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Boundary Organizations as an Approach to Overcoming Science-Delivery Barriers in Landscape Conservation: A Caribbean Case Study

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Abstract - Throughout the Caribbean, conservation is ecologically, politically, and socially challenging due to a number of factors including globalization, climate change, loss of biodiversity, and the spread of invasive species. Relationships between organizations and institutions that govern the region's natural and cultural resources are key to conservation success as partners work to implement plans to meet science, capacity, and information needs. However, the complex challenges involved in conservation work and tenuous relationships among organizations can result in a "knowing–doing gap". Empirical evidence from 130 Caribbean conservation organizations indicates that barriers to bridging this gap are lack of information and data sharing, political constraints, competition, limited resources and technical capacity, and ineffective communications. We suggest that a knowing–doing gap exists in the region and that "boundary organizations" are a solution to overcoming the barriers some conservation entities face. We explore how boundary organizations can use the social sciences and practitioner expertise to successfully become knowledge brokers, and we offer a set of recommendations for implementing our ideas. We conclude by postulating that bridging the knowing–doing gap in resources management could lead to a sustainable future for the Caribbean region.

Introduction

Institutions that control and manage natural resources face a wider variety of challenges than ever before, many of which are regional or global in scale. The combination of complexity and scale has created what have been referred to as "wicked" (Rittel and Webber 1973) and "super wicked" problems (Levin et al. 2012) in conservation (Carcasson 2013) and has led to a perception that traditional resource-management methods are no longer effective (Ludwig 2001). Information to support decisions is lacking, and building partnerships may be a good way to address today's problems (Carcasson 2013, Hartz-Karp 2007, Jacobson and Robertson 2012, Plummer et al. 2013). New, larger, and far-reaching partnerships are developing all over the world, and many researchers and groups assert that more conservation research and knowledge are needed (Cummings et al. 2014,

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DCNA 2014, SCSCB 2014, Sustainable Travel International 2014, Sweeting and Wayner 2003, UN 2014, WIDECAST 2014). However, more than 40 information networks had already been established in the Caribbean by 2002 (Walling et al. 2004), suggesting that the region has ample research capacity.

Some Caribbean conservation organizations report that their greatest needs are not for more information but for capacity building in science and technology (Walling et al. 2004) and recommend that the focus should be on connecting the information to the appropriate users, providing support services to existing governance structures instead of developing new management frameworks (Nicholson et al. 2013), and communicating the information in a way that users can understand and apply (Pigeon and Fischhoff 2011). Specific to conservation planning, Knight et al. (2008) documented what they called a research–implementation gap or a knowing–doing gap (Pfeffer and Sutton 2000). Conservation partnerships are rendered ineffective when research results are not communicated to managers and translated to actions.

Guston (1999, 2001) proposed a solution to address the knowing–doing gap: create or enhance "boundary organizations" that are designed to facilitate collaboration and information flow between the research and public-policy communities. The term has been used to describe groups that facilitate the transfer of knowledge between science and action for the purposes of climate adaptation (Collier et al. 2009), agriculture (Cash et al. 2003), natural-resource management (Clark et al. 2011), and urban water-management (White et al. 2010). These entities are designed to improve the transfer of knowledge between conservation researchers and decision makers so that science outputs effectively inform conservation implementation. Managers, policy makers, and other practitioners suggest using decision-support and science-delivery frameworks to build 2-way bridges between science providers and users (Fig.1). Practitioners are those who put into practice the social and natural sciences on a daily basis, and we define them as conservation professionals and volunteers who may be involved with conducting scientific studies but whose primary work is in natural- or cultural-resource management, organization, or project management, advocacy, and education. The concept is often envisioned as a simple, linear model where scientists and practitioners bring research results to users, and users and implementers bring their challenges, pending decisions, and experiential knowledge to the scientists. The role of institutions in facilitating information flows between providers and users has been studied for decades, and those that developed the simple linear model of boundary organizations now embrace the concept of knowledge networks, with information flow within and between nodes, which may be institutions or individuals (Clark et al. 2011, Henry and Vollan 2014, Janssen et al. 2014, Muñoz-Erickson 2014; Fig. 2). This knowledge flow may occur through formal or informal channels and mechanisms. Conservation-science delivery partnerships that have a web-like structure and function may be more effective in achieving their conservation-science delivery goals (Young et al. 2014). However, establishment of boundary organizations (i.e., building, managing, and implementing them) is a relatively new enterprise, and techniques to build a successful boundary organization,

how to cultivate strong cross-organization relationships among partners, and how to facilitate on-the-ground actions are all being learned through trial and error (Crona and Parker 2012).

In response to the new complexities of large-scale land-use and climate changes the conservation community is facing, the US Department of the Interior, through secretarial order, established an international network of 22 self-directed, applied science–conservation partnerships called landscape conservation cooperatives (LCCs). The LCCs were designed to break down institutional barriers facing landscape-scale conservation efforts and to serve as boundary organizations (Jacobson and Haubold 2014, Jacobson and Robertson 2012). Some institutions have implemented this new concept into their resource-management activities and consistently make partnerships an important facet of their operations. These groups recognize that such collaborations facilitate landscape-scale projects across political jurisdictions to accomplish objectives that would not be possible individually. Jacobson

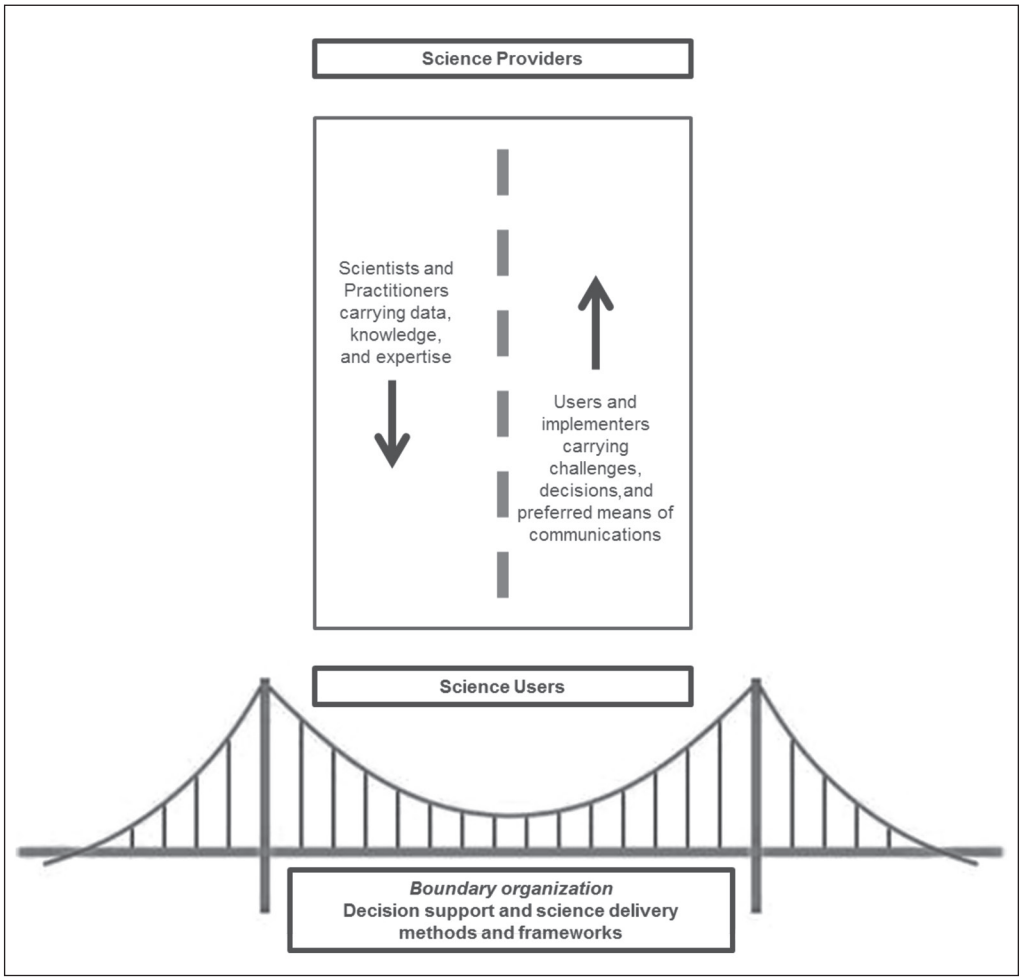

Figure 1. Linear model of information flow between science providers and science users through a decision-support and science-delivery framework, i.e., of a boundary organization.

and Robertson (2012) recognized that the success of the LCCs would depend on attention to the human dimensions of conservation management (Jacobson and Robertson 2012), a conclusion consistent with Knight et al.'s (2008:615) call to action for conservation planners:

> "Ultimately, an effective conservation planner is one who links knowing and doing. Inevitably, this requires engaging people and the choices they make. Excellent examples exist in which conservation planners have built productive partnerships with practitioners …"

When structuring conservation partnerships to deal with the challenges of the 21st century (Carcasson 2013, Levin et al. 2012, Rittel and Webber 1973), boundary organizations benefit from inclusion of the biophysical and social sciences to produce salient, credible, and legitimate information, as assessed by the research community and decision makers (Cash et al. 2003, Clark et al. 2011, Cook et al. 2013).

In this paper, we seek to more clearly identify the needs and roles of boundary organizations in modern conservation. We gathered and assessed information

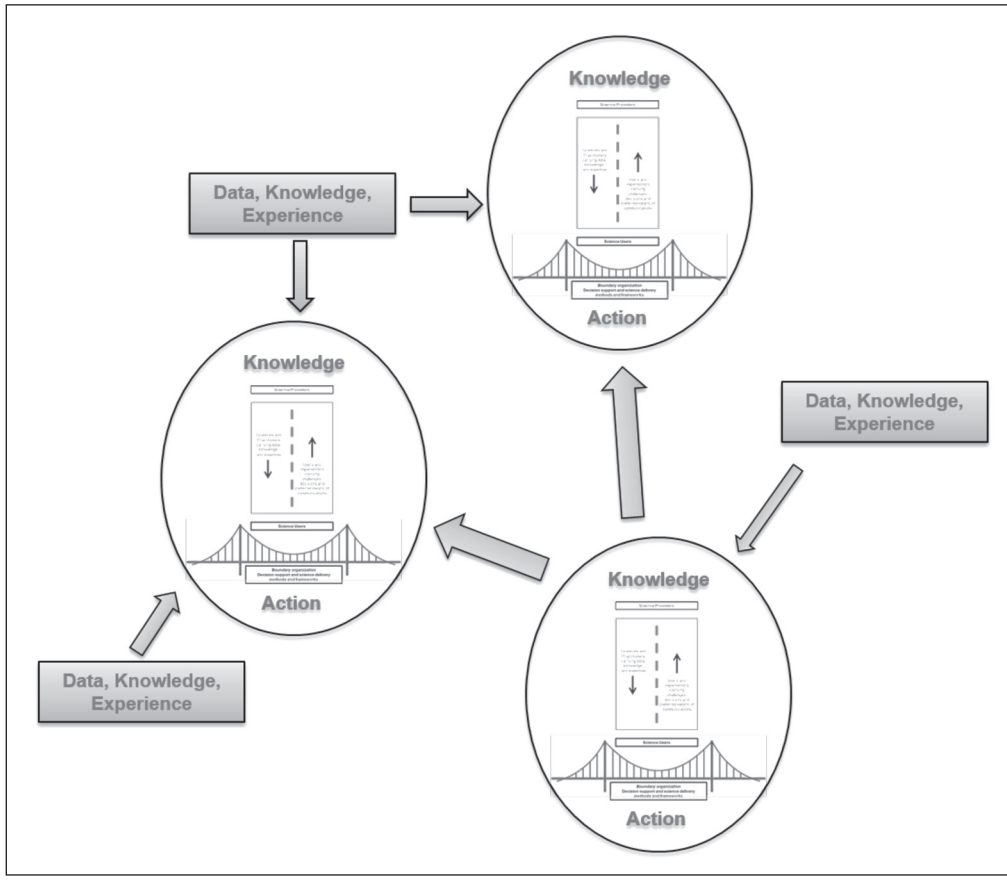

Figure 2. Networked or web-like model of information flow among science providers, science users, and decision-makers taking action (adapted from Muñoz-Erickson 2014).

from US and wider-Caribbean conservation organizations to (1) gain a better understanding of the composition, purpose, and capacity of surveyed conservation organizations; (2) compare and contrast information between the US and wider Caribbean; and (3) evaluate if there is a consistent perception that conservation organizations require more science and information to be effective in their missions. We explore the role of the social sciences and practitioner expertise in boundary organizations. Finally, we present some existing literature and information gathered in this study regarding effective roles of boundary organizations to address conservation challenges.

Methods

We conducted 2 surveys through the Caribbean landscape conservation cooperative (CLCC, established in 2012) in order to gain a better understanding of the capacity and purpose of Caribbean conservation organizations and evaluate the extent to which research-generated information was applied. The US Caribbean Survey—conducted from 30 June to 4 November 2013 and administered by K. Sola and C. Sanfiorenzo-Barnhard—targeted conservation organizations in the US Virgin Islands and Puerto Rico. The international Caribbean Survey—conducted from May to August 2013 and administered by L. Nicholson—targeted Caribbean islands outside US jurisdiction as well as Belize, Suriname, and Guyana.

Both surveys combined existing CLCC contact lists and databases, personal and professional contacts of the researchers, and web-browsing results to develop comprehensive datasets of 150 conservation organizations and coalitions operating in the US Caribbean and 230 entities operating in the international Caribbean. With input from researchers and social-scientist partners, we designed survey questions in English and Spanish that focused on demographic information, institutional background, organizational structure, views on landscape conservation, data needs, and collaborations. We conducted the surveys using phone interviews, email, hard copies of the survey through postal mail, and an online survey via Google Forms (https://www.google.com/forms/about/; US Caribbean) and Survey Monkey (https://www.surveymonkey.com/; international Caribbean). We asked many of the same questions in both surveys and assessed the information gleaned similarly for both. We used the snowball sampling method to identify more participants (Vogt 1999) with preferences given to leaders of organizations. We followed an expanding selection approach (Doreian and Woodard 1992) starting with a fixed list of objects. The researchers added objects connected to those on the initial list as long as the new object had several links to others, not just one.

It is difficult to estimate the number of conservation-based organizations that are currently active in the study area because online databases that list conservation organizations in the region are incomplete and many community-based organizations are not active online. Forty-three groups out of 150 (28.7%) identified provided responses to the US Caribbean questionnaire. Eighty-seven groups out of 230 (37.8%) identified provided responses to the international Caribbean questionnaire. Organizations from 25 countries participated (Table 1).

Results

US Caribbean survey

For at least 50 years, many organizations that focus on education, community-based management, biodiversity, conservation planning, and threatened/endangered species have contributed to ecosystem governance in the Caribbean islands (Table 2). Diplomacy, agroforestry, and international waters were less-common themes; in Puerto Rico and the US Virgin Islands, 30% of the organizations reported these as topics that they address (Table 3). It is important to note that neither survey included tourism as one of the 39 thematic area choices, and only one organization used the "other" option to add tourism (e.g., eco-tourism). Sea-level rise, climate-change mitigation, and climate-change adaptation were listed separately instead of under one thematic area of "climate change" and we would have to conduct a more thorough analysis to determine how many organizations address at least one of these topics. We could then use that number to calculate a more accurate measure of the percent of entities working on climate change in the broad sense. Education was the thematic area most frequently reported by US Caribbean conservation organizations, while biodiversity was the number one thematic area of international Caribbean conservation organizations.

Table 1. Geographic areas covered and number of respondents from each for our 2 surveys. Two of the 45 respondents from the USA were included in the international Caribbean survey because their work take place outside the jurisdiction of the USA.

Country	Number of respondents
Anguilla	4
Antigua and Barbuda	4
Bahamas	5
Barbados	5
Belize	15
Bermuda	3
British Virgin Islands	4
Cayman Islands	5
Dominica	1
Dominican Republic	4
Dutch Caribbean (Curaçao, Bonaire)	3
Grenada	4
Guyana	1
Haiti	2
Jamaica	7
Montserrat	1
St. Eustatius	1
St. Kitts and Nevis	1
St. Lucia	2
St. Maarten	1
St. Vincent and the Grenadines	3
Trinidad and Tobago	8
United Kingdom	1
United States of America (Puerto Rico and the US Virgin Islands)	45
Total:	130

We found that human-resource capacity was a challenge for many conservation organizations, with the majority of organizations reporting only 0–5 full-time employees and 0–5 part-time employees. Only a few respondents had more than 11 staff members (Fig. 3) and all but 2 organizations increased their capacity by utilizing volunteers. The majority of organizations surveyed specialize in education, natural science, public relations, community organizing, planning, and diplomacy (Fig. 4). When we asked the question, "Does your organization have or collect data, knowledge, or information that could contribute to our understanding of conservation issues in the Caribbean?", 51.2% of organizations responded yes, 23.26% said no, and 9.3% responded "I don't know".

International Caribbean survey

Conservation organizations have been active in the Caribbean since at least 1923, with the majority of them founded within the last 2 decades. In general, these

Table 2. The 15 most-common conservation theme areas in the Caribbean. Organizations were able to select more than one conservation theme area from among 39 theme-area options and could add thematic options using an "other" category.

International Caribbean Survey (*n* = 87)

1. Biodiversity (58.6%)
2. Conservation planning (55.2%)
3. Education (55.2%)
4. Marine protected areas (49.4%)
5. Climate change adaptation (44.8%)
6. Invasive species (43.7%)
7. Protected areas (land) (42.5%)
8. Threatened/endangered species (42.5%)
9. Wetlands (41.4%)
10. Coral reefs (40.2%)
11. Climate change mitigation (39.1%)
12. Ecosystem restoration (39.1%)
13. Fisheries (37.9%)
14. Community-based management (36.8%)
15. Human dimensions (e.g., social and societal aspects of environmental issues) (35.6%)

US Caribbean Survey (*n* = 43)

1. Education (74.4%)
2. Community-based management (55.8%)
3. Biodiversity (53.5%)
4. Conservation planning (53.5%)
5. Threatened/endangered species (48.8%)
6. Ecosystem restoration (48.8%)
7. Marine protected areas (46.5%)
8. Human dimensions (e.g., social and societal aspects of environmental issues) (46.5%)
9. Invasive species (44.2%)
10. Land use planning (44.2%)
11. Protected areas (terrestrial) (41.9%)
12. Decision-making and policy (41.9%)
13. Waste management (39.5%)
14. Climate change adaptation (37.2%)
15. Coral reefs (37.2%)

organizations research, plan, and educate about the environment. Policy development and law enforcement are less common functions in the non-US Caribbean, and <30% of respondents identified them as areas they work on (Table 3). No participants in the international Caribbean survey listed tourism as a thematic focus. The majority of organizations responding specialize in natural science, education, environmental management, community organizing, social science, and public relations (Fig. 5).

Table 3. Least-common conservation theme areas—those identified as focus areas by <30% of organizations responding to our surveys.

International Caribbean Survey (*n* = 87)

1. Decision-making and policy (29.9%)
2. Forest management (27.6%)
3. Land-use planning (27.6%)
4. Amphibians/reptiles (25.3%)
5. Avian/birds (25.3%)
6. Law and policy (25.3%)
7. Student researchers (21.8%)
8. Water resources (21.8%)
9. Economic valuation and ecosystem services (20.7%)
10. Waste management (20.7%)
11. Fresh water ecosystems (19.5%)
12. Built environment (e.g., infrastructure) (18.4%)
13. Cultural and historical resources (17.2%)
14. Agriculture (16.1%)
15. Disasters and natural hazards (16.1%)
16. Sea-level rise (14.9%)
17. Energy (11.5%)
18. Agro-forestry (8.0%)
19. International waters (8.0%)
20. Law enforcement (8.0%)
21. Media (8.0%)
22. Diplomacy (2.3%)

US Caribbean Survey (*n* = 43)

1. Disasters and natural hazards (30.2%)
2. Built environment (e.g., infrastructure) (30.2%)
3. Water resources (30.2%)
4. Energy (27.9%)
5. Economic valuation and ecosystem services (27.9%)
6. Law enforcement (25.6%)
7. Data management (25.6%)
8. Media (25.6%)
9. Climate-change mitigation (25.6%)
10. Fisheries (23.3%)
11. Amphibians/reptiles (20.9%)
12. Sea-level rise (20.9%)
13. Avian/birds (18.6%)
14. Forest management (18.6%)
15. Agroforestry (9.3%)
16. Diplomacy (7.0%)
17. International waters (0%)

When asked the question, "Does your organization have or collect data, knowledge or information that could contribute to our understanding of conservation issues in the Caribbean?", 70.1% of organizations responded "Yes" and 18.4% responded "No". As expected, human-resource capacity is low in the international Caribbean conservation organizations with only 0–5 full-time employees for the

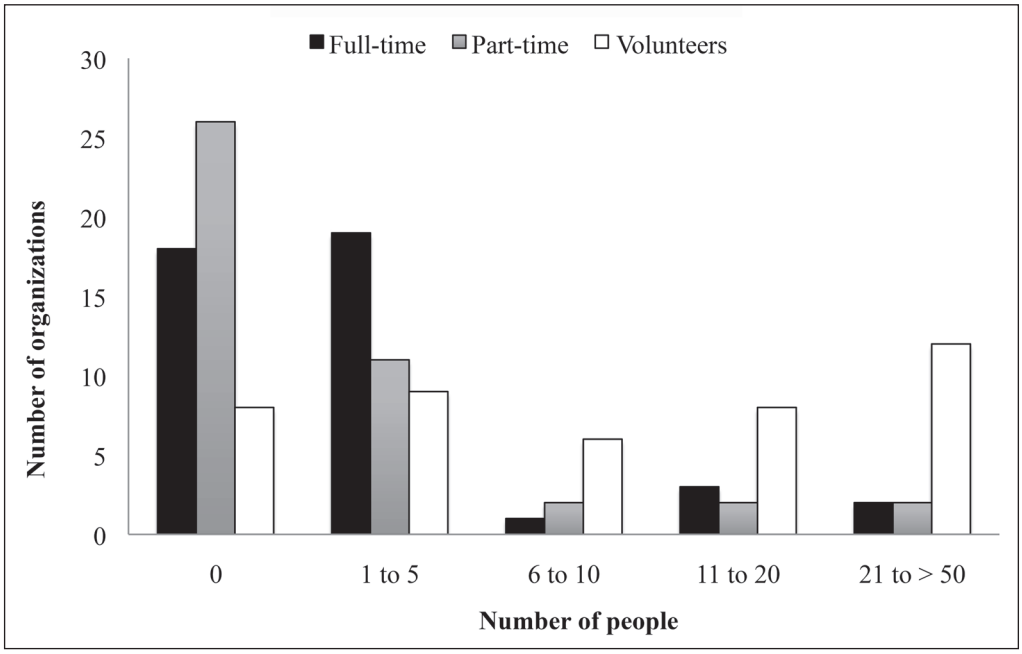

Figure 3. Estimated number of personnel for organizations in the US Caribbean survey, an indicator of human-resource capacity in the Caribbean.

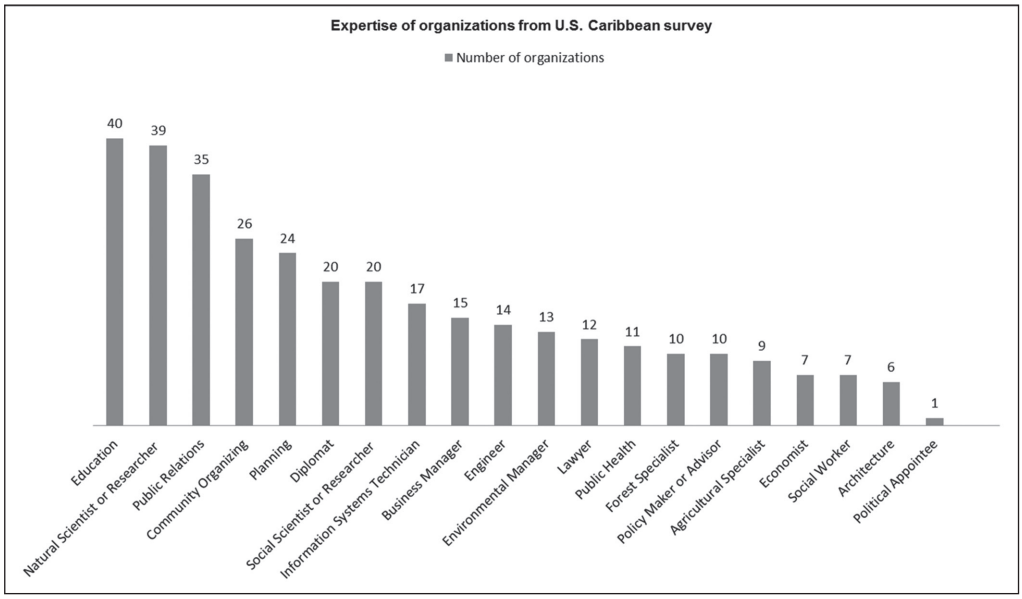

Figure 4. Expertise of organizations from US Caribbean survey.

majority of organizations, and roughly the same amount of part-time staff and volunteers (Fig. 6).

Combined surveys

When asked, "Do you need more science-based information to carry out your organization's objectives?", 75.2% of responding organizations in the

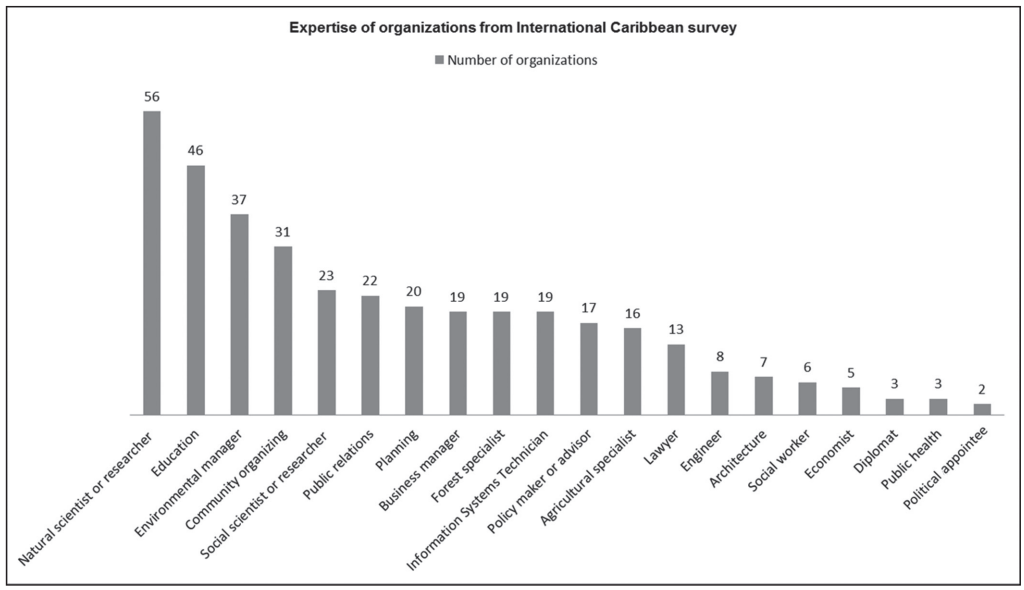

Figure 5. Expertise of organizations from international Caribbean survey.

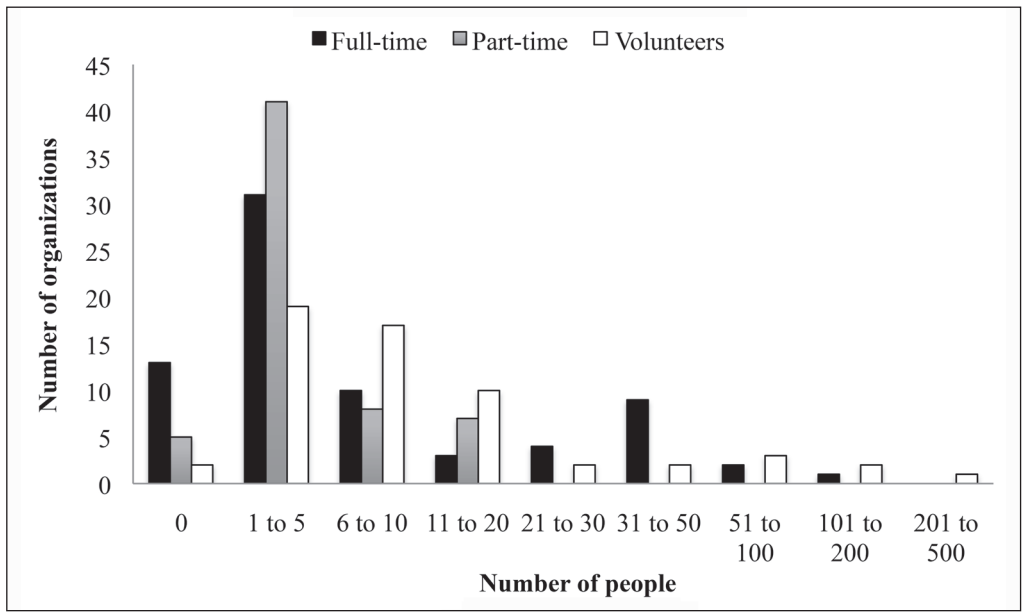

Figure 6. Estimated number of personnel for organizations in the international Caribbean survey, an indicator of human-resource capacity in the Caribbean.

Caribbean (n = 117) responded "Yes" and 24.8% said "No" (Fig. 7). By region, 76% said "Yes" and 24% said "No" for the international Caribbean survey (n = 75), and 74.4% said "Yes" and 25.6% said "No" for the US Caribbean survey (n = 42). Two respondents who said they need more science-based information also reported that all science-based information needed is already available and that access to existing scientific information was limited by a lack of sharing. Those responses are consistent with those of the survey respondents who felt more science-based information was not needed and with the high percentage of respondents that said they collect their own data.

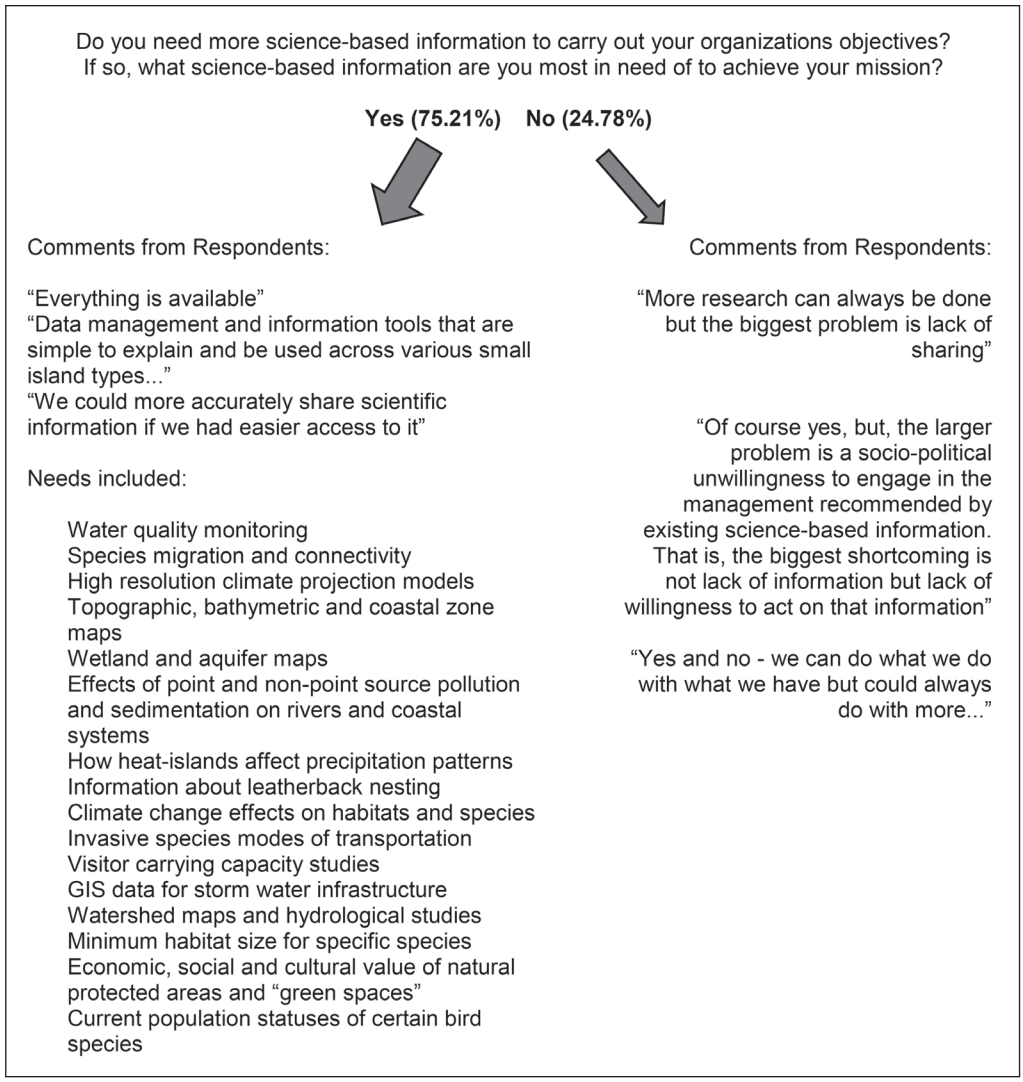

Figure 7. Combined responses (n = 117) from the US Caribbean and international Caribbean surveys to the questions, "Do you need more science-based information to carry out your organization's objectives?" and "If so, what science-based information do you most need to achieve your mission?"

Discussion

A number of survey respondents suggested that the delivery and use of scientific data may be hindered by lack of information and data sharing, political constraints, competition, limited resources and technical capacity, and ineffective communication. These barriers have the potential to cause a bottleneck wherein delays in science-information sharing and implementation negatively affect ecosystem governance and conservation. Our results suggest the need for new approaches to science delivery, and we recommend the development of boundary organizations that bridge the present divide between science needs (mangers) and science production (scientists).

Lack of information and data sharing

The majority of organizations stated that more information was needed to carry out the objectives of their individual organizations, while others identified a need for greater regional data-sharing. If data are proprietary, they may not be available to those best positioned to implement recommendations. As one respondent stated, "Our priority is not that we need more information, it's how to access the information that exists. There is a lot of information [in academia] and in government offices, and NGOs that have been in existence for a while. Trying to get information from government is like walking through minefields—there is always a blockage. More research can always be done but the biggest problem is lack of sharing." Another respondent stated, "Do you need more data? Yes and no… We can do what we do with what we have but could always do with more ..."

Respondents in the international survey said that there are logistical barriers to sharing data horizontally between state jurisdictions, and vertically between hierarchical organizations. For example, political barriers were cited as preventing avian researchers in the British Virgin Islands from collaborating with USVI partners. The vertical distribution of governments, academia, and NGOs was also implicated as a hindrance to collaborative data-sharing.

The literature suggests that establishing boundary organizations to share knowledge can promote collaboration and reinforce agreements among competing interests (Affolderbach et al. 2012). Knowledge management (including data and information) can be supported by boundary organizations that serve as the gathering, interpretation, and synthesis platform for exchange of local- to international-scale scientific knowledge (Seely et al. 2009). Data and information are called boundary objects if they are effectively used at the interface of communities to transmit and share information in the context in which the information exists. (Fong et al. 2007). Boundary organizations provide forums in which the boundary objects are transparent and accessible by all and can be co-produced by people from different sides of the science-provider–science-user boundary (Berkes 2009).

Political constraints

In our survey, one respondent felt that new information and data was needed, "but the larger problem is a socio-political unwillingness to engage in the

management recommended by existing science-based information. That is, the biggest shortcoming is not lack of information but lack of willingness to act on that information." One of the governmental organizations surveyed in the international survey stated, "We collect data to guide politicians/data for policy makers … being a government department, we are constrained by what is politically driven, even if someone were to help build our capacity." These political barriers can come in a variety of forms, which "depends often on a number of non-technical 'enabling factors', e.g., land-ownership issues, historical management-practices, political sensitivity. Opportunities for 'proof of concept' exist when these barriers can be overcome or by working on small uninhabited islands that can be used as demonstration sites."

Cook et al. (2013) said that different factions can have conflicting views about what constitutes legitimate, relevant, and timely information. If the political barriers to action arise from the form in which the management-driven science is being delivered to politically influenced decision-makers, the use of boundary organizations is a framework option. However, Guston et al. (2001) emphasized that well-functioning boundary organizations do not provide policy or offer recommendations about what the user should do with the scientific data. However, partners within the boundary organization clearly have the capacity and need to interpret information to inform policies and decisions. Overcoming political constraints brings further challenges in that boundary organizations provide the important connection between science and policy but need to use methods that allow maintenance of their autonomy. In order to make such autonomy possible, the institutional structure in which environmental science and politics (boundary objects) are co-produced has to establish a knowledge base that is transparent, useful, and that distinguishes between political and scientific debates (Affolderbach et al. 2012).

Competition

"Crowding out" and duplication were cited by some groups in the international survey, which is consistent with Aral and Van Alsyne (2011)'s findings that information is often withheld in competitive settings, even when that information is known to be of interest to others. One respondent referred to the issue of competition in conservation activities: "There is a lack of cooperation across agencies, for development of Caribbean. Specific examples include: biodiversity, climate change, and land management. Duplication due to lack of communication is a challenge, and so is competition for funding."

Boundary organizations that provide boundary objects could help overcome this barrier. People who are boundary spanners are considered boundary objects (Leifer and Delbecq 1976). Individuals who occupy boundary-spanning roles link groups who are separated in terms of location, division, or function (Levina and Vaast 2005, Pawlowski and Robey 2004). Information transfer and networking could also occur between funders and producers so that funders are aware of what projects have been conducted and what additional projects decision makers and scientists recommend should be supported.

Technical capacity and resource constraints

A number of respondents remarked on the challenge of finding the time to properly advise decision makers who need to use the available scientific information. It is not a simple process to effectively provide decision-support services. One respondent stated, "Science is 'easy'. Management, of people, is the hard part." These thoughts from respondents are consistent with the low scores that the law, decision-making, and policy thematic areas received from those responding to both the US and international Caribbean surveys. Organizations with more expertise in the education and natural-science fields are finding themselves in management and decision-support roles instead of the scientific or technical roles suggested by their expertise. On the other hand, one respondent felt the problem in their area was more that there are "too many local agencies involved in protected areas [management], often with no scientific background." It appears that a balance between technical and scientific expertise and law, policy, and decision-support expertise would be appropriate for organizations struggling with this challenge. Boundary organizations can help to create this balance among partners so that each lends its respective expertise and perspective to the conversation.

Sub-par communications to implementers

It is well established in the scientific and practitioner communities that effective communication about conservation science is key to conservation action. The expertise and thematic-area survey results suggest that although organizations are generally heavily focused on education and the natural sciences, a large number of organizations have expertise in and focus on public relations, and community organizing as well. These topics do not round out a complete communications strategy, however essential they are for closing the knowing–doing gap. The low scores that law, decision-making, and policy received as thematic areas highlight some of the possible missing pieces. There is a possible disconnect between the issue that is studied and the issue that the entity cares about and/or has an ability to influence (i.e., land-use policies and the issue of private ownership). Another respondent felt that although they participate a lot in communications activities, they "end up participating in a lot of workshops" and that research papers have been written "but no one reads them, they don't get translated into useful terms." It was mentioned that even when an organization has an extensive research library with data spanning decades, no one accesses it because it is not in a user-friendly format, not translated into something ready to be used, or does not link to everyday needs. Boundary organizations can help scientists improve and facilitate effective communication and the application of scientific information (Osmond et al. 2010).

Operationalizing new partnerships as boundary organizations

It is widely recognized in the management-science literature that a knowing–doing gap exists (i.e., Knight et al. 2008). Specific to the Caribbean, a recent report by the World Resources Institute found that of more than 100 economic valuations conducted for the Caribbean's coastal ecosystems, only 16 were identified that have actually helped to inform policy, management, or investment decisions (Kushner at

al. 2012). This lack of communication occurs on both sides of the knowing–doing boundary, however. The activities of conservation organizations rarely appear to be informed by published research; rather, they tend to rely heavily on the experience of the decision-makers (Pullin et al. 2004). Practitioners frequently do not access primary literature (Arlettaz et al. 2010) and "rarely write about the work they do; instead, what writing is done in conservation organizations is most frequently undertaken by development staff" who are paid fundraisers reporting only successes or partial successes to their funders (Redford and Taber 2000). Donors also only want to report successes. This combination of lack of integration into the literature and the existing reporting norms is leading to less experimentation, limited reporting of failures, and decreased learning (Redford and Taber 2000).

Knight et al. (2008) asked a striking question: "Why are conservation researchers, who have chosen a mission-oriented career, failing to do science that contributes meaningfully toward stemming the environmental crisis?" They emphasized that the research–implementation gap they studied in conservation planning is "almost certainly the norm" for subdisciplines of conservation biology and cited Saunders et al. (1991), Pickett et al. (1997), Ehrenfeld (2000), Stinchcombe et al. (2002), and Linklater (2003). Many more examples of this gap between published conservation-biology research and priorities for action could be cited from the peer-reviewed literature. A look at the grey literature and practitioner-conference and meeting proceedings would yield more insights on this matter.

In fact, there are 2 groups that may be currently underutilized in conservation partnerships: social scientists and practitioners. Most often, scientists work to provide research results to decision makers to help solve social and environmental issues that are affecting the conservation of natural resources. The natural sciences provide information for many decision contexts. For example, they are asked to answer some questions such as: When is too much of an input into a system causing contamination? How viable are species populations? How quickly is erosion occurring along the coastlines? How much can be harvested to allow for a sustainable market? How hot is too hot for a coral-reef ecosystem? What is an adequate riverine buffer?

The social sciences are much less often employed to contribute to decision making in ecosystem management and conservation than the natural sciences (Endter-Wada et al. 1998, Sievanen et al. 2011). Like Klein (1990) and Sievanen et al. (2011), we define social science as any of the academic disciplines that study humans and their social behavior, including anthropology, economics, geography, psychology, political science, and sociology. The social sciences provide information for decision contexts. Many conservation practitioners and scholars have called for increasing involvement of the social sciences in conservation and better integration among the various disciplines engaged in conservation practice (Brosius 2006, Christie et al. 2003, Endter-Wada et al. 1998, Welch-Devine 2010). Manolis et al. (2008) argued that recognizing the social dimension of the problem is one of 8 leadership principles for conservation science. Better utilization of and integration with the social sciences and practitioner expertise is occurring, and this practice is being stressed by LCCs (LCC Network 2014), but

the pace of new efforts and limited reporting of past and current efforts is hindering the experimentation, failure, and learning processes called for by Redford and Taber (2000).

Another step to bridge the knowing–doing gap is to include practitioners in the research cycle. Boundary organizations can help put practitioners and scientists together and develop mechanisms to most effectively put the newest and most relevant science into the hands of the practitioners. Practitioner experiences and abilities serve to connect people, institutions, disciplines, and information and are as necessary for successful policy implementation as the scientific results themselves. Additionally, some practitioners have developed a deep understanding of the environmental systems they work in through extensive experience within that system (i.e., experiential knowledge) and may be able to recognize emergent properties and make useful predictions (Fazey et al. 2006). These boundary agents may not be utilized or valued as much in natural-resource management as compared to other fields such as disaster management and public health. Additionally, they tend to rely and place value on a complex array of information needed to make decisions, including empirical evidence, but also experience and information synthesized from multiple lines of evidence (Cook et al. 2012). The traditional methods of science-based management need to be redesigned.

Bridging the gap relies on effective communication of information and the formation of formal and informal knowledge-networks, which can be accomplished through processes of social learning. According to Pelling et al. (2008), social learning has been interpreted within the literature to mean both individual learning that is conditioned by its social environment, and learning in the sense that social collectives such as organizations and institutions can "learn" in their own right (Collier et al. 2009). For some of these new partnerships, supporting organizational learning will be the first and greatest step toward building bridges between science and action for the conservation of our natural and cultural resources in the Caribbean.

We offer these recommendations for developing boundary organizations:

1. Acknowledge that a knowing–doing gap exists and strategize to narrow it through organizational planning (i.e., partnership membership, charter, staffing, and strategic planning).
2. Regard implementation as an integral part of scientific conservation activity. It constitutes the ultimate assessment of the effectiveness of the science.
3. Explicitly include the human dimensions of conservation within an organizational structure that strives to eliminate the obstacles to integrating the social sciences.
4. Support the science of decision-making as integral to conservation.
5. Develop methods for more broadly transferring practitioner knowledge through experiential learning to all agents within the conservation community.
6. Improve on-the-ground implementation through incentives for implementation, monitoring of implementation projects for lessons learned, and sharing the implementation success stories widely.

7. Expand training opportunities to learn boundary-spanning skills (i.e., facilitation, communication, coordination, innovation).
8. Ensure that research results with management significance can be effectively transmitted to managers and decision makers and that outcomes are widely distributed and explained for non-specialists. This is a key role of boundary organizations in linking science and management.

Improved links between science, policy, and management within an adaptive learning-by-doing framework facilitated by a boundary organization is an important step toward bridging the knowing–doing gap.

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