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Synthesis

Factors influencing social demands of aquatic ecosystems

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ABSTRACT. Aquatic ecosystems provide services essential to human health and economies. Therefore, resource management programs aim to ensure the sustainable flow of these services. Stakeholder engagement is often a critical tool in learning what services are of priority to the public and may be integral to the success of aquatic ecosystem management because public participation in planning and decision making can generate broader support, e.g., financial, intellectual, and labor, for the management plan. The collection of such information may even be statutorily mandated, such as in the Clean Water Act of the United States, which requires that water bodies be classified for the beneficial uses, e.g., fisheries, drinking water, or recreation, they provide. Past evaluations of stakeholder engagement with aquatic ecosystems have considered a wide range of factors influencing engagement. We conducted a critical review of the literature on characteristics of stakeholders and characteristics of the environment that influence stakeholder engagement and participation with aquatic ecosystems. Our objective was to identify factors that should be considered in the creation of surveys to help encourage the inclusion of ecological and social beneficial uses data in large-scale water monitoring programs. Factors identified in our review were, extent and influence of place-based knowledge; proximity to, and frequency of visitation of the resource(s) being considered; basic demographics such as age, gender, education, and income; home community type; aesthetic appeal of the resource; and primary reason for engagement with the resource. We propose these factors, with subfactors, as a template for survey development.

Key Words: *ecosystem services; environmental factors; natural resources; public perception; public value; social factors; stakeholder engagement*

INTRODUCTION

In the United States, information from water quality testing, e.g., National Aquatic Resource Surveys (U.S. Environmental Protection Agency 2016*a*), tracking, e.g., National Pollutant Discharge Elimination System (U.S. Environmental Protection Agency 2017), and modeling, e.g., Index of Watershed Integrity (Flotemersch et al. 2016, Thornbrugh et al. 2018) is used to report comprehensive information on the condition of water bodies throughout the country. However, information regarding social demands (Martín-López et al. 2014) associated with these aquatic resources, i.e., ecological and social beneficial uses, is not systematically reported or collected. The Federal Water Pollution Control Act, i.e., Clean Water Act (U.S. Congress 1972), a benchmark for instream value protection in the U.S., requires that water bodies be classified for the type of beneficial water uses they are to support, e.g., fisheries, drinking water, or recreation. Data on fisheries and recreation, as they relate to water quality, have been studied as ecosystem services (e.g., Winfield 2016, Stålhammar and Pedersen 2017). However, comprehensive national-scale data characterized by public usage and benefit, e.g., aesthetics, spiritual, wellness, or cultural, are absent.

The diversity and scale of social demands on aquatic ecosystems should be considered in any environmental management decision because it supports the exploration of a broader array of management options and a clearer understanding of how various user groups may be differentially impacted (Olsson et al. 2004, Zweig and Kitchens 2010, Ives and Kendal 2014, Rohwer and Marris 2016, Tadaki et al. 2017). This holds true for aquatic ecosystems in crises, chronically degraded, or modified, for which management approaches often fail to fully account for the human causes of change (Zweig and Kitchens 2010, Srinivasan et al. 2012). Historically, watershed management actions have maximized the production of one ecosystem service, e.g., energy or agriculture production, at the expense of other services, e.g., water quantity and quality, that may be of equal or even greater relevance (Musters et al. 1998, Vermeulen and Koziell 2002, Gordon et al. 2010). To minimize such outcomes, Hobbs et al. (2014) suggest that an explicit framework that includes and responds to social needs and values, in addition to environmental considerations, be used to increase management success by more fully considering the range of services and beneficial uses supported by the environment. This information would also aid in the understanding of how trade-offs impact groups differently, (López-Santiago et al. 2014) ultimately helping the exploration of more socially acceptable management options and staving off conflict (Ives and Kendal 2014).

Natural resource managers are increasingly employing socio-cultural approaches that support the recognition and consideration of natural resource values, i.e., demands, largely ignored in the past, e.g., mental health, education, recreation, heritage, and spiritual, (Chiesura and de Groot 2003, Milcu et al. 2013). Increased awareness of such services, i.e., cultural ecosystem services, by resource managers and decision makers is of high value because their inclusion can increase the effectiveness, equality, and efficiency of management approaches (Perreault et al. 1998, as cited in Stratford and Davidson 2002, Milcu et al. 2013). More inclusive approaches increase the relevance of natural resources to a larger audience and in multiple ways (Stratford and Davidson 2002). Additionally, cultural ecosystem services, like provisioning and regulating services, have been well-

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documented as contributing to, if not essential for, human well-being (Chiesura and de Groot 2003, Summers et al. 2012, Milcu et al. 2013, Plieninger et al. 2013, 2015).

Laws that address specific cultural services exist, e.g., Public Law No: 114-249 - Outdoor Recreation Jobs and Economic Impact Act of 2016, but laws that adequately consider other important cultural services, e.g., cultural heritage, local sense of place, or local ecological knowledge, have yet to be crafted. As a surrogate, policy has utilized geospatial features, such as population density and land use (Srinivasan et al. 2012) to represent the public's social values regarding aquatic ecosystems. However, to truly uphold the Clean Water Act, decision makers should consider the social, cultural, and economic characteristics of individual stakeholders and stakeholder groups within a jurisdiction (here, specific to the boundaries of the water bodies; Swainson and de Loe 2011). Yet again, although integral to the understanding and protection of our water resources, national-scale data are not collected systematically to represent social demands as related to ecosystem services of surface waters.

We posit that the collection of social demands data can and should be incorporated into national data collection efforts, as well as testing and modeling approaches, and used in tandem with data on physical water quality in support of the sustainable management of surface waters. Once collected, we propound that social demands data can be incorporated into policy in much the same way that other data, e.g., biological data, are incorporated (e.g., U.S. Environmental Protection Agency 2016*b*). At the most basic level, the opportunity for citizens to provide input can empower stakeholders and communities to partake in activities that better preserve and protect natural resources and the ecosystem services upon which society depends (Millennium Ecosystem Assessment 2005, NACEPT 2016). At higher levels, citizens exercise their right to participate in a decision-making process by informing decision and policy makers on what they consider desirable or undesirable (Irvin and Stansbury 2004). Milligan et al. (2009) and Berenguer et al. (2005) both identified the need for such data if we are to sustainably manage, or more astutely comanage, public surface waters as social-ecological systems (Walker and Salt 2012, Parsons et al. 2016). However, as Parrott and Burningham (2008) state, to achieve such things, more research is needed to understand factors influencing social demands.

The main objective of this research effort was to identify environmental and social factors that have been shown to influence social demands of aquatic resources. This information is highly relevant to efforts that seek to collect social demands of aquatic ecosystems data as it identifies ancillary information that should be collected as part of these efforts given its potential to identify drivers of response data variability, e.g., age, education, income, juxtaposition to resource.

METHODS

The authorship team represents an interdisciplinary group that has expertise in anthropology, environmental justice, fluvial ecology, geography, and microbiology. We worked collectively to identify the most significant items in these fields as related to the research objective of this paper. This technique is referred to as a "critical review," which aims to research the literature extensively, evaluate that literature's quality, synthesize those sources, and produce a product that offers a hypothesis/model for best ways forward for the theoretical/research innovation at hand (cf. Grant and Booth 2009). This technique does not aim for a formal quality assessment of the literature represented, but rather focuses on providing a conceptual contribution from a critical analysis of existing literature. In this case, this work provides a contribution in the form of encouraging attention to and theory on how to best include the public in the assessment of social demands related to water resources in the United States. Through completing this review, we aimed to harness the interdisciplinary expertise of the team and synthesize information from a variety of sources. As such, the product that we provide here represents a purposive approach to connecting significant scholarship from several fields that focus on social values, social-ecological knowledge, watershed assessments, and/or water bodies, and providing information on how these spheres can inform practice in this area. This work provides a jumping-off point for future evaluation and innovation in the realm of encouraging a national-scale project on broader social considerations related to watershed management and the development of a national-scale survey.

In our review, we only considered articles in the English language, including articles from countries outside the United States, and did not use a time frame. Information was categorized into self-emergent categories relevant to our objective. Under each theme, we present the results focused on aquatic ecosystems. Results are then discussed in relation to the findings of other studies having an environmental focus, but one that is not necessarily aquatic. Agency review, and reviews conducted by the journal suggested the inclusion of additional literature; especially with regard to ecosystem services.

RESULTS AND DISCUSSION

We defined six main categories of factors that influence social demands of aquatic ecosystems: extent and influence of place-based knowledge; proximity to, and frequency of visitation of the resource(s) being considered; basic demographics such as age, gender, education, income; home community type; aesthetic appeal of the resource; and primary reason for engagement with the resource (Table 1). Obviously, there is overlap among these categories, but these groupings effectively organized our results relevant to our objective of identifying ancillary factors to explain variability in social demands data of aquatic ecosystems.

Place-based knowledge

Place-based knowledge about a resource influences present-day social demands of aquatic ecosystems. This knowledge can take the form of experiences accrued throughout one's life, or be multigenerational in nature, such as in the case of traditional ecological knowledge (TEK; Berkes et al. 2000, Larson 2012). Regardless of the origin of place-based knowledge, critical environmental experiences can rapidly reshape social demands of ecosystem services in response to changes in the resource and immediate needs. Knowledge spanning longer time frames, such as TEK, provide an increased understanding and appreciation for those services provided by the resource over time, e.g., generations, and those services that the resource could provide into the future if managed accordingly.

Place-based knowledge accrued within a single lifetime contributes to shaping social demands of aquatic ecosystems.

Table 1. Factor categories influencing social demands of aquatic ecosystems, with examples of potential first and second level subcategories.

Categories	Examples[†]
Place-based knowledge[‡]	Cultural relevance
	Dependence
	Longevity of values (e.g., recent, lifetime, traditional ecological knowledge)
Proximity to, and frequency of visitation	Proximity of resource in question to primary residence[§]
	Resident or visitor[‡]
	Frequency of visit (e.g., daily, weekly, yearly, episodic)[†]
Demographic	Age[§]
	Gender[‡]
	Education[§]
	Income[§]
Residence community type[†‡]	Rural
	Urban
Aesthetic appeal of resource[‡]	Perceived condition
	Naturalness
	Familiarity (generic sense of place)
Reason for engagement[‡]	Recreation (e.g., fishing, swimming)
	Provisioning (e.g., fishing)
	Cultural

[†]Specific variables included will be study dependent. For example, a city park would have different variables than a remote wetland for proximity to resource; and for residence type.
[‡]Data likely categorical (e.g., gender, rural, urban)
[§]Data likely numeric groups/classes (e.g., < 10km, 10–50km, 50–100km)

This knowledge may be for a very specific location near one's home, or for a specific type of location that may exist anywhere. The former is easily comprehended: the place-based knowledge stemming from experiences accrued because of place attachment, place meaning (Kudryavtsev et al. 2012), or place dependence (White et al. 2008). The latter is a bit more elusive, especially with regard to management implications. As an example, studying the use of the San Marcos River by students of Texas State University, Julian et al. (2018) found that students who regularly spent time enjoying outdoor activities during childhood and adolescence visited the San Marcos River more than other students, and were actually dependent on this blue space for their well-being. Interestingly, the blue space was valued based on place-based knowledge acquired during childhood and at a different location. Hay (1998) summarized thinking on this topic when discussing the works of Feldman (1990) who described this phenomenon as an affinity for generic types of settlement. Stokols and Shumaker (1981) described it as generic place dependence. Twigger-Ross and Uzzell (1996) termed it place-congruent continuity. These concepts generally refer to a valuing of places with characteristics that provide a sense of place to an individual. This has been considered a survival response to a lifestyle where people do not live in one place for a lifetime (Tuan 1980). In essence, people value a given location type that provides a sense of place, a value more traditionally aligned with feelings for a place among individuals having lived a lifetime in a single location and possessing place-based knowledge of that location.

Knowledge spanning longer time frames, e.g., TEK, which generally spans centuries to millennia, is a unique category of knowledge because it generally combines multiple aspects of sense of place, including cultural and spiritual attachment, ecological stewardship, and the knowledge of the provision of medicinal and way of life services from the ecosystem (Larson 2012). This long-term perspective contributes to an enhanced understanding of inherent values attributed to a given system, e.g., economics, linguistics, and subsistence (Inuit Circumpolar Council 2015). TEK has also been shown to influence spiritual and sensible practices, as well as legal and social understandings of water rights and protections (Larson 2012). The long-term nature of TEK, and the sense of belonging it instills in communities, contributes to an enhanced sense of place, and consequently, long- and strongly held values and knowledge about environmental resources.

In recent years, there has been a notable increase in efforts to collaborate with communities possessing TEK to the mutual benefit of all involved (e.g., Harmsworth et al. 2016). As an example, Harmsworth et al. (2014, 2016) describes how the New Zealand Government has included indigenous Māori values and perspectives associated with aquatic ecosystems in management plans. These include values expressed in the physical environment in tangible geographic locations and in flora, fauna, and associated habitats such as Taonga, which can be whole systems such as groundwater and rivers, or culturally significant species such as fish, animals, birds, plants, etc.

Social demands founded on all forms of place-based knowledge of aquatic ecosystems can quickly change in response to critical environmental experiences. Using surveys conducted before and after a drought, Arcury and Christianson (1990) showed a shift in values toward more environmental perspectives, with major shifts observed among those experiencing imposed water restrictions. The impact of drought on social demands have been documented by others as well. Castro et al. (2016) saw an increase in the demands placed on cultural services and attributed it to how critical environmental experiences like severe drought and

flooding can alter perspectives. A similar shift in perspective was observed by Egan (2006) in response to severe drought during the dust bowl of the 1930s. Both studies attributed the shift in perspectives to how adversity can function to increase a sense of place and belonging in a community.

It is important to note that shifts in demands in response to critical environmental experiences may not always be consistent among different demographic groups. After an earthquake disrupted coastal wetlands in southcentral Chile, Rojas et al. (2017) found that perceptions of ecosystem services differed by gender, age, and ethnicity. For example, women placed a higher value on hazard regulation postdisaster; this possibly related to the disproportionate "impact of the disaster on their labor activities, family income and unemployment rate" (Rojas et al. 2017:13). This finding highlights the value of collecting demographic data found to influence social demands placed on aquatic ecosystems.

Proximity to, and frequency of visitation

The proximity of a stakeholder to a given aquatic ecosystem has also been demonstrated to influence how the stakeholder engages with and what demands are placed on resources. In general, as distance to a resource increases, familiarity with the resource decreases (Castro et al. 2016). This is partially a function of increasing distance reducing frequency of visitation (Julian et al. 2018). Visitation rates and the subsequent knowledge about a resource has been shown to influence public values ascribed to, perceptions of, and engagement with aquatic resources (Hein et al. 2006, García-Llorente et al. 2011, Julian et al. 2018).

In much of the examined literature, the proximity of a stakeholder to the resource is characterized using the terms resident and visitor (Nassauer 2004, Castro et al. 2016, Quintas-Soriano et al. 2018). We consider a resident as a stakeholder that resides in the immediate area of the resource being discussed, and a visitor as someone that does not reside in the immediate area of the resource. Again, we are not concerned with the preferences themselves, but rather the factors that influence social demands or preferences in the case of ecosystem services.

Nassauer (2004) found that residents living near an urban wetland valued it differently than those visiting the resource. Likewise, Castro et al. (2016) reported differences as a function of proximity. They found that residents, business visitors, and tourists placed a higher importance on regulating ecosystem services, whereas stakeholders living three to four hours away considered provisioning ecosystem services of higher importance. A similar finding regarding services was presented by Martín-López et al. (2012) who showed that regular protected area visitors had a greater familiarity with that area and a higher perception of the regulatory ecosystem services. Those less familiar with the area, i.e., members of environmental or social organizations, perceived provisioning services as more important. An interesting observation in both the Castro et al. (2016) and the Martín-López et al. (2012) studies, is that those with greater familiarity of an area, albeit resident or regular visitor, had a greater appreciation for what the location provided over time, i.e., regulating services, rather than what it provided in the moment, i.e., provisioning services.

For visitors, the frequency of visits to an aquatic resource has been shown to influence values. Scholte et al. (2016), studying values associated with a wetland in Bulgaria, reported visit frequency as a good predictor of values. Respondents who visited the wetland frequently recognized water quality, a regulating service, more often than those that visited the resource less often. This finding concurs with those of Castro et al. (2016) and Martín-López et al. (2012), who noted a correlation between increased familiarity and increased awareness and value of regulating services. The effect of visit frequency on values was also noted by Julian et al. (2018) who found that those who regularly visited the river being studied, or its adjacent park, expressed an increased value for recreational services, e.g., fishing or swimming, than nonvisitors who generally ranked aesthetic quality as the most important service.

These studies collectively demonstrate that stakeholder proximity to an aquatic ecosystem, as well as the frequency of visit(s), influences values placed on that resource. Another way of stating this result is that the extent of stakeholder familiarity with the resource influences the demands placed on that resource.

Basic demographics

Demographics are characteristics of a population that describe its structure. The importance of collecting such information is highlighted in the findings of Arcury and Christianson (1993) who stated that sociodemographic factors heavily influenced environmental attitudes and knowledge about the river basin in their study. In our review, traditional demographic factors helped explain and characterize varied social demands placed on aquatic ecosystems including age, gender, education level, and income.

Age

Age has been shown as a factor influencing social demands placed on ecosystems. For example, Yamashita (2002) found children preferred a scene dominated by water, while adults preferred a more balanced landscape. Arcury and Christianson (1993) found that younger individuals are more concerned about the environment and have more positive attitudes toward the environmental movement. Maestre-Andrés et al. (2016) found age as one of the main characteristics influencing sociocultural valuation of a nature park. Differences have even been detected in relatively small age ranges. Julian et al. (2018), studying use of a river ecosystem by college students, found that younger students visited the river much more often than older students, and as age increased, preference to visit the river alone or with one other person increased. Last, studying perceptions of ecosystem services in a Chilean coastal wetland, Rojas et al. (2017) found that young people had a greater perception of services and benefits. Younger and older people also differed regarding what services they valued the most.

Although not specific to aquatic ecosystems, other studies have reported how ecosystem service valuation can differ across age groups. Oteros-Rozas et al. (2014) found that, across an age gradient, younger people had the highest perception of food-related services and older people had the highest perception of the regulating service, habitat for species. Quintas-Soriano et al. (2018) found a similar dichotomy with younger respondents (defined as < 30 yr old) having greater perception of cultural services, then older respondents (defined as > 30 yr old). Martín-López et al. (2012) reported younger people had greater perception of environmental education as an important ecosystem service. Martín-López et al. (2012) also reported that

elderly people from rural areas were more aware of provisioning services and recreational hunting; this is likely because of a lifestyle that depended on the part of the economy that extracted and harvested products from the earth. Finally, García-Llorente et al. (2012) found that younger participants were more willing to participate in their study of landscape preferences. Although modern study designs can account for such biases, the finding underscores the importance of age as a factor influencing social demands, or more astutely, reported social demands, of aquatic ecosystems, as well as an appreciation of how these demands may change as community age structure changes over time.

Gender

Numerous studies have reported gender as a factor influencing social demands of ecosystems and the services provided therein (e.g., Arcury and Christianson 1993, Martín-López et al. 2012, López-Santiago et al. 2014). Specific to aquatic ecosystems, Rojas et al. (2017) found that women in a postdisaster setting placed a higher value on hazard regulation services, water and fuelwood, water and air purification, and groundwater recharge services. These observed differences were at least in part attributed to female gendered persons having experienced substantial impacts to their labor activities, family incomes, and unemployment rates postdisaster. Arcury and Christianson (1993) found that males in their study had a greater global environmental knowledge, a finding somewhat echoed by Quintas-Soriano et al. (2018) who reported males as having a greater global sense of place. Collectively taken, these studies affirm that social demands of aquatic ecosystems can and do differ by gender.

Education

Level of education has been shown to influence social demands of aquatic systems. In a study investigating environmental attitudes and knowledge of respondents in a river basin, Arcury and Christianson (1993) found that more educated respondents had higher scores on measures of environmental world view and had significantly greater global environmental knowledge. The more educated respondents also expressed more concern about the environment and had more positive attitudes toward the environmental movement. In another study, the influence of educational level of parents (or other guardians) in the household was shown to influence university students' uses and perceptions of a nearby aquatic ecosystem (Julian et al. 2018). In brief, students from households with higher educational attainment visited nearby ecosystems more frequently. Household education attainment level also influenced student valuation of ecosystem services provided by that ecosystem, and the perceived sensitivity of the system to rapid urban growth.

Other studies looking at social demands of environmental resources (not specific to aquatic ecosystems) have also documented education level as influencing results. López-Santiago et al. (2014), for example, showed that people with higher levels of education had a stronger appreciation of aesthetic value, tourism, tranquility/relaxation, air purification, plant regeneration, and habitat for species, as well as wood and timber when compared to those with lower levels of education. Looking more specifically at ecosystem services, Martín-López et al. (2012) showed a positive relationship between education level and appreciation for environmental education as an important ecosystem service. Quintas-Soriano et al. (2018) also demonstrated the influence of education on perceptions of ecosystem services, but additionally demonstrated the influence of social-environmental context on findings. Their study examined perceptions of ecosystem services across four place-based research sites. Education-related differences were reported from three of the four; and among the three, results differed. These findings emphasize the influence of sociodemographic factors on social demands and warn against the assumption that factors influencing social demands in one location will apply to others.

Income

A stakeholder's income is another factor that influences social demands of aquatic ecosystems. For example, adequate income affects one's ability to travel to visit a resource, one's ability to purchase or rent equipment necessary to engage in recreational activities, one's ability to live and be a resident near a given resource, and even one's reason to engage with the resource, e.g., for provisioning services vs. recreational services. A few of the papers we reviewed discussed income as a factor influencing environmental knowledge (e.g., Arcury and Christianson 1993 and cited references) and perceptions (Rojas et al. 2017, Quintas-Soriano et al. 2018) of ecosystem services. Arcury and Christianson (1993) found that higher income was positively correlated with a "pro-ecological" world view (as measured by the New Ecological Paradigm Scale; Van Liere and Dunlap 1980). Income-based differences were also reported by Quintas-Soriano et al. (2018). However, like their findings for education, differences detected among income groups varied across the four place-based research sites considered in their study. These results again highlight how sociodemographic factors associated with a given subpopulation can influence social demands.

Community type

Numerous studies have shown that the degree of development extant in the community that a person is from can influence how they think and feel about the natural environment (Berenguer et al. 2005 and cited references). We discuss these differences under the heading of community type (Palmer et al. 2006, Perrin 2015). One commonly used scheme for partitioning community type is the extent of urbanization and industrialization of an area (Teddlie and Yu 2007). Generally speaking, the term urban describes areas where urbanization and industrialization are high, and rural where they are low. Additional terms exist that further subdivide these extremes, e.g., urban-metro, suburban, periurban. Our critical review of the literature revealed that community type, and even cultures within a community type, can strongly influence social demands of aquatic ecosystems.

Specific to aquatic ecosystems, two papers provide insight on the impact of community type. Studying the differences in environmental knowledge and action of residents living within the same river basin, Arcury and Christianson (1993) found that urban residents were more concerned about the environment, and unsurprisingly more positive about environmental activities. An additional interesting finding by Arcury and Christianson (1993) was that urban-metro respondents (those at the core of the urban areas) were more knowledgeable about global environmental issues than others in their study. From an ecosystem services angle, Julian et al. (2018) studied use of blue space by students and likewise reported differences attributed to community type. Julian et al. (2018) found that students from urban environments used

the blue space less than those coming from suburban or rural environments. Students from urban environments also ranked cultural benefits of aesthetics higher than their suburban counterparts. The take-home point from these two studies is that community type has been shown to be a factor influencing social demands of aquatic ecosystems.

Similar findings have been reported by numerous other environmental studies albeit not specifically focused on aquatic ecosystems. For example, López-Santiago et al. (2014) and Maestre-Andrés et al. (2016) both reported community type as having an influence on perceptions and values placed on ecosystem services. Martín-López et al. (2012) and Berenguer et al. (2005) also reported strong gradients in social perception and valuation of ecosystem services across community type. Martín-López et al. (2012) attributed the strong gradient to differences in lifestyles and socioeconomic characteristics across the community types. Berenguer et al. (2005) suggested something very similar, stating that the way a given community type, i.e., rural vs. urban, experiences nature shapes their perspective about the environment.

Of relevance to this discussion is research by Atwell et al. (2009) that discusses perceptions and values as they relate to a given lifestyle. Atwell et al. (2009) found that the perceptions and values of residents in an Iowan watershed regarding sustainable farming practices were strongly tied to rural livelihoods, and the most consistently expressed value was the "rural aesthetic" of living in the countryside. What makes this study relevant to the current study objective is that Atwell et al. (2009) also demonstrated that residents conceived of their surrounding landscape in terms of a "peopleshed." The peopleshed was defined by important aspects of the community, such as family members, that did not align with municipal boundaries or the ecological boundaries of the watershed. The peopleshed concept is similar to that of "microcultures" (Ballantine et al. 2018), both of which represent a small culture unit within a larger main culture. However, landscape characteristics are also critical to the composition of a peopleshed. Although this particular way of viewing a community type is much less explored compared with the urban-rural gradient, it is definitely worth exploring as an explanatory variable influencing social demands of aquatic ecosystems.

Social demands can also vary among cultures within the same community, i.e., geographic space. Sagie et al. (2013) found that the resources valued by Israeli and Jordanian residents of the southern Arava Valley Desert corresponded directly with their culturally based economic identities, e.g., Israelis with a cash economy and Jordanians with subsistence resources. Both cultures valued water as a provisioning service but for different reasons. Israeli values linked with water from local aquifers was associated with commercial uses such as agriculture, renewable energy, and algae-farms. Jordanian values were more aligned with water for livestock and local wild animals; especially those commonly hunted.

Aesthetic appeal of the resource

The aesthetic appeal of an ecosystem has been shown to influence the social demands of that system (e.g., Martín-López et al. 2012, López-Santiago et al. 2014, Julian et al. 2018). Essentially, people want to go to places they like. Several studies have shown that this appeal is linked to the perceived condition, or "naturalness," of the location (Nassauer et al. 2001, Le Lay et al. 2013). Attributes specifically mentioned in the literature as being aesthetically pleasing include residential lawns (Larson et al. 2016), perennial farm practices in rural settings (Atwell et al. 2009), and protected areas like national parks (Martín-López et al. 2012). Although acknowledging that such attributes can and do serve as cultural cues of an environment that is being cared for (Nassauer 2004), the attributes (that the public finds pleasing) can be misconstrued as representing natural conditions (Cronon 1996). For example, several studies have reported that the public preferred wetlands with a tidy, well-managed appearance (Nassauer 2004, Rooney et al. 2015, Scholte et al. 2016 and references therein) even though this state might not represent "naturalness" or scientifically assessed good condition.

Specific to riverine settings, House and Sangster (1991:312) found that the public had an "overwhelming desire for trees and a strong preference for vegetational diversity," and that there was "an equally strong preference for mature, sinuous rivers with natural channels and banks." Although this might be the natural state for some systems, it is obviously not the case for all rivers. These findings concur with those of Le Lay et al. (2013), who found that some members of the public viewed a landscape as aesthetically pleasing when it was not healthy, supporting the argument that aesthetic appeal, often influenced by perceived condition, is a factor influencing social demands of public value placed on ecosystems.

Primary reason for engagement with a resource

Stakeholders engage with ecosystems for a broad array of services. It could be purely to engage in recreational services provided by the area, or at the other extreme, out of dependence on that resource for provisioning-oriented services such as growing crops or gathering food. We found several examples in the literature where reason for engagement served as a factor influencing social demands of ecosystems. We also found this factor to be one of the more difficult ones to interpret given its lack of independence from other potential influential factors discussed herein. For example, a fisherman may be fishing for recreational, cultural, subsistence, or commercial purposes, and could also be a resident or visitor (Marttila et al. 2016, Scholte et al. 2016). Regardless, we present findings that clearly identify this factor as an area influencing social demands.

Reporting on the opinions of two stakeholder groups regarding recent restoration projects on three rivers, Marttila et al. (2016) found that both fisherman and resident stakeholder groups generally supported restoration efforts but did not always express the same level of satisfaction with restoration outcomes. Differences in satisfaction generally related to how restoration outcomes impacted what stakeholders valued about the resource. For example, residents who valued the rivers' aesthetics, criticized the unnatural appearance of some changes. Those who valued the rivers for fishing were much more focused on how changes impacted the fishing experience. In both cases, satisfaction linked back to the stakeholders' principal reason for engagement with the ecosystems. Differences in what stakeholder groups valued were also reported by Scholte et al. (2016) in a study of ecological services provided by a wetland along the lower Danube River. Valued services differed among fisherman, farmers, and residents. For example, residents living along the Danube highly valued landscape aesthetics, whereas fishermen recognized food as an

ecosystem service significantly more often than did farmers or residents.

Studies conducted in other ecosystem types report similar findings. López-Santiago et al. (2014) reported differences in how landscapes were valued by those engaged with recreational services versus those engaged with provisional ecosystem services such as food from agriculture. Rojas et al. (2017) and Bouahim et al. (2015) found a similar alignment: an increased perception of provisioning services among those dependent on those services.

As an interesting aside, environmental experts visiting a resource have also been shown to have a distinct perspective when compared to other groups. Quintas-Soriano et al. (2018) reported that environmental experts tended to perceive cultural services as most important, whereas residents of the study area viewed provisioning ecosystem services as most important. Scott (2002) attributed such differences to the expert's focus on specific aspects of a resource whereas residents generally viewed the landscape more holistically.

CONCLUSION

The Federal Water Pollution Control Act (i.e., Clean Water Act, 33 U.S.C. §§1251-1387) requires that water bodies be classified for the type of beneficial water uses they are to support, e.g., fisheries, drinking water, recreation. Some beneficial uses have been studied using the framework of ecosystem services, e.g., fisheries and recreational uses (Winfield 2016, Stålhammar and Pedersen 2017) while other uses remain less explored, e.g., aesthetics, spiritual, wellness, cultural. Beyond better meeting the requirements of the Clean Water Act, a more complete understanding of the diversity of social demands of aquatic ecosystems could better inform resource managers on the diversity and scale of social demands provided by aquatic ecosystems. This information, in turn, supports the exploration of a broader array of management options and a better understanding of how various user groups may be differentially impacted (López-Santiago et al. 2014). Ideally, this process should result in the discovery of more socially acceptable management options (Ives and Kendal 2014) that reduce conflict, increase public support for management decisions, and ultimately, increase protection of aquatic ecosystems.

To support the collection of social demands data, we conducted a critical review of the literature to discover social and environmental factors that have been shown to influence social demands of aquatic resources. We identified six main categories of factors: extent and influence of place-based knowledge; proximity to, and frequency of visitation of the resource(s) being considered; basic demographics such as age, gender, education, income; home community type; aesthetic appeal of the resource; and primary reason for engagement with the resource (Table 1).

With regard to survey development efforts that seek to collect data on these factors, we have the following recommendations. For place-based knowledge, we recommend the inclusion of variables that inform wider understandings of cultural relevance and dependence on a resource, as well as variables that inform the longevity of these social demands, e.g., Are the demands situational? How might demands change? For proximity to, and frequency of visitation, we recommend the collection of data that measures the proximity of a stakeholder's primary place of residence to the resource, or resources, being studied, e.g., resident or visitor, and the frequency of their visits, e.g., daily, weekly, monthly, yearly, episodic. For demographics, the variables identified as important to consider include many well-established variables, i.e., age, gender, education, income, that are regularly included in surveys writ broadly, but their particular relationship to social demands of aquatic resources is particularly informative.

The community type a stakeholder was raised in, as well as where they currently live was shown to influence social demands. Therefore, we advocate for the collection of home community type in surveys. This would include traditionally used community types, e.g., urban, suburban, rural, as well as nontraditional community types, e.g., peoplesheds and microcultures (Atwell et al. 2009, Ballantine et al. 2018) that may help identify a sociocultural grouping that might otherwise go unrecognized.

We also explored how the aesthetic appeal of an ecosystem can influence social demands of that resource. In short, people want to go places they find aesthetically pleasing. This appeal is often tied to the perceived condition, or perceived naturalness, of the resource, which may or may not align with scientific assessments of condition. It is certainly conceivable that resource managers may be working toward management endpoints that maintain or restore an aquatic resource to a state emulating (to the extent possible) natural condition. These conditions, however, may not align with what the public finds aesthetically appealing. This is not to say that management activities should necessarily align with what the public finds visually pleasing. Rather, it identifies ways in which management activities might be modified to better accommodate social demands, and where planned activity would benefit from the inclusion of educational outreach further increasing public support for the activity and/or effectively explaining to stakeholders how functioning condition and aesthetics correlate or do not correlate. As such, we find this to be one of the more valuable findings of our research.

Last, we also recommend the collection of information on "reason for engagement with the resource." Notably, this variable is heavily influenced by other previously mentioned factors, especially demographic factors, if not a direct function of those factors. However, we feel that independent examination of this variable would likely provide useful information, but it is in the context of the other variables that the provided information becomes of high value to resource managers as it rounds out the who, what, when, where, why aspect of the information, and potentially identifies management options that might otherwise go unrecognized.

In summary, we propound that the collection of data on the social demands of aquatic ecosystems be integrated into existing national data collection efforts and incorporated into policy in much the same way that other aquatic ecosystem data, e.g., biological data, are incorporated (e.g., U.S. Environmental Protection Agency 2016*a*). This would require the development of a national-scale survey on the social demands of aquatic ecosystems. This survey should include the collection of data that informs on drivers of variability in response data discussed in this paper. These factors and proposed subfactors are provided as a template for discussion and survey development (Table 1).

The collection of social demands of aquatic ecosystem data will, we believe, better inform resource managers on the diversity and scale of social demands of aquatic ecosystems, and in turn, support the exploration of a broader array of management options and a clearer understanding of how various user groups may be differentially impacted. This will ultimately result in the discovery of more socially inclusive and appropriate management options that reduce conflict, increase public support for management decisions, and ultimately, increase protection of aquatic ecosystems. We also expect that open-ended, iterative responses on these themes from stakeholders and communities will provide important data in this endeavor. Based on these projected outcomes, we strongly support the continued development, and eventual implementation, of the envisioned national-scale survey on social demands of aquatic ecosystems. The next step in this process is the development and review of a full suite of candidate survey questions.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/11165

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