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Forestry Professionals and Extension Educators vs. Climate Change: Implications for Cooperative Extension Programming

Abstract

Extension educators seeking to integrate climate science into programming must respect different perceptions on climate change. We surveyed forestland managers and owners, researchers, and Extension educators nationally to compare perceptions about climate change adaptation and mitigation management in forests (n=576). Despite differences in perception that climate change is anthropogenic, we found the professional groups were often statistically similar in supporting or rejecting specific actions and receptive to learning more about a variety of forest adaptation and mitigation practices. Our findings support a role for Extension in addressing climate change and indicate areas of common ground that can minimize contention.

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Introduction

Climate change continues to be a volatile issue in public policy debates and forums. While Superstorm Sandy in 2012 and the recent release of the Third U.S. National Climate Assessment (Melillo, Richmond, & Yohe 2014) helped put climate change back onto the national agenda, a core group of Americans continues to express skepticism about climate change, especially regarding the human role in this phenomenon. Shifts in public opinion occur frequently and are influenced by current events. Extension educators are often caught in the middle of this debate and are hard-pressed to keep the focus on science instead of politics. In this article we examine aspects of this debate in the context of Extension forestry and provide solutions for offering objective strategies for mitigating or adapting to climate change to clients such as family forest owners and private and public land managers. The results may also be useful to consider where climate change is an issue in other Extension programs.

The International Panel on Climate Change states in its Fifth Assessment Report (2013) that "the science now shows with 95 percent certainty that human activity is the dominant cause of observed warming since the mid-20th century." On the other side of the spectrum, Idso and Singer (2009) take exception to the IPCC findings, and many Americans accept as credible their arguments that the science remains unsettled and climate change is not necessarily related to greenhouse gas emissions from human activities. Despite the consensus of the broad majority of scientists, the public remains divided about the cause of climate change, which in some cases affects individual decisions on willingness to take action (Lenart & Jones, in review).

This article aims to help Extension educators incorporate climate science into their programming in a way that respects the differences among their audience and partners, as emphasized by Morris, Megalos, Vuola, Adams, and Monroe (2014) and Fraisse, Breuer, Zierden, and Ingram (2009). Since its inception in 1914, the Extension education model has involved Extension educators using information developed by researchers and working with practitioners to incorporate applicable findings into their practices. In this role Extension serves as a bridge, or boundary organization (Breuer, Fraisse, & Cabrera 2010). For reasons that include helping Extension educators function more effectively as the bridge between researchers and practitioners, we surveyed forest land managers and owners, Extension educators, and researchers to compare their perceptions about adaptation and mitigation management practices to address climate change in forests.

We relied upon Millar, Stephenson, and Stephens (2007, 2008) and Joyce et al. (2009) for considering various forestry adaptation and mitigation practices. This article uses the "5-R" strategies as described in the 2008 paper. They include:

1. **Resistance**: Focuses on "*increasing **resistance** to change*." This can include management activities that protect ecosystems from threats such as drought, or secondary climatic effects, such as wildfire or bark beetle infestation. Examples include thinning treatments to reduce mortality from drought and wildfires, and creating local refugia for endangered species.

2. **Resilience**: Focuses on "*promoting **resilience** to change*." The intent of this strategy is to create a diverse and "healthy" forest that can recover from major climatic impacts. Examples include conducting prescribed burns to reduce tree competition, and augmenting endangered species.

3. **Respond**: Promotes efforts to "*enable ecosystems and resources to **respond** to change*." It prescribes a proactive approach to manage for change. Examples include assisting migration of species to follow a changing environment by planting and seeding species from nearby warmer microclimates, such as a southern aspect, and increasing biological and landscape diversity, including through the introduction or acceptance of "neo-native" species (defined as species that seem likely to be suited to anticipated climate conditions).

4. **Realign**: Prescribes "***realigning** conditions to current and future dynamics*." This involves realigning disturbed ecosystems to suit anticipated future environments rather than restoring for pre-settlement or pre-disturbance conditions.

5. **Reduce**: This strategy is equivalent to mitigation. It prescribes "***reducing** greenhouse gases and non-renewable energy use*." It emphasizes using forests as "sinks" for sequestering carbon in

wood, roots and soil. Likewise, using biomass for fuel and other alternative energies can help reduce greenhouse gas emissions from fossil fuels.

Methods

We administered a national survey to attendees of the National Workshop on Climate and Forests held in Flagstaff, Arizona on May 17 and 18, 2011, and online in conjunction with announcements to specific groups. We solicited responses via listservs from the national membership of the: 1) Society of American Foresters (13,000 members) and 2) Association of Natural Resources Extension Professionals (460 members) between May 16 and 20, 2011, and via a newsletter from members of 3) the American Tree Farm System (83,000 members) in April 2012.

We received 1,126 responses, with approximately 9% of responses gathered at the workshop and by mail, and 91% gathered online. Respondents with jurisdictions outside of the United States were omitted from analysis. While 56% (n = 565) of respondents indicated their professional roles included land management, 35% (n = 392) indicated their primarily role was land management. The latter are used in this analysis for comparison to researchers (n = 175) and Extension educators (n = 87), with a further parceling down based on organizational affiliation (Table 1).

Survey respondents were self-selected in a non-random sampling of target groups. The survey sample is limited to those group members who actively review their email messages or membership newsletter and felt strongly enough to respond, and further limited by accepting respondents during a pre-specified time frame. The results of this convenience sample apply therefore to these participants. It is recognized that further research would be needed to apply these results more broadly across forestry and education populations (Evans & Mathur, 2005).

The survey included questions that identified participants' professional role, organizational affiliation, and the region of the country in which they work. It also gauged their perceptions on the occurrence of climate change, willingness to adopt various adaptation and mitigation management practices, confidence in various climate records, and perceptions on climate information needs. In consideration of article length, only perceptions on climate change and adaptation and mitigation management practices are analyzed in detail here, and we touch upon climate record and information needs. Analysis of Variance tests were used to determine which group means were significantly different from all others (α = 0.05), with Tukey HSD applied to address multiple comparisons.

Results

Respondents came from across the country, with about a quarter each from the Southeast and the Northeast, and between 15 and 20 % each from the Southwest (including the Rockies), the Midwest, and the Northwest. Survey respondents representing various sectors of forestry, research, and education were grouped into six professional categories (Table 1). Keeping the Research-Extension-Practitioner model in mind, we compared the perceptions of four categories of forest land managers to those of researchers and Extension educators. The results are shown in Supplemental Tables 1-5. Roman numerals are used to indicate when groups differ from each other in a statistically significant way.

Table 1.
Survey Respondents Used in the Analysis by Professional Category

Professional Categories		No. of Respondents
Land Manager		
Small Landowner		n = 74
Private Company		n =124
Federal Agency		n = 78
State Agency		n = 38
	Subtotal	n =314
Extension Educator		n = 87
Researcher		n =175
	Subtotal	n = 262
Total		n = 576
Other (not used in this analysis)	n = 550	
	Total	n =1,126

Climate Change Confidence and Needs

Most participants were, on average, confident that climate change is occurring (Supplemental Table 1). However, statistical differences of confidence levels between professional categories were also evident, particularly when it came to whether they had confidence that "climate change is occurring because of human activities that release greenhouse gases to the atmosphere." Extension educators were significantly more confident in the latter than the land managers in three of the four categories: private company, federal agency, and small private landowner. (Differences existed, but confidence intervals overlapped for respondents from state agencies.) Most notably, a strong majority (62%) of the private company category was "not at all confident" that climate change was human caused. This divide in confidence that climate change relates to human activities correlated in some cases with how willing respondents were to try specific adaptation and mitigation measures (Lenart & Jones, in review).

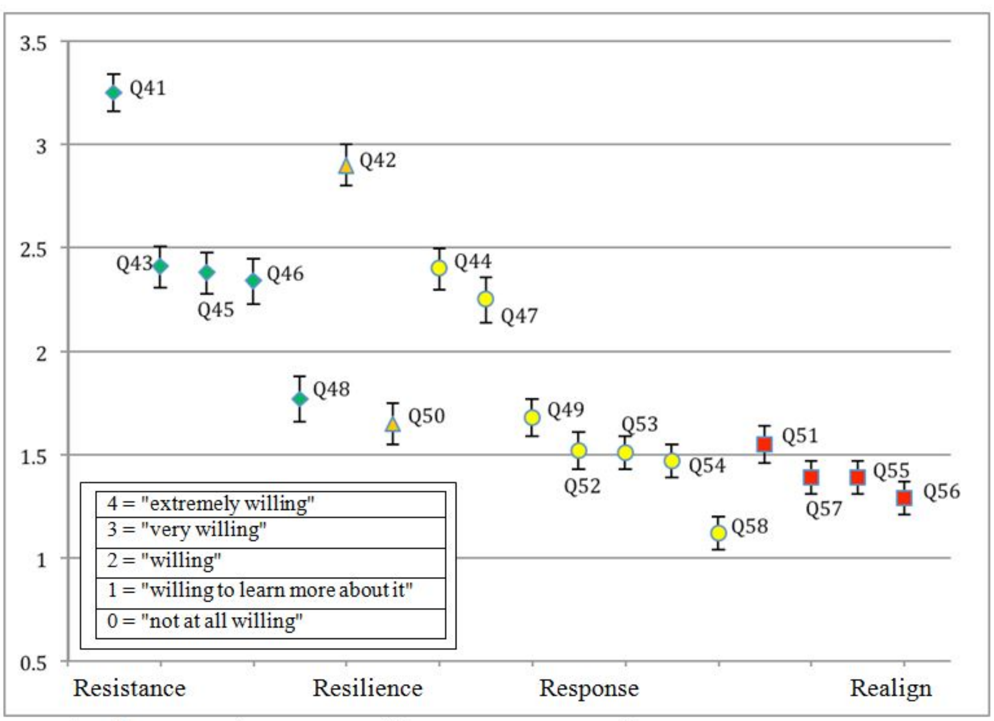
Regarding climate information needs and record confidence (Supplemental Tables 2 and 3), respondents considered weather station observations about temperature and precipitation to be more important than proxy records or projections for future climate, except for researchers, who considered all of the records important. Land managers indicated they were generally confident in proxy records, such as tree-ring reconstructions of fire histories and annual precipitation, and in sediment records of charcoal and pollen that recorded, respectively, pre-history fires and species distribution. They were less confident about proxy records pertaining to carbon dioxide levels, global ice levels, and temperatures. Notably, many land managers are more interested in information about how water resources would be affected, the climatic tolerance of specific plant species, and the effects of rising atmospheric carbon dioxide on specific plants than information on most climate records.

Adaptation Management Actions

When presented with specific adaptation management actions, respondents were more likely to be in agreement. In other words, the means of each group were often more statistically alike than different (Supplemental Table 4). In general, respondents were more likely to favor practices that increase resistance to climate change (Figure 1). Promoting resilience in ecosystems also received extensive support. (In the literature, resistance and resilience practices can be somewhat interchangeable.) Strategies that enable response or encourage realignment were more controversial and generally less popular.

Figure 1.

Overall Mean of Adaptation Responses Grouped by Strategy and Question Key



Standard error values ranged between 0.08 and 0.11

Adaptation Question Key

	Resistance ◆		Resilience ▲		Response ●		Realign ■
Q41	Thin dense forests/reduce wildfire risk	Q42	Prescribe fire/restore fire regime	Q49	Adopt experimental management practices	Q51	Allow invasion of "neo-natives"
Q43	Rapidly remove invasive species	Q50	Augment endangered species via re-introduction into existing habitats	Q52	Relax genetic mgmt. guidelines to augment genetic diversity	Q57	Expand endangered species based on new climatic conditions
Q45	Create early detection of invasive species			Q53	Stock soils using different genotypes of same species	Q55	Following major disturbance, promote the expansion of plants and animals
Q46	Construct fire breaks in key areas	Q44	**Response ●** Foster connected landscapes for natural migration	Q54	Use redundancy, ie, planting on historically non-optimal sites	Q56	Manage "re-alignment" of ecosystems to match climatic conditions
Q48	Create refugia for endangered species	Q47	Enlarge management areas/reduce fragmentation	Q58	Stock soils using species that do not occur locally		

There was common agreement among the groups to undertake several management actions, including:

- Thin trees out of overly dense forests to reduce the risk of large-scale stand mortality from drought and/or wildfire.
- Conduct prescribed burns in forests in an effort to restore or retain natural fire cycles.
- Conduct rapid removal programs on newly detected species considered invasive.
- Foster connected landscapes, such as by retaining or gaining protection of riparian zones, to promote the natural migration of species.
- Create early-detection programs to detect new invasions of undesired exotic species.
- Construct fire breaks in key areas.

Participants were in agreement that they were unwilling to undertake the following management practices, although many were willing to learn more:

- Allow the invasion of "neo-native" species – in effect, those that seem likely to be suited to changing climate conditions.
- Promote the expansion of endangered species populations by introducing animals into a new area deemed suitable for them because of changed climate.

- Consider "re-aligning" the system with different species if it has been pushed too far out of historic conditions – whether by manipulation or disturbance – when considering restoration.
- Promote the expansion – following major disturbance – of plants or animals into different locations that may be climatically suitable for them.
- Stock soils with seeds from plants outside of the standard range (i.e., from environments more suitable to future climate) – using species that do not currently occur in the local area.

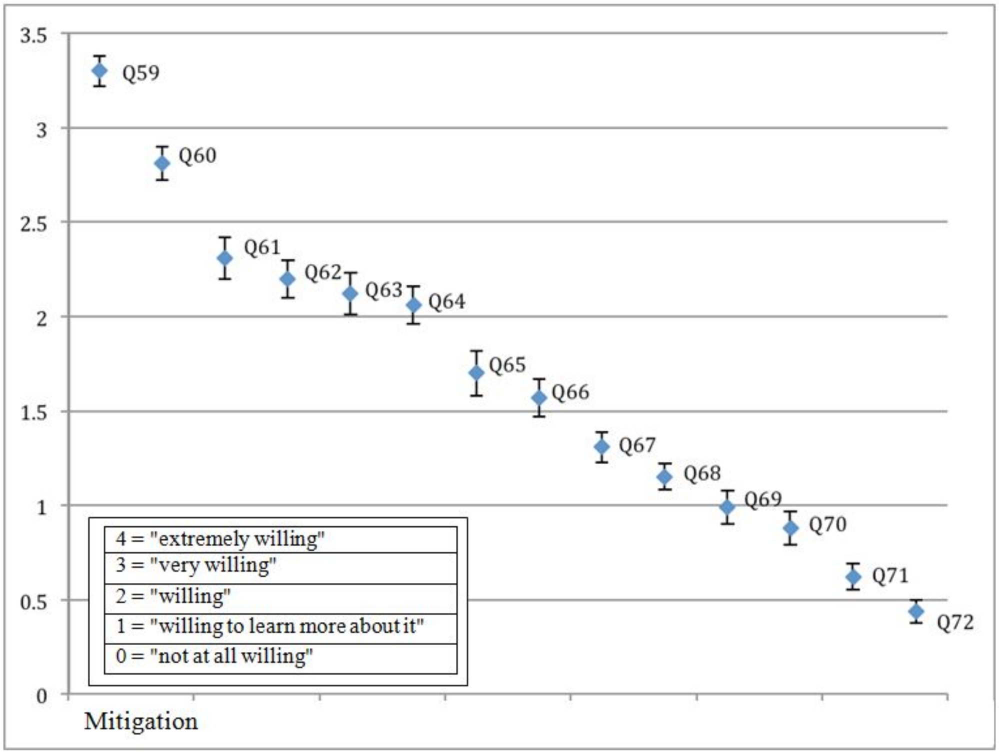
Participants demonstrated differences about the following practices, although overall means fell below "willing to try." In the cases below, respondents from private companies were often significantly less supportive of the practices than researchers, while Extension educators generally bridged both groups (Supplemental Table 4). Researchers averaged out as "willing to try" for the first two options:

- Create local refugia for endangered species.
- Consider adopting management practices even if they have a high level of uncertainty in some situations so that they could serve as experimental efforts.
- Augment endangered species populations via introduction of captive-bred animals into the local area where they already exist.
- Relax genetic management guidelines to include the option of augmenting genetic diversity by collecting from adjacent seed zones or populations for restoration projects.
- Stock soils with seeds from plants outside of the standard range (i.e., those from environments suitable to future climate) – using different genotypes of the same species that exist locally.
- Make an effort to use redundancy (such as also planting on sites that are historically non-optimal for a specific species or community) when restoring a site following disturbance.

Mitigation Management Actions

As was the case with adaptation management actions, respondents in different groups were more likely to agree whether or not to support specific mitigation actions (Figure 2, Supplemental Table 5).

Figure 2.
Overall Mean of Mitigation Responses in Descending Order and Question Key



Standard error values ranged between 0.06 and 0.12

Mitigation Question Key

Q59	Thin overly dense forests to reduce the risk of severe fire	Q63	Retain carbon by protecting existing conservation areas	Q67	Manipulate local species to favor carbon sequestration	Q71	Enhance carbon sequestration by planting exotic species
Q60	Use forest biomass to produce energy	Q64	Enhance carbon sequestration in soils/belowground	Q68	Enhance carbon sequestration by planting "neo-native" species	Q72	Overlook biodiversity and habitat to promote carbon sequestration
Q61	Change personal energy consumption habits to reduce carbon footprint	Q65	Retain carbon by designating additional conservation areas	Q69	Allow or promote woody invasion of grasslands to enhance carbon sequestration		
Q62	Enhance carbon sequestration in wood/aboveground	Q66	Speed rotation of timber harvest to promote transfer of carbon into products	Q70	Purchase carbon "credits" to help offset personal carbon footprint		

Beyond the overall mean, there was broad agreement among the groups to pursue the following management actions for mitigation purposes:

- Thin overly dense stands to reduce the risk of severe fire or stand-destroying disturbance.
- Use forest biomass to produce energy when appropriate.

Participants across all groups also were in agreement that they were unwilling to undertake these management practices:

- Purchase carbon "credits" to help offset their personal carbon footprint.
- Enhance carbon sequestration in forests by planting exotic species.
- Overlook issues such as biodiversity and habitat value to promote carbon sequestration.

All participants were statistically alike in that they were unwilling to undertake the following practices, but largely willing to learn more about them:

- Consider manipulating local species within a forest stand to favor species that promote carbon sequestration.

- Enhance carbon sequestration by planting "neo-native" species expected to thrive because of climate change.

Small forest landowners and land managers affiliated with federal agencies averaged out as "willing to try" sequestering carbon in forests (both above and below ground), while other land managers averaged below that. Respondents generally supported changing personal energy consumption habits, although private company land managers did so to a slightly lesser degree (Supplemental Table 5).

Discussion and Implications

The differences in perception described do suggest that Extension educators need to be sensitive about addressing climate change in outreach programs. Our research results are similar to those by Leiserowitz, Maibach, Roser-Renouf, & Hmielowski (2012) in that they suggest the American public can be segmented into a scale of six categories from Alarmed to Dismissive. This variation of individuals within any Extension audience, as well as within Extension itself (Wojcik, Monroe, Adams & Plate, 2014; Tyson, 2014; James, Estwick, & Bryant, 2014), reinforces the need for Extension educators to be well versed in the science while using outreach methods that can help audiences with different paradigms about climate change to be more open to learning. Hence, even if there was a selection bias due to the convenience sample, the results demonstrate that Extension educators need to assume most audiences will have this variation. Our findings support the Extension delivery approach proposed by Morris et al. (2014), that "Extension should provide climate science information to early adopters and emphasize risk management of specific threats to clients not convinced about climate change, focusing on local solutions and familiar management tools."

Extension has a long history of developing relationships and reaching people who make decisions, helping them to make well-informed choices, using science- and research-based discovery over emotion. Bardon et al. (2009) provide communication techniques for discussing complex, value-laden issues. Public Issues Education is also well established throughout Extension and lends techniques and strategies for dealing with contentious issues (Singletary et al. 2007).

Despite differences in agreement about whether climate change is anthropogenic, the professional groups were more likely to be statistically alike than different in their support for forestry management practices considered options for adaptation and mitigation. Given that Extension professionals often work with early adopters, it is worth noting that most respondents were receptive to learning more about managing forest resources in terms of climate change adaptation and some mitigation actions and were willing to consider those actions they deemed appropriate.

There was widespread support for forestry practices involving thinning of dense stands, using prescribed fire, controlling invasive species, using forest biomass "appropriately" for energy production, and fostering connected landscapes. Extension educators may want to address these through programming as best management practices, with or without mentioning climate change as a reason to adopt these practices.

Respondents across the professional categories indicated a willingness to learn more about a number of proposed management activities described in the Results section. Although not all clients are convinced about the usefulness of these practices, our findings do indicate sufficient interest to make it worthwhile for Extension educators, in their role as a bridge between researchers and land managers, to discuss them at their discretion as "emerging" issues or experimental science.

Our findings also suggest that focusing on observations from weather station records, and even tree-ring records of fire history and pollen records of past species composition, rather than on climate model projections, might help minimize contention. Many land managers are also interested in receiving information about how water resources are likely to be affected by climate, the climatic tolerance of specific plant species, and the effects of rising atmospheric carbon dioxide on specific plant species.

Extension educators could address these informational needs and adaptation and mitigation concepts and practices with clientele though existing programs that deal with natural resources and plant productivity. These programs include Master Forest Owners or other "Master" Extension programs (Grebner, Perez-Verdin, Henderson, & Londo, 2009; Cason, Grebner, Londo, & Grado, 2006). Additionally, a Climate Masters Extension program focusing on climate science communication and reducing greenhouse gas emissions has been piloted in Nebraska recently (Pathak, Bernadt, & Umphlett, 2014).

Some Extension-based resources useful for staying informed about ongoing research, relevant Extension programming, and other opportunities include:

- Web-based eXtension Communities of Practice (COP). The COPs on Climate, Forests and Woodlands (extension.org/climate_forests_woodlands), Wood Energy (http://www.extension.org/wood_energy), and Invasive Species (http://www.extension.org/invasive_species) are particularly relevant.
- National Phenology Network (http://www.usanpn.org/). The NPN's Nature's Notebook program encourages "citizen scientists," including forest landowners, to monitor species of interest (Posthumus et al. 2013), and in many cases partners directly with Extension.
- Climate Science Initiative (CSI) of the Association of Natural Resource Extension Professionals (sites.google.com/site/anrepclimate). The CSI is a forum for professional development and an active network of Extension professionals.

Conclusion

Our results suggest that the Research-Extension-Practitioner model is in operation when it comes to considering adaptation and mitigation options in response to climate change. Extension educators often function as a "bridge" between researchers and practitioners, and our results showed that the means for Extension educators regarding acceptance of many proposed forestry practices in fact did tend to fall between the means of researchers and practitioners. This suggests that the perceptions of Natural Resources Extension educators overall are approximately where they should be in order to continue serving as this bridge.

Extension educators can engage private landowners and other forestry professionals to consider how their local area's temperature and precipitation records have changed and encourage the implementation of largely accepted management practices to build resiliency in the forests they manage or own. Through programs, Extension educators can help educate land managers and other clients about other adaptation and mitigation practices discussed above as "emerging" issues or experimental science to raise awareness of alternative management options. With funding assistance and incentives from state and federal partners (such as occurred with the Healthy Forests Restoration Act of 2003), land owners and managers can be equipped to build the forest resiliency necessary for a changing climate, starting with accepted adaptation practices and advancing to practices that enable ecosystems and resources to respond to change as awareness increases and environmental conditions dictate.

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