SECTION 1. ADMINISTRATIVE INFORMATION

Title: Climate Assessments and Scenario Planning (CLASP)
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Date of this report: October 12, 2018

SECTION 2. PUBLIC SUMMARY

The NE CASC boasts an interdisciplinary array of scientists, from ecologists to biologists, hydrologists to climatologists, each contributing new, original academic research to advance our understanding of the impacts of climate change on wildlife and other natural resources in the Northeast. Needed was an outreach specialist who would interface directly with the management agencies who benefited from this research to aid the integration of this research into their management planning as part of adapting to climate change. A climatologist was preferred to address queries about climate modeling, climate change uncertainties, and other areas of climate science outside the expertise of NE CASC ecologists, biologists, and hydrologists. This person's activities would include responding to inquiries, presenting climate science concepts at management workshops, gathering managers' climate science needs, contributing to the climate portion of synthesis reports and other resources for managers, and collaborating with ecologists on interdisciplinary studies of climate change by providing climate data and guidance on interpretation. The objective was to relay and interpret the scientific findings most relevant to managers' resources of concern and management activities around those resources to guide adjustments to their activities toward better protecting their resources of concern. As an outcome, managers often relied on synthesized climate science to be able to consider how climate trends affect their work, especially those thinking about climate change for the first time in the context of their work. This lays the groundwork for more detailed management-driven science delivery that can aid eventual implementation. Management groups reached by this project include land managers with the National Park Service, state fish and game departments and DNRs, and tribal environmental coordinators.

SECTION 3. PROJECT SUMMARY

The DOI Climate Adaptation Science Centers are challenged to reach managers directly from the formulation of science questions to the delivery of scientific results to guide their management objectives and actions. As academics, conducting original research requires a substantial time commitment, limiting researchers' capacity to meet the expectation of engaging with managers. The Climate Assessments and Scenario Planning (CLASP) "project" was considered more as a "position", designed to engage land managers serving the NE CASC footprint to relay NE CASC science and translate trends in climate data to relevant metrics to aid decisions. As one of only a few physical climate scientists in the network, this boundary spanning position operated akin to a concierge service model, to provide guidance and

technical training to managers and NE CASC researchers on climate science, observational and modeled data, and other needed background. Activities varied based on need, but entailed: computing and tabulating patterns in localized climate data for management jurisdictions, including maps, time series and other visual tools; communicating the local uncertainties in climate change trends and impacts through scenarios as part of the Scenario Planning decision support framework; to presenting basic introductory overviews of climate trends and data (sometimes referred to as Climate 101s") at manager workshops. Research efforts focused on identifying the strengths and limitations of available climate data (observational and modeling) products for use in ecological studies and applications. Outcomes of this project included improved transfer of knowledge of climate change and its impacts on natural resources among the management community, tangible management actions considered in response to communicated climate change and ecosystem science, and progress in ecological research owing to technical assistance and guidance with using climate data products. This increased awareness and communication between scientists and managers, and advanced ecological research and management responses to climate change. Other outcomes are new relationships between the NE CASC and various management agencies, from federal/state government agency personnel to tribal environmental coordinators; a regional synthesis that supported the State Wildlife Action Plans (Staudinger et al., 2015) and a public-facing web-based tool (The Massachusetts Climate Action Tool, climateactiontool.org) showcased NE CASC and partner research and activities. Project activities also included contributions to the development of tribal climate adaptation plans, and multiple peer-reviewed academic publications.

SECTION 4. REPORT BODY

Purpose and Objectives:

Land management agencies, including natural resource managers, are increasingly considering known and potential climate change impacts on the resources they manage. The Climate Adaptation Science Center network, established in 2008, aims to conduct research to better understand the impacts such that managers can know what impacts to consider. Relaying that research to managers is a separate time commitment as it requires careful translation of the scientific results and uncertainties such that they are used properly and responsibly in management planning. The CLASP project aims to interface with managers to help ensure effective delivery and consideration of scientific results in planning, thereby giving NE CASC sponsored research, as well as the broader scientific community, a wider reach and use among the management sector. As a physical climate scientist, the objective of CLASP was to translate climate science and uncertainties for managers to aid considerations of impacts on the resources of concern. The audience for this project consisted of DOI management bureaus (e.g., NPS, FWS), state natural resource agencies (e.g., Fish and Game, DNRs), and Native American tribes. The project goals and objectives were unchanged from beginning to end — to help deliver and interpret science to land managers to assist in adaptive planning efforts — but the approaches used to achieve these goals (see Organization and Approach below) varied depending on the audience.

Organization and Approach:

Initial engagement with agencies with management responsibilities was largely opportunistic, relying on emerging activities within bureaus seeking to incorporate climate change-related information but often lacking the time and funding to break away from routine management duties to engage in climate adaptation planning. Such opportunities included 1) the decadal revision of the State Wildlife Action Plans, 2) Scenario Planning efforts of the NPS Climate Change Response Program, and 3) an NE-CASC-funded project to host planning workshops with tribal environmental departments.

Each project generally involved preliminary information gathering to guide the resource materials provided. This is where the CLASP project evolved the most. Initially, I gathered input on resources of concern (e.g., Regional Species of Conservation Concern, vulnerable habitats, etc.) with the intent of translating climate trends to metrics most relevant to those resources. Two problems emerged: 1) most resources lack known climate thresholds to be able to carry out the translation, but more importantly, 2) even if thresholds are known, the complexities of ecosystem change are such that one cannot merely rely on climate thresholds to anticipate how a resource will ultimately be affected.

Project Results, Analysis and Findings:

The CLASP project includes several distinct sub-projects that fall into two broader categories: 1) **outreach:** sub-projects covering all outreach activities including scenario planning, vulnerability assessments, and other engagement efforts with National Parks, Tribes, etc. and 2) **research:** sub-projects that included comparisons of downscaling methods, for example, using maple syrup tapping season as a case study, and impacts of climate-induced forest compositional change on air quality.

<u>Selected CLASP Outreach Activities</u>

Scenario Planning for Acadia National Park

Acadia National Park in Bar Harbor, Maine is a prominent coastal national park unit threatened by sea-level rise, increased flooding, and other stressors. To consider these changes and identify management options, NPS adopted scenario planning as a primary tool. At Acadia, NPS and I co-produced scenarios for park managers during a two-day workshop, to review, deliberate, and identify possible management actions (Figure 1). For example, one scenario included a temporary (10-20 year) period of cooling that occurs ahead of a period of rapid warming, reflecting potential shifts in the Atlantic Multidecadal Oscillation - a

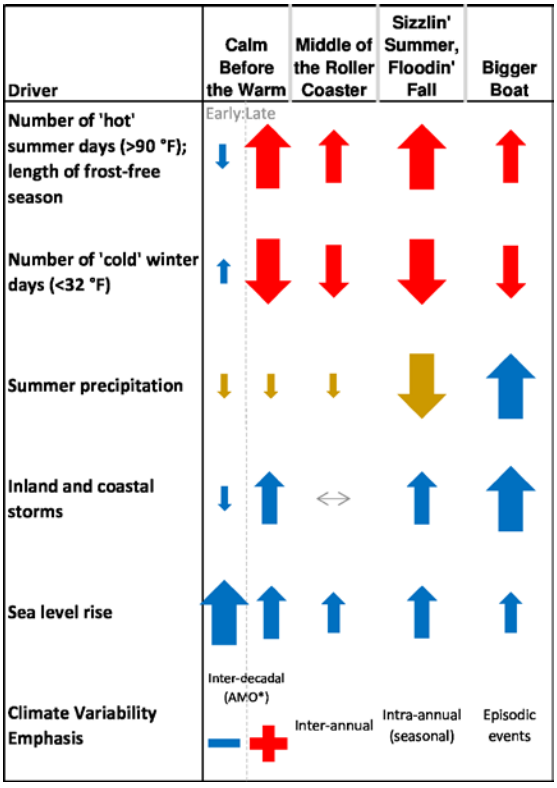

Figure 1. Scenarios for Acadia National Park

mode of climate variability with a strong influence on Northeast climate, especially near the coast. This scenario prompted Park managers to consider using the cooling period to raise awareness, develop response protocols, build partnerships, increase preparedness for invasive species, and collect native seeds (a "seed bank") for future restorations. The process also informed current park management. For example, for a restoration at the summit of Cadillac Mountain, managers were unsure whether to use standard seed mixes or introduce warm-adapted species. The range of uncertainty in potential warming, depicted in our scenarios, prompted staff to test a range of species, to reduce risk and increase local diversity. The scenarios also informed infrastructure and operational decisions (e.g., staff hiring). This included increasing the gravel budget to repair historic carriage roads after washouts from more extreme events; altering the hiring structure to accommodate pressure to open earlier and close later in the year with the expanding warm season; shifting maintenance schedules as seasons change; and integrating the vulnerability of coastal infrastructure in an Environmental Impact Statement.

Climate Change Vulnerability Assessment for Colonial National Historical Park

Like Acadia, Colonial National Historical Park (a.k.a. Jamestown) lies on the Atlantic coast, and thus faces serious threats from sea level rise and storm surge, as well as wind damage and flooding from coastal storms. One of the three corners of the ancient triangular fort site (Fort James) is already under water. Although climate change is not to blame for the sunken post, climate change puts the remainder of the fort, currently an active archaeological dig site, at risk of further erosion. Other concerns include damage or loss of other historic structures or artifacts from the time, navigation around the park due to damage to infrastructure such as roads, bridges, and trails, or maintaining ecosystems that resemble the 1607 landscape for visitors. The goal of this project, in collaboration with NPS's Northeast Region and URI, was to lead the park in conducting a climate change vulnerability assessment (i.e., determining what resources/species were *exposed* to change, which are most *sensitive*, and which cannot *adapt* on their own, and thus are both most vulnerable and require management to preserve). For my role, I used climate model output to estimate "exposure" — the deviation outside the historical climatological norm — for relevant metrics and timeframes (Figure 2). Using this information, park managers and ecologists in the room ranked species by

		Exposure*		
		2020	2050	2100
Temperature	Mean annual temperature	Y	Y	Y
	Daily highs	Y	Y	Y
	Daily lows	Y	Y	Y
	Hot days (> 95 °F)	Y	Y	Y
	Cold nights (< 32 °F)	N	Y	Y
	Warm spells (3+ days of >95 °F)	Y	Y	Y
	Cold spells (3+ days of <32 °F)	N	N	M
	Growing season length**	N	Y	Y
Precipitation	Mean annual precipitation	N	N	M
	Days exceeding 2" precipitation	N	N	M
	Peak daily precipitation	N	N	N
	Dry spell length (3+ days no rain)	N	N	N

* Defined as whether (yes, Y) or not (no, N) the 20-year mean, centered on the year (2020, 2050, or 2100), is greater than the historical (1950-2005) mean plus one standard deviation. An M (for "maybe") indicates exposure according to "major change" but not according to "least change" scenario, suggesting that exposure depends on future greenhouse gas emissions and other sources of uncertainty.

** Defined as the number of days between the last spring freeze and the first autumn freeze, where a "freeze" occurs when the daily low drops below 32 °F.

Figure 2. Exposure for Colonial Nat'l Historical Park

their known sensitivities to the array of projected climate exposure trends. Following the initial exposure ranking workshop, two succeeding workshops assessed sensitivity and adaptive capacity. Since then, the park has begun to propose management actions considering the findings (e.g., build new and raise existing sea walls, build marsh to assist migration of coastal species).

Climate Adaptation Plan Development for Forest County Potawatomi of Chippewa Indians

One service provided by the CLASP project included assisting managers develop their agency's or community's climate adaptation plan by assisting with activities such as reviewing draft plans and contributing text related to the background science. One recipient of this service was the Forest County Potawatomi Tribe of Chippewa Indians (FCPC). The FCPC Tribe began drafting two assessments to incorporate vulnerability information into forthcoming planning activities: climate impacts on 1) natural resources and 2) air quality for the Tribe. Both efforts included a background section on climate change trends to set the context. I reviewed draft documents, adding new research that was relevant to statements made in the report, and included additional background and context. As of the conclusion of the CLASP project, development of the report is believed to be still underway.

Synthesis report: Climate Changes chapter for the SWAP synthesis report

I served as chapter lead author for the first chapter (Climate Changes) in the *Integrating Climate Change into Northeast and Midwest State Wildlife Action Plans* synthesis report. This included delegating and compiling writing samples from 8 authors. The chapter includes trends for 7 variables and regional syntheses for 3 sub-regions (Atlantic Coast, Great Lakes, and Appalachians), as well as an interpretation guide for practitioners. The chapter was heavily cited by the 8 states that used the report, including direct use of figures and text. The information in the report was then converted to supply data and descriptions on climate variable pages in the Massachusetts Climate Action Tool.

Science resource: "Phone calls" & Resilience Dialogues for Minneapolis, MN & East Lansing, MI

On frequent occasion, I fielded inquiries — mostly in the form of emails — pertaining to climate modeling, background physics, or other climate science questions from both other researchers within and outside of NE CASC and managers in the region. I considered these "phone calls" akin to a concierge-style service, and a primary duty of the CLASP fellowship. In a more formal engagement setting, I served as a "subject matter expert" on both the pilot and second iteration of the AGU Resilience Dialogues, interacting with urban planners from Minneapolis, MN and East Lansing, MI. I provided expertise related to the use of climate projections in planning as well as guidance for cities seeking to take adaptive actions in ways that also promote wildlife conservation.

Science resource: Updates to the NE CASC climate web page

As a conclusion to my engagement, I am applying lessons learned over the 4-year CLASP project through my many engagements to compile resources that match the common needs of managers I have engaged with. Many managers in the Northeast and other regions are seriously considering climate change for the first time and thus need, as a first step, a

qualitative summary of the state of our knowledge in terms of climate trends. Managers can then consider how these trends might affect their specific management activities or their specific jurisdictions. Ecologists and managers alike have requested guidance on the most appropriate methods for incorporating climate model products into their research or management actions. A future goal for the NE CASC is to compile a brief overview of best practices for applying different types of data sets in various research and decision-making contexts and make this information available on the website with related links to facilitate direct access to regional resources.

Research projects

Research project 1: Does choice of downscaling method affect ecological impacts studies? A case study with maple syrup production

Two methodological approaches to climate model downscaling, dynamical and statistical are typically defined. Within these two approaches there are well known limitations: 1) dynamical models directly simulate physical processes (e.g., orographic rain) but are computationally expensive, and thus the size of the climate model ensemble is often severely limited, and 2) statistical models are computationally inexpensive and thus it is more feasible to downscale a larger number of climate models, but it is not possible to directly simulate physical processes through numerical modeling. But what do those limitations mean for an ecologist using these models to conduct an impact study, or a natural resource manager using the model to infer impacts on a species of interest with known climate thresholds? Do these "climate" limitations matter for ecological applications and, if so, how? Does one downscaling method tend to yield similar differences that broadly apply to many ecological applications? I tested these questions using the potential effects of climate change on maple syrup production as an ecological management case study. This case study has a direct climate link by tracking freeze-thaw cycles as a driver of sapflow in maple trees, and a strong link to decision making by maple syrup producers of - when is best to tap? Comparing a sampling of dynamical and statistical downscaled outputs driven by the same set of GCMs, I tested for systematic differences between the two downscaling methods, such as whether one method tended to predict a 3-week-earlier tapping season by 2050 versus the other predicting only 3 days earlier. Statistical models, because they are distribution of observations used to construct the empirical model used to downscale the GCM, yield very small year-to-year variability, whereas dynamical models, unconstrained by observations, yield much wider year-to-year variation. However, statistical models, because they are calibrated to observations, provide a reliable estimate of the average tap date a producer can expect by 2050 or 2100. Dynamical models, in contrast, provide a sense of growing or shrinking year-to-year variation, but because they are not calibrated by observations, do not provide a reliable estimate of the actual date ranges to expect as each model shows significantly different results, sometimes showing an opposite trend (*later* shift in tap date, which would be highly unlikely given expected future warming). These results suggest that both models are useful for different purposes and that both provide important pieces of information. Producers are most challenged by the year-to-year variation, and so would be very interested in the dynamical downscaling results if they suggest growing variation. Because producers plan their tapping schedules on a year-to-year basis, shifts in the

average tap date by 2050 or 2100 produced by statistical downscaling are irrelevant for near-term decision making. Predictions of earlier average tap dates do concern them because of the attendant damage to the industry as a whole. But because they can adapt in a matter of a few years, knowing this far in advance does not impact any management decision. The overall lesson — that both dynamical and statistical downscaling methods have utility for providing two key components of information — is broadly applicable to ecological impacts studies and management at large.

Research project 2: How might climate-induced forest change affect the background levels of natural ozone and aerosol precursors relevant for air quality?

Climate change will lead to large shifts in forest composition according to simulations performed by NE CASC PI Dr. Frank Thompson and his research group, with introductions of some species and extirpations of others in certain areas. Different species emit different compounds important for ozone and aerosol formation, thus changes in forest composition will change the landscape of the natural precursors to these pollutants. This study advanced the accomplishments of the Thompson group a step further to examine how their published results of forest change — using the Central Hardwoods as a pilot study — might alter the natural emission of these compounds. This in turn can inform pollution regulation by understanding whether high emitters of a particular precursor are moving closer to or further from an urban area. This work involved strong collaboration with the NE CASC research collaborators at the University of Missouri and the US Forest Service (USFS). We found decreases of one important emittant (isoprene, C_5H_8) in the southwest portion of the Central Hardwoods region and increases in the northeast, while another class of emittants (monoterpenes, $C_{10}H_{16}$), were found to experience increases across the region with the greatest increases in the southwest. The isoprene decreases in the southwest were mostly due to declines in white oak; the increases in the northeast were due to introductions or regeneration of yellow poplar; the monoterpene increases followed a similar pattern to the increases in red maple with most of the increase occurring in the southwest. The project resulted in new insights into some of the indirect drivers of the aerosol dynamics in that we found precipitation drove the original changes in forest composition, marked by a bimodal pattern of drying in the southwest and wetter conditions in the northeast. This presents an important caveat for our study and a source of future work, i.e. our use of a single GCM (GFDL) to simulate atmospheric conditions leaves open the possibility that the use of a different numerical model could yield very different precipitation projections. In fact, the original paper describing the forest modeling (Wang et al. 2015) used two additional climate models. While the authors do not describe the spatial distribution of precipitation in each model, they do note that one of the models (PCM) shows the opposite trend as the one used in this study (GFDL). Knowing now that precipitation is the primary constraint for these forest species, we plan to add the 2 alternate models supplied by the Thompson group.

<u>Miscellaneous contributions</u>

Publication: A revised, management-driven approach to Scenario Planning (SW CASC Detail)

Working with Dr. Carolyn Enquist through a detail with the SW CASC, we worked with an NPS manager and a decision support team supported by the Desert LCC to devise a new, management-driven approach to Scenario Planning. A draft of the approach is currently in press in the proceedings of the Madrean Conference.

Interdisciplinary collaboration: Snowshoe Hare Molt Phenology

I provided climate science and data support for wildlife ecologist and NE CASC Fellow Marketa Zimova as part of her dissertation work studying the climate change impacts on snowshoe hare camouflage capabilities. The project tests whether shorter winters are resulting in increased exposure of snowshoe hare to predators through higher conspicuousness from having their coats remain white as snowpacks melt earlier in the year. I provided guidance toward using snow data products and calculating winter metrics such as the first and last days of snow and average snowpack lifetime.

Cross-CASC Climate Modeling Working Group

As one of only a handful of physical climate scientists in the CASC network, I, in partnership with Derek Rosendahl with the SC CASC, led a monthly discussion group with other likeminded climate scientists in the CASC with the goals of building community, sharing experiences, research, and new developments in the literature, and seeking feedback from others on effective climate science communication with ecologists and natural resource managers, and promoting consistency in how we communicate climate science across our network. This effort also served to promote cross-CASC collaboration. The activities were led by the interests of the participating members, starting out as a journal club to keep up-to-date on the ever-growing literature, and evolving ultimately into a forum to share in-progress projects one-by-one from members of each CASC and seeking feedback on particular issues. Our group also led a successful proposal to lead a 2-hour training session at the 2017 National Adaptation Forum titled *Incorporating Future Climate Projections in Adaptation Planning: A Layman's Guide*.

Publications:

<u>Peer-reviewed journal articles</u>

1. Bryan, A. M. and C. A. F. Enquist (2018): Scenario Planning Around Resource Challenges (SPARC): A Management-Centered Approach to Scenario Planning for Climate Adaptation, Madrean Conference Proceedings, in press.
2. Karmalkar, A. V., J. M. Thibeault, A. M. Bryan, and A. Seth (2018): Identifying credible and diverse GCMs for regional climate change studies. Case study: Northeastern United States, Climatic Change, in rev.
3. Butler-Leopold, P. R., L. R. Iverson, F. R. Thompson III, L. A. Brandt, S. D. Handler, M. K. Janowiak, P. D. Shannon, C. W. Swanston, S. Bearer, A. M. Bryan, K. L. Clark, G. Czarnecki, P. DeSenze, W. D. Dijak, J. S. Fraser, P. F. Gugger, A. Hille, J. Hynicka, C. A. Jantz, M. C. Kelly, K. M. Krause, I. P. La Puma, D. Landau, R. G. Lathrop, L. P. Leites, E. Madlinger, S. N. Matthews, G. Ozbay, M. P. Peters, A. Prasad, D. A. Schmit, C. Shephard, R. Shirer, N. S. Skowronski, A. Steele, S. Stout, M. Thomas-Van Gundy, J. Thompson, R.

M. Turcotte, D. A. Weinstein, and Alfonso Yáñez (2018): Mid-Atlantic Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Mid-Atlantic Climate Change Response Framework Project, Northern Institute of Applied Climate Science (NIACS) / USFS report, in press.

4. Alexander, K. E., W. B. Leavenworth, T. V. Willis, C. Hall, S. Mattocks, S. M. Bittner, E. Klein, M. D. Staudinger, A. Bryan, J. Rosset, B. H. Carr, and A. Jordaan (2017): Tambora and the mackerel year: Phenology and fisheries during an extreme climate event, Science Advances, 13, e1601635.
5. Ashworth, K., S. H. Chung, R. J. Griffin, J. Chen, R. Forkel, A. M. Bryan, and A. L. Steiner (2015): FORest Canopy Atmosphere Transfer (FORCAsT) 1.0: a 1-D model of biosphere-atmosphere chemical exchange, Geoscientific Model Development, 8, 3765–3784.
6. Bryan, A. M., S. J. Cheng, K. Ashworth, A. B. Guenther, B. Hardiman, G. Bohrer, and A. L. Steiner (2015): Forest-atmosphere BVOC exchange in diverse and structurally complex canopies: 1-D modeling of a mid-successional forest in northern Michigan, Atmospheric Environment, 120, 217–226.
7. Bryan, A. M., A. L. Steiner, and D. J. Posselt (2015): Regional modeling of surface-atmosphere interactions and their impact on Great Lakes hydroclimate, Journal of Geophysical Research: Atmospheres 120, 1044–1064.

Non-refereed publications

1. Rubinoff, P., G. Ricci, D. Robadue, A. Babson, and A. M. Bryan (2016): First Workshop Summary: Assessing the Exposure and Sensitivity of Colonial National Historical Park (COLO) to Climate Change, Aug 9, 2016.
2. Star, J., N. Fisichelli, A. M. Bryan, A. Babson, R. Cole-Will, and A. Miller-Rushing (2016): Acadia National Park Climate Change Scenario Planning Workshop Summary. Available at https://necsc.umass.edu/sites/default/files/ACAD_ScenarioPlanningWorshopSummaryFINAL_20160531.pdf.
3. Staudinger, M. D., T. L. Morelli, and A. M. Bryan (2015): Integrating Climate Change into Northeast and Midwest State Wildlife Action Plans. DOI Northeast Climate Science Center Report, Amherst, Massachusetts. Available at http://necsc.umass.edu.

Popular

1. K. Malpeli: "Planning for Possible Futures in Acadia National Park", USGS CASC network news, 5 Jul 2018. Available at https://casc.usgs.gov/content/planning-possible-futures-acadia-national-park.
2. K. Malpeli: "10 Things You May Not Know About Our Coasts", USGS CASC network news, 15 Jun 2018. Available at https://casc.usgs.gov/content/10-things-you-may-not-know-about-our-coasts.
3. C. Puckett and J. Lathrop: "New England's 1816 'Mackerel Year,' Volcanoes and Climate Change Today", USGS Top Story, 18 Jan 2017. Available at https://www.usgs.gov/news/new-england-s-1816-mackerel-year-volcanoes-and-climate-change-today.

4. K. Malpeli and C. Puckett: “Safeguarding Our Cultural Past from Future Climate Change: Stories from Jamestown”, USGS Top Story, 28 Nov 2016. Available at https://www.usgs.gov/news/safeguarding-our-cultural-past-future-climate-change-stories-jamestown.
5. J. Brown: “Historic Jamestown: Assessing the Climate Change Impacts on North America’s First European Settlement”, NE CSC News, 16 Sep 2016. Available at https://necsc.umass.edu/news/historic-jamestown-assessing-climate-change-impacts-north-america’s-first-european-settlement.
6. J. Brown: “Preparing Acadia National Park for Climate Change”, NE CSC News, 29 Oct 2015. Available at https://necsc.umass.edu/news/preparing-acadia-national-park-climate-change.
7. J. Lathrop: “Air Quality and Ozone Pollution Models for Forested Areas May Be Too Simple”, UMass Amherst Press Release, 29 Sep 2015. Available at https://www.umass.edu/newsoffice/article/air-quality-and-ozone-pollution-models.

Presentations:

Invited talks

1. Bryan, A. M.: The Science Behind Climate Change [and changes in the Northeast and Midwest U.S.], Institute for Tribal Environmental Professionals (ITEP) Vulnerability Assessment Training, remote, 3 Oct 2018.
2. Morelli, T. L. and A. M. Bryan: Climate Change in the Adirondacks: What we know & what we don't, Climate Change and Moose Management in NY State, New York Department of Environmental Conservation, 29 May 2018.
3. Bryan, A. M.: Western Mass's Changing Climate, Massachusetts Tree Wardens' and Foresters’ Association Spring Dinner Meeting, Northampton, MA, 27 Mar 2018.
4. Bryan, A. M.: NE CSC: Adapting our land, water, wildlife, and cultural resources to climate change, USGS Eastern Region Center Health Meeting, Reston, VA, 15 Mar 2018.
5. Bryan, A. M.: Climate Change: Fact or Fiction? The Science Behind Climate Change, Norcross Wildlife Sanctuary Winter Lecture Series, Monson, MA, 3 Mar 2018.
6. Bryan, A. M. and C. A. F. Enquist: Scenario Planning for the Madrean Watersheds: An overview, Madrean Scenario Planning Refinement Workshop, Tucson, AZ, 2 Mar 2018.
7. Bryan, A. M. and C. A. F. Enquist: Scenario Planning for the DLCC LCD: An overview, Mojave Indicators Workshop, remote, 26 Feb 2018.
8. Bryan, A. M. and C. A. F. Enquist: Scenario Planning for the DLCC LCD: An overview & update, Madrean Indicators Workshop, Tucson, AZ, 17 Nov 2017.
9. Bryan, A. M.: Climate Change @ FIIS, Climate Change Vulnerability Assessment Workshop for Fire Island National Seashore (FIIS), Ocean Beach, NY, 15 Nov 2017.
10. Bryan, A. M. and B. Ekdahl, Climate-Driven Impacts on Ziizabokdoke (Making Maple Sugar), Michigan Tribal Climate Camp, 9 Oct 2017.
11. Bryan, A. M.: NE CSC: Adapting our wildlife, landscapes, waterways, and cultural assets to climate change, BIA Liaison training, 5 Sep 2017.

12. Osgood, M., A. Bryan, and C. Brown-Lima, Communicating Climate/Invasion Science, 1st Annual Regional Invasive Species & Climate Change (RISCC) Management Symposium, 27 Jul 2017.
13. Bryan, A. M.: The Science Behind Climate Change, Climate Friendly Parks Workshop with Blackstone River Valley National Historical Park, New Bedford Whaling National Historical Park, and Roger Williams National Memorial, New Bedford, MA, 28 Jun 2017.
14. Bryan, A. M.: A sticky situation: When maple syrup producers receive conflicting guidance from different climate models, NE CSC Webinar, 8 Mar 2017. Available at https://necsc.umass.edu/webinars/sticky-situation-when-maple-syrup-producers-receive-conflicting-guidance-different-climate.
15. Bryan, A. M.: Untitled [on Climate Change and Impacts on Wildlife in Western Massachusetts, How Weather Works, Weather Forecast Activity], Hilltown Cooperative Charter Public School, Easthampton, MA, 15 Dec 2016.
16. Bryan, A. M.: Climate Change Science: A Western Perspective, United Southern and Eastern Tribes (USET) Climate Workshop, Oneida, NY, 9 Nov 2016.
17. Bryan, A. M.: The Science Behind Climate Change, National Climate Science Centers Student and Early Career Training, Amherst, MA, 3 Nov 2016.
18. Bryan, A. M.: NE CSC: Adapting our land, water, wildlife and cultural resources to climate change, Great Lakes Adaptation Forum, Ann Arbor, MI, 5 Oct 2016.
19. Bryan, A. M. and O. Gates: Climate Change in the Great Lakes Region, Great Lakes Adaptation Forum, Ann Arbor, MI, 5 Oct 2016.
20. Bryan, A. M.: Climate Change: An overview for the Menominee Indian Tribe of Wisconsin, Menominee Indian Tribe of Wisconsin, Keshena, WI, 1 Aug 2016 and 6 Sept 2016.
21. Bradley, B. and A. M. Bryan: Implications of climate change for invasive species, Northeast Invasive Species and Climate Change (NISCC) Workshop, Amherst, MA, 21 Jul 2016.
22. Bryan, A. M.: Overview of climate change and impacts in the region, Institute for Tribal Environmental Professionals (ITEP) Climate Adaptation Planning Training, Red Cliff, WI, 12 Jul 2016.
23. Bryan, A. M.: COLO's Changing Climate, Climate Change Vulnerability Assessment Workshop for Colonial National Historic Park (COLO), Jamestown, VA, 1 Jun 2016.
24. Bryan, A. M., K. P. Whyte, J. Mauchmar, F. Marsik, C. Caldwell, and M. Schaefer: Assisting Tribes with Climate Change Adaptation as a Federal Agency, Midwest Fish and Wildlife Conference, Grand Rapids, MI, 26 Jan 2016.
25. Bryan, A. M.: Little Traverse Bay Band's Shifting Seasons, Community Meeting on Climate Adaptation Planning, Little Traverse Bay Band of Odawa Indians Community Center, Harbor Springs, MI, 15 Oct 2015.
26. Staudinger, M. D., T. L. Morelli, and A. M. Bryan: Integrating Climate Change into Northeast and Midwest State Wildlife Action Plans, NE CSC webinar, Amherst, MA, 7 Oct 2015.
27. Bryan, A. M.: Climate Change at Acadia Nat'l Park: What we know & what we don't, Acadia Scenario Planning Workshop, Bar Harbor, ME, 5 Oct 2015.

28. Bryan, A. M.: An introduction to the NE CSC and climate change impacts on the Little Traverse Bay Band, site visit with Little Traverse Bay Band of Odawa Indians, Petoskey, MI, 6 May 2015.
29. Bryan, A. M.: An introduction to the NE CSC and climate change impacts on the Grand Traverse Bay Band, site visit with Grand Traverse Band of Ottawa and Chippewa Indians, Grand Traverse Bay, MI, 5 May 2015.
30. Bryan, A. M.: West Virginia's Changing Climate: Future Projections, West Virginia University, Morgantown, WV, 14 Apr 2015.
31. Bryan, A. M.: Climate projections and uncertainties for the region through 2100, Moose, Boreal Forest and Climate Change –- State of the science, MA Division of Fish and Wildlife, Westborough, MA, 4 Feb 2015.
32. Bryan, A. M.: Translating global models to regional and local action: Finding certainty amidst the uncertainty, NOAA Geophysical Fluid Dynamics Laboratory (GFDL), Princeton, NJ, 20 Jan 2015.

<u>Conference presentations</u>

1. Bryan, A. M. and B. Ekdahl: Ziizabokdoke (Making Maple Sugar): A cultural tradition of sugar making for one Midwestern tribe & seven generations of change, 2017 Forest Ecosystem Monitoring Cooperative Conference, Burlington, VT, 15 Dec 2017.
2. D. H. Rosendahl, A. Wootten, R. A. McPherson, E. Mullens, A. M. Bryan, E. Kuster, and J. Blackband: Helping Decision Makers Incorporate Climate Model Projections into their Future Planning, American Geophysical Union Fall Meeting, 13 Dec 2018.
3. Kearney, E., A. Bryan, A. Karmalkar, and T. L. Morelli: When Does Choice of Downscaling Method Matter in Decision Making? A Case Study with Maple Syrup Production.
    a. Northeast Climate Science Center's Regional Science Meeting, Amherst, MA, 15 May 2017
    b. American Geophysical Union Fall Meeting, San Francisco, CA, 12 Dec 2016
4. Bryan, A. M. and A. Babson: Preserving our National Parks in the Northeast in the face of Climate Change: An NPS-NECSC Collaboration, Northeast Climate Science Center's Regional Science Meeting, Amherst, MA, 15 May 2017.
5. Ferguson, D., A. M. Bryan, J. Fraser, A. B. Guenther, C. Geron, F. Thompson, and A. Steiner: Climate Change Impacts on Biogenic Emissions in the Central Hardwoods, American Geophysical Union Fall Meeting, San Francisco, CA, 12 Dec 2016.
6. Kearney, E., A. Bryan, A. Karmalkar, and T. L. Morelli: Different Climate Models, Different Forecasts: When does it Affect my Decision?, National Climate Science Centers Student and Early Career Training, Amherst, MA, 2 Nov 2016.
7. Bryan, A. M. and T. L. Morelli: Informing climate change adaptation in the Northeast and Midwest United States: The role of the Climate Science Centers, American Geophysical Union Fall Meeting, San Francisco, CA, 18 Dec 2015.
8. Terando, A., A. Wootten, M. Eaton, M. Runge, J. Littell, A. Bryan, and S. Carter: Quantifying the Value of Downscaled Climate Model Information for Adaptation Decisions: When is Downscaling a Smart Decision?, American Geophysical Union Fall Meeting, San Francisco, CA, 14 Dec 2015.

9. Bryan, A. M., M. Staudinger, L. Ning, A. Coletti, A. Karmalkar, R. Bradley, T. L. Morelli, and M. Ratnaswamy: Delivering management-relevant climate science in the Northeast, 2015 North Central CSC Open Science Conference, Fort Collins, CO, 20 May 2015.