



Enhancing adaptive capacities in coastal communities through engaged communication research: Insights from a statewide study of shellfish co-management

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A B S T R A C T

Intertidal ecosystems and the small-scale fisheries these ecosystems support are an important part of coastal economies, environments, and cultures. Globally, fisheries such as the soft-shell clam (*Mya arenaria*) face multiple stressors related to climate change, invasive species, and unsustainable land use. Co-management approaches based on shared responsibility for resource management among actors and institutions can build resilience to socio-environmental change by strengthening the use of science in decision making and promoting adaptive capacities such as learning and leadership. In this paper, we demonstrate how engaged communication research can help foster adaptive capacities to enhance the resilience of these systems. We describe perceptions of problems and successes in co-management, as awareness of problem constructions is essential for identifying the ways in which communication shapes adaptive responses. We demonstrate how specific communication factors influence adaptive capacities such as learning, leadership, and equity. We conclude with recommendations and demonstrated evidence of the value of bringing engaged communication research to bear on pressing issues of global coastal change.

1. Introduction

The health of small-scale fisheries is essential to the sustainability of coastal regions throughout the world (Berkes et al., 2001; National Research Council, 2010). Small-scale intertidal fisheries that depend on bivalves such as soft-shell clams, *Mya arenaria*, face numerous environmental threats (Food and Agriculture Organization, 2011), including warming ocean temperatures (Pershing et al., 2015), shifts in predation rates and/or species of predators (Beal et al. 2016; Sorte et al., 2010), increases in harmful algal blooms (Gobler et al., 2017), changing ocean chemistry, and persistent water pollution, among other factors (Harley et al., 2006; Hughes et al., 2003). These fisheries also face complex social issues, many of which are related to poverty and education access (Allison and Ellis, 2001; Defeo and Castilla, 2005; Sobhee, 2004). However, small-scale fishing communities are also rising to meet the challenge of these issues (Gutiérrez et al., 2011). There is an urgent need to identify social factors that enable such adaptation and the resilience of intertidal ecosystems and coastal communities.

The purpose of this paper is to demonstrate how engaged communication research can help meet this need in ways that also actively build adaptive capacities. The soft-shell clam fishery in Maine, a state in the northeastern United States (U.S.), provides an ideal case example for advancing this work. This context is ripe for engaged research and adaptive responses to socio-environmental change for at least three reasons, including the representativeness and diversity of issues within this fishery; the presence, scale, and organization of the shellfish co-management system; and the history of applied marine science in the state. First, this fishery is experiencing similar socio-environmental changes to those observed globally. Soft-shell clam populations are affected by a host of environmental factors, many of which are exacerbated by climate change, such as predation (Beal, 2006a, 2006b; Beal et al., 2018) and water pollution (Evans, Athearn, Chen, Bell, & Johnson, 2017). In eastern parts of the state, studies have detected decreases in clam recruitment over time (Congleton et al., 2006; Vassiliev et al., 2010), though recent studies found that high levels of recruitment are still occurring but rates of post-settlement mortality of juvenile clams exceed 99% (Beal et al., 2018). These ecological shifts

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impact the economic and cultural values of the clam fishery. Clamming has occurred on this coast for at least 1700 years (Dow and Wallace, 1961), as native Wabanaki tribes dug clams for food and trade (Hanna, 2000) and continue to do so today. Over the last two centuries, clamming was an important source of income within what were once diversified fishing livelihoods (Acheson, 1988; Brewer, 2012; Hanna, 2000; Stoll et al., 2016) and often occurred during the fall and winter months when other fishing opportunities were limited (Ambrose et al., 2016) and when water pollution concerns were lessened (Dow and Wallace, 1961). Economically, the soft-shell clam fishery alternates between the second or third most valuable fishery based on commercial landings and it also employs more than 1500 harvesters. Further, it accounts for more than 60% of the total soft-shell clam fishery in the U.S. (Evans et al., 2016; Hanna, 2000). In 2016, the landings value was \$16.2 million, down from \$22.5 million in 2015 (Maine Department of Marine Resources, 2018), and in 2017 the state experienced the lowest clam landings since 1925 (Johnson et al., 2014). In the last forty years state clam landings have decreased by nearly 75% (Beal et al., 2016), and eastern Maine landings have declined by about two-thirds since the early 1980's (Congleton et al., 2006). Though clam landings can serve as a proxy for clam population abundance, factors such as declines in the number of commercial clambers and changes in competing fisheries also influence landings volume, highlighting the need for reliable statewide stock assessments.

Second, the existing shellfish co-management system is one of the key sites where scientific and technical solutions, such as mitigating impacts from the invasive European green crab, *Carcinus maenas*, and other predators (McClenachan et al., 2015; Glude, 1955) by using methods designed to protect juvenile clams from predation (Beal et al., 2016 & 2018), are being advanced. Co-management is a governance arrangement that relies on shared responsibility and power among institutions (Berkes et al., 1991; Pinkerton, 1989; Plummer and Fitzgibbon, 2004) and this approach has a long history in Maine. The legal right of Maine people to harvest clams in the intertidal began with the 1641 Massachusetts Bay Colony Ordinance, which gave rights of fishing, fowling, and navigation in the intertidal to all residents (Hanna, 2000). Today, shellfish ordinances are administered by municipal shellfish committees with guidance from the Maine Department of Marine Resources (DMR) which has a legal mandate to approve ordinances. As determined by state statute (Title 12, Part 9, Chapter 623), towns with approved shellfish programs can restrict entry, charge license fees, require town residency for access, limit the quantity of harvest, set clamming seasons, open and close areas to harvest, and lease up to 25% of their intertidal area. The state requires licensing, defines acceptable harvest tools, sets a minimum harvest size and tolerance, and monitors public health (Hanna, 2000). Today, 74 out of Maine's 77 coastal towns co-manage their shellfish resources, representing 57 total shellfish programs, as some towns collaborate on regional and inter-local ordinances (DMR, personal communication, February 5, 2018).

In many fisheries, co-management has strengthened adaptive capacities and resilience (García-Ayllón, 2017; Gutiérrez et al., 2011; McClenachan et al., 2015; Pinkerton et al., 2014). We define resilience as the ability of a social-ecological system to anticipate and adjust to changes to stay within identified thresholds. For example, resilience is evident when clambers adjust to declines in clam populations by planting clams in an intertidal mudflat to maintain a functioning ecosystem and healthy economy. The ability to respond to change relies on adaptive capacities to maintain or transform system conditions when necessary (Chapin et al., 2009; Folke et al., 2010). Social and policy-based perspectives expand on this approach to resilience by calling attention to the resilience of what, to what, and for whom (Lebel et al., 2006). In the case of shellfish co-management in Maine, we focus on the resilience of intertidal ecosystems, clambers, and shellfishing communities to a set of interlinked ecological, economic, and social changes. The question of *for whom* calls attention to power, which is

particularly relevant in fisheries where power disparities contribute to social inequities (Béné, 2003). Further, experiences with and perceptions of state power shape relations within co-management and contribute to the complexity of communication in this context. Finally, paying attention to power is essential in engaged research that seeks to inform on-the-ground action but can also result in reinforcing existing power disparities (Silka et al., 2008).

Third, there is a history of applied research in Maine's fisheries due, in part, to the Land and Sea Grant mission at the University of Maine (UMaine); the proximity of university system campuses to the coast; frequent employment connections between UMaine's School of Marine Sciences and system campuses with marine biology programs and DMR; and the multiple fisheries organizations in the state. Important aspects of fisheries co-management in Maine have previously been documented, such as the role of cooperation and conflict in the lobster fishery (Acheson, 2013, 1988; Brewer, 2012; Waring and Acheson, 2018; Wilson et al., 2007); the influence of spatial heterogeneity in the harvesting and management of green sea urchins, *Strongylocentrotus droebachiensis* (Johnson et al., 2012; Cleaver, 2014); and how institutional characteristics influence adaptive capacities in shellfish co-management (MacLagan, 2014; McClenachan et al., 2015).

We build from previous studies of resilience in small-scale fisheries and in Maine's fisheries co-management system to demonstrate how engaged communication research can address complex problems for adaptation and resilience. We describe how co-defining problems and metrics of success in co-management can help identify workable communication strategies that can be used to strengthen information sharing and learning (Goldstein, 2012; Pahl-Wostl, 2009; Pinkerton, 2009), diverse forms of leadership (Gunderson et al., 2008; McGreavy et al., 2016; Stoll, 2017), and the development of shared identities and relationships (Agarwal and Buzzanell, 2015). After briefly reviewing concepts that connect theories of resilience and communication, we describe how engaged communication research, which is based on developing partnerships and co-defining research processes to strengthen linkages between knowledge and action, can promote adaptive capacities to enhance responsiveness to change within coastal fisheries (Cash et al., 2003; Trickett and Espino, 2004). We describe our engaged research methodology and qualitative methods for collecting and analyzing interview data (Creswell, 2014; Lindlof and Taylor, 2011). In our results, we share key insights about problem perceptions and criteria for success. We then detail how specific communication factors including strategic, relational, contextual and equity-related issues shape adaptive capacities in shellfish co-management. We highlight three communication recommendations that intend to enhance learning, collaboration, and equity and conclude by demonstrating how engaged research can enable linking social science recommendations with organizational change for resilience in shellfish co-management.

1.1. Communicating resilience within fisheries Co-management

Resilience is a useful framework for understanding complex interactions between ecosystems and people and has been widely used to explain dynamics within small-scale fisheries (e.g. Berkes et al., 2001; García-Ayllón, 2017). Specific factors in co-managed fisheries promote resilience (Basurto, Gelcich, & Ostrom, 2013), many of which connect with Ostrom's (1990, 2007) design principles and analytic framework for Social Ecological Systems (SES). For example, in a systematic analysis of 130 cases, the presence of community leaders and strong social connections, as well as appropriate enforcement, long-term management policies, and the participation of fishers in local markets predicted success in co-management (Gutiérrez et al., 2011). That study combined eight ecological, economic and social metrics including stock abundance, social well-being, and increases in unit price, among others into a holistic assessment of co-management success and SES resilience. Satumanatpan and Pollnac (2017) expand the analysis of social well-being in a small-scale fishery in Thailand, as they identify how social

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