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Managing Transboundary Aquatic Ecosystems: Lessons from the Great Lakes

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I. INTRODUCTION: FROM RULES TO GOVERNANCE

The approach to environmental policy and natural resources management is undergoing a profound shift: from the issue-by-issue, hierarchical, rule-based approach that has predominated over the last several decades, toward a new model of integrated, "place-based," polyarchic, problem-solving, collaborative

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and "networked" governance of ecosystems.[1] This *rules-to-governance* shift is discernible both in domestic environmental policy, and in transboundary environmental and natural resources management.

The shift from rules to governance implies change along several dimensions:

- from a top-down hierarchical model to the horizontal and collaborative one;
- from the centralized and nationally uniform to the contextualized and "place-based";
- from the fragmentary and piecemeal to the integrated and "holistic";
- from a state-centric system in which regulatory authority is presumed to be the exclusive prerogative of the sovereign, to polyarchic and networked multi-party decision-making;
- from a system of exclusive territorial sovereignty characterized by clearly delineated, politically determined spatial-jurisdictional boundaries, to ongoing transboundary collaborative processes that endeavor to match governance institutions to the spatial and temporal scales of natural ecological units; and
- from purely national- or subnational-level politics to a nascent form of transboundary, post-territorial politics that features the emergence of transboundary coalitions, constituencies, and institutions of civil society seeking effective joint management of a shared ecological resource.[2]

As an important corollary of this rules-to-governance shift, international law as conventionally understood—consisting of legally binding, rule-like obligations owed by sovereign states to other sovereign states—is likely to play a somewhat less prominent role in addressing complex transboundary environmental

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1. *See* Richard B. Stewart, *Administrative Law in the Twenty-First Century*, 78 NYU L. REV. 437, 446-49 (2003) [hereinafter Stewart, *Twenty-First Century*] (stating that inflexible, burdensome, and ineffective command-and-control regulatory approaches have led to "regulatory fatigue" and the emergence of "flexible agency-stakeholder networks for innovative approaches to problem-solving"); Orly Lobel, *The Renew Deal: The Fall of Regulation and the Rise of Governance in Contemporary Legal Thought*, 89 MINN. L. REV. 342, 344 (2004) (describing shift from centralized, top-down, expert-driven, command-style regulation, toward participatory, collaborative, multi-party, flexible, context-sensitive "new governance" approaches).

2. In recent work, I have characterized these governance arrangements as "post-sovereign," meaning collaborative rather than hierarchical, polyarchic rather than state-centric, and ecosystem-based rather than strictly territorial governance. *See, e.g.*, Bradley C. Karkkainen, *Post-Sovereign Environmental Governance*, 4 GLOBAL ENVTL. POLITICS 72 (2004). But one should be careful not to misconstrue that term. It is not meant to imply a "withering away of the state," or extra-legality of any kind. In fact, these governance arrangements are typically derived with the active participation and blessing of sovereign states. They recognize, and to some extent, rely upon the formal authority of sovereign states. They survive and prosper at the state's sufferance, and remain subject to its ultimate authority to "pull the plug" if something goes awry.

problems than its most ardent proponents generally suppose. The shift from rules to governance is occurring for a very good reason: the world is a much more complex and messy place than imagined back in the 1970s, which is the decade that heralded both the enactment of the major environmental protection statutes in the United States and the emergence of modern international environmental law. The 1970s was an era of optimism in environmental law. One still believed in comprehensive bureaucratic rationality—the capacity of expert administrative agencies to isolate and analyze particular environmental problems, and to craft and enforce specific, carefully tailored, mandatory or prohibitory rules to cure those problems.[3] This led to a program that preceded piecemeal, one medium, one pollutant, one source category at a time, step-by-step and rule-by-rule;[4] which in turn resulted in a fragmentary, often redundant system of over- and under-regulation. At times, it imposed multiple, detailed, and highly prescriptive rules for a single pollutant depending on the medium and pathway of exposure,[5] and at other times, it yielded a paltry regulatory output[6] that almost never considered how multiple rules, multiple rulemakings, multiple pollutants, or multiple environmental stressors might interact in a particular ecological context.[7]

Now, however, the deep limitations of this rule-based approach have been exposed, and that road appears to lead toward a dead end. The steps taken down the new path toward ecological governance have been rather modest so far. Experimenting (tentatively and often clumsily) with the policies, legal instruments, and institutional arrangements that offer some hope of addressing the current complex policy challenges have only just begun.

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3. *See* Colin S. Diver, *Policymaking Paradigms in Administrative Law*, 95 HARV. L. REV. 393, 396, 409-12 (1981) (stating that the 1960s and 70s featured a "comprehensive rationality" model of rulemaking, an expert-driven process that carefully specifies policy goals, identifies and comprehensively evaluates all alternative means to achieve those goals, and selects the optimal alternative).

4. *See* Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 CAP. U. L. REV. 21, 28 (2001) [hereinafter Stewart, *New Generation*] (stating that "[d]ifferent statutes were enacted for the control of pollutants and waste discharged into different media and each such statute contained a variety of separate provisions aimed at different types of sources or problems with little or no attempt at overall consistency or coordination," producing "fragmentation and lack of coordination in the overall regulatory effort").

5. *See id.* at 29-30 (providing that environmental regulation is plagued by "fragmentation, gaps, overlaps, and inconsistencies," so that "[s]ome quite small risks are intensively regulated, at great cost" while more serious problems are unaddressed); Daniel A. Farber, *Environmental Protection as a Learning Experience*, 27 LOY. L.A. L. REV. 791, 794 (1995) (describing conventional environmental regulation as an "inherently cumbersome" process in which agencies are "bound to make mistakes in both directions: asking more than some industries can reasonably achieve and letting others off too lightly").

6. *See* Stewart, *Twenty-First Century*, *supra* note 1, at 446 (stating that the length of time necessary to formulate, adopt, and implement regulations limits regulatory output and contributes to regulatory obsolescence and inflexibility).

7. *See* John C. Dernbach, *The Unfocused Regulation of Toxic and Hazardous Pollutants*, 21 HARV. ENVTL. L. REV. 1, 3-7 (1997) (indicating that toxic pollutants are regulated under five major statutes using incompatible and uncoordinated standards and approaches, producing gaps and inconsistencies in overall regulatory coverage); *id.* at 28-29 (providing that regulatory agencies possess "very little information" on the synergistic effects of multiple pollutants on human health, effects on other living things, or the fate of pollutants as they mover through the environment).

Having started down the road toward ecological governance, one may find that there is no turning back. The governance path—though challenging and uncharted—seems to offer the only way forward. Yet, its success is far from assured. The results from limited experience with the governance approach must be characterized as mixed—some parts promising, others disappointing. The most important conclusion to be drawn thus far is that details matter, especially the details of the governance arrangements and accountability mechanisms built into the new approach. Yet to date, there has been precious little discussion at that level of detail, either in the academic literature or in responsible policy circles. The increasingly sterile debate over whether the governance path is a good idea in general based on arguments from first principles has yielded few answers. Like it or not, however, the governance era is here, and both its proponents and its skeptics must own up to the fact that some parts are working better than others, and some parts are probably not working at all.

By the same token, proponents of the governance path need to acknowledge that conventional rule-based approaches sometimes have played a positive role, and will continue to do so. It is not a zero-sum, "either-or" choice. The challenge is to match the instrument with the situation. What is needed now is a careful "hard look" at what is working, what is not, and why.

This article draws most of its examples from the Great Lakes—the five very large bodies of fresh water that lie in the eastern half of the midsection of the North American continent, straddling the international border between the United States and Canada, and covering an expanse of some 94,000 square miles.[8] The Great Lakes are a truly priceless and irreplaceable natural resource, the fossil-water relic of the retreating glaciers of the last Ice Age.[9] They are the single most important freshwater resource in the world, accounting for nearly 20% of the planet's supply of fresh surface water[10] and 95% of the fresh surface water in the forty-eight contiguous states.[11] However, they are more than a reservoir of fresh water for human consumption. The Great Lakes are also an extraordinary scenic, aesthetic, recreational, commercial, and ecological resource. They are a true "inland sea" extending deep into the industrial and agricultural heartlands of both the United States and Canada, a region of some 33 million people.[12]

Additionally, the Great Lakes are also the poster child and metaphor for the evolutionary path that environmental policy has followed over the last four decades, both a model of enlightened cooperative management of a major

8. U.S. ENVIRONMENTAL PROTECTION AGENCY & GOVERNMENT OF CANADA, THE GREAT LAKES: AN ENVIRONMENTAL ATLAS AND RESOURCE BOOK 3 (3d ed., 1995) (hereinafter GREAT LAKES ATLAS).

9. *Id.* at 7.

10. *Id.* at 3; *see also* Susan H. MacKenzie, *Toward Integrated Resource Management: Lessons about the Ecosystem Approach from the Laurentian Great Lakes*, 21 ENVTL. MGMT. 173, 174 (1997).

11. U.S. General Accounting Office, Great Lakes: An Overall Strategy and Indicators for Measuring Progress Are Needed to Better Achieve Restoration Goals, 03-515 at 11 (2003) [hereinafter GAO].

12. *See* MacKenzie, *supra* note 10, at 174.

transboundary freshwater resource, yet also emblematic of the difficult management challenges that lie ahead.

II. THE GREAT LAKES IN TRANSITION

Not so many years ago, the Great Lakes were all but written off. The conventional wisdom was that Lake Erie was "dead," the victim of eutrophication so severe that it was choking off all aquatic life.[13] Many believed it would never recover, and Lakes Michigan and Ontario were thought to be not far behind.[14]

There is more. Remember the days when rivers caught fire? At least three important tributaries of the Great Lakes caught fire in the late 1960s and early 1970s: the Cuyahoga River in Cleveland, the Rouge River in Detroit, and the Buffalo River in Buffalo all burst into flames, fueled by flammable pollutants coating their surfaces.[15] Raw sewage poured into the Great Lakes and their tributaries from big cities and small towns.[16] In northern Minnesota, Reserve Mining Company dumped thousands of tons of taconite "tailings," or mining waste, containing "asbestiform" fibers (fibers that some say that was structurally indistinguishable from asbestos) directly into the waters of Lake Superior, the mightiest and most pristine of the Great Lakes.[17] In short, the Great Lakes were on their way to becoming the world's largest open sewer.[18]

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13. *See* DAVE DEMPSEY, ON THE BRINK: THE GREAT LAKES IN THE 21ST CENTURY 113-15 (2004) [hereinafter DEMPSEY, ON THE BRINK]; DAVE DEMPSEY, RUIN & RECOVERY: MICHIGAN'S RISE AS A CONSERVATION LEADER 248 (2001) [hereinafter DEMPSEY, RUIN & RECOVERY] (stating that *Life* magazine declared Lake Erie "dead" in the 1960s); RICHARD N.L. ANDREWS, MANAGING THE ENVIRONMENT, MANAGING OURSELVES: A HISTORY OF AMERICAN ENVIRONMENTAL POLICY 224, 415 n. 36 (1999) (attributing the statement to biologist and environmental advocate Barry Commoner, and stating that it was widely cited in the popular media in the late 1960s).

14. *See* DEMPSEY, RUIN & RECOVERY, *supra* note 13, at 249 (stating that *Newsweek* magazine announced a "deathwatch" for Lake Michigan in 1969).

15. DEMPSEY, ON THE BRINK, *supra* note 13, at 105, 127; David R. Hodas, *Enforcement of Environmental Law in a Triangular Federal System: Can Three Not Be a Crowd When Enforcement Is Shared by the United States, the States, and Their Citizens?*, 54 MD. L. REV. 1552, 1554 n.7 (1995).

16. DEMPSEY, ON THE BRINK, *supra* note 13, at 113-14.

17. *See* Reserve Mining Co. v. EPA, 514 F.2d 492, 500-01 (8th Cir. 1975) (providing that Reserve Mining discharged 67,000 tons per day of "taconite tailings," a mining waste slurry containing asbestos-like fibers, into Lake Superior); Robert L. Rabin, *Federal Regulation in Historical Perspective*, 38 STAN. L. REV. 1189, 1305 (1986).

18. *See* Henry J. Regier et al., *Remediation and Rehabilitation of the Great Lakes*, in PERSPECTIVES ON ECOSYSTEM MANAGEMENT FOR THE GREAT LAKES: A READER 169, 176-78 (Lynton K. Caldwell, ed., 1988) (stating that by the 1950s "the southerly third of the basin was degrading rapidly into a vast ecological slum" while degradation was "less intensive and less pervasive" in the middle third and largely confined to overfishing and localized impacts of mines and pulp mills in the northern third).

The Clean Water Act[19] changed all that using conventional command-and-control-style regulation. The Clean Water Act was enacted in no small measure with the problems of the Great Lakes in mind,[20] and it is well to reflect on just what has been accomplished under the Act. Without question, the Great Lakes and their tributaries are now cleaner than before the Act,[21] but all the action just was not on the U.S. side; the federal government of Canada and the Province of Ontario pitched in with their own pollution control laws.[22]

It was also during this period in the early 1970s that the United States and Canada penned the first Great Lakes Water Quality Agreement ("GLWQA"), a landmark bilateral environmental agreement establishing formal, mutually binding legal commitments to use their respective sovereign authorities to bring water pollution under control in the Great Lakes.[23]

The two nations had long cooperated amicably in other aspects of Great Lakes management. Early in the twentieth century they had entered into the Boundary Waters Treaty (still in force today), which created a unique binational commission—the International Joint Commission ("IJC")—to manage lake levels, approve major water withdrawals, and resolve transboundary disputes concerning the Great Lakes and other waterways along the international border.[24] However, neither the Boundary Waters Treaty nor the IJC did much to address

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19. Federal Water Pollution Control Act of 1972, Pub. L. No. 92-500, 86 Stat. 816 (1972), codified as amended at 33 U.S.C. § 1251 et seq.

20. *See* ANDREWS, supra note 13, at 223-26 (providing that concerns about toxic pollutants, nuclear radiation, oil spills, Great Lakes pollution, and other environmental threats converged to "galvanize a national outpouring of public demand for government action," leading to enactment of NEPA, the Clean Air Act, the Clean Water Act, and creation of the EPA); Tom Henry, *Connecting Scientific Data to Real Consequences for People*, NIEMAN REPORTS, Winter 2002, at 61, 62-63 (concluding that hard-hitting news reporting and editorials on environmental conditions in the Great Lakes "turned up the heat" on political leaders to enact the Clean Water Act).

21. *See* Michael P. Vandenbergh, *An Alternative to Ready, Fire, Aim: A New Framework to Link Environmental Targets in Environmental Law*, 85 KY. L.J. 803, 814-16 (1997); U.S. EPA, *Great Lakes Ecosystem Report 2000*, EPA-905-R-01-001 (Dec. 2000), at 13 (levels of mercury, DDT, PCB, and other persistent organic pollutants have declined sharply since the 1970s due to strict regulatory controls); *id.* at 39 (phosphorus loads decreased by more than 60% since 1968 but remain high in Lake Erie).

22. Under Canadian law, the national government has primary responsibility for managing navigable waters while provincial governments have primary responsibility for environmental protection and natural resources management. The Great Lakes are subject to a Canada/Ontario Agreement, which provides for joint work on actions required by the Great Lakes Water Quality Agreement. *See* GREAT LAKES ATLAS, *supra* note 8, at 40.

23. Agreement on Great Lakes Water Quality, U.S.-Can., 23 U.S.T. 301, T.I.A.S. No. 7312, signed at Ottawa, Apr. 15, 1972, entered into force Apr. 15, 1972. The Great Lakes Water Quality Agreement is not a formal treaty requiring Senate approval, but rather an executive agreement. *See* DEMPSEY, RUIN & RECOVERY, *supra* note 13, at 251. Executive agreements are nonetheless considered binding as a matter of international law. See Jack L. Goldsmith & Eric A. Posner, *International Agreements: A Rational Choice Approach*, 44 VA. J. INTL. L. 113, 123 (2004) ("Under international law and U.S. constitutional law, an executive agreement made on the president's authority alone, without legislative participation, can be legally binding.").

24. Treaty Between the United States and Great Britain Relating to Boundary Waters, and Questions Arising Between the United States and Canada, Jan. 11, 1909, U.S.-Gt. Britain, 36 Stat. 2448, T.S. No. 548 (1909). *See also* GREAT LAKES ATLAS, *supra* note 8, at 41 (describing IJC's institutional role).

water quality issues. Although the IJC had been sounding the alarm about the declining quality of Great Lakes waters for many decades, it had no real regulatory authority in this area, and could do little more than plead for additional binational action.[25] A new agreement, the GLWQA was needed to ensure that water quality problems would be addressed, and by 1972, the time was ripe for such an agreement.

As always in matters of treaty implementation, compliance with the GLWQA has been less than perfect, but overall the parties have taken enormous strides toward the water pollution reduction goals that were set out in the original 1972 agreement and its successors, which are widely cited as being among the most ambitious[26]—and most effective—transboundary pollution control agreements ever adopted.[27]

So far, the Great Lakes appear to be a remarkable success story for conventional legal approaches. First, on the U.S. side, command-and-control regulation in the form of the Clean Water Act worked to reduce point-source water pollution from factories and municipal wastewater systems. Second, the GLWQA also played a positive role, creating a framework for effective bilateral action to manage a vital shared resource. This suggests that international environmental law can be effective, at least in a case like the Great Lakes where the agreement is between two fiscally, administratively, and technically capable states, and is backed by political will on both sides to achieve high environmental standards.

Does this then disprove my central thesis that there is a shift to a softer governance path out of necessity?

No.

The story told so far is accurate, but incomplete. Although important, both the Clean Water Act and the GLWQA have proven quite limited in their reach and effect. Although both the statute and the binational agreement boldly proclaim their purpose to "restore the chemical, physical, and biological integrity" of aquatic ecosystems,[28] they have in fact operated more narrowly as pollution control measures, directed at a limited number of pollutants—especially those coming from the most readily identified and easily controlled large "point

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25. The IJC recognized as early as 1919 that water pollution was a serious problem in the Great Lakes and urged negotiation of the new treaty to address it, but no action was taken until the GLWQA in 1972, prompted in part by the release of a widely noticed IJC report. *See* GREAT LAKES ATLAS, *supra* note 8, at 39.

26. *See* Meredith A. Giordano, *Managing the Quality of International Rivers: Global Principles and Basin Practice*, 43 NAT. RESOURCES J. 111, 121-22 (2003) (listing the GLWQA among a handful of "category one" transboundary water pollution control treaties that set explicit and detailed water quality standards for specified pollutants).

27. *See e.g.*, Nicholas A. Robinson, *Befogged Vision: International Environmental Governance a Decade after Rio*, 27 WM & MARY ENVTL. L. & POL'Y REV. 299, 360 (2002) (characterizing the GLWQA as an "effective illustration" of "regional integration of environmental protection systems"); DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 809 (2d ed. 2002) (characterizing the Great Lakes management effort as "[o]ne of the most widely respected transboundary freshwater management initiatives").

28. *Compare* Clean Water Act, 33 U.S.C. § 1251(a) *with* 1978 GLWQA, Art. II, 30 U.S.T. 1383, 1387 (GLWQA).

sources" of water pollution.[29] They do not effectively address the many hard problems that remain, which include:

- land-based non-point source pollution, such as polluted run-off from farms, forestry, construction sites, highways, and city streets;[30]
- cross-media pollution, including deposition of airborne mercury and other toxic pollutants as well as conventional air pollutants that fall between the cracks of Clean Water Act (aimed at "point source" discharges of pollutants directly into surface waters) and the Clean Air Act (principally a human health-based statute that regulates the quality of the air but pays little attention to the cross-media effects of airborne pollutants on downwind aquatic ecosystems);[31]
- species loss and endangerment;[32]
- wetlands loss and degradation;[33]
- aquatic and riparian habitat loss and alteration caused by unrestrained urban sprawl, uncoordinated recreational development, and other land-use practices, as well as hydrological alterations;[34]
- overharvesting of critical aquatic species; and[35]
- ecological havoc wreaked by hundreds of invasive species, many of them brought in as biological pollutants in the ballast water of oceangoing vessels from distant lands in an era of exploding global trade and commerce.[36]

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29. *See* DEMPSEY, RUIN & RECOVERY, *supra* note 13, at 251 (stating that the original GLWQA focused primarily on reducing phosphorus pollution, especially from municipal wastewater); GAO, *supra* note 11, at 19 (indicating that significant reductions in phosphorus from municipal wastewater as an important environmental success in the Great Lakes); Robert W. Adler, *The Two Lost Books in the Water Quality Trilogy: The Elusive Objectives of Physical and Biological Integrity*, 33 ENVTL. L. 29, 30-32 (2003) (providing that, notwithstanding the Clean Water Act's broad goal to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," the EPA has narrowly implemented the statute to control discharges of chemical pollutants).

30. GREAT LAKES ATLAS, *supra* note 8, at 33; *Great Lakes Ecosystem Report 2000*, *supra* note 21, at 37 (stating that EPA considers polluted non-point source runoff as "the most important remaining source of water pollution" in the Great Lakes basin).

31. GREAT LAKES ATLAS, *supra* note 8, at 30-33, 37.

32. *Id.* at 35.

33. *Id.*

34. *Id.*

35. *Id.* at 20 (providing that Great Lakes fisheries have declined due to overharvesting of more valuable, larger fish and a variety of environmental stressors, and lake trout, once the top predator, survive in sufficient numbers only in Lake Superior); Regier et al., *supra* note 18, at 178 (indicating that overfishing and depredation by the invasive sea lamprey eliminated "[a]ll but a few of the distinct stock of lake trout in the upper lakes").

36. *Great Lakes Atlas*, *supra* note 8, at 35; GAO, *supra* note 11, at 18 (providing that 160 nonnative species threaten native fish and plants of the Great Lakes).

This is not just a laundry list of separate and unrelated problems. Instead, it represents a complex web of interrelated and interdependent problems, none of which can be solved in isolation without considering the networks of causation and consequence that surround it. Fisheries, for example, cannot be managed effectively solely by reference to permissible catch levels for target species or controls on fishery access and technology—the traditional tools of single-issue fisheries management. Fish populations are also affected by other factors, such as the availability and quality of fish habitat, which is in part a function of populations of non-target species at higher and lower trophic levels and throughout complex food webs.[37] Fish habitat is also greatly affected by environmental stressors like pollution, wetlands loss, and alteration or degradation of shoreline habitats and coastal and estuarine waters.[38] In many cases, invasive species play a crucial role, which in turn implicates marine transportation policy and infrastructure development that is believed to be the principal avenues by which invasive species enter the Great Lakes.[39]

Nor is pollution itself simply a matter of controlling classic "water pollution" discharges from large point sources, which is the central emphasis of the Clean Water Act. Water quality is also affected by airborne deposition of nutrients[40] and toxic pollutants, non-point source polluted run-off from farms and city streets, the loss or degradation of wetlands and riparian forest buffers along tributaries and shorelines, patterns of land use,[41] groundwater pollution,[42] and many other factors.

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37. *See* Sharon R. Siegel, Note, *Applying the Habitat Conservation Model to Fisheries Management: A Proposal for a Modified Fisheries Planning Requirement*, 25 COLUM. J. ENVTL. L. 141, 190 (2000) (arguing that regeneration of a fish population depends on the abundance and health of its competitors, predators, and prey, and the condition of its habitat);,U.S. Geological Survey, Circular 1220, *The U.S. Geological Survey and the Chesapeake Bay—The Role of Science in Environmental Restoration* 18 (2002) [hereinafter *Circular 1220*] (describing the importance of submerged aquatic vegetation (SAV) at the base of food webs that support important commercial and sport fisheries in the Chesapeake Bay).

38. *See Circular 1220, supra* note 37, at 18. (describing the role of nutrients, other pollutants, and alterations in biotic composition in degrading the quality of fish and shellfish habitats in the Chesapeake Bay); Donald F. Boesch et al., *Chesapeake Bay Eutrophication: Scientific Understanding, Ecosystem Restoration, and Challenges for Agriculture*, 30 J. ENVTL. QUALITY 303, 307 (2001) (describing how eutrophication stresses fisheries by limiting availability of oxygen and altering habitat, biotic composition, and food chains).

39. *See* Edward L. Mills et al., *Exotic Species and the Integrity of the Great Lakes*, 44 BIOSCIENCE 666, 669 (1994) (describing devastating effects of invasive species on native Great Lakes fish species); *id.* at 667-68 (describing the role of ship hulls, ballast water, and artificial navigation channels as routes by which invasive species entered the Great Lakes).

40. *See* Peter M. Vitousek et al., *Human Alteration of the Global Nitrogen Cycle: Sources and Consequences*, 7 ECOLOGICAL APPLICATIONS 737, 744-45 (1997) (stating that airborne deposition is the largest source of nitrogen pollution in the Great Lakes).

41. *See* Prakash Basnyat et al., *Relationships between Landscape Characteristics and Nonpoint Source Pollution in Coastal Estuaries*, 23 ENVTL. MGMT 539, 540 (1999) (identifying agriculture, urban areas, and uncontrolled shoreline developments as leading contributors to nonpoint source water pollution).

42. USGS researchers estimate that polluted groundwater contributes about half of the total nitrate load in tributary streams in the Chesapeake Bay watershed, complicating efforts to clean up the bay because groundwater pollution is so diffuse and groundwater moves slowly, resulting in long lag times before clean-up efforts show tangible results. *See Circular 1220, supra* note 37, at 13-14.

Protecting environmental quality in the Great Lakes is not just a matter of controlling pollution from major point sources. What is usually thought of as "water pollution" is one of a host of interrelated physical, chemical, and biological stressors on the aquatic ecosystem. Without more, pollution control alone will not maintain and restore environmental quality and ecosystem health in the Great Lakes.[43] Progress toward that goal requires attention to all of these stressors, especially to the synergies and feedback loops among them as they play themselves out in the ecological context of the Great Lakes. The challenge, then, is not to craft a series of fixed rules to manage a series of discrete problems, but rather to manage a complex, dynamic system made up of multiple interrelated and interdependent parts and stressors, each demanding management in light of the role it plays in relation to the others and to the system as a whole. It is in that context that the narrow, fragmentary, one-problem-at-a-time, rule-based approach embodied in the Clean Water Act and the original GLWQA runs up against hard limits. As much as that approach has accomplished, it is manifestly inadequate to the challenges that remain. So the question becomes, where to go from here?

To their credit, both the United States and Canada recognized the need to go beyond the standard fixed-rule, fragmentary regulation almost from the outset. As early as 1978, they amended the GLWQA to call for what became known as an "ecosystem approach." The 1978 agreement sought to restore "the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem," defined in the 1978 agreement as "the interacting components of air, land and water and living organisms including man within the drainage basin of the St. Lawrence River."[44] A protocol was added in 1987 to lend additional substance to the skeletal vision of an ecosystem approach outlined in the 1978 agreement.[45] The 1987 protocol called for the development of ecosystem objectives and indicators; additional emphasis on non-point source pollution, cross-media pollution, and contaminated sediments; the development of local Remedial Action Plans ("RAPs") to clean up the most heavily contaminated "areas of concern"; and a comprehensive, integrated Lakewide Management Plans ("LaMPS") for each of the five lakes.[46]

Since then, academic and government scientists, national and sub-national government agencies, binational institutions, NGOs, intergovernmental organizations, and other partners on both sides of the international boundary joined together in a broad but loosely structured binational collaborative effort to restore the Great Lakes

43. *See* DEMPSEY, ON THE BRINK, *supra* note 13, at 188 (stating that the 1972 GLWQA "contained a hidden flaw" in that it "assumed that water quality problems could be resolved by dealing with water alone," contradicting the "'law' of ecology that everything is interconnected").

44. Great Lakes Water Quality Agreement of 1978; *see also* GREAT LAKES ATLAS, *supra* note 8, at 41.

45. Great Lakes Water Quality Agreement of 1987.

46. *See* GAO, *supra* note 11, at 12-14 & Table 1 (describing the role of RAPs and LaMPS in 1987 protocol).

ecosystem.[47] This collaboration works by advancing ecosystem-specific scientific research,[48] identifying key physical and biological indicators of ecosystem health, educating the public, sharing information, and advocating for better-funded and better-coordinated management of the Great Lakes.

What was omitted from the 1987 protocol, however, turned out to be just as important as what was included. Goals, objectives, indicators, continuing research, collaboration, and coordination are all essential elements in an ecosystem approach. At the end of the day, though, it takes institutions to do the work, and the 1987 protocol had precious little to say about the institutional mechanisms that would be needed to carry out the ecosystem approach it envisioned. In short, the drafters of the 1978 agreement and the 1987 protocol had a bright vision of ecologically integrated management of the Great Lakes, a vision that is widely embraced by most of the key players in the Great Lakes Basin. Yet in important respects, the parties have not advanced much beyond articulating the vision.[49] The hard work of designing, building, and operating the institutional machinery that is necessary to make integrated ecosystem management a reality still remains.[50]

As a consequence, the fragile ecosystem of the Great Lakes is in great peril. A binational panel of scientists recently concluded that the Great Lakes are "at a tipping point," exhibiting "symptoms of extreme stress from a combination of sources that include toxic contaminants, invasive species, nutrient loading, shoreline and upland land use changes, and hydrological changes," threatening "potentially irreversible" damage.[51]

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47. *See* MacKenzie, *supra* note 10, at 174-79 (identifying the national governments of the United States and Canada, the International Joint Commission and its subsidiary boards, other binational agencies like the Great Lakes Fishery Commission, interstate organizations like the Great Lakes Commission and the Council of Great Lakes Governors, eight states and the provinces of Ontario and Quebec, a variety of mission-specific governmental agencies, scientists, coastal and watershed communities, and a variety of stakeholder among the groups playing a role in Great Lakes governance); GAO, *supra* note 11, at 22 (indicating that about 200 federal and state environmental programs operate in the Great Lakes basin); *id.* at 31-34 (stating that charitable foundations, municipalities, nongovernmental organizations, and intergovernmental commissions, and numerous other organizations all play significant roles in Great Lakes restoration activities); *id.* at 35 (providing that the Great Lakes restoration efforts lack a common strategy and inter-agency coordination).

48. *See* GREAT LAKES ATLAS, *supra* note 8, at 43. The International Association for Great Lakes Research operates as a scientific society to promote Great Lakes research. *See* International Association for Great lakes Research, http://www.iaglr.org (last visited Feb. 6, 2006).

49. *See* GAO, *supra* note 11, at 44 (indicating that despite years of planning, Great Lakes restoration programs have yielded relatively little restoration activity or measurable progress).

50. *See* Int'l Joint Comm'n, *Priorities 2001-2003: Priorities and Progress under the Great Lakes Water Quality Agreement*, September 2003, at 105 (providing that GLWQA implementation "requires a great degree of accountability, benchmarks for measuring progress and an aggressive implementation schedule that reflects the urgency of basin ecosystem restoration and protection efforts," as well as "new/revised institutional mechanisms that move the notion of an 'ecosystem approach' from concept to reality by integrating governance responsibilities for air, land, and water management across all relevant levels of government").

51. *See* JACK BAILS ET AL., PRESCRIPTION FOR GREAT LAKES ECOSYSTEM PROTECTION AND RESTORATION: AVOIDING THE TIPPING POINT OF IRREVERSIBLE CHANGES 1 (2005).

This gap between the bright vision and failure of implementation is hugely significant, and perhaps emblematic of the current stance with respect to broader trends in environmental and natural resources policy. This is a pivotal moment for the Great Lakes. At one level, the participants understand the big picture. They clearly grasp that a fragmentary, piecemeal approach is insufficient, and that a holistic, integrated approach that addresses the synergies and interconnectedness of the many parts of, and stressors on, the system is needed. To that extent, the Great Lakes stand as a model of enlightened transboundary freshwater resource management. But the proof is in the pudding. Having the vision is simply not enough.

Can institutional mechanisms that have a real chance of making that vision a reality be put into place? With another periodic review of the GLWQA now under way,[52] the time is ripe for a re-examination of those questions.

III. BROADER TRENDS: SUBJECT, SCALE, AND CAPACITY MISMATCHES, AND THE SHIFT TOWARD ADAPTIVE ECOSYSTEM GOVERNANCE

The situation described in the Part I is hardly unique to the Great Lakes. Since the United States first undertook to manage environmental problems through law in a serious way nearly four decades ago, most of their efforts, both domestically and internationally, went toward crafting and enforcing regulatory rules aimed at discrete categories of problems abstracted from their ecological context. The foundational assumption was that authoritative bodies, backed by scientific and technical expertise, could identify and isolate the most urgent environmental threats, and respond by devising binding rules to curb the behaviors that caused those problems. That is a fairly blunt, direct, seemingly hard-headed, no-nonsense approach, and it seems to appeal to something in the American "can-do" spirit.

In domestic environmental policy, this direct form of regulatory intervention led to what came to be known (somewhat pejoratively) as "command and control" regulation.

In the international arena, things are a bit more complicated because there is no authoritative law-giver as there is in the domestic arena. Rules need to be crafted through negotiation and consensus, which is a painstakingly slow and cumbersome process. At best, it leads to a series of agreements—occasionally bilateral but more often regional, multilateral, or global in scope—in which nominally equal and autonomous sovereign states undertake legally binding commitments to take specified actions. These actions include prohibiting

52. Article X of the GLWQA call for the governments of the United States and Canada to review the GLWQA upon completion of every third biennial report by the International Joint Commission. The IJC's issuance of its 12th biennial report in 2004 consequently triggered the review process, which began with a series of IJC-sponsored public meetings and a public comment period which ended Nov. 30, 2005. *See* International Joint Commission, http://www.ijc.org/en/activities/consultations/glwqa/index.php (last visited Feb. 6, 2006).

production and consumption of chlorofluorocarbons and other ozone-depleting substances within their territorial jurisdiction,[53] or monitoring and policing international trafficking in listed endangered species.[54] This classic form of public international law, consisting of binding (but voluntary) obligations owed by sovereign states to other sovereign states, has been viewed as the only game in town.[55]

With respect to transboundary environmental problems, however, there always has been something of a mismatch—or a series of mismatches—between goal and instrument. First, there is a mismatch with respect to the *subjects* of international environmental agreements. International legal rules create obligations on the part of sovereign states toward other sovereign states.[56] Yet in the ordinary course of affairs, states are not typically engaged directly in the managed activity. Therefore, international environmental law seeks to get at the behavior of individuals or corporate entities obliquely, by inducing sovereign states to submit to binding limitations on their exercise of their own sovereign authority.[57] Individuals and corporations thus come indirectly under the influence of international law, mediated through the exercise of state authority in conformity with international legal obligations. Because the rules and obligations created by international law apply to states and not to private parties in the first instance, the legal solution is always at least one step removed from the problem.

Consider the Great Lakes as an example. The U.S. and Canadian governments are not the principal sources of pollution to the Great Lakes and their tributaries. Farms, factories, waterfront cottages, mines, city streets, municipal wastewater disposal systems, and oceangoing ships with their ballast full of exotic biological pollutants are the principal culprits. Since no one has authority to regulate these kinds of activities across an international boundary, the settled international legal agreement is a kind of "second-best" solution, a "management by proxy" or "vicarious liability" approach. The problem is resolved in a roundabout way through an agreement that creates reciprocal

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53. Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, 1522 U.N.T.S. 3, 26 I.L.M. 1541 (entered into force Jan. 1, 1989).

54. Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, 993 U.N.T.S. 243, 12 I.L.M. 1085, (entered into force July 1, 1975).

55. *See* EYAL BENVENISTI, SHARING TRANSBOUNDARY RESOURCES: INTERNATIONAL LAW AND OPTIMAL RESOURCE USE 49 (2002) (arguing that international law is still dominated by the "Westphalian paradigm" premised on "the still-prevailing perception of nation-states as unitary actors engaging in international competition").

56. *See* John K. Setear, *A Forest with No Trees: The Supreme Court and International Law in the 2003 Term*, 91 VA. L. REV. 579, 588 (2005) ("Classically, public international law is the set of rules governing interactions between co-equal, sovereign states.").

57. *See* Oran R. Young, *Rights, Rules and Resources in World Affairs*, in GLOBAL GOVERNANCE: DRAWING INSIGHTS FROM THE ENVIRONMENTAL EXPERIENCE 1, 7 (Oran R. Young ed., 1997) ("[I]nternational environmental regimes . . . are properly understood as systems of rights, rules, and relationships designed to bring order into the interactions of sovereign authorities rather than as systems of property rights designed to bring order into the interactions of property owners," but "[b]y exercising sovereign rights . . . states can place restrictions on the activities of property rights.").

binding obligations on the part of the relevant sovereign states to exercise their own authority.

Such an approach inevitably creates an extra tier of implementation, monitoring, compliance, and enforcement difficulties, and more generally, principal-agent problems arising from inadequate and mismatched incentives. Certainly, progress has been made in some areas of international environmental law, but looking across the broad landscape, this approach does not seem to work all that well much of the time. International environmental law is usually limited in its aspirations, typically vague in its commitments, and often ineffectual, as measured by tangible environmental outcomes.[58] The difficulty may stem from the limitations inherent in an approach that tries to solve hard problems through such an indirect and mismatched mechanism. Is there a better alternative?

Additionally, international legal solutions often suffer from *scale* mismatches. Environmental and natural resource management problems usually do not map neatly onto the territorial boundaries of sovereign states. In one sense, this is obvious, even trivially true: by definition, transboundary problems are those that extend beyond state boundaries. Less widely appreciated, however, is another but equally important kind of scale mismatch: transboundary environmental and natural resource problems often divide states internally, affecting only part of the nation, while at the same time straddling an international boundary.[59] Problems of this sort tend to be viewed within national states as local or regional rather than truly national in scope and significance, and therefore often rank well down the list on the agendas of national policymakers.

Again, consider the Great Lakes. Protection of the Great Lakes is a fairly high-salience issue within the basin itself. The public exhibits a high degree of awareness of the nature, severity, and extent of the problems facing the Great Lakes, and that awareness is coupled with genuine affection and concern for the resource.[60] By overwhelming majorities, residents of the Great Lakes Basin think that more should be done to protect the lakes,[61] but it is also clear that protection

58. Assessments vary, but a typical view is that of David Victor who concludes that while compliance with international environmental agreements is generally high, the international legal order is characterized by "shallow commitments" that impose limited obligations on participating states, typically emphasizing symbolic action over genuine problem-solving. *See* David G. Victor, *Enforcing International Law: Implications for an Effective Global Warming Regime*, 10 DUKE ENVTL. L. & POL'Y FORUM 147, 151-57 (1999).

59. BENVENISTI, *supra* note 55, at 49 (providing that states are "composed of many competing domestic groups, and hence the competition among these groups is reflected in the external policies adopted by the state").

60. *See* DEMPSEY, ON THE BRINK, *supra* note 13, at 265-70 (describing the emotional attachment of basin residents to the Great Lakes for their scenic, recreational, aesthetic, historical, and cultural values).

61. A recent public opinion survey of 1539 randomly selected respondents in the eight Great Lakes Basin states found that 96% agreed with the proposition that "we need to do more to protect the Great Lakes habitats from pollution," 87% agreed that "we need to do more to protect Great Lakes habitat from development," while 72% disagreed with the proposition that "the Great Lakes continue to renew themselves . . . [and] are in no danger of damage." A strong majority (64%) said it was "extremely important" to protect the Great Lakes for future generations, and 52% said it was important to the identity of the region. Belden Russonello & Stewart Research and Communications, *Great Lakes: Responsibility and Awareness*

of it ranks as a relatively low priority in the national political and policy processes in both the United States and Canada—perhaps slightly higher on the Canadian side, simply because a larger fraction of Canada's citizenry, including the bulk of Ontario's large and politically influential population, lives within the basin.[62] On the U.S. side of the border, however, protection of the Great Lakes is mainly perceived as a regional issue. So even though the challenges confronting the Great Lakes are seen as urgent and compelling by those most directly and immediately affected, that does not always translate into a strong or consistent impulse to act at the national level. In an international order, a decision to act depends upon national-level inter-sovereign agreements, which is a recipe for inaction, or inadequate action, most of the time.

The problem of scale mismatches does not end there. Both the United States and Canada are federal systems in which subnational governments—states and provinces, respectively—enjoy quasi-sovereign authority over important domains of public policy, including crucial aspects of environmental and natural resource management.[63] This introduces further mismatches. First, it means that international agreements between the U.S. and Canadian national authorities need to be not only incorporated into national law and policy, but also into state and provincial law and policy. That can be a messy and uncertain prospect, insofar as constitutional and political constraints may limit the ability of national governments to directly refashion state and provincial policies. This introduces an additional level to the "vicarious liability" problem: when national sovereigns assume international obligations for transboundary problems, they may to try to influence subnational quasi-sovereign authorities to take the necessary legal and policy measures necessary to control or influence the behavior of the private parties that are directly engaged in the problematic activities. No one in this tenuous chain of proxies may have quite the right incentives to take it all seriously.

Just as importantly, the territorial jurisdiction of subnational governments may be also mismatched to the scale of the ecological problem. With the sole exception of Michigan,[64] each of the eight U.S. states in the Great Lakes Basin has more territory outside the basin than in it, and only in Michigan and Ontario

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about a Vital Resource—Summary Analysis of Public Opinion in Great Lakes States (2003), *available at* http://www.biodiversityproject.org/GLSummaryAnalysis.PDF.

62. *See* Statistics Canada, *The Daily*, catalogue number 11-001-XIE, Sept. 28, 2005, at 2, 4, *available at* http://www.statcan.ca/Daily/English/050928/d050928.pdf (last visited Feb. 6, 2006) (estimating that as of July 1, 2005, 12.5 million (or nearly 40%) of Canada's 32.3 million residents lived in the Province of Ontario). Ontario's population is heavily concentrated in the Greater Toronto Area (45.6% of provincial total), nearby Central Ontario (21.9%), and Southwest Ontario (12.7%), which straddle a series of peninsulas between Lakes Huron, Erie, and Ontario. See Ontario Ministry of Finance, *Ontario Population Projections 2004-2031*, February 2005, at 17, 35 *available at* http://www.fin.gov.on.ca/english/demographics/demog05e.pdf (last visited Feb. 6, 2006).

63. *See* GREAT LAKES ATLAS, *supra* note 8, at 40.

64. Both peninsulas of Michigan are entirely within the Great Lakes basin, except for a small sliver of the Upper Peninsula.

do in-basin residents represent a clear majority of the state or provincial population.[65] Consequently, however salient Great Lakes problems may be to residents of the basin, these problems tend to be viewed as essentially local or regional concerns throughout much of the basin.

Because the pattern of subject and scale mismatches is likely to be replicated in other transboundary environmental and natural resource settings, it counsels caution with respect to the degree one can expect to rely on international legal solutions.

Finally, in addition to subject mismatches and scale mismatches, the complex demands of ecosystem management introduce a *capacity* mismatch—a crisis in the capacity of governmental authorities to solve complex problems through familiar forms of fixed-rule regulation, or in transboundary settings through fixed-rule agreements with other sovereign states. For most of the last thirty-five years, environmental regulation has been rule-based and rule-bound,[66] and generally prohibitory in character. That is what states know how to do domestically, and know how to agree to internationally. Recently, however, the limitations of that rule-based approach for environmental problem-solving are beginning to be appreciated: it is easier to prohibit environmentally harmful actions by rule than to mandate environmentally beneficial actions. A prohibitory approach, however, usually leaves regulated parties with little positive incentive to improve.

Rule-based, command-style regulation also tends to be piecemeal and fragmentary rather than broadly integrative.[67] It attacks problems one-at-a-time, paying relatively little attention to the synergies and interrelations between and among environmental problems, their multiple causes, and proposed solutions. In addition, the rule-based approach tends to be rigid and inflexible. It is typically not nimble in adjusting to and incorporating new learning. It tends to lock existing solutions and technological "fixes" into place, and to that extent it may stifle or freeze out innovation.

Also, most rule-based approaches are relatively insensitive to local context. "One-size-fits-all" rules are usually over- or under-inclusive, and insensitive to the particularized needs of the local ecological setting.[68] They do not account well for ecological complexity—the webs of causal interconnectedness and interdependency among the various components and stressors that comprise ecosystems, leading to inherent stochasticity, non-linear threshold and cascade effects, and high levels of irreducible uncertainty.

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65. Major urban centers like Chicago, Milwaukee, and Cleveland exert significant political influence in the states of Illinois, Wisconsin, and Ohio respectively, but each of these states has more residents outside the Great Lakes basin than within it.

66. A. Dan Tarlock, *The Future of Environmental "Rule of Law" Litigation*, 17 PACE ENVTL. L. REV. 237 (2000).

67. Stewart, *New Generation*, *supra* note 4, at 29-30.

68. *Id.*

The presumption underlying the conventional rule-based approach is that if one studies the problem long and hard enough, one will figure out what to do, then proceed to craft an optimal rule, or at least a satisfactory one.[69] As ecologist Frank Egler reminds us, however, "Ecosystems are not only more complex than we think, but more complex than we *can* think."[70] Consequently, there is "never enough information" to be certain that one is doing the right thing.[71]

The response has been a growing interest in both scientific and policy circles in integrated and adaptive ecosystem management, managing particular ecosystems in an integrated way using "place-based," context-sensitive approaches that seek to co-manage the entire suite of interconnected resources and stressors that comprise the ecosystem.[72] That is an enormously complex and far-reaching undertaking, and to do it right would require a foundational realignment of almost the entirety of natural resources and environmental law and policy.

In this brave new world of integrated ecosystem management, however, even the most technically, legally, financially, and administratively capable states quickly find that they lack the competence to specify effective rules to carry out the task. In short, conventional command-style regulation by fixed rule is simply a tool ill-suited to the complex project of managing ecosystems. One cannot manage by fixed rules because one can never be certain what the right rules would be, if indeed there are "optimal" rules at all. Nor can one produce a sufficient number or sufficiently finely tailored rules to address the ecological complexities and dynamic conditions that exist. Thus, the shift described at the outset of this article—from top-down, command-style, categorical and fragmentary rules, toward decentralized, integrated, place-based, collaborative and "networked" multi-party governance—at its most fundamental level, is a policy response to the crisis of state competence, which states themselves increasingly recognize.[73]

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69. *See* A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121, 1132-33 (1994).

70. *See* Reed F. Noss, *Some Principles of Conservation Biology as They Apply to Environmental Law*, 69 CHI.-KENT L. REV. 893, 898 (1994) (quoting Egler).

71. George Frampton, *Ecosystem Management in the Clinton Administration*, 7 DUKE ENVTL. L. & POL'Y FORUM 39, 44 (1997). ("[T]here is never enough information to feel confident about a particular decision. No key ecosystem management decision ever gets made in a setting of adequate information.").

72. Norman L. Christensen et al., *The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management*, 6(3) ECOLOGICAL APPLICATIONS 665 (1996); Fred Bosselman, *A Role for State Planning: Intergenerational Equity and Adaptive Management*, 12 U. FLA. J.L. & PUB. POL'Y 311, 323-25 (2001) (describing increasing prominence of adaptive management in ecological science); A. Dan Tarlock, *Putting Rivers Back in the Landscape: The Revival of Watershed Management in the United States*, 6 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 167, 189-92 (2000) (providing that natural resources management is shifting toward bioregional ecosystem-scale approaches relying on adaptive management strategies).

73. In a remarkably candid expression of this crisis, top EPA officials in 1994 produced a document known as the "Edgewater Consensus," concluding that "even as we resolve the more obvious problems, scientists discover other environmental stresses that threaten our ecological resources and general well-being," and because EPA is caught up in fragmented, "program-driven" standard-setting and permitting, "the Agency has not paid enough attention to the overall environmental health of specific ecosystems." Ecosystem Protection

Of course, the tools of conventional regulation are still available as elements in the new policy mix. However, the new governance model also involves a tacit delegation of state authority to multi-party, polyarchic governance arrangements. That in turn implies a kind of leveling: a reduction in status of the state to merely one among many players (albeit an exceptionally powerful and often central one) in a multi-party collaborative enterprise. The state retains the right to destabilize and de-legitimize the entire operation if it chooses to "take its marbles and go home," but until that happens, it signals its willingness to participate shoulder-to-shoulder alongside other parties that have something to contribute, whether it be expertise, complementary authority, additional resources, or local political legitimacy.

This new style of "post-sovereign" governance is discernible in both domestic and transboundary contexts in places like the Chesapeake Bay, Florida's Everglades, the Baltic Sea, and to some degree, the Great Lakes. In general, these governance arrangements are characterized by a "place-based" focus on a particular ecosystem or hydrologically defined basin, and they are attentive to the specific features of the local environmental and ecological context. They emphasize integrated management of multiple resources and stressors comprising the local ecological context. In turn, this demands high levels of interagency, intergovernmental, and public-private collaboration; and a pooling of the information, expertise, and capacities of a variety of national, subnational, and non-state actors. This blending of competencies then leads to a subtle blurring of the usual distinctions between state and non-state, sovereign and subject, as non-state parties—including environmental nongovernmental organizations (NGOs), independent scientists, industry groups, sub-national governments, and sometimes ordinary citizens—join together with state agencies as collaborators, co-authors, and co-implementers of environmental and natural resources management policy.

These joint management efforts tend to transcend formal territorial and jurisdictional boundaries. Management of the Baltic Sea, for example, becomes a joint exercise in identifying and remediating the most important environmental stressors wherever they occur throughout the Baltic Basin. Joint management of the Great Lakes means that—as a practical matter though not in a formal legal sense—events on the Canadian side of the international boundary become the concern of Canada's governance partners in the United States, and vice versa. Typically, this is not a question of one sovereign nation poking its nose into another sovereign's business. Rather, a subnational official in Michigan, for example, may make inquiries of a Canadian federal official, or the two of them serving side-by-side with NGO and industry representatives from both sides of the border may work together to develop a binational toxics reduction strategy

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Agency Memorandum Summarizing EPA Efforts to Develop and Implement an Ecosystem Protection Plan ("The Edgewater Consensus"), March 16, 1994, *available at* http://www.epa.gov/ecocommunity/order7.htm (last visited Feb. 6, 2006).

that represents an agreed blueprint around which multiple state and non-state parties will undertake to coordinate their own policies and practices, and hold themselves and each other morally, diplomatically, and politically—though not legally—accountable. In this context of multiparty, collaborative transboundary decision-making, the formalities of the Westphalian system of autonomous sovereign states fade, without disappearing altogether, into reduced significance. Formal international law is typically neither the principal driver of transboundary environmental and natural resource management policy, nor the principal means by which this policy is implemented. Instead, it is just one piece in a much richer mix of transboundary cooperation and collaborative decision-making that comprises the transnational governance process.

Law can contribute a framework that allows a degree of flexibility as to goals, targets, timetables, implementation measures, and even important aspects of the governance institutions themselves, which will inevitably have to evolve and adapt along with science, new learning, changing conditions, and changing understandings of those conditions. In a transnational setting, this means that there is an important residual role for formal international agreements, coupled with implementing legislation on both sides of the border, and perhaps in state and provincial capitals, in creating the institutional mechanisms and processes to address environmental problems, even though one can not rely on law itself to directly solve the problems.

IV. INSTITUTIONS FOR EFFECTIVE ECOSYSTEM GOVERNANCE: THE GREAT LAKES AND BEYOND

What would successful institutional arrangements for integrated and adaptive ecosystem governance look like in the Great Lakes and elsewhere? Space permits only a cursory treatment of this important question, but the following paragraphs outline several features of the most successful arrangements, abstracted by the author from some of the most advanced cases.

The key characteristics include:

1) a high level of interagency, intergovernmental, and public-private information-pooling, collaboration, and coordination;
2) integrated databases, common monitoring protocols, and joint ecosystem modeling;
3) a peak coordinating body;
4) a set of functionally defined committees, subcommittees, or working groups;
5) central staff support;
6) a coordinated program of communications, public education, and outreach;

7) nested scales of governance;
8) specific goals, targets, and timetables at all levels;
9) an iterative and adaptive management approach; and
10) genuine integration across issue areas and mission-specific agency responsibilities.

This part will discuss each of these characteristics in turn, and offer a brief description of the current state of practice in the Great Lakes Basin.

A. *Structures and Mechanisms for Regularized Interagency, Inter-Governmental, and Public-Private Information-Pooling, Collaboration, and Coordination*

Successful ecosystem management requires integration of the disparate bits of policy-relevant information held by a broad array of institutions and individuals into the deliberations of an equally disparate array of governmental and non-governmental decision-makers. Collectively, independent scientists, industry experts, NGOs, informed individuals, and the staff and officials of mission-specific governmental agencies hold a wealth of valuable information about the ecosystem to be managed. Unfortunately, that information is usually fragmentary and widely dispersed, and decision-making authority tends to be equally fragmentary and dispersed. As a result, policy-relevant information filters only haphazardly and incompletely into decision-making. Because decisions are not effectively coordinated, overall policy is riddled with gaps and inconsistencies.

Ecosystem governance institutions seek to overcome these structural problems by creating mechanisms for information-pooling, collaboration, and coordination across institutions, levels of government, and mission-specific lines of agency responsibility. Intergovernmental coordination must occur along both horizontal (nation-to-nation, subnational-to-subnational) and vertical (national-to-subnational) dimensions, and interagency coordination must occur among functionally specialized agencies, such as those responsible for pollution control, land use, wildlife, fisheries, navigation, and water resources. In addition, non-state actors—including independent scientists, environmental and other NGOs, key industries, trade associations, and major landowners—often possess unique information or control crucial assets and decision-making authority, and can be valuable partners in the governance effort. Although the precise institutional mechanisms vary, successful ecosystem management initiatives typically provide regular fora for parties with a diverse array of institutional missions and expertise to share information and participate meaningfully in analyzing a problem and implementing agreed measures that have been agreed to.

A number of benefits follow from this collaborative approach. First, pooling information from diverse sources and disciplinary perspectives can contribute to a richer understanding of the nature of the resource and the problem to be addressed, as well as the expected consequences of proposed policies. Second, an

open, collaborative process may contribute to the formation of consensus at the level of problem definition, possibly laying the groundwork for subsequent consensus on (or at least reduced opposition to) proposed solutions. Third, an open, collaborative process may lead to higher levels of "buy-in" among the participants, enhancing the perceived legitimacy of both the governance process and proposed solutions, while laying the groundwork for higher levels of cooperation at the policy implementation stage.

On its surface, this sort of "stakeholder" collaboration may appear to be a purely political process, but the basic approach is endorsed by leading scientists who recognize that it can contribute to improved cross-disciplinary scientific understanding and provide additional channels for scientific information and perspectives to reach key decision-makers.

Intergovernmental, inter-agency, and public-private collaboration occurs throughout the Great Lakes Basin, but these efforts are sporadic, disjointed, and often ad hoc. Opportunities for ongoing collaboration occur across a confusing hodge-podge of institutional settings, rather than as part of a coherent institutional design aimed at maximizing their effectiveness.

B. Jointly Managed and Integrated Databases, Common Monitoring Protocols, and Joint Exercises in Ecosystem Modeling

Successful ecosystem management initiatives usually devote a good deal of effort to building a common, trusted, comprehensive, and scientifically informed knowledge base to which all participants have full access. Jointly managed and integrated databases—typically organized around GIS mapping, common monitoring protocols, and jointly developed ecosystem models—provide the technical platform for that knowledge base. These databases serve as the central repository for new scientific and technical information, monitoring data, and other policy-relevant information to be integrated with existing stores of knowledge. Data integration allows for the development of richer information tools and products, contributes to shared analyses of the nature of the problem and the range of possible solutions, aids in identification of gaps in data and in the underlying science, and allows for a better-informed process of identifying future research and monitoring needs and priorities. Integrated databases and the analyses that follow from them also play a central role in translating scientific findings and monitoring data into policy-relevant assessments and information products. Finally, publicly accessible integrated databases can serve as important vehicles to ensure transparency and accountability, both internally within the far-flung and often loosely knit web of governance institutions, and between governance institutions and democratic polities.

The most successful ecosystem governance initiatives have adopted common monitoring protocols focusing on a manageable number of physical, chemical, and biological indicators of ecosystem health. In the Chesapeake Bay Program, for example, a network of 165 monitoring stations spanning three states and the

District of Columbia monitors nineteen key indicators of ecosystem health twenty times per year in the bay mainstem and its most important tributaries.[74] A Chesapeake Bay Program Monitoring and Analysis Subcommittee works to ensure that all new and redesigned monitoring efforts are scientifically valid, consistent across the region, and adequate to support management decisions.[75] The subcommittee also works to ensure that monitoring data are fed into publicly accessible integrated databases in suitable formats.[76] Similarly, in the Baltic, the Cooperative Monitoring in the Baltic Marine Environment ("COMBINE") program sets out a common approach to monitoring the key physical, chemical, and biological indicators of ecosystem health.[77] Each state party in the Baltic region is responsible for monitoring in its own waters, but the data are produced under common monitoring standards and protocols, and are submitted in standard electronic formats to centralized, publicly accessible databases. The result is comparable and combinable data that can be easily aggregated, disaggregated, and compared at various spatial and temporal scales. Separately, each state party is responsible for monitoring and reporting airborne deposition loadings, and nutrient and other waterborne loadings from within its territorial jurisdiction. As in the Chesapeake Bay, the Monitoring and Assessment Group (the "HELCOM MONAS") is responsible for coordinating and overseeing the implementation of all HELCOM environmental monitoring programs.[78] But in contrast to the Chesapeake Bay program, HELCOM MONAS is itself responsible for synthesizing the monitoring data into policy-relevant fact sheets, indicator reports, thematic reports, and periodic basin-wide assessments.[79]

Finally, ecosystem modeling is a crucial tool for simulating and estimating imperfectly measured dimensions of the ecosystem (for example, delivery, diffusion, and impacts of land-based and airborne nutrient loadings, or the impacts of projected rates of urban sprawl on water quality), and in estimating and evaluating the effects of proposed policy measures. In the Chesapeake Bay, collaboration among the U.S. Environmental Protection Agency ("EPA"), U.S. Geologic Survey, state agencies, and university scientists produced sophisticated watershed, estuary, and airshed models that serve as a common information base and analytical tool used to inform policy evaluations in all relevant jurisdictions. These models are periodically re-evaluated and revised under the supervision of the Chesapeake Bay Modeling Subcommittee.[80]

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74. Chesapeake Bay Program: Chesapeake Bay Restoration, http://www.chesapeakebay.net/restrtn.htm (follow "Monitoring" hyperlink) (last visited Jan. 18, 2006).

75. *Id.*

76. *Id.*

77. Manual for Marine Monitoring in the COMBINE Programme, http://sea.helcom.fi/Monas/CombineManual2/CombineHome.htm (last visited Jan. 18, 2006).

78. Helsinki Commission, http://www.helcom.fi (follow "Groups" hyperlink, then follow "MONAS" hyperlink) (last visited Jan. 18, 2006).

79. *Id.*

80. Chesapeake Bay Program, *supra* note 74.

At present, a great deal of effort is spent on monitoring, data management, and modeling in the Great Lakes Basin, but the absence of central coordination and a focal information hub leaves these efforts riddled with redundancies, gaps, inconsistencies of approach, and data incompatibilities.[81] As a result, the combined effort is under-informative relative to what might be achieved for a comparable expenditure through a better coordinated approach.

C. A Peak (Central) Coordinating Body

A peak or central coordinating body performs several crucial functions. At a minimum, it operates as a central hub where information held across an otherwise widely dispersed network of institutions can be collected, synthesized, evaluated, and redistributed. In addition, the peak body may play a central role in articulating overall program goals and priorities; evaluating progress toward those goals; identifying and addressing program deficiencies; and readjusting goals, objectives, plans, and priorities in light of experience, new scientific learning, monitoring data, and system change.[82] In this way, an iterative, adaptive, and reflexive process is built into the core of institutional arrangements.

The exact institutional configuration of the peak body varies. In the Chesapeake Bay Program, the peak body is the Chesapeake Executive Council. The council is comprised of the governors of Maryland, Virginia, and Pennsylvania, the mayor of the District of Columbia, the Administrator of the U.S. EPA, and a representative of the Chesapeake Bay Commission, which is a tri-state legislative coordinating body. In the Baltic region, the central coordinating role is assigned to the Helsinki Commission, consisting of designated representatives ("heads of delegation") of the contracting state parties to the Helsinki Convention.[83] In the San Francisco Bay-Delta region, this role is assigned to the California Bay-Delta Authority, an independent commission consisting of representatives of six state and six federal agencies, seven appointed "public" members (five regional and two at-large), one representative of the Bay-Delta Public Advisory Committee, and four ex-officio members representing the key state legislative committees.[84]

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81. *See* GAO, *supra* note 11, at 49 ("[C]urrent environmental indicators do not provide an adequate basis for determining overall progress" in Great Lakes restoration, with recent assessments relying on "a mix of quantitative data and subjective judgments . . . frequently citing [program] outputs rather than environmental outcomes."); *id.* at 51-53 (describing that even where indicators have been developed, they are "not generally supported by sufficient underlying data" due to insufficient resources, lack of planning for indicator development, and lack of control over data collection); *id.* at 56-57 (indicating that the lack of an adequate monitoring system makes it impossible to measure progress and compliance with GLWQA goals and objectives).

82. *See* GAO, supra note 11, at 35-37 (describing the role of the South Florida Ecosystem Restoration Task Force in developing an overarching restoration strategy for the Florida Everglades, and of the Chesapeake Bay Executive Council in coordinating restoration efforts in the Chesapeake Bay region).

83. Chesapeake Bay Program, *supra* note 74 (follow "Executive Council" hyperlink).

84. CAL. WATER CODE § 79412(a) (West 2003).

The powers and duties of the central coordinating body also vary. In both the Chesapeake and Baltic regions, resolutions and "directives" issued by the peak body appear to lack binding legal force, but are nonetheless considered quite influential in shaping the overall program direction, and in ensuring accountability of the parts to the whole and of the overall program to the public. By contrast, the California Bay-Delta Authority has important direct operational responsibilities, including power to review and approve program budgets, plans, and projects.

The role of a peak or central coordinating body may be controversial among those who believe the complex task of ecosystem governance is best addressed through decentralized, non-hierarchical networked structures. It should be emphasized, however, that central coordination and a largely decentralized, non-hierarchical, networked institutional architecture are not necessarily incompatible. In many of these institutional configurations, the role of the "center" is not that of an authoritative commander in a top-down decision-making process, but rather that of a central information hub, absorbing, integrating, and redistributing information from all the specialized components of the larger arrangement. The center can also play a coordinating role to see that all the parts cohere into some unified whole, articulating systemwide "big picture" goals, and assessing progress toward those goals. In the Chesapeake Bay Program, for example, the Executive Council meets infrequently and its decisions are mainly non-binding in character, but this body performs an essential role in formally articulating and ratifying consensus views on overall program direction and priorities that have percolated up through ongoing collaborative, networked decision-making processes involving multiple institutions and actors.

At present, there is no clearly identifiable peak or central coordinating body overseeing and coordinating restoration efforts in the Great Lakes Basin.[85] A number of distinct, and to some extent rival, bodies—including the Binational Executive Committee, the International Joint Commission, the Great Lakes Commission, the Conference of Great Lakes Governors, the Great Lakes Fishery Commission, the Great Lakes Interagency Task Force, EPA's Great Lakes National Program Office, and Environment Canada's Our Great Lakes program—play significant coordinating roles with respect to some aspects of the management effort, but none assumes central responsibility for overall program direction and coordination.[86] This fragmentary approach increases the likelihood of gaps, inconsistencies, and incoherence in the overall effort.

85. *See* GAO, *supra* note 11, at 38-44 (describing competing, and largely ineffective, efforts in basin-wide coordination by a number of bodies in the Great Lakes basin).

86. *See id.*

D. Beneath the Peak Institution, a Set of Functionally Specialized Committees, Subcommittees, and Working Groups

Typically, most of the real work of collaborative interaction, information-pooling, analysis, coordination, and operational decision-making occur at the committee, subcommittee and working group level. Here, again, the structure varies. In the Chesapeake Bay Program, for example, the rung immediately below the Executive Council is occupied by a central Implementation Committee, together with a Citizens' Advisory Committee, a Local Government Advisory Committee, a Scientific and Technical Advisory Committee, and a Water Quality Committee. Another rung down are a series of specialized functional subcommittees on Monitoring, Modeling, Nutrients, Toxics, Land Use, Living Resources, Communications and Education, and Information Management, all reporting to the Implementation Committee. Another rung down are a series of specialist technical working groups on subsidiary or cross-cutting topics. Membership on the subcommittees and working groups largely consists of government agency officials and employees, but the bodies are also open to NGOs, independent scientists, and other interested persons. This provides further opportunities for broad participation, collaboration, and input by scientists and other informed experts.

In the Baltic, the rung immediately below the Commission is occupied by a central Permanent Implementation Task Force responsible for implementing the basin-wide Joint Comprehensive Environmental Action Program, as well as functionally specialized committees on Maritime Issues, Habitat, MONAS, Land, and Emergency Response issues. The next rung down is occupied by specialist working groups and project task forces. Under the Baltic arrangements (and in contrast to the Chesapeake program), only designated representatives of the agencies of member states officially serve on committees, working groups, and task forces, but non-state parties may be afforded official "observer" status. These non-state parties may participate in the discussion, but they cannot vote. Thus, the expert views of non-state actors may penetrate and inform official deliberations.

While present management efforts in the Great Lakes Basin do include numerous functionally specialized committees, subcommittees, working groups, and task forces, these are not arrayed in any coherent institutional design.

E. Centralized Staff Support

Generally, the peak coordinating body and the subsidiary committees, working groups, and task forces are all staffed by a central secretariat staff. The staff organizes meeting logistics, keeps and transmits records, ensures timely collection and distribution of meeting documents and agendas, provides information to the public and program participants, and acts as an important institutional "glue" and central information repository. In the Chesapeake Bay

Program, this function is principally performed by the staff of a specialized office in Annapolis, Maryland, but additional support is provided by staff "seconded" to the Chesapeake Bay Program by various national and subnational governmental agencies.

In the Baltic, this function is principally performed by the HELCOM Secretariat, a permanent staff serving both HELCOM (the peak coordinating commission) and its subsidiary committees.

Although numerous governmental and intergovernmental agencies and organizations assign staff to work on various aspects of Great Lakes management, it is impossible to identify any present central support staff responsible for overall coordination of ecosystem management efforts.

F. A Coordinated Program of Communications and Public Education

A vital element in successful ecosystem management is a coordinated program of communications and public education to make scientific findings, monitoring data, indicator reports, periodic assessments, legal and policy documents, annual reports, fact sheets, newsletters, educational and explanatory materials, and other forms of policy-relevant information available to the general public, the press, educational institutions, and other interested constituencies. Ideally, this is accomplished through a convenient "one-stop" approach that provides access to both electronic and hard copy versions of these materials. Such a program is necessary to provide transparency and accountability in the ecosystem governance effort; to increase public awareness and understanding of the ecological resource and its associated problems, issues, governance arrangements, and policy responses; to encourage voluntary public support for, and participation in, ongoing ecosystem restoration efforts; and to provide a vehicle by which interested citizens might connect with other individuals, agencies, organizations, and restoration activities in their own communities and throughout the basin.

The importance of this communication and public education effort for scientifically informed decision-making should not be underestimated. In democratic societies, public policy decisions are powerfully constrained by public opinion. Against that background, reliance on "back channel" communications between the scientific community and governmental decision-makers is not sufficient. The findings of contemporary science and scientifically informed perspectives on current public policy issues must be translated into understandable forms, and effectively communicated to the broader public to inform public discourse as well as governmental decision-making. However, there is a fine line between public education on the one hand and grassroots lobbying on the other. Consequently, programs of this sort must be managed carefully and in a non-partisan spirit.

While much of the information of the kind described here is currently available in the Great Lakes Basin through a variety of decentralized channels,

there is no convenient "one-stop" information outlet providing a unifying "face" and authoritative voice for the Great Lakes Basin restoration effort. The Chesapeake Bay Program (www.chesapeake bay.net), HELCOM (www.helcom.fi), and CALFED (www.calwater.ca.gov) websites are exemplary in this regard.

G. Nested Scales of Governance

In addition to the functional division of labor between a central coordinating body and specialized committees, effective ecosystem governance typically involves a nesting of governance institutions and responsibilities at different spatial scales. A large, complex ecosystem usually exhibits characteristic systemwide properties and processes, requiring that its parts be understood in relation to the whole. On the other hand, the biotic components, physical and chemical properties, and ecological processes that comprise the larger system are typically not distributed uniformly and homogeneously across the entire system; the larger system has spatially distinct subsystems. Consequently, while one set of basin-wide governance institutions may be needed to address systemwide problems and processes, and to coordinate the efforts of spatially differentiated parts, another level of more localized institutional arrangements may be necessary to address locally varying conditions.

For example, although the Executive Council and its subsidiary committees and subcommittees in the Chesapeake Bay Program address basin-wide policies, programs, goals, and targets, it is also recognized that locally tailored objectives must be articulated and implementation plans must be developed and carried out at sub-basin, tributary-specific scales, both to address local problems and to ensure that local efforts are compatible with basin-wide goals and objectives. These localized units will not necessarily coincide with conventional subnational political and jurisdictional boundaries, so that the collaborative governance structure discussed above may need to be replicated at sub-basin as well as at basin-wide scales. Conditions and stressors near the mouth of the Chesapeake Bay differ from those further up the bay mainstem, for example, and because the bay's various tributaries make differential contributions to pollution and other problems in the bay mainstem, they require differentiated responses on a tributary-specific developed basis compatible with the achievement of basin-wide goals.

At a conceptual level, the need for this nested approach appears to be well understood in the Great Lakes Basin. Even as work proceeds on the development of basin-wide goals and programs, work is also proceeding on Lakewide Management Plans for each of the five Great Lakes.[87] At another nested level, work proceeds on localized Remedial Action Plans for each of 130 identified

87. *See* GAO, *supra* note 11, at iv, 14 (describing the role of LaMPS).

"Areas of Concern" ("AOCs"), which are typically heavily contaminated toxic "hotspots."[88] However, these various efforts do not appear to be well coordinated. Each RAP proceeds more or less independently at its own pace, with little effort made to integrate RAP efforts horizontally, or to tie them systematically into either LaMP or basin-wide initiatives. Similarly, LaMPS are neither horizontally nor vertically integrated into basin-wide plans and initiatives. Relatively weak signals are provided at the basin-wide level as to actionable goals, targets, priorities, and timetables, providing little guidance to LaMP or RAP planners as to how they might more effectively link their efforts to achievement of basin-wide goals.

H. Specific Goals, Targets, and Timetables at All Levels

It is puzzling to many people how multi-party collaborative governance arrangements can be effective in the absence of mandatory, command-style rules enforceable by coercive sanctions. In transboundary settings, however, no single sovereign is in a position to issue and enforce rules that are binding on all relevant actors. On the other hand, the ordinary processes of international lawmaking have not produced—and are unlikely to produce—a body of inter-sovereign rules of obligation sufficiently robust, detailed, elaborate, contextual, and flexible to address all relevant aspects of the complex and inherently dynamic undertaking of ecosystem management. Yet, sovereign states are often reluctant to cede legally binding rulemaking and enforcement authority to permanent supranational institutions.

In these circumstances, the most successful collaborative ecosystem governance arrangements centrally rely on what might be considered "soft law" mechanisms. In other words, all parties agree in principle to make good-faith efforts to achieve mutually agreed goals and objectives, and to implement such measures as subsequently may be deemed necessary, yet neither the goals nor the agreed-to measures are considered legally binding under either international or domestic law. Typically then, binding intersovereign agreements only operate as framework agreements, setting overarching goals stated at a very high level of generality and establishing the constitutive governance arrangements under which more detailed but legally non-binding goals, objectives, and timetables will be specified. Although achievement of these detailed objectives, plans, and other measures is neither legally obligatory nor subject to coercive sanctions for non-compliance, neither is implementation left strictly to the goodwill of the parties. "Soft law" informational mechanisms are typically created to provide transparency and some measure of accountability (both internally within the web of governance arrangements and "externally" to the broader democratic polity) with regard to actual progress toward stated objectives. The central operative

88. *See id.* (describing the role of RAPs and AOCs).

mechanism is joint articulation of clear, specific, and objectively measurable goals that are usually stated in terms of numerical progress with respect to specified physical, chemical, and biological indicators of ecosystem health. This is coupled with mechanisms to monitor progress and full public reporting. Failure to achieve the stated objectives subjects the responsible parties to public exposure, criticism, "jawboning" by their collaborative partners, moral suasion, political pressure, and similar "soft law," non-legal sanctions.

The ultimate effectiveness of these "soft law" mechanisms is open to dispute, and a full assessment of their effectiveness—and of the likely effectiveness of any alternative—is beyond the scope of this article. However, it should be noted that the process described here—of setting detailed goals and objectives with respect to specified indicators, then monitoring and assessing the results and reformulating plans and measures in light of what is learned—is a process that centrally emphasizes the role of science in decision-making. In contrast to more legalistic approaches to decision-making in which science may be forced to take a back seat, the emphasis here is on the selection of scientifically defensible indicators as the best measure of progress toward overall system objectives; empirical measurement of outcomes; scientific analysis and assessment of the results; the development of hypotheses about probable causes for deficiencies in outcomes and alternative measures hypothesized to be most likely to succeed; and rigorous field testing of those hypotheses through implementation at the next stage of decision-making. In short, the approach described here is fully compatible with the "adaptive management" approach first proposed by conservation biologists as a way of advancing scientific understanding of ecosystems, while grounding decision-making in the best information that contemporary science can offer.

Efforts at all levels in the Great Lakes—basin-wide, LaMPS, and RAPS—are hampered by a paucity of clearly articulated, objective, and measurable goals, objectives, targets, and timetables. This is closely related to the problem of coordination across nested scales. Absent clear signals as to basin-wide goals and objectives, it is difficult to integrate lake-level planning through the LaMP process with basin-wide initiatives. The lack of clear goals and objectives also leads to a lack of transparency and accountability within the far-flung parts of the overall management effort, and from the management effort to the public.

I. An Iterative and Adaptive Management Approach

The new governance arrangements are also characterized by an iterative, adaptive, and experimentalist management approach, driven by the complex and dynamic nature of the undertaking. Ecosystem management addresses a subclass of what are called in the business management literature "wicked problems"—complex,

multifaceted, and dynamic problems made up of numerous interdependent factors.[89] Often, this literature indicates that there is not even a single, definitive formulation of the nature of the problem itself, much less anything resembling a clear and fully specified solution. There might not even be unambiguous criteria for what would count as success in addressing the problem, due to the less-than-fully-specified nature of the problem itself.

The general problem-solving approach discussed in the management literature on "wicked problems" centrally relies on discussion, information-pooling, consensus, and adaptive decision-making, an iterative process that treats every decision as necessarily provisional in the expectation that new information, experience, and dynamic changes in the character of the problem itself will inevitably require course corrections or even wholly new approaches in subsequent iterations.[90] This approach aims to build institutional learning capacity into the management system. A robust business management literature describes the applications of this approach in areas such as software development, new product design, and more generally, in any management setting involving highly competitive, innovative, fast-changing, technology-driven industries.

In conservation ecology, the same basic idea is embraced in the concept of "adaptive management," which holds that policy interventions should be constructed as carefully designed experiments to test specific hypotheses in practical application.[91] Follow-up monitoring and analysis then leads to reevaluation and revision of policies in light of what is learned from that practical experiment. The adaptive management concept has gained some currency in natural resource management circles, and is the subject of much discussion at the U.S. Forest Service, Department of the Interior, and other U.S. federal agencies.

Unfortunately, however, in most cases the United States is not very far along in actually implementing adaptive management or putting in place the institutional arrangements necessary to support this management approach.[92] In this respect, too, the Great Lakes are a bellwether of broader trends.

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89. *See* H.W.J. Rittel & M.M. Webber, *Dilemmas in a General Theory of Planning* 4 POLICY SCIENCES 155, 160 (1973) (defining "wicked problems" as that "defy efforts to delineate their boundaries and to identify their causes, and thus to expose their problematic nature").

90. *See* Michael Pacanowsky, *Team Tools for Wicked Problems*, ORGANIZATIONAL DYNAMICS, Winter 1995, at 36-37.

91. *See* ADAPATIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (C.S. HOLLING ED., 1978); KAI N. LEE, COMPASS AND GYROSCOPE: INTEGRATING SCIENCE AND POLITICS FOR THE ENVIRONMENT (1993); CARL WALTERS, ADOPTION MANAGEMENT AT RENEWABLE RESOURCES (1986).

92. *See* Bradley C. Karkkainen, *Adaptive Ecosystem Management and Regulatory Penalty Defaults: Toward a Bounded Pragmatism*, 87 MINN. L. REV. 943, 954-56 (2003) (providing examples of federal implementation of adaptive management).

J. Genuine Integration across Issue Areas and Mission-Specific Agency Responsibilities

Integration across issue areas and agencies is an aspirational goal that has not been achieved perfectly anywhere. The first lesson of ecology is that the biotic, physical, and chemical components, processes, and stressors that jointly comprise an ecosystem are profoundly and complexly interdependent. Consequently, and in contrast to conventional fragmentary approaches to environmental protection and natural resources management, scientifically informed ecosystem management must reckon with these interdependencies and seek to integrate management of a complex array of resources and stressors, each in light of its relation to the others and to the ecological whole. So, for example, in contrast to conventional approaches to fisheries management, which attempt to manage commercial and recreational fish stocks primarily by regulating harvest levels (perhaps supplemented by artificial restocking with hatchery-raised fish), an ecosystem approach recognizes that fisheries cannot be managed effectively without considering the condition of fish habitat. Thus, the management effort must be attentive to population dynamics and trends at both higher and lower trophic levels, and throughout the complex food webs upon which target species ultimately depend. An ecosystem approach to fisheries management also implicates environmental stressors like pollution, wetlands loss, and anthropogenic alterations of shorelines, near-shore waters, estuaries, and other sensitive aquatic habitats. The role of invasive species is also crucial, especially in enclosed waters like the Great Lakes, which in turn implicates marine transportation policy and infrastructure development. Pollution control is not a simple matter of regulating identifiable outfalls of traditional "water pollution," but instead is a multi-faceted problem that implicates airborne deposition, contamination of tributary groundwater, non-point source run-off (further implicating land use, especially in coastal areas and along tributaries throughout the basin), loss of wetlands and other vegetative buffers and filters, and loss of filter-feeding aquatic organisms that may play an important role in regulating water quality.[93]

Integrated management of all these interrelated pieces of the whole is a daunting challenge. The 1987 protocol to the Great Lakes Water Quality Agreement set forth a vision of integrated ecosystem management throughout the basin. That was an important first step. That agreement largely bracketed the difficult matter of establishing governance institutions capable of translating that vision into concrete policy. However, without effective coordination through the mechanisms described above, management efforts in the Great Lakes Basin will

93. It is estimated that filter-feeding oysters historically filtered the entire volume of water in the Chesapeake Bay in about three days. Now, with oyster populations reduced to about 1% of historic levels due to pollution, overharvesting, alteration of prime oyster habitat, disease, and other factors, it takes an entire year, complicating efforts to improve water quality. *Id.* at 947.

continue as they are presently characterized: relatively low levels of policy integration, whether horizontally (nation-to-nation, state-to-state, state-to-province), vertically (nation-to-state), or functionally (across mission-specific agency lines).

V. CONCLUSION

In many respects, the history and present-day reality of amicable cooperation and coordination between the United States and Canada in management of the vital shared resource of the Great Lakes is exemplary, as is the level of sophistication displayed in their shared vision of an integrated ecosystem approach to environmental quality and natural resource management. Similarly, some institutional arrangements in the Great Lakes Basin, including not least the International Joint Commission, are exemplary. Yet at the end of the day, current institutional arrangements must be judged inadequate to achieve the stated objective of effective transboundary cooperation and coordination in the complex and challenging task of managing the Great Lakes ecosystem. Repairing that deficiency will be neither easy nor uncontroversial. There is no perfect or easily replicable model to which to turn. Nonetheless, there are vital lessons to be drawn from experience elsewhere.

This article has drawn on efforts both within and outside the Great Lakes Basin to identify ten core characteristics of governance arrangements associated with integrated, adaptive ecosystem management. Current institutional arrangements in the Great Lakes Basin must be either judged underdeveloped or seriously deficient with respect to each of these ten characteristics.