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From conflict to collaboration: The role of expertise in fisheries management

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ABSTRACT

This paper illustrates the need for and proposes avenues through which the concepts of Studies in Expertise and Experience (SEE) can be developed towards application to address real-world problems, such as fisheries management. Using analytical literature reviews and reanalysis of four case studies of SEE and fisheries management within the frames of trust and sentiment, this paper shows that the inclusion of interactional expertise can facilitate collaboration. However, those collaborations can disintegrate when latent distrust is triggered in situations where the collaborators have a contentious history. These contentious collaborations are marked by sentiment-laden decision making and judgments of credibility. Combining the concepts of SEE with tools, such as blind reviews, moral imagination, or tools for mitigating implicit bias might help to sustain and improve these contentious collaboration. The research on the application of these tools might move the theoretical concepts of Studies in Expertise and Experience closer to becoming practical instruments that are useful for building and sustaining the collaborations needed to address environmental problems, such as those found in fisheries management.

1. Introduction

A sub-field of Science, Technology, and Society (STS), the burgeoning and highly debated (Collins and Evans, 2003; Gorman, 2002; Jasanoff, 2003; Rip, 2003; Wynne, 2003) area of Studies in Expertise and Experience (SEE) has yielded a normative theory of expertise. This theory could help determine who is best equipped to make science and science-policy decisions based on knowledge and experience (Collins, 2004; Collins and Evans, 2002, 2007). Despite the criticism imbuing the debate, the number of scholars working in the field of SEE continues to grow.

For such a young and theoretical field SEE has attracted a breadth of researchers and practitioners. The growth of the field of SEE is in part because SEE offers a promising framework for how to bridge the disciplinary disconnects prevalent in the multidisciplinary approaches needed to address complex real-world problems. The areas of study of those who have published on SEE include psychology (Gorman, 2002), sociology and physics (Collins and Sanders, 2007), environmental studies (Jenkins, 2007), and ethics and philosophy (Selinger et al., 2007). The papers often feature retrospective application of SEE concepts to explain past events in science and science-policy decision making (i.e. decisions that pertain to matters of science or science policy regardless of whether the decision is made by a scientist or science policymaker) (Boyce, 2006; Carolan, 2006; Collins and Evans, 2002; Evans and Plows, 2007; Jenkins, 2007, 2010a; Ribeiro, 2007; Weinel, 2007). In some cases the articles are derived from the author's experience as a participant in the event (Collins, 2007; Collins and Evans, 2002; Collins and Sanders, 2007; Shrager, 2007). All of these articles discuss cases in which, SEE concepts were not explicitly applied as such. Rather the researchers, identified characteristics in the case studies that were in keeping with SEE concepts after the fact. In fact, to date, no studies have been conducted in which SEE concepts were prospectively applied to real-world case studies.

The growing SEE literature of retrospective studies and the wide appeal of SEE reveal the field's practical potential to inform how expertise is discerned and employed in making science and science-policy decisions. But are the concepts of SEE as they currently stand sufficient to inform a substantial progress in how expertise is appropriately used in real-world situations? The SEE literature has not directly addressed this question. However, this paper will build a case drawing on a critical deconstruction of Collins' and Evans' writings and an analytical literature review to argue that they are not sufficient and will then support this argument with case studies from fisheries management. While theories drawn from STS often do not figure prominently in the fisheries management literature, many fisheries management conflicts are

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excellent illustrations of STS concepts. At their heart fisheries management conflicts are often about the implications that scientific findings and technological regulations hold for fishing communities. There are several case studies in the literature focusing on SEE and fisheries management (Jenkins, 2007, 2010a; Johnson, 2011; Johnson and McCay, 2012). This paper will draw on this subset of the SEE literature, examining how SEE helps explain past failures of collaborative efforts in fisheries management, and how SEE might be enhanced with future research.

The goal of this paper is to encourage the field of SEE towards the first steps of honing the theory so that it will be applicable to help solve real-world problems. It will also suggest avenues of future research that could yield tools for addressing the deficiencies in the application of SEE concepts to real-world problems. By no means is the intent to suggest that SEE is an alternative fisheries management scheme. Rather at this stage SEE concepts should be viewed as a knowledge innovation nearing prototype stage. If future development and testing is successful, SEE concepts might be a tool to add to the fisheries management toolkit, as well as to other applied fields, such as environmental management writ large and public health.

2. Background

In their inaugural SEE paper, Collins and Evans (2002) divide science studies into three waves. They delineate the First Wave of Science Studies as occurring in the 1950s and 1960s. During this Wave, society accepted that a sound scientific training licensed a person to speak with authority and decisiveness on their and other fields of study. The status quo was top-down decision making with scientists at the top deciding on matters of science and technology.

Collins and Evans define the Second Wave of Science Studies as beginning in the early 1970s and continuing today. This is “the age of democracy” that sought to balance the top-down system and be more inclusive. During this Wave, political rights have become interchangeable with scientific expertise, removing the boundary between scientists and the public. Under this paradigm, any person with an interest in a technical matter has a right to engage in decision making about it. The result is that the decision-making process is laden with too many actors, some of whom have an interest in the problem but no relevant knowledge or skills that can help address it. Finding that neither of these Waves is acceptable for facilitating the best decision making in scientific and technical matters, Collins and Evans proposed a Third Wave of Science Studies (Collins and Evans, 2002).

The Third Wave would be “the age of expertise”. Collins and Evans proposed the redrawing of a boundary line, not between scientist and laity, but between experts and non-experts. They suggest that the Second and Third Waves can and should coexist. The addition of the Third Wave will allow people to exercise their political rights to be heard on a matter, but will confer decision-making authority to those with relevant expertise (Collins and Evans, 2002).

SEE identifies different categories of expertises, most notably interactional and contributory expertises. Interactional expertise is the ability to speak about a specialism as though one were an expert in that area. It is gained through immersion in a community or culture and is defined as a solely linguistic ability; an interactional expert would not be able to practice the specialism about which they can converse. Contributory expertise on the other hand, is the ability to make an advancement in a specialist field. As presented by Collins and Evans the designations of these expertises is properly determined by analysis of the written knowledge (i.e. can a person write in such a way that an expert would judge them to be an expert as well). However, this is an arbitrarily restrictive constraint that does not reflect, real-world discernment of expertise, especially the influence of social bias on discernment.

By drawing on analytical literature reviews and case studies that apply SEE concepts to fisheries management, this paper will show that there is a consistent pattern of social issues that hindered the utility of SEE concepts. The remainder of this paper will demonstrate that the issues of accessibility, credibility, and bias that the Second Wave sought to address remain intimately tied to the concepts of the Third Wave. One cannot strive to objectively determine decision-making authority based on expertise without accounting for the fact that people are often sentimental and subjective in their judgments.

The findings section of this paper will show that while one's ability to discern expertise can be beneficial in increasing the effectiveness of some decision-making processes, it can also disrupt those processes if one's discernment is bias. Furthermore, the reliance on social perceptions to discern expertise tends to be a default mechanism related to the fact that technical expertise is built on ubiquitous expertise, i.e. the ability widely held by most members of society to make a technical judgment on the basis of social understanding. Moreover, this default dependence on social perceptions over technical knowledge in making judgments of expertise tends to be triggered in circumstances of controversial, adversarial, and stressful conditions. This paper will illustrate these ideas with case studies where contributory and interactional expertises were engaged but the decision-making processes still floundered. To further support these ideas, this paper will build upon past studies of factors influencing trust and perceptions of credibility as well as research on unconscious bias. Finally, the discussion section will then offer avenues, such as moral imagination, for developing tools that could be combined with the concepts of SEE to allow for more accurate discernment of expertise and facilitate more collaborative multidisciplinary decision making in science and science policy.

3. Methods

This study is comprised of four stages: 1) a critical deconstruction of the SEE theory, 2) an analytical review of the applied SEE literature, 3) reanalysis of four existing SEE case studies within the frames of trust and sentiment, and 4) conceptual validation. The central method in each analytical stage was constant comparison, which involves an inductive qualitative process of iterative examination and note-taking to identify meaningful similarities and differences between pieces of data (Bernard and Ryan, 2010).

3.1. Critical deconstruction of the SEE theory

Stage one involved a critical deconstruction of the core theoretical writings of Collins and Evans, the founders of SEE. The research questions driving this phase of research was: What are the logical inconsistencies and weaknesses in SEE theory concerning the concept of discernment and application of expertise? And, how might these inconsistencies impact the real-world utility of SEE theory? After identifying these inconsistencies/weaknesses, the study drew on related bodies of research to illustrate that these inconsistencies/weaknesses were relevant concerns.

3.2. Analytical review of the applied SEE literature

Stage two moved the study from theory to application. It involved identifying and analyzing SEE literature pertaining to the application of SEE concepts (or more exactly interventions that were characteristic of SEE concepts) to real-world case studies.

Papers were identified from the publications list at the Expertise Project,[1] a search on Web of Science for the term “interactional expertise”, and an examination of references cited in known SEE papers. This list was further narrowed by selecting papers with case studies of multi-group science decision making in real-world situations, thus excluding theoretical or experimental papers. The research question guiding this phrase of research was: What factor(s) best account for the range of outcomes in SEE case studies? This stage of research yielded three research hypotheses:

H1: The inclusion of interventions characteristic of interactional expertise facilitates collaboration between groups.
H2: Judgments of expertise are based in part on sentiment.
H3: Issues of sentiment and latent distrust can cause collaborations to degrade even with the inclusion of interactional expertise.

3.3. Reanalysis of SEE case studies

The third stage of research tested these hypothesis by reexamining four existing published case studies within the frames of trust and sentiment. Two of these case studies were added to the literature after the completion of phase two, which lends additional rigor to the analysis as they were not part of the literature review that yielded the hypotheses. The data included in the analysis of these two case studies was drawn primarily from the published papers with a few additional clarifying facts solicited directly from the corresponding author of the studies.

The remaining two case studies represent original work conducted by the author of this paper. Aspects of these two case studies have been published elsewhere, but this is the first treatment of them within the frames of trust and sentiment. One of these case studies examines the case of turtle excluder devices (TEDs) beginning in 1976 when research began to reduce incidental catch of sea turtles in fishing nets (i.e. bycatch). The final year, 1998, included in the TED case study was the last year of TED development before major changes in TED regulations. The second case study examines the tuna-dolphin problem and the surrounding activities between 1964 and 1981. The year 1964 was when dolphin bycatch was first brought to the government's attention while 1981 was the last year that a dolphin-conservation-technology-development program existed within the U.S. government.

For these two case studies, the author gathered data by examining inventions, conducting interviews, and analyzing documents. The author conducted forty-nine on-site, semi-structured and unstructured, in-person interviews with key informants. These interviews mostly occurred during five, two-week trips in 2003 and 2004. The sample population consisted of representatives from stakeholder groups, including federal and state policymakers and managers, scientists, inventors, as well as fishing industry and environmental-organization representatives. The author initially established a sample frame using a purposive sample of prominent individuals frequently mentioned in the literature pertaining to the study. The purposive sample led to a snowball sample; informants were asked to name other individuals who were knowledgeable about the case study and many of these were then interviewed (Bernard, 2002).

The author also collected approximately seven hundred documents, including government reports, research records, memos, and personal letters from the key informants' archives. Most of these documents are publically available and all can be obtained from the author of this paper. The author analyzed the text of the interviews and documents in the spirit of grounded theory, allowing theories to grow out of categories of concepts that initially emerged from the analysis of the texts (Strauss and Corbin, 1998). The author then linked the grounded theories that emerged from the case studies to existing theoretical frameworks, such as SEE, that offered compelling explanatory value.

3.4. Conceptual validation

The final stage was validation, which is a requisite for a grounded theory approach to analysis (Bernard, 2002). In this phase the findings from the analysis are presented to knowledgeable individuals for critique and validation, not unlike a peer-review. This phase may trigger further analysis and refinement of the theory. The validation for this study involved a review of an early manuscript by the corresponding author of the two other case studies and a presentation and question and answer session with SEE researchers attending the SEE annual meeting.

4. Findings

4.1. Deconstruction of the SEE theory

The deconstruction of SEE theory revealed that discrimination (i.e. discernment) of someone's level of expertise is vulnerable to social bias. In their 2002 paper Collins and Evans, introduce the concept of discrimination, which is the process by which people determine if purported experts are credible and truly have expertise relevant to the problem at hand. (Given that the everyday usage of “discrimination” has been maligned by its frequent association with negative social practices (e.g racism, sexism, ageism, etc.) a better term than “discrimination” might be “discernment.” For disambiguation, the remainder of this paper will use “discernment” to refer to Collins and Evans concept of “discrimination” and will use “stereotypical” or “prejudice” to refer to the negative social practice of “discrimination.”) In their subsequent writing, Collins and Evans (2007) expound on the concept of discernment, identifying additional categories of discernment, such as ubiquitous discernment and associated expertises, some of which rely on social perceptions.

With Ubiquitous [discernment], “the judgment turns on whether the author of a scientific claim appears to have the appropriate scientific demeanor and/or the appropriate location within the social networks of scientists and/or not too much in the way of political and financial interest in the claim.” Collins and Evans (2007) acknowledge that this type of discernment can be “very unreliable because of the temptation to read too much into stereotypical appearances and stereotypical behavior.” To illustrate this point they cite the past tendency to give “scientists in white coats” authority in a wide range of scientific matters, even those outside their area of expertise, because they had the appearance of knowledge and power.

However, more insidious than empowering those who are not qualified based on appearance and behavior, is the practice of disempowering those who *are* qualified based on appearance and behavior. For example, the progress of women in Science, Technology, Engineering, and Mathematics (STEM) fields is partly hindered by “a cultural expectation that math and science are for men” (Gee, 2011; Stout et al., 2011). Clearly if judgment of expertise rely in part on ubiquitous discernment, then women and other people groups that are the subject of social bias will be incorrectly discredited in some instances.

[1] http://www.cardiff.ac.uk/socsi/contactsandpeople/harrycollins/expertise-project/publications/index.html.

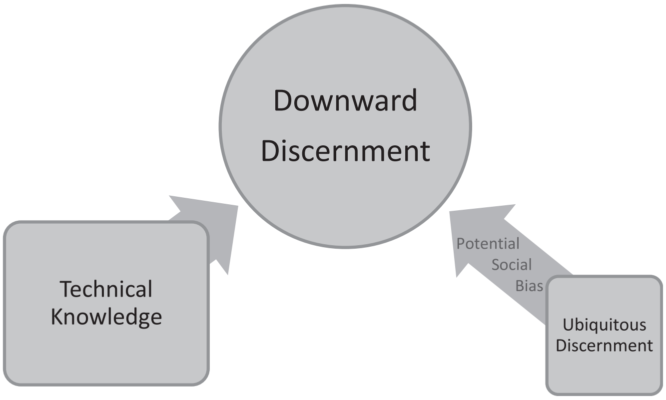

Fig. 1. Relationship between downward discernment and ubiquitous discernment, noting the avenue for potential social bias to factor into judgments.

Collins and Evans (2007) identify abilities to discern that are based on a technical knowledge of an expertise. One of these abilities is called "downward [discernment]" in which a person with a higher level of expertise in a discipline judges the credibility of a person with a lower level of expertise in that discipline. This type of discernment is prevalent in STEM fields. But Collins and Evans also note that despite the ability to make judgments based on technical knowledge, "judgments on the basis of demeanor and social position are often made within science." They cite the criteria that some scientists use to judge the validity and relevance of other scientists' research; these criteria include the personality of the other scientist, where he or she works, and the size and prestige of that institution. All of these are social indicators more than technical ones. Collins and Evans also state that "ubiquitous expertise are the beginnings from which all other expertises are built."

So one can easily extrapolate that even individuals with the ability to make judgments based on technical (presumably more objective) information will still incorporate social more subjective information in their decisions (Fig. 1). This then is a mechanism through which people's ability to discern relevant problem-solving expertise can be hindered by their pre-existing social biases. Thus the utility of the concept of discernment would be improved if it was explicitly broadened to account for the influence of sentiment, in the fullest sense of the word (i.e. a complex combination of objective consideration, feelings and opinions). The concept of sentiment acknowledges that one's discernment of another's expertise and one's decision to interact with someone is a combination of emotion and intuition with all the vagaries of decision making that entails.

This is also a reason why interactional expertise can be insufficient for sustaining collaborations in contentious situations with disparate interest groups. Collins' and Evans' (2007) themselves speculate that interactional expertise allows all conflicting parties to be at the negotiating table, but is insufficient to settle the conflict. But while Collins' and Evans' writings do touch on these points, their research to date has purposely avoided examining how social considerations can limit the utility of interactional expertise, treating them as idiosyncratic elements of individual cases (Collins and Sanders, 2007).

4.2. Analytical review of the applied SEE literature

The analytical review of applied SEE literature showed that the utility of interactional expertise for improving collaboration is mediated by values, traditions, respect, and trust. A couple of case studies (Carolan, 2006; Collins and Sanders, 2007) have shown that the inclusion of interactional expertise into a science decision-making process increased communication and was sufficient for improving the process, while other case studies (Jenkins, 2007, 2010a; Johnson, 2011; Johnson and McCay, 2012) have shown that interactional expertise only led to a brief improvement that was not ultimately sustained. Among this group of case studies the defining difference was the pre-existing and shared culture of values, traditions, and mutual respect or the lack thereof. For example, managers of large science projects used interactional expertise to communicate with scientists from different disciplines, facilitating the managers' ability to make informed technical decisions outside of their area of expertise (Table 1). However, managers of large science projects are almost always "drawn from the ranks of scientists" and "they cleave to the same academic traditions and values" (Collins and Sanders, 2007). So in this case the gap between science managers and the scientists they manage is simply the difference of expertise, which interactional expertise can aptly bridge.

But, what if there are no shared values and traditions, as was the case in Carolan's study (2006) of sustainable farmers and agricultural scientists? Here there was a mutual history of respect for the importance of each group's expertise, as was evident by multiple independent initiatives to seek each other's expertise. The issues that hindered cooperation between groups was that the scientists did not speak "farmer talk" and the farmers did not understand core principals of the scientific process. Again, interactional expertise was the tool that successfully bridged the divide (Table 1). If there is no shared culture *or* history of mutual respect, is interactional expertise still a sufficient tool for spanning the communication and cooperation divide between groups of experts?

Probing this phenomenon, it appears that in some cases SEE concepts are necessary but insufficient because while they address the factual aspects of how people discern and apply expertise, they do not account for the emotional and opinion-driven aspects (i.e. sentiment) that can be involved in this process (Table 1). This held true for the fisheries management case studies in which interactional expertise facilitated collaboration between fishers, scientists, and managers in the face of latent distrust (Jenkins, 2007, 2010a; Johnson, 2011; Johnson and McCay, 2012). Unlike the management of major science projects the various expert groups in these case studies do not share values and traditions. Furthermore, unlike the relationship between farmers and agricultural scientists, the relationship between fishers and fisheries scientists and managers is often highly contentious and marked by long histories of distrust (Table 1) (Dobbs, 2000; Finlayson, 1994; Jenkins, 2007, 2010a; Johnson, 2011; Johnson and McCay, 2012). In all four cases, persistent negative sentiment and/or the occurrence of a fraught situation triggering the latent distrust led to the degradation of the collaboration.

4.3. Case studies

The root of the contentious relationships around fisheries management in the United States dates back at least to the 1970s. Before this time the U.S. fisheries agency (then the Bureau of Commercial Fisheries and later the National Marine Fisheries Service) managed fisheries with the primary purpose of promoting their growth and expansion. Not surprisingly, this was generally a time of mutual respect and amicable relationships between fishers and fisheries scientists and managers. However, in the 1970s the U.S. Congress passed a number of new environmental and fisheries management laws, such as the Marine Mammal Protection Act of 1972 (MMPA), Endangered Species Act of 1973 (ESA), and the

Table 1
Summary of how SEE concepts and other elements can combine to lead to sustained or unsustained communication/collaboration.

Study description	Actors	Elements of discord	Elements of collaboration	Outcome
Managing large scientific projects (Collins and Sanders, 2007)	Project managers; Research scientists	Actors had different disciplinary backgrounds	All actors were scientists and shared the same academic traditions and values; Referred expertise[a]; Interactional expertise	Projects proceeded forward without major unresolved conflict
Informing sustainable agriculture (Carolan, 2006)	Sustainable farmers; Agricultural scientists	Lack of shared technical expertise and language	Mutual respect; Interactional expertise	Increased and sustained communication in a research team of farmers and scientists
Fisheries management (Jenkins, 2007; Jenkins, 2010a; Johnson, 2011; Johnson and McCay, 2012)	Fishers; Managers/scientists	History of distrust; Lack of shared technical expertise and language	Interactional expertise	Temporary but unsustained increase in collaboration

[a] Referred expertise occurs when skills that have been learned in one area are indirectly applied to another area.

Fishery Conservation and Management Act of 1976. These laws mandated that the National Marine Fisheries Service (NMFS) institute conservation practices that were sometimes in direct conflict with their other mission of promoting the growth of the fishing industry (Jenkins, 2007, 2010a). Each of these Acts required the use of the "best available science" in making decisions. Fisher knowledge is often "qualitative, tacit, and anecdotal," (Johnson, 2011) so under this new regime their knowledge might not be considered valid expertise for use in science decision making (National Research Council, 2004; Wilson and Degnbol, 2002). Some fishers began to believe that the fisheries scientists did not recognize and respect their expertise. Likewise, some fisheries scientists and managers believed that fisher knowledge was no longer considered valid expertise for use in the shift to evidence-based- management decision regimes. These two factors among others were the seeds of distrust that led to an adversarial relationship between some fishers and fisheries scientists and managers in the United States (Jenkins, 2010a). Each of the following four case studies (Table 2) center on fisheries management and apply the concepts of SEE, trust, and sentiment to explain the unfolding of events (Jenkins, 2007, 2010a; Johnson, 2011; Johnson and McCay, 2012).

4.3.1. Turtle excluder devices

[2]Bycatch of sea turtles became a management issue for the United States' shrimp fishery after the listing of several sea turtle species under the ESA. NMFS has responsibility for managing marine fisheries and protecting sea turtles. In order to fulfill this responsibility, NMFS began research to invent a device to reduce sea turtle bycatch, which came in the form of a TED—a type of turtle escape hatch in the fishing net. The successful development of this device required contributory expertise in animal behavior and biology from scientists, in hydrology and engineering from engineers, and in fishing gear and procedures from fishers. However, for these groups to cooperate effectively they needed interactional expertise.

The need for interactional expertise became most evident in the testing of prototype TEDs that government scientists had designed. In order to test the prototype TEDs, NMFS hired commercial fishing vessels and crew. Many of the shrimpers who worked aboard these vessels believed they had relevant expertise to share about how to improve the TED's performance. But these shrimpers felt that their ideas were ignored. The perception was that NMFS personnel thought that they were experts in experimental gear modification and shrimpers were not. The reason for NMFS' resistance to shrimpers' ideas may be a result of NMFS' attempt to limit experimental variables as stated in this quote from a 1980 NMFS report:

> an accurate estimate of trawl performance, particularly shrimp loss estimates, is difficult on vessels where full control cannot be exercised. Sources of error are introduced into the experimental design using a cooperative commercial fishing operation. In order to minimize the sources of error, the number of cooperative vessels must be kept at a level where the number of available qualified gear technologists can closely monitor each vessel's operation during the experiment (Watson, 1980).

This quote while justifiably emphasizing sound scientific method also essentially identifies the fishers as sources of error whose practices should be routinized and controlled to make the development of TEDs possible. Clearly, the two groups were not cooperating effectively, so Sea Grant interceded, providing interactional expertise.

Sea Grant is a change agency that engages with fishing communities on numerous issues, transferring new fishing technologies and educating the industry about new regulations. Most often Sea Grant serves to transfer information from NMFS to the fishing industry, to do so Sea Grant agents must speak the language of government scientists and managers as well as fishers. In other words, by virtue of their job description proficient Sea Grant agents are interactional experts. Sea Grant summarizes the work of its agents this way:

> On-the-ground experts, located in every coastal and Great Lakes state, translate sound scientific information … Sea Grant's locally-based professionals … live in, and are intimately connected to, the communities they serve. As both trusted residents and coastal experts charged with providing balanced and reliable science-based information…[3]

This description contains all the key characteristics associated with interactional experts. Notably, Sea Grant agents are steeped in the community of practice and they have the ability to communicate information between various groups such as fishers, scientists, and policy-makers.

[2] For a full discussion of this case study read Jenkins (2010a). The evolution of a trading zone: a case study of the turtle excluder device. Studies in the History and Philosophy of Science 41, 75–85, Jenkins (2010b). Profile and influence of the successful fisher-inventor of marine conservation technology. Conservation & Society 8, 44–54.

[3] Quote from http://www.mdsg.umd.edu/sites/default/files/files/2011NationalFinal.pdf accessed on November 12, 2013.

Table 2
Comparative summary of case study issues and evidence of interactional expertise and its insufficiency to sustain collaboration.

Case study	Fisheries management issue	Evidence of interactional expertise	Insufficiency of interactional expertise
Turtle excluder devices	• Need to invent a bycatch reduction device to protect sea turtles required input from shrimpers and scientists	• Sea Grant agents are steeped in the community of practice of and can communicate between fishers and scientists	• Decisions about which shrimp-invented TEDs to develop were based on social perceptions of inventors' reputations and motives rather than technical merits
	• Initially scientists did not consult shrimpers, so they developed ideas separately	• Sea Grant agents translated anecdotal evidence about the efficacy of shrimper-invented TEDs into scientific proof of performance	• Technical communication between fishers and scientists provided by interactional expertise could not overcome the social divide of stereotypical attitudes
Tuna-dolphin problem	• Need to invent a bycatch reduction device to protect dolphins required input from fishers and scientists	• A government scientist's extensive, immersive, and hands-on fishing boat experience led to interactional expertise in fishing	• A government scientist's interactional expertise could only mend distrustful relationship between himself and fishers, but not between other scientists and fishers
	• Public scrutiny and lack of government transparency led to distrust between scientists and fishers	• A government scientist built relationships and avenues of communication with fishers	• Fishers continued to refer to other scientists disparagingly and to exclude them from their boats
	• Cultural differences between scientists and fishers about decision-making authority	• A government scientist gathered and refined fisher ideas to create four successful bycatch reduction devices	
Illex squid fishery	• Need to create a system to incorporate fisher knowledge and improve real-time assessment and management of *Illex* squid fishery	• The consultant was able to communicate scientific information with nonscientists and to communicate fishing industry's concerns to scientists	• The collaborative process was productive and had merit, but participation in the program declined because of persistent trust issues
	• Lack of information yielded an inaccurate assessment of the squid fishery that led to an early closure	• The lead scientist built trust with the fishing industry by learning about the fishery, asking the fishers questions, and going out to sea with them	• When NMFS restricted a different fishery, squid fishers stopped participating because they feared the data they provided could lead to restrictions in their fishery
Trawl survey advisory panel	• Need to improve the bottom trawl survey used to conduct population assessments	• Fishers and scientists had extensive previous experience in cooperative research with each other	• Distrust and lack of transparency eroded the avenues of communication between scientists and fishers
	• Skepticism about the validity of population assessments after NMFS used an incorrectly configured survey trawl to gather data	• The scientists could discuss fishing gear and procedures knowledgeably with fishers	• Interactional expertise could not overcome the damage caused by actions that were viewed as cavalier, offensive, and dismissive of fishers' knowledge
		• The fishers on the Panel could aptly talk about technical matter with the scientists	

In the TED case, Sea Grant agents engaged with shrimpers, who had begun to develop new TEDs on their own, external to the NMFS TED invention system. They also interacted with NMFS about the continued refinement of NMFS-invented TEDs, which were large and cumbersome. Sea Grant agents recognized that for shrimpers to accept TEDs, the devices would need to be more practical for commercial use. Furthermore, they believed the best way to achieve this would be to bring shrimpers' TED ideas to the attention of NMFS scientists. So Sea Grant sponsored a demonstration event comparing a NMFS-invented TED with three shrimper-invented TEDs. Drawing on their interactional expertise and cultural understanding of the two groups, Sea Grant convinced shrimpers and government scientists to participate. During the demonstration Sea Grant collected data on the TEDs performance, effectively translating the shrimpers ideas and anecdotal evidence of performance into scientific proof that eventually led NMFS to approve all three shrimper-invented TEDs for commercial use. Subsequently, Sea Grant helped develop more collaborative TED research between NMFS and shrimpers. But the relationship was still fraught with issues around trust, credibility, and respect that hampered the overall effectiveness of the collaborations.

Even with the involvement of Sea Grant, to a degree NMFS was still resistant to shrimper ideas. One example is the case of a shrimper, who was a successful TED inventor, having created TEDs that are widely used. NMFS however claimed to have a personality conflict with this shrimper, who was known to doggedly pursue and advocate for his ideas, and did not collaborate with him. Often during the process of determining which proposed idea to further develop, NMFS would consider the reputation of the person proposing the idea. In another instance, NMFS refused to pursue an idea because the shrimper was unknown to the reviewers. The record of documents surrounding this event show that this shrimper offered a detailed history of his fishing experience and training in gear manufacturing to no avail. In another example, the idea of a shrimper was blocked from being forwarded to NMFS for consideration by a state official even though the official did not have the expertise relevant to evaluate the idea on its merits. The official blocked the idea, because he believed that based on past reputation, the shrimper who proposed it was “just trying to make trouble”, but the official offered no critique of the merit of the idea itself. Moreover, several state and federal government personnel involved with the TED case referred to some shrimpers as “wheel-huggers” a disdainful term used to refer to shrimpers who inexpertly fishes with a no clear knowledge of or concern for how to use the gear properly. These examples reveal that assessments of people's expertise in the TED case were in part based on observation and rational judgment, but were also stereotypical and emotional. Furthermore, these instances illustrate situations when ubiquitous discernment based on social perceptions was employed, but when downward discernment drawing solely on technical expertise would have been more appropriate.

4.3.2. Tuna-dolphin problem

[4]In the late 1960s the first reports of the large amount of dolphin bycatch and subsequent death by the tuna fishery began to surface in the media. In 1972 Congress passed the MMPA. One outcome of this legislation was an effort to prevent the bycatch and death of dolphins during tuna fishing. To achieve this goal of preventing dolphin bycatch, government and the fishing industry needed to work together. NMFS required the fishing knowledge and experience of the industry, and industry required the financial and scientific support of NMFS.

Unfortunately, several points of contention made it difficult for them to coordinate their actions. Concerned about negative media coverage and potential lawsuits from environmentalists, NMFS was secretive about its tuna-dolphin research. This lack of transparency led many fishers to question whether or not NMFS—which in the past had been a consistent advocate of fishery development—was truly committed to the continuance of the tuna fishery. Many NMFS personnel, on the other hand, believed that the majority of tuna fishers were not committed to fully addressing the dolphin bycatch problem. Distrust of each other's motives created an unstable foundation on which to build collaborative projects.

Furthermore, there was a fundamental cultural difference in how NMFS and the tuna industry determined rights to decision-making authority. NMFS treated academic credentials as the appropriate warrant for authority and decision-making power. Whereas, tuna fishers relied on superior fishing skills gained from experience at sea. Captains, who have almost monarchial authority while at sea, were now subject to the decisions of young NMFS staffers (known as gear technicians) with little commercial fishing experience. The fishers also felt that their opinions were not valued. As one senior participant put it "NMFS didn't listen to fishermen."

The tuna fishers affirmed that they viewed themselves as superior to the gear technicians in knowledge by referring to the technicians as "college kids" who learned most of what they knew on the job from the fishers. One well-respected fisher and gear inventor, collaborated with NMFS but refused to allow gear technicians on his boat. It seems that the captains were disgruntled by having these "kids" evaluate the merit of dolphin conservation technology prototypes that they might be required to use on their boats. Notably, the gear technicians did not have interactional expertise in fishing gear and procedures.

The tuna fishers did, however, embrace one NMFS scientist. He was often the only government employee allowed in some private tuna industry meetings. The tuna industry even appointed him to the advisory council of their research organization. Not surprisingly, he had interactional expertise that he acquired through years of immersing himself in fishing culture. For example, on one research expedition he spent three-fifths of one year at sea, which is on par with the at-sea schedule of many fishers. He claimed to have been on every type of fishing vessel on both coasts and to be the only government scientist with such wide experience of boats. The hands-on experience he acquired on these boats, assisting with their operations, amounted to the gaining of somatic tacit knowledge, (i.e. a skill-based knowledge embodied in the brain and body that is difficult to verbally articulate, such as how to ride a bike.)

This extensive experiential expertise helped further build his contributory expertise in marine engineering, while being immersed in fishing culture yielded interactional expertise. He applied the interactional expertise he gained to building a relationship with the tuna fishers and approaching them for ideas. He then used downward discernment, assessing ideas on their technical merits, to select the most promised ideas that he then refined by applying his contributory expertise in mechanical engineering. The outcome is compelling. In the span of five years, he invented four technologies for reducing dolphin bycatch, while all other successful inventors in the tuna-dolphin case study only invented one. His work was later credited as being pivotal for addressing dolphin bycatch in the tuna fishery.

Even though, the inclusion of interactional expertise via this government scientist made the tuna-dolphin research program more productive, contentious relationships among the fishers, gear technicians, and scientists still persisted, hindering a broader collaboration. The industry's implied sentiment toward gear technicians by their exclusionary actions and use of terms like "kids", shows how the tuna-dolphin collaborative research was hindered by sentiment even after the inclusion of interactional expertise through the one favored government scientist. Thus, this example illustrates that collaborations can still falter even when one person with interactional expertise provides an avenue of communication between contentious groups and downward discernment is appropriately applied using technical expertise only. These SEE tools when applied through one individual were still insufficient to overcome the disruptive effect of sentiment in contentious collaborations.

4.3.3. Illex Squid Fishery

[5]*Illex* squid is a difficult fishery to manage. This species of squid only lives one year and the population levels vary widely from year to year, in part because of variable ocean conditions (a relationship that is poorly understood). To further compound the problem, *Illex* squid are highly migratory and the surveys NMFS uses to estimate population size do not cover the entire habitat range of the squid.

The end result of the poor information available for population assessments is that the yearly limit set for fishers to catch *Illex* squid can be grossly off the mark. This is believed to have been the case in 1998 when the squid fishery was closed early, because the fishers reached the limit set by the government. Evidence suggests that NMFS set the limit too low that year and that the closure was not necessary. This was a moment of crisis and a turning point in the management of the fishery. In this study Johnson (2011) analyzes the outcome of an effort by both the fishing industry and NMFS to create a system that would better incorporate fisher knowledge and allow real-time assessment and management.

The squid fishing industry hired a fisheries scientist from a university as a consultant to conduct research to support real-time management. A NMFS scientist partnered with this consultant and the fishing industry to create a voluntary collaborative data collection program. The consultant was able to "recognize the value of fishermen and their knowledge and [was] able to communicate scientific information with nonscientists… [and was] able to communicate the industry's concerns to other scientists" (Johnson, 2011). These qualities marked the consultant as having interactional expertise. He also "helped foster trust, legitimacy, and buy-in" (Johnson, 2011) to the NMFS' effort to develop a real-time management system by being a conduit for expressing industry's thoughts and concerns about the process. However, this ability to exercise interactional expertise can be hindered if the consultant scientist is viewed as politically motivated or extremely passive or aggressive towards NMFS scientists. Again this highlights the importance of trust and credibility in applying interactional expertise.

[4] For a full discussion of this case study read Jenkins (2007). Bycatch: interactional expertise, dolphins and the US tuna fishery. Stud. Hist. Phil. Sci. 38, 698–712.

[5] For a full discussion of this case study read Johnson (2011). Fishermen, Scientists, and Boundary Spanners: Cooperative Research in the US *Illex* Squid Fishery. Society & Natural Resources 24, 242–255.

Fishers who participated in the collaborative data collection program kept detailed records on their catches and provided squid samples as specimens for the NMFS scientists to collect biological data. The lead scientist built trust with the fishing industry by devoting time at the beginning of the project to learning about the fishery, asking the fishers questions, and going out to sea with them. Notably, these are also the types of activities that can eventually lead to gaining interactional expertise. This initial period of trust building paid off with an inaugural participation rate in the collaborative project of 63% of the fishing fleet in 1999. This rate peaked in 2001 at 67%, before hitting a low of 7% in 2003 (Johnson, 2011). Most of the informants who provided information about this case study agree that the collaborative process was productive and had merit. They credit the dramatic decline in participation to persistent trust issues, because fishers had “long-standing concerns that data may be used against them in the development of fishing regulations” (Johnson, 2011).

When NMFS implemented regulations to restrict fishing areas in another fishery, squid fishers perceived that if NMFS restricted one fishery then it might restrict the squid fishery as well, resulting in a flare of latent distrust and a decline in project participation. Some may question whether distrust is a sentiment, but arguably, trust falls within the broad definition of sentiment i.e. a complex combination of feelings and opinions. In fact, scholars have argued that trust is characteristic of an emotion because it narrows the perception of facts so that a person readily accepts facts that support the sense of trust/distrust and resist facts that negate the sense of trust/distrust (McLeod, 2011). This case study clearly suggests that decline in fishers' participation was driven by a resurgence of negative opinions and distrust of NMFS' motive, in other words it is indicative of sentiment. Yet again, this case study illustrates how interactional expertise can temporarily improve the cooperation among groups, but in contentious and complex situations this effect fails to persist because of pre-existing negative sentiments.

4.3.4. *Trawl survey advisory panel*

[6]There is a long standing debate between fishers and NMFS scientists about the appropriate use of a fishing gear, known as a bottom trawl, to survey fish populations. Fishers believe that the type of trawl that NMFS uses is outdated and that they tow the gear too slowly through the water. Furthermore, the fishers think that the gear should be modified (as the fishers do with their own gear) to better suit the different bottom types upon which it are used. Fishers argue that these problems lead to an underestimation of fish populations. In 2002, the brewing debate exploded into an incident that became known as “trawl gate”, drawing reference to the infamous “Watergate” of the Nixon Administration. Like Watergate, trawl gate was perceived as being an incident of government misconduct followed by a purposeful effort of cover-up. In this case, a fisher noticed that the survey trawl was not configured according to NMFS' own standards and reported the problem to NMFS officials. NMFS did not confirm the error for two years. This built on a history of distrust and led to skepticism about the validity of population assessments and fisheries management recommendations.

Johnson and McCay (2012) examines NMFS' response to the mounting crisis, which was to appoint an advisory panel to provide recommendations on the bottom trawl survey. The Trawl Survey Advisory Panel was comprised of fishers and scientists who had interactional expertise. They had extensive previous experience in cooperative research during which they were steeped in each other's professions. Thus, the scientists on the Panel did not have contributory expertise in fishing, but could discuss fishing gear and procedures knowledgeably with fishers. Likewise, the fishers on the Panel did not have contributory expertise in assessing fish populations, but could aptly talk about technical matters with the scientists.

Initially the Panel was collaborative and productive with the fishers and scientists accepting each other's objectives. The scientists strove towards a trawl design that would more accurately reflect modern fishing and fishers embraced maximizing data quality over maximizing the amount of fish caught. The Panel's collaborative work led to the construction and testing of a promising prototype for a new trawl system.

The collaborative momentum of the Panel stumbled when NMFS decided to test an alternative trawl without input from the fishers. NMFS was concerned that the Panel's trawl design would be too complex and would require constant adjustment. But the fishers were not concerned about this because they routinely adjust their fishing nets. NMFS' apprehension gave weight to fishers' concerns that the NMFS scientists did not have the contributory expertise to operate the trawl gear for the surveys. Moreover, the fishers felt that the scientists' unilateral decision was “cavalier” and “offensive” (Johnson and McCay, 2012). They believed that the scientists ignored their contributory expertise in fishing and its full relevance for designing a trawl survey. Even though the Panel had worked together for three years, this incident triggered a resurfacing of distrust and skepticism. An open and respectful conversation among the Panel members and a refocusing on the original prototype trawl led to a short-lived recovery of the Panel.

Ultimately, however, the Panel disintegrated because of a persistent problem with the prototype's trawl doors (i.e. the part of the fishing gear responsible for holding the net open). After discussion and testing of various trawl doors, the Panel made a recommendation that NMFS did not implement and rather chose a door design that the fishers believed would extremely hinder the trawl's performance. The fishers thought that NMFS scientists were reinstating scientific privilege and disparaging fisher's expertise. In response the Panel chair, a fisher, stated, “We have got some major, major communication problems and a mistrust to a level that … There is zero communication between [NMFS] and the [Panel]” (Johnson and McCay, 2012).

Both of NMFS's unilateral decisions “created a space for Panel member speculation about hidden agendas … These speculations emerged because of the politically sensitive nature of the survey, and the long history of distrust that existed between fishers and scientists … [These] decisions … took place 'behind closed doors' and represented the dismissal of [fishers'] knowledge, including their interactional expertise” (Johnson and McCay, 2012). The authors of this study concluded that “the interactional expertise held by members of the Panel was not sufficient for the [Panel] to persist.” It appears that the interactional expertise of the members while bona fide, was an insufficient tool to overcome the obstacle of negative sentiments.

5. Discussion

All four case studies consistently showed that even in contentious situations interactional expertise holds value for science and science-policy decision making and can increase the collaboration among disparate groups (Table 2). The inclusion of interactional expertise increased the capability to communicate, introduced a way of translating information between groups operating in different paradigms and led to short-term improvements in collaboration. These are reasons why exploration of SEE concepts

[6] For a full discussion of this case study read Johnson and McCay (2012). Trading expertise: The rise and demise of an industry/government committee on survey trawl design. Maritime Studies 11, http://dx.doi.org/10.1186/2212-9790-1111-1114.

and their potential application should continue to be pursued. Thus the findings of the case study are consistent with Hypothesis One: The inclusion of interventions characteristic of interactional expertise facilitates collaboration between groups. Hypothesis One was not falsified.

However in all four case studies the collaborations either remained troubled or eventually disintegrated, revealing the need to couple SEE concepts with other social science tools to sustain the collaboration when issues dealing with sentiment are encountered (Table 2). A likely explanation for why some collaborations persisted in a troubled state while others disintegrated, was the presence or absence of a legal mandate for action that required multi-group collaboration. In the two Johnson case studies in which the collaborations disintegrated, the impetus behind the collaboration was a voluntary management action. In the two Jenkins case studies that persisted, the management action was mandated by law, creating a compelling impetus to engage at some level even though the collaborations were greatly troubled.

However, in all cases sentiment was at the center of the degradation of relations between groups. The way fishers and governmental personnel referred to each other (e.g. wheel-huggers and kids) in the case studies was sentiment charged. The evidence reveals that assessments of people's expertise in part drew on downward discernment based on observation, rational judgment and technical expertise, but were also stereotypical and emotional social perceptions that indicate the use of ubiquitous discernment. Thus, the findings are consistent with Hypothesis Two: Judgments of expertise are based in part on sentiment. Hypothesis Two was not falsified. In this, the case studies are reminiscent of the perceptions of the expertise of Cumbrian sheep farmers following the Chernobyl disaster (Wynne, 1989). In this case, scientists favored what proved to be inaccurate scientific tests over the intimate knowledge and expertise the farmers had about their land and sheep, resulting in unnecessary loss of livelihoods. There too, the experiential-based expertise unsupported by scientific credentials appears to have been given less weight than it should have been given.

Reliance on sentiment can result in accurate or inaccurate judgments of technical expertise, but either can have a negative impact on collaboration. Inaccurate judgments driven by sentiment are especially worrisome, because they artificially reduce the pool of relevant people and expertise available to address a problem. The TED case offers such an example. Letting their sentimental judgment rule, NMFS scientists did not initially include shrimpers in the invention network as collaborative peers, even though the shrimpers had contributory expertise.

On the other hand in the tuna-dolphin case, the fishers acknowledged the contributory expertise of NMFS scientists and accepted them as collaborative peers, but rejected the gear technicians as peers. The gear technicians initially had no expertise, but gained interactional expertise through the instruction of NMFS scientists and fishers. The problem was that the gear technicians conducted gear evaluations that fishers believed required contributory expertise. Furthermore, the gear technicians were granted decision-making authority as though they had contributory expertise and this authority was greater than fishers' authority in making decisions about the bycatch reduction devices. The fishers' sentiment was that the gear technicians had nothing to offer them but could cause them harm by collecting data that could paint a damning picture of dolphin mortality. Arguably this was an accurate judgment of the gear technicians expertise, but in response some fishers chose to limit their interaction with NMFS. A notable and more productive alternative action was when some fishers successfully created a collaborative structure that more appropriately aligned expertise with decision-making authority. One example was the inclusion of the one favored government scientist on the advisory board of the tuna industry's research organization. Thus the findings are consistent with Hypothesis Three: Issues of sentiment and latent distrust can cause collaborations to degrade even with the inclusion of interactional expertise. Hypothesis Three was not falsified.

6. Tools to improve application of see concepts

How does one address something as instinctual and ambiguous as the role of sentiment in science and science-policy decision making? First, minimize the opportunity for sentiment to unduly influence decision making. A study of hiring practices in orchestras, showed that blind auditions increased the likelihood of women being hired and promoted (Goldin and Rouse, 2000). Likewise, a blind review of TED ideas would have helped ensure that TED prototypes were evaluated on technical merit rather than impressions about the reputation or sincerity of the inventor. When possible, future evaluations of scientific or technical proposals, especially in situations with a history of contention, should employ blind evaluations as part of the evaluation process. This could easily be achieved during the review of written proposals by stripping identifying information from the proposal.

A second means of managing the role of sentiment in decision-making is to acknowledge the influence of sentiment on collaboration and employ mitigation measures. The literature on implicit bias offers some useful corollaries and tools in this regard. Large-scale studies have shown that implicit bias is prevalent throughout society. One study found that people are implicitly bias in favor of white people, young people, able-bodied people, heterosexual people, and thin people. In the majority of categories of bias the level of implicit bias exceeded the level of explicit bias (Nosek et al., 2007). In other words, even when people were aware that they were bias and reported it, the level of bias they unconsciously held was higher than the level of reported bias. Social factors such as class, power, and prestige, which are common divides between fishers, scientists, and managers, have also been shown to influence perceptions of scientific credibility (Whyte and Crease, 2010). These studies reveal that judgments about expertise and decision-making authority should be approached with caution and skepticism, even when the judgments appear rationale. Furthermore, arguably there is a need for an added degree of caution in complex and contentious situations, in which negative sentiments are likely to abound. Clearly the process of becoming an interactional expert in technical issues does not automatically address pre-existing biases and could even inadvertently instill biased means of assessing expertise.

Studies of implicit bias have shown several tools to be effective at reducing implicit bias, such as intergroup sharing of counter-stereotypical beliefs (Sechrist and Stangor, 2001), purposefully thinking counterstereotypical thoughts (Blair et al., 2001; Stewart and Payne, 2008), training and education programs (Kawakami et al., 2000; Rudman et al., 2001), and viewing photographs of admired exemplars belonging to the group subject to stereotyping (Dasgupta and Greenwald, 2001). However, some studies have shown that changes in implicit bias does not necessarily result in changes in explicit behavior and attitudes (Dasgupta and Greenwald, 2001; Dasgupta and Rivera, 2008). Still other research has shown that when people suppress stereotypical thoughts or are externally pressured to reduce prejudice this can result in a rebound or backlash of anger or increased explicit and implicit prejudice (Legault et al., 2011; Macrae et al., 1994; Plant and Devine, 2001). There is much research that remains to be done in this area, but SEE researchers can begin to employ some of these tools in conjunction with interactional expertise to see whether this multi-tool approach could sustain collaboration in contentious situations.

Another tool that SEE researchers should consider exploring as a means of sustaining collaborations enabled by interactional expertise is moral imagination (Gorman et al., 2012). Moral imagination is the equivalent of interactional expertise concerning values; it involves being able to 'step into the shoes' of a person from another group and see a situation from the perspective of the other person. Moral imagination requires a reflexive ability, because a person must be aware of his own perspective before being able to inhabit another's. Seeing one's perspective as values-based rather than necessarily an absolute truth allows a person to appreciate another point of view without having to agree with it. It also opens avenues for developing mutual overarching goals that aid collaboration. In addition, it opens up the possibility of evolving new shared values that transcend existing differences.

Developing moral imagination involves being steeped in the culture of another group over time. Studies have shown that brief interactions between groups can decrease implicit bias, but does not affect explicit behaviors or improve fisheries management outcomes (Dasgupta and Rivera, 2008; Pettigrew and Tropp, 2006; Young et al., 2013). Longer-term interaction, however, can increase trust and decrease explicit prejudice behaviors (Dasgupta and Rivera, 2008; Young et al., 2013). Moral imagination could especially be a useful tool for situations in which groups do not trust each other's motives, such as in the tuna-dolphin case study, or when value systems are in conflict, such as the trawl-survey case study.

The tools of blind reviews, moral imagination, and methods of reducing bias are simply a starting point for ways to improve application of SEE concepts. Coupling of tools like this with SEE concepts could improve collaborations, especially in often contentious situations such as fisheries management and other environmental issues. However, as SEE is still a young theory, much applied research must be conducted before any of these tools could be responsibly applied to fisheries management, or other real-world problems on a large scale. Moreover, these tools only begin to address the undue influence of sentiment through the inappropriate use of ubiquitous discernment rather than discernment based on technical expertise. They do not attempt to address encumbering issues with the overall science and science-policy decision-making processes themselves. This itself is a separate but worthwhile line of inquiry.

7. Conclusion

This paper has shown that the theoretical concepts of SEE, such as interactional expertise, hold utility for addressing real-world problems, such as fisheries management. Interactional expertise can lead to collaboration, but those collaborations can be derailed when latent distrust is triggered in situations where the collaborators have a contentious history. These contentious collaborations are marked by sentiment-laden decision making and judgments of credibility that are based on the social perceptions fundamental to ubiquitous discernment rather than based on technical expertise. Combining the concepts of SEE with tools, such as blind reviews, moral imagination or those for mitigating implicit bias may help to sustain and improve these contentious collaboration. Future SEE case studies, should seek to couple these tools with the application of SEE concepts in order to empirically study the value of this toolkit approach for addressing real-world problems of science and science-policy decision making and environmental management.

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