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A Learning Collaboratory: Improving Federal Climate Change Adaptation Planning

*Alejandro E. Camacho**

I. INTRODUCTION

*Human history becomes more and more a race between education and catastrophe.*¹

*Adapt or perish, now as ever, is Nature's inexorable imperative.*²

Though composed many decades ago, these observations by H.G. Wells hold as true today—in the context of global anthropogenic climate change—as ever. The regularly dynamic global climate is currently shifting precipitously, caused at least in part by increases in greenhouse gas concentrations due to continuing development and industrialization.³ Evidence confirms that widespread⁴ harmful effects to ecological and human systems have already occurred.⁵ Amidst projections of a wide range of risks to both

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1. HERBERT GEORGE WELLS, *THE OUTLINE OF HISTORY* 1100 (1920).

2. HERBERT GEORGE WELLS, *MIND AT THE END OF ITS TETHER* 19 (1945).

3. See RICHARD ALLEY ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS* 10 (2007) (linking climate change to human activity).

4. See Camille Parmesan, *Ecological and Evolutionary Responses to Recent Climate Change*, 37 ANN. REV. ECOLOGY EVOLUTION & SYSTEMATICS 637, 639 (2006) (“[T]he direct impacts of anthropogenic climate change have been documented on every continent, in every ocean, and in most major taxonomic groups.” (citation omitted)).

5. See Parmesan, *supra* note 4 (discussing the effects of climate change); see also NEIL ADGER ET AL., SUMMARY FOR POLICYMAKERS, CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 8–9 (2007) (discussing observed impacts of climate change on the human and natural environment); CAMILLE PARMESAN & HECTOR GALBRAITH, OBSERVED IMPACTS OF

biota⁶ and humans⁷ from future warming in the United States over the next several decades,⁸ some have even suggested treating such change as not only an agent or catalyst of other catastrophic environmental events,⁹ but as a natural disaster in itself.¹⁰ Perhaps more importantly, global anthropogenic climate change magnifies the uncertainty that exists for private parties, resource managers, and regulatory institutions in planning for or responding to environmental problems. As a result, the continuing health of natural resources—and indeed the effectiveness of environmental governance—hinges on the capacity of regulatory institutions to inform, to learn, and to adapt.

Unfortunately, American environmental and natural resources law and its institutions are poorly suited to cultivate successful adaptations to climate change because they are not designed to reduce uncertainty and foster learning by both regulators and the

CLIMATE CHANGE IN THE U.S. (2004); U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 9–12 (Thomas R. Karl et al. eds., 2009).

6. See ADGER ET AL., *supra* note 5, at 10–12 (projecting additional harm to coastal and freshwater resources); PETER C. FRUMHOFF ET AL., CONFRONTING CLIMATE CHANGE IN THE U.S. NORTHEAST 47 (2007) (projecting a significant change in the character of forests in the American Northeast); Mike G. Ryan et al., *Land Resources: Forests and Arid Lands*, in U.S. CLIMATE CHANGE SCIENCE PROGRAM, THE EFFECTS OF CLIMATE CHANGE ON AGRICULTURE, LAND RESOURCES, WATER RESOURCES, AND BIODIVERSITY IN THE UNITED STATES 96–103 (Margaret K. Walsh et al. eds., 2008) (projecting substantial disturbance to forests from disease and fire).

7. See ADGER ET AL., *supra* note 5, at 12 (projecting adverse effects to health from heat waves); Peter Backlund et al., *Executive Summary*, in U.S. CLIMATE CHANGE SCIENCE PROGRAM, THE EFFECTS OF CLIMATE CHANGE ON AGRICULTURE, LAND RESOURCES, WATER RESOURCES, AND BIODIVERSITY IN THE UNITED STATES 6 (Margaret Walsh et al. eds., 2008) (projecting increased disease and failure in grain and oilseed crops); NAT'L ASSESSMENT SYNTHESIS TEAM, U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS ON THE UNITED STATES (2000) (explaining that climate change causes decreased carbon storage, erosion protection, and water and air purification).

8. See Backlund et al., *supra* note 7, at 3 (“Warming is very likely to continue in the United States during the next 25 to 50 years, regardless of reductions in greenhouse gas emissions . . .”).

9. See Daniel A. Farber, *Introduction: The Role of Lawyers in a Disaster-Prone World*, 31 NOVA L. REV. 403, 407 (2007) (stating it is plausible to connect the dramatic rise in tropical storms and other disasters to global warming, and as climate change progresses disasters “are likely to become more frequent and more severe”).

10. See Robin Kundis Craig, “Stationarity Is Dead”—*Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 16 (2010) (asserting that for adaptation purposes, the impacts from climate change should be regarded “as a long-term natural disaster rather than as anthropogenic disturbances” (citation omitted)).

public.¹¹ This Article proposes the development of a revised regulatory infrastructure that requires and promotes systematic monitoring, assessment and adjustment of management decisions, and also establishes an interactive information-sharing network.¹² Drawing on emerging cyberinfrastructure research initiatives, the paper asserts that an adaptive “collaboratory” dedicated to climate change adaptation can facilitate not only information dissemination but also collaborative learning among resource managers, research scientists, and the public.

The Article then describes how recent attempts to manage the effects of climate change, while encouraging, have insufficiently improved existing regulatory institutions’ efforts to promoting agency learning.¹³ It details two of the most advanced climate change adaptation initiatives by the federal government to date—the Environmental Protection Agency’s Climate Ready Estuaries program and the Council on Environmental Quality’s Federal Agency Adaptation Planning Implementing Instructions. Though better than the existing management framework, these initiatives largely fall well short of requiring and otherwise promoting the necessary framework that will help agencies and the private sector manage uncertainty. The Article concludes that instilling continued assessment and an adaptation collaboratory as a part of these new initiatives would enable sharing among authorities, help reduce uncertainty, foster more accountable and adaptive resource management, and thus help natural resources governance adapt.

II. THE LIMITATIONS OF AMERICAN NATURAL RESOURCES MANAGEMENT

As I have argued elsewhere, as significant as the physical and ecological effects of climate change already are and are likely to be in the foreseeable future, uncertainty is the greatest challenge raised by climate change.¹⁴ Climate involves more complex and potentially

11. See *infra* Part I.

12. See *infra* Part II.

13. See *infra* Part III.

14. See Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L.J. 1, 12–15 (2009) [hereinafter Camacho, *Adapting*]; Alejandro E. Camacho, *Transforming the Means and Ends of Natural Resource Management*, 89 N.C. L. REV. 1405, 1409–13 (2011) [hereinafter Camacho, *Transforming*].

confounding variables than most environmental issues, and the localized modeling needed to aid adaptation decisions is especially difficult.¹⁵ However, deficiencies in knowledge are certainly not only limited to the effects of climate change; there also is substantial uncertainty regarding the efficacy of potential adaptation strategies. This lack of information is attributable in part to the fact that information about the performance of adopted resource management strategies is rarely, if ever, systematically generated. It is also partly due to insufficient avenues for sharing sources of information and coordinating action between potentially interested parties.

To begin with, most resource management agencies neglect ambient monitoring,¹⁶ monitoring the effects of management actions, and assessing the effectiveness of adopted strategies at achieving regulatory goals.¹⁷ Furthermore, resource managers are not required to adjust adopted management strategies over time.¹⁸ Because such activities are not required, they do not regularly occur.¹⁹ As they do not regularly occur, of course, information about them cannot be collected and disseminated. This failure to monitor and adapt regulatory actions applies not just to individual project decisions, but also to broader, programmatic decisions as well.²⁰ Because of a lack of resources and incentives, agencies simply do not consistently gather information regarding the efficacy of adopted strategies.

As a consequence, there is weak agency accountability and no systematic mechanism for evaluating and improving decisions and decision processes. Thus, it becomes difficult to reduce uncertainty

15. See Camacho, *Adapting*, *supra* note 14, at 13–15.

16. See, e.g., Eric Biber, *The Problem of Environmental Monitoring*, 83 U. COLO. L. REV. (forthcoming 2011), available at <http://ssrn.com/abstract=1680000> (detailing the problems with ambient monitoring by resource agencies).

17. See Camacho, *Adapting*, *supra* note 14, at 38, 40–42; Alejandro E. Camacho, *Can Regulation Evolve? Lessons from a Study in Maladaptive Management*, 55 UCLA L. REV. 293, 332–42 (2007) [hereinafter Camacho, *Can Regulation Evolve?*]; Camacho, *Transforming*, *supra* note 14, at 1414.

18. See Camacho, *Adapting*, *supra* note 14, at 38.

19. See Camacho, *Adapting*, *supra* note 14, at 41–42, 47; Camacho, *Can Regulation Evolve?*, *supra* note 17, at 332–35; cf. BYRON K. WILLIAMS ET AL., ADAPTIVE MANAGEMENT WORKING GROUP, ADAPTIVE MANAGEMENT 9 (updated ed. 2009) (asserting that successful adaptive management requires a mandate for its use and a long-term “institutional capacity and commitment” to implement it).

20. See Camacho, *Transforming*, *supra* note 14, at 1416–17.

or improve the effectiveness of regulation. Existing natural resources law is thus ineffective for promoting climate change adaptation, in part because it is not designed to induce managers to adapt decisions to new information or changed circumstances.

In addition, the information infrastructure in American natural resources governance is fragmented, with a multitude of local, state, and federal authorities having distinct but overlapping jurisdiction over a wide diversity of natural resources.²¹ This not only can lead to collective action problems and agency inaction for diffuse, long-term problems like climate change,²² it also inhibits interagency learning. Managers do not have the opportunity to learn from the analyses and strategies used by other agencies and managers.²³

Thus, though decentralizing management authority may offer the possibility of innovation and learning by allowing for provision of a diversity of management strategies,²⁴ agencies as they are currently designed do not have sufficient incentives or genuine opportunities to learn from or inform others. They not only are missing information about environmental impacts and the effectiveness of potential strategies, but they are also short of useful avenues for learning such information.

III. AN ADAPTIVE AND COLLABORATIVE LEARNING INFRASTRUCTURE

Accordingly, as detailed in this Part, the process of natural resources decision making must be improved to reduce uncertainty and cultivate learning. First, natural resource decision making must be more adaptive, drawing on the lessons of the use of adaptive management. Second, natural resources institutions must seek to promote the generation, collection, and dissemination of information, drawing on the emerging use of interactive cyberinfrastructure to foster information sharing and learning.

21. See Camacho, *Adapting*, *supra* note 14, at 26–27; Camacho, *Transforming*, *supra* note 14, at 1418–19.

22. See Camacho, *Adapting*, *supra* note 14, at 26–28.

23. See *id.* at 29.

24. See David E. Adelman & Kirsten H. Engel, *Adaptive Environmental Federalism*, in PREEMPTION CHOICE 290 (William W. Buzbee ed., 2009); David E. Adelman & Kirsten H. Engel, *Adaptive Federalism: The Case Against Reallocating Environmental Regulatory Authority*, 92 MINN. L. REV. 1796, 1847–48 (2008); Kirsten H. Engel, *Harnessing the Benefits of Dynamic Federalism in Environmental Law*, 56 EMORY L.J. 159, 178–79 (2006).

A. Incentivize Monitoring, Assessment, and Adjustment

Increasingly, environmental scholars and agencies have endorsed the use of adaptive management as a way for regulators to manage uncertain resource problems through persistent monitoring, assessment, and adjustment of provisional decisions.²⁵ Indeed, adaptive management has been promoted as vital to addressing the effects of climate change.²⁶ However, encouraging manager learning and the adaptability of regulatory processes does not require formal adaptive management; less rigid forms of adaptive regulation may also incentivize monitoring, assessment, and periodic adjustment.²⁷

It is important to note, however, that an agency simply stating that adaptive management is useful is not the same thing as an agency implementing it successfully. Yet the growing literature evaluating the use of adaptive management by natural resource agencies is increasingly recognizing the need to attend to the incentives of managers and stakeholders in designing adaptive decision-making processes. As with most regulatory initiatives, to be successful, adaptive regulation must of course be supported by sufficient and stable funding.²⁸ In addition, several have noted the importance of mandated assessment and adjustment,²⁹ including requiring clear goals and priorities, as well as concrete performance thresholds that, if met, would trigger an adjustment of management activities.³⁰ As stated in one recent evaluation of the use of adaptive management:

25. For a partial list of the scientific and legal literature on adaptive management, as well as agency use of adaptive management, see Camacho, *Transforming*, *supra* note 14, at 1415 n.34–35.

26. See Camacho, *Adapting*, *supra* note 14, at 39–40; Emma L. Tompkins & W. Neil Adger, *Does Adaptive Management of Natural Resources Enhance Resilience to Climate Change?*, 9 *ECOLOGY & SOC'Y* 1, 1–2 (2004), available at <http://www.ecologyandsociety.org/vol9/iss2/art10/>.

27. See Camacho, *Transforming*, *supra* note 14, at 1449.

28. See, e.g., HOLLY DOREMUS ET AL., CENTER FOR PROGRESSIVE REFORM, MAKING GOOD USE OF ADAPTIVE MANAGEMENT 13 (2011), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1808106.

29. See, e.g., Camacho, *Can Regulation Evolve?*, *supra* note 17, at 349 (“[W]ith only vague legislative guidance to promote . . . an adaptive, experimentalist framework, administrative officials will not scrupulously . . . engage in regulatory adaptation.”).

30. See DOREMUS ET AL., *supra* note 28, at 11; Alejandro E. Camacho, *Beyond Conjecture: Learning About Ecosystem Management from the Glen Canyon Dam Experiment*, 8 *NEV. L.J.* 942, 949–50 (2008) (criticizing lack of quantifiable targets); Lawrence Susskind et al., *Collaborative Planning and Adaptive Management in Glen Canyon: A Cautionary Tale*, 35 *COLUM. J. ENVTL. L.* 1 (2010) (criticizing adaptive management experiment’s lack of clear

One of the most significant weaknesses of adaptive management to date has been that agencies have promised future adaptation but not delivered it. Therefore, one of the most important prerequisites for successful adaptive management is devising a workable strategy up front to ensure that changes actually take place when new information shows them to be necessary.

In order to ensure that adaptation occurs, management plans should set forth clear benchmarks for adapting to new information or changing circumstances. . . . [I]nitial management plans can establish clear thresholds that will trigger future adjustments to management, or at least put in motion specific procedures for making adaptation decisions. . . .

. . . Without clearly specified criteria and processes for making adjustments to a management plan, adaptive management can become a tool to rationalize uncertainty or cover flaws in initial decisions, rather than a mechanism for improving management over time.³¹

Regulatory institutions also should consider establishing other incentives for continued assessment and adjustment of management actions. These include tying manager performance to learning,³² offering regulated entities incentives for assisting agency monitoring,³³ and providing other authorities or stakeholders opportunities to aid or ensure performance of monitoring, assessment, or management changes.³⁴

B. Develop an Information-Sharing “Collaboratory”

In addition to adopting concrete legal mechanisms that promote the use of adaptive management, promoting learning includes developing a more effective shared and public information network that collects and disseminates information and tools for analyzing

goals and directives for translating assessments into management adjustments).

31. DOREMUS ET AL., *supra* note 28, at 11 (emphasis omitted).

32. *See, e.g., id.* at 12 (“Career advancement and budgets should be tied to learning, not solely to ‘bean-counting’ measures of success, and not to reduction of political controversy. Effective adaptive management requires political courage. In high-profile conflicts, management agencies must have the backing of their legislative and executive branch bosses.”).

33. *See, e.g.,* Camacho, *Can Regulation Evolve?*, *supra* note 17, at 355–57 (suggesting use of loans, grants, tax credits, penalties, and bonds to encourage monitoring or assessment by applicants).

34. *See* DOREMUS ET AL., *supra* note 28, at 12 (advocating allowing interested citizens to enforce adaptive management provisions); Camacho, *Adapting*, *supra* note 14, at 74–75.

both the effects of climate change and the performance of management strategies. This requires a move away from conventional approaches to information gathering and dissemination that rely on a single, often isolated entity for generating, collecting, and disseminating relevant scientific and management information. A broad information-sharing regulatory network should move beyond the simple formation of a publicly accessible data clearinghouse to form more interactive and adaptive mechanisms for creating and disseminating information. In doing so, regulatory institutions should draw on the increased reliance on and growing literature promoting the development of virtual modes of collaboration both for scientific research specifically and for information sharing more generally.³⁵

As originally coined by William Wulf, prior director of the National Science Foundation's Directorate for Computer and Information Science and Engineering, a "collaboratory" was envisioned as virtual scientific research collaboration: "A 'center without walls,' in which . . . researchers can perform their research without regard to geographical location—interacting with colleagues, accessing instrumentation, sharing data and computational resources, accessing information in digital libraries."³⁶ Collaboratories are characterized by features that include: (1) a shared interest in a common goal and/or problem; (2) active contribution and interaction by participants; (3) shared information resources; (4) extensive use of technologies, such as rare equipment, shared databases, community websites, file transfer and database

35. See NAT'L RESEARCH COUNCIL, NATIONAL COLLABORATORIES: APPLYING INFORMATION TECHNOLOGY FOR SCIENTIFIC RESEARCH 73 (1993) ("The committee believes that the time is right for a focused initiative to pursue scientific collaboratory projects and develop associated technologies."); Thomas A. Finholt & Gary M. Olson, *From Laboratories to Collaboratories: A New Organizational Form for Scientific Collaboration*, 8 PSYCHOL. SCI. 28 (1997); Noriko Hara et al., *An Emerging View of Scientific Collaboration: Scientists' Perspectives on Collaboration and Factors that Impact Collaboration*, 54 J. AM. SOC'Y FOR INFO. SCI. & TECH. 952 (2003).

36. William A. Wulf, *The National Collaboratory: A White Paper*, in TOWARDS A NATIONAL COLLABORATORY: REPORT OF AN INVITATIONAL WORKSHOP AT THE ROCKEFELLER UNIVERSITY, MARCH 17–18, 1989 app. a (J. Lederberg & K. Uncaphar eds., 1989); see also *Workshops: The Social Underpinnings of Collaboration: Final Summary*, SCI. COLLABORATORIES, <http://tinyurl.com/7mn3azd> (last visited Nov. 27, 2011) (defining collaboratory as a "network-based facility and organizational entity that spans distance, supports rich and recurring human interaction oriented to a common research area, fosters contact between researchers who are both known and unknown to each other, and provides access to data sources, artifacts and tools required to accomplish research tasks").

software, and/or cyberinfrastructure; and (5) boundary crossings that can be geographical, temporal, institutional, and disciplinary.³⁷ In this vision, a collaboratory not only serves to facilitate the sharing of resources and relevant data, but importantly also attempts to cultivate interaction among colleagues that supports learning among all participants.³⁸

Of course, collaborative learning is a staple of traditional research settings, as scientists could “easily get access to one another and find conditions for sharing tacit knowledge that is necessary to do their work.”³⁹ However, in the past several decades, technological advances in computing such as networking technologies have made more dispersed modes of collaboration easier.⁴⁰ Beyond their increased technological feasibility, collaboratories have propagated because they leverage scarce resources and disparate information and knowledge toward common problems.⁴¹

Most collaboratories have proliferated in academic research settings in the United States, particularly in the physical and life sciences.⁴² However, as a portmanteau of two terms with dynamic meanings—“collaboration” and “laboratory”—collaboratories are an evolving concept, “through which participants constantly negotiate the objects of their activities.”⁴³ Types of collaboratories include: (1) shared instrument collaboratories, which increase access to scientific instruments; (2) community data systems, which use a geographically distributed community to create, maintain, and/or improve an information resource; (3) open community contribution systems, which aggregate efforts of many geographically separate individuals

37. See K.J. Lunsford & B.C. Bruce, *Collaboratories: Working Together on the Web*, 45 J. ADOLESCENT & ADULT LITERACY 52 (2001).

38. Cf. MARISA PONTI, ACTORS IN COLLABORATION: SOCIOTECHNICAL INFLUENCE ON PRACTICE-RESEARCH COLLABORATION 40 (2010) (“For Wulf, a collaboratory aimed at doing what a laboratory does, that is, providing access to scarce and expensive resources . . . and supporting interaction with colleagues, without the temporal or geographical constraints of physical locations, thanks to improved technological capabilities.”).

39. *Id.*

40. Finholt & Olson, *supra* note 35.

41. See Diane H. Sonnenwald, *Scientific Collaboration*, 41 ANN. REV. INFO. SCI. & TECH. 643 (2007); see also J.S. Katz & B.R. Martin, *What is Research Collaboration?*, 26 RES. POL'Y 1 (1997); PONTI, *supra* note 38, at 37.

42. See PONTI, *supra* note 38, at 43T; Finholt, *Collaboratories*, 36 ANN. REV. INFO. SCI. & TECH. 73 (2002); G. Melin, *Pragmatism and Self-Organization: Research Collaboration on the Individual Level*, 29 RES. POL'Y 31 (2000).

43. See PONTI, *supra* note 38, at 42.

(often including the general public) toward a common research problem; (4) virtual communities of practice, which are networks of individuals who share a research area and communicate about it online; (5) virtual learning communities, which increase participant knowledge, but not necessarily to conduct original research; (6) distributed research centers, which are akin to university research centers but geographically-distributed; and (7) community infrastructure projects, which seek to develop common resources that facilitate science to further work in a particular domain (and often are interdisciplinary projects).⁴⁴

Collaboratories are also consistent with interactive collaborations that seek to connect not only scientific researchers but also government regulators, managers, agencies, and even the public. A growing number of federal agencies,⁴⁵ as well as a range of public authorities in the United States and Europe,⁴⁶ are experimenting with the use of social media as a way to promote information sharing among government officials or between agencies and the public. For example, Intellipedia⁴⁷ is a wiki-based secure online platform used only by United States intelligence agencies that “enables the direct collaborative drafting of intelligence reports by analysts from different intelligence agencies, with little or no hierarchical filtering.”⁴⁸ Direct analyst-to-analyst sharing of information allows officials to pool information and harness the experience of others.⁴⁹ “Regulation Room,” an online public participation platform partnered by Cornell eRulemaking Initiative and the United States

44. See N. Bos et al., *From Shared Databases to Communities of Practice: A Taxonomy of Collaboratories*, 12 J. COMPUTER-MEDIATED COMM. 318, 325–333 (2007), available at <http://jcmc.indiana.edu/vol12/issue2/bos.html>.

45. See Soon Ae Chun et al., *Government 2.0: Making Connections Between Citizens, Data and Government*, 15 INFO. POLITY: THE INT’L J. OF GOV’T & DEMOCRACY IN THE INFO. AGE 1, 4 (2010) (“The US government has been adopting social media to share information within government agencies and across government agencies. . . . Above all, the government disseminates information to the wider public, making a rich set of government information available to stakeholders and individual citizens and allowing massive participation of users, often called ‘crowd sourcing.’ The use of this technology has greatly extended the notions of participatory democracy and of a digital marketplace of information.”).

46. See DAVID OSIMO, EUROPEAN COMMISSION JOINT RESEARCH CENTRE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES, *WEB 2.0 IN GOVERNMENT: WHY AND HOW?* 21–22 (2008).

47. Dept. of Nat. Intelligence, INTELINK, <https://www.intelink.gov/wiki> (last visited Nov. 27, 2011) (subscription required).

48. See OSIMO, *supra* note 46, at 27–28.

49. See *id.*

Department of Transportation (“DOT”), is an illustration of agency-public interaction “that uses selected ‘live’ DOT rulemakings to experiment with the most effective forms of human and computer support for broader, better civic engagement in rulemaking.”⁵⁰

In this sense, collaboratories are congruent with President Obama’s recent Open Government Directive that seeks to promote interaction among federal agencies and with nonfederal agencies and the public.⁵¹ However, collaboratories place particular emphasis on interactions among a wide variety of actors. Though a hub is created with outlying nodes, it is not just one-way or even two-way traffic. Information flows between the various nodes with only limited oversight by the central hub.

IV. INNOVATIVE YET FLAWED CLIMATE CHANGE ADAPTATION STRATEGIES

Unfortunately, most agencies do not sufficiently focus on developing an adaptive regulatory process or a collaborative and interactive learning infrastructure. In fact, though it is slowly improving, hardly any natural resource management agencies have adopted any concrete climate change adaptations, with the few agencies considering climate change adaptation mostly still in the early planning stages.⁵² Nonetheless, a few recent federal initiatives

50. Cynthia R. Farina et al., *Rulemaking in 140 Characters or Less: Social Networking and Public Participation in Rulemaking*, 31 PACE L. REV. 382, 388–89 (2011). Similarly, “ExpertNet” is a software tool being designed by the Office of Management and Budget and General Services Administration for all agencies to use when seeking public comments on proposed agency actions. See WENDY GINSBERG, CONG. RESEARCH SERV., R 41361, THE OBAMA ADMINISTRATION’S OPEN GOVERNMENT INITIATIVE: ISSUES FOR CONGRESS 26–27 (2011).

51. See Memorandum for the Heads of Executive Departments and Agencies: Transparency and Open Government, 74 Fed. Reg. 4685 (Pres. Doc. Jan. 21, 2009) (“*Government should be collaborative*. Collaboration actively engages Americans in the work of their Government. Executive departments and agencies should use innovative tools, methods, and systems to cooperate among themselves, across all levels of Government, and with nonprofit organizations, businesses, and individuals in the private sector.”). But see Susan Copeland Wilson & Dennis Linders, *The Open Government Directive: A Preliminary Assessment*, in 2011 CONF. PROC. 393 (2011) (discussing how the initiative benchmarks focus on technology and not the agency infrastructure change).

52. See U.S. GOV’T ACCOUNTABILITY OFFICE, GAO-10-113, CLIMATE CHANGE ADAPTATION: STRATEGIC FEDERAL PLANNING COULD HELP GOVERNMENT OFFICIALS MAKE MORE INFORMED DECISIONS 5 (2009), available at www.gao.gov/new.items/d10113.pdf; Camacho, *Adapting*, supra note 14, at 40–41; JOEL B. SMITH ET AL., PEW CTR. ON GLOBAL CLIMATE CHANGE, ADAPTING TO CLIMATE CHANGE: A CALL FOR FEDERAL LEADERSHIP 2 (2010), available at <http://www.pewclimate.org/docUploads/adaptation-federal->

that seek to engage in adaptation planning are encouraging. This Part focuses on arguably the two most innovative federal regulatory programs attempting to prepare for and address the effects of climate change in the United States. The Interagency Climate Change Adaptation Task Force is a federal system-wide strategy, while the Environmental Protection Agency's Climate Ready Estuaries initiative is a program-specific strategy for addressing the effects on estuaries. Both of these programs have noted that existing resources management does not provide sufficient mechanisms for evaluating and adjusting management strategies and for generating and disseminating information. However, as of yet they do not provide sufficient infrastructure or incentives to build the needed adaptive capacity.

A. The Interagency Climate Change Adaptation Task Force and CEQ's Implementing Instructions

The most comprehensive attempt to date in the United States at climate change adaptation planning has been through the federal government's Interagency Climate Change Adaptation Task Force's ("Task Force") and the Council on Environmental Quality's ("CEQ") implementing instructions to other federal agencies of some of the Task Force's recommendations. The Task Force began meeting in spring 2009⁵³ but was formally established by the President on October 5, 2009 through Executive Order 13,514.⁵⁴ Section 8(i) of Executive Order 13,514 requires each federal agency to "evaluate agency climate-change risks and vulnerabilities to manage the effects of climate change on the agency's operations and mission in both the short and long term."⁵⁵ Section 16 instructs the

leadership.pdf.

53. THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, PROGRESS REPORT OF THE INTERAGENCY CLIMATE ADAPTATION TASK FORCE: RECOMMENDED ACTIONS IN SUPPORT OF A NATIONAL CLIMATE CHANGE ADAPTATION STRATEGY 9 (Oct. 5, 2010) [hereinafter INTERAGENCY TASK FORCE REPORT], available at <http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-Change-Adaptation-Progress-Report.pdf>.

54. Exec. Order No. 13,514, 74 Fed. Reg. 52,117 (Oct. 8, 2009); see also THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, PROGRESS REPORT OF THE INTERAGENCY CLIMATE ADAPTATION TASK FORCE 2 (March 16, 2010) [hereinafter INTERIM INTERAGENCY TASK FORCE REPORT], available at <http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100315-interagency-adaptation-progress-report.pdf>.

55. Exec. Order No. 13,514, *supra* note 54, at 52,122; see also THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, INSTRUCTIONS FOR IMPLEMENTING CLIMATE CHANGE ADAPTATION PLANNING IN ACCORDANCE WITH EXECUTIVE ORDER 13,514, at 2 (2011)

CEQ chair to provide, after consulting the Task Force, “a progress report on agency actions in support of the national adaptation strategy and recommendations for any further such measures as the CEQ Chair may deem necessary.”⁵⁶

1. Development of the Task Force and Implementing Instructions

The Task Force includes twenty federal agencies and executive branch offices and is co-chaired by the CEQ, the National Oceanic and Atmospheric Administration (“NOAA”), and the Office of Science and Technology Policy.⁵⁷ It convened workgroups focusing on various topics, initially including adaptation science, agency planning, water resources, insurance, and international issues.⁵⁸ Later workgroups also focused on communications and outreach, urban issues, health, and plants/fish/wildlife.⁵⁹

The Task Force released an *Interim Progress Report* in March 2010 after conducting a literature review, analyses of federal and nonfederal adaptation efforts, and a variety of listening sessions and discussions with nonfederal regulators and identified stakeholders.⁶⁰ The *Interim Progress Report* outlines the Task Force’s progress to date, discusses “significant gaps” in the U.S. approach to climate change adaptation and building resilience,⁶¹ and “recommends key components to include in a national strategy on climate change adaptation.”⁶² The six components include: (1) integration of science into adaptation decisions and policy, (2) communications and capacity-building, (3) coordination and collaboration, (4)

[hereinafter IMPLEMENTING INSTRUCTIONS], *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf.

56. Exec. Order No. 13,514, *supra* note 54, at 52,124–25; *see also* THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, IMPLEMENTING CLIMATE CHANGE ADAPTATION PLANNING IN ACCORDANCE WITH EXECUTIVE ORDER 13,514 SUPPORT DOCUMENT 6 (2011) [hereinafter IMPLEMENTING INSTRUCTIONS SUPPORT DOCUMENT], *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_support_document_3_3.pdf.

57. *See* INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 9. For a list of all agencies participating in the workgroups, *see id.* at app. B at B-1.

58. *See* INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 2.

59. *See* INTERAGENCY TASK FORCE REPORT, *supra* note 53, at app. B at B-2.

60. INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 3.

61. *Id.* at 3–4.

62. *Climate Change Adaptation Task Force*, THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, <http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation> (last visited Nov. 27, 2011).

prioritization, (5) a flexible framework for agencies, and (6) evaluation.⁶³

On October 2010, the Task Force released a more detailed *Progress Report*.⁶⁴ It includes eight guiding principles:

1. Adopting integrated adaptation approaches;
2. Prioritizing the most vulnerable populations;
3. Using the best-available science;
4. Building strong partnerships with other resource managers;
5. Applying risk-management methods and tools;
6. Applying ecosystem-based approaches;
7. Maximizing mutual benefits; and
8. Continuously evaluating performance.⁶⁵

Consistent with these guiding principles, the *Progress Report* also recommends five overarching actions “intended to reinforce existing adaptation efforts, harness a range of capabilities and resources across the federal government, and build strong partnerships with local, state, regional, Tribal, and international stakeholders to advance a common adaptation agenda.”⁶⁶ These include:

1. Mainstreaming adaptation planning across the federal government;
2. Improving the integration of science into decision making;
3. Addressing key cross-cutting issues;
4. Enhancing efforts to lead and support international adaptation; and
5. Coordinating capabilities of the federal government to support adaptation.⁶⁷

63. INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 4–6.

64. *Obama Administration Officials Release Progress Report on Work of Climate Change Adaptation Task Force*, THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY (Oct. 14, 2010), <http://tinyurl.com/7y5hez2>.

65. *See* INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 10.

66. *Id.*

67. *See id.* at 11–12.

Pursuant to Section 5(b) of Executive Order 13,514, which provides that the Chair of CEQ “shall issue instructions to implement the order,”⁶⁸ in March 2011 CEQ issued *Implementing Instructions*⁶⁹ and a *Support Document*⁷⁰ on adaptation planning for all federal agencies.⁷¹ Under the *Implementing Instructions*, federal agencies must submit certain adaptation planning information to CEQ by a series of deadlines.⁷² The instructions require each agency over time to:

1. Participate in CEQ workshops in 2011;
2. Identify a lead point of contact by April 2011;
3. Issue a short agency-wide policy statement committing to adaptation planning (and responses to CEQ’s guiding questions) by June 2011;
4. Submit a draft climate change vulnerability analysis (and identify three-to-five priority adaptation actions to be implemented in FY 2012) by September 2011;
5. Complete the vulnerability assessment by March 2012; and
6. Submit and make available for public comment an adaptation plan by June 2012⁷³

Though the *Implementing Instructions* do include provisions requiring individual federal agencies to take actions consistent with the *Progress Report*, they do not purport to implement all of the report’s recommendations. However, the Task Force continues to meet to “maintain an interagency forum for discussing the federal government’s adaptation approach and to monitor the implementation of recommended actions.”⁷⁴ Moreover, in furtherance of one of the *Progress Report’s* recommendations, in October 2011 CEQ released a National Action Plan⁷⁵ to “aid

68. IMPLEMENTING INSTRUCTIONS, *supra* note 55, at 2.

69. *Id.*

70. IMPLEMENTING INSTRUCTIONS SUPPORT DOCUMENT, *supra* note 56, at 4.

71. Council on Env’tl. Quality, *Climate Change Adaptation Task Force*, THE WHITE HOUSE, <http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation> (last visited Nov. 27, 2011).

72. *See* IMPLEMENTING INSTRUCTIONS SUPPORT DOCUMENT, *supra* note 56, at 8.

73. *Id.* at 5.

74. INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 52.

75. THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, NATIONAL ACTION PLAN:

freshwater resource managers in managing and protecting the Nation's water resources" in light of a changing climate.⁷⁶ Simultaneously, the Task Force released a *2011 Progress Report* to serve as an update on federal government adaptation progress in line with the policy goals set forth by the Task Force in 2010.⁷⁷ The Task Force plans to release another update in March 2014, following the release of the 2013 National Climate Assessment Synthesis Report.⁷⁸

2. Recommending adaptive and collaborative information sharing

By bringing together managers from various federal resource agencies to discuss both the deficits in existing federal adaptation planning and possible solutions, this emergent federal Task Force effort is undoubtedly an important step forward for adaptation planning in the United States. Perhaps of greater significance is the requirement by CEQ that each federal agency must engage in adaptation planning—the first mandatory manifestation of the Task Force's activities. Indeed, the various reports by the Task Force repeatedly identify the need to promote more adaptive management and agency collaboration in adaptation planning. Nonetheless, both of these efforts fall short of developing a truly comprehensive framework for agency and stakeholder learning because they fail to require and otherwise incentivize adaptive management throughout the governance process and do not establish a comprehensive information sharing mechanism.

Encouragingly, both the *Interim Progress Report* and *Progress Report* recognize the need for adaptive management and promoting learning through continuous evaluation. The *Interim Progress Report* identifies, as a major gap to adaptation in the United States, the lack of "[a] robust approach to evaluating and applying lessons

PRIORITIES FOR MANAGING FRESHWATER RESOURCES IN A CHANGING CLIMATE (Oct. 2011) [hereinafter FRESHWATER NATIONAL ACTION PLAN], available at http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_national_action_plan.pdf.

76. See Council on Env'tl. Quality, *Council on Environmental Quality Releases Draft Plan to Protect Water Quality and Availability from Climate Change Impacts*, THE WHITE HOUSE (June 2, 2011), <http://tinyurl.com/7d5fq3r>.

77. THE WHITE HOUSE COUNCIL ON ENVTL. QUALITY, FEDERAL ACTIONS FOR A CLIMATE RESILIENT NATION: PROGRESS REPORT OF THE INTERAGENCY CLIMATE ADAPTATION TASK FORCE (Oct. 28, 2011) [hereinafter 2011 INTERAGENCY TASK FORCE REPORT], available at http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_adaptation_progress_report.pdf.

78. *Id.* at 25.

learned.”⁷⁹ To address this gap, the *Interim Progress Report* recommends “a commitment to dynamic engagement, iterative understanding of results, and rigorous evaluation. . . . Adaptation plans must allow for a ‘feedback’ mechanism, whereby new information, lessons learned, and modified priorities can be incorporated into ongoing adaptation processes.”⁸⁰ Similarly, the *Progress Report* includes as a guiding principle that agencies must “continuously evaluate performance.”⁸¹ As part of this flexible planning framework, the Task Force states that “[a]daptation plans should include measurable goals and performance metrics to continuously assess whether adaptive actions are achieving desired outcomes.”⁸² Agencies are also encouraged to engage in “ongoing evaluation and revision of management activities and decisions through adaptive management.”⁸³

Similarly, the Task Force’s progress reports emphasize the need for more and better information for adaptation planning and the value of interagency coordination on information sharing. Both reports emphasize the need for accurate data and tools,⁸⁴ as well as the need to make such data both accessible to and informed by resource managers⁸⁵ and the public.⁸⁶ Indeed, the Task Force effort

79. INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 4.

80. *Id.* at 6 (recommending “a consistent but flexible framework,” including “developing an adaptation mandate with success measures” and “assessing the results and learning from the process to improve future adaptation and resilience”).

81. INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 22.

82. *Id.* at 22; *see also id.* at 26 (“In their adaptation action plans, agencies should identify measures to incorporate climate change-related considerations into existing agency planning processes, including the development of measurable goals and performance metrics to guide adaptation efforts and assess whether efforts are achieving desired outcomes.”).

83. *Id.* at 25–26; *see also id.* at 27–28 (recommending a framework “to enable a process that is both consistent and tailored to the specific planning needs of each agency,” including to “evaluate and learn”). The *Freshwater National Action Plan* also recommends the incorporation of “sustained evaluation of implementation actions and of the overall success of adaptation efforts” into the water resources and climate change planning process. FRESHWATER NATIONAL ACTION PLAN, *supra* note 75, at 16.

84. INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 3 (recognizing the need for “[r]elevant climate change and impact information that is accessible and usable by decision-makers and practitioners”); *id.* at 4 (“[I]nstitutional changes are needed to enable the use of science that informs adaptation, including the translation of this science into decision-support tools and policy.”); INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 10 (“Adaptation should be grounded in the best-available scientific understanding of climate change risks, impacts, and vulnerabilities.”).

85. *See, e.g.*, INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 4 (“Managers and planners need to understand how to best access and take advantage of science as improvements are made to guidance, standards, and best practices.”); INTERAGENCY TASK

itself is an interagency attempt at developing recommendations for a national adaptation strategy in part based on the collective experience of various agencies and input from other governments and stakeholders. In addition, the *Interim Progress Report* stresses the need for collaboration and coordination between federal agencies,⁸⁷ while the *Progress Report* endorses the federal government playing a key coordinating role with other stakeholders in addressing climate change.⁸⁸ Focusing specifically on information gathering and sharing, the *Progress Report* acknowledges that federal climate change research is fragmented, leading to gaps and redundancies in information gathering.⁸⁹ The Task Force Reports also recommend increased federal coordination in information gathering and dissemination domestically⁹⁰ and internationally.⁹¹

FORCE REPORT, *supra* note 53, at 32 (recommending building “science translation capacity to improve the communication and application of science to meet the needs of decision makers”); *id.* at 33 (“The Federal Government should consider decision makers needs when prioritizing scientific research for science to be useful to adaptation planning.”).

86. *See, e.g.*, INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 5 (“[B]uild awareness and engage relevant stakeholders in developing adaptation approaches and ensuring the success of adaptation efforts.”); INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 10 (stating agencies “should build on the existing efforts and knowledge of a wide range of public and private stakeholders”).

87. *See, e.g.*, INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 5 (“Adaptation to climate change and building resilience will require collaboration and coordination between U.S. government entities. . . . A formal approach, with clear processes and facilitation, is required to ensure that this coordination and collaboration occurs.”).

88. *See, e.g.*, INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 7–8, 18–19 (discussing the coordination and collaboration role of the federal government); *id.* at 50 (“Maintaining an open dialogue between Federal and non-Federal decision makers is critical to successful adaptation planning and implementation. The Task Force should establish a partnership committee composed of local, state, Tribal, and Federal Government representatives to exchange information and views on adaptation needs.”).

89. *See id.* at 31 (“Many programs across the Federal Government produce science that informs and supports climate change adaptation decision making Currently, most of these activities are occurring independently of one another, leading to gaps and redundancies.”).

90. *See, e.g.*, INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 31 (recommending “enhanced coordination on science at the Federal level, through agencies working together more closely to leverage existing capabilities” and stating “[c]oordination would help Federally sponsored science identify, understand, and meet the needs of decision makers implementing adaptation strategies on the ground”); *id.* at 52 (recommending “strengthen[ing] interagency coordination to build a robust body of accessible science and tools to inform and support adaptation decisions”); INTERIM INTERAGENCY TASK FORCE REPORT, *supra* note 54, at 6 (recommending “a focus on common tools and information . . . [which] could include common scenario-based analyses, integrated climate change database management, or new modeling tools that match downscaled climate information with other data collected by individual agencies such as demographics, land use, or energy production”).

91. *See* INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 47–48.

The *Progress Report* also calls for the coordinated development of user-friendly decision-support tools,⁹² and even suggests the federal government “[e]xplore approaches to develop an online data and information clearinghouse for adaptation”⁹³ to make data more accessible to resource managers in the United States⁹⁴ and internationally.⁹⁵ The Task Force identifies an early-stage effort by some agencies “to adapt the NOAA Climate Services Portal prototype, currently hosted at Climate.gov, into an operational interagency online portal.”⁹⁶ The *Progress Report* recommends that these agencies work “to identify the necessary components of an online data and information clearinghouse for adaptation,” and “evaluate the appropriate roles for the federal government” and “private and public partners.”⁹⁷

3. *Limitations of the task force and implementing instructions*

These preliminary recommendations of the Task Force that counsel for more adaptive and collaborative management would constitute a significant overhaul of existing regulation throughout the federal government. Though limited to the federal government, such changes, if fully implemented, would also considerably upgrade the adaptive capacity of nonfederal public and private institutions to manage the uncertain effects of climate change. Unfortunately, these recommendations on their own do not bind federal authorities, and the *Implementing Instructions* by CEQ that serve as the directive on adaptation planning to federal agencies are significantly more modest in promoting adaptive management. Similarly, existing efforts at

92. *See id.* at 26–27 (“Agencies should work with OFEE and OMB to identify and coordinate the development of common and shared effective tools for science translation, economic and decision analysis, and evaluation of agency adaptation efforts.”); *id.* at 32 (“Create user-friendly methods for assessing climate impacts, vulnerability, and risk, including models and tools to assess the environmental, social, and economic outcomes of alternative adaptation actions.”).

93. *Id.* at 33; *cf.* FRESHWATER NATIONAL ACTION PLAN, *supra* note 77, at 23 (recommending that NOAA and the US Army Corps of Engineers “develop a Federal Internet portal to provide current, relevant, and high quality information on water resources and climate change.”).

94. *See id.* at 32 (“Online infrastructure can . . . support these efforts by improving the accessibility of information and share lessons learned both to and from end users.”).

95. *See id.* at 47–48 (suggesting one option to make international climate information more available is “to provide this information thorough an online information clearinghouse”).

96. *Id.* at 33.

97. *Id.* at 33–34.

developing an interactive information-sharing infrastructure remain limited.

The *Implementing Instructions* and its *Support Document* require agencies to “adopt the [Task Force’s] guiding principles and framework for adaptation planning,”⁹⁸ including continued evaluation and learning.⁹⁹ Yet the CEQ’s documents pull back from making such a process truly mandatory and concrete. The *Implementing Instructions* include language encouraging agencies to revisit and adjust plans over time,¹⁰⁰ but do not require a systematic and concrete process of adaptive management. The *Support Document* is explicit that “[t]he flexible planning framework is not meant to be prescriptive,” choosing only to encourage agencies to use it because it will be helpful to them.¹⁰¹ Moreover, the only required action in the *Support Document* to ensure that agencies are engaging in continued evaluation and learning is that they “[p]articipate in CEQ workshops.”¹⁰² CEQ did not even mention either adaptive management or evaluation of management processes in its *2011 Progress Report*. Though workshops will likely be useful in providing opportunities for information sharing and learning, they alone do not constitute a rigorous commitment to adaptive management.

Similarly, in contrast to the *Progress Report*, which recommends requiring agencies to identify measurable goals and performance metrics, the *Support Document* explicitly states that “performance metrics are not required by the *Implementing Instructions*.”¹⁰³ As stated earlier,¹⁰⁴ the literature evaluating the use of adaptive management by natural resource agencies is increasingly recognizing the importance of mandated assessment and adjustment,¹⁰⁵ including

98. IMPLEMENTING INSTRUCTIONS, *supra* note 55, at 24.

99. *See id.* at 16.

100. *See id.* at 27 (“Revisiting the plan and incorporating new information on climate change and adaptive actions will be an important part of effective adaptation planning and implementation.”).

101. *Id.* at 15.

102. *Id.* at 22; *see also id.* at 16, 27. Following this requirement, CEQ reported holding a “series of workshops” for federal agencies in 2011 to “share information and best practices for managing climate risks,” 2011 INTERAGENCY TASK FORCE REPORT, *supra* note 77, at 7.

103. *Id.* at 18.

104. *See supra* notes 28–34 and accompanying text.

105. *See, e.g.,* Camacho, *Can Regulation Evolve?*, *supra* note 17, at 349 (“[W]ith only vague legislative guidance to promote . . . an adaptive, experimentalist framework, administrative officials will not scrupulously . . . engage in regulatory adaptation.”).

clear goals, priorities, and concrete performance thresholds that if met trigger an adjustment of management activities.¹⁰⁶ Unfortunately, the *Implementing Instructions* do not require systematic procedures and concrete metrics to adequately promote adaptive management.

The *Implementing Instructions* also do not push for robust information sharing. Like the Task Force's progress reports, the *Support Document* emphasizes that coordination on cross-cutting issues is important.¹⁰⁷ However, there is no mandatory language to promote an information gathering and sharing infrastructure in the *Implementing Instructions* or *Support Document*. The CEQ acknowledged the lack of, and need for, such an infrastructure in its 2010 *Progress Report*, recommending the exploration and evaluation of the appropriate role for the Federal Government in developing an online data and information clearinghouse for adaptation.¹⁰⁸ However, in the 2011 *Progress Report*, CEQ reports that the USGCRP still is only "exploring options for developing and maintaining" a portal of this type.¹⁰⁹ The *Support Document* does reference a new webpage on the FedCenter website,¹¹⁰ developed by the Office of the Federal Environmental Executive, but it only invites agencies to contribute "by providing resources and case studies or lessons learned to the FedCenter staff for inclusion in the website adaptation program area."¹¹¹

Moreover, though better than conventional fragmented agency information gathering, the FedCenter's adaptation webpage only serves as a modest clearinghouse to assist federal agencies in complying with the *Implementing Instructions*. The FedCenter site was created as a "technical and compliance assistance center" to help federal agencies comply with certain presidential executive orders and

106. See, e.g., DOREMUS ET AL., *supra* note 28, at 11; Camacho, *supra* note 30, at 949–50 (criticizing lack of quantifiable targets); Lawrence Susskind et al., *supra* note 30, at 1 (criticizing adaptive management experiment's lack of clear goals and directives for translating assessments into management adjustments).

107. IMPLEMENTING INSTRUCTIONS SUPPORT DOCUMENT, *supra* note 56, at 19 ("As agencies identify priority areas and set goals for their own climate change adaptation plans, it is critical that they coordinate with other appropriate agencies and interagency national planning efforts on adaptation issues that cut across agency jurisdictions.")

108. INTERAGENCY TASK FORCE REPORT, *supra* note 53, at 33–34.

109. 2011 INTERAGENCY TASK FORCE REPORT, *supra* note 77, at 16.

110. *Welcome to FedCenter*, FEDCENTER.GOV (Sept. 15, 2011), <http://www.fedcenter.gov>.

111. IMPLEMENTING INSTRUCTIONS SUPPORT DOCUMENT, *supra* note 56, at 19.

initiatives on the environment, health, and safety.¹¹² For each program, the site provides access to information on primary laws and policies, training materials, events, data, and tools to support planning and case studies.¹¹³

The climate adaptation page was added in June 2011.¹¹⁴ It provides a basic introduction and links to the Executive Order, *Implementing Instructions*, Task Force Reports, and its flexible planning framework.¹¹⁵ The webpage also provides links to external materials, including (1) reports, publications, and case studies of adaptation and mitigation efforts by various federal, state, and local authorities; (2) federal agency adaptation policy statements required by the *Implementing Instructions*; (3) websites of certain federal, nongovernmental, and international organizations; and (4) information on two listservs, three conferences, and four training materials.¹¹⁶

Though the access provided by the FedCenter's climate adaptation webpage to certain adaptation information is laudable, unfortunately, the webpage is undeveloped and misdirected. Much of the information included is not particularly useful for adaptation planning. For example, the referenced reports on state activities focus largely on climate change mitigation and energy-related activities rather than adaptation,¹¹⁷ as do most of the links to the websites of federal agencies and other organizations.¹¹⁸ There are simply too few concrete applications or directly relevant decision-support tools available to aid any federal agencies attempting to engage in the *Implementing Instructions'* adaptation planning process.

112. *About FedCenter*, FEDCENTER.GOV (Sept. 30, 2010), <http://www.fedcenter.gov/help/about/>.

113. *See, e.g., Climate Change Adaptation*, FEDCENTER.GOV, <http://www.fedcenter.gov/programs/climate/> (last visited Nov. 27, 2011).

114. *New Climate Adaptation Program Area Announced*, FEDCENTER.GOV (Jun. 9, 2011), <http://tinyurl.com/3pg7gok>.

115. *Climate Change Adaptation*, *supra* note 113.

116. *Id.*

117. *See, e.g., U.S. State & Regional Climate Change Policy*, WORLD RESOURCES INSTITUTE, <http://www.wri.org/project/state-regional-climate-policy> (last visited Nov. 27, 2011); *U.S. States & Regions, Climate Action*, PEW CENTER ON GLOBAL CLIMATE CHANGE, <http://www.pewclimate.org/states-regions> (last visited Nov. 27, 2011).

118. *See Supporting Information and Tools, Climate Change Adaptation*, FEDCENTER.GOV, <http://www.fedcenter.gov/programs/climate/#tools> (last visited Nov. 27, 2011).

Perhaps of equal importance, the webpage fails to take advantage of readily available cyber-technology to make information development more dynamic and interactive. Advice provided regarding the *Implementing Instructions* planning process and the case studies on federal agency adaptation planning are simply text grafted from the *Support Document*.¹¹⁹ No method is provided for participants to upload data or tools to the site. Though the webpage does reference two EPA listservs that may serve as discussion forums for urban “heat islands” and state and local climate and energy, neither is focused on federal adaptation planning.¹²⁰ The only link to a website that allows users to add and edit content is to a wiki that is unrelated to climate change adaptation.¹²¹

In short, the Task Force is a pioneering initiative that has brought federal agencies together to promote adaptation planning. Admirably, it attempts to pool the collective experience of various federal agencies to develop recommendations for a national adaptation strategy and recommends that agencies use an adaptive and collaborative information-gathering and planning process. Yet, actual implementation of these recommendations has been quite modest, with the CEQ failing to heed the lessons of prior adaptive management experiments and the Task Force only developing a modest information clearinghouse with few opportunities for interactive learning. As further discussed later,¹²² the Task Force should establish a comprehensive, collaborative mechanism for

119. Compare, e.g., *Planning Step: Evaluate and Learn*, FEDCENTER.GOV, http://www.fedcenter.gov/_kd/go.cfm?destination=Page&Pge_ID=3860 (last visited Nov. 27, 2011), with IMPLEMENTING INSTRUCTIONS SUPPORT DOCUMENT, *supra* note 56, at 16. See also *Case Study in Agency Level Adaptation Planning: The Department of Homeland Security*, FEDCENTER.GOV, <http://tinyurl.com/3b7o2ck> (last visited Nov. 27, 2011).

120. See *Heat Island Listserv*, FEDCENTER.GOV, http://www.fedcenter.gov/Bookmarks/index.cfm?id=18170&pge_prg_id=33425&pge_id=3853 (last visited Nov. 27, 2011); *State & Local Climate and Energy Listserv*, FEDCENTER.GOV, <http://tinyurl.com/3jfd25m> (last visited Nov. 27, 2011). Though not part of the climate change adaptation webpage, elsewhere the FedCenter site keeps a list of FedCenter mailing lists for federal employees, including one entitled “climate-change” and another entitled “westcoastclimate.” See *FedCenter Mailing Lists*, FEDCENTER.GOV, <http://www.fedcenter.gov/assistance/listservs/fedcenter/#forums> (last visited Nov. 27, 2011).

121. See *Materials Management Approaches for State and Local Climate Protection*, WEST COAST CLIMATE AND MATERIALS MANAGEMENT FORUM, <http://captoolkit.wikispaces.com/Home> (last visited Nov. 27, 2011) (focusing on “[m]aterials [m]anagement strategies [that] reduce greenhouse gas (GHG) emissions associated with waste, materials and products through a lifecycle and systems approach”).

122. See *infra* notes 186–216 and accompanying text.

information sharing and require continued monitoring, assessment, and adjustment of management decisions throughout the governance process.

B. EPA's Climate Ready Estuaries Program

In similar fashion, the United States Environmental Protection Agency's ("EPA") Climate Ready Estuaries program ("CRE") is a positive step toward effective climate change adaptation planning at the program level; yet it also lacks key components of a collaborative and adaptive learning infrastructure. EPA's Climate Ready Estuaries program was created in 2008 as part of the National Estuaries Program ("NEP").¹²³ Estuaries are sensitive ecosystems that are likely to be substantially affected by climate change. Since estuaries are coastal water bodies, where freshwater and saltwater mingle, they are incredibly productive habitats, serve as home to significant human populations, and are a source of significant economic activity.¹²⁴ Unfortunately, estuarine systems also are especially vulnerable to a number of alterations associated with global climate change, including sea level rise, "increased sea surface and air temperatures, changes in precipitation and storm intensity, and ocean acidification."¹²⁵ These transformations could lead to land, wetland, and infrastructure loss, harm to water quality and availability, and loss and degradation of biological resources.¹²⁶

123. U.S. ENVTL. PROT. AGENCY, CLIMATE READY ESTUARIES 2009 PROGRESS REPORT 1 (2009), *available at* <http://www.epa.gov/climatereadyestuaries/downloads/2009-CRE-Progress-Report.pdf> [hereinafter 2009 PROGRESS REPORT].

124. U.S. ENVTL. PROT. AGENCY, CLIMATE READY ESTUARIES INFORMATIONAL BROCHURE 2 (2009), *available at* http://www.epa.gov/climatereadyestuaries/downloads/CRE_trifold_508comp_spreads.pdf [hereinafter INFORMATIONAL BROCHURE] ("Estuaries . . . are highly productive and unique ecosystems. Millions of people live, work, and play in estuaries, and they are home to many industries critical to our nation's prosperity.").

125. U.S. Env'tl. Prot. Agency, *Saving our Estuaries: EPA's Climate Ready Estuaries Program Plans Ahead*, SCIENCE MATTERS NEWSLETTER (April 2011), <http://www.epa.gov/ord/sciencematters/april2011/estuary.htm> [hereinafter *Saving our Estuaries*]; *see also* 2009 PROGRESS REPORT, *supra* note 123, at 1.

126. INFORMATIONAL BROCHURE, *supra* note 124, at 2 (noting that the detrimental effects may include "[d]amage to and loss of wetlands, coastal property, and infrastructure due to inundation and more severe coastal storms"; "[c]hanges to water availability and quality, including impacts to groundwater and drinking water"; and "[c]hanges in habitat, fisheries, and other plant and animal distributions"); *see also* 2009 PROGRESS REPORT, *supra* note 123, at 1.

1. Development of the CRE program

The NEP is the core estuary protection program in the United States. The twenty-eight participating NEP estuaries are each composed of federal, state, and local government agency representatives with management jurisdiction over some element of the estuary, as well as a variety of interested community members.¹²⁷ As required under the Clean Water Act, each NEP estuary has developed a Comprehensive Conservation and Management Plan (“CCMP”) that coordinates management of a variety of estuary resources, though the focus is on water quality.¹²⁸

Each NEP estuary relies to some degree on interjurisdictional collaborative decision making and ecosystem-based management. As stated by EPA, “[e]ach NEP consists of a collection of stakeholders, organized in a decision-making framework that facilitates collaboration, consensus-building, and public input . . . Together the group works to articulate common goals and take action to address a wide range of issues in their CCMP.”¹²⁹ Within each NEP estuary, participating authorities are encouraged to share information and management practices with each other and to work toward improving estuarine conditions.¹³⁰

In 2008, EPA initiated the CRE program as part of the NEP. Its asserted purpose was “to build capacity among coastal managers to improve the resilience of coastal areas to the impacts of climate change.”¹³¹ The CRE program seeks to do this through providing tools and technical and financial assistance for vulnerability assessments, education, and adaptation planning to NEPs that elect to participate.¹³² Besides targeted funding, the CRE program’s chief

127. *Saving our Estuaries*, *supra* note 125.

128. See *National Estuary Program*, U.S. ENVTL. PROT. AGENCY, http://water.epa.gov/type/oceb/nep/index_cfm (last visited Nov. 27, 2011) (“The Clean Water Act Section 320 directs EPA to develop plans for attaining or maintaining water quality in an estuary. . . . Each program establishes a Comprehensive Conservation and Management Plan to meet the goals of Section 320.”).

129. U.S. ENVTL. PROT. AGENCY, NATIONAL ESTUARY PROGRAM BROCHURE 2 (2009), available at <http://tinyurl.com/3gbmrma>; see also *id.* (“The NEP is a voluntary ecosystem-based management program.”).

130. OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, NATIONAL WATER PROGRAM STRATEGY: RESPONSE TO CLIMATE CHANGE KEY ACTION UPDATE FOR 2010–2011, at 15 (Aug. 2010), available at <http://water.epa.gov/scitech/climatechange/upload/2010-2011-Key-Action-Update.pdf>.

131. 2009 PROGRESS REPORT, *supra* note 123, at 1.

132. *Id.* at 3–4.

approach to providing such assistance is through direct communication with each participating NEP, occasional workshops, and online toolkits.¹³³ To qualify as “Climate Ready,” a participating estuary must adopt an adaptation plan that includes a climate change vulnerability assessment, a summary of considerations for setting priorities and selecting actions, a description of specific adaptation strategies, a plan for communicating with stakeholders and decision makers, and a plan for monitoring and evaluating results.¹³⁴

2. Recommending adaptive and collaborative information sharing

Encouragingly, the CRE program does establish a kernel of an information infrastructure. It includes fifteen participating NEP estuaries, to which EPA has provided some targeted initial funding, technical support, and information on the local effects of climate change and developing and implementing adaptation plans.¹³⁵ Thus, the CRE program provides incentives and technical support to regulators to engage in climate change adaptation.

The program also asserts a desire to foster agency learning about adaptation planning, both through capacity building within each NEP estuary as well as through the pooling of knowledge among participating estuaries. Within estuaries, EPA states that it seeks to promote leadership and expertise on adaptation by enabling local decision makers.¹³⁶ In addition, EPA sees as a goal of the CRE

133. *Estuaries Preparing to Be Climate Ready*, U.S. ENVTL. PROT. AGENCY (Jun. 19, 2008), <http://tinyurl.com/3cjq856> [hereinafter *Estuaries Preparing to Be Climate Ready*].

134. *Adaptation Planning for the National Estuary Program*, U.S. ENVTL. PROT. AGENCY, WHITEPAPER 1 (May 2009), <http://www.epa.gov/climate-ready-estuaries/downloads/CREAdaptationPlanning-Final.pdf>. “For an estuary to be recognized as ‘Climate Ready,’ an adaptation plan including these critical elements must be approved by the estuary’s management committee after consultation with EPA as well as other appropriate reviewing organizations, such as state or local oversight programs.” *Id.*

135. See *Explore Climate Ready Estuaries*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/cre/explore.html#assistance> (last visited Nov. 27, 2011) (“CRE provide[s] targeted assistance to a small group of NEPs to identify climate change vulnerabilities, develop adaptation plans, and begin to implement selected actions within these plans.”); 2009 PROGRESS REPORT, *supra* note 123, at 1; U.S. ENVTL. PROT. AGENCY, CLIMATE READY ESTUARIES 2010 PROGRESS REPORT 22 (Dec. 2010), <http://www.epa.gov/cre/downloads/2010-CRE-Progress-Report.pdf> [hereinafter 2010 PROGRESS REPORT]. In addition to the eleven estuaries participating since 2008 or 2009, four new NEPs were selected in 2010. See *id.*

136. *Saving Our Estuaries*, *supra* note 125 (“This joint effort is working to enhance knowledge in the NEPs to enable them to develop local leadership and expertise to adapt to the effects of climate change.”).

program harnessing the experience from the initial pilot estuaries “to provide information and leadership to other coastal communities around the nation.”¹³⁷

To accomplish these goals, the CRE program offers occasional workshops that bring together similarly situated officials to discuss adaptation planning. The program has provided annual symposia for dialogue among participants, which might provide opportunities for interaction and information sharing among participating estuaries.¹³⁸ EPA promisingly sees such workshops as an opportunity for more veteran participating estuaries “to share their experiences and discuss lessons learned” with newer ones and includes some of the broader lessons in annual reports.¹³⁹

Perhaps most notably, the CRE program created a publicly accessible Coastal Toolkit to aid estuaries in adaptation planning. This toolkit currently includes three EPA reports on the progress and lessons from the CRE program; four federal government publications relevant to coastal adaptation; six strategies, guides or reports by private organizations or other federal agencies relevant to vulnerability assessment; and seven reports or guides relevant to adaptation planning.¹⁴⁰ It also links to three external websites that provide further tools for adaptation.¹⁴¹ So, the CRE toolkit provides access to existing information that seemingly would be useful to coastal resource managers.

Until July 2011, the CRE’s Coastal Toolkit also collected, provided, and regularly updated a much more extensive set of information relevant to coastal climate change adaptation, including:

1. Links to raw climate, sea level rise, and ecological data;¹⁴²

137. *Estuaries Preparing to Be Climate Ready*, *supra* note 133.

138. See 2009 PROGRESS REPORT, *supra* note 123, at 6 (In 2009, “[e]ach NEP representative presented their ongoing CRE activities and participated in focused discussions and strategy sessions.”).

139. *New Website Offers Access to Climate Change Resources and Discussion Forum*, 3 READY 3, 3 (2009), available at <http://tinyurl.com/3ne7h96> [hereinafter *New Website*].

140. See *Climate Ready Estuaries, Coastal Toolkit*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climatereadyestuaries/toolkit.html> (last visited Oct. 4, 2011).

141. See *id.*

142. See *Climate Ready Estuaries: Where to Find Data*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climatereadyestuaries/data.html> (last visited Oct. 4, 2011), which is not currently linked to the CRE homepage.

2. A variety of software and tools for engaging in risk and vulnerability assessments and planning;¹⁴³
3. Manuals for developing impact indicators;¹⁴⁴
4. Actual vulnerability assessments and adaptation plans organized by EPA region;¹⁴⁵
5. A more extensive range of reports and guidance on adaptation options and adaptation planning;¹⁴⁶
6. Information about possible funding resources;¹⁴⁷ and
7. Materials for communicating climate change and adaptation planning to the public.¹⁴⁸

It also provided links to other resources on the web, such as the Ecosystem-Based Management Tool Network¹⁴⁹ (an external clearinghouse of decision-support and climate modeling tools) and the Climate Change Clearinghouse¹⁵⁰ (developed by the Water Research Foundation to help water utility decision makers).¹⁵¹

143. See *Climate Ready Estuaries: Coastal Vulnerability and Adaptation Tools*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climateradyestuaries/vulnerability.html> (last visited Oct. 4, 2011) (including “[s]oftware, data, and methodologies for assessing the vulnerability of areas to weather and storm-related stressors,” such as FEMA HAZUS Software (“risk assessment software for analyzing potential losses from floods, hurricane winds and other disasters”) and NCAR MAGICC and SCENGEN tools (“These coupled, user-friendly interactive software suites allow users to investigate future climate change and its uncertainties at both the global-mean and regional levels.”)).

144. See *Climate Ready Estuaries: Monitoring Climate Change*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climateradyestuaries/monitoring.html> (last visited Sept. 13, 2011) (supplying links to “provide guidance on coastal monitoring and indicators of climate change,” such as NOAA’s National Climate Impact Indicators program and Cleanair-Coolplanet Climate Change Indicators in the Northeast U.S.).

145. See *Climate Ready Estuaries: Coastal Toolkit: Coastal Vulnerability and Adaptation Tools: Examples of Vulnerability Assessments for Coastal Areas*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climateradyestuaries/vulnerability.html> (last updated June 20, 2011).

146. See *Climate Ready Estuaries: Coastal Toolkit: General Resources for Adaptation Planning*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climateradyestuaries/adaptationresources.html> (last updated June 20, 2011) (providing “[r]eports [to] serve as guidebooks or frameworks for the risk assessment and adaptation process”).

147. See *Climate Ready Estuaries: Coastal Toolkit: Sustainable Financing Options*, U.S. ENVTL. PROT. AGENCY, <http://epa.gov/cre/financing.html> (last updated Feb. 9, 2010). The page links to an EPA watershed funding portal for general funding information for state and local governments, nonprofit organizations, and funders. See *id.*

148. See *Climate Ready Estuaries: Coastal Toolkit: Communications and Outreach Materials*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climateradyestuaries/communications.html> (last updated June 20, 2011).

149. ECOSYSTEM-BASED MANAGEMENT TOOL NETWORK WELCOME PAGE, <http://www.ebmtools.org/> (last visited Nov. 27, 2011).

150. CLIMATE CHANGE CLEARINGHOUSE, <http://tinyurl.com/mv68xs> (last visited

3. *Limitations of the CRE program*

Unfortunately, though EPA has not completely removed all of these links and resources from its website, it no longer updates such pages¹⁵² nor links to any of these from the Coastal Toolkit or CRE program. CRE officials have indicated that though the initial toolkit was popular, it was becoming too difficult to manage on the program's limited resources.¹⁵³ As a result, the program made significant changes to the website that greatly reduced the toolkit's content because they "found that the toolkit became overpopulated, outdated, and difficult to navigate."¹⁵⁴ Congressional budget cuts for 2011 that substantially cut EPA spending on climate change¹⁵⁵ also played a role.¹⁵⁶

In any event, though the initial vision for the CRE program's toolkit was considerably more ambitious and comprehensive, even the more modest existing framework is likely to be useful to coastal resource managers seeking to engage in adaptation planning. It provides access to relevant publications and reports for determining potential effects and developing possible management strategies, and it links to a few external resources that provide more comprehensive coverage. Importantly, it provides at least a short summary of what EPA CRE program officials consider the "lessons learned" from the program.¹⁵⁷ With this supplemental information and links to outside sources, the CRE toolkit is definitely an upgrade on conventional

Nov. 27, 2011).

151. See *Climate Ready Estuaries: Coastal Toolkit: Coastal Vulnerability and Adaptation Tools*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climate-ready-estuaries/vulnerability.html> (last updated June 20, 2011).

152. E-mail from Jeremy Martinich, Environmental Scientist, U.S. Env'tl. Prot. Agency, Climate Change Division, to Jennifer Chin, Research Assistant to Alejandro Camacho, UC Irvine School of Law (July 11, 2011, 10:37 EST) (on file with author).

153. Telephone Interview with Jeremy Martinich, Environmental Scientist, U.S. Env'tl. Prot. Agency, Climate Change Division (Aug. 2, 2011).

154. *Id.*

155. See Gabriel Nelson, *Budget Deal Slams State, Regional Programs*, GREENWIRE (Apr. 12, 2011), <http://www.eenews.net/public/Greenwire/2011/04/12/2> (reporting \$1.19 billion cut below 2010 levels and that "[c]limate change work by EPA and the Interior Department . . . would end up with \$49 million less" than in 2010).

156. Telephone Interview with Jeremy Martinich, *supra* note 153.

157. See 2009 PROGRESS REPORT, *supra* note 123, at 6-9; 2010 PROGRESS REPORT, *supra* note 135, at 15; U.S. ENVTL. PROT. AGENCY, LESSONS LEARNED FROM THE CLIMATE READY ESTUARIES PROGRAM (2011), available at <http://tinyurl.com/717vuam> [hereinafter LESSONS LEARNED].

information sharing, with the potential to foster some interagency learning.

Nonetheless, the CRE program is quite limited, and by and large an opportunity missed. First, the CRE program is very limited in content and funding. The annual budget for the program is less than half a million, most of which is dispersed as grants to participating NEP estuaries, with only a small fraction dedicated to producing reports, maintaining the website, and holding workshops.¹⁵⁸ Only one non-EPA fellow works full-time on the CRE program, with two EPA officials dedicating no more than half of their time to its functioning.¹⁵⁹ Though the design of the toolkit changed recently, the content of the toolkit largely has not been updated in a year. As information and tools proliferated, EPA opted to substantially decrease the toolkit's scope rather than provide more funding and personnel for updating the toolkit.

Second, the program does not focus on evaluating and improving the efficacy of previously adopted management strategies or plans, but simply assembles existing scientific data about climate vulnerabilities and adaptation strategies. The coastal toolkit is certainly useful, but it is mostly an annotated bibliography of a few readily available reports and links to external information and tools on adaptation. The few reports on adaptation planning provide some help by enumerating several management options for managers to consider adopting. However, the options are not based on any rigorous empirical analysis of the past performance of management strategies in achieving regulatory goals. They are simply compilations of possible adaptation strategies generated by private parties, academics, or agencies, without any systematic data about their effectiveness.

This is because there is little in the NEP or CRE program that requires or encourages systematic use of adaptive management or adaptive governance.¹⁶⁰ The Clean Water Act may require each NEP estuary to develop a Comprehensive Conservation and Management Plan ("CCMP") that coordinates estuarine management.¹⁶¹

158. Telephone Interview with Jeremy Martinich, *supra* note 153.

159. *Id.*

160. See Camacho, *Adapting*, *supra* note 14, at 58–61.

161. See *National Estuary Program*, U.S. ENVTL. PROT. AGENCY, <http://water.epa.gov/type/oceb/nep/index.cfm> (last visited Nov. 27, 2011) ("Section 320 of the CWA calls for each NEP to develop and implement a Comprehensive Conservation and Management Plan (CCMP). The CCMP is a long-term plan that contains specific targeted actions designed to

However, nothing in the Act or the NEP program requires NEP estuaries or EPA to evaluate whether a CCMP has met stated goals, to adjust the CCMP if it has not, or to disseminate information regarding the CCMP's progress publicly.

Similarly, the CRE program does not require systematic adaptive management or adaptive governance of any adaptation plans adopted by participating NEPs. In fact, there is no requirement that an NEP estuary participate in the CRE program at all. As a result, though some NEP estuaries are engaging in substantial climate change adaptation planning, others are doing very little.¹⁶²

Encouragingly, the CRE program does require each participating estuary to adopt as part of its adaptation plan a "plan for monitoring and evaluating results" to qualify as "Climate Ready."¹⁶³ However, it does not require the incorporation of triggers or thresholds for action ensuring that the adopted plan is adjusted regularly to account for information learned through such assessment processes. Likewise, the CRE program does not have clear obligations to systemically assess and adjust the program itself over time. The only feedback on the efficacy of management strategies are brief annual reports where CRE officials provide their general "lessons learned" from individual CRE participating estuaries.¹⁶⁴ It is important to note that these self-assessments of the program are undoubtedly an upgrade from conventional agency inattention to learning. Even so, they certainly are insufficient to establish a rigorous commitment to regulatory experimentation or agency learning.

Finally, the information infrastructure and sharing created by the CRE program is largely one-dimensional. In both the original and more truncated versions of the CRE's toolkit, EPA provides the data, guidance, and models, with the exception of three external sites with which EPA has no involvement. The coastal toolkit is not at all collaborative; it does not provide regulators or managers the opportunity to interact with each other. As such, there are very few opportunities for interjurisdictional information sharing. One of the

address water quality, habitat, and living resources challenges in its estuarine watershed.").

162. Telephone Interview with Jeremy Martinich, *supra* note 153 (stating some NEPs "still to this day haven't even said the words 'climate change' or even thought about climate change adaptation vulnerability much at all").

163. U.S. ENVTL. PROT. AGENCY, ADAPTATION PLANNING FOR THE NATIONAL ESTUARY PROGRAM 1 (2009), *available at* <http://tinyurl.com/3mz44ws>.

164. *See* 2009 PROGRESS REPORT, *supra* note 123; 2010 PROGRESS REPORT, *supra* note 135; LESSONS LEARNED, *supra* note 157.

few circumstances under which communication between participants is facilitated is through intermittent workshops.¹⁶⁵ Again, such workshops are likely valuable fora for managers to learn from each other; yet they do not qualify as an infrastructure for sustained communication or collaborative learning.

In fact, EPA even conceded the absence of an ongoing forum for communication and coordination as a notable limitation of the CRE program in its 2009 Progress Report.¹⁶⁶ To address this acknowledged shortcoming, EPA suggested the development of “a broadly accessible and user-friendly means to exchange ideas, knowledge, resources, and technical expertise” and “an interactive online web forum moderated by CRE staff where documents can be posted and discussion groups can be formed and supported.”¹⁶⁷ Though EPA has helped facilitate communications among the CRE participants through newsletters, workshops, and outreach materials,¹⁶⁸ no interactive forum has ever materialized.

The closest venues to such a forum are external fora for coastal resource management currently or previously linked to by the CRE toolkit. NOAA’s Coastal Services Center Coastal Climate Adaptation website, for example,¹⁶⁹ provides the capacity for helping coastal decision makers connect and collaborate. Importantly, it includes a little-used forum where coastal climate adaptation practitioners “can suggest new resources, engage in dialog on the issues, and submit comments and questions.”¹⁷⁰ Additionally, at the request of some members, the site created four web pages for collaboration and file sharing: one specific to adaptation training, and three for regional coastal conservation in the Mid-Atlantic, the Southeast and Caribbean, and South Carolina, respectively.¹⁷¹

165. See 2009 PROGRESS REPORT, *supra* note 123, at 3.

166. See *id.* at 16 (“[T]here is no ongoing forum to facilitate communication and coordination among Partners, or a way for them to tap into broader networks of information.”).

167. *Id.* at 17.

168. See *id.* (recommending EPA “[f]acilitate communications among the NEPs and CRE Partners through newsletters, listservs, workshops, and outreach materials”).

169. See *New Website*, *supra* note 139, at 3 (stating Coastal Climate Adaptation website “focuses on adaptation-related resources, such as local and state plans, new policies, case studies, risk and vulnerability assessments, and decision support tools”).

170. See *id.*

171. *Coastal Climate Adaptation Sub-Groups*, COASTAL CLIMATE ADAPTATION, <http://tinyurl.com/3sr4g6r> (last visited Nov. 27, 2011).

Another of the external links is to the Climate Adaptation Knowledge Exchange (“CAKE”), a privately created site “aimed at building a shared knowledge base for managing natural systems in the face of climate change.”¹⁷² The site seeks to provide information and data relevant to climate change adaptation, build “a community via an interactive online platform,” and create “a directory of practitioners to share knowledge and strategies.”¹⁷³ It also “houses community forums for the discussion of current issues in conservation in a changing climate.”¹⁷⁴

The Coastal Toolkit also used to directly link to StormSmart Coasts, a social networking site designed primarily to help local community decision makers prepare for and manage the effects of coastal storms.¹⁷⁵ Organized on a state-specific basis (currently only for seven states),¹⁷⁶ the site includes information and tools to help local decision makers prepare for, manage during, and recover from storm events and other coastal disasters.¹⁷⁷ The network also includes a social-media section called StormSmart Connect that seeks to help “coastal decision makers connect and collaborate”¹⁷⁸ through group¹⁷⁹ and event¹⁸⁰ pages that allow members to post messages and

172. See *About CAKE*, CLIMATE ADAPTATION KNOWLEDGE EXCHANGE, <http://www.cakex.org/about> (last visited Nov. 27, 2011).

173. *Id.*

174. *Id.* The third external site to which the CRE program currently links is the Climate Ready Water Utilities Toolbox, established through another EPA program to provide resources for water utilities to engage in adaptation planning. See *Climate Ready Water Utilities Toolbox*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/safewater/watersecurity/climate/toolbox.html> (last updated Aug. 5, 2011). This database is searchable and includes information about funding opportunities, reports, tools and models, and other activities and seminars on climate change relevant to local government and utilities in the water sector. See *id.* EPA developed and makes available through the toolkit the Climate Resilience Evaluation and Awareness Tool, a risk assessment and scenario-based program, and the Tabletop Exercise Tool for Water Systems, created to help utilities engage in vulnerability assessments and adaptation planning. See *Climate Resilience Evaluation and Awareness Tool*, U.S. ENVTL. PROT. AGENCY, <http://water.epa.gov/infrastructure/watersecurity/climate/creat.cfm> (last updated Oct. 3, 2011); *Tabletop Exercise Tool for Water Systems: Emergency Preparedness, Response, and Climate Resiliency*, U.S. ENVTL. PROT. AGENCY, http://yosemite.epa.gov/ow/SReg.nsf/description/TTX_Tool (last visited Nov. 27, 2011).

175. See *NATIONAL STORMSMART COASTS NETWORK HOME*, <http://stormsmartcoasts.org/> (last visited Nov. 27, 2011).

176. The state-specific sites are for Massachusetts, Mississippi, Louisiana, Alabama, Texas, Florida, and Rhode Island. See *id.* The site states that four more states are “coming soon”. See *id.*

177. See *id.*

178. *Id.*

179. See *StormSmart Connect Groups Directory*, STORMSMART.ORG, <http://>

documents. As of November 2011, there are currently 705 active members of the network, mostly located where there are state-specific sites.¹⁸¹ Though not focused on climate change and concentrating on promoting state-specific interactions, the website does provide a forum for sustained interaction among regulators.

These non-CRE sites are certainly helpful at providing a subset of interested managers with information relevant to climate change adaptation, and they also provide opportunities for communication and interaction among their participants. However, they do not meet the need for a coordinated governmental hub dedicated to promoting learning by agency officials and more adaptive and effective management over time. Though innovative and interactive, the StormSmart Coasts Network's focus on local officials and coastal storms is restricted to too narrow a subset of authorities and subject matter. Furthermore, the most recent iteration of the CRE's Coastal Toolkit no longer even mentions StormSmart Coasts.¹⁸² NOAA's Coastal Climate Adaptation website and the privately run CAKE site focus on climate change adaptation, but their discussion forums are obscure and seldom used. Only eighteen threads have ever been posted in NOAA's different forums,¹⁸³ and just five threads (and two comments) have been created so far in 2011.¹⁸⁴ Similarly, CAKE's discussion forums have included only seventy-seven posts since its creation (virtually all by a few administrators) and twenty responses,¹⁸⁵ despite featuring such topics as "Adaptation in the News," "Causes and Impacts of Climate Change," and "Adaptation

stormsmart.org/groups/ (last visited July 15, 2011).

180. See *StormSmart Connect Events Directory*, STORMSMART.ORG, <http://stormsmart.org/events/> (last visited Nov. 27, 2011).

181. *StormSmart Connect Members Directory*, STORMSMART.ORG, <http://stormsmart.org/members/> (last visited Nov. 27, 2011).

182. See *Coastal Toolkit*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/climatereadyestuaries/toolkit.html> (last visited Nov. 27, 2011).

183. *Coastal Climate Adaptation Forums*, COASTAL CLIMATE ADAPTATION, <http://collaborate.csc.noaa.gov/climateadaptation/pages/forum.aspx> (last visited Nov. 27, 2011) (including fifteen posts under "General Topics," one under "Adaptation Trainings," one under "Coastal Habitat Conservation for the Mid-Atlantic," one under "Southeast and Caribbean Climate Extension and Outreach Community of Practice," and none under "South Carolina Coastal Information Network").

184. *Forum of General Topics*, COASTAL CLIMATE ADAPTATION, <http://collaborate.csc.noaa.gov/climateadaptation/Lists/forum/AllItems.aspx> (last visited Nov. 27, 2011).

185. See *Discussion Forums*, CLIMATE ADAPTATION KNOWLEDGE EXCHANGE (CAKE), <http://www.cakex.org/forums/Discussion%20Forums> (last visited Nov. 27, 2011).

Strategies”¹⁸⁶—topics on which there are thousands of new sources created on a daily basis.¹⁸⁷

Though these sites may be laudable, they are treated only incidentally as venues for information sharing and agency learning, not only by CRE but also by the sites themselves. Both the CAKE and StormSmart Coasts Network sites are nongovernmental sites, and the NOAA’s site is external to CRE; thus, these sites are not integrated into the information gathering and learning apparatus of EPA, participating NEP estuaries, or their constituent local agencies. These sites are not part of a regulatory regime that requires or otherwise encourages participating agencies to monitor, assess, and broadcast their adaptation plans or adopted strategies. There is no statutory or administrative requirement embedded in the program for participating agencies to adjust their management strategies or planning decisions over time. In short, none of the sites are intended to serve as core centers of information gathering, planning, or learning for government resource managers or the public.

Moreover, all three of the sites primarily seek to provide other—mostly local—resource managers with information that the sites’ supervisors unilaterally deem important for those managers to have in order to engage in adaptation planning. Despite the implication in CAKE’s name—that it is a knowledge exchange—the compilation of CAKE’s library and tools is centrally controlled by the site’s administrators, like CRE’s toolkit and the other external sites. Though each site attempts to provide some method for information sharing among participants, those efforts are perfunctory and peripheral.

V. CONCLUSION: INDUCING ADAPTIVE AND COLLABORATIVE LEARNING

Because jurisdiction over natural resources in the United States is divided among a wide number of overlapping private, local, state, and federal authorities, there are substantial opportunities for management experimentation and interjurisdictional learning.¹⁸⁸ The considerable uncertainty regarding the nature and scope of local

186. See *Discussion Forums*, *supra* note 185.

187. For example, a search in Google News on September 16, 2011 for “climate change” yielded 21,600 results for the preceding twenty-four hour period.

188. See Jonathan H. Adler, *Jurisdictional Mismatch in Environmental Federalism*, 14 N.Y.U. ENVTL. L.J. 130, 135–37 (2006).

effects of climate change¹⁸⁹ makes this capacity for learning incredibly important. Unfortunately, because regulators are not obliged to learn and adapt, and because authorities are not provided opportunities to learn from each other, U.S. natural resources management is not well designed to promote systematic regulatory experimentation and learning.

As exemplified by the two prominent federal climate change adaptation initiatives, the Environmental Protection Agency's Climate Ready Estuaries program and the Council on Environmental Quality's Federal Agency Adaptation Planning Implementing Instructions, even those environmental and natural resource management officials in the United States who are most assiduously seeking to engage in adaptation planning have failed to create more adaptive institutions and processes that encourage collaborative learning. A few agencies may be focusing on reducing uncertainty, but they are doing so by merely collecting readily available scientific information and quickly assembling ideas about what adaptation options might make sense.

The Interagency Climate Change Adaptation Task Force does advise managers to adaptively manage, collaborate, and share information.¹⁹⁰ Yet, ignoring the evidence of prior uses of adaptive management, it does not require concrete triggers for or otherwise incentivize continued assessment and adjustment of management decisions.¹⁹¹ The Task Force also ignores the growing cyber-technology on collaborative learning, failing to provide an adequate infrastructure to promote information sharing. Similarly, the CRE program is in the vanguard of adaptation planning by providing funding, a toolkit, and guidance to local resource managers.¹⁹² However, the CRE pays insufficient attention to systematic assessment and adjustment of management, and its coastal toolkit is very limited in scope and provides few opportunities for collaborative learning.

189. *See supra* notes 14–15 and accompanying text.

190. *See infra* notes 76–96 and accompanying text.

191. *Cf.* FRESHWATER NATIONAL ACTION PLAN, *supra* note 75, at 29 (recommending but not requiring that federal agencies “develop benchmarks for incorporating adaptive management into their planning and operations and . . . allocate a portion of project funds for monitoring for adaptive management”).

192. *See infra* notes 134–150 and accompanying text.

These initiatives thus demonstrate the continued reluctance of regulatory institutions to systematically monitor, assess, and adjust management activities in furtherance of program goals.¹⁹³ Accordingly, even when agencies develop mechanisms such as clearinghouses and toolkits for sharing information, substantial and avoidable information gaps about the efficacy of management options exist. This prevents not only the performing manager from learning from past performance, but also inhibits other managers and the broader public from doing the same. Natural resources law must require and otherwise encourage periodic monitoring, assessment, and modification of management activities to reduce uncertainty.

Moreover, the few existing government information repositories for climate change adaptation are largely unidirectional. They establish an information hub for which local resource managers or management agencies are the peripheral nodes, with information traffic largely in one direction—from the hub to the nodes. Information only intermittently and informally travels from the nodes to the hub, and there is little, if any, traffic between the various nodes. Such a structure fails to sufficiently harness the substantial experience of and information possessed by the various nodes and underestimates the value of interactive learning.

Natural resources regulatory institutions must develop and support an adaptive and interactive information-sharing cyberinfrastructure. The Collaboratory for Adaptation to Climate Change,¹⁹⁴ a collaborative research effort of which I am a co-investigator, seeks to provide such a learning environment in which stakeholders, researchers, and the broader public can interact and collaborate to improve adaptation planning. The Collaboratory draws in part on my earlier proposals for the development of an information-sharing and learning infrastructure to facilitate climate change adaptation.¹⁹⁵ With funds awarded by the National Science Foundation's Office of Cyberinfrastructure, an interdisciplinary research group of ecologists, computer scientists, a political scientist, a sociologist, and a legal scholar¹⁹⁶ have begun developing a new

193. See Camacho, *Adapting*, *supra* note 14, at 40–42, 47–50, 60; Camacho, *Can Regulation Evolve?*, *supra* note 17, at 332–42.

194. COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/home> (last visited Nov. 27, 2011).

195. See Camacho, *Adapting*, *supra* note 14, at 65–70.

196. See *Our People*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/about/ourpeople> (last visited Nov. 27, 2011).

virtual environment for researchers, policy makers, and any other interested participants to share ideas, assimilate information, and form new strategies relevant to the effects of climate change and adaptation planning. In its initial stages, the Collaboratory will focus on adaptation for wildlife and biological resources, but is expected to expand further to incorporate other climate change impact areas.¹⁹⁷

The Collaboratory relies on cyberinfrastructure, data and knowledge management, simulations, scenario analysis, and visual analytics. The basic framework of the Collaboratory is being built on the HUBzero software platform¹⁹⁸ and tailored to allow for other climate change exercises and other dimensions of adaptation to climate change. Akin to more conventional, comprehensive information clearinghouses, the Collaboratory is being designed to include a range of searchable information, including (1) international, federal, and state legal and policy information;¹⁹⁹ (2) next-generation biological models for simulating geographic-range change and assessing ecosystem vulnerability due to climate change, such as the Climate Change Vulnerability Index and OpenModeller Desktop Tool,²⁰⁰ as well as other decision-support tools that can be accessed via a web browser to examine future scenarios and potential adaptation strategies;²⁰¹ (3) publications,²⁰² examples and case studies,²⁰³ educational materials,²⁰⁴ and other online resources relevant to climate change adaptation;²⁰⁵ (4) survey research of

197. See *About Us*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/about> (last visited Nov. 27, 2011).

198. See HUBZERO, <http://www.hubzero.org> (last visited Nov. 27, 2011).

199. *Resources: Regulatory Information*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/resources/regulatoryinformation> (last visited Nov. 27, 2011).

200. *Resources: Tools*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/resources/tools> (last visited Nov. 27, 2011).

201. See *Decision Support*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/about/decisionsupport> (last visited Nov. 27, 2011).

202. *Resources: Publications*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/resources/publications> (last visited Nov. 27, 2011).

203. *Resources: Case Studies*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/resources/casestudies> (last visited Nov. 27, 2011).

204. *Resources: Educational Materials*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/resources/educationalmaterials> (last visited Nov. 27, 2011).

205. *Resources: Other Online Resources*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/resources/otheronlineresources> (last visited Nov. 27, 2011).

scientific experts and resource managers on climate change impacts on biodiversity and strategies for managing those effects on ecological resources;²⁰⁶ and (5) analyses of the combined effects of (a) ecological capacity for range change in species due to climate change and (b) jurisdictional differences in environmental regulations that allow humans to manage those species.

However, the Collaboratory will also provide many opportunities for participants to provide data and interact with other participants. Two of the primary goals of the Collaboratory are “[f]acilitating interactions among researchers and decision makers,” and “[p]roviding a vibrant online medium that converts data into knowledge.”²⁰⁷ The Collaboratory is designed to facilitate participation by a wide range of users, including “scientists, natural resource managers and planners, students and the interested public.”²⁰⁸ In addition to providing community forums,²⁰⁹ it will allow participants to create accounts and contribute data, publications, and tools for others to share.²¹⁰ Participants also will be able to send and receive messages with other participants, provide feedback to administrators, participate in polls,²¹¹ customize their own page,²¹² and form working groups with other participants.²¹³

In addition to promoting flexibility and the iterative growth of the Collaboratory, this initiative also seeks to cultivate adaptive learning about learning and decision-making processes themselves. It will incorporate experimental study of the effects of user interaction with the virtual organization on decision making and collaboration. This includes partnerships with the Nature Conservancy, the City of Chicago, Chicago Wilderness, and other organizations to build an initial base of Collaboratory users through a series of climate clinics with government and private natural resource managers.

206. See *About Us*, *supra* note 197.

207. See *id.*

208. See *id.*

209. See *Questions & Answers*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/answers> (last visited Nov. 27, 2011).

210. See *About Us*, *supra* note 197.

211. See *Poll: Latest*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/xpoll> (last visited Nov. 27, 2011).

212. See *my Adapt*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/myhub> (last visited Nov. 27, 2011).

213. See *Groups*, COLLABORATORY FOR ADAPTATION TO CLIMATE CHANGE, <https://adapt.crc.nd.edu/groups> (last visited Nov. 27, 2011).

The federal government should more widely develop a similarly adaptive and interactive collaboratory dedicated to climate change to facilitate collaborative learning among resource managers, research scientists, and the public. Though modest in scope, at least one other initiative is similarly seeking to leverage cyber-technology and public participation to collect and share information on the effects of climate change on plants and animals.²¹⁴ If established and funded, perhaps the Obama administration's proposed NOAA Climate Service could provide scientific data on climate as well as decision-support tools for managers and the public.²¹⁵ However, Congress declined to approve and fund such a Climate Service in 2011, and is likely to do so in 2012 as well.²¹⁶ Even if such a service were approved, the Administration's intent for the Climate Service is a reorganization of existing NOAA activities that are focused on scientific research and monitoring;²¹⁷ as such, it is unlikely that it will assemble or provide access to evaluative information on the past performance of management strategies to inform future decision making.²¹⁸

An interactive and adaptive learning infrastructure, used more broadly, would help increase information to and provide tools for researchers, decision makers, and stakeholders to help them better understand the potential consequences from changes in climate and the tradeoffs of possible strategies for reducing such effects. Perhaps

214. See, e.g., USA NAT'L PHENOLOGY NETWORK, <http://www.usanpn.org> (last visited Nov. 27, 2011) ("The USA National Phenology Network brings together citizen scientists, government agencies, non-profit groups, educators and students of all ages to monitor the impacts of climate change on plants and animals in the United States. The network harnesses the power of people and the Internet to collect and share information, providing researchers with far more data than they could collect alone."). This network "uses the power of the Internet to empower stakeholders to enter phenological observations into an online database that can be used to assist decision-makers in responding to climate change." Joseph A. Siegel, *Collaborative Decision Making on Climate Change in the Federal Government*, 27 PACE ENVTL. L. REV. 257, 290 (2009).

215. See NAT'L OCEANIC AND ATMOSPHERIC ADMIN., PROPOSED CLIMATE SERVICE IN NOAA, available at <http://tinyurl.com/3bfbgxn> [hereinafter PROPOSED CLIMATE SERVICE].

216. Allison Winter, *Appropriations: Request for NOAA Funding Increase Faces Key Test*, ENV'T & ENERGY DAILY (July 5, 2011), <http://www.eenews.net/EEDaily/2011/07/05/archive/6?terms=%22Climate+Service%22>.

217. See PROPOSED CLIMATE SERVICE, *supra* note 215.

218. Cf. Jean Chemnick, *Climate: Science Panel Grills NOAA Chief on Proposed Climate Office*, GREENWIRE (June 5, 2011), <http://www.eenews.net/Greenwire/2011/06/22/8> (login required) (stating that NOAA chief Jane Lubchenco affirmed that "the role of the center would be to coordinate NOAA's response to weather trends, not to advocate for policy").

of equal importance, by providing a range of concrete mechanisms for interaction, this cyberinfrastructure would offer managers more opportunities to communicate with other similarly situated regulators and thus promote interjurisdictional learning and collaboration. It would also facilitate more transparent debate and deliberation between regulators, researchers, and, most importantly, the broader public about remaining uncertainties and the relative value of management alternatives.

Of course, a collaboratory would work particularly well if combined with a regulatory mandate that managers engage in sustained monitoring, assessment, and adjustment of agency management strategies and adopted plans. Such a directive would increase the production of available information about the efficacy of alternative management strategies, while the collaboratory would both help disseminate such information and harness the broader experiences of a range of resource managers in evaluating and addressing specific management decisions. In all, a climate change adaptation collaboratory, combined with a regulatory framework that requires and promotes systematic adaptive governance, would help reduce uncertainty and foster more accountable and adaptive resource management. In so doing, it would build the capacity for managers and private parties alike to learn to better plan for and manage uncertainty and change.

