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Engaging Fishers' Ecological Knowledge for Endangered Species Conservation: Four Advantages to Emphasizing Voice in Participatory Action Research

Kathryn R. Wedemeyer-Strombel[1*], *Markus J. Peterson*[1,2], *Ramon Neftali Sanchez*[3], *Sofía Chavarría*[3], *Melissa Valle*[3], *Eduardo Altamirano*[4], *Velkiss Gadea*[4], *Stacey K. Sowards*[1,5], *Craig E. Tweedie*[1,2] and *Michael J. Liles*[3]

[1] *Environmental Science and Engineering Interdisciplinary Program, University of Texas, El Paso, TX, United States,* [2] *Department of Biological Sciences, University of Texas, El Paso, TX, United States,* [3] *Asociación ProCosta, San Salvador, El Salvador,* [4] *Fauna and Flora International, Managua, Nicaragua,* [5] *Department of Communication, University of Texas, El Paso, TX, United States*

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***Correspondence:**
Kathryn R. Wedemeyer-Strombel
krwedemeyer@gmail.com

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Using social science to integrate local knowledge into conservation science can provide unique insights to conservation challenges. Especially when baseline data of a vulnerable wildlife population are deficient, these methods can help fill critical data gaps. In this study, we integrate the principals from the trinity of voice (TOV) and participatory action research (PAR) to generate baseline data on in-water habitat use of critically endangered hawksbill sea turtles (*Eretmochelys imbricata)* and to build mutually beneficial relationships with local stakeholders near the hawksbill's two primary nesting grounds: mangrove estuaries in El Salvador and Nicaragua. Local stakeholders, in this study referred to as fishers, hold expert knowledge they have acquired both experientially and culturally. Using TOV to shape PAR, we invited stakeholders to use their fishers' ecological knowledge (FEK) to enhance conservation of this at-risk species. Our results demonstrate that in addition to using FEK to produce quantifiable data (e.g., turtle habitat use), there are four advantages to emphasizing voice throughout a PAR project: (1) provides locality-specific information, (2) enhances mutual learning and leadership, (3) incorporates local experience, knowledge, and creativity, and (4) encourages local participation and commitment to the conservation challenge.

Keywords: conservation, sea turtles, trinity of voice, participatory modeling, habitat use, mangrove estuary

INTRODUCTION

In the Anthropocene, people are increasingly recognized as crucial to conservation (Palsson et al., 2013; Virapongse et al., 2016; Bennett et al., 2017; Ban et al., 2018). For example, many conservation issues involve competition for scarce resources between an endangered species and subsistence/traditional harvesters (e.g., Bulbeck and Bowdler, 2008; Rioux et al., 2012; Liles et al., 2015a), and human-generated pollution that harms wildlife and human health (Venter et al., 2006; Vegter et al., 2014; Schuyler et al., 2015; Wedemeyer-Strombel et al., 2015). Other challenging human-wildlife interactions include fisheries bycatch (Lewison et al., 2014; Liles et al., 2017), and illegal harvest and/or hunting (Brashares et al., 2004; Von Essen et al., 2016; Silvy et al., 2018). In the European Union and United States, government regulatory agencies responsible for evaluation and enforcement of laws protecting at-risk species and ecosystems are required to allow public input, but often do so with reluctance as the process becomes complicated and additional conflict surfaces when trying to reach common ground (Peterson and Horton, 1995; Clarke and Peterson, 2015). International environmental non-governmental organizations (ENGOs) and conservation scientists often face similar struggles when working in low-income regions (i.e., developing countries). While not necessarily a legal requirement, the meaningful participation of local people has proven to be critical for the sustainable success of conservation initiatives (Drew and Henne, 2006; Schafer and Reis, 2008; Liles et al., 2015a).

Although natural scientists increasingly engage with local community members to improve implementation of conservation initiatives, they rarely engage with local people to generate baseline knowledge upon which to build these science and conservation efforts (Drew, 2005; Hind, 2014; Bennett et al., 2017). Lack of baseline data for a population or species of concern offers especially troubling problems, and often leads natural scientists to base their recommendations on data that were collected in other locations and developed for related, but different, species (Schafer and Reis, 2008; Liles et al., 2015b). Building effective management plans that enable conservation of at-risk species, however, is difficult without data regarding the target population and species (Fraser et al., 2006; Schafer and Reis, 2008; Seminoff and Shanker, 2008; Wallace et al., 2010; Liles et al., 2015b). One option to create baseline knowledge in these situations is to employ local knowledge to generate baseline data (Johannes et al., 2000; Fraser et al., 2006; Schafer and Reis, 2008).

Two recent review papers (Rees et al., 2016; Bennett et al., 2017) call on conservation scientists to work with social scientists to engage local human populations in management, and numerous reviews have highlighted the value of local knowledge garnered via social science methods (for examples, see Johannes et al., 2000; Drew, 2005; Hind, 2014). They point out that, to benefit from the full potential of local knowledge, scientists must open their minds and research to other knowledge cultures and approaches (Hind, 2014), a challenging hurdle (Bennett et al., 2017). This is made more challenging by institutional and political barriers preventing multi-disciplinary integration (e.g., single discipline journals, different methods of professional evaluation for researchers in different fields). Another difficulty may be that traditional and local ecological knowledge often are seen as merely anecdotal by biologists, even though the fisheries conflict literature has acknowledged the value of local ecological knowledge (Pauly, 1995; Sáenz-Arroyo et al., 2005; Haggan et al., 2007; Liles et al., 2015a), and local knowledge is revered in disciplines such as history and oceanography (Pauly, 1995; Sáenz-Arroyo et al., 2005).

Ignoring this expert local knowledge has been detrimental to conservation on multiple scales (reviewed in Johannes et al., 2000; Drew, 2005; Hind, 2014). For example, from the 1960s through 2008, conservation scientists and international ENGOs appeared to have largely dismissed local knowledge in the case of eastern Pacific (EP) hawksbill sea turtles (*Eretmochelys imbricata*). They thought EP hawksbills were ecologically extirpated, assuming local fisherman were mistakenly identifying green sea turtles (*Chelonia mydas*) as hawksbills (Gaos and Yañez, 2012). In 2008, conservation scientists heeded the advice of local fishermen, and re-discovered this population nesting in mangrove estuaries (Vásquez and Liles, 2008)—a natural history that is unusual for sea turtles worldwide (Gaos et al., 2012b; Seminoff et al., 2012). Conservation scientists now acknowledge that >70% of the approximately 800 nesting females in this population, which ranges from Mexico through Peru, nest within *Bahía de Jiquilisco*, El Salvador (Bahía) and *Estero Padre Ramos*, Nicaragua (EPR) (Liles et al., 2015b; Gaos et al., 2017). Limited satellite tracking studies (Gaos et al., 2012a,b,c), and genetic analysis (Gaos et al., 2018) demonstrate that adults also forage in these mangrove estuaries, but we know neither the extent, nor how EP hawksbills utilize these habitats across multiple life stages.

In an attempt to answer these questions, we employed participatory action research (PAR) to generate baseline information that may enhance conservation of this critically endangered species (Fals-Borda, 1987; Johannes et al., 2000; Wadsworth, 2006). Although it was originally envisioned as a way to improve the quality of public participation venues, we used Senecah's trinity of voice (TOV) to shape the project as a means of creating spaces for the emergence of local stakeholder voices. Our results demonstrate that fishers' ecological knowledge (FEK) can provide significant amounts of high-quality data that enable developing appropriate conservation plans and future research, which is especially important for at-risk species. Our analysis further suggests that this approach to gathering baseline data can be extended beyond fishers, to include other subsistence/traditional harvesters. Specifically, we combined informant-directed semi-structured interviews and participatory modeling to develop the first detailed in-estuary habitat use map for critically endangered EP hawksbill turtles. We demonstrate that by integrating social science principles and grounded methodology, conservation scientists can increase their knowledge base, while creating a mutually beneficial relationship with local people (Drew, 2005). Based on this case study and insights from others (Greenwood et al., 1993; Kapoor, 2001; Drew, 2005), we conclude that employing PAR in this way has four major advantages: Doing so (1) provides locality-specific information, (2) enhances mutual learning and leadership, (3) incorporates local experience, knowledge, and creativity, and (4) encourages local participation, ownership, and commitment to the conservation challenge.

THEORETICAL PERSPECTIVE

Fishers' Ecological Knowledge

Local expert knowledge is often classified as traditional ecological knowledge (TEK) or local experiential knowledge (LEK). These terms are often used interchangeably (Turvey et al., 2014). Turvey et al. (2014) makes an important distinction between the two, however, defining LEK as "experiential knowledge derived from lived interactions with the local environment, and able to provide information about the contemporary status of target species and ecological resources" (P. 189) and TEK as, "representing the cumulative body of ecological knowledge and belief passed down between generations by cultural transmission" (P. 189). When interacting with local resource users, such as fishers, local knowledge may be a combination of TEK and LEK, with the expert knowledge of local resource users being the product of both information passed down through generations, and that obtained through personal experiences. Drew (2005) dissected TEK to include both experiential and generational knowledge, while Johannes et al. (2000), who also studied marine systems, combined TEK and LEK to create FEK. Building off of Johannes' work (Johannes, 1978, 1981; Johannes et al., 2000), a detailed review of FEK was conducted by Haggan et al. (2007). Analogously, attempts to discover knowledge of local resource users in studies focused on terrestrial ecosystems might have used terms such as Ranchers' or Hunters' Ecological Knowledge. We too refer to the knowledge of local resource users as FEK, as it is both more particular and more general than TEK or LEK: more particular in that it targets people working within a particular profession in a specific part of an ecosystem, and more general in that it combines both methods of knowledge acquisition (i.e., TEK and LEK).

Acknowledging the value of FEK is only one aspect of PAR. Finding ways to incorporate this knowledge into conservation action respectfully and effectively requires professional researchers to step outside their formalized concept of expertise, and recognize that expertise is not limited to those who are academically trained. As Peterson and Horton (1995) note, professional researchers and local resource users can build a foundation of mutual respect to encourage collaborative development of information on which to inform research and, later, management practices.

Participatory Action Research

Participatory approaches to research require a highly collaborative process where professional researchers relinquish their authority as principle investigator, and both conceptualization and execution of the research is shared between professional researchers and local participants (Greenwood et al., 1993; Johannes et al., 2000; Wadsworth, 2006). It acknowledges there are at least two world views at hand, with professional researchers and local participants working toward a shared goal (Fals-Borda, 1987). Other studies have successfully used PAR and participatory modeling to incorporate FEK, primarily in the fisheries management literature (Close and Hall, 2006; Riolo, 2006; Schafer and Reis, 2008). To achieve full participation, the professional researcher/local participant relationship must be shifted, and framed as subject/subject, rather than the more traditional subject/object (Greenwood et al., 1993). Dissolving traditionally asymmetric relations into a joint effort enables a situation where "… academic knowledge plus popular knowledge and wisdom may give as a result a total scientific knowledge of a revolutionary nature…" (Fals-Borda, 1987, p. 332). To achieve this equality, it is important that participants realize their knowledge is validated and respected. Reed (2008) specifies that stakeholder participation should be considered early, and throughout, a participatory process, and that it needs to be supported by a research philosophy that emphasizes empowerment, opportunities for meaningful collaborative engagement, and two-way learning. Following these recommendations, we adapt Senecah (2004)'s TOV template to underpin our collaborative process, as it emphasizes stakeholder empowerment through access, standing, and influence.

Trinity of Voice

Senecah (2004) suggests one way to indicate that their knowledge is respected, and to build stronger relationships with local participants, is by affording them opportunities to experience access, standing, and influence on conservation. She combines access, standing, and influence as a trinity of voice (TOV), which helps build and maintain trust between professional researchers and participants (Senecah, 2004). Access is provided via multiple pathways, including demonstrated consideration for the participants' schedule and comfort when choosing times and locations for gatherings, and use of accessible language in informational materials (Senecah, 2004). Conservationists can demonstrate that local participants have standing by engaging in active listening and mutual learning, which requires that the research effort include varied opportunities for dialogue (Senecah, 2004). Access and standing together are required to produce influence, where participants' inclusion is more than a formality, and decisions indicate that local expertise has been fully acknowledged and respected (Senecah, 2004).

Although TOV was originally intended to describe a normative framework for making public hearings more inclusive, in this paper we demonstrate that it can be used as a mechanism for designing PAR, and adapted to fit a case's unique resources and context, as suggested in Senecah (2004) and Walker et al. (2006). While using TOV as a template to frame our PAR cannot guarantee authenticity of voice, it does bring us closer to a more robust understanding, and consideration, of multiple stakeholder voices. In addition to building trust between researcher and participant, TOV can help transform personal identities of participants from resource users to resource experts. For example, Horton et al. (2016) discuss how role-based identities are shaped by multiple communicators in an interaction. This is further supported by Greenwood et al.'s (1993), claim that "…incorporating organization members and the extensive local knowledge they have in the research process results in the development of their own roles and stakes in the research process and outcomes" (P.178). Thus, research that acknowledges participants' expertise, while emphasizing empowerment, equity, and learning, may encourage participants to identify as expert conservationists, and develop ownership of the conservation program.

METHODS AND RESULTS: INTEGRATING TRINITY OF VOICE INTO PARTICIPATORY ACTION RESEARCH

Because PAR is an emergent process that must develop rather than be forced or assumed *a priori* (Greenwood et al., 1993), we attempted to create a highly-collaborative process whereby mutual respect and knowledge exchange encouraged full participation by all participants, allowing FEK to emerge as a central component of the research. To encourage FEK to emerge, we conducted informant directed semi-structured interviews (Mccracken, 1988; Peterson et al., 1994) and aimed to enable TOV throughout each interaction.

Informant Directed Interviews

Over the past several years, we developed a collaborative relationship with local residents. Five authors (KRWS, MJL, NRS, SC, MV) conducted the interviews 7 May−8 June 2016 in fishing communities surrounding Bahía (13°13′N, 88°32′W) and EPR (12°48′N, 87°28′W). Interviewees were identified through connections through the local hawksbill conservation network, forged by the Eastern Pacific Hawksbill Initiative (ICAPO, in Spanish), Asociación ProCosta, and Flora and Fauna International, and supplemented with snow-ball sampling (Goodman, 1961). Authors NRS, SC, and MV are Salvadorans who have lived and worked with the communities in Bahía for a combined total of 36 years; NRS is native to one of the Bahía communities; EA worked for seven years within the EPR community, KRWS spent 2 weeks living in the communities prior to the interviews, and MJL has lived in Salvadoran communities and worked with residents of both locations for 10 years.

Interviews were conducted in the local residents' primary language, Spanish. They followed (Mccracken, 1988) long form interview, and were conducted as informant-directed semi-structured interviews, as described in Peterson et al. (1994). We began with generalized questions, encouraged continued discourse with "floating prompts" (e.g., head nods), and ended with a planned prompt, where we provided a map of the informants' local mangrove estuary to facilitate participatory modeling (Mccracken, 1988; Peterson et al., 1994; Yearly et al., 2003). To ensure anonymity, interview citation formatting in this manuscript is adapted from (Horton et al., 2016).

All transcripts were translated from Spanish to English, with a subset double-translated to ensure that original meanings were not lost in translation (Marín and Marín, 1991). A partially emergent thematic analysis (Kincheloe and Mclaren, 2005) was used to analyze the translated transcriptions of the 62 recorded interviews. During initial interview processing, author KRWS organized translated interview transcripts into single units of meaning labeled as "utterances." Through this process, and in combination with field notes taken while conducting the interviews, KRWS' ecological knowledge of EP hawksbills, and the FEK further explored in this paper, distinct themes emerged (Peterson et al., 1994, 2010). Using these themes, data were coded into four categories. KRWS and NH then developed a codebook which defined the four categories and their respective subcategories, and used it to train themselves and assess intercoder reliability (Krippendorff, 2013). KRWS and NH independently coded ∼20% of utterances, and calculated intercoder reliability across all categories and subcategories with weighted Cohen's kappa of 0.9886 (Cohen, 1968). Coding was done using NVivo 10.0 qualitative software (QSR International, Doncaster, Victoria, Australia). Depending on fit, individual utterances were coded in 0 to 4 categories.

Participatory Modeling Activity

We employed participatory modeling to produce spatial representations of FEK regarding habitat use by hawksbills within Bahía and EPR (Yearly et al., 2003; Close and Hall, 2006; Riolo, 2006). Participatory modeling uses individual mapping exercises to capture local expert knowledge, where resource users are considered technical experts (Yearly et al., 2003), as their lives and livelihoods revolve around marine resources, including hawksbill sea turtles (Liles et al., 2015a). Participatory modeling can be used to generate knowledge and to assure the quality of knowledge; here we use it to generate baseline data regarding the in-water habitat use by EP hawksbills throughout their growth and development in Bahía and EPR.

We provided informants with a basic map of their local mangrove estuary. We oriented informants to where we were located on the map by pointing out key landmarks. We then asked each informant to label on the map where within the estuary, or in the open-coast ocean waters, they see hawksbill turtles of various sizes (**Figure 1**). For each interview, a new blank map was used, with an exception of two interviews in Bahía, due to extra interview opportunities arising without extra maps on hand. When asking informants to mark the map, we reminded them that we were only interested in hawksbills in the water, not hawksbills nesting on beaches nor any other turtle species. We prompted informants, as needed, by asking questions such as, "where do you fish," "when you are there fishing, do you see turtles," how many, how often, what size."

To ensure that size categories of hawksbills were referred to consistently across interviews, we provided five cardboard cutouts of hawksbill turtle silhouettes, each labeled with a different letter (A-E). The sizes of the cutouts approximated five size classes and life history stages of hawksbill turtles, and represent the curved length of their dorsal shell, from the top of the shell to the point above the tail (curved carapace length, CCL). The cutouts were as follows: A ≈ hatchling (4 cm), B ≈ yearling (15 cm), C ≈ juvenile (30 cm), D ≈ sub-adult (65 cm), E ≈ nesting adult (84 cm; **Figure 2**). When informants talked about seeing turtles in a particular location, we asked them to select the cutout that was closest in size to the turtles they had seen. We directed them to the cardboard cutouts to clarify which sizes they were referring to if they used general statements like, "we'd see small turtles." Participatory modeling was completed when informants indicated they had marked all areas on the map where they observe hawksbills in the water.

Oral informed consent was obtained from all study participants. All informants were asked if they consented to participate in the study prior to the start of the interview, and if they consented to voice recording in addition to the interview. We used voice consent because some of our informants were not comfortable with written language. All interviews were conducted in Spanish. At the end of each interview, we collected

FIGURE 1 | Participatory modeling exercise results for individual interviews: **(A)** Interview 024 in Bahía, and **(B)** interview 063 in EPR. Dots and lines drawn in by informants indicate where they have seen hawksbill turtles in the water (as opposed to nesting), and letters refer to the size class of hawksbills seen at indicated points. Letters refer to the cardboard cutouts that were provided to create consistency when referencing size.

basic demographic information about the informants. The University of Texas at El Paso Institutional Review Board approved all interview practices (IRBNET ID 896427-1). Informants were not paid to participate, but were offered a snack after the interviews had finished. Interviews were conducted in both Bahía and EPR until saturation of information was reached.

After all participatory modeling was conducted, KRWS scanned a blank map of each estuary, georeferenced it in ArcMap 10.4.1 (ESRI, Redlands, California), and digitized (Bolstad, 2012) each of the interview data points onto the map. She then identified for each interview point which size classes were identified at that point. After all points were entered, she used the

FIGURE 2 | RNS **(left)**, a fisher **(middle)**, and KRWS **(right)** work together on the participatory modeling activity. RNS and a fisher are marking on the map where hawksbill turtles have been seen within the estuary waters. Cardboard cutouts pictured from right to left are: A, hatchling, 4 cm CCL; B, yearling, 15 cm CCL; C, juvenile, 30 cm CCL; D, subadult, 65 cm CCL; E, nesting adult, 84 cm CCL. Written informed consent was obtained from KRWS and RNS to include this picture in this manuscript.

"calculate geometry" function to generate latitude and longitude of the points (**Figure 3**).

Enabling Trinity of Voice

Access

Informants chose where the interviews were conducted to create a relaxed environment where they felt comfortable sharing their knowledge (Senecah, 2004; Liles et al., 2015a). Interviews were ideally conducted with one informant at a time in case some informants would not feel comfortable speaking in front of others (Ferguson and Messier, 1997), but if an informant felt more comfortable being interviewed with another informant, this was permitted. At minimum, two people conducted the interviews, and one of the interviewers was always a respected local community member to the area in which the interview was being conducted (Marín and Marín, 1991). This built trust with the participants and helped create the equal subject/subject dynamic of interviews (Fals-Borda, 1987).

Standing

Before each interview officially started, we explained that we were there to learn from the fishers, that we were interested in understanding their expert knowledge regarding where in the water we can find hawksbill turtles. We emphasized our recognition that, as fishers, they have expert knowledge about their local mangrove estuary and the local hawksbill turtles. As open-ended interviews, the first question was always, "please tell me about your experiences encountering hawksbill turtles in the water within the estuary." We used colloquial words and non-scientific terminology throughout interviews to ensure that the questions were clear. Prior to interviews, all questions were examined by local collaborators to ensure that appropriate terminology was used, and questions were adjusted as necessary for each locality (Marín and Marín, 1991).

Influence

We encouraged informants to exercise influence over the project by asking them to speculate on the significance of their observations, and to propose their own hypotheses on where the turtles go and why. Many of our informants demonstrated awareness of their potential influence by asking follow-up questions about the study, including asking how they could further contribute to the research. The recognition of their own influence enabled us to extend our initial goal of creating baseline ecological data to include additional scientific and conservation benefits, and revealed four major advantages to engaging local experts in all stages of research.

FOUR MAJOR ADVANTAGES OF USING TOV TO SHAPE PAR

In addition to baseline data generation for this critically endangered species, four major advantages to employing PAR in a manner shaped by the TOV emerged during our study:

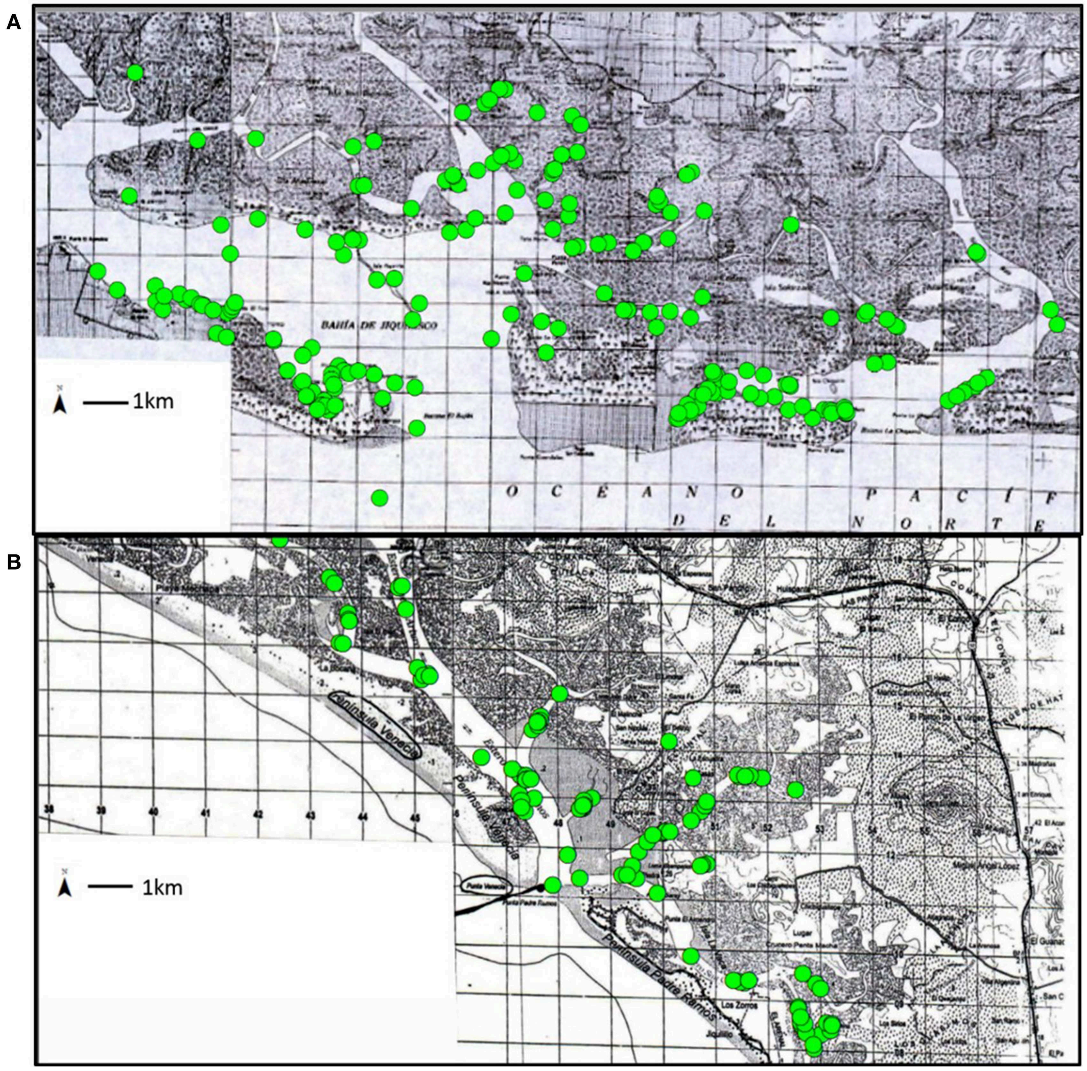

FIGURE 3 | Compiled 301 multidimensional data points from all participatory modeling conducted in **(A)** Bahía ($N = 38$ interviews, 200 data points) and **(B)** EPR ($N = 30$ interviews, 101 data points). Each point represents where a hawksbill turtle has been seen in the water (as opposed to nesting), and each point includes size data of turtles seen at that locality.

(1) provides locality-specific information, (2) enhances mutual learning and leadership, (3) incorporates local experience, knowledge and creativity, and (4) encourages local participation, ownership and commitment to the conservation challenge.

Locality-Specific Information

Fishers of different kinds (e.g., shellfish fishers, harpoon fishers, single line fishers) from each community fish in different sections of the estuary, and as a result know those areas well. As we wound our ways through the maze of estuaries on the maps provided, they each appeared to know exactly where we were, down to the slightest curve of the channel on the map. In Bahía, we interviewed 38 fishers. The participatory modeling generated 200 points on the Bahía map where they had observed hawksbills. In EPR we interviewed 30 fishers, generating 101 points where they had observed hawksbills. Each data point signifies at least one individual hawksbill turtle. Thus, we generated the first detailed habitat use maps for EP hawksbills near their two primary rookeries (**Figure 3**). All five size classes of hawksbills were indicated on maps, with some locations hosting multiple hawksbill size classes.

Enhancing Mutual Learning and Leadership

Most fishers were generous with their time and were open to sharing their knowledge. Only one fisher declined our invitation to talk because he was in the middle of re-roofing his house (KRWS, *personal observation)*. One fisher was waved down as he was driving by on the back of a friend's motorcycle, and the interview was conducted on the side of a dirt road, near an angry bull. His friend came back to pick him up after the interview was over and they drove off (KRWS field notes, 6/4/16). During a few interviews, fishers explicitly commented on the mutual learning generated through the project. For example,

> …and of the hawksbill, well (laughter), what I can do is learn with all of you. But we do [collaborate]. We are trying [fighting]. Because that is the point, to learn from one another. (Responses B013.09-.12, translated from Spanish).

Although at a general level, participants touched on the same topics, the structure of our interviews and our partially-emergent analysis allowed for different voices to emerge. For example, another fisher stated:

> That's why I tell you that each one of us [fishers] has their own point of view...to collect a little bit from each one and we are going to get something from everyone…we are going to reach a conclusion when you work as a team.…we are here to help (Responses O032.05-.08, translated from Spanish).

Fishers' use of phrases such as "when you work as a team," and "learn with all of you," illustrate their sense of influence over the project.

Throughout the interview process, leaders emerged within each of the local communities. In El Salvador, the same local fishers accompanied KRWS for most interviews, while in Nicaragua the local collaborator changed depending on the community. In both cases, the local collaborators identified whom we should talk with, and facilitated introductions between KRWS and informants. New local collaborators who assisted with interviews were interviewed prior to assisting to minimize bias that could be developed after witnessing others' interviews. These local collaborators were able to showcase their knowledge of their local estuary, hawksbill turtles, and their connections within their communities. As the interviews progressed, local collaborators gradually began taking greater initiative within the interview process. For example, they clarified questions the informants had without asking for permission to do so, and pointed out estuary landmarks on the map to help orient informants. When walking between interviews they would chat with KRWS about life in their towns, about the hawksbill turtles, and began to postulate their own hypotheses about hawksbill turtle life history based on personal experience, knowledge acquired through the interviews, and ideas generated during conversations with KRWS (KRWS field notes, May 2016). Through these knowledge exchanges, KRWS and local collaborators learned to challenge what they had previously thought about hawksbill habitat use and to approach the research question in novel ways.

In Nicaragua, one local fisher accompanied KRWS on all interviews throughout one of the communities. Because of the equal-collaborator relationship that was built, when KRWS returned for follow-up in-water capture fieldwork months later, the same fisher immediately took initiative on this next phase of the project, and quickly became the project co-leader once again (KRWS field notes, Nov. 2016).

Incorporating Local Experience, Knowledge, and Creativity

The *invention* of a tool designed for collecting sea turtle samples for a related project illustrates the importance of harnessing local experience, knowledge, and creativity. The data points this study provided baseline data for a follow-up in-water capture study. As we were compiling the information from our interviews in El Salvador, our field team, comprised mostly of locals to the area, were testing hawksbill turtle sampling techniques for the next part of our study. We realized immediately that the standard plastic tool used to take the samples we needed would not work on EP hawksbills, as their shells are much denser than other populations and species (personal observations). We shopped around for a tool that would work with no success. Then, one collaborator based in the United States suggested we use a power drill with a diamond coated core drill bit, and one of these was flown to El Salvador from the United States. However, that was also unsuccessful. After several days of troubleshooting, the local ProCosta field coordinator in El Salvador, RNS, asked for one of the original plastic tools so he could think further about it. The next day he came back and said he knew a man on the mainland who could likely forge a custom tool for us to attach to the power drill. Two days later, we had a made-to-order tool. The non-local authors agree we would not have thought of this solution ourselves. Being intrigued by the question, RNS took it upon himself to solve the problem. This new tool, which we named a "Broca Nefta" after its creator, was later successfully duplicated and used to take samples from hawksbills in Bahía and EPR (Wedemeyer-Strombel, 2019). Not only did this tool allow us to take the needed samples, it also helped reduce the amount of trash we generated while conducting the research using disposable biopsy punches, which is especially important in remote locations.

All sea turtle tissue sampling was approved by the University of Texas at El Paso Animal Use Protocol (A-201608-1), El Salvador Ministry of the Environment and Natural Resources (MARN: MARN-DEV-GVS-007-2016; MARN-DEV-GVS-008-2016), and Nicaragua Ministry of the Environment and Natural Resources (MARENA: DGPN/DB-IC-014-2016).

Encouraging Local Participation, Ownership and Commitment to the Conservation Challenge

One of the questions we asked in the interviews was: "Do you see hatchlings in the estuary?" Many said no, but also indicated their belief that at least some of the hatchlings remain within the estuaries throughout their lives. In these cases we followed up with: "If we don't see hatchlings after they are released, then where are they? Where do they go?" On several occasions, local fishers were as perplexed by this question as we were, and many said they had not thought about it before (KRWS field notes, May 2016). After some thought, several mentioned the tides could be pulling the hatchlings deep into the mangroves, which is why they did not see them. Others suggested that the tides serve an opposite purpose, pulling at least some of the hatchlings out into the open ocean. Others postulated that food and protection kept the hawksbills in the estuary (e.g., interviews 001, 007, 031, 039, 045).

A few fishers voluntarily added on their commitment to the conservation challenge. For example, at the end of one interview, when KRWS was thanking an informant, the fisher explained:

> But to say it that way; everyone is conscious about what they do [in regards to the turtles] but it is the need of the people that results in the egg going to market when there are no projects. Right; sadly and thanks to the institutions [conservation projects] that in that respect, they are helping a lot and I am one of those that likes to help sometimes. Because to be honest that is not my job. But I do like to help because when one of those projects comes to our community we must appreciate it (Responses F013.11-.14).
>
> [KRWS] Thank you for everything that—
>
> [Fisher interrupts KRWS], No, thank you because that's how you learn right, that's how you learn from one another, we all learn (Response F013.15).

Another informant shared the importance of preserving the turtles for future generations:

> And at least there is a chance that in the time that the kids grow up they will be able to see that turtle and they will say it was good what my parents did or what the others did. Because I think that the parents sometimes, even if all of us are not going around working there, but if we provide the support to the kids that work there and we tell our kids: look you are going to go fish but don't touch the little eggs that are laying there. You are going to go to work but you will not take a Hawksbill out and if you find one its better if you turn it in to a hatchery (Response A043.38-.40, translated from Spanish).

In addition to information gleaned directly from the interviews, at the end of each interview day, the local experts who accompanied KRWS to help build trust with community members, and to aid in clarifying questions and colloquial terms during the interviews, shared their own theories about where hatchlings go and why, without being prompted or formally interviewed. After interviews were complete, KRWS returned to the field 4 months later for follow-up in-water capture studies. One Salvadoran fisher who had accompanied her on several interviews said that because of our interviews, he had become curious to figure out where the small turtles were in the estuary. In the 5 months between the first and second field visits, he took it upon himself to go out and look for small hawksbills on his own. He reported that on one occasion he did see one hawksbill between sizes B (15 cm) and C (30 cm), did not have a proper net to catch it, but that he would like to continue searching, because it does not make sense to him that we do not see them more often (KRWS field notes, Oct. 2016). As a community leader and lead collaborator with ProCosta, he has all the training and necessary permits to handle hawksbills for research purposes.

DISCUSSION

In this study, we demonstrate a way to strengthen a PAR framework by focusing on TOV among local experts. In this setting, researchers can respectfully collaborate with local experts to incorporate FEK into the knowledge base for future conservation initiatives. Our results support the insights of Greenwood et al. (1993); Kapoor (2001); and Drew (2005). Greenwood et al. (1993) explicitly points out that, "participatory action research enhances problem formulation, hypothesis formulation, data acquisition, data analysis, synthesis, and application" (p. 177). Data from this PAR project, for example, have provided crucial baseline information for the conservation of a critically endangered species. Further, the project indicates four major advantages to using the TOV to shape PAR: (1) provides locality-specific information, (2) enhances mutual learning and leadership, (3) incorporates local experience, knowledge and creativity, and (4) encourages local participation, ownership and commitment to the conservation challenge.

The baseline data provided by FEK suggests a narrative describing a novel life history strategy of EP hawksbill turtles, as mangrove estuary residents. This idea, which has only one previous mention in the professional literature (Fryer, 1911), has been disregarded throughout subsequent sea turtle academic literature as merely anecdotal. As such, the original citation (Fryer, 1911) is mentioned briefly in Witzell (1983), which is then cited in The Biology of Sea Turtles Vol 1. (Lutz and Musick, 1997, p. 152), but is left out as a possible life history strategy in the two subsequent volumes of The Biology of Sea Turtles (Lutz et al., 2002; Wyneken et al., 2013). Vol 2 includes a full chapter on life history patterns and variations, but does not include the mangrove estuary resident (Bolten, 2003). Thus far, this study has led to a new problem and hypothesis formulation (i.e., life history strategy of EP hawksbills), novel data acquisition (i.e., baseline habitat use maps), the basis for a capture inventory of EP hawksbills and stable isotope analysis (Wedemeyer-Strombel, 2019). All of which may contribute to improved conservation initiatives that benefit both the informants (Liles et al., 2015a), and the EP hawksbills with whom they share critical habitat.

This project demonstrates that knowledge gained via PAR and TOV is multidimensional and more than just a point on a map. In this example, it provided information not only about where animals are, but how many are seen in certain areas, seasonality influences, and other environmental factors that are witnessed throughout years on the water, (Schafer and Reis, 2008). Schafer and Reis (2008) gleaned 124 fishing areas through FEK, more than 80% of which were known only to local fishers and previously unknown to researchers. In our study, only some of the identified areas were known to biologists working in the area as hawksbill habitat, and some locations were new to the local fishers aiding in our interviews.

In a recent review regarding incorporating social sciences in conservation, Bennett et al. (2017) note that when financial resources are limited, natural science budgets are often prioritized. However, our study and several others (Close and Hall, 2006; Fraser et al., 2006; Riolo, 2006; Schafer and Reis, 2008) demonstrate that much is to be gained for conservation science through social science methods, particularly when resources such as time and funding are limited. For example, the cost of interviews, including travel to and from the field sites and room and board for KRWS, was $4,046. Previously, satellite tracking studies were able to track 16 adult female turtles over a span of 2 years (Gaos et al., 2012a,b,c), which gave important insight into hawksbill habitat by providing 2,981 location points; however, these efforts address only a small number of turtles and life-history stages. Further, satellite tracking costs range from $1,200–$5,000 per tag and about $300–$1,500 for ARGOS time, not including travel to and from the field site, cost to capture turtles, and apply the tags. We recognize the numbers provided here are limited to data collection, and do not include costs for analysis, which is required in both social and natural science research. While satellite tracking effectively generates numerous locations on individual turtles, when time and funding are limited, it is impractical to track large numbers of turtles in all age classes.

We are not suggesting discontinuing satellite tracking or other traditional natural science methods, as each approach provides important perspectives to conservation questions. Instead, we argue more robust data could be obtained by conducting social science research grounded in a PAR framework, particularly in areas where habitat of the species being studied and human presence overlap. Further, collaborative social science could be the first step toward identifying baseline information to guide further natural science studies.

Readers will have noted that using PAR is incredibly resource intensive. We are not suggesting PAR is appropriate in every circumstance; sometimes a less resource intensive approach to social science will accomplish the conservation needs (see Reed, 2008; Reed et al., 2009; Clarke and Peterson, 2015). In many situations where the addition of social science has been suggested (e.g., energy policy change), a standardized survey may provide sufficient information about the stakeholders' beliefs and/or preferences (Shackley et al., 2007; Johnsson et al., 2010). However, in instances such as our case study, where endangered species are found in biodiversity rich and threatened habitats that overlap with a rapidly developing, traditionally subsistence, human society, an integrative approach that incorporates local knowledge is crucial for the sustainability of conservation initiatives (Haggan et al., 2007; Liles et al., 2015a).

Our approach to developing an equal collaboration with local fishers highlights the value of localized information, mutual learning, leadership, and creativity, and demonstrates how centralizing the TOV can guide the development and deployment of PAR that both discloses and further strengthens the commitment of local experts to conservation goals. We also recognize that collaborative relationships such as those described herein depend largely on groundwork such as that conducted by colleagues over at least a decade (Vásquez and Liles, 2008; Gaos et al., 2010; Gaos and Yañez, 2012; Liles et al., 2015a). Through this research, we learned more than we hoped to, and a great deal of that knowledge came from the analytical power of TOV. Using this approach encouraged awareness of our *a priori* biases, as well as directing our attention to the ongoing challenge of incorporating multivocality into conservation research. Continual attention to the TOV's central concepts of access, standing, and influence enabled us to design and implement a project that provided space for voices to emerge, as well as encouraging us to avoid the hubris of assuming our own omniscience. At the same time we realize our participants are sophisticated beings who strategically choose to perform their identities in certain ways, we also realize that performativity does not equate to inauthenticity (Burke, 1969). In our case, empirical validation of the information fishers shared offers one type of evidence for the authenticity of the their voices (Wedemeyer-Strombel, 2019). Our goal here was to demonstrate how the TOV can shape PAR in ways that open conservation science and the resulting programs to discovery of all potentially interested human voices involved. While TOV was primarily intended to guide more formal opportunities for public participation, we found that designing and implementing PAR projects along the lines indicated by the TOV enhances multiple dimensions of said projects.

Conclusions and Conservation Implications

A 2010 review of the global priorities of sea turtle research included a call for future studies to go beyond mark-recapture and satellite telemetry to understand spatial ecology of sea turtles by incorporating multiple approaches such as genetics and stable isotope analysis (SIA) (Hamann et al., 2010). More recently, experts added a call to incorporate local knowledge throughout the research process, from species assessment through management (Rees et al., 2016). Rees et al. (2016) also includes a recommendation for natural scientists to work more closely with social scientists to enhance the conservation impact of their research.

This study of FEK regarding hawksbill habitat use within local mangrove estuaries produced the first detailed map of EP hawksbill habitat use across all life history stages, from hatchling through adult. The study provides important baseline data, in the form of nominal and geographical identification of hawksbill habitat use as observed by local fishers within Bahía and EPR. Using PAR in a way that focused on participants' voice enabled us to further explore connections identified by Liles et al. (2015a) that extend beyond local economic use of hawksbill turtles, to include cultural affinity between turtles and people.

We encourage conservationists to recognize that collaborative social science can create baseline knowledge quickly and efficiently. In addition, we caution that developing conservation initiatives without including the voices of local people can result in push back from the local community, ultimately making the research unnecessarily inefficient and expensive (Schafer and Reis, 2008; Liles et al., 2015a). Drew and Henne (2006) note that engaging local community members is highlighted in many case studies, but actual integration of local expertise in the early stages of research is rare. Our paper demonstrates one way to engage local community members in shaping conservation research that can be used to generate multidimensional baseline data, as well as encourage critical participation among local residents. It demonstrates the value and depth of local knowledge, the power of applying PAR to conservation, and how opening our minds to knowledge cultures beyond our own, enables us to, as advocated by Fals-Borda (1987), generate knowledge of a revolutionary nature.

DATA AVAILABILITY

The datasets for this study will not be made publicly available because the raw data sets generated from the interviews in this project are protected by the University of Texas, El Paso Institutional Review Board (IRBNet ID 896427-1). Only those authorized under the IRB protocol are able to access the raw data for this study. However, aggregated versions could be made available upon request.

ETHICS STATEMENT

This study was carried out in accordance with the Institutional Review Board requirements (IRBNet ID #896427-1) at the University of Texas at El Paso. University of Texas, El Paso Institutional Review Board waived written consent and authorized verbal consent from respondents as it is not culturally appropriate to have rural participants sign a consent document, since for an illiterate population, an inability to sign can cause embarrassment. Additionally, the socio-political situation in Latin America could also make potential participants uneasy if required to sign a document, even though no risk is expected from the study, a signed document would be the only personal identifier that could lead back to the participant.

AUTHOR CONTRIBUTIONS

KW-S conducted all interviews, data analysis, and drafted the manuscript. MP and SS provided logistical and writing support. RS, SC, and MV assisted with all interviews conducted in El Salvador. ML coordinated fieldwork, provided logistical support in the field, and facilitated translation of interviews. CT provided GIS and logistical support. EA and VG provided logistical support in the field. Co-authors contributed to editing the final manuscript.

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