Sense of Place and Perceived Community Change in Perceived Impacts of and Cooperation with Local Aquaculture Development in the U.S.

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Abstract

The emotional, social, and other bonds people have with specific locations, labeled "sense of place" (SoP), have been covered by diverse academic literatures, but conceptual and methodological contradictions and omissions leave their effects unclear. For example, the role of SoP in support of or resistance to siting of potentially hazardous energy facilities is uncertain due to mixed findings, disparate methods, and no consideration of mechanism(s) for SoP effects. We use a survey (n = 523) of Americans living near three proposed or operating land-based recirculating aquaculture systems (RAS) facilities to explore how multiple dimensions of SoP might affect local support for these developments, with perceived community change and perceived facility impacts as serial mediators. Direct effects of SoP were absent, but indirect effects of identity with place, and especially of social bonding with local family and friends, increased support via positive evaluations of past community change and/or perceived facility impacts; bonding with nature did not affect facility support, or even perception of the facility's environmental impacts. Examining effects of different dimensions of SoP, as well as the mediating effects of seeing community change generally as positive, may provide both the basis for explanatory mechanisms of SoP effects and for divergent findings; however, causal claims would depend on longitudinal or experimental methods.

Keywords: sense of place; community change; facility siting; perceived risk; social license to operate; recirculating aquaculture systems

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1. Introduction

Measured with varied concepts and methods, sense of place (SoP) has gained increasing attention in environmental research to understand how and why people act in their spatial and social contexts. That people bond with locations where they live, work, and play, with such bonds exercising potentially powerful effects (e.g., on recreating, resisting change, or moving away), is increasingly compelling. A small but growing literature has used SoP to partly explain behavioral intentions in support of energy development (e.g., Devine-Wright, 2009; Hall et al., 2014), also referred to in the trust literature as "cooperation" (Earle & Siegrist, 2006). Yet the diverse concepts and measurements applied within and across disciplines and the underdeveloped theoretical basis for understanding the impact of SoP obscure its implications for environmental behavior. For instance, does strong attachment to a place always foster opposition to a facility siting, and if so, why, and by what mechanism? Might this reaction occur in contexts outside of wind farms, nuclear power reactors, and other energy development?

We use the example of aquaculture development—specifically, recirculating aquaculture systems (RAS) to raise salmon in tanks on land—to offer insights into both how different kinds of SoP can differentially affect residents' response to this variety of facility siting, and these larger questions of the role of SoP in understanding responses to novel development. Taking a process-oriented approach, we use a serial mediation model to measure the relationship between SoP and support for a facility, as mediated by perceived project impacts and perceived community change. In doing so, we also extend the SoP-energy siting framework (Devine-Wright, 2009) to the context of land-based aquaculture, a development issue posing interconnected environmental, animal, and human health benefits and risks, and related "threats" or "opportunities" to specific places and their associated meanings (Jaquet & Stedman, 2014).

The study reported here comes from a larger project conducting the first known systematic analysis of public and stakeholder attitudes toward land-based RAS in U.S. communities where they have been proposed (and, in one site, operating). We focus on results from a public opinion survey in three communities, finding that SoP can both increase and decrease facility-related cooperation, depending upon its dimension (e.g., nature- vs. family-related place bonds). Perceived beneficial impacts of the facility strongly shaped cooperation, as did perceptions of community change. Regarding the serial mediation model, we find partial evidence of SoP influencing perceived community change, which, in turn, influences perceived project impacts and then cooperation. Besides discussing implications of our results for existing theory linking SoP and siting, we also explore their practical implications for supporting future aquaculture development in the U.S. and elsewhere.

2. Literature Review

2.1. Context: Aquaculture

Humans have engaged in aquaculture—raising finfish and shellfish in contained areas in the ocean, estuaries, or ponds—for thousands of years, though far briefer than the even older technique of hunting and gathering of wild seafood with fishing lines, nets, cages, and weirs. Over the past few decades, aquaculture has become the fastest-growing food producing sector worldwide, with global production of 179 million tons in 2018 and annual values over $250 billion exceeding capture fisheries (Food and Agriculture Association of the United Nations [FAO], 2020; Naylor et al., 2021; Tacon, 2020). Expanding global trade, declining availability of wild fish, and urbanization, among other factors, have helped aquaculture production increase

527 percent between 1990-2018 (Naylor et al., 2021). A particular form of finfish aquaculture, land-based recirculating aquaculture systems (RAS), is a suite of technologies allowing producers maximum control over inputs and outputs, from egg to harvest. Fish move between multiple tanks at various life stages, calibrated to match their biological needs. Filters remove solid waste through a mechanical filtration process; another biofiltration process removes dissolved wastes (e.g., ammonia, carbon dioxide) before the water is disinfected and reused. Producers constantly monitor system attributes, such as water quality, optimizing parameters for fish health (Recirculating Aquaculture Salmon Network [RAS-N], 2022). Successful land-based RAS facilities maximize biosecurity—i.e., fish are unlikely to escape, and pathogens and predators unlikely to enter—to address a limitation of ocean-based net pen aquaculture (RAS-N, 2022), and inland siting can offer communities previously without local seafood a fresh option entailing fewer "food-miles" (Weber & Matthews, 2008).

2.2. Aquaculture Facility Siting

Focused on potentially noxious or other "inherently" undesirable operations (e.g., sewage waste facilities), the facility siting literature has tended to stress economic benefits as potentially outweighing perceived and actual negative impacts, and often a "not in my backyard" (NIMBY) reaction: neighboring residents do not necessarily object to the technology or service provided, but do not want it nearby (e.g., Forcade, 1984; B. Johnson, 1987). We agree with scholars (e.g., Wolsink, 2006) who believe that developers' and officials' use of this term both misrepresents the full nature of opposition to proposed facilities and tends to obstruct siting success. More recently, siting of some energy facilities and operations (e.g., Boudet, 2011; Gottlieb et al., 2018; Tanaka, 2004) has prompted alternative interpretations (e.g., "not in *anyone's* backyard"), while other studies—e.g., on local reactions to some windmill farm proposals—have reaffirmed the

NIMBY model (e.g., van der Horst, 2007) and argued that institutional capacity constrains siting more than lack of public support (Wolsink, 2000).

Siting aquaculture facilities, in water or on land, entails engaging with local communities which may greet such facilities with delight (e.g., more jobs, tax revenues, improved local food markets), despair (e.g., competition with wild harvesters, environmental impact, incompatibility with tourist and/or local amenities), or some combination (D'Anna & Murray, 2015; Hanes, 2018). Public opposition to new aquaculture development might appear to exemplify NIMBYism (e.g., van der Horst, 2007); upon deeper reflection, such debates reflect how individuals, interest groups, and communities value natural and cultural resources, and trust various institutions to manage them (Devine-Wright, 2013; Mather & Fanning, 2019); perceive risks and benefits to their health, environment, and the economy (Rickard et al., 2020); and envision a shared future (Hanes, 2018; T. Johnson & Hanes, 2017).

With lower visual profiles than some energy development, RAS facilities may partly escape negative siting dynamics. However, such facilities are often locally novel and may conflict with what locals deem culturally "appropriate" behavior (e.g., exchanging "hunting and gathering" of native seafood for "factory farming" of "unnatural" stocks; Feucht & Zander, 2015; *reference omitted*), and/or meanings they currently or historically associate with a given place (Alexander, 2021). For example, lifelong residents with local ancestry and low socioeconomic status (SES) may tend to tolerate or even welcome aquaculture and other activities, particularly if deemed consistent with local resource extraction histories, while more opposition may occur among voluntary residents in the community, with high SES and high community activity (e.g., retirees, second-home owners, or "amenity migrants" [Hanes, 2018; Stedman, 2006; Sullivan & Young, 2018]). In a recent study of oyster aquaculture in Rhode

Island (U.S.), Dalton et al. (2017) found differences in tolerated levels of ocean-based aquaculture development depending on whether the respondent could see the water from their home. The authors suggested that this finding indicates "the importance of considering not just what people think about the activity being proposed, like aquaculture, but also what they think about the place where the activity is proposed" (Dalton et al., 2017, p. 201; see also Ryan et al., 2017).

The current model of acceptance of novel activities and technologies, in which trust in their promoters and/or opponents affects publics' perceived benefits and risks, which in turn affect acceptance (Frewer et al., 2011; Siegrist, 1999, 2000), is likely applicable to aquaculture in general (Rickard et al., 2020), as well as to many siting efforts (*reference omitted*). But it is likely not detailed enough to assist communities and aquaculture promoters in understanding and addressing more localized reactions to specific projects. Having explored elsewhere (*reference omitted*) the role of trust in shaping benefit-risk beliefs and thus support for a local RAS facility (i.e., "cooperation"; Earle & Siegrist, 2006), here we examine the effect of SoP and perceived community change on cooperative public responses to siting land-based RAS facilities. We describe these concepts in turn.

2.2.1. Cooperation. Earle and Siegrist (2006) define cooperation as behaviors, behavioral intentions, or other indicators of "support" stemming from trust or confidence in a decision-maker. We focus here on behavioral intentions and argue that using multiple measures reflects increasing evidence that combining multiple behaviors into a single index—e.g., the count of protective actions against a natural hazard a household has adopted (e.g., Lindell & Whitney, 2000)—prevents understanding how factors in their adoption vary across behaviors (e.g., Johnson, 2019). In selecting cooperation measures we emphasized behaviors at least hypothetically observable—e.g., voting in support of the facility in a hypothetical referendum—to probe a variety of facility responses.

Our emphasis on "cooperation" reflects our theoretical interests in such behavior as a potential outcome of trust (*reference omitted*), plus our desire to emphasize potentially observable behaviors, even if self-reported. That said, our approach to cooperation may fall under more general categories proposed in the literature, such as classifying social acceptance of a given technology into socio-political, community, or market-related categories (e.g., Devine-Wright et al., 2017; Wustenhagen et al., 2007), or social license to operate (SLO), the often implied, ongoing acceptance and approval of an industrial operation by a broad swath of the local population (Alexander, 2021). While the cooperative behaviors we focus on here can certainly be presumed to signal "acceptance and approval," they cover a fairly narrow scope (i.e., actively seeking to get the facility operating, or stop its operation, and consuming its products). In our view, SLO constitutes much more than this—tacit neutrality, recommending employment there, urging other businesses to follow its lead in locating in town, citing it proudly as a community asset, using it as a taken-for-granted directional cue ("turn right at the fish plant"), mourning its evolution into a vestigial feature of the utilitarian landscape (e.g., Chappell et al., 2020), and so forth—although we believe further clarification of what constitutes SLO in aquaculture facility siting is warranted. Hall et al. (2013) employed qualitative methods across several Australian case studies to identify four themes—trust, procedural justice, distributive justice, and place attachment—as underlying support for wind farms, and other research, both qualitative and quantitative, has proposed similar concepts as comprising SLO, as in the mining (e.g., Moffat & Zhang, 2014) or aquaculture (e.g., Baines & Edwards, 2018; Sinner et al., 2020) contexts. An even broader concept is that of the "social carrying capacity" (SCC) for a new aquaculture venture at a given site, identified via knowledge of technical and biophysical constraints and opportunities as well as those posed by the local social responses defined by cooperation narrowly, and by SLO broadly (Dalton et al., 2017; T. Johnson et al., 2019). In this research, we use cooperation to indicate a relatively narrow set of explicitly RAS-facility-targeted behaviors, while acknowledging the complementary, broader concepts of SLO or SCC regarding a community's warrant for a facility's local operation.

2.2.2. Sense of place. Despite multidisciplinary, partly conflicting definitions (e.g., Lewicka, 2011), SoP entails cognitive, emotional, and social links to specific places, and includes such concepts as place identity ("who we are" tied to physical or symbolic settings); place dependence (the physical setting supports intended uses); social bonding (links to specific individuals; sense of shared history or interests); and nature bonding (historical, emotional, or cognitive ties to the non-human environment) (Raymond et al., 2010). Residence time and home ownership are strongly linked with SoP (Lewicka, 2011), but degree, type, and scale (e.g., neighborhood vs. country) of place attachment can vary (Devine-Wright, 2013; Devine-Wright & Batel, 2017; Lewicka, 2011, 2013). Results of research on the relationship between SoP and support for proposed (and existing) energy development have been mixed. In a foundational study in a rural Norwegian community, Vorkinn and Riese (2001) found the strength of attachment to areas affected by proposed hydropower development undermined project support, explaining more variance than demographic variables. Later studies also found strong place attachment associated with opposition to high voltage power line development in southwest England (Devine-Wright, 2013; Devine-Wright & Batel, 2017), and wind farm development in northern Wales (Devine-Wright & Howes, 2010). Yet, other survey-based studies found positive associations between place attachment and support for energy development, for wind farms in

Canada (Chappell et al., 2021) and the U.S. (Hoen et al., 2019), and for tidal energy in Northern Ireland (Devine-Wright, 2011). Other studies found no statistically significant relationship between SoP-related variables and support for solar facilities in California (Carlisle et al., 2014) and nuclear power stations in the UK (Venables et al., 2012). To date, studies specific to aquaculture SLO—in contrast to Hall et al. (2013) on wind farm siting—have yet to employ SoP explicitly, though a recent overview of the topic identified community "context," including "historical, international, national, and local industry contexts"—in which SoP presumably might be categorized—as exerting strong influence on perceptions and, in turn, SLO (Alexander, 2021).

Despite much literature suggesting that SoP influences public reaction to energy development, its nature appears to hinge on how a proposed technology or specific facility may "disrupt" (Jacquet & Stedman, 2014) or complement individuals' perceptions of "the type of place a community is" (Devine-Wright, 2009). Integrating SoP and social representations theory, Bergquist et al. (2021) examined how proposed energy transmission lines in the U.S. Midwest could seem "place enhancing" or "place threatening" depending on symbolic meanings stakeholders associated with a given location. Other mixed method research on wind development in the UK and Australia also reports that support for energy development stems from how much a project aligns with the character of a place as, e.g., tourist destination or industrial site (Devine-Wright & Howes, 2010; Hall et al., 2014). As Jacquet and Stedman (2014) argue, the "social-psychological disruption" of energy development poses the risk of losing critical place meaning. It is telling that neighbors of such development increase support with perceived project benefits, and increase opposition with perceived project risks (Boyd, 2017; Carlilse et al., 2014; Devine-Wright, 2013).

The perceived compatibility of a proposed aquaculture facility with its locale also could greatly affect perceptions of its benefits and risks, implying that facility promoters who design and market a seemingly compatible facility may be more likely to succeed (e.g., Alexander, 2021). Yet despite the plausibility that SoP could affect one's support for a local land-based RAS facility (i.e., cooperation), evidence on this relationship's sign is mixed, and appears to hinge on seeing positive or negative impacts from the siting. Thus, we pose the following:

RQ1. *Does sense of place (SoP) increase or decrease cooperation?*

H1. *Cooperation is positively related to perceived project benefits (i.e., perceived impacts).*

RQ2. *Does SoP increase or decrease perceived project benefits?*

Some scholars have proposed SoP as multi-dimensional, positing variation in bases for connection with a place, such as social bonds versus bonds with physical nature (e.g., Raymond et al., 2010). Many such studies have focused on non-siting-related SoP (e.g., farmers in Raymond et al., 2010) or recreational amenities (e.g., hikers in Kyle et al., 2003), rather than on siting issues such as those raised for energy development. Criticisms of current multi-dimensional measures as inadequate for assessing SoP in "working landscapes" (Eaton et al., 2019), such as farming, fishing, logging, mining, and other communities where people make their living from extracting natural resources, and where land-based RAS facilities may be proposed, do not offset lack of attention to whether SoP dimensions might have distinct associations with responses to facility siting. While a few studies have applied SoP-adjacent concepts (e.g., "lived experience" — [D'Anna & Murray, 2015; Murray & D'Anna, 2015] and "natural capital" —Pierce & McKay [2008]) to marine aquaculture development, even fewer have drawn from existing literature to measure SoP concepts. A sole example of the latter, Shafer et al. (2010) assessed coastal recreational use and related perceptions (i.e., place dependence), finding that neighbors of a proposed New Zealand marine aquaculture development believed the farm would detract from SoP (e.g., "change my personal attachment to the area"; "cause me to use other areas for my recreation"). Given this absence of attention to SoP dimensionality effects in the aquaculture context, we selected three Raymond et al. (2010) dimensions—identity, family, and nature—to assess the following:

RQ3. *Are some SoP dimensions more related to cooperation than others?*

H2. *The nature dimension of SoP will be negatively related to perceived environmental benefits of a facility, and thus negatively to cooperation.*

2.2.3. Community change. Studies of barriers to, and how to implement, community change (e.g., Bishop et al., 2009) dominate research focusing on non-activist, non-mental health responses to change in one's community, versus whether locals' retrospective evaluation of observed change affects their evaluation of prospective community change following a new development (e.g., an aquaculture facility). However, scholars have examined outcomes of change within communities, such as changes in interpersonal relationships (e.g., family, inter-generational, romantic) that may be deemed generally negative (e.g., Kral et al., 2011); those due to rapid growth and consequent influx of new social groups into the community (e.g., Cortese, 1982; Freudenburg, 1986; Gordon et al., 2010; Smith & Krannich, 2000), including possible disruption of SoP within the community (e.g., Greider et al., 1991; Keske et al., 2017); or the construction of potentially hazardous local facilities. As an example of the latter, Hughey et al. (1983) showed how, over a five-year period, attitudes toward a local nuclear power plant became more negative, with these attitudes best predicted by early (e.g., during or shortly after construction) beliefs about hazards, community disruption, and economic benefits. An interest in community perceptions of utilitarian landscapes—and particularly in climax thinking, in which people seem to see their surroundings as temporally and/or spatially optimal (e.g., they report belief that past or vestigial landscape features fit well in the local landscape, and feel sad at their loss)—drove a study of whether this kind of cognition would promote opposition to the landscape change associated with wind farms (Chappell et al., 2020). Findings were that both place attachment (measured primarily by place identity items taken from the same scale used in the present research; Raymond et al., 2010) and climax thinking led to support rather than opposition to wind farms in an Atlantic Canada sample, but varied by geographical level and exposure. Statistically significant associations were found for national and regional (the level which seems most similar to our 5-mile radius sampling area—see Section 3.2) but not for support within view of one's home among those who could see the wind turbines, while climax thinking was significantly associated with regional and home-view support but not national support. Among those who could not see the wind turbines from home, place attachment was significantly associated only with national support, and climax thinking not significantly associated with any geographic level (Chappell et al., 2020). Although in this study place attachment and climax thinking were empirically independent factors— that is, "being attached to the . . . area itself is different from attachment to the specific features it holds" (Chappell et al., 2010, p. 9)—we see these concepts as not necessarily "inverse" or conflicting concepts. Although they respectively focus on the entire place versus specific features within it, both potentially entail the prospect of the place having reached its optimum, although neither currently measure that optimum belief directly.

We have yet to find studies of a simpler question that arose while we planned this study: are positive or negative evaluations of change in one's community generally—i.e., from whatever source, whether the (potential) introduction of an aquaculture facility or otherwise—associated with behavioral intentions towards such a facility? We thought it plausible that someone seeing the community as experiencing more versus less change—and, particularly, experiencing change deemed more negative than positive—would be more likely to treat the facility as undesirable, and thus have more negative intentions regarding the facility. Other studies do bring in related issues about the larger context, but do not quite address this issue. For example, a study of the role of proximity and location in attitudes toward proposed rail-to-trail projects in an Ohio community suggested that opposition may reflect anxieties over larger changes in and around the community than the specific concerns raised about the trail itself (e.g., safety, property values) (Hawthorne et al., 2008). Concerns over rapid or declining population growth may dominate concerns over uncertainties about hazardous waste management facilities in the community; in fact, for some people any stigmatization of the community produced by such a facility may have the benefit of dampening in-migration (Wulfhorst, 2000). Absent a theoretical rationale to suggest a directional relationship, we posed the following:

RQ4. *Does perceiving large and/or negative change in the community affect cooperation?*

We also considered perceived community change as a potential mediator of SoP effects on cooperation. A few qualitative studies document a relationship between SoP and perceptions of past (e.g., historic dam construction) and/or proposed (e.g., planned dam removal) community change (Rybråten et al., 2018; Sherren et al., 2016), yet obviously cannot make claims about the order of these variables. Nor has survey-based research on SoP's relation to local reaction to energy facility development (see earlier discussion) proposed a mechanism for such relationships. We speculate that people with strong SoP might see general change in the community—experienced or anticipated—as negative, given that change need not enhance the community attributes to which they are attached. If so, this negative evaluation of change could undermine positive intentions toward the RAS facility:

H3. *Community change evaluation mediates the association between SoP and cooperation.*

H4. *Perceived impacts mediate the association between community change evaluation and cooperation.*

Benefits and risks. Positive behavioral intentions toward aquaculture in general are associated with higher perceived benefits and lower perceived risks (Rickard et al., 2020; Witzling et al., 2020). Elsewhere, we established that perception of the net balance of benefits and risks from a land-based RAS facility strongly predicts behavioral intentions toward the facility and mediates effects of trust in the sponsoring corporation on such intentions, although trust also retains direct effects under such mediation (*reference omitted*). Here, we advance this literature in two ways. First, we assess ratings of both concrete impacts (e.g., jobs, property values, economic growth, environmental quality, local fish supplies and prices) with more abstract, if often deeply felt, perceived impacts of facility siting (e.g., local ways of life; outsiders' perceptions of the community) to assess more broadly such beliefs than in some studies. Second, we posit a serial mediation model (Figure 1) to examine the indirect effect of SoP on cooperation. Specifically, we examine whether SoP effects on cooperation are mediated not only by community change evaluations, but also that those change evaluations affect perceived impacts which then affect facility responses.

2.2.4. Other factors. We controlled for a few potential predictors, without posing any hypotheses or research questions about their effects, including: 1) years of community residence; 2) gender, given its association with risk perception (e.g., Davidson & Freudenberg, 1996) and previous findings that women supported aquaculture more in a U.S. sample (Rickard et al., 2020); 3) age; 4) education; 5) income; and (6) political ideology given political polarization over some hazards, such as COVID-19, and its relationship to behavioral intentions (e.g., Clinton et al., 2021). We also controlled for self-reports specific to certain kinds of cooperation—i.e., frequency of voting in local elections for our facility vote measure; prior attempts to influence government for our influence and expand measures. Finally, we controlled for self-reported familiarity with the RAS project, as this affected earlier results (*reference omitted*).[1] We summarize our hypotheses and research questions in Figure 1.

[Figure 1]

3. Methods

3.1. Community Selection

Three of the larger project's four current or proposed RAS sites were selected for the survey, to maximize diversity in geography, corporate ownership, and current operating status within the constraint of RAS's embryonic status in the U.S.: Homestead, Florida, Belfast, Maine, and Samoa, California. Located approximately forty miles south of Miami, and outside of the city limits of Homestead, the Florida site sits adjacent to agricultural fields, with the Everglades to the west and Biscayne Bay to the east. Atlantic Sapphire, a Norwegian firm, operates the large facility which is currently being expanded to produce and process upwards of 220,000 tons Atlantic salmon (*Salmo salar*) yearly by 2031.

The Maine and California sites are in various stages of permitting and review, both proposed by Nordic Aquafarms (NAF), also a Norwegian company. Located in scenic mid-coast Maine, the city of Belfast features a working waterfront district and a sizable tourist population. NAF's Belfast site is projected to raise 33,000 tons of Atlantic salmon annually at the former Belfast Water District site along the Little River, which discharges into the Penobscot Bay. The proposed site abuts a popular hiking trail which will remain accessible to the public after construction, although public concerns about access persist. Though NAF has received all necessary city, state, and federal permits to proceed with construction, the company is embroiled in ongoing court disputes involving Belfast residents and local environmental groups regarding (1) the legality of these permits; and (2) ownership of part of the intertidal zone where NAF intends to build their future facility's intake and wastewater outflow pipes, operations that raise concerns about water quality.

"Behind the redwood curtain" in a less populous region of the state, the California facility will be located on the Samoa peninsula at the former Evergreen Pulp mill, a site leased to Nordic Aquafarms by the Humboldt Bay Harbor District. A former "Superfund" site, as designated by the U.S. Environmental Protection Agency, the location is considered a brownfield, whose development may be beneficial (e.g., tax revenues; local employment) but complicated by prior contamination. Nonetheless, the waters near it support a wide diversity of marine life (e.g, mammals, fish, birds, eelgrass), recreational uses (e.g., surfing), and seafood harvesting and production. While the Nordic Aquafarms RAS facility has been approved by Humboldt County's Planning Commission, three local environmental groups recently appealed the results of the County-approved Environmental Impact Report, suggesting that the report minimizes several project impacts, including its greenhouse gas emissions, energy use, and water quality threats that it may pose to commercial fisheries and coastal and bay ecosystems.

3.2. Sampling

Census tracts, block groups, and blocks within a five-mile radius of the facility's physical (proposed or existing) site, defined by latitude and longitude, were selected as target areas for the survey. After gaining study approval from [*name of university omitted*] Institutional Review

Board, we contracted with the Survey Research Institute at Cornell University (SRI) to design, mail, and conduct data entry for a scannable mailed questionnaire using the tailored design method (Dillman et al., 2014). Using random address-based sampling of deliverable, permanent-resident addresses in the target census areas, an invitation was mailed to 4,500 addresses on October 13, 2020, containing a letter and a web link to complete the survey online via Qualtrics. The next mailing on October 20, 2020 included a cover letter with a web link to the online site, a paper questionnaire, and a self-addressed reply envelope. This was followed by a postcard reminder (November 3, 2020), and another full mailing including the questionnaire to 4,118 remaining sample members (January 7, 2021). Data collection for mail and online surveys closed on March 30, 2021.

SRI launched a non-respondent shortened survey on May 4, 2021 via telephone. Targets were non-respondents for whom we had telephone numbers, to assess whether and how they differed from respondents on a subset of community connections, facility and trust attitudes, anticipated behavior, and demographic characteristics (see below). Data collection closed on May 27, 2021.

3.3. Survey Instrument

After informed consent, respondents reported their community, with multiple choice options specific to the target region within five miles of the facility site. This provided the context for SoP and subsequent questions (pertinent items appear in Table 1 in order of occurrence), phrased in terms of "this community" or "this . . . project will have in or near your community."

Measuring SoP and related concepts is a contentious multi-disciplinary debate that we cannot detail here (e.g., Lewicka, 2011). We adapted items from a multi-dimensional "place attachment” scale (Raymond et al., 2010) because it offered us more specificity. The “place identity” dimension is central to most SoP models, entailing a strong connection or identity between self and the place, so that potentially any threat or opportunity seemingly posed by the facility to the place will be so personally salient as to evoke strong responses (Eaton et al., 2019). A “nature bonding” dimension links self to the local natural environment, implying that people with environmental quality concerns about RAS might be higher in nature bonding. Because RAS draws the water it “recirculates” from outside rivers, bays, or estuaries, and after recirculation deposits the remainder back into that environment to replace it with fresher salt or fresh water (also discharging waste), such concerns may be among the most prominent regarding local RAS siting. Raymond et al. (2010) proposed separate dimensions of “family bonding” and “friend bonding/belongingness,” or connections between the place and one’s close social network; for brevity our items combine these two types of connections. If this social bonding dimension of SoP has any impact on facility views, we expect it to be on non-environmental quality impacts (e.g., economic; social/cultural). Raymond et al. (2010) also included a “place dependence” dimension (e.g., this “is the best place for the activities I like to do”), a concept that has traditionally implicitly emphasized amenity dependence (e.g., recreational opportunities), omitting work-related dependence (Eaton et al., 2019). We omitted measures of both dependence concepts to keep the instrument short.

After asking about familiarity with RAS, the questionnaire said:

> **Here is a short definition of land-based aquaculture to help you answer the next questions:** Unlike traditional aquaculture, which grows fish and shellfish in the ocean, lakes, or ponds, land-based, recirculating aquaculture raises fish in tanks in buildings on land. The water in the tanks is continually run in and out of the tanks to filter it, keep it fresh, and reduce the amount of new water that needs to be added regularly.

Judgments of the sponsoring corporation (not covered here), and cooperation measures and controls, followed. The instrument ended with demographic questions on sex, age, education, ethnicity, political ideology (strong conservative-strong liberal), and household income.

Asterisks in Table 1 indicate questions retained for the non-respondent (telephone) instrument. Sex, age, education, and ethnicity were retained for this short instrument.

[Table 1]

3.4. Analyses

Survey data were analyzed with SPSS Statistics (version 27) and Amos (version 27) using descriptive and inferential statistical approaches. Mediation analyses were conducted with model 6 of PROCESS 3.5.3 (Hayes, 2017) using 5000 bootstrapped samples with 95% confidence intervals and the HC3 heteroscedasticity-consistent inference model; analyses separately included and excluded covariates (residence time, demographics, cooperation-specific controls, and project familiarity).

4. Results

4.1. Sample

Of 523 respondents: 293 (56.0%) hailed from Maine (240 or 81.9% from Belfast, site of the proposed facility); 175 (33.5%) from California (163 or 93.1% from Eureka, three miles from the proposed site); and 55 (10.5%) from Florida (48 or 87.3% from Homestead, site of the operating facility). Respondents comprised 63.2% women, a mean age of 58.9 years (SD = 17.9; 46.9% 65+), 87.2% non-Hispanic white, 61.3% with a bachelor's degree or more, mean household income in the \$60,000-\$99,999 range (27.2%; 21.8% < \$30,000; 25.5% \$100,000 or more), and were majority leaning or strong liberals (59.0%; 19.1% leaning or strong conservative).

The non-respondent sample comprised 3,963 (88.1%) addressees from the original sample. A total of 1,800 contacts with available phone numbers were randomly selected (600 per site) from this remainder to be called at least once. Some 984 (54.7%) were pending (answering machine, callback appointment, no answer), 693 (38.5%) were non-working numbers, 15 were non-household numbers, 8 were excluded as being in an ineligible region, 2 refused, and 2 featured a language problem. Of 1,080 potentially eligible contacts in this sample, 96 people (8.9%) completed the non-respondent telephone survey, averaging 7 minutes each. Qualitative responses from people reluctant to answer or complete the telephone survey indicated two main reasons: unfamiliarity with [*university name withheld*], and disinterest in and unfamiliarity with the topic after hearing the RAS definition.[2]

4.2. Descriptive and Other Statistics

Table 2 summarizes various descriptive and other statistics. On cooperation, we observed majority support for the facility if a hypothetical referendum were held, but substantial opposition; low intention to influence government decisions on the facility, but roughly equal support or opposition; and even lower immediate intention to support or oppose any future expansion of the currently proposed or operating facility, or of a new facility in the community, by joining an activist group, but with opposition much greater. We created an aggregate measure of "cooperation" across the three measures.[3] On SoP, ratings were generally high, with good reliability. Confirmatory factor analysis found a one-factor model fit the data very poorly (Table 3). The baseline 3-factor model did not fit badly, but it did not fit the data well either, but standardized regression weights for the family factor showed one very low loading ("Without my relationships with family and friends in this community, I would probably move."). Fit improved substantially when the "move" item was removed. On community experience, overall residence time was extended, mean perceived change was generally moderate, and the valence of this change was deemed more positive than negative. To assess how this change experience and evaluation affected facility cooperation, we created a variable multiplying perceived magnitude of change and judged valence of change after 1) excluding people who reported no change, 2) recoding the remaining magnitude responses to 1 (slight) to 4 (extreme), and 3) recoding the valence responses from -2 (very negative) to +2 (very positive), but coding the "neither positive nor negative" response as 0.1 to avoid confounding any effect of the magnitude response when the two question responses were multiplied. Results for this change variable were skewed slightly positively. Finally, on RAS beliefs and attitudes project familiarity was moderate; expected impacts of the project were on average deemed most positive on jobs, and least positive on environmental quality, with the most variance. Confirmatory factor analysis found a 1-factor model for the seven impacts measures; this model fit the data poorly (Table 4), although an index of these was reliable (ω = .92). A 2-factor model separating economic items (jobs, fish, growth, property) from other items (environment, outsiders, local lifeways) fit the data slightly worse on most fit statistics, so we used a single impact index for path analyses.

[Tables 2-4]

4.3. Correlations

As expected, the aggregate cooperation measure correlated highly with the original cooperation measures, but these explained only 31%-38% of each other's variance (Table 5). SoP dimensions were significantly correlated but explained even less of each other's variance, with few and varying associations with cooperation. SoP-nature marginally decreased intentions to influence the facility decision, while SoP-family significantly increased positive vote intentions; these show both kinds of effects considered in RQ1, and variance across dimensions, as raised in RQ3. The impact index was very strongly and positively associated with cooperation measures, consistent with H1, but only SoP-family was significantly and positively correlated with project impact ratings, addressing RQ2. The positive attitude toward community change was moderately but consistently associated with cooperation, addressing RQ4, but only SoP-identity was significantly correlated with change ratings. Impacts and change views were significantly correlated; the environmental impacts measure was not significantly associated with SoP-nature, much less negatively correlated as expected by H2.

As for associations of demographic and community experience covariates with our main measures, aggregate cooperation was lower for political liberals, women, and the better-educated, and higher for longer residence and more project familiarity. SoP-identity was higher for those with long residence, more project familiarity, older residents, and frequent local voters. SoP-nature was stronger for local voters, the educated, those who try to influence the government, the project-familiar, and political liberals. SoP-family was stronger for the project-familiar and local voters, and weaker for political liberals and the educated. Positive attitudes toward community change were associated with political liberalism. Negative views of project impact were linked to liberalism, education, and experience influencing government.

[Table 5]

4.4. Serial Mediation Analyses

Table 6 shows the results for four outcome measures (vote, influence, expand, and the aggregate measure, cooperation), without and with covariates. Inclusion of covariates affected explained variance little; for those few situations in which more than one indirect effect was statistically significant, indirect effects were not themselves significantly different.

Sense of place was associated with a positive sense of community change only for the identity index, but that SoP dimension did not significantly affect facility impact beliefs, and SoP-identity did not directly affect any cooperation at $p < .05$, although SoP-identity did marginally reduce influence intentions. By contrast, SoP-nature and SoP-identity had no direct association with community change beliefs. SoP-nature had weak ($p < .10$) negative effects on impact judgments (i.e., those highly identifying with nature in their community were less likely to see facility benefits), but this weak association disappeared with covariates included. As with SoP-identity, SoP-nature had no direct effects on cooperation except for a marginally negative association with influence. SoP-family had a positive influence on beliefs about project impacts, although it weakened with covariates included, weakened influence intentions (with and without covariates), and marginally weakened expansion and cooperation intentions with covariates included. Results offer little support for direct effects of SoP on cooperation (RQ1), although some variation occurred across SoP dimensions (RQ3).

Impact beliefs strongly affected cooperation, consistent with H1; change evaluations affected cooperation directly to some extent (RQ4), but more indirectly via impact beliefs as a mediator (H4), while also mediating the SoP-cooperation association (H3).

[Table 6]

5. Discussion

5.1. Major Findings

In answer to declining wild stocks and increasing global seafood demand, aquaculture production continues to expand rapidly in the U.S. and abroad (Naylor et al., 2021). While novel aquaculture technologies increasingly pose benefits, such as local jobs and a sustainable food source, aquaculture development can also be understood as threatening traditional livelihoods (e.g., fishing), or as an industry misaligned with the “type of place” a community is (Stedman, 2006). Working from a research precedent in the energy facility siting context (e.g., Devine-Wright, 2009), this study explored how SoP might likewise influence behavioral intentions toward an existing or proposed land-based recirculating aquaculture facility, paying particular attention to the mechanism(s) of this relationship: here, the mediating roles of perceived community change and perceived project impacts, plus SoP-dimensional variation. Our findings indicate that SoP can both increase and decrease facility cooperation (RQ1), depending upon its dimension (e.g., nature- vs. identity-based) (RQ3), and that SoP-nature was not negatively related to perceived environmental benefits of an aquaculture facility, contrary to expectation (H2). Perceived positive (beneficial) impacts strongly shape cooperation (H1). In terms of the serial mediation model, perception of community change did affect cooperation (RQ4) and mediate the SoP-cooperation association (H3), while perceived change effects on cooperation were indeed mediated by impact beliefs (H4). Before expanding on the theoretical and applied implications of these findings, we present limitations of this study.

5.2. Limitations

Given the cross-sectional survey data used, we cannot claim a causal relationship between the variables measured; further, other variables not included in this model, such as trust, perceived risk, or affect, may also be related to cooperation, as previous research has shown (*reference omitted*). The low response rate, typical of survey responses over the past few decades, and small sample limit generalization to the adult population of our target areas (i.e., within five miles of the facility site). Our non-respondent survey indicated that they might have been more distrustful of an unfamiliar organization (the sponsoring university) and/or less interested in the RAS topic than respondents. Our study also considered a single topic of low to moderate controversy and familiarity in our target communities, perhaps limiting the influence of SoP on cooperation, and (perhaps, in part, because of this) featured a low overall response rate. Our need to include other topics, such as trust and information-seeking, also limited the questionnaire space available to ask about SoP, and future research should include more complete measurement of various dimensions, including place dependence. Replication and expansion of this effort to other communities with existing or proposed aquaculture facilities—land-based RAS or otherwise—as well as to renewable energy and other facility siting seems warranted.

Another potential conceptual limitation, raised by a reviewer, requires further attention. Our items used to measure SoP—as well as other concepts, such as perceived facility impacts—were phrased in terms of "this community," which was defined earlier by the respondent's specification of the "community" in which that person lived (based on multiple choice and open-ended responses). The reviewer expressed concern that this terminology meant that we were really studying effects of "sense of community" rather than "sense of place," which seemed to the reviewer to incorporate "relations with space" not included in the notion of community, and that any given settlement of any size might "host multiple communities so 'the community' is misleading." We appreciate this concern, as it reflects a long-standing debate in the field that partly reflects differences across disciplines in conceptualization and operationalization of SoP (e.g., Lewicka, 2011); however, we believe this concern is over-drawn. Most SoP studies have utilized well-known names for well-defined areas, whether those are national parks, protected areas, or recreation areas (e.g., two protected areas in Tasmania, Australia; Lin & Lockwood, 2014), historically-defined farming areas (e.g., Adelaide and Mount Lofty Ranges, South Australia; Raymond et al., 2010), a reasonably discrete geographic area (e.g., Chignecto area or isthmus, on the border between New Brunswick and Nova Scotia provinces, Canada; Chappell et al., 2020), or, indeed, a municipality or community (e.g., Nailsea, England; Devine-Wright, 2013). Because qualitative research conducted beforehand (reinforced by our survey finding of skewed familiarity) suggested varying awareness of the proposed or operating RAS facility both within and between sites, we chose to sample from residences within a five-mile radius of the site's location to maximize the chance that we could elicit informed opinions; however, that address, those longitude-latitude coordinates, or that radius may not carry references to place; they may only indicate a location in space.[4] Because these sites were within, or near to, named municipalities or villages, most of our respondents, who were residents of such places presumably would be interested in the benefits or harms that a RAS facility might bring to that "community." Furthermore, we measured not only attachment to "social relations" (i.e., the SOP-family subscale), which the reviewer acknowledged would be accounted for by the concept of "sense of community," but also SOP-nature—which accounts for at least one crucial relation with space, not to mention our measurement of place identity generally. While we do not expect these examples and counterarguments to be definitive on this point, given the aforementioned long-standing debate, we believe there are grounds to suggest that this research, in fact, tapped into sense of place.

5.3. Implications

Despite these limitations, our study reveals that SoP is useful in understanding local cooperation with aquaculture facility development, but that this relationship appears to be mostly indirect, mediated through perceptions of community change and perceived impacts of a project on both the physical place and its social fabric. The little-direct-effect finding contradicts prior survey research that finds positive or negative effects of SoP on facility siting support through linear regression (e.g., Hoen et al., 2019; Vorkinn & Riese, 2001; Devine-Wright, 2009, 2011, 2013; Chappell et al., 2020). However, our results align more with work finding no direct relationship between SoP and support for an energy project. For example, SoP mediated between proximity to the risk source (here, a nuclear power station) and risk perception, explaining 70% of the latter, although in a regression analysis SoP did not contribute significantly to acceptance of building a new nuclear power plant in the community (Venables et al., 2012). With a more geographically diverse sample (e.g., a county in Florida vs. a 5-mile radius of the facility), future research focusing on perceived impacts related to existing or proposed aquaculture development could likewise explore whether SoP might play a mediational role between one's proximity to the facility and cooperation.

The divergence in the (primarily energy facility) siting literature on whether SoP prompts support or opposition also merits further attention to the supposed mechanics underlying such associations. The concept of climax thinking (Chappell et al., 2020) may be useful here, not so much in opposition to place attachment, as in teasing out how we conceive of place attachment's sources and outcomes. Climax thinking is posited as belief that features in the landscape (at least, in a utilitarian landscape in which salt marsh-draining dykes, foundries, hay barns, and radio towers appeared in the past) are optimal, becoming part of the local "cultural identity" regardless of their toxicity or other negative consequences. Thus their loss could shape "resistance to overwrite past landscapes to make space for new needs," although it has been suggested that renewable infrastructure might be framed "as continuations of the region's industrial heritage and technology in the landscape, potentially helping increase acceptance among people who may not otherwise support renewable energy," while people fearful of change may be better able to adapt to such new infrastructure than they expected (Chappell et al., 2010, pp. 8-9). What we see here, however, is not so much a conflict among these concepts than missing theoretical and empirical bridges or complements. As we noted earlier, operationalization of both concepts has not directly measured whether people believe their landscape or its features are “optimal,” and to us it seems that neither place attachment nor climax thinking (as measured in Chappell et al., 2010 by perceived fit of a vestigial feature to the landscape and by sadness over its loss) require a belief in optimality. Further, we speculate that perhaps direct belief in optimality, of the place and/or its features, might indeed be associated with opposition to new features and landscapes, but that sub-optimality beliefs—whether they concern a perceived decline from prior glory or an aspirational “we’re not yet there” view—could be a path towards supporting new facilities and activities. This is not a criticism of either concept, but rather a suggestion that their further respective development of temporal and spatial dynamics might help resolve why place attachment specifically seems to have both positive and negative effects on facility siting.

Our findings underline that SoP cannot be characterized as a unitary response, as the few hypothesized dimensions of SoP we could measure relate differently to facility cooperation; that is, identity and particularly family dimensions increased cooperation, while SoP-nature had no effect significant at $p < .05$. Among future research priorities, we suggest consistently measuring these and other SoP dimensions (e.g., place dependence) rather than the standard approach (at least in much siting research) of treating SoP as one-dimensional. Doing so would be critical for marine aquaculture, given potential interference with coastal recreation, and for at least some land-based facilities, given proximity to hiking or biking (as at the proposed Belfast, ME site), and perhaps also for working landscapes (Eaton et al., 2019), where aquaculture operations may compete economically or otherwise with local fishing or seafood harvesting industries. While much attention has been devoted to qualitative SoP research, including on place meanings associated with a specific locale (e.g., Stedman, 2006), few survey-based studies have combined measures based on such data with the generic measures we used, to determine if the latter capture most of the variance in SoP and its effects. (If so, assessment of SoP effects would be simplified, as researchers could arguably employ a set of standardized measures across locations). While assessing differences in SoP across geographic scales has long been part of SoP research in general (e.g., Lewicka, 2011), we do not know to what extent attachment at the hyperlocal level (e.g., the intertidal zone of the Belfast facility's outflow pipe into Penobscot Bay) versus community, which was what we elicited in this study (e.g., Belfast), state or regional levels (e.g., Maine or New England) makes a difference (cf. Mather & Fanning, 2019, on scale in relation to SLO.) More ambitious still would be longitudinal studies to measure perceived change in both SoP and its associations with cooperation and other behaviors over time, particularly important given not all proposed facilities become operating facilities, and controversy or contention over evolving issues such as permitting can likely influence public attitudes, just as increasing familiarity might revise the SoP-cooperation association.

We had speculated that perception of community change affects cooperation, and indeed found that perceiving larger and more positive local change generally was associated with more RAS facility support. That said, this relationship was small, and while we explicitly prohibited that people include COVID-19-related change in their assessment, we did not feel it appropriate to exclude perceived change due to the facility (operating or proposed). Despite these caveats, for several outcome variables perceived positive community change mediated the association between SoP-identity and cooperation.

Finally, regarding practice, in line with recent SLO and SCC literature, our results suggest that aquaculture facility promoters need to consider more than biophysical attributes of a site, such as availability of clean water or distance to local markets, when considering whether to invest in a community, and anticipating how such development might be received (Alexander, 2021). Besides understanding historical community context and change, such as important past and present industries, "adjacent" development projects (e.g., other forms of aquaculture or green energy projects), and local forms of governance (Alexander, 2021; Rickard et al., 2022), we recommend that prospective developers learn more about residents' SoP. When developing strategic communication about their planned or existing facilities, we further suggest that developers emphasize benefits specific to the place and community, in line with multiple dimensions of SoP—i.e., not just about jobs, but also about social fabric, and "the kind of place we live in." (See Rickard et al., 2021, for the effectiveness of a narrative format on communicating sustainable aquaculture benefits to public audiences). The varying degrees of cooperation across different hypothetical behaviors and sites also should give developers pause; although, on average, cooperation outweighed opposition, the local stance toward local operation of a RAS facility was not unequivocal.

6. Conclusions

Sense of place is a concept that has been at least as exciting for environmental psychologists as for the many other disciplines involved in developing its manifestations, implications, and measurement tools (Lewicka, 2011), given their long history of studying how humans engage with their natural, built, and social surroundings. Yet our collective grappling with the challenges and complexities of exploring the effects of SoP has so far fallen short of fully exploiting this promise. This study contributed to this important effort by 1) applying the SoP siting framework to the context of land-based aquaculture, 2) discriminating among SoP dimensions, and 3) accounting for evaluations of perceived impacts and community change as mediating variables. We hope our insights into these dynamics can inspire our colleagues to continue moving this fruitful concept forward.

Notes

1. Although researchers have emphasized the role of trust and credibility in support for aquaculture processes and products (e.g., Flaherty et al., 2019; Mazur & Curtis, 2006), we did not control for it here as we examined its effects separately (*reference omitted*).
2. Overall, respondents were slightly more active (in resources and behavior) in the community, and more negative about the project and its sponsor, than non-respondents; non-response had only marginally significant effects on vote intentions in an ordinal regression analysis (results available from authors). Mail respondents were significantly older, more likely non-Hispanic white, had longer residence and local voting experience, and reported higher project knowledge than online respondents, but otherwise these groups did not differ on demographic or attitudinal responses. Sites differed on some demographics (e.g., Maine older, better educated, more non-Hispanic white, more politically liberal), but little on other measures used here: e.g., Californians were more likely to vote for the project, and exert supportive influence, and Mainers more likely to join a group organized to oppose an expanded or new facility. Maine respondents reported stronger SoP-identity than the other two states but did not differ in SoP-nature or family; they also had more positive responses to community change than the other two states, with the negative reaction among Floridians marginally lower than the California reaction. Impact assessment was significantly more negative in Maine than in California, although all were on the positive side of the 1-5 response scale.

3. Controls (covariates in mediation analyses) were voting in local elections (76.2% always) for the vote question; trying to influence government (14.6% often; 48.4% sometimes) controlled for the influence and expand measures. No association occurred between vote intentions and local election experience ($r = .08$, $p = .075$), or between the two influence measures ($r = -.04$, $p = .396$), with a modest association of influence experience and expansion responses ($r = -.15$, $p = .001$).
4. It is important to note that the process of siting a facility may shift a "space" (as defined simply by latitude-longitude coordinates, for instance) into a place imbued with social representations and meaning (e.g., Devine-Wright, 2022; Lai, 2019; Pierce et al., 2011).

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Table 1. Survey Measures

Sense of Place (1 strongly disagree, 5 strongly agree)

Identity
I feel that this community is a part of me.
This community is very special to me.
I identify strongly with this community.

Family
I live in this community because my family and friends are here.
My relationships with family and friends in this community are very special to me.
Without my relationships with family and friends in this community, I would probably move.

Nature
I am very attached to the natural environment in and around this community.
When I spend time in the natural environment in and around this community, I feel at peace with myself.
I learn a lot about myself when spending time in the natural environment in and around this community.

Community Experience and Change

*How many years have you lived in this community?
Before COVID-19, how much change do you think this community was going through? (1 no change at all, 5 extreme change)
[for answers 2-5 for prior item] How would you rate the overall effects of that pre-COVID change? (1 very negative, 5 very positive)

Project Impact

impact you think this land-based aquaculture project will have in or near your community based on the following factors (1 strongly negative, 5 strongly positive)

Jobs
Environmental quality
Local fish supply/price
Economic growth
Outsiders' perceptions of your community
Property values
*Local ways of life

Cooperation

*If an election were held tomorrow on the future of this land-based aquaculture project, I would (1 vote against having the project in or near my community, 2 vote for having the project in or near my community, 3 not vote)

I plan to try to influence state or local decisions about land use related to this land-based aquaculture project (1 to prevent its operation, 2 to support its operation, 3 do not plan to influence these decisions in either direction)

Suppose in the future this corporation proposes an expansion of its project, or another corporation proposes another large land-based aquaculture project, in or near your community. Citizen groups form to urge decision-makers to approve or reject that expanded/new project. How would you most likely react in this situation? (1 do nothing, because I don't care about the issue, 2 do nothing immediately, because I would want more information before I decide, 3 join the group urging approval, 4 join the group urging rejection)

Controls for Intentions
*How often do you vote in local elections? (1 never, 4 always)
How often have you tried to influence state or local decisions about land use in or near your community for projects other than this land-based aquaculture project? (1 never, 4 always)
In a typical month, how often do you eat fish? (1 never, 3 often)

Note. *Item also included in non-respondent survey

Table 2. Descriptive and Other Statistics[1]

Cooperation	For	Neutral	Against
Vote in hypothetical referendum on RAS facility	55.6%	11.8% not planning to vote	32.5%
Intention to influence siting decision	21.5%	60.6% not planning to influence	17.9%
	Join group urging approval	Do nothing	Join group urging rejection
Expand current, or add new, facility	9.0%	67.3% more information 2.0% don't care	21.8%
Sense of place	Identity	Nature	Family
1-5 (all items included)	CA 3.83 (0.79) FL 3.75 (0.93) ME 4.05 (0.77)	CA 4.29 (0.64) FL 4.23 (0.71) ME 4.26 (0.61)	CA 3.99 (0.88) FL 4.12 (0.86) ME 3.96 (0.89)
Reliability (McDonald's omega ω [95% confidence interval]; mean inter-item correlation)	.88 (.86, .90) .70 (.65, .75)	.78 (.74, .81) .53 (.48, .58)	.73 (.68-.78) PFA .61 (.55-.66) without move item
Community experience			
Residence (3 = 6-10 years; 4 = 11-20 years)	CA 4.28 (1.14)	FL 4.23 (0.98)	ME 3.77 (1.24)
Perceived change (1-5); 1.4% no change; 4.1% extreme; 54.8% moderate	CA 2.87 (0.82)	FL 3.48 (0.93)	ME 3.11 (0.69)
Change valence	Positive 49.9%	Neither 17.9%	Negative 32.2%
Change (constructed; -8 to +8)	$M = 0.45$, $SD = 2.84$ ($n = 500$)	13.6% ($\leq$ -3)	17.2% ($\geq$ +3)
RAS beliefs and attitudes			
Project familiarity (1-4)	M_{CA} 2.05 (0.87)	M_{FL} 2.02 (0.84)	M_{ME} 2.78 (0.78)
Impacts (1-5); ω = .92 (.91, .93); mean inter-item correlation .61 (.57, .65)	Jobs 3.90 (0.82)	Economic growth 3.73 (0.93)	Local fish supply/price 3.34 (0.96)
	Outsiders' views of community 3.04 (0.98)	Property values 2.97 (1.04)	Local ways of life 2.91 (1.02)
	Environmental quality 2.74 (1.21); 40.6% negative, 25.9% positive		

Note. Mean (standard deviation) unless otherwise specified. CA = California; FL = Florida; ME = Maine.

Table 3. Confirmatory Factor Analyses of Sense of Place Items

		1-factor	3-factor	3-factor without Move item
Model Fit				
Chi-square		511.024***	135.380***	52.969***
Degrees of freedom (df)		27	24	17
Chi-square/df		18.927	5.641	3.116
Root mean square of approximation [RMSEA] (90% CI)		.188 (.174, .202)	.096 (.080, 112)	.065 (.045, .085)
Probability of RMSEA p < .05		.000	.000	.102
Standardized root mean square residual [SRMR]		.1128	.0787	.0376
Comparative Fit Index [CFI]		.747	.942	.980
Tucker-Lewis Index [TLI]		.662	.913	.968
Akaike information criterion		565.024	195.380	106.969
Correlation among factors				
	Identity-Family	NA	.563**	.572***
	Identity-Nature	NA	.608***	.608***
	Family-Nature	NA	.434*	.437***
Standardized regression weights				
Factor 1 (Identity):	Part of me	.754	.761	.761
	Very special	.855	.866	.866
	Identify strongly	.864	.880	.880
Factor 2 (Family/Friends):	Here	.402	.591	.601
	Very special relationships	.613	1.03	1.014
	Probably move	-.146	.119	NA
Factor 3 (Nature):	Very attached	.535	.707	.707
	Feel at peace	.529	.823	.823

	1-factor	3-factor	3-factor without Move item
Learn about myself	.474	.676	.676

Note. NA = not applicable.

Table 4. Confirmatory Factor Analyses of Impact Items

		1-factor	2-factor
Model Fit			
Chi-square		136.972***	129.265***
Degrees of freedom (df)		14	13
Chi-square/df		9.784	9.943
Root mean square of approximation [RMSEA] (90% CI)		.135 (.115, .157)	.137 (.116, .159)
Probability of RMSEA p < .05		.000	.000
Standardized root mean square residual [SRMR]		.0405	.0383
Comparative Fit Index [CFI]		.944	.947
Tucker-Lewis Index [TLI]		.916	.914
Akaike information criterion		178.972	173.265
Correlation among factors			
	Economy-Other	NA	.964
Standardized regression weights			
Factor 1 (Economy):	Jobs	.734	.751
	Fish	.661	.668
	Growth	.791	.811
	Property	.839	.835
Factor 2 (Other):	Environment	.818	.828
	Outsiders’ perceptions	.805	.806
	Local lifeways	.842	.853

Table 5. Listwise Pearson's Correlations of Covariates and Main Measures (*n* = 363)

	Project vote	Project influence	Project expand	Cooperation	SoP identify	SoP nature	SoP family	Change	Impact	Impact-environment
Covariates										
Gender (female)	-.132*	-.135**	-.097†	-.145**	-.014	.053	-.001	-.034	-.092†	-.073
Age	.014	.047	.021	.030	.182***	.039	.085	-.064	.008	.017
Education	-.095†	-.092†	-.096†	-.110*	.067	.156**	-.126*	.032	-.146**	-.184***
Income	.044	.071	.083	.072	.084	.071	.029	.065	.062	-.020
White	.056	-.013	.000	.025	-.027	-.078	-.047	.091†	-.063	-.110*
Ideology	-.126*	-.145**	-.156**	-.163**	.036	.112*	-.145**	.149**	-.170***	-.232***
Residence time	.121*	.060	.066	.104*	.252***	.068	.372***	-.043	.058	.118*
Project familiarity	.069	.136**	.069	.104*	.210***	.125*	.073	.019	.020	-.040
Vote local	.057	.018	-.043	.023	.173**	.229***	.139**	.070	-.017	-.025
Influence government	-.120*	-.008	-.070	-.086	.100†	.135**	.020	-.100†	-.146**	-.117*
Main measures										
Project vote		.614***	.556***	.902***	.057	-.042	.109*	.208***	.738***	.685***
Project influence			.565***	.841***	.005	-.090†	-.005	.188***	.692***	.596***
Project expand				.787***	-.012	-.063	.029	.144**	.643***	.623***
Cooperation					.027	-.072	.064	.217***	.820***	.752***
SoP identity						.532***	.536***	.108*	.058	.081
SoP nature							.308***	.033	-.053	-.046
SoP family								-.011	.142**	.128*
Change									.178***	.108*

Table 6. Serial Mediation Analyses of Cooperation as a Function of Sense of Place, Community Change Perceptions, and Facility Impact Beliefs

								Standardized indirect effects of X on Y			
Vote (no covar)	X > M1	X > M2	M1 > M2	X > Y #1	M1 > Y	M2 > Y	X > Y #2	X > M1 > Y	X > M2 > Y	X > M1 > M2 > Y	Variance explained
Identity (n = 442)	.13**	-.01	.19**	.01	.07*	.74***	.02	.0090 (.0011, .0206)		.0189 (.0052, .0375)	.57***
Nature (n = 441)	.01	-.09†	.20***	.00	.07*	.74***	.00				.57***
Family (n = 443)	.00	.13**	.20***	.01	.07**	.74***	.01		.0986 (.0333, .1643)		.57***
Vote (covar)											
Identity (n = 373)	.14**	.01	.20**	-.02	.06†	.73***	-.02			.0195 (.0037, .0417)	.58***
Nature (n = 372)	.01	-.04	.21**	-.02	.06	.73***	-.02				.58***
Family (n = 374)	-.00	.10†	.21***	-.03	.06	.73***	-.03				.58***
Influence (no covar)											
Identity (n = 443)	.13**	-.01	.20***	-.00	.07†	.70***	-.00			.0177 (.0041, .0357)	.51***
Nature (n = 442)	.01	-.08†	.21***	-.04	.07*	.69***	-.04				.51***
Family (n = 444)	.00	.13**	.21***	-.09**	.06†	.71***	-.06**		.0942 (.0300, .1609)		.52***
Influence (covar)											
Identity (n = 370)	.13**	.01	.19**	-.07†	.09*	.67***	-.06†	.0121 (.0009, .0292)		.0170 (.0030, .0361)	.51***
Nature (n = 369)	.04	-.03	.20**	-.07†	.09*	.67***	-.07†				.51***
Family (n = 370)	.01	.09†	.21**	-.14***	.08*	.68***	-.09***				.52***

Expand (no covar)											
Identity (n = 446)	.13**	-.01	.20***	-.02	.02	.67***	-.02			.0170 (.0044, .0340)	.45***
Nature (n = 445)	.01	-.09†	.20***	-.02	.02	.66***	-.02				.44***
Family (n = 447)	.00	.13**	.21***	-.04	.01	.67***	-.02		.0892 (.0303, .1503)		.44***
Expand (covar)											
Identity (n = 372)	.14**	.01	.18**	-.06	.05	.62***	-.04			.0157 (.0025, .0328)	.42***
Nature (n = 371)	.04	-.03	.20**	-.03	.04	.61***	-.02				.41***
Family (n = 372)	.01	.09†	.20**	-.08†	.03	.61***	-.05†				.41***
Cooperation (no covar)											
Identity (n = 438)	.13*	-.01	.20***	-.01	.07*	.82***	-.00	.0083 (.0008, .0192)		.0206 (.0048, .0417)	.69***
Nature (n = 437)	.01	-.08†	.21***	-.02	.07*	.81***	-.02				.69***
Family (n = 439)	.00	.13**	.21***	-.04	.06*	.82***	-.03		.1105 (.0372, .1833)		.69***
Cooperation (covar)											
Identity (n = 370)	.13*	.01	.20**	-.05	.08*	.80***	-.04	.0103 (.0010, .0231)		.0217 (.0045, .0458)	.70***
Nature (n = 369)	.03	-.04	.22***	-.03	.07*	.80***	-.03				.70***
Family (n = 371)	.01	.10†	.22***	-.09*	.07*	.81***	-.05				.70***

Note. Standardized coefficients. Covar: Covariates are years of community residence (categorical clusters); demographics (gender, age, education, ethnicity, income, political ideology); cooperation-specific controls (frequency of voting in local elections [vote]; prior attempts to influence government [influence, expand]); project familiarity. X > Y: #1 is the direct effect without mediation; #2 is the direct effect with mediation. Standardized indirect effects: Completely standardized indirect effects of X on Y (with bootstrapped 95% confidence intervals); non-significant effects (interval includes zero) omitted. 5000 bootstrap samples were generated with a heteroscedasticity consistent standard error and covariance matrix estimator (HC3).
† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Figure 1. Schematic of Study Hypotheses and Research Questions

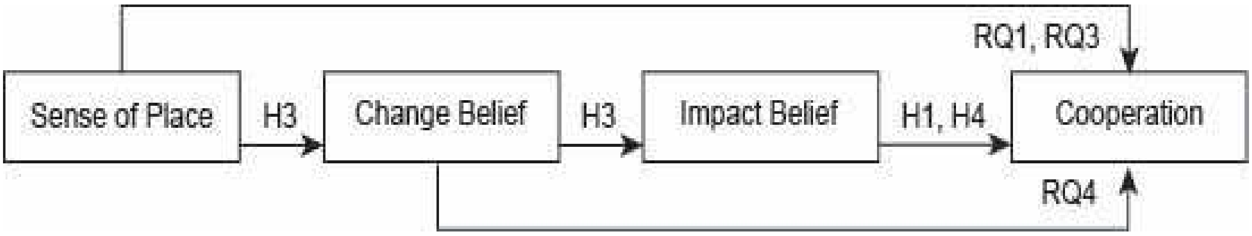

Figure 2. Sense of Place (Identity) Effects on Cooperation as Mediated by Change and Impact Beliefs