS 1986 TO 1997, *supra* note 356, at 9. An inventory of wetlands resources compiled by the National Resources Conservation Service ("NRCS") during a slightly earlier period (1982 to 1992) estimated average annual wetlands losses on non-federal lands of between 70,000 and 90,000 acres. *See* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 89. The NRCS also estimated wetlands losses for the latter half of the period covered by Dahl's Fish & Wildlife Service report. The NRCS reported that an average annual loss of 32,600 acres occurred on non-federal lands between 1992 and 1997. *See* 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 45. Although these estimates are not necessarily inconsistent—they clearly show a trend of declining wetlands losses—the absence of a "single set" of reliable numbers to evaluate progress towards "no net loss" has been criticized. *See* U.S. GEN. ACCT. OFFICE, WETLANDS OVERVIEW: PROBLEMS WITH ACREAGE DATA PERSISTS 2 (1998). In May 1998, the Clinton Administration issued a plan for developing a single report on the status and trends of wetlands. *See id.* at 3.

371. *See supra* note 30 and accompanying text.

372. *See* CLEAN WATER ACTION PLAN, *supra* note 36, at 40 (referring to both interim and long-term goals).

373. Under the Swampbuster program, landowners who plant an agricultural commodity in a wetland that had not been used as farmland prior to December 23, 1985, may lose their agricultural subsidies. *See* NAT'L RES. COUNCIL, COMPENSATING FOR WETLAND LOSSES, *supra* note 45, at 303.

374. *See* 1996 NATIONAL WATER QUALITY INVENTORY, *supra* note 214, at 89.

375. *See* 2000 NATIONAL WATER QUALITY INVENTORY, *supra* note 29, at 45. Only 8% of the nation's total wetlands acreage was assessed by the states. *Id.* at 47.

376. *See id.* at 46-47.

377. *Id.*

6. Beach Closures

The EPA has been surveying the condition of the nation's beaches since 1997.[378] Of the 2823 beaches that were reviewed in 2002, 709, or 25%, either experienced the closing of at least one swimming area or was the object of a beach advisory at some point during the 2002 swimming season.[379] The duration of most closings or advisories was three to seven days, and the main reason was the presence of elevated levels of bacteria associated with human or animal waste.[380] Swimming in such contaminated water can cause a wide range of health problems ranging from gastroenteritis, dysentery, and hepatitis, to ear, nose, and throat infections.[381] Even swimming in water contaminated by urban runoff from storm sewers presents a greater risk of causing fevers, chills, ear discharge, vomiting, and other health problems than swimming in cleaner waters.[382] The largest identified source of pollution causing these beach problems was stormwater runoff (that led to 21% of the advisories and closings), followed by wildlife (11%), septic systems (4%), various sewer overflows (4%), boat discharges (3%), sewer line breaks (3%), and discharges from malfunctioning sewage treatment plants (3%).[383] Although the number of beaches included in the survey has grown over the years, from 1021 in 1997 to the current 2823 beaches, the percentage of the surveyed beaches that are affected by advisories or closings has remained fairly constant—averaging about 25% per year.[384]

7. Shellfish Bed Closures

Population growth and coastal development are placing a great deal of stress upon the health of American shellfisheries since oysters, clams, and mussels are so sensitive to contamination from sewage and other sources of pathogens. In 1995, over 25 million acres of coastal and estuarine waters were classified as shellfish growing areas under a program jointly administered by the states and federal government.[385] Of the 4230 growing areas

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378. *See* U.S. ENVTL. PROT. AGENCY, OFFICE OF WATER, EPA'S BEACH WATCH PROGRAM: 2002 SWIMMING SEASON 2 (2003) [hereinafter EPA, 2002 BEACH WATCH].

379. *Id.* Of these beaches, 2031 were ocean beaches, and 792 were located on inland lakes or streams. *See id.* The Natural Resources Defense Council, which has been monitoring beach conditions since 1991, surveyed a slightly larger sample of beaches in 2002—a total of 2929—and found that these beaches were either closed or the subject of an advisory for more than 15,100 days during the year. *See* NAT. RESOURCES DEF. COUNCIL, TESTING THE WATERS 2003: A GUIDE TO WATER QUALITY AT VACATION BEACHES, at vi-ix (2003), *available at* http://www.nrdc.org/water/oceans/ttw/exesum.asp.

380. *See* EPA, 2002 BEACH WATCH, *supra* note 378, at 2-3.

381. *See* CEQ, 25TH ANNIVERSARY REPORT, *supra* note 197, at 255-56.

382. *See id.*

383. *See* EPA, 2002 BEACH WATCH, *supra* note 378, at 3.

384. *See id.*

385. NAT'L OCEANIC & ATMOSPHERIC ADMIN., OFFICE OF OCEAN RES. CONSERVATION & ASSESSMENT, THE 1995 NATIONAL SHELLFISH REGISTER OF CLASSIFIED GROWING WATERS 1 (1997) [hereinafter 1995 NATIONAL SHELLFISH REGISTER]. These shellfish growing areas comprise an area somewhat larger than the state of Maine and produce an annual harvest of shellfish worth approximately $200 million at the wharf. C.E. ALEXANDER, NAT'L OCEANIC & ATMOSPHERIC ADMIN., CLASSIFIED

that were so classified, 69% were fully approved for shellfish harvesting; 19% were conditionally approved, restricted, or conditionally restricted; and only 13%—the lowest percentage on record—were placed completely off-limits to shellfish harvesting.[386] In addition, the total area subject to harvest limitations of various sorts fell from a high of 42% in 1985 to 31% in 1995.[387] The 1995 statistics indicate that part of the reason for this improvement was a significant reduction in pollution from industrial facilities and from municipal wastewater treatment plants.[388] So progress is being made. On the other hand, typical non-point sources of water pollution—agricultural runoff, wildlife, and urban runoff—were responsible for an increasing number of harvest limitations.[389]

8. Sediment Contamination

Many pollutants settle and accumulate in the silt and mud located at the bottom of rivers, lakes, and estuaries.[390] Much of the contaminated sediment in the United States was polluted years ago by pesticides such as DDT and other substances such as PCBs whose use and production have now been banned.[391] While these chemicals are now found less frequently in overlying waters, they degrade very slowly and can persist in sediment for many years.[392] These contaminants can accumulate in bottom-dwelling organisms and move up the food chain to fish and then humans.[393] Today, a number of chemicals—discharged from stormwater systems or from industrial or municipal treatment facilities, carried off in polluted runoff from mining operations, old industrial sites, and agricultural activities, and even deposited from the atmosphere—are still finding their way into sediments and are still accumulating in harmful amounts.[394] The EPA estimates that approximately 10% of the sediment underlying the waters of our nation is contaminated to such an extent by toxic substances that they pose a possible risk to humans,

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SHELLFISH GROWING WATERS (1998), *available at* http://state_of_coast.noaa.gov/bulletins/html/sgw_04/sgw.html.

386. *See id.* The National Shellfish Register was first published in 1966. *See* 1995 NATIONAL SHELLFISH REGISTER, *supra* note 385, at 1.

387. *Id.*

388. *See* EPA, COASTAL CONDITION REPORT, *supra* note 328, at 56. The percentage of harvest limitations due to industrial discharges fell 8% from 1990 levels, and the percentage of such limitations due to discharges from POTWs fell 13%. *See* ALEXANDER, *supra* note 385, tbl.4.

389. *See* ALEXANDER, *supra* note 385, tbl.4. The percentage of harvest limitations due to agriculture rose 6% over 1990, while the percentage due to wildlife grew 13% and the percentage due to urban runoff increased 2%. *See id.* Other pollution sources responsible for limitations on shellfish harvesting are unspecified upstream sources, runoff from animal feedlots, malfunctioning septic tanks and discharges from waterside residences, marinas, boating, and combined sewer overflows. *Id.*

390. OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, *Foreword* to EPA'S CONTAMINATED SEDIMENT MANAGEMENT STRATEGY (1998) [hereinafter EPA, CONTAMINATED SEDIMENT STRATEGY].

391. *Id.*

392. *Id.*

393. *See id.*, at i; EPA, ENVIRONMENTAL INDICATORS OF WATER QUALITY, *supra* note 111, at 18.

394. EPA, CONTAMINATED SEDIMENT STRATEGY, *supra* note 390, at 5.

wildlife, and aquatic species that consume fish.[395] Contaminated sediments, in fact, have been responsible for many state advisories that warn against the consumption of fish or shellfish from certain areas.[396]

The highest concentrations of contaminated sediment are found in or near industrial areas, areas with high ship traffic, and locations with relatively poor flushing action such as harbors, canals, and narrow intracoastal waterways.[397] According to NOAA, which has used sediment cores to reconstruct the history of contamination, levels of contamination rose slowly in the late nineteenth century, accelerated during the mid-twentieth century, and peaked around the 1970s.[398] Since the 1970s, the concentrations of many contaminants have been declining, with lower levels generally observed for banned chemicals and substances whose use is decreasing such as cadmium and arsenic.[399] The most frequently cited contaminants have been heavy metals such as mercury, metalloids like arsenic, pesticides, PCBs, and polycyclic aromatic hydrocarbons.[400]

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395. *Id.* at 1-2. Contaminated sediments, for example, have been proven to cause fin rot, tumors, and reproductive toxicity in fish, as well as leading to lessened biodiversity in aquatic systems. *Id.* at 2.

396. *See id.* at i; CEQ, 25TH ANNIVERSARY REPORT, *supra* note 197, at 252.

397. EPA, CONTAMINATED SEDIMENT STRATEGY, *supra* note 390, at 5.

398. CEQ, 25TH ANNIVERSARY REPORT, *supra* note 197, at 251.

399. *Id.* EPA's assessment of historical data from 1980 to 1999 "tended to show" either a drop or no change in sediment contamination in most areas where data were available. *See* U.S. ENVTL. PROT. AGENCY, FACT SHEET: DRAFT REPORT ON THE INCIDENCE AND SEVERITY OF SEDIMENT CONTAMINATION IN SURFACE WATERS OF THE UNITED STATES, NATIONAL SEDIMENT QUALITY SURVEY: SECOND EDITION (Dec. 2001), *available at* http://www.epa.gov/waterscience/cs/surveys.html.

400. EPA, CONTAMINATED SEDIMENT STRATEGY, *supra* note 390, at 3. The remediation of contaminated sediment can be accomplished in certain instances under the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§ 9601-75 (2000). Approximately 20% of the sites on the National Priorities List have contaminated sediment, and PCBs and heavy metals were the primary culprits, followed by pesticides. OFFICE OF SOLID WASTE & EMERGENCY RESPONSE, U.S. ENVTL. PROT. AGENCY, CONTAMINATED SEDIMENTS IN SUPERFUND, *at* http://www.epa.gov/superfund/resources/sediment/index.htm (last updated Oct. 21, 2003). At about 75% of the sites, dredging was specified as the cleanup method for sediment, and at 80% of those sites, less than 50,000 cubic yards of sediment was removed. *Id*.

Contaminated sediment can also be cleaned up in two instances under the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C. §§ 6901-92k (2000). EPA can order a corrective action if the sediment is hazardous waste and has been released at an RCRA-permitted or interim status hazardous waste facility. *See* RCRA § 3004(u), (v), 42 U.S.C. § 6924(u), (v). EPA, as well as private citizens, can also attempt to force the cleanup of contaminated sediment where it meets the definition of solid or hazardous waste and where there is evidence of an imminent and substantial endangerment to human health or the environment. *See* RCRA §§ 7002(a)(1)(B), 7003, 42 U.S.C. §§ 6972(a)(1)(B), 6973.

Under the CWA, water quality criteria could be established for sediment that could assist with both the identification of problem areas and with permitting decisions. *See* SEDIMENT OVERSIGHT TECHNICAL COMM., U.S. ENVTL. PROT. AGENCY, CONTAMINATED SEDIMENTS: RELEVANT STATUTES AND EPA PROGRAM ACTIVITIES 50-51 (1990) [hereinafter EPA, CONTAMINATED SEDIMENTS]. In a few cases, states have identified waters under section 304(l) of the Act, 33 U.S.C. § 1314(l) (individual control strategies for toxic pollutants), that are impaired by contaminated sediment. In such cases, the dischargers contributing to such contamination should receive more stringent permit limitations in order to halt continued contamination. EPA, CONTAMINATED SEDIMENTS, *supra*, at 55. The EPA's Great Lakes National Program Office has also undertaken a study and demonstration project under section 118(c)(3) of the Act, 33 U.S.C. § 1268(c)(3), to address the control and removal of sediments contaminated with toxics in the Great Lakes. *See* EPA, CONTAMINATED SEDIMENTS, *supra,* at 66-68.

9. Fish Consumption Advisories

Although most of the waters in the nation contain fish that are safe to eat, states issue consumption advisories to warn their residents about the risks associated with consuming fish, crustaceans, or shellfish from specific waterbodies due to chemical contamination.[401] The number of waterbodies for which such warnings have been issued has increased consistently since 1993, which was the first year such statistics were kept. The total number of river miles under advisory increased 13% between 1993 and 2002, and the total of lake acres under an advisory jumped 25%.[402] This increase is due in part to a rise in the number of assessments performed by the states and the increasing willingness on the part of states to issue consumption advisories.[403] The 2800 advisories that were in effect in 2002 covered 15% of the nation's river miles and nearly 33% of its lake area.[404] In addition, all of the Great Lakes were under advisory, as were about 71% of the coastline in the lower forty-eight states.[405] Mercury is cited as a reason for nearly 75% of the warnings, and mercury, together with PCBs, chlordane, DDT, and dioxin, were responsible, at least in part, for 96% of all fish advisories in 2002.[406]

10. Species at Risk

The biological diversity of the nation's waters have suffered greatly from the habitat destruction that followed in the wake of agricultural expan-

401. OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, 2002 NATIONAL LISTING OF FISH & WILDLIFE ADVISORIES 1 (2003). The advisories may warn persons to either avoid or limit their consumption of certain fish or other aquatic life. *Id.* Contaminated fish and shellfish are of particular concern for persons in high-risk categories such as pregnant women, nursing mothers, children, and persons with weak immune systems. EPA, DRAFT REPORT ON THE ENVIRONMENT, *supra* note 139, at 2-20. Fish consumption is also of real concern to people of color, lower income individuals, and Native Americans who are more likely to eat fish in large quantities and at greater frequencies than is the norm and thus ingest larger doses of mercury, PCBs, and other contaminants. Catherine A. O'Neill, *Risk Avoidance, Cultural Discrimination, and Environmental Justice for Indigenous Peoples*, 30 ECOLOGY L.Q. 1, 27 (2003). This later fact provides more than adequate reason for the EPA to lower the fish consumption rate (currently based on a mean consumption rate for fish consumers in the general population) that it uses in setting water quality criteria and reviewing state water quality standards. *See* Catherine A. O'Neill, *Variable Justice: Environmental Standards, Contaminated Fish, and "Acceptable" Risk to Native Peoples*, 19 STAN. ENVTL. L.J. 3, 45-50 (2000).

402. OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, FACT SHEET UPDATE: NATIONAL LISTING OF FISH AND WILDLIFE ADVISORIES 2 (2003).

403. *Id.*

404. *Id.* Twenty-eight states have statewide advisories currently in effect. In 2002, Florida, Illinois, and Rhode Island added statewide advisories for all lakes and rivers due to mercury contamination. *Id.* at 2-3.

405. *Id.* at 2, 4. Ninety-two percent of the Atlantic coast is currently under advisory as is 100% of the Gulf coast. All of the Gulf coast advisories are for mercury while the Atlantic coast advisories have been issued for a number of substances which include mercury, PCBs, cadmium, and dioxin. *Id.* at 4.

406. *Id.* at 5. Although the use of the pesticide DDT was banned in 1975, the number of advisories citing it as a contaminant has been increasing slightly, an experience shared by another substance, PCBs, whose manufacture has been banned and use restricted since the late 1970s. *See id.* at 5-6. In contrast, a number of advisories for the pesticide chlordane, whose use was banned in 1988, have been rescinded during the last few years because it degrades more readily than either DDT or PCBs. *See id.* at 6.

sion, industrial growth, massive logging operations, and the impoundment of thousands of rivers and streams.[407] Although pollution has played a role in causing the decline in the health of aquatic ecosystems, physical and biological impairment are more significant factors.[408] Rob Adler recently reported that "most experts agree that the largest single cause of aquatic species decline is the massive destruction and alteration of all forms of aquatic habitats on a virtually nationwide scale."[409] In 2002, about 23% of all riparian areas had either farmlands or urban development located within 100 feet of the water's edge,[410] and floodplain development had destroyed about 50% of the nation's woody riparian habitat.[411] In addition, over 600,000 miles of U.S. rivers have been flooded by thousands of dams,[412] while many thousands of additional miles have been "channelized, dewatered, riprapped, and otherwise altered in ways that impair or destroy important habitat."[413]

As a result, the four groups of species most at risk of extinction in the United States are all species that depend upon rivers, streams, and lakes: freshwater mussels, crayfish, amphibians, and freshwater fish.[414] Sixty-seven percent of U.S. freshwater mussels are either vulnerable to extinction or are already extinct.[415] Thirty-seven percent of U.S. freshwater fish species—some 303 different kinds of fish fauna—are at risk of extinction.[416] And 51% of crayfish and 40% of amphibians are either imperiled or vulnerable to extinction.[417] Of the eleven species of fish that once produced a commercial harvest of 1.4 million kilograms per year in the Great Lakes, four are extinct today, and the other seven species are at risk.[418] Of freshwater species in the United States, approximately 13% are critically imperiled, 8% are imperiled, 11% are vulnerable, and 4% either are or may be ex-

407. *See* JANET N. ABRAMOVITZ, IMPERILED WATERS, IMPOVERISHED FUTURE: THE DECLINE OF FRESHWATER ECOSYSTEMS 6-10 (1996); Adler, *The Water Quality Trilogy*, *supra* note 41, at 50-51.

408. Adler, *The Water Quality Trilogy*, *supra* note 41, at 51.

409. *Id.*

410. STATE OF THE NATION'S ECOSYSTEMS, *supra* note 139, at 140.

411. *See* Adler, *The Water Quality Trilogy*, *supra* note 41, at 51; *see also* NAT'L RES. COUNCIL, RIPARIAN AREAS: FUNCTIONS AND STRATEGIES FOR MANAGEMENT 8-12 (2002) (discussing the deleterious impact of hydrological modifications, agriculture, mining, transportation, and urbanization upon the ecological health of riparian areas). According to the National Research Council, "traditional agriculture is probably the largest contributor to the decline of riparian areas." *Id.* at 10.

412. AMERICAN RIVERS, ABOUT RIVERS: RIVER FACTS, *available at* http://www.amrivers.org/aboutrivers/riverfacts.htm (last visited Feb. 9, 2004).

413. Adler, *The Water Quality Trilogy*, *supra* note 41, at 51.

414. THE NATURE CONSERVANCY, 1997 SPECIES REPORT CARD: THE STATE OF U.S. PLANTS AND ANIMALS (1997) (copy on file with the author).

415. *See* THE NATURE CONSERVANCY, RIVERS OF LIFE: CRITICAL WATERSHEDS FOR PROTECTING FRESHWATER BIODIVERSITY 6 (1998) [hereinafter NATURE CONSERVANCY, RIVERS OF LIFE]. Since the beginning of the twentieth century, 10% of the mussel species in North America have become extinct, while 297 species and subspecies are currently endangered, threatened, or in some way at risk. ABRAMOVITZ, *supra* note 407, at 5-6.

416. NATURE CONSERVANCY, RIVERS OF LIFE, *supra* note 415, at 6.

417. *Id.*

418. *See* ABRAMOVITZ, *supra* note 407, at 10. Before dams were built along the Columbia River, the river supported some 10-16 million salmon. Today, only 2 million survive, and most of these are bred in hatcheries. Adler, *The Water Quality Trilogy*, *supra* note 41, at 53.

tinct.[419] In other words, approximately one-third of all freshwater animal species in the United States are at risk today.[420]

11. Oil Spills

According to the U.S. Coast Guard, the number of oil spills has steadily decreased since 1972.[421] During the first ten years after the passage of the CWA, an average of approximately 9100 spills occurred every year, whereas an average of 8300 spills occurred annually during the ten-year period ending in 2001.[422] More importantly, however, the amount of oil that is spilled annually has declined in significant fashion. Between 1973 and 1982, an average of 14.28 million gallons of oil was being spilled in U.S. waters every year.[423] By 1991 through 2001, that number had dropped to an average of 1.65 million gallons per year[424]—or just a little over one-tenth of the average volume spilled during the earlier period. The magnitude of this improvement strongly suggests that the implementation of section 311 and the new Oil Pollution Act have had a real positive impact upon the industry.[425]

V. CONCLUSION

The CWA has produced a great deal of progress during the past thirty years. The discharge of organic wastes from publicly-owned waste treatment facilities has dropped 46%, while similar discharges from industry have fallen 98%. Dissolved oxygen levels have increased downstream from point source discharges all over the country, and the improvements are so significant that they can often be discerned throughout entire river basins. The greatest improvements, however, can be seen in many rivers and lakes located in urban, industrialized areas, which in the past suffered most from point source discharges. Truly extraordinary progress, therefore, has been experienced in places as diverse as the Delaware estuary and the Chattahoochee River, New York Harbor, and the Potomac estuary. The progress, moreover, is not limited to just conventional pollutants, but includes heavy metals and toxic water pollutants. As a result, Pittsburghers today enjoy

419. STATE OF THE NATION'S ECOSYSTEMS, *supra* note 139, at 144.

420. *Id.* The number of species at risk is much higher in Hawaii and the Southeast than elsewhere in the country. *Id.*

421. Letter from Captain Michael B. Karr, Chief, Office of Investigations and Analysis, U.S. Coast Guard, to the Maritime Community 1 (Aug. 2003), *available at* http://www.uscg.mil/hq/g-m/nmc/response/stats/chief.htm [hereinafter Karr Letter]. For a thorough discussion of the biological impact of oil spills, see NAT'L RES. COUNCIL, OIL IN THE SEA III: INPUTS, FATES, AND EFFECTS 119-57 (2003) [hereinafter NAT'L RES. COUNCIL, OIL IN THE SEA III].

422. Karr Letter, *supra* note 421, at 1.

423. *See* U.S. COAST GUARD, POLLUTING INCIDENT COMPENDIUM: CUMULATIVE DATA AND GRAPHICS FOR OIL SPILLS 1973-2001 (2003), *available at* http://www.uscg.mil/hq/gm/nmc/response/stats/summary.htm (last updated Aug. 2003).

424. *See id.*

425. *See* CEQ, 25TH ANNIVERSARY REPORT, *supra* note 197, at 250.

their three rivers as a place for picnics and boating and summer arts festivals, and from Boston to Baltimore to Savannah, Americans are finding beauty and recreation along their restored harbors.

The application of technology-based effluent limitations through the NPDES permit system has proven to have been a wise approach for the initial control of point source pollution. Together with the funding of thousands of municipal wastewater treatment facilities, the technology-based approach has produced remarkable reductions in both municipal and industrial pollution. The CWA has proven successful in other ways as well. The rate at which wetlands are lost has declined some 90% since the early 1970s, and the amount of oil spilled annually into our waters has fallen to one-tenth of the level that prevailed during the 1970s. All of this was done without causing harm to the economy or to our international competitiveness. In fact, the cost of complying with the Act has been lower than the EPA anticipated, and eleven of our largest trading partners actually spend more per capita on controlling water pollution than we do. The economic benefits produced by the Act, moreover, appear to be greater than many had assumed. The Act and its success stand as a testament to the vision, insight, and courage of its drafters. Unfortunately, but not surprisingly given the limits of human and political capacity, neither the design of the Act nor its implementation have been perfect.

More than a little fine-tuning remains to be done. The rate at which permits and pre-treatment requirements are violated is too high, and government enforcement efforts are too anemic. The nation's existing infrastructure for collecting and treating municipal waste is aging while the population is growing, and combined sewer overflows and sanitary sewer overflows persist as serious problems in hundreds of communities. The federal government must therefore commit itself, in partnership with state and local government, to providing additional capital for building new wastewater treatment capacity and replacing or upgrading old, outdated facilities. A number of effluent limitations need to be upgraded to reflect a broader array of pollutants and recent improvements in technology, and new administrative and legislative steps must be taken to protect our remaining wetlands. Perhaps most importantly, the EPA and the states must complete the two-part strategy that was set forth in 1972—permit conditions must be driven not only by technology-based limits but by any additional reductions necessary to comply with water quality standards. Water quality-impaired rivers and lakes must be identified in comprehensive fashion—and to do so, we will need to expand the scope and the accuracy of water quality monitoring efforts. And total maximum daily loads must then be set for all impaired waters and the loads allocated among the responsible sources—point sources and non-point sources alike; and finally, the waste load allocations must be implemented through both discharge permits and management plans.

The full implementation of water quality standards would begin to address the most significant remaining water pollution problem—non-point source pollution. The CWA has never addressed non-point source pollution in a straightforward comprehensive way. Instead, it has been treated as something of an afterthought, a troublesome area to be primarily left in the hands of state and local government. As a consequence, non-point source pollution has evolved into the largest single obstacle to improving water quality. Approximately 82% of the rivers and streams that fail to meet water quality standards and 77% of such lakes are impaired because of agricultural runoff and hydrological modifications. Non-point source pollution, however, is more varied than we once thought. In addition to such obvious sources as polluted runoff from agriculture, logging operations, mines, and urban areas, non-point source problems are posed by cross-media transfers such as the deposition of air pollutants into our waters, and biological diversity is threatened by habitat destruction. In addition, many of our waterways suffer from the residue of prior industrial practice and misconduct—namely, sediments which are contaminated with heavy metals, PCBs, and pesticides. Therefore, more than TMDLs will be necessary. Water quality criteria will need to address habitat destruction, biological integrity, pesticides, and contaminated sediments. And we will have to start addressing a number of air pollutants and their emitters as significant sources of water pollution.

Ultimately, however, the success of any program aimed at controlling non-point source pollution will depend upon the wisdom and the will of our political and governmental leaders—at the local, state, and federal levels—to deal with a number of powerful lobbies and a number of sensitive questions involving land use and property rights. Water pollution control is no longer just an effort by the larger community to regulate a relatively small number of conspicuous point source dischargers. The challenge today, in fact, is fundamentally different and more difficult—at least politically—since the sources of non-point source pollution are so numerous and so diffuse. Success at this next stage will demand ingenuity, courage, innovation, a few incentives, more regulations, more federal involvement, more public education, and above all, a much more mature sense of civic responsibility. The drafters of the CWA and those who have administered it faithfully during the past thirty years have made a tremendous contribution towards restoring and maintaining the chemical integrity of our nation's waters. It is now up to us to finish that task and ensure that the physical and biological integrity of those waters are also restored and maintained for existing and future generations.