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Sea otters, social justice, and ecosystem-service perceptions in Clayoquot Sound, Canada

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ABSTRACT

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In this paper, we take a first step towards better integrating social concerns into empirical ecosystem services (ES) work. We do this by adapting cognitive anthropological techniques to study the Clayoquot Sound social-ecological system, on Canada's Pacific coast. There, we used freelisting and ranking exercises to elicit measures of locals' ES values, and preferred food species, analyzing the data with ANTHROPAC. We consider the results in light of an ongoing 'trophic cascade,' caused by the reintroduction and spread of sea otters (Enhydra lutris) along the island's coast. We find that, one, the standard academic ES typology is not well reflected in the mental categories participants (including trained ecologists) use to think about ES. Two, we find that based on current ecological models it is First Nations individuals, and women, specifically, who are most likely to perceive the most immediate ES losses from the trophic cascade, with the most certainty. The inverse holds true for non-First Nations, and men. This suggests current conservation practice in the region may be inadvertently perpetuating an experience of social injustice amongst historically marginalized demographic groups.

INTRODUCTION

Over the past two decades, the ostensibly anthropocentric 'ecosystem services' (ES) framework has gained remarkable traction as a tool for mainstreaming conservation (e.g., from Daily 1997 to MA 2005). (As per Daily (1997) and MA (2005), here we refer to 'ecosystem services' broadly as the things, or processes, nature renders unto humans.) As the framework has grown in popularity, many have written of a need to attend to 'social,' 'distributional,' or 'equity' concerns. This argument has mostly taken two forms: one, critiques of an unreflective ES approach (e.g., Menzel & Teng 2009; Kosoy & Corbera 2010; Chan et al. 2012a; Schroter et al. 2014); and two, frameworks and guidelines for how

'social,' 'cultural'(e.g., Chan et al. 2012b; Ban et al. 2013; Raymond et al. 2013) and 'distributional' (e.g., Tallis et al. 2008; Daw et al. 2011; McDermott et al. 2013) factors could, in theory, be integrated into ES assessments. Yet, with the exception of some PES assessments (e.g., Chen et al. 2009; Garcia-Amado et al. 2011), relatively few published ES case studies explicitly focus their method on accounting for what are often interlinked social, cultural and distributional factors.

In this paper we take an initial step toward remedying that knowledge gap. To do this we adapt basic cognitive anthropology methods to an ES study of the Clayoquot Sound UNESCO Biosphere Reserve, on the west coast of Vancouver Island (WCVI), Canada. There, a reintroduction and recent boom in the once decimated sea otter (Enhydra lutris) population is having substantial, rapidly cascading effects on the local nearshore ecosystem (Markel 2011; Watson & Estes 2011; Singh et al. 2013; Markel & Shurin 2015). As sea otters continue to multiply and spread unimpeded under the protection of Canada's Species at Risk Act, the mammal comes into direct competition with humans for edible shellfish and other marine invertebrates (Levine et al. 2015; see Appendix E in Supporting Material). Specifically, otters are widely perceived by coastal Nuu-Chah-Nulth First Nations to target species of clams and sea urchins which have historically been prized foods of these Nations (McKechnie 2007; Levine et al. 2015; see Appendix E in Supporting Information).

Yet without predation pressure from otters, sea urchins tend to decimate kelp beds (Espinosa-Romero et al. 2011). Thus, ecologists and many non-First Nations laypeople see the otters' spread as a normatively positive return to an earlier more 'natural' and biodiverse equilibrium characterized by denser, more ubiquitous kelp beds (Espinosa-Romero et al. 2011; FOC 2013; E. Gregr, SciTech Environmental Consulting, personal communication; see Appendix E in Supporting Information). This process constitutes a classic trophic cascade (Market &

Shurin 2015). Because of sea otters' charismatic appeal, their successful expansion down WCVI has also been vaunted by a range of interests as a golden opportunity for the local ecotourism industry (FOC 2004; Loomis 2006).

However, such positive assessments are relatively low-resolution, meaning they do not reflect the nuance of the region's demographic makeup. They do not, in other words, highlight who is likely to perceive what degree of loss, versus gain, over what timespan, from otters' expansion. For instance, despite recent signs of increasing economic integration, very few First Nations in Clayoquot Sound are employed in ecotourism. As of 2016, only one of over 20 formal-sector ecotour businesses in the area is First-Nations owned (L. Loucks, Research Coordinator--Clayoquot Sound Biosphere Trust, personal communication). Rather, the industry is still dominated by non-First Nations business owners in conjunction with often transient or seasonal non-First Nations employees (L. Loucks, Research Coordinator--Clayoquot Sound Biosphere Trust, personal communication).

Various projected ecological effects of the sea otter's return also fall at different points along a spectrum of scientific uncertainty. While ecological data strongly suggest that the trophic cascade will foster more biodiversity in kelp beds (Espinosa-Romero et al. 2011; Markel 2011; Markel & Shurin 2015), the ambiguities of current ecological models (Espinosa-Romero et al. 2011; E. Gregr, SciTech Environmental Consulting, personal communication) suggest that some projected effects are more certain to materialize than other, only vaguely hypothesized ones.

Namely, there is strong empirical evidence from the local ecosystem that, in addition to otters' aforementioned consumption of invertebrates, otter-driven growth in kelp beds leads to greater abundance in demersals such as lingcod, kelp greenling and multiple species of rockfish (Markel 2011; Markel & Shurin 2015). Both these effects are reported as relatively

certain (Markel 2011; Singh et al. 2013; Markel & Shurin 2015). Less certain is an oft-repeated hypothesis that growth in kelp beds will lead to higher survival rates for juvenile salmon or herring (E. Gregr, SciTech Environmental Consulting, personal communication). All else held equal, there is some literature from other, otter-absent ecosystems that suggests this outcome (e.g., Shaffer 2004; Mumford 2007). However, as yet there is no published empirical evidence from otter-populated WCVI to support it. In fact, in the case of herring, there is some evidence from otter-populated Alaska to the contrary (Lee et al. 2009).

When considered through a combined social-ecological lens, the asymmetry in the likelihood of these various effects has social repercussions. There is evidence to suggest contrasts in how different demographic groups (i.e., First Nations individuals versus non-First Nations; men versus women; local laypeople versus government managers) perceive (Levine et al. 2015), and value, those components of their shared ecosystem likely to be affected by otters (see subsequent sections; Appendix E in Supporting Information).

This is topical, as relations amongst First Nations and multiple other stakeholders on the WCVI are already inherently tense due to years of controversial settler-colonial policies, and outstanding resource-rights litigation (Schreiber & Newell 2006; Okerlund 2007; Harris 2008; L. Loucks, Research Coordinator--Clayoquot Sound Biosphere Trust, personal communication). Any divergent normative interpretations, and perceived inequities, in the benefits and losses wrought by the nascent trophic cascade thus threaten to further strain multistakeholder relations, impeding effective, socially-inclusive management.

We sought to investigate this potential tension in the form of a multidisciplinary research agenda. In this paper we report on empirical findings pertaining specifically to differing ecosystem service (ES) and species valuations amongst various demographic groups in Clayoquot Sound UNESCO Biosphere Reserve. Clayoquot Sound was chosen for four

reasons: (1) its relatively high population of both First Nations- and non-First Nations residents; (2) its status as a biosphere reserve and regional ecotourism hub; and, crucially (3) because sea otters are now beginning to spread throughout Clayoquot Sound, whereas previously they had been limited in range to more northern areas, closer to where they were first reintroduced.

METHODS

Prior to the collection and analysis of data reported in this paper, we first conducted a limited series of in-depth interviews (N=5 First Nation participants, 4 non-First Nation participants), and a focus group, in two adjacent remote communities in Kyuquot Sound, located 140km northwest of Clayoquot Sound. Kyuquot Sound is where sea otters were first reintroduced in the late 1960s and early 1970s, and is thus where the species has been present the longest (see Appendix E, in Supporting Information, for the full methods and key results). The results of this exploratory round of data collection suggested cultural differences in environmental perception and valuation, particularly around the issue of sea otters and their prey. This outcome led us to query whether a similar pattern existed in the more densely populated communities of Clayoquot Sound, to the south, where otters were gradually beginning to spread. This second round of inquiry constitutes the focus of the current paper. We describe our respective methods below.

The primary methodological tool we applied in Clayoquot Sound was a structured interview protocol involving a number of listing and sorting tasks (see Appendix D in Supporting Information for the complete protocol). For each participant, the relevant end products of these tasks were twofold. One was a list (known as a ‘freelist) of the local ecosystem services (ES) that each given participant was able to bring to mind, in the order that such services

occurred to them. (In our interaction with participants, we avoided using the potentially mystifying term 'ecosystem services,' and instead asked them to list "things that nature does for people, or gives people, here on the west coast of Vancouver Island"). To do this, participants were provided a series of blank flash-card sized pieces of paper, and asked to write down one ES per piece of paper, as the ES occurred to them. The ES that participants listed, and the order in which they listed them, were recorded for subsequent analysis. Participants were then asked to physically re-order the ES they had listed from "most to least important," as defined subjectively by each given participant. This second ranking was also recorded for subsequent analysis.

Directly prior to this, we elicited comparable data on which local species, in particular, participants each deemed most important across four different dimensions of value (in chronological order): personal importance, food preference, economic value and ecological value (see Appendix C and D in Supporting Information for select results and the full protocol). The value dimension of concern for our present analysis, below, is food preference. While food and its collection have numerous important dimensions of both subsistence and cultural value for ecosystem-dependent communities such as the Nuu-Chah-Nulth (Chan et al. 2012b), to be as conservative as possible in our analyses, we focus in this paper on only the narrowest dimension thereof: simply, consumptive preference, or "tastiness " (see Discussion).

Having recorded these multiple lists and orderings, we then sorted and coded the listed items into a minimally reductive sub-set of item-names, aimed at facilitating the inductive value of the subsequent analysis, while preserving as much of the participants' original conceptual category structure as possible. We then used the freelist-analysis software package ANTHROPAC to calculate a group-level measure of the relative importance of each of these

list items (i.e., ES- and species-codes) within the rubric of each respective listing and ranking activity. This analysis assigned each item a 'Smith's salience index', *S*, on a scale of zero to one (see Appendix B in Supporting Information for the relevant formula, further described in Smith & Borgatti (1997)). The group-level results were analyzed across three contrasting axes of demographic difference: First Nations versus non-First Nations, men versus women, and general public versus government managers. (See Appendix A in Supporting Information for a detailed rationale behind our selection of demographic groups.) The end results are sets of commensurable quantitative data on the environmental values of each demographic group within each comparative pair (see subsequent sections, Figs. and Appendix A in Supporting Information).

In the course of the interview protocol, participants were also asked, all else held equal, which of two evidence-based scenarios they would prefer: "more otters, more kelp and less shellfish" or "less otters, less kelp, and more shellfish". (The scenarios were derived conservatively from the published WCVI-specific available evidence at the time, and did not include Markel and Shurin (2015)'s subsequent documentation of the effects of the trophic cascade on WCVI demersal fish species—such data was being collected simultaneous to our own development of the protocol). We then prompted participants to explain their answers, and to elaborate on any further thoughts and opinions they had regarding kelp or sea otters.

In total, we interviewed 71 individuals in and around Clayoquot Sound. Four of these participants were government managers, who we regard as a distinct group given their professional mandate. This leaves a total of 67 interviewees from the general public, ranging from the ages of 20 to 80. There were 29 females, and 38 males. 26 participants self-identified as First Nations, primarily from the Ahousaht and Toquaht Nations, as well as the Tla-oh-qui-aht and Yuułuʔiłʔath (Ucluelet) First Nations. Participants were recruited by

poster in central town locations, by Band Council leadership (in the case of Ahousaht and Toquaht nations), and occasionally by word of mouth. (Note that the protocol served multiple research purposes, and otters were not a species of emphasis in recruitment materials). Ahousaht- and Toquaht-member interviews were conducted on their respective Nations' territory as per the preference of the Band Council and individual participants, while all other interviews were conducted at a place of the participants' choosing outside of First Nations administered territory in and around the twin Clayoquot towns of Tofino and Ucluelet. All participants were offered financial compensation for their time at a rate of $15 CAD per hour. Recruitment ceased based on time and funding limitations.

RESULTS

Our interviews were part of a larger project that studied several dimensions of ecosystem perception and value beyond the immediate scope of this paper. Here, we report only those results most directly relevant to the question of how the trophic cascade is likely to be *perceived* by contrasting demographic groups as sea otters continue to expand their range. For a wider set of results, see Appendix C, in Supporting Information, and Levine et al. (2015).

Ecosystem services: relative salience

The first results of note include which ES participants listed most readily, and most often, in response to the question "what things does nature do for people, or give people, here on the west coast of Vancouver Island?".

"*Food*", was the highest-scoring response by far, both among the general public as a whole (S = 0.540) and among government managers (S = 0.929). In the context of our particular protocol, food provision was thus clearly the most cognitively salient (i.e., readily thought of) ecosystem service for the majority of Clayoquot Sound respondents (see Fig. 1).

It is important to note here that, as with our conservative focus on consumptive preferences described in Methods, above, for the purposes of our present analysis, we regard participants' mention of food explicitly and primarily as a provisioning service, despite the fact that food has a much wider range of value dimensions, particularly for historically ecosystem-dependent communities such as the Nuu-Chah-Nulth (Chan et al. 2012b). If we were to consider these wider—but vaguer—values associated with food in our present analysis, it would considerably augment the relevant effect addressed in the Discussion.

Note from Fig. 1 that, amongst the general public, *shelter* received the next highest cognitive salience score (S = 0.161), followed by *water* (S = 0.146). Many participants also readily listed *recreation* and *employment*, although First Nations participants were an exception to this rule, and managers mentioned these terms much earlier and more often than did the general public. *Clean air* or simply *air* were also two relatively universally salient services for all groups examined.

Ecosystem services: subjective importance rankings

The pattern of results described above shifts when we move from looking at the relative salience of ES for participants, to how participants re-ordered those ES according to their perceived importance (see Figs. 2 and 3). Particularly striking is a comparison of First Nations participants' rankings with those of non-First Nations (see Fig. 2; for the data on

other demographic groups' comparative rankings, see Appendix C in Supporting Information).

Specifically, First Nations participants tended to rank a particular subset of intangibles much more highly than did their non-First Nations counterparts. Namely, *well-being* (S = 0.157), *happiness* (S = 0.129), *tranquility* (S = 0.117), *health* (S = 0.102), *beauty* (S = 0.083) and *community* (S = 0.083) all appeared within First Nations participants' collective top-10 list.

Remarkably, with the exception of *food*, non-First Nations and First Nations participants' top-10 lists do not boast a single ecosystem service in common. Rather, non-First Nations' list is dominated by provisioning services (*water*, *shelter*, *clean air*), terms relating to income opportunities (*tourism*, *employment*) and also *recreation* and *entertainment*. These particular cultural services are notably different in tenor from those ranked highly by First Nations participants, whose terms of choice reflected more emotional states.

While this distinction may seem primarily linguistic, it is worth noting that current advances in cognitive linguistics and neuroscience emphasize the degree to which the associative links and underlying metaphors inherent in different terminology engage different neuronal pathways associated with different kinds of physical, embodied experiences (e.g., Lakoff & Johnson 1999; Canovas & Manzanares 2014). This means that it is unlikely people are merely 'using different words for the same thing.' Rather, they are emphasizing explicitly different subjective, embodied experiences, each with its own set of both cultural and individual-level contextual influences, nonetheless each perceived through the shared biological architecture of human perceptive capacity, in a shared environment. See, e.g., Slingerland 2008, for a fuller account of the epistemological implications of these advances in cognitive theory for the integration of social and hard sciences.

Food preference: rankings

The results of the species ranking by food preference (taking a conservative approach to the value of food, as outlined in *Methods*) begin on a relatively homogenous note. *Salmon*, *halibut* and *crab* consistently feature highly in the rankings of multiple demographic subgroups within our participant sample. *Prawns* and *clams* also feature highly, although *prawns* were notably ranked higher by non-First Nations than by First Nations participants (see Appendix B in Supporting Information).

However, First Nations participants also highlighted a substantial number of food species that non-First Nations did not mention in the context of food preference at all. These included *urchins* (S = 0.168), as well *as herring roe* (S = 0.132) and *herring* (S = 0.040), in addition to a greater diversity of specific marine invertebrates: *chitons* (S = 0.024); *acorn barnacles* (S = 0.016); *butter clams* (S = 0.016); and *littleneck clams* (S = 0.008).

Conversely, non-First Nations listed a wide range of rockfish—both as a genus, and as specific varieties—that First Nations participants themselves did not (see Fig. 3): *rockfish* (in general) (S = 0.055); *rock cod* (S = 0.050); *quillback* (S = 0.035); *yelloweye rockfish* (S = 0.034); *copper rockfish* (S = 0.030); *rougheye rockfish* (0.025); *cabezon* (0.025); and *China rockfish* (0.015). Note that none of these species is eaten by otters, and all of them are anticipated to flourish on WCVI under trophic cascade conditions (Markel 2011; Markel & Shurin 2015) (see *Discussion*).

The results of our food-preference analysis also demonstrate a gender dimension (see Fig. 4). As a group, women ranked the term *clams* more than twice as highly as did men (S = 0.198, versus S = 0.078, respectively). Women also scored a range of other shellfish, including *urchins*, *oysters*, *scallops* and *mussels* more highly than did their male counterparts.

Inversely, males mentioned a wide variety of rockfish species that—like First Nations participants— females simply did not mention. Males also ranked *lingcod*, another kelp-dwelling species, more than four times as highly as did females (S = 0.122, versus S = 0.028, respectively).

Scenario preference: more otters versus less otters

Regarding the two alternative scenarios proposed (see *Methods),* we performed a logistic regression on the data, revealing a statistically significant (p=0.003) cultural difference in the expressed preferences of non-First Nations and First Nations participants. The odds of non-First Nations favouring a scenario with more, rather than less, otters were 10 times greater than those of First Nations participants, OR = 0.10 (CI 0.022-0.447) (i.e., 17 of N=32 non-First Nations participants who responded to the question favoured more otters, compared to only 3 of N=25 First Nations participants who responded to the question).

Moreover, while non-First Nations' qualitative descriptions of kelp were all neutral-to-positive, First Nations participants were more reluctant to offer their views. Among those who did, some expressed neutral-to-positive assessments, but others expressed more ambivalent views, including assertions that kelp "gummed up boat engines," "smothered [sea]life," or were "taking up all the oxygen" under the water.

While such assertions regarding kelp's ecological role are not supported by current science (e.g., Markel 2011; Markel & Shurin 2015), the fact that some First Nations participants nonetheless *perceived* things this way hints at potentially contrasting mental models (e.g., Levine et al. 2015), and may explain some of the valuation differences amongst demographic groups observed in the data (see Discussion).

DISCUSSION

As otters continue to expand their range southward down western Vancouver Island, it appears that Clayoquot First Nations individuals are likely to perceive a number of short-term losses in access to preferred traditional foods, conservatively defined (see Fig. 3). (This would echo the experiences of Kyuquot First Nations, to the north, described in Appendix E in Supporting Information). In contrast, non-First Nations who enjoy a variety of rockfish (i.e., especially males, see Fig. 4) can expect such losses to be somewhat alleviated by increased abundance in demersals, a phenomenon of high certainty that is supported by locally-collected empirical data (Markel 2011; Markel & Shurin 2015).

The range of invertebrate species ranked highly amongst First Nations participants (see Fig. 3) suggests the relatively high resolution at which First Nations individuals tend to think about edible shellfish and, by implication, the relatively prominent position these species play in Nuu-Chah-Nulth food culture. Archeological evidence affirms the centrality of many of these foods for Nuu-Chah-Nulth culture dating back to before European contact (McKechnie 2007). With reference to the present-day trophic cascade, it is crucial to note that all of these shellfish types (e.g., sea urchins, clams, chitons, mussels, etc.) are locally known to be eaten by sea otters (Singh et al. 2013; Levine et al. 2015; see Appendix E in Supporting Information).

(We should note local residents and managers assert that, historically, First Nations would actively use force to exclude sea otters from certain areas reserved for mariculture harvest--e.g., so-called "clam gardens" (Williams 2006; see Appendix E in Supplementary Material). However, under Canada's Species at Risk Act, it is currently illegal to kill, harm or ‘harass’ sea otters in any way without official federal sanction (CBC 2009).)

On the issue of perceptions, note that our present mode of analysis (simply tallying S scores in a commensurable fashion) discounts the fact that humans have been demonstrated to be more averse to loss than they are appreciative of gain (Kahneman et al. 1991). We have also discounted the many cultural and personal emotional ties that ecosystem-dependent peoples tend to have with respect to food species and food collection (Turner et al. 2008; Chan et al. 2012b). If we were to take these facts into account, our results would suggest an even more pronounced imbalance in how non-First nations, versus First Nations individuals in particular, are poised to experience the effects of the trophic cascade.

Note that Nuu-Chah-Nulth First Nations have historically relied almost entirely on traditional local seafoods for sustenance (McKechnie 2007). Even as they have been steadily alienated from their traditional fishing grounds by successive settler-colonial policies (Harris 2008), Nuu-Chah-Nulth communities continue to place significant cultural value on access to and collection of edible marine invertebrates. This is particularly the case for Nuu-Chah-Nulth women, who spend considerably more time in the nearshore environment than do men. (Nuu-Chah-Nulth men, alternatively, spend relatively more time on the open ocean fishing for salmon and halibut). In contrast, non-First Nations residents are relatively recent arrivals in the area, whose livelihoods are more directly connected to the wider settler-colonial market economy. They do not have as deep a history of close dependence on marine invertebrates, neither for subsistence, nor in terms of cultural identity. While the ecosystem is still pivotally important for non-First Nations coastal dwellers, the ways and degree to which this is the case differ from their First Nations neighbours by virtue of history (Harris 2008).

A similar pattern to that described above emerges when contrasting the responses of male and female participants (see Fig. 4). Women's relatively high valuation of edible shellfish leaves them vulnerable to experiencing losses as otters expand their range (Watson & Estes 2012;

Singh et al. 2013). Men also appear to enjoy a range of edible shellfish, but their loss of the former is likely to be at least partially alleviated by men's relatively high valuation of multiple demersal fish species that flourish in kelp beds and are shown to benefit from otters' presence (Markel 2011; Markel & Shurin 2015). This bifurcation of food preference along gender lines may be explained by the fact that fishing for rockfish is a heavily male-dominated activity in the region, and thus men may have developed a disproportionate taste for their catch, while shellfish collection has, historically, involved women to a much greater extent.

With respect to our ecosystem services data, the Clayoquot public appears to hold an intuitive typology of ES ("things that nature does for people, or gives people") that differs considerably from that of the academic and grey literature (e.g., Daily 1997; MA 2005). Rather than focus on ecological processes, participants appear to think in terms of phenomenologically-derived categories more immediately familiar to lived human sensory experience. Some of the terms participants used (e.g., *food, water, shelter, income*) do map fairly well onto the academic category of "provisioning services." However, a number of terms repeated by participants do not map as clearly onto any one given academic category of ES. For instance, rather than identify processes, such as "the cleaning of water" (a supporting service), as distinct from the provision of end products, such as "drinking water," participants appeared to think in terms that combined both the ecosystem process, and the ultimate benefit, into one single, efficient, linguistic-mental object that could be readily perceived: e.g., *clean water*, *clean air*, *good weather*, and so forth. Neither supporting, nor regulating, services appeared to be especially obvious as discrete processes to our participants, managers included. This suggests that people may well have a figurative blind spot for the 'life-support' (Daily 1997) services that the ES framework is largely designed to highlight. This is

an empirical question that could benefit from future inquiry, with possible implications for multistakeholder management and public engagement in conservation.

Other terms that participants invoked during the ES-ranking exercise specifically reference gestalt experience, or emotion: e.g., *tranquility, isolation, health, well-being* or *depression* (an apparent ecosystem 'disservice'). The subjective experiences these terms correspond to are relatively challenging to operationalize, and are thus harder to measure with certainty than are more concrete ES such as *employment* or *tourism*.

This has repercussions when we consider how participants ranked the subjective importance of the ES they listed. First Nations participants tended to rank such experiential or emotional state-based ES more highly than did non-First Nations. Non-First Nations, on the other hand, tended to rank more concretely observable ES more highly. Crucially, several of those ES ranked highly by non-First Nations (e.g., *employment, recreation, tourism, entertainment*) can be reasonably expected to increase with rising sea otter numbers, in the relative short-term—i.e., in the form of ecotourism (FOC 2004; Loomis 2006). It is less certain, however, that increased sea otter presence would similarly boost the kinds of ecosystem-based experiences ranked highly by First Nations participants. Such experiences amongst First Nations are both harder to measure, and less clearly tied to an increase in ecotourism, particularly given local First Nations' relative non-involvement in that sector (L. Loucks, Research Coordinator--Clayoquot Sound Biosphere Trust, personal communication). In fact, as foreshadowed by results from our Kyuquot Sound pilot, insofar as First Nations participants believe their emotional and physical well-being to be a function of continued access to a variety of traditional foods (see Appendix E in Supporting Information), these data further suggest Clayoquot Sound First Nations individuals are liable to view a surging sea otter population negatively, at least in the short term.

CONCLUSION

In the Clayoquot context, the preferences and experiences of historically disadvantaged demographic groups (Harris 2008) are being either discounted or ignored by current conservation practice. While there may be good reasons to protect sea otters from humans on an ecological basis (Markel 2011; Markel & Shurin 2015)—or even an animal-rights basis—our results suggest there are social equity trade-offs for decision-makers to take into account going forward.

Perceptions of environmental injustice can have visceral, real-world consequences for community building and intergroup relations (Kemp-Benedict 2013; Burns 2008). When these social factors strain, this can in turn make managing a shared commons even more fraught than it might have otherwise been (Adger 2000; Andersson & Agrawal 2011).

While rudimentary, our approach of comparing and tallying S scores across demographic subgroups is one example of how to collect a richer data set on the variegated potential social effects of conservation. As has been lamented extensively in the literature, such efforts to integrate social considerations into ES studies are sorely needed (e.g., Tallis et al. 2008; Menzel & Teng 2009; Kosoy & Corbera 2010; Daw et al. 2011; Chan et al. 2012a; Chan et al. 2012b; Ban et al. 2013; McDermott et al. 2013; Raymond et al. 2013; Schroter et al. 2014).

We feel that by continuing our present effort to draw on techniques already developed in methodologically relevant fields such as cognitive anthropology (e.g., Medin & Atran 1999; Atran & Medin 2008), psychology (Benet-Martinez et al. 2002; Storbeck & Clore 2008; Henrich et al. 2010) or behavioural and experimental economics (Kahneman & Knetch 1992; Henrich et al. 2001), researchers can go on to better address important social aspects of conservation that have hitherto been neglected as subjects of empirical inquiry.

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Figure 1. *Top 10 ecosystem services by relative salience: general public versus government managers.* This figure presents the relative ease with which various ecosystem services (ES)

were recalled by members of the general public (left) and government managers (right). We order the 10 most commonly mentioned ES for each group by most salient (top), to least salient (bottom). The size of the font for each ES is scaled according to its S score amongst the relevant group. S score (i.e., Smith's salience score) is calculated from participants' freelists using the formula developed by Smith and Borgatti (1997). The color of each ES corresponds to which of the UN-designated ES categories (MA 2005) the given service most clearly matches. Some ES do not fit obviously into any of the preformulated categories, and hence are coded as 'intangible/other.' In cases when an ES could arguably be coded as belonging to more than one category, the font is highlighted in a lighter shade of the color that corresponds to the secondary category option.

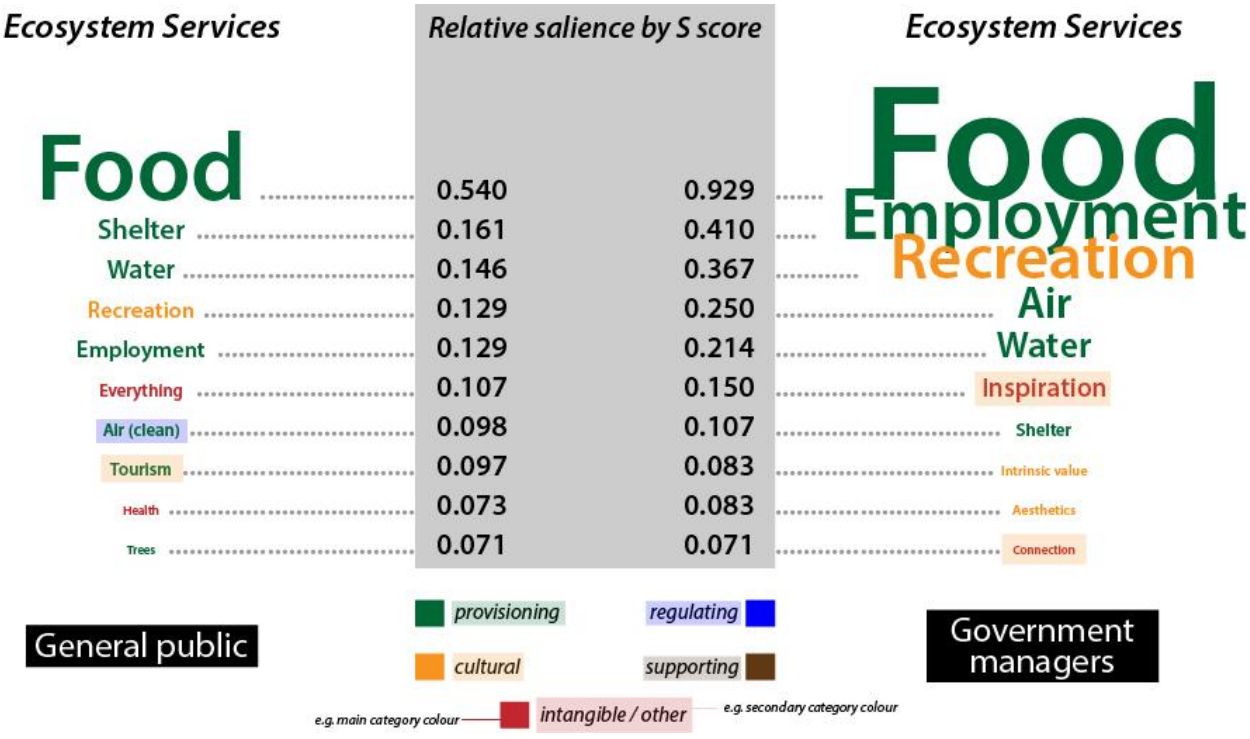

Figure 2. *Top 10 ecosystem services ranked by relative subjective importance: First Nations versus non-First Nations.* This figure presents a top 10 list of those ES that First Nations participants (left) deem most important, contrasted with those of non-First Nations participants (right). The same visualization method was used as in Fig. 1, above.

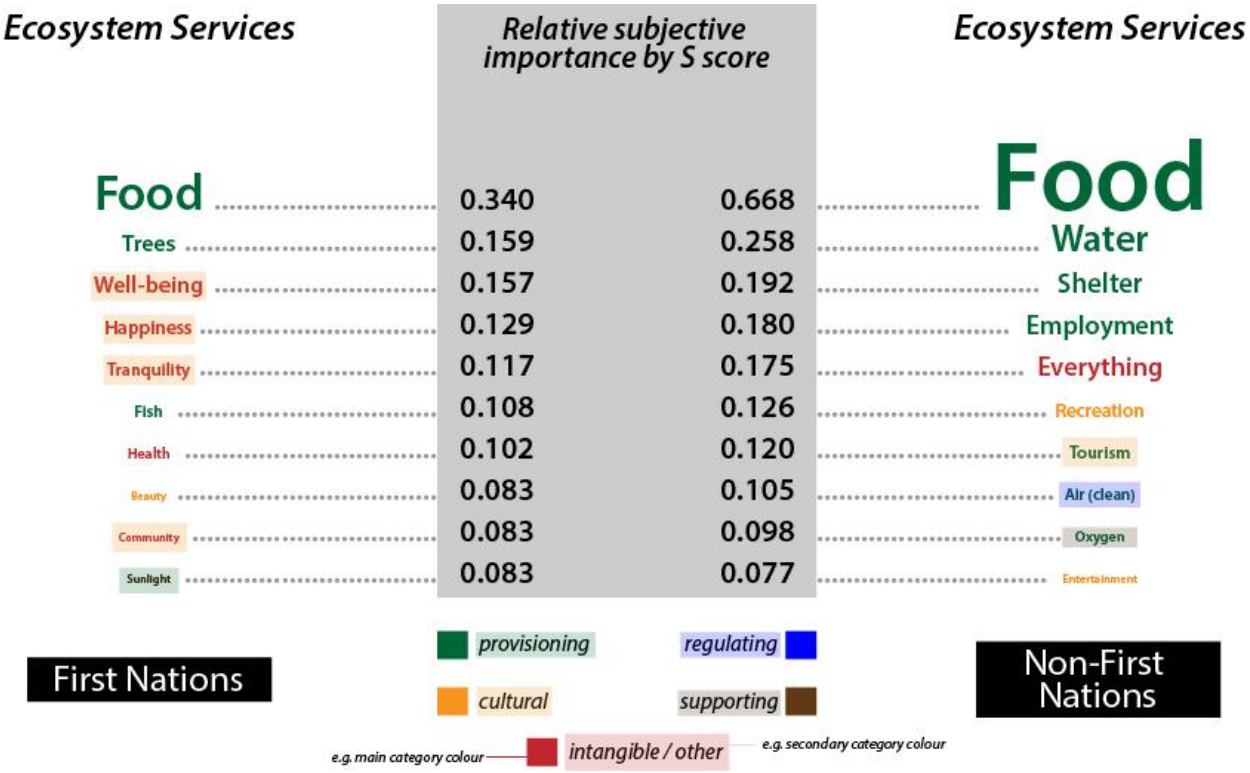

Figure 3. *Projected losses in preferred foods under trophic cascade conditions: First Nations versus non-First Nations.* This figure lists those particular species that have both been empirically demonstrated to either diminish, or flourish, as sea otters expand their range (Markel 2011; Espinosa-Romero et al. 2011; Watson & Estes 2011; Singh et al. 2013; Markel & Shurin 2015) and which First Nations and non-First Nations participants also ranked as important preferred foods (conservatively defined). Note that the resulting projections are themselves very conservative: we avoid all double counting, to the point of discounting cases in which participants may or may not have been referring to the same species (e.g., we do not count the oft-cited general category of 'rockfish,' or 'clams', but only specific species of rockfish or clams mentioned). We also leave out herring and herring roe entirely, even though there is some evidence suggesting that sea otters can and do learn to predate on herring roe, thus negatively effecting that fishery (Lee et al. 2009). If we were to include these additional factors in the calculation, the asymmetry in projected losses would be even more pronounced.

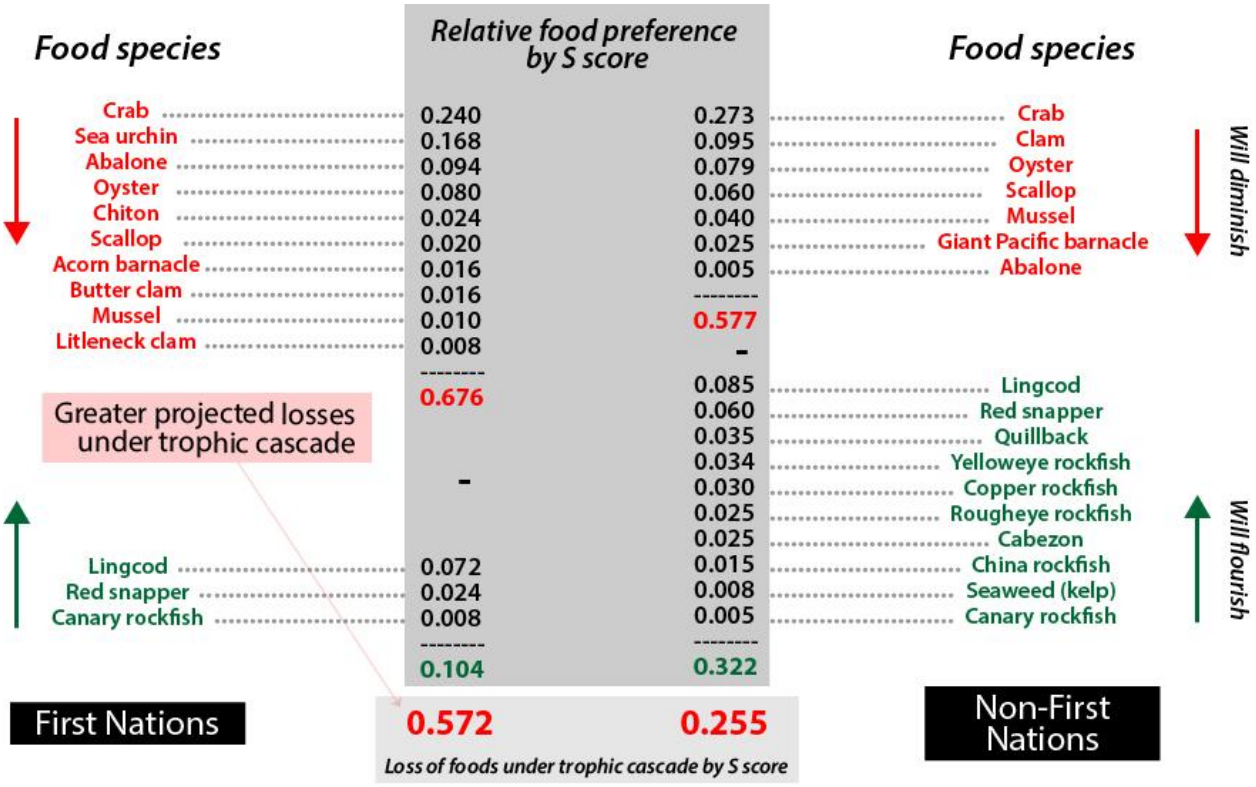

Figure 4. *Projected losses in preferred foods under trophic cascade conditions: females versus males.* This figure lists those particular species that male and female participants ranked as important preferred foods (conservatively defined) and which have also been empirically demonstrated to either diminish, or flourish, as sea otters expand their range (Markel 2011; Espinosa-Romero et al. 2011; Watson & Estes 2011; Singh et al. 2013; Markel & Shurin 2015). The same method was used as in Fig. 3, above.