
Co-producing conservation and knowledge: Citizen-based sea turtle monitoring in North Carolina, USA

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Abstract

In this paper we examine a volunteer-based sea turtle management project run by the state of North Carolina, USA, to explore collaborative conservation and citizen science. Through this case study, we unpack assumptions from the volunteerism literature and apply theories of co-production to understand how citizens evaluate science and produce knowledge while conducting wildlife monitoring. We demonstrate that the project maintains a healthy give and take between the state and the volunteers as they work together to manage endangered sea turtles. When tensions do emerge over specific issues such as nest relocation, volunteers engage with scientific debates and apply their knowledge gained through the project to push their priorities. While volunteers understand the state's position on conservation science, they counter with evidence from scientific literature and locally situated observations informed by an alternative view of human–environment relationships and specific goals for the project. Overall, we find that there is little evidence to support the notion that knowledge is 'co-produced' in the project. Instead, the combination of volunteer control over the local spaces of conservation and the state's need for volunteer labor results in the co-production of conservation practice.

Keywords

boundary work, citizen science, co-production, volunteer, wildlife conservation

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Chatting excitedly about the chance of seeing a live sea turtle hatchling, tourists and local North Carolina residents cram around the sand enclosure marked with wooden stakes and caution tape. Despite no official notice being released, a sizeable crowd has gathered on the beach at sunset to watch volunteers excavate a sea turtle nest that hatched several nights earlier. Two volunteers dig into the nest and pull out eggshells, while another volunteer carefully lays them out in a grid pattern on the sand in order to reconstruct how many eggs were in the nest and what stage of development they reached. One of the volunteers pulls a live hatchling from the nest pit and the crowd jockeys for good viewing positions as the hatchling crawls across the sand and into the surf. While the excavation team records data from the nest, another volunteer lectures to the crowd about the biology of NC's nesting sea turtles. This scene is recreated throughout the summer along the NC coast as citizens collaborate with state authorities to manage and protect sea turtle nests as part of the North Carolina Sea Turtle Project (NCSTP).

In this paper we examine the NCSTP as a site of citizen science and knowledge production. The NCSTP is a program of the North Carolina Wildlife Resources Commission (NCWRC), a state agency, and the NCWRC is reliant on volunteers to fulfill its mandated responsibility to protect sea turtles under the Endangered Species Act. Through this case study, we aim to help enhance understandings of how lay citizens participate in science, specifically in the realm of environmental monitoring and conservation. This study examines the nature of environmental knowledge in field science and considers what counts as 'natural' in conservation. In our analysis, we use 'knowledge' to refer to what volunteers know and learn about sea turtles and conservation, based on their experiences in the field as well as their engagements with scientists and scientific literature. We use 'practice' to refer to the physical acts associated with implementing sea turtle conservation and monitoring. Through our analysis of how volunteers and the state collaborate to conserve turtles, we explore the social and material dimensions of scientific knowledge production. We consider how the performance of conservation enacts aspects of environmental science and models particular relationships between humans and wildlife. Overall, we explore the role of knowledge politics in a collaboration involving state authority, institutional science, and citizen-based knowledge production.

Citizens, science and knowledge

Lay participation in science is encapsulated in the term citizen science, which 'evokes a science which assists the needs and concerns of citizens ... [and] implies a form of science developed and enacted by citizens themselves' (Irwin, 1995: xi). Citizen science emerges when citizens seek knowledge to address their own concerns and interests and employ scientific methods and theories in the process. The power of citizen science resides in its potential to enable citizens to engage with scientific and political institutions using scientific knowledge acquired through their own work (Irwin, 1995). Citizen scientists may use scientific knowledge to push their priorities and to act on agendas that are important to them by advocating such agendas to the government as well as creating new projects (Carr, 2004; Leach and Fairhead, 2002). Some advocates of citizen science assert that participants may gain greater knowledge and acceptance of science (Brossard et al., 2005; Evans et al., 2005). Other scholars argue that citizen science can create a democratization of science, such that citizens become credible participants in the process of knowledge

production and are able to influence the standards and practices of science (Epstein, 1996; Jasanoff, 2004; Leach et al., 2005).

While there is much scholarly discussion of what citizen science is supposed to do, few studies have evaluated what it actually accomplishes in particular contexts. Ellis and Waterton (2004, 2005) document how volunteers in a UK biodiversity project became frustrated that, while their data were being used, they had no authority to participate in decision-making processes informed by the data. The volunteers lamented that the project did not recognize their knowledge, knowledge that was garnered outside the narrow confines of the project-designed data cards (Ellis and Waterton, 2004). Similarly, Lorimer (2008) found that volunteers on a bird-monitoring project often held ways of understanding the monitored species that were not captured on data sheets. The exclusive focus on data categories established by the project and its scientists limited the ways in which volunteers could contribute their unique knowledge. In excluding participants' ways of knowing that did not fit precisely within data standards, the projects studied by Ellis and Waterton (2005, 2004) and Lorimer (2008) effectively thwarted participant attempts to legitimate their knowledge and gain authority.

How do volunteers gain knowledge? Within natural science and conservation fields, there is a long history of amateur naturalists making observations and collecting specimens to learn about the world. As field sciences were professionalized, these amateurs found themselves excluded from 'science' as part of boundary work done by professionals to establish their authority and expertise (Gieryn, 1995; Ogden, 2008). This boundary work is similar to the ways in which professional scientists distance their scientific work from that of volunteer citizen scientists. Not recognizing these non-professional contributions to the canon of natural science erases particular relationships and renderings of nature – the intimate knowledge developed through the practice of field science. In conservation monitoring, the practice of field science makes the objects of conservation vividly present; the 'facts' about the natural world emerge through particular practices that constitute the realities of knowing nature (Hinchliffe, 2008; Hinchliffe and Whatmore, 2006). Data collection and the creation of classifications do not record a static, external nature, but instead shape reality through their interactions with and ordering of the world (Waterton, 2003). This understanding of how nature is fundamentally shaped by the performance of human/non-human relations, as well as the potential marginalization of citizen contributions, informs our analysis of the NCSTP.

Drawing upon these concepts, we examine how the NCSTP may support an opening of science, enabling the participants to contribute to the knowledge-production process and to use their ways of knowing sea turtles to influence project priorities. In this case study, we consider how the volunteers evaluated sea turtle science within the context of their participation in monitoring and conservation management, and how those volunteers sometimes attempted to supplement the science used by the state. Finally, we explore how the NCSTP volunteers engaged with the state, and investigated whether they used their knowledge and experience gained from the project to assert themselves as authoritative actors in sea turtle conservation.

NCSTP:A case study

In this paper, we explore a case study of citizen volunteers working with the NCWRC, a state agency, to monitor endangered sea turtles, primarily loggerhead sea turtles (*Caretta*

caretta). As species listed both on the International Union for the Conservation of Nature's Red List and under the US Endangered Species Act, sea turtles are significant for conservation, both because of their status and their broad public appeal. Sea turtles are recognized as a flagship species (Eckert and Hemphill, 2005) – animals that generate public support for conservation, in part due to their appealing characteristics, including their large size, aesthetically pleasing appearance and docile nature (Kellert, 1985). On the beach, nesting sea turtles can be approached with relative ease, broadening the opportunities for volunteers to work 'hands on' with the animals (Campbell and Smith, 2006). On the Atlantic coast of the USA, in the Carolinas, Georgia, and Florida, an estimated 1500 people volunteer to work with sea turtles. Of these states, North Carolina, has one the largest networks of volunteers, currently numbering 700 people.

In North Carolina, the NCWRC collaborates with 12 all-volunteer beach organizations (VBOs) in the NCSTP to monitor beaches and collect sea turtle nesting data.¹ At the time of this research, the NCWRC employed two full-time sea turtle biologists who were responsible for managing sea turtle nesting and strandings on the entire coast, making the approximately 700 volunteers in the NCSTP critical to the success of the project. Volunteers in the NCSTP collect data on sea turtle nests, monitor the beaches daily, report on nesting activity and success, and educate the public about sea turtle biology and conservation. VBO coordinators oversee the volunteer activities and ensure that work is completed according to terms of their state permit. The data collected by the volunteers are used by state and federal agencies, and have been used for specific federal and university research projects. In some cases, volunteers take on additional data collection in support of such projects (see, for example, Avens et al., 2008).

The project has grown and developed a larger presence on the beaches since its inception. Sea turtle monitoring by the NCWRC originated with aerial surveys of nesting in 1982, and shifted to on-the-ground nest monitoring. Volunteers were involved from the beginning of these nesting surveys, starting in the state and national parks and spreading to municipal beaches. Originally, sea turtle monitoring was the responsibility of a temporary scientist who worked on other wildlife management projects within the NCWRC. As the NCSTP expanded in scope, including more beaches and larger VBOs, the NCWRC made managing the project a permanent, full-time position in 1995, and a second biologist was retained in a permanent position in 2005. The project now covers the North Carolina coast and it is notable as one of the few programs within the NCWRC that focuses on endangered, non-game species.

Sea turtle conservation is conducted in the context of beach erosion (and efforts to combat it), amid large human developments on the beach front, both resident and tourist. With increasing amenity migration and tourism in North Carolina's coastal spaces (Boucquoy et al., 2010), beachfronts outside of national or state protected areas are increasingly populated with retirement and vacation homes as well as rental properties. Municipalities along the coast, especially those on sand barrier islands, are under pressure to maintain beachfront structures in a dynamic environment with ongoing processes of sand accretion and erosion. Currently, North Carolina does not allow the construction of hardened structures that block sand loss, and houses in North Carolina may become over-washed by tidal waters. To prevent such drastic losses, however, municipalities often implement 'beach nourishment' projects, where sediment dredged from offshore is pumped onto beaches.

This process is costly and the benefits are often short-term; for example, seasonal tropical storms can whisk away the new sand deposits in a short time. Beach nourishment is part of the ongoing struggle over the physical character of the beach that characterizes human relationships with natural coastal areas. This struggle is an important part of the case we explore in this paper.

Similar to most research on volunteering, existing studies of sea turtle volunteers working in North Carolina and elsewhere along the Atlantic coast of the USA focus on motivating and recruiting volunteers with special attention to their demographics (Bradford, 2003; Bradford and Israel, 2004; Hopkins-Murphy and Seithel, 2005; Johnson et al., 1996). A recent ethnographic study in North Carolina examined the learning processes of participants and how their identities emerged in relation to their participation in the project (Martin, 2009), but overall, discussion of volunteer contributions to science has been limited to institutional scientists' concerns about volunteers' ability to collect data properly. Yet, volunteering in sea turtle conservation offers a platform for investigating citizen participation in science, for at least two reasons. First, science plays an important role in setting the agenda for sea turtle conservation (Campbell, 2002, 2007), and, as there are significant gaps in biological knowledge of sea turtles, local sea turtle monitoring provides a means to collect much needed data (Bird et al., 2003). Second, the existence of these knowledge-gaps creates the potential for disagreement between scientists and citizen participants over the best ways to manage sea turtles.

The research we describe here is part of a 3-year NSF funded project that uses the case of the NCSTP to explore science–society relations, and to assess the potential of the citizen volunteers to improve such relations. The project adopted a mixed-methods approach, and included ethnographic research with two VBOs, focus group interviews with a subset of volunteers from 12 VBOs, interviews with the 12 VBO coordinators, and a mail-based survey of all 700 volunteers. We also conducted interviews with past and present state sea turtle biologists ($n=8$) and other state managers and research scientists ($n=13$) who used data collected in the NCSTP. In this paper, we rely primarily on the ethnographic component of the work and on interviews with VBO coordinators and sea turtle biologists.²

Conserving sea turtles on North Carolina beaches: The work of VBOs

The NCSTP's VBOs vary individually on a number of fronts, including the size of the areas they patrol, the number of volunteers they engage, and the way they organize to fulfill their mandate and any additional activities they adopt. VBOs' activities range from a strict focus on the nest-monitoring to a more expansive approach to the project, emphasizing education and public outreach. Membership size in the VBOs also differs; some groups embrace all interested volunteers, while others limit membership. Town residents interested in volunteering for the latter groups must wait until a space opens up. The largest group has over 100 members and the smaller groups have approximately 25 members. Considerable variation exists in the size of the patrol areas, with the northern-most VBO in the state covering over 30 miles (50 km), while others cover 4 to 7 miles (7 to 11 km).

Morning beach patrols to search for sea turtle tracks and nests are the primary monitoring task for volunteers. Patrolling either by foot or with all terrain vehicles, all volunteers

hit the beach before 7am to avoid missing the turtle tracks that can be erased by rising tides and foot-traffic. Spending every morning of the turtle-nesting season patrolling for nests connects the volunteers to the beach and establishes it as a space for sea turtles. Although nightly nest monitoring is not required by the state, the volunteers have developed this practice when nests are due to hatch in order to watch for the ‘boil’ – a term used to describe the mass exodus of hatchlings from the nest. The volunteers protect hatchlings from land predators such as ghost crabs, and ensure that the hatchlings are not led astray by beach lighting when they emerge. Nest sitting, as the volunteers call their nightly vigils, is a popular activity, as it is an opportunity to see hatchlings. Not all nest sitters get to see a nest boil, but those who do speak of the event as transformational for them, and it is a much sought after experience. Three days after the nest has boiled, volunteers will return in the early evening and conduct an excavation. These excavations are integral to data collection for the NSCTP, but the volunteers also use them to educate the public about sea turtles and their conservation, drawing large crowds of tourists and local residents.

At the top of the VBO hierarchy is the coordinator, who oversees all activities of the VBO on the beach and in the community. They organize the morning patrols, run training sessions for new and returning volunteers, respond to calls about turtle tracks and strandings, manage the nest sittings and excavations, as well as coordinate any activities outside of the monitoring duties, such as fundraising and educational events. They make decisions about how the VBO is structured, for example whether membership is limited in numbers or not, and how management tasks are carried out. Before attaining leadership of the VBO, coordinators had either volunteered for years, or had started the first sea turtle monitoring on their respective beaches. Several of the coordinators have over a decade of experience, and have been in their positions longer than the state biologists. Coordinators are also the line of communication between the state and volunteers, and a VBO permit is issued in the coordinator’s name. It is the coordinator’s job to ensure that the group adheres to the rules of the permit. When tensions arise over management practices, the coordinators engage with the state. In the next section, we draw on interviews with the volunteer coordinators and state biologists to explore how scientific and other knowledge claims are negotiated in the NCSTP.

‘I’m not a scientist’: Volunteers as data collectors

When speaking generally about science, VBO coordinators most often emphasized its importance for sea turtle conservation. As one coordinator told us, ‘It’s going to require scientific evidence for changes to be implemented, whether that be beach management, whether that be fisheries management.’ Many of the coordinators directly contrasted scientific evidence with other forms of knowledge in policy-making processes:

If we’re asking the federal government for protections and we want to up-list the loggerhead [sea turtle] and stuff like that you can’t just have lay people like me, non-scientists, say well they need more protection. You know because that isn’t going to be listened to, because everyone has an opinion. If we can actually have the science behind it, that’s what’s going to make the difference. We can only build policy on the science.

These quotes reflect the importance coordinators placed on the science-policy nexus, where science is valuable for informing policy – above and beyond other ways of knowing – rather than being important in and of itself.

When asked directly about the VBOs' contributions to science, coordinators saw the role of volunteers primarily as data collectors, and disassociated themselves from data analysis: 'All we can do is collect what we can collect and turn it in to somebody else who is going to use that to figure out what the trends are.' Reflecting on the interpretation of data from the nesting beaches, one coordinator explained that 'the scientists, they have the training, they have the knowledge about science ... that a volunteer is not going to have'. In these broad discussions of sea turtle science, the coordinators recognized the authority and expertise of scientists, while downplaying the scientific ability of the volunteers. Although volunteers support science through data collection, from the coordinators' perspectives, this does not make volunteers scientists.

Coordinators included themselves among the volunteers as non-scientists. Several coordinators provided the disclaimer 'I'm not a scientist' when discussing their views on sea turtle conservation. Sometimes the disclaimer was made prior to an in-depth description of an aspect of sea turtle biology or ecology, such as temperature-dependent sex determination. Other times it preceded a critique of a state policy or conservation approach with which they disagreed. In these discussions, coordinators not only reinforced the division between volunteers and scientists, but also maintained the hierarchical relationship inherent in that division.

The coordinators were most willing to defer to official scientific authorities in the abstract when discussing the NCSTP in general. That dynamic changed when coordinators addressed the specifics of sea turtle conservation policy and management, and in particular, the practices with which they disagreed. In such instances, the coordinators engaged with the science around these issues and asserted their expertise in sea turtle management. They invoked their personal experience from working with sea turtles on the beach, as well as scientific findings that supported their positions, in order to assert their authority in local sea turtle conservation. This phenomenon was most prevalent when the coordinators discussed what has historically been one of the more difficult issues for the project, the relocation of sea turtle nests. Nest relocation is used when nests are laid in areas that threaten their survival, and volunteers dig up and relocate nests to safer areas of the beach. During interviews, both with state biologists (past and present) and VBO coordinators, almost everyone identified nest relocation as an ongoing area of conflict in the project. Volunteers generally wanted to relocate nests more frequently than the biologists advocated, but the issue was particularly contentious during the course of this research with two VBOs, which took place at the end of, and immediately following, a 5-year ban on nest relocation on a barrier island.

The NCWRC instituted the ban on relocation to facilitate a study of whether beach nourishment impacts sea turtle nests. Although ideally beaches are nourished with sand similar to that on the existing beach, the new sand is often of different grain and composition than the original sand. The NCWRC study sought to understand whether nourished beaches had different sand temperatures from unnourished ones, a question of importance due to temperature-dependent sex determination in sea turtle hatchlings. Warmer temperatures produce female sea turtles and cooler temperatures produce males, and North Carolina beaches produce significant quantities of male hatchlings for the northern Atlantic loggerhead population (Hawkes et al., 2005). To facilitate the study, the NCWRC had to ensure that it was measuring temperatures in nest sites selected by turtles rather than by volunteers. The 5-year study found that sand temperatures in nourished areas were warmer

than in non-nourished areas, and that nest temperatures were warmer for nests laid in nourished sand, which likely increased the number of female hatchlings produced (Holloman and Godfrey, 2008). Beyond the management implications of the study findings, the ban brought to the fore the ongoing tension over nest relocation in the NCSTP.

We emphasize that, overall, the NCWRC biologists and volunteers collaborated amicably towards wider goals of sea turtle conservation, and there were few specific incidents that marked conflict in the project as a whole. Our research overlapped with the end of and immediately following the relocation ban, and thus the issue was still fresh for the two affected VBOs, providing us with the opportunity to explore how the views of VBO coordinators and state scientists differed in an intensified context. More generally, though, relocation had been a point of contention throughout the history of the project, acknowledged by both biologists and coordinators. The other ten VBO coordinators, who were not affected by the ban, identified relocation as an issue requiring negotiation between themselves and the state. These conflicts over nest relocation offered an opportunity to explore how knowledge claims were contested, negotiated, and reconciled in the NCSTP.

The uncertain science of nest relocation

The validity of nest relocation as a conservation technique is subject to ongoing debate in sea turtle conservation and biology. Sea turtle nests are sometimes relocated to protect nests from threats such as human harvesting, beach erosion, predators, and heavy beach traffic (Baskale and Kaska, 2005; Eckert and Eckert, 1990; Marcovaldi et al., 2005). Although nest relocation is practiced within a variety of contexts, scientists sometimes deliberate among themselves about whether nest relocation negatively impacts sea turtle hatchlings and the species population as a whole.

Some sea turtle scientists attest that conservation programs using nest relocation can successfully increase sea turtle populations (Dutton, et al. 2005; Marcovaldi and Chaloupka, 2007), but others question the impacts of relocation on egg development. Carthy et al. (2003) argue that relocating eggs inhibits the natural diversity of incubation environments, and that such diversity is integral to ensuring that at least some hatchlings have characteristics fit for survival. Other studies have found that relocating sea turtle eggs to hatcheries alters the sex ratios of hatchlings, but suggest that the sex ratios can be preserved when seasonal variations in sand temperatures are taken into account, as well as careful duplication of the conditions of the nest depth and sand type and temperature (Chan and Liew, 1995; Morreale et al., 1982; Naro-Maciel et al., 1999; Öz et al., 2004). The impact of relocation on hatch success rates has also been examined, with some studies finding higher hatch success rates in relocated nests (Kornaraki et al., 2006; Wyneken et al., 1988), while others have found lower hatch success rates in relocated nests (Eckert and Eckert, 1990; Marcovaldi and Laurent, 1996; Pintus et al., 2009).

Most relevant to the situation in the NCSTP are the discussions about the relocation of eggs from locations subject to tidal inundations that can potentially destroy a nest. Eckert and Eckert (1990) argue that while there is some reduced hatchling success in relocated eggs, there is an overall gain by saving eggs at risk of inundation. Yet Foley et al. (2006) found that nests lying close to inundation zones are important for producing male sea turtle hatchlings. They also argued that nests left in areas of inundation survive remarkably well

and called for a reconsideration of relocating nests in inundated areas. In addition, some scholars have raised other concerns about relocating nests laid in areas of inundation, arguing that if these turtles are laying eggs doomed to failure, relocating the eggs propagates more turtles in the population that lay nests subject to inundation (Mrosovsky, 2006, 2008). A recent study counters this theory by asserting that younger, inexperienced nesting sea turtles choose unsuccessful nest sites, while more experienced nesting turtles choose appropriate nest locations; thus relocating doomed eggs would not negatively impact species genetics (Pfaller et al., 2008). The conflicting findings on nest relocation have yet to be reconciled, and sea turtle experts continue to disagree about the utility and impacts of relocation in sea turtle conservation. In practice, policies on relocation are decided by the scientists in charge of particular conservation projects, and relocation is deployed or not in line with their scientific views.

On North Carolina beaches the NCWRC is cautious about relocating nests. The management plan for the state takes into consideration that the North Carolina sea turtle rookeries, while small compared with those in other parts of the Atlantic seaboard, are an important subpopulation and produce proportionally higher numbers of male sea turtles than more southern US beaches (Hawkes et al., 2005). For the most part, the NCWRC wants nests left in situ. As a NCWRC scientist explained, 'One of the overarching principles is to make the sea turtle reproductive cycle as natural as possible.' However, the VBO coordinators favor a different strategy. They assert that nest relocation is a viable conservation technique and can be used to maximize the production of hatchlings on the North Carolina coast. Thus, they have a more proactive attitude toward moving nests than do the state biologists.

Outside of the aforementioned 5-year ban on nest relocation on Bogue Banks, the NCWRC allows nest relocation under specific conditions, when: (1) the nest is below the average high tide line and will be subject to regular inundation; (2) the nest is laid in an area prone to erosion; (3) the nest is laid under an escarpment and will be buried too deeply; (4) the nest is in a site subject to an exemption from the ban on dune-pushing³ (North Carolina Wildlife Resources Commission, 2006). The volunteers do not disagree with these criteria, but may read conditions on the beach differently than do the state biologists, specifically the evaluation of regular inundation of a nest laid below the high tide line. Underlying the disagreements over the application of the criteria are ideas of human–nature relationships, the objectives of sea turtle conservation, and the nature of expertise, knowledge, and authority in participatory conservation.

'Nature can't take its course anymore': Views of human–wildlife relationships

The state's goal to make sea turtle nesting on North Carolina beaches as natural as possible reflects the aims of the environmental sciences more generally, sciences which tend to separate the environment from humans and where management often aims to remove or reduce human impacts (Adams and Hutton, 2007; Odenbaugh, 2003). A NCWRC scientist asserted that 'a natural beach is the best' and that management efforts should protect or mimic natural conditions. Natural risks, such as tidal inundation of nests, are acceptable because they are deemed part of the normal lifecycle of sea turtles. As one NCWRC scientist explained, 'I expect a few [eggs] to get lost, and that's part of the process.'

According to another NCWRC scientist, in the life cycle of a sea turtle ‘an egg doesn’t have as high a reproductive value as say a large juvenile’. The NCWRC takes into consideration the naturally high mortality of embryonic and hatchling life stages as a ‘natural’ part of the life cycle of sea turtle populations (Heppell, 1998; Heppell et al., 2005). The state prefers management interventions that reduce or remove the human presence, rather than create more direct human–wildlife interactions.

The volunteer coordinators adopted a sea turtle management approach informed by a different vision of human–nature relationships, one distinct from the state’s position. ‘Science is good because ... it does research, it finds out about the different species, but it also I think can interfere because they [scientists] always want nature to take its course.’ This coordinator expressed a sentiment common among the volunteers: that the emphasis in conservation science on the separation of human and natural realms actually hinders conservation. Many of the volunteers live in the nesting environment of sea turtles, and walk directly out of their homes onto the beach to participate in monitoring. Consequently, they viewed the beach front as a human-populated landscape where managing for natural conditions is not possible:

We’ve already screwed up all the natural there is. So ‘let nature take its course’ doesn’t really work anymore. Because people say well, ‘What are you doing with the sea turtles? They’ve been doing it for over a million years.’ They have, but they’ve been doing it without electricity and without people vacationing. And that’s a new concept anyway in the history of the world. You know on these beaches, nature can’t take its course anymore so that is why we have to interfere.

This coordinator addressed a common critique volunteers often hear from the public – that sea turtles have thrived as a species without human assistance. Yet, the past absence of humans is exactly the point to this coordinator; people are now part of the environment of sea turtles, especially through developments that pose problems for nesting sea turtles, such as beach lighting, increased erosion, and nourishment projects. For the volunteers, their efforts are not only justified, but are necessary to balance human–nature relationships.

Rather than separate themselves from nature, the coordinators believed that conservation requires deeper human relationships with nature to counter human-created hazards.

You got an animal that’s been around for millions of years and its numbers have dwindled. And a lot of those are human causes, whether it’s things we put in the ocean, whether it’s random trash or Ziploc bags or whatever else goes out there, balloons that float by. It’s important because we can have a role. It’s important that people know we can do something.

During the morning beach patrols, we found many of the volunteers picked up trash on the beach. The volunteers connected their trash pick-up, not only to the improvement of the beachfront, but specifically to protecting sea turtles from injury or death through ingesting trash such as plastic bags and balloons. Rather than conceptualizing this work as creating more ‘natural’ conditions on the beaches, the volunteers approached conservation as a remaking of beach spaces to account for the welfare of sea turtles, while maintaining human developments on the beach.

This understanding of human relationships with wildlife informed how the coordinators made management decisions about nest relocation. A coordinator described how he

deliberated over whether or not to relocate a nest that was laid next to sand bags in an area prone to erosion.

Part of me was saying you know ‘let it be ... they’ve all not made it throughout the history’. And the other part was ‘this wouldn’t look like this on this beach if it wasn’t for those houses’, because of the erosion and it was right near the [sand] bags. Those [sand] bags ultimately caused that problem that made it go the way it did with the big erosion back there.

This coordinator decided to relocate a nest because he felt part of his job is to create conditions on the beach that support sea turtle nesting. For the volunteers, morning nest patrols built a connection to the turtles by creating awareness of their presence on and use of the beach, but the practice of nest relocation created a more intimate physical connection with sea turtles, a connection the volunteers believed benefited sea turtles. This kind of affective relationship with wildlife is integral to the volunteer approach to the NCSTP and feeds into their push for more proactive nest relocation.

‘Get as many baby turtles into the water’: Views of the NCSTP objectives

The NCWRC manages sea turtle species among many other species under its care, and its primary means of knowing and relating to sea turtles is through statistics. Sea turtles in North Carolina are measured in terms of population units of endangered species, and nest numbers are tracked over time for the state as a whole. For the project’s biologists, sea turtles in North Carolina are part of a larger north-east Atlantic loggerhead population, to be managed as such. North Carolina biologists work collaboratively with sea turtle programs in neighboring states, and their concern with sand temperatures on North Carolina beaches reflects their interest in the overall health of the loggerhead population, and North Carolina’s contributions to it. As the previous section illustrated, hatchlings are a particular life stage in a sea turtle population, and biologists expect a certain proportion of eggs and hatchlings to be ‘lost’. The NCWRC aims to protect and conserve sea turtles while maintaining what it considers to be natural balancing forces in the North Carolina sea turtle populations.

Although the volunteer coordinators were concerned about the status of sea turtles worldwide, and the Atlantic loggerhead population in particular, they focused their conservation efforts at the local level. The volunteers felt strong ownership over the nesting beach under their VBO’s control. On an even finer scale, volunteers patrolling certain strips of the beach tended to focus on that particular strip. When nests were laid in this area, the volunteers considered these nests *their* nests, laid by *their* turtles. When the hatchlings emerged, the volunteers were there to look after ‘our babies’, and some VBOs referred to the people assigned to nest-sit as ‘nest parents’. Each VBO focused on the nesting numbers for their beach. They were interested in nesting in other parts of the state, sometimes in a spirit of friendly competition, but their overall concern was decidedly local. Within their sphere of influence, they wanted to protect all of ‘their’ nests, see that each nest produced as many hatchlings as possible, and then get the hatchlings to the water: ‘Our idea is to get as many baby turtles into the water safely as we can, and once they’re in the water, that’s out of our hands.’

The volunteers, and especially the coordinators, gauged their success based on where they had the power to be most effective:

I really feel like we are doing something to save an endangered species. Each one of those turtles that we get in the water, I know once they hit the water they're on their own, but at least we are getting them in there, you know, we're trying to be there at every single nest that hatches, so they don't get caught up in the lights or go the opposite way or get eaten on the beach or anything like that. So I do feel like we're helping them in a real way.

Coordinators understood that sea turtles 'overproduce' eggs and that many of the hatchlings will not make it to adulthood; but by getting as many hatchlings to the water as possible, the coordinators believe they are intervening to give the turtles a better chance of surviving to the next stage in the sea turtle life cycle. It is in their power to maximize survival of the eggs and hatchlings on the beach, and they felt compelled to do so.

In this context, the use of nest relocation as a conservation tool is consistent with the volunteer goal to ensure that all the nests produce viable hatchlings. The NCWRC moratorium on nest relocation for two VBOs required volunteers in the two groups to leave in place nests that could be inundated and potentially destroyed by rising tides. The volunteers felt that leaving such nests in place directly contradicted the aims of the project and their mission as volunteers. Some volunteers from the affected beaches quit the NCSTP in protest over the ban. One volunteer described to us the horror she had felt while watching a nest while it was inundated each day on her morning patrol; a nest that under normal circumstances would have been relocated. When the two VBOs could not relocate nests threatened with inundation, the coordinators felt their conservation efforts were being undermined:

If they ever got [sea turtle] populations back up where there was not a problem with it anymore then fine, I could understand it a little bit better. But [to] see a nest that you know you are going to lose and people are sitting out there, waiting for it and then it's rotted, that's not the easiest thing to do.

The volunteers regarded the plight of sea turtles as critical, requiring all measures possible to maximize the quantity of viable hatchlings, overriding the concerns raised by the state about the impacts of nest relocation.

Concern about maximum hatchling production and the utility of nest relocation is driven, in part, by the volunteer performance of conservation activities. Through their participation in the NCSTP, the volunteers developed a strong emotional relationship with sea turtles. They individualized the turtles – wondering if the same turtles come back each year to the same VBO's beach. Volunteers were drawn to what Lorimer (2007) defines as aesthetic charisma, the appearance and behavior of the turtles, especially the hatchlings. The cute appearance of the hatchlings crawling through the sand evokes a powerful sympathy for these 'turtle babies', that volunteers often joked were abandoned by their 'mothers' and needed volunteers to shepherd them to the sea. This perception of hatchlings feeds into how volunteers constructed their stewardship of sea turtles. In addition, the volunteers connected with the corporeal charisma of the turtle nest boils, experiencing 'interspecies epiphanies' (Lorimer, 2007: 921) while watching the hatchlings emerge from the nest. Many volunteers described a nest boil as a profound experience during which they

developed an emotional bond with turtles. This affective relationship built through conservation practices underpinned the volunteers' goals in the NCSTP, and sometimes conflicted with the state's non-individualized approach to conservation.

'I'd like to say we're street-wise': Knowledge and decision-making authority

The contrasting positions of the state and the coordinators on human–wildlife relationships and the objectives of the project underlie struggles over knowledge and decision-making authority in the NCSTP. While conceding the general authority of science and scientists, the coordinators also pointed to the limits of academic training compared with practical experience in nest management. A coordinator gave an example of such limits when describing how she had helped a university scientist properly identify sea turtle tracks on the beach.

I'd like to say we're street-wise, you know we're not trained biologists but we've seen everything there is to see in that beach that can happen with a turtle, so I've actually helped biologists My volunteers and I were able to give them a lot of advice on how to handle the nests, again just based on what we've done over the years, because knowing her biology is one thing, but knowing what [the sea turtles] do and how they behave on the beach and our conditions here is another thing.

Overall, the coordinators criticized what they saw as institutional scientists' distance from project management, and their relative lack of practical embodied experience with implementing conservation.

[The state biologist] has worked all over, at least the Americas. And he's been to these other [sea turtle] symposiums . . . he's had way of a lot more experience, but a lot of his is academic as well. And sometimes the common laborer knows a whole lot more about how to pound a nail than the contractor does.

When coordinators criticized academic state experts' distance from practical project work, they highlighted the knowledge of sea turtles that the volunteers have gained from their intensive work in particular beach sites.

During discussions of nest relocation, coordinators asserted their experiential expertise and described the seriousness of their approach to nest relocation. Several coordinators provided elaborate descriptions of their decisions to relocate certain nests, drawing on their years of experience with beach conditions and nest hatching. Coordinators emphasized that they carefully considered the impacts of nest relocation. When explaining her approach to nest relocation, one coordinator said, 'You're having a profound effect on the outcome of that nest by relocating it and it is a big responsibility.' The coordinators believed themselves to be well-equipped to make the relocation decision because they knew the complexities of their particular beach and were connected to the turtles that nest in that area. From the perspective of the coordinators, the state lacked this embodied experience with the North Carolina beachfront and turtles, and therefore did not evaluate the mortality associated with inundated nests in the same way as the volunteers, leading to greater restrictions on nest relocation.

Although most coordinators framed their arguments for nest relocation around practical experience rather than scientific findings generated through the NCSTP, they also engaged with the scientific debate on relocation.

There's a lot of different science around [nest relocation], you know in terms of hatchling fitness on moved nests and different things like that, the consequences of moving them. [The state biologist] is in the 'never, no matter what don't move 'em.' That's [his] stance.

This coordinator illustrated her awareness of a wider scientific debate, the existence of which allowed her to describe the state biologist's position as a personal 'stance'. During interviews, another coordinator cited the study finding that most of the turtles that nest in areas subject to tidal inundation are inexperienced, and thus relocation would not create turtle populations reliant on relocation for viable nests. Scientific debates on relocation created an opportunity for volunteers to challenge the certainty of the state's position. While some coordinators addressed the specifics of the scientific debate on relocation, for the most part they assessed the overall scientific consensus as unresolved. In the face of scientific uncertainty, the coordinators relied on their experience to confirm that relocation was a viable and important tool for conservation management.

In the NCSTP, state biologists and coordinators must ultimately reconcile their approaches to sea turtle conservation in order to keep the project functioning. The physical landscape of the management area and the limited government infrastructure mediated negotiations over conservation practice in the NCSTP. As the NCWRC does not have the personnel and monetary resources to monitor North Carolina beaches by itself, it relies on volunteers and has limited day-to-day oversight of volunteer activities. Sometimes volunteers leveraged this control over the physical nesting spaces. As one coordinator told us:

There's still a lot of people in the crowd that are still going to do it their own way. I'll tell you that right up front. When it comes down to the big moment they're going to say, 'well I'm going to move this [nest], the goal is to get those turtles hatched and out in the ocean.' And that's their philosophy.

Coordinators have a certain degree of latitude when interpreting the nest relocation criteria, because only in very few cases would a biologist be in a position to visit the beach and inspect the nest sites. However the state was not afraid to exert its formal authority over the volunteers, as in one contentious instance during the Bogue Banks relocation ban. In that case, a coordinator was temporarily 'fired' from the project (according to the coordinator) or formally reprimanded (according to the state biologist). Coordinators pushed for aggressive nest relocation and the state exercised its authority to rein in what it viewed as excessive and unnecessary relocations.

A certain amount of disagreement is expected within collaborative management – it indicates that the partners are invested in the success of the project. In the process of including the perspectives of the volunteers and the state, both groups come to a better appreciation and understanding of their respective positions. As one coordinator explained, 'we've left nests over the past couple of years where we never would have left them before, and what that has proved to me is that we don't have to move as many nests that we probably have been.' Several of the coordinators told us that they negotiated directly

with the head state biologist about nest management and that they felt the state was willing to work with them on specific strategies for managing their beach. While conservation may not be enacted as each would ideally have liked, on both sides there is recognition and negotiation.

What distinguishes the NCSTP from citizen science projects studied by Ellis and Waterton (2004) and Lorimer (2008) is that the NCSTP volunteers do have an authoritative role in the performance of sea turtle conservation in North Carolina. While the volunteers did not tackle the canon of scientific knowledge or claim epistemic equality with scientists, they asserted their knowledge in decision-making processes for their beach zones and partook in the co-production of conservation practice. In the context of the collaboration, primarily the combination of North Carolina's physical geography and state's management capacity, the volunteers were able to bring their knowledge of sea turtles to bear on management practices, and their rendering of sea turtles and conservation became part of the conservation process.

Conclusion: Collaboration, negotiation and the co-production of conservation

As suggested in much of the literature on wildlife volunteers (Brossard et al., 2005; Evans et al., 2005; Trumbull et al., 2000), we find that volunteer coordinators in the NCSTP were appreciative of science and of what they learned through volunteering. Contrary to the literature, however, our findings suggest that this appreciation arises primarily from coordinator recognition of the role of science in influencing policy, rather than from their 'improved understanding' of what science is or of its findings. While coordinators have gained appreciation for the role of science in conservation, this does not translate into an unconditional acceptance. They used their 'improved understanding' of science to challenge it. Specifically, they exploited scientific uncertainty and the competing theories on the costs and benefits of nest relocation. They positioned the state biologists' views on nest relocation as being aligned with one 'side' of a scientific debate, with themselves aligned with the other. In so doing, they drew attention to the social and material processes in which science and scientific truths emerge.

Within the work of the NCSTP, the coordinators asserted their understandings of sea turtles as important and meaningful. By being embedded within the nesting habitat of sea turtles through living on or near the beachfront and enrolled in the practical embodied work of field science, the volunteers sought to deepen their relationships to the turtles. The state, committed to understanding sea turtles through statistics and operating from a more stringent nature-society divide, favored a distancing of human-wildlife relationships, and preferred to retreat from beach spaces and from direct interventions into turtle habitats and reproduction. This tension over appropriate human-wildlife relationships played out in the making of conservation practice in the NCSTP and in producing what matters in the management of sea turtles.

These types of broader issues are rarely addressed in the NCSTP, but bringing such a discussion to light may help state biologists and volunteers better appreciate each others' positions. We have found that biologists have tended to characterize the volunteer preference to move nests as reflecting a 'need' or 'desire' to be active. Our results suggest that

a much deeper commitment to the project's perceived goals, underlain by a particular vision of human–environment relations, informed coordinator desires for active management measures. Rather than attempting to 'educate' the coordinators about the state's scientific position on nest relocation, the state should consider these types of issues. It is not that volunteers failed to understand the science behind nest relocation and other management practices, but that they evaluated that science based on their experience with field science in the project.

At the same time, the NCSTP has provided a platform for volunteers to engage in greater ownership of and advocacy for sea turtle conservation. Volunteers in the southern region of the North Carolina coast created an all-volunteer-run sea turtle rehabilitation facility for injured turtles, and a VBO in the northern area of the North Carolina coast works in partnership with the North Carolina Aquarium to run another sea turtle rehabilitation facility. Working in these facilities not only allows volunteers to contribute to the wellbeing of adult turtles, but also engenders a deepening of their practical, embodied relationship with turtles. In 2010, out of a concern about the sea turtle bycatch, the all-volunteer rehabilitation facility filed a lawsuit against the North Carolina Marine Fisheries Commission and the Division of Marine Fisheries to prohibit them from authorizing the use of gillnets. While the lawsuit does not directly engage volunteer knowledge acquired through data collection, it does enable volunteers to address conservation issues not covered in their beach monitoring. These activities allowed volunteers to delve more deeply into sea turtle conservation issues, and to expand upon their knowledge and skills in conservation.

On the surface, the collaborative management in the NCSTP does not encompass the complete democratization of science. Volunteers did not take ownership of science in such a way as to challenge the canon of science; the state does not reckon with volunteers as epistemic equals, nor do the volunteers consider themselves epistemic equals to scientists. Yet, within the project there was a significant opening of the practice of conservation field science, and the volunteers' knowledge was brought to bear on the management of the turtles. This opening may matter most of all to the volunteers themselves, as they believe their role on the 'front lines' is critical to the survival of sea turtles in North Carolina.

In an unusual twist, the opening of science to citizen knowledge in the NCSTP did not proceed in a predictable fashion. Volunteers gained recognition for their knowledge through their ability to leverage control over aspects of the project, such as space and labor, rather than through an acknowledgement of the legitimacy of their knowledge claims. Perhaps one of the reasons for this outcome is that the democratization of science is, paradoxically, more challenging in collaborative projects. In collaborations, citizens participate at the invitation of institutions, and are subject to the hierarchical terms of the offered role. In cases where citizens engage with science in order to challenge authorities, they are focused on breaking barriers and transgressing boundaries, and may create alliances with other scientific actors in order to shore up their knowledge claims (Epstein, 1996; Holifield, 2009; Leach and Fairhead, 2002; Scott and Barnett, 2009).

Yet, in collaborations, the state and other institutional scientists are intended to be working on the same side as citizens. If citizens confront their partner institution, they will have lost their association with their collaborator's scientific authority. Over the course of a project, if citizens become too confrontational, they can be removed. Granted, state agencies depending on citizen labor may suffer if they remove all citizens who

challenge their authority. However, challenges to the science of governing institutions can be read as challenges to its very legitimacy, and if collaborations become too caught up in conflict, they will collapse. In light of these findings, we perhaps should pause to reconsider the potential for citizens to co-produce science in the context of collaborations.

Beyond the implications for citizen science in collaborative projects, the results from the NCSTP case also call attention to another aspect of the democratization of science. While many theorists focus on the democratization of science, it is important to examine how citizen science can influence other facets of science. The NCSTP volunteers do not directly contribute to institutionalized scientific knowledge on sea turtles, and their knowledge is not spread to sea turtle conservation outside of North Carolina. However, they do contribute to science as it is practiced in the field, influencing the practical, embodied work of research. In thinking about the democratization of science, we should consider the myriad of scientific processes at work and the ways in which these can be opened.

Notes

1. Parts of the North Carolina coast lie within national and state parks, or are under military control. Sea turtles are monitored in these locations, and sometimes volunteers play a role in monitoring them. Here, we focus exclusively on VBOs working outside of such areas, where they are the organization permitted to conduct the work of the NCSTP.
2. The pronoun 'we' is used throughout this article for simplicity, though the bulk of data collection was completed one of the authors (MC).
3. Dune-pushing is a procedure that aims to re-build dunes after major tropical storms and hurricanes, and entails the use of bulldozers for pushing sand to beach areas where dunes have been diminished.

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