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CAN ADAPTIVE MANAGEMENT HELP ALASKA'S NATURAL RESOURCE MANAGERS RESPOND TO CLIMATE CHANGE?

ABSTRACT

Many legal scholars have called attention to the inability of stationary natural resource management laws to respond to a changing climate. There are various proposals for remedying these laws, including the use of adaptive management, through which resource managers can monitor changes and adjust policies accordingly. Yet there are practical and political challenges to implementing adaptive management. This article considers the extent to which adaptive management has been or could be implemented in response to Alaska's rapid climate change. Alaska is an important case study as it is warming far more quickly than many other parts of the globe, paving the way for species shifts and new commercial and industrial developments. The article is informed by interviews with twelve natural resource managers and researchers in Alaska as well as additional interviews with Alaskan agency representatives and community members. It concludes that adaptive management is occurring at small scales in Alaska and elsewhere, typically involving actions by lower-level managers in the context of permits or regulations that apply to a single species. These adaptive measures may not be labeled as "adaptive management" in agency regulations or even directly provided for in regulations, but they occur in spite of the many challenges to adaptive management.

1. INTRODUCTION

Law is intended to be predictable rather than flexible.[1] Predictability has long been considered an essential component of capitalist democracies, as it allows

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1 Ahjond S. Garmestani & Melinda Harm Benson, *A Framework for Resilience-Based Governance of Social-Ecological Systems*, 18 ECOLOGY AND SOCIETY 9 (2013); J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems: Applications to Climate Change Adaptation Law*, 89 N.C. L. REV. 1373, 1394 (2011).

one to "plan one's individual affairs."[2] It should not be surprising that conventional natural resource management law, like other bodies of law, is predictable. It is based on the idea of stable ecosystems that may fluctuate within a bounded range, but can be governed with preordained rules and static long-term plans.[3] For example, the U.S. Endangered Species Act[4] aims to preserve all presently existing species in more or less their current genetic form.[5] Likewise, the Comprehensive Environmental Response, Compensation, and Liability Act[6] aims at restoring lands containing hazardous waste to their condition prior to contamination.

But ecosystems can and do change, and many are changing rapidly as the climate changes.[7] Responding to climate change may require the law to provide natural resource decision-makers with more flexibility and options for management that address current as well as future circumstances[8] while maintaining the rule of law. In this article, I consider how natural resource management policies could be more adaptive. I focus on how adaptive management[9] may be carried out by national and state agency managers in Alaska.

Focus on Alaska is important for several reasons. First, the climate is changing far more rapidly in Alaska (and across the Arctic) than at lower altitudes.[10] Second, compared to other jurisdictions, there is a great deal of public land, both national and state,[11] that could benefit from a more adaptive management regime. In

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2. Friedrich A. Von Hayek et al., The Road to Serfdom, READER'S DIGEST, Apr. 1945, at 57.

3. ROBERT L. FISCHMAN & JILLIAN R. ROUNTREE, THE LAW OF ADAPTATION TO CLIMATE CLIMATE : U.S. AND INTERNATIONAL ASPECTS 22 (Michael Gerrard & Katrina Fischer Kuh 2012); Robin Kundis Craig, "*Stationarity Is Dead*"*—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 29 (2010).

4. Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544 (1973).

5. Fischman & Rountree, *supra* note 3, at 20.

6. 42 U.S.C. § 9621 (1986).

7. Craig, *supra* note 3, at 29; F. STUART CHAPIN III, CARL FOLKE & GARY P. KOFINAS, PRINCIPLES OF ECOSYSTEM STEWARDSHIP: RESILIENCE-BASED NATURAL RESOURCE MANAGEMENT IN A CHANGING WORLD 15 (F. Stuart Chapin III, Carl Folke, & Gary P. Kofinas eds., 2009).

8. Garmestani, *supra* note 1; Shannon M. McNeeley, Examining Barriers and Opportunities for Sustainable Adaptation to Climate Change in Interior Alaska, 111 CLIMATIC CHANGE 835, 837 (2012); F. Stuart Chapin & Patricia Cochran, *Community-Empowered Adaptation for Self-Reliance*, 19 ENVTL. SUSTAINABILITY 67 (2016).

9. Yee Huang et al, *Climate Change and the Puget Sound: Building the Legal Framework for Adaptation*, 2 CLIMATE L. 299, 309 (2011); Robin Kundis Craig & J. B. Ruhl, *Designing Administrative Law for Adaptive Management*, 67 VAND. L. REV. 1, 7 (Jan. 2014).

10. C.B. FIELD ET AL., CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY, CONTRIBUTION OF WORKING GROUP II TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 32 (2014); F. STUART CHAPIN III ET AL., CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 536 (2014); Russell S. Vose, Mike Squires, Derek Arndt, Imke Durre, Chris Fenimore, Karin Gleason, Matthew J Menne, et al., *Deriving Historical Temperature and Precipitation Time Series For Alaska Climate Divisions Via Climatologically Aided Interpolation*, 10 J. SERV. CLIMATOLOGY 1 (2017).

11. Alaska Department of Natural Resources, Land Ownership in Alaska (2000), http://dnr.alaska.gov/mlw/factsht/land_fs/land_own.pdf. Steve Colot, *What's the Economic Importance of Alaska's Healthy Ecosystems?*, INST. OF SOCIAL & ECON. RES., 1 (2001), http://www.iser.uaa.alaska.edu/Publications/formal/rsummary/rs61.pdf. (Nearly ninety percent of Alaska's 375 million acres are public lands, with about 240 million acres of national lands and close to 100 million acres of state lands.)

particular, there is far more land in Alaska than other states[12] that is subject to management under the Wilderness Act[13], a stationary conservation law that is challenging to follow with rapid climate change.[14] Third, in contrast to other states, many Alaskans are dependent on natural resources (specifically fish and game) for their nutritional and cultural needs.[15] An adaptive management approach may be needed to respond to fluctuations in a manner that satisfies these fishing and hunting interests.[16]

This article draws on research I did from 2015 to early 2017 for my Ph.D., for which I spoke with 153 people regarding climate change adaptation in Alaska and reviewed U.S. national and State of Alaska laws, agency plans, and literature relevant to climate change adaptation and adaptive management. [17] I discussed adaptive management and challenges related to inflexible laws with 12 individuals that were either from agencies with responsibility for fish and game or land management or had knowledge of how management is being carried out in Alaska. In this article, I explore the extent to which adaptive management has been or could be better applied by state and federal agencies in Alaska to improve management in the face of climate change. Section 2 considers how adaptive management could make natural resource management more flexible and responsive to climate change. Section 3 focuses on examples of adaptive management in Alaska. Section 4 offers recommendations for better application of adaptive management by agencies in Alaska.

2. BACKGROUND

A. Adapting Management Regimes for Climate Change

This section serves as a review of laws and literature pertaining to adaptive management. Particularly in the law review literature, there has been a call to shift the current stationarity-based administrative law system to a more flexible system capable of responding to climate change.[18] This shift could involve "triaging" laws

12. WILDERNESS CONNECT, https://wilderness.net/practitioners/wilderness-areas/summary-reports/acreage-by-state.php (last visited Sept. 9, 2017).

13. Wilderness Act of 1964, 16 U.S.C. §§ 1131–1136 (2012).

14. David N. Cole, *Beyond Naturalness: Adapting Wilderness Stewardship to an Era of Rapid Global Change*, 18 INT'L. J. WILDERNESS 9 (2012); Roger Kaye, *What Future for the Wildness of Wilderness in the Anthropocene?* 13 ALASKA PARK SCI. 41 (2014).

15. Patricia Cochran, et al., *Indigenous Frameworks for Observing and Responding to Climate Change in Alaska*, 120 CLIMATIC CHANGE 557, 560 (2013); Davin Holen, *Fishing for Community and Culture: The Value of Fisheries in Rural Alaska*, 50 N. FISHERIES 403 (2014); Shannon Michele McNeeley, Seasons out of Balance: Climate Change Impacts, Vulnerability, and Sustainable Adaptation in Interior Alaska, 6 (August 2009) (unpublished Ph.D. dissertation, University of Alaska Fairbanks).

16. James D. Nichols, Michael C. Runge, Fred A. Johnson & Byron K. Williams, *Adaptive Harvest Management of North American Waterfowl Populations: A Brief History and Future Prospects*, 148 J. ORNITHOLOGY 343 (2007).

17. E.B. Ristroph, *Presenting a Picture of Alaska Native Village Adaptation: A Method of Analysis*, 5 SOC. & ANTHROPOLOGY 762 (2017).

18. Craig, *supra* note 3; Victor B. Flatt, *Adapting Laws for a Changing World: A Systemic Approach to Climate Change Adaptation*, 64 FLA. L. REV. 269, 285 (2012); J.B. Ruhl, *Panarchy and the Law*, 17

to determine which laws are so important that they should remain "as-is," even if they are static; which laws are impossible to achieve and should be scrapped or greatly altered;[19] which laws could be modified for greater flexibility;[20] and which laws could simply be reinterpreted to provide better flexibility.

Calling for a complete overhaul of federal and state law is relatively easy—effecting such change is much harder. Sunk costs, vested interests, and interdependencies operate to maintain the status quo.[21] Minor modifications by Congress and state legislatures are somewhat more feasible, as is the potential for agencies to reinterpret existing laws (particularly those with multiple-use mandates) and issue new regulations.[22] Thus, for the remainder of this article, I focus on what agencies can do to adapt to climate change with little to no legislative change. In particular, I consider how agencies can better implement adaptive management , which aims to align decision-making to the natural scale so that it is more dynamic and responsive.[23] Adaptive management generally involves setting management goals, monitoring outcomes, determining impacts, and refining goals to incorporate lessons learned.[24]

Some U.S. natural resource laws already provide a degree of flexibility to agency decision-makers that enables adaptive management. "Multi-purpose" management laws such as the Federal Lands Management Policy Act[25] (for Bureau of Land Management) and the National Forest Management Act[26] (for the Forest Service) are an example.[27] Agencies could interpret multiple and sustained use

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ECOLOGY AND SOC'Y 3 (2012); Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L. J. 1 (2009).

19. For example, saving some endangered species or restoring an ecosystem to a previous state may not be practical, such that the Endangered Species Act may need to be restructured. Flatt, *supra* note 18, at 272; Craig, *supra* note 3, at 69; Mary Jane Angelo, *Stumbling Toward Success: A Story of Adaptive Law and Ecological Resilience*, 87 NEB. L. REV. 950, 1001 (2009); Peter Kareiva & Emma Fuller, *Beyond Resilience: How to Better Prepare for the Profound Disruption of the Anthropocene*, 7 GLOBAL POL'Y 107 (2016).

20. The first three parts of this sentence are based on Craig, *supra* note 3, at 63, and J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems — With Applications to Climate Change Adaptation Law*, 89 N.C. L. REV. 1373, 1386 (2011).

21. Johan Munck af Rosenschöld, Jaap G. Rozema & Laura Alex Frye-Levine, *Institutional Inertia and Climate Change: A Review of the New Institutionalist Literature*, 5 WILEY INTERDISC. REVIEWS: CLIMATE CHANGE 639, 646 (2014); Stefania Munaretto & Judith E. M. Klostermann, *Assessing Adaptive Capacity of Institutions to Climate Change: A Comparative Case Study of the Dutch Wadden Sea and the Venice Lagoon*, 2 CLIMATE L. 219, 221 (2011).

22. Garmestani & Benson, supra note 1; Barry Smit & Johanna Wandel, *Adaptation, Adaptive Capacity and Vulnerability*, 16 GLOBAL ENVTL. CHANGE 282, 289 (2006); Emily Boyd et al., *Anticipatory Governance for Social-Ecological Resilience*, 44 AMBIO S149, S154 (2015).

23. Jon Barnett, *Adapting to Climate Change in Pacific Island Countries: The Problem of Uncertainty*, 29 WORLD DEV. 977, 983 (2001); Nathan L. Engle, *Adaptive Capacity and Its Assessment*, 21 GLOBAL ENVTL. CHANGE 647, 652 (2011).

24. Ruhl, *supra* note 20, at 1388; Yee Huang et al, *Climate Change and the Puget Sound: Building the Legal Framework for Adaptation*, 2 CLIMATE L. 299, 309 (2011); Craig & Ruhl, *supra* note 9.

25. 43 U.S.C. §§ 1701-1787 (2017).

26. 16 U.S.C. §§ 1600-1687 (2017).

27. Flatt, *supra* note 18, at 272.

standards in these laws[28] to vary depending on projected climate change impacts.[29] The Forest Service has taken advantage of its broad enabling legislation by incorporating adaptive management provisions across its planning efforts to involve more monitoring and revisions.[30]

Another example of a law that allows for adaptive management is the National Environmental Policy Act ("NEPA").[31] Law review literature suggests that NEPA can be interpreted so that environmental reviews can better accommodate the uncertain future effects of climate change.[32] First, an agency can use "tiering"[33] to return to a decision later in time when there is new information, so long as it is not "piecemealing" a decision or ignoring cumulative impacts.[34] This provision has been in place since the Council of Environmental Quality ("CEQ") promulgated NEPA regulations in 1978.[35] Second, when an agency within the Department of the Interior ("DOI") is evaluating alternatives, it can consider different climate scenarios for each regime, and plan to shift management if a particular scenario occurs.[36] This provision is based on 2008 DOI regulations allowing, but not requiring adaptive management.[37]

Even when there is not a particularly flexible enabling law, some agencies (particularly during the Obama Administration) have found ways to work adaptive management provisions into permitting and planning processes so as to require additional mitigation measures at a later time. An example is the letter of authorization issued by the National Marine Fisheries Service ("NMFS") for activities that would otherwise violate the Marine Mammals Protection Act ("MMPA"). NMFS used its general authority under MMPA[38] to issue an adaptive management regulation whereby it can modify mitigation requirements after an initial authorization is issued.[39] The regulation specifies possible sources of data that could contribute to a decision to modify requirements.[40] Other examples include the

28. *E.g.*, 43 U.S.C. § 1732 (2017);16 U.S.C. § 1604 (2017).

29. Craig, *supra* note 3, at 48.

30. *E.g.*, 36 C.F.R. § 219.5(a) (2019).

31. 42 U.S.C. §§ 4321-4347 (2017).

32. *See* Fischman & Rountree, *supra* note 3, at 19-47; Katrina Fischer Kuh, *Impact Review, Disclosure, and Planning*, *in* THE LAW OF ADAPTATION TO CLIMATE CHANGE: U.S. AND INTERNATIONAL ASPECTS 543, 543-567 (Michael Gerrard & Katrina Fischer Kuh eds., 2012); Mark Squillace & Alexander Hood, *NEPA, Climate Change, and Public Lands Decision Making*, 42 ENVTL. L. 469, 479 (2012).

33. *See* 40 C.F.R. § 1502.20 (2019).

34. *Compare* High Sierra Hikers Ass'n v. Weingardt, 521 F. Supp. 2d 1065 (N.D. Cal. 2007) (overturning a Forest Service decision to liberalize the rules limiting campfires in high-country parts of a wilderness area that were made in spite of a record raising a number of problems with the decision), *with* Theodore Roosevelt Conservation P'ship v. Salazar, 616 F.3d 497 (D.C. Cir. 2010) (upholding a tiered analysis of natural gas development that considered a broad plan but did not yet authorize a specific ground-disturbing activity).

35. Implementation of Procedural Provisions, 43 Fed. Reg. 55,978 (Nov. 29, 1978) (to be codified at 40 C.F.R. pts. 1500-1508).

36. 43 C.F.R. § 46.145 (2019).

37. 43 C.F.R. § 46.145 (2008).

38. 16 U.S.C,A. § 1361 (1994).

39. 50 C.F.R. § 218.148 (2015).

40. *Id.*

U.S. Fish and Wildlife Service's regulation on permits for eagle take,[41] the Army Corps of Engineers and Environmental Protection Agency's regulation for compensatory mitigation,[42] and the U.S. Department of Transportation's rules for developing mitigation plans for metropolitan transportation.[43]

The Obama Administration took steps to develop climate change adaptation policy that incorporated adaptive management. Executive Order 13653, which called for agency adaptation plans, said that agencies should promote "adaptive learning, in which experiences serve as opportunities to inform and adjust future actions."[44] In response to this order (and even prior to this order), 38 federal agencies submitted adaptation plans.[45] A number of these plans reference adaptive management. For example, the Army Corps of Engineers' 2014 plan committed to developing "benchmarks for incorporating adaptive management into water project designs, operational procedures, and planning strategies."[46] The Department of the Interior's 2014 plan called for "management of resources in the face of uncertainty . . . [by employing] scenario planning to allow planners and managers to explore the effectiveness of various strategies across a range of plausible futures."[47]

Through Executive Order 13783,[48] President Trump revoked Obama's climate change adaptation plan and Executive Order 13653. Interior Secretary Ryan Zinke correspondingly issued Secretarial Order No. 3349, which sought to revoke other Obama Administration policies that did not sufficiently support drilling.[49] The Trump Administration's orders did not specifically discuss adaptive management, although some policies mentioning the need for adaptive management have been found inconsistent with Executive Order 13783. For example, Secretarial Order 3360[50] revoked BLM's mitigation policy, which provided for adaptive management of mitigation measures to use lessons learned to improve future mitigation measures.[51] Likewise, the National Park Service revoked[52] a policy providing for an

41. 50 C.F.R. § 22.26 (2017) ("The permit will specify circumstances under which modifications to avoidance, minimization, or compensatory mitigation measures or monitoring protocols will be required . . . .").

42. 33 C.F.R. § 332.7 (2008); 40 C.F.R. §230.97 (2008).

43. 23 C.F.R. § 450.214 (2016).

44. Exec. Order No. 13653, 78 Fed. Reg. 66817 (Nov. 1, 2013).

45. HANNAH CONNERS ET AL., U.S. ARMY CORPS OF ENG'R, REPORT PROVIDING COMPARISON OF ADAPTATION PLANS SUBMITTED TO THE WHITE HOUSE IN 2014 2 (2015), https://www.usace.army.mil/Portals/2/docs/civilworks/climate/docs/Comparison_of_2014_Adaptation_Plans_JUNE_2015.pdf?ver=2017-12-27-141534-707.

46. U.S. ARMY CORPS OF ENG'R, CLIMATE CHANGE ADAPTATION PLAN 48 (2014), https://www.usace.army.mil/Portals/2/docs/Sustainability/Performance_Plans/2014_USACE_Climate_Change_Adaptation_Plan.pdf.

47. DEP'T OF THE INTERIOR, CLIMATE CHANGE ADAPTATION PLAN 20 (2014).

48. Exec. Order No. 13783, 82 Fed. Reg. 16093 (Mar. 28, 2017).

49. RYAN ZINKE, DEPT. OF THE INTERIOR, SECRETARIAL ORD. 3349, AM. ENERGY INDEP. (2017).

50. DAVID BERNHART, DEPT. OF THE INTERIOR, SECRETARIAL ORD. 3360, RESCINDING AUTHORITIES INCONSISTENT WITH SECRETARY'S ORD. 3349, "AMERICAN ENERGY INDEPENDENCE" (2017).

51. DEPT. OF THE INTERIOR, BUREAU OF LAND MGMT., MS-1794, POLICY 1.6(A)(7) (2016).

52. NAT'L PARK SERV., CHANGES TO POL'Y GUIDANCE (2017).

adaptive or flexible approach to decision-making that considers the uncertainties of climate change.[53]

Arguably, even if the Trump Administration does not support climate change policy, adaptive management is a sufficiently distinct topic that policies providing for the adaptive management of natural resources could remain in place.[54] Indeed, the concept of adaptive management predates much of the climate change policy debate, and would be relevant even without climate change.

In Alaska, adaptive management policies have been discussed in the context of climate change adaptation but were not adopted. Governor Sarah Palin formed a Climate Change Sub-Cabinet in 2007 to prepare communities in Alaska for the anticipated impacts from climate change.[55] The Sub-Cabinet's 2010 Climate Change Strategy called for agencies to mainstream adaptive management into resource management programs and practices.[56] The Strategy sought to set up a monitoring network and suggested that some resource management policies and statutes might need to be modified as a result.[57] Specific to hunting and fishing, the Strategy called for a more timely regulatory process to respond to short- and long-term changes in climate that can decrease harvest success.[58]

Formal efforts to address climate change adaptation stalled after Governor Palin left office in 2012, but Governor Walker's administration started a new climate change planning process in 2018. A draft policy called on the State to "make decisions that are based on adaptive management,"[59] but this recommendation did not appear in the final policy document.[60] As Governor Walker was not re-elected in November 2018, it is unlikely that the policy will be implemented in the near future.[61]

What is common to much of the policy on adaptive management, at both the national and state level, is the lack of guidance regarding how agencies can actually make adaptive management work. Many researchers have sought to fill this gap by providing guidance and suggestions on how adaptative management might

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53. JONATHAN B. JARVIS, NAT'L PARK SERV., DIRECTOR'S ORDER #100: RESOURCE STEWARDSHIP FOR THE 21ST CENTURY (2016).

54. *See* ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (C.S. Holling ed., 1978). (C.S. Holling introduced the idea of adaptive management in his 1978 work, Adaptive Environmental Assessment and Management, which calls for an iterative, incremental, decision-making process built around a continuous flow of monitoring the effects of decisions and adjusting decisions accordingly.)

55. SARAH PALIN, ADMIN. ORD. 238 (2007), https://gov.alaska.gov/admin-orders/238.html.

56. ALASKA CLIMATE CHANGE SUB-CABINET ADAPTATION ADVISORY GROUP, ALASKA'S CLIMATE CHANGE STRATEGY: ADDRESSING IMPACTS IN ALASKA, DRAFT FINAL REPORT 5-4 (2010).

57. *Id.* at 5-9.

58. *Id.*

59. CLIMATE ACTION FOR ALASKA LEADERSHIP TEAM, STATE OF ALASKA'S CLIMATE CHANGE POL'Y (DRAFT) 2 (2018).

60. CLIMATE ACTION FOR ALASKA LEADERSHIP TEAM, CLIMATE CHANGE ACTION PLAN RECOMMENDATIONS TO THE GOVERNOR (2018).

61. Emily Kwong, *With Election of Dunleavy, is Climate Action Team Out in the Cold?* KCAW (Nov. 15, 2018), https://www.kcaw.org/2018/11/15/with-election-of-dunleavy-is-climate-action-team-out-in-the-cold/ (suggesting that Governor Walker's successor will focus on things "more important than the climate task force.").

be used by agencies.[62] Yet there are relatively few examples and publications on how agencies have successfully used adaptive management.[63] The next subsection, based on the literature, discusses obstacles to making adaptive management a reality, while Section 3 offers a few examples of success in Alaska.

B. Challenges to the Application of Adaptive Management

While many have heralded adaptive management as a way to address climate change and other fluctuations in natural resources, it has also been criticized as a mechanism to cover up information gaps, avoid making difficult decisions, or conceal political accommodations.[64]

Several commentators have suggested that there are some instances where adaptive management is not practical, such as where (1) the long-term stability of decisions is important, such as child labor controls; (2) decisions cannot easily be adjusted once implemented, such as where to locate a completed highway intersection; or, (3) it is essential that an agency retains firm authority to say "yes" or "no."[65] Adaptive management may be better suited to situations where information gaps exist; there is high uncertainty regarding the future; there is little controversy regarding goals and values; decision-makers are able to experiment with and learn from different styles of management; and such experimentation has a low risk of leading to adverse results (i.e. plans are large-scale with long timeframes).[66]

Even where adaptive management may be deemed "appropriate," its integration into agency decisions has been slow and challenging.[67] This may relate

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62. *See, e.g.* Melinda Harm Benson, *Adaptive Management Approaches by Resource Management Agencies in the United States: Implications for Energy Development in the Interior West*, 28 J. ENERGY & NAT. RES. L. 87 (2010) (analyzing how BLM might employ adaptive management in the context of oil and gas development in areas such as Wyoming's Powder River Basin); Michael Peat, Katie Moon, Fiona Dyer, William Johnson, & Susan J. Nichols, *Creating Institutional Flexibility for Adaptive Water Management: Insights from Two Management Agencies*, 202 J. ENVTL. MNGMT. 188 (2017) (interviewing representatives from the South Florida Water Management District and an Australian agency: both with adaptive management as part of their mandate); Ronald Thom, Tom St. Clair, Rebecca Burns, & Michael Anderson, *Adaptive Management of Large Aquatic Ecosystem Recovery Programs in the United States*, 183 J. ENVTL. MNGMT. 424 (2016) (Interviewing representatives of ecosystem restoration programs across the United States, which are led by agencies or citizen boards).

63. Nichols et al., *supra* note 16 (discussing U.S. Fish and Wildlife's successful implementation of an adaptive approach to manage the sport hunting of mallard ducks in 1995); U.S. FISH & WILDLIFE SERVICES, ADAPTIVE HARVEST MANAGEMENT: 2018 HUNTING SEASON (2017), http://www.fws.gov/birds/management/adaptive-harvest-management/publications-and-reports.php (discussing AHM expansion to other duck species).

64. Fischman & Rountree, *supra* note 3, at 19; Flatt, *supra* note 18, at 272; Craig Anthony Arnold, *Adaptive Watershed Planning and Climate Change*, 5 ENVTL. & ENERGY L. & POL'Y J. 417, 435 (2010); George Cameron Coggins, *Of Californicators, Quislings, and Crazies: Some Perils of Devolved Collaboration*, *in* ACROSS THE GREAT DIVIDE: EXPLORATIONS IN COLLABORATIVE CONSERVATION AND THE AMERICAN WEST 171, 163-71 (Philip Brick, Donald Snow, & Sarah F. Bates eds., 2000).

65. Craig & Ruhl, *supra* note 24, at 13; Huang et al., *supra* note 24, at 310; Fischman & Rountree, *supra* note 32, at 42.

66. Craig & Ruhl, *supra* note 24, at 19; Huang et al., *supra* note 24, at 310; Fischman & Rountree, *supra* note 32, at 37; Arnold, *supra* note 64, at 439.

67. Craig & Ruhl, *supra* note 24, at 9.

to the static nature of the Administrative Procedure Act, which governs how U.S. agencies make decisions.[68] Like natural resource laws, this Act assumes that final decisions are made at the beginning of a process.[69] Agencies are also constrained by the Information Quality Act,[70] which creates strict guidelines for the quality of information coming from national agencies. Another challenge to implementing adaptive management is the role of public participation.[71] Adaptive management requires quick reaction, which may not leave enough time to get public input and consensus on a particular action.[72]

Even where adaptive management can be practically achieved in terms of science, it may not be politically feasible.[73] The legislature must be willing to allocate management funds to an agency over extended time frames, and allow agencies the flexibility needed to adjust management.[74] Deviating from the status quo can mean political risk and challenges to an agency's standard operating procedures and budgets.[75] Further, the threat of a lawsuit can reduce an agency's ability to implement a creative experiment that does not clearly comply with the law.[76] Courts may not be able to clearly distinguish legitimate adaptive management from tactics designed to avoid legal compliance, in part since laws typically do not spell out an adaptive management methodology for agencies to follow.[77]

3. EXAMPLES OF ADAPTIVE MANAGEMENT IN ALASKA

In spite of the challenges and lack of top-down guidance, national and state agencies in Alaska have taken some steps to make natural resource management more adaptive. In some cases, adaptive management is part of an official management plan. In a number of other cases, however, adaptative management has emerged more organically. One state official who participated in my research suggested that many state agencies sought to implement aspects of Alaska's 2010 Climate Change Strategy even though it was not made into official policy. Such "bottom-up" efforts may or may not be labeled as "adaptive management" but they are adaptive nonetheless. In this section, I give examples of adaptive policies that have been carried out by national and state agencies in Alaska, ranging from those based in writing to those that are less formal.

An example of a formal effort to incorporate adaptive management comes from the regulation of timber harvests in the Tongass National Forest in southeastern

68. The State of Alaska has a similar Administrative Procedure Act. ALASKA STAT. ANN. §§ 44.62.010-950 (West 2019).

69. Craig & Ruhl, *supra* note 24, at 4; Ruhl, *supra* note 20, at 1390-91.

70. Consolidated Appropriations Act of 2001 § 515, Pub. L. No. 106–554 (codified as 44 U.S.C. 3504(d)(1), 3516).

71. Ruhl, *supra* note 18, at 33; Craig & Ruhl, *supra* note 24, at 30.

72. Angelo, *supra* note 19, at 1002.

73. Ruhl, *supra* note 18, at 33.

74. Craig and Ruhl, *supra* note 24, at 25; Brian Walker, C.S. Holling, Stephen R. Carpenter, and Ann Kinzig, *Resilience, adaptability and transformability in social-ecological systems*, 9 ECOLOGY & SOC'Y 2 (2004).

75. Fischman and Rountree, *supra* note 32, at 22.

76. Craig and Ruhl, *supra* note 24, at 33.

77. *Id.* at 34.

Alaska. In the late 1990s, managers attempted to start a more adaptive approach in which they would collect and analyze data to verify and modify earlier projections of market demand.[78] Managers formed a partnership with policy-neutral research scientists, who pointed out that some of the earlier management assumptions were incorrect.[79] Managers agreed to continue to collect and test data and make changes to the overall management strategy.[80] The 2016 Forest Management plan[81] officially provides for an adaptive approach to managing cave resources,[82] sensitive plants,[83] timber sales,[84] and to amend the overall plan, although official plan amendments would require NEPA review.[85] But outside of any official strategy, managers apparently took actions on their own to respond to changing conditions, such as planting trees where they may be more likely to survive, moving trees to sites with higher elevation slopes, and selecting less healthy trees for harvest.[86]

A related example involving a formal change in policy concerns the State Board of Forestry's adoption of a new regulation for planting trees under the Forest Resources and Practices Act.[87] The original regulation required reforestation with trees of the same native species, elevation, and latitude as those that were harvested.[88] This regulation was adjusted based on the research of a manager who found that a particular population of trees doing well in a particular area were native to an area five to ten degrees latitude toward the south. The regulation now allows reforestation in certain areas with a "mix of seed for native species from similar conditions with seed from up to 10 degrees latitude south of the planting site."[89]

Another example is the Alaska Department of Natural Resource's use of monitoring stations to determine when it is safe to open the tundra to general off-road travel.[90] Travel opens not on a specific calendar date, but when there is sufficiently low ground temperature (-5˚C) and snow cover (six to nine inches, depending on location). Travel closes when thawing conditions have resulted in

78. U.S. FOREST SERVICE, RESPONDING TO THE MARKET DEMAND FOR TONGASS TIMBER: USING ADAPTIVE MANAGEMENT TO IMPLEMENT SEC. 101 OF THE 1990 TONGASS TIMBER REFORM ACT, 22 (2000).

79. Charles G. Shaw, Fred H. Everest, and Douglas N. Swanston, *Working with Knowledge at the Science/Policy Interface: A Unique Example from Developing the Tongass Land Management Plan*, 27 COMPUTERS & ELECTRONICS IN AGRIC. 377, 384 (2000).

80. Morse, *supra* note 78, at 32.

81. U.S. DEP'T OF AGRICULTURE, LAND AND RESOURCE MANAGEMENT PLAN, R10-MB-796J (Dec. 2016),
https://permanent.access.gpo.gov/gpo77976/Land%20and%20Resource%20Management%20Plan,%20Tongass%20National%20Forest,%20December%202016.pdf

82. *Id*. at 4-23.

83. *Id*. at 4-39.

84. *Id.* at 4-67.

85. *Id.* at 6-2 to -3.

86. Lauren E. Oakes, Nicole M. Ardoin, & Eric F. Lambin, *"I Know, Therefore I Adapt," Complexities of Individual Adaptation to Climate-Induced Forest Dieback in Alaska*, 21 ECOLOGY & SOC'Y Art. 40 (2016), https://www.ecologyandsociety.org/vol21/iss2/art40/ES-2016-8464.pdf.

87. *See* ALASKA STAT. tit. 41, ch.17 (2019).

88. ALASKA ADMIN. CODE tit. 11, § 96.375(f) (2004).

89. ALASKA ADMIN. CODE tit. 11, § 96.375(f)(2) (2017).

90. The Department regulates tundra travel through permits under ALASKA ADMIN. CODE tit. 11, § 96.014 (2019).

snow that will be too thin to permit travel without damaging tundra. Off-road vehicle operators are then notified and given 72 hours to move their vehicles and other equipment off the tundra onto the road.[91] Nothing in the Department's policy or regulation refers to this practice as "adaptive management," but it is clearly a way to adapt to the shortening winter season.

A fourth example is the Alaska Board of Game's ("BOG") approach to determining some hunting quotas. State regulations provide for an "intensive management" program if BOG finds that a moose, deer, or caribou populations have been depleted, and that this depletion may result in a significant reduction in hunting.[92] Intensive management rules consist of predator culling by authorized parties as well as measures that ease or encourage predator hunting by hunters (i.e., eliminating bag limits and permits, allowing baiting and feeding, and allowing the sale of skulls).[93] There are more specific management requirements for different ungulate herds and wolf or bear populations in different areas. For example, wolf culling in the Mulchatna Caribou Herd Predation Management Area may be triggered when the caribou population becomes too low, and suspended when the caribou population rises to a certain level=.[94] Predation management or control areas are set up where significant moose, deer, or caribou hunting occurs.[95]

In addition to regulations that essentially provide for adaptive management, BOG has mechanisms to revise regulations in response to species changes. Proposed revisions from the public or agencies go through advisory boards and are then considered at regular BOG meetings.[96] Emergency petitions for rule changes can be reviewed outside of the normal meeting process.[97]

As with the Department of Natural Resources' tundra travel policy, nothing in the BOG regulations refers to the concept of "adaptive management." The policies are a way to handle natural and climate change-related fluctuations in game and predator populations. As much as BOG's regulations may appear to be adaptive, they are unsatisfactory to many hunters who feel that they cannot keep the pace with

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91. ALASKA DEP'T OF NATURAL RES., DIV. OF MINING, LAND AND WATER, FACT SHEET, OFF-ROAD TRAVEL ON THE NORTH SLOPE ON STATE LAND 1 (April 2015), http://dnr.alaska.gov/mlw/factsht/land_fs/off-road_travel.pdf.

92. *See* ALASKA ADMIN. CODE tit. 5, §§ 92.106, 92.191 (2019).

93. *See* ALASKA BOARD OF GAME, FINDINGS OF THE ALASKA BOARD OF GAME 2016-215-BOG, BOARD OF GAME WOLF MANAGEMENT POLICY (2016), http://www.adfg.alaska.gov/index.cfm?adfg=gameboard.findings; Julie Lurman and Sanford P. Rabinowitch, *Preemption of State Wildlife Law in Alaska: Where, When, and Why*, 24 ALASKA L. REV. 145, 156 (2007).

94. *See* ALASKA ADMIN. CODE tit. 5, § 92.111(c)(6) (2019). Other examples are the system for reevaluation of wolf culling for the Unit 21(E) Predation Control Area; *see* ALASKA ADMIN. CODE tit. 5, § 92.124(b)(5) (2019); and provisions for ADFG to adjust the size of the Unit 24(B) Predation Control Area, ALASKA ADMIN. CODE tit. 5, § 92.124(c)(1) (2019).

95. For example, the Unit 1(A) Predation Control Area consists mostly of Forest Service lands. *See* ALASKA ADMIN. CODE tit. 5, § 92.127(b)(1) (2019); Twelve percent of Unit 26(B) is BLM land. 5 Alaska Admin. Code § 92.127(b)(2)(E).

96. ALASKA STAT. §44.62.220 (2019); ALASKA ADMIN. CODE tit. 5, § 96.625(a) (2019).

97. ALASKA STAT. ANN. § 44.62.230 (West 2019), ALASKA ADMIN. CODE tit. 5, § 96.625(f) (2019), 36 C.F.R. §36.19(a), 50 C.F.R. §100.19(a) (2019).

climate change.[98] Based on my interviews, I found that some managers took actions not outlined in the regulations in order to be more responsive. For example, managers, for both the state and the national government, have occasionally lengthened a season or expanded a usage area for fishing and hunting, though there is nothing in the regulations directly providing for such a decision. One manager developed a unique system in which different types of hunters (i.e., sport or subsistence) self-identify their hunting priorities and are regulated accordingly. Those that just want meat for subsistence and are willing to forego the value of the animal's horns value are categorized as subsistence hunters and are able to hunt under the preferential laws for subsistence hunters. In contrast, those that want the opportunity to keep the horns must apply for a permit and hunt at a later time. This system allows the manager to space out the different groups of hunters and control the harvest, so that subsistence hunters are less impacted by climate change and sport hunting.

A fifth example of adaptive management—actually adaptive co-management—is the conflict avoidance agreement between National Oceanic and Atmospheric Administration and the Alaska Eskimo Whaling Commission ("AEWC"), a Native entity that co-manages Alaska's bowhead whale hunt pursuant to the Marine Mammal Protection Act.[99] Each year, AEWC enters into an agreement with companies who will conduct oil and gas activity or shipping in the region. These agreements avoid conflict between whaling and the development activity.[100] The agreement is revisited annually based on offshore activities proposed for that year. Thus, it is able to adapt to changing conditions in the Arctic and industry's evolving understanding of where and how it would like to operate.[101]

A sixth example relates to Alaska's Landscape Conservation Cooperatives ("LCCs"). During the Obama Administration, the Secretary of the Interior[102] established these public-private partnerships to bring together different jurisdictions in the management of a single landscape. Five Alaska-based LCCs were created, including the Aleutian and Bering Sea Islands LCC, the Arctic LCC, the North Pacific LCC, the Northwest Boreal LCC, and the Western Alaska LCC. Each worked with Alaska's agencies, communities, and tribes to share adaptation strategies. One participant distinguished LCCs from the typical top-heavy bureaucracies that make up most U.S. agencies, as the LCC is more of a horizontally organized structure with

98. *See* Philip A. Loring et al., *Ways to Help and Ways to Hinder: Governance for Effective Adaptation to an Uncertain Climate*, 64 ARCTIC 73, 78-79 (2011); *see also* Shannon M. McNeeley, SEASONS OUT OF BALANCE: CLIMATE CHANGE IMPACTS, VULNERABILITY, AND SUSTAINABLE ADAPTATION IN INTERIOR ALASKA 174 (2009); *see also* Shannon M. McNeeley, *Examining Barriers and Opportunities for Sustainable Adaptation to Climate Change in Interior Alaska*, 111 CLIMATIC CHANGE 835, 847 (2012).

99. Marine Mammal Protection Act of 1972, § 119, 16 U.S.C. § 1388 (2018).

100. ALASKA ESKIMO WHALING COMMISSION, *Open Water Season Conflict Avoidance Agreement*, http://www.aewc-alaska.com/caa.html (last visited Dec. 31, 2019).

101. ALASKA ESKIMO WHALING COMMISSION, *Comments on 2019-2024 Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program and Scoping 9* (Mar. 8, 2018), https://s3-us-west-2.amazonaws.com/ktoo/2019/03/AEWC_Comments_on_Five-Year_Plan_FINAL.pdf.

102. DEP'T OF THE INTERIOR, SECRETARY OF THE INTERIOR ORDER NO. 3289: ADDRESSING THE IMPACTS OF CLIMATE CHANGE ON AMERICA'S WATER, LAND, AND OTHER NATURAL AND CULTURAL RESOURCES (2009).

nodes of decision-making. This structure allowed LCCs to change their strategic plans regularly to take advantage of opportunities when they arose.

The Trump Administration has sought to eliminate funding for LCCs,[103] and the Northwest Boreal LCC has adapted by changing its partnership structure into a non-government entity.[104] While federal policy changes such as the elimination of LCCs appear to be setback to adaptive management, it is not clear that adaptive management policies under the Obama Administration were effectively being implemented. The examples I have described in this article are mostly "bottom-up" initiatives led by lower-level managers. During my interviews, which took place at the end of the Obama Administration, only a couple of my participants who discussed adaptive management thought it was being successfully implemented. Others offered reasons for its lack of success, including agencies' lack of power, funding, time, and/or knowledge to implement adaptive management as well as difficulties associated with staff turnover and political change. The following three comments from agency participants shed more light on the challenges of adaptive management:

> Adaptive management in its purest form requires some level of control that I don't think we always have. Strict adaptive management doesn't work, but we need something that allows flexibility.
>
> As illogical as it might seem, adaptive management takes a whole lot of forethought and foresight. You can't just decide all of the sudden to implement it. It is easiest to implement at the project scale (as opposed to a programmatic level) by monitoring and adjusting stipulations.
>
> Doing something new takes so much longer than if you just copy the process the way that you've been doing it since the 1970s. If you have an unrealistic deadline, you just default to doing it the old way.

In summary, adaptive management is occurring at small scales in Alaska, though it is often not labeled as "adaptive management," and agency managers remain frustrated by the lack of flexibility they have to adapt management.

4. RECOMMENDATIONS

Impediments to adaptive management in Alaska result from agencies' lack of capacity to respond to changes as they happen as well as lack of political will at higher levels to make policy changes in response to resource changes. The first impediment is easier to address than the second. Better communication within and beyond an agency could allow for more rapid exchange of new information and

103. Union of Concerned Scientists, *The Trump Administration Has Undermined a Nationwide Conservation Program* (Apr. 22, 2019) https://www.ucsusa.org/center-science-and-democracy/attacks-on-science/trump-administration-has-undermined-nationwide.

104. Chris Smith, *Northern Landscape Conservation Cooperatives Envision Their Future*, 71 WILDLIFE MGMT. INST. 11 (Nov. 2017), https://wildlifemanagement.institute/outdoor-news-bulletin/november-2017/northern-landscape-conservation-cooperatives-envision-their.

learning from mistakes in a manner that facilitates adaptive management.[105] Horizontal partnerships between agencies and private entities (such as those formed through LCCs) are one way to facilitate communication.[106] Another could involve partnerships with resource users, namely subsistence participants who observe changes in real time, whereby the participants are equipped with technology to report changes.[107] Such a partnership could build on existing organic knowledge exchange systems like the Local Environmental Observer Network, in which subsistence participants upload images and information regarding climate change impacts.[108] Ideally, better integrating subsistence participants in the data collection process could shift the political process, as the value of these stakeholders in decision-making is recognized.

The second impediment is being addressed to some degree by agency managers who quietly seek ways to better do their jobs. These actions add to the literature regarding the importance of bottom-up processes to promote adaptive management,[109] community adaptation,[110] and more generally, resilience.[111] Over time, actions and recommendations of lower level managers can become law (such as Alaska's example of reforestation with native species). The second impediment might also be addressed by crafting regulations that are more specific regarding thresholds for triggering adaptive management (such as the State of Alaska intensive predator management regulations) and the timeframe and process for adjusting policy (i.e., notice and consultation with the permittee or public).

The need to "scale-up" adaptive management from the project level to larger decisions is likely to become increasingly important in Alaska (and elsewhere) for at least two reasons. One is that iconic landscapes and species populations (such as the Wilderness lands within the Arctic Refuge and the polar bear) will change significantly with climate change.[112] Managers will need to figure out what measures

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105. *See* Brian H. Walker et al., *Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems*, 11 ECOLOGY & SOC'Y 13 (2006); Frances Westley, *Governing Design: The Management of Social Systems and Ecosystems Management*, 391–427 in PANARCHY : UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS, Lance H. Gunderson and C. S. Holling (eds.) 402 (1995).

106. *See* Per Olsson et al., *Adaptive Comanagement for Building Resilience in Social-Ecological Systems*, 34 ENVTL. MGMT. 75, 85 (June 2004).

107. Carl Folke et al., *Ecological Practices and Social Mechanisms for Building Resilience and Sustainability*, *in* LINKING SOCIAL AND ECOLOGICAL SYSTEMS: MANAGEMENT PRACTICES AND SOCIAL MECHANISMS FOR BUILDING RESILIENCE 414, 416 (Carl Folke et al. eds., 1998).

108. *See* ABOUT LEO NETWORK, https://www.leonetwork.org/en/docs/about/about.

109. Peat et al., *supra* note 62, at 193.

110. Philip Berke & Ward Lyles, *Public Risks and the Challenges to Climate-Change Adaptation: A Proposed Framework for Planning in the Age of Uncertainty*, 15 CITYSCAPE 181, 198 (2013);
F. Stuart Chapin, Corrine N. Knapp, Todd .J Brinkman, Robin Bronen, & Patricia Cochran, *Community-Empowered Adaptation for Self-Reliance*, 19 CURRENT OPINION IN ENVTL. SUSTAINABILITY 67 (April 2016); Zhenghong Tang, Samuel Brody, Courtney Quinn, Liang Chang, & Ting Wei, *Moving from Agenda to Action: Evaluating Local Climate Change Action Plans*, 53 J. ENVTL. PLAN. & MGMT. 41 (2010).

111. Garmestani & Benson, *supra* note 1; GARY KOFINAS, *Building Resilience in the Arctic: From Theory to Practice*, *in* ARCTIC RESILIENCE REPORT 202 (M. Carson and G. Peterson eds., 2016).

112. Brooke C. Stewart et al., *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 7, Climate of Alaska* (2013), http://www.

they can and must take under natural resource laws to preserve these landscapes and species. In the case of lands protected by the Wilderness Act, agencies and managers will need to decide the degree to which conservation measures are permissible and which interfere unduly with the "wilderness character"[113] of the land.[114] The opportunity to experiment and adjust policy according to new data could be a valuable way to avoid being stuck with a policy that could permanently alter a landscape. Indeed, such a large-scale management decision with many unknowns is precisely the kind of situation for which the law review literature prescribes adaptive management.[115]

A second need for adaptive management comes with the truncated environmental reviews required by the Trump Administration under NEPA.[116] With shorter timeframes to fully consider the implications of management policy and permits, agencies should be able to impose additional mitigation measures as needed during the life of the project. In Alaska, as the ecologically fragile National Petroleum Reserve of Alaska and possibly the Arctic National Wildlife Refuge are opening up for development,[117] hasty decisions without room for revision could cause permanent damage.[118]

5. CONCLUSION

Adaptive management is already occurring in Alaska and elsewhere at the level of small-scale plans, projects, and permits, whether or not it is specifically called "adaptive management." The need to integrate adaptive management into larger-scale decision-making processes is becoming more important with climate change. While agencies exercising adaptive management may risk reduced funding

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nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_ Report_142-7-Climate_of_Alaska.pdf; Chapin et al., *supra* note 10, at 536.

113. 16 U.S.C.§ 1133.

114. Cole, *supra* note 14; Kaye, *supra* note 14.

115. Craig & Ruhl, *supra* note 24, at 19; Huang et al., *supra* note 24, at 310; Fischman & Rountree, *supra* note 32, at 37; Arnold, *supra* note 64, at 439.

116. *See* SOI Order No. 3355, Streamlining National Environmental Policy Act Reviews and Implementation of Executive Order 13807, "Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects" (Aug. 31, 2017) (instructing each Bureau and Office serving as a NEPA lead agency to prepare EISs that are no longer than 150 pages (300 pages for unusually complex projects) and to complete each Final EIS within 365 calendar days of publishing the associated Notice of intent unless otherwise approved by the Department).

117. Notice of Intent to Prepare an Environmental Impact Statement for the Coastal Plain Oil and Gas Leasing Program, Alaska, 83 Fed. Reg. 17562 (Apr. 20, 2018); Margaret Kriz Hobson, *New NPR-A assessment to spark debate over expanded drilling*, E&E NEWS (Dec.18, 2017); Notice of Intent To Prepare an Environmental Impact Statement for the Willow Master Development Plan Oil and Gas Prospect, Alaska, 83 Fed. Reg. 38725 (Aug. 7, 2018).

118. U.S. FISH & WILDLIFE SERVICE, Arctic National Wildlife Refuge, Potential Impacts of Proposed Oil and Gas Development on the Arctic Refuge's Coastal Plain: Historical Overview and Issues of Concern (Jan 17,2001) https://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_1/Arctic/PDF/arctic_oilandgas_impact.pdf; Raymond D. Cameron, Walter T. Smith, Robert G. White & Brad Griffith, Central Arctic Caribou and Petroleum Development: Distributional, Nutritional, and Reproductive Implications, 58 ARCTIC 1 (2005); NATIONAL RESEARCH COUNCIL, Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (The National Academies Press 2003).

and more lawsuits, there is a lack of empirical research showing that this is the case. There is a need for more research highlighting successful examples of adaptive management. This research should examine the role of formal rules and informal practices pertaining to thresholds for shifting management and the notice and consultation involved in management shifts.