The role of remote engagement in supporting boundary chain networks across Alaska

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A B S T R A C T

Boundary organizations serve multiple roles in linking science and decision making, including brokering knowledge, supporting local- and cross-level networks, facilitating the co-production of knowledge, and negotiating conflict. Yet they face several challenges in providing services for an ever-increasing number of actors and institutions interested in climate information and adaptation. This study evaluates how the Alaska Center for Climate Assessment and Policy (ACCAP) innovated its boundary spanning role to improve outcomes by partnering with other boundary organizations through its ongoing climate webinar series. We utilize the concept of boundary chains to investigate outcomes associated with different extended network connections. Our evaluation is based on the analysis of three datasets, including interviews (2013) and two web-based questionnaires (2010 and 2013–2015). Findings from the evaluation reveal several ways that remote engagement via the ACCAP webinar series facilitates learning, decision application, and cross-level network building, and overcomes barriers associated with large geographic distances between communities. In an organic evolution and innovation of the climate webinar series, ACCAP partnered with other boundary organizations to establish satellite hub sites to facilitate in-person gatherings at remote locations, thereby increasing the number and diversity of participants served and supporting local networking within organizations, agencies, and communities. Leveraging complementary resources through the satellite hub sites provided mutual benefits for ACCAP and partnering boundary organizations. These findings advance our understanding of the value of remote engagement in supporting boundary spanning processes and how boundary organizations innovate their roles to build capacity and increase the usability of climate information.

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Introduction

Boundary organizations are emerging as an important feature of the science–policy interface given their ability to foster communication between researchers and decision makers, facilitate the two-way transfer and translation of information, support local networking and cross-level linkages, and mediate conflict (Cash, 2001; Buizer et al., 2010; Hoppe et al., 2013). In the climate arena alone, several processes and approaches are utilized by boundary organizations to increase...
the usability of information and build adaptive capacities (McNie, 2013). These processes vary greatly in terms of their institutional arrangements and commitment of human and financial resources, and evaluations consistently highlight the importance of understanding specific decision making contexts, sustained interaction, trust building, and innovation and adaptability (Dilling and Lemos, 2011; Lemos et al., 2012; Knapp and Trainor, 2013).

Empirical studies reveal several challenges facing boundary organizations in providing and sustaining climate services among a growing number of individuals involved in climate-sensitive decisions, including time and resource constraints and willingness to sustain partnerships (Kirchhoff, 2013). Social networks serve several important roles in overcoming these challenges and supporting climate adaptation through the dissemination of information, leveraging and pooling of resources, negotiation of conflict, and co-production of knowledge to meet the ever increasing and dynamic needs along the science-policy divide (Pahl-Wostl, 2009; Juhola and Westeroff, 2011; Dow et al., 2013; Kalafatis et al., 2015). Extended networks between two or more boundary organizations, known as boundary chains, are theorized to further improve the provision and use of climate information as well as increase the efficiency and effectiveness that services are provided (Bidwell et al., 2013; Lemos et al., 2014).

Information and communication technologies, including teleconferencing and web-based seminars, offer great potential in supporting boundary organizations and boundary chains, especially for organizations separated by large geographic distances (Trainor et al., accepted). These remote forms of engagement have demonstrated their ability to overcome distance and cost barriers in the delivery of information and the development of social networks (Sheppard and Mackintosh, 1998; Porter and Donthu, 2008; Johnstone and Boyd, 2014). Although different approaches have been used by boundary organizations to create and adapt their boundary spanning activities to local contexts (Feldman and Ingram, 2009; Rice et al., 2009; Lemos et al., 2014), there remains a limited understanding of the role of remote engagement in supporting boundary spanning processes and enabling boundary chains.

This paper explores the role of remote engagement in supporting traditional boundary spanning processes and boundary chains in Alaska, with a case study of an ongoing climate webinar series (CWS) hosted by the Alaska Center for Climate Assessment and Policy (ACCAP). We begin by discussing the role of boundary organizations, social networks, and information and communication technologies in supporting climate adaptation. We then provide background information about ACCAP and the CWS, situating the CWS as a boundary object in facilitating the transfer of information and knowledge between science and society and developing network connections among participants and speakers. We discuss two innovations of CWS, whereby ACCAP partnered with other boundary organizations, to promote networking and information exchange, fitting the boundary chain model. We highlight how the organic evolution of webinar series increases the capacity of ACCAP and participating boundary organizations to reach a larger and more diverse audience, foster local network connections, and reach key organizational missions. We situate these findings in how boundary organizations innovate their boundary spanning roles to build capacity and increase the usability of climate science for decision making.

Literature review

Boundary organizations

The conceptual and theoretical foundation of a boundary organization stems back to social studies of science in the 1960s when philosophers and scholars theorized on the demarcation of science, a long standing analytical problem. These early efforts focused on the institutionalization of scientific norms and specification of criteria that separated science from other intellectual activities (Popper et al., 1965; Merton, 1973); however, scholars struggled to demarcate science as many of the proposed characteristics also existed in other intellectual activities (Elkana, 1981). Gieryn (1983) later argued that demarcation was a practical problem and ideological effort by scientists to distinguish their work from non-scientific intellectual activities, as the construction of a social boundary provided protection against ‘pseudo-science’ and political interference in scientific research. Gieryn (1983) labeled these efforts of scientists as “boundary work.” The concept of boundary work was soon extended into science-policy applications and the separation of scientific and political activities (Jasanoff, 1990).

Boundary organizations are generally considered to have three defining characteristics (Guston, 1999). First, they involve individuals engaged in the production of science, use of information, and mediation of interests. Second, they provide a space for the creation of boundary objects and other products that facilitate communication among actors across both sides of the boundary. These objects allow “members of different communities to work together around them, and yet maintain their disparate identities” (Guston, 1999, 89). Boundary objects can take many different forms including, climate models, decision support tools, workshops, scenarios, and web-based seminars (Girod et al., 2009; Buizer et al., 2010; White et al., 2010; Trainor et al., accepted). Third, they function at the frontier of science and decision making and maintain distinct lines of accountability for the producers and users of information (Guston, 1999). This third characteristic is built on principal-agent theory (Jensen and Meckling, 1976; Eisenhardt, 1989), a political-economic approach, which when applied to science-policy contexts, suggests that organizational relationships are based on contracts between ‘principals’ (users) that seek information from the scientific community and ‘agents’ (producers) seeking incentives from the policy community. Principal-agent theory helps structure boundary organizations as a mechanism to address conflict of interest between principals and agents.
Several boundary organizations have emerged in the past decade to address climate variability and change at multiple levels of governance (Hoppe et al., 2013). In the US, this includes federal programs such as NOAA’s Regional Integrated Sciences and Assessment (RISA) program (Pulwarty et al., 2009), Regional Climate Centers, and regionally-based Fish and Wildlife Service (FWS) Landscape Conservation Cooperatives (LCC, 2014), and state-level cooperative extension programs of National Sea and Land Grant Institutions (Tribbia and Moser, 2008; Prokopy et al., 2015). These boundary organizations often vary in terms of their degree of formalization, size, geographic scope of services, and stakeholder diversity (Crona and Parker, 2012). Some boundary organizations serve a relatively homogenous group of constituents, while others serve constituencies with more diverse backgrounds, interests, experience, and scales of jurisdiction. These parameters significantly influence the boundary objects applied, strategies used, level of interaction, and the qualities deemed important in evaluating the success of boundary organizations.

Boundary organizations serve two major roles in linking science and decision making (Guston, 2001). First, they facilitate the brokering and co-production of knowledge, including translating scientific research into decision making and communicating decision maker priorities, needs, and concerns to scientists and policy makers (Cash et al., 2003; Buizer et al., 2010). Such a role is critical given the increasing desire to production ‘usable’ information for decision and policy making (US Congress, 1990; NRC, 2007). Second, they act as an impartial broker that maintains dual lines of accountability in order to enable both sides of the boundary to preserve their identities and adhere to principals (e.g., Ehrlich and Ehrlich, 1996; Guston, 1999; Sarewitz, 2004).

Several studies have investigated the role of boundary organizations in linking climate science and decision making (Buizer et al., 2010; Kirchhoff, 2013; McNie, 2013). Early research focused the production and use of climate information in applied research settings, including air pollution (Keating, 2001), agricultural extension (Cash, 2001), and climate predictions in industrialized and less-industrialized regions (Agrawala and Broad, 2001). More recently, a significant body of scholarship has demonstrated that fostering iterative interactions between scientists and decision makers through boundary organizations increases the use and usability of climate information, especially when such information is aligned with user needs and decision contexts and interplays with existing information use (Tribbia and Moser, 2008; White et al., 2010; Crona and Parker, 2011; Lemos et al., 2012). Boundary organizations also serve critical capacities in supporting local networking and cross-level linking, negotiating conflict, and ensuring equitable representation (Cash, 2001; Hahn et al., 2006; Trainor et al., accepted). These functions institutionalize a space to foster communication, develop partnerships, and exchange knowledge (Cash, 2001; Tribbia and Moser, 2008; Buizer et al., 2010), though specific roles and features of each boundary organization may vary considerably (Miller, 2001; Cash et al., 2003).

At the same time, boundary organizations face several challenges in providing an arena for and facilitating interactions between scientists and decision makers (Lemos et al., 2014). It may be difficult to support the dynamic and growing landscape of actors, organizations, and agencies involved in climate sensitive decisions. Supporting interactions requires the commitment of time and resources, which may overwhelm the capacity of a single boundary organization (Bidwell et al., 2013; Kirchhoff et al., 2013). As a consequence, boundary organizations may underserve some populations, especially those with limited capacities (Kirchhoff, 2013). Creating and maintaining linkages across science and policy may also pose significant costs, especially for those that facilitate cross-level linkages (Termeer et al., 2010; Fidelman et al., 2013).

Various methods are used to evaluate the effectiveness of boundary organizations in supporting climate adaptation and decision making. Crona and Parker (2011) use social network analysis to evaluate how interactions between researchers and policy makers affect knowledge utilization by policy makers within a boundary organization. Other research engages standard program evaluation techniques, including interviews, questionnaires, and web statistics to evaluate the success of climate-related boundary organizations and advance use-inspired research (Singletary et al., 2011; Moser, 2013).

Social networks and boundary chains

Research on the role of social networks suggests they may play an important role in supporting boundary organizations to more effectively link science and decision making (Crona and Parker, 2011; Lemos et al., 2014). Social networks facilitate the exchange of climate information and the specific needs, priorities, and concerns between scientists and decision makers (Cash and Buizer, 2005; Owen et al., 2012; Dow et al., 2013); aid in distributing risk, identification of common priorities and goals, negotiation of conflict, and consensus building (Juhola and Westeroff, 2011); support collaborative partnerships by reducing costs through the pooling of resources and sharing lessons learned (Armitage et al., 2011); and increase the credibility, legitimacy, and saliency of shared efforts (Cash et al., 2003). Within boundary organizations, more frequent interaction among policy makers and researchers is related to a greater likelihood of information use (Crona and Parker, 2011).

Researchers are beginning to theorize and examine the role of extended network connections between boundary organizations (Bidwell et al., 2013; Kirchhoff, 2013; Lemos et al., 2014). These extended network connections, which establish interactive collaborations between two or more boundary organizations, are known as “boundary chains.” Emerging empirical research suggests that boundary chains increase the capacity of partnering organizations to improve production efficiency and provision of use-inspired science (Lemos et al., 2014). For example, through a competitive grant proposal competition, the Great Lakes RISA demonstrated how emerging partnerships with local boundary organizations enabled the RISA program to reach a wider range of decision makers and increase exposure to (and use of) their products and services, while also providing partnering boundary organizations increased access to climate data and regional climate experts (Lemos et al., 2014).
Social networks, including boundary chains, may take several different forms (Bodin and Crona, 2009; Klijn and Koppenjan, 2012; Lemos et al., 2014). Some networks have stable network membership over time, while others are more fluid. In terms of their level of formality, some networks are based on regulatory frameworks and others are more spontaneous, self-organized, or ad-hoc. Both formal and informal networks play important roles in capacity building efforts to address multi-level governance challenges such as climate change (Pahl-Wostl, 2009). Networks also vary based on the types of connections, including boundary spanning between and within organizations as well as networking across multiple levels of governance (Cash, 2001; Buizer et al., 2010). Social networks may also be supported virtually or in-person. Although the emerging literature is beginning to document how boundary chains are supporting use-inspired science through in-person interactions, there remains a limited understanding of the role of remote engagement in supporting extended network connections between boundary organizations.

Information and communications technology

Information and communications technologies, such as video conferencing, teleconferencing, and web-based seminars, offer significant potential in supporting climate adaptation and boundary chains, especially for organizations with shared interests that are separated by geographic distance (Trainor et al., accepted). These remote forms of engagement have emerged as important means for disseminating information across a wide range of applications, including health care, university-based distance learning, extension services, and science-policy contexts (Sheppard and Mackintosh, 1998; Willems and de Lange, 2007; Porter and Donthu, 2008; Rich et al., 2011; Johnstone and Boyd, 2014), fostering innovation in research and development (Ahuga et al., 2003), and supporting continuing education (Buxton et al., 2012). They also provide opportunities to link previously unconnected or minimally connected groups, which enables access to new information, resources, and contacts (Granovetter, 1973; Wellman et al., 1996), and maintain and strengthen existing networks (Haythornthwaite, 1996). In the context of economics, online communities serve a critical role as intermediaries between marketeers and advertisers (Kannan et al., 2000). Although trust building and sustained interaction are often best accomplished with face-to-face meeting, remote engagement is often necessary when boundary organizations serve large geographic regions (Trainor et al., accepted).

Background: ACCAP and the climate webinar series

ACCAP was established as one of NOAA’s RISA programs in 2007 with the mission to improve the ability of Alaskans to prepare for and respond to climate variability and change. ACCAP partners with scientists, decision makers, and other boundary organizations to advance climate science, integrate research and decision support tools, and inform climate adaptation planning and strategies. Our primary audience consists of scientists, planners and engineers, policy makers, NGOs, Alaska Native communities, and industry. In this section we discuss the both the context and design of the ACCAP CWS.

Alaska

The State of Alaska encompasses roughly 580,000 square miles of land, spans 44,500 miles of coastline, and covers multiple ecoregions including intermontane, arctic tundra, boreal forests, and coastal rainforests (Nowacki et al., 2003). Although the majority of Alaskans reside in Anchorage, Fairbanks, and Juneau, there are over 300 smaller communities, including several Alaska Native villages – many of which have limited infrastructure and may only be accessed via river or air. Oil and gas development, mining, seafood and fishing, and tourism are the primary economic activities across the state.

Notable climate- and environmental-related changes have occurred across Alaska over the past century, including increased coastal erosion, permafrost melt, sea ice loss, wildfires, and ocean acidification (Markon et al., 2012). These changes pose a high risk potential for government services, subsistence food harvest, the diversity of economic sectors across the state. To address these challenges, there is a wide range of actors working on multiple aspects of climate in Alaska – all with different ranges of experience and expertise. These actors include state and federal resource managers, Alaska Native communities, NGOs, as well as researchers and climate service providers, such as the National Weather Service (NWS) Alaska Pacific River Forecasting Center (APRFC). They also include several climate-related boundary organizations in Alaska, such as Alaska Sea Grant, five Alaska LCCs, Kachemak Bay National Estuarine Research Reserve (KBRR), and the Alaska Ocean Observing System (AOOS). A meta-analysis of stakeholder needs assessments in Alaska highlights a wide range of climate sensitive decisions and information needs, as well as the desire for climate information, decision support tools, and adaptation planning (Knapp and Trainor, 2013). There is also increasing support for the development of organizations and partnerships to support network building and knowledge sharing (State of Alaska, 2011; Markon et al., 2012; Knapp and Trainor, 2013).

Webinars, or web-based seminars, may be especially well suited for supporting networks in Alaska given their ability to create virtual communities of practice, facilitate collaboration across large geographic spaces, and increase group solidarity and trust (Johnson, 2001; Pigg and Crank, 2004). In the climate realm alone, webinars are increasingly being used to disseminate information and support knowledge to action networks (Trainor et al., accepted).
Climate webinar series

The ACCAP CWS was created in 2007 to increase the usability of climate science information, provide a forum for dialogue among scientists and stakeholders with interests in climate across Alaska, and establish a platform for ACCAP to connect with its stakeholders directly. Individual webinars are hosted monthly and last approximately one hour. The webinar series addresses a wide range of topics, reflecting the diversity of climate impacts across Alaska, rather than targeting hazard or sector specific issues. Webinar presentations focus on climate science and impacts, decision support, adaptation planning, as well as local- to international-level reports and initiatives. We seek a balance among marine/coastal and terrestrial issues as well as issues of specific interest across Alaska (Trainor et al., accepted). Speakers are invited from a wide range of professions and outlets including universities, federal and state agencies, boundary organizations, and NGOs across Alaska and throughout the US. Participants may attend individually or as a group at a "satellite site," typically sponsored by a partnering boundary organization.

ACCAP webinars are designed deliberately to ensure that topics are timely and relevant. In the late summer webinar topics often include research on impacts to sea ice, salmon populations, or wildfire. In other cases, webinars are selected based on the release of relevant national or artic-wide reports (e.g., National Climate Assessment). The ACCAP team frequently solicits webinar presentations, though some webinars are hosted at the request of other organizations (e.g., National Science Foundation, U.S. Arctic Research Commission, and the U.S. Global Change Research Program).

The accessibility of webinars is enhanced through consideration of several factors. First, participants may attend webinars via either telephone audio only or through internet based coupled audio and visual components, which facilitates participation among individuals in rural villages in Alaska with limited internet bandwidth or connectivity (Goodman et al., 2001). Webinar slides are available for download on the ACCAP website a day prior to the presentation if participants cannot stream the presentations. Second, participants direct their internet browser to URL directly, rather than installing software. Installing software on computers may be especially problematic for government officials that do not have administrative permissions to install software on government-owned computers. Third, presentations are archived on the ACCAP website to facilitate people access who were interested in participating but could not attend. Fourth, webinars are publicized widely via the ACCAP listserv and social media (Facebook and Twitter), other organizations and agencies, such as the Arctic Institute, the Arctic Research Consortium of the US, NOAA, the University of Alaska Fairbanks media relations, as well as through satellite sites that publicize within their own networks.

Methods

Analysis of the ACCAP CWS is based on three datasets, including interviews (2013) and web-based questionnaires (2010 and 2013–2015). Fourteen semi-structured interviews conducted in April and May 2013 with webinar participants \( n = 12 \) and speakers \( n = 2 \) were the primary dataset for analysis. Interviewees were asked questions relating to knowledge obtained during the webinar, actions taken based on that knowledge, and feedback on the content and organization of the CWS. Of the 14 interviewees, 4 were hosts of active and formal satellite sites, which were asked additional questions related to motivations for establishing a satellite hub, level of interaction before, during, and after the webinar, and organizational benefits from hosting. Interviewees were selected based on their previous participation in the ACCAP CWS. A purposeful sampling technique was used to select participations representing a wide range of organizations (federal, state, NGO, Alaska native, etc.), frequency of attendance, and geographic locale in Alaska. Interviews were digitally recorded, transcribed, and coded using NVIVO content analysis software. Interviews were coded based on themes related to information transfer, network processes, and how networking among boundary organizations provided mutual events. Specific sub-themes included climate information needs, priorities, and concerns and cross-level and local networking. Transcripts were reviewed to ensure accuracy of the transcription process.

Interviews are supplemented by two web-based questionnaires. These questionnaires were designed according to standard program evaluation methods (Singletary et al., 2011) and administered to assess the efficacy of the CWS. The 2010 questionnaire \( n = 56; 11\% \) response rate) was distributed to the entire ACCAP listserv and focused on themes related to participant motivation for attending the CWS over the past three years, as well as the use and relevancy of information obtained during the webinar. The Sept 2013–April 2015 questionnaire \( n = 220; 13\% \) response rate) obtains information from participants immediately following each webinar presentation and focuses on satisfaction of the webinar content and technology platform.

Findings

Webinar participation

The network created by the ACCAP CWS is expanding, fluid, and diverse (Trainor et al., accepted). The mean attendance for climate webinars in 2014 was approximately 87 participants per event; nearly triple the participation in 2007. In total,
Facilitating learning, decision-application, and network building remotely

Analysis of the interview and questionnaire data reveals several ways that remote engagement via the ACCAP CWS serves capacity building functions within ACCAP as well as in its partner boundary organizations. These include facilitating learning and decision-applications and supporting network development – functions consistent with other traditional boundary organizational arrangements to support climate-sensitive decisions (Cash, 2001; Buizer et al., 2010).

The majority of interviewees provided examples of how the ACCAP CWS facilitated learning about specific aspects of climate science, impacts, adaptation, and decision-support tools. For example, many interviewees, including those from other boundary organizations, commented that the March 2013 webinar on the Alaska Chapter of the National Climate Assessment was especially helpful in providing a “foundational” overview that helped to clarify “competing scientific visions” for what is happening across Alaska. Others commented that they gained information on specific climate impacts, such as infrastructure, public health, and food security. Such information is deemed important for informing operational management decisions, such as parameterizing hydrologic models and learning about the linkages between climate and management concerns, and increasing the knowledge base among staff at boundary organizations. These findings are consistent with results from both the 2010 and 2013–2015 questionnaires. In the 2010 questionnaire, 54% \( (n = 22) \) of survey respondents indicated they had used information obtained from the webinar in their work. For the 2013–2015 questionnaire, 89% \( (n = 192) \) of survey respondents agreed or strongly agreed that the information presented in the webinar was useful for their work (based on a five-point Likert response option question).

The CWS also fosters learning among participants and boundary organizations regarding constituent priorities, needs, and concerns. For example, a state-level employee, who had recently moved to Alaska, attended multiple webinars because “being new in the area, new to Alaska entirely, and it’s a new job, I thought it would be a good way to keep informed and a good way to get to know my clients and stakeholders” (Participant 11, College/University). Other individuals, such as a hydrologist for the APRFC, participate to further understand client needs and improve climate services. This sentiment is shared by other participants seeking to increase their understanding of local concerns across the state.

Other interviewees and respondents in the web-based questionnaires commented that the ACCAP CWS facilities building network connections. “It’s great to find out who the experts are within the state of Alaska, to know there are those local experts, that one can go to if needed” (Participant 3, Media). As described by one respondent in the 2013–2015 questionnaire, “if you work in Alaska, you need to hear what is going on, who is doing what...it helps to form collaborative partnerships and keep up to date” (Anonymous). The webinar on the five Alaska LCCs was considered especially effective in supporting network connections and dialog. This webinar was designed specifically to introduce what the LCCs are, what they do, where their boundaries are, and who are the points of contact. Several interviewees, including the LCCs and participants from other boundary organizations, discussed how the webinar helped build and maintain partnerships, networking, and collaboration among private and public organizations to address landscape-scale challenges. During an interview, a LCC science coordinator who gave the webinar presentation discussed the importance of the webinar series in facilitating dialog with Alaska Native constituents.

How to engage aboriginal participation and how to incorporate cultural values into the LCC planning process...is something we have struggled with...But through follow-up conversations with the [webinar] participant, we’ve been able to identify various individuals that we would like to talk [with] about...how to move forward.

[(Speaker 1, USFWS)]

As such, ACCAP CWS provides one avenue for increasing adaptive capacities through facilitating network connections between federal agencies and Alaska Native communities (Knapp and Trainor, 2013).

Significantly, the webinar series fosters cross-level linkages by creating a virtual environment for participants to gather and connect with experience and jurisdiction at multiple levels of governance. Bridging across levels most commonly occurs during presentations and subsequent discussions for state to national level engagement sessions such as the USGCRP National Climate Assessment, the Integrated Arctic Management Report on “Managing for the Future in A Rapidly Changing Arctic: A Report to the President”, and the America’s Climate Choices report. These webinars provide opportunities for Alaskans to learn about national level reports and for state and national level policy makers to learn about local- and regional-level concerns and interests. On some occasions, federal agencies such as the US Arctic Research Commission and the National Science Foundation have contacted ACCAP, requesting an opportunity to solicit Alaskan input. These cross-level linkages and local networking functions enabled through the CWS are critical in supporting knowledge to action networks, especially for climate adaptation, where the driving forces, impacts, and vulnerabilities occur at multiple levels and scales (Mimura et al., 2014).
Using information and communication technologies to reduce geographic isolation

Webinars were considered an effective platform to connect scientists and decision makers across Alaska and overcome barriers associated with the geographic isolation of and distance between communities, including travel costs and time constraints. As illustrated by two webinar speakers:

In a place like Alaska where travel distance is large and long, this is a good way to efficiently get [climate] information to people across the state, and out of state.

[(Speaker 2, Alaska Climate Science Center)]

When you are working across the entire state of Alaska, or in our case in Alaska, Northwest Territories, Yukon territory, and British Columbia, there's no way to get people face to face at that frequency.

[(Speaker 1, USFWS)]

This sentiment was shared by several other webinar participants who referenced the challenges of bringing experts into rural communities and traveling to other locations. One participant noted that the ACCAP CWS was “one of the few options we have” given his/her remote location. As stated by another participant: “It is one of the few opportunities for rural Alaska communities (non-scientists) to hear about what research is going on” (Webinar questionnaire 11/2015).

Building the boundary chain: linking with other boundary organizations and expanding engagement

There are at least two ways that the ACCAP CWS illustrates the “key chain arrangement” proposed by Lemos et al. (2014) – an arrangement theorized to enable boundary organizations to save resources and reach broader networks. Below we discuss innovations in the ACCAP CWS to establish these boundary chain arrangements and how partnerships established between ACCAP and other boundary organizations extend the reach of the CWS to a larger and more diverse audience and provide benefits through the sharing of resources.

Boundary organizations as webinar presenters

First, shortly after the inception of the CWS in 2007, ACCAP began inviting individuals from other boundary organizations to present their work in the CWS, in addition to inviting presentations by scientists. This innovation provides opportunities for other boundary organizations to connect with their constituents directly and builds ACCAP constituents and expands network ties. For example, a speaker from The Alaska Native Tribal Health Consortium (ANTHC) gave a presentation on the Local Environmental Observer Network, a decision support tool developed by ANTHC, which provides Alaska communities an internet-based reporting and monitoring tool to track health related climate impacts across the state. Additional examples include presentations on climate adaptation planning in Alaska Native Communities by an Alaska Sea Grant extension agent and Alaska climate forecast briefings by a NWS climate science and service manager. By inviting presentations from other boundary organizations for the CWS, ACCAP simultaneously strengthens partnerships with those organizations and builds constituent bases. As articulated by a science coordinator for an Alaska LCC:

[The webinar] gave us access to a broader group of stakeholders than we may have gotten from a different venue or holding a webinar on our own, so it was great to have this connection with people who tie into the ACCAP webinars and are interested in learning more about different issues that are going on in Alaska that are related to climate change.

[(Speaker 1, USFWS)]

Boundary organizations as satellite hubs for webinars

Second, and most significantly, ACCAP began developing and fostering satellite sites for the CWS in 2009. Satellite sites are located in partner boundary organizations, where individuals set up a conference room with a screen and audio link as a place to convene local webinar participants remotely. The organic evolution of the CWS was aimed to strengthen relationships between ACCAP and partnering boundary organizations, extend the reach of the webinar series, and support local networking. While a few organizations self-organize ad hoc satellite viewings, formal satellite sites were first organized as a way to extend the reach of ACCAP and further build and support partnerships state-wide. For each of the formal satellites, ACCAP identifies a host contact and provides additional publicity material.

There is a wide variety of satellite sites in terms of their stakeholder base, attendance rates, frequency of participation, level of formality, and mission (Table 1). Satellite sites are hosted by various agencies and organizations, including the federal government, NGOs, and rural campuses of the University of Alaska System. Some satellite sites host webinars internally (e.g., APRFC, National Park Service (NPS)) and others open their doors to the community (e.g., KBBR, Alaska Sea Grant). Eight formal satellite sites are currently active (Fig. 1). Individual webinars typically have 2–4 hub sites per webinar and attendance for formal satellite sites generally ranges from 3 to 15 people. The design of the CWS to enable individual satellite sites to participate or opt out of monthly webinars depending on topic salience and time availability addresses one of the critical
challenges of institutionalizing activities in a boundary space, while also adapting to constantly changing needs and interests (Cash et al., 2003).
Satellite hub sites contributed to 20% of the total views (n = 1043) between 2009 and 2014. Although the total number of satellite site viewings and individuals participating at those sites varied from year to year, there was a substantial increase in

<table>
<thead>
<tr>
<th>Boundary organization</th>
<th>Mission</th>
<th>Stakeholders</th>
<th>Attendance (per webinar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska Ocean Observing System (AOOS)</td>
<td>Increase access to existing coastal/ocean data; package data in a manner that meets stakeholder needs; increase observing and forecasting capacity</td>
<td>Fisherman, search and rescue; scientists; managers, educators, subsistence</td>
<td>3–10</td>
</tr>
<tr>
<td>Alaska Sea Life Center</td>
<td>Generate &amp; share scientific knowledge to promote understanding &amp; stewardship of marine ecosystems</td>
<td>General public; K-12 teachers and students</td>
<td>5–10</td>
</tr>
<tr>
<td>Alaska Sea Grant – Marine Advisory Program (MAP)</td>
<td>“Enhance the wise use and conservation of Alaska’s marine, coastal, and watershed resources through research, education, and extension” (Alaska Sea Grant, 2013)</td>
<td>Costal managers, planners, teachers, industry</td>
<td>3</td>
</tr>
<tr>
<td>Kachemak Bay National Estuarine Research Reserve (KBRR)</td>
<td>Enhance understanding of estuaries; provide information coastal managers to inform decisions; partner with local communities, researchers, and agencies; build capacity</td>
<td>Coastal managers; K-12 teachers and students; researchers</td>
<td>4–7</td>
</tr>
<tr>
<td>University of Alaska Fairbanks (UAF) Cooperative Extension</td>
<td>“Interpret and extend relevant research-based knowledge in an understandable and usable form; and to encourage the application of this knowledge to solve the problems and meet the challenges that face the people of Alaska; and, to bring the concerns of the community back to the university” (CES, 2014)</td>
<td>General public, researchers</td>
<td>3–10</td>
</tr>
<tr>
<td>University of Alaska Rural Campuses</td>
<td>“The University of Alaska inspires learning, and advances and disseminates knowledge through teaching, research, and public service, emphasizing the North and its diverse peoples” (University of Alaska, 2000)</td>
<td>Local communities, students, researchers</td>
<td>3–10</td>
</tr>
</tbody>
</table>

Satellite Sites for the ACCAP Climate Webinar Series

Fig. 1. Locations of active satellite sites.
sustainable use of shared resources to the President” (Clement et al., 2013). Residents in these communities had provided input into the report, and the opportunity to hear about a recently released report entitled: “Managing for the Future in A Rapidly Changing Arctic: A Report to the President” (Clement et al., 2013). Residents in these communities had provided input into the report, and the

Hosting satellite site viewings also provided participating boundary organizations opportunities to strengthen their local network connections by convening community members, organization staff, or agency personnel into a single location and holding pre- and post-webinar discussions. Within the NPS and APRFC, webinars serve as a focal point for gathering employees with diverse backgrounds from a single agency into a single location. As articulated by a regional education coordinator for the NPS Alaska Region:

I work in a regional office, so it’s an opportunity for folks from [different] disciplines to get together and watch it [the webinar]. I’ve been in the room with folks from our air quality division and maybe a couple of natural resource managers or cultural resource managers and so as we’re colleagues that know each other anyway because we work on other climate-change related topics, but in many cases, the topic or the speaker is something germane to what we’re working on, so bringing us together in a room and listening to it we can have a conversation around the presentation itself and sometimes it inspires more conversation once the presentation is finished.

[(Participant 6, NPS)]

Local networking within communities also provides opportunities for participants from a diverse community of needs to gather face to face. Local face-to-face networking is especially well described by KBRR staff, although similar discussions were reported for other satellite sites.

Following the webinar we usually take 15–20 min to just debrief on the webinar, share our thoughts on the information that was learned [and share] any ideas on how the information could be applied to our work…It’s just the idea of sharing and seeing what new information was learned and how that information could be applied for the work that they [community members attending satellite site viewing] are doing.

[(Participant 2, KBRR)]

Finally, satellite partnering assisted other boundary organizations reach key organizational objectives and engage remote and difficult to reach stakeholders. For example, the KBRR disseminates climate information through the ACCAP webinar series and uses participation records for their satellite site in their annual reports to quantify and document stakeholder engagement. In other instances, satellite hosts organize webinar viewings to provide an opportunity for members of local communities to hear about national level reports. For example, staff from a state-level boundary organization, which provides services to rural communities, organized a satellite site viewing to hear about a recently released report entitled: “Managing for the Future in A Rapidly Changing Arctic: A Report to the President” (Clement et al., 2013). Residents in these communities had provided input into the report, and the webinar provided an opportunity for her/his constituents to hear the results of the findings. As stated by the interviewee:

Here’s an opportunity to talk about marine mammals and we’re out in the rural satellite areas where we often are providing information, we’re often a topic of discussion that we’re not fully engaged both at the gathering information stage or with the dissemination of information. So I said hey, here’s a way I can get somebody that may have participated in this earlier and also for our region that relies on marine mammals for food and this topic is pertinent.

[(Participant 12, Anonymous)]

Even single participation in the webinar series may lead to meaningful collaborations and partnerships. For example, a participant saw direct linkages between his research and the mission of the LCCs and contacted the speaker following the presentation, which resulted in the LCC Steering committee endorsing his research proposal. “Had it not been for the webinar, he would not have made that connection.” (Speaker 1, USFWS)

**Mutual benefits: partnering, leveraging and sharing resources**

Partnerships established between ACCAP and other boundary organizations through the CWS provide several benefits and efficiencies through the sharing, leveraging, and pooling of human, technical, and financial resources (Bidwell et al., 2013; Lemos et al., 2014). For partnering satellite sites, the ACCAP CWS increases access to climate information by covering the costs of hosting each webinar (approximately $1000 per webinar, including licenses for the online software, telephone costs, and staff time to organize and publicize the event) and providing fliers and other publicity information for satellite sites. As stated by one satellite host, “Having the fliers helped because it’s such a time sink to make your own” (Participant 12, university/college). At the same time, satellite sites offer their facilities for a webinar viewing, thus reducing the costs for ACCAP to provide remote viewings and further expand ACCAP engagement. Further, leveraging existing and cascading long-term relationships with satellite sites and their constituents is key to extending the reach of the ACCAP CWS and accelerating the brokering of relevant and timely climate information. In this way the shared investment of resources and
leveraging of existing networks increases opportunities to develop and strengthen connectivity among the links in the boundary chain and increase the usability of climate information.

Discussion

Although boundary organizations are widely acknowledged as an important feature in the climate science–practice interface, there remains limited work on the role of remote engagement in supporting boundary spanning processes, including boundary chains. This study illustrates how remote engagement via webinars can serve as effective boundary object for connecting science and practice (Fig. 2) through supporting the two-way transfer of information and knowledge between science and society and developing local- and cross-level network connections. This research also reveals how employing satellite webinar host sites adds links to the chain of networked boundary organizations (Fig. 3). These extended network connections provide mutual benefits for partnering boundary organizations, promote organizational missions, enhance learning, networking and decision-application, and expand stakeholder bases – conditions important in supporting climate-sensitive decision making and adaptation (Dilling and Lemos, 2011). The following sections discuss the efficacy of climate webinars in supporting climate-related boundary spanning processes, factors contributing the success of remote engagement, and the use of emerging technologies to support remotely-based boundary spanning processes.

Efficacy of webinars in support of remote engagement

Our findings reveal insights into efficacy of climate webinars in supporting the goals of climate-related boundary organizations. First, climate webinars have the capacity to remotely bring scientists, decision makers, and boundary organizations together across vast geographic regions (i.e., individuals involved in the production, use, and mediation of information) (Guston, 1999). Facilitating network interactions through remote engagement is a critical step in overcoming distance barriers, which may constrain opportunities for the co-production of knowledge, development of networks, and implementation of adaptation strategies.

Second, the ability of webinars to facilitate interactions within and across multiple levels of governance remotely offers a promising direction for supporting cross-level networking opportunities. Such opportunities are important in multi-level risk governance challenges, such as climate adaptation, especially when there are differences in planning priorities across multiple jurisdictions (Kettle and Dow, 2014). Informal and ad hoc networking opportunities, enabled through the CWS, may also be important in supplementing more formal networks, especially in situations where political support for climate change is limited (Dow et al., 2013; Haywood et al., 2014).

Third, the innovation of satellite hub sites increases the capacity of the CWS to support and expand networks, enhance information flow, and leverage resources. Building on standard webinar formats, this case study illustrates how the CWS satellite hub configuration strengthens the links in the boundary chain between ACCAP and its partner organizations and provides mutual benefits (whereby reducing “transaction costs”) (Lemos et al., 2014). However, additional research is needed that explicitly focuses on efficiencies obtained through boundary chains, including how efficiencies from in-person interactions compare to remote engagement.

Factors contributing to successful remote engagement

Our experience highlights several factors contributing to the success of webinars as a remote form of engagement in supporting boundary spanning processes. ACCAP’s function as network leader and sponsor of the CWS plays a critical role in fostering its success through core funding, initiating partnerships, and project management (Provan and Kenis, 2008; Giest and Howlett, 2014). Within this role, the commitment of human and financial resources to develop long-term relationships with individuals on both sides of the boundary is critical in support of the CWS (Dilling and Lemos, 2011). In the case of the CWS, this includes staying current with issues and activities to ensure topics are relevant and salient for both individual participants and satellite hub sites. It also requires interacting with satellite host sites, presenters, and participants before, during, and after the presentations, and nurturing network connections in order to identify new speakers and satellite sites. There are also significant commitments of financial resources critical in supporting the technical platform, including the webinar software and phone lines. The institutional structure of the CWS is dependent on the skills, relationships, reputation, and experience of the individuals who run and sustain the project (Guido et al., 2013). At the same time, satellite sites provide local venues for participants to gather together remotely, and provide local name recognition for the CWS. These

Fig. 2. Traditional boundary arrangement, whereby ACCAP links science and society through the climate webinar series. Figure modified from Lemos et al. (2014).
mutually supportive relations between ACCAP and participate satellite sites, whereby each node in the network provides a complementary input or clear division of labor, increases the potential for positive synergies and efficiencies and is the foundation for knowledge co-production and interaction (Evans, 1996; Ostrom, 1996).

The ACCAP CWS has been presented monthly since 2007. Building and sustaining long-term relationships is fundamental to the success of supporting use-inspired science (Dilling and Lemos, 2011). One could hypothesize that the longevity and institutionalization of the CWS contributes to participant awareness of the CWS as a platform for engagement, participation, and science application in decision-making. However, more work is needed to develop a better understanding of the extent to which the long-term institutionalization of the CWS and the establishment of satellite hub sites enhances the efficacy of the CWS in decision application and climate adaptation over time. Findings from such research would have policy implications for supporting the longevity of existing boundary organizations and similar programs.

Use of emerging technology in the design of remote-based boundary spanning

The remote engagement and boundary chain configuration described in this paper is contingent upon the utilization of webinar technology that allows for remote presentation, remote viewing, and dialog among presenter and participants. Over the eight year lifetime of the CWS, ACCAP has changed the technical platform three times to overcome technical limitations with growing participation and stay current with and meet user demands for new tools such as on-line chat and Voice Over Internet Protocol (Trainor et al., accepted). These adaptations are important as the success of organizationally-sponsored online communities is related to the provision of quality content, level of interaction, trust, and perceived member embeddedness (Porter and Donthu, 2008) – factors consistent with the literature on use-inspired science. While emerging technology makes the CWS and expanded network and information exchange possible, it is also important to note potential limitations of relying on technology for engagement and boundary work (Reddy et al., 2009). For example, the CWS is dependent on reliable internet and phone connections. Early in the CWS, a webinar had to be canceled because a road construction severed the fiber optic cable and Fairbanks was without internet for two days.

Our findings demonstrate how complementary forms of interaction are a key feature in enabling boundary chains through remote technology, increasing networking opportunities, and enhancing the usability of climate information (Lemos and Morehouse, 2005; Lemos et al., 2012). Virtual interactions, such as providing other boundary organizations an opportunity to be a webinar speaker, facilitate the transfer of knowledge between science and decision-making, promote dialog and network connections, and build social capital within and across groups (Pigg and Crank, 2004). At the same time, face-to-face interactions that occur before, during, and following the webinar at satellite hub sites provide additional opportunities to build bonding and linking social capital through local- and cross-level networking within communities and agencies (Adger, 2003; Szreter and Woolcock, 2004).

This research also shows how ACCAP’s use of information and communication technologies expands networking and knowledge exchange boundary functions through the CWS and the satellite hub sites (Figs. 2 and 3). Continued research is needed on the extent to which the ACCAP CWS intersects with and is embedded within other networks in Alaska. Such assessments could reveal additional boundary chain arrangements, how the CWS builds upon more established environmental networks, and what could be done to integrate these networks more effectively (Vogel et al., 2007). Further research

![Diagram of ACCAP Climate Webinar Series](image-url)
could also assess the extent that virtual networking and engagement via technology such as webinars emulates personal interaction and the extent that remote engagement may be effective across different socio-cultural contexts. For example, how does the efficacy of webinars to support climate adaptation vary based on the sector served, population of stakeholder community, and degree of geographic isolation?

Conclusion

Our research advances understanding of how boundary organizations innovate their boundary spanning roles to build capacity and increase the usability of information to inform decision making (van Kerkhoff and Slezak, 2010; Lemos et al., 2014). Two innovations are particularly germane to our analysis. First, ACCAP’s adoption of remote engagement via vis the CWS helped overcome several time and resource constraints that are often associated with supporting boundary spanning processes across large distances between communities. Information and communication technologies were a key asset in providing a platform to connect scientists, decision makers, and other boundary organizations, as well as facilitate learning, decision application, and network building. Second, ACCAP innovated its boundary spanning role by partnering with other boundary organizations in order to enhance information exchange and foster network development. Partnering occurred through inviting individuals from other boundary organizations to be speakers for the CWS and establishing satellite hub sites. Consistent with emerging research on boundary chains and knowledge co-production (Evans, 1996; Lemos et al., 2014), these partnerships provide mutual benefits and synergies through the sharing of complementary resources. Developing new and innovative arrangements to foster partnerships between boundary organizations is central in tackling complex challenges such as climate adaptation.

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