Networks of Change: Extending Alaska-Based Communication Networks to Meet the Challenges of the Anthropocene

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Abstract

The Anthropocene is a contested term. As I conceptualize it throughout this dissertation, the Anthropocene is defined by an increased coupling of social and environmental systems at the global scale such that the by-products of human processes dominate the global stratigraphic record. Additionally, I connect the term to a worldview that sees this increased coupling as an existential threat to humanity's ability to sustain life on the planet. Awareness that the planet-wide scale of this coupling is fundamentally a new element in earth history is implicit in both understandings. How individuals and communities are impacted by this change varies greatly depending on a host of locally specific cross-scale factors. The range of scales (physical and social) that must be negotiated to manage these impacts places novel demands on the communication networks that shape human agency. Concern for how these demands are being met, and whose interests are being served in doing so, are the primary motivation for my research.

My work is grounded in the communication-oriented theoretical traditions of media ecology and the more recent social-ecological system conceptualizations promoted in the study of resilience. I combine these ideas through a mixed methodology of digital ethnography and social network analysis to explore the communication dynamics of four Alaska-based social-ecological systems. The first two examples capture communication networks that formed in response to singular, rapid change environmental events (a coastal storm and river flood). The latter two map communication networks that have formed in response to more diffuse, slower acting environmental changes (a regional webinar series and an international arctic change conference). In each example, individuals or organizations enter and exit the mapped network(s) as they engage in the issue and specific communication channel being observed. Under these parameters a cyclic pattern of network expansion and contraction is identified. Expansion events are heavily influenced by established relationships retained during previous contraction periods.

Many organizational outreach efforts are focused on triggering and participating in expansion events, however my observations highlight the role of legacy networks in system change. I suggest that for organizations interested in fostering sustainable social-ecological relationships in the Anthropocene, strategic intervention may best be accomplished through careful consideration of how communicative relationships are maintained immediately following and in between expansion events. In the final sections of my dissertation I present a process template to support organizations interested in doing so. I include a complete set of learning activities to facilitate organizational use as well as examples of how the Alaska Native Knowledge Network is currently applying the process to meet their unique organizational needs.

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Introduction

In this dissertation, I am concerned with how human-environmental relationships in Alaska are evolving in the context of the Anthropocene. I look in depth at the role of communication and social media networks to facilitate strategic action in environments undergoing rapid social-environmental changes.

The Anthropocene represents a transition in earth history from a world little affected by human agency at the global scale to one deeply impacted by it (Braje & Erlandson, 2013; Crutzen, 2006). This transition is ultimately geologic in scope and characterized by processes of increasingly complex human-environmental, or social-ecological, system relationships, the byproducts of which are actively being recorded in the stratigraphic record and mark a distinctly new era in earth history (Smith & Zeder, 2013).

The social-ecological systems (SES) that define the Anthropocene are complex by nature, with system elements interacting across multiple physical scales and social levels (Kotchen & Young, 2007; Walker, Holling, Carpenter, & Kinzig, 2004). As in all complex systems, the relationships within them are vulnerable to cascading failures and tipping point transitions that are difficult to predict with fine granularity (Crucitti, Latora, & Marchiori, 2004). However, there is valid concern that current human demands are outpacing the ability of natural systems to meet them, stressing the limits of adaptability and making it more likely that current configurations will flip into states generally less desirable to human health and wellbeing (Steffen et al., 2011).

In the rock record, there are other examples of large-scale global transition. However, in the past, these have either been driven by rapid external events (like those attributed to the mass extinctions marking the Permian-Triassic boundary) (Shen & Bowring, 2014) or slower biochemical forcing like those associated with the evolution of photosynthesizing prokaryotic and eukaryotic organisms (which produced oxygen as a waste product and eventually altered the global atmosphere sufficiently to force a massive extinction of anaerobic organisms 2.3 billion years ago) (Holland, 2006). However, unlike during these other major shifts in earth history, collective human agency has the potential to respond to shifting environmental demands both by adapting to them, as well as physically altering them (Anderies, Folke, Walker, & Ostrom, 2013). This research looks at some of the communicative mechanisms for how that might occur.

I begin my research with the supposition that communication is the foundational mechanism that humanity utilizes to organize collective action and thus exert its agency on the physical world (Ostrom, 1998). Starting from this basic premise, my work examines the communication networks that develop around environmental change issues at a range of scales with the hope of gaining insight into how these networks can be influenced at the local and regional level. My motivation in this work is to support organizations that are working to actively respond to issues of environmental change that threaten both human and ecological sustainability.

I situate my research in Alaska for three primary reasons. First, the physical environment of the state is undergoing rapid environmental change that can be directly attributed to larger patterns of global climate change (Chapin et al., 2014). Many regions in Alaska have experienced sustained average temperatures greater than 10° F above normal during winter (Galloway, Moore, Thoman, 2014). Wildland fires seem to be increasing in frequency, intensity, size, and length of season (DeWilde & Chapin, 2006; Partain et al., 2016; Rupp, 2008; Wotton, Nock, & Flannigan, 2010**.** Sea ice is becoming thinner, more dynamic, and less reliable (Ballinger & Sheridan, 2016; Hauser et al., 2016; Henry P. Huntington, Quakenbush, & Nelson, 2016). Permafrost is thawing at increasing rates, resulting in increased erosion and subsidence threatening built infrastructure (Hinzman et al., 2005; Melvin et al., 2017). These physical changes are forcing human, as well as ecological communities, to respond, which leads to the second reason I situate my research in Alaska. The social dynamics of the state are heavily influenced both politically and economically by coalitions of Alaska Native organizations. The people of these organizations are culturally linked to longstanding environmental relationships (often referred to as 'subsistence' in Western literature) and are thus intimately aware of the physical changes the state is experiencing (Berman & Kofinas, 2004; Huntington et al., 2016; Moerlein & Carothers, 2012; West & Ross, 2012). Additionally, a history of Western pop-culture "outdoorsman" lore and modern natural resource extraction by the more politically and economically powerful non-Indigenous residents of the state has maintained a strong social connection to the physical environment within this community as well, although the two groups see their connection to the landscape through vastly different worldviews. These combined factors suggest that Alaska is an ideal location to explore how communication networks are facilitating adaptation to the Anthropocene because 1) there are large, documented changes occurring here, and 2) two of the major demographic groups living in the state maintain strong ties to the natural environment, and thus are likely to be relatively attuned to changes in it. The third reason I situate my work in Alaska is my own personal connection to the state. Both my parents and son call the state home, as did my grandmother until her recent passing. This gives my work a sense of place and personal value tied to the wellbeing of my own family into the future.

Researcher Bias

As I will describe throughout this research, communication networks represent the potential information paths through which communities can organize around shared and contested worldviews to address communal issues (Monge & Contractor, 2003). This is a reflexive process, where worldview is essentially the self-constructed understanding—through communication with the external environment—of physical and social space (Koltko-Rivera, 2004). Communication network graphs attempt to empirically map the information links that define this communal space. As a researcher, the boundaries I set in defining my research question, as well as the types of network relationships I choose to include as valid, are strongly influenced by my own worldview (Tan, 2016), because of this it is inescapable not to recognize my own role (bias) in shaping the networks I observe. While the goal is to limit this bias where feasible, it is never completely possible to do so. Therefore, in understanding my work it is important to be aware of my biases from the very start—to the extent that I can recognize them in any case (Adams, Wilson, Heavy Head, & Gordon, 2015).

I have a clear predilection to Western empirical research. However, I am highly critical of current scientific and political institutional power structures and distrustful of their ability to cope with the changing dynamics of the Anthropocene. Further, I consider myself a pragmatic environmentalist. There are certain demands we as a species place on the Earth that we must equitably meet in order to survive. This will have an unavoidable impact on the environment that I feel more stereotypical "conservation" oriented environmentalists often ignore, undervalue, or devalue. That said I believe there is a spiritual need for humanity to interact with natural systems in a more holistic manner than the prevailing Western doctrine of industrial and technological domination (Barnhardt & Kawagley, 2005; Grim, 2001; Tiwari, 2016).These two worldviews of Western environmentalism and industrialism stand in tension with one another as more and more natural systems are modified to meet the quality of life expectations required of an increasing "middle-class" minded global population (Ravallion, 2010). Therefore, the purpose of my research is to explore how changing communication practices can be utilized to expand our understanding of human-environmental and human-human relationships to better negotiate a balance point between these opposing tensions. Ultimately the goal of my work is to improve the responsiveness of communication networks to changes in social-environmental systems and to strengthen social and environmental justice efforts. I'll begin with a brief description of how I framed my research, followed by a more detailed explanation of key topics relevant to it.

Research Question

In this dissertation, I am interested in answering the question: Can organizational use of social media be strategically manipulated to meet the demands of Anthropocene-based environmental change issues?

Theory

I theorize that social media, by blending interpersonal and broadcast communication styles is well suited to developing diverse bridging relationships between established groups of tightly bonded communicators. Further, that establishment of bridging relationships between diverse groups serves to enhance the whole network's restructuring capacity in times of need or change. This improves the ability of network members to draw in appropriate resources when confronted by novel social and ecological challenges.

Hypothesis

I am interested in exploring if individual organizations can enhance the size, flexibility and diversity of their communication network by designing communication strategies that 1) use the principles of resilience and robustness theory to define system boundaries and key players, and

2) take careful assessment of the communication content, mode, and preferred communication channel of identified stakeholders within the system. Additionally, can doing this improve organizational ability to respond to rapid changes in the social-ecological systems they operate in?

Methods

Collectively the methods I use in this research could be described as digital ethnography, and perhaps fall into the academic disciple of Ethnoecology as seen through the lens of Communication Studies. However, it is a truly an interdisciplinary and mixed-methods study that involves a reflexive process of data mining, text-based analysis, and social network analysis grounded in theories from Communication, Media Studies, Indigenous Studies, Network Science, and Ecology. I borrow heavily from both John Law and Latour's ideas on Actor Network Theory (Latour, 1999, 2005, 2011; Law, 1992), as well as Marshal McLuhan's thoughts on Media Ecology (McLuhan, 1994) to construct multi-level communication networks from both quantitative and qualitative data sources. I use resilience and robustness models (Anderies, Janssen, & Ostrom, 2004; Holling, 1973) to interpret the implication of network relationships with regards to Anthropocene-driven environmental and social changes of the types described above.

This process is cyclic and reflexive. The first step is to define a problem area that the network will be built around. All the networks in this research involve issues tied to how people in Alaska are addressing rapid environmental changes associated (directly, or indirectly) with global climate warming. I use a case study methodology to examine four sub-networks in a broadly defined statewide SES, which will be described in some detail below. Quantitative data sources are used to define traceable connections between communicators involved in each of these sub-networks, but the data types between them varies depending on the medium of communication examined and reason for the formation of the sub-network. Data for social media communication involves tracking post and response actions. While quantitative methods for more traditional websites involve tracking individual website hyperlinking patterns. More formally structured communication environments, like webinars and workshops, involve tracking co-attendance records. Mapping these types of quantitative data sources makes visible the structure of interrelationship among communicators through specific mediums, or channels of communication. Through Graph Theory, these relationships can then be empirically assessed (Borgatti & Halgin, 2011). I use qualitative data from text and image records try to and understand the context-based attributes individual communicators bring into the network through ethnographic study of the actions taken through each medium examined (Murthy, 2008). Consistent reflection on both quantitative and qualitative results influences the boundary conditions that are used to make each successive network map. Hence the order that each case study was developed in is important to be aware of. I present each of the case studies below chronologically—with the first study being the first I explored in my research and the last, the most recent.

Combined, the intent of using these methods is to look for trends or patterns in the flow of communication within a defined social-ecological system, ultimately to facilitate strategic intervention when current configurations are not providing equitable solutions to the problems they are trying to solve. A more detailed description of the variety of network methods I use throughout my research will be presented below. Additionally, within each case study, specific modifications to these general methods will be explained in greater detail.

As mentioned, I present four case studies in this work. Each describes a network under a different context of environmental change. Two are formed under single, rapid change events; a strong Bering Sea storm along the west coast of Alaska, and a Yukon River ice jam in the community of Galena. The last two case studies examine networks developed around structured institutional attempts at addressing environmental change. The first of these examines networks intentionally created to address international collaboration and coordination issues arising across the US-Russian border around the Bering Strait region. The second explores international science efforts to engage local and regional stakeholders in pan-Arctic research during the Arctic Science Summit Week 2016 conference held at the University of Alaska Fairbanks (UAF) in the spring of 2016.

In the last section of my dissertation I apply lessons learned through explorations of the above case studies to the ongoing implementation of new communication strategy for the Alaska

Native Knowledge Network (ANKN)—a UAF-based organization with the mission of promoting Indigenous worldviews within Western institutions (Vance-Borland & Holley, 2011).

Background

Anthropocene

Applying the term Anthropocene to nearly all of the world's problems is becoming increasingly in vogue (Castree, 2017). And, while this is probably a needed social awareness to address the many challenges faced by this transition, some bounds do need to be placed on what the term means. Anthropocene in its purest form is a contested geologic term defining the current epoch of earth history (Crutzen, 2006; Smith & Zeder, 2013). In this form it can be defined through stratigraphy as the point in which evidence of human activity is the dominant physical processes recorded at the global scale (Steffen et al., 2011). This threshold meets the same stratigraphic naming requirements as the transitions mentioned in the introduction (Lewis & Maslin, 2015). Geologists, however, are currently arguing over exactly when, or if, the recorded stratigraphic switch from 'natural' processes to human processes occurred (Zalasiewicz et al., 2008). They are even still debating what suite of physical changes should constitute the indicators to use for identifying this (Autin & Holbrook, 2012; Zalasiewicz, Waters, & Head, 2017).

Some argue that the actual process that led humans to become the dominate driver of change at a global scale began with the develop of agriculture (Erlandson & Braje, 2013). They make this argument based on the idea that since we can detect when this new human-environmental relationship took place through changes in methane values in the stratigraphic record (at the global scale), that the start of the Anthropocene should coincide with the development of agriculture and the domestication of animals. From this perspective, the Anthropocene is thousands of years ongoing and likely began around 15,000 years ago with pig domestication in Mesopotamia, followed by rice domestication in China approximately 13,500 years ago. Others argue, based on the increased production of greenhouse gases, and subsequent sedimentary changes associated with them, that the beginning of the Anthropocene should be marked by the start of the industrial revolution in the mid 1700s, and so is hundreds of years ongoing. A third argument has been made to mark the transition with the first nuclear tests (and their subsequently distinctive stratigraphic signature). These tests began on July 16th, 1945 and immediately marked all subsequent sediments with a post-nuclear age isotopic signature. Using this event as the transition would make the Anthropocene only decades old (Braje & Erlandson, 2013; W. Steffen et al., 2011). All three are viable stratigraphic markers and each point to a fundamentally import phase in human development, and the key steps that led to our eventual ability to be change drivers at a global scale; however, from the perspective of adapting to our new global role, there is reason to believe that using the third option as the marker makes system-oriented sense (Zalasiewicz et al., 2015).

Beginning around 1950, humanity began to experience what has been termed "the Great Acceleration" (Biskaborn et al., 2015; Crutzen, 2006; Smith & Zeder, 2013). At this point, primed by centuries of technological development and triggered through global crises (the destruction of WWII and subsequent political and economic restructuring) nearly all indicators of human global influence make an exponential increase. This was true for things as diverse as water and fertilizer consumption to the number of household telephones in use, as well as many other economic and social indicators (Figure 1) (Steffen et al., 2011).

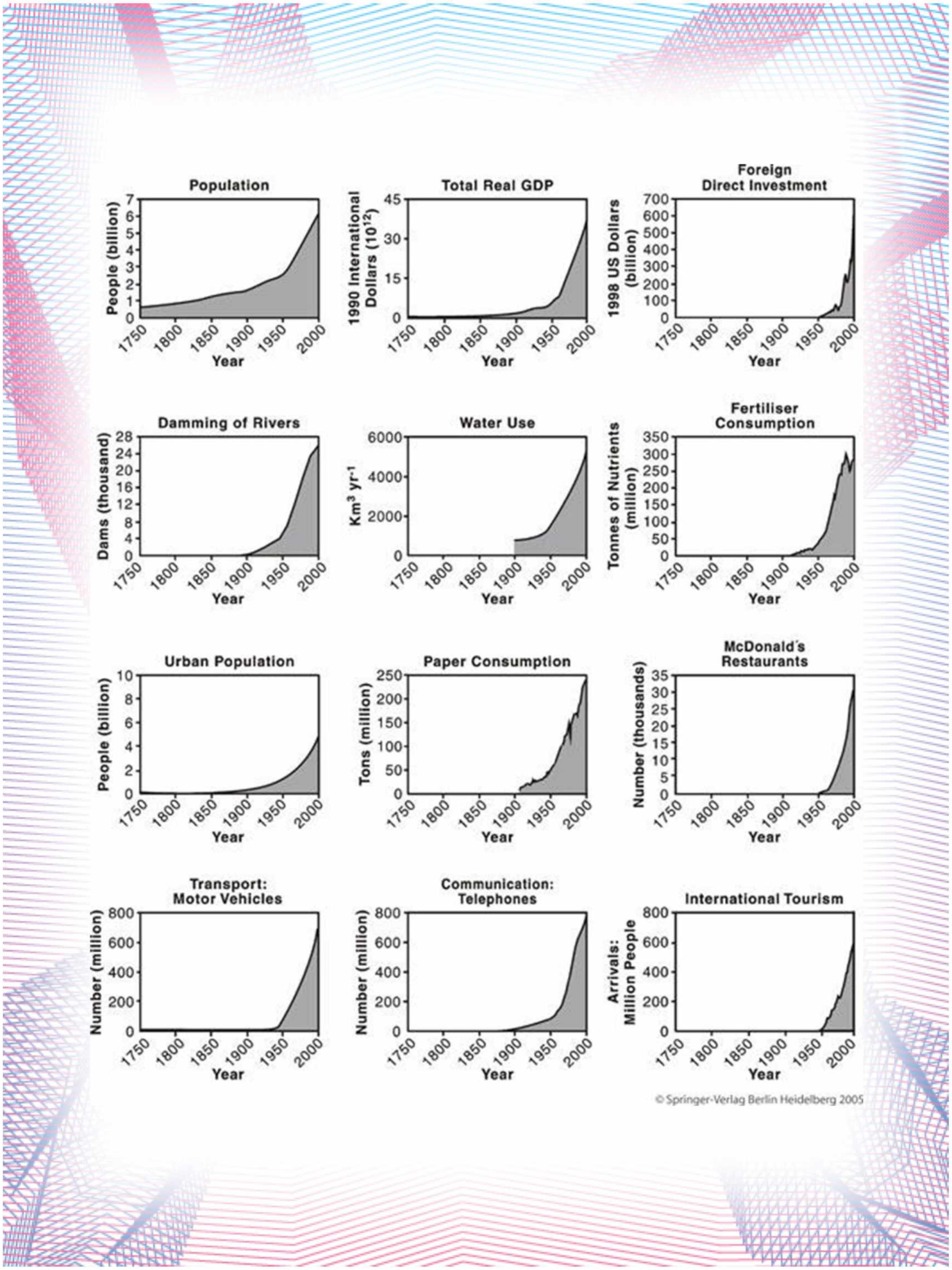


Figure 1: Anthropocene changes. A variety of markers indicating the rapid increase in human activity at global scales (Steffen et al., 2005)

The ramifications of the Great Acceleration were felt at many societal and ecological levels, both positively and negatively (Malm & Hornborg, 2014). This resulted in rapid economic growth in some sectors and equally rapid ecological collapse in others through an increased coupling of human and natural systems and a strengthening of the feedback mechanisms between human actions and ecological consequence (Young, Berkhout, Gallopin, Janssen, & Van Der Leeuw, 2006). Concern for the latter in recent years has produced the idea of planetary boundaries (Biermann, 2012; Rockström et al., 2009a, 2009b; Steffen et al., 2015).

The concept of planetary boundaries acknowledges the social-ecological system impacts inherent in the Great Acceleration and identifies nine distinct biophysical systems (Figure 2) that humanity must consider and maintain to support itself on earth (Rockström et al., 2009b). The introduction of planetary boundaries provides a framework to understand the concepts of sustainability at the scale of earth history. The planetary boundaries framework defines the chemical and biophysical service requirements humanity needs from the earth to survive (Rockström et al., 2009a; Steffen et al., 2015); with that as a metric, sustainability can then minimally be defined as decisions, behaviors, and outcomes taken in the present that preserves or enhances the earth's ability to provide those same or replacement services into the future (Rockström et al., 2009a). Social or ecological justice need not be explicitly addressed in defining sustainability, but in real terms it is needed to produce the kinds of decisions, behaviors, and outcomes that actually result in systemic system change and ultimately lasting sustainability (Biermann, 2012; Dalby, 2011; Lövbrand et al., 2015).

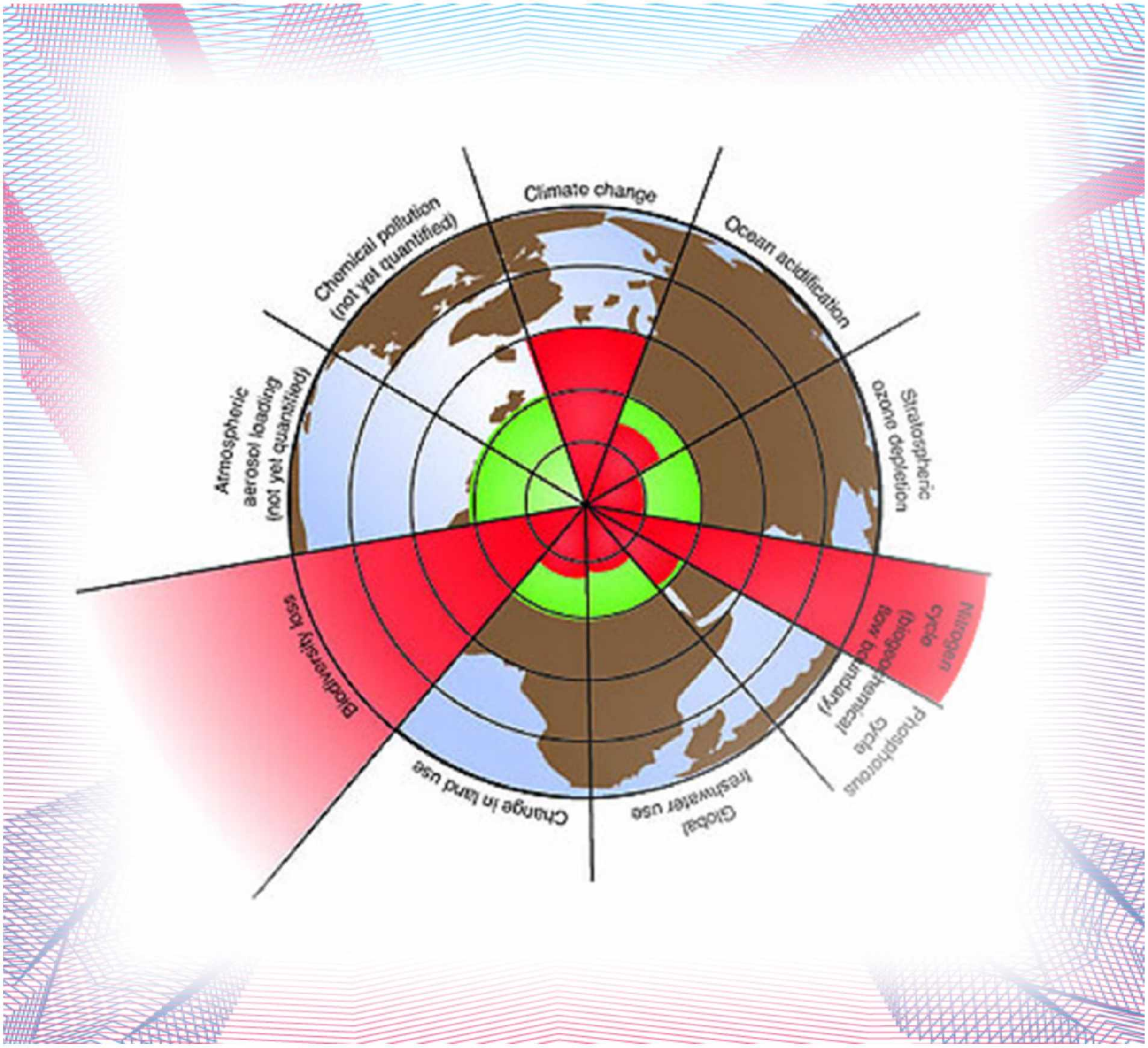


Figure 2: Planetary boundaries. Planetary boundaries define thresholds for a number of critical environmental indicators that if crossed could result in series challenges to the sustainability of humanity on earth (Rockström et al., 2009b). *Categories that are colored red identify indicators that have exceeded, or nearly so, presumed sustainability thresholds.*

To work toward sustainability in the Anthropocene, key human-environmental or social-ecological systems that impact our ability to stay within planetary boundaries need to be understood. The conceptual model of resilience, initially developed within the field of ecology, serves this purpose well (Holling, 1973).

Resilience is a model of ecological change that 1) explicitly acknowledges the dynamic nature of ecological systems and refutes the idea of steady-state ecological systems, and 2) seeks to identify cross-scale relationships that can create cascading, or tipping-point failures within the system (Walker et al., 2004). Concepts of resilience were adapted to broader social-ecological relationships when the strong interconnectivity between human and non-human systems became impossible to ignore in the later half of the twentieth century. In examining how communication networks are changing in the Anthropocene, and how they can be shaped to improve sustainability, I lean heavily on concept of resilience. Therefore, I will discuss it in greater detail below, but first I need to provide a basic background on the changing communication practices of the Anthropocene.

Communication Networks in the Anthropocene

The communication boom of the Great Acceleration, as indicated by the rise of telephone use seen in Figure 1, is only one example of the rapid communication changes humanity has experienced since the 1940s and '50s. Broadcast media has greatly expanded its audience both in numbers and geographic distribution. Television became dominant, but radio and print media led the expansion and continued to grow in influence until the rapid rise of the Internet (Dijck, 2013; Hirst, Harrison, & Mazepa, 2014; Prior, 2007). Broadcast media wasn't the only form of communication to rapidly evolve during this timeframe; interpersonal networks also expanded. The phone networks have already been mentioned, but beyond telecommunication infrastructure, modern transportation networks evolved and extended the geographic distance between where people lived, worked, and socialized (Weingroff, 1996). This is the period where rapid expansion of highways and regional to local commuter railways opened the suburbs in the United States, a trend in the geographic expansion of work networks that extended internationally through the organizational, logistical, and financial networks of the modern global economic system (Cidell, 2006; Woodburn, Allen, Browne, and Leonardi, 2008). Increased access to affordable air travel stretched the distances people could conveniently travel for work or play from the local and regional to the national and international (Cidell, 2006; Shaw & Thomas, 2006). The ability to move farther and quicker across the landscape rapidly changed how, with whom, and where people interacted, altering people's relationship to both their physical and social environment.

These types of changes can be understood by envisioning the differences between traveling by foot to work vs. commuter rail or highway system, or the social ramifications that brings by inducing the need, or opportunity, to build family and friend relationships in the one location with work ties maintained many miles away. These factors allowed interpersonal networks to geographically expand in many ways as much as broadcast networks did—though with clear boundaries between the two. Interpersonal networks rarely interacted directly with broadcast networks, except through indirect influence of the type Agenda Setting Theory is concerned with (Scheufele, 2000; Wanta & Wu, 1992).

This began to change with the advent of digital communication technologies, and specifically social media and Web 2.0 communication platforms. Today there is much more direct feedback, or overlap, between broadcast and inter-personal networks than there was in the beginning of the Great Acceleration (Ngai, Tao, Spencer & Moon, 2015). Evolution of digital technologies has magnified the trend of expanding geographic reach even further, though at the expense of early technologies (declining TV viewership, vastly constricted print-based news industry) (Dijck, 2013). The case studies and application examples presented below offer illustrations of how these trends are playing out in Alaska, but before going further a more fundamental understanding of how I define communication is needed.

I define communication as the exchange of information between an individual and the environment they inhabit. Communication is not limited to human-to-human interaction in this definition; it includes interactions with all environmental elements—from the temperature outside to this very text you are currently reading (Latour, 1999, 2005; Law, 1992; McLuhan, 1964; McLuhan, 1994; Oller & Griebel, 2004). At its most basic level, communication involves the transfer—and translation—of energy from the external environment into forms the mind can contextualize through meaning. Based on this definition I begin my research from the perspective that communication, in all its variety of forms, acts as the core mechanism through which individuals interact with both their social and physical environment (Oller & Griebel, 2004). As such, it plays a vital role in worldview construction (Latour, 2011; McLuhan, 1964)

Through this understanding of communication, media can be defined as any technologic or biologic device that modulates or regulates the flow of information (energy) between an individual and the environment (McLuhan, 1994). This is not to be confused with the more common use of the term 'media' as a news or entertainment entity (McQuail, 2010). Rather this definition derives its meaning from medium, or the substance through which energy of is passed.

Given these definitions for communication and media, the ecology of mediated communication systems can be described as the study of the energy relationships that form and dissolve through information transfer between environmental actors, and including, the methods/tools through which energy is manipulated to do so. The communication networks I construct in my research are rudimentary attempts to map this dynamic exchange of energy into structured information.

Specific bounds will be discussed for each case study. However, for any given system, extreme differences will exist between the ability of individuals, or classes of individuals to directly communicate with one another. When trying to look at a complete social-ecological system, the variety of classes of individuals I am referring to includes non-human physical and biological elements, as well as human agents.

The ability to communicate, as normally accepted in Western society, with all elements of the system is obviously limited. At one level this results from a mechanistic inability between agents to receive or transmit information in mutually understandable forms—literally the right wavelength, at an electromagnetic level, to understand on another (Oller & Griebel, 2004). At another, it is the result of a wide variability in how system agents internalize and process information (Federle & Bassler, 2003; Firnkes, Bartels, Bidoli, & Erhard, 2017; Liang, Zen, Zhang, Zhang, & Chen, 2013; Tchernichovski, Feher, Fimiarz, & Conley, 2017). The human inability to perceive, or not (without technological mediation), and the energy frequency bats use in echolocation, can illustrate both issues.

The bat "sees" by transmitting high frequency energy into the environment and "listening" to the return signals (Fenton, 1997). Unaided, humans can't perceive this signal at all, and completely miss this level of environmental information exchange. We are forced to understand the bat through signals we can interpret—perhaps visual or auditory signals transmitted through the bat's kinetic response to echolocation information (how it moves), or through technological modulation of the echolocation signals themselves to a frequency we can perceive (a technologically mediated sensor). We cannot directly perceive the primary information bats use to interact with the world around them via the form they perceive it, but we can mediate the energy into an understandable form via technology (Fenton, 1997). This translation forces changes in how the information is decoded to direct action. Obviously, structural differences between human and bat brains impact internal sense making far more and there is little to no overlap between how a bat "sees" the world and how a human does. Nevertheless, both mechanisms impact how each species understands and behaves in the world.

The differences between human and non-human agents are extreme in this example, but demonstrate one end of a scale that has human-to-human communication located at the other end, with—perhaps—human-to-animal relationships, like those between people and dogs or people and horses, somewhere in the middle. All the same, the idea of media ecology is generally more concerned with finer scale differences in worldview construction between humans (McLuhan, 1994). However, because it is not limited to them, it allows for a theory-based connection to be made between communication practices and resilience-based models which consider both social and ecological elements in a system (Latour, 1999; Law, 1992).

Operationalizing the theoretical elements of media ecology and applying them to understanding the dynamics of communication around social-ecological systems requires the term 'media' be defined in greater detail. Media speaks to the tools or methods used in communication (McLuhan & McLuhan, 1992; McLuhan, Molinaro, McLuhan, & Toye, 1987). Specifically the tools of mobility, shelter and clothing that extend (or narrow) our ability to interact with the external world. The term media refers to the technology we use to extend our unmediated sensory range (McLuhan, 1994; McLuhan, 1964). Taken to an extreme this technology can include external environmental elements. Our individual and cultural media preferences deeply impact our 'sense of place' by structuring how—in terms of form, volume, and intensity (rate)—external environmental information (of human origin, or not) is prioritized and interpreted in the mind. Mediating technology can also include things like eyeglasses and hearing aids, but more commonly, media technology is about direct communication tools like the newspaper, telephone, television, and computer. In these cases, the term 'channel' can serve to delineate further differences within in different types of media—book versus flyer, a webpage versus e-mail versus blog, etc. The term 'mode' can then be used to further breakdown the communication process into the distinct senses—sight, sound, touch, taste, feel, and hearing—that are activated (or enhanced) by any given medium or channel.

Scale is important to consider when thinking about the different forms of media common in our lives. Three dimensions are particularly relevant to consider, 1) the distance different forms of media allow us to communicate across, 2) the synchronicity with which they force us to interact, and 3) the size of the communication networks we can create through them (Ngai, Tao, Spencer & Moon, 2015). For any given medium (and/or channel), these scalar dimensions will be modified further by the volume and rate of total information that they can transfer under variable conditions.

Alaska's large geographic size, the remoteness of communities, and its extreme climate all play a central role in shaping both historic and modern communication networks in the state (Hudson, 2015; Hudson & Parker, 1973). Traditionally, Indigenous cultures were spatially organized in clusters closely aligned to the geophysical and biophysical divisions found in the state. Unique language groups formed along with unique technologies, patterns of movement, and social institutions between culture groups and tightly bound to local geography and ecology Krauss, 1996; Williams, 2009). Inter-group communication media typically involved face-to-face, localized, experiential channels within tightly bonded groups—with regular, but episodic, communication between groups via travel, seasonal gatherings, etc. (Kari, Fall, Pete, & Alex, 2003; Luke & Jackson, 1998). A wide range of modes are involved in these channels of communication—from storytelling to gift giving—but they all involve relatively small social groups shared locally with high frequency, and regionally with more episodic frequencies through travel (Brower & Brewster, 2004; Frank, Frank, Mishler, Erick, & Alaska Native Language Center, 1995; Kari, Fall, Pete, Alex, & Alaska Native Language Center, 2003).

Colonization extended the geographic reach of communication in Alaska in multiple ways (usually to the detriment of local communities). In one way it simply extended the physical reach of the already established communication patterns (small group, face-to-face) by extending the transportation systems active in the region (Case, 1989; Wexler et al., 2013). Through this process communication networks were enlarged in total size but the mechanisms used to pass information stayed the same, and thus involved similar modes but increased scale distribution. Continual introduction of more mediated technologies—from written language to the radio, and eventually television (still the most ubiquitous in Alaskan village households) and the internet—represent a second more fundamental change in the communication ecology of Alaska post-colonization. This shift can be increased by not only the scale of communication networks in Alaska, but also the volume and intensity of information present in them.

Broadcast and mass media (television, radio, print) were particularly crushing in their ability to expose local communities to powerful one-way messages that didn't allow them room to negotiate their content. These forms of media only allow limited modes of information transfer to interpret the context of their content, therefore when not locally produced there are few mechanisms available to clarify meaning, or to make relevant connections to local conditions (Ginsburg & Ginsburg, 2016; Howley, 2010). VHF radio on the other hand preserves the reflexive back-and-forth mechanism needed to negotiate meaning. This is characteristic of face-to-face communication and aligns to traditional patterns for both Indigenous and Western people's interpersonal communication needs. Thus, the modern communication environment in Alaska needs to be framed by an understanding of both the historically positive and negative community impacts created by the introduction of new tools to mediate communication.

The physical infrastructure to actually mediate communication has also been shaped by the remoteness of Alaskan communities and cultural difference that impact state politics and the allocation of public and private resources (Anders, 1987; Hudson, 2012). Given this, some basic contours for the communication landscape in Alaska are as follows:

- Most the state has access to the breadth of modern communication tools—telephone, mobile phone, TV, internet, e-mail, etc., but regional differences in access and quality can be extreme

- Urban areas have the greatest access and quality, followed by hub communities, and then villages
- Schools and clinics typically have the greatest connectivity in rural communities
- Mobile coverage is scarce between population centers
- There are access disparities across rural regions—rural Western Alaska has much better service than rural Interior communities
- Facebook is heavily used across Alaska and particularly in rural Alaska; Twitter and other social media platforms have higher activity in the urban centers
- Facebook friend circles in rural Alaska are large relative to the general Facebook population; women are the dominant users in the 35-55 age bracket

Given this general communication landscape the typical media ecology that forms in Alaska can best be described as involving interpersonal groups that are connected by physical proximity that—around issues of human-environmental conflict—often enlarge geographically and in number through e-mail, telephone, and co-participation and travel to regular regional, state, national, and international level meetings, workshops, and trainings.

Broadcast media is driven at the state level via television and print outlets located in the urban centers. However, there are a few regional examples from rural hubs, notably the Nome Nugget, the Arctic Sounder, the Delta Discovery, the Tundra Times, and the Council. Radio is the primary regional broadcast media source in rural areas of the state (Wikipedia, 2017a, 2017b, 2017c). Increased access to digital channels, particularly social media, is altering this media landscape but to date has not been well studied.

In understanding how social media is changing this pattern, it is important to understand that traditionally the channels of communication that advantaged interpersonal communication fostered small tightly bounded networks (Knapp & Daly, 2002; Norris, 2004). Generally, these involved high communicative transaction costs because they were bound by tight space and time restrictions. That is, you needed to be in close physical proximity to maintain them through regular small-group and individual face-to-face interactions, and you needed to invest large blocks of individual time to each group (De Silva & Ratnadiwakara, 2008; Dyer & Chu, 2003; Holloway, Nicholson, Delgado, Staal, & Ehui, 2000). The telephone expanded the geographical extent of these networks, but fragmented information flow across the network because of the limits on how many people can participate in any one call at a time. It also comes at the expense of not being able to communicate any non-verbal information (Maltz, 2000; Rice & Danowski, 1993). E-mail comes with similar costs and benefits, with the additional loss of inflection in conveying meaning. The financial and time expenses of attending regional and broader scale meetings, workshops, and trainings increase the resources needed to maintain larger networks through these channels (Arnfalk & Kogg, 2003; Bal & Foster, 2000). Despite these expenses, interpersonal networks are the social bonds that allow us to enact, or implement, strategic agency in solving human-environmental issues and thus we devote a lot of time and attention to them.

Broadcast media, on the other hand, fosters larger networks that aren't tightly bound (Kiousis, 2001; McLuhan, 1964; McQuail, 2010; Monge & Contractor, 2003; Moy & Scheufele, 2000). These networks do not directly implement strategic action. Rather, these networks serve to synthesize the actions of subsets of the society into a larger context. In that role, they act to catalyze the agency of individual interpersonal networks into broader coalitions by sharing general practices to broad audiences (Vowe & Henn, 2016.). An important mechanistic distinction between these two forms of media is the reflexivity between communicators.

In interpersonal networks, there is a high degree of reflexivity which allows communicators to co-negotiate meaning (Gallois, Giles, Gallois, & Giles, 2015; Giles & Powesland, 1997). The implied back-and-forth nature of interpersonal communication required to achieve shared meaning has traditionally been a limiting factor on the size and composition of interpersonal networks. Broadcast forms of media have traditionally had very limited levels of reflexivity; a single message was pushed out to a large audience with limited and restrictive communicative paths to directly respond to them.

In my dissertation, I work from the theoretical premise that social media blends interpersonal and broadcast styles of communication by allowing for high levels of meaning negotiation in a large public sphere (Danescu-Niculescu-Mizil, Gamon, & Dumais, 2011). Modern channels of social media allow messages to be pushed out to large audiences while also maintaining high levels of reflexivity between communicators (O'Sullivan & Carr, 2017). This has enriched the communicative landscape by reshaping the mechanisms through which individuals in a communication network can establish new ties while lowering the cost of maintaining old ones

(Danescu-Niculescu-Mizil et al., 2011; Sandel, 2014; Schwanda Sosik & Bazarova, 2014; Viswanath, Mislove, Cha, & Gummadi, 2009). This expansion of audience size, while maintaining reflexivity, is the core shift in the media ecology of the Anthropocene that I investigate in this research.

Resilience in the Anthropocene

While my research is primarily concerned with measuring communication networks to better understand how they function in the Anthropocene—ultimately to promote more sustainable human-environmental relationships than at present—resilience is the framework I use to understand how these networks fit into the broader global context.

The idea of resilience (in an ecological context) is primarily concerned with system relationships—agents, functions, and feedbacks. It makes clear that systems are in a constant state of flux where one cannot define a static state of equilibrium (Holling, 1973). Rather, resilience utilizes a 'basin of attraction' concept to refer to specific system configurations that are more stabile than others (Figure 3). This model allows for system relationships to react to both internal and external perturbation with some level of flexibility and remain in the same general state (Walker et al., 2004). The adjustment of system relationships without moving into a new basin of attraction is considered 'adaptation' in this model. If system relationships are fundamentally altered, and the system moves into a new basin of attraction, the system is transformed.

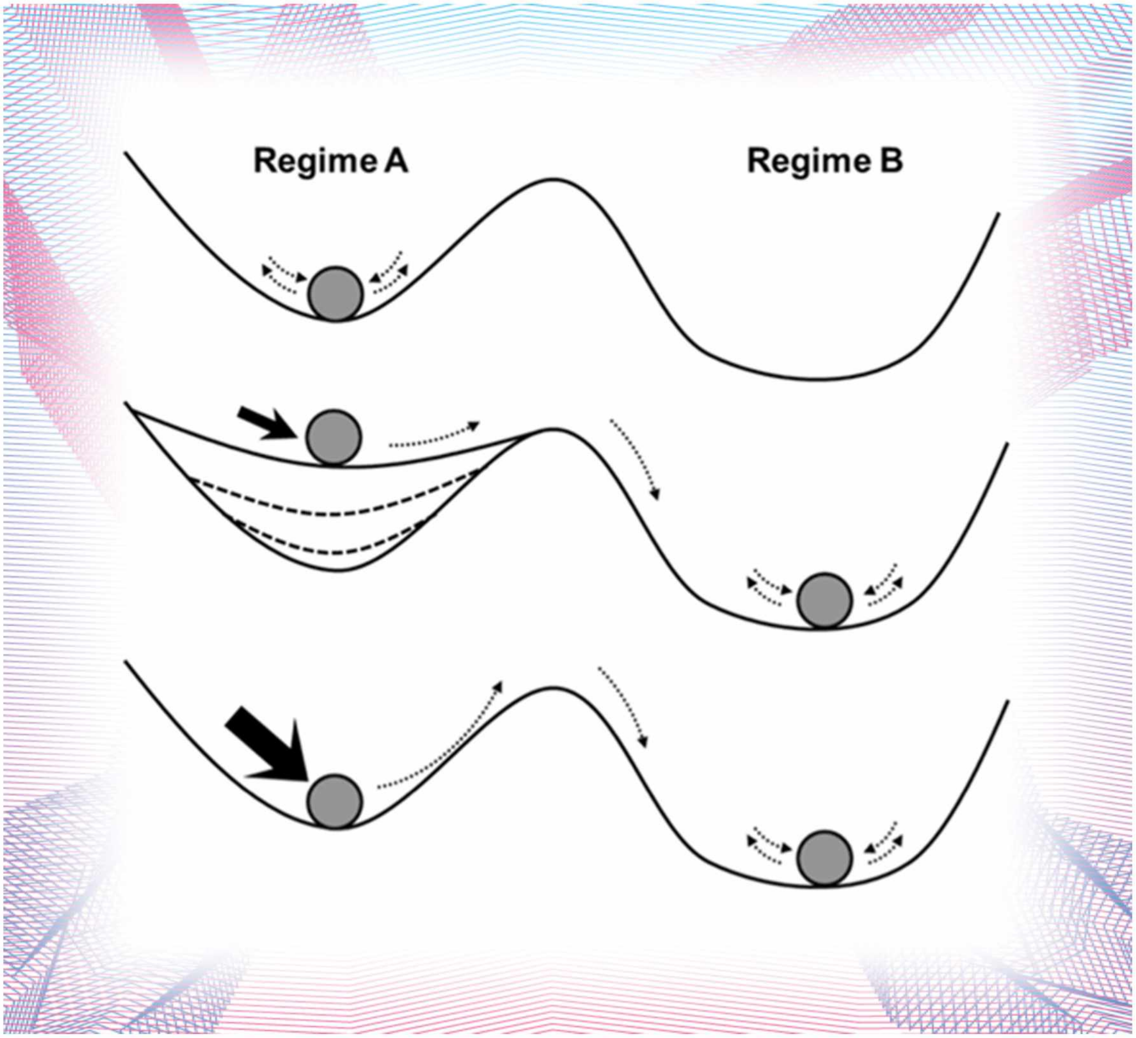


Figure 3: Basin of attraction model for system change. In this iconic model the gray ball represents a given set of system relationships and the lines represent the large-scale social-environmental landscape that the system is embedded in. The arrows represent perturbations to the system. Given either changes in the strength and directionality of perturbations and/or changes in the shape of the larger social-environmental landscape a system my move from one basin to another, or it may simply rock back and forth within a single basin (Walker et al., 2004). *A system is said to adapt to perturbations if it does not cross a threshold between basins. If it does cross the threshold into another basin, it is said to have transitioned.*

Resilience places this complex system model of adaption and transformation into a social-ecological system framework (Walker et al., 2006). There are several different ways people have attempted to describe the processes and mechanisms involved in a generalized social ecological system. Chapin et al. in a 2006 piece published the figure below (Figure 4) (Chapin et al., 2006).

There is a lot to digest in this figure, but relative to my study the dimensions along which variables change on both the ecological and social sides of the figure are important to highlight. Namely—rates of change and how they interact across physical scales are critical to note and distinguish between the simple presence of change. It is also worth highlighting, though somewhat obvious, that individuals, as well as organizations act as the mechanisms through which social processes impact ecological process. However, from the perspective of this research it is only though organizations (formal and informal) that individual actions can become a geologic force at the global scale. Prior to the Anthropocene, the ecological side of the figure acted as a buffer to unsustainable social processes such that there was no direct ramification to global society—though decoupled local and regional impacts were surely felt on occasion. In the Anthropocene however, local and regional actions have been coupled to global processes through an increase in human organization to such an extent that the ability of ecological processes to buffer poor social decisions has been exceeded. Therefore, the ability of human actors to force sustainable strategic—or intentional—system change across the two sides of this figure is critical if we want to seriously address modern issues sustainability. The idea of robustness (Anderies et al., 2004; Folke, Hahn, Olsson, & Norberg, 2005) will be introduced below to address this issue. However, to frame that discussion the concept of the adaptive cycle will be discussed first and then elaborated on further in the case study section of this dissertation.

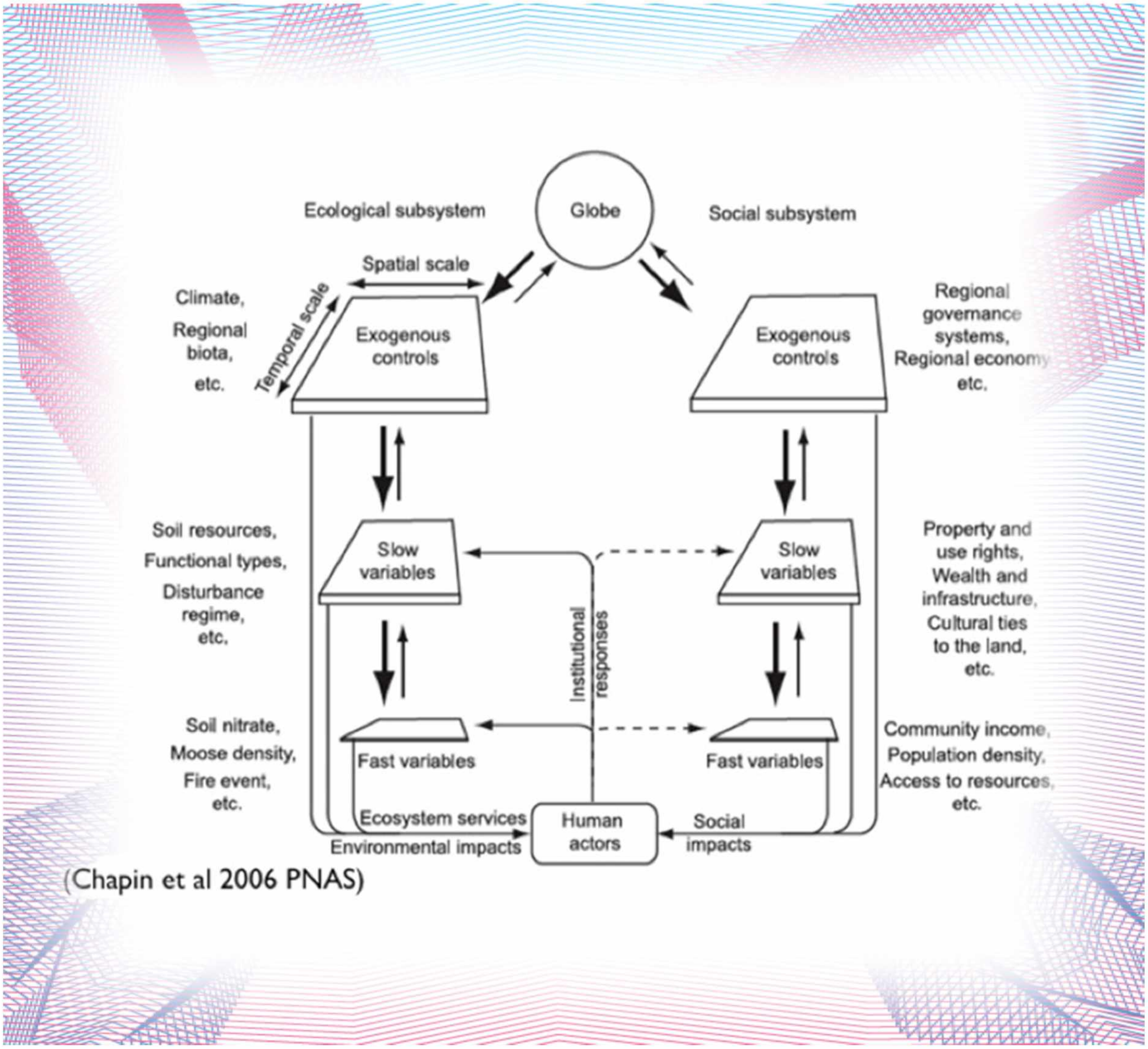


Figure 4: An example of the relationships between social and ecological environment protagonists. Of particular relevance to this study are the different rates of change interacting across different levels of social structure (Chapin et al., 2006).

The adaptive cycle is a conceptual model within Resilience Theory. It idealizes the phase changes a simple (singe dimension) system will pass through as it responds to both internal and external perturbations (Walker et al., 2004). The concept is built around an infinity loop (Figure 5), with four divisions aligning to four phases of system change identified as important in resilience theory—release, re-organization, exploitation, and conservation (Walker et al., 2004)**.**

These four divisions are often grouped into either the foreloop or backloop of the infinity diagram. The foreloop (exploitation and conservation phases) generally involves slow system evolution, growth, increasing complexity, and resource accumulation through the exploitation of free energy within the system and conservation of established connections (Walker et al., 2004). The backloop (release and reorganization phases) often involves rapid change—the release of resources and energy in response to system strain, as well as the initial reorganization of new system relationships as the system either adapts, or transforms to new environmental conditions (Walker et al., 2004). As a conceptual model, it is important to remember that while systems often move through these phases essentially in the sequence described, the amount of time spent in each phase can vary greatly between systems, and different system can and often do jump or skip phases—often in response to cross-scale interactions not initially considered in the single dimension that the adaptive cycle attempts to illustrate.

Social-ecological systems of the types I am concerned with in this work are always complex systems, meaning they invariable involve systems with multiple dimensions interacting with one another (Bodin & Tengö, 2012). This could take the form of long-term climate factors interacting with short-term weather events, or fast-acting economic factors (losing a job) interacting with long-term socio-economic challenges (systemic regional poverty). Since social-ecological systems are also complex systems, the idea of nested adaptive cycles, or panarchy (Figure 5), has been developed with some basic properties of cross-scale interactions being noted. Often the connection between smaller scales and larger scales occur most dramatically at the release point of the smaller scale. Smaller scale dynamics tend to invigorate larger systems, while larger systems can stifle smaller ones (Gunderson & Holling, 2002). It is also argued that transformation at small scales increase resilience in larger scales. Experimental transformation of smaller subsystems then allows for adaptation (change within a stability regime) at larger scales (Folke et al., 2010).

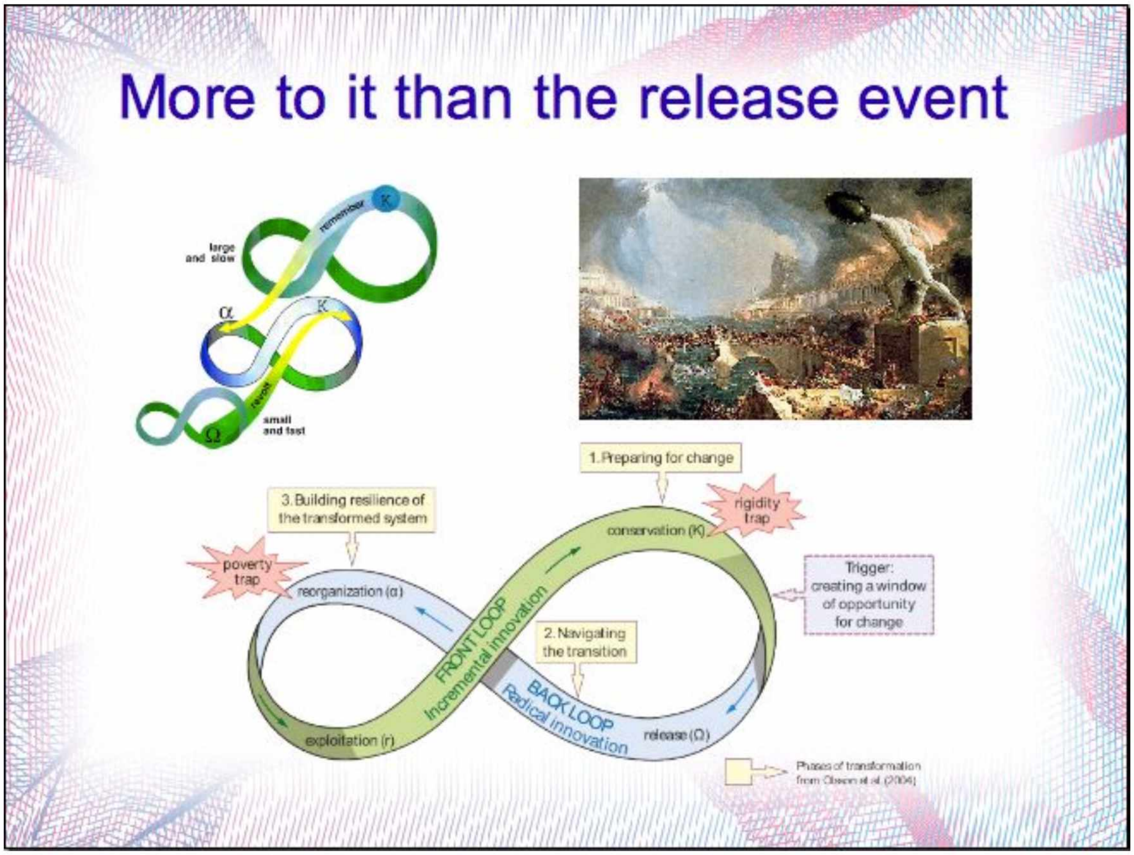


Figure 5: Panarchy and the adaptive cycle. The adaptive cycle describes the evolution of a system through four primary phases (release, reorganize, exploitation, and conservation) at a single scale of consideration. Panarchy attempts to conceptualize how multiple scales interact (Gunderson & Holling, 2002) *through these same phases. The painting, Destruction from the Course of Empire by Exlore Cole, illustrates a common social representation of the release phase of the adaptive cycle.*

Resilience does a nice job of helping to frame and understand the complex systems humanity has embedded itself in with transition into the Anthropocene. However, it struggles to address the degree of agency human actors possess in most social-ecological systems (Anderies et al., 2013). In other words, resilience helps us understand how the system works, but gives us very little guidance on how to impact it sustainably—i.e. to work together and stay within (or redefine) planetary boundaries. Robustness attempts to address this issue.

Robustness in the Anthropocene

The concept of robustness, when applied through a resilience framework, is borrowed and modified from the engineering community to help understand how human agency negotiates important system outcomes, which hopefully will lead to greater sustainability (Anderies et al., 2004). To do this, robustness focuses on cognitively structuring a given social-ecological problem by first identifying the resource at issue, and then connecting the form(s) of governance and infrastructure associated with it to the people (and organizations) concerned about it. Fundamentally, robustness is concerned with output rather than internal system arrangement (which is the focus of resilience more broadly) and involves a four-element system conceptualization that can be seen in the figure below (Figure 6). This visualization links a natural resource to the users of the resource, the public infrastructure that maintains access to the resource (including both built and institutional elements), and the resource managers who maintain the infrastructure (Anderies et al., 2013, 2004; Janssen, Anderies, & Ostrom, 2007). In the robustness model the relationships between the individual people (or organizations) that fill both the resource user role and resource manager role is thought to be critical. Though much work is still needed to develop a deeper understanding of these relationships in a greater variety of systems, these early studies seem to indicate that higher overlap between individuals who fill both a user and provider role (i.e. the same person/organization fills both roles) result in greater resource sustainability.

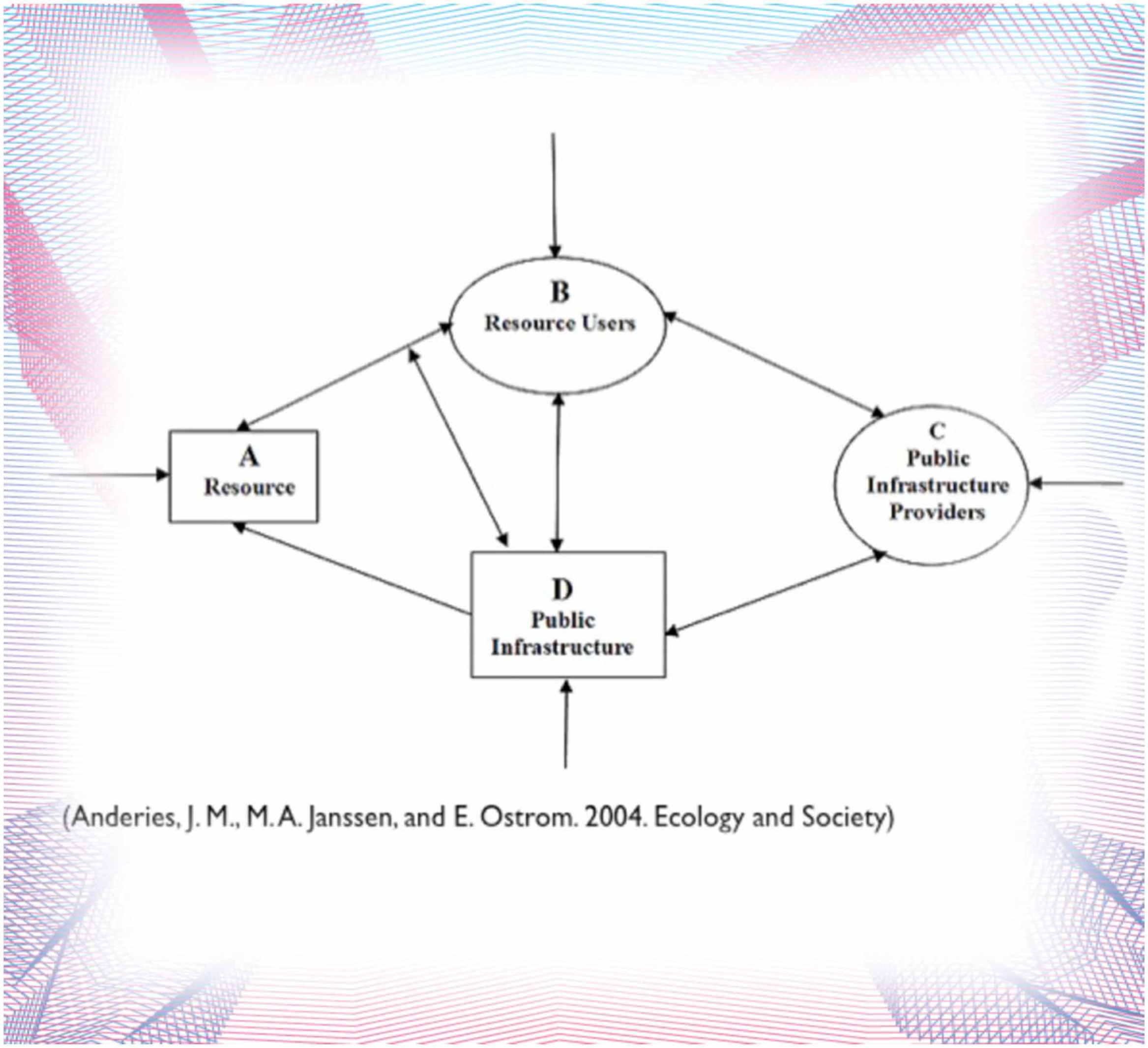


Figure 6: Relationships within the robustness model as applied to social-ecological systems. This model differs from the adaptive cycle in that it is less interested in system relationships than system output. A high overlap in the individuals who fill the roles of "resource users" and "infrastructure providers" has been proposed as potentially optimal for maintaining consistent (sustainable) output despite changing systems stresses (Anderies et al., 2004). I this study I am largely concerned with mapping the communication networks that define this connection.

With this in mind, a robust system is one that can maintain consistent output when faced with variable input and shifting external conditions (Anderies et al., 2004; Fleischman et al., 2010). This conceptual frame allows for human agency to strategically force system transformation at one scale or level and to adapt at another—remaining in a desirable state at the scale deemed of most value to individual system participants.

Sustainability in the Anthropocene

In the end, the term Anthropocene is just stratigraphic nomenclature that labels the accumulating detritus produced by the rapid coupling of human and natural systems. In practice however, it represents a distinct transition in humanity's experience on earth. It marks the transition from an empty world scenario—one where natural systems are globally capable of buffering the consequences of ecologically harmful social choices, to a full world scenario where this is no longer true (Beddoe et al., 2009). The coupling of systems at such a large scale requires greater social awareness of planetary limits than in previous periods of earth history (e.g. the Pleistocene and Holocene) for the simple reason that we now hold the collective power to overwhelm them. I define sustainability in this context as describing the act of remaining within planetary boundaries (Steffen et al., 2015).

Unfortunately, what exactly our planetary limits are is a contested issue—in both scientific and political terms (Lewis, 2012; Seidl & Tisdell, 1999). To a large degree, my work tries to make visible the social alliances contesting this issue by mapping the evolution of communication networks as they respond to social-ecological changes that are internally thought to be threatening local and regional sustainability (i.e., individuals/groups within the system believe there is cause for concern). In doing this, it is important to remember that every agent within the networks I develop has their own unique perspective and understanding of what the system limits are even if they all agree there is an issue (Borgatti & Halgin, 2011; Hauck, Stein, Schiffer, & Vandewalle, 2015). This means that more than not, each agent will be striving to alter the system to a slightly different version of sustainability than others around them; nevertheless, by the boundaries I placed on developing the networks presented here, agents within them are assumed to be working toward the idea of sustainability as best as they individually understand it. In the case studies presented below, I selected events where people willingly came together to solve issues they believed were not sustainable. Alternatively, networks could be built to examine more antagonistic relationships (i.e., climate change deniers efforts to impact policy, which is a radically different communicative context than any I present here).

Sustainability as an end-goal concept can be viewed in a binary fashion— "this is a sustainable action" or "this isn't." (Anderies et al., 2013;Ostrom, 2009; Turner et al., 2003) Resilience and robustness, on the other hand, are process and output-oriented conceptual frameworks that attempt to account for the legacy impacts and the continually dynamic nature of system change in ways sustainability alone does not (Chapin, Kofinas, Folke, & Chapin, 2009; Folke, 2006; Holling, 1973; Young, 2010). When thinking about the challenges humanity faces with transition into the Anthropocene, resilience considers the processes (via a complex-system perspective) through which human and natural elements interact, robustness attempts to account for the strategic agency of humans (both individually and through collective action) to impact the human-environmental system (Anderies et al., 2004; Janssen et al., 2007; Anderies et al., 2013), and the concept of sustainability serves as the goal to motivate strategic action and a deeper understanding of the processes that regulate system resilience.

To support the needs of sustainability in the Anthropocene, my research takes the praxis-oriented stance that resilience theory can help us to understand the changing dynamics of the multi-scale, social-ecological relationships that define the Anthropocene, while concepts of robustness can help us dig into the institutional processes that govern how humans flex their individual and collective agency to exert change on—and within—them. But most importantly, by understanding the social networks that make this type of institutional change possible, individuals and organizations can strategically intervene to affect greater overall system sustainability.

Communication and communication networks enter this integrated system model as the theoretical mechanism through which humanity interacts to contest the form and content of our collective agency on the environment (Bodin et al., 2016; Bodin & Tengö, 2012; Carlsson & Sandström, 2007). In other words, without communication, we as a species would never been capable of coordinating our individual power to exert change on the external environment to such scales as currently define the Anthropocene. From this perspective, communication networks are the very real manifestations of the social relationships that define humanity's larger relationship to the natural environment. This connection is fundamental to my research—as I map the communication networks for each case study using them as proxies for robustness relationships, and then applying network analysis and theory to assess the systems resilience—and ultimately, sustainability.

Social Network Theory

A brief review of some basic social network theory is appropriate then at this point, though I will go into more detail below as needed with each case study. A social network (any network) is constructed of nodes and ties (Scott & Carrington, 2011). In this study, nodes are required to be social-ecological system elements but generally only include individuals and organizations, and do not directly include non-human elements. Ties represent traceable action-based communicative connections between nodes, which include commenting or liking on a social media platform or co-attendance at an in-person conference.

Network theory is a diverse discipline with scholars from such divergent fields as theoretical physics and cultural anthropology, and a large body of literature has developed to understand network dynamics across a range of phenomena. In social networks specifically, this has generally taken two directions. The first approaches networks from an abstract mathematical perspective and attempts to quantify network behavior through advancements in the math behind graph theory or linear algebra. The second attempts to understand network dynamics by applying a wide range of human behavioral theory to observed network relationships. My work pulls from both these veins of scholarship to understand networks from a community activism and resilience perspective; however, just four basic network principals are critical to understanding the bulk of my findings: 1) bonding relationships, 2) bridging relationships, 3) network density distribution, and 4) node centrality.

Bonding structures refer to networks where a set of nodes shares numerous ties among themselves (Figure 7) (Borgatti & Halgin, 2011). An everyday example of this is the shared connection within a close family or circle of friends. A common functional property of this structure is an equal distribution of shared knowledge (Borgatti, Mehra, Brass, & Labianca, 2009). Which is to say, if you tell something to your mother—it likely won't be long before your father also knows it too! These types of network structures are associated with the ability to provide strong emotional support (positive or negative) to individuals within the group (Monge & Contractor, 2003). However, they are often observed to have difficulty incorporating new resources (knowledge, material, or opportunity) into the network because there is no outside connection to provide exposure to them (Bodin et al., 2016).

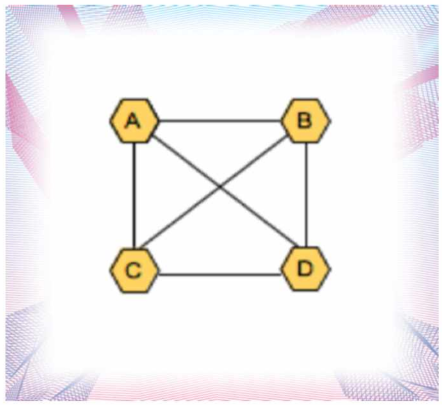


Figure 7: Idealized bonded network. In a strongly bonded network individual nodes share common connections with other nodes in the network. I.e. nodes A and B both share common connection with C and D, as well as with one another.

The introduction of new resources into a network, therefore, is more strongly associated with bridging structures (Granovetter, 1973). This is a situation where two bonded groups are connected by only a few members maintaining relationships across groups (Figure 8). The ability to bring in new resources to one side or the other of this network makes intuitive sense, in that through the bridging structure exposure to potentially novel resources is possible from either side of the network. Granovetter's work empirically showed this by examining the social network relationships of successful and unsuccessful job seekers. He found that those with lots of bridging relationships more quickly found employment, while those who maintained more bonded relationships had a harder time finding new work if they were forced to do so. This result has been observed in network after network since then (Alexander, Armitage, & Charles, 2015; Borgatti, 2006; Gilbert & Hamill, 2009; Janssen et al., 2006; Scott & Carrington, 2011)

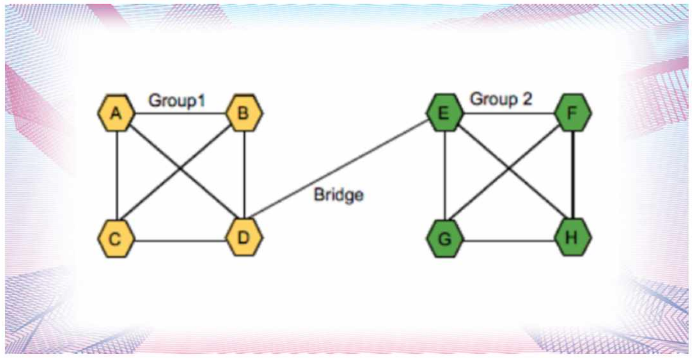


Figure 8: Bridging Network. Groups 1 and 2 are tightly bonded internally. The tie between nodes D and E represents a bridging relationship. This connection allows group 1 potential access to the resources of group 2, and vice versa.

The concept of network density distribution is the analytical method used to identify bridging and bonding relationships. Network density is simply the average number of ties any given node maintains relative to the hypothetical maximum it could maintain if it was connected to every other node (Borgatti & Halgin, 2011). Network density distribution then refers to changes in this ratio in different regions of the network. A tightly bonded group would have a high density, because each member in that group is connected to many of the other members in the group, but each is less connected to other nodes in the network. Clustering algorithms to define subgroups within networks use this principle to make their grouping decisions by running through combinations of nodes, calculating densities, and selecting groups that have the highest number of internal connections and lowest number of external links (Monge & Contractor, 2003)

An example of differences in the distribution of tie density can also be seen in figure 8 (Figure 8), where there is an increase in tie density within the groups and a decrease between them. Differences in the density distribution of ties are used to define groups or subgroups within networks and indicate areas within the network where specialized information or resources may be found—relative to other groups in the network (Oh & Monge, 2016).

Node centrality refers to the structural position of a given node within the larger network. This can be measured in a variety of ways, the most basic being "degree" which records the number of ties that connect the node to the rest of the network (Figure 9)(Borgatti & Halgin, 2011). Using degree, a more central node will have a greater number of ties connecting it to the network. Betweeness and Eigenvector analysis are more refined variations of this general theme of counting ties at the node level, however they weight the importance of different ties based not just on the total number of ties a node is connected to, but also on the relative centrality of the nodes linked through those connections. That is to say, if nodes A and B each maintain just one other connection (giving each a degree centrality of just 1) but A's connection links to four other nodes and B's only connects to two other nodes, then in betweeness and eigenvector centrality node A will have a higher total centrality score. Though each centrality measure attempts to weight the value of ties in different ways, all centrality measures are attempting to identify which nodes have more influence over the network than others (Valente & Davis, 1999.). This is because early—and continued—network observation has shown that centralized nodes often hold the greatest influence on a given network (Bavelas, 1950; Carlsson & Sandström, 2007; Luthe & Wyss, 2016); however, there are many complicating factors to that simple conclusion that the purely structural calculations can't solve (Borgatti, 2006). Therefore, centrality must be used carefully when applied as an indicator of influence and be supported by a qualitative understanding of the network. In the case studies I present below, the nuances of using different centrality measures, along with their meaning in the context of the specific networks I explore will be discussed in more detail as needed.

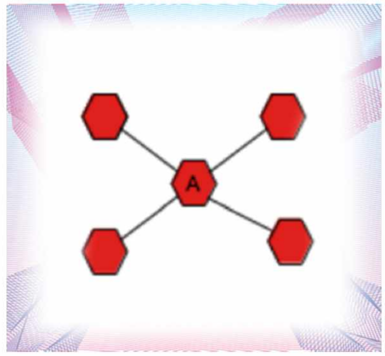


Figure 9: Centrality. Node A in this network is the most central with a degree cnetrality of four, where all other node have a degree of one. Additionally, node A maintains four bridging connection and no bonding relationships with any of the other nodes.

Social network theory has been built from initial recognition of these few basic types of network structures and measures into a complex and rich academic discipline. Social network analysis as a method describes a suite of quantitative tools used to explore social network theory and is grounded in principles of linear algebra (Oh & Monge, 2016). Essentially, a network as we are used to envisioning it can be represented as a mathematical matrix where the column and row headings reference individual nodes and the internal body of the matrix is filled with information that describes the ties shared between nodes (Borgatti, Everett, & Johnson, 2013). These are often simply represented by a 0 or 1 to indicate the presence or absence of a tie, but may also utilize a range of numerical values to indicate various aspects of different tie strengths and relationships (Borgatti, Everett, & Johnson, 2013). Once a network is conceptualized as a matrix, a variety of calculations can be performed to analyze relationships within it. The usefulness of this form of conceptualization is that analysis can be performed at a wide range of network scales, based on research need, from individual node to whole network characterizations (Monge & Contractor, 2003).

Explicit in most modern conceptualizations of network theory is the concept that information (and depending on context, material goods) flow through ties to nodes. Thus, understanding network structure, and the implications of its various structural forms, is a critical step in understanding the access individuals within a given network have to information needed for knowledge construction and the material goods required to meet physical needs (Borgatti & Halgin, 2011).

With that in mind, social network theorists debate the extent to which overall network structure constrains individual agency versus to what degree individual agency shapes network structure—the classic chicken or egg question (Borgatti & Halgin, 2011). There is no real consensus in the literature on how to answer it, although there is strong debate**.** However, some generalities are agreed upon, 1) where an individual sits within a social network does have very real consequences to the types and diversity of information that individual will be exposed to (Alexander et al., 2015; Bodin & Tengö, 2012; Marin Ricke, 2010) that social networks are dynamic, and like the larger social-ecological systems they sit within, are constantly in flux (Bodin & Tengö, 2012; Borgatti & Halgin, 2011).

The use of social networks in resilience studies of social-ecological systems has been growing in intensity (Borrett, Moody, & Edelmann, 2014) and there are a number of excellent studies that have been done recently to map out stakeholder networks in these systems. The majority of these studies have focused on specific ecosystem service or conservation-oriented issues and have produced good result in beginning to sort through what network factors are most determinant in predicting resilient outcomes (Alexander et al., 2015; Carlsson & Sandström, 2007; Chang, Allen, Dawson, & Madsen, 2012; Hauck et al., 2015; Larson, Alexander, Djalante, & Kirono, 2013; Rathwell & Peterson, 2012). Some of these have been summarized (Imperial, Johnston, Pruett-Jones, Leong, & Thomsen, 2016) in the list below:

- Networks have life-cycles and success should not be measured by their ability to perpetually endure; we introduce the concept of a "healthy and useful life" to underscore the constant nurturing required by network processes
- Networks need to attract suitable members, who must represent their respective organizations and participate on their behalf
- Politicians, managers, and funders should give networks space, flexibility, and time so that network processes can develop at their own pace

- The ability of a network to survive for a long period of time requires institutionalizing the social relationships upon which that network is founded
- It is important to recognize when a network has come to the end of a functional life cycle and to redeploy network resources to more productive public purposes

My work contributes to this scholarship by proposing that the dynamic nature of communication networks can reasonably be conceptualized using the principles of the adaptive cycle and panarchy as guides to strategic intervention in network evolution. Given that, some of the key processes areas that have been identified to impact resilience are the distribution of sub-network clusters (density distribution), the degree of brokering or gatekeeping by key individuals (centrality), and the ratio of bridging and bonding relationships in the network. Broader network structures, including core-periphery, star, and disconnected forms, have also been identified as potentially import patterns of social connection to explore (Janssen et al., 2006; Wang, Tanjasiri, Palmer, and Valente, 2016). However, this a very young line of research—even within the new field of resilience itself, so no strong, consistent correlations have been found between network structure, process, and outcome to date (Imperial et al., 2016).

Rather, it seems a variety of structures and process combinations can result in resilient systems (Imperial et al., 2016) With the exception being that a strong and dynamic core-periphery structure—where individual nodes are often moving back and forth between being core at one instance then periphery in another—seems to facilitate change with less output disruption than other forms (Luthe & Wyss, 2016). This is likely due to a consistent influx of 'fresh' ideas while still maintaining some connection to legacy knowledge. There is stronger evidence to more generally conclude that social networks are the mechanisms through which social change propagates through social-ecological systems (Alexander et al., 2015; Bodin & Tengö, 2012; Hauck et al., 2015; Lazega, Jourda, Mounier, & Stofer, 2008; Marin Ricke, 2010). Therefore the paths through the network that propagation has available to follow must dictate societies' ability to respond to change—the key question is how ductile are these paths in response to change and are there preventative steps that can be taken to 'prime' critical networks for change without hurting their robustness to current conditions (Vance-Borland & Holley, 2011)? These are the questions my case studies ultimately seek to explore.

In the case studies I use a range of communication channels as data sources with the goal to map the communication networks that form in response to environmental triggers. In each case study I focus in particular on social media channels—as they are a fundamentally new form of communication in the Anthropocene. Given that, in the next section I will delve in more depth on the function and form of social media.

Social Media

Defining social media can be tricky. The impulse is often to define it through the platforms that compose it—Facebook, Twitter, YouTube, etc. However, it is more accurate to define social media based upon the socio-technological infrastructure that it is built upon (Kaplan & Haenlein, 2012; Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). Kaplan & Haenlein's 2010 definition is as good starting point as any—and there are many to be found in this new virtual space—they define social media as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0 and that allow the creation and exchange of user-generated content" (Kaplan & Haenlein, 2010, p. 61). Implicit in this definition is the core ability to communicate interpersonally, back and forth, between content creator and audience. This is what fundamentally sets social media apart from more traditional forms of broadcast and print media, as well as early Web 1.0 content development (Fuchs et al., 2010). From a functional perspective, a concept called the 'honeycomb of social media' has been developed (Kietzmann et al., 2011) that addresses the interpersonal communication roles different forms of social media attempt to fulfill (Figure 10). In this model, seven different communicative functions are defined—identity construction, relationship building, reputation, group formation, conversation, sharing, and presence. Not all social media platforms are designed to fill all of these needs, but these are generally the needs people seek to fill in engaging with social media (Smith, 2011).

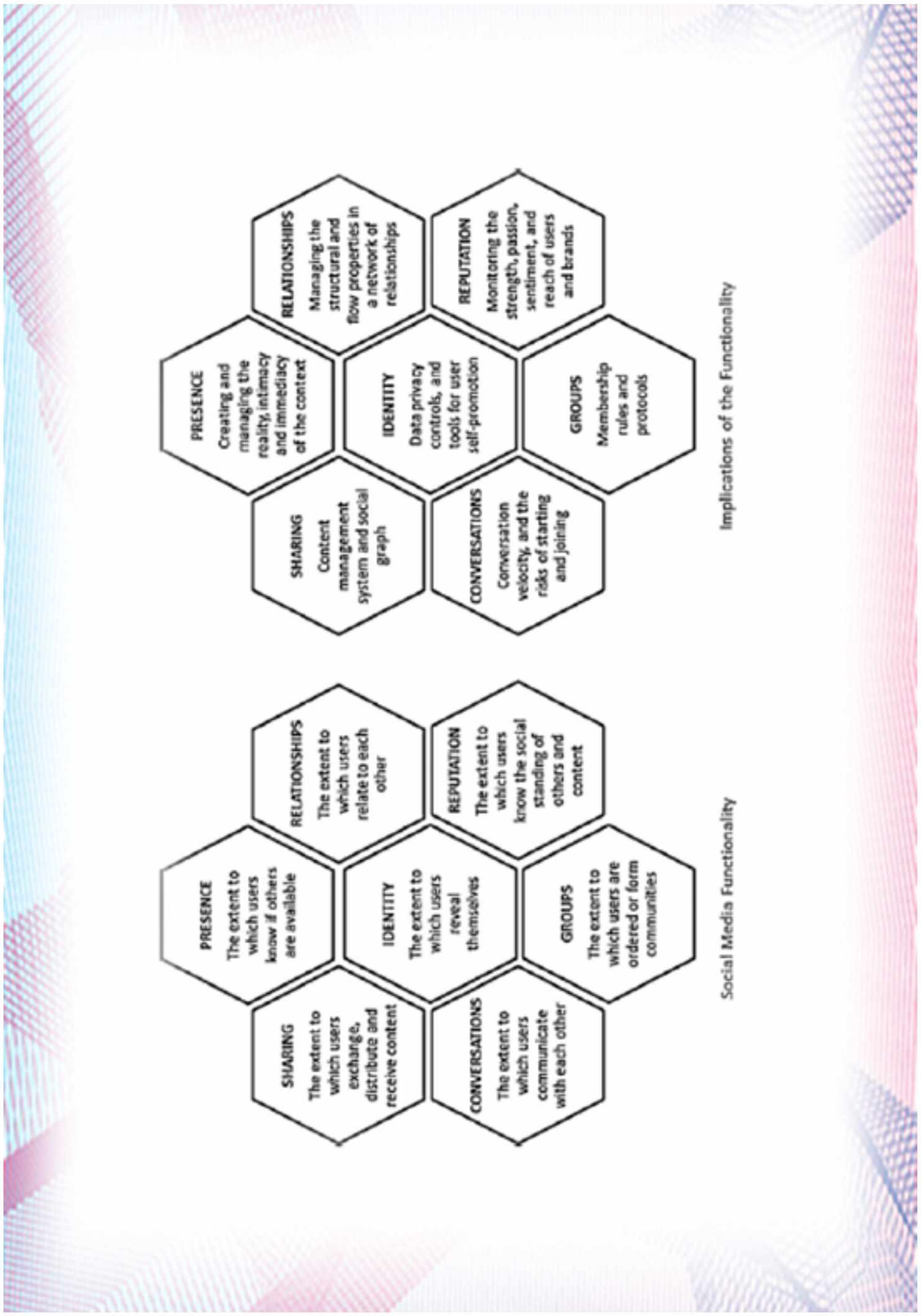


Figure 10: The functional building blocks of social media. This figure shows both the functional communicative elements of social media as well as their implications (Kietzmann et al., 2011). *Individual social media platforms differ in their focus on each of these basic communicative building blocks, just as users vary in the communicative needs they attempt to fill on each platform.*

As an example, Kietzmann et al. (2011) identify the dimensions that Facebook highlights as presence, relationships, and reputation. They explain that on Facebook there are tools for others to know when you are online or not (presence). You also have the ability to form shared context through the variety of modes of media that can be posted and engaged with via the like, comment, and share features, this allows for relationship-building. The fact that what you do on Facebook stays on your wall or your friends walls means you leave visible trails of your actions on the site—building reputation. YouTube, on the other hand, is thought to support reputation building, group formation, conversation, and sharing (Kietzmann et al., 2011). These are probably debatable designations, and certainly individuals will take advantage of different features to meet their own unique needs, but they do point to the fact that social media provide a venue for some core communicative functions. They also illustrate how not all social media platforms will perform all functions equally well.

In practical terms, each of us has our own norms in how, when, and to what purpose we use different forms of media to fill our individual communicative needs (Zhao, 2008). Depending on what aspect of our lives we are most concerned with, we will seek different media to fill the function most required for the setting. The Pew Institute has a done a number of studies exploring how Americans use social media (Hampton, Goulet, Rainie, & Purcell, 2011; Madden, 2012; Smith, 2011). However, Americans are a decreasing subset of the total global population of social media users, as non-US adoption rates are increasing while in the US we seem to be nearing saturation with around 65% of the population using social media (Perrin, 2015). So the degree to which Pew's study can be generalized across the entirety of social media use is questionable, as communication norms are incredibly sensitive to differences in broader cultural norms (Wilkinson, Basto, Perovic, Lawrentschuk, & Murphy, 2015). Additionally, I know of no research exploring specifically how and why Alaskans use social media—other than my own, which is not expressly focused on that issue, and importantly spends more time examining the structural ramifications of actions once users are online and is not particularly concerned with what motivated them to be there in the first place. However, Pew's study is the most broad, and like the definition I provided for social media, is as good a place as any to begin developing a baseline appreciation for why people may use social media—being fully aware that in every network these ideas need to be re-evaluated and understood through the lens of specific network members. Pew has found that people turn to social media for any number of reasons from entertainment and news, to staying in touch with distant (and close) family and friends. Social media is also a huge, open commercial market and so people use it for selling and/or promoting both commodities and ideologies. People share the major and minor events of their lives through social media, build knowledge by grooming networks that feed them information tailored to their needs, and coordinate both important and inconsequential activities through their interactions on it (Dijck, 2013; Ngai, Tao, Spencer & Moon, 2015; Smith, 2011). My general feeling is that people (that is, individuals) in Alaska use social media for all these same reasons, but I can't support that empirically. It certainly fits with my qualitative impressions over the past fifteen years of being involved in efforts to reform distance education in the state through the use of modern communication tools, including social media, but the Pew study found such a wide range of reasons why people use social media as simply to reinforce the idea that the reason for use must be assessed on an individual network-by-network basis as the research progresses.

Agencies and organizations use social media with slightly more strategic goals in mind. Unlike most individuals using social media, businesses and organizations are not there for informal social exchange. Instead, they have an overt mission to promote their public agendas. Carr & Hayes (2015) identified three communicative strategies they utilize to meet their goals (Carr & Hayes, 2015). The first is by publishing basic informational content—"did you know today is the first day of fire season?" The second is by creating community-building content—"yippee John! Winner of the latest bi-annual monthly 50/50!" Finally, the third (and most import) are calls to action—"join us Saturday on the Park Strip for a march in support of traditional hunting and fishing rights!" Organizations from all levels—local, regional, state, federal, and international are active on Alaskan social media networks from a variety of institutional structures—including tribal governments, NGOs, state governments, academic, research, and k-12 education, as well as health, wellness, and safety sectors, and, of course, the traditional broadcast media companies.

Connecting social media back to the idea of resilience in the Anthropocene, robustness provides a framework for assessing the adaptive capacity of specific institutional arrangements around the sustainability of a resource. To do so, robustness serves to map out a conceptualized set of system relationships between the resource, the resource user, and infrastructure used to interact with the resource, and the resource managers of that infrastructure. Robustness further sets out that there are certain optimum relationships between the level of overlap between individuals filling the roles of resource user and infrastructure manager (Anderies et al., 2013). In my frame of study, these relationships represent communicative ties—or in reality, sets of communicative ties that can be tracked, measured, and visualized through principals of social network theory (Borgatti & Halgin, 2011; Latour, 2011; Law, 1992). Each of these ties can be filled through a variety of communication media, social media being just part of the system, however a part that can rapidly be identified and mapped—providing closer to real-time assessment of social processes occurring in social-ecological system than is possible via most other data sources (Bengston, Fan, Reed, & Goldhor-Wilcock, 2009). In the series of case studies that follow, these ties and relationships will be mapped out in order to look for any general patterns or norms that organizations working on Anthropocene-based problems can take advantage of to improve the efficacy of their own communication efforts (Bixler et al., 2016; Vance-Borland & Holley, 2011).

Alaska Case Studies

The primary function of this dissertation is to explore how changing communication patterns—both in terms of the tools we use and the way we use them—are altering how we approach solving complex social-environmental problems. In order to do this, I have documented a number of Alaskan networks that formed in response to concerns over environmental change. Through an exploration of each of these networks, a resilience-based assessment framework is developed to evaluate and strategically intervene in mediated communication networks.

Each network is developed around a central social-environmental issue: two precipitated by specific (and rapid) environmental events and two by more diffuse (and slow) concerns over environmental change in Alaska and the circumpolar region more generally. The network dynamics for each study are aligned to the adaptive cycle and attributes from each are assed via roles defined in robustness. A set of general guidelines is developed that links the position of the network-triggering event on the adaptive cycle to characteristic network properties. These guidelines are then used in the final chapter of my dissertation to structure and implement a communication plan for the Alaska Native Knowledge Network (ANKN).

Ultimately, the purpose of this exploration is to determine if/how organizations interested in social-ecological equity and sustainability can strategically manipulate their communication networks to more effectively meet their needs. I suggest that modern communication tools have co-evolved with many other physical and social systems since the Great Acceleration (Latour, 2005; McLuhan, 1994)—just as many ecological systems have become more tightly coupled between local, regional, and global scales (Crutzen, 2006), so too have our communications systems. In particular, communications systems have increased their reach along three dimensions: 1) the distances across which we can communicate, 2) the synchronicity with which we communicate across those distances, and 3) the size of the networks we can build through them (Fuchs et al., 2010; Kaplan & Haenlein, 2010; Kietzmann et al., 2011; McLuhan, 1994; O'Sullivan & Carr, 2017).

A fundamental mismatch identified in the Anthropocene is that both formal and informal social institutions are struggling to keep up with the increased rates of environmental change being driven by tighter coupling of cross-scale environmental processes (Kotchen & Young, 2007; Young, 2010). This creates formal policy gaps in governance, as well as general ignorance in societies' collective zeitgeist with regards to the rate, magnitude, and potential impacts of changes occurring. This issue often defines the well known "transboundary" dilemma in resilience studies (Cash et al., 2006; Lovecraft, 2007; Young, 2013; Young, 2002).

Given the basic assumption for this work that communication is the primary mechanism through which social institutions affect change, the increased reach of modern communication systems offers an opportunity for communication networks to span these boundaries. The ultimate purpose of this work, then, is to explore how to strategically develop these types of cross-scale or transboundary communication networks in order to maximize efforts at building social-environmental equity at local and regional scales. The network studies that follow track communication flows which have formed around issues of this kind. I present these studies as examples through which to illustrate a flexible and (importantly) internally consistent evaluation methodology—including both theoretical and analytical guidelines—to support organizational (and individual) efforts at strategic intervention in stressed social-ecological systems.

Evaluation Framework

Revisiting the Adaptive Cycle, Panarchy, and Robustness: Approaching them as a Communication-based Conceptual Framework

As discussed in the introduction, the adaptive cycle is a conceptual model useful in understanding system change from a dynamic perspective. The model has proven an effective tool in understanding change from such diverse disciplines as natural resource management, business, education, and healthcare (Dooley, 1997; Pelling & Manuel-Navarrete, 2011; Siemens, 2008; Stange, Ferrer, & Miller, 2009). Here I use it to frame how communication networks are changing under a variety of environmental stresses. While similar to work done by other resilience scholars (Janssen et al., 2006) this framework is exclusive to communication networks. Specifically, I develop an idealized set of network structures tied directly to phases of the adaptive cycle (Figure 11). Development of the idealized network structures has been a reflexive process combining network and resilience theory with empirical experience through the case studies presented here, and many more that have not directly made the pages of this work (Appendix 1). The result is a set of basic network parameters that can be used as a comparative, rather than absolute, evaluation tool in assessing communication networks across a variety of social-environmental contexts.

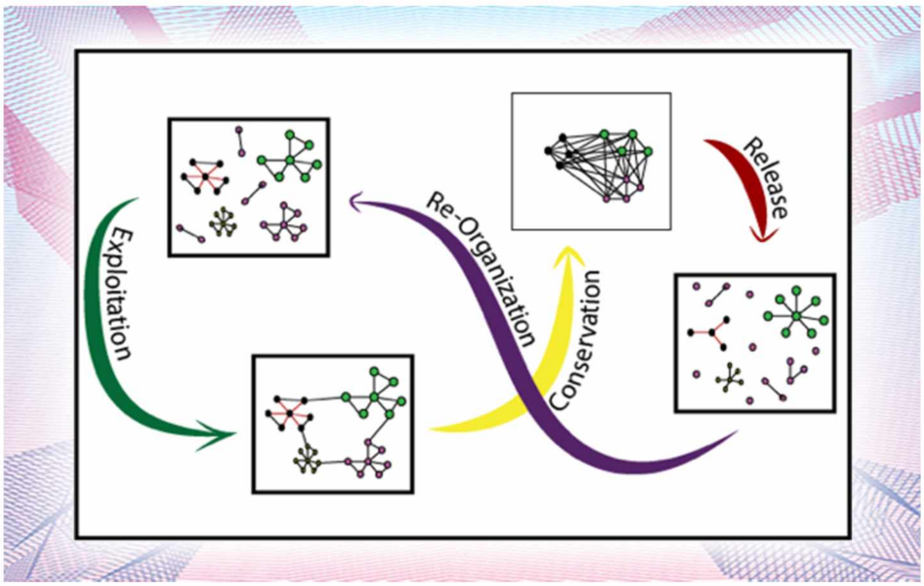


Figure 11: A network-based adaptive cycle framework. This framework was developed as part of my dissertation to serve as a comparisson tool for assessing the evolution of communication networks both within and between the case studies. Release networks are idealized as having a high number of small components with few bonding relationships. The re-organization phase is charecterized by a general decline in the number of components, an increase in their size, and a more dramtic rise in bonding relationships. Explotation sees a continued decline in the number of components, and the rise of bridging relationships between multiple, smaller bonded groups. Conservation is defined by low component counts, a high number of bonding relationships, and a low number of bridging ties.

The conceptual logic of the model is as follows. First, when a communication system is at the initial point of release, communication breaks down. People or organizations that used to communicate with one another no longer can, and/or, what they communicate about is ineffective in holding off system change. The idealized communication network at the release point then is going to reflect this communication breakdown through the release of communication ties with a network structure consisting of a high number of isolated individual and/or disconnected components of communicators (note: a component is a portion of a whole network that does not share ties with other network members. I will discuss this in greater detail throughout the case studies). Analytically this will look like a network with a high number of components (that is parts of the network completely disconnected from others) and low average centrality scores (degree, betweeness, eigenvector) across the network. In other words, people can be active in the system, but there is not enough proper communicative links between them to adapt to system stressors and relationships break apart. Further into the release phase—in an attempt to cope with the changes the system is experiencing—individuals and organizations often attempt to reach outside their normal networks to access new resources (Burkhardt & Brass, 1990). This can create a "hub and spoke" network structure where a central communicator is connected to a number of others who are not connected to each other(Aykin, 1994; Getchell & Sellnow, 2016; Lee et al., 2016). Combined, the beginning of the release phase can be idealized by a high number of isolated and disconnected communicators, while the later stages of the release can be idealized by an increase in frequency and size of "hub and spoke" structures—analytically identifiable by a greater percentage of higher degree individuals within the network.

During reorganization people are strengthening relationships, identifying who has what skills, and how those skills can be of use under the new, changed conditions (Namkoong, Shah, & Gustafson, 2016; Parks, 2015). The idealized network in this phase of the adaptive cycle is going to be characterized by decreasing "hub and spoke" structures as people initially brought together by a single central communicator build relationships among one another and/or drop out of the network. At this phase only the most committed stay involved, and if they are committed, they soon find common ground with others who are as well, building ties of shared interests or goals, which results in more distributed communicative ties across the network. The net result is that after the initial shattering and then expansion of the network, it contracts and ties become stronger within it.

As the adaptive cycle progresses through the exploitation phase there is a rapid increase in the number of shared ties within individual subgroups, as well as increasing ties between the subgroups. Communication links quickly form in the vacuum of new system needs and opportunities.

As the conservation phase is entered, the formation of new connections slows and the network becomes less dynamic and more rigid. Under stable condition the network can become very efficient. Under changing conditions it may become increasingly inflexible—with too limited an ability to reach out and access new resources (cognitive and material) when needed as the demands of the system evolve. Given enough change, established ties will become ineffective in meeting the new demands and dissolve or become irrelevant, defining a new release point and beginning the cycle anew.

The adaptive cycle is meant to describe system change along a singular dimension. In applying this to communication networks it is important to understand the multiple modes and channels that individuals and organizations communicate through on a daily basis. The meaning of "channel" was discussed above but the is the first time the term "mode" has been introduced, so I will take an aside here and define it.

The mode of communication refers to what senses are needed to receive information that is being passed—e.g. sight while reading a book about fly fishing, ears while listening to a radio show on tying a fly, all five senses while on the river fishing. Mode is easily confused with medium, which defines the substance through which information is passed—paper for a book, a specific range on the electromagnetic spectrum for radio, etc.—and not the specific sense required to interpret it. While somewhat technical, medium is more closely related to channel, which implicitly defines the medium, while also more clearly delineating the technology involved in delivering and receiving the information. Examples of channels of communication include face-to-face, the telephone, e-mail, blogs, Facebook, radio, and print. Different channels restrict or enhance the rate at which communication can be completed, as well as which sensory bundles are preferenced. Mode and channel selection is dependent on the context of the conversation and is set by environmental factors (a natural disaster in an urban area as opposed to in a rural setting) and the cultural preferences of participants (sight-biased scientists operating in a world of text and graphics to interact with moose compared to multimodal subsistence hunters who use all their senses while on the landscape. Modern real world communication networks describe a complex system of information flows as participants from diverse worldviews attempt to connect across a range of modes using increasingly varied and abundant channels (Timm, Hum, & Druckenmiller, 2016.).

Given that the adaptive cycle only captures change along a single dimension, the concept of panarchy needs to be applied to understand how different channel and mode combinations impact overall network adaptability and resilience. As we remember from above, panarchy allows that within any single adaptive cycle conceptualization, smaller scale cycles are occurring, while simultaneously, the cycle of interest itself is enmeshed within a larger cycle, or even multiple cycles. With communication networks, the dimensions of interest are rate of change (fast, intermediate, slow), size of network (both in number of nodes and geographic distances between them), and cognitive interest/situational context (health of local fishery versus regional drainage system versus global environmental degradation). The interaction of these different scales can occur across any of the adaptive cycle phases. So, a small cycle may undergo a release while the cycle of interest is in an exploitation phase, all while in the larger cycle connectivity is tightening and moving into a conservation phase. These types of cross-scale interaction can have varied outcomes at individual levels. Often, change in small-scale system elements can invigorate the larger system as a whole, while larger system dynamics may act to dampen change. At other times the opposite may occur, and there are no hard and fast rules for how these cross-scale interactions will occur (our be perceived as having occurred by different agents within the system). The critical element is that change can cascade through system scales, and when we measure a communication network along a single communication channel we are only examining a single level of the system. Because we are measuring distinct individual's, or organization's, connections into that level, different portions of the network may be "feeling" the effects of different scales to greater or lesser degrees. A hypothetical example is a network built around wildlife resource abundance issues on Facebook. In that case, game managers and resource users may both be interacting on the single channel of Facebook. But, the managers may have made the choice to communicate through Facebook because of system change within their face-to-face networks—say a growing motivation to invest further in co-management efforts, and a recognition that Facebook might be their best avenue for access to their most important stakeholders (who often live and work many miles away from one another). In which case, the managers will be entering the Facebook network via a release phase driven by their professional face-to-face network needs. In this example, the Facebook network from the managers perspective will open and dynamic, idealized by hub-and-spoke features and lots of low density connections to new people. The resource user's perspective, however might be very different, potentially entering the Facebook network through the conservation phase of their face-to-face networks—with well established and densely connected ties to other resource users who they live and work near. Their perspective of the network will be dense and interconnected with fewer external links, or openings, for the managers to enter. This example points to how even when defining a network along a single dimension—Facebook in this hypothetical illustration—effects from closely associated channels (dimensions) bleed into the results. This means that when using the idealized network structures presented above, sub-regions within a single channel network can be examined, based on the functional robustness roles of individuals within the sub-region, to discover potentially important dynamics occurring through other channels.

Operationalizing Panarchy: Developing a Conceptual Base Map

Many different scales of social-ecological systems are interacting across Alaska. In order to assess the potential role social media can have in extending the communication networks associated with these systems and sub-systems, a number of in-situ network case studies have been explored.

The case studies presented below are organized using a panarchy-based framework. System boundaries within this framework are defined by the geographic space of modern-day Alaska and through the lens of geologic time. System elements making up the base scale in this panarchy conceptualization are described in the "Field-Context" section below and presented as brief histories of the state's physical, biologic, cultural, and communication environments. Each case study is then placed within in this larger system based on the triggering event(s) that spurred the formation of the network, and the scale and level of actors involved in the network. Case study assessment is then based on a comparative analysis of measured networks to the idealized adaptive-cycle structures discussed above—using both qualitative narrative and quantitative network analytics. Emphasis is placed primarily on local level implications, but up-scale feedback mechanisms are also explored.

Each case study was selected to highlight a specific type of social-ecological problem. The first two represent rapid and singular environmental triggers that required immediate social response. The third and fourth detail networks that formed as a result of slower, more diffuse environmental events. In the first, Facebook networks that formed in response to an unusually large fall storm in the Bering Sea are explored. The storm created regional concern along the Norton Sound of western Alaska for storm surge induced coastal flooding and shoreline erosion. The networks in this case study explore social media reach from an individual perspective and look at the relationships that formed during the build up and immediate aftermath of the storm. The second case study looks at how the city of Galena responded to an ice-jam induced flood that destroyed much of the community's physical infrastructure—forcing the evacuation and long-term displacement of many of its residents. This case study looks at the networks from a community perspective and focuses on the relationships internal to the community as well as those with aide organizations and the media externally. The third and fourth case studies were triggered by concerns for relatively slower and more wide-ranging social-ecological changes. The third examines the efforts of a single regional organization to develop an international network of grassroots community members in order to address a range of political, environmental, and social issues common to communities in the Bering Strait region on both sides of the border with Russia and the United States. The final case study explores aspects of how the Arctic scientific community came together for the 2016 Arctic Observation Summit to foster interdisciplinary relationships among physical and social science researchers, along with stakeholder input. Together, these case studies represent a range of communicative contexts in the Anthropocene and provide an example of the types of networks that form from modern distance communication technology. They are clearly not exhaustive, but do provide a foundation for developing the communication strategy discussed in the final application section of this dissertation.

Field Context: The State of Alaska

All of the case studies that will be presented below are subsets of a broader social ecological system that defines life in Alaska within the context of this research. In this next section I will describe the critical elements of this statewide system as related to the case studies I explore. I present this overview in order to establish the context from which I assessed each case study. This also serves to provide the reader with a reference point from which to critique my assessment. It is important to remember that each individual involved in the networks below (including myself) will hold their own unique understanding of this system, and therefore, their own unique ideas and experiences with regards to what are the most critical elements to it. Still, the goal here is to present as universal a picture as possible, and then allow the network studies below to help delineate how different individuals and groups may vary in their understanding of the system as a whole. Ultimately, the goal of the research is to apply that understanding to help support more robust social networks during periods of rapid environmental change (at an organizational level) as will be discussed in the application chapter.

To characterize the statewide system, I have divided it into four main sub-environments: the physical environment, the biological environment, the cultural environment, and the communication environment. The communication environment may more properly be considered a subset of the cultural environment (Crowley & Heyer, 2015; McLuhan, 1964), but since this is primarily a communication study, it deserves a bit more attention. Collectively, these four main sub-environments comprise the media ecology of the state, as described in this work. Through time these environments respond reflexively to one another yet operate at many different rates. The complexity of this interaction is a defining component of all social-ecological systems and the core subject of the case studies below.

I've structured the order that I describe these different environments specifically in an attempt to represent the larger scale patterns through which they have historically interacted. That is, the physical environment, starting with the tectonic and geomorphologic setting of the state, and including climatic processes, has acted as a meta-structural control mechanism to the overall system. It is the template upon which the others have grown, and therefore, I describe the physical environment first. The broad structure of the biologic environment has largely been guided by the results of physical environmental processes, and is described second. Cultural environments traditionally have been heavily influenced by a mixture of both physical and biological processes, and so are described third. The communication environment is described last, and although it is more accurately a part of the cultural environment, it is described separately here for the reasons mentioned above.

As we saw in the introduction, transition into the Anthropocene implies a fundamental restructuring of this order at the global scale, such that cultural behaviors are now reshaping many physical and biological processes. In the Anthropocene, human agency has overcome many of the boundaries geologic and biologic processes have always placed on humanity, but at the same time highlighted many of the weaknesses in our ability to act collectively. The case studies I present after these general environmental descriptions look specifically at how local and regional communication networks are responding to this shift.

The Physical Environment

Alaska is a large state with diverse topography. Geologically, the state sits primarily on top of the North American continental plate. To the north, there is a passive boundary with the Arctic oceanic plate. To the south and west is an extremely active transform and subduction boundary with the Pacific oceanic plate. These meta-structural features help define the past and present geography of the state (Plafker, George & Berg, 1994)

Arcing from the southeast to the far west, and delineating the southern edge of the state are a series of young and rugged mountain ranges. The Alaska Range, home of North America's tallest peak—Denali—is one of the better known of these, as are the Aleutian Islands. However there are many lesser known ranges including the Chugach, Talkeetna, Kenai, and Southern Coastal Ranges. Each has been formed as a result of the Pacific Plate sliding north and under the North American Plate; some of them have been uplifted by compressional forces internal to the plates themselves while others are exotic terrains carried north by the Pacific plate and added onto the North American plate as the Pacific plate subducts (Nokleberg, Plafker, George, & Wilson, 1994).

In modern terms, these regions are identified as Southeast, Southcentral, the Alaskan Peninsula, Kodiak, and the Aleutian Islands (listing from the southeast to far west). The steep mountains and close proximity to the Pacific Ocean tend to keep these regions of the state relatively wetter and warmer than others (Shulski & Wendler, 2007). This is because the waters of the Pacific provide moisture to the atmosphere, while the mountains act to squeeze it out before storms can pass inland. Consequently, heavy rain and snow are typical in these regions. The warm Pacific waters also tend to regulate temperatures resulting in these regions generally having warmer winters, but cooler summers than other parts of the state. Temperate rainforest can be found in coastal Southeast Alaska, with a more transitional, or mixed, coastal-boreal forest in Southcentral Alaska. To the west, moving out onto the Alaskan Peninsula, Kodiak, and the Aleutian Islands, winds become stronger and more frequent, until eventually the forests taper off to coastal grasses and tundra (Alaska Department of Fish and Game, 2015).

At the far northern edge of the state, the passive boundary with the Arctic plate is responsible for the broad, gently dipping coastal plain of the North Slope and home to the Alaska oil fields. The land here gradually tilts down to the north away from the Brooks Range, and across wide, tundra covered, plains until it gently slides into the Arctic Ocean (Grantz, Arthur, May, & Hart, 1994) This is a subtle landscape, and in the winter when both the ocean ice and land are covered in snowdrifts, the boundary between land and sea can be hard to distinguish. This part of the state is above the Arctic Circle. The high latitude and historically expansive ice cap tended to keep the region much colder and drier than southern parts of the state, however, powerful windstorms are common (Searby & Hunter, 1971).

In the roughly east-west running region between the Arctic and Pacific plates, geographically between the Brooks Range to the north, the Aleutian and Alaska Ranges to the south, and the Bering Sea to the west—lies an expansive region of rolling hills, valleys and large rivers. The Kobuk, Yukon, and Kuskokwim river basins define the drainage basins of this region. In the modern lexicon of the state, this area is subdivided into a few smaller regions. Western Alaska and Northwest Alaska border the Bering Sea on the west. Western Alaska can geographically be bounded by the large delta that the Yukon and Kuskokwim rivers have combined to form. While, Northwest Alaska is more easily characterized as the region surrounding the Kotzebue Sound.

The Seward Peninsula separates the two. The eastern boundaries of both these regions are somewhat indistinct and fade into an area typically referred to as progressively the Western, Central, and Eastern Interior (Alaska Humanities Forum, 2017). The climate close to the Bering Sea is transitional between the southern and northern regions of the state. In the northern regions where heavy winter sea ice forms, temperatures can be fairly cold, comparable to the North Slope and Interior regions of the state. In the south however, where widespread ice is not as consistent, the closeness of the Bering Sea acts to regulate temperatures to a degree somewhat similar to Southcentral Alaska. Intense storms are typical in the region with high winds and large storm surges. Depending on seasonality, weather patterns that move up from the south and over the Pacific and Bering Sea, will typically be warmer and wetter, while those coming from the north across the eastern Russian Arctic, tend to be colder and drier. The closeness of the Bering Sea tends to keep the all of the western areas cooler in the summer. Moving east, upriver and away from the Bering Sea into Central and Eastern Interior Alaska, winter temperatures get much colder and summers much hotter, with less all around precipitation than along the coast. The interior is cloaked in an expansive boreal forest that fades to tundra closer to the Bering Sea (Shulski & Wendler, 2007)

The geologic structure and subsequent geographic and ecologic features overlaid upon it have provided Alaska with an enormous abundance of natural resources.

The active tectonics across much of the state has left numerous ore deposits of economic value. Active mining districts dot every region of the state from Southeast Alaska north through the Interior, along the Brooks Range, and back down through Western Alaska (Brooks, 1906). Subsidence and uplift throughout geologic time has formed and exposed large coal deposits in many of these same regions, while large petroleum reserves are found along the North Slope and offshore basins (Houseknecht & Bird, 2005). Smaller oil and gas deposits have been found in Southcentral Alaska's Cook Inlet and limited areas of Interior Alaska around the community of Nenana and select basins of the Yukon River drainage (Magoon, Adkison, & Egbert, 1976; Interior U.S. Department, 1990) .

How these physical resources are consumed, exploited, and/or conserved is at the center of much of the historic political conflicts in the state (McBeath & Morehouse, 1994), modern issues are only heightened by the impacts of Anthropocene-induced environmental shifts in both global economics and climate regimes, and are at the center of this research (Blair, 2010; Chapin et al., 2006; Krupa, Chapin III, & Lovecraft, 2014; Maynard, 2010; Robards & Lovecraft, 2010; Trainor et al., 2009).

The Biological Environment

Ecologists have mapped a variety of diverse ecoregions to help organize and understand the biomes of Alaska (Nowacki, Flemming, Brock, and Jorgenson, 2003). Each of these ecoregions is closely connected to the underlying tectonic structure of the state (Beikman, 1980). Starting from the south and moving to the north there are the temperate coastal rain forests of Southeast and Southcentral Alaska. Swinging to the west these forests continue out onto Kodiak Island before temperate coastal grasslands takeover on most of the Aleutians Islands (Alaska Center for Conservation Science and UAA, 2016b). Western Alaska, including Bristol Bay, the Yukon-Kuskokwim River Delta, Seward Peninsula, and Kotzebue Sound are primarily classified as subarctic tundra, transitioning into arctic tundra further north along the arctic coast and North Slope (Alaska Center for Conservation Science & UAA, 2016b). Interior Alaska is chiefly composed of boreal forest (Alaska Department of Fish and Game, 2006). Shifting relationships within and between each of these ecoregions under the pressures of the Anthropocene (Scenarios Network for Arctic Planning & EWHALE lab, 2012) to a large extent precipitate the communication networks I examine in my research and therefore warranty a brief discussion.

The climate of Southeast Alaska supports a coastal rainforest biome (Alaska Department of Fish and Game, 2006). The southern section of this region can experience up to 200 inches of rainfall a year while the more northern areas typically receive around 30 inches per year. Temperatures are moderate, ranging from an annual average of 46 degrees Fahrenheit (8° C) in the south to 33 (1° C) toward the north (Alaska Climate Research Center, n.d.; Shulski & Wendler, 2007). This climate range, along with geography of steep mountains and numerous islands, results in a one of Alaska's most diverse ecosystems**.** Tree and shrub species include the western hemlock, Sitka spruce, western red cedar, Alaska-cedar, mountain hemlock, shore pine and lodge pole pine, Pacific yew, alders, and cottonwood. Many of these trees are of commercial grade and of interest to large scale logging corporations (Orians & Schoen, 2017). Land animals are abundant in the region. The geographic isolation of the steep terrain and numerous islands has fragmented populations. In many areas, megafauna like black and brown bear are present, as are wolf and black-tailed deer. Moose, lynx, and even coyote can be found in the northern areas of this region. Small furbearers such as beaver, river otter, mink, weasel, and red squirrel can also be found in Southeast Alaska. The region supports large runs of all five species of Pacific salmon. Halibut are present in the marine system and steelhead, Dolly Varden trout, and rainbow trout can be found in fresh waters. Multiple species of both toothed and baleen whales frequent the coastal waterways, along with a variety of seal, sea lion, and otter (Orians & Schoen, 2017)

Moving north, the coastal and marine portions of Southcentral Alaska are similar in many ways to Southeast Alaska, with much the same species composition of whale, seal, sea lion, otter, salmon, and halibut (North Pacific Research Board, 2017). The climate is colder however, and land species diversity is more limited. This is particularly true in the variety of tree species present. Inland areas of this region are composed of a mixed coastal and boreal forest, with cottonwoods dominating the riparian zones and black and white spruce common in the uplands (Alaska Forest Association, 2015). Moose, black, and brown bears are the iconic megafauna species in this region (Alaska Department of Fish and Game, 2017).

To the west of Southcentral Alaska, Kodiak Island and the Alaska Peninsula begin to transition into the unique grasslands of the Aleutian Island chain. This region stretches over a thousand miles to the west of the Alaska mainland toward Asia and serves as a narrow, discontinuous land boundary between the Bering Sea and Pacific Ocean. As a result, it is predominately influenced by marine processes and impacted by strong open ocean weather patterns. Winds are constant, limiting vegetation to an interesting mix of Asian and North American species, including Alaska arnica, Siberian beauty, caltha-leaved avens, western buttercup, and Kamchatka rhododendron. Short willow and alder shrubs are found in protected locations where they can grow sheltered from the severe winds (Shacklette et al., 1969).

Back on the mainland, most of Western Alaska is primarily underlain by discontinuous permafrost (Jorgenson et al., 2008). This acts to keep the ground generally wet by restricting groundwater movement and promoting the growth of a thick organic surface layer. This defines a wet tundra ecosystem dominated by sedges, mosses, willow, alder, and birch (Jorgenson et al., 2008). Additionally, across the region, patches of spruce forest can be found in protected and well-drained areas (Alaska Center for Conservation Science & UAA, 2016a). Caribou herds can be found in this region along with moose, bear, and wolf (USGS, 2016). All five salmon species are found offshore and in the river systems of the region, with Bristol Bay supporting the one of the largest wild commercial salmon fisheries in the world (Jorgenson et al., 2008). Whales frequently pass by offshore along the entire coast; with orca and beluga often coming nearer to shore to feed on the salmon runs in some select areas. Seal, however, are more common near-shore residents, as are walrus at particular times of the year when following the ice flows (Greenwald, Callimanis, Garty, Peters, & Schafer, 2006)

Further north, the North Slope has been defined as an arctic tundra ecoregion. This area is treeless, covered instead by a thick vegetative mat of sedges, grasses, mosses, lichen, liverwort, and small shrubs (Alaska Center for Conservation Science & UAA, 2016a). Permafrost is continuous in the region and creates a thermokarst surface topography (Jorgenson et al., 2008). Critically, like in Western Alaska, permafrost limits groundwater transportation and promotes lake and wetland growth. Migratory birds flock to the region in the spring and summer, including geese, swan, brant, loons and eiders to take advantage of this feature. While small mammals like lemmings, voles, arctic hares, and fox live year round in the region. Larger mammals like the wolf, polar bear, and caribou can also be found in northern Alaska. Caribou in particular are iconic in the region with four herds (Western Arctic, Teshekpuk Lake, Porcupine, and Central Arctic) using the area for summer calving. Offshore, a number of marine mammal species are present. Bowhead, grey, and beluga whales are common, along with walrus and a number of different species of seals. Dolly Varden, cisco, and whitefish frequent the larger river systems

The Interior is a true boreal forest, composed mainly of white and black spruce with cottonwood, alder, and poplar trees lining the riparian zones and occurring in other areas free of permafrost. Upland areas of the region can transition more into a barren land taiga of mixed forest and tundra vegetation. Small furbearers like the beaver, river otter, and weasel can be found in the region, along with predators such as the lynx, fox, and wolf. The iconic megafauna of moose, caribou, and black and brown bear are also found in Interior Alaska. Salmon run up all the major rivers, and are found in the freshwater system alongside grayling, pike, and whitefish (Alaskaweb, 2017).

The Cultural Environment

There are seven main Indigenous cultural groups in Alaska, although, within each there are a number of subgroups. These are the Tlingit, Haida, Alutiit (Sugpiat), Aleut (Unangan), Yup'ik (Yupiit), Iñupiat, and Athabaskans (Dené). Each of these groups has historically called one of the main geographic regions described above home, developing skills, knowledge, and traditions unique to the environmental demands of that region. The Tlingit and Haida are from Southeast Alaska, the Aleut (Unangan) from the Aleutians, the Alutiit (Sugpiat) in South-central Alaska, the Yupiit from Southwestern and Western Alaska, the Iñupiat from the Northwestern and Northern regions, and the Athabaskans (Dené) from the Interior (Krauss, Holton, Kerr, & West, 2011).

Persistent Western contact came with Russian fur trappers in the mid 1700s and had extremely negative outcomes for Native cultures. Sea otter fur was a prized commodity in the European and Asian fashion markets of the time; as a result the otters off the Aleutian and Kodiak Islands, Southcentral, and to a lesser extent, Southeast Alaska were exploited to near extinction. Seal fur was also in demand and rookeries in the Bering Sea, off Western Alaska's coast, were extensively hunted. Hunters and traders coming into the region for the fur trade brutally forced the Native populations into cooperating with the overharvest of otters and seals, and a great many Unangax (Aleuts) and Sugpiat (Alutiit) were enslaved (Partnow, 2001). Subsequent influxes of Western people into the state have largely followed a similar boom and bust cycle of natural resource exploitation and colonial subjugation—largely this continues today (Williams, 2009). Each repeated cycle has left its mark on the current population dynamics, as well as the built infrastructure that defines the modern cultural environment of Alaska. Today, Alaska is a rich mix of European-American, international, and Alaska Native cultures. The presence of these different cultures is not uniformly distributed across the state, however. Alaska Native cultures dominate in rural regions that are closely tied to their traditional homelands. Urban areas are more diverse (US Census Bureau, 2017).

Much of this study is focused on case studies originating out of rural Alaska or issues important to rural Alaska—which, as mentioned, is predominately Alaska Native. The final application chapter also addresses the communication strategy of an Indigenous-issues driven organization—the Alaska Native Knowledge Network (ANKN)—part of the Center for Cross-Cultural Studies at the University of Alaska Fairbanks. Because of this, the description of the cultural environment that follows will emphasize the relationship between the Indigenous cultures of Alaska and Western colonizing groups.

Simplistically, Alaska has evolved into a state where power resides in the urban centers—economically in Anchorage (Southcentral Alaska) and Fairbanks (Central Interior Alaska), through the road and rail system that connects them, and politically in Juneau, as the seat of state-level government (Jones, 2014; Thomas, Savatgy, & Klimovich, 2016). The three urban centers are internationally diverse, with Anchorage schools often ranking as some of the most diverse in the nation (Tunseth, 2016; US Census Bureau, 2017). They are, however, predominately white. A large relative percentage of Native Alaskans also lives in these urban centers. A number of small, mostly white communities are connected along the road system that loops through a small portion of the state to connect Anchorage and Fairbanks, as well as stretches south down the Kenai Peninsula and southeast toward Valdez. Along the highways that spur of this large loop—the Tailor Elliott and Steese, as well as the southern section of the Alaskan portion of the Alaska Highway—most communities are majority Alaska Native (US Census Bureau, 2017). However, the majority of the geographic breadth of Alaska is disconnected from this road system and can only be accessed via either air or marine transportation systems. There are two main types of communities in rural Alaska: hubs and villages. Hubs are larger, and since rural Alaska is mostly disconnected from rail and road systems, they serve as regional logistical centers for freight barged in by sea and river or flown in through commercial jet-capable airports. Villages are smaller and are typically accessed via commercial small plane operations, or seasonally via small boat or snow machine (DCCED, 2017; Igiugig Village Council, 2016).

Differences between hub and village communities can be defined by the population size and services available in each. Hub communities typically have populations of a few thousand residents while villages are 1-2 orders of magnitude less—ranging from fewer than 50 residents to near a thousand (US Census Bureau, 2017). Often services that can be found in villages are limited compared to larger hub communities, or certainly the urban centers. Typically, a small health clinic, school, post office, airfield, city and tribal office, power plant, water treatment facility, fuel station, tank farm, and small general store define the public infrastructure present in most villages (DCCED, 2017). Communities in rural Alaska are rarely interconnected via road networks but generally do have well developed communications infrastructure (Hudson, 2015). In addition to radio, television, and phone service being available in most rural Alaska homes, high-speed Internet connectivity is minimally available at the community level through the school, health clinic, tribal and city offices in nearly all communities. Individual homes increasingly have access as well, but not often at the broadband level; substantial efforts from both public and private investment are well underway to improve this infrastructural network, however (Hudson, 2012; Terra, 2017).

Hub communities, on the other hand, have greater service options: larger stores, small hospitals, more developed shipping infrastructure (though still very limited by most US standards), and commercial jet air service (DCCED, 2017). Hubs connect the villages of rural Alaska to the urban centers of Anchorage, Fairbanks, and Juneau, as well as to larger shipping ports along the west coast of the US via ocean and river-going barges. Most villages not on the road system depend upon a single hub to reach more urbanized areas and are separated from one another by considerable spatial distances; though considerably less social distance via long standing kinship, sharing and trading relationships (Wexler, 2011; West & Ross, 2012). The location of hub communities (and the surrounding communities they serve) is closely connected to traditional cultural territories and geophysical characteristics. They are predominantly Indigenous and very remote (Hamilton et al., 2012). The combination of these factors makes a subsistence life-way extremely important both economically and culturally in rural Alaska (Berman & Kofinas, 2004;

Callaway et al., 1999; Case, 1989; Fall, 1990; Georgette & Shiedt, 2005; Huntington et al., 2016; Lonner, 1980; Moerlein & Carothers, 2012; West & Ross, 2012)

Communities across rural Alaska are relatively small and physically remote. They are interconnected regionally via strong Indigenous traditions and ways of knowing, but are economically and materialistically linked to larger urban areas that do not share this worldview. The urban centers can be better characterized by belief structures directly descendent from the colonizing institutions that have historically done so much damage to Native populations in the state (Justice Center, n.d.; Kawagley, 1999; Williams, 2009). Unfortunately, with each fresh repetition of resource-based exploitation, Western and Native worldview conflicts have increased, not diminished, and Indigenous ways of knowing and living have been challenged, undervalued, and dismissed at every turn.

Now, ironically, with the realization that the challenges of the Anthropocene are largely the result of new complex socio-environmental relationships that traditional Western disciplinary reductionist methods are proving ineffective in addressing, there is growing awareness that these types of complex problems require solutions that involve multiple disciplinary knowledge realms interacting simultaneously and thus require more holistic methods to understand and manage (Berkes & Jolly, 2002; Folke, 2004; Huntington et al., 2006). I see this as a Western institutional evolution toward a more Indigenous way of knowing and being. It marks a movement away from the reductionist cause-and-effect academics that has fueled transition into the Anthropocene to a more relational and system-oriented form of scholarship. This new form of scholarship is likely better adapted to the demands that increased physical coupling between humanity and the global environmental systems we depend on, place on humanities' collective ability to learn. Institutional recognition of this need is evident in the rapid increase of interdisciplinary graduate study programs, as well as the combination of research themes and project evolution criteria currently promoted by the National Science Foundation (NSF, 2017), and subsequent production of academic publications. One of the manifestations of this growing awareness in Alaska has been an increase in scientific interest of Indigenous ways of knowing and particularly the deep environmental knowledge held there within (commonly termed traditional knowledge, or inaccurately traditional ecological knowledge).

The first two case studies presented below describe communication networks that developed through rapid environmental change events typical of the new complex socio-environment relationships that characterize the Anthropocene. The next two describe networks that have formed around the general issue of organizing collective action across worldviews to address these kinds of complex relationships before they become crises. All are overwritten upon the broader history of abuse and distrust between Western institutions and Indigenous ways of knowing.

The Communication Environment

We all intuitively understand that good communication is important to our wellbeing, but rarely do we think critically about how communication actually occurs. Modern technology has created a rich media landscape that allows us to connect in ways hardly imagined just twenty years ago. We move seamlessly from talking with friends and collogues face-to-face to interacting through text messaging, e-mail, and social media (Rainie & Wellman, 2012). We weave a balance of these, and many more communication tools into our daily lives at work, at home, and at play. To no small degree, the way we communicate shapes our worldview, and because of this, the rapid changes in communications technologies over the past few decades have created both challenges and opportunities (Hansen, Shneiderman, & Smith, 2011). These need to be understood when thinking about Anthropocene-based social-ecological changes.

Historically communities in Alaska maintained extensive communication networks via movement across the landscape as part of the traditional subsistence lifeway (Brower & Brewster, 2004; Frank et al., 1995; Kari, Fall, Pete, & Alex, 2003; Kawagley, 1999) which fostered close interpersonal relationships within regions, but limited external (mediated) connections (Hudson, 2015). Introduction of the VHF radio complimented this form of communication and was widely adopted, increasing external connectivity (Hudson, 2006). Today, VHF remains an important communication tool in the state, but particularly the rural, especially coastal, regions. Demand for greater connectivity across the state and broader world in general, spurred to greater or lesser extent by political movements surrounding the Alaska Native Claims Settlement Act (ANCSA) and development of the Trans-Alaska Pipeline, introduced satellite technology to many rural Alaskan communities in the 1970s (Hudson, 2015). This allowed for more synchronous media broadcasts to be transmitted around the state and improved telephone service. However, low population sizes and large distances between communities make investments in communications infrastructure economically challenging and historically connectivity has lagged well behind the continental United States (Hudson, 2009). Many communities not located on the road system still depend on satellite technology to connect outside their local networks.

Under the context described above current rural communication infrastructure can be defined by three distinct system levels. When we log into our e-mail, or check the weather online we are accessing the final mile of this system. This is the point at which service providers directly link to end-users. In rural Alaska a middle mile step is required to transfer traffic between local networks and larger hubs in Anchorage (similar to transportation infrastructure). The final step is to connect the middle mile systems to global cable and fiber optic networks. Throughout most of rural Alaska, community network traffic is sent via satellite to Anchorage (the middle mile step), where it is then fed into global networks (Hudson, 2014). The use of satellites to meet middle mile demands makes this system slower than using cable or fiber optic options.

Extensive use of digital communication tools is not new in Alaska, both community health clinics and schools have had reasonable connectivity for nearly two decades even in the smallest of communities (Hudson, Suzanne, & Hill, 2015; Hudson & Parker, 1973; Hudson, 2011). This has resulted in a generation of students growing up connected, at least in the schools, if not at their individual homes. These young community members are now emerging as community leaders and expect high levels of connectivity as a matter of course in living their lives, furthering the integration of digital communication tools into community life.

In education, increased connectivity has expanded course offerings, curriculum design, assessment practices, and stakeholder engagement activities at both the K-12 and university levels through the use of online learning management systems, teleconferencing equipment, and performance-based analytics. Evolving technologies such as virtual reality goggles, 3-D printing, and the internet-of-things promise continued rapid changes in the learning environment (ASTE,

2017) In healthcare, access to reliable broadband increases the services that village clinics can provide through a variety of telemedicine tools (Hudson & Parker, 1973). Broadband connectivity has also allowed access to increased governmental services—from filing federal income taxes to purchasing a state business or hunting license (Hudson et al., 2015). At the local organizational or individual level, increased broadband service has improved access to outside resources including grant opportunities and the ability of small businesses to reach distant customers. Increased connectivity is not without its downsides. Concerns for the cultural impact of such widespread access to western media influences are not unwarranted, but yet to be resolved.

Because of the large cost to improve and maintain communication infrastructure in the Arctic, development has been predominately funded through institutions and agencies at the state and federal level (Hudson, 2015) A federal surcharge is placed on all US telephone bills to support the Universal Service Fund (USF). USF funds projects through grant programs like e-Rate and the Rural Healthcare Program. Through these mechanisms education and rural healthcare needs play an important role in broadband infrastructure improvements across the state. More recently, local governmental needs and demands for individual access have motived change. The basic strategy is to use established anchor institutions within communities (e.g. schools, libraries, health clinics) to support middle mile capacity building, and then expand that capacity to improve final mile access at the individual level (Hudson, 2006)

Large-scale projects to expand broadband access have recently occurred in western and northern Alaska. GCI's TERRA project is one example, a hybrid cable and wireless system it seems to offer a number of advantages over older satellite systems—not the least of which is wireless access while out on the landscape**.** GCI recently completed a smaller scale project connecting Kotzebue to their terrestrial broadband network, and there are unfunded plans to increase the size of this network. Further, GCI and ACS recently formed a partnership to expand wireless connectivity across the North Slope Borough.

Communication infrastructure is highly dependent on technological discovery. It's an active field of research and while gradual upgrades and system expansions in wireless and land-based technology seem the current trend, the history of communication technology is punctuated by breakthrough events and rapid system change. A proposed project to lay a major fiber optic cable along the Northwest Passage from Europe to Asia includes provisions to connect Alaskan communities. If this occurs it would eliminate the need for many northern and western networks to tie into Anchorage. This would vastly improve connectivity speeds, perhaps triggering a rapid change in how rural networks interact with the Internet, and the over all communication landscapes in these regions.

Examples of Alaskan Networks

The above sections describe in broad strokes how the physical, biologic, cultural, and communication landscapes of Alaska have evolved through time. This provides the context through which the networks described below have developed. In terms of the panarchy model, the settings described above represent the largest scale adaptive cycle(s) I consider in this research and are focused on the physical space of "Alaska," across time spans that narrow from the geologic to a more understandably human generational framework. In the following sections I look more in depth at smaller scale cycles and the network dynamics associated with them. These are organized using the adaptive cycle model described above, and positioned within that model based on triggering event characteristics. The first two represent rapid-release style events triggered by singular but episodic events. The first of these, the Bering Sea Superstorm, is explored from an individual—or ego—perspective. The second case study, the Galena Ice Jam, is examined from a community perspective. While the third and fourth case studies look at inter-community dynamics positioned along the reorganization and exploitation phases of the adaptive cycle, and triggered by more diffuse concerns for longer-term regional change.

Bering Sea Superstorm Case Study

Individual/Community; approaching release phase (Figure 12).

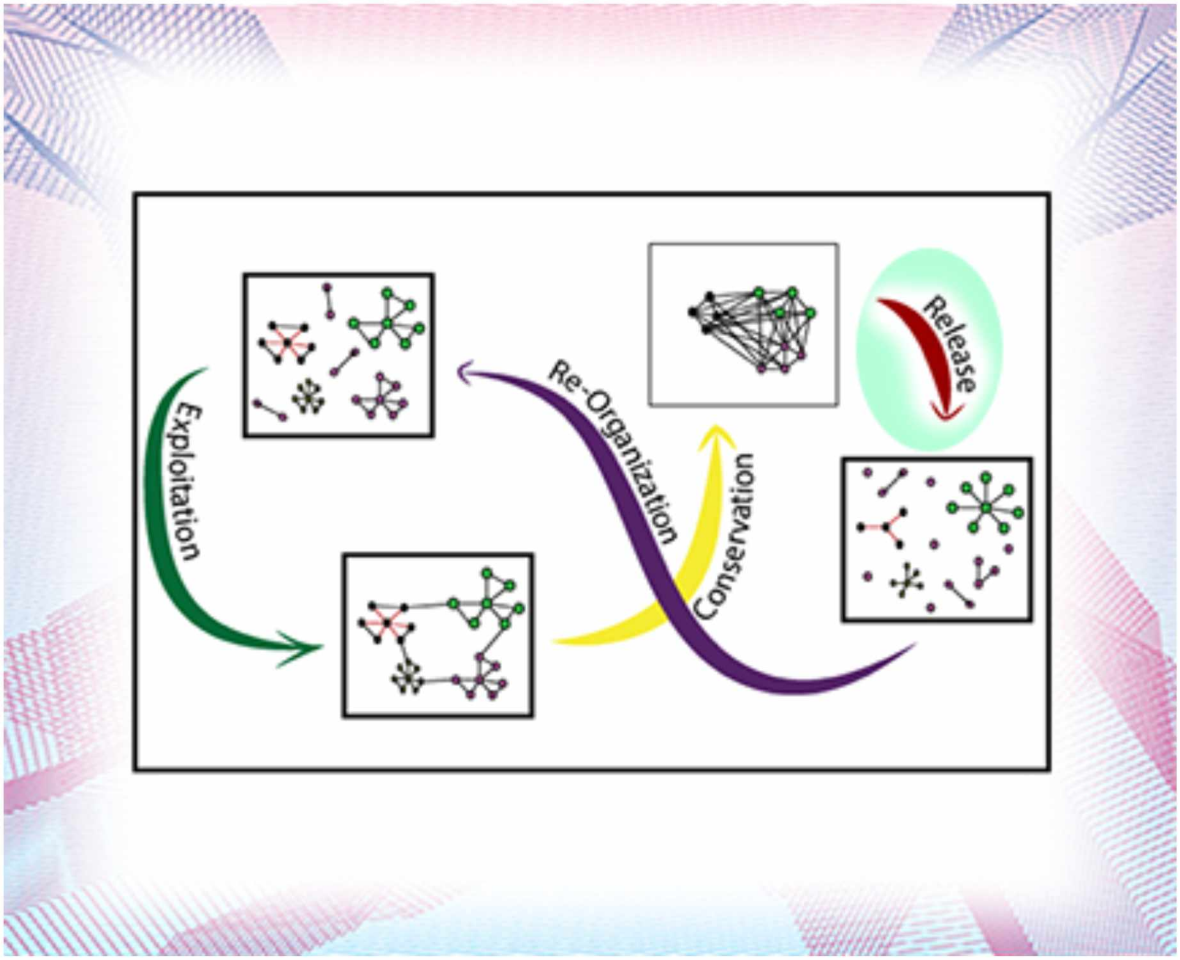
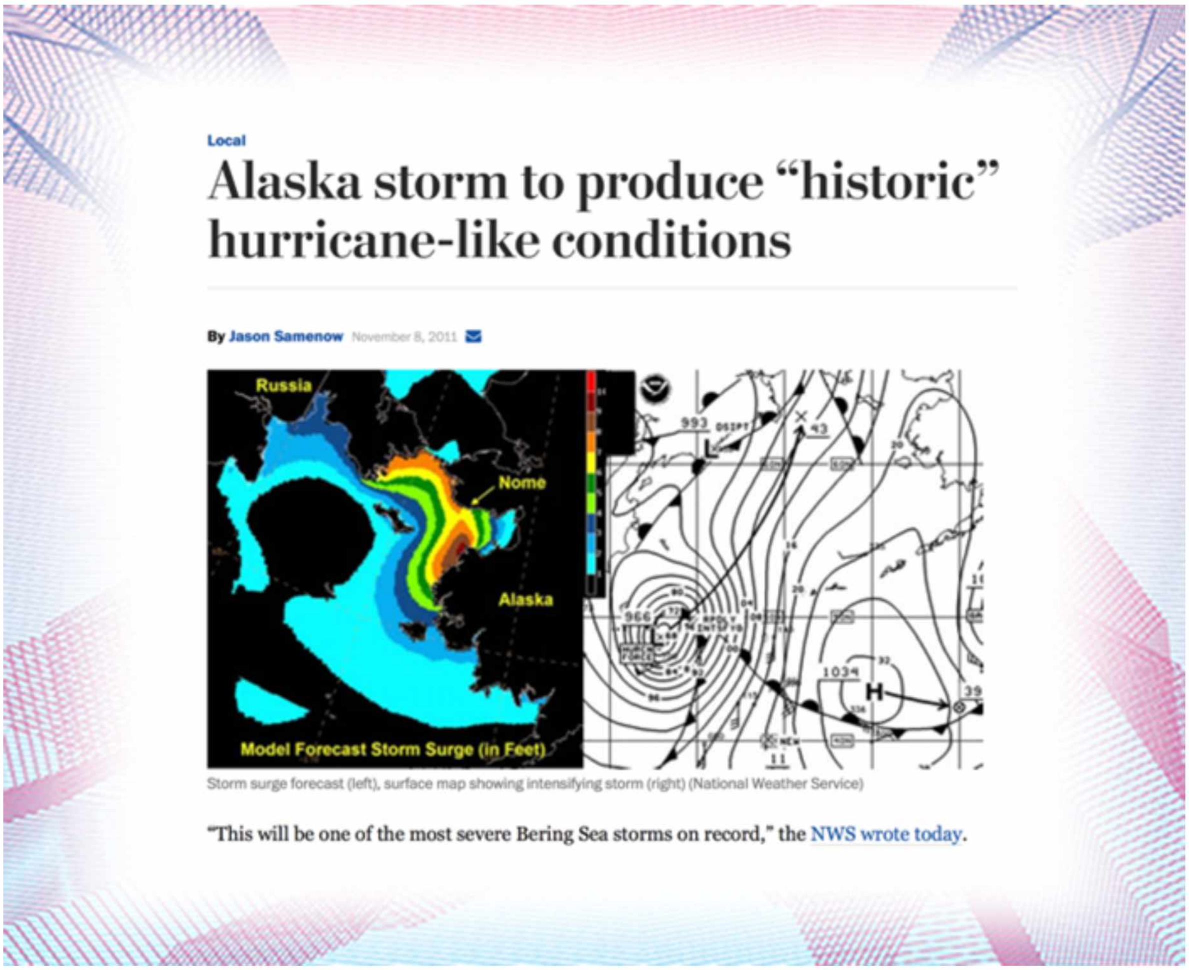


Figure 12: The Bering Sea superstorm. *Networks souro*u*nding the the Bering Sea superstorm are understood to be triggered from a relaese-style focusing event.*

Context and Triggering Event

In early November 2011, a deep low-pressure system developed in the southwestern Bering Sea and progressed eastward and northward toward the west coast of Alaska. By the afternoon of November 7th the Alaskan office of the United States National Weather Service (NWS) had issued a formal Public Information Statement explaining the potential for widespread coastal flooding across the entire shoreline of the eastern Bering Sea (Figure 13) (Ferrell, 2011). Storm surges were expected in the 8-9 foot range. Severe winds and low-visibility blizzard conditions were forecast, as well (Burt, 2011; Lendon, 2011)


Local

Alaska storm to produce "historic" hurricane-like conditions

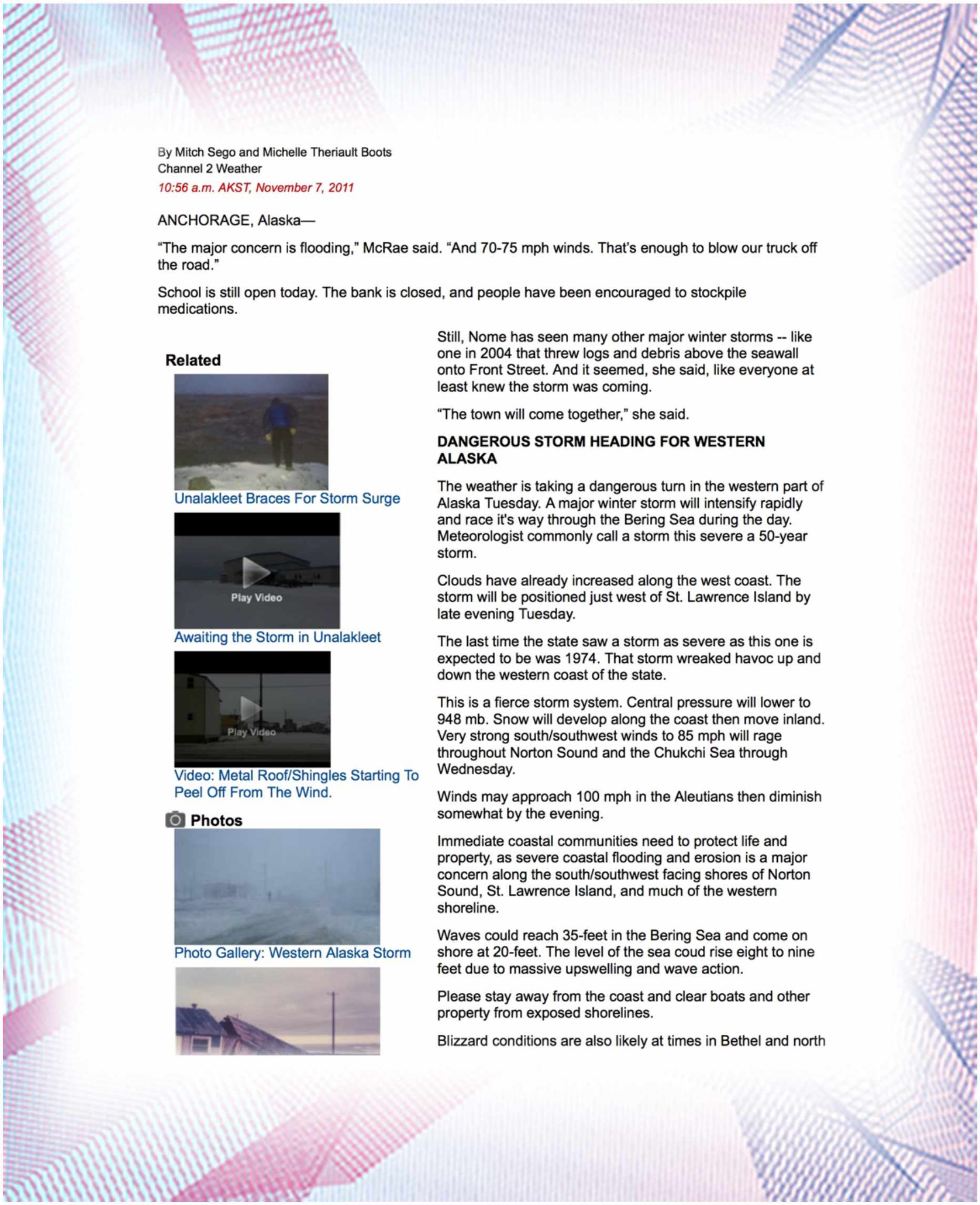
By Jason Samenow November 8, 2011

Storm surge forecast (left), surface map showing intensifying storm (right) (National Weather Service)

"This will be one of the most severe Bering Sea storms on record," the NWS wrote today.

Figure 13: Storm reporting. An example of news media coverage showing the intensity of the storm and potential storm surge hieght. (Samenow, 2011)

The northeastern Bering Sea is not unaccustomed to large storms and residents are typically well prepared for these types of events as part of their daily lives. However, the media and weather outlets made widespread comparisons to a similar storm in 1974 (Freeman, 2014). This historical storm brought hurricane-force winds and a 13.4-foot storm surge. The 1974 storm caused widespread damage across the region, and is remembered today by older residents for its exceptional ferocity. Considering this, the 2011 storm became a prominent news story across the state of Alaska (Figure 14) and even made national news (Associated Press, 2011; Lendon, 2011; Samenow, 2011), where it became known as the Alaskan “Superstorm” of 2011—a year before “Superstorm Sandy” made the phrase a household term in the US.



By Mitch Sego and Michelle Theriault Boots
Channel 2 Weather
10:56 a.m. AKST, November 7, 2011

ANCHORAGE, Alaska—

"The major concern is flooding," McRae said. "And 70-75 mph winds. That's enough to blow our truck off the road."

School is still open today. The bank is closed, and people have been encouraged to stockpile medications.

Related

Unalakleet Braces For Storm Surge

Play Video

Awaiting the Storm in Unalakleet

Play Video

Video: Metal Roof/Shingles Starting To Peel Off From The Wind.

Photos

Photo Gallery: Western Alaska Storm

Still, Nome has seen many other major winter storms -- like one in 2004 that threw logs and debris above the seawall onto Front Street. And it seemed, she said, like everyone at least knew the storm was coming.

"The town will come together," she said.

DANGEROUS STORM HEADING FOR WESTERN ALASKA

The weather is taking a dangerous turn in the western part of Alaska Tuesday. A major winter storm will intensify rapidly and race it's way through the Bering Sea during the day. Meteorologist commonly call a storm this severe a 50-year storm.

Clouds have already increased along the west coast. The storm will be positioned just west of St. Lawrence Island by late evening Tuesday.

The last time the state saw a storm as severe as this one is expected to be was 1974. That storm wreaked havoc up and down the western coast of the state.

This is a fierce storm system. Central pressure will lower to 948 mb. Snow will develop along the coast then move inland. Very strong south/southwest winds to 85 mph will rage throughout Norton Sound and the Chukchi Sea through Wednesday.

Winds may approach 100 mph in the Aleutians then diminish somewhat by the evening.

Immediate coastal communities need to protect life and property, as severe coastal flooding and erosion is a major concern along the south/southwest facing shores of Norton Sound, St. Lawrence Island, and much of the western shoreline.

Waves could reach 35-feet in the Bering Sea and come on shore at 20-feet. The level of the sea coud rise eight to nine feet due to massive upswelling and wave action.

Please stay away from the coast and clear boats and other property from exposed shorelines.

Blizzard conditions are also likely at times in Bethel and north

Figure 14: Media reports on the storm. These examples provide an insight into the tone of news stories published just prior to the storm passing through the study region.

Regionally, there was significant concern for the impacts the event could have on local communities. The geography and social dynamics of the affected region are such that many western Alaskan communities are located on coastal lowland areas, either very close, or within, the active littoral zone. Severe coastal erosion issues are an ongoing challenge in the region, with popular sentiment and research linking it to larger warming shifts in the climate (Chapin et al., 2014; "Shishmaref Erosion and Relocation Coalition", n.d.; Hinzman et al., 2005; Melvin et al., 2017). Because of this, concern has increased that the catastrophic impacts of a 1974-style storm could be much greater under today's these new environmental conditions. In response, many communities have active coastal erosion projects in place, and in some cases, full-scale relocation efforts are underway. However, fears for the size and intensity of the storm heightened concerns that the event might overwhelm the adaptive capacity of local communities and trigger a release event.

Under this context, we can make some baseline assumptions on the different communication networks that likely formed prior to the empirical networks I will present below. For our needs, we can begin at the point where weather forecasters recognized the magnitude of the event. Because the storm was detected well before any physical impacts were felt in Alaska, these networks were necessarily mediated by highly specialized technical channels (Mass, 2003; Murphy & Brown, 1985) that stretched across ocean basins via remote sensing tools to connect the storm to forecasters thousands of miles away in Anchorage (NOAA, 2013). Once there, information about the storm was likely mediated through face-to-face, email, and phone conversations to networks of scientists, administrators, and public outreach professionals until it eventually crossed out of these limited interpersonal networks into the public sphere (Gladwin, Lazo, Morrow, Peacock, & Willoughby, 2007; Golden & Adams, 2000; Rappaport et al., 2009).

Once the magnitude and potential hazards associated with the storm were understood in the public sphere, networks rapidly expanded as information about the storm flowed through traditional broadcasting channels (the radio, TV, websites), as well as social media sites like Facebook (Figure 15). As information on the storm spread, sub networks would have evolved, specializing to meet unique functional roles—public information, state and federal agency response, local organization, etc. Additionally, individuals would have interacted in many of these networks simultaneously, linking one to the other in the process. The empirical work below enters this system by examining public communication dynamics at the individual level through the lens of a single channel (Facebook), as the storm approached and passed over the coastal communities of western Alaska and the Seward Peninsula.

Figure 15: US National Weather Service storm post. *An example of the types of social media content published by the US National Weather Service. Of note is the number of times the post was shared, as each represents an opportunity for the institunal posts of the National Weather Service to enter local networks such as the one described in this case study.*

Network Bounds and Methods

As a matter of research design, I set three qualifications to bound the network I explored in this case study. First is the accessibility of public content and actions through Facebook—defined by the individual privacy choices of users within the network. Second is place, and while online mediated networks like Facebook can—and often do—span large geographic distances, the networks in this study were required to originate from activity initiated out of a single community in the path of the storm. The third bounding qualification is the type of Facebook actions that are tracked. In this case, only text-based content was assessed, and only if it related to the storm event.

To meet the first boundary condition, "public content" for the sake of this study was defined as any material that I as the researcher could see while logged into a generic Facebook account, but not material I would have needed to be Facebook "friends" with a person to see. To facilitate this, my researcher Facebook account had no formal "friend" connections to anyone in the network. Facebook's privacy policies change regularly, but at the time (2011) this gave me access to profile information and "wall" content for any user who's personal preference settings were set to "public." Since this time more nuanced settings have become available, and considering how new this channel of communication is, and with consideration to the fact that privacy norms are still being negotiated through it, reasonable efforts have been made to obscure the specific location and names of network elements that I report on despite the ultimately public nature of the content.

To define the second, place oriented boundary condition, communities predicted to be impacted by the storm were identified through National Weather Service forecast statements and forecast maps. Facebook-users from each community were then located. Communities in the region are small, making it possible to accomplish this task by hand using the "Find Friends" feature on Facebook and entering the community of interest into the "current city" search criteria. Results from this search returned Facebook users who had voluntarily entered this information into their public profile. Users who left this information blank, or made it private, did not show up in the results. Therefore, this process served to define the initial network privacy and place boundaries.

To meet the third (content-focused) boundary condition, only the Facebook activity of users who, 1) allowed public access to their "wall" content, and 2) made some mention of the storm on their "wall," were considered for further exploration. This process excluded all topics that were not mentioned in context of the storm. Taken together, these three research design decisions result in the analysis of networks formed around shared thematic concerns that are tied to a specific physical place and event but are not spatially limited by them (in that friends of friends could enter the network from outside the physical region).

The purpose of looking at this case study is to explore how rapid, episodic type triggering events impact social networks at the individual level. This type of network is termed an "ego network" in the jargon of social network analysis (Borgatti & Halgin, 2011), and it looks at the broader communication network from a single communicators structural position within it (Monge & Contractor, 2003).

Selection of which individual's network (Ego) to examine was determined by identifying the individual who created the greatest total number of public storm related posts during the storm event. The reason for this research design choice is based on observations that user engagement with social media often follows a power law distribution, where "super-users" initiate the majority of content (Kim, Newth, & Christen, 2013, 2014; Luo, Zhu, Zeng, & Yao, 2014), and are therefore central to the overall network and are consequently directly connected to more members of the whole network than most other individuals (Oh & Monge, 2016). Communicatively, this structural position likely plays a normalizing role, negotiating shared meaning across large sections of the network by accessing (reaching out, pulling in) a variety of otherwise disconnected perspectives on the periphery of the network, negotiating new meaning, and then sharing that with a broader selection of the network (Borgatti & Halgin, 2011; Kietzmann et al., 2011; Luthe & Wyss, 2016). Selection of Ego was made to try and capture as wide a "feel" for the network as possible—capturing the mainstream, rather than the fridge, which is the role the above diffusion studies indicate super-users fill in social media networks.

To do this, after finding all the community members who were making public Facebook comments about the storm, selection was made by counting who posted the most content meeting the boundary requirements—i.e. by identify who was the "super-user" in the network?

Once this determination was made, the ego-network of the individual was traced out two degrees of separation. That is, everyone who commented or liked one of Ego's storm related posts was identified. Then that person's wall content was examined for storm related content, as well (so long as their content was also public). This process defines a first degree of separation from ego. Next, people who liked or commented on the posts of the first-degree network members were identified—using the same procedures—to define the second degree of separation.

It should be noted that because data collection was limited to publicly available information, some ties between 1st and 2nd degree individuals could not be identified. Therefore, the resulting ego-net represents a minimum in network size and scope.

After 2nd degree individuals were identified, connection information (defined by "like" and "comment" actions on Facebook) were tabulated into a matrix and graphed to understand the structure of the network. Degree centrality was used to identify the top ten most connected nodes (including Ego) in the network. This subset of nodes within Ego's network were then explored in more detail (renamed Ego and Ego's Friend 1-9 (EF 1-9)), to help define the context of information flowing through the network around the time period of the storm.

To do this, all public "wall" information for Ego and each of the nine EF's was downloaded from mid-October through mid-December and converted into Rich Text Format for coding. The coding framework described in Table 1 was developed to contextualize content flow in a structure suitable for analysis using the robustness concepts of resource, resource user, infrastructure, and infrastructure manager discussed earlier. Network, not nodal, scale patterns are of interest in this study, so no effort was made to break up each post internally with sub codes. Rather, when a post spanned code definitions it was simply coded for both classifications. Examples can be seen in Table 1, as well. Additionally, observation-based ethnographic notes were kept throughout the process for Ego and each EF. A summary of this data can also be found in the results and discussion below.

Table 1: Capital asset based coding scheme. The capital asset coding scheme was devised to broadly categorize Facebook content into a robustness-based classification system.

Capital Assets	Example Coding	Example Themes
Built (infrastructure)	Homes, roads, communications technology, material goods and needs, where people shop, how they travel, etc. Those things that have been built or manufactured by people—large scale infrastructure to small, day-to-day material items	
Natural (triggering event)	Relating to natural conditions and observations. The non-manufactured resources (and processes) in the environment.	
Social (infrastructure)	Relates to human interaction and support for one another- spirituality, religion, planning, communication methods, event/holiday/birthday wishes, cultural context, native language, family, sporting events. Involves interactions and skills that allow individuals to function collectively. This includes formal and non-formal governing institutions, learning institutions, institutions of spirituality, and cultural traditions.	

Table 1 Continued		
Capital Assets	**Example Coding**	**Example Themes**
Human (Resource)	Relates to the individual—condition, health, education, love, happiness, money, food etc. Behavior that is centered on self-identity, education, health care, eating habits, etc. The reflexive nature of self and community identity cannot be overstated, particularly in the remote, predominately Native communities that the storm impacted.	

Results and Discussion

Results from ethnographic work immediately revealed that Ego served as a leader in the official city response to the storm event (Figure 16). As a reminder, Ego was initially selected based on 1) the Facebook generated list of users in the community, and 2) the pure volume of storm related content Ego produced. So, while Ego's selection was not based on robustness roles, Ego clearly fills an infrastructure-provider/resource-manager role in this system. This result, combined with the methodology in identifying Ego, is an indication that at least some local resource managers were actively utilizing Facebook as an important communication channel during the event.

Figure 16: Command center. These posts highlight the leadership role Ego filled during the storm.

Additionally, it is clear through reading the full corpus of Facebook post collected for this study that the most connected members of Ego's network are made up of tight family and community relations between Ego and the EFs. Recall that in robustness, the amount of overlap between resource managers and resource users is in an important relationship to understand (Anderies et al., 2004). With that in mind, the relationships within Ego's network lend themselves to exploring the system for questions of role overlap—an opportunity that was not known at the start of the study. However, first we need to define the remaining robustness elements.

In this case, looking at the system form Ego's position in the formal crisis response, the resource in question would be both the physical health and emotional wellbeing of the community at large. However, specific built infrastructures of concern include electricity, water, and communications systems, as well as, damage to a variety of different types of personal property needed for shelter, food preparation, and transportation. Social infrastructures include dissemination of general storm-related information, weather reports, damage reports, as well as action-oriented content such as evacuation notices. Some examples from Ego's posts that illustrate how these concerns were expressed through Facebook can be seen in Figures 17 and 18. In the following sections ethnographic, network, and coding data will be presented describing the flow of information through Ego and the EFs.

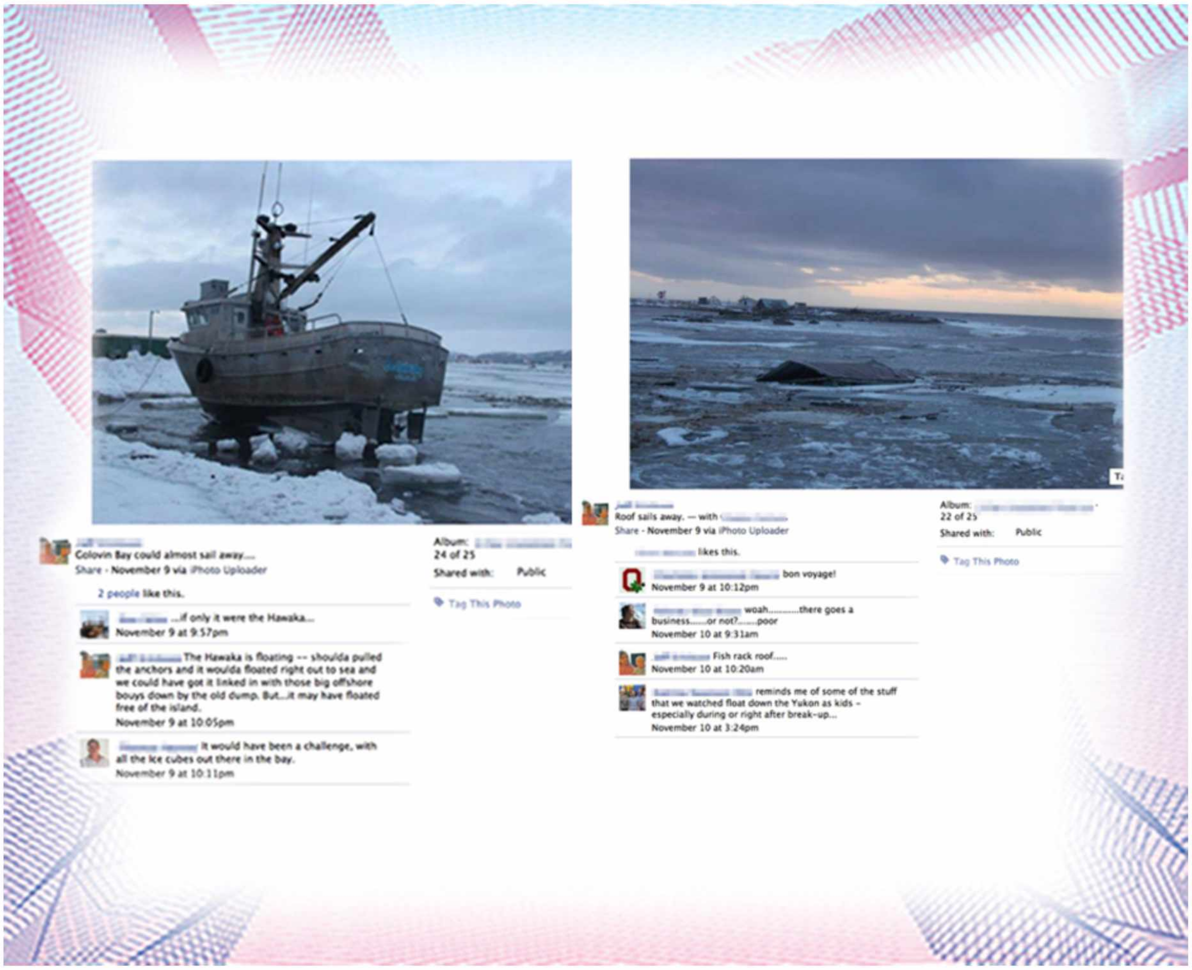


Figure 17: Example storm posts. Example posts made by Ego during the storm event.

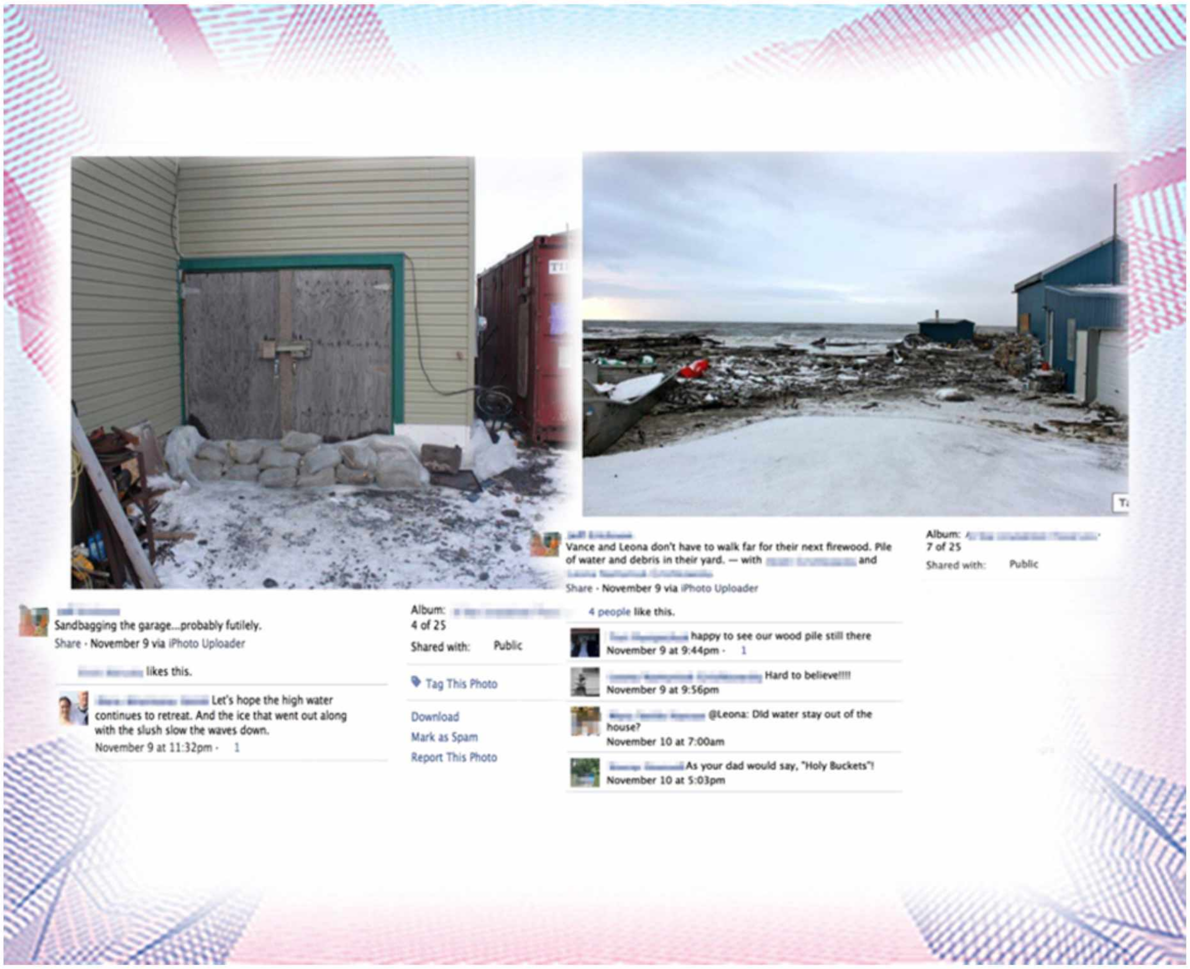


Figure 18: Further examples of posts made by Ego before and after the event. The post on the left displays some of the preparations that were made before the storm, and thoughts about them, while the post on the right illustrates the limited damage that occurred during the storm.

Information flow between Ego and the EFs represents the core of the virtual community defined by this network (Figure 19). Connections between Ego and the EFs are dense and perfectly illustrate the idea of bonding relationships defined by network theory (see Background chapter above). These are multiplex connections. Content within the Facebook conversations makes direct reference to multiple communication channels used by network members to maintain relationships. The additional channels referenced in individual Facebook posts include face-to-face, Skype, the phone and US Postal Service. These types of multiplex relationships are what make this core group ideal for examining questions of role overlap. However, Ego and the EF's can each be seen connecting to many unique individuals that none of the others connect with. This indicates that during the storm, not only did Ego and the EFs share Facebook conversations with each other, they each also communicated with many other people that the others did not. These people represent the periphery of Ego's network and represent potential bridging-type network connections into and out of the Ego's core network during the storm event. From the perspective of network theory, these are the types of relationships that are thought to be able to bring in new resources—material and/or intellectual—to a system (Borgatti & Halgin, 2011; Carlsson & Sandström, 2007; Granovetter, 1973; Lampe, Ellison, & Steinfield, 2007). Therefore, assessment of these peripheral relationships can offer some insight into the ability of Ego's network to pull in external help when needed. However, ultimately the storm did not overwhelm either the physical or social infrastructures of the community and external resources were not actually required in this instance (Ferrell, 2011). Therefore, only minor attention is paid to the peripheral network elements in the discussion that follows. The adaptive capacity of this system was not breached by the physical impacts of the storm. We will see in the following case study on the Galena ice flood—where this is not the case, and the adaptive capacity was breached—that peripheral network members become much more important to the overall wellbeing of the system.

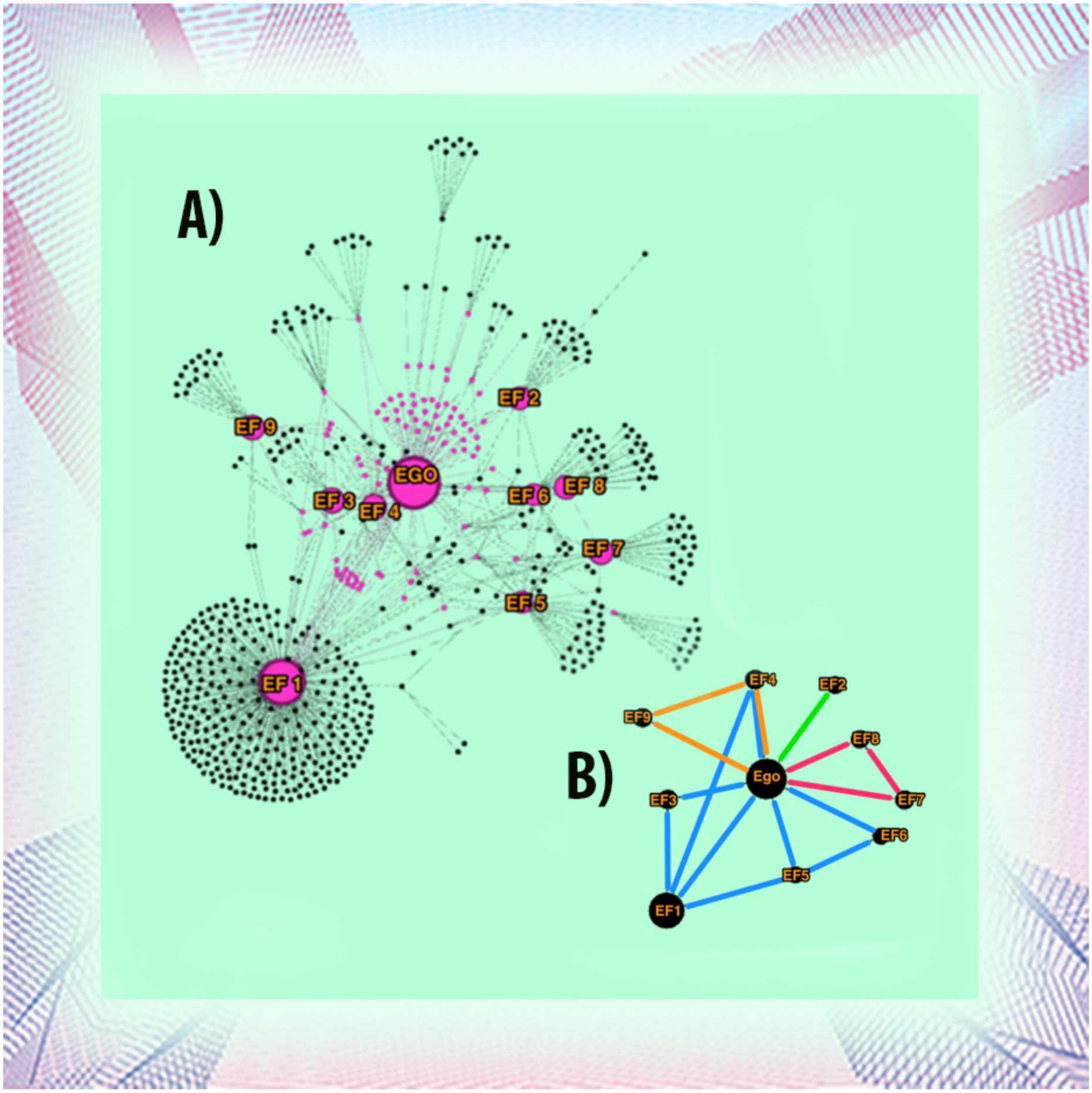


Figure 19: Ego's storm related network. Visualization A represents ego's complete network, while B illustrates how Ego's core network relate to one another.

Given that the storm did not overwhelm the capacity of Ego's core network to address any issues that it created, it is in the core of the network that we can look to better understand the adaptive capacity of this system during the storm. To do so, understanding the infrastructure provider and resource user roles within the core network is of most interest in the resilience and robustness models being exploited in this study. In particular, getting a handle on the dynamics of what roles Ego and Ego's EFs serve during the storm is of the most interest.

As mentioned above, the structure of Ego's Facebook network maps out a system that is characterized by a periphery of single tie contacts radiating out from a core of more tightly connected network members (the EF's). Probing deeper into this network to identify the structural position of EFs reveals an inner core of four relatively distinct groups that Ego interacts with (Figure 19, above) during the timeframe data was collected (Oct 18- Dec 12, 2011).

Within this inner, tightly connected network, role relationships are examined in more detail and grounded coding results are used to understand how different parts of the network responded to the events of the storm.

Beginning with a qualitative assessment of the storm related conversations engaged in by Ego and the EFs, there was a tendency for Natural and Built coded posts to become more prevalent during the storm than before or after—which would be expected during a major weather event such as this one (Figure 20). As stated above, the storm generally did little to no real community-wide infrastructural damage; perhaps had damage been more widespread, conversations around Built capital would have been more prevalent, and in fact this is exactly what we see in the Galena case study presented below. However, here conversations generally transition from those around Human or Social content before and after the storm to ones around Natural capital topics during. Ethnographic nuances evident by reading the posts, but not captured well in the coding scheme, show that during the storm conversations coded as Natural move from initially being concerned with incoming weather reports and forecasts—preparations and letting people know about the potentially historic magnitude of the event—to reports and discussions of current conditions—wind speeds, directions, water levels, shoreline ice/slush conditions, etc. After the storm passes, conversations almost immediately convert back to pre-storm topics and patterns.

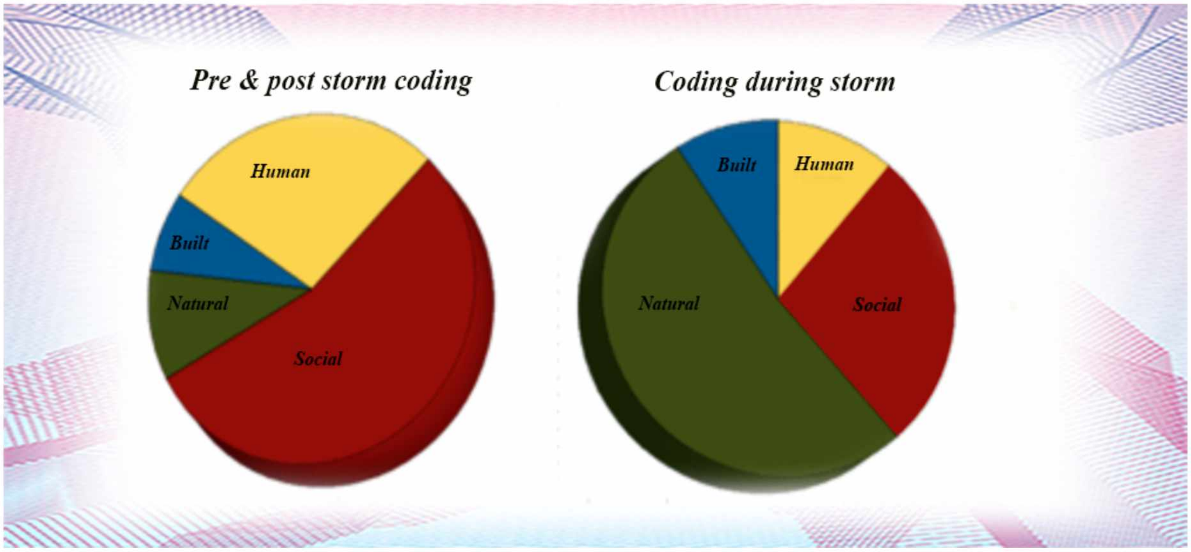


Figure 20: Capital asset coding. Qualitative content coding was conducted for Facebook post made before and after the storm, as well as during the storm. Content before and after the storm was of similar tone and compiled into a single chart. A shift from Social and Human capital to Natural capital themed conversations occurred during the storm.

When we start to break down what information was exchanged between the subgroups within Ego's core network during the event, the first storm related post is made by EF2. This implies that EF2 holds an important cognitive position in the network as the provider of new information across this specific channel of the system. She is not connected to any of the other subgroups within Ego's core network (Figure 21). This structural position, combined with the functional/content role of initiating the storm related conversation indicates that EF2 serves a bridging role in the core network—though what other networks she is bridging across are not directly traced in this study, they likely tie into specific versions of the hypothetical networks described above.

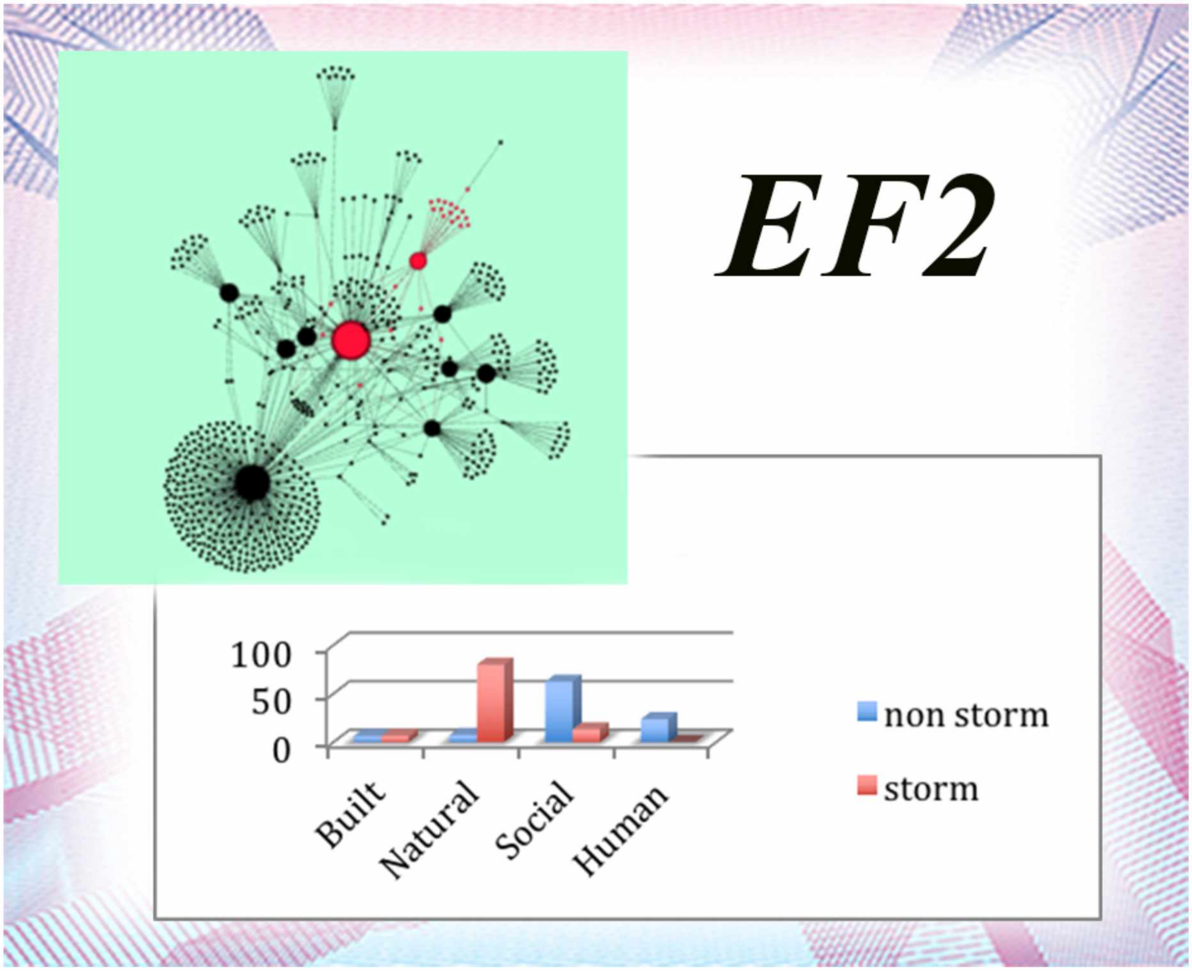


Figure 21: Structural position and thematic shifts of EF2. Red nodes in the graph highlight the portions of Ego's entire storm network that EF2 is connected to. EF2 fills a bridging role, connecting to just to Ego and none of the other members of Ego's core-network. During the storm, EF2's content shifts from topics around Social and Human capital to a focus on Natural capital discussion. At no point is EF2's content primarily focused on Built capital.

Additionally, EF2 is not from the same physical community as Ego or most of the other EFs. She is however, from a nearby community that was also impacted by the storm. EF2's posts regularly contain Natural capital oriented content outside the context of the storm. She noted the first snowfall in mid-October and shared and posted multiple stories about being out on the landscape for one activity or another throughout the timeframe I collected data. Others in the core network did not do this to the same extent. These posts by EF2 generated engagement outside the rest of

Ego's network around Natural capital topics and likely helped her maintain a personal network primed to pick up on the communication signals of the storm earlier than others in Ego's network. This difference may explain the initiating role EF2 plays in the core network, and from the perspective of this work—where the goal is to use network analysis as a tool to identify potential future intervention strategies, and not just an academically interesting observation tool—the role she played in introducing novel information into the core network is important to note, as it supports the idea that strategically fostering relations with specific individuals prior to an event can serve as a starting point to bridge into already established network relationships during times of crisis. We will see in the Galena example below where this same pattern repeats, with a non-Galena resident (though with deep social connections to the community) initiating a grassroots resource network for displaced residents of the physical community.

My empirical data does not rigorously "validate" these mechanistic conclusions, however they are in line with generally accepted network theory (Borgatti & Halgin, 2011; Granovetter, 1973) and provide an empirically-based starting point for developing and implementing an evidence-based communication strategy. As such, the "objective" truth (if ever present in social systems) of causal relationships is only relevant here in how it manifests in the implementation and results of future communicative actions. In other words, the goal of the work is to define a process for empirically guiding communicative actions into the future. Any "mistakes" that truly matter in the causative model developed through this process will show up as undesired or un-anticipated results in the next round of actions based on them. The new results then, simply provide further information to refine system understanding through a continuously iterative process that eventually focuses in on the causative mechanisms relevant to the communicator. An obvious implication to this methodology is that each communicator, based on their own communicative style, personal interpretations of the data, and ability to implement actions based on those interpretations is going to understand the mechanisms of change within the network slightly different as their interactions with it evolve over time. I do not view this inability to define an "objective" truth a flaw, or limitation to the method, but rather a confirmation that it is empirically flexible enough to account for the cognitive differences in how we all internally process shared experiences. The ability to iterate the methods of action and assessment is what makes this process powerful as a strategy tool. However, in the case studies I present here, there is no attempt to influence the future dynamics of the networks, so system understanding is being built based on data from a single iteration of communicative behaviors—and that is not sufficient to establish causation on its own. This means that ideas on causation can only be considered preliminary at this point, and are offered here as examples of the types of initial analysis intended as starting points for guiding future communicative actions.

It is for this reason that taking note, and making some assumptions on the structural position and functional role of EF2 is relevant—despite the lack of complete scientific rigor. The bridging role of EF2 combined with the tendency to stay engaged in natural capital topics outside of times of crisis, supports a working hypothesis that Granovetter's (1973) ideas on the strength of weak ties can be applied to environmental change issues and most importantly here—that this basic network theory model can be used as a starting point in developing initial communication strategies around environmental change issues.

A focus on Natural capital in EF2's everyday Facebook network may account for why she was the first to introduce storm related content into Ego's network, but even if that is not the reason, she was clearly playing an infrastructure provider role in this system by creating an initial link into the broader statewide storm networks described in the "context" section of this case study. Like Ego and all the EFs, EF2 posts regularly on Social and Human capital related posts. Many of these are around playing online social games, namely poker in this case. While not coded specifically, many of the other EFs play games as well, however, they seem more interested in word games. Which may be another influence on why EF2 and the other core network members are not connected via Facebook (or reflexively, it may be another result of them not be connected), though undoubtedly in these small communities they have other channels of communication where they are connected. The net result is that through Facebook, EF2 is filling an (information oriented) infrastructure provider role with very little role overlap as a direct resource user within Ego's network (or physical community in this case). She is structurally a network-bridging element that does seem to act, as network theory would predict, to bring in new resources (i.e. information on the storm) to Ego's network.

Ego (Figure 22) is by definition the center of the network and connected to all subgroups within the core. The blue group (Figure 19) is the largest he maintains and will be discussed in detail next.

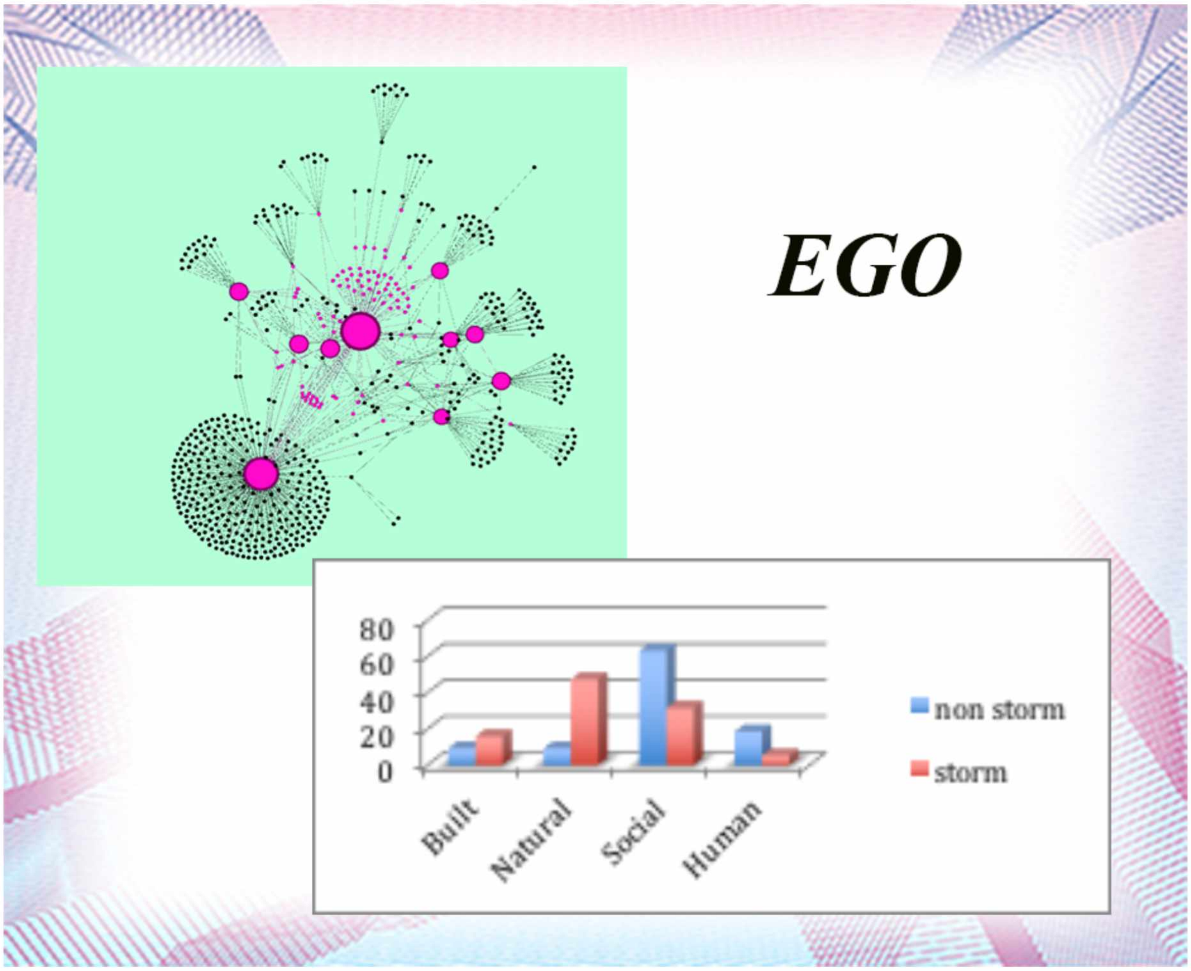


Figure 22: Structural position and thematic shifts of Ego. Ego, by definition, connects directly to all other members of the core network. Ego's content follows the general pattern shift to more Natural capital oriented discussions as seen in the content of other network members, however Ego regularly shows more concern for Built capital issues than the rest of network.

In the blue group (EF1, EF3, EF4, EF5, and EF6) the member with the strongest network connections to Ego is EF1—for good reason (Figure 23). Ego and EF1 are married and they exchange a lot of mutual information before, during, and after the storm. As an example, prior to the storm they jointly organized a regional charity auction using Facebook, Skype, texts, the phone, mail service, and local face-to-face contacts. Together they are highly active and influential in the social fabric of the region through charity activities, the church, and school system.

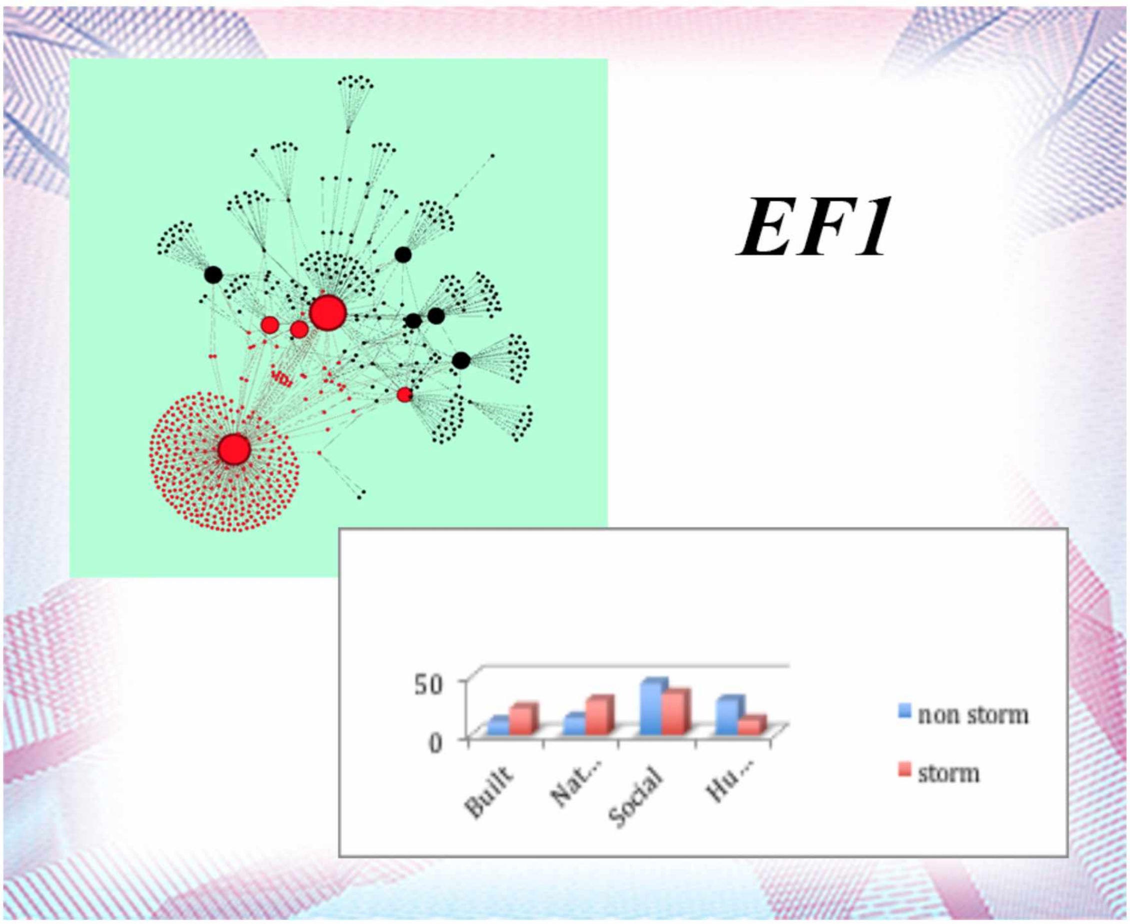


Figure 23: Structural position and thematic shifts of EF1. EF1 is located in the lower left hand corner of the network map and maintains a large peripheral network that is not connected to other members of Ego's core network. Unlike EF2 however, EF1 is directly connected to three other members of Ego's core network and is not interpreted to fill a bridging role during the storm to the same level that EF2 did. Content analysis of EF1 Facebook activity shows more regularly engagement in all asset categories than any of the other EFs.

While heavily interconnected, they each maintain slightly different networks. Before and after the storm, Ego posted more content coded to Natural capital than EF1, and more even than EF2. For Ego, this seems to be at the expense of Human capital oriented posts. EF1, on the other hand, tended to post more Human and Social capital oriented content at the expense of Natural capital content. The qualitative context these codes miss reflects the different roles Ego and EF1 play in the community, and consequently differences in the networks they maintain. Religious contexts are equal among both; however, Ego interacts regularly with the school district while EF1 is a home caregiver. The context of their Facebook posts reflects the differences in their daily activities, and supports differentiation in who engages with them through this specific channel of communication.

EF1's network is much larger and more actively engaged than Ego's. Surely this has to do with the nature of their daily activities. As a home caregiver of a special needs child EF1 lives in a world where her daily concerns are not shared by a large network of physical contacts dealing with similar experiences. Rather, other caregivers living similar experiences are widely dispersed and physically isolated, particularly in rural Alaska. Distance communication then is their only real option for interacting with others who can intimately relate to their daily lives. EF1's extended network reflects this by the diversity of where members live. Her network contains people from within the local region, but is also widely participated in by people in urban Alaska and the Lower-48. One can imagine this places more relevant importance on communication through this channel for EF1 than Ego, whose daily life experiences are shared by people that he has more regular physical contact with. His network is made up of more local and regional community members, as well as has lower levels of activity both in terms of volume and frequency of posting than EF1.

During the storm the pair use differences in their networks effectively to both increase the reach, but also the diversity of their networks. EF1 shared many (nearly all) of Ego's posts during the storm, consequently Ego's message could penetrate a sub network of people who relied on Facebook as an important communication channel much more than his own direct network—namely the caregiver and/or charity oriented networks at the regional, state, and national levels which EF1 was actively involved in prior to the storm. Additionally, where their networks overlapped through local and regional religious connections Ego's work as an Infrastructure Provider was strongly reinforced. Consequently, the connection to EF1 is highly influential in his overall network and particularly in the blue subgroup, where EF1 serves essentially as a surrogate, or informal, Infrastructure Provider supporting the formal response Ego's role in the command center represents.

Others in the blue subgroup (EF3, EF4, EF5, and EF6) play a much more clear-cut Resource User role—consuming rather than originating storm related content.

EF5 and EF6 (Figures 24 and 25 respectively) share similar structural connections to Ego. Neither lives directly in the community and both dramatically shift Facebook conversations from those coded as Social to those interpreted as Natural.

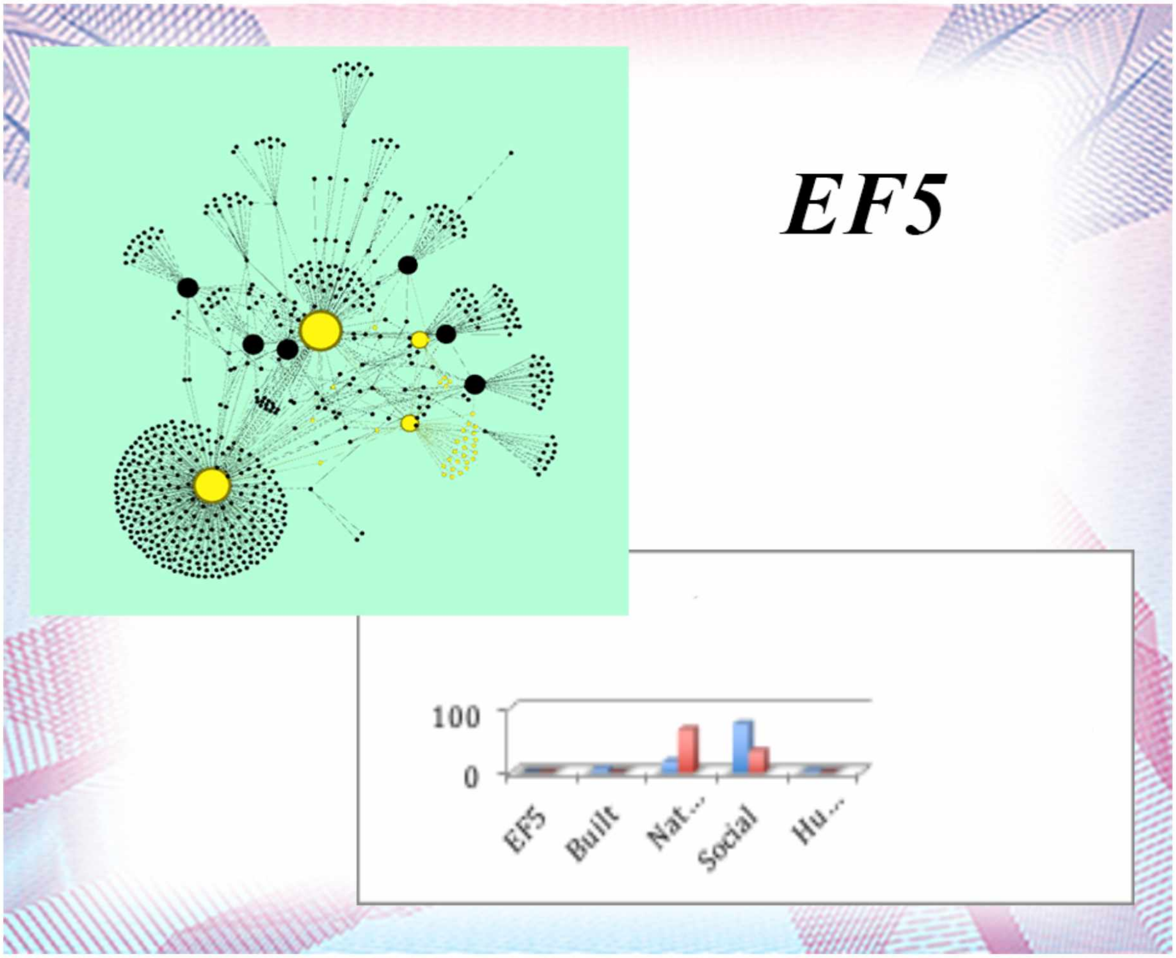


Figure 24: Structural position and thematic shifts of EF5. Within Ego's core network (see Figure 19) EF5 is directly connected to EF2 and EF6 in addition to Ego. EF5 is also a member of the larger Blue subgroup, and thus a part of Ego's most central sub-network. EF5's Facebook content before and after the storm is almost complete tied to social capital with some Natural capital influence. During the storm, EF5's content maintains a strong connection to the social, while increasing a focus on Natural capital themes.

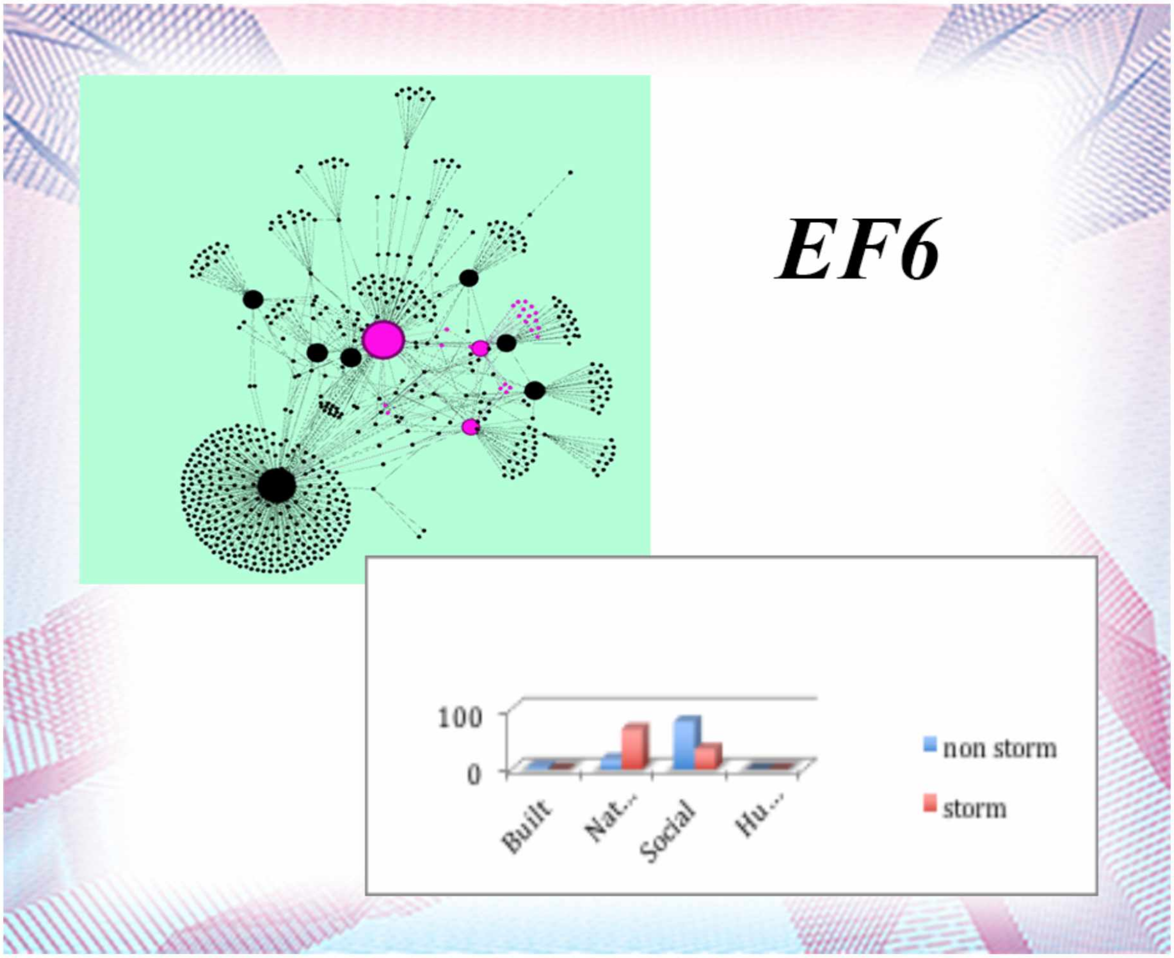


Figure 25: Structural position and thematic shifts of EF6. EF5 and EF6 share very similar structural positions in Ego's core network. The content of their Facebook posts shift between Social and Natural capital in similar fashion, as well.

EF 5 connects through the religious networks described above, but is also a relative. Indeed most blue group members are either family and or close family friends. EF5 lives in the Lower-48 and also connects to EF1 as well as to Ego. Again, via the overlapping religious networks that Ego and EF1 both participate in. EF6 also shares these religious connections but is from the same regional community as EF2—although they are not connected in this network. Similar to EF2, EF6 and Ego overlap in a more consistent posting of Environmental content before and after the storm. This highlights how Ego and EF1 maintain networks that emphasize different physical scales depending on context, and supports the interpretation that Ego's non-Facebook, regional networks influence his Facebook network more that EF1's regional face-to-face networks do. That is, within Facebook, Ego's focus on the regional rather than larger scales likely influenced his connection with EF6 at the regional scale, where as Ego and EF1's overlapping interest in spiritual—or more accurately, church—concerns allowed them to share a connection with EF5 at the national scale.

Continuing to examine the blue group, EF4 (Figure 26) and EF5 are each connected to both Ego and EF1, but neither is connected to each other. EF4, however, does serve as a unique bridge connecting both Ego and EF1 to the orange group (Figure 19).

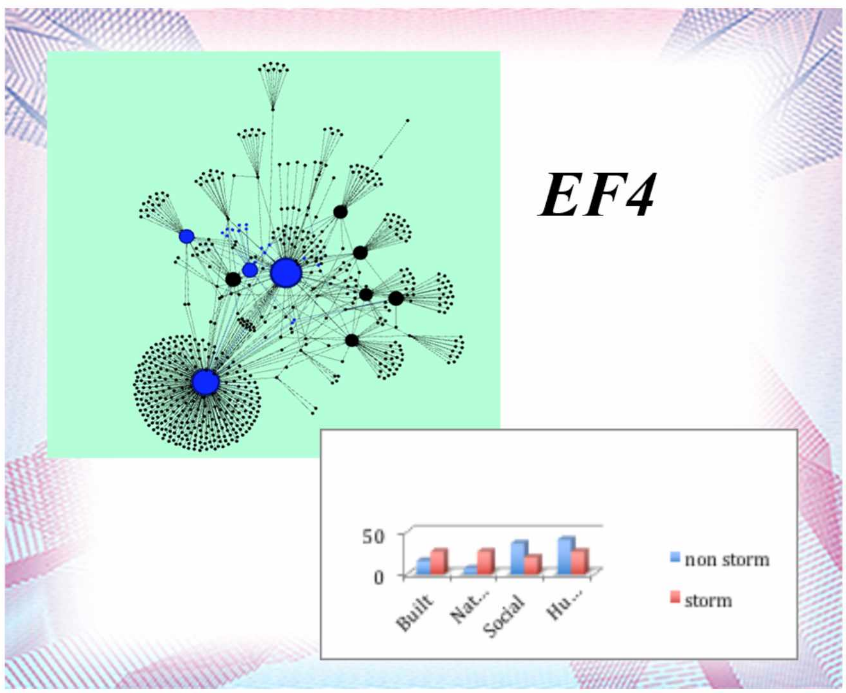


Figure 26: Structural position and thematic shifts of EF4. EF4 maintains a bridging position between the Blue and Orange subgroups in Ego's core network (see Figure 19). Similar to EF1, EF4's Facebook content is fairly balanced across all four capital asset categories during the storm, however before and after there is little engagement in Natural capital content.

EF3 (Figure 27) and EF4 are both family members to Ego and EF1, which supports the idea that this subgroup is heavily influenced by close family and friend relationships outside of Facebook.

Interestingly compared to the other members of the blue group, EF5 and EF6 are of the same general generation as Ego and EF1, and their posts shift from the social to the natural, whereas EF3 and EF4 are of a younger generation, and their posts shift more dramatically from Human coded content (that in context, is associated with a lot of interpersonal drama) to the Natural content engaged with during the storm. They shift back to Human capital topics immediately following the storm.

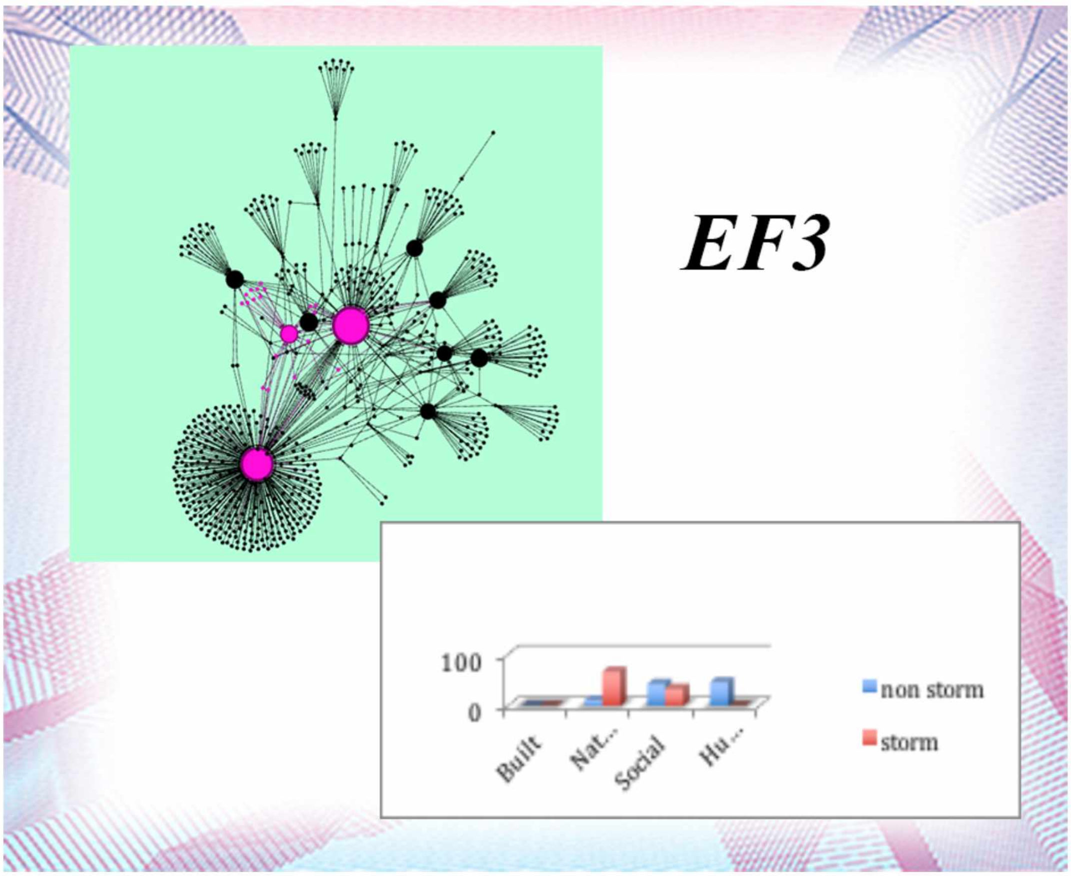


*Figure 27: **Structural position and thematic shifts of EF3.** EF3 is a member of Ego's Blue subgroup (see Figure 19) and is strongly connected to both Ego and EF1. EF3's content during the storm dramatically shifts toward Nature capital issues, but maintains a strong affinity to Social capital topics.*

During the storm, all blue group members engage with Ego and EF1 to learn general public information related to current conditions and the potential actions they may need to take to either help others or secure their own safety. None of them are formally or informally connected with the official community crisis response, meaning they are not serving direct Infrastructure Provider roles, but rather fill Resource User roles during the storm. However, for each member of the blue group, Facebook represent only one of many communication channels used to maintain these relationships (e.g. the multi-channel Skype auction). Ego and EF1 often serve as Infrastructure Providers in the region through these multiplex relationships (i.e. they organized the Skype auction).

The orange group is made of Ego, EF4, and EF9 (Figure 28). As described above EF4's conversation shifts from Human coded content to Natural during the storm. EF4 is local to the community and connects to EF9 who is away at collage within the state. EF4 and EF9 are of similar age and their posting activities follow a similar pattern of transitioning from Human coded content to Natural coded content and then back. The context, however, is slightly different for EF9 who is experiencing many of the common emotional ups and downs associated with leaving home to go to college. This group would seem to be closely related to the blue group, an interpretation structurally supported by the connection of EF4 to EF1. Likely, it is again bonded through a multiplex of other channels of communication and tied together through shared family and friendship experiences. Again, EF4 and EF9 are filling Resource User roles—consuming the information Ego and EF1 are generating, and then passing it on to their individual peripheral networks.

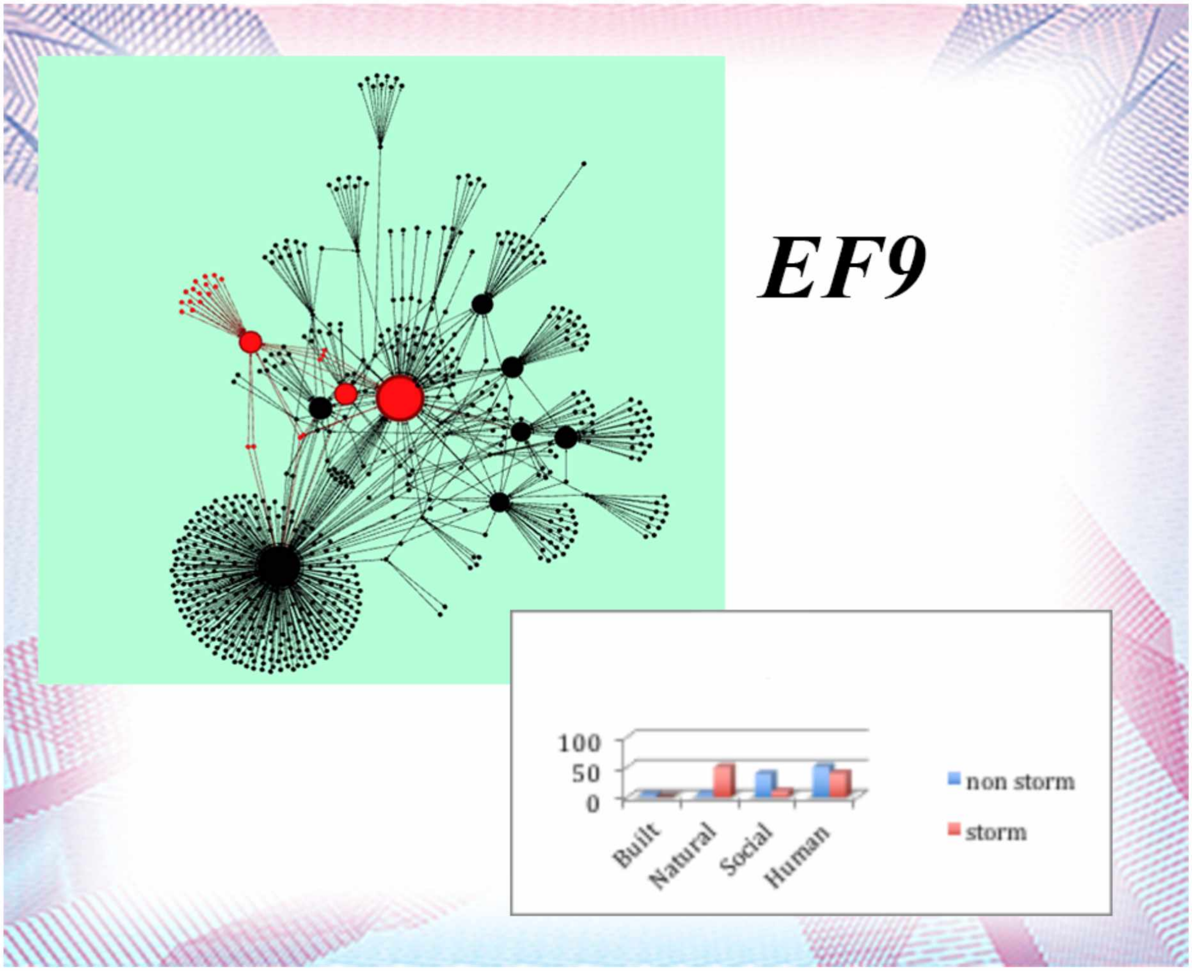


Figure 28: Structural position and thematic shifts of EF9. Is connected to the Orange subgroups (see Figure 19) and unlike many of the EF's in the Blue groups, EF9's engagement in Social capital issues drops during the storm. Instead, EF9 engages in more Human capital issues along with Natural capital themes.

In the pink group EF7 and EF8 seem to be connected to ego through shared school district activities (Figures 29 and 30), and through this context fill a similar Resource User role as the other groups. The probable lack of family ties with the subgroup means that EF7 and EF8 would more often relate to Ego as an Infrastructure Provider than mutual Resource User. Though all are in the same small community so multiplex relationships are certainly present.

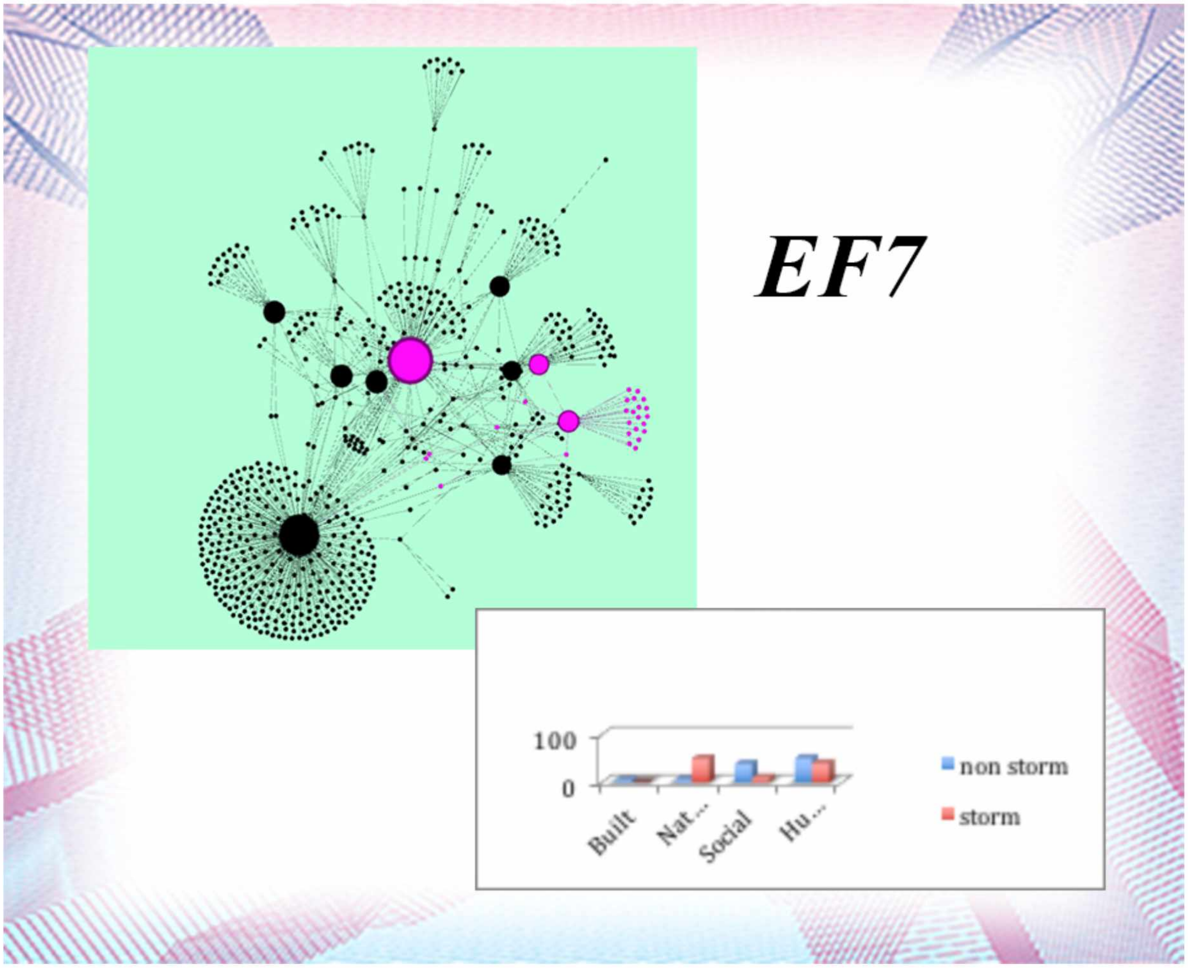


Figure 29: Structural position and thematic shifts of EF7. EF7 and EF8 are both members of the Pink subgroup, which is disconnected from any other subgroup other than the shared connection with Ego. EF7's content follows a similar relative increase in Human capital relative to Social capital as EF9. Interestingly, despite being part of the same subgroup, EF8's storm-related content shifts do not.

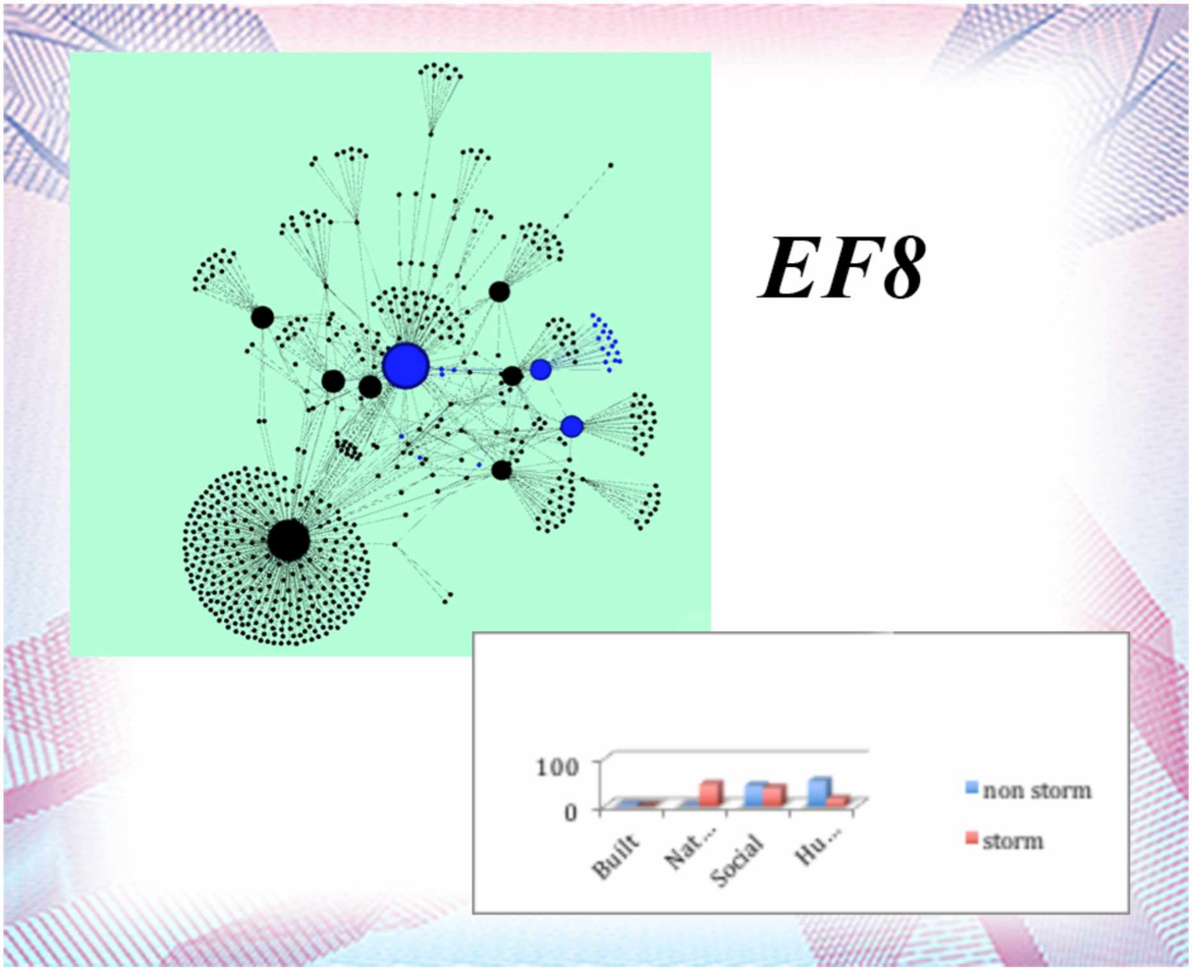


Figure 30: Structural position and thematic shifts of EF8. EF7 and EF8 are both members of the Pink subgroup. The themes of the content they engage in during the storm however, show different relative engagement in Human and Social capital topics.

Bering Strait Superstorm Conclusion

While the storm was still well out to sea small communication networks began to form around it. These developed through highly mediated technical channels between Alaska-based forecasters and remote sensing technology. As these networks evolved, more information was gathered and the potential magnitude of the storm was realized. The communication networks around the event expanded to stretch across Alaska, as well as into the Lower-48. It can be imagined that through word-of-mouth, face-to-face, and mediated channels (email, phone, face-to-face meetings) the highly mediated communication between the storm and the forecasters grew to include statewide media and mass broadcasting elements, as well as state and local institutional responders.

In this case study, I pick up the empirical trail at the point that the broader societal networks breach the local Facebook network of a community directly in the path of the storm. Specifically, by examining in detail the network relationships that develop between a key local responder—Ego, and his close network relationships (the EFs), we were able to explore the import question of role overlap addressed by Andreas (2013, 2004) in a real-world context—albeit through a single mediated channel. In this case it is clear that from Ego's perspective, he fills many different roles in his network, and specifically with high overlap between Infrastructure Provider and Resource User roles in meeting personal and community health and wellbeing obligations. Given the "resource" definition above, centered on ideas of community health and wellbeing, during the storm Ego served as an Infrastructure Provider but relied heavily upon overlapping networks derived from his different roles in the community. These relationships support the idea that greater role overlap produces greater local resilience, if you accept that this network provided sufficient communication for those within it to act with informed intent and take actions during the storm to maintain the health and wellbeing of the network at large.

I believe it did, and thus I conclude this case study illustrates an example where high overlap in robustness roles can positively contribute to overall network—or system—resilience. It is interesting, however, that within this broader pattern of high overlap, during the event Ego actually maintains a number of distinct subgroups within his inner network. This star, or hub-and-spoke-like pattern allows Ego to reach out in his role as Infrastructure Provider to distribute his information to distinct portions of his network, and in that way effectively reach out through it with relatively novel information to each member.

The radiating star like pattern of subgroups within Ego's inner network is an example of the type of structures I associated with release-style adaptive cycle events at the beginning of this chapter. In this case one branch of the network was responsible for gathering unique information while the others were devoted to sharing out. The high overlap in robustness roles is likely an important factor as to why these connections did not take on the more narrow classification of a true hub-and spoke network (i.e., there were radiating groups, not individuals in Ego's inner network). That amount of overlap allows for bonding relationships within each subgroup to support the value of the information and stress the need for action when needed. This is likely the network mechanism that supports the conclusion of Anderies et al. (2013, 2004) that high overlap lends itself to high resilience, but the evidence for that is tentative and a key area that any future communicative interventions would need to experiment with.

However, while the storm triggered a release style mobilization of resources (setting up a command center, evacuation orders), the event itself did not develop to the worst-case scenario of either storm forecasters or media broadcasters (Figure 31). Consequently, the actual events of the storm fell well within the physical infrastructure limits of the impacted communities, with only limited physical damage. In the flow of Facebook conversation, coded communication patterns return to very similar relationships after the storm as before (Figure 20). Combined these two observations suggest the network oscillated from an at rest condition, with tight connections and conversations around human and social issues to a more segment network during the event concerned with natural—and to a very limited degree infrastructure issues—then back to conversations around human and social concerns. The overall system was resilient in physical terms. From the networked communication model I am presenting here, it can be understood as moving from a conservation phase to near the release phase, and then back to a conservation phase.

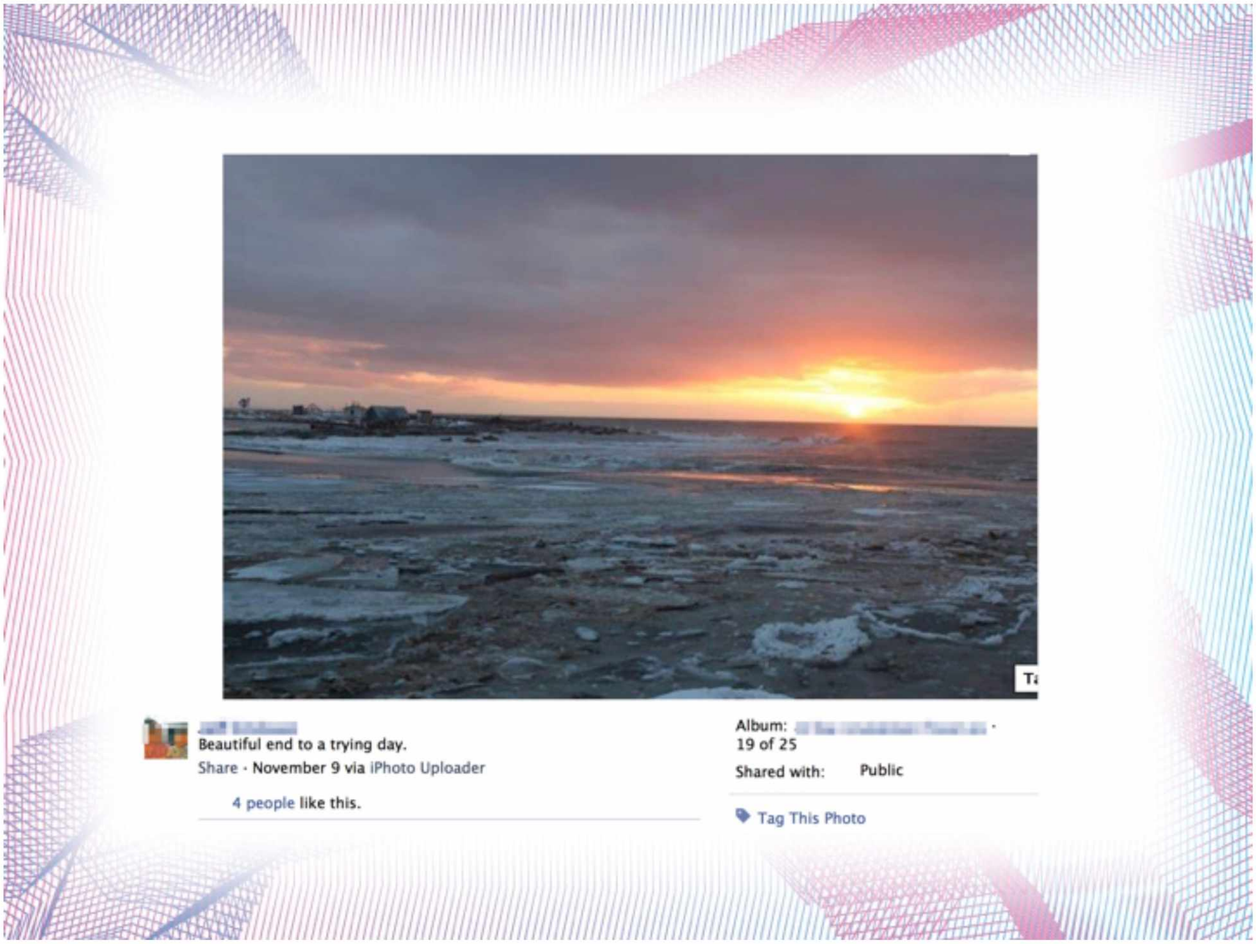


Figure 31: Sunset after the storm. An ideal literal metaphor for how this particular system responded to the stresses of the fall 2011 super-storm.

Galena Ice Jam Flood Case Study

Community; release to reorganization phase (Figure 32).

This is not the situation in our next case study. In Galena (Figure 32), I explore a second Facebook crisis-response network. This one also formed in response to an extreme, but known, natural hazard in the region. However, in this example, the natural event—an ice flood during spring breakup on the Yukon River—completely overwhelms the physical infrastructure of the community. This forces the community to rapidly shift through conservation, release, and re-organization phases of the adaptive cycle as they try and maintain the social and environmental continuity of their community. I shift the level of analysis shifts in this next example as well, moving from the individual to the community in order to illustrate how some of the patterns observed at the individual level translate to higher social structures.

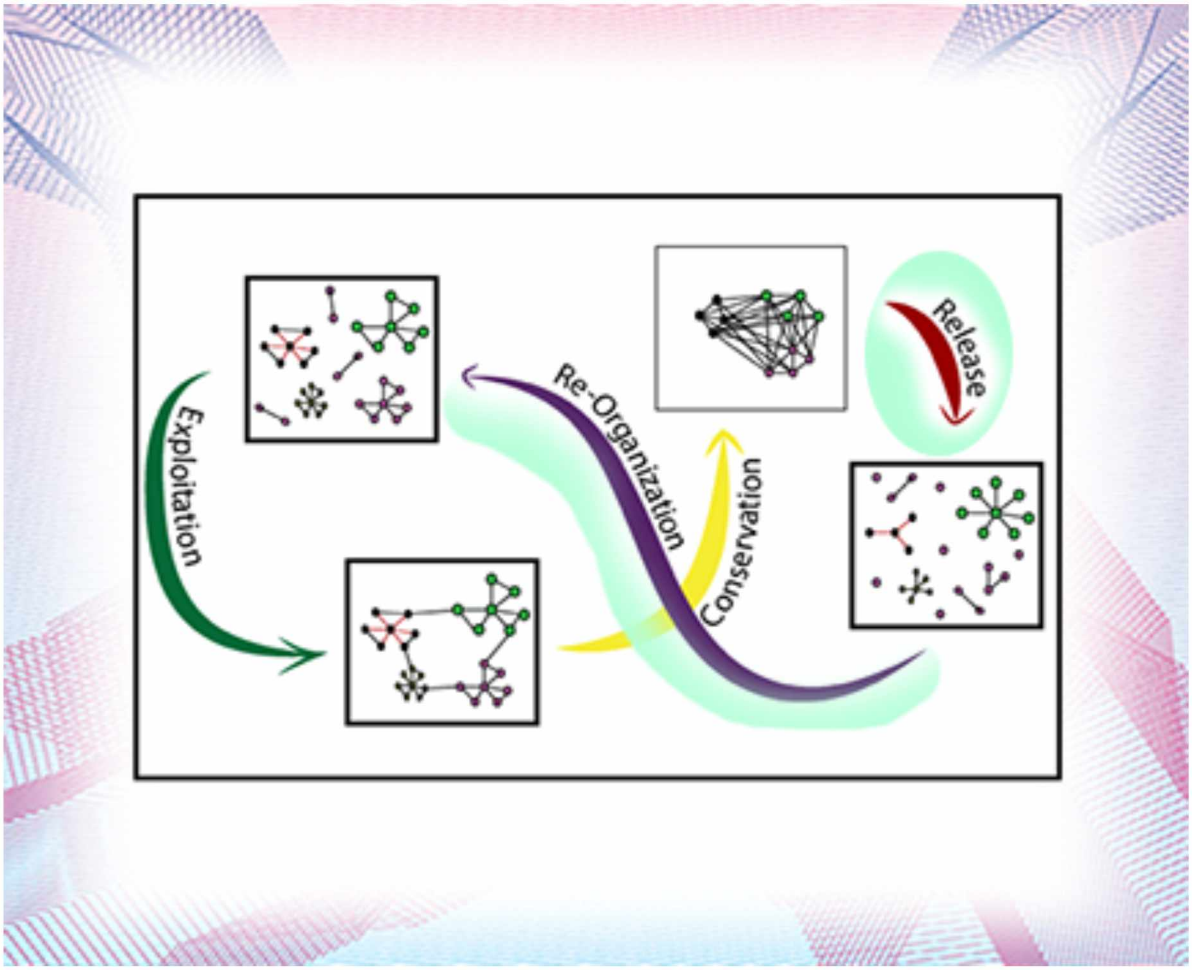


Figure 32: The Galena flood, community release to reorganization phase. The Galena case study traces a crisis-relief network through the Release and Re-organization phase of the adaptive cycle. The Release phase is characterized by high numbers of components as ties are broken by the stress of the crisis. Hub-and-spoke structures may be present. The Re-organization phase is characterized by fewer components and more interconnectivity between nodes.

Within the framework of this dissertation, the Galena flood example describes social-ecological events that transition from the release phase through to the re-organization phase of the adaptive cycle (Figure 11). Applying the basic elements of the robustness model to this system, the ecological triggering point is clearly the flood itself, while the resource of concern is once again the physical and social infrastructure that maintains the established health and wellbeing of the place-based local community of Galena, Alaska. The specific physical infrastructures of concern are the water/septic, electric, and transportation systems along with the physical property (homes, vehicles, clothing, etc.) and food security needs of community members. Social infrastructures to maintain the health, education, and governance systems are also at issue, as well as family and friend relationships. Infrastructure Providers and Resource User roles will be discussed in detail below.

Much of the work below is adapted from a collaborative project with Dr. Karen Taylor and Dr. Yekaterina Kontar (Taylor, Hum, & Kontar, 2016). It was my great pleasure to work with both of these researchers and with great appreciation I acknowledge their contributions to my dissertation—both in the specifics of the case study below, and in the wider ranging conversations that have informed it.

Context and Triggering Event

In May 2013, an ice jam caused major flooding in Galena, a remote village in interior Alaska (Figure 33). Although the flood did not result in fatalities or major injuries, it still caused significant suffering to Galena's residents, destroying nearly the entire region's infrastructure in just two days (Figure 34), and displacing over 300 residents (Andrews & DeMarban, 2013) out of an approximate population of 470.

Figure 33: Galena location map. Galena is located in interior Alaska on the northern banks of the Yukon river. Air travel is the primary mode of transportation into and out of the community, however during the ice-free month river barges do provide additional material shipping options.

Figure 34: Galena flood damage. During the flooding event hundreds of photos from news media, relief agencies, and residents who did not evacuate were posted online. These four screen captures from that media influx illustrate the severity of flooding the community had to deal with.

Ice jam flooding is not uncommon along the Yukon River; it is controlled by a set of local factors that include river channel morphology, ice cover thickness and strength, flow hydrograph, freeze-up conditions and seasonal scale weather patterns (Beltaos & Burrell, 2015). These factors make ice jams on the Yukon River very sensitive to changes in climatic conditions.

The spring of 2013 was unusual. April and early May were the coldest in decades in Interior Alaska (Andrews, 2013a). As a result, the winter snowpack in the Yukon River drainage basin remained in place weeks later than normal, and river ice remained solid (Andrews, 2013a) throughout this timeframe. When the cold snap finally did break, it was late into the melt season and the solar radiation was intense compared to more normal years. The increased intensity of solar radiation and a deep snow pack (relative to the time of year) forced a lot of runoff down the still frozen river, lifting the ice and moving it down stream while it was still quite thick. Thus, when the inevitable jams occurred they were held together by thicker than normal ice, and therefore persisted longer before being degraded enough to wash downstream. For these reasons the 2013 spring break-up along the Yukon River was unusual and created a number of flooding events for communities along its banks.

The community of Eagle, Alaska, was flooded on May 17, 2013 (for the second time in four years), when a short-lived ice jam backed up water into several homes (Schwing, 2013b). Two days later, almost every building suffered flood damage in Circle, Alaska, when an ice jam developed just below the town. That ice jam broke out quickly and the floodwater receded (Andrews, 2013b) equally fast, limiting damage. However, the most stubborn of these ice jams formed on May 26 at Bishop Rock, just down river of the community of Galena. This created major flooding in the community, far surpassing what had occurred in either Eagle or Circle (Figure 35).

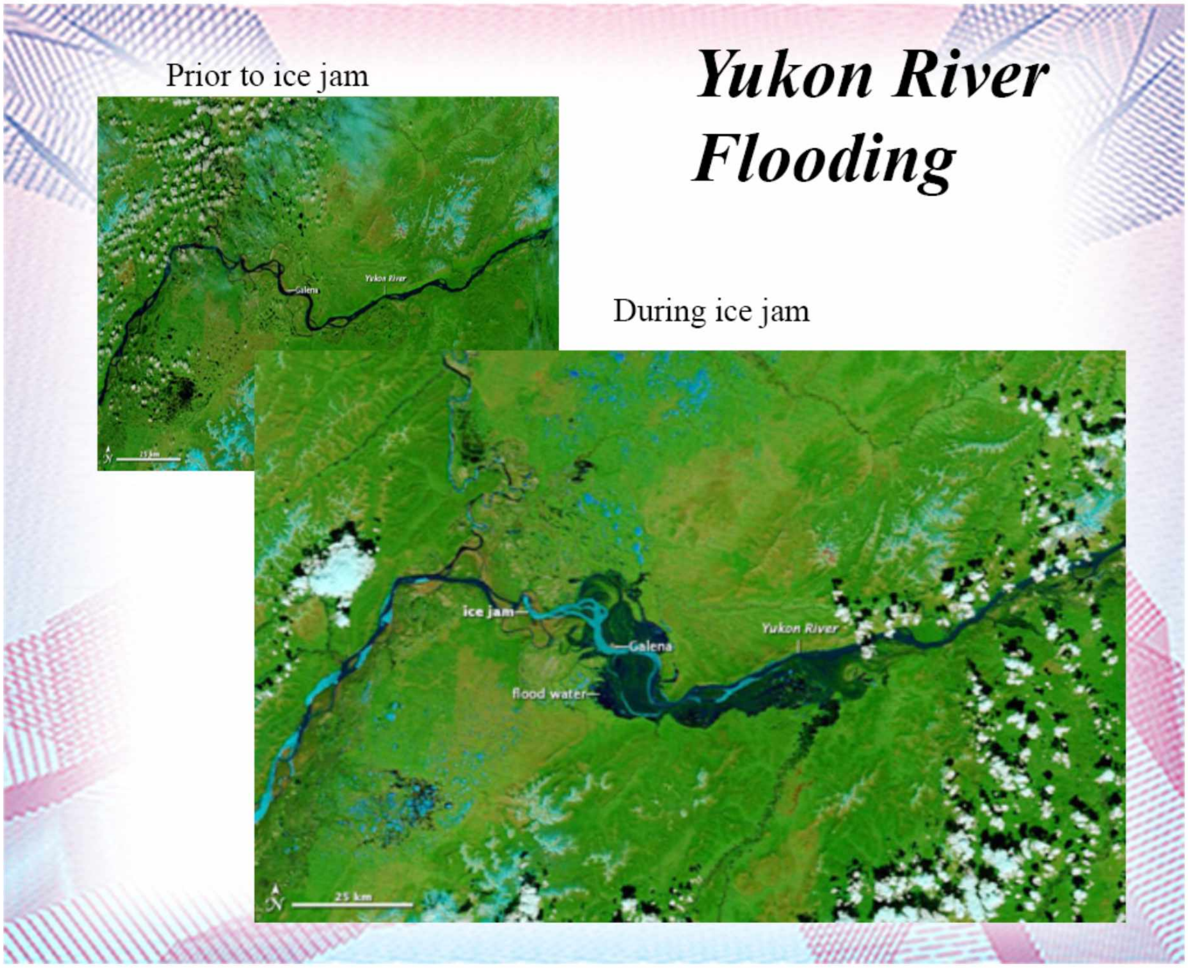


Figure 35: Impounded water behind Bishop Rock ice jam. (" Ice jam on the Yukon River floods Galena, Alaska: image of the day," 2013)

Ice backed up more than forty miles behind the Bishop Rock jam before it released on May 29, 2013. As the flood inundated Galena, evacuation efforts began on May 26. Within two days, the majority of Galena residents were evacuated. A few people chose to stay behind and were stranded in the levee-protected temporary shelters at the Galena airport and the Sidney C. Huntington School building.

The response and recovery in Galena was challenged by logistical and cultural factors unique to Alaska (Senkowsky, 2014). The community is located in the central interior region of Alaska, just south of the Arctic Circle, approximately 270 air miles (435 km) away from the urban center of Fairbanks. It is not connected by the road system in Alaska. Thus the community can only be reached by air or river travel and supplies must be delivered via plane to the community airport or barges on the Yukon River when it is ice-free. The river, however, remains ice-free for only a few short summer months. During winter, it can only be traveled via snow-machines (snowmobiles).

Partly as a result of the difficulty of receiving outside goods, but primarily due to strong cultural ties to Koyukon Dené (Athabascan) ways of being, Galena residents rely on subsistence hunting and fishing as a key element in their food security system, as well as the sharing and social networks that facilitate these activities. The flood impacted nearly ninety percent of Galena homes, and many residents lost the opportunity to participate in subsistence activities during the following summer and fall (Senkowsky, 2014). This was true for three important reasons: the majority of the population was, 1) dislocated to urban Alaskan communities, 2) lost the physical means to participate in them (destroyed nets, fish wheels, smokehouses, freezers, etc.), or 3) were preoccupied with rebuilding efforts. Many residents were impacted by a combination of all three.

Over the course of five days (May 26-30), the town was progressively inundated. First Galena's oldest and primary neighborhood—Old Town—was flooded and then parts of New Town were submerged. Old Town contains homes and buildings including the town's post office, the Yukon Inn bar and restaurant, and municipal offices. It is situated close to the river and just meters above it, making it susceptible to annual spring flooding. Old Town is located between the Yukon River and a levee built in 1939 around Galena's former Air Force station, which is now a fully operational and state-owned airport ("Galena City", n.d.). New Town is primarily composed of homes.

Air traffic is the primary method of transportation into or out of the community when the river is not navigable, as a result, although the airport is situated in close proximity to the river, it is protected by levees. Emergency flood assistance was possible during the flooding due to the fact that the airport runway remained operable. The majority of people evacuated within the first three days to Anchorage, Fairbanks, Ruby, and Tanana (Alaska Prepares for More Spring Breakup Flooding, 2013). Some people left via private aircraft, while the majority used aircraft that were sponsored by the Tanana Chiefs Conference, a tribal consortium of 42 Interior Alaska villages (Andrews & DeMarban, 2013). Approximately 30 people remained in Galena during the flood, choosing to stay at the local school building and military dorms, which were converted into a temporary shelter (Hopkins, 2013). The town lost both water/septic and electric service, creating sanitation issues for those who stayed.

During the actual flood, and in the months that followed, many residents were critical of the evacuation and response efforts. This criticism was primarily directed at a perceived slowness to act by state and federal agencies—community perception familiar to many in rural Alaska, and one specifically shared by many in the community of Eagle, Alaska, which experienced a similar ice-jam flood event in 2009 (Schwing, 2013a). To a certain extent, during the Galena event this can be explained by communication challenges associated with the immediacy of the flooding. However, even after, it took three weeks for a federal disaster to be declared. Finally, at that point, formal collaborations between local, state, tribal, federal, and non-governmental partners could provide residents with necessary life-sustaining services in a coordinated effort (Andrews, 2013b). This lack of timely coordination and reliable communication between community members, state and federal agencies, and their individual representatives was a common refrain from all involved throughout the recovery process. In the absence of formal coordination, ad hoc networks developed to meet the needs of displaced community members. The Yukon River Rescue Facebook group is one such network, and the primary focus of this case study.

A federal disaster declaration wasn't issued until late June. Rebuilding and recovery in Galena, which was estimated to exceed $80 million, was slowed by problems with transportation, supplies, and bureaucracy (Andrews, 2013b; NWS Flood Safety, US Department of Commerce, & NOAA, 2014). The remoteness of the community from the infrastructure that the Federal Emergency Management Agency (FEMA) typically relies on slowed the federal response to the disaster. However, the seasonal challenges of a short building season and the limited time period the river is open for the delivery of building materials placed further time-constraints on the relief effort.

The Yukon River is only reliably open for boat traffic from June through August, and is the primary route for transportation in the region ("Galena City", 2014). A year later, reconstruction of Galena was still in progress, and nearly 10 percent of residents remained in shelters in Fairbanks and other towns (Friedman, 2014). Through this context we explore how the Yukon River Rescue Facebook group served to initially fill in gaps between formal and informal relief networks during and immediately following the flooding events and then transitioned into more of a social-maintenance role as the long term nature of individual community members physical displacement from Galena wore on.

Network Bounds and Methods

In this case study the network boundaries as well as analysis methodology are slightly different than in the Bering Sea case study. To begin, the networks described below can be considered "whole networks" in that they are bounded by the complete posting, commenting, and liking behavior of participants on the public, or "open," Facebook group site Yukon River Rescue (YRR). YRR formed explicitly in response to the Galena Flood. In the Bering Sea example, on the other hand, all the assessed networks were based on the single perspective--Ego. Quantitatively then, in the Galena case study I am scaling up my analysis from the individual to community-level network perspective. The scale change to a whole-network allows for a variety of new analytics to be used in understanding the communication dynamics during and after the Galena flood that were not appropriate for the ego-networks examined in the Bering Sea example. The background section on network theory in the introduction reviews the main principles behind these assessment tools, while the evaluation framework discussed in the beginning of the Alaska case study section describes what these tools can tell us about the communication dynamics within a network. Two specific analytics are not discussed in either of those sections and are particularly important in this case study.

The first is network diameter. Simply described, diameter is just the number of nodes a single piece of information needs to pass through (steps) to go from one side of the network to another.

The children's game of "telephone" illustrates this measure well. In the game a message is whispered from one child to another around a circle. The number of children playing is the diameter of the network that they form during the game. The fun in playing "telephone" is in how silly and distorted the message becomes by the time it makes it all the way back around to the child that began it, which gives some indication of how network diameter can impact information fidelity across a network. Therefore the diameter of a network can serve as an initial indicator for the fidelity of information flow across it (Borgatti et al., 2009; Borgatti & Halgin, 2011; Getchell & Sellnow, 2016).

Closely related to network diameter, in terms of how information flows through a communication network is the concept of network density. Network density measures the number of connections in a network relative to the number of nodes. A dense network has a greater number of connections relative to nodes than a less dense network and thus dense networks provide more paths for information to flow through the network than less dense networks. Size matters however, and in order to compare density across networks, calculations must be normalized based on the total number of nodes involved (Borgatti et al., 2009; Borgatti & Halgin, 2011; Getchell & Sellnow, 2016). The distribution of density differences within a network is the foundation for structurally identifying subgroups within a network.

Network diameter and density can only be calculated if all nodes in the network are connected. In an ego network, every node is connected to the others at least through ego—by definition. In the Bering Sea example the diameter was set by my methodological choice of tracing out two steps from Ego, which is why it is not a relevant measure in that study. In whole networks on the other hand, all nodes may not be connected to one another and the diameter is determined by the actions of network members and not by methodological choices. In networks where some nodes are not connected to others through any path, each disconnected group is termed an individual component of the whole network. Networks can then have any number of components, and components themselves can be any size, from a single node (common on Twitter) to all the nodes in the network (e.g. an ego network).

In understanding connectivity across a network the number of components gives a first approximation, with a high number of components indicating a lack of cross-network connectivity. Network diameter then provides a more granular indicator of connectivity within components, where larger diameter networks can often indicate lower levels fidelity across the network, but this is complicated by network density, which can disrupt the flow of information across the network. Therefore, differences in density across regions of the network provide the finest scale understanding of overall network connectivity.

In collecting data for the Facebook group, NodeXL software was used exclusively for content retrieval, network analysis, word-pair analysis, and graph visualization. Longitudinal data was collected at both monthly and daily scales. May-December 2013 and May 28-July 31, 2013, respectively. Posting activity frequency curves were constructed for each time scale. Key points along this curve were identified for more detailed network and content analysis at both scales.

NodeXL is designed to provide a simple and fast method to create explorative social network analysis studies (Bonsignore et al., 2009; Hanna, Rohm, & Crittenden, 2011; D. L. Hansen et al., 2011; Hansen, Shneiderman, & Smith, 2009), as such it is an ideal tool to use when looking for dynamic network relationships because time-sliced networks can be relatively easily constructed.

The first step in our workflow is to retrieve the social media data. To do this we used the NodeXL add-on Socialnet Importer, and taking advantage of their Facebook group import feature pulled time-sliced information from YRR. YRR formed during the active evacuation of the community (as did a handful of other related groups), and quickly became the most active group, and hence the focus of our study.

Two sets of data were collected. One aggregated group activity across monthly time intervals for a seven-month period following the flood. The second focused on the early phases of group development and aggregated group activity at a finer daily resolution for a shorter total time period.

Network analysis sought to characterize dynamics at a community level. As such, post/comment frequency, number of network components, geodesic distance (diameter), and density measures were calculated using NodeXL's basic metric functions. Word-pair analysis was also conducted using NodeXL default language analysis tools. Lastly, graph visualizations were developed using NodeXL's visualization package. The networks in this study are small enough (<7,000 edges for any one time slice) that filtering is not required and all networks were visualized using the same protocols—namely the Fruchterman-Reingold layout algorithm with node color and size dependent on centrality (a simple "degree" measure, unless otherwise noted), and edge thickness based on tie strength.

Results and Discussion

The analysis of both the monthly and daily Facebook data began by examining the frequency of activity both in terms of unique posts, and the level of engagement with them (number of comments and likes). At each scale there is an initial burst of activity that then rapidly trails off, in a rough power-law form. This is interpreted to represent an initially broad public interest in the flood when the event was "news," people's needs were immediate, and concern was focused on meeting the essential needs of life—food, clothing, shelter, etc. The network wide structure that developed, describes a large hub-and-spoke type of structure similar to what we saw in the periphery networks of the Bering Sea storm case study. A qualitative reading of the content in these conversations (Appendix A)—much like in the Bering Sea case, suggests these bridging-type relationships seem to allow new resources into the system. Much of the content here is focused on offering to help with immediate food, shelter, and clothing needs. Additionally, most of these offers are coming from people less directly connected to the community than those who actually lived there. Combined this represents an introduction of new resources into the network. Through a series of expansion and contraction cycles, and over a relatively short period of time however, the network evolves into a structure more characteristic of the bonding-type relationships that we saw in the Bering Sea core network and associated with closer knit intra-community relationships (Bodin & Crona, 2009). Early in the response, it is during these bonding phases of the network's evolution that offers of help are turned into action as posting turns to the logistics of when, where, and how to get material goods to the people that need them. Later in the response, these periods of closely bonded communication are where social, rather than material, needs are met (organizing a softball tournament). Looking at specific points along the activity frequency curves provides a more nuanced understanding of how the network changed over time.

First, in the monthly data (Figure 36) we see an almost instant explosion in activity when the page is created on May 28, midway through the flood. This likely has a lot to do with the urgency of the context—i.e. people are being flooded and fleeing with very little in the way of material possessions in real-time as people interact with the page. The extreme rate at which activity grew on the YRR page (from zero on May 25th –i.e. prior to its creation, to over 8,000 combined posts and comments on May 26th –the first day of its existence), however, suggests that to at least some extent it is taping into already established networks that shared some (unknown from the perspective of this research) cognitive connection to the physical community of Galena. It is important to remember that the actual physical community is small. The initial level of activity on the YRR Facebook page far exceeded what the physical population of the community likely could sustain. It seems fair to assume then, that any pre-established networks that were tapped to support YRR's relief efforts were likely maintained through both face-to-face and at-distance communication channels in order to reach outside local physical boundaries. Under this context, YRR served as a spontaneous focusing platform for ties otherwise established (and maintained) through a wide variety of (likely) diverse, but unobserved communication channels. This is an important observation to note for institutions and organizations interested in coordinating with and facilitating grassroots relief efforts, as it highlights the importance of investing in local relationship building activities outside the normal domains of crisis relief organizations. In other words, it highlights the need to develop role overlap between resource-users and managers prior to a crisis such that when crises networks form, established routes (network ties) for participation are already established.

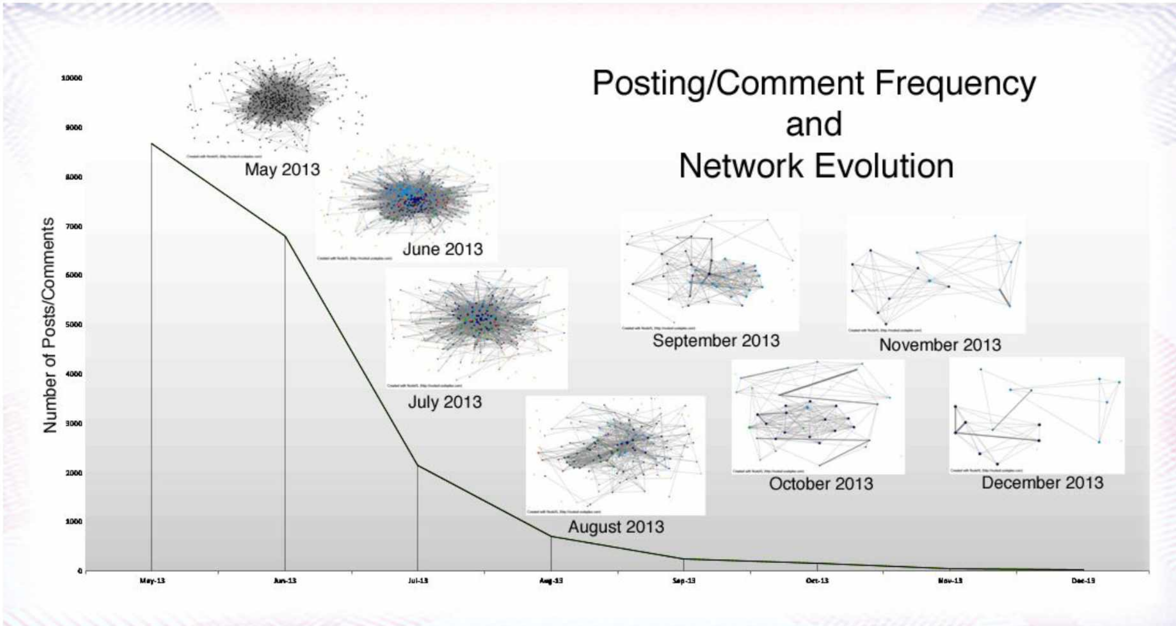


Figure 36: Posting frequency and network structure compiled at monthly intervals. Dates are listed by month then year. At this scale the network shows a steady decline in overall activity. Network structure is initially defined by high numbers of bridging relationship and small, disconnected sub-components to increased bonding relationships and fewer and fewer disconnected sub-components.

The YRR networks in these early phases (Figures 36 and 37) have a large number of components (63 and 73 on May 26th and 27th, respectively). As described above, a network component is a segment of a whole network with no ties to other parts of the network. From a communication connectivity perspective, high numbers of components result in little to no information fidelity across the network. Of course in this case, we are only identify connections based on comments and likes on each YRR posts, and certainly more people are reading each post than are engaging with it, thus the networks presented here represent a minimum level of total network connectivity. Nevertheless, the large number of components we see when YRR activity first emerges aligns well with the idealized network structures I've tied to the release phase of the adaptive cycle and described in the background section above. In the adaptive cycle this is a period where old system relationships have been proven ineffective and new ones are forced to develop in response to new system demands. The creation of the YRR page itself represents one level of system re-adjustment in response to the flood, as prior to the crises no reason existed for its existence. During and after the flood, new communication demands challenged the community and one response was the creation of YRR, but within YRR this same process was repeated on a smaller scale (i.e. within a single communication channel) as community members re-organized through this new channel to meet their various needs. The high number of components reflects this initial disconnected network structure.

Close examination of the early YRR networks (Figure 37) show that the vast majority of components are small in size (1-3 nodes). However, one component is much larger than the others. The diameter of this main component is also fairly large—which means that while most nodes in the network are connected to this large component, they are not well connected to one another within it. Which is to say there are a few central nodes connecting people. Instead, the majority of people are connected through linked chains of friends-of-friends-of-friends, rather than directly to one another in a dense network structure. Correspondingly, individual node centrality in the network is highly segmented, with a few nodes being highly central but the majority having only weak centrality scores (Appendix A).

We interpret these combinations of network properties to be indicative of an initial broadcast form of communication, where a few very central players are driving a large portion of the communicative traffic. In other words, these highly central network members are disseminating and/or originating the majority of information through the network. That content is then picked up by less, but still active users who then pass it along through their individual connections in a more one-on-one (or interpersonal) fashion down their unique chain of friends. This creates long trailing spokes in the hub-and-spoke pattern and accounts for the large diameter that we see in the early phases of YRR's development (Figure 37, May 29th and June 1st).

As the summer turns to fall and then into winter, total YRR activity initially declines rather dramatically, then steadies and tails off gradually through December (Figure 36) Network dynamics mimic this pattern through both a decline in the number of components and the diameter of the largest component through this time period. Density increases within components as well, and centrality distributions become more even across the network. These patterns define a shift from large volume information dissemination and coordination early in the flood response to more intimate, bonded, and supportive communicative practices as time progresses.

In this case study we use a burst frequency analysis to examine the text-based Facebook data using an algorithm that focuses on “stop” words and selects terms based on frequency-of-use relative to frequency in the overall expected use based on the language as a whole, a statistical technique useful for “big data” sets (Bengston et al., 2009). In subsequent case studies I use simple frequency counts along with word pair analysis (visualized via word cloud diagrams) to accomplish the same quantitative language processing goals, regardless of method however, all of the quantitative results are heavily influenced by (and undertaken in support of) the qualitative reading of the Facebook content (Appendix A).

When we explore the burst frequency data for the Galena flood we find that personal names, place names, and even personal phone numbers are among the terms that come up throughout the summer months (June through August), as people establish (re-establish) connections across multiple communication channels via YRR. Common verbs used during this period are “assist,” “answer,” “**hate**,” “hire,” “join,” “loan,” “limit,” “pass,” “**pile**,” “**pitch**,” “**play**,” “receive,” “realize,” “remind,” “**sell**,” “sign,” “ship,” “**spread**,” “suggest,” “support,” and “work.” The bolded terms are those that were most statistically significantly different in terms of frequency of posting relative to their frequency in the language as a whole. Notice that all of these represent actions done by single persons, at least in this context, but additionally they describe the internal workings of a community operating across a range of communication mediums.

The initial first-day posting rate dropped to 400 on the second full day of the site’s creation (Figure 37) and by June 2nd the daily posting rate was down below 100. It then spiked upward again on June 7. The rate of drop-off after the June 7 spike was slower than the initial drop off. This may be because it was a secondary flare up of an already weakly established network, possibly indicating that interacting on the site was more of a communication norm at this point. Pulses in the network activity, as shown in figure 37, with changing ratios of intensity and duration seem to act as a cementing mechanism to test out, reject, and re-organize different network configurations that later serve as the foundations for more resilient bonding relationships.

On June 11 a low point was reached (no posts with that date), and then activity returned to a short-term plateau of approximately 100 postings per day for almost a week (Fig. 37), after which a rapid decline occurred. Posting continued at a low, but fairly steady rate, averaging 40 per day for the remainder of the time during which the site was observed—about six months.

During the second month, post content reveals a shift to greater inclusion of various disaster response organizations, either through indirect reference in commenting between established network members or direct representation by the agencies themselves (Appendix A). In the first month, the only organization mentioned on the site was the Small Business Administration (SBA), with only a low frequency. During the second month, we see SBA, FEMA, the Catholic Diocese, the Yukon Tribal Conference, the "school" (in reference to a regional boarding school located in Galena). Of those, the Catholic Diocese had the highest burst frequency result, and religious organizations remain important in the networks throughout the period we observed them. The verbs that are represented on the burst frequency analysis are "**adopt**," "contact," "**contribute**," "distribute," "enjoy," "**include**," "learn," "manage," "**pick**," "**plan**," "provide," "rebuild," and "**went**." Again, the verbs occurring with highest frequency are bolded here. It might be interesting to note that these verbs are on average longer, only four single-syllable examples instead of the half-dozen in the first month's burst frequency analysis. Most of these are words we associate with actions that are coordinated across multiple individuals. For example, the verb "adopt" occurs with such frequency because it conveys a caretaking relationship and those responsibilities were being shifted and re-negotiated (at least temporarily, with potential for longer-term implications). This is a change from the first month when the focus was on individuals as informal community oriented institutions formed to support the displaced community members. YRR was just one channel of communication supporting this informal institutional development, but within it we see examples of how a geographically dispersed group of people came together spontaneously to support one another. By the second month the informal networks had cemented their internal needs and structure, and began actively seeking external support as a cohesive group—sharing and disseminating information through established informal paths just as formal institutions finally began to be able to work collaboratively (with the federal disaster declaration).

During the third month, verbs include “continue,” “cover,” “donate,” “follow,” “gave,” “hope,” “inform,” “need,” “send,” and “touch.” During the final months of our analysis, few words are added that had not been part of previous conversations. Of those that do appear in the burst frequency analysis, most mark a shift to a strongly positive tone. “Glad,” “good,” “happy,” “love,” and “prize” are the most notable. It would be pleasant to believe this indicates that by this time period, the Galena story is wrapping up towards a happy ending. Of course, it could also represent a return/reinforcement to the Facebook norm that encourages primarily positive posting.

An interesting characteristic about these verbs is that each month tends to have clusters of initial letters (i.e. the first letter of each unique word is the same). In terms of the verbs, the first letter of words in the first month tend to cluster around the letter **s** (6 out of 21, or 29%, or 50% of the highest frequency terms), in the second month initial letters clusters around **p** (3 out of 13, or 24%, or 33% of the highest frequency terms). Instances like this in conversation get referred to as examples of “convergence,” that is, of styles shifting to reflect each other’s speech patterns (Giles,1997). High levels of convergence usually would be taken as a sign of emerging community, or already-existing community.

Data aggregated at the daily scale gives us a more nuanced perspective on how this transition occurred. Our daily aggregates cover the time period from the initial formation of the group on May 28, 2013 until July 31, 2013. Like the monthly data, the daily frequency curve shows high volume activity instantly once the group is formed then a rapid tailing off. This, again, would seem to indicate that YRR tapped into well-established networks at its onset. At the daily scale, however, more variability can be seen in the frequency curve (Figure 37).

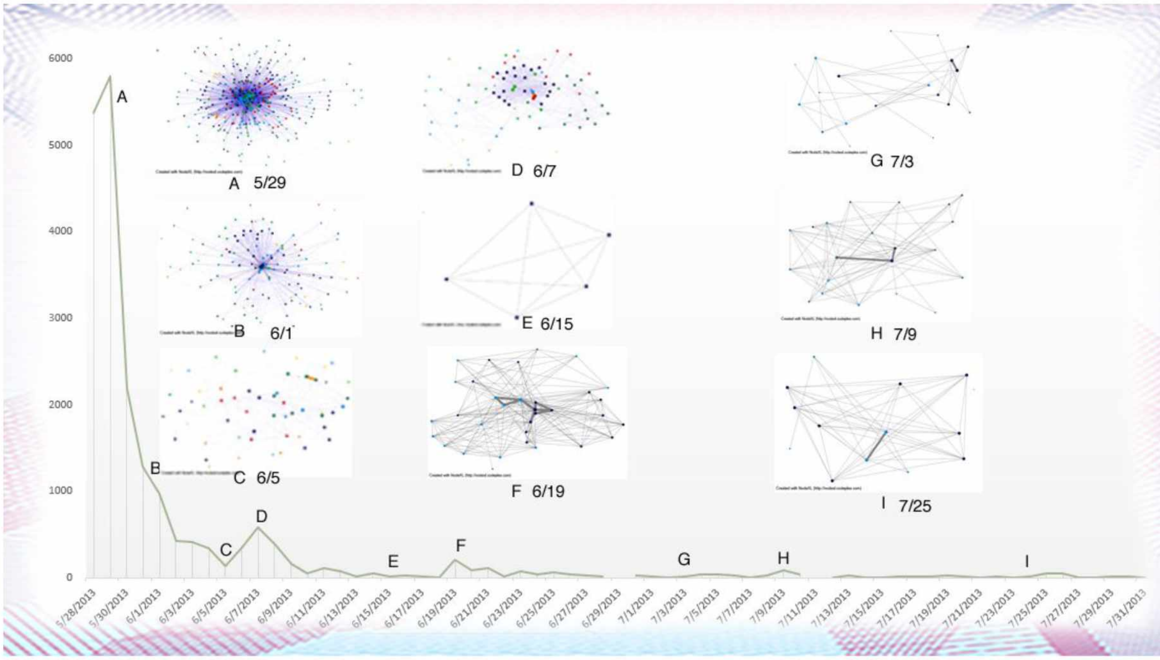


Figure 37: Posting frequency and network structure compiled at daily intervals. At the daily scale we can see that the smooth transistions observed in monthly compilations are not smooth at all, but rather puncutated by smaller scale expansion and contraction events. Key inflection points are labled. Initial expansions (A and D) follow release-style expectations with large numbers of small components and a large disparity in the distrubution of centrality across network nodes. The expansion at point F is slightly different and results in an increased information flow and network size through bonding-style relationships rather than bridging.

As stated, initial activity levels taper off very quickly—within just a few days of the flood, as we see in points A, B, and C in figure 37. The daily networks through this initial phase of group evolution look very much like the early monthly networks—a central component of large diameter and a few highly active members (Figure 36, May through July). This again, is interpreted to represent a broadcast style of communication where a few key people are driving communication. The hub-and-spoke pattern seen from May through July (Figure 36) in the monthly aggregate data as well as points A and B in the finer grain daily data (Figure 37) are characteristic of the network structure expected in the beginning stages of a release event. There are a large number of small, disconnected components dominated by a single much larger central component. Within the main component there are a high number of bridging relationships, which increase the diameter of the network. These bridging ties form the periphery of the central component. The core of the central component is defined by increased connectivity between nodes (increased density), this is characteristic of the bonding-type network relationships discussed in the introductory discussion on network theory.

Content of the initial burst of messages tended to focus on individuals and village-level concerns as discussed above (Appendix A). High-frequency descriptors included “flood,” “Galena,” and “water.” Words that did not overlap but were seen with high frequency on Facebook included the verbs “know,” “get,” “thank” and “help.” Indeed throughout the first two weeks, “thank” remained constantly among the highest frequency words per day. The first mention of any organization occurs on June 1, referencing the Tanana Chiefs Tribal Council (TCC on Facebook).

We see that by June 5th (Figure 37, point C) as activity begins to decline the dominant hub-and-spoke pattern of points A and B (Figure 37) diminishes. Overall network density increases and the diameter decreases. Individual centrality measures become more uniform across the network as well. These properties indicate a network transitioning from a broadcast type of communication (with a large diameter, high percentage of low centrality periphery members and a few highly central core members) to a more interpersonal style of communication characterized by increased density, a relatively small diameter, and centrality measure that are more evenly distributed across the network. It seems that the network is trying to come to a new balance as the benefits each network member can bring to the system are explored. This defines the re-organization phase of the adaptive cycle, but cannot be captured in a single time slice, as it is the fluctuation between bridging (or broadcast) and bonding (or interpersonal) network configurations that illustrates the experimentation and testing characteristic of the processes occurring during the transition from release to reorganization phase.

By June 7th (Figure 37, point D), activity flares back up. When this happens the diameter of the network expands, a number of small, disconnected components spring up, and centrality distributions again differentiate before evening out as the activity quickly diminishes by June 15 (Figure 37, point E). From a smaller scale than we are examining here, this burst of activity represents a new release phase, and serves to reshuffle the bonding connections that were starting to form on June 5th. But, from the scale we are concerned with this is representative of a continued process of reorganization along the adaptive cycle.

The June 7th spike, reaching a height of about 500 messages, centered on conversations thanking the village of Fort Yukon, upstream of Galena, for organizing a cleanup effort and fundraiser to help support it. No reference to FEMA appears until July 9th (Figure 37, point F), at which point it becomes the single most frequent word. It is interesting in this case that the network does not react in the same way it did previously (points A, B, and D) to increased activity. In those cases the network reverted to release-like structures to accommodate the increased activity, in this case it maintains a strongly bonded structure but grows in size (i.e. there is an increase in the total number of nodes without any substantial increase in overall diameter or decrease in density). This is likely an indication that at this stage the network is fully into the reorganization phase of the adaptive cycle. Throughout the remainder of the time slices examined minor burst of activity occurred (points F, H, and I) and in each strongly bonded structures persist.

Galena Ice Jam Flood Conclusion

Interestingly, in the Bering Sea example we saw that the individual-level and local-scale virtual networks had high overlap between Infrastructure Provider and Resource User roles—and the system was able to maintain and sustain its integrity throughout as well as after the crisis. In the Galena example we see this is also true at the community level and statewide scales (i.e. the success of the YRR page to maintain community despite physical dislocation). Unfortunately, with the jump to national level agency support at statewide scales (i.e. agency relief networks based in urban Alaska centers), we see the overlap diminish to arguably poorer physical results. This further lends support to the idea that high overlap between individuals who fill both Infrastructure Provider and Resource User roles will increase the robustness of the infrastructure system they help maintain, and ultimately improve the resilience of the larger social-ecological system that the infrastructure is embedded in.

However, from a structural network perspective, there are some interesting dynamics that we see in this longitudinal study that were not as evident in the static Bering Sea networks. The first is that after the initial explosion of growth seen immediately after the evacuation, the network regularly pulses in size and activity. Each time this happens, the hub-and-spoke pattern seen in the initial development phase is repeated. After each burst, the network relaxes into a more settled state with higher levels of connectivity between members (bonding-style network configurations). It is in this more relaxed state where trusting relationships are built, which makes this a potentially important phase in network evolution for individuals or organizations to foster the development of greater overlap between Infrastructure Provider and Resources User roles. This is an interesting result, but a follow up questions for future work should address how membership at the individual level fluctuates with these contractions. Do engaged members come and go between these contractions? Or, is there a resistance to change in core membership during contractions? Likely, it will prove to be a highly context-dependent combination of the two and much more in-depth analysis of the factors that shape any particular systems willingness to accept new membership during network contraction will prove to be a rich research vein—one that will be very important to test throughout the adaptive-learning process of a working communication strategy. In Galena, we see that these bursts of network activity are where new connections are initially triggered. As time passed, these network expansions become fewer and fewer and the network contracted to become denser with the establishment of cross ties to multiple nodes. This behavior suggests that individuals within larger level agencies need to watch carefully for these bursts of activity to initially become involved in the community, when the network is in a hub-and-spoke configuration, but then they must pay particular attention to how they maintain those connections when the network begins to contract.

The Bering Sea case study illustrated how one individual's social media network responded to a potentially serious environmental event. In the Galena case study we examined a community-wide response to a similar type of episodic environmental event. Both share a combination of social-ecological interactions between large and small-scale environmental drivers managed through a range of social levels. This creates unique cross-scale institutional challenges to adapt to the needs of a society experiencing rapid environmental change. These challenges are exacerbated in Alaska by the small size and remoteness of many of the communities that populate the state and are further enhanced by the urban-center (Anchorage, Fairbanks, etc.) centralization of state and federal agencies tasked to service them. This separation creates a physical, as well as cultural barrier between those who understand the unique individual community needs of rural Alaska and the state and federal agencies mandated to support them. This essentially defines a robustness model where Infrastructure Providers and Resource Users physically do not overlap to any large degree across local levels. In theory, social media can provide a low transaction cost communication channel to bridge this gap in advance of a large crisis. Had this occurred in Galena—a community predictably susceptible to this type of catastrophic event—formal institutional relief efforts may have more quickly penetrated the rapid community-generated relief networks, though they still would have been handicapped by the slow formal declaration of disaster).

In the Galena example we saw that the local and extended community was quickly able to reconfigure through Facebook to help meet both the physical and social needs of the displaced populace. However, we saw through our study of statewide news coverage, as well as formal institutional agency response, that there was little overlap between the communication paths of these state and national level organizations and those used by the successful local level community effort. Thus, while both the news media and institutional agencies (playing Infrastructure Provider roles) undoubtedly utilized social media as part of their regular communicative practices, they never really penetrated the specific community level network that ultimately represented the Resource Users most impacted by the flood. Clearly, since relief was provided, grants and federal loans distributed, insurance paid out, and rebuilding conducted, communication networks did form between agencies and community members. However, it was slow and forced many displaced residents to spend over a year removed from their physical home. Given the speed with which the local community was able to re-organize itself through the Yukon River Rescue page, and the success they achieved in doing so—both in terms of providing for the immediate physical needs of the displaced residents, as well as, meeting many of their social and emotional needs (via the page itself but also events organized through it)—it seems likely an intentional communication strategy to find and build partnerships through this community level network by state and national level agencies could have hastened the entire process. The final chapter of this dissertation looks in detail at how such a communication strategy can be devised, implemented, and maintained. However, before moving into that discussion, the next two case studies look in more detail at the exploitation and conservation phase of the adaptive cycle—as any comprehensive communication strategy must account for, navigate, and at times consciously strive to develop all four phases of the adaptive cycle simultaneously.

The Bering Strait Messenger Network Case Study

International organization working at regional community scales; exploitation phase (Figure 38).

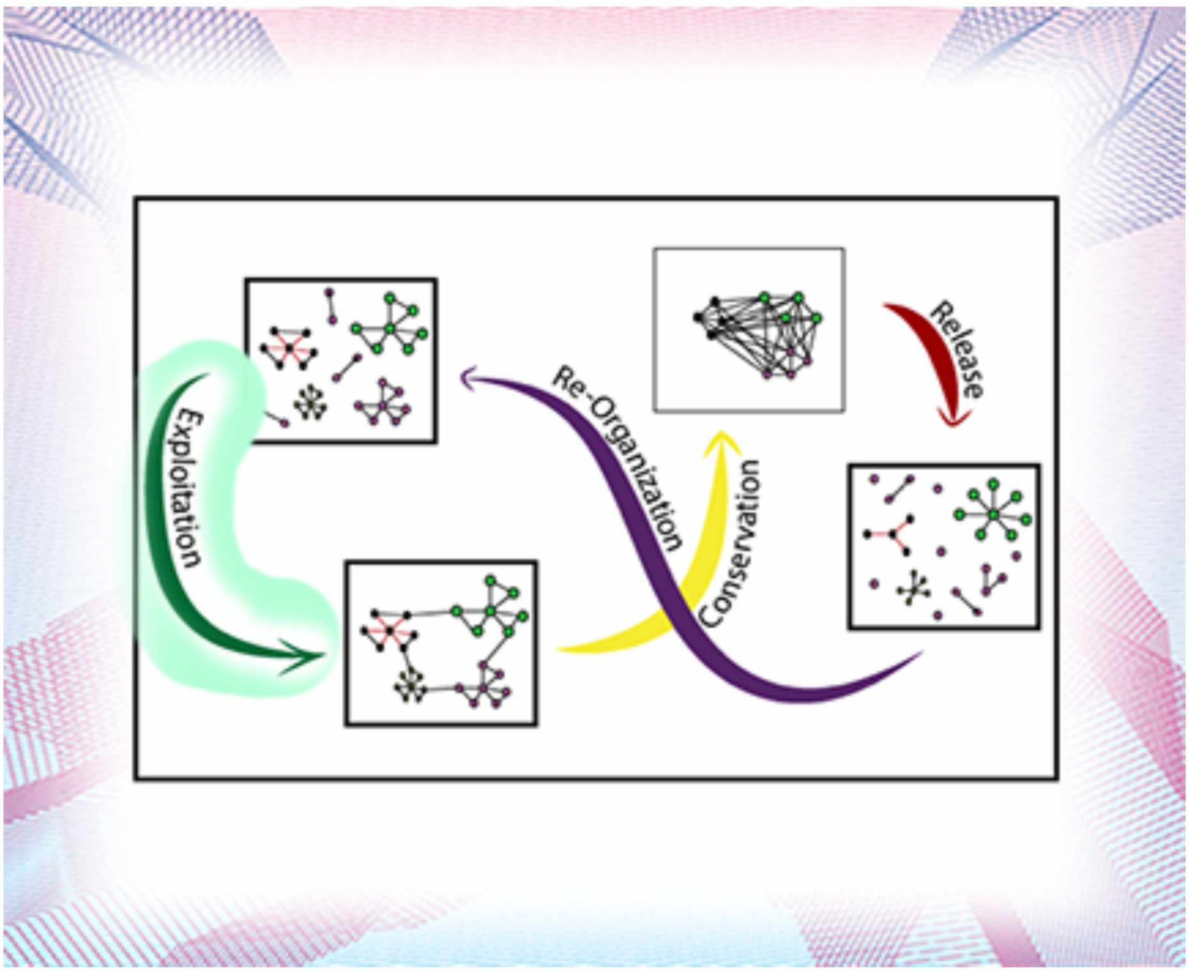


Figure 38: Bering Strait Messenger Network. An international project focused on local and regional level change.

This case study explores the Facebook network of the Bering Strait Messenger Network (BSMN)—a pan-Arctic, community-based communication project facilitated by the Institute of the North ("Bering Strait Messenger Network", 2014). BSMN is just one of many regionally oriented projects that the Institute of the North works on and each shares the same general goal of improving stakeholder communication around social and ecological issues in the far north. Details on both the Institute of the North, and how the Bering Strait Messenger Network project relates to it, will be given below. The empirical evidence presented in this case study is derived from a Facebook page that the Institute of the North initiated to support the BSMN project, as well as the monthly teleconferences that were the focus of organizational efforts during the timeframe of the study. Unlike our first two case studies, this example is triggered by an organizational effort to address non-crisis point system pressures. Given this, the methodologies used in this study are focused on understanding the system from the organization's perspective—rather than the participants.

Context and Triggering Event

The Bering Strait Messenger Network (BSMN) was a project developed by the Institute of the North, a 501(c)3 non-profit based in Alaska and founded by former state Governor Walter J. Hickel ("Institute of the North", 2017a). The Institute of the North's mission is to "cultivate an engaged citizenry" around governance issues of "commonly-owned resources" in the far north to improve individual and community wellbeing in the region. They state "core values" to guide their actions that are based on a mandate to manage resources for the benefit of the all in the region, to balance human needs with those of nature, to respect the life-ways of communities in the north, and to "elevate the voices of Alaskans in state, national, and international arenas" ("Institute of the North", 2017b).

In line with both this mission and their stated values, a major focus of the programs the Institute of the North develops is to build communication ties between key players filling a wide spectrum of cultural, economic, and governance roles across the pan-Arctic region. Simultaneously, there is an emphasis on building relationships across community, state, and international social levels. The focus on cross-scale and level interconnectivity is prevalent in both the language of their printed materials and the activities they invest time in. Table 2 presents, verbatim, the language that the Institute of the North uses to define itself via its webpage.

Table 2: The Institute of the North's organizational purpose.

Mission	The Institute of the North's mission is to inform public policy and cultivate an engaged citizenry consistent with our focus on the north and our belief that commonly-owned resources should be developed and managed for individual and community prosperity.		
Core Values	**What We Do**	**Scope**	**Core Principals**
Governor Hickel strongly believed in the power of an idea to change the world. The Institute of the North is inspired by his approach and is committed to a robust and thriving future for Alaskans, the Arctic and the world. The Institute's core values come from our founder and comprise our decision-making framework: Valuing Alaska's obligation to manage our resources for the benefit of the total. Balancing people, people's needs and nature. Understanding and communicating the reality, the richness, and the responsibility of the North. Elevating the voices of Alaskans in state, national and international arenas.	The Institute of the North is both forward-thinking and global in its approach to the challenges and opportunities stemming from Alaska's strategic location. The Institute of the North develops initiatives that cross sectors and the circumpolar North to empower northern peoples by increasing knowledge of northern issues, at a local, national and global level and strengthening Alaskans' voices in northern decision-making. The Institute of the North carries out its mission while seeking out and sharing information that will help improve management of the Alaska's resources. Much of our work is based on establishing and sustaining cross-border relationships that benefit Alaskans. In the Arctic, the Institute is both an advocate and a convener. Our focus is on: Strengthening Alaska and the global North, expanding knowledge around economic and resource governance, creating opportunities for the next generation of leaders to step up.	The Institute of the North is able to accomplish its mission by approaching it at different levels: Individual – Providing opportunities for Alaskans to engage in their civic responsibilities. Community – Exploring opportunities for community control in decision-making State – Convening Alaskans in creative discussion about the future. National – Bringing national leaders together to leverage Alaska's strategic location Arctic – Highlighting Alaska's role in developing Arctic infrastructure and policy. Global – Sharing and learning best practices for sustainable development.	The Institute's core principles shape how we engage with critical issues on each of these levels. We believe in: Diversity, not division. Responsible development. Non-partisanship. Dialogue.

Table 2 Continued			
Core Values	**What We Do**	**Scope**	**Core Principals**
	The Institute of the North Convenes and Facilitates Civic Discourse, performs outreach and education, hosts policy, presentations and discussions, sustains networks, synthesizes research. In order to Engage Alaska's private and public sectors in issues critical to America's Arctic: Educate Alaskans about Alaska's role as an Arctic state, including the challenges and opportunities inherent to the Arctic, provide a toolkit of information for educating national audiences, the media and policymakers on the state's needs; the wealth of potential opportunities; and the increasing relevance and importance of the Arctic – and Alaska's position in the Arctic, facilitate the development of Alaska Arctic policy.		

The impetus for the Institute of the North's organizational work is a recognition that change—both social and environmental—is occurring rapidly in the north and that building greater understanding between all the levels of society involved in managing that change is the best way to improve the governance of commonly owned resources for overall community wellbeing. This defines the organizational context through which BSMN was shaped. Specifically, the organizational mission of BSMN is as follows:

> The Institute of the North has developed a Bering Strait Messenger Network between Alaska, U.S.A. and Chukotka, Russia. Developing and strengthening

effective communication systems will be the hallmark of this program, beginning at the community level and growing to incorporate regional and cross-border components. The Bering Strait Messenger Network will emphasize a value on traditional indigenous knowledge, respect for elders, and a commitment to youth and emerging leaders, while leveraging interest in the Arctic.

The Bering Strait Messenger Network will evaluate and contribute a facilitative framework to the existing communication systems, while fostering inter- and intra-community, as well as cross-border, relationships. This project will support current and future capacity building for regional collaboration and contribute to existing initiatives working on policy and governance in the Arctic region. At the same time, the Bering Strait Messenger Network will provide a helpful structure for accessing and sharing regional priorities, with a positive feedback loop created between local communities, the region, national and international policy makers and researchers.

An increasingly busy Arctic means that communities in the Bering Strait region are faced with new and different challenges – and opportunities. Clearly communicating within the region, learning from one another, and sharing the latest, factual information is a critical component of local decision-making informing broader policy objectives. The Bering Strait Messenger Network will facilitate this process by inviting interested and active community members to become participants.

The Network will act as an ad hoc working group for the region, hosting monthly teleconferences with:

Regular updates about key issues affecting communities on both sides of the border;

Communications from key policy makers, including the Alaska Congressional delegation, state and federal agencies, and international partners; and

> Themed discussions focused on co-management and governance of what some refer to as the Bering Strait "chokepoint" – an inaccurate misnomer for those who live there." ("Bering Strait Messenger Network," 2014)

Given these goals and organizational perspective, the context that BSMN is operating under is not a release point environmental or social crises. Rather, it is functioning in a climate of broad (but rapid) change without the focusing influence of a specific change event.

Grounded in our model of the adaptive cycle BSMN is attempting to connect and build synergy between established but disconnected groups across a range of social levels and geographic scales. This is in hopes of establishing greater capacity to advert, address, or respond to a host of possible changes. Changes that may impact a local community in very unique ways, but tied to shared regional, or even global drivers. Essentially, BSMN is attempting to strategically build—or prime—the type of regional level bridging connections that we saw form in both the Bering Sea storm and Galena flood examples. Ideally, this would result in faster peripheral activation during times of crises, however, since BSMN participants (thankfully) did not have to respond to a crises during the projects lifespan, no evidence in this work can test the ultimate results of these efforts.

BSMN efforts were additionally attempting to establish new and deeper connections between participants in order to expand the core network of regional stakeholders engaged in change issues. A word of caution, however, is that these two goals are slightly in tension with one another. A large and tightly connected core can come at the expense of a diverse periphery as individuals within the network deal with a heavy cognitive load to manage high numbers of tight connections (Goel et al., 2016; Kaplan & Haenlein, 2010; Kietzmann et al., 2011). Depending on the legacy impacts of how the core formed, a lack of diversity within the system can 1) be hard to break through, and 2) lead to the resilience concept of a "rigidity trap," where a system can be extremely resilient to a certain set of environmental parameters but highly vulnerable to conditions outside of those parameters (Pelling & Manuel-Navarrete, 2011). Therefore, it is worth reiterating that these two goals of priming the peripheral network and also strengthening the core network, sit somewhat in tension with one another.

Considering all these factors, we can locate the Institute of the North's work somewhere between the exploitive and conservation phase of change. Specifically, the BSMN project is working to build the types of network connections that bridge locally established networks across larger, physically defined regional scales.

A unique aspect to this effort is that while on either side of the Bering Strait environmental and some Indigenous cultural similarities abound, the primary colonizing states of Russia and the US have built international-level political and institutional walls that divide the region along state-level institutional and policy practices, as well as create additional language beyond those of the traditional regional differences. As a result, building communication bridges across the region required at a minimum translation between Russian and US participants either through the bilingual skills of participants themselves or the external services of translators. On Facebook, the online translation tool is insufficient to reliably establish strong communicative relationships without external help or support. This state-level language issue is on top of regional differences in Indigenous languages at the local level.

Given the lack of an externally driven focusing event, BSMN used a futures oriented question of, "What will the Beringia region look like in 2050?" as the focal point for facilitating conversation and expanding the regional communication network. To seed the network and initiate the conversation, partnerships were built with the Russian Association of Indigenous Peoples of the North (RAIPON), Bering Straits Native Corporation (BSNC), the Eskimo Walrus Commission, the Russian Academy of Public Administration, and the University of Alaska Fairbanks. These organizations—and importantly the network of local, state, and international relationships they each maintain—represent the unique, pre-established networks across which BSMN hoped to bridge connections ("Bering Strait Messenger Network", 2014). In the adaptive cycle model each of these unique networks represents the disconnected components we see as an outcome of the reorganization phase, the project's goal is to build ties between them to move through the exploitive phase and partially into the conservation phase—but not so much as to loose the flexibility of maintaining a dynamic periphery network.

Network Bounds and Methods

The Institute of the North developed two main communication channels to accomplish their goals—a monthly teleconference and a public BSMN Facebook page. The teleconference served as the primary communication channel and involved only the most engaged BSMN participants with the strongest organizational ties. The Facebook page was intended to serve a more diffuse public audience (N. Andreassen, personal communication, May 2015). The networks for each are examined below.

Facebook Activity

As part of the Institute of the North's communication efforts, they maintained a BSMN Facebook page ("Bering Strait Messenger Network," 2014, "The Bering Strait Messenger Network," 2016). The Facebook network analyzed in this report has been constructed by creating a link between users who "liked" or "commented" on the same posts between January 2013 and May 2015. This can be viewed as a proxy measure of shared interests between linked users (Schwanda Sosik & Bazarova, 2014; Viswanath et al., 2009; Willey, Meng, & Gardner, 2015). In doing this, the network that emerged shows clusters, or subgroups, of users who tend to respond to the same content themes (Hansen et al., 2011) and are thus likely concerned about the same types of change issues.

In analyzing these patterns I explored three types of relationships: 1) network centrality, 2) network clustering/subgroup distribution, and 3) post content. Network centrality was measured via each user's "betweeness" score. This measurement identifies users who are connected to the greatest diversity of other users and is an indicator of influence within the network (Borgatti, Mehra, Brass, & Labianca, 2009), network clusters were then determined by identifying main structural features and tracing user connectivity within and between them. These networks are relatively small and the tracing of these structural features was accomplished through a series of exploratory network visualizations (see below) combined with digital ethnographic work on the Facebook page itself to identify what posts were connecting these individuals. For more detailed information on the methodology of digital ethnography see the how-to section of Application chapter below. Content analysis was conducted via word and word-pair counts weighted to account for the level of user interaction that each post generated and interpreted through the lens of having already done the ethnographic analysis.

Teleconference Network

The BSMN teleconference network was created using two primary documents—BSMN_6mnth_review_dec2013 and BSMN_report_May14_May15_report (Appendix A). These documents allowed for network analysis at the community level from Jan. 2014 through April 2015. In 2015 the months of July, August, October, November, and December lacked information. Network analysis was conducted to examine which communities participated in which teleconferences. Simple word and word-pair based content analysis was conducted using the reported minutes for each conference.

Results and Discussion

Facebook Activity

At the macro level, network results indicate a strong core-periphery structure (Figure 39). In the network there is a large number of disconnected users ringing a core of highly interconnected users. This is common on most active Facebook pages (Hansen et al., 2011). This type of periphery seems to form when users interact with the page only occasionally. They have likely only made one comment (or like) on the page, and therefore don't overlap with any other users besides those on that particular post. It is likely, because of how Facebook serves users content, that the friends of the people making up the periphery are more deeply connected to the central parts of the network than they are, and as a result, they see many more of BSMN posts than they themselves actually engage with (Del Vicario, Zollo, Caldarelli, Scala, & Quattrociocchi, 2017; Levy, 2013). The largest, and thus most central component of the network (recall a component is a subset of the overall network where all nodes are connected) is composed of users who have liked or commentated on multiple and overlapping BSMN posts. Therefore, this central component represents the most engaged users of BSMN's Facebook network and is the focus of further analysis below (Figure 40).

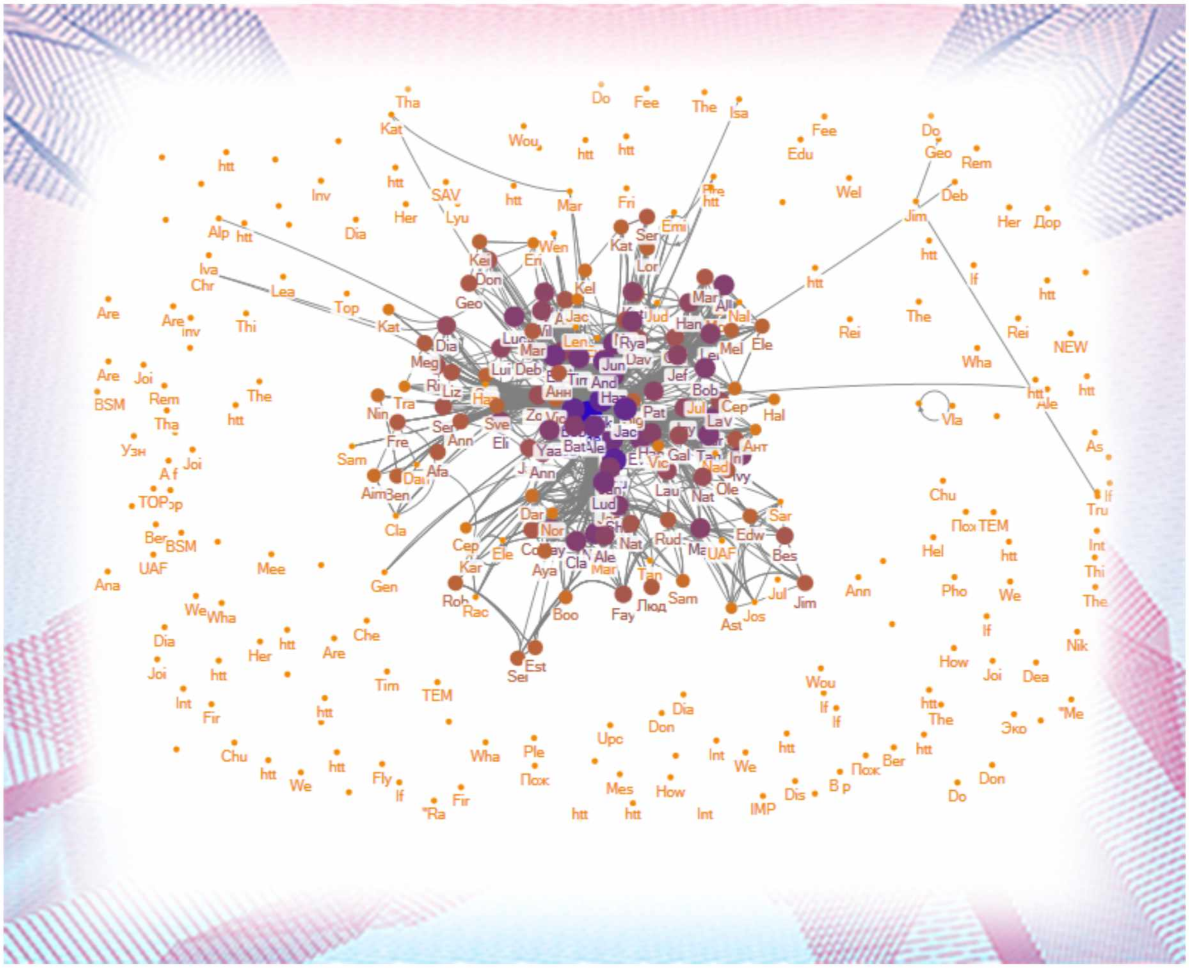


Figure 39: BSMN's complete Facebook network. Darker nodes represent the core while the lighter colored nodes identify the periphery. A high number of small, disconnected components are present, with a relatively large diameter central component. In a slight deviation from what might be expected from a release phase network, individual members in the central component do not show wide distributions in centrality, i.e. the component is rather well bonded compared to the bridging characteristics we saw in the initial Galena networks (Figure 37, points A and D).

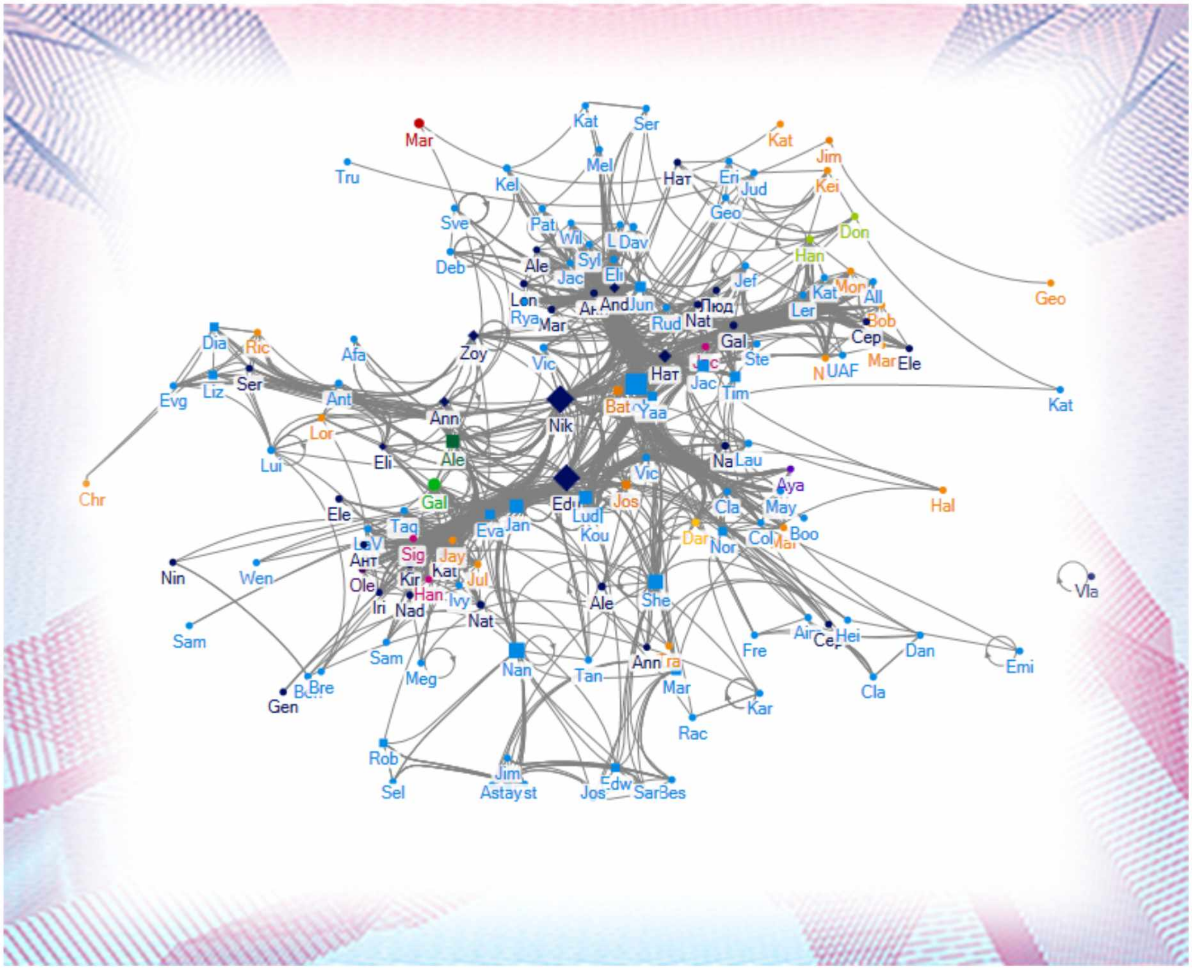


Figure 40: Expanded view of central component. *Dark blue nodes represent users associated with Russia, while light blue indicates users from Alaska. Orange nodes indicate users whose geographic associations could not be determined. The overall number of Alaskan participants is greater than Russian participants. Russian participants however are more central in the network. So while there are fewer Russians participating, individually they are more engaged. This seems to indicate an overall balanced participation between the two regions, however there is likely a greater diversity of Alaskan viewpoints being represented alongside a more singular Russian perspective. While not observed by the bounds of the networks in this case study, these centrality difference will have impacts on how knowledge generated by BSMN is disseminated and absorbed between the regions at the community level.*

Network Details: Centrality

Network centrality measures show a quasi-power law distribution between users (Figure 41). This is a very typical pattern on social media and is the analytical representation of the "super user" concept (Kim et al., 2013) we discussed in the Bering Sea case study—and saw again on the YRR Facebook page. In this case, two individual users fill that role with high—but essentially equal—betweeness scores. Each of these users is from the Russian side of the Bering Strait. What is interesting in these results is that after these two users there is a rather long tail to the curve, with a number of users still very active. This more diffuse group of less active users is predominantly from the US side of the Bering Strait (Table 3)

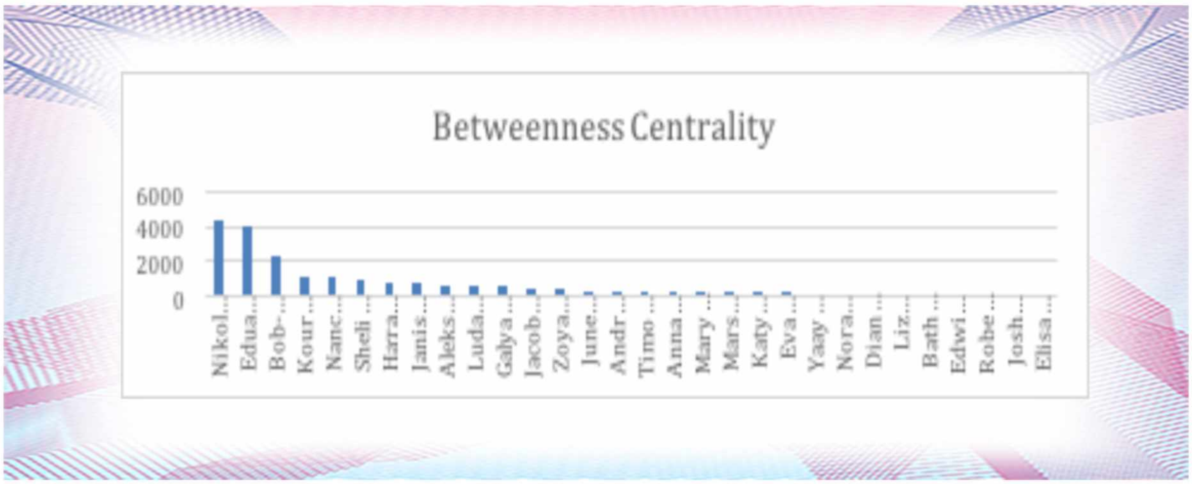


Figure 41: Betweeness centrality for the BSMN Facebook network. Of note is the rapid decrease in centrality between the two most central network members and the remainder of the network. The two highest represent Russian communities (Table 3), the next four Alaskan, then a more evenly distributed mix. These measures quantify the visual interpretations of Figure 40 and support the idea that a more diverse range of Alaskan perspectives were likely represented in BSMN networks than Russian.

Table 3: Top 30 users by location ranked via betweeness scores.

Region	Betweenness Centrality	Region	Betweenness Centrality
Chukotka	4361	Alaska	319
Chukotka	4094	Chukotka	318
Alaska	2275	Alaska	295
Alaska	1119	Norway/Arctic in general?	270
Alaska	1092	Chukotka	241
Alaska	950	Alaska	219

Table 3 Continued			
Region	**Betweenness Centrality**	**Region**	**Betweenness Centrality**
Chukotka	722	Alaska	177
Alaska	713	Alaska	149
Russia (Moscow?)	680	Alaska	143
Alaska	651	Alaska	139
Arctic in general?	625	US (Oakland?)	125
Alaska	465	Alaska	120
Chukotka	453	Alaska	101
Alaska	342	US (Pt. Townsend WA)	100
Chukotka	324	Chukotka	98

There maybe a number of possible reasons for this structural difference in engagement across the Bering Strait, not the least of which is platform access issues in the form of either language, technological, or infrastructural challenges on the Russian side. Regardless of the cause though, the net result is that across this platform (Facebook) only two individuals are representing the range of Russian communities targeted in the project. However, these two users engage with nearly all posted content. On the US side there are more total individuals engaged (from a greater diversity of communities), but each one is more select in what topics they interact with (and thus has a more limited investment in the network as a whole).

Putting this into our robustness framework, all the participants engaged in the BSMN must be considered Infrastructure Providers. This is based on the defined level BSMN is itself engaging in the system, and is a result of the Institute of the North actively seeking partner organizations that fill Infrastructure Provider roles (e.g. Kawerek). However, at the individual level, BSMN participants likely fill a mixed Infrastructure Provider-Resource User role in their home communities. This assumption is based on the idea that as local residents these participants both advocate for, and take advantage of whatever positive (or negative) results occur as a result of their participation in the project. This is especially true via Facebook where the intended audience is specifically a broader range of stakeholders than those who participated in the teleconferences. Therefore, on Facebook, there is likely a bias toward greater Infrastructure Provider and Resource User overlap than in the teleconference network, where participation likely leans heavier on individuals filling more distinct Infrastructure Provider roles.

The structural difference between how the Russian communities are engaged in the network (i.e., through two highly active users) and how the US communities are engaged (i.e., via a larger number of less active users) will have down level impacts on how the work of BSMN disseminates through local communities. One scenario would point to the possibility of higher robustness role-overlap on the US side than the Russian side. This is based on the observation that empirically just two Russian participants are representing all the Russian communities targeted in the project, while each US participant—simply because there are a higher ratio of them involved, from a greater diversity of communities—is representing more locally specific stakeholder groups. This higher role overlap (structurally defined) would potentially indicate a likeliness of more resilient implementation of BSMN projects, ideas, or collaborations on the US side. On the other hand, each side must begin from the specific legacy structures developed through the national political and cultural history of their region. Differences in centrality relationships, proxies for influence and power (Borgatti & Halgin, 2011), may simply be inherent in working across borders that span distinctively different political histories. In this case, one structure may not be more resilient than the other within the context of its own social-environmental setting. Rather, it may simply be an example of the type of structural relationships that projects of this type must bridge to be effective.

To explore the consequences of these structural differences is difficult in this case as the network must be assessed as it reacts to a crises to take this measure of resiliency. No crisis occurred during the time frame of the study though. Additionally, the true success of building communicative capacity in this way is in the crises that are averted (knowingly or inadvertently), again another measure that is difficult to quantify and not approached here. However, these are the very types of "next-step" questions that the communication assessment framework being developed in this dissertation is designed to uncover. If used as part of an active communication strategy, the true relevance of the structural difference between US and Russian participation could be explored in the next round of communicative actions, and then assessed specific to the needs and capabilities of the organization.

Network Details: Structural Core

Six, somewhat, distinct subgroups can be constructed from the structural relationships found in the core of the network. Each will be described below paired with a visualization of the language used in the BSMN Facebook posts associated with the forming of the subgroup.

Network Details: Subgroups Found in Network Core

Subgroup A is closely tied to the center of the core network (Figure 42). It also contains strong ties to subgroup B. Content analiyisis indicates this group is mostly involved in general posts that deal with the logistic and planing of other BSMN engagement activities—namely teleconferences ("Teleconference," "Call," "Friday," "join," "call-in"). However, there seems to also be a strong connection to Saint Lawrence Island ("Savoonga," "Lawerence," "island"). This relationship also comes through via content analysis of the entire network. This may indicate that at least on Facebook, BSMN's goals (content themes) and activites (channel selection) resonate with folks from this region. Perhaps this is not suprising given the location and cultural history of the island. Saint Lawarence island is located in the central northern Bering Sea basin. The two communities on it (Gambell and Savoonga) are predominatley Siberean Yupik, and have traditionally maintained cultural ties on both sides of the Bearing strait and have been active in reestablishing ties with the fall of the Soviet Union ("Kawerak, Inc.", 2012).

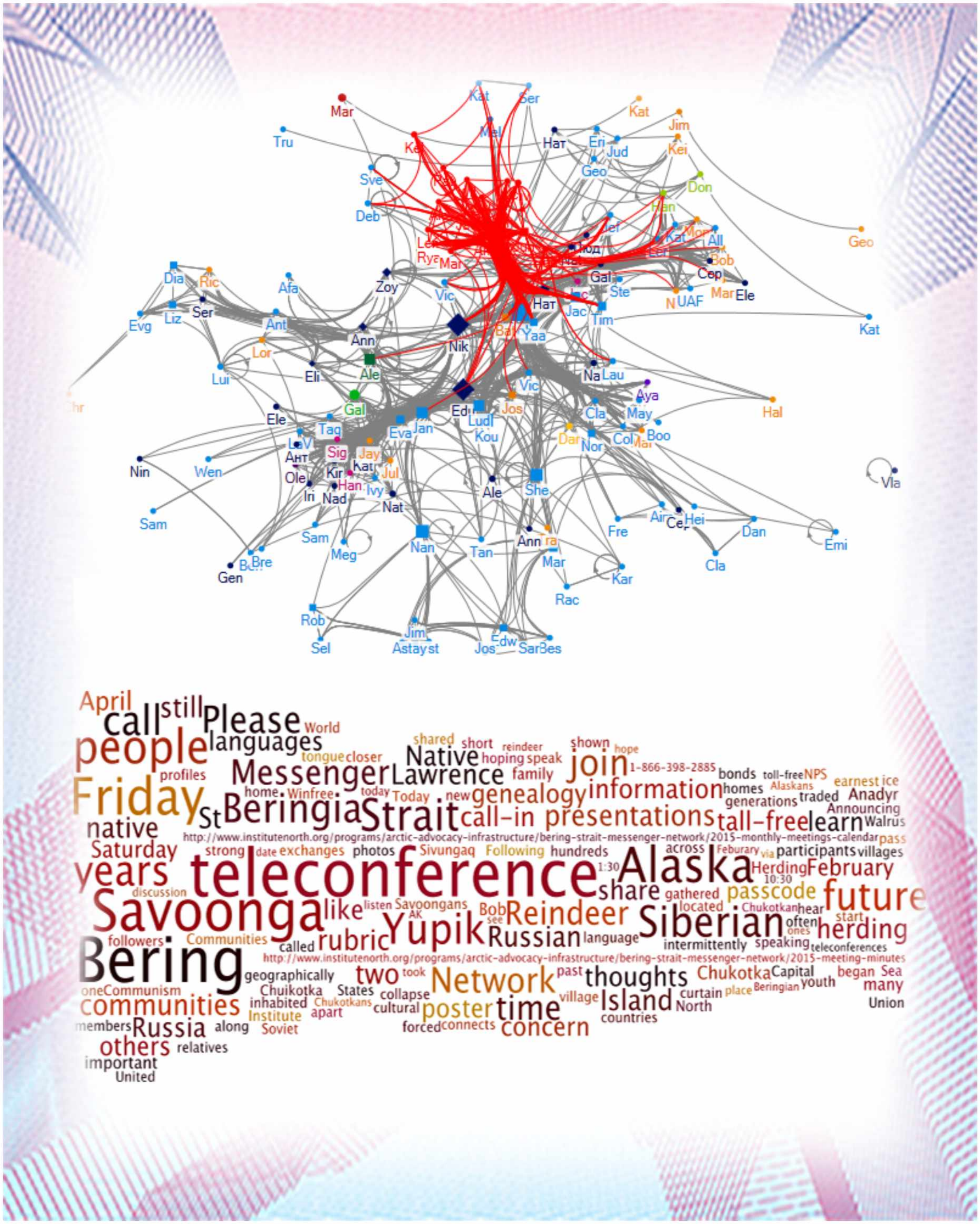


Figure 42: BSMN Facebook network subgroup A. Subgroup A is highlighted in red.

Subgroup B (Figure 43) is similar in content to A (“Savoonga,” “Yupik,” Lawrence”), with the distinction that this group is less concerned with BSMN logitics (dissapearance of “teleconference,” “call-in,” etc.) and more issue oriented (“walrus,” “language,” “family,” “relatives,” “communism”). Additionally there still seems to be a strong connection to St. Lawrence island in this part of the network.

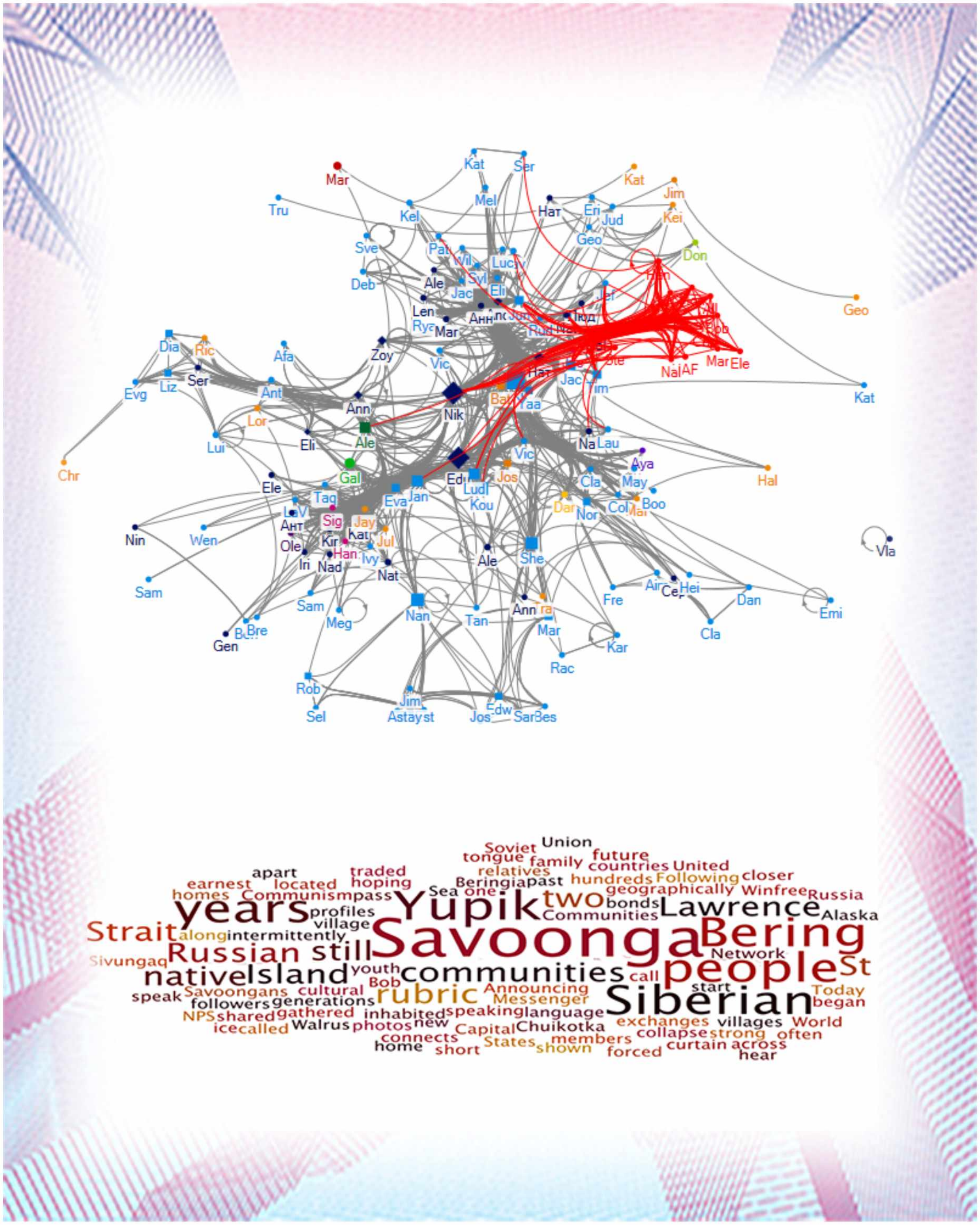


Figure 43: BSMN Facebook network subgroup B. Subgroup B is highlighted in red.

In subgroup C (Figure 44) there is a much greater Russian empahsis which is seemigly tied to a specific set of more personal content (“Ivan,” “Family”). Interstingly, while a few users in this group are Russian, the majority are Alaskan—which would seem to indicate that the network is serving as a communication bridge across the region, rather than a central hub where users from each region generally just communicate among themselves about themselves. In other words, the focus on Russian themes with both Russian and US participants is an indicator of the cross-region communication.

Figure 44: BSMN Facebook network subgroup C. Subgroup C is highlighted in red.

Subgroup D is interesting (Figure 45). It is the most diffuse of the groups (i.e. membership is spread across the network) but has the greatest sailence in language analysis. This group is clearly concerned about the potential of a deep water port at Port Clerance ("Clarence," "Port," "hunt," "food," "subsistence," "genrations," "livelihood") and arguably less willing to become involved in other regional issues (lack of engagement into other parts of the network). These are folks who may benefit from being drawn into other areas of the network to build up greater/broader support for their own, more limited, primary concerns regarding the port. In any case this group has considerably weaker connections among themselves and between other subgroups than others in the network.

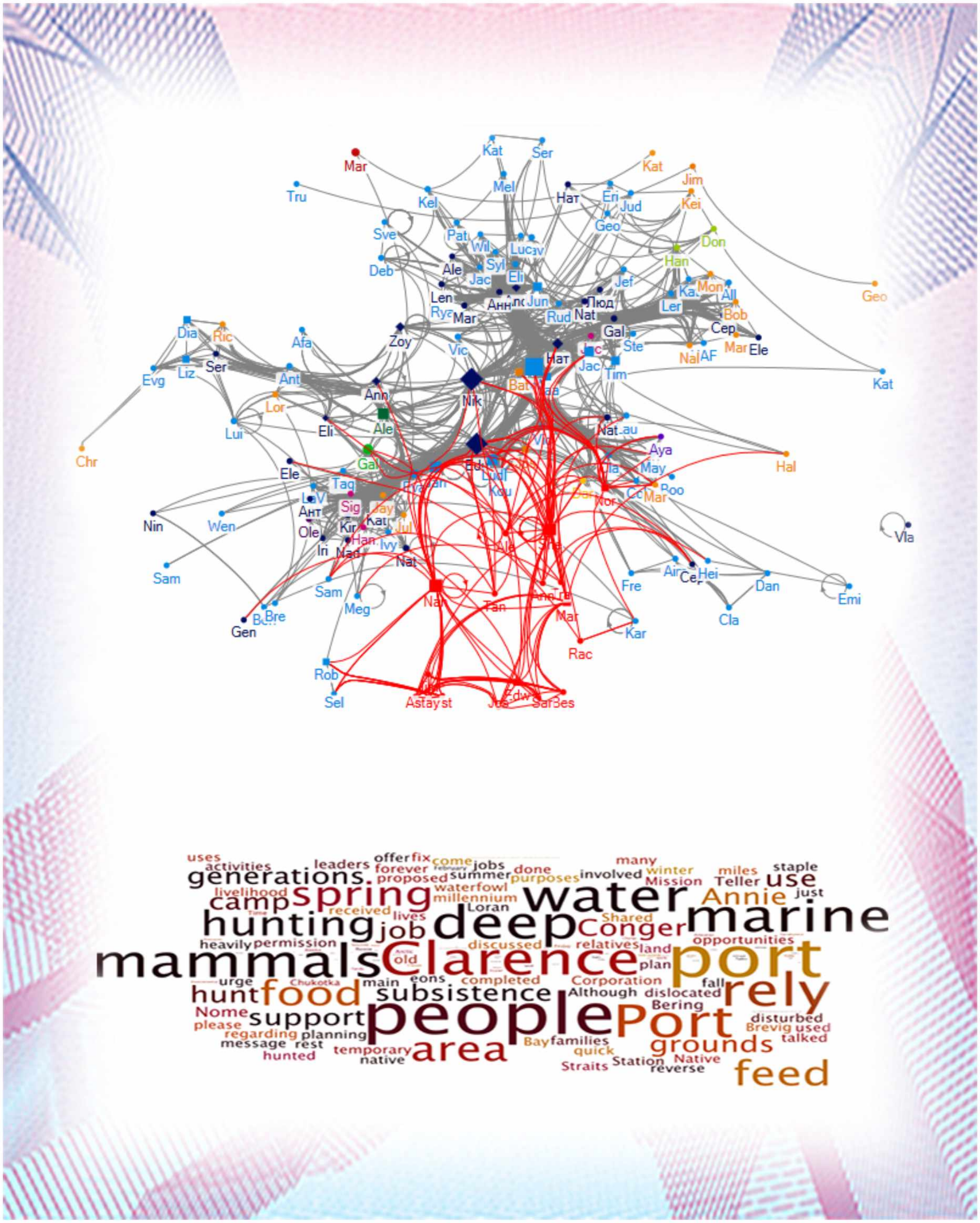


Figure 45: BSMN Facebook network subgroup D. Subgroup D is highlighted in red.

Subgroup E is also an itersting group (Figure 46). Content-wise, this group is obviously mostly concerend with issues around reindeer herding, but they are also engaged in the more logistical elements of BSMN—i.e., when meetings will occur, what will be discussed, and what the tone of those meetings will be. There is a much stronger Chukotka emphasis than in other groups, which makes sense given the relative role of reindeer between the two regions (stronger on the Russian side), but this group also has the greatest regional involment of any of the groups. This would preliminarly suggests that these themes are the most cross-cutting of those covered on BSMN's Facebook page. It is also a highly interconnected subgroup, as was subgroup A, both of which shared content related to logistics. This implies that when users take part in discussions around logistics and planning they tend to build tighter relationships—lending support to the idea that, to the extent possible, offering as much participatory opportunities as practical in the logitics of the network improves participant connectivity.

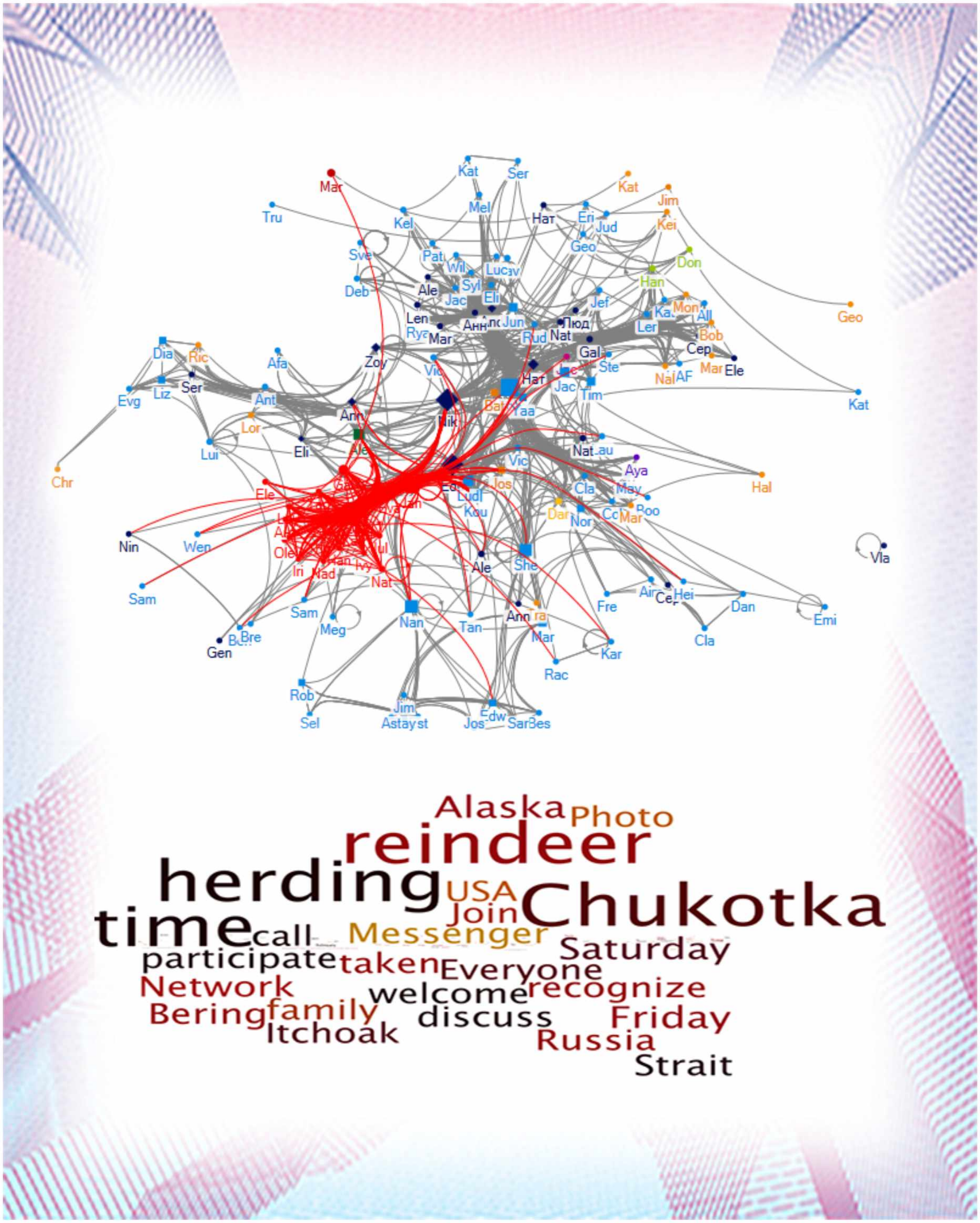


Figure 46: BSMN Facebook network subgroup E. Subgroup F is highlighted in red.

Subgroup F (Figure 47) has mostly formed around personal interest and “feel good” type content (designing a new logo). Predominately this group is based on shared interaction around two posts. One, a story about a Russian musher in Kotzebue, and the second a post on BSMN’s new logo. These are users who likely “lurk” a fair amount on the page but are not deeply engaged in the primary issues being discussed. They are however, interested enough to follow along with the groups activity, occassionally commenting enough to remain part of the community.

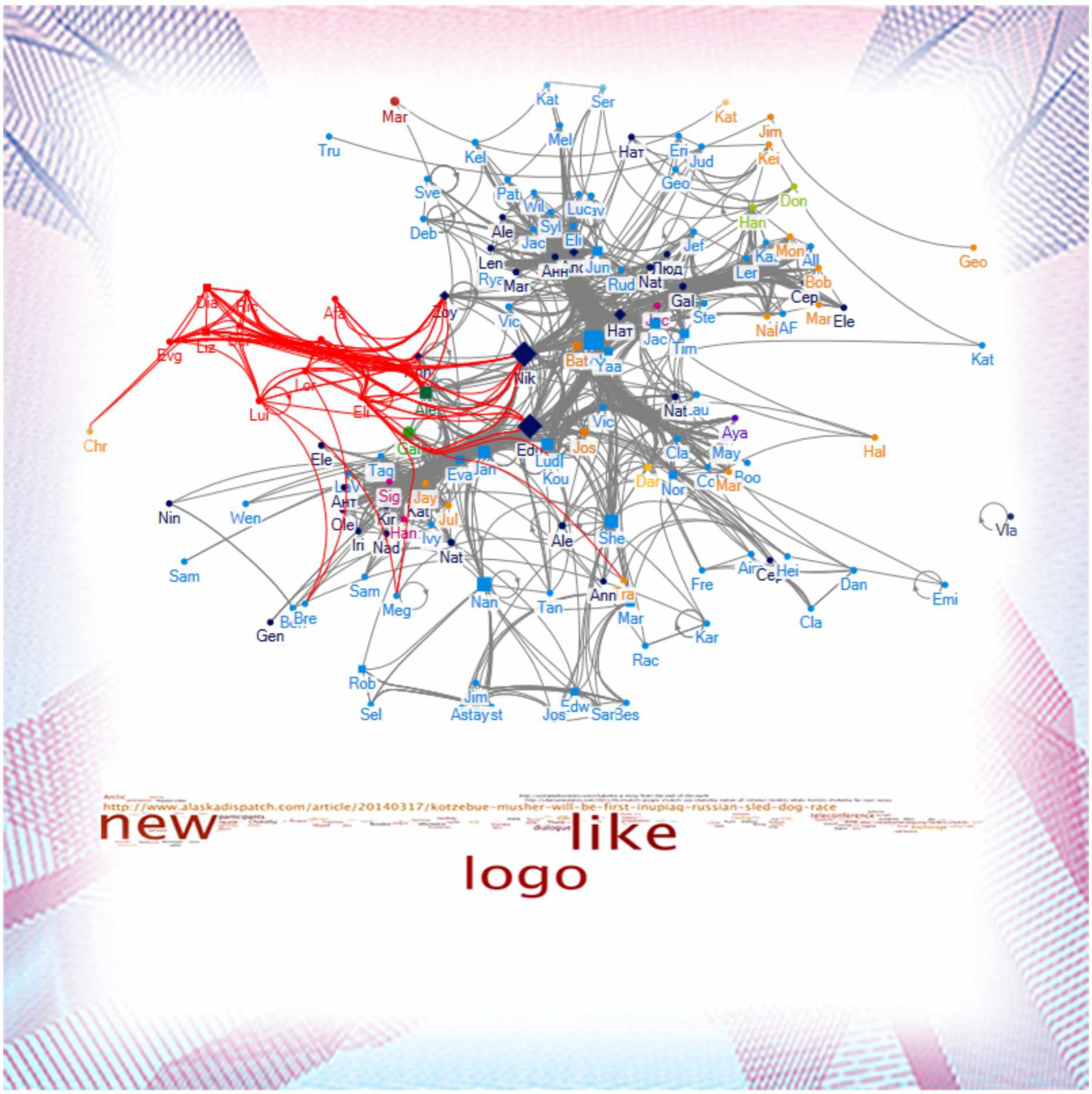


Figure 47: BSMN Facebook network subgroup F. Subgroup F is highlighted in red.

Facebook Network: Summary

One of the Institute of the North's main objectives with BSMN was to establish stronger communicative ties between the communities on either side of the Bering Strait, the Facebook network overall exhibits a balanced influence between the two regions, and so by that measure is an organizational success. There are differences in the form of participation, however—a few very active users characterize Russian participation while US participation is characterized by a more diffuse set of slightly less active users. How this impacts robustness role-overlap on either side of the strait given the differences in how European and Western colonizing institutions have evolved, is uncertain but certainly something follow-up communicative actions should explore and attempt to understand in greater detail.

In the central core of the network, users do tend to cluster together around specific themes. To some extent this is driven by regional relevance of certain topics and shows some sorting into clusters by those regions. This is a pretty weak relationship however, and there is a good deal of cross-region connectivity even within the topics presumably of more local interest. This would suggest that BSMN did actively build and maintain a network that crossed geographic and social levels through their social media communication efforts.

Teleconference Network

Teleconference results indicate a well-established network (Figure 48) of communities who regularly participate in conferences supplemented by a number of other communities participating less frequently—mimicking again the core-periphery pattern we have seen in other case studies. This can be a very healthy structure if the core group provides continuity and stability between events while the periphery brings in more diverse, specialized, and fresh perspectives—potentially invigorating discussions and guarding against the negative aspects of limited creativity and critical thought associated with closed networks and associated rigidity traps (Marin Ricke, 2010; Pelling & Manuel-Navarrete, 2011).

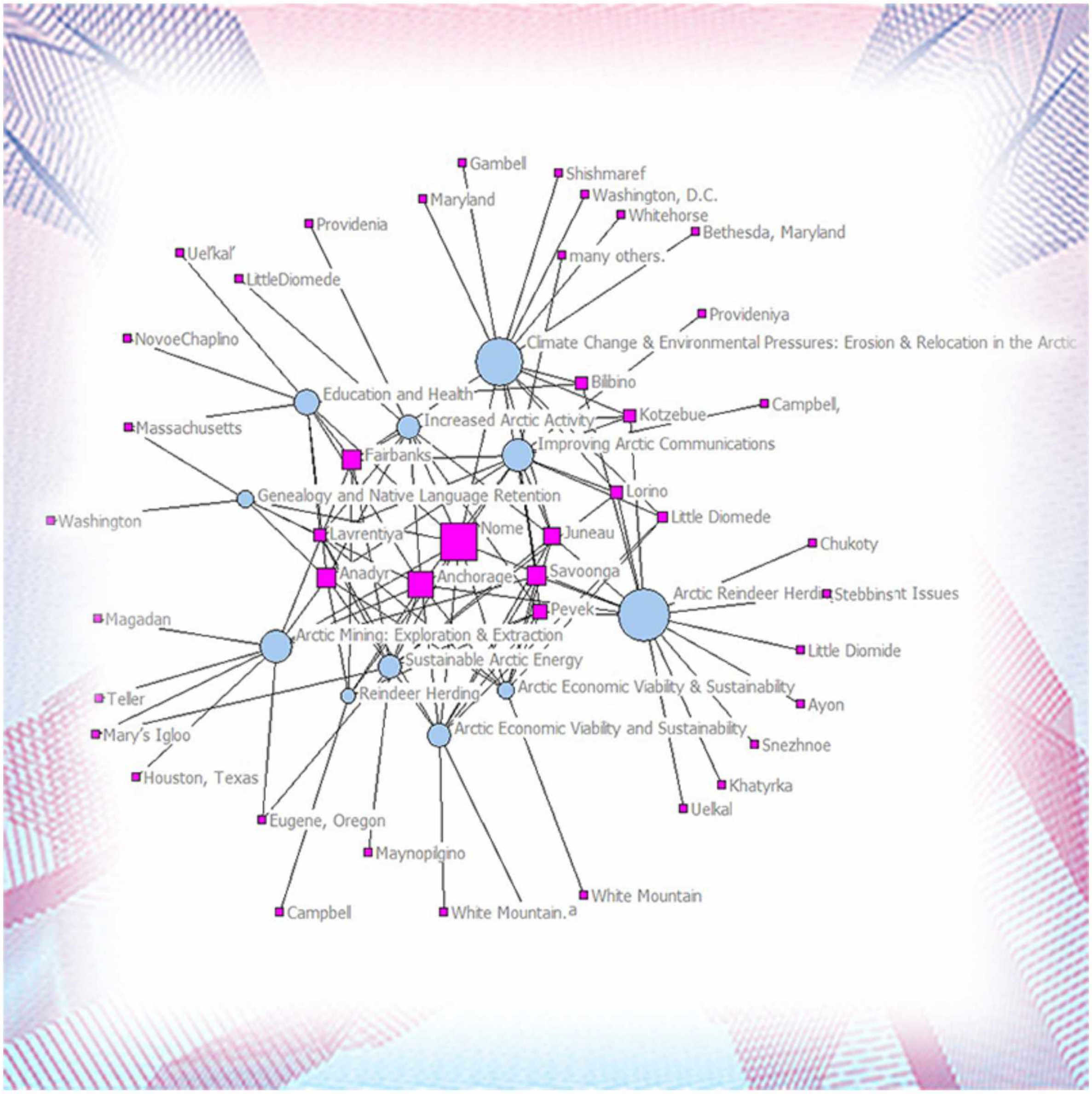


Figure 48: The blue circles in this graph represent each monthly teleconference. The pink squares represent each community that participated in the conference. The size of each is based on betweeness score and can be indicative of the engagement levels of different communities in specific teleconference topics. This interpretation however, should be made in context with organizational and logistical constraints that may have varied between conferences—thus potentially limiting the extent to which simple attendance can be used as a proxy for interest.

Recall this is a similar core-periphery structure that we have seen most often tied to the early re-organization phase of the adaptive cycle, specifically in the immediate period after a release. The structure's presence in the teleconference network would support the idea that each teleconference is acting as a slight reorganizing agent within the broader exploitation phase of BSMNs larger objectives (of building bridges between already established local organizations). With that in mind, each conference can be seen as a triggering mechanism that serves to make micro corrections to the core of the larger network. Again, we saw a similar pulsing structure in the Galena case study as periodically events would trigger an expansion of periphery participation, and then fall back to a smaller, more tightly bonded, and dense core structure. In each case it seems theses pulses in the expansion and contraction of the network—expressed through the ratio of engaged core and periphery network elements—acts to cement longer term relationships as the system moves toward a more conservative phase, with less fluctuations and more consistent internal ties.

It is important to remember that these case studies are being explored to provide an observational framework to guide strategic communicative action. From this perspective, developing a working theory to devise and test different intervention strategies is an important objective. Given the repeated pattern of expansion and contraction we have seen in multiple instances, using this dynamic as a foundation for a working theory makes sense. Additionally, as the core network acts as a stabilizing network force—maintaining continuity between events, as well as seeding paths for future expansions—this portion of the network also makes sense to pay special attention to because of the central role it will have in shaping future events. In that regard, it is important to both maintain established core relationships, as well as bring in occasional new voices to keep things current. The concept of maintaining core relationship is not new and organizational activities have been designed around it for generations. Events like stakeholder meetings, company picnics, and potlatches, are all tried-and-true ways to enhance in-group connectivity (in one form or another). I would argue however, that these represent social forms adapted to Holocene-stable environments. For organizations working to address the rapidly shifting social-ecological changes characteristic of the Anthropocene, a focus on the regularity with which new voices join the core is as important as preserving established relationships within. The emerging patterns we have seen so far in the case studies hint that the contraction phase after an expansion event is an important entry point for new core-network members. If this is true, then network interventions should focus on communication strategies that pay special attention to the maintenance of relationships during network contraction events. If it is not true, assessment of these strategies will at least yield new working theories to test in future organizational activities in a continues learning loop.

Teleconference Network: Structure

In Figure 48 above, we can see that the network core is composed of an inner cluster of communities that attend multiple conferences and an outer ring of the conferences themselves. The periphery of the network is composed additional communities. Communities with the most regular attendance can be found in the very center of the network. These communities are interconnected via shared attendance at multiple teleconferences. The conferences themselves make up the outer ring of the core and are connected to the periphery of the network by communities that share attendance at only one conference. The well-balanced internal core structure of this network—lacking any of the subgroups found in BSMN's Facebook network—speaks to a well-established set of participants and connections in these central communities. Further, the lack of subgroups likely indicates that participants from these communities broadly share an overall interest in the topics and mission of BSMN. This may indicate a strong commitment to the partner organizations that initially brought together the teleconference participants.

Differences in the numbers of peripheral communities that participate in any specific teleconference can be interpreted as an indicator of the relevance of the conference topic to specific portions of the network—larger bursts indicate greater interest from specific stakeholders. Taking into consideration what we learned about the expansion-contraction process from the previous two case studies, understanding which stakeholders react to which topics is a key strategic outcome of assessing communication in this way, as it supplies critical information needed to tailor communication through all phases of network evolution. However, in particular with these peripheral communities, attention needs to be paid in interpreting the results with regards to the differing outreach and logistical complications in setting up each conference. Understanding—and taking advantage of—the media ecology that each stakeholder group can engage through is at least as important as understanding the content that is relevant to them (as we see in the differences between Russian and Alaskan communities in the Facebook network). This implies that organizations need to design their communication efforts around multi-channel strategies that fit the established practices of their targeted audiences—not their own organizational norms. We will see a well-implemented example of this type of strategy in our next case study.

Teleconference Network: Centrality Measures

The most central communities in the network can be seen below (Figure 49). Of note is the prevalence of US communities over Russian communities—both in overall number and total betweeness score. Betweeness centrality gives an indication of which communities participated in the most well attended teleconferences, and thus whose voices and concerns are sustained the most readily across all the conferences (events). This is an important structural role as these are the network members exerting the most influence on how the network contracts after each event. There are a number of possible reasons for the geographic disparity in these results, including closer ties on the US side between the Institute of the North and Alaskan communities (i.e., the impact of legacy networks not observed in this study), linguistic challenges, or simply varied topical interest between communities—regardless of country origin.

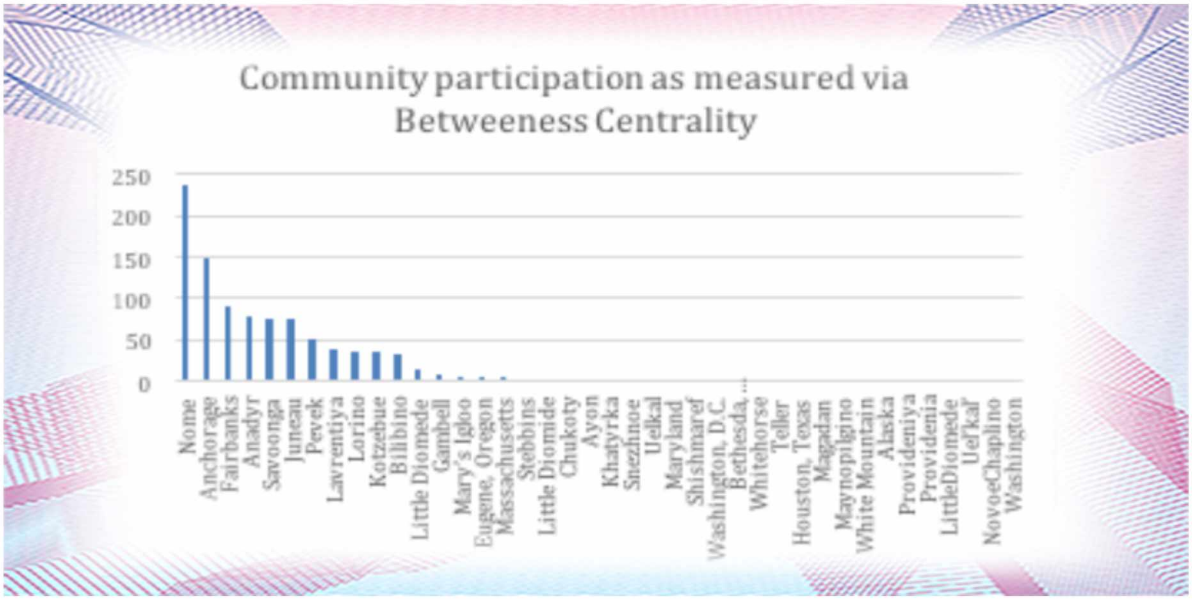


Figure 49: Community-based betweeness scores for BSMN teleconferences. Unlike in the Facebook network, Alaskan communities dominate centrality scores for the teleconference network.

However, it is interesting that this pattern did not hold via the Facebook network—where the most central actors were from Russian communities. The differences between the two channels of communication are numerous, obviously, but fundamentally Facebook is a much less formal and/or institutionalized channel, with fewer gatekeepers barring individual involvement. Worthy of particular thought then is how individuals from different communities accessed each channel and what project (or organizational) goals were met through them. The consequences here seem to be that more diversity was brought in through Facebook—the less formal of the two channels used by the Institute of the North.

To be involved in the teleconference required a very formal path of invitation. To be a participant you must have been invited to the teleconference via the established social network of the Institute of the North and their partner organizations. In the parlance of network science this describes a structured organizational and social status-oriented gatekeeping environment (McLuhan, 1964). In other words, it was important who you knew in the partner organizations in order to be involved in the teleconferences. The opposite is true of Facebook, where the gatekeeping factors have more to do with 1) awareness and a shared interest in the topic, and 2) technological access to the platform (Smith, 2011).

These two different gatekeeping environments are ultimately linked through the legacy networks (social, cultural, governance, and economic) that have established the background communication landscape that the BSMN hoped to change (as a stated project goal). The extent to which these legacy networks have shaped the BSMN is unknowable based on the data explored in this study. However, the differences in cross-border participation between the teleconferences and Facebook channels indicate that providing both formal and informal communication channels did access different audiences. This suggests that informal channels allow for a greater break from historical patterns. Ultimately, the inclusion of new voices in the evolution of legacy networks is the core goal of BSMN, so these results align well with their organizational goals.

Overall it could be expected that because the Institute of the North is a US or Alaska-based organization, its legacy ties could reasonably be assumed to be stronger in Alaskan communities. A logical conclusion from that would be that any new network they attempt to develop will have stronger initial connections to Alaskan communities. Empirically, we see the consequences of this in the teleconference analysis—where Alaskan communities are by far the most central. The inclusion of the informal Facebook channel, however, flips this (or more likely builds upon it) and allows Russian participants more opportunity to break into the network and become more central. Practically, how that informal access versus formal access breaks down to concrete action in communities is uncertain. However, because the goal of the project was to develop new communicative ties, without a specific focusing event to take action on, from the stand point of the Institute of the North and their goals for this specific project, the centrality results between channels have to be considered a positive outcome—even if what will result from those connections in times of crises or action are as of yet unknown.

Still, betweeness is a nuanced indicator. Communities with high betweeness scores are likely communities that participated in a high number of conferences, but more specifically they participated in conferences that drew in the greatest diversity of other participants. It is not simply a matter of attending the most conferences; it is more a function of attending select conferences that were well attended by others (Borgatti & Everett, 1997). In other words, if you go to a lot of conferences, but they are all have low attendance—then your betweeness score would be lower than someone else who went to fewer conferences, but the ones they went to were well attended by others. Because of this, communities with high betweeness scores are likely to have a high level of influence on the overall network because they provide a bridge between communities that otherwise wouldn't be connected. This can have a positive or negative influence on network outcomes—positive if applied to build continuity between conferences, negative if there is intended or unintended brokering of select/privileged information, with particular attention to unintentional agenda setting. This study isn't capable of addressing this level of value-based information flow through the network; internal to the organization this might be more knowable and hence actionable information.

Interpreting the centrality measures for individual conferences is a bit more complex than looking at the centrality of participants.

Ideally these measures would provide an indication as to which conference topics were of interest to the greatest number of communities. However, while not absolute, there is an observed tendency for the centrality measures to decrease with time, i.e., the most recent conferences were the least well attended (Figure 50). That trend is likely not based on thematic interest but more due to external organizational factors (event marketing, seasonal fluctuations, project lifecycle). It is difficult to see through this noise with just a centrality measure, but to the extent possible, it seems likely that the topic selection process developed by the Institute of the North produced a well-balanced and regionally relevant list of topics and that declines are for the most part due to the external factors mentioned above.

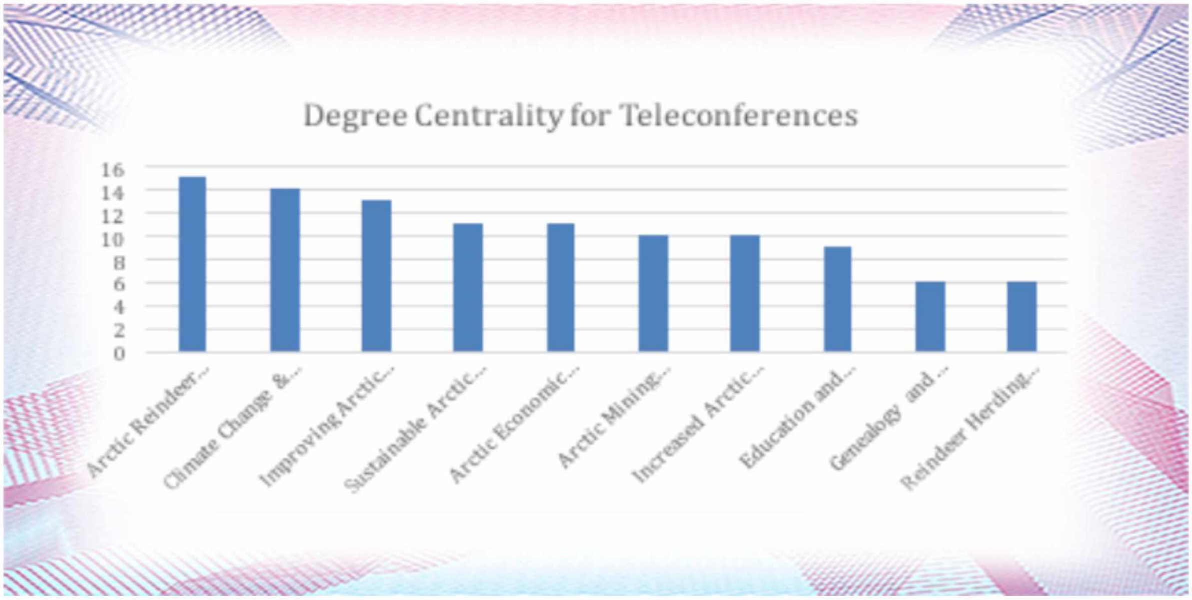


Figure 50: Degree centrality results for the BSMN teleconference network. Degree centrality, as used here, is a measure of community participation. The gradual decline in centrality correlates with the chronological order the teleconferences occurred, the first being the most central. This is likely an indication lowered organizational outreach efforts rather than differences in thematic interest. Note: the first and last conferences both covered topics around reindeer herding in the Arctic.

Teleconference Network: Internal Network Dynamics and Content Analysis

In figures 51-57 I visualize both the community participation network for each individual conference, as well as word frequency results. The data for the word frequencies is derived from the minute notes kept by Institute of the North representatives during each teleconference. This network is laid out slightly different than in the above figure 48. In this sequence of visualizations, teleconferences are located in the very center of the network, ringed by the communities that attended them. The highly central communities (Nome, Anchorage, etc.) are located close to the center while the less central communities sit on the very outside of the network.

The first conference on Arctic reindeer herding (Figure 51) was the most highly attended of all the teleconferences. However, many of these communities did not attend further conferences, and thus are peripheral to the overall network. In terms of the dynamic network model we have been exploring in the last two case studies, this first teleconference can be seen as the initial expansion event of the project. In other words, core and peripheral relationships are yet to be worked out and all participants are peripheral at this point. It is important to remember this assessment is only for the teleconference network. In all likelihood email, phone, and face-to-face channels have pre-established stronger connections with some communities than others. Ultimately, those connections likely influenced participation in the teleconference, however as far as the empirical evidence in the teleconference data can elicit (in this opening conference) all participants were equally connected. The observation that this was the most highly attended conference is not be totally unexpected, as often at the beginning of a multi-event project like this there is greater overall enthusiasm than in the middle or toward the end of the project.

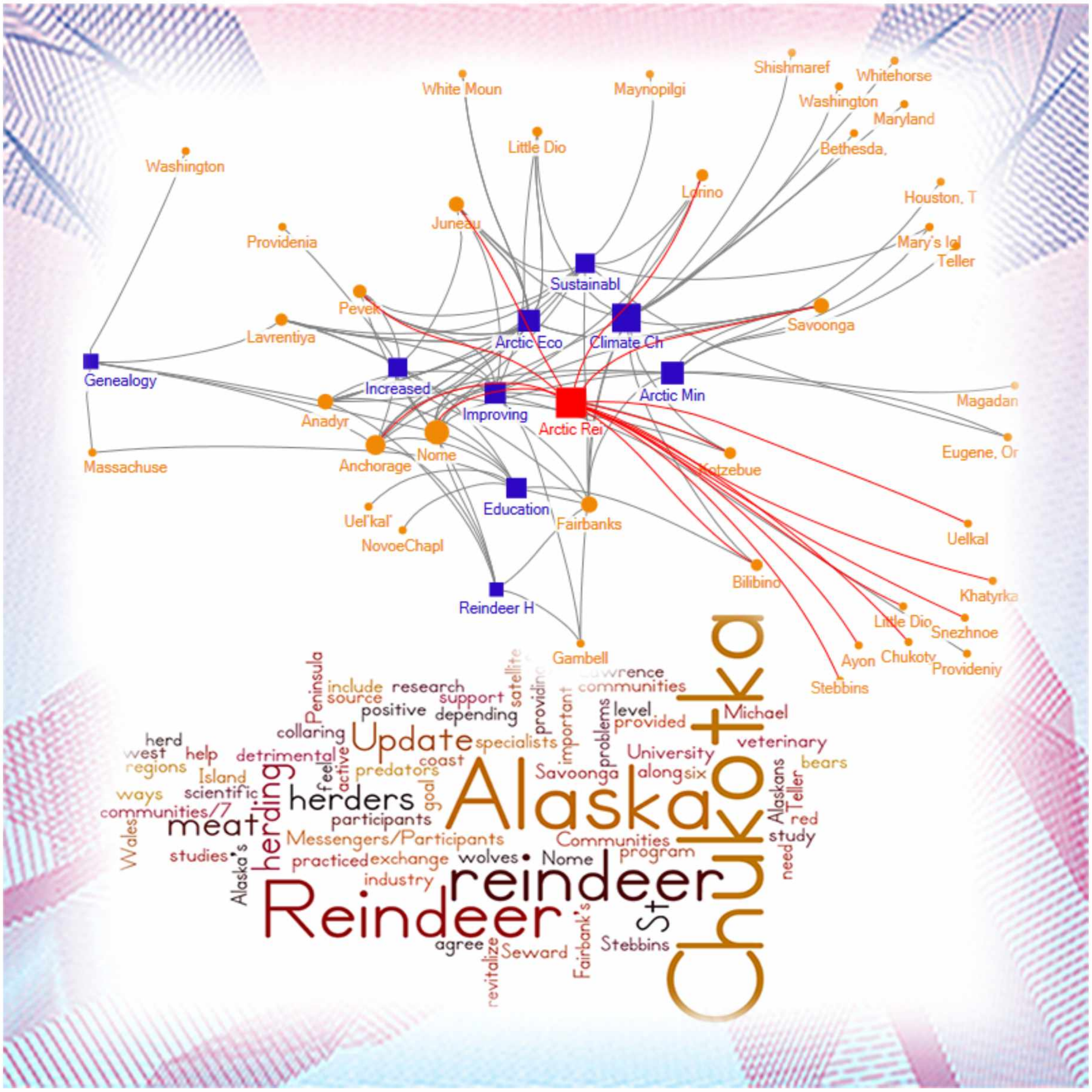


Figure 51. Arctic Reindeer Conference network and word frequency visualization.

Regional place names ("Alaska," "Chukotka") have the highest word frequency, likely indicating that these early discussions were grounded in place through introductions. Again, not an unexpected result as introductions often involve identifying where we are "from" in order to get to know one another more fully, and as the first conference, there would be a number of introductions to accomplish—both between participants, as well as to explain the overall project goals. The term “reindeer” is also prominent in use, and reflective of the teleconference topic. A second level (in frequency) of word-use shifts from the regional to the local (Teller, Stebbins, Savoonga, etc.). There seems to be very little word use tied to specific local Russian place names, however by looking closely at the network (Figure 51) we can see that many Russian communities did participate. Mixed in the same general level of use is subject-oriented language that would indicate a wide-ranging conversation centered on reindeer herding—“herd,” “collaring,” “veterinary,” “research,” “specialists.”

The second conference, titled *Climate Change and Environmental Pressures: Erosion and Relocation in the Arctic*, also brought in a fair number of new and peripheral communities (Figure 52). Many of these were from the US and Canada, with little Russian representation during this teleconference. “Chukotka” and “Alaska” were still recorded frequently in the conference minutes, but themes otherwise seem to be less place-based (i.e., place-names have a lower relative frequency than in the first meeting). Instead, word use is more focused on language that defines the challenges and possible solutions of climate change. Concerns tied to subsistence are prominent (“hunters,” “parasites,” “infected,” “whales,” “hunters,” “hunting,” etc.) Energy issues show up as well, with regular use of the words “nuclear,” “electric,” “pipeline,” “renewable,” etc. The number and diversity of different words would seem to indicate discussions, like in the first conference, that are broad in scope but on topic with regard to conference themes.

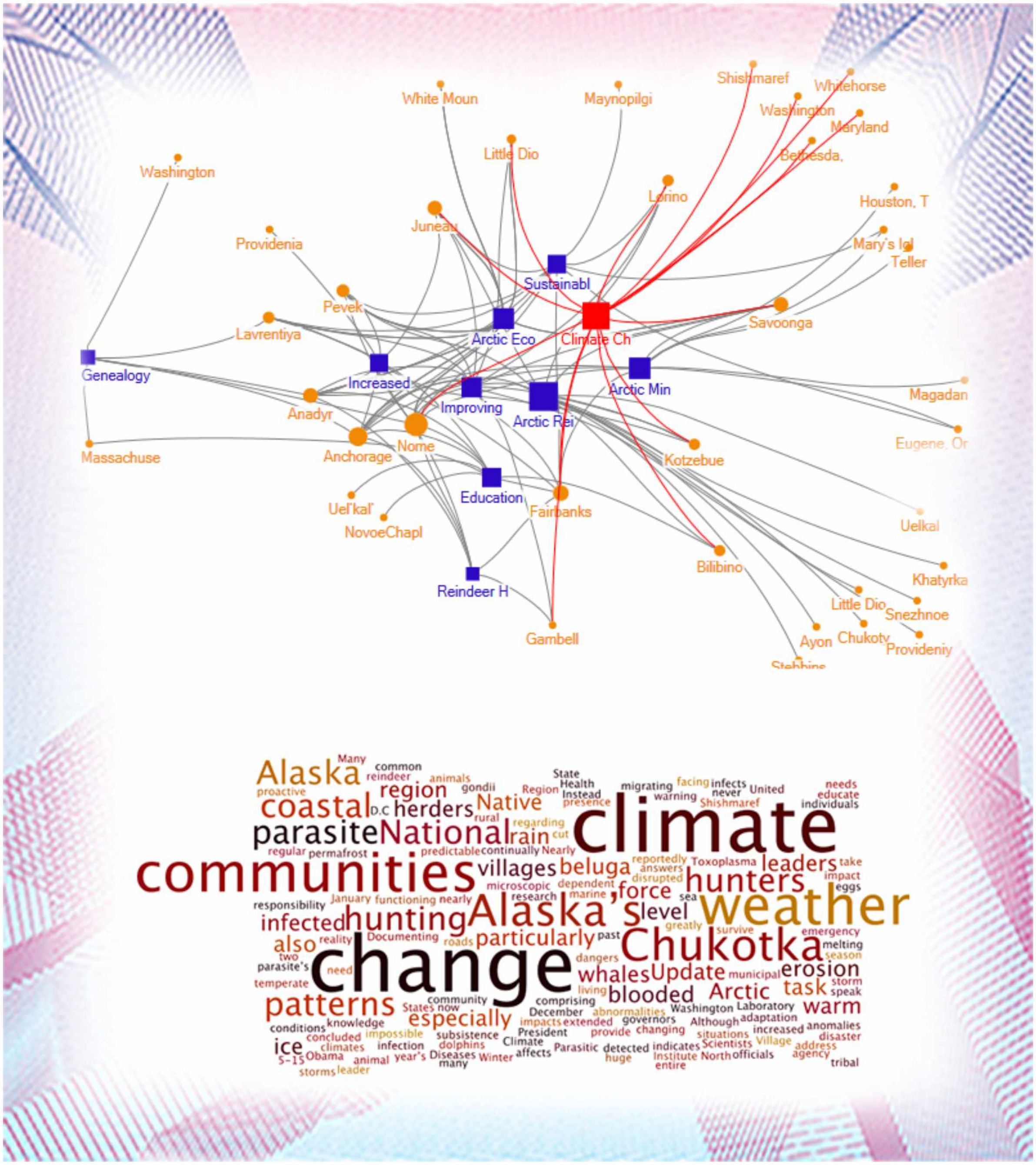


Figure 52: Erosion and Relocation Conference. Network and word frequency visualization for the Climate Change and Environmental Pressures:

Structurally the third conference on sustainable arctic energy is a more balanced mix of core and non-core communities than in previous events (Figure 53). Specifically, Russian communities are better represented in the network graph and “Chukotka” re-emerges in the word frequency counts as well. “Energy,” “power,” and “sources” are frequently used. “Nuclear,” combined with the lowercase version “nuclear” are prominent. They were also common in the previous teleconference, suggesting a lot of regional interest in the topic.

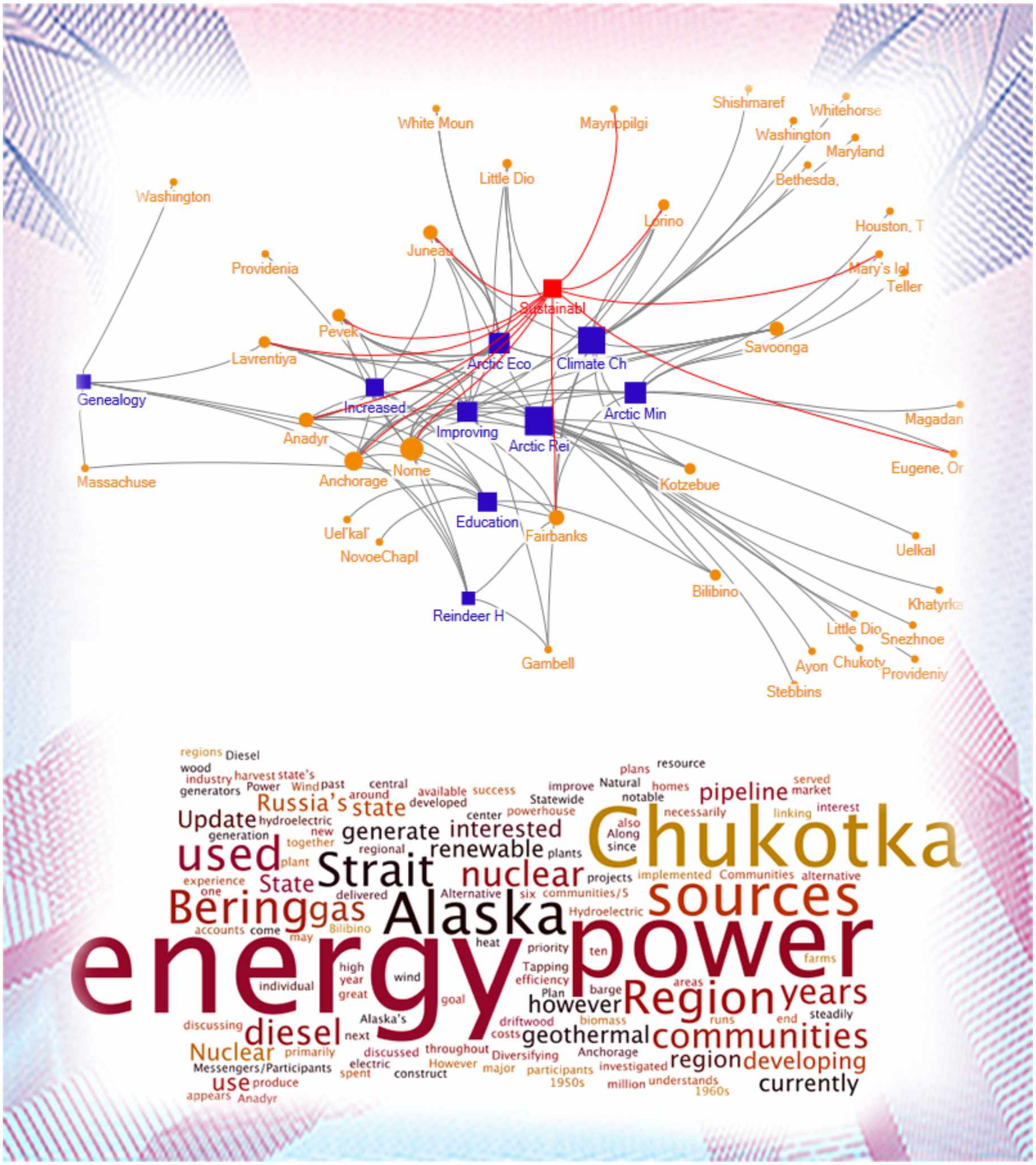


Figure 53: Sustainable Arctic Energy Conference network and word frequency visualization.

Although it is difficult to discern value around the word with certainty, some tentative conclusions can be drawn from assessing the nature of lower frequency words in the conversation. In this case, language such as; “alternative,” “renewable,” “generate,” and “interested,” supports an interpretation that participants were discussing future options, possibilities, or desires and not the potential negative consequences of nuclear energy. The listing of other energy sources; “diesel,” “geothermal,” etc., would further seem to indicate that the discussion was on topic and centered on energy possibilities—of which, nuclear played an important role in participants conversations. Combined with the structural relationships of who was participating in the previous two conferences (i.e., a nice balance of both core and periphery communities from both the US and Russia), it can reasonably be argued that nuclear energy is an important crosscutting theme among participants—a theme that could perhaps be capitalized on in the future if/when greater participation is needed to re-energize the network (i.e., in the middle, or toward the end of a project’s lifecycle when participation often tends to wane) (Vance-Borland & Holley, 2011).

The teleconference on arctic economic viability and sustainability represents a continued “settling in” of the network with a high number of core communities participating. Structurally this is indicated by the lack of substantial peripheral network engagement—White Mountain being the only exception (Figure 54). In many ways the initial peripheral growth of the network, followed by growth of strong core relationships and diminished periphery, represents a similar type of network expansion and contraction sequence as we saw in the Galena example. The observed commonality of this pulsing dynamic highlights the importance of understanding network contraction. Contractions serve to deepen communicative bonds between core network members, which in turn strongly influence the types of connections that become available during the next expansion.

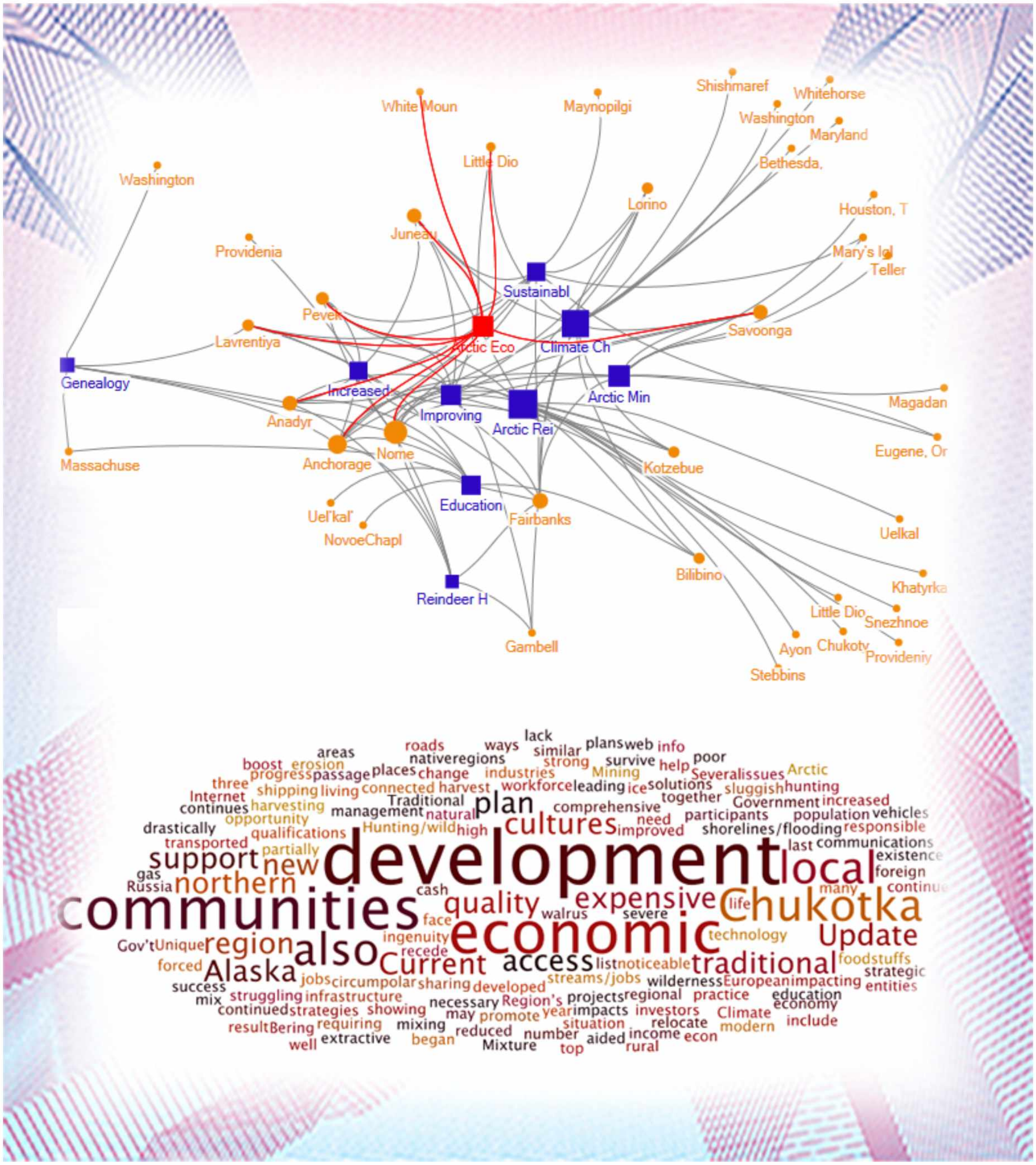


Figure 54: Arctic Economic Viability and Sustainability Conference network and word frequency visualization.

This is important to understand from an organizational communication perspective--where bridging style relationships are critical to introduce new resources into a network (Granovetter, 1973), bonding-type relationship are actually how things get done (Borgatti & Halgin, 2011; Lee & Monge, 2011; Vance-Borland & Holley, 2011)At different times organizational needs are going to oscillate between these two (often competing) needs of increasing available resources while investing in the time and energy needed to form bonding (trusting) relationships. Recognizing what phase the network is in is useful from a strategy perspective as it can guide the types of communication actions that are ultimately invested in. However, taking advantage of that knowledge requires developing working theories on why (or how) the structural (empirical) relationships observed in the network have come to be and why they change. These theories don't have to be objectively "right," they simply have to provide a context to assess future communicative actions against.

In this case then, one possibility for the above observations is that at this stage (the 4th conference), attendance is becoming routine. Specifically, the local organizational resources needed to support participation (e.g. organizational staff time) are normalizing to the demands of the teleconferences and thus consistent attendance has become easier. This explains the core-network relationships, but not why there is such limited periphery participation—especially on a topic that one could reasonably expect would have wide appeal across the entire region. To account for this observation, it is possible to imagine that the Institute of the North's own outreach efforts have momentarily tapered off at this phase in the project—as the monthly conferences have became routine to them as well, and there is possible less sense of urgency to find new participants for each new event.

Thematically this was an interesting conference, as well particularly in how the language of the title was renegotiated through the discussions that occurred during it. The title of the conference was "Arctic Economic Viability and Sustainability." While the word "Economic" (and descriptors like "development") show up prominently in the word frequency data, "Sustainability" does not. This absence of a result, is slightly surprising as previous conferences have all had the words in their titles prominently show up in the frequency counts. However, the word “traditional” does feature strongly in the word counts—and in about the ratio one might expect for a title word (based on expectations from earlier teleconferences).

Concepts of “traditional,” at least in Alaska, are often closely tied to cultural identity and concern for the loss or revitalization of it. These are themes that could reasonably be associated with concepts of sustainability. Therefore it is interesting to theorize—and may prove beneficial from the perspective of guiding a communication strategy—to question if the concept of sustainability and cultural identity are deeply entwined in this network, with “traditional” representing the qualifying language for what sustainability means to the core participants of the network. A wide range of less frequent words register in the word cloud as well, from “education” and “climate” to “workforce” and “industries.” I interpret this to represent the wide range of ideas tied up in the concepts of economic development and sustainability and a lack of clear consensus on what these terms mean at a local level across the region. Given this, from the perspective of fostering cross-organizational communication, these are going to be difficult concepts to rally large coalitions around, because the diversity of ideas people associate with them will make it difficult to define a single, simple message that is easily transferable to others and still recognizable as a shared ideal.

The fifth conference on Arctic mining and mineral development, like the second one, brought in a number of new and/or periphery communities; “Chukotka” is again dominant in the word frequency results—interesting since in this conference only one Russian community participated (Figure 55). Like we saw in the climate change conference, there are a number of place names with reasonably high frequency counts, at both local and regional scales (“Savoonga,” Provideniya,” “Kamchatka,” “Breviq”). To some extent the reference to place names might be attributable to new members establishing their place-based relevance to the core group—as there is a slight tendency for this to happen in all the conferences with a lot of periphery participation. However, here it may be more attributable to the topic—In that the point source nature of mining is likely more conducive to discussions around specific places than the more diffuse impacts of climate change.

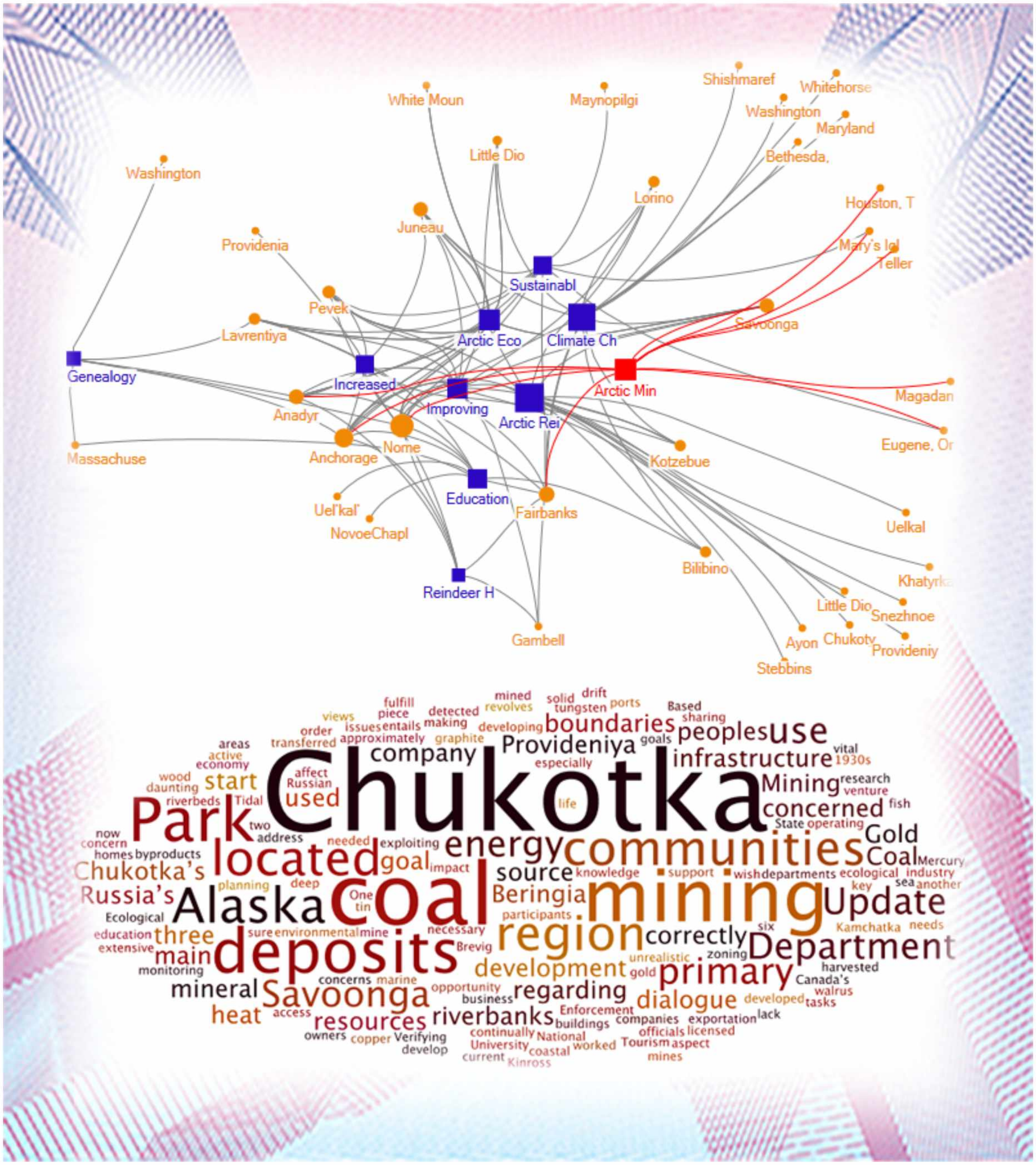


Figure 55: Arctic Mining and Mineral Development Conference network and word frequency visualization.

The education and health conference (Figure 56) also drew in a number of new communities, including a number from Russia. Because of this, it seems likely that education and health are strong crosscutting themes across the region, but it may also be that Institute of the North reinvigorated their efforts at pulling in new communities to the teleconferences.

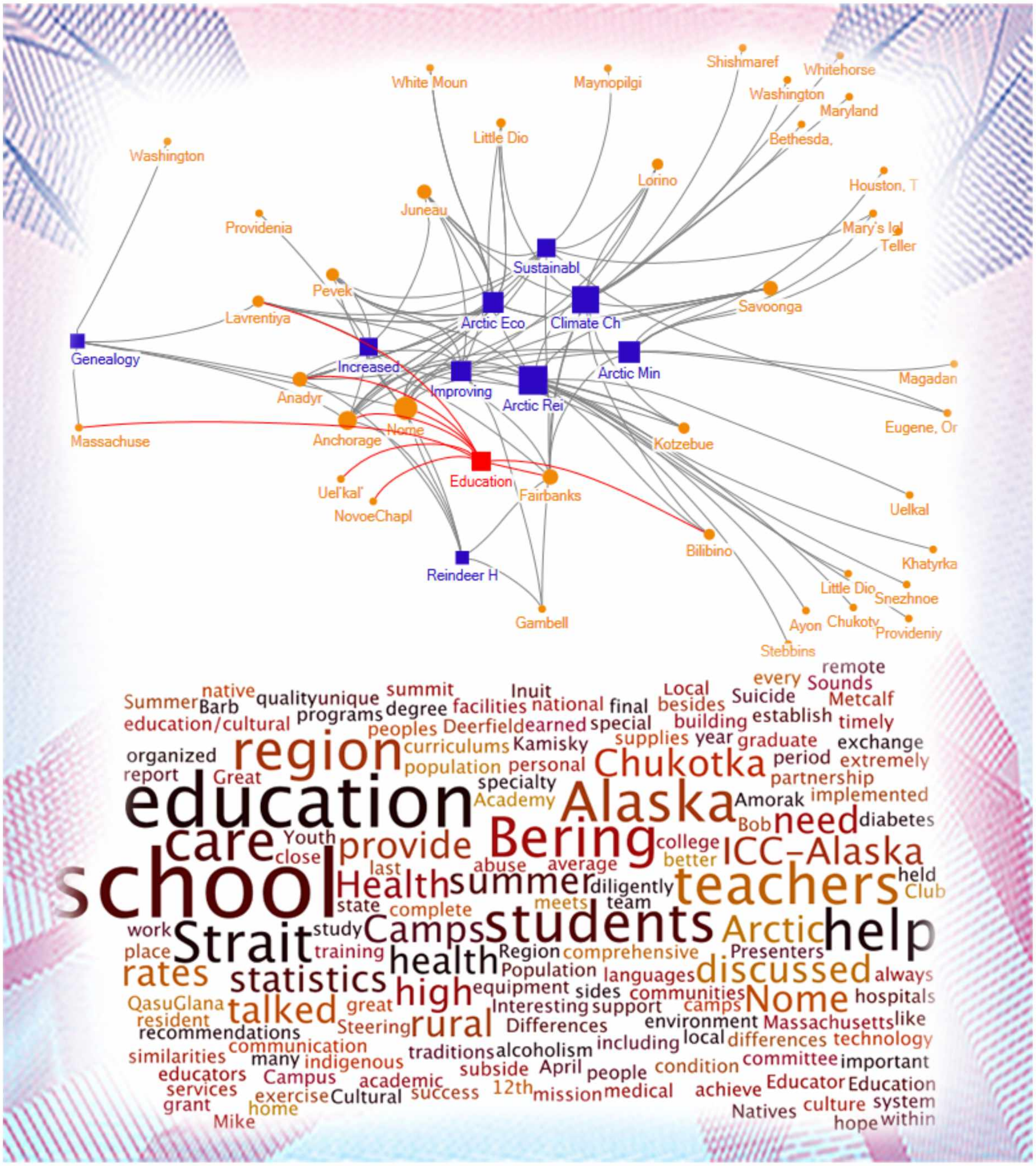


Figure 56: Education and Health Conference network and word frequency visualization.

The last conference on genealogy (Figure 57) is one of the few conferences where more peripheral, than core, communities participated. Themes are highly focused and place is clearly important. This is seemingly a topic that is deeply important, but only to a limited group of deeply engaged people (i.e., sufficiently motivated to find and attend a teleconference event that they otherwise have little direct connection to).

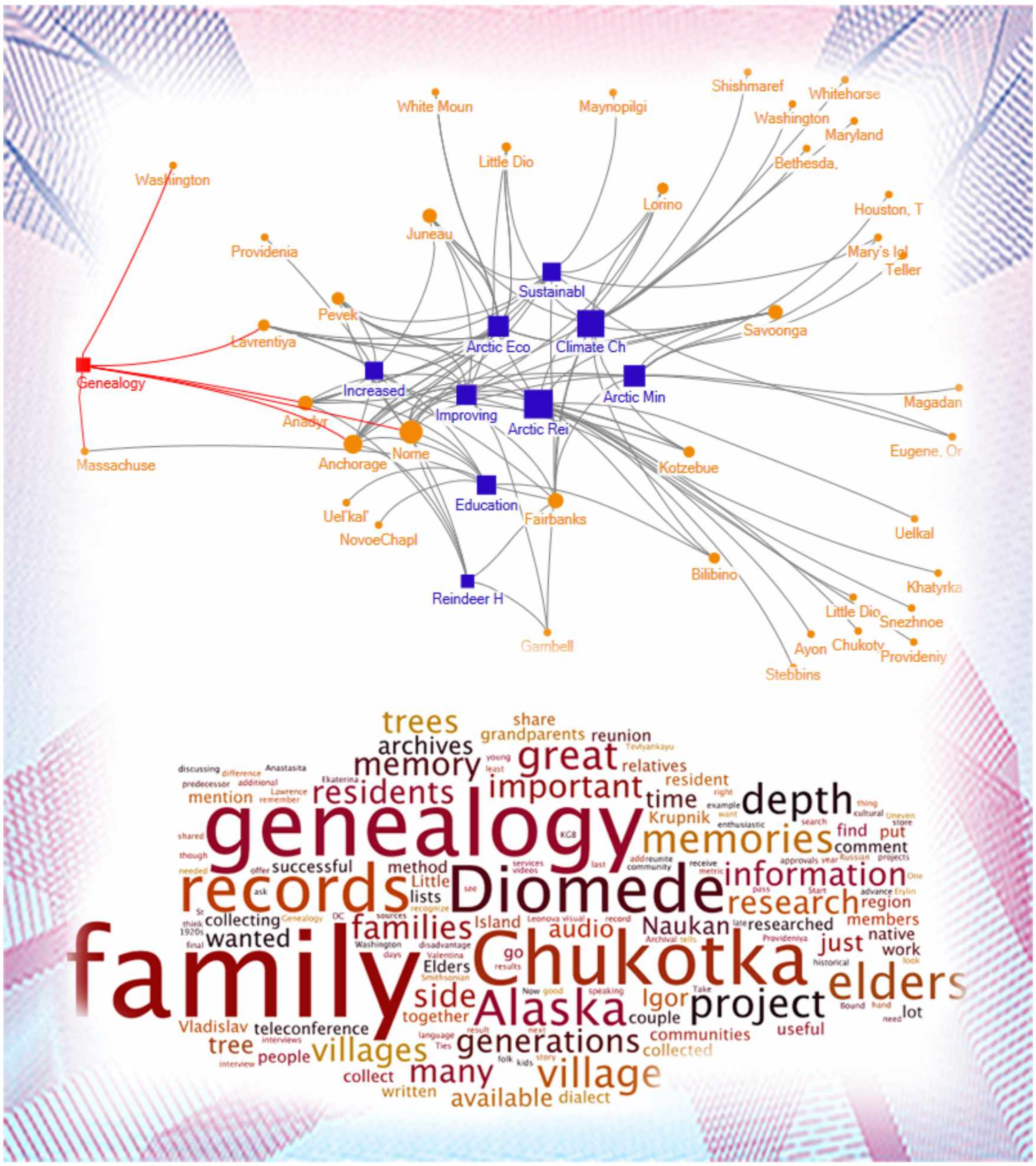


Figure 57: Genealogy and Native Language Retention Conference network and word frequency visualization.

Teleconference Network: Summary

In general, the BSMN teleconference network shows a strong core of communities who regularly participate in the conferences. In this core group of communities, there does seem to be an overrepresentation of US locations. However, this is not an overwhelming trend. Many different Russian communities are represented throughout the different conferences. This is a good indication of a well-established outreach network spanning both countries—one capable of bringing in diverse locations when topics are relevant, but also likely indicates slightly deeper connections into US community organizations. This might be expected given that Institute of the North is an Alaska-based organization.

The relationship between core and peripheral communities is an interesting one when considered alongside the content analysis results. In conferences where only core communities attended, themes tend to be narrower and more action oriented. In conferences when a higher percentage of core and peripheral communities participated jointly, themes were topically broader, more "problem definition" in form, and concerned with spatial identification. The oscillation between these two different forms of content—definition/discovery to solution/action—suggests a healthy dynamic between core and peripheral communities and is certainly a positive sign in assessing the success of the network in meeting the organizational goal of establishing new communication ties.

Bering Strait Messenger Network Conclusion

Based on the goals that Institute of the North operated under in forming the BSMN it must be said that they did an excellent job. The networks they seeded through their teleconference and Facebook activities show an overall well balanced participation across both place-based measures (distribution of participants across Russian and US communities) and thematic topics. In other words, they achieved their stated goals from a communication and network analytic perspective. The end result from a resilience perspective is unobservable in the data presented here, and ultimately unknowable to any quantifiable level. This is true because first, until a crisis event occurs and the connections built through BSMN are required to respond—there is nothing to measure. Second, the very presence of these connections may prevent a number of crisis from even occurring (an obvious, if unstated, organizational goal), and of course, that is also a scientifically un-measurable quantity since there can be no control group.

However, if we assess these networks using the combined panarchy, robustness, and network structure-based model that we have been using throughout the case studies, we can develop a monitoring strategy to assess their evolution overtime and test working theories on their social-ecological outcomes.

In this system, once again, the resource of interest is the health and wellbeing of the communities and regions involved. A large and complex resource to be sure, more cumbersome perhaps than our previous case studies in that concern for the resource has not been triggered by a specific event-driven crisis, but rather concern over more diffuse, slower acting changes to the SESs of the region. By initiating the BSMN project the Institute of the North hopes to serve as an Infrastructure Provider around general concerns for SES changes. The Infrastructure that is attempting to be created is new communicative ties across the physical and institutional communities at play in the region. From that perspective, their organizational partners serve as the Resource Users. This is fairly straightforward and describes the organizational level of the Panarchy model of concern in this case study. The strategy of using the already established communicative networks of the partner organizations to seed BSMN, defines a second Panarchy-based level.

This second level of panarchy is the level investigated in this study and shows a higher resolution of just how the Institute of the North's efforts involved communities across the region. At this level, all participants served an Infrastructure Provider role and the Institute of the North's goals were met. This implies the strategy of bridging collaborations at the organizational level to take advantage of established communication networks is appropriate for seeding these kinds regional, general interest networks. However, the question of concern for longer-term resilience is: At the participant and thematic level, what ratio of Infrastructure Provider and Resource User role overlap do we see in the BSMN, and most importantly, when a crisis occurs in one of the thematic areas involved (say a storm event with impacts to coastal erosion) how are these new connections utilized?

We can take away some hints at role overlap differences on either side of the Russian-US border based on centrality measurements. On the Russian side we saw fewer communities involved, with fewer individuals representing them. On the US side we saw both more communities and more raw numbers of individuals involved. Using that as a guide, it's likely that there is more role overlap occurring on the US side. Robustness would then imply that connections built through BSMN would be more beneficial to the US communities than Russian (i.e., because of greater role-overlap) but as no crisis were observed during this study that question is empirically unknowable in this work. However, it would point to a need for an evolving Institute of the North strategy to focus efforts on extending BSMN's reach into the more diffuse populace of Russian communities. Both the physical and social impacts of differences in the formal institutional governance regimes will dictate the best ways to accomplish this. It is very likely that at this point in time each region has different needs and abilities to adapt to changes in role overlap. While robustness suggests that greater role-overlap leads to improved resilience, continued monitoring of network, specifically when crisis occur can serve to guide Institute of the North's continued facilitation of the network. Specifically, we have discussed that pulses in the expansion and contraction of the network seem to serve as mechanism for adjusting core network membership. Testing this relationship, as part of an ongoing organizational communication strategy, it is during crisis, when the network expands, that Institute of the North may best be able to 1) increase role overlap across specific portions of the network, and 2) ensure that doing so results in the type of increased community resilience that their mission statement outlines.

Arctic Science Summit Week 2016 Case Study

An international scientific and governance-oriented conference representing established institutional interests in the exploitation to conservation phase of the adaptive cycle (Figure 58).

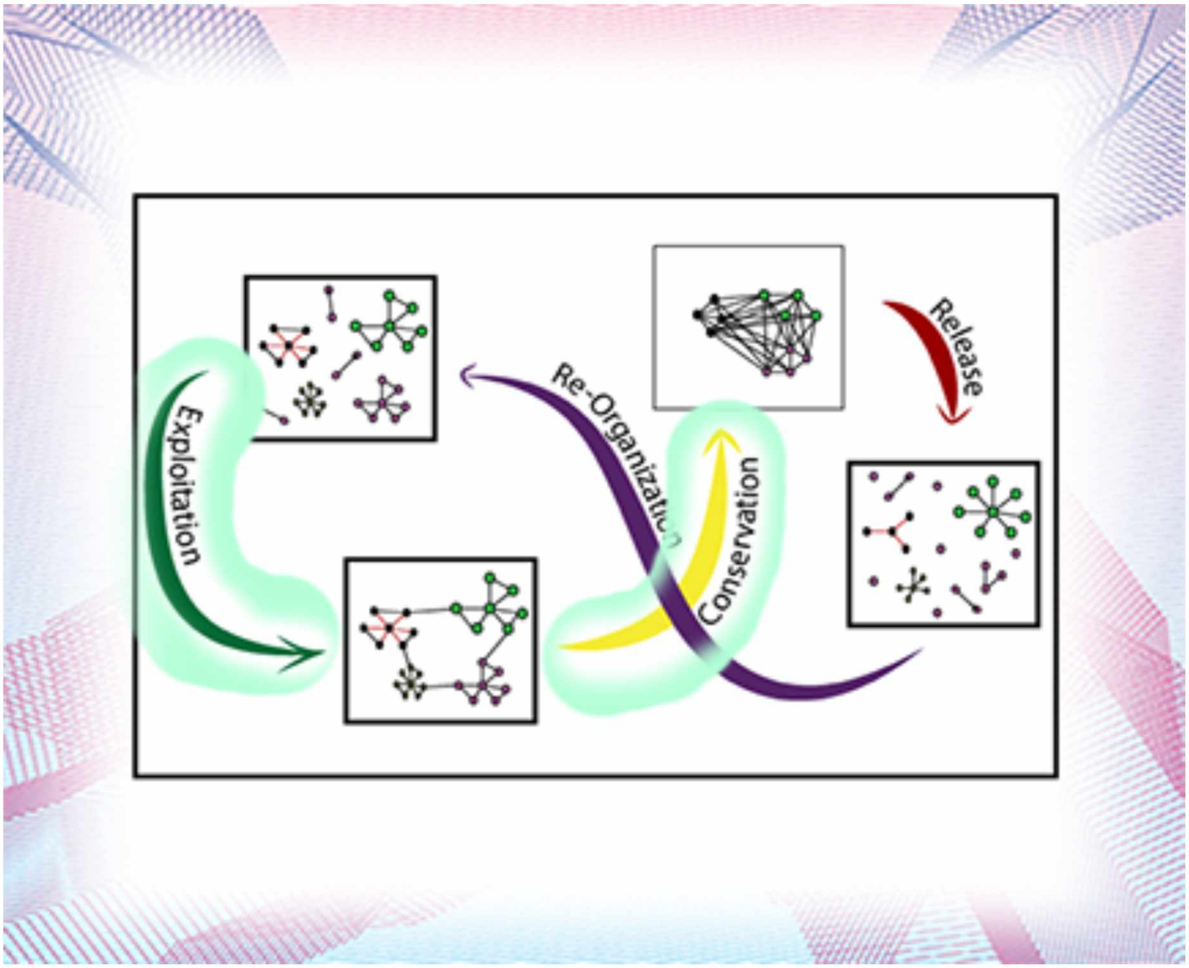


Figure 58: Arctic Science Summit Week 2016. An international effort to improve scientific observation and governmental policy in the arctic.

Context and Triggering Event

The 2016 Arctic Science Summit Week (ASSW2016) occurred March 12-18, 2016. It was the 18th running of the annual event and was hosted by the University of Alaska Fairbanks as a combined set of conference, workshop, and symposium-style presentations. As the name implies, the annual gathering is designed around scientific themes. However, organizers identified a range of stakeholder groups they were interested in having participate. These included international level policymakers, practitioners from many different scientific disciplines, artists, and Indigenous representatives, as well as journalists and the general Fairbanks public (2016 Arctic Science Summit Week, 2016). The impetus for the yearly gathering is concern by the global scientific community and their political allies for the potential social-ecological impacts of dramatically increased rates of environmental change in the Arctic—with a specific concern for the overall health and wellbeing of Arctic ecosystems, Arctic research (as an informal institution), and Arctic governance at the international level (as a formal institution)("2016 Arctic Science Summit Week", 2016).

The logistical structure for the event was rather complex with multiple sub-events occurring throughout the week. From a participant and low-level volunteer perspective (both roles I filled at various times throughout the week) the gathering was busy, and numerous choices had to be made as to what sub-events to attend. There was no way to attend all that was occurring. However, depending on hierarchal standing within the institutions mentioned above, access was limited during specific events such that not all participants were welcome at all events—an interesting logistical choice, as the organizational granting of privilege to one stakeholder group over another makes visible the biases of the organization with regards to which stakeholder groups are seen as integral collaborators and which were seen simply as digesters of the information science attempts to produce. It should be noted this structure is at odds with the collaborative messaging of the organization.

From an organizational perspective, the week broke down along three main strands (Figure 59). The first was the Arctic Science Summit Week with general presentations and business meetings. The second was the Arctic Observing Summit working groups and breakout sessions. The third was the Arctic Council senior officials' gathering. While participants had to select which of these strands to attend, joint keynote presentations and informal mixing driven by shared meal and refreshment options did provide opportunities for comingling. Each of these strands represented a slightly different organizational objective with distinctly different desired outcomes and invested stakeholders ("2016 Arctic Science Summit Week", 2016). Logistically, each of these strands was composed of its own unique programing, with each offering their own set of presentations and breakout sessions based on the differing goals and objectives of each strand.

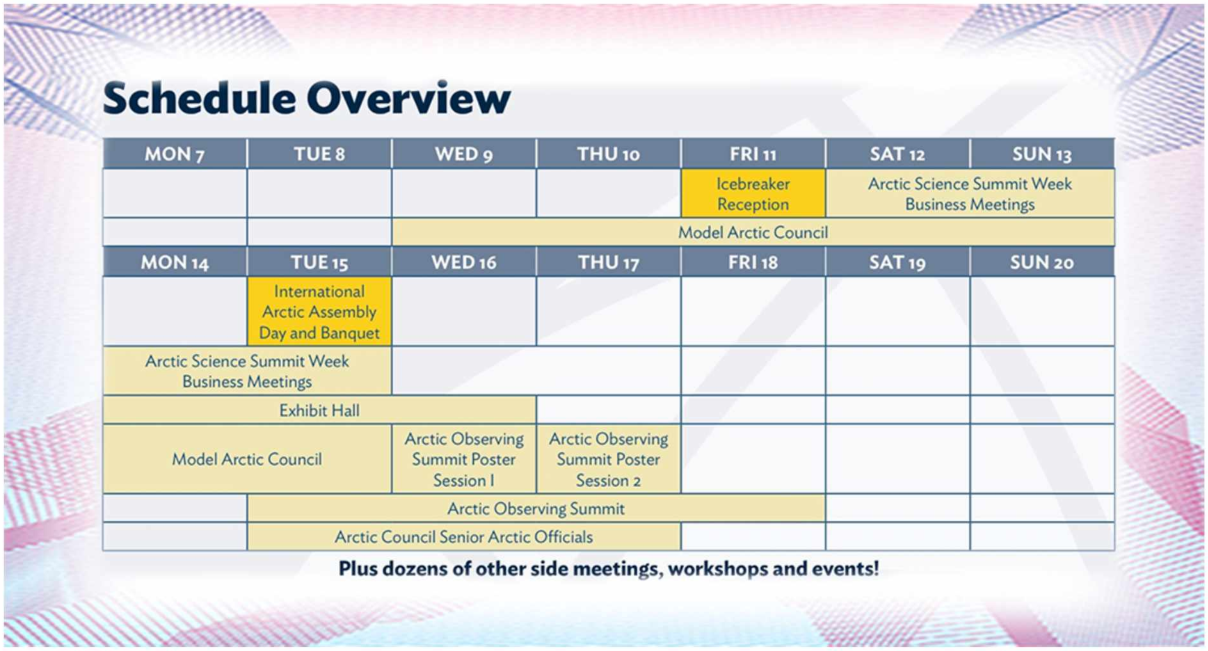


Figure 59: Arctic Science Summit Week 2016 schedule overview. Three different contnent strands were the focus of the conference schedule; 1) general science presentations and business meetings, 2) observation-oriented working groups, and 3) Arctic Council senior official gatherings.

The three distinct strands were meant to work together in meeting the overarching goal of the Arctic Science Summit Week (ASSW), which was to provide a forum for *"an annual gathering of international scientists and policymakers who advance Arctic research. The conference promotes coordination, collaboration and cooperation in all fields of Arctic science."* ("Arctic Science Summit Week (ASSW) 2016", 2016). The Arctic Observing Summit (AOS) functions to drill down a bit on these general goals by serving as a platform to facilitate and support "*a common vision for sustained, long-term observations of the Arctic,"* as well as *"serve as a forum for the planning and coordination of such measurements"* ("Arctic Science Summit Week (ASSW) 2016", 2016).The direct, and unquestioned, linkage between "observations" and "measurements" in this statement is a clear indication of the conference bias toward understanding Arctic change through a quantitative worldview. While the conference is ostensibly a scientific gathering, and thus rightly should focus on scientific models of knowledge, the unchecked assumptions in the statement work in opposition to the stated goal of building new communicative bridges. Rather, this language suggests a continuation of the "loading dock" model of scientific communication—where scientists attempt to simply deliver information to an audience in a one-way, broadcast format, rather than invest in interpersonal relationships with invested stakeholders. This model of scientific communication has proven ineffective in communicating across worldviews to engage diverse stakeholders and change entrenched opinions (Timm, Hum, & Druckenmiller, 2016).

Where ASSW is primarily driven by the agenda of the established Arctic scientific community, the Arctic Council attempts to influence international governance, serving as a high-level international policy forum "*promoting cooperation, coordination and interaction among the Arctic States, Arctic indigenous communities and other Arctic inhabitants on common Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic*" ("The Arctic Council: A backgrounder", 2016). This language, as a more sophisticated political device, is less overtly biased than the AOS phrasing. However, given the vastly different worldviews held by many Indigenous Arctic and sub-Arctic residents, it is questionable if all stakeholders define the term "sustainable" in a similar fashion. It is equally questionable if they are even aware of the possibility that differences could exist. However, the combined meeting of high-level Arctic Council members at a science sponsored, designed, and implemented gathering (of this size and scope) is a clear indication of where Arctic Council sensibilities rest. This again, is structurally problematic to the goal of building communication bridges across diverse stakeholder groups (that are not already embedded in the process).

Within the boundaries of an unquestioned "rightness" given to the scientific worldview, the three slightly different objectives of ASSW, AOS, and the Arctic Council, as well as differences in the social domains they originate from (Western science and governance), did serve to create a diversity of stakeholders intermingling on the campus of the University of Alaska Fairbanks during the entirety of ASSW 2016 events.

And again, setting aside unchecked systemic biases, this mixing of groups was inline with the organizer's stated objective for the conference to "*advance Arctic science, technology, policy, and stakeholder issues.*" As well as their belief that *"convening these meetings together here, at one time, allows for unprecedented interaction between scientists, policy makers, journalists, and the public—all of whom are concerned with promoting and facilitating coordination, cooperation, and collaboration in the Arctic Region"* (2016 Arctic Science Summit Week, 2016).

The main question, however, is to what degree did new network relationships develop between diverse stakeholder groups? Specifically, those not already in the ASSW fold? In other words, to what degree were already-established network relationships simply maintained or strengthened, rather than new forms of relationships developed?

It is important to realize that these questions themselves carry bias. As I mentioned in the very opening paragraphs of this dissertation, my personal bias as a researcher leads me to be critical of established power structures, which ASSW certainly represents. How I answer the above questions, through interpretation of empirical network results, is colored by this bias. Awareness of the bias allows me to recognize the need to reflexively check and recheck my interpretations against this bias. This doesn't remove the bias, but rather makes it explicit, letting my readers assess my interpretations on more informed footing.

The questions themselves, however, are directly derived from this bias as well, which is obvious in their critical tone. Yet, from my perspective, the goal of these case studies is to develop an understanding of communication networks reacting to social-environmental pressures—from a practical application perspective that focuses on how an individual organization can manipulate their own networks to effect greater influence on the broader domain that they operate within.

This perspective requires a critical tone to identify weaknesses in an organization's communication strategy and implementation in order to strengthen them. Therefore, this theme of internal critique will come up again in the following chapter on application—as part of a strategy that depends on an adaptive learning and continuous improvement model of implementation. The central factor then, in asking these types of critical questions, is to assess how well the results of communicative actions align with organizational objectives and to do so explicit awareness of organizational bias is mandatory.

Network Bounds and Methods

The size and complexity of ASSW2016 ensures that no two observers are likely to perceive the event in a similar fashion—an obvious statement perhaps. But along these same lines, there are also numerous different network perspectives that can be drawn to describe the gathering.

This case study focuses on the Facebook and Twitter networks that developed around the conference. The networks derived from these channels however, were embedded in a multitude of different channel-based networks that were not explicitly developed for this work. The next few paragraphs describe potential implications the more relevant of these (un-examined) channels may have had on the networks that were analytically assessed. I then describe in detail how the Facebook and Twitter networks were constructed.

ASSW2016's communication team put together and implemented a balanced, considered, and (by Alaskan scales) extensive marketing and communication plan for the entirety of the conference (K. Timm, personal communication, March 2016). They used both new and traditional media extensively to reach out into different identified stakeholder groups. In Fairbanks, during the conference participants and general community members were exposed to print flyers hung on store bulletin boards, more elaborate signage across the sprawling campus and nearby city streets, radio marketing, as well as broadcast news stories and community event announcements. Depending on your connection to the University and the conference itself, you would also have had exposure to the conference website, numerous social media feeds, listserv notices, and regular email updates. All of this together produced a rich, interlinked, communicative landscape that included Facebook and Twitter but was not in any way limited or shaped by them.

During the conference, face-to-face networks formed and dissolved at every keynote, panel discussion, Arctic Council meeting, breakout session and coffee break. In practical terms, from the perspective of tracking the effectiveness of an ongoing communication plan, these networks are invisible from a quantitative perspective. In other words, they can't really be directly measured without an extensive survey of all participants and their diligent willingness to track each of their social interactions (Scott & Carrington, 2011) throughout the conference. However, this information is probably the most important for an organization facilitating a conference to understand to strategically manage the conference. Because of this, and despite the difficulty, this type of study has been attempted in a few instances (Camarinha-Matos & Afsarmanesh, 2005; Darling, Shiffman, Côté, & Drew, 2013; Mergel, Huerta, & Van Stelle, 2007) but it really is not feasible at an application level (Scott & Carrington, 2011) where longitudinal changes are critical and require even more commitment on the part of participants to diligently (while still fully participating in the conference) record their own data. So instead of direct measurement, organizations generally turn to qualitative "what did you think?" kinds of questions (to random or select participants) to assess the outcomes of events. Sometimes expanding this version of assessment to include a follow-up survey sent to participants via Survey Monkey or some other similar online tool. Additionally, co-authorship relationship (academic publications, policy documents) between attendees can be measured following an event as a proxy indicator for longer-term network changes. But, in general, large-scale face-to-face networks are very difficult to construct for larger conferences, despite their importance. This clearly presents a major obstacle for organizations attempting to analytically understand the efficiency and outcomes of their communication efforts. It's my belief, and one of the main suppositions of this dissertation that social media can serve as a proxy indicator for the purposes of guiding communication strategy assessment for these types of professional gatherings. Further, social media assessment can work in concert with the above-mentioned proxies/methods (Co-authorship tracking of participants, online post-event survey, intra-organizational debriefing of individual experiences, etc.) to approach this problem of measurement at large conferences from a range of directions. With that in mind, I focus this case study on ASSW2016's Facebook and Twitter network both to understand the broader communication outcomes of the conference, as well as develop a baseline for assessing how the Arctic science and governance networks evolve into the future.

ASSW2016 actively engaged in Facebook and Twitter as part of their broader communication plan—producing, sharing and commenting on both their own and others' original content (K.

Timm, personal communication, March 2016). Therefore, Twitter and Facebook are explored specifically in this case study as an example of how social media can be used as a proxy to better understand events using multiple channels of communication. During ASSW2016 each platform had its own unique attributes and users, although many users engaged with both Twitter and Facebook and content produced on one platform was often shared on the other. Content derived from mainstream (broadcast) media sources showed up on all platforms as well.

As will be discussed in the results section, the context of these posts makes it clear that many of the users engaged on these two platforms were also in physical attendance at the conference. This is especially true for people using Twitter. Not surprisingly, since for Twitter-users sharing experiences by Tweeting at live events is a common and accepted practice (Smith, 2011). This social practice is an actively developing norm and involves a highly interpersonal level of communication—with rapid back and forth Tweets between individual participants, presenters, and the organization often intermingled with regular face-to-face encounters (i.e. Listening to a plenary session, getting coffee between sessions, etc.). My own experiences in attending a diverse range of disciplinary conferences (from Education to Climate Science) since the early 2000's reflect this research. While at ASSW I often found myself Tweeting with peers during sessions—comparing what the different presenters were saying in real-time, only to continue the conversation face-to-face during breaks or when we went to the same session. These experiences give real-world credibility to Smith's research and lend weight to the idea that Twitter is a reasonable proxy for face-to-face networks at conference-style events—with caveats, of course. In this case, Twitter's likely user bias skews toward professional and intellectual social classes (Mislove, Lehmann, Ahn, Onnela, & Rosenquist, 2012.). However, at a professional conference like ASSW2016, that is actually a large percentage of the target audience, which again supports the appropriateness of using Twitter as a face-to-face proxy at ASSW—at least for these stakeholders.

This is not always the situation, and so being aware of channel bias (in this case platform bias) is critical to using individual channels as broader system proxies. Specifically, it is important to make sure that channel bias aligns with the stakeholder group(s) that a communication strategy is targeting. That is important here because beyond the professional scientific and governance stakeholders at ASSW2016, Indigenous and Arctic community members were also identified as key stakeholders ("2016 Arctic Science Summit Week", 2016). There is little published research to this end, but my anecdotal experience of living and working in both urban and rural Alaskan communities since the late 1990's tends to make me *feel* that Twitter is not going to be an efficient platform to reach these particular stakeholders. This puts an obvious limit to what extent conclusions can be draw from Twitter with regard to the experiences of Indigenous and Arctic community members at the conference—given they are not likely on this specific platform, even if they were physically at the conference. This group is likely to be on Facebook (as the previous case studies show) and is an example of why being aware of channel bias and assessing through multiple channels is important when possible.

The Facebook network explored in this study was developed using similar methods as in the Galena and BSMN case studies to empirically define structural relationships and then qualitatively assess the conversations forming those relationships. The ASSW2016 organizing committee created and maintained a Facebook page leading up to and through the conference. NodeXL was used to pull three separate time slice of activity on this page from January 1, 2016 through February 25, 2016, February 26, 2016 through March 8, 2016, and March 9, 2016 through March 20, 2016. These particular time slices were chosen to represent three relatively distinct phases in the run up to the conference. The first slice covers the period where marketing and communications begin to ramp up in the last few months before the event. The second slice attempts to cover the final flurry of communicative activity just prior to the conference, and the third covers the time period the conference was occurring. Ideally, a fourth period would be considered following the conference. Unfortunately, I was not able to collect that data before the organizers shutdown the page shortly following the event.

In the Facebook networks, connections (ties) are made between users who either liked or commented on the same ASSW2016 Facebook post. Text analysis was run using NodeXL's standard word-pair analysis tool on both original ASSW2016 posts, as well as the text of any comments made in response to a post. Public profile information was used to assess where network members were from and which of the identified stakeholder groups they likely represented. A thorough and sequential reading of the posts, in conjunction with word-pair and group analysis, combined with profile information was used to assess the context of conversations across the network. In total this represents a large body of data and is difficult to present in its entirety via print format, however, links to the raw data files can be found in Appendix A.

The Twitter network was also explored using NodeXL, and similar analytical techniques as just described for the Facebook networks. The primary distinction, however, is that the Twitter networks are created based on content identified via the hashtags #ASSW2016 and #AOS2016 rather than pulling data from a single organizationally managed media feed. Briefly, hashtags are a quick and easy content identification system common on Twitter. Nearly all active-users are familiar with their use and depend on them to personalize the content they see on the site (Rosenberg, Greenhalgh, Koehler, Hamilton, & Akcaoglu, 2016; Small, 2011). The conference tags were developed and marketed by the ASSW2016 communication team, and as much as possible on a platform like Twitter, represent the formal networks the communication team attempted to foster and grow.

Twitter networks were developed on a daily time interval beginning March 10, 2016 and ending March 19th, 2016.

For both the Facebook and Twitter networks group identification was calculated using the Clauset-Newman-Moore algorithm per NodeXL's stock clustering features. Development of group detection algorithms is an intensely active field of study at the moment with wide ranging applications in fields as diverse as law enforcement, healthcare, education and global finance (Leskovec, Lang, & Mahoney, 2010; Papadopoulos, Kompatsiaris, Vakali, & Spyridonos, 2012; Xie, Kelley, & Szymanski, 2013; Yang & Leskovec, 2015). Specific new methods are constantly being developed and fine tuned to meet the differing needs of such a wide range of applications. However, as explained elsewhere in this dissertation, they all generally work by trying to optimize the ratio of in-group ties relative to the number of out-group ties (Hanneman & Riddle, 2005) and they do this—one way or another—by brute force, iterating different in-group/out-group combinations over and over to achieve the desired results (i.e., the highest number of in-group ties relative to out). A consequence of this method is that no two trials of the function ever result in exactly the same group arrangements. Additionally, the algorithms used to create network visualizations work on this same iteration premise. As a result, each network visualization is (slightly) unique (Leydesdorff & Nerghes, 2015; Mislove, Marcon, Gummadi, Druschel, & Bhattacharjee, 2007; Scott & Carrington, 2011).

Results and Discussion

Facebook Results

The evolution of ASSW2016's Facebook network is visualized in Figure 60. I will go into each of these networks in greater detail momentarily, however, the visualization of them in sequence provides a unique perspective on the overall network evolution. Again, these networks map the connections between people engaging with ASSW2016 through Facebook. Nodes in these networks are people or organizations, and ties are drawn between people when they like or comment on the same ASSW2016 post.

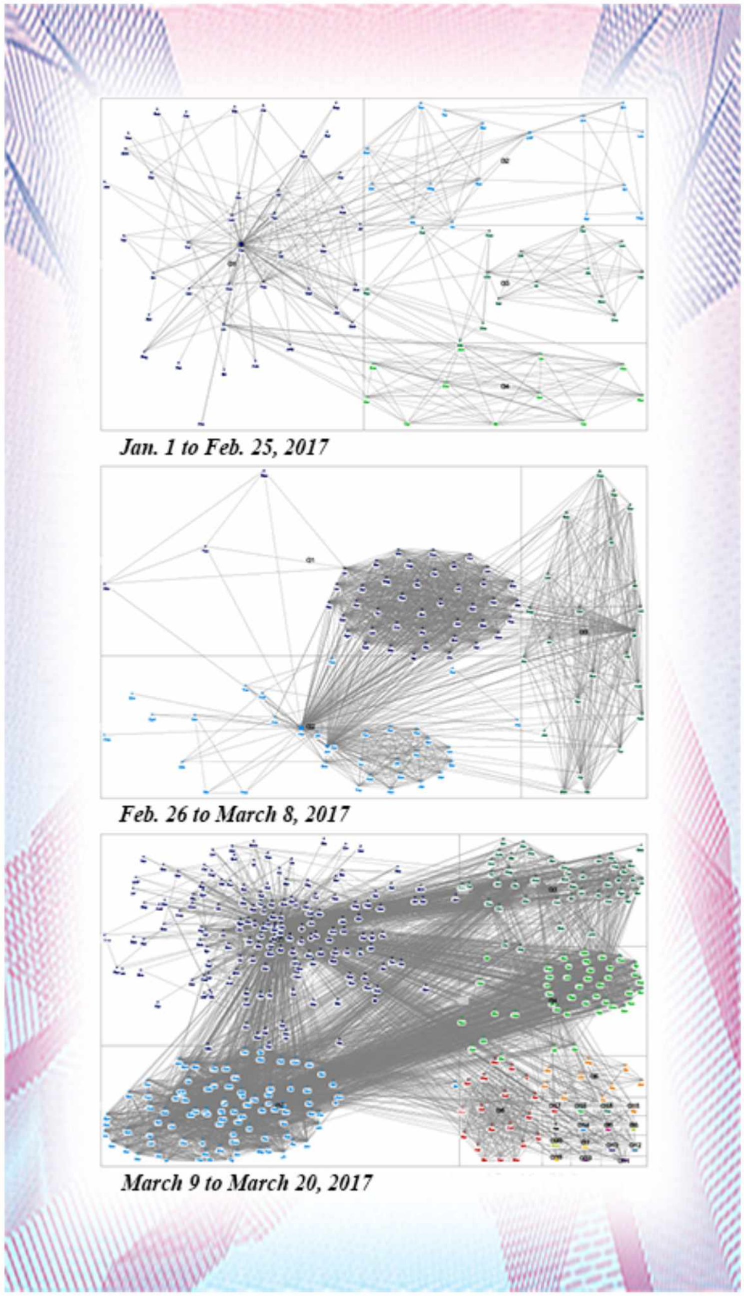


Figure 60: ASSW2016 Facebook page network evolution. The three networks visualization here illustrate how the ASSW2016 Facebook network evolved prior to, and during, the conference.

An interesting observation in this case is the relatively consistent number of main groups at each time slice. In each slice there are three to five large groups (though during the conference many lesser groups form, as well) (Figure 60). We will see in the qualitative descriptions of the content that brought these groups together that there are thematic and organizational connections between the groups in all three networks. As the event approaches, the size and exact number of these main groups shifts, but from the meta-structure of the networks we can see that the general grouping patterns are persistent. What noticeably does change is the total number of connections within and between groups (increasing), and the ratio of in-group ties to out-group ties (first increasing as the conference gets closer, then decreasing during the event).

The first visualization in this series (Figure 60, January 1 through February 25, 2016) represents the early coordination efforts between planners and partner organizations in the run-up to the conference. The small size of the network indicates that it records a time period before much general participant interest was generated. This marks the coming together of the network and the start of a shared-use of this specific channel of communication—likely by individuals who already have established some form of connection to the event outside the ASSW16 Facebook page (perhaps even including other social media-based relationships, but likely through a range of professional and personal contacts). In the second visualization, the increased ratio of in-group connections seems to indicate an activation of stakeholders within each partner organization. One can imagine this pattern forming as each partner group starts to ramp up their own internal marketing for the event—sharing information with people already in their personal network. During the event, in-group ties become more diffuse. This maybe because the event itself is providing a new shared experience across groups, providing a touchstone for participants original tied to distinct subgroups to relate to one another individually and discuss the event as a common whole. Regardless of the exact reason though, the structural result is that subgroups become less distinct during the conference with more cross-group connectivity. This result should please organizers, as it represents empirical evidence they achieved their goal to increase connectivity across stakeholder groups.

Undoubtedly other scenarios can be envisioned to account for this structural evolution. However, the empirical transition from high in-tie group ratios to more diffuse connections is an ideal example of the conceptual shift from the exploitation phase of the adaptive cycle to the conservation phase. This was described in more detail in the beginning of the chapter, but here we can see how the network initially meets the description of the exploitation phase by having lots of in-group clusters with a few strong bridges between them, then, triggered by the conference, the network evolves to have many more connections across the groups—with individual stakeholders in each communicating directly with one another rather than indirectly through the original bridging member.

The persistence of the main groups is worth noting here because it highlights the role of legacy networks in shaping the diversity of worldviews that are likely to be represented in the conservation phase of a communication system (if it progresses to that point). This suggests interesting implications to how worldview diversity enters complex social-ecological systems in the Anthropocene. There are tradeoffs for both an abundance of diversity, as well as a lack of it (Vance-Borland & Holley, 2011). Too much diversity can make for cumbersome and slow decision making, to little can create scaled versions of group think, lacking the creativity and critical lens needed to effectively adapt to changing social and physical environments. Individual organizations are each going to have to decide what is the appropriate level of diversity to maintain in their core network, however, here it seems the organizers did meet most of their target audiences through the expansion of their core networks, and so likely they are maintaining close to their desired level of diversity within their core relationships.

When we look closer at the first time-slice from January 1, 2016 through February 25, 2016 (Figure 61) we see four main groups.

The largest group, labeled G1, contains the central node of ASSW2016's organizational Facebook page (Table 4). This is not surprising given the methods used to create the network. The ASSW2016 node is well connected into each of the four groups. However, by exploring the public profiles of users within G1 (see Appendix A for complete data sets) we can see that other nodes in this group tend to fall into one of three categories, 1) connected to a UAF-based organization helping to plan the conference, 2) connected to mainstream media and planning for Fairbanks community events during the conference, and 3) miscellaneous connections to planning organizations through science-based UAF academic ties.

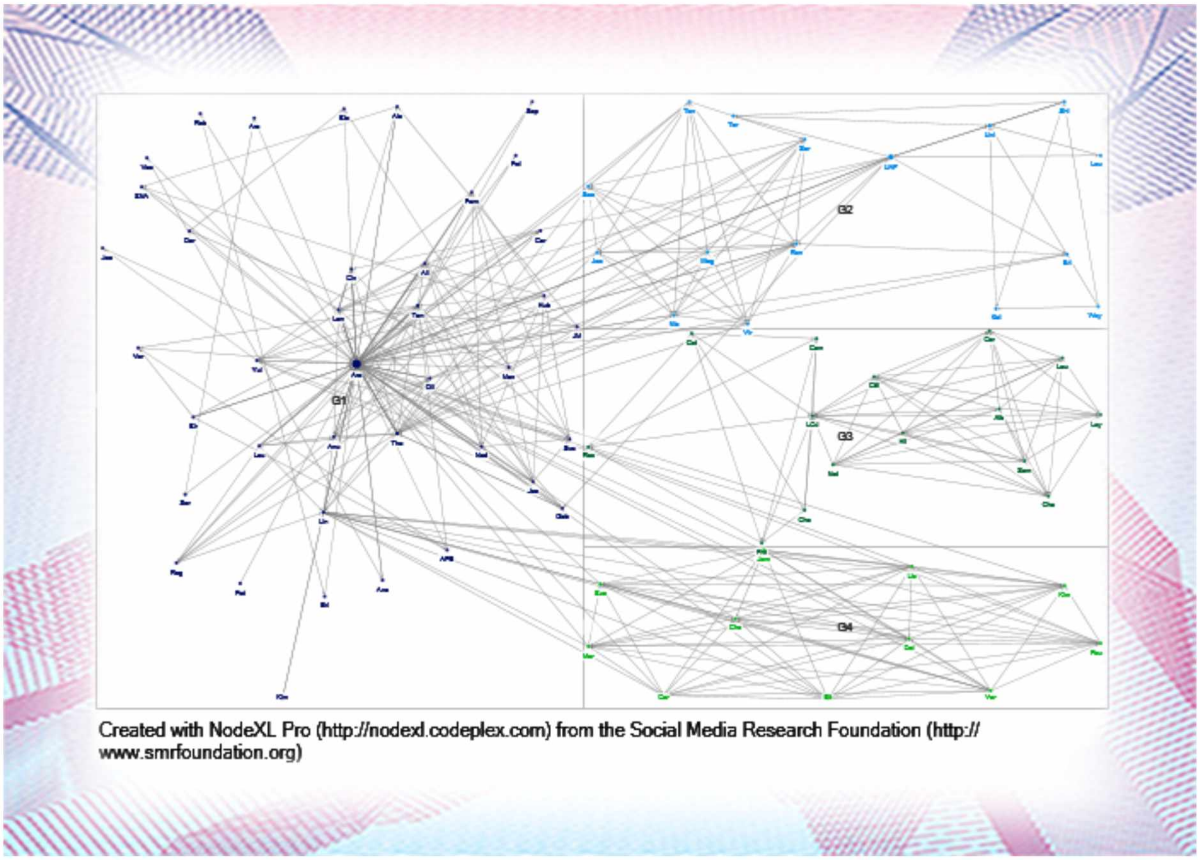


Figure 61: Time-slice one ASSW2016 Facebook page. Four main subgroups can be found in this initial network (January 1-Feburay 25, 2017). Each are seen to form around established stakeholder groupings targeted by the conferences organizers.

Table 4: Time-slice one ASSW2016 Facebook page, Group 1. Table 4 lists the most central nodes in Group 1 of the initial network (January 1-Feburay 25, 2017) ranked via betweeness scores. Many of these nodes maintain outside connections to the planning and marketing of the conference.

1-1 to 2-25-16		In-degree	Out-degree	Betweeness	Location
G1	Arctic Science Summit Week 2016	60	2	3135.500	Fairbanks, Alaska
G1	Theresa Bakker Smith	11	8	134.500	Fairbanks, Alaska
G1	Tony Croft	8	11	109.167	No Data
G1	Lindalee Andruske	17	2	83.000	No Data
G1	Lena Krutikov	4	7	63.000	Fairbanks, Alaska
G1	Olivia Lee	3	7	31.000	Fairbanks, Alaska
G1	Alice Orlich	8	3	17.167	Fairbanks, Alaska
G1	Anupma Prakash	7	3	11.500	Fairbanks, Alaska
G1	Yulia Zaika	5	4	7.000	No Data
G1	Alaska Fire Science Consortium	1	3	0.000	Fairbanks, Alaska

Group 2 (G2) contains the UAF campus-wide Facebook page, as well as the Chancellor's personal page, and the UAF Alumni page (Table 5), all of which suggests this group was reaching into the general UAF community. We will see this in the Twitter networks as well, together the two results would seem to indicate that through these two channels of communication at least, the organizers did a nice job of breaking into established UAF-wide community networks—which was one of their stated objectives. The topics that drove engagement in this group focused on generating local community participation in the conference and marketing the different kinds of conference events that general Fairbanks community members could get involved in. G1 then, is mainly composed of nodes with users representing the scientific community at UAF and is associated with the primary ASSW2016 organization. G2 bridges to the broader UAF community.

Table 5: Time-slice one ASSW2016 Facebook page, Group 2. Table 5 lists the most central nodes in Group 2 of the initial network (January 1-Feburay 25, 2017) ranked via betweeness scores. Many of these nodes are associated with the general UAF academic community, but not directly linked to the associated with planning organization.

1-1 to 2-25-16		In-degree	Out-degree	Betweeness	Location
G2	UAF Alumni Association	2	10	717.333	Fairbanks, Alaska
G2	University of Alaska Fairbanks	6	0	128.000	Fairbanks, Alaska
G2	Shiv OM	1	4	122.000	No Data
G2	Ronald Binder	11	1	44.833	Inuvik Northwest Territories
G2	Brian Rogers	2	2	0.000	Fairbanks, Alaska
G2	Jessica Veldstra	4	5	0.000	Homer, Alaska
G2	Kelsey Barham	2	1	0.000	Anchorage, Alaska
G2	Laura Brown	1	1	0.000	No Data
G2	Maggie Hess	1	8	0.000	Fairbanks, Alaska
G2	Nishit Goel	7	2	0.000	No Data

Group 3 (G3) is perhaps the most interesting of the four groups. It is completely disconnected from the remainder of the network. It is also associated with posts written in French, and the most central node within the group is run by the International Youth Offices of Québec (Table 6). The content of posts in G3 are focused on generating youth participation in the conference. And, while it is not explicit in the posts, it is likely this is mostly related to generating participation in the Arctic Youth Council activities and thus representative of one aspect of the international governance-based stakeholder groups that the organizers were trying to reach—another positive result for the organization.

Table 6: Time-slice one ASSW2016 Facebook page, Group 3. Table 6 lists the most central nodes in Group 3 of the initial network (January 1-Feburay 25, 2017) ranked via betweeness scores. This group is almost entirely composed of French speakers and specifically focused on generating interest in the Arctic Youth Council.

1-1 to 2-25-16		In-degree	Out-degree	Betweeness	Location
G3	LOJIQ - Les Offices jeunesse internationaux du Québec	14	0	90.000	Montreal, Canada
G3	Aïsha Krma	1	8	0.000	No Data
G3	Camille Audet	2	3	0.000	No Data
G3	Carrefour Jeunesse Emploi Côte-des-Neiges	6	3	0.000	Montreal, Canada
G3	Catherine Castagner	0	5	0.000	Montreal, Canada
G3	Célia B. Beaudin	5	4	0.000	Sherbrooke, Canada
G3	Charles Caron-Melançon	1	4	0.000	Toronto, Canada
G3	Charles Normand	8	1	0.000	No Data
G3	Frédérique Lef	3	2	0.000	Saint-Chrysostome, Canada
G3	Hilda Sanchez	2	7	0.000	No Data

Group 4 (G4) is connected directly to G1, but to neither of the other groups. This group formed around an ASSW2016 post sharing information about a movie event scheduled for the conference (Table 7). As part of that event, a memorial showing of Archana Bali's "Voices of the Caribou People" was planned. Sadly, Archana passed away earlier in 2016, and group 4 is namely made up of a subset the UAF scientific community who knew and worked with her—specifically, students and alumni of the Resilience and Adaptation Program (RAP), of which I am also a member. So, in this case, I have insider knowledge of the contexts of the interactions in this group. We were commenting and sharing information in respect and honor of our lost friend.

Table 7: Time-slice one ASSW2016 Facebook page, Group 4. Table 7 lists the most central nodes in Group 4 of the initial network (January 1-Feburay 25, 2017) ranked via betweeness scores. This group is heavily influenced by outside connections developed through the UAF RAP program. Alumni from the program were important to the planning of the conferences communication efforts and this particular grouping formed around a memorial showing of a video produced by a fellow alumni.

1-1 to 2-25-16		In-degree	Out-degree	Betweeness	Location
G4	Bithi De	3	9	0.000	No Data
G4	Carol Armijo	6	6	0.000	No Data
G4	Chas Jones	8	4	0.000	Corvallis, Oregon
G4	Delia Vargas Kretsinger	7	5	0.000	No Data
G4	Faustine Bernadac	9	3	0.000	Fairbanks, Alaska
G4	James Labenski	0	12	0.000	No Data
G4	Kimberley Maher	11	1	0.000	Fairbanks, Alaska
G4	Lisa Baraff	2	10	0.000	No Data
G4	Marion Glaser	4	8	0.000	Moose Pass, Alaska
G4	Susmita Hazra	5	7	0.000	Nagaon, India

RAP is an interdisciplinary program at UAF that for many years has supported cohorts of graduate students interested in social-ecological system research. The genesis of this dissertation itself can be traced back to my time in RAP. As students in the program, we each spend roughly a year together in close physical contact while taking a series of RAP required coursework. Then, because we generally each come from a wide variety of home disciplines, we tend to have less contact with one another once the course work is finished and we each get deeper into our own individual research problems. Facebook has evolved as a place that we have found to stay in at least distant contact with one another. The primary communication manager in the ASSW2016 organization was a RAP alumnus, as well. The strong showing of this subgroup of the UAF science community, early in the network evolution is an indication of how important legacy networks are in the exploitation and conservation phase of the adaptive cycle—directly down to the individual level communicators within an organization.

The second time slice examined in the ASSW2016 Facebook network is visualized in Figure 62. This network represents the time frame immediately prior to the conference. It is a shorter overall time period than first one and still the network grows from 81 nodes to 100. Though not a large increase, given the shorter timeframe it certainly represents a ramping up of activity as the conference approaches.

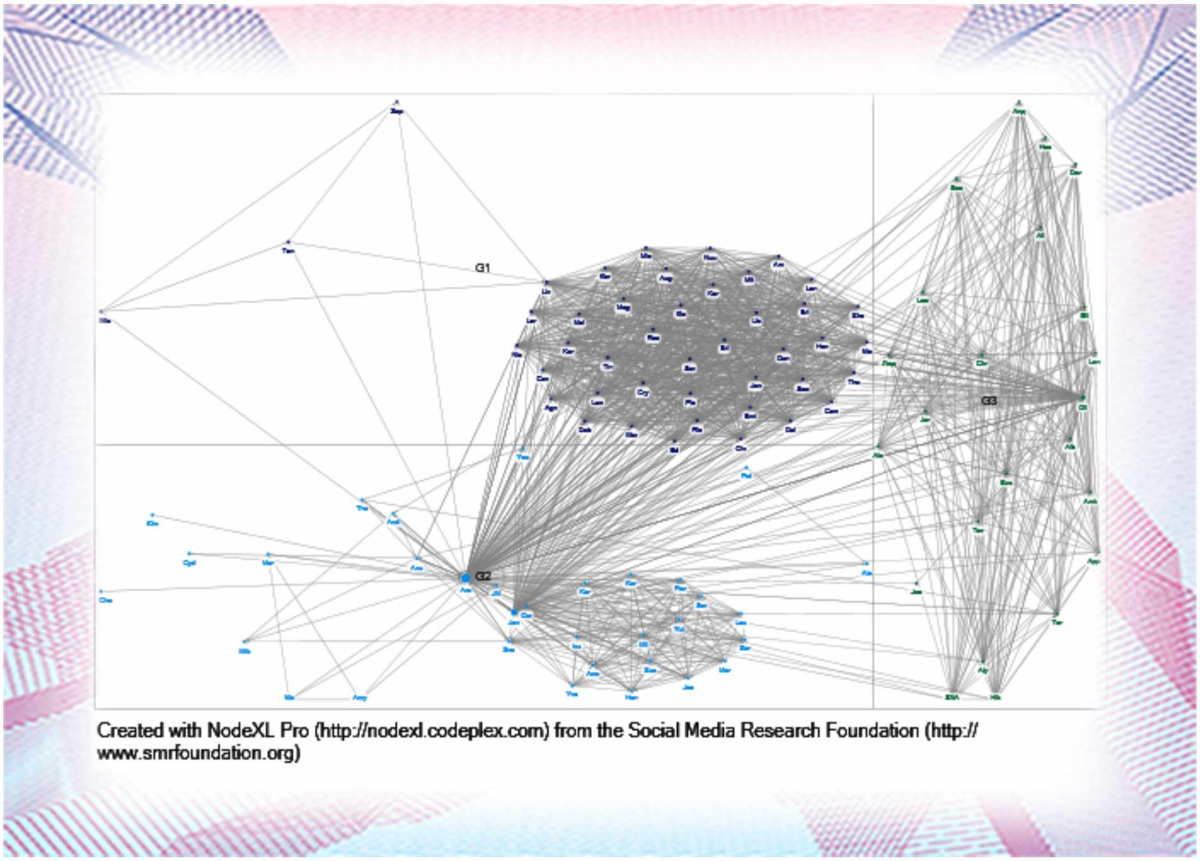


Figure 62: Time-slice two ASSW2016 Facebook page. Three main subgroups can be found in this second network (February 26-March 8, 2017). During this time period the network is at its most internally segmented.

The total number of groups drops from four to three between the first time-slice (Figure 61) and the second (Figure 62). Each group is strongly interconnected but connectivity across the groups is weak. Additionally, only one or two posts in each group trigger the interconnectivity within groups. This is different than what we saw in the BSMN case study, where groups, or clusters, developed around shared engagement in multiple organizational posts. Here the more focused engagement pattern results empirically in a greater proportion of in-group ties to out-group ties, and practically in less shared content binding group members together. This means that these groups can form and reform rather quickly as new material is engaged with, and as I will describe in greater detail below, this is probably why this time-period dropped from four to three groups—G2 here being composed of individuals who were members of G1 and G4 from the first time-period.

In Group 1 (G1) of the second time-slice (Figure 62) a post advertising a science-themed art show planned during the conference sparked a lot of engagement by both scientific and art oriented Facebook users. The actual event shows up in the Twitter networks as a distinct subgroup as well and clearly drew salient attention from a particular set of stakeholders. Exploring the public information on the user's Facebook accounts engaged in the post, it is clear there is a range of backgrounds drawn into the conversation, and from a range of locations. Of note however, is the international mix and lack of Fairbanks-based participants. It is also worth pointing out the strong contingent of commenters from multiple communities in Greenland (Table 8). We'll see in the next time-slice that this strong presence of Indigenous and community-based participation out of Greenland persists but is not matched by similar participation from other Arctic regions.

Table 8: Time-slice two ASSW2016 Facebook page,Group 1 through 3. Table 8 ranks the most central nodes for groups 1-3 during the time February 26- to March 6, 2016. Relative to the subgroups observed in the two other time frames, these three groups have the least inter-connectivity.

Group	2-26 to 3-8-2016	In-degree	Out-degree	Betweeness	Location
G1	Lindalee Andruske	31	18	149.000	No Data
G1	Arnaq Johansen	31	13	0.000	Nuuk, Greenland
G1	Augustinus Abelsen	30	14	0.000	Qaqortoq, Greenland
G1	Brita Broberg	36	8	0.000	Mullsjo, Sweden
G1	Camilla Nymand Petersen	37	7	0.000	Nuuk, Greenland
G1	Canadian Science Publishing	1	42	0.000	Canada
G1	Christa Arnannguaq Brøns Appelt	40	4	0.000	Glamsbjerg, Denmark

Table 8 Continued					
Group	**2-26 to 3-8-2016**	**In-degree**	**Out-degree**	**Betweeness**	**Location**
G1	Crystal Dillon	9	36	0.000	Edmonton, Alberta
G1	Deborah Smeltzer	21	23	0.000	No Data
G1	Delia Lee	6	37	0.000	No Data
G2	Arctic Science Summit Week 2016	100	37	4245.500	Fairbanks, Alaska
G2	Janet Warburton	36	51	1850.333	No Data
G2	Svein Mathiesen	17	4	43.833	Kautokeino, Norway
G2	Anupma Prakash	2	7	18.500	Fairbanks, Alaska
G2	Theresa Bakker Smith	0	4	2.500	Fairbanks, Alaska
G2	Andrija Ilic	2	3	2.167	Torshavn, Faroe Islands
G2	Alevtina Alevtina	2	1	0.000	No Data
G2	Amy Breen	1	3	0.000	Fairbanks, Alaska
G2	Carol Lick-Pearse	6	12	0.000	No Data
G2	Chas Jones	0	1	0.000	Corvallis, Oregon
G3	Olivia Lee	38	30	671.667	Fairbanks, Alaska
G3	Tori Tragis	13	11	21.333	Fairbanks, Alaska
G3	Sean Diplodocus O'Rourke	13	11	21.167	No Data
G3	Aibitdin Yanabaev	5	18	0.000	Salekhard, Russia
G3	Alexis DiAngelo	2	21	0.000	No Data
G3	Aliyah Levon	10	13	0.000	no Data
G3	Alyssa Enriquez	1	22	0.000	No Data
G3	Amberlynn Lopez-Sprague	7	16	0.000	Bend, Oregon
G3	Christie Ericson	19	4	0.000	Anchorage, Alaska
G3	David Rojo Lorenzo	8	15	0.000	No Data

Specifically, there are no rural Alaskan communities represented despite the organizing committee being based in Alaska and also choosing to predominately use Alaska Native imagery in their marketing and branding of the event. On their webpage alone, nine of the thirty-three photos on the main landing page are of Alaska Native cultural practices or speakers (“Arctic Science Week 2016”, 2016). The dichotomy of such high levels of Indigenous imagery alongside almost a complete lack of representation in the digital communication networks studied here is troubling and hints that the organizers had little success in reaching into the rural communities of Alaska—clearly a goal represented in both their graphic design and mission statement.

G1 is only connected to G2 and G3 through a few bridging nodes in each (Figure 62), while there is no obvious bridging node in G1. This means that in G2 and G3, there are one or two key users who are connected to many G1 members, but most G1 members are only connected to a couple users in G2 and G3. It is possible then that G1 is largely a result of the key bridging members in G2 and G3 activating a different part of their broader Facebook network in much the way that G4 formed in the first time-slice then dissolved into G2 of the second. This once again reinforces the role of legacy networks in expanding diversity. G2 and G3 in this second time-slice are namely composed of Fairbanks-based members with relatively direct ties to the organizing committee. G1 is composed of members from more diverse locations, but they would not have been involved without awareness of the events sparked by their connections to a few very specific core members of G2 and G3.

The relationships between these three groups highlight the role of individual network members to bridge across thematically distinct interest areas. As it evolved, the network in this second time-slice does have some connectivity across the subgroups. It is weak, however, and dependent on just a few members to persist. If any of these key nodes (users) were not active the network would break apart into three distinct components, with no connectivity between them and/or one or two of the groups (namely G1) would likely never have engaged in these conversations in the first place. This points to the import role of these bridging members in building connectivity between groups that are otherwise unaware of their common interests—and particularly to the legacy networks these key bridging members maintain.

In organizational, management, and to some extent resilience studies, the role these key users are playing would be termed "brokering" and discussion of the impacts of "brokers" on organizational cooperation, and in resilience studies—ecological conservation—has become an evolving focus of research (Alexander et al., 2015; Kietzmann et al., 2011; Luthe & Wyss, 2016; Marin Ricke, 2010; Vance-Borland & Holley, 2011). Much hope is placed on the role of brokers to create new alliances and organizational configurations when demanded by shifting social and environmental conditions. Brokers are clearly present in time-slice 2, and as we will see in time-slice 3, the evolution of the network into a much more interconnect form during the conference lends credence to the idea that these brokers can facilitate network diffusion during events such as conferences through the manner in which they prime the network prior to the event.

In the third time-slice (Figure 63), we see how these early bridging connections evolve into more widely distributed ties across the network. However, in time-slice two, the network ideally illustrates the types of connections we expect to see in the exploitation phase of the adaptive cycle—where various groups have come together around specific aspects of a larger problem, but have yet to make strong connections to one another beyond a few key brokering agents.

In the March 9 through March 20, 2016 ASSW2016 Facebook page activity (Figure 63) we see the network becomes much more active. This time frame covers the period of the conference, so the increased activity is not surprising given that the physical events of the conference are the focus of the network in the first place. Reading through the content of conversations for this time-slice we see that many participating in the Facebook conversation are also in attendance at the conference. This overlap of the physical and virtual has been a common theme throughout the case studies I have presented here. In each case, when physical activities reach a climax the virtual networks expand and become more active as well. They each have contracted after the physical event, with—to varying degrees—new network relationships forming and dissolving with each pulse. I will discuss this more in the following application-oriented chapter, but recognizing, and to some extent controlling the pulsing behavior of these networks is the key to managing a strategic communication plan designed to address social-ecological challenges.

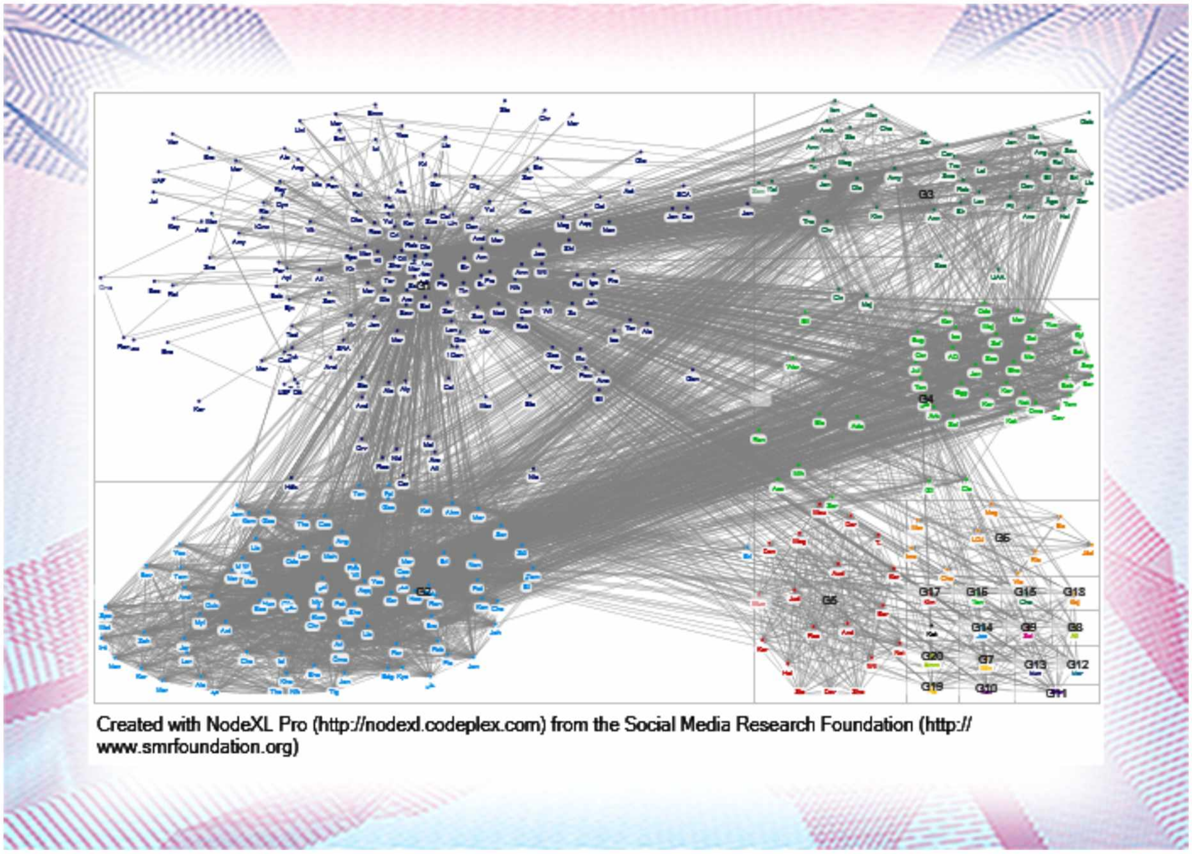


Figure 63: Time-slice three ASSW2016 Facebook page. Twenty subgroups can be found in the third network (March 9-March 20, 2017) and the volume of exchanges increases. While there is an increase in the overall number of subgroups, interconnectivity between them increases as well, making this the time period where the network is most cohesive.

In the third-time slice (Figure 63), strong clustering is still present, but the number of groups dramatically jumps to 20. The number of connections within groups versus the number of connections between groups also changes. In-group density decreases while between group connectivity increases. Although many of the clusters are very small (13 of the groups contain just one node), six of the groups are bigger (9, 19, 43, 44, 90, and 158). All of them show relatively strong connectivity across the entirety of the network rather than strong alliances between just one or two groups. In other words, members of one group maintain connections to members of most of the other groups, rather than to just one or two other directly related groups. This is different than the first two time slices, where only a handful of network participants maintained bridges across groups. Here it seems to indicate a network wide interest in the breadth of conference posts and not select interest in specific topics by overly differentiated subgroups. Early in the dissertation I described this strengthening of connectivity between groups (a decrease in the ratio of in-group ties relative to out-group ties) to be the empirical network representation of a transition from the exploitation to conservation phase of the adaptive cycle and this seems to be what is occurring here.

During the conference, G1 is the largest and least internally cohesive (as measured by intergroup tie density). This is the group with the ASSW2016 node, and many people in this group engage with just a few of the ASSW2016's posts. The contexts of these posts are generally very diverse, as the ASSW2016 organization is trying to report on the wide range of events occurring during the conference. G1 then represents the breadth of content the conference is concerned with (from the organizer's perspective) and draws in a wide variety of different participants—though the most central members are still namely from urban Alaska (Table 9). Engagement is diffuse, and a lot of different posts pull in small levels of activity that combine over the course of the conference to form this large group of generally involved participants. This is similar to what we saw in the Russian elements of the BSMN network where they were more broadly involved in the network compared to Alaskan participants who showed greater topical differentiation. Other groups in the ASSW2016 network form around fewer posts and are thematically more internally consistent. These tighter clusters indicate thematic areas of greater shared interest between group members than we see in G1, but the overall high connectivity between groups still indicates wide-ranging interest by most participants (in the Facebook network) across the range of post made during the conference. In relation to the adaptive model, this network configuration (with a de-emphasis on individual bridging connections and strengthening of bonding-types relationships) indicates a strong movement toward the structures expected during the conservation phase of the cycle.

Table 9: Time-slice three ASSW2016 Facebook page, Group 1. Table 9 ranks the most central nodes for group 1 during the final time period of March 7-March 20, 2017. Internally this group contains a number of bridging relationships and many of the nodes seem to be serving a broadcast role in sharing the organization's messaging.

3-9 to 3-20-16		In-degree	Out-degree	Betweeness	Location
G1	Arctic Science Summit Week 2016	360	21	85838.918	Fairbanks, Alaska
G1	Piope Plush	124	69	7747.544	Seward, Alaska
G1	Anupma Prakash	59	73	4856.247	Fairbanks, Alaska
G1	Christie Ericson	97	49	4790.467	Anchorage, Alaska
G1	Bettisworth North Architects and Planners	5	19	2238.000	Fairbanks, Alaska
G1	Arctic Youth Ambassadors	23	20	1972.149	Anchorage, Alaska
G1	Aditaya Akheramka	65	29	1635.273	Fairbanks, Alaska
G1	Dana Eidsness	15	3	1206.516	Portland, Maine
G1	Olivia Lee	19	25	1057.289	Fairbanks, Alaska
G1	Sean Diplodocus O'Rourke	39	24	965.740	No Data

The organizer's goal for the conference was to bring together groups already working in the Arctic and facilitate the breaking of established academic silos to build a more collaborative Arctic research environment. We can see in the evolution of their Facebook network how this goal was accomplished by reaching out through their already established connections (the key bridging members we saw in the previous time-slices) to targeted stakeholder groups. The conference should be considered a success in this regard. It does seem to have helped build greater connectivity between these groups, facilitating the strengthening of weak ties into potentially stronger ties—depending on how after-conference connections are maintained via both Facebook (which will be difficult since the page has been shut down) and the blending of different communication channels not explicitly explored here (face-to-face, e-mail, co-authorship, etc.).

A consideration, however, is who is not in this network. One of the identified stakeholders that the organizer wanted to draw into their ideas on pan-Arctic cooperation and governance were Indigenous and Arctic rural community members. If we look at the self-identified hometown locations of members in the remaining groups of time-slice 3 (composed of more than a single individual), we can see that the Facebook networks are still predominately filled with people and organizations from Fairbanks and other urban or non-Arctic communities and likely represent predominately Western institutions (Table 10). Therefore, there is little evidence that much progress was made in engaging with these stakeholders—other than those from Greenland, as mentioned above.

Table 10: Time-slice one ASSW2016 Facebook page, Group 2 through Group 16. Table 10 ranks the most central nodes for group 2 through group 16 during the final time period of March 7-March 20, 2017.

3-9 to 3-20-16		In-degree	Out-degree	Betweeness	Location
G2	Peter Karl Filemonsen	125	28	1924.189	Greenland
G2	Kwanjit Songkham	71	71	1289.167	Bangkok, Thailand
G2	Ömer Ömer Koçar	45	49	957.623	Aleppo, Syria
G2	Jørgen Boller	37	45	854.336	Greenland
G2	Karoline Petersen	66	34	831.755	Greenland
G2	Costel Miron	57	42	758.139	No Data
G2	Vasile David	50	44	661.864	No Data
G2	Ariel Guevara	42	59	624.091	No Data
G2	Yaser Albnaya	77	37	613.043	Botngaard, Norway
G2	Niyazi Gasimov	47	53	529.539	No Data
G3	Amy Hartley	67	60	2119.455	Fairbanks, Alaska
G3	Jennifer Imus	52	26	1017.913	Fairbanks, Alaska
G3	Diego Cuesta Kaasti Tlein	41	24	408.618	Fairbanks, Alaska
G3	Theresa Bakker Smith	36	8	344.863	Fairbanks, Alaska
G3	Swarup Mitra	33	19	249.611	No Data
G3	Trevor Fuller	24	21	146.179	Valdez, Alaska
G3	Maja Lisowska	1	28	91.828	Skawina, Poland
G3	Megan Boldenow	23	4	88.127	Fairbanks, Alaska
G3	Åge Uugi Pike	20	11	0.000	Ittoqqortoomiit, Greenland
G3	Amber Churchill	4	13	0.000	Boulder, Colorado
G4	Tania Clucas	38	36	629.445	Fairbanks, Alaska
G4	Arkalo Lars Olsen	59	33	499.439	Sisimiut, Greenland
G4	Ehab Masoud	51	34	410.771	No Data
G4	Nicholas Petersen	30	50	362.770	Nuuk Greenland
G4	Karen Ezekiassen	27	51	314.118	Nanortalik, Greenland
G4	Sally Calderon Acita	29	35	171.418	Nuuk Greenland
G4	Elaguila Azteca	14	37	107.184	No Data
G4	Morteza Haidari	26	25	37.030	No Data
G4	Sasithorn Chankamnerd	11	39	37.030	Frederikstad, Norway

Table 10 Continued					
3-9 to 3-20-16		In-degree	Out-degree	Betweeness	Location
G4	Karnes Kûitse	19	32	22.254	Narsaq, Greenland
G5	Andrew Eastman	7	12	0.000	No Data
G5	Audrey Kania	12	7	0.000	No Data
G5	Barry McPherson	2	17	0.000	No Data
G5	Dartmouth Alumni	19	0	0.000	Hanover, New Hampshire
G5	David Bracken	3	16	0.000	No Data
G5	Don Sterner	5	14	0.000	No Data
G5	Holiday Inn Express Springfield	1	18	0.000	No Data
G5	Judie Brown Campbell	8	11	0.000	Palm Springs, California
G5	Karl Thurmond	13	6	0.000	Los Angeles, California
G5	Kerrin Pratt	4	15	0.000	No Data
G6	LOJIQ - Les Offices jeunesse internationaux du Québec	9	0	0.000	Montreal, Canada
G6	Jäde B. Boivin	8	1	0.000	Montreal, Canada
G6	Chantiers jeunesse	7	2	0.000	Montreal, Canada
G6	Martine Hébert	6	3	0.000	Montreal, Canada
G6	Imane Mak	4	5	0.000	No Data
G6	Victor Sanchez Lopez	3	6	0.000	No Data
G6	Elsa Mvil	2	7	0.000	No Data
G6	Richelieu International	1	8	0.000	Ottawa, Canada
G6	Magali Langlois	0	9	0.000	No Data
G7	Mindy L. O'Neall	1	23	0.000	Fairbanks, Alaska
G8	Allona Mayost	3	21	0.000	Canada
G9	Salomon Egede	4	20	0.000	Nuuk, Greenland
G10	Nanna Rasmussen Therkelsen	5	19	0.000	Aasiaat, Greenland
G11	Sheyla Abarca Barreira	6	18	0.000	No Data
G12	Marie-france Nicole Gariepy	8	16	0.000	Saint-Hyacinthe, Canada
G13	Nungasak Snyder	10	14	0.000	North Slop, Alaska
G14	Josefa Flores	11	13	0.000	No Data
G15	Chai Voelker	12	12	0.000	Anchorage, Alaska
G16	Tonya Kaloa	14	10	0.000	Tyonek, Alaska

Facebook Discussion

In most regards, the Facebook networks of ASSW2016 met their organizational objectives and should be considered a successful communication effort.

As the event progressed structurally defined groups within the network became less distinct and more highly interconnected. The contexts of conversations that occurred through these networks and the public profile information of those engaged in them, show clear indications that a range of science and governance oriented stakeholders, as well as the broader Fairbanks community, were involved. By the organization's own stated goals, this must be considered a positive outcome for the energy they put into this channel of communication.

The only potentially negative outcome might be a failure to more fully engage Indigenous and rural-Arctic community residents. Thematically, there was a traditional and local knowledge thread woven throughout the conference—via plenary presentations, as well as breakout group discussions (2016 Arctic Science Summit Week, 2016). As a result, some Indigenous and Arctic community representatives were onsite for the conference. Despite this, there is little evidence that their presence engaged any broader community involvement through Facebook (apart from the Greenland communities discussed above). Had it, we certainly would have seen a greater representation of rural Alaskan, Canadian, or Russian communities in the hometown profile data. While it is not my intent to overly distract from the successes of the conference, this is an interesting result and perhaps symptomatic of broader communication issues between local knowledge holders and larger scale institutional players involved in Arctic change issues.

Facebook has a relatively high threshold for establishing network connections compared to other social media platforms. Generally people consider Facebook an extension of their close personal identity, as opposed to a more guarded professional or public identity (Dijck, 2013; Madden, 2012; Poell, Abdulla, Rieder, Woltering, & Zack, 2015; Rainie & Wellman, 2012). While people may friend or like a large number of other people or organizational pages on Facebook, they engage with a very small percentage of them on a regular basis (Catanese, De Meo, Ferrara, Fiumara, & Provetti, 2011; Strano, 2008). Therefore, Facebook (again relative to many other social media platforms—Twitter for example) is an intimate communicative space. People use it to stay in touch with friends and family, and those people and topics that they most care about (Perrin, 2015). As a result, of all the friends and organizational pages people accept or follow on Facebook, much of the content they produce is not interesting to the user other than on unique occasions (e.g. a natural disaster or conference). At any given point in time, when a user logs onto Facebook, there are an estimated 1500 possible wall posts active in their network. The average user, on the other hand, only looks roughly 30-50 posts per session (Oremus, 2016). In the end, Facebook is a for-profit cooperation that has a vested interest in the user being happy when on the site, so they will return more often, and thus are more regularly exposed to the adds Facebook sells as a key element in their business model. This means Facebook must filter the total possible posts the viewer sees down by two orders of magnitude—while still making the user happy and excited to log on again and again. That's a rather difficult task on the surface of it, but Facebook has used network theory to conclude that any given user is most likely to be satisfied and enthused by the site if they are presented with content that others in their close network have already engaged with (Davis, 2017). This means that over time the user will see less and less of their overall network and more of specific regions that they already have strong ties with (Carlson, 2017).

This content-presentation strategy makes it a rather difficult task to break out of already established networks and develop new relationships. Therefore, despite the presence of Indigenous and Arctic community stakeholders at the conference, the relationships that were established by their being there both physically and cognitively (via "Indigenous Knowledge" programming strands) does not seem to have been strong enough to break through Facebook's structural barriers. So while stakeholders with already established ties into the conference organizer's existing networks strengthened their social media ties through the conference, those without established ties did not enter the network—despite a conscious effort to target those specific stakeholder groups during the physical event.

Twitter Results

The compiled search network seen below (Figure 64) illustrates the diversity and disconnected nature of Arctic related conversations occurring on Twitter just prior to the conference. There are 402 subgroups in this network and 382 components—remember that a component refers to a portion of the network that is not connected to any other. The high number here illustrates how many different sets of people were talking about the Arctic in isolated little clusters just prior to the conference.

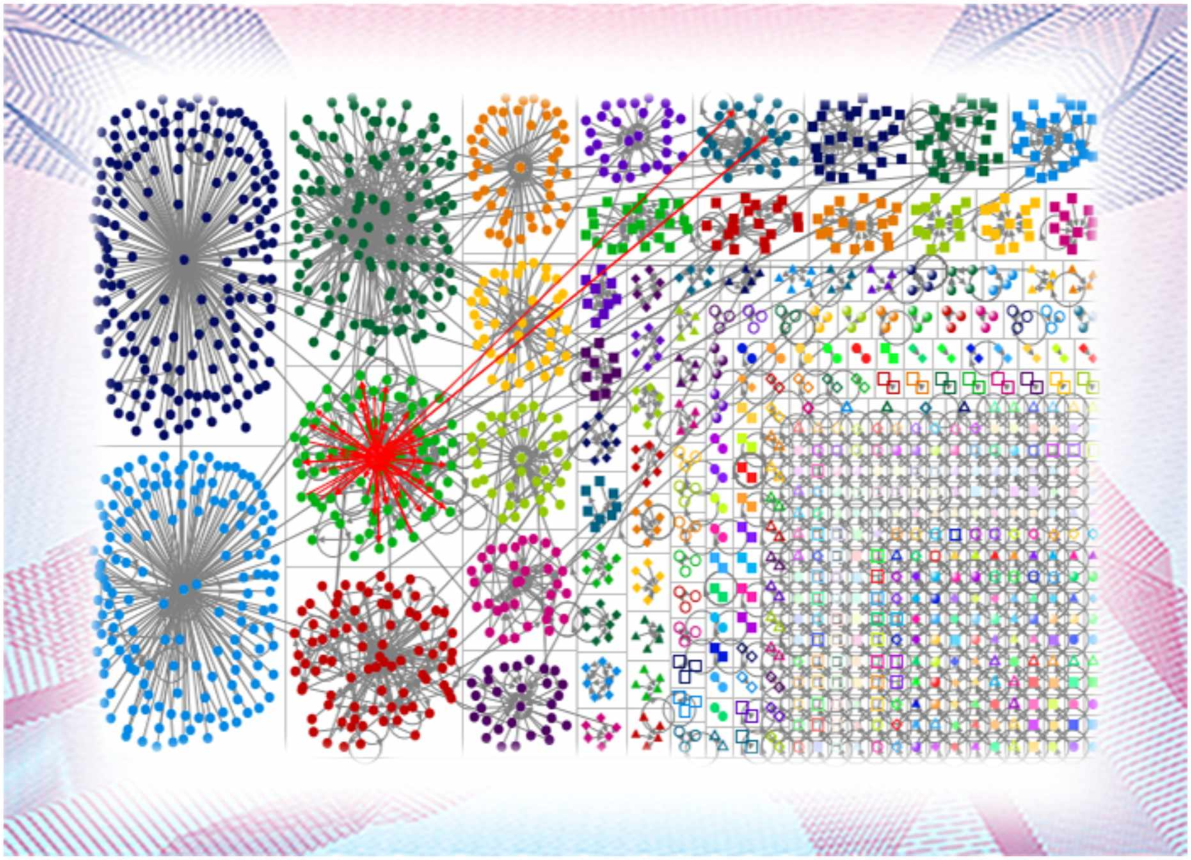


Figure 64: Twitter networks prior to the start of ASSW2016. This visualization maps the network of Twitter conversations occurring around arctic themes prior to the conference. A large number of disconnected components are present, many of which are very small. However, of the larger components (as well as subgroups within the larger components) two network structures can be identified; hub-and-spoke networks—characterized by high numbers of bridging ties, and bonded networks—with high levels of internal connectivity. Elsewhere in this work I align these types of networks with broadcast and interpersonal forms of communication. Based on that, this network clearly illustrates how weakly connected these two forms of communication are.

Of note in the structure of the subgroups is the strong, single-node, hub-and-spoke pattern present in some of them (G1,2,6,7,8), where others (G3,4,5,9,10), maintain the hub-and-spoke pattern but with multiple nodes serving as the hub (Figure 64). This is interesting in that it implies two different types of conversations are occurring in the subgroups around Arctic issues. The first is very much in the mold of a broadcast model of communication with a single communicator pushing out a message to a (relatively) large number of (relatively) passive listeners—who then take that information and incorporate it into their lives in ways we cannot see through these networks, but certainly not by sharing it with their own Twitter followers (or else we would see secondary connections). The second is a more interpersonal form of communication, where there is a higher level of back and forth interactions among a core community, who then also share out to larger audiences. This pattern of a small group of more densely connected core members tied to a weakly connected periphery is very similar in structure to what we saw in the Bering Sea Storm case study. Like there, this would structurally seem to indicate a socially active community has evolved around the topics being discussed in these subgroups, and/or, the topics being discussed are tapping into an already active community—as defined by communication (or social) ties, and not physical proximity.

In both the broadcast and more interpersonal types of conversations, participants in these larger clusters of conversation represent the more influential stakeholder groups interacting through this platform prior to the conference (I am empirically defining influence here simply based on the size of the component). Engagement varies between the two types of groups, with the Twitter users involved in the more interpersonal subgroups demonstrating (via shared dialog) greater engagement in Arctic issues than those in the broadcast subgroups (Appendix A). However, the broadcast groups do give us an indication of what Arctic relevant themes or topics are of greatest interest to the less engaged public (i.e., more relevant themes result in a more structural "spokes"). Conversations in the multi-hub groups revolve around topics of climate science and scientific indicators of rapid change in the Arctic (Table 11). Group 4 is interesting because it is the seed group for the ASSW2016 conference. Group 5 is composed of national and international level governmental organizations, and interestingly is the only group that Indigenous issues are discussed. This is slightly problematic in the Alaska context, however, because while tribes, as semi-sovereign nations, should be interacting at this level, Twitter is not a platform widely used by tribal members and none are present in the list of top Tweeters in that group (Table 11). Throughout all the topics discussed by multi-hub subgroups there is a tone of concern for the environmental changes being discovered, and the potential impacts to society that they could trigger—indicating that most engagement in Arctic change issues is around concern, not optimism, for what changes are occurring and what they might mean for social-ecological systems in the Arctic. It is important to remember that these results are bound by the language

"Arctic change," it may very well be that people who view changes in the Arctic more optimistically (e.g., the resource extraction and global logistics communities) simply use different words to discuss the same issues and thus do not show up in these networks. The fact that the ASSW2016 organization shows up in this network however, indicates an empirically derived connection to a worldview that sees changes in the Arctic as problematic.

Table 11: Group-based statistics for pre-conference Twitter networks.

Multi-hub Subgroups			**Single-hub Subgroups**	
Top Domains in Tweet in G3	**Top Domains in Tweet in G4**	**Top Domains in Tweet in G5**	**Top Domains in Tweet in G1**	**Top Domains in Tweet in G2**
insideclimatenews.org	assw2016.org	theguardian.com	nytimes.com	nationalobserver.com
theguardian.com	twitter.com	gc.ca	theguardian.com	twibble.io
arcticdeeply.org	caff.is	washingtonpost.com	takepart.com	greenpeace.org
wordpress.com	instagram.com	nytimes.com	arcticportal.org	co.uk
whitehouse.gov	newsminer.com	theglobeandmail.com	twitter.com	columbia.edu
assw2016.org	arcus.org	whitehouse.gov		savethearctic.org
openscienceworld.com	theglobeandmail.com	nunatsiaqonline.ca		theguardian.com
nationalobserver.com	arctichorizons.org	oxfamamerica.org		insideclimatenews.org
nasa.gov	campaign-archive1.com	highnorthnews.com		
nytimes.com	wordpress.com	wwf.ca		
Multi-hub Subgroups			**Single-hub Subgroups**	
Top Hashtags in Tweet in G3	**Top Hashtags in Tweet in G4**	**Top Hashtags in Tweet in G5**	**Top Hashtags in Tweet in G1**	**Top Hashtags in Tweet in G2**
arctic	assw2016	arctic	climatechange	savethearctic
climate	arctic	climatechange	eu	climatechange
climatechange	aos2016	cdnpoli	arctic	arctic
divest	fairbanks	pmdc	us	globalwarming
methane	biodiversity	zika	canada	co2
fish	alaska	mepolitics	globalwarming	nasf2016
actonclimate	monitoring	climate		saveearth
savethearctic	mac2016	uscanada		
biodiversity	science	sustainabledevelopment		
nasf2016	uaf	canada		

Table 11 Continued				
Multi-hub Subgroups			**Single-hub Subgroups**	
Top Word Pairs in Tweet in G3	**Top Word Pairs in Tweet in G4**	**Top Word Pairs in Tweet in G5**	**Top Word Pairs in Tweet in G1**	**Top Word Pairs in Tweet in G2**
victims,big	arctic,science	climate,change	rt,unep	stop,destructive
big,impacts	science,summit	continue,respect	amp,canada	destructive,arctic
arctic,even	summit,week	respect,promote	canada,pledge	arctic,frishing
tiniest,victims	climate,change	promote,rights	pledge,cooperation	frishing,fleets
even,climate	biodiversity,monitoring	rights,indigenous	cooperation,preserving	fleets,before
climate,change's	rt,kmftimm	indigenous,peoples	preserving,arctic	before,fishing
change's,tiniest	fairbanks,assw2016	peoples,climate	arctic,amp	fishing,season
via,insideclimate	rt,rvirginiapolar	change,arctic	amp,fighting	season,starts
impacts,via	assw2016,aos2016	canada,continue	fighting,climatechange	starts,savethearctic
impacts,insideclimate	arctic,perspectives	change,decision	unep,amp	rt,greenpeace
Multi-hub Subgroups			**Single-hub Subgroups**	
Top Replied-To in G3	**Top Replied-To in G4**	**Top Replied-To in G5**	**Top Replied-To in G1**	**Top Replied-To in G2**
	leehiyona	cdnclimateforum		
	sendansullivan	usarctic		
	lisamurkowski	potus		
	pckjaergaard	justintrudeau		
Multi-hub Subgroups			**Single-hub Subgroups**	
Top Mentioned in G3	**Top Mentioned in G4**	**Top Mentioned in G5**	**Top Mentioned in G1**	**Top Mentioned in G2**
insideclimate	arctic2016	justintrudeau	unep	greenpeace
suzyji	uafairbanks	potus	toni_bacala	natobserver
climatehawk1	kmftimm	usarctic	nilimajumder	arctic_watch
climatehome	arcticcouncil	jeraldsabin	zeroco2_	greenpeaceca
climatecentral	rvirginiapolar	barackobama	cikinc1	unep
climatenexus	polar_research	bobpaquin1	globalgoalsun	fairwindstc
arcticdeeply	caffsecretariat	roynorton1	dw_espanol	
guardian	alaskamuseum	annawilding	foro_tv	
climateinstitut	arcticresearch	chelliepingree		
jackcushmanjr	firstroadnorth	meanwhileincana		
Multi-hub Subgroups			**Single-hub Subgroups**	
Top Tweeters in G3	**Top Tweeters in G4**	**Top Tweeters i n G5**	**Top Tweeters in G1**	**Top Tweeters in G2**
natransversal	questionforall	globeandmail	nilimajumder	robinsnewswire
johnlundin	iramey	pwm4u	law1gloria	krustyallslopp
theearthnetwork	visualpersist	copperbronzed	foro_tv	kauanous
guardian	newsminer	_carloscam_	percievedlogic	elucidatus
marcvegan	kenjerakota	de_giovannna	kelzywelzy	havantacluotmp
justmemarie2	uafairbanks	democrats14	windinyurhairjo	oldkhayyam

Table 11 continued				
Multi-hub Subgroups			**Single-hub Subgroups**	
Top Tweeters in G3	**Top Tweeters in G4**	**Top Tweeters i n G5**	**Top Tweeters in G1**	**Top Tweeters in G2**
cleanairmoms	juliafbxlawrpt	strategicpolicy	antonboym	sysred_angel
clayengberg	ejwensing	mindlessrobot37	ayeelyssa03	realdavidcarter
seeyouguyscom	uaf	joypathall	augustusconsult	ng_engine
yuukifushimi	karencalifornia	heralddeparis	naturalkitchen7	yashkverm

Topics in the single-hub subgroups pickup on this theme of worry and convey it to a broader audience. Top nodes in these groups are all global warming and environmental-activist oriented. They are picking up and broadcasting the more observational and science-based conversations of the multi-hub groups and focusing on their negative impacts to societies and environments. These are themes that have very well defined and involved stakeholders, but limited reach outside their own bubbles (Frondel, Simora, & Sommer, 2016; Maibach, Roser-Renouf, & Leiserowitz, 2009). This is rather a classic "preaching to the choir" situation and is interesting and perhaps problematic in that science's products are being broadcast mostly by this single worldview.

Within this broader landscape of Twitter communication, the conference organizers hashtag campaign was implemented. In pure volume of posts we can see (Figure 65) that as the conference went on the volume of conversation about it increased. I believe the increase in volume is a function of conference participants becoming aware of the hashtag and starting to use it in their own Twitter interactions via onsite marketing (flyers, notices, etc.) of the hashtag. There is a synergy created by doing this, as it works to connect many of the disconnected subgroups we saw in the pre-conference network under a single banner (e.g. hashtag). The net result is a general gathering of many separate conversations into a single virtual space within the Twitter landscape. The rapid adoption rate over the course of the conference, additionally, suggests that in-person conference participants (i.e., scientists and policymakers) are active Twitter users.

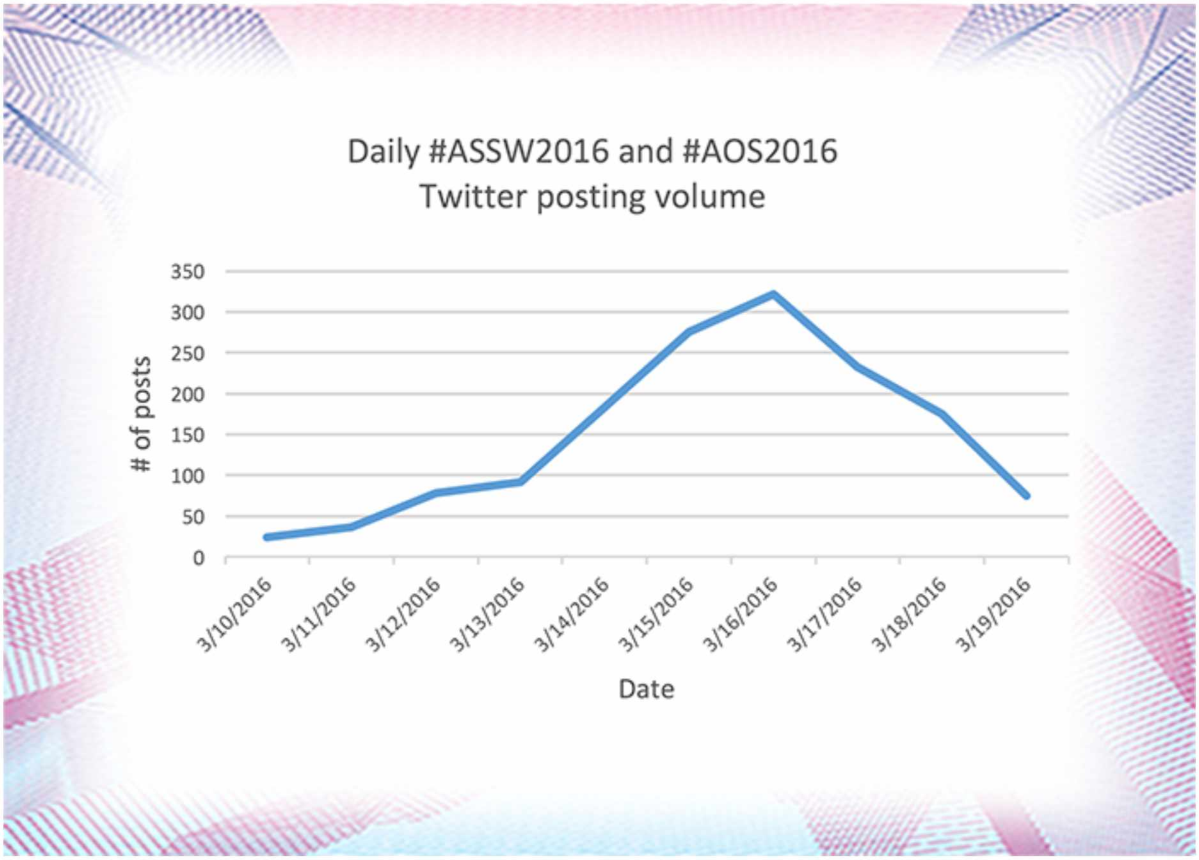


Figure 65: Daily Twitter posting volume. Peak volume is reached just as the Arctic Observing Summit portions of the conference are beginning. This was an integral and well-attended element of the overall conference, however, by design participants spent much time in small group, discussion, or working-group style breakout sessions. It is possible these face-to-face bonding style communicative opportunities filled the needs many participates initial met through Twitter. Additionally, the tapering in volume of Tweets may reflect the difficulty of keeping stakeholders engaged over extended periods of time via a single channel of communication.

In the daily networks (Figures 66-75) we see how the ASSW2016 seed group from the pre-conference network rapidly expands during the conference into it's own larger network—then rapidly contracts following the conference. This provides the opportunity to look in a bit more detail at how the core network evolved throughout the event. Namely we see a few core members at the start rapidly expand their periphery networks to connect and tap into other, already established networks. One important example occurs when the main UAF Twitter account and the UAF Alumni accounts begin sharing ASSW2016 content on March 13^{th} (remember this also occurred in the Facebook network). By March 15^{th} they developed into a major subgroup of their own and were pulling in information from throughout the network to disseminate to their own unique stakeholders. They continue to do this throughout the conference. If we look closer at the subgroups that UAF and UAF Alumni accounts are drawing information from, we see that they are all composed chiefly of scientific and policy-oriented stakeholders, and that the most central nodes in each subgroup are composed of the core pre-conference users. As the conference winds down and the network contracts, the main UAF account continues to push out content but loses a large amount of its unique audience, the core pre-conference users maintain ties but also lose much of their periphery audience. This results in a post conference network that looks much like the pre-conference core, with the exception that the UAFairbanks user has, at least temporarily, joined the group.

The persistence of this connection suggests that the organizers of ASSW 2016 did indeed meet their goal of building stronger local (UAF) community engagement with changes occurring in the Arctic. It is unknown how the periphery network of UA Fairbanks translated their experiences with the conference into other dimensions of their life (modes of communication), but it does not seem out of reason that awareness built through these events on Twitter will influence their response to future news or events occurring in the Arctic—regardless of the communication channel they learn of it through.

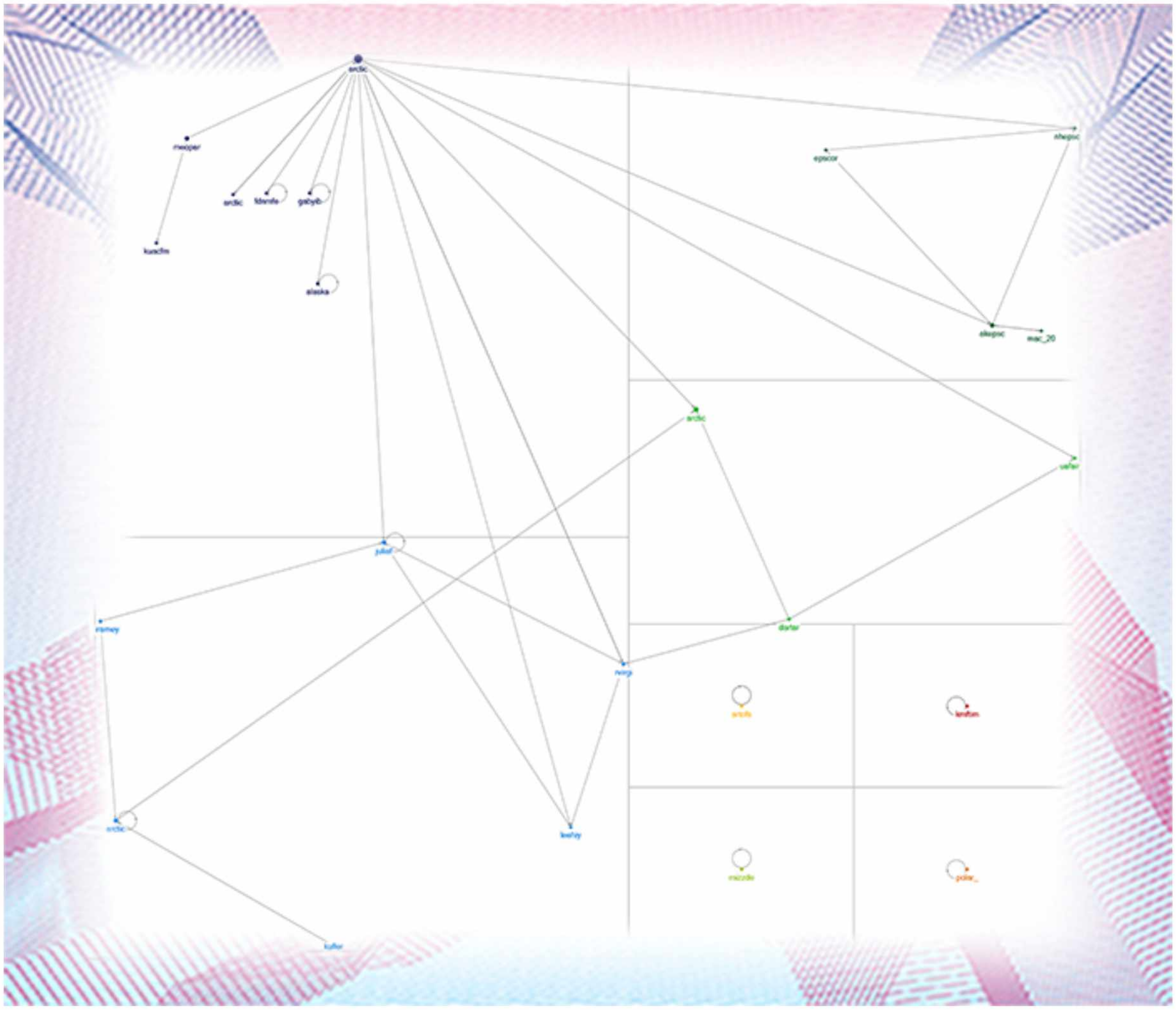


Figure 66: #ASSW2016 Twitter network, March 10, 2016. The March 10 Twitter network is small and well connected despite some weak subgroup formation. Network membership is largely tied to individuals and organizations involved in conference planning (see Appendix A).

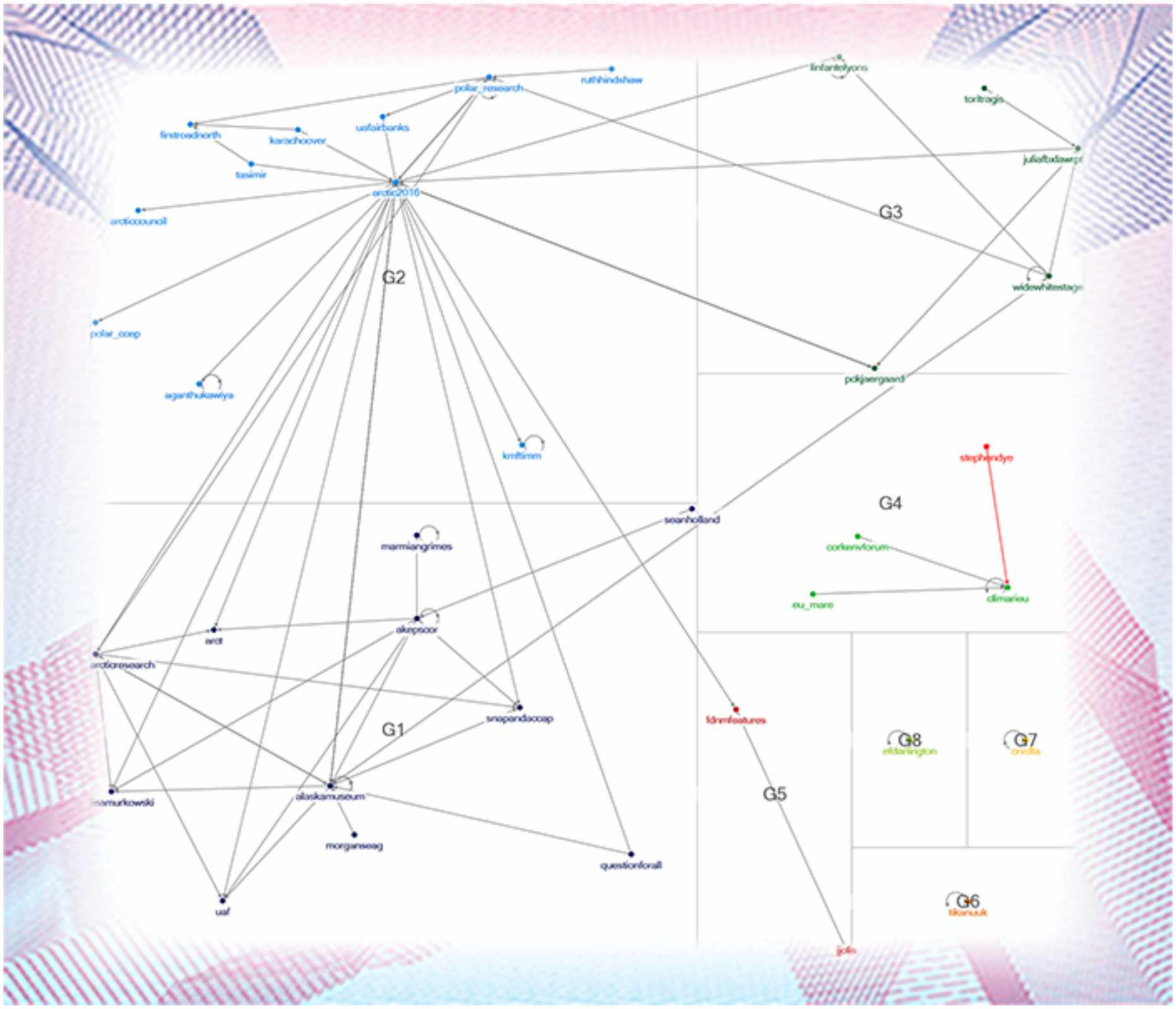


Figure 67: #ASSW2016 Twitter network, March 11, 2016. By March 11th the network is clearly growing, although with slightly more subgroup formation than on the 10th, there is however, still high levels of cross group communication. The network at this point is remains primarily composed of members closely tied to the arctic scientific community, or more specifically, the conference organizers at UAF (see Appendix A).

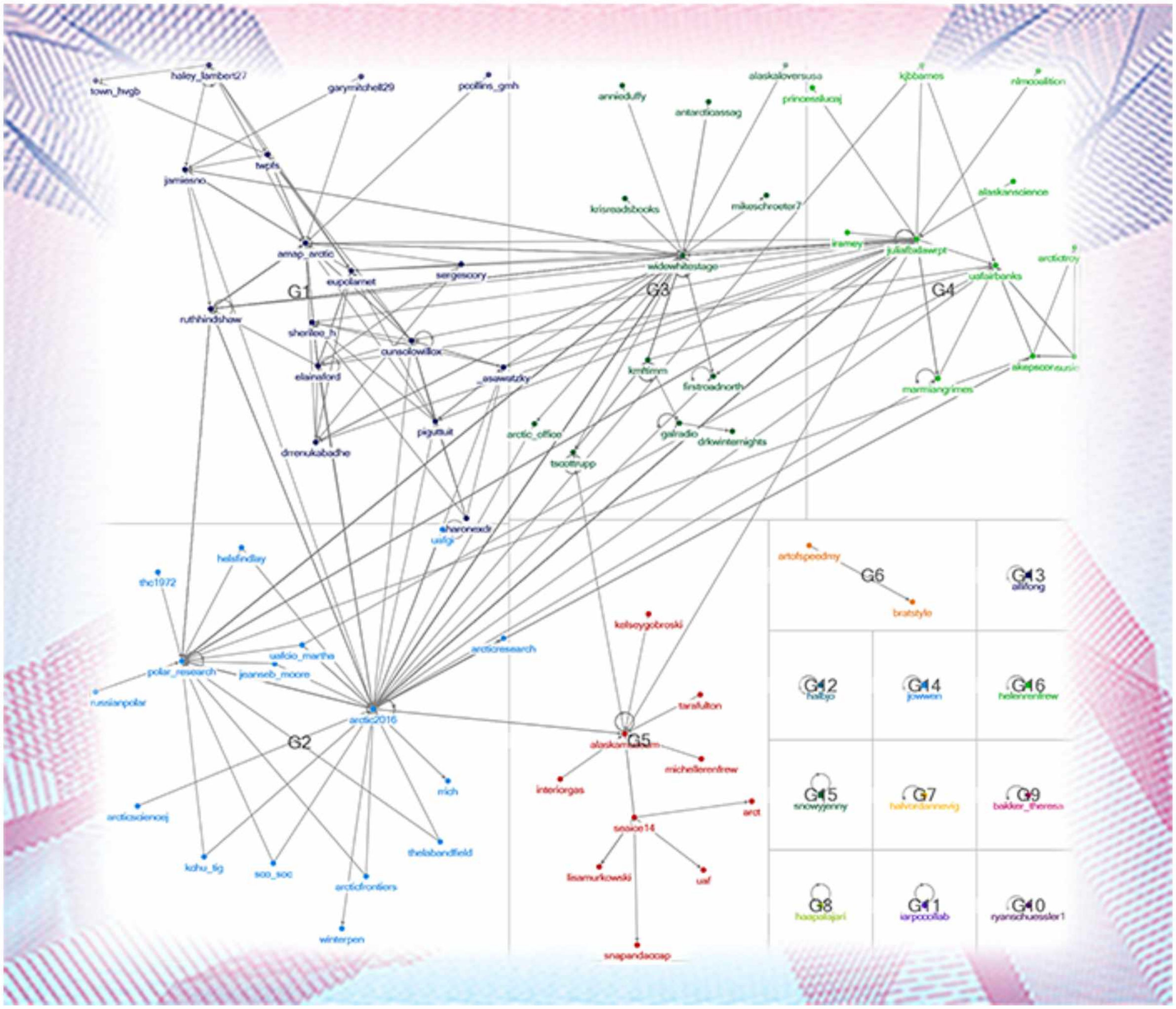


Figure 68: #ASSW2016 Twitter network, March 12, 2016. The March 12th network continues to grow with high levels of cross group connectivity within the main component of the network (groups 1-5). However, an increased number of disconnected components appear in the network (groups 6-16). Additionally, this is the first day that non-science community (red subgroup) enters the network. (see Appendix A).

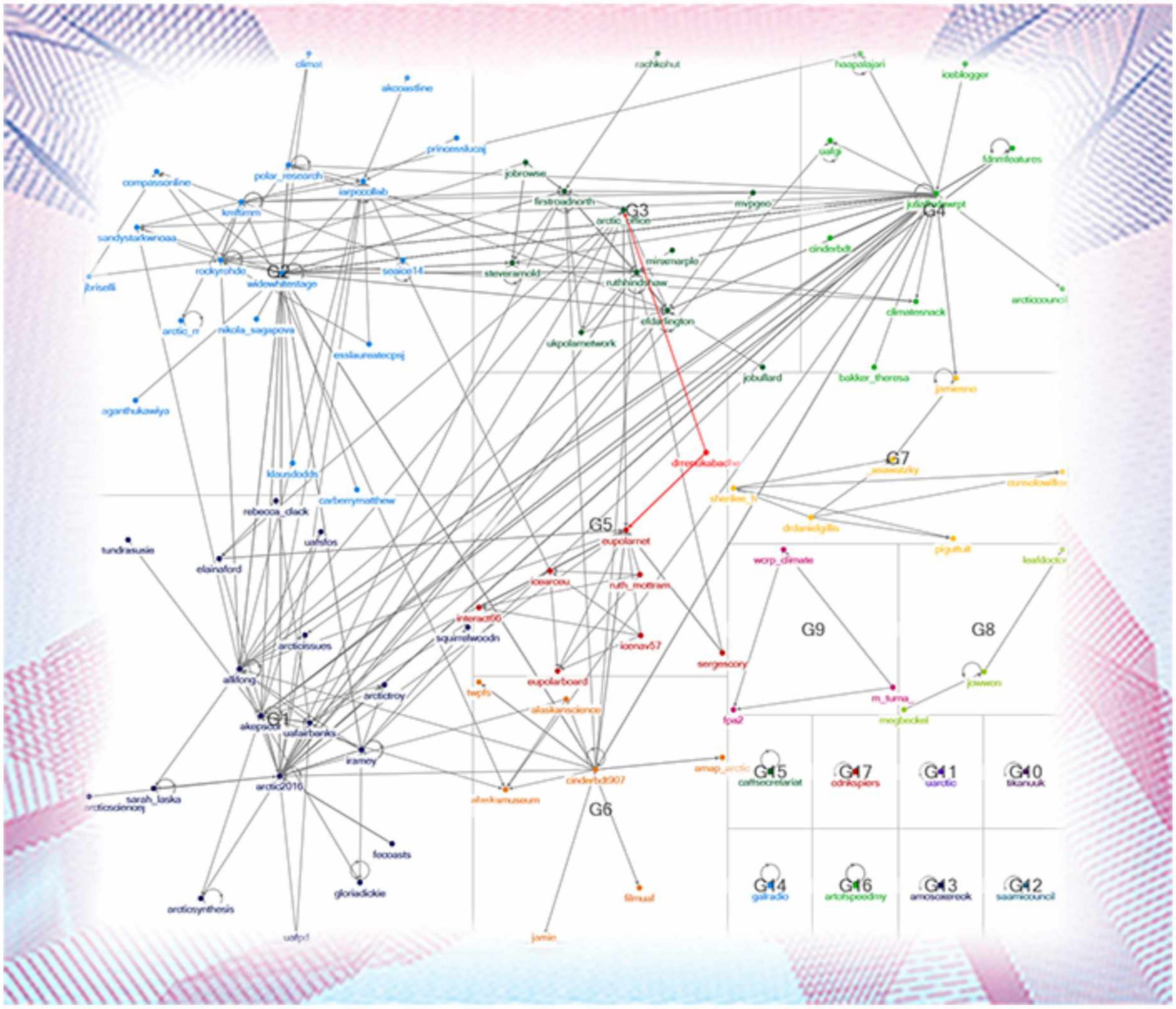


Figure 69: #ASSW2016 Twitter network, March 13, 2016. On March 13th there was little network growth but continued strong cross group connectivity. UAFairbanks enters the network (in group 1) on this day. Involving the greater UAF academic community was a stated goal of the organizers and the entry of UAFairbanks is an indication that they were at least achieving this through their use of social media.

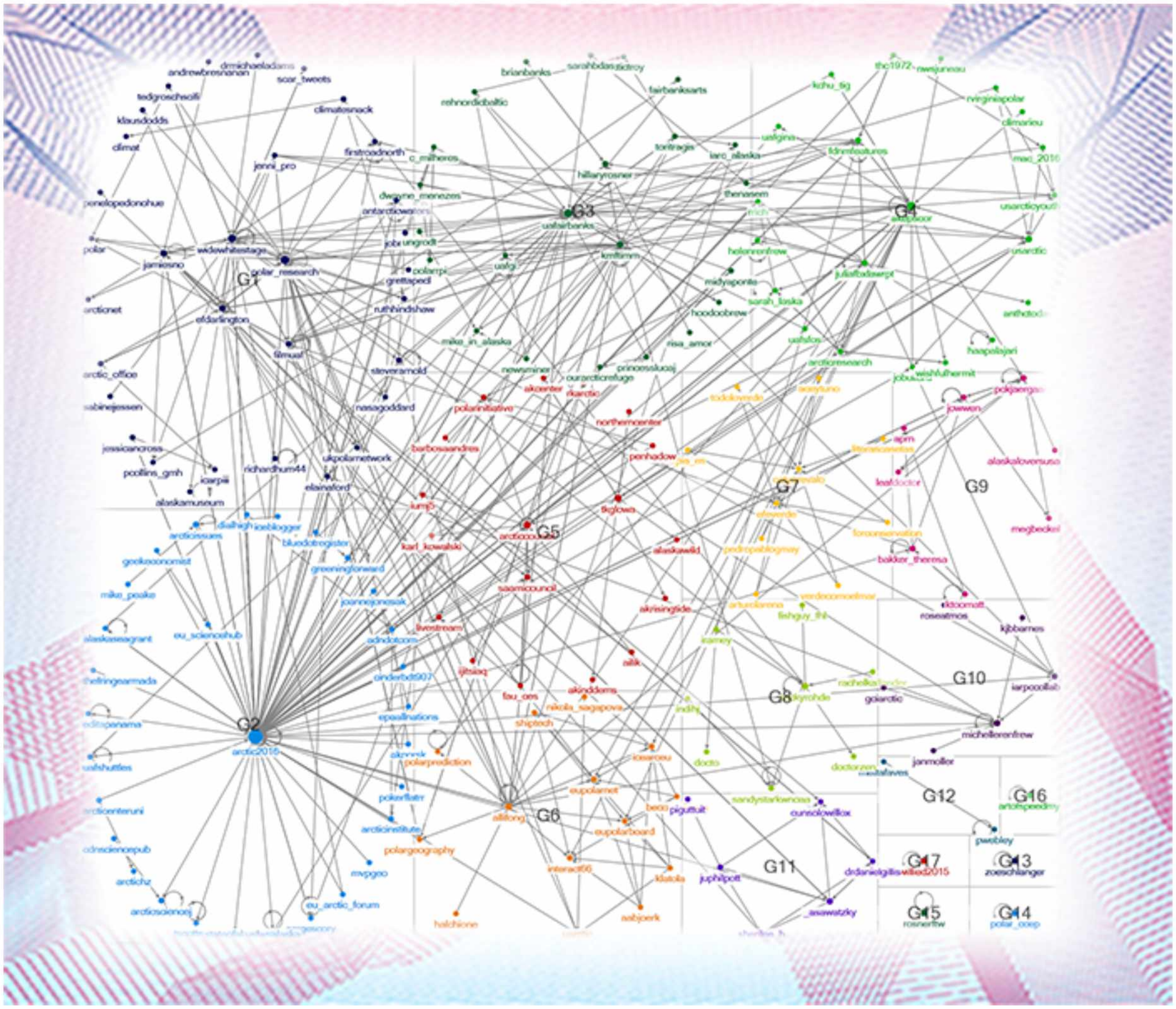


Figure 70: #ASSW2016 Twitter network, March 14, 2016. The size and volume (Figure 65) of activity increases dramatically on March 14th. This is also the day that the first distinctive hub-and-spoke structures form within in subgroups. The correlation of these two events may suggest that broadcast, rather than interpersonal, styles of communication are beginning to dominate communication within the network.

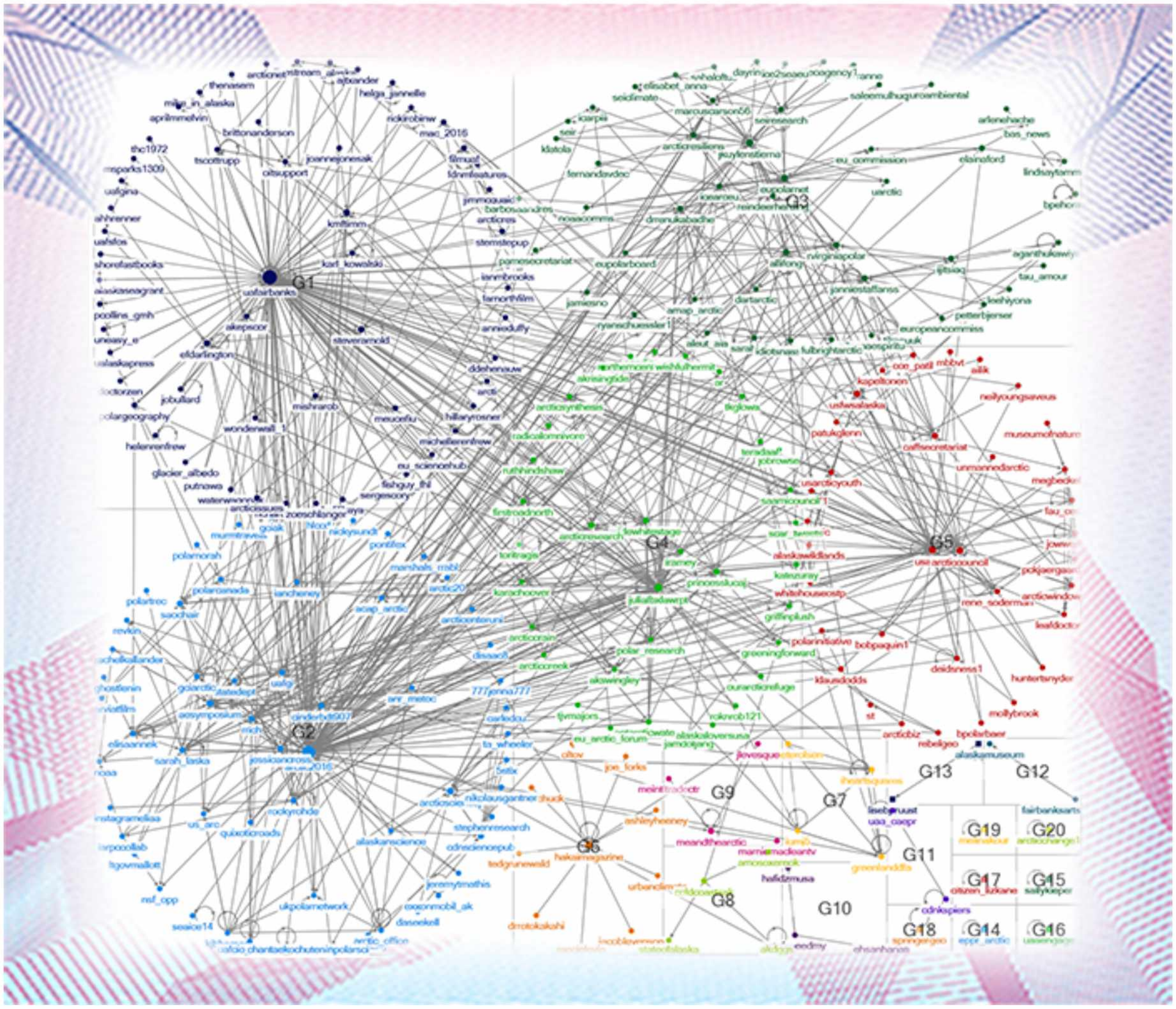


Figure 71: #ASSW2016 Twitter network, March 15, 2016. On March 5th the network continues to expand chiefly through increasing peripheral network activity within the hub-and-spoke structures of individual subgroups. Notably, connectivity is maintained between the hubs of each hub-and-spoke subgroup.

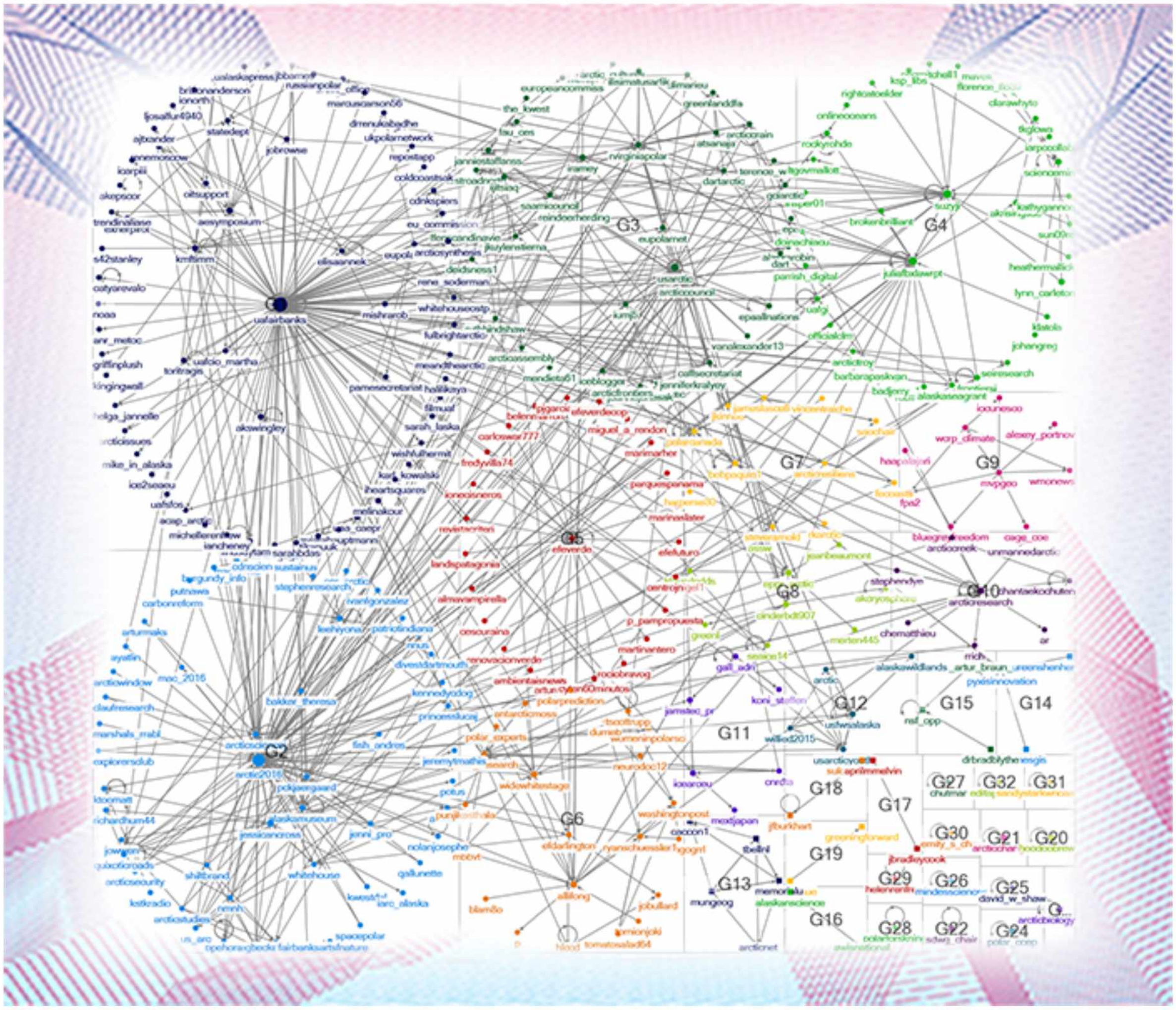


Figure 72: #ASSW2016 Twitter network, March 16, 2016. March 16th represents the peak of network activity during the study period. The dominant hub-and-spoke structures increase in size within subgroups, while cross-group hub ties persist.

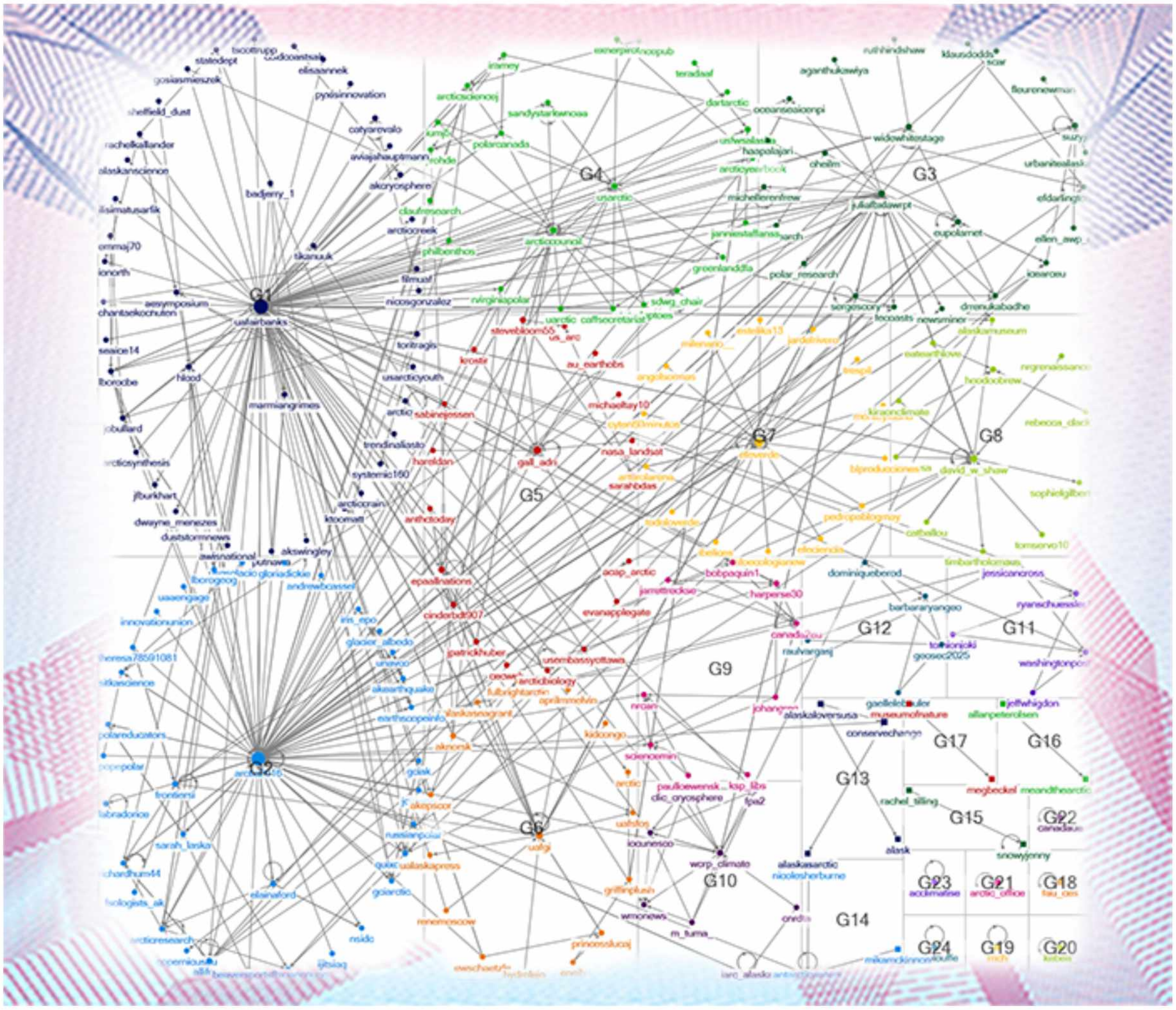


Figure 73: #ASSW2016 Twitter network, March 17, 2016. On March 17th there is a slight tapering off of network activity, yet he hub-and-spoke structures persist. Bonding ties between hubs do not seem to be diminishing as quickly however, as the bulk of the decrease in activity seems to be derived the peripheral regions of the hub-and-spoke structures.

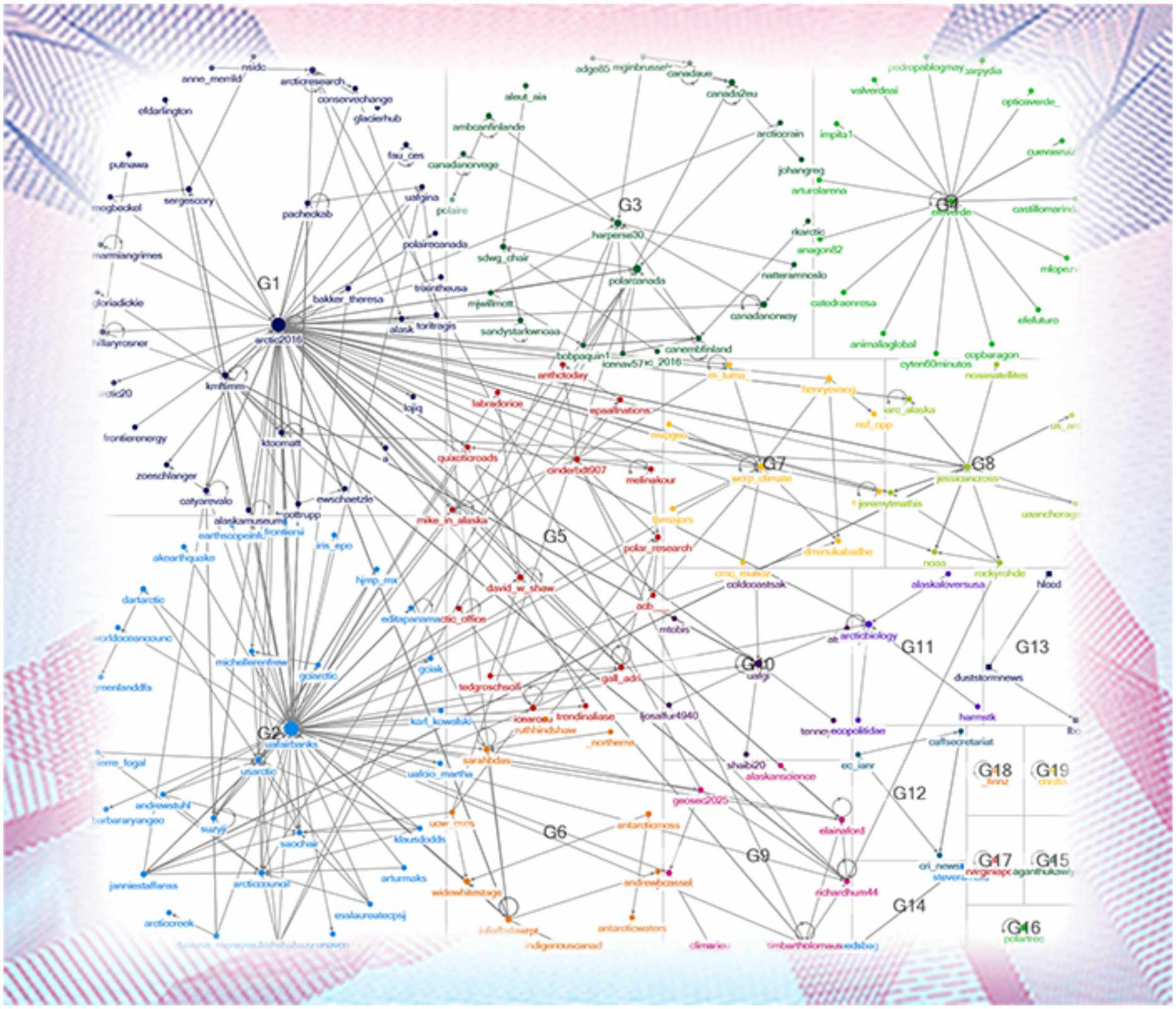


Figure 74: #ASSW2016 Twitter network, March 18, 2016. On March 18th we see a continued decrease in peripheral activity with relatively constant activity between core members.

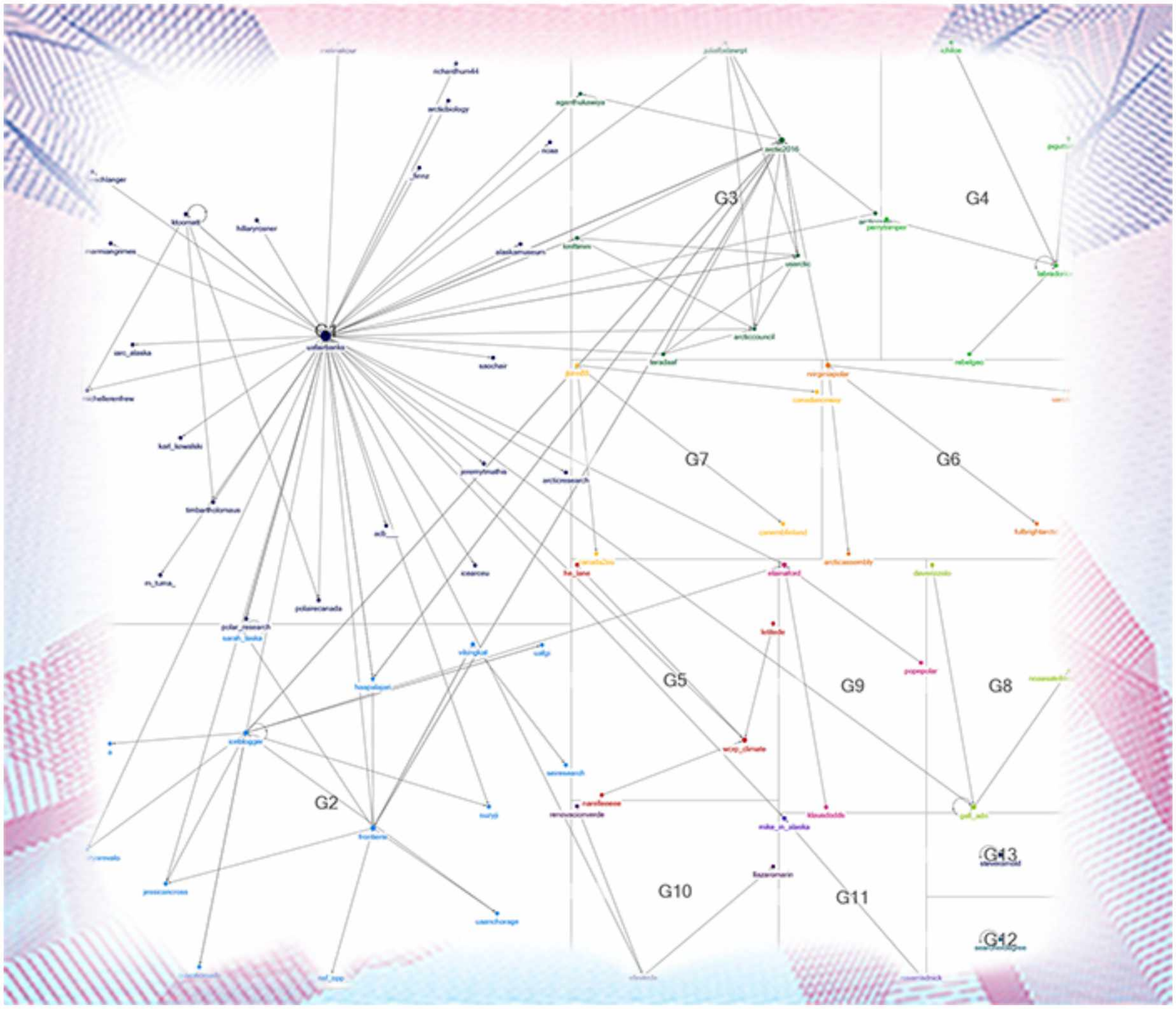


Figure 75: #ASSW2016 Twitter network, March 19, 2016. March 19th sees the virtual disappearance of peripheral networks and fairly disorganized restructuring of core network.

ASSW2016 Conclusion

An overall assessment of the communication outcome of the ASSW2016 conference must be positive. On multiple levels they succeeded in meeting their pre-conference objectives. Empirical evidence suggests that their core audience expectations were met at a minimum on Facebook and Twitter. Arctic scientists, policymakers, and to some extent community members comingled face-to-face during the event, doing so across a wide spectrum of communication channels from coffee breaks to Twitter (and including everything from shared plenary experiences to small-group discussions in breakout sessions). Additionally, for at least some period of time during the conference the extended networks of both the scientific and governance-oriented stakeholders combined through Facebook and Twitter. A lack of representation by rural Alaskan and pan-Arctic communities (excepting those in Greenland as discussed above) may be the only main objective they did not meet in their social media networks. I personally interpret this as symptomatic of larger tensions between Indigenous and scientific/governance communities and a possible indication that current strategies to heal historic distrust between these groups are either not yet seeing strong results and/or not effective and need to be re-evaluated.

Returning to a robustness perspective to draw some final conclusions, overall the conference did an excellent job using key "brokering" agents to bring together established networks of Infrastructure Providers from science and policy fields—perhaps failing only to bring in a more balanced level of local community representation. The resource is the wellbeing of the Arctic ecological system, with more concern for the ramification of social systems at a global level than the impacts at local community levels (based on stakeholder engagement patterns). The Infrastructure of concern (through the Arctic council) is the international policies (and structures for making them) that support management of Arctic ecosystems, but more strongly the maintenance of scientific knowledge to support policy actions. Given the large scales involved, Users in this system would be the entirety of the global population but more directly would be working Arctic scientists—who need strong ties to policy systems in order to give their work meaning beyond the intrinsic value academics place on knowledge purely for knowledge's sake. While local community residents are a stated user by the organizers, in practical application, the conference was only moderately directed toward them, or their concerns—beyond building local Fairbanks community buy-in as a happenchance consequence of where the event was held. The social media networks show clear evidence that the organizers met the community buy-in goal and also that the priority target of building increased bridges across policy and scientific fields was achieved during the event. How a strengthening relationship with science translates out into the larger geopolitical realm that policymakers must operate in is uncertain. And this is also true for how an increased awareness for policy-oriented thinking will alter science's efforts in the Arctic. Robustness would predict each will become more responsive to the other through continued interactions like ASSW2016 and that science policy aspects of the overall Arctic SES will be more resilient to overall system changes. However, given that both stakeholder groups targeted here are really supposed to be serving communities, the lack of meaningful community-level representation in the networks indicates that ultimately the resilience of this relationship (science to policy) may not be relevant to the wellbeing of people actually impacted by the processes science and policy are observing and attempting to manage.

Case Study Summation

In summing up the lessons learned from all four of the above case studies, the most interesting and novel finding is that networks regularly exhibit a pulsing pattern of expansion and contraction through time and in response to both internal and external events. In the networks explored, expansion initially occurs via growth in the periphery of the network through bridging-type relationships. Contraction seems to occur through a winnowing away of periphery connections and the development of bonding relationships with select communicators. Nowhere in the adaptive-learning, crises, organizational, or resource management literature have I seen this observation noted, though it is hard to believe it has escaped other's awareness. Marshal McLuhan, in the Extensions of Man, clearly envisions a shifting and dynamic model for the evolution of how people communicate (McLuhan, 1994). Monge and others build on this by conceptualizing communication as a series of multi-level networks (Lee & Monge, 2011; Monge & Contractor, 2003). Network science scholars such as Borgatti & Granovetter have provided the theoretical backbone to tie structural network properties to possible social processes (Borgatti & Halgin, 2011; Granovetter, 1973) and an active contingency of resilience researchers are working to apply network tools to what essentially amount to natural resource-oriented communication issues (Alexander et al., 2015; Hauck et al., 2015; Larson et al., 2013; Mills et al., 2014; Vance-Borland & Holley, 2011). Empirical network evolution (longitudinal) studies are rare, however, and I have not seen any one looking—let alone, finding—this type of repetitive pattern.

From my perspective, while this is a totally interesting result purely from a curiosity point of view, the truly import question to ask after making this observation is, "How can this information be applied to addressing the new communicative challenges of the Anthropocene?"

Generally speaking, the role and impact of using social media to support resilience-based outcomes is going to be more diffuse than the impact of higher transaction cost communicative events like workshops, training courses, webinars, face-to-face or even telephone conversations. And no one form of communication mode should be utilized as the only means of communication; rather, a blending of different transaction-cost modes of communication should be incorporated into a comprehensive communication strategy that matches the range of bridging and bonding-type relationships identified as important by the organization. We saw how this could be strategically accomplished in the ASSW2016 and BSMN case studies. The natural expansion of the Arctic change and science network triggered by the face-to-face event of the conference acted as a catalyst across communication channels to build initial ties into stakeholder groups previously only weakly tied to the network. To some extent we also saw this in the Bering Sea Messenger Network. However, in that case audio conferences replaced the face-to-face triggering event, and the monthly format allowed for deeper, perhaps longer lasting ties to be developed through the at-distance channels (telephone and Facebook).

Leading into the next chapter on application it is important to make some big generalizations from these results in order to develop and implement an actual working communication strategy—that can then, in context, test them. First, social media is big and fast. Second, mass media is big and slow. Third, workshops are small and slow and, fourth, webinars are small and fast. Each of these will have different impacts on the evolution of a multi-channel communication network depending on exactly how they are set up (say a well designed online training vs. a poorly designed one), but in generally social media is going to act as diffuse background "noise" that helps set the context for the smaller scale, more costly—but perhaps more intense and meaningful—interactions like conference, meetings, or other highly interpersonal communicative events. Mass media does that too, but social media also has an added element of interpersonal communication (both in the ability to directly exchange information and the frequency with which it can be exchanged) that gives it more individual influence (witness the rise of "fake news" in the modern zeitgeist, and its propaganda-on-steroids like impacts on our modern political environment). This is a result of interpersonal elements of social media allowing it more potential trust-building capacity than traditional broadcast media. The interpersonal element also provides the opportunity for trust building across scales typically not reached in workshops, trainings, etc. This type of online trust relationship is then prime to be converted into more productive use of time during higher transaction cost events like workshops because initial trust has already been developed. Further, the public nature of social media allows it to be used to help set highly relevant themes and activities for participants of higher transaction-cost events. So in this way, social media can really be seen as playing a supportive role in maintaining diffuse and diverse networks that agents within specific social-ecological systems can then call upon when their more tightly connected networks need to draw on outside ideas or resources. The remaining sections of my dissertation outline a process-oriented strategy to develop and implement a communication plan that takes advantage of the network dynamics observed in the above case studies.

A Systems-oriented Communication Strategy

This dissertation explores how changing communication patterns—both in terms of the tools we use and the ways we use them—can be utilized to address Anthropocene-based social-ecological challenges in Alaska. In the introduction I defined these challenges around changing human relationships to the environment, namely a relatively recent human ability to affect large-scale global changes through networked local actions. I argued that this ability represents a fundamental shift in human-environmental relationships. These changes have had positive and negative impacts on societies around the world depending on a host of political and historical factors, but have largely had negative environmental impacts. Reversing this trend of physical-environmental degradation is the primary outcome I hope my work will support. My intent is that by improving communication across worldviews a better understand of the environmental implications of local decision-making can be had. This fundamentally rest on the idea that by bringing more worldviews into the process of deciding how environmental resources are used, fewer externalities will be left out of the process, and decisions will more adequately reflect the needs of all people impacted by them.

This goal firmly places the application of my research into an arena of adaptive management—of both natural and social resources. However, my approach places emphasis on the social.

In the first chapter I introduced a set of communication and resilience-based theories to help conceptualize how the modern communication landscape interacts with current ideas on sustainable social-ecological relationships—and the lack of sustainable practices driving the Anthropocene to date. Through examining the case studies in chapter two, we saw how different networks responded to different external events. Empirically assessing the networks in relation to their location on the adaptive cycle, we identified a distinct structural pattern of network expansion and contraction. Now in this final chapter, the goal is to apply these understandings to a working communication strategy with the intent to 1) assess in more detail the causal mechanisms for network expansion and contraction, and 2) support effective adaptation efforts in Alaska through facilitating more effective cross-cultural communication networks.

To do this, I will first explain a process for developing a communication strategy that accounts for modern communication practices, the use of new and social media, and the need to rapidly shift between a range of communication channels depending on context, targeted stakeholders, and the demands of the problems being addressed. I'll provide a template suitable for organizations to test these methods independently. I will also provide one last case study, this time illustrating how I am implementing this process in my own work as director of the Alaska Native Knowledge Network through the Center for Cross-Cultural Studies at the University of Alaska Fairbanks.

Communication Strategy as a Process

As we have seen in all the case studies examined so far, communication networks are dynamic and constantly shifting under the demands of changing social and environmental conditions. With that in mind, developing and implementing a good communication strategy must be thought of as an evolving learning process rather than a one-off planning session.

To ensure that this form of short term, stagnate, single-event thinking doesn't happen, a number of key factors should be considered.

Fundamentally, any communication strategy must first consider the basics of stakeholder identification, goal-setting, and assessment practices—key first steps common to nearly all organizational strategic planning processes. How an organization defines its stakeholders, how those stakeholders relate to the organization's mission, what changes they hope their communication will result in, and how they measure if those changes occurred, are all questions individual organizations need to answer in order to develop an effective communication plan. This is a fundamental baseline that must be initially established.

However, to be dynamic and responsive to the types of complex social-ecological system changes I have been discussing throughout this dissertation, a strategic communication plan must also consider the broader social-ecological context shifts that are occurring in the communication landscape they operate across. For each stakeholder group an organization identifies as important to engage with, they must 1) consider the range of communication channels each different stakeholder group currently participate in, 2) why that group participates in any specific channel (or platform), and 3) how their participation may (or may not) relate to the organization's own objectives. Doing so defines the stakeholders in rich, humanistic terms—facilitating the development of a more nuanced plan for increasing stakeholder engagement than more typical assessment strategies. Mapping communicative ties across the different channels, platforms and stakeholder groups creates a holistic multiplex network capable of bridging the gap between qualitative and quantitative understanding of communicative relationships. This helps an organization target engagement activities, but perhaps more importantly defines the communication landscape the organization is hoping to impact. Regular monitoring of this landscape is critical in developing a dynamic communication plan because it is by monitoring this landscape that the opportunities (and potential pitfalls) of the regular pulsing of communication networks can be first detected and utilized by an organization. In the following sections I will present a process-template for developing a communication strategy based on network dynamics.

A Process Template

The template below is presented as a set of questions to think through in devising a communication strategy. For each main heading in the template a list of multimedia learning activities is hyperlinked. Upon the completion of this dissertation this tool will be developed further as a resource for the Alaska Native Knowledge Network community and the organizations they serve. A brief overview of each learning activity is presented below the process template.

The methods an organization deploys to work through and implement this template are important. Many methods can be instituted to accomplish this, from top-down decrees to small group consensus-building activities. The specific method chosen will have an impact on how the overall strategy is understood and used throughout the organization. Top-down strategies can be concise and quick to develop but may suffer from low buy-in (i.e., little local interest) if elements of an organization feel alienated by the new strategy. Rapid, quickly evolving system changes may require this type of strategy. Given the leisure of working with more slowly evolving systems, the consensus building process is likely to improve local interest and more universally consistent implementation of the strategy (Petko, Egger, Cantieni, & Wespi, 2015). However, covering detail organizational governance structures and decision-making processes outcomes is beyond the scope of this dissertation. What is important, with respect to this work, is for organizations to consider the types of system changes they hope to facilitate, and align the process of developing this strategy with the end outcomes they desire and there is a large body of both academic (Peachey, Zhou, Damon, & Burton, 2015; Stahl & Sully de Luque, 2014) and popular-culture literature (Johnson, 2006; McCann & Selsky, 2012) to support decision making on this aspect of a developing a communication strategy.

Personal and Organizational Communication Strategy

Context

(See below Intro to Theory for associated learning activities).

Understanding the context your communication strategy must operate under is the fundamental first step in the process template as I present it. The context should be understood through the lens of the organization's mission and/or vision statement, and be described in such a way as to identify the needs the organization hopes to meet in implementing a communication plan. Three fundamental questions should be answered to place an organization's communication goals in context with their internal purpose and the external systems they are hoping to impact.

The most important question to answer is, "Why is having a communication strategy important to your organization?" This question should be answered explicitly and address the specific areas of the organization's work that implementing a (new) communication plan needs to improve. An example might be improving communication internal to the organization in order to better align the work of individuals across different branches of the organization. Alternatively, an organization might be interested in developing a communication strategy to improve external communication, say to better understand stakeholder needs—or, it maybe a mix of both. The specific reason(s) will be unique to every organization, but the important element is simply to explicitly state and discuss them to build a shared understanding of what the communication plan is trying to accomplish.

The second question to ask is "What aspects of the organization's mission will be prioritized in the communication strategy?" All strategies are going to have tradeoffs. In an organizational setting communication at a minimum requires energy and time. It often involves a monetary expense, as well. This then requires priorities to be placed on how those resources are spent. Therefore, this question involves examining and prioritizing the range of activities an organization participates in in their day-to-day operations. Looking at these activities and determining which are the most central to the success of the organization's primary mission is the first step in identifying what communication practices need to be emphasized in the communication strategy.

These first two questions have dealt primarily with the internal functioning of the organization. The final question is concerned with the condition of the external system the organization is trying to affect change upon. It is not a single question as much as series of questions that tie back to our model of robustness introduced in the first chapter of this work. In this step it is important to identify what resource the organization is concerned with. Who the different users of the resource are? What infrastructure is involved in maintaining the resource? And lastly, who keeps the infrastructure working? In other words, who are the infrastructure providers?

An organization may fill any of those roles. However, often they will see themselves mostly filling an infrastructure provider role—as generally organizations provide a service in one form or another. This is an easy perspective to take, but in determining how an individual organization fits into the larger system they are operating in, it is important for the organization to attempt to visualize how their activities maybe viewed by others in the system (Barkema, George, & Tsui, 2015; Smircich & Stubbart, 1985). So, a library may view itself filling an infrastructure provider role with "knowledge" as the resource, books as the infrastructure, and patrons as the users. While at the same time the publishing industry that libraries must work with to purchase their materials might see books as the resource, ordering and shipping as the infrastructure, themselves as the infrastructure provider, and the libraries as the users. In beginning to develop a strategic communication plan organizations must take time early on to think through how the different elements within their system view it from their own unique perspectives.

Working through these three questions at the start of developing a communication strategy will allow for more refined questions to be asked in the next set of steps with regards to audience identification, messaging, and network-building. The answers to those questions shape the specific communicative actions that an organization will want to take in trying to meet their communication goals. Reevaluating the general system context that on organization is operating in is an important part of maintaining a dynamic and responsive communication network with strategy; therefore, revisiting these questions at a regular interval is an important aspect of the assessment procedures discussed below.

The learning activity presented for setting context covers introductory theory on communication, as well as modern changes in how people communicate in the Anthropocene. However, it is through internal discussion of how these basic principles and changes apply to the unique needs of an organization that the true context for their strategy will be uncovered. In other words, this introductory learning activity is focused on the basic function of communication in a modern blended face-to-face and at-distance communication landscape. Individual organizations will then need to apply those concepts to their own unique situations.

Audience

(See below Digital Ethnography, Search Ontology, and NodeXL for associated learning activities).

Audience identification is the next challenge to tackle. Identification of who an organization's target audiences are should be tied to an organization's mission or vision statement. This highlights the need for organizations to be clear on their own broader strategic plans prior to focusing on a communication strategy. In other words, organizations must be clear on the purpose and direction of their work in order for any communication plan to be coherent and internally consistent upon implementation.

There are four critical questions to answer about an organization's audience:

1. Who are they?
2. What do they care about?
3. How does what they care about figure into what an organization does?
4. How/where do they share information? (mode, channel, platform)

I have developed three different learning activities to help answer these questions: Digital Ethnography, Search Ontology, and NodeXL. The Search Ontology activity is designed to help identify subtle differences in organizationally relevant stakeholder groups that may influence how different stakeholders are reached. The Digital Ethnography activity works to answer questions two, three, and four. NodeXL is introduced here as a user-friendly quantitative tool for an organization to visualize the networks their stakeholders communicate through.

Relevant Networks

(See below Digital Ethnography, Search Ontology, and NodeXL for associated learning activities).

Developing a list of relevant networks is closely related to the audience identification step. As a result they share the same set of learning activities. However, defining relevant networks requires going one step further, to organize the individual audience members into relational groups. This step requires organizations develop enough understanding of their audience and established communication practices to start making thematic connections between their different audience groups, as well as where and how they communicate. In the audience step each learning activity is viewed somewhat separately to learn specific pieces of information about stakeholders, this step requires a synthesis of the learning activities to develop an understanding of the system as a whole. I will demonstrate this more thoroughly in the Alaska Native Knowledge Network case study below.

Network Building

(See Network-building below for associated learning activities).

Network building fundamentally asks the question: What steps are you going to take to build your network? At one level, this question asks about what information are you going to try and convey to your audience or stakeholders, but at a deeper level it asks: What relationship do you want to have with your stakeholders? And, once that is defined: How do you want that relationship to evolve?

At the root, this step in the process uses what has been learned about the audience's network relationships to try and restructure it such that the organization's own mission and goals are more central to their audience's daily networks. This is the phase of the template process where the application of the principles learned in the case study chapter become important. The dynamics of evolving network contraction and expansion dictate the opportunities organizations have to 1) extend their network into new audience or stakeholder groups, and 2) strengthen and evolve core network membership to remain relevant and consistent with their primary organizational goals.

Therefore, the network building aspects of the strategy template should look to identify the types of places and events the organization could become involved in to meet their short and long-term goals. This will look different for different types of organizations. Examples of expansion (or bridging) opportunities might be anything from attending an academic conference to getting involved in relief work after a major environmental disaster. While contraction (or bonding) opportunities could range from planning a faculty and student dinner to organizing a disaster-planning workshop for local agencies already working together on related issues.

Message

(See Digital Story below for associated learning activities).

Once an organization's audience has been identified and a plan for how the organization might be able to communicate with them in the future has been made, it is time to develop an actionable messaging strategy. The message strategy needs to address both the content of the message and the delivery of the message. It is important to remember in this step that social media adds a new interpersonal dimension to traditional broadcast-style platforms. More back and forth dialog can be expected and organizations should expect to have less control over their messaging, but at the same time can improve their ability to be more responsive to changing stakeholder needs (Constantinides, 2014). Thus, how an organization shares its stories has to adapt to higher levels of dialog. The following questions are designed to help in that process.

- What do you need to communicate? To who?
- When do you need to do it?
- What tools do you have to use?
    a. Webpage/blog?
    b. Facebook?
    c. Twitter?
    d. YouTube?
    e. Others?

In addition to these questions, it is also important at this stage to return to the digital ethnography findings and critically assess the already established messaging techniques used by stakeholders—asking the above questions again, this time answering them from the stakeholders' perspective. This can't be highlighted enough—accommodating a stakeholders preferred communication norms with regard to medium and mode is far easier than asking them to converge on the organization's established practices. Therefore, channel and platform preferences must be identified and matched. Less obvious elements should be looked at as well, including things like color preferences and language structure. An organization then has to decide how or if those motifs fit into their own story, and how to highlight the similarities and difference in such a way as to build the types of relationships that are desired.

The digital storytelling learning activity covers the production of multimedia content, as well as how to connect content across channels and platforms. The production elements are similar to traditional broadcast techniques, while in the multi-channel and platform dynamics more interpersonal modes of communication are developed. The primary goal with messaging has to be to adapt an organization's established method of presenting content to the patterns of their audience, while simultaneously remaining consistent in the thematic content they are presenting, and remaining true to their own purpose. In other words, it is the goal of strategic messaging to adapt to the presentation expectations of their audience while simultaneously restructuring the thematic norms (the "stuff" they talk about or do) to greater alignment with the organization's own mission. As discussed in the Intro to Theory learning activity, social and new media technologies increase the reflexivity between an organization's messaging efforts and stakeholder impact by increasing the rate of the base communication unit compared to more traditional broadcast tools. A result of this increased reflexivity is a form of communication much more akin to traditional storytelling than broadcast media—where the narrator shifts and moves the story in response to real-time audience response rather than depending on pre-planned and professionally produced presentations.

Goal Setting

Goal setting is the next step and serves simply as a marker to check progress during the assessment process. Goals should have two elements, a production side and an outcome side.

The production side is tied to the messaging section above and should set out goals for how much communication your organization wants to initiate. An example might be something like four Twitter post a day, two Facebook post a day, one new YouTube video per week, and one new blog post per month, along with publishing two academic journal articles and attending two professional conferences per year.

These production targets should align to the network building strategy. As in the example just given, the social media targets are intended to prime peripheral networks, while the face-to-face and traditional media targets (conferences and journal articles) are aimed at improving bonding relationships in the core of the network.

Setting outcome goals is concerned with the results of the content production.

An example here might look something like growing followers on Twitter and Facebook by 50% monthly, establish three new research partnerships as a result of attending conferences, etc. The trick in doing this of course, is in balancing the total communicative energy any organization or individual has to devote to any specific channel of communication.

How, when, and what goals are set should be directly tied to the overall mission of the organization and the larger system context they are operating in. They should be reviewed regularly through a pre-established assessment procedure. Assessment is the next step in the process template I've developed and serves as the core mechanism for evolving the entire strategy as organizational needs change.

Assessment

(See Assessing your Strategy below for associated learning activities).
Assessment is a critical part to any a strategic plan, communication or otherwise. To do it correctly there are two main forms of assessment that should be understood, formative and summative. Each are covered in the learning activities but in short, formative assessments are used to make corrective changes as a project or plan is underway while summative assessments are used at the end of a project or event as part of a larger review process (McMillan, 2013; Zuiker & Whitaker, 2014). Of the two, formative assessment is the most important on a daily basis as it allows for micro-adjustments in meeting project goals on a consistent basis and reflects more accurately the dynamic nature of communication networks and the need for organizations to respond quickly to changes in modern communication landscapes. Summative assessments are important on longer timelines, where they offer an organization a stopping point to reevaluate broader organizational goals and longer-term changes they would like to see

implemented. However, at different scales a formative assessment may seem summative and vice versa, therefore these definitions are more based on how the results will be used rather than how the assessment was conducted.

The assessment process should be tied directly to measuring the results of goal setting activities and specific communicative strategies. They should be scaled to provide regular updates on fast moving elements of a communication strategy (daily checks of engagement with individual social media posts) and more infrequent assessments of longer-term outcomes (yearly review of stakeholder diversity engaging across different social media platforms as a whole). Additionally, consistent, but infrequent review of the overall system context are important as they help ensure the organization evolves with external changes in the broader systems they serve.

Learning Activities

Learning activities are tied to each of the process template steps described above. I present the learning activities below as a survey of the topics covered and not as a complete explanation of the content they contain. I have designed and created these activities so they can be accessed through a variety of different interactive and online-based tools. For the most part, these tools do not translate well into the written text of an academic dissertation, thus I encourage the reader to follow the links embedded in throughout this document to gain a richer understanding of the concepts the learning activities cover. Additionally, the form and content of these activities will evolve over time. The self-reflective nature of research cannot be escaped, and in this case the maintenance and evolution of these activities factors heavily in my own personal communication goals as an academic. Currently these activities sit on two platforms, Voice Thread and Google Drive. This is an artifact of most recently using these activities in a one-to-one mentoring relationship with a fisheries student hoping to improve her science and cross-cultural communication skills. We met regularly face-to-face via Google Hangouts, and therefore used the learning activities presented here as a backdrop for those conversations. With the completion of this dissertation, my needs as a communicator will change through changes in the context that I am operating. As a result, the platforms this information is presented in will need to evolve.

After completing a personal assessment of how these activities performed in that one-to-one context, I have begun to re-strategize how I need to alter them to meet my future needs. Now, after having successfully run a trail version of the activities at the individual level—where I could get rapid feedback on what worked or didn't work—my need is to expand their usability to larger audiences. With that in mind, the next phase in my communication plan is to develop video versions of the content along with interactive Google forms to facilitate the hands on implementation of the activities with out my direct (real-time) guidance. Additionally, now that I have more confidence in their effectiveness, I will begin to link the activities to networks I have already established through my researcher blog, Facebook, Twitter, and YouTube accounts, as well as my Center for Cross-Cultural Studies faculty webpage and through my role as director of the Alaska Native Knowledge Network. This process is a direct example of applying the organizational communication strategy I have outlined above to a personal communication strategy, and despite the fact that these activities are regularly evolving both in content and presentation, I have included them here to provide a general appreciation for the learning factors that are involved in developing and implementing a resilience-based communication strategy.

Theory: Context

The intro lecture is a public presentation on the web-based platform VoiceThread (Table 12) reviewing the basic principles of communication, sensory awareness, media ecology, changing media practices and the increasingly networked communication norms of the Anthropocene that were discussed in the introductory chapter of this dissertation. This learning activity is designed in the classic lecture format, which is why Voice Thread was selected as the delivery medium. The intent is to provide sufficient background information on the changing communication landscapes of the Anthropocene such that organizations can start to frame their own place within it but not to explicitly cover how to answer the guiding questions described in the above "context" section. That was left for the real-time conversations where we were able to quickly converge on a shared understanding of terms and then rapidly move into focusing on her specific communication needs. A non-synchronous version of this element will need to be added for it to be more useful in a less directed learning environment. Social media, of one platform or another may be able to fill this functional role and will be implemented and assessed in the next iteration of these learning activities.

Table 12: Theory. The first learning activity introduces the basic communication, media, and network theory needed to implement the process template I have defined above.

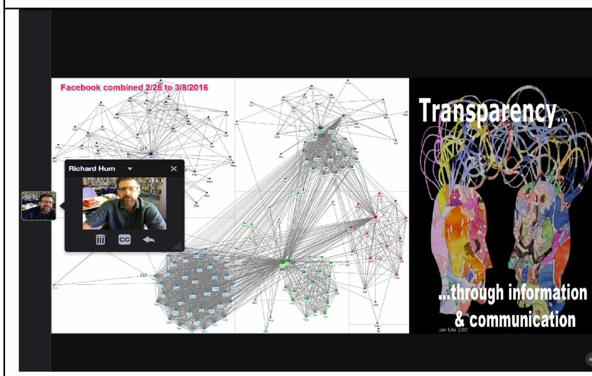
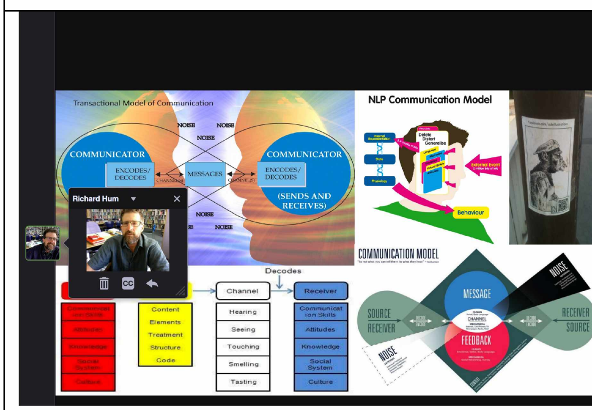
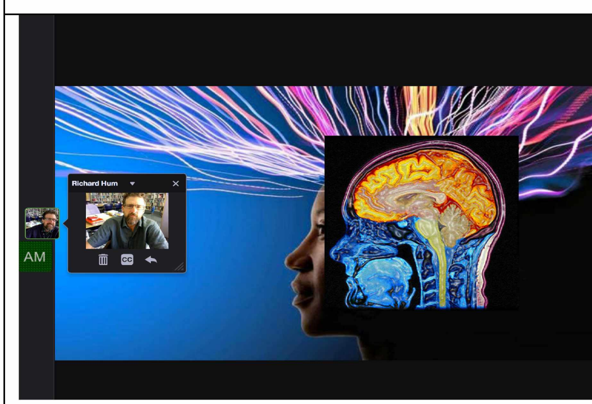
<table>
<tr><th>Image</th><th>Narration</th></tr>
<tr><td>
</td><td>This week is a basic introduction to the conceptual framework we'll be using to understand–and improve–cross cultural communication
It is grounded in the idea that communication represents the FLOW of information between environmental agents
And for us humans, that flow happens through our senses…
sight, sound, touch, taste, smell.
So when we start to systematically look at how communication occurs between different people… we can start by studying how different communication practices impact the senses involved.</td></tr>
<tr><td>
</td><td>Let's start at the start.…
The basic unit of communication can be defined by the following four steps…
1) An agent sends a signal (which could be anything from a smell-perfume, to a visual clue—emojicon
2) Another agent becomes aware of the signal, and replies/responds
3) The original agent receives the response.…
4) And… reflects, and is changed
That's our working definition of the most basic… but complete, communication cycle… the base communication unit. Send a signal, receive a signal, change</td></tr>
<tr><td>
</td><td>Our brains are amazing,
and at any given moment, a number of these cycles are being sorted, linked, and contextualized from external information gleaned from each of our senses.
Through time and habit we tend to preferentially "pay attention" to information from different ratios of senses… say sight when reading a book, hearing when on the phone, smell and taste while eating…
In a very real sense, the preferred ratio a person depends upon under a given condition shapes/defines the meta structure of their world view… in that it limits the modes of information that will receive attention… say a fisherman that can understand the condition of his net by putting a hand on the corkline, or the lab-scientist that can tell there is a problem by a change in the hum of their equipment. Or the chief, by the smell of a soup… etc.…</td></tr>
</table>

Table 12 Continued

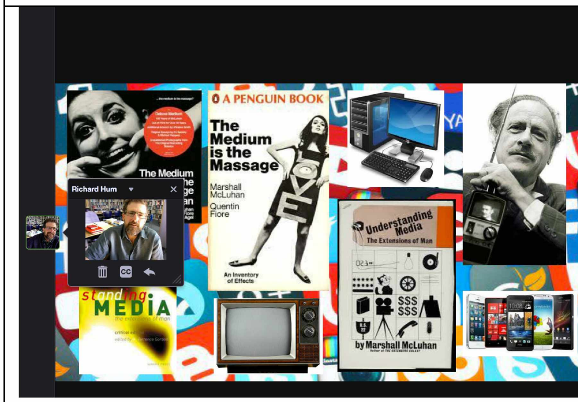
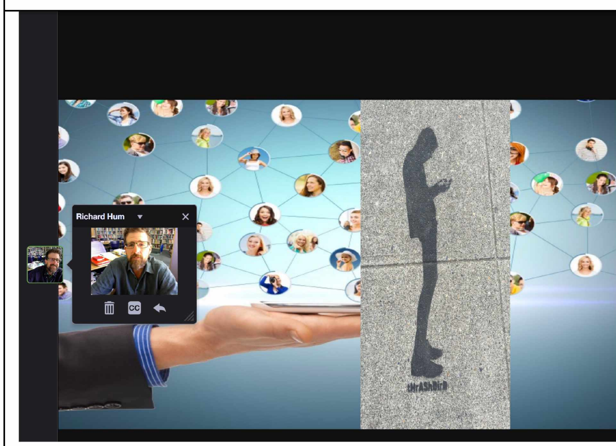
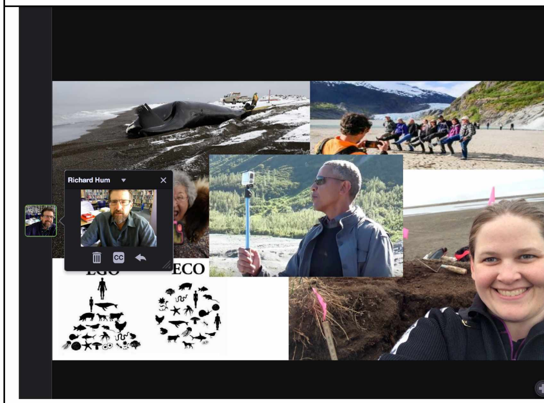
Image	Narration
	We know from Marshal McLuhan's work on Media Ecology, and his Media is the Message ideas, that different media tools preference different sensory ratios.… … essential what he is saying is that all of our material/constructed tools… from clothing to transportation to the phone, etc.… extend our ability to interact with the environment AND, preference some senses over others… Sight of sound… the written word over oral history. From a practical sense, what this means is that we can look at the tools people prefer to use in communication as proxies for the sensory ratios they prefer.… And from that we can think about the effects on worldview… and how we try to communicate across worldviews.
	Then we have the "connected" or "networked" world of New media… the interactive tools of the web… and the new mobility of devices that can connect to it… They Broaden the geographic reach and time constraints of modern communication… they alter the rate that the basic communication unit is completed, and they diversify the modes that can be communicated… In a face-to-face conversation all senses are involved, but it is proximal and limited in size and space to the very local. Distance communication tools used to extend these variables at the expense of the limiting modes of communication. Think about the telephone--- involving just sound, and limited to only a few people interacting… Or the Television, bringing in sight and sound to extend the geographic range and raw number of people involved… but at the expense of completing the second half of the base communication cycle. New media changes all of that by offering high levels of interaction– that is rapid, or flexible, completion of the communication cycle, and multi modes of interaction. Combined these factors have worked together, promoted by technology advancements and social pressures to globalize, to create larger, more dynamic, and specialized communication networks.… That are more open and observable than non-new media meditated networks. The networked society.…

Table 12 Continued

Image	Narration
	In this course, we'll be taking advantage of the connection between media choices, sensory preferences, and worldview… combined with open and observable nature of modern networked society to explore, describe, and ultimately improve cross-cultural communication.

The next set of activities starts with a guide for developing a search ontology. The search ontology is designed to support stakeholder identification, as well as identify what communication channels and/or platforms different stakeholders prefer. The digital ethnography activity is designed to develop structured qualitative skills needed to determine differences in how stakeholders are communicating across channels. The NodeXL activity introduces a few basic, hands-on, data mining and social network analysis skills needed to help visualize and assess the communication landscape that will be uncovered via the search ontology and digital ethnography efforts.

Search Ontology

The search ontology activity (Table 13) is designed to help with audience identification in the process template described above. It also supports defining relevant networks, and taking the first steps in concretely defining the communication landscape the organization is operating in. This is accomplished by developing a methodical and repeatable approach to searching for stakeholder and/or audience related information online—and through a variety of platforms. Defining the term ontology is important at this point, as its use here is more closely related to a Computer Science than Philosophy definition. Guarino in his 1998 paper does a good job of describing the relevant differences for this work; "In the philosophical sense, we may refer to an ontology as a particular system of categories accounting for a certain vision of the world. As such, this system does not depend on a particular *language*: Aristotle's ontology is always the same, independently of the language used to describe it. On the other hand, in its most prevalent use in AI, an ontology refers to an *engineering artifact*, constituted by a specific *vocabulary* used to describe a certain reality, plus a set of explicit assumptions regarding the *intended meaning* of the vocabulary words" (Guarino, 1998). In this case, the semantic-based online search tools of the current web unquestionably force a vocabulary word specific usage of the term ontology.

Developing a search ontology is the first activity in this set. The key purpose is to locate and identify stakeholders important to the organizational mission. The process is iterative and based on developing Internet search strings of phrases and terms around three elements tied to the organization's mission: 1) the primary subject or theme that the organization is focused on, 2) the physical location (or social space) the organization's mission is most concerned with, and 3) the broad interest groups involved in the issues important to the organization. The structure of these strings—topic, place, and group—reinforces the concept of a thinking about the communication plan through a system's perspective, and leads to easier identification of robustness roles by initially defining stakeholder groups in reference to the resource that is of key importance.

Once these strings are developed they are applied to a range of web-based platforms to locate different stakeholder related networks currently interacting with one another on the Internet. Each platform requires modification of the string to fit within the search tool provided through the platform. After detailing the generic development of the search strings, this learning activity then dives into applying them through Google's primary search engine, Facebook, and Twitter, while illustrating through practice how these methods can be adapted to other platforms.

Table 13: Search Ontology. The search ontology learning activity describes a process for identifying text-based language differences between different stakeholders in a specifically bounded social-ecological system. The process is iterative and based on developing an increased understanding of place, resource, and engaged stakeholders.

Search Ontology Learning Activity
Search Ontology Finding the meaning in Other's words **"Salmon" and "Alaska Native"** **"Salmon" and "Scientist"** 
Purpose The big picture goal! Develop a method for discovering how different people, in different places, understand a common "resource" (through digital channels)

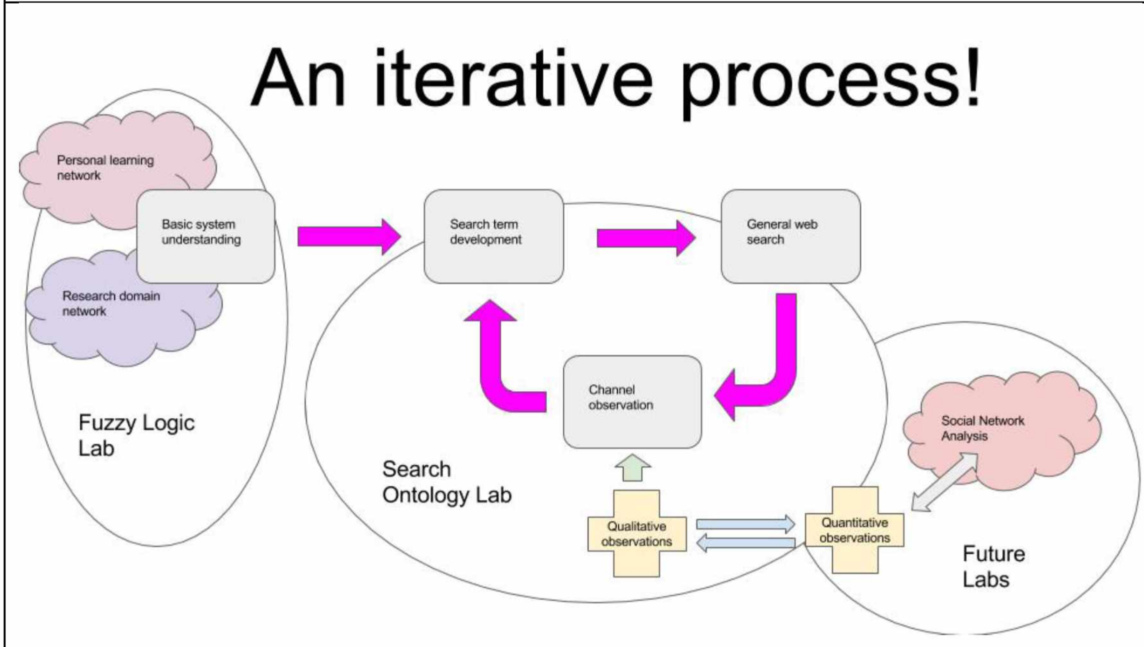
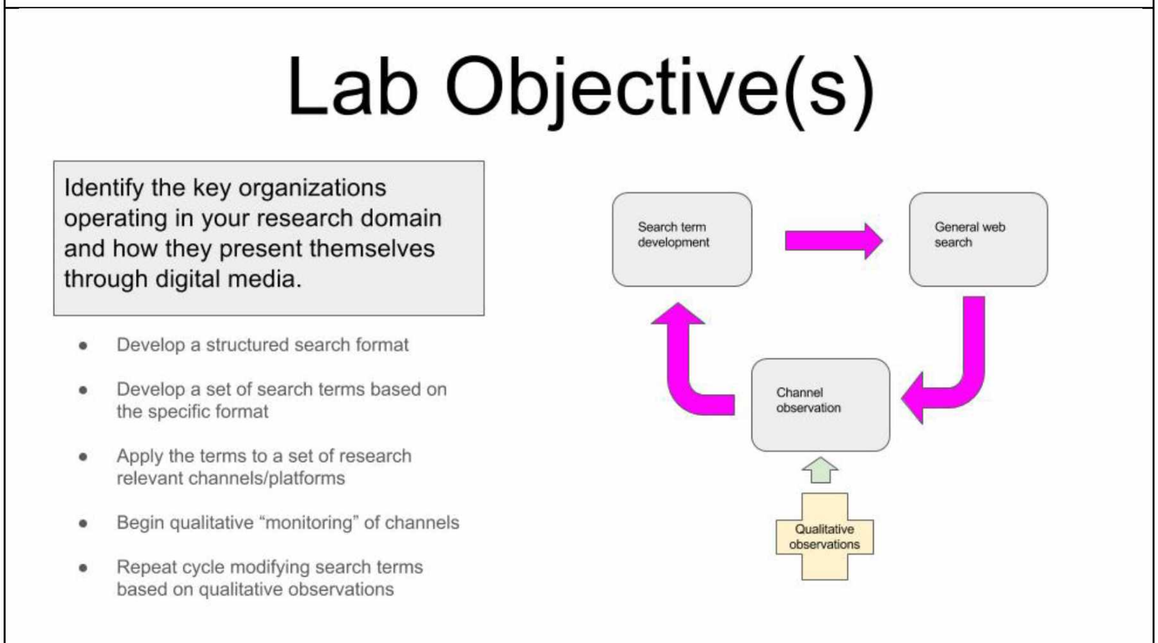
Table 13 continued
Search Ontology Learning Activity



Table 13 continued

Search Ontology Learning Activity

Developing the search **structure**

3 things to consider...

1. The subject… (or resource/focus or your research)
2. The location…(at a research relevant scale)
3. Stakeholders groups… (not specific people or organizations)

Putting it together… search strings

Subject/resource

Stakeholder/people/organizations

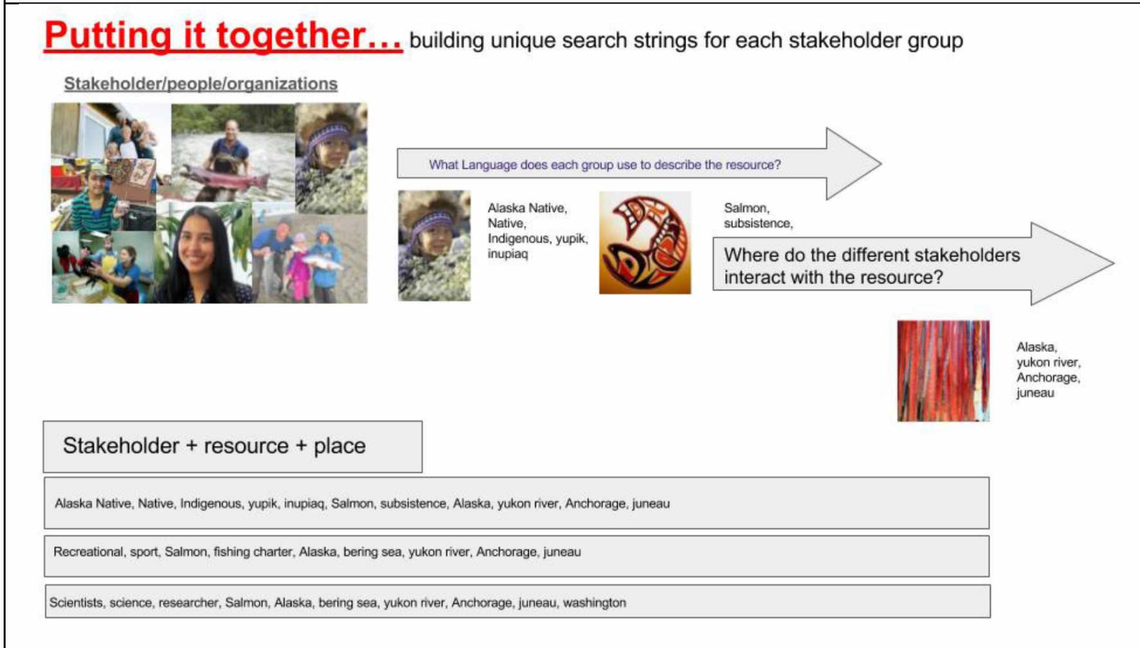
Place

Table 13 continued

Search Ontology Learning Activity

Table 13 continued

Search Ontology Learning Activity



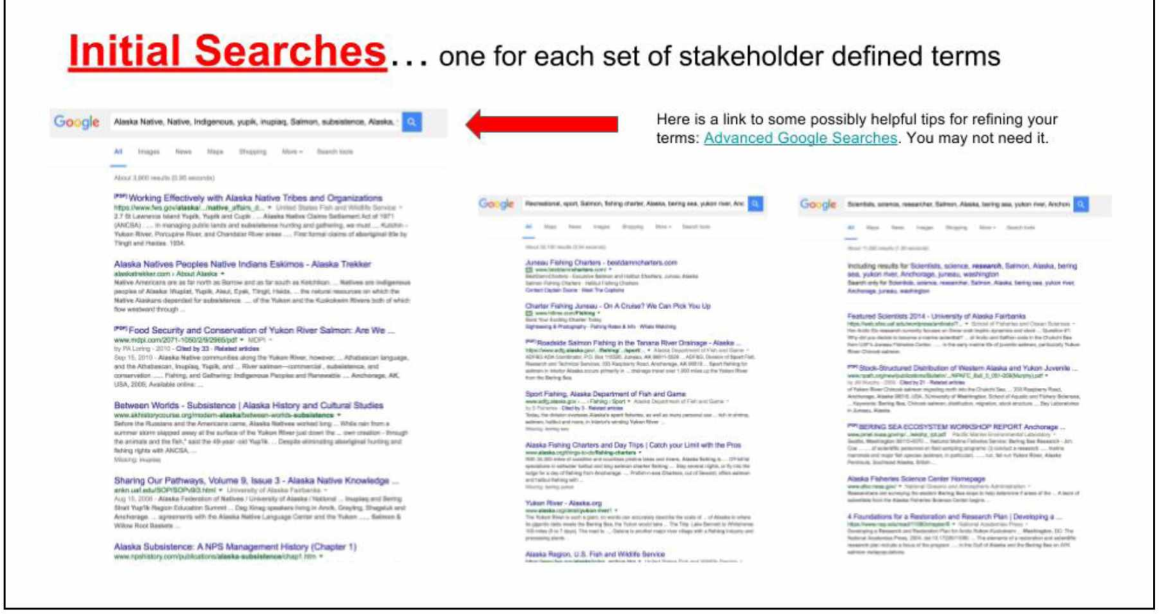


Table 13 continued

Search Ontology Learning Activity

Initial Discovery… let's Google!

Important questions while interpreting the results … the story line!!

What types of sites are being returned? (blogs, traditional websites, social media sites, news reports etc.)

Who has created them? (specifically we are interested in what organizations are active online)

Why did they create them? (What's their purpose?)

Secondary questions to ask … the subplot!!

What exactly are they talking about? (How are they relating to the resource?)

Using what language and/or word choices?

Under what different contexts? (to enforce regulation, to promote social change, to develop knowledge)

Assess Your Results!! Do the organizations that you are returning make sense with your current understanding of the system? Most will likely be familiar to you, some could be new.

Record your results by creating a Google Sheet that looks like this one: Search Ontology- Salmon Fishery (we will be adding to this sheet throughout the semester)

This is our lab book and should contain sufficient information for others to repeat our process.
Each search trial should have the terms recorded
In the initial discovery phase the goal is (1) to identify key organizations involved in our research domain and (2) refine your initial search ontology.

First iteration… 2nd round searches

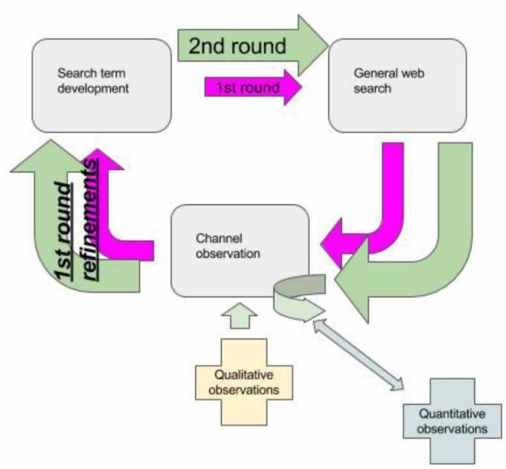
Re-assess stakeholders… do any need to be added, removed, or combined?

Re-examine search terms… add, combine, or delete where needed-- maintaining search structure

Run second set of trials

Add to spreadsheet any newly identified organizations.

Like, follow, subscribe, etc. to "discovered" organization's social media channels (on "researcher" accounts)



After the basic search ontology has been developed and implemented, a number of key stakeholders (individual people and organizations) and more general stakeholder groups (Arctic scientists, Indigenous language experts, the oil and gas industry, etc.) will have been identified. The next step is to dig into how these different stakeholders and groups are interacting online.

The digital ethnography activity is designed to help with that through qualitative assessment of their communication practices.

Digital Ethnography: Audience, Relevant Networks

Developing digital ethnographic skills (Table 14) is fundamentally concerned with looking at the preferred modes of communication different stakeholders use directly through their online communication actions and indirectly by drawing inferences into what their face-to-face mode preferences might be based on their online behaviors. This involves looking for, and thinking about, both what platforms different identified stakeholders are active on, as well as which platforms they are not active on. As we learned in the introduction chapter, different platforms emphasize different modes of communication by the tools they allow users to interact through. Facebook, as an example, allows video, image, and text-based information to be easily conveyed. This emphasizes sight and sound, but the movement in video can tap into the kinesthetic (touch) mode, as well. Where as, more purely text-based platforms such as blogs might only focus on sight. By cataloging where different stakeholders are active and where they aren't an organization can, most obviously, focus their energies on communicating through the channels where their intended audience are already active, but less obviously, an organization can get a better handle on the more general mode preferences of their audiences by comparing which modes different platforms emphasize and then making extrapolations on audience preferences based on platform use. Then, when we get to the messaging activities below, these extrapolations can be tested and refined by presenting similar content themes to the same stakeholders using different modes of communication (one message with heavy use of text, one with imagery, one with video, etc.), measuring engagement for each, and focusing future efforts on the most effective modes of presentation for specific content themes and stakeholder groups.

Table 14: Digital ethnography. This learning activity describes in detail the specific types of digital ethnographic information that can be derived from traditional websites, Facebook, and Twitter.

Digital Ethnography Learning Activity

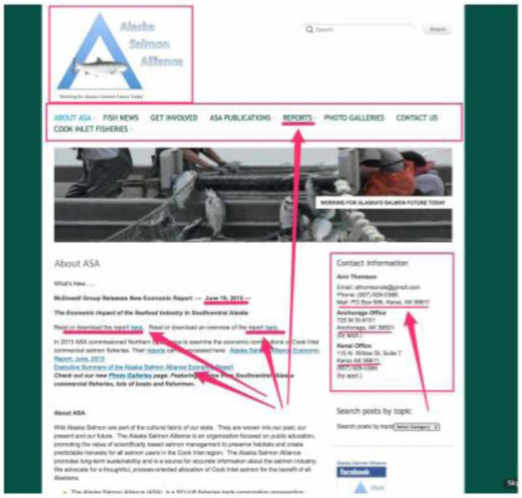

Table 14 continued

Digital Ethnography Learning Activity
Objectives: 1) Find and follow organizations discovered through the search ontology lab on FaceBook, Twitter, and Youtube. 2) Combine elements of your search ontology (stakeholder, place, and thematic terms), with each channel's uniques search tools to extend your observation networks beyond the seed sites discovered in the search ontology lab 3) Use principles of media literacy (plot, subplot, intended audience) to build a greater perspective for how different stakeholders approach your research domain.
Traditional Websites -More difficult to update than social media, so... -Information presented is often more central to the Organization's mission/purpose social media -Requires people to specifically "find" the site for a specific purpose, so… -Audience is more invested than social media channels, which are accessed for more general informational needs Wikipedia's take on what a "web page" is https://en.wikipedia.org/wiki/Web_page

Table 14 continued

Digital Ethnography Learning Activity

Traditional websites… what can we learn?



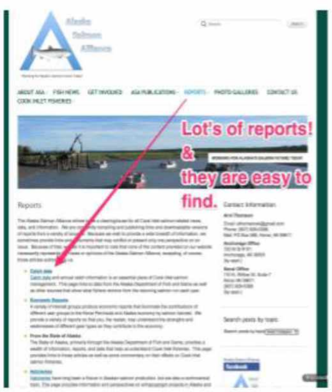
What kinds of information is presented…and in what way?

-narrative story, technical reports, news updates?

-lot's of text? Still images? Video?

The different ratios of these elements, combined with elements of design (color, position, imagery) to set plot and subplot which work consciously and subconsciously to speak more loudly to different and specific stakeholder groups all interested in the same general themes/topics of the site.

Traditional Websites… see the bias



About ASA

Wild Alaska Salmon are part of the cultural fabric of our state. They are woven into our past, our present and our future. The Alaska Salmon Alliance is an organization focused on public education, promoting the value of scientifically based salmon management to preserve habitats and create predictable harvests for all salmon users in the Cook Inlet region. The Alaska Salmon Alliance promotes long-term sustainability and is a source for accurate information about the salmon industry. We advocate for a thoughtful, process-oriented allocation of Cook Inlet salmon for the benefit of all Alaskans.

The bias here…

Is explicit in their "about" statement (the Plot)

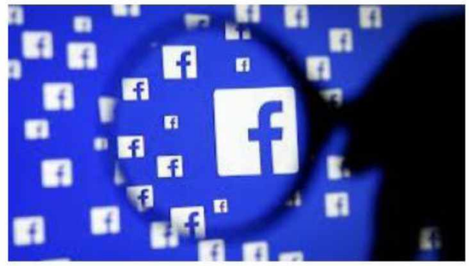
& implicit in the form and volume of content (the subplot)... i.e. text heavy in this case, which speaks to specific types of policy oriented people and turns off others.

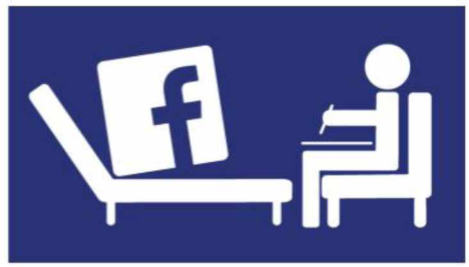
Table 14 continued

Digital Ethnography Learning Activity

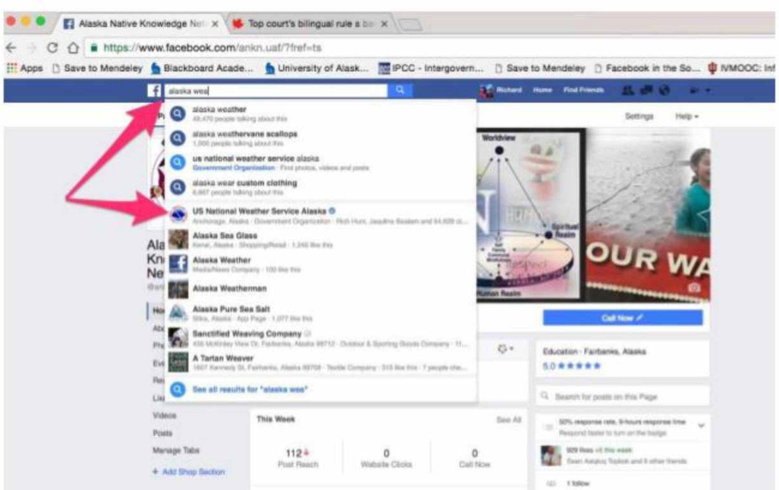
Facebook- the goal

- See how much content is out there in your research domain.
- Understand what kind of information can be learned through this channel
- "Follow" a number of pages and begin to observe how they are using Facebook… what they are talking about, and how they are talking about it!





Facebook- Searching



Using the Search feature:

Directly type in the organization's name

Sometimes their Facebook name is not exactly the same as their official name… so you may need to play with it some.

Also watch for unknown (to you) organizations that pop up as Facebook tries to help you find whatever it is it thinks you're looking for.

Table 14 continued

Digital Ethnography Learning Activity

Facebook-- search by subject

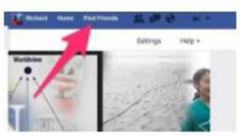
Using themes tied to your search ontology

Click to see all results

Play with all the options to get a "feel" for what is out there in Facebook land on this topic

Hone in place, time, and page type in particular.

Facebook- Search for people



You can find specific people based on a number of settings… place is most relevant for us.

Exploring a range of people from specific communities or regions can give an overview of how people are using Facebook in the area

Relationships can then be made with individuals who are posting content around your research themes… Or not, this has to be approached carefully...

Table 14 continued

Digital Ethnography Learning Activity

Facebook- people (cont.)

Privacy settings

On personal pages individual's privacy choices may not be obvious.

Profile pictures are public… so if all you see are profile pictures then you know the person wants their activity private.

If you see lots of different types of posts then they likely don't care that it is in the public sphere (and/or are unaware)

Facebook-- what kinds of information can you learn?

Things to be thinking about…

- Frequency of posts
- Frequency of interaction (commenting, liking/"reactions," shares)
- Types of posts (text, link, photo, meme, video, etc.)
- Formal presentation of identity via… profile images, page banner image, information in "about" section
- Informal presentation of identity via… content of posts, friends, group members, page followers, pages followed, groups joined

Wikipedia's take on Facebook https://en.wikipedia.org/wiki/Facebook

Table 14 continued

Digital Ethnography Learning Activity

Facebook Groups

Facebook groups are open spaces where no one participant has dominance in the conversation…

Sub themes will develop under the larger interest area of the group

Group administrators have structural control of the site-- banner image, membership rules-- but content creation is shared equally among group members.

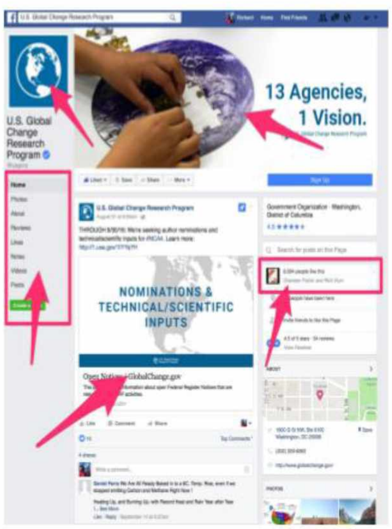
Groups can be open or closed… and site administrators set the rules for that.

Things to consider with Groups (beyond those listed on the previous slide)...

- Size and diversity of membership
- Diversity of posters… does the same member initiate all the posts? Are there patterns between who posts on certain sub themes? In who comments of likes them?
- How geographically diverse is the group?
- Gender diversity? Age diversity?
- Does the group interact through other venues? Face-to-face, others?
- What other groups does Facebook think are similar to this one?

(which is likely determined by Facebook looking into the network of group members to find trends in what other groups they are members of… tricky people! ;-)

Facebook-- organizations



Facebook organizational pages are similar to a typical facebook users own personal page.

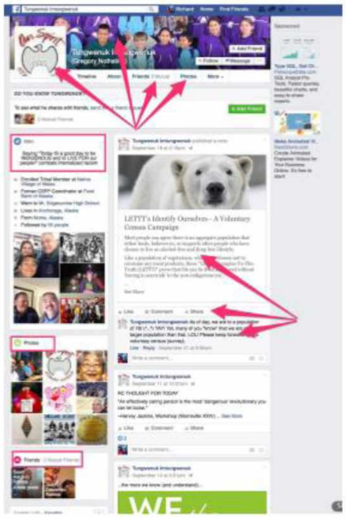
Things to consider with Organizations (beyond those listed on the previous slide)...

- How active is the page? Does it seem like Facebook is an important channel of communication for the organization being explored?
- What other organizations does the page "like?"
- Do any of your "friends" like this page as well? (you might need to look them up on your personal account rather than your Researcher account)
- What kind of content do they find most important? Links to other resources/information? Videos? Images? News of their own activities? Other's activity?
- What sub themes to their overall organizational goal do they most often discuss or reference?

Table 14 continued

Digital Ethnography Learning Activity

Facebook-- people



People are ethically tricky! Public accounts are… just that public, but any information learned once a “friend” request has been accepted is privileged and should be considered the same as a private conversation.

Things to consider with people (beyond those listed on the previous slides)...

- Is the user active on Facebook
- How big is their total “Friend” list vs. how many different people interact on the page
- What parts of their life do they comment on the most… family, vacations, religion, politics, etc…? How much does this vary through time? (vacation in the summer, family during the Holidays, fishing in the spring/early summer, etc.)

Twitter- goals

Find “people” and organizations to follow

- Based on applying principles of search ontology
- Based on seed organizations

Determine which stakeholders use this channel, and for what purpose

Wikipedia’s take on Twitter. https://en.wikipedia.org/wiki/Twitter (way younger than I remebered!)

Table 14 continued

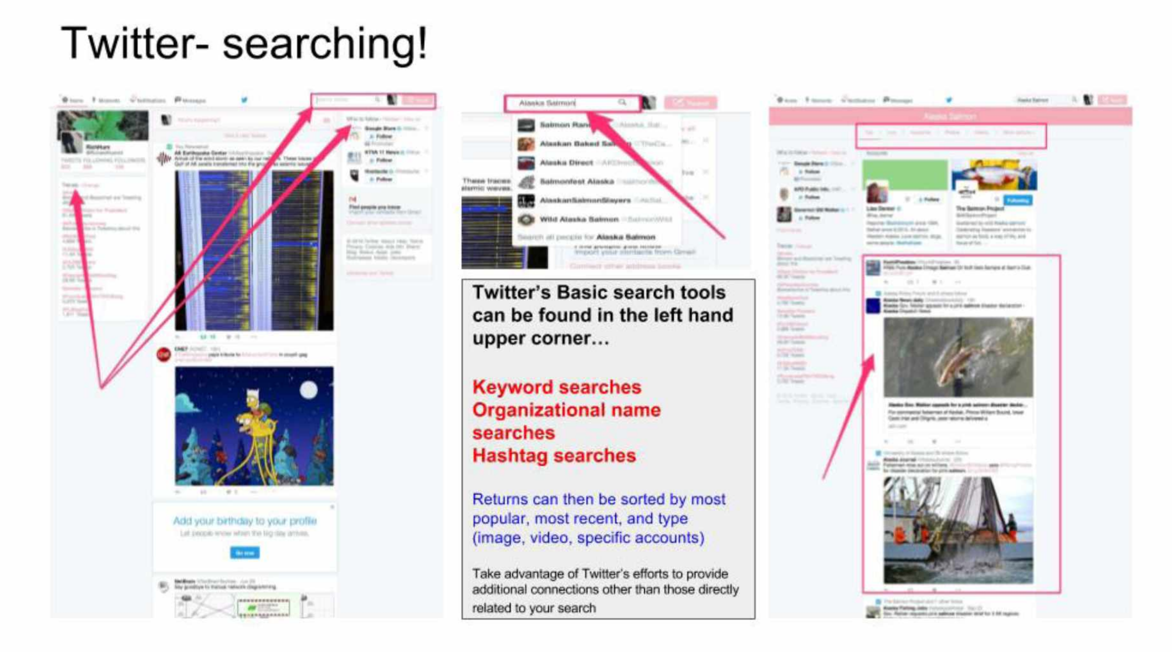
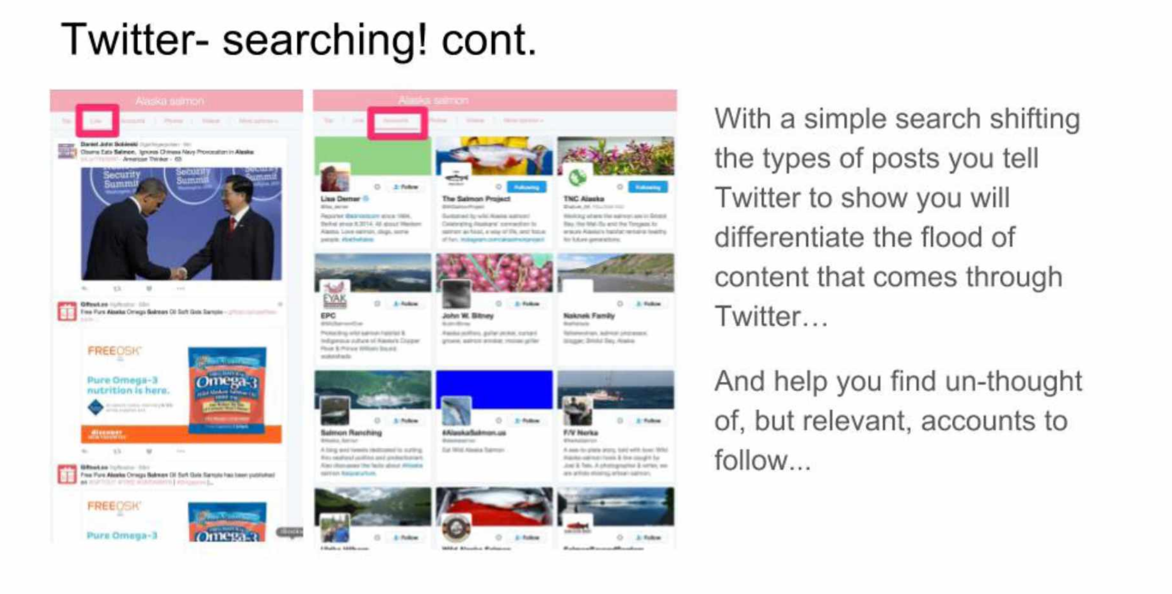
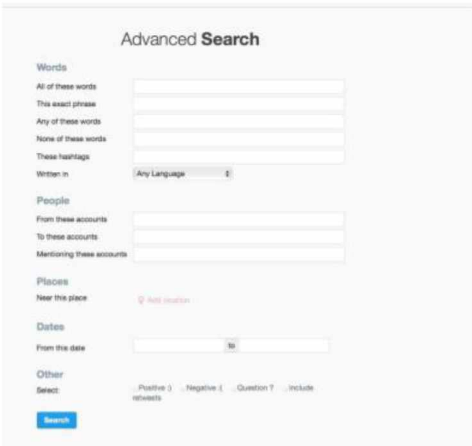
Digital Ethnography Learning Activity



Table 14 continued

Digital Ethnography Learning Activity

Twitter- advanced searching

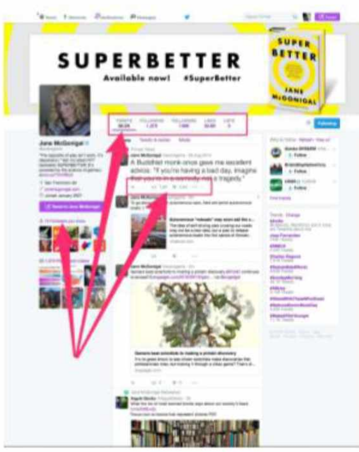


This feature allows almost direct application of your search ontology on the Twitter platform.

It narrows your results, so is less exploratory than a simple search.

Combined with TweetDeck (next slide) can be very powerful!

Twitter-- a user's account



Very much like a Facebook organization page

User accounts are always public

Networks tend to be bigger

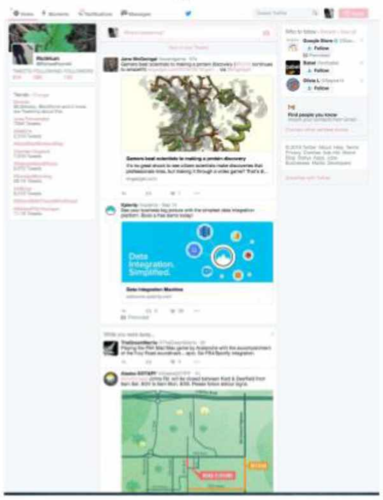
Things to consider (beyond those listed on the previous slides)...

- Is user particular user a person, organization, or "bot"
- How often do they Tweet?
- Are they "followed" more by accounts than they "follow"... are they information distributors (followed by) or information gathers (follow others), or somewhere in the middle.
- Are they passing on information (a link to something someone else has initiated) or sharing new information (something they initiated)
- All the other identity presentation and topic/sub-topic items from earlier (profile image, post content types, overlap with your own networks, etc.)

Table 14 continued

Digital Ethnography Learning Activity

Twitter-- your feed



Twitter is fast and disjointed! Information will come through your feed constantly (once you start following enough people) from a variety of sources who may or may not be very well interconnected so topics will vary a lot.

--Play with who follow a lot!

--Follow and unfollow people to see the effects

--You may want to use TweetDeck (next slide) to help organize the volume and chaos of Twitter! ;-)

TweetDeck-- a Twitter "helper"

TweetDeck is an application that allows you to follow a number of different Twitter searches side by side.

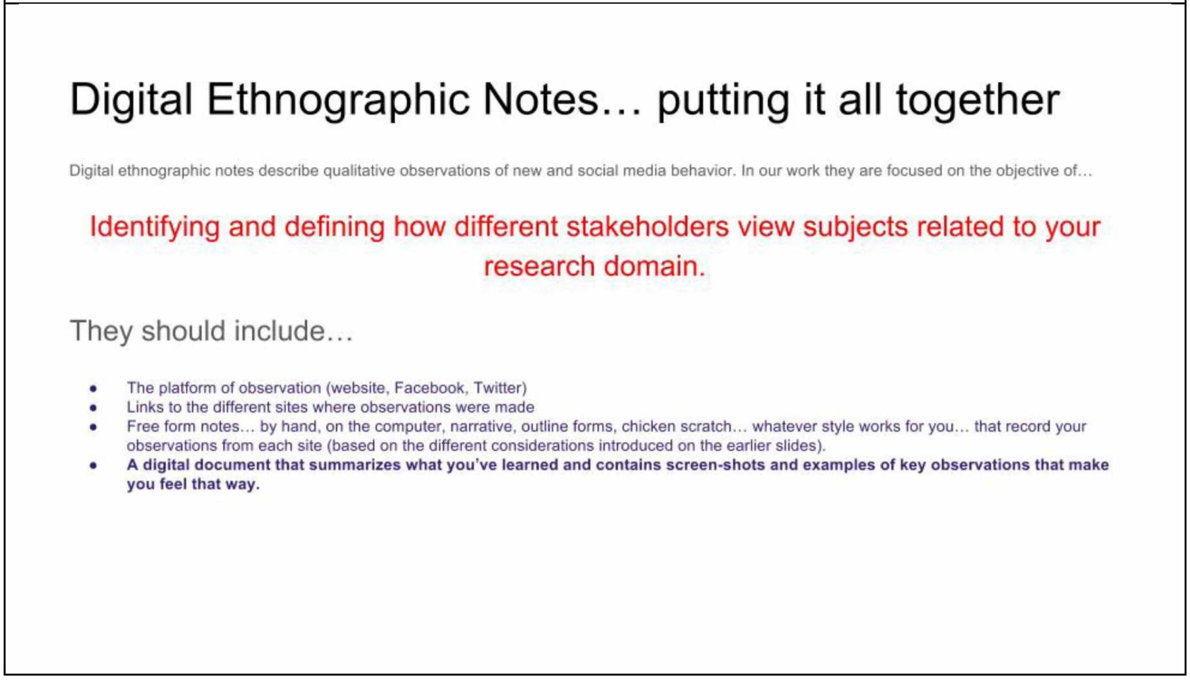
You can use it to watch (in realtime) how your different search trial vary in content, form, and frequency.

More TweetDeck info here:

https://support.twitter.com/articles/20169620

(you don't have to use TweetDeck to understand Twitter, but it is helpful)

Table 14 continued

Digital Ethnography Learning Activity


Digital ethnography allows for a qualitative means for an organization to understand their audience at multiple levels. At one level it gives the organization information on the basic communication preferences of their audience. But combined with the search ontology activities—applied across multiple different platforms—it provides a nuanced picture of how subgroups within the overall target audience relate (or don't) to one another. Information on platform preference, color norms, language use, and choices as to which types of media to interact with, all give critical clues into worldview differences and similarities between stakeholders important to an organization's mission. Additionally, iteratively linking the search ontology to the digital ethnography activities serves as a reflective discovery tool to expand the list of individual stakeholders an organization may want to direct communication efforts toward. By refining the string of search phrase after each round of digital ethnographic review, a grater understanding of the overall system an organization is working in can be developed and incorporated into the network building activities presented below. First, however, NodeXL, the main network tool I have used throughout this dissertation, is presented as a quantitative means to understand and map the information learned through the digital ethnography activities.

NodeXL: Audience, Relevant Networks

Using NodeXL is a quick and relatively easy tool to derive quantitative information about the communication networks and organization is concerned, as the NodeXL learning activity makes clear (Table 15). As NodeXL has been explained in detail in other sections of my dissertation, I will not go into great detail here on the capabilities and limitations of the program. I will simply say NodeXL is a plug-in for Microsoft's Excel software and runs through the typical Excel interface that most people who are used to dealing with spreadsheet data are familiar with. The widespread comfort level with Excel makes the NodeXL network plug a relatively quick tool for users to learn. This learning activity walks an organization through all the steps needed to download the tool, install it, apply their search ontology to import network data, map it, and start exploring the network. It is a straightforward how-to and hands-on activity that depends heavily on tutorials produced by the makers of the plug-in. Additionally, many of the data sets linked in the case study chapter are NodeXL files, this learning activity providers readers with all the information they will need to explore these data sets own their own.

Table 15: NodeXL. The NodeXL learning activity provides both technical information for using NodeXL as a strategy tool, as well as how to tailor its use to individual organizational needs.

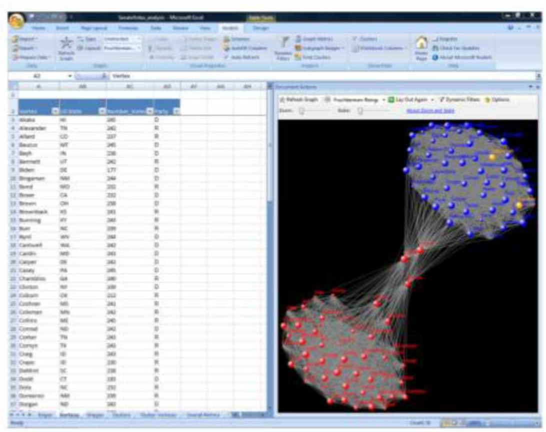
NodeXL Learning Activity
NodeXL Building your first network
Objectives -download and install NodeXL -import data -visualize your network -calculate basic measures -think through word pairs -develop structured report (link to template) 

Table 15 continued

NodeXL Learning Activity

Download NodeXL

Free version

Fee version

Link to Download

Intro tutorial video

Intro tutorial slides

Import Data

From the Alaska

US Weather Service Facebook page.

-for the last 10 posts

-for the month of September 2016

-NodeXL tutorial on importing data

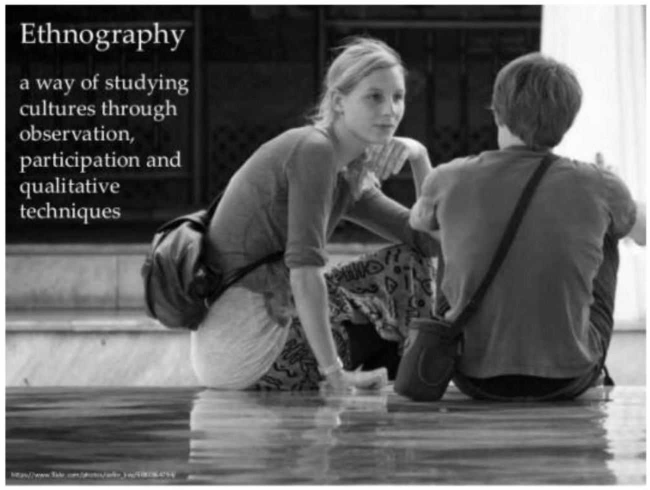
Table 15 continued

NodeXL Learning Activity

A quick ethnographic review

Take brief notes of your general impressions of the page and specifically the content that is being pulled.

-note content themes and tone/level of engagement



Visualize the network

Play with 2-3 different visualization layouts… consider how they impact your general understanding of the network. Be sure you can defend why you selected the visualization that you eventually pick.

Visualization Tutorial

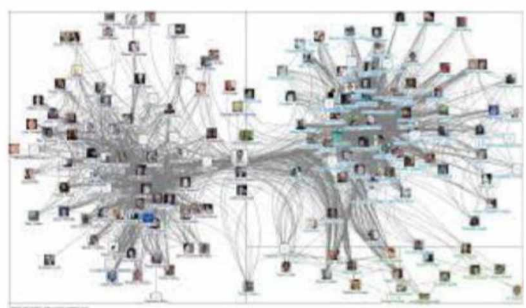


Table 15 continued

NodeXL Learning Activity

Calculate metrics

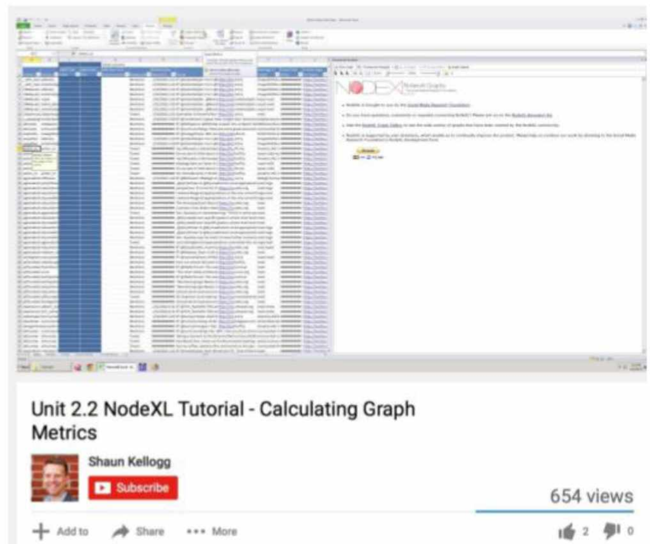
Video tutorial

Add metrics to visualization

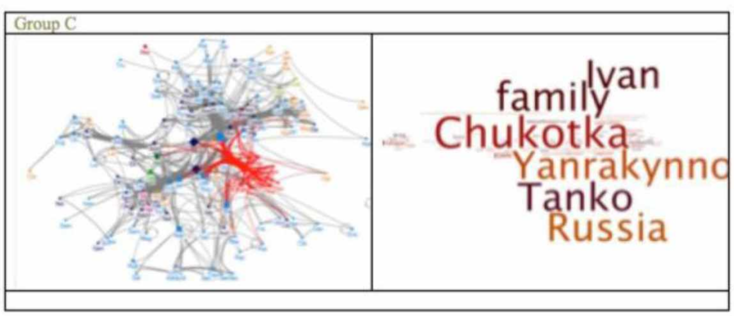
Video Tutorial

Calculate word pairs

Video tutorial



Develop narrative "story" for the network



Subgroup D is interesting. It is the most diffuse of the groups but has the greatest sailence in language analysis. This group is clearly concerned about the potential of a deep water port at Port Clerance and arguably less willing to become involved other regional issues. These are folks who may benefit from being drawn into other areas of the network to build up greater/broader support for their own, more limited, primary concerns. In anycase this group has considerably weaker connections among themselves and between other subgroups than others in the network.

Through the search ontology activity greater general system understanding was built, framing that understanding through a robustness-oriented structure (as a note this was the same process used in the case studies described above). Through the digital ethnography and NodeXL activities both a qualitative and quantitative understanding of the relevant stakeholder networks were developed. Next, the network building activity provides the opportunity to think through how an organization would like to engage in the networks that have been discovered through this process.

Network Building

This learning activity is heavily focused on utilizing the general patterns of network expansion and contraction that were observed throughout the case study networks (Table 16). The basic approach is to identify and take advantage of network expansion opportunities to establish initial connection with new stakeholder or audience groups through participation in the peripheral portions of their network, then to carefully foster deeper relationships with the most important connections through the contraction period. For an organization looking to build new connections into science communities, this might look like identifying one or two key science-based conferences to send representatives to, with the goal of establishing a large number of new, but weak, ties into that community. Then, after the conference identify a handful of those new connections to carefully foster and deepen ties with. The communication landscape in this case may include e-mail and institutional list-serves to identify a conference, various social and new media platforms for understanding the context of the conferences, and perhaps making early contacts with others planning to attend followed by the face-to-face interaction of attending conference sessions and socials—maybe enhanced using Twitter interactions with others (both in attendance and at-distance) to expand the experience even further. Finally, after the conference, using email, the phone, and other at-distance tools (online collaboration tools, various social media platforms) to stay in touch with new contacts and support fostering deeper relationships, perhaps through co-authoring a paper or working together to implement a community-based project.

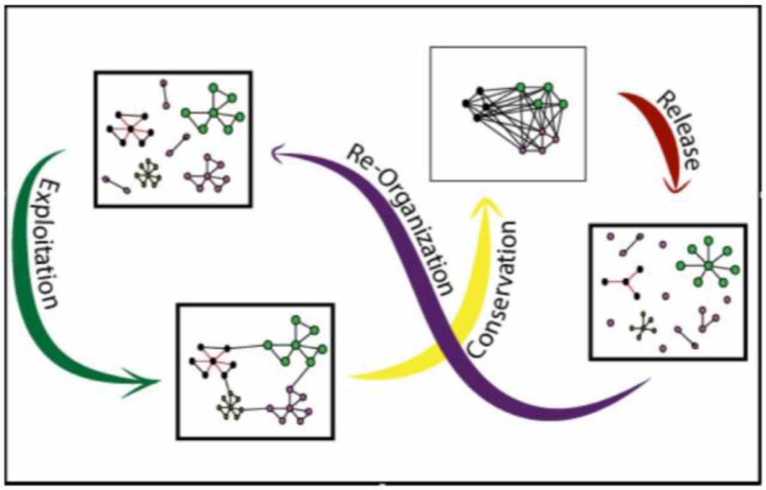
Table 16: Network building. This learning activity connects the network-based adaptive cycle model the case study observations of pulsing network expansion and contraction events. Building on these principles, activities focus on developing a strategy for using the pulsing behavior to meet core network needs. In this learning I introduce a general strategy of using expansion events to maintain large periphery networks, while carefully guiding bonding relationships during contraction periods to foster a vibrant core community of stakeholders.

Network Building Learning Activity


Table 16 continued

Network Building Learning Activity

Adaptive cycle and networks



A storm-- release

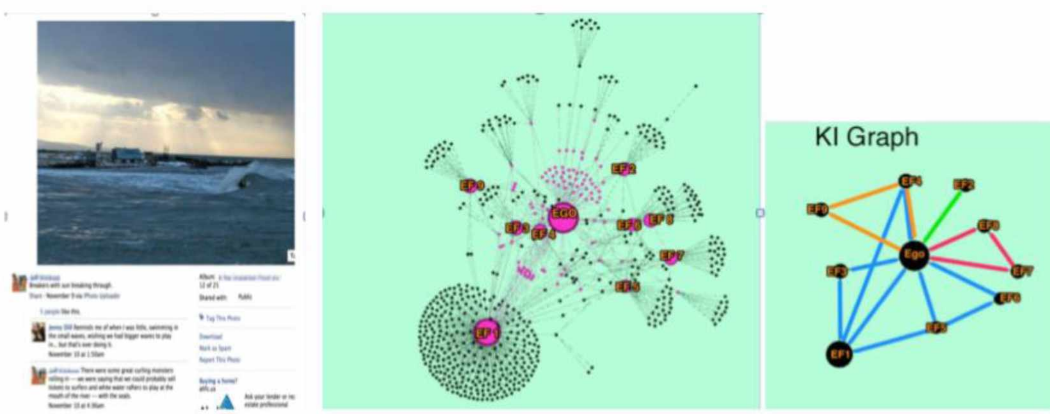
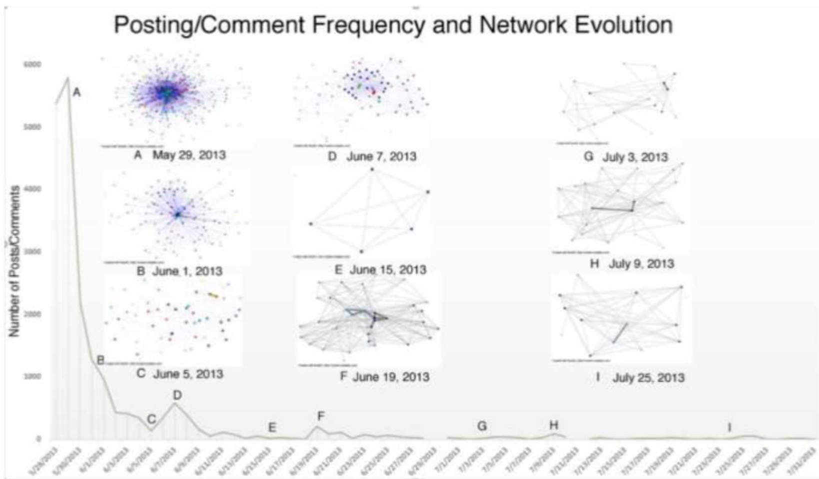


Table 16 continued

Network Building Learning Activity

A Flood-- release through conservation



An NGO effort

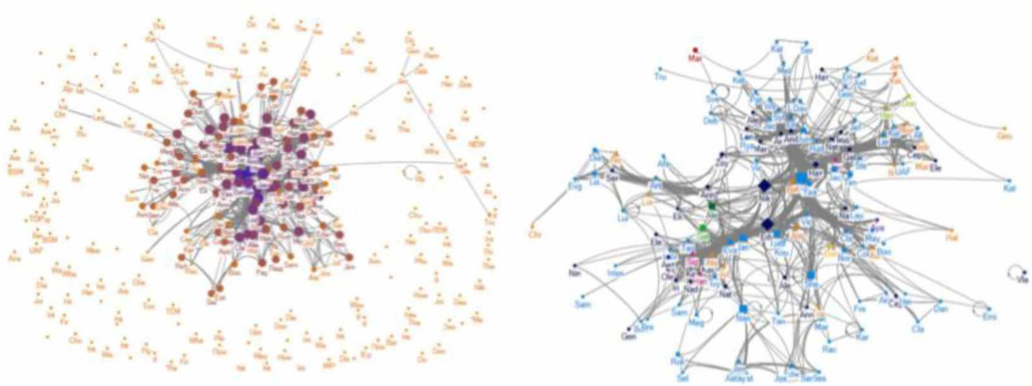
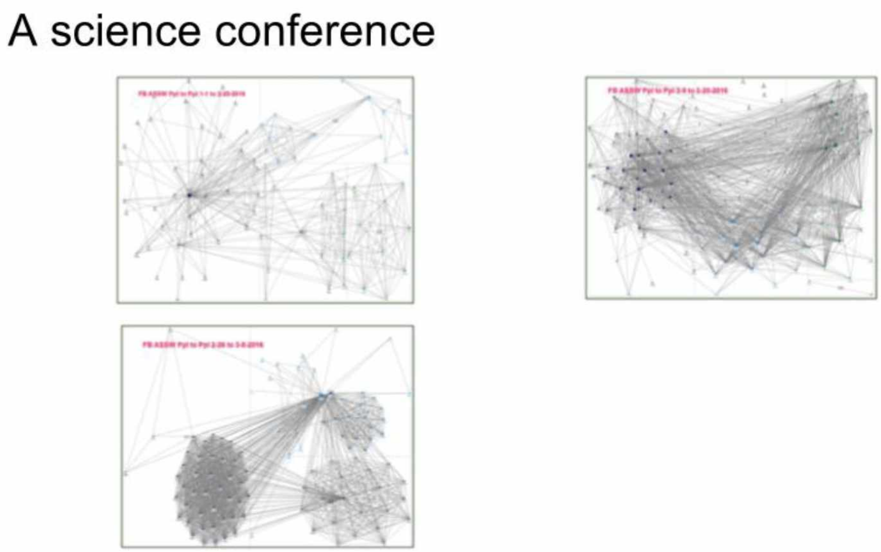
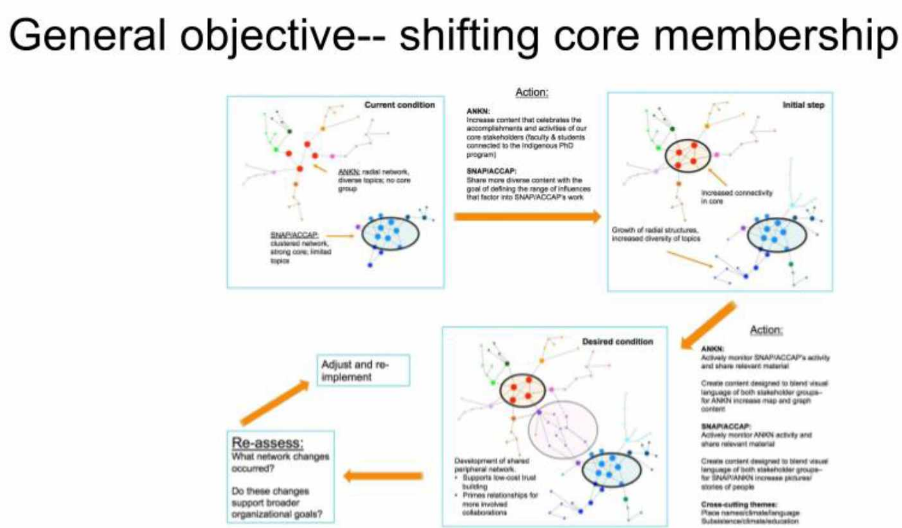


Table 16 continued

Network Building Learning Activity



The network building learning activity is very focused on the structural plan for how to manage an organization's communication networks. It looks at whom an organization wants to communicate with and how they can go about initiating or maintaining those connections. It does not examine or attempt to figure out what they will "say" once those contacts are made. Learning activities around that element of building a communication network are presented below through activities on digital storytelling. It should be mentioned though, that in reality the structural plan of who to communicate with, and the content-oriented side of how to communicate with them, can't really be understood in this linear fashion and that in practice both should be thought through together.

Digital Story

Telling a digital story is really about using knowledge on how different modes of communication impact the listener to convey a multi-modal message—that is to tell a story that touches multiple senses. A popular misconception is that digital story is really just the process of making and sharing digital videos. There is more to it however, and when thinking about digital story an organization needs to consider both the overriding story they wish to tell through their messaging, as well as the platforms across which they are going to tell it. The structure of this learning activity (Table 17) mimics these considerations by first covering media literacy and story deconstruction techniques, then moving through story arc and narrative form, and lastly, persuasive techniques and common logic fallacies. The activity then applies these principles to the creation of text, image, sound, and video-based storytelling. The activities then cover putting it all together via a cohesive multi-platform strategy along with platform-specific tutorials. The goal of these activities is simply to provide a basic understanding of the different elements of digital storytelling, and then move quickly into how these elements can interact across multiple channels to produce a consistent message on each. This is important because if stakeholders are differentiating across channels, an organization's messaging must be flexible to engage users on each, but also provide similar content to move all stakeholders to a shared understanding of the organization's mission and goals.

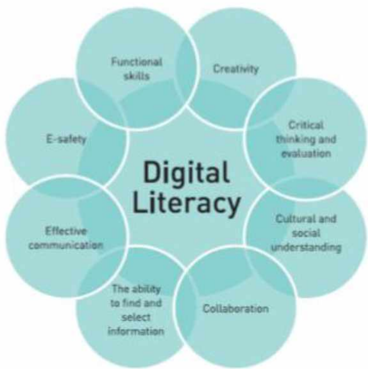
Table 17: Digital story. The learning activity for digital storytelling covers basic digital literacy, narrative structure, mode-specific tool use, and channel (and platform) delivery. Digital storytelling is a rich and expanding genre of art, entertainment, and scholarship. The learning activities presented here are intended as entry points for individuals and organizations to begin to tell their story, but offer a mere glimpse into the increasingly rich media options we have for sharing our perspective on the world.

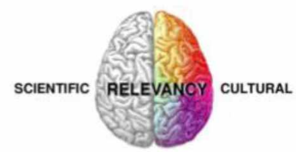
Digital Story Learning Activity

Table 17 Continued

Digital Story Learning Activity

Digital literacy- Deconstructing for context and subcontext



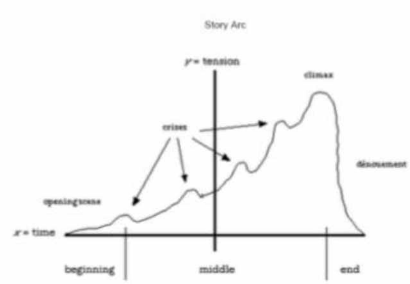


http://www.mathiaspoulsen.com/a-model-for-digital-literacy/

The narrative

https://en.wikipedia.org/wiki/List_of_narrative_forms

http://www.poynter.org/2007/alternative-story-forms-are-effective/84368/



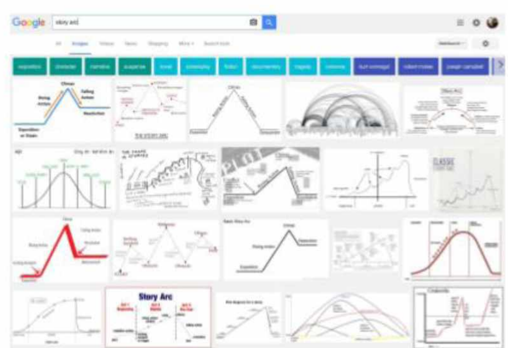
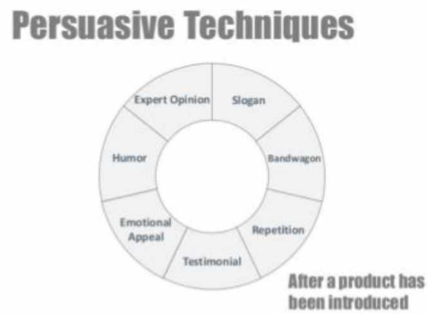
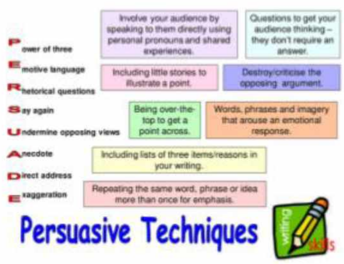


Table 17 Continued

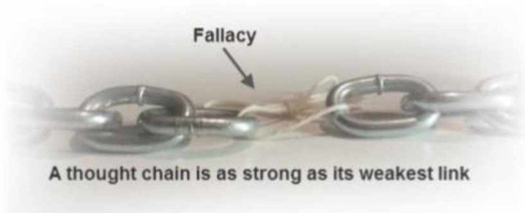
Digital Story Learning Activity

Persuasion





Fallacies



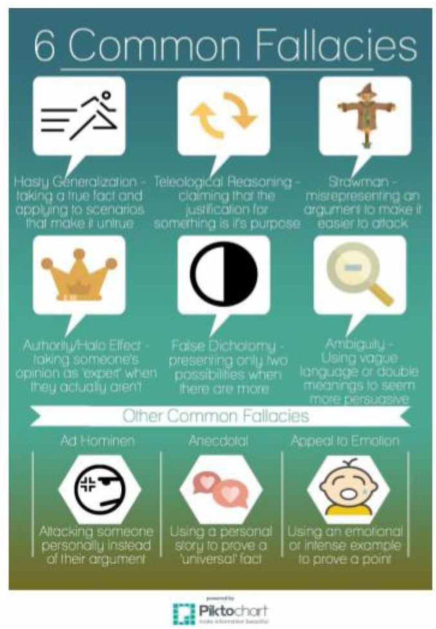


Table 17 Continued

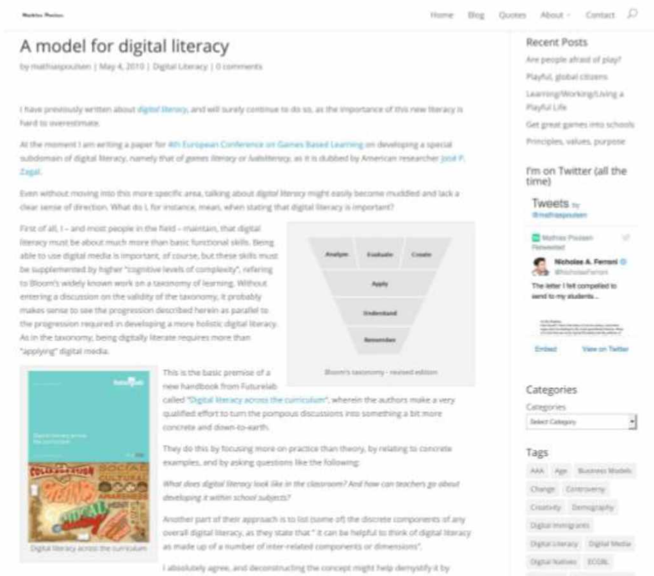
Digital Story Learning Activity

Text

Information density

Visual presentation

Embedded media

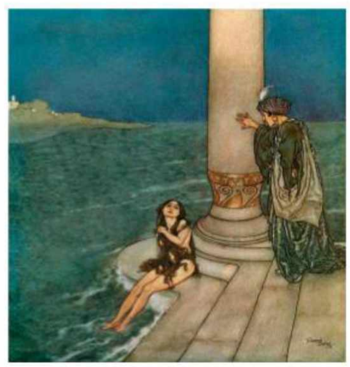


photos

Composition

Eye movement

Subject - context/subcontext



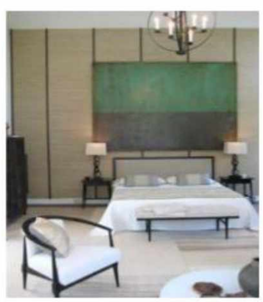


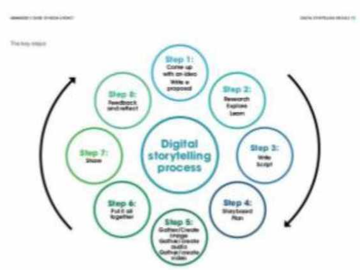
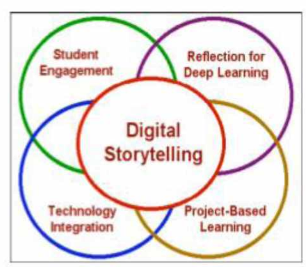
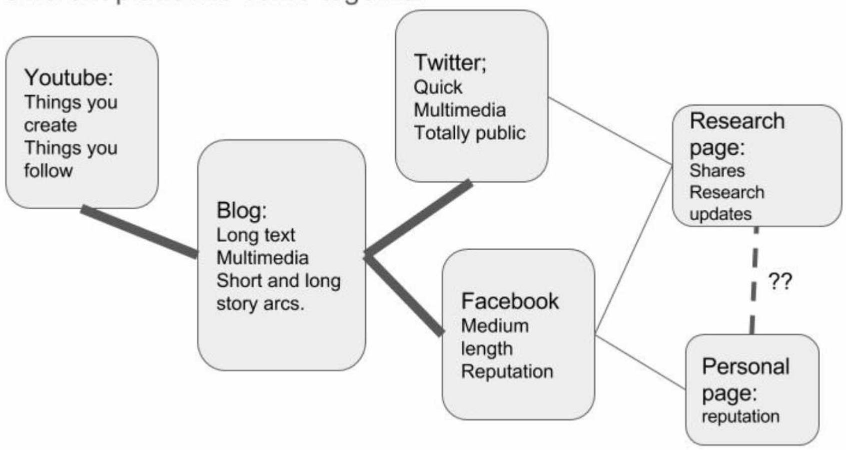
Table 17 Continued
Digital Story Learning Activity
sound? Usually in video Mood/place music Spoken word Environmental sounds 
video Composition Visual Sound Context/subcontext Mood/setting 

Table 17 Continued

Digital Story Learning Activity

Putting it together

Picture of how different platforms come together



Putting it together- the blog

The Hub

Purpose

Pacing

Sources

A written form of your personal learning network

Table 17 Continued

Digital Story Learning Activity

Putting it together- Facebook

Reputation

Posting- text,link,image, video

Sharing/ commenting/ liking

Live video, messenger, etc...

Putting it together- Twitter

Public

Frequency

Original content- hashtags,text, images, video

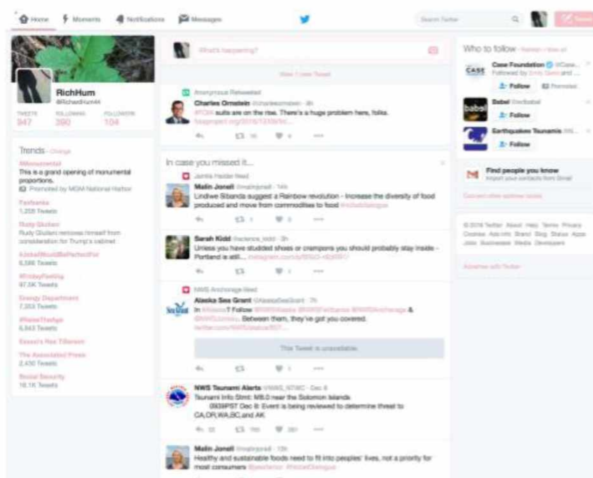
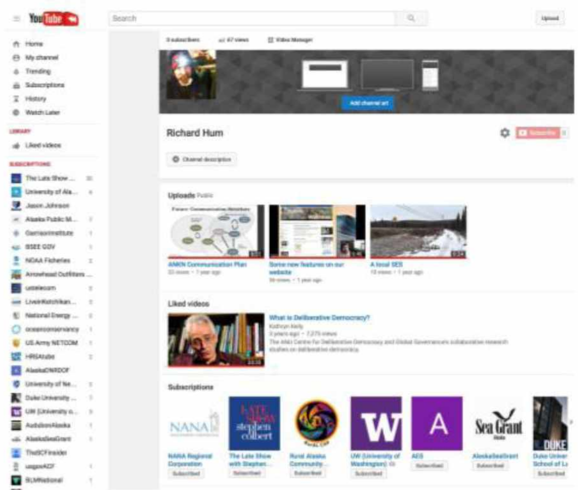


Table 17 Continued

Digital Story Learning Activity
Putting it together- Youtube Public/private Connected to Google Video editing High content production cost relative to other social media (usually) 

After identifying and gaining a basic understanding about the target audience, developing a network strategy to engage them, and a messaging (storytelling) plan to implement it, assessment is the final step in completing a strategic communication plan.

Assessment

The case studies in this dissertation show the dynamic nature of communication networks. They are always shifting, realigning, expanding, contracting and evolving as the social-ecological systems they are embedded in react to changing internal and external pressures. This understanding is the premise behind using a resilience-based network model as the framework for structuring an organizational communication strategy.

Communication networks are a subset of the broader social-ecological systems they serve. Like these larger systems, there is no static norm for communication networks to return to after a disturbance. Disturbances can be widely defined, but it is important to remember that every communicative effort is, at one level or another, a disturbance. This is particularly true when new communicative norms are attempting to be established through implementation of a communication strategy. This means the system is going to change after each effort, and it is never going to return to the same form as prior to the effort. Regularly scheduled and consistently applied assessment is the only way for an organization to keep track of, plan, and respond to these changes in a strategic rather than reactive manner.

The assessment learning activity (Table 18) focuses on two types of assessments that can be tied to the concepts of formative and summative assessment discussed above. They are also closely related to Argyris' work on double-loop learning (Argyris, 2002; Chris Argyris & Argyris, 2015). Argyris' work is focused on organizational learning, and in that context defines learning as problem solving—a somewhat limited definition, but appropriate for this application). It then breaks down the mechanisms of learning into two levels, or "loops" in the learning process (his later work added a third, but is not considered here). It defines single-loop learning as simply identifying a problem, developing a solution, implementing it, and then assessing to see if the problem was solved. Double-loop learning then looks more at the base logic, premise, or ideology of how the problem was understood— asking why the problem was defined the way it was, and if it is still an appropriate way to understand the issue. The first loop asks, "Did our solution work?" While, the second loop asks, "Is our identification and understanding of the problem still valid?" This two-step process is critical in a communication strategy because in the first step the efficacy of new communication efforts can be assessed on a basic level: "Did putting more videos on Facebook engage more diverse stakeholders?" While the second loop forces thought on deeper questions such as, "Does engaging more diverse stakeholders through Facebook actually advance our organizational mission?" This two-step, multi-level learning model fits well with the resilience-based communication model that I have developed throughout this research because it places learning in the same dynamic systems model as the broader SESs it is reacting/evolving with. To apply this to our communication strategy we need to formalize these two loops (or levels) of learning into our assessment process.

To do that, we need to return to the idea of formative and summative assessments. Formative assessments are checks and measures that are taken at regular intervals during an active learning event. An appropriate example of this is the committee review process this dissertation has undergone. Each round of review prior to the defense is designed to help me adjust and adapt my work to the needs of my audience—the committee, but also the greater academic community, and ultimately the Dean of Graduate Studies at UAF. After that formative process is complete, the “final” copy is sent to the Dean, who in turn, passes a summative assessment of the work by approving it or not.

Thinking through this then, we can see that summative assessments are well aligned to checking single-loop learning efforts—answering the question “did what we tried work?” While formative assessments are much more suited to evaluating double-loop learning efforts—where the organization must evaluate how to evolve and adapt with the ever-changing communication networks they operate in. Summative assessments should be tailored to check specific actions an organization is implementing (e.g., more videos on Facebook, or warm color schemes versus cool color schemes to attract different stakeholders). This generally requires taking advantage of the assessment tools individual channel and platform providers develop for their users (Google Analytics, Facebook Insights, etc.). The learning activities for this section cover each of these tools. Most importantly, however, they stress aligning the tool use with the network-building goals and strategies developed in the earlier sections of the process template. It important to understand however, that summative assessments at one scale can serve a formative role at another. If a plan entails making three Facebook post a day for one month, with the goal to increase audience by ninety total users, then at the daily level a summative assessment might simply measure the number of post made, perhaps combined with the number of any new users who became engaged. This could be considered a summative assessment at this scale, “Did we meet our daily goals? Yes or no.” But at the monthly scale, this data could be considered formative if it is used to modify actions to meet the broader goal, “Hmm, today we actually made five posts by mistake, but we engaged eight new users. Tomorrow let’s try increasing our posting frequency again and see what happens.” In this way, the difference between formative and summative assessments has a lot to do with the purpose to which the results will be put to use. Formative assessments put an emphasis on how the results can guide future actions. Summative assessments put an emphasis on past actions.

Through this process the individual actions tied to the implementation phase (three Facebook post per day) of a communication strategy are tied to specific goals and objectives (increase network size three fold monthly), which are then aligned to the organizational mission (improve cross-cultural communication). The individual actions are assessed against the goals and objectives they were designed to meet, while the impact of meeting those goals and objectives is re-assessed against the broader organizational mission statement. This multi-leveled assessment approach allows an organization to guide the implementation of individual elements in a communication strategy while at the same time ensuring they grow and evolve as the broader system they operate in responds to their, and others', system influences.

Table 18: Assessing your strategy. As a communication strategy process template, with specific emphasis on the word "process," using the assessment of previous communicative actions to guide future efforts is a core principle. The learning activity for strategy assessment introduces aligns the network-based adaptive cycle framework developed throughout this dissertation with Argyris' Double-Loop learning model to formalize a self-reflective element into the strategy assessment process. Specific network and platform based measures and goals are then tied the assessment process.

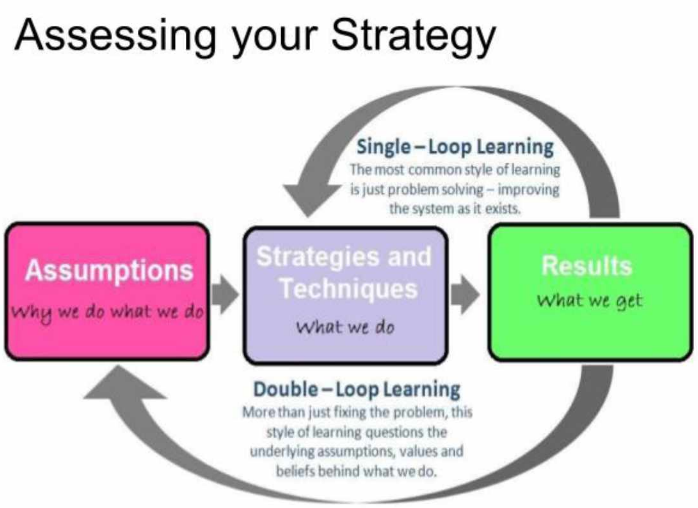
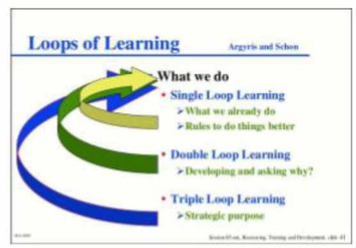
Assessing Strategy Learning Activity
 

Table 18 continued

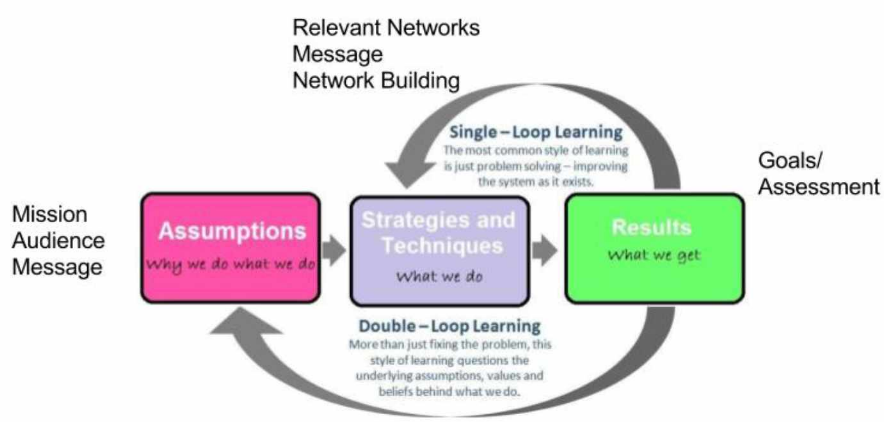
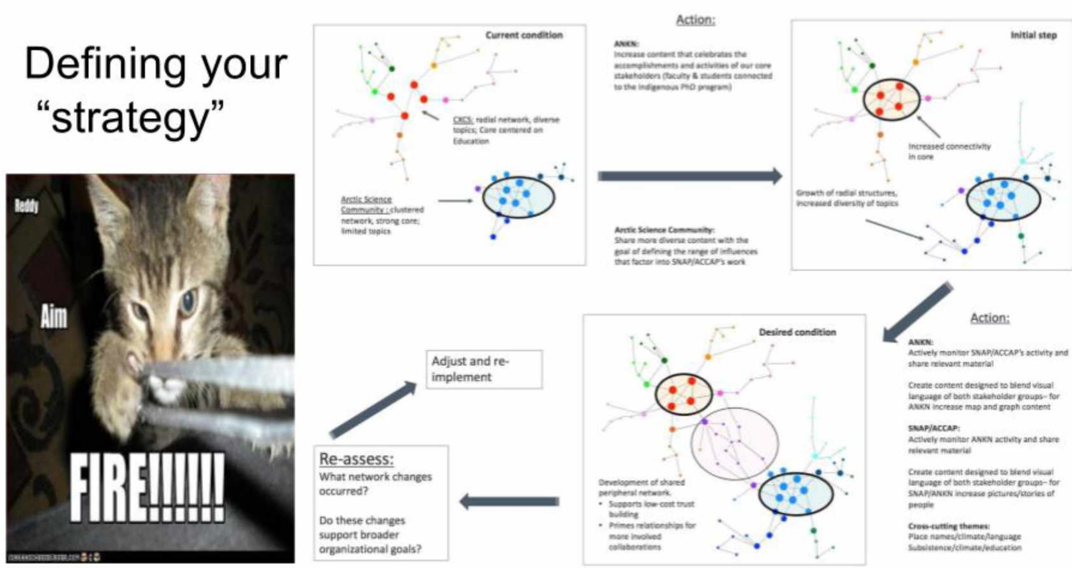
Assessing Strategy Learning Activity



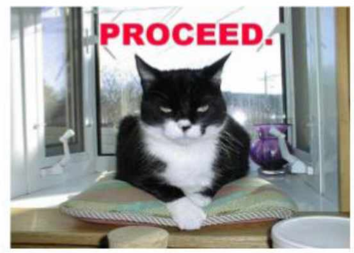
Table 18 continued

Assessing Strategy Learning Activity

Assessing!

Measurable Qualities-- size of network, structure of network, themes, modes, channels

Intangible Qualities-- How people *feel* in the network. What people *do* with your information



Network Structure & the Adaptive Cycle

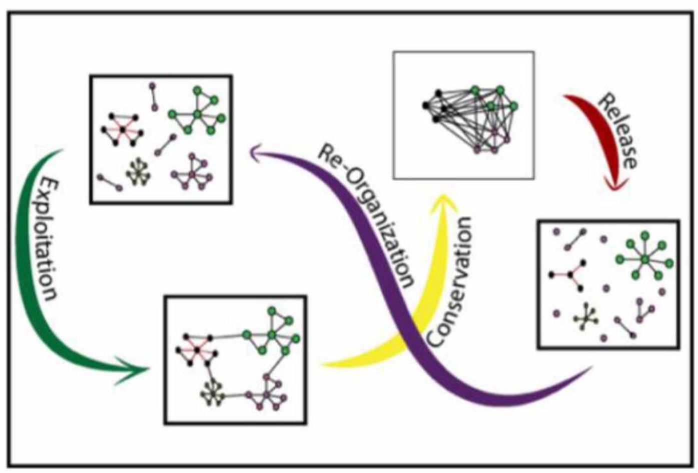
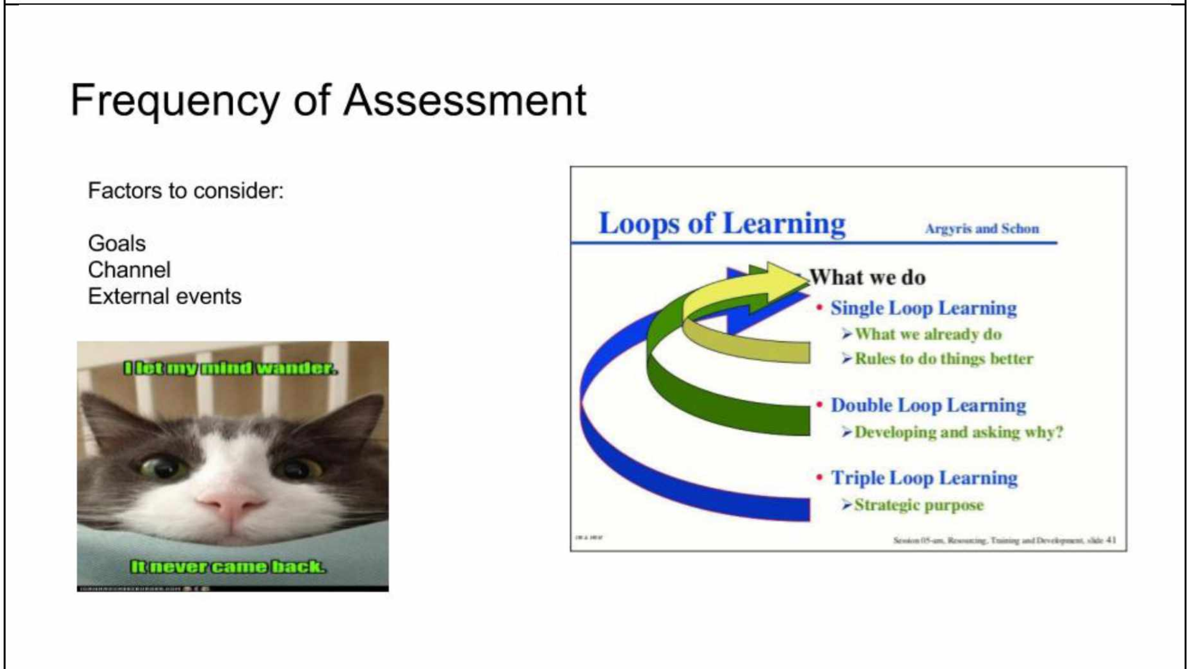
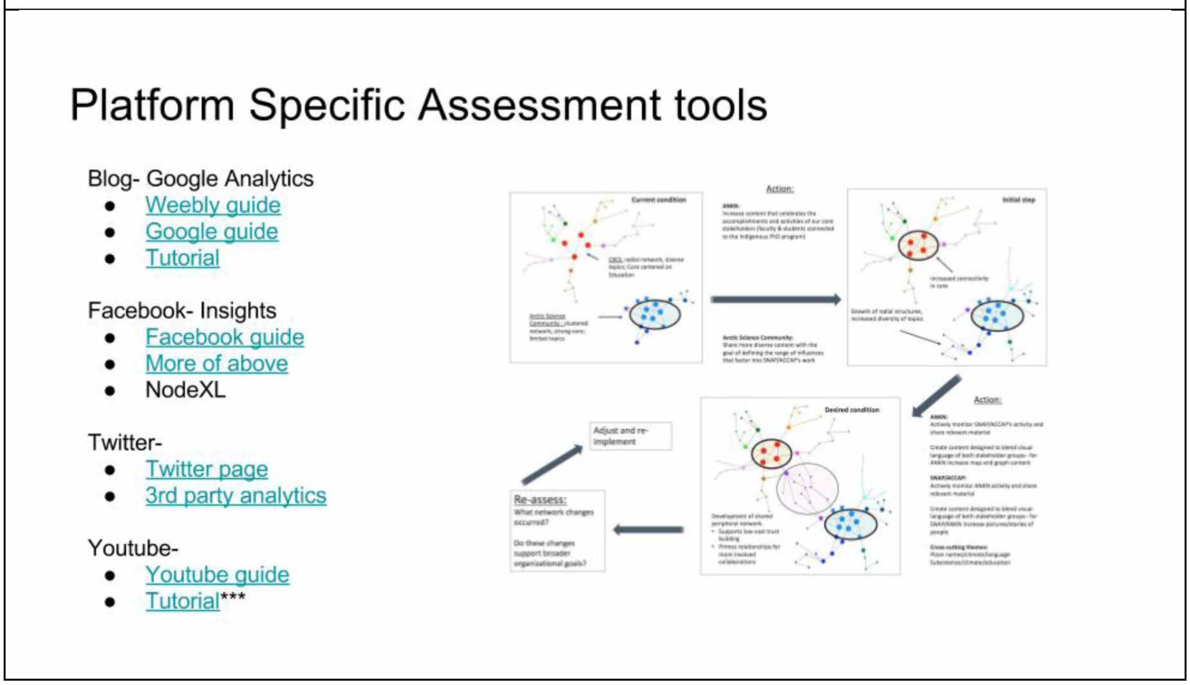


Table 18 continued

Assessing Strategy Learning Activity





My purpose in developing and presenting the communication strategy process template and associated learning activities has been to detail a method for organizations to foster greater connectivity amongst themselves and others working to address the numerous challenges that face humanity in the Anthropocene. The wealth of new communication channels that have opened up in the past twenty years have made space for people to connect in fundamentally new ways—across distances and in timeframes that were unheard of just a single generation ago. I personally see this as a good thing given the many new ways we have also interlinked our influence on local, regional, and global environments. It is important to realize however, that these same tools can reinforce closed networks and isolated clusters of thinking. This could be positive, say in the case of Indigenous language revitalization. Or, it could be negative, as in the case of ideological extremism in hate groups. The challenge for organizations is to find the balance point between internal connectivity to people and groups who agree with them and their worldview, and external connectivity to entities that do not share their worldview, but all the same have an impact on the environments they operate in. The final case study of my dissertation examines the ongoing implementation of a new communication plan for the Alaska Native Knowledge Network (ANKN), and it tells the story of how I have begun to negotiate these questions in my own role managing ANKN.

Alaska Native Knowledge Network Case Study

In late summer 2015 I was hired to direct the Alaska Native Knowledge Network and serve as faculty in the Center for Cross-Cultural Studies at the University of Alaska Fairbanks. This was a great opportunity for me as it combined two major influences in my life. The first is obvious and has to do with the major themes discussed throughout my dissertation. The second is less so. Prior to returning to school and pursuing first my MA, and now my PhD, my wife I founded Kigluait Educational Adventures and became deeply involved in many educational reform projects around the state (as a side note: the name "Kigluait" was taken from a 1940s or '50s-era USGS topographical map for the mountain range that runs east to west on the Seward Peninsula—where we were living at the time and the map I used to explore the region with, on more current maps these mountains are usually labeled "Kigluaik"). In this work we combined our passion for being outside and learning, with distance communication tools to promote place-based educational reform in Alaska, the Lower-48, and Australia. To do this we heavily focused on building a sense of virtual community between the different student and administrative stakeholders we interacted with; our goal was to create a learning community where people could learn from one another's unique environmental experiences. My current research is a direct result of questions that first come to me while working on these virtual learning community issues. The Alaska Native Knowledge Network, and more specifically its guides to culturally responsive schools, were key resources we used in designing our projects and guiding how and who we worked with in schools. So, the opportunity to combine my previous interests with the knowledge I have gained since coming back to the university, and so directly give back to an organization that guided me into the process in the first place is, and has been, a great honor.

It is from that personal context that I approached developing ANKN's new communication strategy when I was hired.

ANKN's Strategy

In describing ANKN's communication strategy I will be using the process template I introduced above. It is important to state that while ANKN's strategy fits well into this template, it is not an exact fit. The template, as presented, was designed reflexively while developing and implementing ANKN's strategy. In other words, the above template is a more refined iteration of the process I have actually gone through with ANKN.

Context

ANKN operates as a resource support service for the University of Alaska Fairbanks Center for Cross-Cultural Studies (shortened throughout its history as either CXCS or CCS). The specific mission and vision statements for each can be seen below (Table 19). Prior to my hire, both CXCS and ANKN had undergone rapid shifts in leadership, as well as a drastic contraction in funding and staffing. However, student interest and need remained(s) very high. Since my hire the department leadership has stabilized and one new faculty has been hired. However, from a communication perspective our systems are still adapting to this new contracted environment and to a certain extent contained on outdated technology. Facilitating that adaptation is one of the biggest challenges our communication plan needs to address.

Table 19: Alaska Native Knowledge Network mission and vision statements.

Entity	Mission	Vision
Center for Cross Cultural Studies	The mission of the center for cross-cultural studies is to draw and build upon the academic and research capabilities at UAF to offer an integrated course of advanced graduate study that addresses long-standing issues of concern to the state, the nation and the world. The program consists of an ma in cross-cultural studies and a PhD in indigenous studies, each with a common core curriculum that all students complete, coupled with six thematic areas of emphasis from which students choose a concentration: indigenous research; indigenous knowledge systems; indigenous education; indigenous languages; indigenous leadership; and indigenous sustainability.	Our purpose at the Center Cross Cultural Studies is the improvement of educational and professional development opportunities for rural Alaskans and to serve as a forum for the examination of cross-cultural and Indigenous education and community development issues. Our goal is to provide technical support and information to school districts, social service agencies, Native corporations, tribal governments, community colleges, state, and federal agencies in Alaska.

Table 19 continued		
Entity	**Mission**	**Vision**
Alaska Native Knowledge Network	The Alaska Native Knowledge Network (ANKN) is designed to serve as a resource for compiling and exchanging information related to Alaska Native knowledge systems and ways of knowing. It has been established to assist Native people, government agencies, educators and the general public in gaining access to the knowledge base that Alaska Natives have acquired through cumulative experience over millennia.	ANKN as multimedia and interdisciplinary resource center working to connect Alaska Native knowledge systems to agencies/institutions involved in indigenous education, health/wellness, natural resource mang. and governance issues. The center should involve teaching, research and communication elements.

Education is a core theme for a number of our students, many of whom are focused on topics of language retention and revitalization, teacher preparation, culturally responsive pedagogy and curriculum, as well as the need to address the education system's role in the historical trauma Indigenous peoples have endured and survived. A second group of our students is very interested in a range of topics dealing with community healing, wellbeing, and sovereignty. This group of students draws from a range of academic disciplines to meet their research goals, including tribal management, ecology, communication, physics, linguistics, sociology, anthropology, and fisheries. A shared passion and respect for Indigenous knowledge systems weaves all of our students' research interests together.

Perhaps our biggest success has been to develop a model, methodology, or pedagogy for increasing Indigenous voice in western educational contexts. This involves:

- The development of cognitive models that bridge multiple knowledge systems/worldviews
- Translation of models between specific stakeholders
- Identification and development of tools to help different stakeholder groups engage

Our students are now starting to expand the use of this model into all the social sectors involved in community healing, wellness, and sustainability. Facilitating network connections into these areas is a second need our communication plan must meet.

On a broader level, both ANKN and CXCS are charged—as an underlying core value of their founders—to promote and lead the effort at training more Indigenous PhDs to assume leadership roles in traditionally Western institutions. The ultimate goal being to "indigenize" these systems and take back the rights of self-determination that have been stripped from Indigenous people since colonization. Our belief is that we can accomplish this by supporting interdisciplinary research that builds community partnerships and addresses research problems driven by community need. Through these efforts we can facilitate cross-cultural communication and increase the role of Indigenous worldviews in academe-based knowledge production.

Audience

Identification of ANKN's audience (Figure 76) is based on groups and concepts identified in our mission statement. First and foremost ANKN is charged with serving the needs of CXCS students and faculty. A second level of stakeholders we are concerned with is defined by the needs of Alaska Native and Indigenous scholars working both in Alaska and internationally. The third level of stakeholders considered in ANKN's communication plan consists of community-oriented organizations and agencies working in fields relevant to Indigenous scholars and Indigenous wellbeing more broadly.

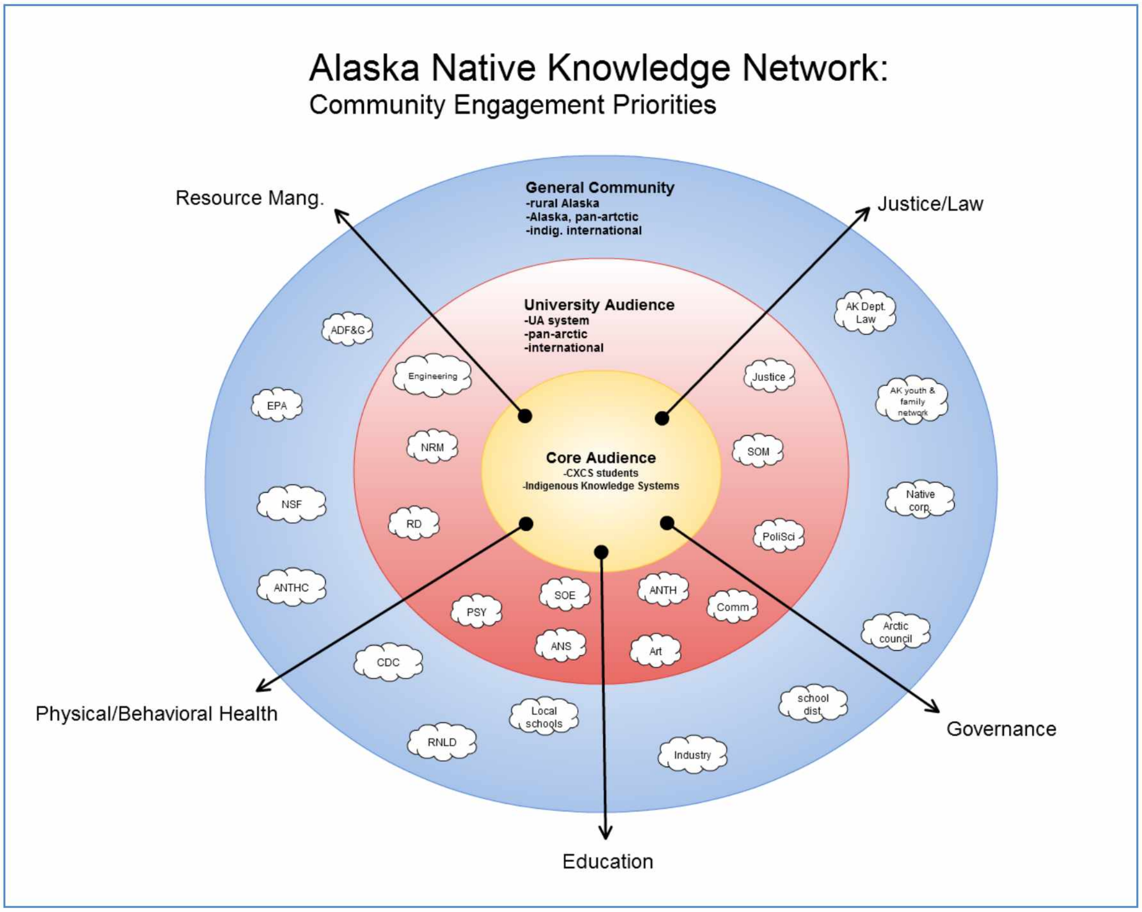


Figure 76: ANKN stakeholders. This visual representation of ANKN stakeholder priorities is aligned to CCS' Indigenous Studies PhD program emphasis areas. ANKN's goal is to facilitate network connections across each stakeholder level in order to both allow our students greater research opportunities in a more balanced partnership with communities.

Relevant Networks

The relevant networks that we are concerned with at ANKN were determined by developing a search ontology as described above in both the process template and learning activity sections. This specific ontology was based on combining the results from a series of searches designed to differentiate thematic areas of interest along differences of stakeholder engagement. Sets of nine different word strings were developed to represent the different thematic or content areas ANKN is interested in based on our current students research interests (Table 20). Additionally, four different strings were developed to represent the various stakeholder groups ANKN wishes to serve. A unique search was run for each thematic string tied to each stakeholder string, for a total of 36 searches. The results from these searches were cleaned using the rules described below and key sites were ethnographically explored based on the methods described in the digital ethnography learning activity. From that qualitative exploration, a set of nine additional search strings were developed and compiled with the results from the original 36 searches.

Table 20: ANKN search ontology.

Category	Terms
Wellness	Search 1 Wellness, "mental health", "cultural belonging", spirituality, "substance abuse", "language revitalization", language, culture, Wellness, "physical health", disease, nutrition, activity, injury, "climate change", subsistence, hunting, fishing, "berry picking", salmon, caribou, whale, seal, walrus, fire, permafrost. "traditional food"
	Search 2 Wellness, "mental health", "cultural belonging", spirituality, "substance abuse", "language revitalization", language, culture,
	Search 3 Wellness, "physical health", disease, nutrition, activity, injury, "climate change", subsistence, hunting, fishing, "berry picking", salmon, caribou, whale, seal, walrus, fire, permafrost. "traditional food"
Healing	Search 4 Healing, law, safety, regulation, "substance abuse", Subsistence, abuse, "subsistence regulation", housing, Healing, sovereignty, "source of regulation", regulation, resource, "resource allocation", "resource use", "cost of living", "recognition of traditional knowledge", "pan arctic collaboration", "tribal governance", "sustainable energy", "access to markets", demographics
	Search 5 Healing, law, safety, regulation, substance abuse, subsistence regulation, housing
	Search 6 Healing, sovereignty, source of regulation, resource allocation, resource use, cost of living, recognition of traditional knowledge, pan arctic collaboration, tribal governance, sustainable energy, access to markets, demographics

Table 20 Continued	
Category	**Terms**
Learning	Search 7 Learning, "formal education", pre-k, k-12, "higher education", vocational, "teacher preparation", language, teacher, school, education, "early education", curriculum, "boarding school" Learning, "informal education", "community experiences", "life experience", "family experience", "transmission of traditional knowledge", "traditional knowledge", knowledge, "cultural knowledge", culture, "cultural transmission", "cross generational communication", "elder youth", language, elders, youth, family, tradition
	Search 8 Learning, "formal education", pre-k, k-12, "higher education", vocational, "teacher preparation", language, teacher, school, education, "early education", curriculum, "boarding school"
	Search 9 Learning, "informal education", "community experiences", "life experience", "family experience", "transmission of traditional knowledge", "traditional knowledge", knowledge, "cultural knowledge", culture, "cultural transmission", "cross generational communication", "elder youth", language, elders, youth, family, tradition
Stakeholder Strings	For all trials labeled 'A'… Alaska Native For all trials labeled 'B'…. Alaska Indigenous For all trials labeled 'C'… Alaska For all trials labeled 'D'… Indigenous
Extra Searches	Alaska Native health Alaska health Alaska Native justice Alaska justice Alaska Native education Alaska education Alaska Arctic Change Alaska Subsistence Alaska native language revitalization

All search results were cleaned to focus in on specific organizations relevant to the search themes. The cleaning rules were applied as follows:

- News stories brought to "paper" that published it (i.e., http://www.adn.com/article/20140928/shift-traditional-foods-takes-toll-alaska-native-populations --> http://www.adn.com/
- .pdf were removed
- Google books removed
- All social media sites (YouTube, etc.) removed
- .ppt removed
- .docs removed
- Jstor articles removed
- Ericdigest articles removed
- Amazon results removed

- Onlinelibrary results removed
- Duplicate domains removed

Using the cleaned search results as seed sites, a hyperlink network was built (Figure 77). Hyperlink networks map the virtual exchange of resources between organizations through the sharing of online materials (L. E. Young and Leonardi, 2012). This kind of resource exchange has been shown to represent an ideological if not material link between organizations (Park and Thelwall, 2008), and here I use it to give me (as ANKN's director) an idea of the broad communication landscape ANKN was operating in (Figure 2) when I began developing our communication plan. Not surprisingly, ANKN sits firmly connected to education-related organizations, with only weak ties to other knowledge domains. Clearly, given the shifting priorities of our students, building stronger ties into these other domain areas has to be one of the priorities for ANKN's communication strategy.

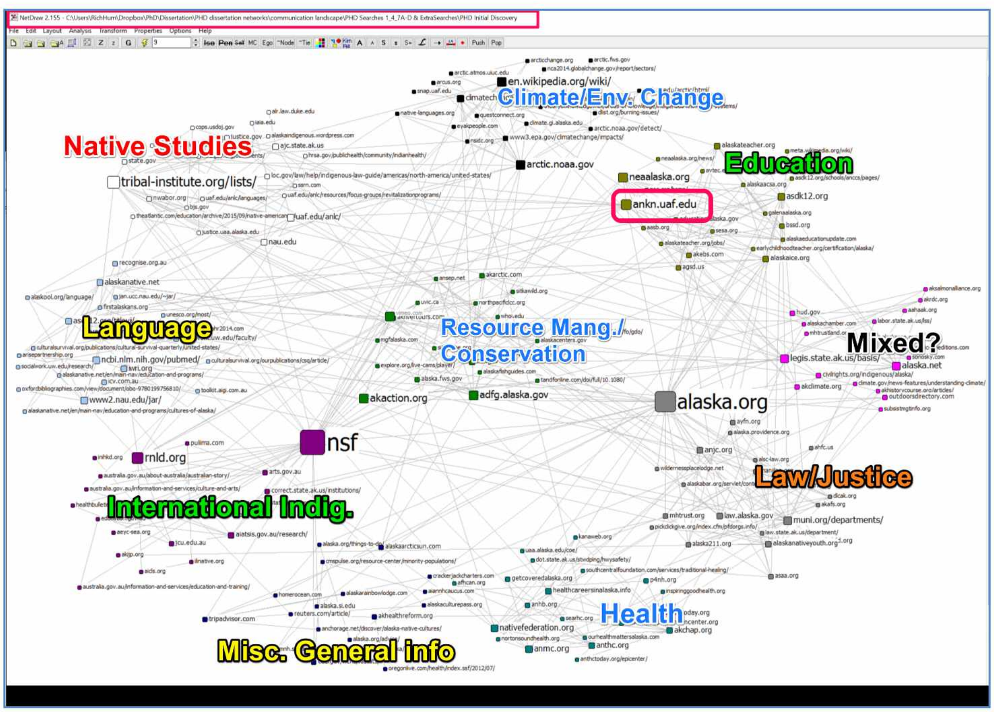


Figure 77: ANKN hyperlink network. ANKN's core audience.

Hyperlink networks are the representation of direct resource sharing between organizations and can be used as a proxy indicator of cognitive alignment. ANKN is clearly embedded in the Education region of the network but serves as a bridge to other disciplines. This is reflected in our student network.

Network Building

ANKN's strategy revolves around maintaining an idealized network illustrated below (Figure 78). At its core, our network is driven by the research needs and interest of the faculty and students working in the Center for Cross-Cultural Studies at the University of Alaska Fairbanks. These are our key stakeholders and so our idealized network must maintain tight connections between them.

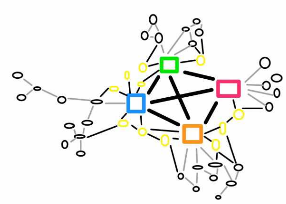


Figure 78: Idealized ANKN Network. Faculty are represented by the square nodes, students by yellow ovals, and the larger University and state community by the black ovals. ANKN's primary network strategy is to build and maintain a vibrant core network of students and faculty by taking advantage of expansion events in the periphery of the network (University and state-level communities) to increase the number of bridging relationships they maintain, while using contraction events to draw in new core members and strengthen existing bonded relationships.

Faculty are, theoretically, the most institutionally stable in our organization, followed by students (i.e., individual faculty—generally—remain in the network longer than students, followed by PhDs and then MAs). The peripheral, and typically most transient network members are the people and organizations our faculty and students encounter in performing their work—coming in and out based on the changing membership and interests of the core. At the same time, these peripheral members enliven and energize the core by extending our network into new directions as discussed throughout this dissertation.

A focus on letting our students' interests' drive the development of our peripheral network allows our overall network to remain flexible and responsive to the larger social-ecological systems that our students are embedded in prior to joining our program, which are—completing the circle—directly tied to the peripheral elements of our legacy networks. Ultimately then, the energy, purpose and success of our network rests in the diversity of the students that pass through it. This implies that the long-term maintenance of our network rests in the student recruitment process of CXCS. This may seem counter intuitive in some ways given that ANKN's direct mission is outward focused—acting as a resource hub for a broad range of ideological and physical communities beyond those found purely on the university. However, as primarily a degree granting university program, our ability to function and maintain relevance in this broader communication landscape is completely tied to first serving the needs or our students. It is then through them, and trying to meet their evolving needs, that ANKN can meet its more outward oriented goals, because of this, the sustainability and resilience of ANKN (as currently) configured is highly dependent on the interests and success of our graduate students. As faculty our initial ability to influence this system then comes into play during the recruitment process, and that is reflexively dependent on the evolution of our periphery network.

Therefore, the dynamic structure of the periphery is critical to the over all adaptability of the network. Our ability to capture new core members (i.e., students) from initially periphery contacts is key to how our network will remain responsive to broader community needs into the future. To do this, we need to take advantage of natural fluctuations in network structure that occur as a result of changing internal and external events. That is, we need to take advantage of the many different scaled release events that impact our core audience—faculty and students—through the course of their academic endeavors in CXCS. This includes looking for network reactions to things like changing faculty and student roles, experiences through coursework and research, attendance at workshops, conferences, participation in community events and celebrations, research events, etc.

The different media, or communication channels, through which the network is maintained, are important as well. ANKN, as a resource service under CXCS has unique channel needs and norms (Figures 79 and 80). In this case, ANKN's are driven by the at-distance nature of our student body and main stakeholder groups. This places an emphasis on building (and maintaining) a sense of community through virtual channels in order to support the limited face-to-face opportunities our faculty and students have together.

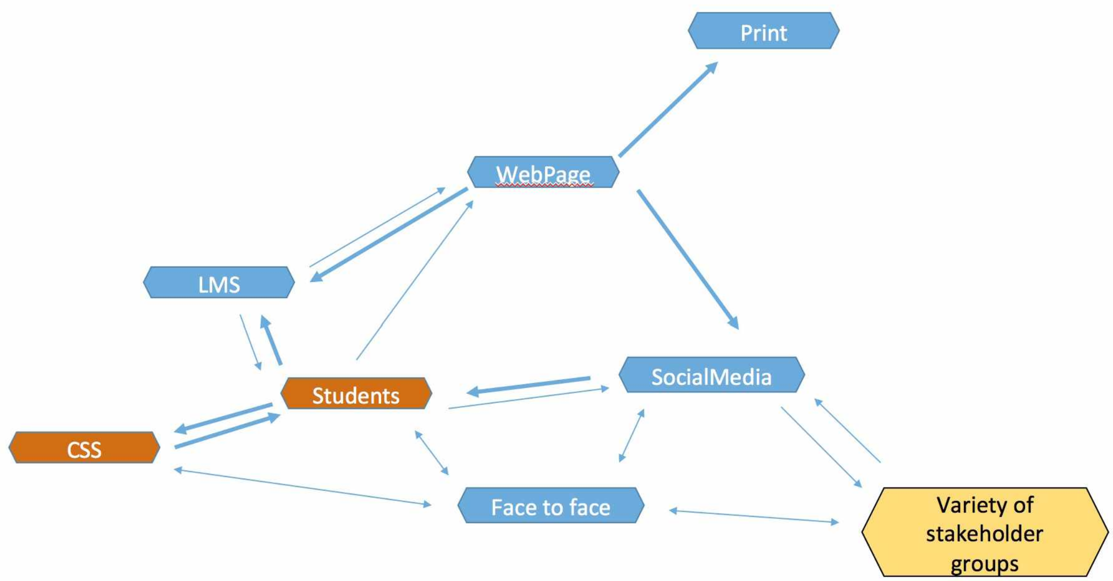


Figure 79: ANKN and CXCS ***communication channels.*** *Initially, a rough map of the relationships between identified stakeholders and the communication channels they interact with ANKN was created. The purpose of creating this map is to formalize the exploration process and to develop very broad understandings of ANKN's communication network.*

Our current plan is to build upon the strong place-based educational pedagogy that CXCS and ANKN have developed in the past for k-12 applications, and to apply it to our own faculty-student relationships. We are primarily an at-distance program, so in order to adapt a place-based model to the virtual arena, we have to focus on taking full advantage of new interactivity tools available through modern online learning management systems (LMS) in the development and delivery of our course content. Our core network then is grounded upon engagement through shared coursework and research experiences that are built through limited face-to-face interactions and regular contact through our LMS and more one-on-one distance tools such as Google Hangouts or Skype, and also e-mail and the phone.

We also want to maintain an active periphery; our strategy here is to foster connectivity between our core audience and our second and third level stakeholder groups via face-to-face events (conferences, workshops), interactions on social media, our more traditional webpages, and print-based publications.

In the overall process template, once the channel selection and purpose has been identified the amount of effort to place on each channel has to be determined. Again this is going to ultimately depend on individual organizational needs and assets. ANKN developed the model seen in Figure 80 to help weight how each channel was used by balancing the effort of communicating through that channel with the network impact it was likely to have.

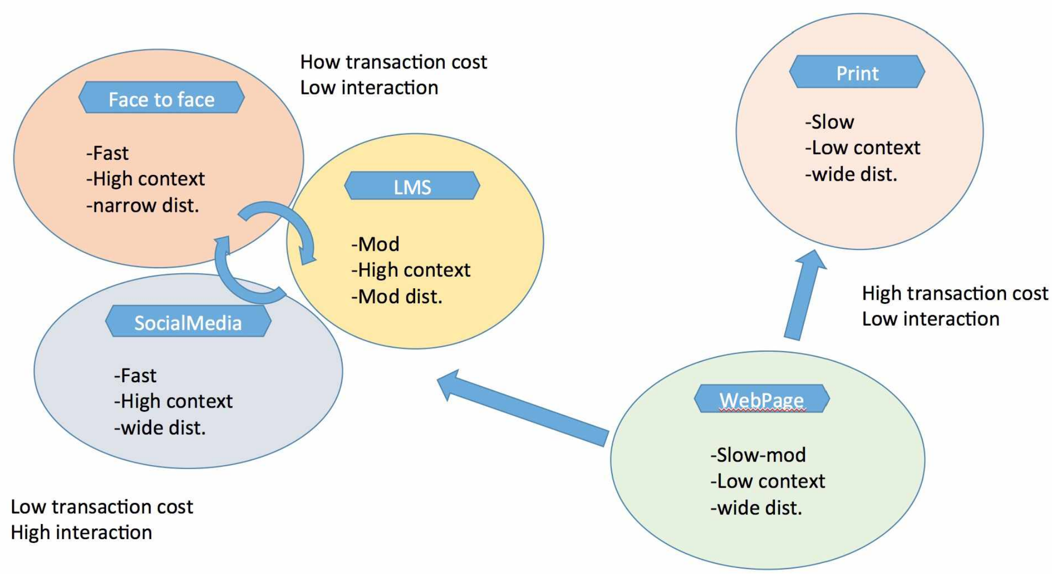


Figure 80: ANKN communication channel functions. As an initial step in understanding, and beginning to strategically shape, ANKN's communication efforts the inherent structural properties of each primary communication channel were explicitly mapped inconsideration of the communicative effort and expected results they require. Elements specifically consider are the rate at which the base-communication unit is completed, the size of the network reached, and the level of shared context required to fully participate. These properties are discussed in more detail in the learning activity on communication theory (see Table 12).

Using this model we developed a plan for each channel that identified its current role in our communication efforts, changes we wanted to test, and how those changes relate to our broader organizational mission (Table 21).

Table 21: ANKN communication architecture. Defining ANKN's IT architecture requires aligning channel and platform use to the organizational role it is intended to fill. The combination of ingrained structural channel and platform properties, combined with unique content choices and patterns-of-use, results in a unique and dynamic IT architecture for every organization. Shaping how the architecture changes over time is an important outcome of implementing the processes template I have developed in this dissertation.

IT	Current Service	Re-Focus	Tied to Missions	Role
Webpage	Info, archive	Info	Disseminate	Identify, recruiting, tool, outreach
LMS	Archive, teaching	Archive, teaching, production	Research, education, archive, process/ procedure	Gathering, identity, in-reach
Facebook (social media in general)	Info	Info, curation	Research, collect, disseminate	Identity, gathering, recruiting, in and out-reach
Print	Info	info	Disseminate	Out-reach
DVD/ CD	Info	info	Disseminate	Out-reach

Message

Tied to ANKN's mission statement, our storytelling needs to convey the diverse experience of Alaska Native communities. It needs to tell of current conditions and the proper history for how they have come to be. And, it needs to originate from, and speak directly to these same communities. However, in some tension, it also needs to be relevant to a broader audience with the intent of fostering outside allies to help support locally derived solutions to locally identified problems.

To do this we have identified three key topical themes to tie together all our storytelling—education, wellness, and healing. As a content guide, one of these themes must be touched upon in all of our messaging, combined with one of our seven PhD emphasis areas, including Indigenous knowledge systems, leadership, and sustainability. Our stakeholders all have different communication mode preferences, but our primary stakeholders have a strong inclination toward place-based, or full modal, learning environments. Since communication is learning (i.e., based on internal transformation), this means we have to try to stimulate as many different sensory modes as possible in our messaging. We try to do that by focusing on providing a lot of interaction in our media—using as many different platforms as we can that emphasize interpersonal communication styles. Paired with video, and supported by infrequent face-to-face events, we try to always include simple back and forth communication options to all the messages we initiate. This includes taking advantage of the range of social media platforms that inherently provide social tools, but also embedding tool like Google Forms into our webpage to encourage interaction even in a typically more broadcast form of media like a traditional webpage.

Goal Setting: Production and Outcome

Purpose and Goal

While our message defines the content that we focus our communication around, the structural design of ANKN's communication plan is largely outlined in how we have laid out our initial communication goals (Table 22) and objectives (Table 23). In both cases we have organized our plans around the three main communication environments we operate in—internal and external communication, and instructional delivery. For our goals, we then defined our current channel preferences and our future ideal. In our outcomes, we set specific objectives and actions that (we believe) will take us to our future ideal. Then in the assessment process we will check that belief summatively to see if we did what we said we would do, and formatively to guide the next round of actions.

The three communication environments we identified were selected specifically to meet our unique organizational communication needs. Every organization will need to define their own relevant communication environments but I will discuss ours in sufficient detail to give a sense of the types of conversations and questions an organization will need to address in defining their own needs.

Table 22: ANKN and CXCS communication goals. Initially, established IT infrastructure (platform and channel preferences) was examined and future goals were determined.

Communication Type	Current Situation	Future Ideal
Internal communication	Email, phone, face-to-face	Email, phone, face-to-face, Google Hangout, shared calendar, shared planning documents
External communication	Webpage, email, phone, face-to-face, print	webpage, e-mail, phone, face-to-face, Facebook, Twitter, YouTube, Instagram, UAF list-serves, limited publishing
Instructional delivery	Synchronous Mixed audio and in-person (lecture/discussion) Asynchronous LMS (Moodle and purely to store readings)	Synchronous Video, webcast, audio, in-person (discussion, activity, collaboration) Asynchronous LMS (assignments, activities, collaborations) Course Webpage (class resources, video/audio lectures)

Table 23: ANKN and CXCS outcomes. Once future goals were determined, specific actions needed to reach them are identified and aligned to the end objective.

Communicate Type	Objective	Actions
Internal communication	-Raise comfort level with Google Hangout across faculty and students -Increase use of shared Calendar and Doc	-Google how-to screencasts -Set up departmental calendars and shared folders -Train the trainers
External communication	-Convert bulk of webpage to Roxen -Set up list-serves -Engage social media	-OIT or Manual conversion -Start list-serves and transfer LetterRip files -Reactive Facebook page, create Twitter account, create YouTube account, link to webpage
Instructional delivery	-Convert Fall '16 courses to Blackboard -Backup Moodle onto new server -Start eLearning departmental page	-Manual conversion -Load Moodle instance -Contact eLearning

Our internal communication is structurally defined by the boundaries of interactions between our core stakeholders—faculty, staff, and students (of both ANKN and CXCS). This is the core of our network as defined through a working interpretation of our mission statement. Individuals in this group will also be active in both the other environments. Functionally though, this core group has to accomplish a high level of coordinated tasks and needs channels of communication that offer both a strong degree of interpersonal interaction and selective exclusivity. Our future ideal builds on the channels that have worked for us in the past, but also adds new ones to try and improve the ease with which we coordinate with one another.

Our external communication can structurally defined by the weak-tie interactions that our core members have with individuals, communities, and organizations in the course of their daily lives and related to ANKN and CXCS topics. Unlike in our internal communication, high levels of coordinated action are not functionally as important in our external communication. In this environment more general (and diverse) information gathering type connections are a higher priority. Our channel needs shift to a more broadcast form of communication because of this, with an increased need for inclusivity rather than exclusivity. Both ANKN and CXCS were early adopters of web-based technology and already had an established traditional webpage and Facebook page, each needed invigorating however. Additionally, ANKN developed an extensive print publication service in the late '90s and early 2000s. Since that time funding has contracted and the original publication model is no longer sustainable. As a result, multiple new social media tools are proposed in this plan to try and fill the gap left by not being able to reliable maintain physical inventory into the future.

While many organizations may find it worthwhile to conceptually model their communication strategy around practices tied to internal and external communication environments, our approach to include instructional delivery as a distinct communication environment is unique to our educational mission and the identification of our students as key to the sustainability of our network into the future. Once again both ANKN and CXCS were early adopters of on-line learning technology. Specifically, they had modeled their course design on a mixed real-time audio and web-based learning management system (LMS) beginning in the early 2000s. This model was ahead of its time and is still relevant today. The specific platforms that have been used however, have become outdated. As a result, our communication strategy here namely calls for updating the platforms to more current versions and introducing some new tools to increase interactivity and sense of community.

Assessment

At the point where I stopped collecting data for this dissertation very little assessment had been conducted for any actions outlined in our communication plan. At that time, assessment had only been conducted to gain an understanding of our network as it looked prior to implementing any changes. The results of which have been used to inform the previous sections of our communication plan. In this final section of the process template then, I will only be presenting a very early update (Table 24) on some of the actions described in table 23 above. I will describe in more detail however, our assessment plans and how we will use them to guide our future strategy.

Table 24: ANKN and CXCS assessment. Early actions revolve around updating and modernizing IT infrastructure before content-based decisions are deeply assessed.

	Objective	Actions	Early Assessment
Internal communication	-Raise comfort level with Google Hangout across faculty and students -Increase use of shared Calendar and Doc	-Google how-to screencasts -Set up departmental calendars and shared folders	-Partially complete, faculty and staff attended Google course led by e-learning -Calendar and folders setup, low adoption so far.
External communication	-Convert bulk of webpage to Roxen -set up list-serves -engage social media	-OIT or Manual conversion -Start list-serves and transfer letterRip files -re-activated Facebook page, create Twitter account, create YouTube account, link to webpage	-Structure complete, some content converted…both pages still running. -Incomplete… do have shared Google "group" mailing list for active grad students -All social media up and running
Instructional delivery	-Convert Fall '16 courses to Blackboard -Backup Moodle onto new server -Start eLearning departmental page	-manual conversion -load Moodle instance -contact eLearning	-All courses off Moodle -Historical Moodle courses not backed up or accessible -eLearning contacted but nothing has come of it yet

Much of the initial actions outlined in table 23 lend themselves to simple check-off style assessments—this is done, this isn't done. Early assessments of this type (Table 24) show that while many of the actions have been implemented a few key areas are incomplete (conversion of the webpage, collaborative document use). Additionally, where implementation is complete, it is only recently so. The net result is that while a summative assessment of what has been completed or not can be made at this point (and areas to finish identified from it), it is too early for more formative assessments to tell us much with regards to whether or not our actions are moving us towards our objectives, and if those objectives are meeting the needs of our mission. With that in mind the following descriptions review the types of assessments we will be conducting in the future and how we will use information gained from them to guide our future actions.

A key working assumption in our communication plan is that a healthy dynamic between our graduate students, the communities they work in, and our department faculty and staff is critical to the overall sustainability of our network. This implies that management of our internal communication environment should be a high priority in our assessment plan. The key changes we are trying to implement here revolve around increasing collaboration options among core members and the tool we've introduced to help with this is the suite of Google Apps. Monitoring the frequency our faculty, staff, and students use these tools will be important. Additionally, assessing the network arrangements of who is working with whom, and on what general themes or projects, will help us refine these efforts and focus our limited resources on the areas of greatest need to our students.

The main change we are attempting to implement in our external networks is an increase in our social media presence. Early assessment shows that we've implemented this change and are starting to see some results. Our Facebook network has become much more active (Figure 81) and both our YouTube and Twitter accounts are up and running. Assessment of how these networks grow and evolve will follow a similar style and structure as the methods used in the case studies I have presented in this work. Information learned from the networks with regards to what topics or themes resonate with what stakeholder groups will be used in conjunction with the internal communication networks to ensure that they are both aligned and serving the needs of our students. We will then use the working theory on the expansion and contraction cycles of communication networks that I presented above to seek opportunities to grow the network where needed, as well as shrink it where required. That process will likely be unpredictable and we need to be prepared for as many failures as successes.

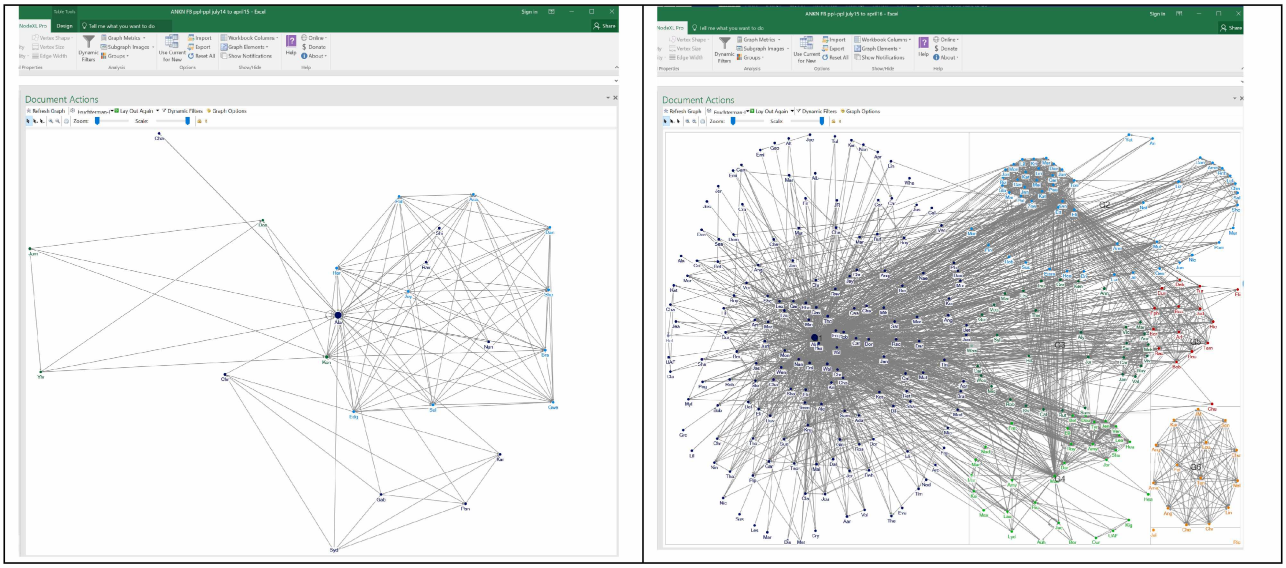


Figure 81: ANKN Facebook network. The network map on the left represents ANKN's Facebook activity prior to implementing the strategic communication process I outline in this dissertation. The graph on left illustrates initial Facebook activity after implementation. After implementation there is an increase in both activity and subgroup formation. Information gained from examining both the resulting network structure, as well as the content that spurred it will be directly incorporated into future communication decisions and strategy modifications.

We don't expect large functional impacts to the composition of our network as a result to changes in our instructional delivery. The changes we've implemented were largely technical and made simple to lessen the behind-the-scenes maintenance costs that our previous LMS required. In terms of changes to the network as a result, no change is a positive outcome in this case. Negative indicators that might warrant further consideration or adjustments in how we are implementing these changes would include otherwise un-explainable decreases in class enrollment numbers or a decrease in student satisfaction on the end-of-semester evaluations.

We are clearly just beginning to implement this communication strategy and our full assessment process is still evolving. In this first phase of implementation we are working on the principle that reinvigorating relationships between our current and future graduate students will both strengthen our core network and support growth in our peripheral networks. In other words, this strategy is based on a belief that focusing on our students will increase our organizational resilience, and through the values exposed in our mission statement, improve the overall adaptability of the social-ecological systems that ANKN and CXCS try to influence. As a result, our assessments in the single-loop learning phase of this strategy need to test the relationship between our efforts to recruit and retain successful students to their overall impact on network resilience through measures described throughout the case studies in this work.

After one-and-a-half years' pause in accepting graduate students due to faculty capacity issues, in the fall of 2017 we will once again be accepting new students into our program. Simultaneous to this we will be initiating a series of student gatherings, writing workshops, retreats, and brown bag lunch seminars designed to provide group-orientated opportunities for real-time interaction at roughly monthly intervals (i.e. similar to the frequency of BSMN teleconference). Additionally tied to these events a non-credit online course is being designed to guide students through the graduate experience and provide students a portal to get connected with one another outside the formal events faculty and staff facilitate. Understanding how these activities impact both our internal, core networks and our external, peripheral networks over the course of the next year or two will be the focus of our assessment efforts. Initially these assessments need to be used formatively to continuously shape how we implement the above plans. However, after the initial year or two time period is expired, the compiled assessments over that time period will need to be re-evaluated summatively to complete the second-loop of learning and address whether or not the core principle of the strategy—focusing on students—is valid, and should continue to be a focus into the future, or is invalid and needs to be re-addressed.

Conclusion

In this dissertation I have tried to accomplish three main objectives. The first is to explore and document how communication patterns are changing in the Anthropocene, and specifically how they are impacting the way Alaskan communities interact with one another around issues of environmental change. The second is to survey multiple academic disciplines and traditions in hopes of using parts from each to develop a multidisciplinary framework capable of fostering improved communication in this context. The third, and personally most meaningful, is to combine information gained from the efforts working on the first two objectives into actionable knowledge that organizations can directly apply to their own communication practices. To a large extent I feel I have been successful in meeting these goals, but the linear nature of this list (and how it is slightly re-ordered in the meta-structure of my dissertation) in no way reflects the reflexive process that I have gone through in achieving them. That process in fact, has looked much more like the expanding and contracting relational networks I've been researching than the text-based, linear methodology of Western scientific or academic traditions. As I am finishing this work, it occurs to me that the struggles I've had to conform the reflexive nature of my lived-experience conducting this research into the very linear presentation models acceptable to established academia is emblematic of the challenges I see the dominant Western worldview needing to overcome to successfully confront the complex challenges we've created for humanity in the Anthropocene.

The natural environment has played a central role in my life from an early age, and does to this day. Because of this, the changes in earth systems implied by the term Anthropocene have had real consequences on my life. This history has produced a distinct bias in my worldview that cannot help but be expressed in this work. I've directly experienced many of the physical changes that define the Anthropocene, and I don't perceive them as positive or beneficial to my wellbeing. If anything, I see them as primarily detrimental to both me, and society as a whole. This clearly gives my work the bias of seeing changes in Anthropocene as "problems," rather than "opportunities." And while I am personally more comfortable "playing" in the non-social side of social-environmental systems, overtime it has become apparent to me that our current social institutions are not keeping up with the needs of our rapidly shifting environments sufficiently to sustain the kind of world I would like my grandchildren to inherit. Therefore I also enter into this work with a bias toward changing the current trajectory of social institutions, and not simply to understand them in the purist illusions of objective research. This is another serious, though I would not say negative, bias in my work. Taken together these two influences shape my understanding of the Anthropocene, my approach to researching related phenomena, and my hopes for how my results will be used.

Resilience scholarship was a natural place for me to begin my academic studies, with its systems approach taken chiefly from the natural, rather than social sciences (Holling, 1973). It's from this field that much of my ideas on the adaptive cycle, panarchy, and robustness are derived. The field relies heavily on network-style models and conceptual frameworks to understand social-ecological systems. In Communication, two main sub-disciplines fit nicely into my understanding of resilience models and the role communication plays in social-ecological systems. The first is Marshall McLuhan's media-ecology (McLuhan, 1964), which takes a holistic and sensory approach to how information is conveyed through a spectrum of communicative mediums—each with distinct effects on an individual's (and collectively, society's) worldview. The second is a combination of thoughts on multi-level communication networks (Monge & Contractor, 2003) combined with the philosophical musings of Latour and actor network theory (Latour, 2005). Together these literature strands, when applied to the conceptual frameworks of resilience point to both the importance of communication in social-ecological systems and the role of cross-scale interactions in shaping their evolution.

Two common dominators that can be identified across these literature threads are 1) a network perspective on trying to understand how systems are evolving and 2) awareness that cross-scale interactions are critical to overall system functioning. This understanding drove the initial development of the methods I applied to the case studies presented here. As observations began to accumulate from working on them (and many others over the course of my studies, see Appendix A), the idealized network-based model of the adaptive-cycle emerged. The reflexive nature of this process can't be highlighted enough because it is the fundamental principal that the application portion of this work uses to build adaptive capacity into organizational communication strategies—that is the idea of formalizing learning from experience by incorporating a network-based assessment process as opposed to using reductionist models of knowledge assessment.

The development of an idealized adaptive cycle tied to network properties was an important step in my research because it provides a framework for network-based assessment. The nature of communication networks is that they are highly context based. I know from my experiences in learning how to build networks that changing slight rules in how the network is made (effectively changing the network boundaries, or the context that binds the network) creates large differences in the resulting network properties. Every network then needs to be assessed on its own terms and cross network comparisons become very difficult. While some measures remain impossible to directly compare across different networks (raw density as an example) the network linked adaptive cycle model allows a framework for benchmarking networks to broader system elements (e.g., trigger events), which allows for easier comparison of network evolution patterns across systems, and identification of potential future trigger points designed around intentional system change. To that end, a key finding in this research has been a consistently observed pulsing of communication networks. Taking advantage of aspects of this cycle is a major challenge for all organizations, however in ANKN's communication strategy we see where the higher pass-through rate of students in the network serves to trigger regular expansions in the network while the (typically) slower turnover of faculty acts to facilitate contraction.

Pulsing was observed in nearly all networks regardless of scale. Pulses during release phase events generally take the form of rapidly expanded periphery network connections, with "weak-tie" connections into the network core (defined by density distributions). These expansions are typically triggered by some initial event either directly intended by members of the core network (e.g. the BSMN teleconferences and ASSW face-to-face conference) or external to their planning (the Bering Sea storm or flood in Galena). Either way, release-based expansion events open the core to new information and (often) material resources by increasing the number of people they are connected to. In the case studies we see the length of the expansion events can vary depending on the nature of the triggering event, but eventually contraction closes off the flow of new resources through a densification of the network and dramatic decrease in the number of bridging ties. In contraction however, core members have the opportunity to build tighter connections with one another and potentially use the resources they do have more efficiently. The identification of this pulsing pattern (benchmarked to specific network structures) introduces a number of possibilities for individuals or organizations interested in strategically intervening in specific communication environment to take advantage of network mapping tools as a strategic aid, but it also raises a number of ethical or value-based decisions that need to be considered in designing and managing a communication strategy. Chiefly among them is the question of how network structure impacts the worldview of individuals embedded in it.

I entered this research believing that open networks were the solution to the challenges of the Anthropocene as I saw them. Therefore to take best advantage of the network pulsing patterns I was observing, organizations should work to promote expansion, to increase the number of bridging ties they maintained. I felt our ability as a species to influence natural systems through local actions (that have global impacts) had expanded to the point where closed networks, dominated by bonding-type connections, could no longer address the multi-level social interactions that are needed to manage the cross-scale environmental dynamics of the Anthropocene. Additionally, I believed that new and/or social media tools were the critical communication evolutions that would allow us to more effectively open our networks and bridge scale and level gaps needed to sustainably manage critical social-ecological systems by letting us easily communicate (through multi-modal channels) across the limited physical bounds of our local communities. I believed this extension of bridging networks would be wholly positive. Then I had the opportunity to co-teach a seminar on Indigenous education and language revitalization in the Fall of 2016, while the 2016 US presidential election was in full production and the term “fake news” was entering diner table conversation around the world.

The impact of “fake news” on the national election of course, as every professional news agency has been explaining since they became aware of the “problem,” is largely empowered by the amplifying effects of very large, essentially closed, social media networks. What the election showed me was that despite the fact that I saw a range of diversity entering my regional (and local) social media networks; people were clustering in very distinct, closed groups at scales outside the scope my case studies. The very tool I felt (still feel) can help open networks was in point of fact serving the opposite function at scales larger than I was observing in my case studies.

A key reason for this is based on the business models of the corporations that actually own the communicative spaces we've come to consider as the public sphere (i.e. Facebook, Twitter, etc.). These corporations survive by us—both the consumer and producer of content on their service—consistently logging on and engaging in material on their webpage. By doing that we expose ourselves to the advertising they sell and inject into both the content flow and visual design of their service (i.e. Facebook ads and sponsored content). The more we engage with the site the more ad revenue they can generate. As a general strategy to improve platform engagement, social media sites try to present us with material they think we will enjoy, so we will want to return to time and time again, and thus be exposed to more ads. In trying to do this they assume we will like the same kind of content our closest friends do (which we usually do). They use network theory to determine our most closely bonded friend group, and then serve to us (on our individual feed) content those friends have already engaged with. The net result of this corporate strategy is to structurally facilitate the formation of subgroups across their platform by reinforcing established connections and making it more difficult to form new links outside your current subgroup. This in turn makes it difficult for novel information to enter into your social media feed for all the reasons I have discussed throughout this dissertation. While this structural handicap to open networks can be overcome by using the communication strategies I've proposed in this work, they are not easily overcome without conscious effort—something many (most) people do not expend in managing their social media accounts. Ultimately this creates serious, as of yet unanswered questions for me about the role new and social media will play in the Anthropocene.

While the US presidential elections raised questions for me about the ability of social and new media to effectively bridge across national scale issues, it strongly reconfirmed my thoughts on the value (and ultimate outcome) of open vs. closed networks. However, the language revitalization course showed me that closed networks might not always be negative. Depending on the legacy of the system, closed networks may indeed be a needed healing element in many social contexts. Around the issue of Indigenous language revitalization, it is the outside influence of Western worldviews that have destroyed so much of the Indigenous way of life, and the direct outside influence of Western education systems that have overtly attempted to destroy Indigenous languages and cultures. Sheltering language revitalization efforts from the continued (though now largely systemic rather than overt policy) of these influences may be a critical factor in giving the space for new language networks to form. In which case, for some period of time at least, closed networks maybe absolutely necessary. Many Indigenous language Facebook pages are currently active and effective at very small scales and certainly closed (simply based on the language barrier to engage in them, if for no other reason), however it is uncertain if these networks are playing a critical role in more specific face-to-face language revitalization efforts.

Through these experiences, I saw how closed networks (on both sides) resulted in a white populist/nationalist movement sweeping into the Whitehouse on the heels of the country twice electing its first African American president. In another, I saw a rapidly opened network (colonization) lead to the near extinction of all Indigenous languages in Alaska, which is likely now benefiting from sheltered (if not, completely closed) networks. Based on my values, these outcomes couldn't be more different, but it's important to note they both show similar network structures and dynamics. Throughout this dissertation I have explained through theory and example the role social networks play in social-ecological systems. Perhaps most importantly, I've identified a range of communication network structures that can result from change. I've benchmarked those structures to key phases in a system's evolution, and I have developed both a process template and complete series of learning activities to support organizations in implementing my network assessment system. Ultimately however, it is the worldview of individuals within a network that shape the outcomes the network is capable of producing. It's my hope that the tools I have developed in this work will be helpful for organizations working to shape networks that connect individuals and organizations working to promote sustainable social-ecological systems in the Anthropocene and limit the influence of those who see no reason for alarm.

However, reshaping network structures to limit the influence of some and strengthen that of others is a double edge sword and success is often in the eye of the beholder, as the US presidential elections and language revitalization experiences showed me. Therefore I will close with just a final thought. Often the day to day routine of when, where, and who we communicate with can seem rather trivial, second nature, and just something we do without thinking much about it (unless it is a unique or special event), however, the accumulation of these actions largely shapes how we see and understand the world—how we develop our individual and unique worldview. As individuals we are embedded in these day-to-day communication networks, and they in turn are under the influence of many other networks. All across that system there are elements trying to influence your worldview by shaping (and reshaping) your available communication paths (including me in producing this research and publishing it for others to read). Given all those competing interests, good and bad, the most important thing I have learned from this work is that it is not the structure of your network that matters most, but rather the most important thing is to be aware of where you fit into it.

References

2016 Arctic Science Summit Week. (2016). *2016 Arctic science summit & arctic observing summit program* [Program Guide]. Fairbanks, AK. Retrieved from http://assw2016.org/img/20160309_ASSWprogram_web.pdf

2016 Arctic Science Summit Week. (2016). Retrieved March 11, 2017, from http://assw2016.org/

Adams, D. H., Wilson, S., Heavy Head, R., & Gordon, E. W. (2015). *Ceremony at a Boundary Fire: A Story of Indigenist Knowledge.* Longmont, CO; Sydney Australia: Sydney eScholarship Repository. Retrieved from https://ses.library.usyd.edu.au/handle/2123/13689

Alaska Center for Conservation Science, & UAA. (2016a). *Vegetation map for Northern, Western, and Interior Alaska*. Alaska Center for Conservation Science. Retrieved February 21, 2017, from http://accs.uaa.alaska.edu/vegetation-ecology/vegetation-map-northern-western-and-interior-alaska/

Alaska Center for Conservation Science, & UAA. (2016b). *Vegetation map for Southern Alaska and the Aleutian Islands*. Alaska Center for Conservation Science. Retrieved February 21, 2017, from http://accs.uaa.alaska.edu/vegetation-ecology/vegetation-map-southern-alaska-and-the-aleutian-islands/

Alaska Climate Research Center. (n.d.). *Alaska Climate Research Center*. Retrieved February 21, 2017, from http://climate.gi.alaska.edu/stations/juneau

Alaska Department of Fish and Game (2015). *Alaska wildlife action plan*. Retrieved from http://www.adfg.alaska.gov/index.cfm?adfg=species.wap2015revision

Alaska Department of Fish and Game. (2006). *Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources*. Juneau, AK p. 824-824

Alaska Department of Fish and Game. (2017). *Mammals found in Alaska*. Alaska Department of Fish and Game. Retrieved February 21, 2017, from http://www.adfg.alaska.gov/index.cfm?adfg=animals.listmammals

Alaska Division, S. A. (2013). *Alaska's EDS director recognized nationally for Galena work (31 May 2014)e*. Retrieved March 2, 2015, from http://www.salvationarmyalaska.org/alaska/news/VOAD_Recognition

Alaska Forest Association. (2015). *Alaska forest facts*. Retrieved February 21, 2017, from http://www.akforest.org/facts.htm

Alaska prepares for more spring breakup flooding. (2013). *Red Cross*. Retrieved March 7, 2017, from http://www.redcross.org/news/article/Alaska-Prepares-for-More-Spring-Breakup-Flooding

Alaskaweb. (2017). *The interior region of Alaska*. Retrieved February 22, 2017, from https://alaskaweb.org/region-interior.html

Alexander, S. M., Armitage, D., & Charles, A. (2015). Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries. *Global Environmental Change*, *35*, 213–225. https://doi.org/10.1016/j.gloenvcha.2015.09.001

Alfeed Brooks, B. H. (1906). Report on progress of investigations of mineral resources of Alaska in 1906. Administrative Report. *U.S. Geologic Survey*, *284*.

Anderies, J. M., Folke, C., Walker, B., & Ostrom, E. (2013). Aligning key concepts for global change policy: Robustness, resilience, and sustainability. *Ecology & Society*, *18*(2).

Anderies, J. M., Janssen, M. A., & Ostrom, E. (2004). A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society*, *9*(1), 18.

Anders, G. C. (1987). Incompatible goals in unconventional organizations: The politics of Alaska native corporation. *Developing America's Northern Frontier* (pp. 133–157). University Press of America.

Andrews, L. (2013a, December 31). 2013: A year of Alaska weather extremes, from Barrow to Juneau, *Alaska Dispatch News*. Retrieved from http://www.adn.com/article/20131231/2013-year-alaska-weather-extremes-barrow-juneau

Andrews, L. (2013b, September 20). Hard lessons for FEMA: Galena rebuilds with federal help, in spite of federal help, *Alaska Dispatch News*. Retrieved from http://www.adn.com/article/20130920/hard-lessons-fema-galena-rebuilds-federal-help-spite-federal-help

Andrews, L., & DeMarban, A. (2013, May 28). Rescue aircraft evacuating more Galena residents as flooding worsens, *Alaska Dispatch News*. Retrieved from http://www.adn.com/article/20130528/rescue-aircraft-evacuating-more-galena-residents-flooding-worsens

Andrews, L., & DeMarban, A. (2013, May 28). Rescue aircraft evacuating more Galena residents as flooding worsens. *Alaska Daily News*. Retrieved from https://www.adn.com/alaska-news/article/galena-evacuates-yukon-river-floods-interior-town/2013/05/29/

Arctic Science Summit Week (ASSW) 2016. (2016). Retrieved March 11, 2017, from https://www.arcus.org/events/arctic-calendar/21029

Argyris, C. (2002). Double-loop learning, teaching, and research. *Academy of Management Learning & Education*, *1*(2), 206–218. https://doi.org/10.5465/AMLE.2002.8509400

Argyris, C., & Argyris, C. (2015). Double-loop learning. In *Wiley Encyclopedia of Management* (pp. 1–2). Chichester, UK: John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118785317.weom110140

Arnfalk, P., & Kogg, B. (2003). Service transformation—managing a shift from business travel to virtual meetings. *Journal of Cleaner Production*, *11*(8), 859–872. https://doi.org/10.1016/S0959-6526(02)00158-0

Associated Press. (2011). Hurricane-force storm bears down on Alaskan coast. *CBS News*. Retrieved from http://www.cbsnews.com/8301-201_162-57320809/hurricane-force-storm-bears-down-on-alaskan-coast/

ASTE. (2017). *ASTE - Where technology and education converge*. Retrieved February 22, 2017, from https://www.aste.org/

Autin, W. J., & Holbrook, J. M. (2012). Is the Anthropocene an issue of stratigraphy or pop culture? The Anthropocene debate. *GSA Today*. https://doi.org/10.1130/G153GW.1

Aykin, T. (1994). Lagrangian relaxation based approaches to capacitated hub-and-spoke network design problem. *European Journal of Operational Research*, *79*(3), 501–523. https://doi.org/10.1016/0377-2217(94)90062-0

Bal, J., & Foster, P. (2000). Managing the virtual team and controlling effectiveness. *International Journal of Production Research*, *38*(17), 4019–4032. https://doi.org/10.1080/00207540050204885

Ballinger, T., & Sheridan, S. (2016). Sea ice impacts on polar surface weather types in the North American Arctic. *Climate Research*, *67*(2), 117–134. https://doi.org/10.3354/cr01363

Barkema, H. G., George, G., & Tsui, A. S. (2015). West meets east: New concepts and theories. *ACAD Manage J. 58(2)* 460-479. https://doi.org/10.5465/amj.2015.4021

Barnhardt, R., & Kawagley, A. O. (2005). Indigenous knowledge systems/Alaska Native ways of knowing. *Anthropology and Education Quarterly*, *36*(1), 8–23. Retrieved from http://www.ankn.uaf.edu/curriculum/Articles/barnhardtKawagley/Indigenous_Knowledge.html

Bavelas, A. (1950). Communication patterns in task-oriented groups. *The Journal of the Acoustical Society of America*, *22*(6), 725–730.

Beddoe, R., Costanza, R., Farley, J., Garza, E., Kent, J., Kubiszewski, I., … Woodward, J. (2009). Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(8), 2483–9. https://doi.org/10.1073/pnas.0812570106

Beikman, H. M. (1980). *Geologic Map of Alaska: U.S. Geologic Survey*. Retrieved from http://dggs.alaska.gov/pubs/id/20521

Beltaos, S., & Burrell, B. C. (2015). Hydrotechnical advances in Canadian river ice science and engineering during the past 35 years 1. *Canadian Journal of Civil Engineering*, *42*(9), 583–591. https://doi.org/10.1139/cjce-2014-0540

Bengston, D. N., Fan, D. P., Reed, P., & Goldhor-Wilcock, A. (2009). Rapid issue tracking: A method for taking the pulse of the public discussion of environmental policy. *Environmental Communication*, *3*(3), 367–385.

Bering Strait Messenger Network. (2014). Retrieved March 10, 2017, from https://www.institutenorth.org/programs/arctic-advocacy-infrastructure/bering-strait-messenger-network/

Bering Strait Messenger Network. (2016). Retrieved March 10, 2017, from https://www.facebook.com/beringstraitmessengernetwork/

Berkes, F., & Jolly, D. (2002). Adapting to climate change: Social-ecological resilience in a Canadian western Arctic community. *Conservation Ecology*, *5*(2), 18.

Berman, M., & Kofinas, G. (2004). Hunting for models: Grounded and rational choice approaches to analyzing climate effects on subsistence hunting in an Arctic community. *Ecological Economics*, *49*(1), 31–46.

Biermann, F. (2012). Planetary boundaries and earth system governance: Exploring the links. *Ecological Economics*, *81*, 4–9. https://doi.org/10.1016/j.ecolecon.2012.02.016

Biskaborn, B. K., Lanckman, J.-P., Lantuit, H., Elger, K., Streletskiy, D. A., Cable, W. L., & Romanovsky, V. E. (2015). The new database of the Global Terrestrial Network for Permafrost (GTN-P). *Earth System Science Data*, *7*(2), 245–259. https://doi.org/10.5194/essd-7-245-2015

Bixler, R. P., Johnson, S., Emerson, K., Nabatchi, T., Reuling, M., Curtin, C., … Grove, J. M. (2016). Networks and landscapes: A framework for setting goals and evaluating performance at the large landscape scale. *Frontiers in Ecology and the Environment*, *14*(3), 145–153. https://doi.org/10.1002/fee.1250

Blair, B. (2010). *Risk Society On The Last Frontier: Indigenous Knowledge And The Politics Of Risk In Oil Resource Management At Alaska's North Slope*. Retrieved from https://www.researchgate.net/profile/Berill_Blair/publication/278668787_Risk_society_on_the_Last_Frontier_Indigenous_knowledge_and_the_politics_of_risk_in_oil_resource_management_at_Alaska's_North_Slope/links/5582094508ae12bde6e4af37.pdf

Bodin, Ö., & Crona, B. I. (2009). The role of social networks in natural resource governance: What relational patterns make a difference? *Global Environmental Change*, *19*(3), 366–374. https://doi.org/10.1016/j.gloenvcha.2009.05.002

Bodin, Ö., & Tengö, M. (2012). Disentangling intangible social–ecological systems. *Global Environmental Change*, *22*(2), 430–439. https://doi.org/10.1016/j.gloenvcha.2012.01.005

Bodin, Ö., Robins, G., McAllister, R. R. J., Guerrero, A. M., Crona, B., Tengö, M., & Lubell, M. (2016). Theorizing benefits and constraints in collaborative environmental governance: A transdisciplinary social-ecological network approach for empirical investigations. *Ecology and Society*, *21*(1), art40. https://doi.org/10.5751/ES-08368-210140

Bonsignore, E. M., Dunne, C., Rotman, D., Smith, M., Capone, T., Hansen, D. L., & Shneiderman, B. (2009). First steps to netviz nirvana: Evaluating social network analysis with NodeXL. In *2009 International Conference on Computational Science and Engineering* (pp. 332–339). IEEE. https://doi.org/10.1109/CSE.2009.120

Borgatti, S. P. (2006). Identifying sets of key players in a social network. *Computational & Mathematical Organization Theory*, *12*(1), 21–34.

Borgatti, S. P., & Everett, M. G. (1997). Network analysis of 2-mode data. *Social Networks*, *19*(3), 243–269.

Borgatti, S.P., Everett, M. G., Johnson, J. C. (2013). *Analyzing social networks*. Los Angeles [i.e. Thousand Oaks, Calif.]; London: SAGE Publications.

Borgatti, S. P., & Halgin, D. S. (2011). On network theory. *Organization Science*, *22*(5), 1168–1181. https://doi.org/10.1287/orsc.1100.0641

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. *Science*, *323*(5916), 892.

Borrett, S. R., Moody, J., & Edelmann, A. (2014). The rise of network ecology: Maps of the topic diversity and scientific collaboration. *Ecological Modelling*, *293*, 111–127. https://doi.org/10.1016/j.ecolmodel.2014.02.019

Braje, T. J., & Erlandson, J. M. (2013). Human acceleration of animal and plant extinctions: A late Pleistocene, Holocene, and Anthropocene continuum. *Anthropocene*, *4*, 14–23. https://doi.org/10.1016/j.ancene.2013.08.003

Brower, H., & Brewster, K. (2004). *The whales, they give themselves: Conversations with Harry Brower, Sr.* Anchorage, AK.: University of Alaska Press.

Burkhardt, M. E., & Brass, D. J. (1990). Changing patterns or patterns of change: The effects of a change in technology on social network structure and power. *Administrative Science Quarterly*, *35*(1), 104. https://doi.org/10.2307/2393552

Burt, C. C. (2011). Super extra-tropical storms; Alaska and extra-tropical record low barometric pressures. [Web log]. Retrieved from http://www.wunderground.com/blog/weatherhistorian/super-extratropical-storms-alaska-and-extratropical-record-low-baro

Callaway, D., Eamer, J., Edwardsen, E., Jack, C., Marcy, S., Olrun, A., … Whiting, A. (1999). Effects of climate change on subsistence communities in Alaska. Workshop Proceedings. *Assessing the Consequences of Climate Change for Alaska and the Bering Sea Region*, 59–73.

Camarinha-Matos, L. M., & Afsarmanesh, H. (2005). Collaborative networks: A new scientific discipline. *Journal of Intelligent Manufacturing*, *16*(4–5), 439–452. https://doi.org/10.1007/s10845-005-1656-3

Carlson, M. (2017). Facebook in the news. *Digital Journalism*, 1–17. https://doi.org/10.1080/21670811.2017.1298044

Carlsson, L. G., & Sandström, A. C. (2007, November 11). Network governance of the commons. *International Journal of the Commons*. Retrieved from http://www.thecommonsjournal.org/index.php/ijc/article/view/URN%253ANBN%253ANL%253AUI%253A10-IJC-08003

Carr, C. T., & Hayes, R. A. (2015). Social media: Defining, developing, and divining. *Atlantic Journal of Communication*, *23*(1), 46–65. https://doi.org/10.1080/15456870.2015.972282

Case, D. S. (1989). Subsistence and self-determination: Can Alaska Natives have a more effective voice. *University of Colorado Law Review.*, *60*, 1009.

Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., … Young, O. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society*, *11*(2), art8. https://doi.org/10.5751/ES-01759-110208

Castree, N. (2017). Anthropocene: Social science misconstrued. *Nature*, *541*(7637), 289–289. https://doi.org/10.1038/541289c

Catanese, S. A., De Meo, P., Ferrara, E., Fiumara, G., & Provetti, A. (2011). Crawling Facebook for social network analysis purposes. *Arxiv Preprint arXiv:1105.6307*.

Chang, C.Y., Allen, J. C., Dawson, S. E., & Madsen, G. E. (2012). Network analysis as a method for understanding the dynamics of natural resource management in rural communities. *Society & Natural Resources*, *25*(2), 203–208. https://doi.org/10.1080/08941920.2011.571753

Chapin, F. S., III, Trainor, S. F., Cochran, P., Huntington, H., Markon, C., McCammon, M., McGuire, A. D., and Serreze, M.(2014). Ch. 22: Alaska. Climate change impacts in the United States. In *Climate Change Impacts in the US. US Global Change Research Program.* Retrieved from https://doi.org/10.7930/J00Z7150

Chapin, F. S., Kofinas, G. P., Folke, C., & Chapin, M. C. (2009). *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World.* New York, NY: Springer Science LLC.

Chapin, F. S., Lovecraft, A. L., Zavaleta, E. S., Nelson, J., Robards, M. D., Kofinas, G. P., … Naylor, R. L. (2006). Policy strategies to address sustainability of Alaskan boreal forests in response to a directionally changing climate. *Proc Natl Acad Sci USA*, *103*(45), 16637–16643. https://doi.org/10.1073/pnas.0606955103

Cidell, J. (2006). Air transportation, airports, and the discourses and practices of globalization. *Urban Geography*, *27*(7), 651–663. https://doi.org/10.2747/0272-3638.27.7.651

Constantinides, E. (2014). Foundations of social media marketing. *Procedia - Social and Behavioral Sciences*, *148*, 40–57. https://doi.org/10.1016/j.sbspro.2014.07.016

Crowley, D., & Heyer, P. (2015). *Communication in History: Technology, Culture, Society*. New York, NY: Routledge. Retrieved from https://books.google.com/books?hl=en&lr=&id=UmCkCgAAQBAJ&pgis=1

Crucitti, P., Latora, V., & Marchiori, M. (2004). Model for cascading failures in complex networks. *Physical Review E*, *69*(4), 45104. https://doi.org/10.1103/PhysRevE.69.045104

Crutzen, P. J. (2006). The Anthropocene. In *Earth System Science in the Anthropocene* (pp. 13–18). Springer.

Dalby, S. (2011). Geographies of the international system: Globalization, empire and the Anthropocene. In *International Studies* (pp. 125–148). London: Palgrave Macmillan UK. https://doi.org/10.1057/9780230342934_5

Danescu-Niculescu-Mizil, C., Gamon, M., & Dumais, S. (2011). Mark my words! In *Proceedings of the 20th international conference on World Wide Web - WWW '11* (p. 745). New York, New York, USA: ACM Press. https://doi.org/10.1145/1963405.1963509

Darling1, E. S., Shiffman, D., Côté, I. M., & Drew, J. A. (2013). *The role of Twitter in the life cycle of a scientific publication*. Retrieved from http://arxiv.org/abs/1305.0435

Davis, J. L. (2017). Curation: A theoretical treatment. *Information, Communication & Society*, *20*(5), 770–783. https://doi.org/10.1080/1369118X.2016.1203972

De Silva, H., & Ratnadiwakara, D. (n.d.). *Using ICT to reduce transaction costs in agriculture through better communication: A case-study from Sri Lanka*. Retrieved from http://www.lirneasia.net/wp-content/uploads/2008/11/transactioncosts.pdf

Del Vicario, M., Zollo, F., Caldarelli, G., Scala, A., & Quattrociocchi, W. (2017). Mapping social dynamics on Facebook: The Brexit debate. *Social Networks*, *50*, 6–16. https://doi.org/10.1016/j.socnet.2017.02.002

DeWilde, L., & Chapin, F. S. (2006). Human impacts on the fire regime of interior Alaska: interactions among fuels, ignition sources, and fire suppression. *Ecosystems*, *9*(8), 1342–1353. https://doi.org/10.1007/s10021-006-0095-0

Dijck, J.V. (2013). *The culture of connectivity : A critical history of social media*. New York, NY: Oxford University Press.

Dooley, K. J. (1997). A complex adaptive systems model of organization change. *Nonlinear Dynamics, Psychology, and Life Sciences*, *1*(1), 69–97. https://doi.org/10.1023/A:1022375910940

Dover, J., & Galloway J. (Eds.)(1990). *Geologic studies in Alaska by the U.S. Geological Survey 1989*. [U.S. Geological Survey Bulletin 1946]. United States Government Printing Office, Washington. Retrieved from https://books.google.com/books?id=lm8SapnGsbEC&dq=nenana+alaska+petroleum&lr=&source=gbs_navlinks_s

Dyer, J. H., & Chu, W. (2003). The role of trustworthiness in reducing transaction costs and improving performance: Empirical evidence from the United States, Japan, and Korea. *Organization Science*, *14*(1), 57–68. https://doi.org/10.1287/orsc.14.1.57.12806

Erlandson, J. M., & Braje, T. J. (2013). Archeology and the Anthropocene. *Anthropocene*, *4*, 1–7. https://doi.org/10.1016/j.ancene.2014.05.003

Fall, J. A. (1990). The division of subsistence of the Alaska Department of Fish and Game: An overview of its research program and findings: 1980-1990. *Arctic Anthropology*, 68–92.

Federle, M. J., & Bassler, B. L. (2003). Interspecies communication in bacteria. *The Journal of Clinical Investigation*, *112*(9), 1291–9. https://doi.org/10.1172/JCI20195

Fenton, M. B. (1997). Science and the conservation of bats. *Journal of Mammalogy*, *78*(1), 1–14. https://doi.org/10.2307/1382633

Ferrell, J. (2011). *Alaska superstorm stats and update*. [Web log] Retrieved from http://www.accuweather.com/en/weather-blogs/weathermatrix/alaska-superstorm-stats-and-update/57552

Firnkes, A., Bartels, A., Bidoli, E., & Erhard, M. (2017). Appeasement signals used by dogs during dog-human communication. *Journal of Veterinary Behavior: Clinical Applications and Research*. https://doi.org/10.1016/j.jveb.2016.12.012

Fleischman, F. D., Boenning, K., Garcia-Lopez, G. A., Mincey, S., Schmitt-Harsh, M., Daedlow, K., … Ostrom, E. (2010). Disturbance, response, and persistence in self-organized forested communities: Analysis of robustness and resilience in five communities in southern Indiana. *Ecology & Society*, *15*(4).

Folke, C. (2004). Traditional knowledge in social-ecological systems. *Ecology and Society*, *9*(3), 7.

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology & Society*, *15*(4).

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, *30*(1), 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Forum, A. H. (2017). *Alaska history and cultural studies: Places and regions*. Retrieved February 20, 2017, from http://www.akhistorycourse.org/geography/places-and-regions

Frank, J., Frank, S., Mishler, C., Erick, J., & Alaska Native Language Center. (1995). *Neerihiinjìk : Johnny Sarah Hàa Googwandak = We Traveled From Place To Place : The Gwich'in Stories Of Johnny And Sarah Frank*. Alaska Native Language Center.

Freeman, A. (2014). *Alaska storm becomes strongest in Bering Sea history*. Retrieved from http://mashable.com/2014/11/08/alaska-storm-strongest-bering-sea/

Friedman, S. (2013, September 18). Galena won't receive federal funds for rebuilding in flood-prone area, *Newsminer*. Retrieved from http://m.newsminer.com/news/local_news/galena-won-t-receive-federal-funds-for-rebuilding-in-flood/article_40c73f36-1f6f-11e3-af14-001a4bcf6878.html?mode=jqm

Friedman, S. (2014, June 13). Galena making progress in flood recovery, *Newsminer*. Retrieved from http://www.newsminer.com/news/local_news/galena-making-progress-in-flood-recovery/article_e6a7aa46-f2d0-11e3-9f6f-001a4bcf6878.html

Frondel, M., Simora, M., & Sommer, S. (2016). *Risk perception of climate change: Empirical evidence for Germany*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866661

Fuchs, C., Hofkirchner, W., Schafranek, M., Raffl, C., Sandoval, M., & Bichler, R. (2010). Theoretical foundations of the web: Cognition, communication, and co-operation. Towards an understanding of web 1.0, 2.0, 3.0. *Future Internet*, *2*(1), 41–59. https://doi.org/10.3390/fi2010041

Galena City. (n.d.). Retrieved March 7, 2017, from http://www.ci.galena.ak.us/

Gallois, C., Giles, H., Gallois, C., & Giles, H. (2015). Communication accommodation theory. In *The International Encyclopedia of Language and Social Interaction* (pp. 1–18). Hoboken, NJ, USA: John Wiley & Sons, Inc. https://doi.org/10.1002/9781118611463.wbielsi066

Galloway, K., Moore, B., Thoman, R., Wendler, G. (2014). Winter 2013–14: A memorable weather season in Alaska. *Alaska Climate Dispatch*. Retrieved from https://accap.uaf.edu/sites/default/files/AK_climate_dispatch_mar14_final.pdf

GCI TERRA. (2017). GCI Terra Home Page. Retrieved August 2, 2017, from http://terra.gci.com

Georgette, S., & Shiedt, A. (2005). Whitefish: Traditional Ecological Knowledge and Subsistence Fishing in the Kotzebue Sound Region, Alaska. *Alaska Department of Fish and Game, Division of Subsistence*. Retrieved from http://www.adfg.alaska.gov/techpap/tp290.pdf

Getchell, M. C., & Sellnow, T. L. (2016). A network analysis of official Twitter accounts during the West Virginia water crisis. *Computers in Human Behavior*, *54*, 597–606. https://doi.org/10.1016/j.chb.2015.06.044

Gilbert, G. N., & Hamill, L. (2009). Social circles: A simple structure for agent-based social network models. *Journal of Artificial Societies and Social Simulation*, *12*(2).

Giles, H., & Powesland, P. (1997). Accommodation theory. In *Sociolinguistics* (pp. 232–239). London: Macmillan Education UK. https://doi.org/10.1007/978-1-349-25582-5_19

Ginsburg, F., & Ginsburg, F. (2016). Indigenous media from U-matic to YouTube: Media sovereignty in the digital age. *Sociologia & Antropologia*, *6*(3), 581–599. https://doi.org/10.1590/2238-38752016v632

Gladwin, H., Lazo, J. K., Morrow, B. H., Peacock, W. G., & Willoughby, H. E. (2007). Social science research needs for the hurricane forecast and warning system. *Natural Hazards Review*, *8*(3), 87–95. https://doi.org/10.1061/(ASCE)1527-6988(2007)8:3(87)

Goel, R., Soni, S., Goyal, N., Paparrizos, J., Wallach, H., Diaz, F., & Eisenstein, J. (2016). The social dynamics of language change in online networks. *Socinfo16*. DOI: 10.1007/978-3-319-47880-7_3

Golden, J. H., & Adams, C. R. (2000). The tornado problem: Forecast, warning, and response. *Natural Hazards Review*, *1*(2), 107–118. https://doi.org/10.1061/(ASCE)1527-6988(2000)1:2(107)

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, 1360–1380.

Grantz, Arthur, May, S.D., and Hart, P. E. (1994). *Geology of the Arctic continental margin of Alaska.* Retrieved February 20, 2017, from http://www.dggs.alaska.gov/pubs/id/22282

Greenwald, N., Callimanis, S., Garty, A., Peters, E., & Schafer, K. (2006). *A biodiversity assessment of vertebrate species.* Retrieved from http://www.biologicaldiversity.org/publications/papers/BeringSeaRpt.pdf

Grim, J. (2001). *Indigenous traditions and ecology: The interbeing of cosmology and community*. Distributed by Harvard Press for the Center for the Study of World Religions, Harvard Divinity School.

Guarino, N. (1998). *Formal ontology and information systems*. Retrieved from http://www.loa.istc.cnr.it/old/Papers/FOIS98.pdf

Gunderson, L. H., & Holling, C. S. (2002). *Panarchy: Understanding transformations in human and natural systems*. Washington D.C.: Island Press.

Hamilton, L. C., White, D. M., Lammers, R. B., & Myerchin, G. (2012). Population, climate, and electricity use in the Arctic integrated analysis of Alaska community data. *Population and Environment*, *33*(4), 269–283.

Hampton, K. N., Goulet, L. S., Rainie, L., & Purcell, K. (2011). Social networking sites and our lives. *Pew Research Center's Internet & Technology.* Retrieved from http://www.pewinternet.org/2011/06/16/social-networking-sites-and-our-lives/

Hanna, R., Rohm, A., & Crittenden, V. L. (2011). We're all connected: The power of the social media ecosystem. *Business Horizons*, *54*(3), 265–273. https://doi.org/10.1016/j.bushor.2011.01.007

Hanneman, R. A., & Riddle, M. (2005). *Introduction to social network methods.* Riverside, CA.: University of California, Riverside. Retrieved from http://faculty.ucr.edu/~hanneman/nettext/

Hansen, D. L., Shneiderman, B., & Smith, M. A. (2011). *Analyzing Social Media Networks with Nodexl : Insights from a Connected World*. Burlington, MA.: Morgan Kaufmann.

Hansen, D., Shneiderman, B., & Smith, M. (2009). *Analyzing Social Media Networks: Learning by Doing with NodeXL*. Retrieved from www.codeplex.com/nodexl

Hauck, J., Stein, C., Schiffer, E., & Vandewalle, M. (2015). Seeing the forest and the trees: Facilitating participatory network planning in environmental governance. *Global Environmental Change*, *35*, 400–410. https://doi.org/10.1016/j.gloenvcha.2015.09.022

Hauser, D. D. W., Laidre, K. L., Stafford, K. M., Stern, H. L., Suydam, R. S., & Richard, P. R. (2016). Decadal shifts in autumn migration timing by Pacific Arctic beluga whales are related to delayed annual sea ice formation. *Global Change Biology*. https://doi.org/10.1111/gcb.13564

Hinzman, L. D., Bettez, N. D., Bolton, W. R., Chapin, F. S., Dyurgerov, M. B., Fastie, C. L., Yoshikawa, K. (2005). Evidence and implications of recent climate change in northern Alaska and other arctic regions. *Climate Change*. DOI: 10.1007/s10584-005-5352-2

Hirst, M., Harrison, J.& Mazepa, P. (2014). *Communication and new media : From broadcast to narrowcast*. New York, NY: Oxford University Press.

Holland, H. D. (2006). The oxygenation of the atmosphere and oceans. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *361*(1470).

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*(1), 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245

Holloway, G., Nicholson, C., Delgado, C., Staal, S., & Ehui, S. (2000). Agroindustrialization through institutional innovation Transaction costs, cooperatives and milk-market development in the east-African highlands. *Agricultural Economics*, *23*, 279–288. Retrieved from www.elsevier.com/locate/agecon

Hopkins, K. (2013, May 29). With Galena a ghost town, Koyukuk braces for “flash flood.” *Alaska Daily News*. Retrieved from https://www.adn.com/alaska-news/article/galena-ghost-town-koyukuk-braces-flash-flood/2013/05/29/

Houseknecht, D. W., & Bird, K. J. (2005). Oil and gas resources of the arctic Alaska petroleum province. *U.S. Geological Survey Professional Paper 1732–A*.

Howley, K. (2010). *Understanding community media*. Thousands Oaks, Ca.: SAGE Publications.

Hudson, H. E. (2006). *From rural village to global village : Telecommunications for development in the information age*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Hudson, H. E. (2009). Digital diversity: Broadband and indigenous populations in Alaska. *Institute of Social and Economic Research*. Retrieved form https://scholarworks.alaska.edu/handle/11122/4131

Hudson, H. E. (2011). Connecting the underserved: Broadband strategies and lessons from North America. In *Pacific Telecommunications Council Proceedings*. (p.p. 891-904). Honolulu, Hi. Retrieved from http://toc.proceedings.com/11341webtoc.pdf

Hudson, H. E. (2012). Internet and broadband adoption in indigenous communities: An analysis of rural Alaska. In *ITS Biennial Conference, Bangkok 2012: Moving Forward with Future Technologies - Opening a Platform for All 72534, International Telecommunications Society (ITS)*. Retrieved from https://ideas.repec.org/p/zbw/itsb12/72534.html

Hudson, H. E. (2014). Beyond infrastructure: Broadband for development in remote and Indigenous regions. *Journal of Rural and Community Development*, *8*(2).

Hudson, H. E. (2015). *Connecting Alaskans : telecommunications in Alaska from telegraph to broadband*. Anchorage, AK: University of Alaska Press

Hudson, H. E., & Parker, E. B. (1973). Medical communication in Alaska by satellite. *New England Journal of Medicine*, *289*(25), 1351–1356. https://doi.org/10.1056/NEJM197312202892506

Hudson, H. E., Suzanne, S., & Hill, A. (2015). After broadband: A study of organizational use of broadband in Southwest Alaska. *Institute of Social and Economic Research*, University of Alaska Anchorage. Retrieved from https://scholarworks.alaska.edu/handle/11122/5959

Huntington, H. P., Quakenbush, L. T., & Nelson, M. (2016). Effects of changing sea ice on marine mammals and subsistence hunters in northern Alaska from traditional knowledge interviews. *Biology Letters*, *12*(8).

Huntington, H. P., Trainor, S. F., Natcher, D. C., Huntington, O., DeWilde, L., & Chapin III, F. S. (2006). The significance of context in community-based research: Understanding discussions about wildfire in Huslia, Alaska. *Ecology and Society*, *11*(1), 40.

Ice jam on the Yukon River floods Galena, Alaska: Image of the day. (2013, May 28). Retrieved from http://earthobservatory.nasa.gov/IOTD/view.php?id=81227

Igiugig Village Council (2016). *Village Life - Village of Igiugig, Alaska*. Retrieved February 23, 2017, from http://www.igiugig.com/village-life

Imperial, M. T., Johnston, E., Pruett-Jones, M., Leong, K., & Thomsen, J. (2016). Sustaining the useful life of network governance: Life cycles and developmental challenges. *Frontiers in Ecology and the Environment*, *14*(3), 135–144. https://doi.org/10.1002/fee.1249

Institute of the North. (2017a). Retrieved March 10, 2017, from https://www.institutenorth.org/about/

Institute of the North. (2017b). Retrieved March 10, 2017, from https://www.institutenorth.org/about/mission-vision/

Interior US Department. (1990). *Geologic Studies in Alaska by the U.S. Geological Survey During ... - Google Books*. USGS. Retrieved from https://books.google.com/books?id=lm8SapnGsbEC&dq=nenana+alaska+petroleum&lr=&source=gbs_navlinks_s

Janssen, M. A., Anderies, J. M., & Ostrom, E. (2007). Robustness of social-ecological systems to spatial and temporal variability. *Society and Natural Resources*, *20*(4), 307–322.

Janssen, M. A., Bodin, Ö., Anderies, J. M., Elmqvist, T., Ernstson, H., Mcallister, R. R. J., … Ryan, P. (2006). *Insight, part of a special feature on exploring resilience in social-ecological systems toward a network perspective of the study of resilience in social-ecological systems.* Retrieved from http://frst411.sites.olt.ubc.ca/files/2015/01/0c96052a7b5076c538000000.pdf

Johnson, S. (2006). *Who Moved My Cheese?* New York, NY.: Penguin Putnam Inc.

Jones, B. (2014). Politics, Alaska-style. *NYTime*s. Retrieved February 23, 2017, from https://www.nytimes.com/2014/10/02/opinion/politics-alaska-style.html?_r=0

Jorgenson, M. T., Yoshikawa, K., Kanevskiy, M., Shur, Y., Romanovsky, V., Marchenko, S., … Jones, B. (2008). Permafrost characteristics of Alaska. In *Proceedings of the Ninth International Conference on Permafrost*. Fairbanks, Alaska. Retrieved from http://www.cryosphericconnection.org/resources/alaska_permafrost_map_dec2008.pdf

Justice Center, A. N. (n.d.). *Alaska Native Justice Center*. Retrieved February 23, 2017, from http://www.anjc.org/

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of social media. *Business Horizons*, *53*, 59–68. https://doi.org/10.1016/j.bushor.2009.09.003

Kaplan, A. M., & Haenlein, M. (2012). Social media: Back to the roots and back to the future. *Journal of Systems and Information Technology*, *14*(2), 101–104. https://doi.org/10.1108/13287261211232126

Kari, J. M., Fall, J. A., Pete, S., & Alex, M. (2003). *Shem Pete's Alaska : The territory of the Upper Cook Inlet Dena'ina*. Anchorage, AK: University of Alaska Press.

Kawagley, A. O. (1999). Alaska Native education: History and adaptation in the new millenium. *Journal of American Indian Education*, *39*(2).

Kawerak, Inc. (2012). Retrieved March 10, 2017, from http://www.kawerak.org/index.html

Kietzmann, J. H., Hermkens, K., McCarthy, I. P., & Silvestre, B. S. (2011). Social media? Get serious! Understanding the functional building blocks of social media. *Business Horizons*, *54*(3), 241–251.

Kim, M., Newth, D., & Christen, P. (2013). Modeling dynamics of diffusion across heterogeneous social networks: News diffusion in social media. *Entropy*, *15*(10), 4215–4242. https://doi.org/10.3390/e15104215

Kim, M., Newth, D., & Christen, P. (2014). Trends of news diffusion in social media based on crowd phenomena. In *Proceedings of the 23rd International Conference on World Wide Web - WWW '14 Companion* (pp. 753–758). New York, New York, USA: ACM Press. https://doi.org/10.1145/2567948.2579325

Kiousis, S. (2001). Public trust or mistrust? Perceptions of media credibility in the information age. *Mass Communication and Society*, *4*(4), 381–403. https://doi.org/10.1207/S15327825MCS0404_4

Knapp, M. L., & Daly, J. A. (2002). *Handbook of interpersonal communication*. Thousand Oaks, Ca.: SAGE Publications. Retrieved from https://books.google.com/books?hl=en&lr=&id=t97fuAcjS-YC&pgis=1

Koltko-Rivera, M. E. (2004). The Psychology of worldviews. *Review of General Psychology*, *8*(1), 3–58. https://doi.org/10.1037/1089-2680.8.1.3

Kotchen, M. J., & Young, O. R. (2007). Meeting the challenges of the anthropocene: Towards a science of coupled human--biophysical systems. *Global Environmental Change*, *17*(2), 149–151.

Krauss, M. (1996). *Alaska Native Languages : Past, Present, and Future*. Fairbanks, AK.: Alaska Native Language Center.

Krauss, M. E., Holton, G., Kerr, J., & West, C. (2011). *Indigenous peoples and languages of Alaska*. Retrieved February 23, 2017, from http://www.uaf.edu/anla/collections/map/

Krupa, M. B., Chapin, III, F. S., & Lovecraft, A. L. (2014). Robustness or resilience? Managing the intersection of ecology and engineering in an urban Alaskan fishery. *Ecology and Society*, *19*(2), art17. https://doi.org/10.5751/ES-06274-190217

Lampe, C., Ellison, N. B., & Steinfield, C. (2007). The benefits of Facebook friends: Social capital and college students use of online social network sites. *Journal of Computer Mediated Communication*, *11*(2).

Larson, S., Alexander, K. S., Djalante, R., & Kirono, D. G. C. (2013). The added value of understanding informal social networks in an adaptive capacity assessment: Explorations of an urban water management system in Indonesia. *Water Resources Management*, *27*(13), 4425–4441. https://doi.org/10.1007/s11269-013-0412-2

Latour, B. (1999). On recalling ant. *The Sociological Review*, *47*(1_suppl), 15–25. https://doi.org/10.1111/j.1467-954X.1999.tb03480.x

Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.

Latour, B. (2011). Network theory| networks, societies, spheres: Reflections of an actor-network theorist. *International Journal of Communication*, *5*(0), 15.

Law, J. (1992). Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. *Systems Practice*, *5*(4), 379–393. https://doi.org/10.1007/BF01059830

Lazega, E., Jourda, M.T., Mounier, L., & Stofer, R. (2008). Catching up with big fish in the big pond? Multi-level network analysis through linked design. *Social Networks*, *30*(2), 159–176. https://doi.org/10.1016/j.socnet.2008.02.001

Lee, S. J. C., Higashi, R. T., Inrig, S. J., Sanders, J. M., Zhu, H., Argenbright, K. E., & Tiro, J. A. (2016). County-level outcomes of a rural breast cancer screening outreach strategy: A decentralized hub-and-spoke model (BSPAN2). *Translational Behavioral Medicine*, 1–9. https://doi.org/10.1007/s13142-016-0427-3

Lee, S., & Monge, P. (2011). The Coevolution of Multiplex Communication Networks in Organizational Communities. *Journal of Communication*, *61*(4), 758–779. https://doi.org/10.1111/j.1460-2466.2011.01566.x

Lendon, B. (2011). Arctic “hurricane” slams Alaska. *CNN*. Retrieved from http://news.blogs.cnn.com/2011/11/09/arctic-hurricane-slams-alaska/?hpt=hp_t3

Leskovec, J., Lang, K. J., & Mahoney, M. (2010). Empirical comparison of algorithms for network community detection. In *Proceedings of the 19th international conference on World Wide Web - WWW ’10* (p. 631). New York, NY, USA: ACM Press. https://doi.org/10.1145/1772690.1772755

Levy, S. (2013, January 15). Facebook’s Bold, Compelling and Scary Engine of Discovery: The Inside Story of Graph Search. Retrieved March 10, 2017, from https://www.wired.com/2013/01/the-inside-story-of-graph-search-facebooks-weapon-to-challenge-google/

Lewis, S. L. (2012). We must set planetary boundaries wisely. *Nature*, *485*(7399), 417–417. https://doi.org/10.1038/485417a

Lewis, S. L., & Maslin, M. A. (2015). Defining the Anthropocene. *Nature*, *519*(7542), 171–180. https://doi.org/10.1038/nature14258

Leydesdorff, L., & Nerghes, A. (2015). Co-word maps and topic modeling: A comparison from a user’s perspective. *Journal of the Association for Information Science and Technology*. Retrieved from http://arxiv.org/abs/1511.03020

Liang, H., Zen, K., Zhang, J., Zhang, C.Y., & Chen, X. (2013). New roles for microRNAs in cross-species communication. *RNA Biology*, *10*(3), 367–370. https://doi.org/10.4161/rna.23663

Lonner, T. D. (1980). Subsistence as an economic system in Alaska: Theoretical and policy implications [Technical Paper #67]. *Alaska Department of Fish and Game*. Retrieved from http://www.subsistence.adfg.state.ak.us/techpap/tp067.pdf

Lövbrand, E., Beck, S., Chilvers, J., Forsyth, T., Hedrén, J., Hulme, M., … Vasileiadou, E. (2015). Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene. *Global Environmental Change*, *32*, 211–218. https://doi.org/10.1016/j.gloenvcha.2015.03.012

Lovecraft, A. L. (2007). Transnational Environmental Management: U.S.-Canadian Institutions at the Interlocal Scale. *American Review of Canadian Studies*, *37*(2), 218–245. https://doi.org/10.1080/02722010709481856

Luke, H., & Jackson, J. S. (1998). *My Own Trail*. Fairbanks, AK.:Alaska Native Knowledge Network.

Luo, Z., Zhu, H., Zeng, D., & Yao, H. (2014). A trace-driven analysis on the user behaviors in social e-commerce network. In *2014 IEEE International Conference on Communications (ICC)* (pp. 4108–4113). IEEE. https://doi.org/10.1109/ICC.2014.6883964

Luthe, T., & Wyss, R. (2016). Resilience to climate change in a cross-scale tourism governance context: A combined quantitative-qualitative network analysis. *Ecology and Society*, *21*(1), art27. https://doi.org/10.5751/ES-08234-210127

Madden, M. (2012). Privacy management on social media sites. *Pew Research Center Internet & Technology*. Retrieved from http://www.pewinternet.org/2012/02/24/privacy-management-on-social-media-sites/

Magdanz, J. S. (2010). Subsistence harvests in Northwest Alaska: Kivalina and Noatak, 2007. [Technical Paper #354] *Alaska Department of Fish and Game, Division of Subsistence*. Retrieved from http://www.subsistence.adfg.state.ak.us/techpap/tp354.pdf

Magoon, L. B., Adkison, W. L., & Egbert, R. M. (1976). Map showing geology, wildcat wells, Tertiary plant fossil localities, K-AR age dates, and petroleum operations, Cook Inlet area, Alaska. *IMAP 1019*. Retrieved from https://pubs.er.usgs.gov/publication/i1019

Maibach, E., Roser-Renouf, C., & Leiserowitz, A. (2009). *Global warming's six Americas 2009: An audience segmentation analysis*. Retrieved from https://trid.trb.org/view.aspx?id=889822

Malm, A., & Hornborg, A. (2014). The geology of mankind? A critique of the Anthropocene narrative. *The Anthropocene Review*, *1*(1), 62–69. https://doi.org/10.1177/2053019613516291

Maltz, E. (2000). Is all communication created equal?: An investigation into the effects of communication mode on perceived information quality. *Journal of Product Innovation Management*, *17*(2), 110–127. https://doi.org/10.1111/1540-5885.1720110

Marin Ricke, A. (2010). *Networks and co-management in small-scale fisheries in Chile.* (Master Thesis) Retrieved from https://umanitoba.ca/institutes/natural_resources/canadaresearchchair/thesis/Masters%20Thesis%20Marin%202010.pdf

Mass, C. F.(2003). IFPS and the Future of the National Weather Service. *Weather and Forecasting*, *18*(1), 75–79. https://doi.org/10.1175/1520-0434(2003)018<0075:IATFOT>2.0.CO;2

Maynard, J. E. (2010). *Factors Influencing The Development Of Wind Power In Rural Alaskan Communities.* (Master Thesis) University of Alaska Fairbanks. Retrieved from http://www.uaf.edu/files/rap/Maynard-thesis.pdf

McBeath, G. A., & Morehouse, T. A. (1994). *Alaska politics and government*. Lincoln, NE: University of Nebraska Press.

McCann, J. E., & Selsky, J. W. (2012). *Mastering Turbulence : The Essential Capabilities of Agile and Resilient Individuals, Teams, and Organizations*. San Francisco, Ca.: Jossey-Bass.

McLuhan, M. (1964). *The medium is the message*. In Understanding Media: The extensions of man. (pp. 23-35, 63-67) New York: Signet. Retrieved from https://books.google.com/books?hl=en&lr=&id=I8dPhB88Sx4C&oi=fnd&pg=PA107&dq=marshall+mcluhan&ots=CD-HrycwhP&sig=W_jDd_M2Bd-0jMRT2zjGGgAu0oY

McLuhan, M. (1994). *Understanding media: The extensions of man*. Cambridge, MA.: MIT Press

McLuhan, M., & McLuhan, E. (1992). *Laws of media: The new science*. Toronto, OT: University of Toronto Press. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0,2&q=marshall+mcluhan#5

McLuhan, M., Molinaro, M., McLuhan, C., & Toye, W. (1987). *Letters of Marshall McLuhan*. New York, NY.: Oxford University Press

McMillan, J. H. (2013). *SAGE handbook of research on classroom assessment*. Thousand Oaks, Ca.: SAGE. Retrieved from https://books.google.com/books?id=YcU5DQAAQBAJ&dq=formative+and+summative+assessment&lr=&source=gbs_navlinks_s

McQuail, D. (2010). *McQuail's mass communication theory*. Thousand Oaks, Ca.: SAGE Publications. Retrieved from https://books.google.com/books?hl=en&lr=&id=7_eyvmCjzkoC&pgis=1

Melvin, A. M., Larsen, P., Boehlert, B., Neumann, J. E., Chinowsky, P., Espinet, X., … Marchenko, S. S. (2017). Climate change damages to Alaska public infrastructure and the economics of proactive adaptation. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(2), E122–E131. https://doi.org/10.1073/pnas.1611056113

Mergel, I., Huerta, T., & Van Stelle, J. (2007). *How do networkers network?* Retrieved from http://kops.uni-konstanz.de/handle/123456789/36100

Mills, M., Álvarez-Romero, J. G., Vance-Borland, K., Cohen, P., Pressey, R. L., Guerrero, A. M., & Ernstson, H. (2014). Linking regional planning and local action: Towards using social network analysis in systematic conservation planning. *Biological Conservation*, *169*, 6–13.

Mislove, A., Lehmann, S., Ahn, Y.Y., Onnela, J.P., & Rosenquist, J. N. (2012). Understanding the demographics of Twitter users. *Association for the Advancement of Artificial Intelligence*. Retrieved from http://www.ccs.neu.edu/home/amislove/publications/Twitter-ICWSM.pdf

Mislove, A., Marcon, M., Gummadi, K. P., Druschel, P., & Bhattacharjee, B. (2007). Measurement and analysis of online social networks. In *Proceedings of the 7th ACM SIGCOMM conference on Internet measurement* (pp. 29–42).

Moerlein, K. J., & Carothers, C. (2012). Total environment of change: Impacts of climate change and social transitions on subsistence fisheries in northwest Alaska. *Ecology and Society*, *17*(1), 10.

Monge, P. R., & Contractor, N. S. (2003). *Theories of communication networks*. Oxford ; New York: Oxford University Press.

Moy, P., & Scheufele, D. A. (2000). Media Effects on political and social trust. *Journalism & Mass Communication Quarterly*, *77*(4), 744–759. https://doi.org/10.1177/107769900007700403

Murphy, A. H., & Brown, B. G. (1985). A comparative evaluation of objective and subjective weather forecasts in the United States. In *Behavioral Decision Making* (pp. 329–359). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4613-2391-4_15

Murthy, D. (2008). Digital ethnography: An examination of the use of new technologies for social research. *Sociology*, *42*(5), 837–855. https://doi.org/10.1177/0038038508094565

Namkoong, K., Shah, D. V., & Gustafson, D. H. (2016). Offline social relationships and online cancer communication: Effects of social and family support on online social network building. *Health Communication*, 1–8. https://doi.org/10.1080/10410236.2016.1230808

Ngai, E. W. T., Tao, Spencer, S. C., & Moon, K. K. L. (2015). Social media research: Theories, constructs, and conceptual frameworks. *International Journal of Information Management*, *35*(1), 33–44. https://doi.org/10.1016/j.ijinfomgt.2014.09.004

NOAA. (2013). *NWS telecommunications operations center home page - The documentation and descriptions of practices of the center*. Retrieved February 27, 2017, from http://www.nws.noaa.gov/tg/

Nokleberg, W.J., Plafker, G., and Wilson, F. H. (1994). *Geology of south-central Alaska*. Retrieved from http://www.dggs.alaska.gov/pubs/id/22290

Norris, P. (2004). *The bridging and bonding role of online communities*. Thousand Oaks, California: Sage Publications. Retrieved from https://www.academia.edu/2749938/The_bridging_and_bonding_role_of_online_communities

North Pacific Research Board. (2017). *Gulf of Alaska Project*. Retrieved February 21, 2017, from http://www.nprb.org/gulf-of-alaska-project/about-the-project/

Nowacki, G., Flemming, M., Brock, T., & Jorgenson, T. (2003). Unified Ecoregions of Alaska: 2001. [Open-File Report 02-297] *U.S. Geological Survey*. Retrieved from https://pubs.er.usgs.gov/publication/ofr2002297

NSF. (2017). *Interdisciplinary - National Science Foundation search results.* Retrieved February 23, 2017, from https://search.usa.gov/search?query=interdisciplinary&affiliate=nsf&search=

NWS Flood Safety, US Department of Commerce, & NOAA. (2014). NWS Flood Safety Home Page. Retrieved March 7, 2017, from http://www.floodsafety.noaa.gov/states/ak-flood.shtml

O'Sullivan, P. B., & Carr, C. T. (2017). Masspersonal communication: A model bridging the mass-interpersonal divide. *New Media & Society*, 146144481668610. https://doi.org/10.1177/1461444816686104

Oh, P., & Monge, P. (2016). Network theory and models. In *The International Encyclopedia of Communication Theory and Philosophy* (pp. 1–15). Hoboken, NJ, USA: John Wiley & Sons, Inc. https://doi.org/10.1002/9781118766804.wbiect246

Oller, D. K., & Griebel, U. (2004). *Evolution of communication systems : A comparative approach*. Cambridge, MA.: MIT Press.

Oremus, W. (2016). Who controls your Facebook feed? *Slate*. Retrieved from http://www.slate.com/articles/technology/cover_story/2016/01/how_facebook_s_news_feed_algorithm_works.html

Orians, G. H., & Schoen, J. W. (2017). *North Pacific temperate rainforests : Ecology and conservation*. Seattle, WA.: University of Washington Press.

Ostrom, E. (1998). A behavioral approach to the rational choice theory of collective action: Presidential address, American Political Science Association, 1997. *American Political Science Review*, *92*(1), 1–22. https://doi.org/10.2307/2585925

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science (New York, N.Y.)*, *325*(5939), 419–22. https://doi.org/10.1126/science.1172133

Papadopoulos, S., Kompatsiaris, Y., Vakali, A., & Spyridonos, P. (2012). Community detection in social media. *Data Mining and Knowledge Discovery*, *24*(3), 515–554. https://doi.org/10.1007/s10618-011-0224-z

Park, H. W. & Thelwall, M. (2008). Developing network indicators for ideological landscapes from the political blogosphere in South Korea. *Journal of Computer-Mediated Communication*, *13*(4), 856–879. https://doi.org/10.1111/j.1083-6101.2008.00422.x

Parks, M.R. (2015). Social networks and relationships. In *The International Encyclopedia of Interpersonal Communication* (pp. 1–9). Hoboken, NJ, USA: John Wiley & Sons, Inc. https://doi.org/10.1002/9781118540190.wbeic066

Partain, J. L., Alden, S., Bhatt, U. S., Bieniek, P. A., Brettschneider, B. R., Lader, R. T., … Ziel, R. H. (2016). *An assessment of the role of anthropogenic climate change in the Alaska fire season of 2015*. https://doi.org/10.1175/BAMS-D-16-0149.1

Partnow, P. H. (2001). *Making history : Alutiiq/Sugpiaq lıfe on the Alaska Peninsula*. Anchorage, AK.: University of Alaska Press.

Peachey, J. W., Zhou, Y., Damon, Z. J., & Burton, L. J. (2015). Forty years of leadership research in sport management: A review, synthesis, and conceptual framework. *Journal of Sport Management*, *29*(5), 570–587. https://doi.org/10.1123/jsm.2014-0126

Pelling, M., & Manuel-Navarrete, D. (2011). From resilience to transformation: The adaptive cycle in two Mexican urban centers. *Ecology and Society*, *16*(2), art11. https://doi.org/10.5751/ES-04038-160211

Perrin, A. (2015). Social media usage: 2005-2015. *Pew Research Center Internet and Technology*. Retrieved from http://www.pewinternet.org/2015/10/08/social-networking-usage-2005-2015/

Petko, D., Egger, N., Cantieni, A., & Wespi, B. (2015). Digital media adoption in schools: Bottom-up, top-down, complementary or optional? *Computers & Education*, *84*, 49–61. https://doi.org/10.1016/j.compedu.2014.12.019

Plafker, G. and Berg, H. C. (1994). *The Geology of Alaska: Geologic Society of America*. Retrieved from http://dggs.alaska.gov/pubs/id/22261

Poell, T., Abdulla, R., Rieder, B., Woltering, R., & Zack, L. (2015). Protest leadership in the age of social media. *Information, Communication & Society*, 1–21. https://doi.org/10.1080/1369118X.2015.1088049

Prior, M. (2007). *Post-broadcast democracy: How media choice increases inequality in political involvement and polarizes elections*. Cambridge, England: Cambridge University Press.

Rainie, H., & Wellman, B. (2012). *Networked : the new social operating system*. Cambridge, MA.: MIT Press.

Rappaport, E. N., Franklin, J. L., Avila, L. A., Baig, S. R., Beven, J. L., Blake, E. S., … Tribble, A. N. (2009). Advances and challenges at the National Hurricane Center. *Weather and Forecasting*, *24*(2), 395–419. https://doi.org/10.1175/2008WAF2222128.1

Rathwell, K. J., & Peterson, G. D. (2012). Connecting social networks with ecosystem services for watershed governance : A social ecological network perspective highlights the critical role of bridging organizations. *Ecology & Society*. https://doi.org/org/10.5751/ES-04810-170224

Ravallion, M. (2010). The developing world’s bulging (but vulnerable) middle class. *World Development*, *38*(4), 445–454. https://doi.org/10.1016/j.worlddev.2009.11.007

Rice, R. E., & Danowski, J. A. (1993). Is it really just like a fancy answering machine? Comparing semantic networks of different types of voice mail users. *Journal of Business Communication*, *30*(4), 369–397. https://doi.org/10.1177/002194369303000401

Robards, M. D., & Lovecraft, A. L. (2010). Evaluating comanagement for social-ecological fit: Indigenous priorities and agency mandates for pacific walrus. *Policy Studies Journal*, *38*(2), 257–279. https://doi.org/10.1111/j.1541-0072.2010.00361.x

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S. I., Lambin, E., … Foley, J. (2009a). Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*, *14*(2), art32. https://doi.org/10.5751/ES-03180-140232

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., … Foley, J. A. (2009b). A safe operating space for humanity. *Nature*, *461*(7263), 472–475. https://doi.org/10.1038/461472a

Rosenberg, J. M., Greenhalgh, S. P., Koehler, M. J., Hamilton, E. R., & Akcaoglu, M. (2016). An investigation of State Educational Twitter Hashtags (SETHs) as affinity spaces. *E-Learning and Digital Media*, *13*(1–2), 24–44. https://doi.org/10.1177/2042753016672351

Rupp, T. S. (2008). *Projected vegetation and fire regime response to future climate change in Alaska.* Retrieved from https://www.snap.uaf.edu/sites/default/files/preliminary.pdf

Samenow, J. (2011). Alaska storm to produce & hurricane-like conditions. *The Washington Post.* Retrieved from http://www.washingtonpost.com/blogs/capital-weather-gang/post/historic-alaska-storm-to-produce-hurricane-conditions/2011/11/08/gIQAaiqy0M_blog.html

Sandel, T. L. (2014). "Oh, I'm Here!": Social media's Impact on the cross-cultural adaptation of students studying abroad. *Journal of Intercultural Communication Research*, *43*(1), 1–29. https://doi.org/10.1080/17475759.2013.865662

Scenarios Network for Arctic Planning & EWHALE lab (2012). *Predicting Future Potential Climate-Biomes for the Yukon, Northwest Territories, and Alaska.* Retrieved from https://www.snap.uaf.edu/attachments/Cliomes-FINAL.pdf

Scheufele, D. A. (2000). Agenda-setting, priming, and framing revisited: Another look at cognitive effects of political communication. *Mass Communication and Society*, *3*(2–3), 297–316. https://doi.org/10.1207/S15327825MCS0323_07

Schwanda Sosik, V., & Bazarova, N. N. (2014). Relational maintenance on social network sites: How Facebook communication predicts relational escalation. *Computers in Human Behavior*, *35*, 124–131. https://doi.org/10.1016/j.chb.2014.02.044

Schwing, E. (2013a). Four years later, Eagle is still recovering from historic flood. *KUAC*. Retrieved March 7, 2017, from http://fm.kuac.org/post/four-years-later-eagle-still-recovering-historic-flood

Schwing, E. (2013b). Second largest flood on record hits eagle as Yukon breaks up. *Alaska Public Radio*. Retrieved from http://www.alaskapublic.org/2013/05/19/second-largest-flood-on-record-hits-eagle-as-yukon-breaks-up/

Scott, J., & Carrington, P. J. (2011). *The SAGE handbook of social network analysis*. Thousands Oaks, Ca.: SAGE Publications.

Searby, H. W., & Hunter, M. (1971). Climate of the North Slope, Alaska. *NOAA* [Technical Memorandum]. Retrieved from https://docs.lib.noaa.gov/noaa_documents/NWS/TM_NWS_AR/TM_NWS_AR_4.pdf

Seidl, I., & Tisdell, C. A. (1999). Carrying capacity reconsidered: From Malthus' population theory to cultural carrying capacity. *Ecological Economics*, *31*(3), 395–408. https://doi.org/10.1016/S0921-8009(99)00063-4

Senkowsy, S. (2014). Alaska's EDS Director Recognized Nationally for Galena Work. *Salvation Army – Alaska Division* (2014, May 31). Retrieved from http://www.salvationarmyalaska.org/alaska/news/VOAD_Recognition

Shacklette, H., Durrell, L. W., Erdman, J. A., Keith, J. R., Klein, W., Krug, H., … Weber, W. A. (1969). *Vegetation of Amchitka Island, Aleutian Islands, Alaska*. Retrieved from https://pubs.usgs.gov/pp/0648/report.pdf

Shaw, S., & Thomas, C. (2006). Discussion note: Social and cultural dimensions of air travel demand: Hyper-mobility in the UK? *Journal of Sustainable Tourism*, *14*(2), 209–215. https://doi.org/10.1080/09669580608669053

Shen, S., & Bowring, S. A. (2014). The end-Permian mass extinction: A still unexplained catastrophe. *National Science Review*, *1*(4), 492–495. https://doi.org/10.1093/nsr/nwu047

Shishmaref Erosion and Relocation Coalition. (n.d.). *Shishmaref Erosion and Relocation Coalition.* Retrieved June 06, 2017, from http://www.cakex.org/directory/organizations/shishmaref-erosion-and-relocation-coalition

Shulski, M., & Wendler, G. (2007). *The climate of Alaska*. Anchorage, AK.: University of Alaska Press.

Siemens, G. (2008). *Learning and knowing in networks: Changing roles for educators and designers.* [Technical Report] Retrieved from http://www.academia.edu/2857165/Learning_and_knowing_in_networks_Changing_roles_for_educators_and_designers

Small, T. A. (2011). What the hashtag? *Information, Communication & Society*, *14*(6), 872–895. https://doi.org/10.1080/1369118X.2011.554572

Smircich, L., & Stubbart, C. (1985). Strategic management in an enacted world. *Academy of Management Review*, *10*(4), 724–736. https://doi.org/10.5465/AMR.1985.4279096

Smith, A. (2011). Why Americans use social media. *Pew Research Center Internet and Technology.* Retrieved from http://www.pewinternet.org/2011/11/15/why-americans-use-social-media/

Smith, B. D., & Zeder, M. A. (2013). The onset of the Anthropocene. *Anthropocene*, *4*, 8–13. https://doi.org/10.1016/j.ancene.2013.05.001

Snow, hurricane-force winds batter Alaska coast. (2011). *CBS News*. Retrieved from http://www.cbsnews.com/8301-201_162-57322078/snow-hurricane-force-winds-batter-alaska-coast/

Stahl, G. K., & Sully de Luque, M. (2014). Antecedents of responsible leader behavior: A research synthesis, conceptual framework, and agenda for future research. *Academy of Management Perspectives*, *28*(3), 235–254. https://doi.org/10.5465/amp.2013.0126

Stange, K. C., Ferrer, R. L., & Miller, W. L. (2009). Making sense of health care transformation as adaptive-renewal cycles. *Annals of Family Medicine*, *7*(6), 484–7. https://doi.org/10.1370/afm.1032

State of Alaska Department of Commerce, Community, and Economic Development: Community and Regional Affairs (2017). *Community Database Online*. Retrieved February 23, 2017, from https://www.commerce.alaska.gov/dcra/DCRAExternal/community/

Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., … Svedin, U. (2011). The Anthropocene: From global change to planetary stewardship. *AMBIO*, *40*(7), 739–761. https://doi.org/10.1007/s13280-011-0185-x

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., … Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223).

Steffen, W., Sanderson, R.A., Tyson, P.D., Jäger, J., Matson, P.A., Moore III, B., … Wasson, R.J. (2005). *Global change and the earth system : A planet under pressure*. New York, NY.: Springer.

Strano, M. M. (2008). User descriptions and interpretations of self-presentation through Facebook profile images. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *2*(2), 5.

Tan, C. (2016). Investigator bias and theory-Ladenness in cross-cultural research: Insights from Wittgenstein. *Current Issues in Comparative Education*, *18*(1), 83–95.

Taylor, K. M., Hum, R., & Kontar, Y. Y. (2016). *Comparative analysis of virtual relief networks and communication channels during disaster recovery after a major flood in Galena, Alaska, spring 2013* (pp. 151–171). New York, NY. Springer International Publishing. https://doi.org/10.1007/978-3-319-20161-0_10

Tchernichovski, O., Feher, O., Fimiarz, D., & Conley, D. (2017). How social learning adds up to a culture: From birdsong to human public opinion. *Journal of Experimental Biology*, *220*(1).

The Arctic Council: A backgrounder. (n.d.). Retrieved from http://www.arctic-council.org/images/PDF_attachments/2015-07-03_Arctic_Council_Backgrounder_PRINT_VERSION_NO_LINKS.pdf

The Bering Strait Messenger Network. (n.d.). Retrieved June 15, 2017, from https://www.facebook.com/beringstraitmessengernetwork/

Thomas, C. S., Savatgy, L. C., & Klimovich, K. (2016). *Alaska politics and public policy : The dynamics of beliefs, institutions, personalities and power*. Anchorage, AK., University of Alaska Press.

Timm, K., Hum, R., & Druckenmiller, M. (2016). Using communication theory and strategy to develop researcher-stakeholder relationships. [White paper]. *Arctic Observing Summit*. Retrieved June 14, 2017, from http://www.arcticobservingsummit.org/sites/arcticobservingsummit.org/files/Timm-Hum-Druckenmiller-REVISEDRC-AOS-Statement-Revised-1222016.pdf

Tiwari, D. N. (2016). Spiritual ecology and environmental ethics. *Cultura International Journal of Philosophy of Culture and Axiology*, *13*(1), 49–68. https://doi.org/10.5840/cultura20161313

Trainor, S. F., Calef, M., Natcher, D., Chapin III, S. F., McGuire, A. D., Huntington, O., … Lovecraft, A. L. (2009). Vulnerability and adaptation to climate-related fire impacts in rural and urban interior Alaska. *Polar Research*, *28*(1), 100–118. https://doi.org/10.1111/j.1751-8369.2009.00101.x

Tunseth, M. (2016). *Anchorage public schools lead nation in diversity*. Retrieved February 23, 2017, from https://www.adn.com/education/article/anchorage-melting-pot-diversity/2015/05/24/

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., … Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences U S A*, *100*(14), 8074–8079. https://doi.org/10.1073/pnas.1231335100

US Census Bureau (2017). *Census demographics*. Retrieved February 23, 2017, from https://datamapper.geo.census.gov/map.html

USGS. (2016). *Wildlife and habitat research at the Alaska science center*. Retrieved February 21, 2017, from https://alaska.usgs.gov/science/topic.php?tid=1

Valente, T. W., & Davis, R. L. (1999). Accelerating the diffusion of innovations using opinion leaders. *Annals of the American Academy of Political and Social Science*, *566*, 55-67

Vance-Borland, K., & Holley, J. (2011). Conservation stakeholder network mapping, analysis, and weaving. *Conservation Letters*, *4*(4), 278–288. https://doi.org/10.1111/j.1755-263X.2011.00176.x

Viswanath, B., Mislove, A., Cha, M., & Gummadi, K. P. (2009). On the evolution of user interaction in Facebook. In *Proceedings of the 2nd ACM workshop on Online social networks* (pp. 37–42).

Vowe, G., & Henn, P. (Eds.)(2016). *Political communication in the online world : Theoretical approaches and research designs*. New York & London, Routledge Taylor and Francis Group.

Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., & Schultz, L. (2006). A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society*, *11*(1), art13. https://doi.org/10.5751/ES-01530-110113

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, *9*(2).

Wang, R., Tanjasiri, S. P., Palmer, P., & Valente, T. W. (2016). Network structure, multiplexity, and evolution as influences on community-based participatory interventions. *Journal of Community Psychology*, *44*(6), 781–798. https://doi.org/10.1002/jcop.21801

Wanta, W., & Wu, Y.C. (1992). Interpersonal Communication and the Agenda-Setting Process. *Journalism & Mass Communication Quarterly*, *69*(4), 847–855. https://doi.org/10.1177/107769909206900405

Weingroff, R. F. (1996). Milestones for u.s. highway transportation and the federal highway administration. *Public Roads*, *59*(4).

West, C. T., & Ross, C. (2012). Local institutions for subsistence harvesting in western Alaska: Assessing their adaptive role in the context of global change. *Journal of Ecological Anthropology*, *15*(1).

Wexler, L. (2011). Intergenerational Dialogue Exchange and Action: Introducing a Community-Based Participatory Approach to Connect Youth, Adults and Elders in an Alaskan Native Community. *International Journal of Qualitative Methods*, *10*(3), 248–264.

Wexler, L., Moses, J., Hopper, K., Joule, L., Garoutte, J., & LSC CIPA Team (2013). Central role of relatedness in Alaska native youth resilience: Preliminary themes from one site of the Circumpolar Indigenous Pathways to Adulthood (CIPA) study. *Am J Community Psychol*, *52*(3–4), 393–405. https://doi.org/10.1007/s10464-013-9605-3

Wikipedia. (2017a). *List of Newspapers in Alaska*. Retrieved February 16, 2017, from https://en.wikipedia.org/wiki/List_of_newspapers_in_Alaska#Daily_newspapers_.28currently_published.29

Wikipedia. (2017b). *List of radio stations in Alaska*. Retrieved February 16, 2017, from https://en.wikipedia.org/wiki/List_of_radio_stations_in_Alaska

Wikipedia. (2017c). *List of television stations in Alaska*. Retrieved February 16, 2017, from https://en.wikipedia.org/wiki/List_of_television_stations_in_Alaska

Wilkinson, S. E., Basto, M. Y., Perovic, G., Lawrentschuk, N., & Murphy, D. G. (2015). The social media revolution is changing the conference experience: Analytics and trends from eight international meetings. *BJU International*, *115*(5), 839–846. https://doi.org/10.1111/bju.12910

Willey, K., Meng, Q., & Gardner, A. (2015). *Insights from using a subject specific Facebook group for student engagement and learning*. Retrieved from https://opus.lib.uts.edu.au/handle/10453/36633

Williams, M. S. T. (2009). *The Alaska native reader : History, culture, politics*. Durham, NC.: Duke University Press.

Woodburn, A., Allen, J., Browne, M., & Leonardi, J. (2008). *The impact of globalisation on international road and rail freight transport activity. Past trends and future perspectives OECD/ITF Global Forum on sustainable development:Transport and environment in a globalising world -Guadalajara, Mexico*. Retrieved from http://www.oecd.org/greengrowth/greening-transport/41750077.pdf

Wotton, B. M., Nock, C. A., & Flannigan, M. D. (2010). Forest fire occurrence and climate change in Canada. *International Journal of Wildland Fire*, *19*(3), 253–271.

Xie, J., Kelley, S., & Szymanski, B. K. (2013). Overlapping community detection in networks. *ACM Computing Surveys*, *45*(4), 1–35. https://doi.org/10.1145/2501654.2501657

Yang, J., & Leskovec, J. (2015). Defining and evaluating network communities based on ground-truth. *Knowledge and Information Systems*, *42*(1), 181–213. https://doi.org/10.1007/s10115-013-0693-z

Young, L. E., & Leonardi, P. M. (2012). Social issue emergence on the web: A dual structurational model. *Journal of Computer-Mediated Communication*, *17*, 231–246. https://doi.org/10.1111/j.1083-6101.2011.01566.x

Young, O. R. (2002). *The institutional dimensions of environmental change : Fit, interplay, and scale*. Cambridge, MA.: MIT Press.

Young, O. R. (2010). Institutional dynamics: Resilience, vulnerability and adaptation in environmental and resource regimes. *Global Environmental Change*, *20*(3), 378–385. https://doi.org/10.1016/j.gloenvcha.2009.10.001

Young, O. R. (2013). Sugaring off: Enduring insights from long-term research on environmental governance. *International Environmental Agreements: Politics, Law and Economics*, *13*(1), 87–105. https://doi.org/10.1007/s10784-012-9204-z

Young, O. R., Berkhout, F., Gallopin, G. C., Janssen, M. A., & van der Leeuw, S. (2006). The globalization of socio-ecological systems: An agenda for scientific research. *Global Environmental Change*, *16*(3), 304–316. https://doi.org/10.1016/j.gloenvcha.2006.03.004

Zalasiewicz, J., Waters, C. N., Williams, M., Barnosky, A. D., Cearreta, A., Crutzen, P., … Oreskes, N. (2015). When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal. *Quaternary International*, *383*, 196–203. https://doi.org/10.1016/j.quaint.2014.11.045

Zalasiewicz, J., Waters, C., & Head, M. J. (2017). Anthropocene: Its stratigraphic basis. *Nature*, *541*(7637), 289–289. https://doi.org/10.1038/541289b

Zalasiewicz, J., Williams, M., Smith, A., Barry, T. L., Coe, A. L., Bown, P. R., … Rawson, P. (2008). Are we now living in the Anthropocene? *GSA TODAY*, *18*(2). https://doi.org/10.1130/GSAT01802A.1

Zhao, S. (2008). Identity Construction on Facebook: Digital empowerment in anchored relationships. *Computers in Human Behavior*, (24), 1816–1836.

Zuiker, S., & Whitaker, J. R. (2014). Refining Inquiry with Multi-Form Assessment: Formative and summative assessment functions for flexible inquiry. *International Journal of Science Education*, *36*(6), 1037–1059. https://doi.org/10.1080/09500693.2013.834489

Appendix

Title	Location	Description
Windows into Other Worlds		My personal blog. This channel provides boiled down analysis of the case studies and theories presented in this dissertation. Additional cases studies are explored through this channel as well.
Google Drive PhD Files		This channel provides public access to the full body of data developed as part of this dissertation. Additionally, materials that illustrate the reflexive nature of the research process are achieved in this space. Including: my comprehensive exams, a sequential progression of dissertation drafts, and my defense
Acadamia.edu		This channel provides public access to the full body of data developed as part of this dissertation.
Researcher gate		This channel provides public access to the full body of data developed as part of this dissertation.
Google Drive Learning Activity Files	https://drive.google.com/open?id=0B-SWQftFc_U1djAwNU5GdURhNjg	This channel provides access to additional learning activity resources.

Appendix A: Data archive. This study is based on the exploration of dynamic communication networks. These types of networks, along with the methods I have compiled to build and assess them produce a vast quantity of data—far more than can be presented in a printed dissertation format. Appendix A provides links to a variety of active communication channels that I maintain as components of my own professional communication strategy and serve as repositories for the full data sets used in this work. Given the transitory (and commercial) nature of modern digital media, I maintain multi platforms of very similar content as a hedge against any one platform going out of business.