



**Essential Readings in Environmental Law**  
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## **RESILIENCE AND ENVIRONMENTAL LAW**

**Tracy-Lynn Humby**, University of the Witwatersrand, South Africa

### **OVERVIEW OF KEY SCHOLARSHIPS**

#### **Reviews of resilience, adaptive management and adaptive co-management in non-legal literature**

1. Walker, B., and D. Salt, *Resilience thinking: Sustaining ecosystems and people in a changing world* (Island Press, 2006).
2. Folke, C., “Resilience: The emergence of a perspective for social-ecological systems analysis”, (2006) 16, *Global Environmental Change*: 253–267.
3. Plummer, R., B. Crona, R. D. Armitage, P. Olsson, M. Tengö, and O. Yudina, “Adaptive comanagement: A systematic review and analysis”, (2012) 17:3 *Ecology and Society*, 11.
4. Folke, C., T. Hahn, P. Olsson, and J. Norberg, “Adaptive governance of social-ecological systems”, (2005) 30 *Annual Review of Environmental Resources* 441–473.

#### **Implications of a resilience perspective for law and governance**

5. Ruhl, J. B., “General design principles for resilience and adaptive capacity in legal systems – with applications to climate change adaptation”, (2010 – 2011) 89 *North Carolina Law Review* 1373–1403.
6. Cosens, B., “Transboundary river governance in the face of uncertainty: Resilience theory and the Columbia River Treaty”, (2010) *Journal of Land, Resources and Environmental Law* 229–265.
7. Arnold, C., and L. Gunderson, “Adaptive law and resilience”, (2013) 43 *Environmental Law Reporter News and Analysis* 10426.
8. Humby, T. “Law and resilience: Mapping the literature” *Seattle Environmental Law Journal* (forthcoming Winter 2014).

#### **Theoretical and empirical discussions on law and adaptive management**

9. Lee, N. K., and J. Lawrence, “Adaptive management: Learning from the Columbia River Basin fish and wildlife program”, (1985) 16 *Environmental Law* 431–460.
10. Ruhl, J.B., “Regulation by adaptive management – is it possible?” (2005–2006) 7 *Minnesota Journal of Law, Science & Technology* 21–57.

11. Angelo, M. J. “Stumbling towards success: A story of adaptive law and ecological resilience”, (2008) 87 Nebraska Law Review 950–1007.

### **Critiques of adaptive management**

12. Doremus, H. “Adaptive management as an information problem”, (2010–2011) 89 North Carolina Law Review 1455–1498.

### **Background**

Resilience is a term encountered with increasing frequency in a broad range of disciplines. The proliferation of talk about resilience can in part be ascribed to recent enthusiasm for armouring the human race against climate change, and ‘climate-resilient development’ is emerging as a term of art in its own right. However, the turn to resilience is reflective of a broader paradigm shift in the disciplines of ecology and natural resources management that extends as far back as the 1970s. This is a paradigm shift marked by attempts to apprehend and develop conceptual resources to manage complexity in both natural and social systems. Theories of resilience, along with ‘adaptive management’ and ‘adaptive governance’, therefore constitute a maturing conceptual frame for thinking about how law can contribute to sustainability in a complex world.

### **Reviews of resilience, adaptive co-management, and adaptive governance in non-legal literature**

1. **B. Walker** and **D. Salt’s** *Accessible Treatise Resilience Thinking: Sustaining Ecosystems and People in a Changing World* arose out of appeals for a plainly written account of resilience theory and adaptive management as it has developed since the ground breaking work of ecologists **C. S. (‘Buzz’) Holling** and **C. J. Walters** in the late 1970s and 1980s. The authors outline the essence of resilience thinking in terms of key theoretical propositions, and enrich this discussion with five case studies illustrating the significance of resilience thinking when applied to real-world situations. After identifying optimization and efficiency as key drivers of unsustainable development, the authors point to the importance of taking a systems perspective of how the world works. This entails recognizing that we are all part of linked systems of humans and nature (the important concept of social-ecological systems), that these systems are both complex and adaptive (both sustained and changed by the relations among the system’s component parts), and that resilience, as a property of social-ecological systems (the capacity of a system to absorb disturbance and still retain its basic structure and function), is the key to the sustainability of these systems. The authors go on to explain the importance of thresholds and adaptive cycles. The final chapter concludes with thoughts on how to apply resilience thinking to the real world, and includes an identification of nine values that could drive the realization of a more resilient world. **Walker** and **Salt** have subsequently brought out a companion volume to Resilience Thinking entitled **Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function** (Island Press, 2012).

2. **C. Folke's** 2006 article *Resilience: The emergence of a perspective for social-ecological systems analysis* is a more detailed review of the origin of the resilience perspective, and its subsequent development, with citations to the seminal literature in ecology, natural resources management, environmental psychology, cultural theory and common property research, amongst others. **Folke** argues that the resilience perspective emphasizes non-linear dynamics, thresholds, uncertainty and surprise, and how periods of gradual and rapid change alternate and relate across spatial and temporal scales (explaining **Gunderson** and **Hollings'** concept of panarchy). He proposes an expanded understanding of resilience to include, in addition to the system's capacity to absorb disturbance and still remain within the same state or domain of attraction, its capacity to self-organize and the quality of that self-organization, and the degree to which the system can build and increase the capacity for learning and adapting. He outlines recent attempts to understand the social dimension of resilience, pointing to advances made in understanding, amongst others, systems of adaptive governance.
3. Adaptive management and adaptive co-management have developed as approaches to apply resilience theory to natural resources management. In their 2012 article titled *Adaptive comanagement: A systematic review and analysis*, **R. Plummer et al.** explain the emergence of adaptive co-management (ACM) in the combination of the adaptive and collaborative narratives in resource management. Adaptive co-management, they hold, forges both horizontal and vertical linkages for shared learning by doing between various actors, over a medium to long time horizon. Their detailed analysis of more than 100 published items on ACM unpacks the ACM construct, characterizes the literature, and examines relationships among aspects of ACM based on accumulated experiences to date.
4. The article *Adaptive governance of social-ecological systems* by **C. Folke et al.** explores the social dimension that enables adaptive ecosystem-based management. In particular, they investigate the social sources of renewal and reorganization that enable adaptive governance of social-ecological systems during periods of rapid change. For such systems to re- and self-organize, they highlight the importance of social networks able to draw on various knowledge systems and experiences in order to develop a common understanding and policies. The authors note that enabling legislation and government policies can support self-organization while framing creativity for ACM efforts.

### **Implications of a resilience perspective for law and governance**

5. The mainstream scientific literature on resilience, adaptive management and adaptive governance has been accused of, at times, sidelining the role of law. With its emphasis on certainty and predictability, law has even been viewed as one of the factors undergirding the resilience of unsustainable social-ecological systems. Since at least

1985, however, legal scholars have been actively engaged in applying the insights of resilience theory and its associated concepts to legal systems. Building on his earlier work, **J. B. Ruhl**, in *General design principles for resilience and adaptive capacity in legal systems – with applications to climate change adaptation*, summarizes the theoretical context and principles for designing legal systems that will prove to be resilient and adaptive. **Ruhl** distinguishes between the resilience of legal systems, the resilience of laws they produce, and the resilience of the underlying social-ecological systems they are designed to address. Taking as a point of orientation the design of adaptive climate change adaptation law, **Ruhl** emphasizes the need: to unshackle environmental and water law from comprehensive rational planning and other “front-end” decision-making processes; to move away from command-style, fixed regulation by fiat in favour of “new governance” theories that advocate stakeholder participation, collaboration amongst interests, decentralized governance structures, integration of policy domains, flexibility, and an emphasis on non-coerciveness and adaptation; to make the case for local and regional governance in adaptation policy; and to facilitate the work of trans-governmental networks.

6. In the law and resilience literature, the work of **B. Cosens**, stands out by virtue of her own scientific background and her work with members of the Stockholm Resilience Institute. In a 2010 article, entitled *Transboundary river governance in the face of uncertainty: Resilience theory and the Columbia River Treaty*, **Cosens** introduces and reviews some of the relevant work on the concept of resilience in governance, before examining how the concept can be applied to the issue of uncertainty in transboundary water governance. Specifically, she examines the 1964 Treaty between the United States and Canada that mandated joint operation of the river for purposes of hydropower production and flood control, and argues that this multi-jurisdictional attempt at river governance can be improved through the application of a resilience lens.
7. **C. Arnold** and **L. Gunderson**'s article, titled *Adaptive law and resilience*, provides an up-to-date account of the features of environmental law in the United States that render it maladaptive and unsuited to managing abrupt and unpredictable change. These include systemic goals that are too narrowly focused; monocentric institutional structures that centralize authority; the use of single, uniform, and fragmented models to solve problems; inflexible methods that employ rules and legal abstractions and promote resistance to change; and rational, linear, legal-centrist processes that assume away uncertainty. Their advocacy for an alternative, resilience-promoting model of “adaptive law” is based on the following features: multiplicity of articulated goals; polycentric, multimodal and integrationist structure; adaptive methods based on standards, flexibility, discretion and regard for context; and iterative legal-pluralist processes with feedback loops, learning and accountability.

8. A review by **T. Humby**, entitled *Law and resilience: Mapping the literature*, discusses the general features of the law and resilience literature, based on an analysis of 74 published items. She finds that aspects of law and governance marked as deficient by legal commentators include: incorrect understandings of the dynamics of natural systems; substantive goals that legitimate resource optimization; monocentric, uniscalar, and unimodal governing authority; and linear, front-loaded legal processes. Law and governance can instead enhance resilience by opting for a systems view of the object of regulation; enhancing monitoring, reflexivity and information generation and diffusion; supporting multiscalar, polycentric and open governance; and accommodating the adaptability of the legal system itself.

### **Theoretical and empirical discussions on law and adaptive management**

9. There have been many accounts, in the legal scholarly literature, of the relationship between law and adaptive management. In one of the earliest case studies, **K. N. Lee** and **J. Lawrence** describe the application of adaptive management to the “unusual requirements” of the Columbia River Basin Fish and Wildlife Council of the Northwest Power Planning Council in their 1985 article *Adaptive management: Learning from the Columbia River Basin fish and wildlife program*. The article is notable for articulating many of the supporting arguments for the application of adaptive management, particularly the capacity of this approach to generate new knowledge. Adaptive management emphasizes the learning opportunities implicit in protecting and enhancing fish and wildlife, they argue, and by treating program measures as experiments one is able to proceed with rebuilding while learning to do so more effectively in the future.
10. In his 2005 article, *Regulation by adaptive management – is it possible?* **J.B. Ruhl** argues that adaptive management requires institutionalisation of monitoring-adjustment frameworks that allow incremental policy and adjustment decisions at the “back end”. Because adaptive management is information driven, requiring that performance results be fed into the ongoing regulatory process, it requires affording regulatory agencies a certain degree of latitude. Such latitude may be impaired by legislatures failing to empower the regulatory agency, or by interest groups that challenge every decision at every turn, or by courts second-guessing their judgment. In this article, Ruhl explores these concerns with reference to the Habitat Conservation Plan program under the United States of America’s *Endangered Species Act*.
11. In one of the best case studies of law and adaptive management, **M. J. Angelo** explores the stuttering success of applying adaptive management to the Lake Apopka restoration project in her article *Stumbling towards success: A story of adaptive law and ecological resilience*. **Angelo**’s fine-grained analysis highlights many of the features and difficulties associated with adaptive management. After some initial success in attracting a number

of bird species back to the lake, scientists overseeing the program were shocked when only a few months later hundreds of birds were dying. The deaths were later ascribed to incorrect models for estimating pesticides in soils and the scientists involved were later able to develop improved methods for modeling this phenomenon based on what they had learned from the bird deaths. In the immediate aftermath of the tragedy, however, and although the federal agencies had been co-operating with the agency, the U.S. Justice Department initiated a criminal investigation into the matter. The carcasses of the birds were seized, preventing a proper scientific investigation into the cause of their deaths, and the scientists were no longer able to work together or share information. The criminal and civil issues arising from the bird kill were later resolved in a Memorandum of Understanding between the SJRWMD and the United States, but the case dramatically depicts the extent to which values associated with conventional legal processes can come into conflict with the requirements of adaptive management.

### **Critiques of adaptive management**

12. With a few exceptions, legal scholars have tended to embrace resilience and adaptive management somewhat uncritically. However in an article, entitled *Adaptive management as an information problem*, **H. Doremus** argues that adaptive management should only be used when it promises to improve management outcomes sufficiently to justify the additional costs it imposes. She holds that an explicit formal analysis of the prospects for learning and the value of learning for management should precede any decision to apply adaptive management. Such analyses could also provide guidance on facilitating information production and improving information diffusion.

### **Appendix I: Further Recommended Readings**

1. Adelman, D. E., "The challenge of abrupt climate change for US environmental regulation", *Emory Law Journal* (2008 – 2009) 58: 379–410.
2. Adger, W.N., "Vulnerability", *Global Environmental Change* (2006) 16: 268–281.
3. Aguirre, B.E., "Dialectics of vulnerability and resilience", *Georgetown Journal on Poverty, Law & Policy* (2007) 14(1): 39–59.
4. Alder, R. W., "Resilience, restoration and sustainability: Revisiting the fundamental principles of the Clean Water Act" *Washington University Journal of Law and Policy* (2010) 32: 139-174.
5. Angelo, M. J., "Stumbling towards success: A story of adaptive law and ecological resilience", *Nebraska Law Review* (2008) 87: 950–1007.
6. Ankersen, T., and R. Hamann, "Ecosystem management and the Everglades: A legal and institutional analysis", *Journal of Land Use and Environmental Law* (1995–1996) 11: 473–536.
7. Armitage, D., "Resilience and administrative law", *Ecology & Society* (2013) 18(2): 11–12.

8. Armitage, D., R. Plummer, F. Berkes, R. L. Arthur, A. T. Charles, I. J. Davidson-hunt, A. P. Diduck, N. C. Doubleday, D. S. Johnson, M. Marschke, P. McConney, E. W. Pinkerton, and E. K. Wollenberg, "Adaptive co-management for social-ecological complexity", *Frontiers in Ecology and the Environment* (2009) 7(2): 95–102.
9. Arnold, C. A., "Adaptive watershed planning and climate change", *Environmental and Energy Law & Policy Journal* (2010) 5: 417–487.
10. Arnold, C. and L. Gunderson, "Adaptive law and resilience", *Environmental Law Reporter News and Analysis* (2013) 43: 10426.
11. Aslan, J., "Building Alaska native village resilience in a post-peak world", *Vermont Law Review* (2012) 37: 239–269.
12. Barnes, R.A., "The capacity of property rights to accommodate social-ecological resilience", *Ecology and Society* (2013) 18(1): 6.
13. Benson, M. H. and S. A. Garmestani, "Embracing panarchy, building resilience and integrating adaptive management through a rebirth of the National Environmental Policy Act", *Journal of Environmental Management* (2011) 92: 1420–1427.
14. Benson, M.H., "Intelligent tinkering: The Endangered Species Act and resilience", *Ecology and Society* (2012) 17(4): 28.
15. Bosselman, F., "A role for state planning: Intergenerational equity and adaptive management", *University of Florida Journal of Law and Public Policy* (2000) 12: 311 – 333.
16. Brand, F.S., and K. Jax, "Focusing the meaning(s) of resilience: Resilience as a descriptive object and boundary concept", *Ecology and Society* 2007 12(1): 23.
17. Bromley, D.W., "Environmental governance as stochastic belief updating: Crafting rules to live by", *Ecology and Society* (2012) 17(3): 14.
18. Brunner, R. D., and A. H. Lynch, *Adaptive Governance and Climate Change* (American Meteorological Society, 2010).
19. Burleson, E., "Energy revolution and disaster response in the face of climate change", *Villanova Environmental Law Journal* (2011) 22: 101–119.
20. Camacho, A.E., "Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure", *Emory Law Journal* (2009) 59: 1.
21. Camacho, A., "Transforming the means and ends of natural resources management", *North Carolina Law Review* (2010–2011) 89: 1405–1545.
22. Coleman, W. T., "Legal barriers to the restoration of aquatic ecosystems and the utilization of adaptive management", *Vermont Law Review* (1998) 23: 177.
23. Cosens, B., "Resilience and law as a theoretical backdrop for natural resource management: Flood management in the Columbia River Basin", *Environmental Law* (2012) 42: 241–264.
24. Cosens, B., "Transboundary river governance in the face of uncertainty: Resilience theory and the Columbia River Treaty", *Journal of Land, Resources and Environmental Law* (2010) 229–265.

25. Cosens, B., and M. Williams, "Resilience and water governance: Adaptive governance in the Columbia River Basin", (2012)  
[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1942587](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1942587)
26. Craig, R.K., "Legal remedies for deep marine oil spills and long-term ecological resilience: A match made in hell", *Brigham Young University Law Review* (2011) 1863–1897.
27. Cumming, G., "Scale mismatches and reflexive law", *Ecology and Society* (2013) 18(1): 15.
28. D'Agostino, J.R., "Resistance to resilience: Coastal hazard policy, science and planning in New Jersey", *Sea Grant Law and Policy Journal* (2008) 1(1): 116–129.
29. Davidson, J. H. and T. E. Geu, "The Missouri river and adaptive management: Protecting ecological function and legal process", *Nebraska Law Review* (2001) 80: 816.
30. Doremus, H., "Adaptive management as an information problem", *North Carolina Law Review* (2010–2011) 89: 1455–1498.
31. Doremus, H., "Adaptive management, the Endangered Species Act, and the challenges of 'New Age' environmental protection" *Washburn Law Journal* (2001) 41: 50–89.
32. Duit, A., V. Galaz, K. Eckerberg, and J. Ebbesson, "Introduction: Governance, complexity and resilience", *Global Environmental Change* (2010) 20: 363–368.
33. Ebbesson, J., "The rule of law in governance of complex socio-ecological changes", *Global Environmental Change* (2010) 20(3): 414–422.
34. Flatt, V. B., "Adapting laws for a changing world: A systemic approach to climate change adaptation", *Florida Law Review* (2012) 64: 269–293.
35. Flournoy, A.C., "Protecting a natural resource legacy while promoting resilience: Can it be done?", *Nebraska Law Review* (2008) 87: 1008–1035.
36. Folke, C., "Resilience: The emergence of a perspective for social-ecological systems analysis", *Global Environmental Change* (2006) 16: 253–267.
37. Folke, C., T. Hahn, P. Olsson, and J. Norberg, "Adaptive governance of social-ecological systems", *Annual Review of Environmental Resources* (2005) 30: 441–473.
38. Gallopin, G.C., "Linkages between vulnerability, resilience and adaptive capacity", *Global Environmental Change* (2006) 16: 293–303.
39. Garmestani, A.S., C.R. Allen, and H. Cabezas, "Panarchy, adaptive management and governance: Policy options for building resilience", *Nebraska Law Review* (2008 – 2009) 87: 1036–1054.
40. Garmestani, A.S., C.R. Allen, and M.H. Benson, "Can law foster social-ecological resilience" *Ecology and Society* (2013) 18(2): 37.
41. Glicksman, R.L., "Ecosystem resilience to disruptions linked to global climate change: An adaptive approach to federal land management", *Nebraska Law Review* (2008) 87: 833–892.

42. Green, O.O., B. Cosens, and A.S. Garmestani, "Iterative processes for resilient transboundary water management: Collaboratively governing the Okovango for adaptation" (2012) [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2039023](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2039023)
43. Green, O.O., B. Cosens, and A.S. Garmestani, "Resilience in transboundary water governance: The Okovango river basin" *Ecology and Society* (2013) 18(2): 23.
44. Gunderson, L.H. and C.S. Holling, (eds) *Panarchy: Understanding Transformations in Human and Natural Systems* (Island Press, 2002).
45. Hayes, P. "Resilience as emergent behaviour" *Hastings West-Northwest Journal of Environmental Law and Policy* (2009) 15: 175.
46. Hiedanpää, J. "Institutional misfits: Law and habits in Finnish wolf policy" *Ecology and Society* (2013) 18(1): 24.
47. Holling, C.S. "Resilience and stability of ecological systems" *Annual Review of Ecology and Systematics* (1973) 4: 1–23.
48. Holling, C.S. *Adaptive Environmental Assessment and Management* (Wiley & Son, 1978).
49. Holling, C.S. "The resilience of terrestrial ecosystems: Local surprise and global change" In: Clark, W.C., Munn, R.E. (eds) *Sustainable Development of the Biosphere* (Cambridge University Press, 1986), 292–317.
50. Holling, C.S. "Reponse to 'Panarchy and the Law'" *Ecology and Society* (2012) 17(4): 37.
51. Hornstein, D.T. "Complexity theory, adaptation and administrative law" *Duke Law Journal* (2004) 54: 913–960.
52. Jackson, L. "Agricultural trade and climate change: Can the WTO promote resilience in the face of uncertainty?", *Georgetown Journal of International Affairs* (2008) 9: 25–32.
53. Karkkainen, B. C., "Panarchy and adaptive change: Around the loop and back again", *Minnesota Journal of Law, Science and Technology* (2005) 7: 59.
54. Karkkainen, B. C., "Collaborative ecosystem governance: Scale, complexity and dynamism", *VA Environmental Law Journal* (2002) 21: 189.
55. Karkkainen, B. C., "Adaptive ecosystem management and regulatory penalty defaults: Toward a bounded pragmatism", *Minnesota Law Review* (2002–2003) 87: 943.
56. Lebel, L., J. M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T. P. Hughes, and J. Wilson, "Governance and the capacity to manage resilience in regional social-ecological systems" *Ecology and Society* (2006) 11(1): 19.
57. Lee, K.N and J. Lawrence, "Adaptive management: Learning from the Columbia River Basin fish and wildlife program", *Environmental Law* (1985) 16: 431–460.
58. Light, A. R., "Tales of the Tamiami trail: Implementing adaptive management in Everglades restoration", *Journal of Land Use and Environmental Law* (2006) 22: 59.
59. Mears, D.K., and S. McKearnan, "Rivers and resilience: Lessons learned from Tropical Storm Irene" *Vermont Journal of Environmental Law* (2012) 14: 177.

60. Miller, F., H. Osbahr, E. Boyd, F. Thomalla, S. Bharwani, G. Ziervogel, B. Walker, J. Birkmann, S. Van der Leeuw, J. Rockström, J. Hinkel, T. Downing, C. Folke, and D. Nelson, "Resilience and vulnerability: Complementary or conflicting concepts?" (2010) 15(3): *Ecology and Society* 11.
61. Monteiro de Lima, D. L., "The principle of resilience" *Pace Environmental Law Review* (2013) 30(2): 697–810.
62. Norton, B. G., "The rebirth of environmentalism as pragmatic adaptive management", *Virginia Environmental Law Journal* (2005) 24: 353.
63. Pieraccini, M., "A politicized legal pluralist analysis of the commons' resilience: The case of the Regole d'Ampezzo", *Ecology and Society* (2013) 18(1): 4.
64. Plummer, R., B. Crona, D. R. Armitage, P. Olsson, M. Tengö, and O. Yudina, "Adaptive comanagement: A systematic review and analysis", *Ecology and Society* (2012) 17(3):11.
65. Profeta, T.H., "Managing without a balance: Environmental regulation in light of ecological advances", *Duke Environmental Law and Policy Forum* (1996) 7: 71.
66. Resilience Alliance 'Adaptive management' Available at [http://www.resalliance.org/index.php/adaptive\\_management](http://www.resalliance.org/index.php/adaptive_management) (accessed 15 August 2013).
67. Ruhl, J.B., "Regulation by adaptive management – is it possible?", *Minnesota Journal of Law, Science & Technology* (2005 – 2006) 7: 21–57.
68. Ruhl, J.B., "Climate change adaptation and the structural adaptation of environmental law", *Environmental Law* (2010) 40: 363–435.
69. Ruhl, J.B., "General design principles for resilience and adaptive capacity in legal systems – with applications to climate change adaptation", *North Carolina Law Review* (2010 – 2011) 89: 1373–1403.
70. Ruhl, J.B., "Panarchy and the law", *Ecology and Society* (2012) 17(3): 31.
71. Ruhl, J.B., and R. Fischman, "Adaptive management in the courts", *Minnesota Law Review* (2010) 95: 424.
72. Ruppert, T., "Tools in the resilience toolbox: But are we willing to use them?" *Ocean and Coastal Law Journal* (2011) 16: 551.
73. Sabine, E., G. Schreiber, A. R. Bearlin, S. J. Nicol, and C. R. Todd, "Adaptive management: A synthesis of current understanding and effective application", *Ecological Management and Restoration* (2004) 5(3): 177–182.
74. Schramm, D., and A. Fishman, "Legal frameworks for adaptive resource management in a changing climate", *Georgetown International Environmental Law Review* (2009–2010) 22: 491–520.
75. Schultz, C., and M. Nie, "Decision-making triggers, adaptive management, and natural resources law and planning", *Natural Resources Journal* (2012) 52: 443–520.
76. Schwab, A.K., and D. J. Brower, "Increasing resilience to natural hazards: Obstacles and opportunities for local governments under the Disaster Mitigation Act of 2000", *Environmental Law Reporter News and Analysis* (2008) 38: 10171.

77. Showalter, S., "What is coastal resiliency" *Sea Grant Law & Policy Journal* (2008) 1: i–iii.
78. Siegel, J.A., "Collaborative decision-making on climate change in the federal government" *Pace Environmental Law Review* (2009) 27: 257–312.
79. Susskind, L., A. Camacho, and T. Schenk, "Collaborative planning and adaptive management in Glen Canyon: A cautionary tale", *Columbia Journal of Environmental Law* (2010) 35: 1–55.
80. Tarlock, A.D. "The nonequilibrium paradigm in ecology and the partial unraveling of environmental law", *Loyola of Los Angeles Law Review* (1993–1994) 27: 1121–1144.
81. Tarlock, D., "Slouching toward Eden: The eco-pragmatic challenges of ecosystem revival", *Minnesota Law Review* (2003) 87: 1173.
82. Thrower, J., "Adaptive management and NEPA: How a non-equilibrium view of ecosystems mandates flexible regulation", *Ecology Law Quarterly* (2006) 33: 871.
83. Turner II, B.L., "Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science", *Global Environmental Change* (2010) 20: 570–576.
84. Van Rijswijk, M., and W. Salet, "Enabling the contextualization of legal rules in responsive strategies to climate change", *Ecology and Society* (2012) 17:2 18.
85. Walker, B. and D. Salt, *Resilience thinking: Sustaining ecosystems and people in a changing world* (Island Press, 2006).
86. Walters, C.J., *Adaptive Management of Renewable Resources* (Macmillan, 1986).
87. Ward, C., "Dance, don't drive: Resilient thinking for turbulent times", *Utah Environmental Law Review* (2011) 31: 107–115.
88. Wiersema, A., "A train without tracks: Rethinking the place of law and goals in environmental and natural resources law", *Environmental Law* (2008) 38: 1239.
89. Wiley, L.F., "Adaptation to the health consequences of climate change as a potential influence on public health law and policy: From preparedness to resilience", *Widener Law Review* (2009) 15: 483–519.
90. Zellmar, S., and L. Gunderson, "Why resilience may not always be a good thing: Lessons in ecosystem restoration from Glen Canyon and the Everglades" *Nebraska Law Review* (2008) 87: 893–949.