

Social-Ecological Systems

ECL 298/ENV 200C

Winter 2019 Syllabus

Course Requirements

- Attend class and participate in discussion: 30%
- Submit discussion questions: 30%
- Final paper: 40%

Possible Paper Formats

- Conference paper
- Literature review
- Grant application
- Qualifying exam/thesis proposal
- Policy brief

World Cafe Format

- 6 Groups of 5 or 6 students
- Day 1 (Jan 10): Split into six groups and choose social ecological system for case study
- Day 2 (Jan 15): Groups 1-3 provide summary presentation of study applying Ostrom framework
- Day 3 (Jan 17): Groups 4-6 provide summary presentation of study applying Ostrom framework
- Weekly Facilitated Discussions: Based on 3-5 questions chosen from submitted reading questions, group applies those questions to their case studies. Rotation and report out. Each student must take one turn reporting out, and writing a document for submission and grading.

Week 1 (January 8/10): SES Frameworks

*Folke, Carl, Thomas Hahn, Per Olsson, and Jon Norberg. (2005). "[ADAPTIVE GOVERNANCE OF SOCIAL-ECOLOGICAL SYSTEMS \(Links to an external site.\)Links to an external site.](#)" *Annual Review of Environment and Resources* 30 (1): 441-473.

*Ostrom, Elinor. (2009). "[A General Framework for Analyzing Sustainability of Social-Ecological Systems.](#)" (Links to an external site.)Links to an external site. *Science* 325 (5939): 419-422.

*Epstein, Graham, et al. "[Missing ecology: integrating ecological perspectives with the social-ecological system framework \(Links to an external site.\)Links to an external site.](#)" *International Journal of the Commons* 7.2 (2013): 432-453.

Partelow, Stefan 2018 A Review of the Social-Ecological Systems Framework: Applications, Methods, Modifications, and Challenges. *Ecology and Society* 23(4).<https://www.ecologyandsociety.org/vol23/iss4/art36/> ([Links to an external site.](#))[Links to an external site.](#)

Vogt, Jessica M., Graham B. Epstein, Sarah K. Mincey, Burnell C. Fischer, and Paul McCord. 2015. "[Putting the 'E' in SES: Unpacking the Ecology in the Ostrom Social-Ecological System Framework \(Links to an external site.\)](#)[Links to an external site.](#)" *Ecology and Society* 20 (1). doi:10.5751/ES-07239-200155.

Anderies, J. M., M. A. Janssen, and E. Ostrom. (2004). [A framework to analyze the robustness of social-ecological systems from an institutional perspective \(Links to an external site.\)](#)[Links to an external site.](#) *Ecology and Society* 9(1):

Janssen, Marco A., Michael L. Schoon, Weimao Ke, and Katy Börner. (2006). "[Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change \(Links to an external site.\)](#)[Links to an external site.](#)" *Global Environmental Change* 16 (3): 240-252.

Binder, Claudia R., Jochen Hinkel, Pieter WG Bots, and Claudia Pahl-Wostl. "[Comparison of Frameworks for Analyzing Social-ecological Systems \(Links to an external site.\)](#)[Links to an external site.](#)" *Ecology and Society* 18, no. 4 (2013): 26.

Wang, B., Pan, S.Y., Ke, R.Y., Wang, K. and Wei, Y.M., 2014. [An overview of climate change vulnerability: a bibliometric analysis based on Web of Science database \(Links to an external site.\)](#)[Links to an external site.](#) *Natural hazards*, 74(3), pp.1649-1666.

Williams et al. 2019. [Coral Reef Ecology in the Anthropocene. \(Links to an external site.\)](#)[Links to an external site.](#) *Functional Ecology*

Week 2 (January 15/17): Case Study Overviews: Student Groups

Student teams present basic ideas and research questions in relation to the SES frameworks.

Week 3 (January 22/24): Resilience, Vulnerability, and Adaptive Capacity

*Folke, Carl. (2006). "[Resilience: The emergence of a perspective for social–ecological systems analyses \(Links to an external site.\)](#)[Links to an external site.](#)" *Global Environmental Change* 16 (3): 253-267.

*Adger, W. Neil. (2006). "[Vulnerability \(Links to an external site.\)](#)[Links to an external site.](#)" *Global Environmental Change* 16 (3): 268-281.

*Smit, Barry, and Johanna Wandel. (2006). "[Adaptation, adaptive capacity and vulnerability \(Links to an external site.\)](#)[Links to an external site.](#)" *Global Environmental Change* 16 (3): 282-292.

*(empirical example) Brooks, Nick, W. Neil Adger, and P. Mick Kelly. "[The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation.](#)" (Links to an external site.)Links to an external site. *Global environmental change* 15, no. 2 (2005): 151-163.

Moser, Susanne, Sara Meerow, James Arnott, and Emily Jack-Scott. "[The turbulent world of resilience: interpretations and themes for transdisciplinary dialog](#) (Links to an external site.)Links to an external site." *Climatic Change* (2019): 1-20.

(empirical example) o'Brien, Karen, Robin Leichenko, Ulka Kelkar, Henry Venema, Guro Aandahl, Heather Tompkins, Akram Javed et al. "[Mapping vulnerability to multiple stressors: climate change and globalization in India.](#) (Links to an external site.)Links to an external site." *Global environmental change* 14, no. 4 (2004): 303-313.

(empirical example) Milman, Anita, et al. "[Assessment of institutional capacity to adapt to climate change in transboundary river basins](#) (Links to an external site.)Links to an external site." *Climatic change* 121.4 (2013): 755-770.

Gallopín, G.C., 2006. [Linkages between vulnerability, resilience, and adaptive capacity.](#) (Links to an external site.)Links to an external site. *Global environmental change*, 16(3), pp.293-303.

Gunderson, Lance H. (2000). "[Ecological Resilience--In Theory and Application](#) (Links to an external site.)Links to an external site." *Annual Review of Ecology and Systematics* 31 (ArticleType: research-article / Full publication date: 2000 / Copyright © 2000 Annual Reviews): 425-439.

Holling, C. S. (1973). "[Resilience and Stability of Ecological Systems.](#)" (Links to an external site.)Links to an external site. *Annual Review of Ecology and Systematics* 4 (ArticleType: research-article / Full publication date: 1973 / Copyright © 1973 Annual Reviews): 1-23.

Barbara, J. Downes, Miller Fiona, Barnett Jon, Glaister Alena, and Ellemor Heidi. 2013. "[How do we know about resilience](#) (Links to an external site.)Links to an external site.?" An analysis of empirical research on resilience, and implications for interdisciplinary praxis." *Environmental Research Letters* 8 (1): 014041.

Lebel, L., J. M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T. P. Hughes. and J. Wilson. 2006. [Governance and the capacity to manage resilience in regional social-ecological systems](#) (Links to an external site.)Links to an external site.. *Ecology and Society* 11(1): 19.

Benson, M. H. and R. K. Craig (2014). "[The End of Sustainability](#) (Links to an external site.)Links to an external site." *Society & Natural Resources* 27(7): 777-782.

Turner, Billie L., Roger E. Kasperson, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley et al.
[<http://www.sustainability-science.org/2014/02/22/a-framework-for-vulnerability-analysis-in-sustainability-science/>] "A framework for vulnerability analysis in sustainability science (Links to an external site.)"

site.)Links to an external site.." *Proceedings of the national academy of sciences* 100, no. 14 (2003): 8074-8079.

Turner, Billie Lee, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Grete K. Hovelsrud-Broda et al. "[Illustrating the coupled human–environment system for vulnerability analysis: three case studies. \(Links to an external site.\)Links to an external site.](#)" *Proceedings of the National Academy of Sciences* 100, no. 14 (2003): 8080-8085.

Engle, Nathan L. "[Adaptive capacity and its assessment \(Links to an external site.\)Links to an external site.](#)" *Global Environmental Change* 21.2 (2011): 647-656.

Week 4 (Jan 29/31): Institutions and Collective Action

* Ostrom, Elinor. "[Coping with tragedies of the commons \(Links to an external site.\)Links to an external site.](#)" *Annual review of political science* 2.1 (1999): 493-535.

*Epstein, G., J. Pittman, S. M. Alexander, S. Berdej, T. Dyck, U. Kreitmair, K. J. Raithwell, S. Villamayor-Tomas, J. Vogt, and D. Armitage. 2015. [Institutional fit and the sustainability of social–ecological systems \(Links to an external site.\)Links to an external site.](#) *Current Opinion in Environmental Sustainability* 14:34-40.

*Adger, W. Neil. 2003 "[Social Capital, Collective Action, and Adaptation to Climate Change \(Links to an external site.\)Links to an external site.](#)" *Economic Geography* 79 (4): 387-404

Henrich, Joseph, R. Boyd, S. Bowles, C. Camerer, E. Gehr, H. Gintis and r. McElreath. (2001) "[In Search of Homo Economicus: Behavioral Experiments in 15 Small-Scale Societies \(Links to an external site.\)Links to an external site.](#)" *The American Economic Review* 91 (2): 73-78

Berkes, Fikret. "[From community-based resource management to complex systems: the scale issue and marine commons. \(Links to an external site.\)Links to an external site.](#)" *Ecology and Society* 11, no. 1 (2006): 45.

Ostrom, Elinor, Joanna Burger, Christopher B. Field, Richard B. Norgaard, and David Policansky. "[Revisiting the commons: local lessons, global challenges \(Links to an external site.\)Links to an external site.](#)" *Science* 284, no. 5412 (1999): 278-282.

Ostrom, Elinor. (2000). "[Collective Action and the Evolution of Social Norms \(Links to an external site.\)Links to an external site.](#)" *Journal of Economic Perspective* 14 (3): 137-158.

Ostrom, Elinor, James Walker and Roy Gardner. (1992). "[Covenants With and Without a Sword: Self-Governance is Possible \(Links to an external site.\)Links to an external site.](#)" *American Political Science Review* 86 (2): 404-417

Toonen, Theo. "[Resilience in public administration: The work of Elinor and Vincent Ostrom from a public administration perspective \(Links to an external site.\)](#)[Links to an external site.](#)" *Public Administration Review* 70.2 (2010): 193-202.

Week 5 (Feb 5/7): Complex Adaptive Systems

*Levin, Simon A. "[Ecosystems and the biosphere as complex adaptive systems. \(Links to an external site.\)](#)[Links to an external site.](#)" *Ecosystems* 1, no. 5 (1998): 431-436.

*Lansing, J. Stephen. "[Complex adaptive systems \(Links to an external site.\)](#)[Links to an external site.](#)" *Annual review of anthropology* (2003): 183-204.

*Lubell, Mark. 2013. "[Governing Institutional Complexity: The Ecology of Games Framework. \(Links to an external site.\)](#)[Links to an external site.](#)" *Policy Studies Journal* 41 (3): 537-59.

*Liu, Jianguo, Thomas Dietz, Stephen R. Carpenter, Marina Alberti, Carl Folke, Emilio Moran, Alice N. Pell, et al. 2007. "Complexity of Coupled Human and Natural Systems." *Science* 317 (5844): 1513.<https://doi.org/10.1126/science.1144004> ([Links to an external site.](#))[Links to an external site.](#)

Ostrom, Elinor. (2010). "[Polycentric Systems for Coping with Collective Action and Global Environmental Change \(Links to an external site.\)](#)[Links to an external site.](#)" *Global Environmental Change* 20 (4): 550-557.

Preiser, Rika, Reinette Biggs, Alta De Vos, and Carl Folke 2018
Social-Ecological Systems as Complex Adaptive Systems: Organizing Principles for Advancing Research Methods and Approaches. *Ecology and Society* 23(4).<https://www.ecologyandsociety.org/vol23/iss4/art46/> ([Links to an external site.](#))[Links to an external site.](#)

Cairney, Paul. "[Complexity theory in political science and public policy \(Links to an external site.\)](#)[Links to an external site.](#)" *Political Studies Review* 10, no. 3 (2012): 346-358

Arrow, Kenneth J., Paul R. Ehrlich, and Simon A. Levin. "[Some Perspectives on Linked Ecosystems and Socio-Economic Systems. \(Links to an external site.\)](#)[Links to an external site.](#)" *Environment and Development Economics: Essays in Honour of Sir Partha Dasgupta* (2014): 95.

Levin, Simon A., Scott Barrett, Sara Aniyar, William Baumol, Christopher Bliss, Bert Bolin, Partha Dasgupta et al. "[Resilience in natural and socioeconomic systems. \(Links to an external site.\)](#)[Links to an external site.](#)" *Environment and development economics* 3, no. 02 (1998): 221-262.

Levin, Simon. "[Complex adaptive systems and the challenge of sustainability \(Links to an external site.\)](#)[Links to an external site.](#)" *Toward a Science of Sustainability* (2010): 129.

(math models!) Levin, Simon. "[Complex adaptive systems: exploring the known, the unknown and the unknowable \(Links to an external site.\)Links to an external site.](#)" *Bulletin of the American Mathematical Society* 40, no. 1 (2003): 3-19

(math models!) Lade, Steven J., Alessandro Tavoni, Simon A. Levin, and Maja Schlüter. "[Regime shifts in a social-ecological system \(Links to an external site.\)Links to an external site.](#)" *Theoretical ecology* 6, no. 3 (2013): 359-372.

Week 6 (February 12/14): Human Decision-making and Environment

*Simon, Herbert A. (1985) "[Human Nature in Politics: The Dialogue of Psychology with Political Science \(Links to an external site.\)Links to an external site.](#)" *The American Political Science Review*, 79 (2): 293-304

*Tversky, A., & Kahneman, D. (1974, September). [Judgment under uncertainty: Heuristics and biases \(Links to an external site.\)Links to an external site.](#) *Science*, 185, 1124-1131.

*Gigerenzer, G., Goldstein, D. (1996). "[Reasoning the Fast and Frugal Way: Models of Bounded Rationality \(Links to an external site.\)Links to an external site.](#)" *Psychological Review*, 103(4): 650-669.

(this is a good summary of prospect theory)Christopher Trepel, Craig R. Fox, Russell A. Poldrack, [Prospect theory on the brain? Toward a cognitive neuroscience of decision under risk, \(Links to an external site.\)Links to an external site.](#) *Cognitive Brain Research*, Volume 23, Issue 1, April 2005, Pages 34-50.

Simon, H. (1972). "[Theories of Bounded Rationality \(Links to an external site.\)Links to an external site.](#)" *Decision and Organization* Chapter 8: 161-176

Gigerenzer, G., Hoffrage, U. (1995). "[How to Improve Bayesian Reasoning without Instruction: Frequency Formats \(Links to an external site.\)Links to an external site.](#)" *Psychological Review* 102 (4): 684-704.

Kahneman, Daniel. 2003. "[Maps of Bounded Rationality: Psychology for Behavioral Economics \(Links to an external site.\)Links to an external site.](#)" *The American Economic Review* 93 (5): 1449-1475.

Kahneman, D. (2003) "[A Perspective on Judgment and Choice: Mapping Bounded Rationality \(Links to an external site.\)Links to an external site.](#)" *American Psychologist*, 58 (9): 697-720.

Lempert, Robert J., David G. Groves, Steven W. Popper, and Steve C. Banks. "[A general, analytic method for generating robust strategies and narrative scenarios \(Links to an external site.\)Links to an external site.](#)" *Management science* 52, no. 4 (2006): 514-528.

Lempert, Robert J., and David G. Groves. "[Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American west \(Links to an external site.\)Links to an external site.](#)" *Technological Forecasting and Social Change* 77.6 (2010): 960-974.

Groves, David G., and Robert J. Lempert. "[A new analytic method for finding policy-relevant scenarios \(Links to an external site.\)Links to an external site.](#)" *Global Environmental Change* 17.1 (2007): 73-85.

Week 7 (February 19/21): Linking Science to Policy

*Haas, P. (1989). "[Do Regimes Matter? Epistemic Communities and Mediterranean Pollution Control. \(Links to an external site.\)Links to an external site.](#)" *International Organization* 43(3): 377-403.

*Guston, David (2001). "[Boundary Organizations in Environmental Policy and Science: An Introduction. \(Links to an external site.\)Links to an external site.](#)" *Science Technology, & Human Values* 26(4): 399-408.

*Newman, Joshua, Adrian Cherney, and Brian W. Head. 2016. "[Do Policy Makers Use Academic Research? Reexamining the 'Two Communities' Theory of Research Utilization \(Links to an external site.\)Links to an external site.](#)" *Public Administration Review* 76 (1): 24–32. doi:10.1111/puar.12464.

*Heikkila, Tanya, and Andrea K. Gerlak. "[Building a conceptual approach to collective learning: lessons for public policy scholars \(Links to an external site.\)Links to an external site.](#)" *Policy Studies Journal* 41, no. 3 (2013): 484-512.

Gerlak, Andrea K., and Tanya Heikkila. "[Building a theory of learning in collaboratives: Evidence from the Everglades Restoration Program \(Links to an external site.\)Links to an external site.](#)" *Journal of Public Administration Research and Theory* (2011): muq089.

Young, O. R. 2008. [The architecture of global environmental governance: bringing science to bear on policy. \(Links to an external site.\)Links to an external site.](#) *Global Environmental Politics* 8:14-32.

Crona, B., & Parker, J. (2012). "[Learning in Support of Governance: Theories, Methods, and a Framework to Assess How Bridging Organizations Contribute to Adaptive Resource Governance. \(Links to an external site.\)Links to an external site.](#)" *Ecology and Society* 17(1):32

Policansky, David. (1998). "[Science and Decision Making for Water Resources \(in Invited Feature: Freshwater Systems\) \(Links to an external site.\)Links to an external site.](#)" *Ecological Applications* 8(3): 610-618.

Haas, P. (2004). "[When Does Power Listen to Truth? A Constructivist Approach to the Policy Process. \(Links to an external site.\)Links to an external site.](#)" *Journal of European Public Policy* 11(4): 569-592.

Sarewitz, D. Pielke, R. (2007). "[The Neglected Heart of Science Policy: Reconciling Supply of and Demand for Science \(Links to an external site.\)Links to an external site.](#)" *Environmental Science and Policy*10(1): 5-16.

Jasanoff, S. (2008). "[Speaking Honestly to Power \(Links to an external site.\)Links to an external site.](#)" *American Scientist*, Book Review.

Agrawala,S., Broad, K., & Guston, D. "[Integrating Climate Forecasts and Societal Decision Making: challenges to an Emergent Boundary Organization \(Links to an external site.\)Links to an external site.](#)"*Science Technology, & Human Values* 26(4): 454-477.

Singh, G. G., Tam, J., Sisk, T. D., Klain, S. C., Mach, M. E., Martone, R. G., & Chan, K. M. A. (2014). [A more social science: barriers and incentives for scientists engaging in policy \(Links to an external site.\)Links to an external site.](#) *Frontiers in Ecology and the Environment*, 12(3), 161-166. doi: 10.1890/130011

Week 8 (February 26/28): Networks in SES Systems

*Berardo, R., Scholz, J. (2010). "[Self-Organizing Policy Networks: Risk, Partner Selection, and Cooperation in Estuaries. \(Links to an external site.\)Links to an external site.](#)" *American Journal of Political Science*,54 (3): 632-649.

*Schneider, M., Scholz, J., Lubell, M., (2003) "[Building Consensual Institutions: Networks and the National Estuary Program \(Links to an external site.\)Links to an external site.](#)" *American Journal of Political Science*, 47(1): 143-158.

*Janssen, M.A., Bodin, Ö., Anderies, J., Elmqvist, T., Ernstson, H., McAllister, R., Olsson, P., & Ryan, P. (2006) "[Toward a Network Perspective of the Study of Resilience in Social-Ecological Systems \(Links to an external site.\)Links to an external site.](#)", *Ecology and Society* 11(1): 15.

*Bodin, Ö., & Crona, B. (2009) "[The Role of Social Networks in Natural Resource Governance: What Relational Patterns Make a Difference? \(Links to an external site.\)Links to an external site.](#)" *Global Environmental Change*, 19(3): 366-374.

*Bodin, Ö., & Tengö, M. (2012) "[Disentangling Intangible Social-ecological Systems \(Links to an external site.\)Links to an external site.](#)" *Global Environmental Change* 22(2): 430-439.

Bodin, Örjan, Annica Sandström, and Beatrice Crona. "[Collaborative Networks for Effective Ecosystem-Based Management: A Set of Working Hypotheses \(Links to an external site.\)Links to an external site.](#)"*Policy Studies Journal* (2016).

[Bodin \(Links to an external site.\)Links to an external site.](#), Ö., Crona, B., & [Ernstson \(Links to an external site.\)Links to an external site.](#), H. (2006). "[Social Networks in Natural Resource Management: What is There to Learn from a Structural Perspective \(Links to an external site.\)Links to an external site.](#)" *Ecology and Society* 11(2).

Crona, B., & Bodin, Ö. (2006) "What You Know is Who You Know? Communication Patters Among Resource Users as a Prerequisite for Co-management." *Ecology and Society* 11(2): 7. [\[PDF\] from ecologyandsociety.org \(Links to an external site.\)Links to an external site.](#)

Treml, Eric A., et al. "[Analyzing the \(mis\) fit between the institutional and ecological networks of the Indo-West Pacific.](#)" (Links to an external site.)Links to an external site. *Global Environmental Change* 31 (2015): 263-271.

Scheffer, M., Carpenter, S., Lenton, T., & Bascompte, J. (2012) "[Anticipating Critical Transitions \(Links to an external site.\)Links to an external site.](#)" *Science* 338(6105): 344-348.

Scholz, J., Berardo, R., Kile, B. (2008). "[Do Networks Solve Collective Action Problems? Credibility, Search, and Collaboration \(Links to an external site.\)Links to an external site.](#)" *Journal of Politics*, 70 (2): 393-406.

Week 9 (March 5/7): Cultural Evolution (Pete Richerson guest lecture)

*[The cultural niche: Why social learning is essential for human adaptation.](#) With **Robert Boyd** and Joseph Henrich. PNAS, www.pnas.org/cgi/doi/10.1073/pnas.1100290108 (Links to an external site.)Links to an external site., 2011.

*[Cultural group selection plays an essential role in explaining human cooperation: A sketch of the evidence.](#) With Ryan Baldini, Adrian Bell, Kathryn Demps, Karl Frost, Vicken Hillis, Sarah Matthew, Emily Newton, Nicole Narr, Lesley Newson, Cody Ross, Paul Smaldino, Timothy Waring and Matthew Zefferman. Open for Commentary in *Behavioral and Brain Sciences*.

*[The Darwinian theory of human cultural evolution and gene-culture coevolution.](#) With Robert Boyd. Chapter 20 in *Evolution Since Darwin: The First 150 Years*. M.A. Bell, D.J. Futuyma, W.F. Eanes, and J.S. Levinton, (eds.) Sinauer, pp. 561-588. 2010

*[Rethinking paleoanthropology: A world queerer than we supposed.](#) In press in *Evolution of Mind*, Gary Hatfield, Editor. Penn Museum Conference Series.

Waring et al. 2015. A multilevel evolutionary framework for sustainability analysis. Forthcoming, *Ecology and Society*(see [Smartsite](#))

[Tribal social instincts and the cultural evolution of institutions to solve collective action problems.](#) With Joe Henrich. *Cliodynamics* 3: 38–80. 2012.

Week 10 (March 12/14): Collaborative Ecosystem Management

*R.E. Grumbine. (1994). "[What is Ecosystem Management? \(Links to an external site.\)Links to an external site.](#)" *Conservation Biology* 8(1): 27-38.

*Derek R Armitage, et al. 2012. [Adaptive co-management for social–ecological complexity \(Links to an external site.\)Links to an external site.](#) *Frontiers in Ecology and the Environment*.

*Hearn, A. (2008). “[The Rocky Path to Sustainable Fisheries Management and Conservation in the Galápagos Marine Reserve \(Links to an external site.\)Links to an external site.](#)” *Ocean & Coastal Management* 51(8-9): 567-574.

Levin, Simon A., and Jane Lubchenco. "[Resilience, robustness, and marine ecosystem-based management \(Links to an external site.\)Links to an external site.](#)" *Bioscience* 58.1 (2008): 27-32.

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Yaffee, S.L. (1999). “[Three Faces of Ecosystem Management \(Links to an external site.\)Links to an external site.](#)” *Conservation Biology* 13(4): 713-725.

Endter-Wada, Joanna, Dale Blahna, Richard Krannich, and Mark Brunson. "[A framework for understanding social science contributions to ecosystem management \(Links to an external site.\)Links to an external site.](#)" *Ecological Applications* 8, no. 3 (1998): 891-904.