Improving human and environmental conditions through the Coral Triangle Initiative: progress and challenges

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The Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) is an ambitious marine conservation and governance program engaging six countries in Southeast Asia and Melanesia that has attracted significant international support, including an investment of over $40 million from the United States through the five-year U.S. Coral Triangle Initiative Support Program. In this paper, we examine outcomes of the USCTI documented through the Learning Project (LP), a collaborative, interdisciplinary project capturing lessons learned from USCTI and CTI-CFF. The co-design process and collaborative spirit of the LP allowed it to collect a large body of information from a diverse range of informants in a relatively short time frame and provide important documentation of the achievements and challenges of USCTI. For instance, social surveys of resource users and policy makers in the Coral Triangle region and the United States document that the CTI-CFF has resulted in impressive management outcomes, including: improved MPA enforcement, increases in national and regional management capacity, leadership creation, and integrated conservation-fishery-climate change planning. Significant challenges remain to ensure that overall planning processes effectively link regional-level, national-level, subnational-level (district/provincial) and community-level efforts and that international donors and policy-makers, managers, and resources users in the region remain committed to this conservation experiment.

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Introduction

Marine ecosystems are subjected to numerous stressors that alter ecosystem condition, from overfishing of threatened fish stocks [1,2] to thermal stresses placed on valuable ecosystems like coral reefs [3,4] to projected changes in fish stock abundance and distribution [5]. Recently, in response to this suite of threats, many marine governance systems — including governmental and non-governmental organization (NGO) programs, as well as collaborative efforts among multiple government and NGO partners — have increased the geographic scale of their activities and shifted toward programs that focus on management of entire or larger portions of ecosystems and bridge conventional management boundaries [6–8]. Globally, there has been a proliferation of marine ecosystem-based management programs emphasizing ecosystem-level planning, cross-jurisdictional harmonization of management frameworks, and balancing societal needs and ecological function [9–11]. Also functioning at an ecosystem scale are marine protected area (MPA) networks, groups of spatially-linked MPAs that attempt to achieve ecological and social benefits that could not be realized through individual MPAs [12–14]. Other programs, such as the Locally Managed Marine Area Network in the Indo-Pacific [15] or the global Big Ocean [16], have focused on creating peer-to-peer learning networks that link managers and practitioners across regions to share knowledge and improve management both locally and regionally.

One example of a large-scale marine governance approach is the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF). CTI-CFF is an

ambitious, and arguably unique, regional collaboration among six countries to better manage the marine resources of the Coral Triangle (CT) region [17]. CTI-CFF builds off of the work of other collaborative efforts in the region working to improve the health of oceans and coasts. For instance, the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) and the Coordinating Body on the Seas of East Asia (COBSEA), are two partnerships that began prior to CTI-CFF, cover part of the CT region and have engaged various government, non-governmental, and private partners in designing plans to better protect the region's marine resources [18,19]. The CT covers nearly 2.3 million square miles of ocean, encompassing all or parts of the waters of Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste — countries with remarkably diverse cultures and governance systems [20]. The CT supports some of the greatest concentrations of marine biodiversity on Earth [21]. Yet the CT's marine and coastal resources are threatened, and the goods and services they provide are at immediate risk from a range of factors that adversely impact food security and livelihoods [3].

To address the threats facing their shared ecosystems, the six CT country (the CT6) heads of state officially signed the Coral Triangle Declaration in May 2009 [17]. CTI-CFF goals range from the adoption of an ecosystem approach to fisheries management (EAFM) [22•], to climate change adaptation planning, to establishing and effectively managing a regional system of MPAs [23••,24••]. The United States government provided human and financial support to the CTI through the U.S. Coral Triangle Initiative Support Program (USCTI), a five-year, multiparty effort.

The U.S. Coral Triangle Initiative (USCTI) Support Program

The United States government was a crucial partner in providing initial funding to implement CTI-CFF. Through coordinated efforts by the U.S. Agency for International Development (USAID), the National Atmospheric and Oceanic Administration (NOAA), Department of State (DOS), and other agencies (collectively known as the USCTI), the United States committed over $40 million in technical and financial assistance from 2009-2013 to support the CT6. The main conduit for this aid was the Coral Triangle Support Partnership (CTSP), a five-year project implemented by a consortium led by World Wildlife Fund (WWF) with The Nature Conservancy (TNC), and Conservation International (CI) — three NGOs with histories of engagement in the region but who had previously not aligned their regional activities. This consortium augmented U.S. government funds with a $12.8 million in-kind contribution.

To capture lessons learned from the novel approach to ocean governance taken by USCTI and CTI-CFF, the authors of this paper designed and implemented the Learning Project (LP) — an interdisciplinary, collaborative effort funded by USAID through USCTI partners examining key outcomes of the USCTI. The overarching goal of the LP was to employ interdisciplinary assessment methods to understand lessons learned from the USCTI at local, national, and regional levels [25]. Given the increasing prevalence of large scale marine-governance approaches and the amount of money invested in these initiatives, understanding the outcomes of programs like CTI-CFF can be critical to the design and implementation of other similar initiatives. Limited research regarding the outcomes of these programs has been conducted to date; thus, the LP and results we present here are an important contribution to the field of large-scale marine governance and ecosystem-based management. We will focus on the social and ecological, capacity, and governance impacts generated through the USCTI, and also reflect at the end of the manuscript on the process of conducting an interdisciplinary assessment of a complex, multinational program.

Goals of the Learning Project

The LP was conducted over the course of six months (June–December 2013). Through an intensive project design process that involved collaboration with USCTI leadership and LP researchers and involved multiple in-person planning meetings, we identified multiple, interrelated goals for the LP that resulted in a careful documentation and assessment of the USCTI:

(1) Work with USAID and USCTI implementing partners to develop an assessment design and focus that meets the interests of the USCTI partners and USAID, and contributes specific recommendations for how further support should be structured.

(2) Use various assessment methods to develop a rigorous understanding of the evolution of the USCTI at local, national and regional levels that contributes to recommendations on future program design.

(3) Identify lessons learned from the USCTI to inform the CTI-CFF governments and implementing partners regarding possible follow-on programs.

(4) Disseminate assessment findings through the inclusion of results in the USCTI reports to USAID, a comprehensive LP report, and peer reviewed publications.

(5) Increase the capacity for applied multi-disciplinary assessment in the region.


Methods

Analytic framework

USCTI, through its NGO partners and in collaboration with national governments and local communities, implemented a broad suite of management activities to improve social and ecological conditions, such as designing and implementing an MPA system, creating and implementing an EAFM framework, climate change adaptation (CCA) planning, topical trainings, and national and regional policy development. The analytic framework below (Figure 1) guided the LP and how general topics were deconstructed into discrete, measurable topics related to USCTI programmatic interventions. The 'management activities' were key components of the USCTI, which were variably implemented in each country, with specifics tailored to the country's context. These activities were designed to meet three programmatic goals: increased institutional and human capacity, improved governance of marine and coastal areas, and sustained environmental management planning. The LP team, which was composed a multi-disciplinary team of 25 people with assessment and conservation experience and included senior researchers, post-doctoral researchers, graduate students, and field assistants, used surveys and interviews to measure the degree to which (1) institutional capacity was increased (with technical skills development) and leadership improved; (2) governance was improved through vertical and horizontal integration

of planning efforts and institutional collaboration; and (3) the planning process was sustained through development and implementation of national plans of action (NPOA) and Regional plans of action (RPOA), a regional CTI secretariat, and a sense of 'ownership' and control by CT member countries. This analysis focuses on findings related to capacity development and governance improvement only, and offers recommendations to improve and sustain the most essential and effective aspects of the CTI.

Methods

To measure perceived impacts of management activities, we applied a triangulated approach [26], incorporating document analysis, quantitative social surveys, and qualitative semi-structured interviews. Mixed-methods allow for greater internal and external validity of results [27]. We used three types of quantitative social surveys: (a) surveys of community member informants living within CTI-CFF project and control sites in Indonesia, the Philippines, the Solomon Islands, and Timor-Leste; (b) social network surveys of participants in regional exchanges (REXs) coordinated by USCTI; and (c) surveys of leaders (e.g., program directors, high-level fisheries and natural resource agency officers) in USCTI, CTI-CFF, and CTSP members in Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste. For the surveys of community members, an attempt was made to

Figure 1
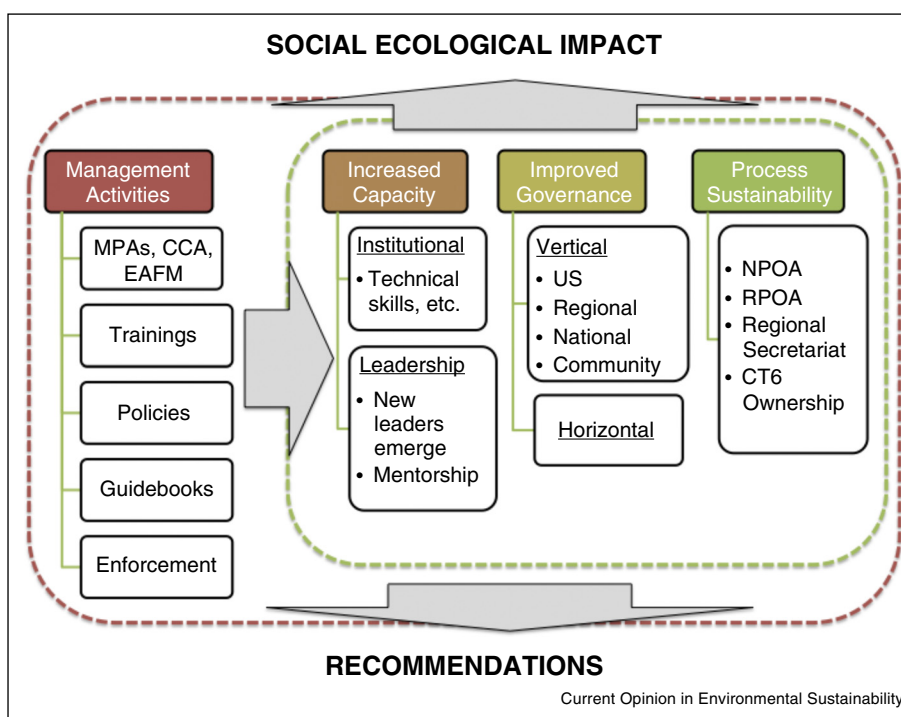
Analytic framework guiding the LP analysis.

ensure that community survey results included a representative gender distribution. By country, the proportions of men and women sampled were: Indonesia, 87% male; 13% female; the Philippines, 58% male, 42% female; the Solomon Islands, 64% male, 36% female; and Timor Leste, 60% male, 40% female. The Indonesian sample was particularly biased toward male informants. Surveys from all countries are combined in this analysis. The overall sample was 72% male and 28% female.

Informants for social surveys and semi-structured interviews were sampled using random and purposive sampling, depending on the type of informant (e.g., community marine resource users were randomly sampled; high level government officials were purposively sampled to ensure equal representation of different types of high-level government officials across the six countries) (Table 1). For surveys of community members, surveys were conducted in the most appropriate language for the site, including Bahasa Indonesian, Tagalog, Tetum, Neo Melanesian pidgin, and English. Semi-structured interviews were conducted in Bahasa Indonesian, Tagalog, and English. Informant types included: community marine resource users, community leaders, community conservation leaders, local government officials, national CTI-CFF and CTSP leaders, and regional USCTI,

CTSP and CTI-CFF senior leaders. Study sites (Figure 2) were determined by the study team, in consultation with the USCTI and CTSP partners.

Analysis overview
Community and leadership survey data were analyzed using SYSTAT and SPSS statistical software, while social network surveys were analyzed using UCINET software, a common statistical package used for analysis of social network data [28]. Semi-structured interviews were transcribed using a naturalized transcription approach [29], but quotes were lightly edited to improve reader comprehension while strictly maintaining the meaning of quotes. Qualitative interview data were analyzed using ATLAS.ti [30] using a grounded theory approach, a research method that allows researchers to use qualitative data to discover patterns in qualitative data and form theories regarding the data [31,32], to assess USCTI progress and outcomes and complement the field surveys and social network analysis.

Results and discussion
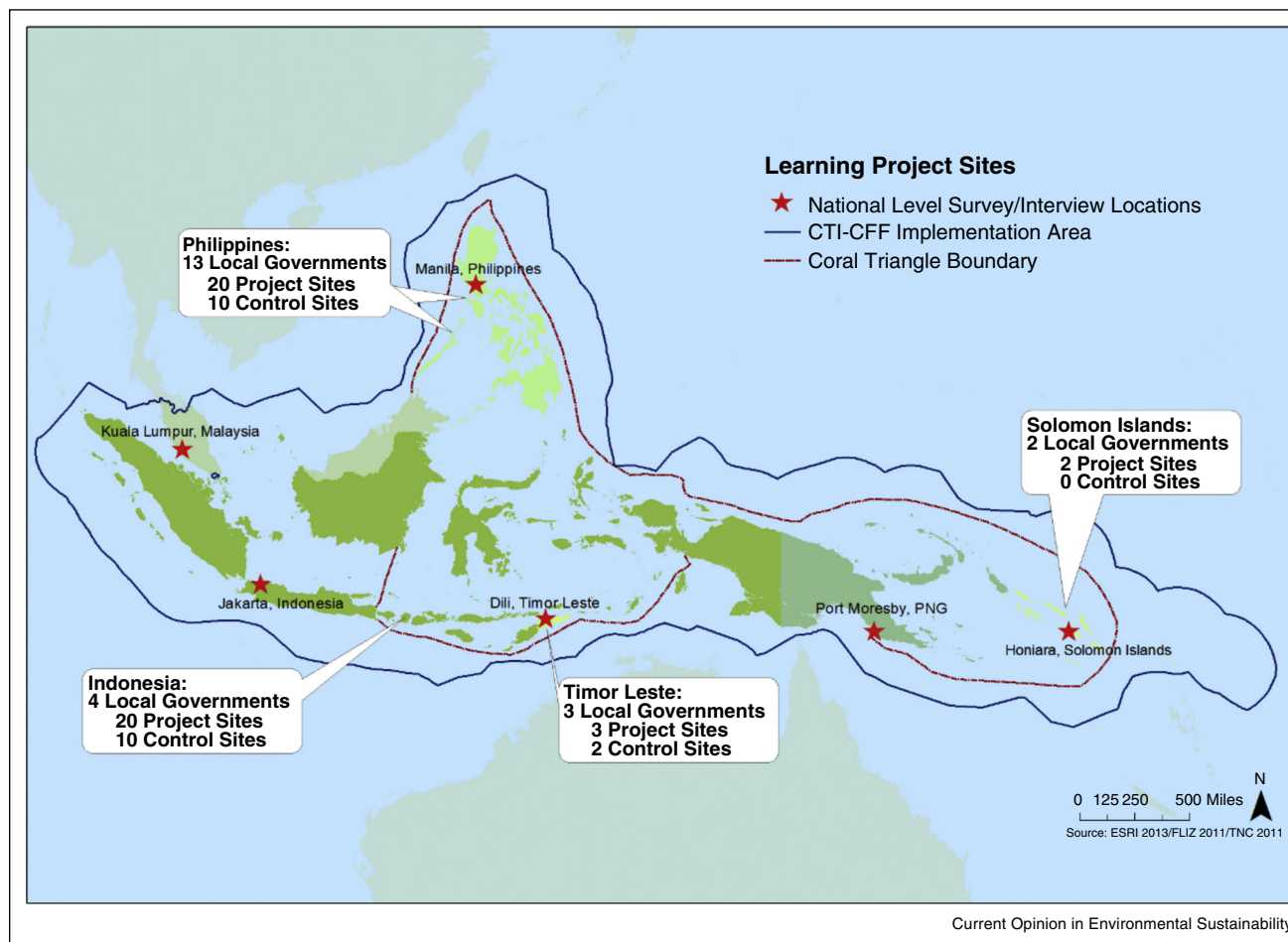### Social and ecological impacts
CTI-CFF's overarching goal is to improve the conditions of coral reefs and food security of CT6 inhabitants [17]. The social and ecological conditions in the CT are varied,

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Table 1

Methods used and sampling procedure for the various methods used throughout the LP. Total numbers of informants are provided for all sampling methods, and informant numbers are broken down by country for the community member surveys

Method type	Counties sampled	Sampling type	Total # of informants
Quantitative surveys			
Community members surveys	1. Indonesia 2. Philippines 3. Solomon Islands 4. Timor Leste	Random sampling within USCTI project and control sites	1. 921 2. 933 3. 78 4. 161 Total: 2093
Social network surveys	1. Indonesia 2. Malaysia 3. Papua New Guinea 4. Philippines 5. Solomon Islands 6. Timor Leste 7. Partner countries	Sampling of all individuals who had participated in CTI-CFF REXs on MPAs, CCA, and EAFM	253
Leadership surveys	1. Indonesia 2. Malaysia 3. Papua New Guinea 4. Philippines 5. Solomon Islands 6. Timor Leste	Purposive sampling to target high-level government officials and USCTI and CTSP leaders	167
Qualitative interviews			
Semi-structured key informant interviews	1. Indonesia 2. Malaysia 3. Papua New Guinea 4. Philippines 5. Solomon Islands 6. Timor Leste 7. Partner countries	Purposive sampling to target high-level government officials and USCTI and CTSP leaders (informants sampled until conceptual saturation reached)	85

Figure 2

Learning Project Sites
★ National Level Survey/Interview Locations
— CTI-CFF Implementation Area
—·— Coral Triangle Boundary

Philippines:
13 Local Governments
20 Project Sites
10 Control Sites

Manila, Philippines

Kuala Lumpur, Malaysia

Solomon Islands:
2 Local Governments
2 Project Sites
0 Control Sites

Jakarta, Indonesia

Dili, Timor Leste

Port Moresby, PNG

Honiara, Solomon Islands

Indonesia:
4 Local Governments
20 Project Sites
10 Control Sites

Timor Leste:
3 Local Governments
3 Project Sites
2 Control Sites

0 125 250 500 Miles

N

Source: ESRI 2013/FLIZ 2011/TNC 2011

Current Opinion in Environmental Sustainability

Study sites and types of methods used at each site. Control sites were not sampled in the Solomon Islands, as sampling control sites would have required extensive boat travel and was not possible due to funding and time restraints.

but frequently quite difficult with community members dealing with urgent day-to-day issues, such as food security. Respondents were asked whether they agreed or disagreed with the following statement: 'There are no longer enough fish in the sea to provide for our food and income.' Responses showed that food insecurity was high across sample sites. Approximately one-half of project (51%) and control site (48%) informants reported that fish is sufficient to meet their food and income needs. The difference between project ($n = 1297$) and control ($n = 658$) communities was not statistically significant ($P > 0.050$, Fisher exact test and chi square, $n = 1955$). The high levels of perceived food insecurity and insufficient fish for income call into question the extent to which CTI-CFF will be able to achieve increases in food security. In analysis of the ability of CTI-CFF to realize its food security goals, Foale *et al.* [33•] suggest that there is a need for CTI-CFF to develop more specific goals and targets related to food security; however, achieving sufficient levels of fish for

food and income is a complicated and time intensive process and may improve within project communities over time if existing activities are sustained.

While there is a high incidence of perceived food insecurity in surveyed communities, the USCTI project sites with MPAs reported improvements in fish abundance, coral health, and mangrove health between 2008 and 2013. Resource users were asked how coral reef health, fish abundance and mangrove conditions have changed over the last five years using a five-point scaled question, where responses ranged from (1) very poor to (5) very good to assess both previous and current condition. Results from the three questions were summed. USCTI project site resource users reported higher mean improvements (mean = 10.36) than control sites (mean = 9.77). Past (Project, $n = 1,264$, Control, $n = 695$) versus present (Project, $n = 1,265$, Control, $n = 643$) change in total fish, coral, and mangroves were significantly different for resource users with MPAs in their

community ($P < 0.01$, t-test). In addition to perceived positive changes in ecosystem condition, survey results demonstrated participants felt CTI-CFF was having positive impacts on national food security, sustainable fisheries, and coral reef health. National ($n = 146$) and regional ($n = 20$) respondents were asked how well the CTI-CFF helped their countries achieve food security, sustainable fisheries, and coral reef conservation goals using a ten-point scale, where responses scaled from no achievement to high achievement. National and regional informants indicated positive improvements across all three categories (Figure 3). Collectively, these results suggest the USCTI had a positive impact on improving perceived environmental conditions that are an essential prerequisite for food security, both at the community and national level.
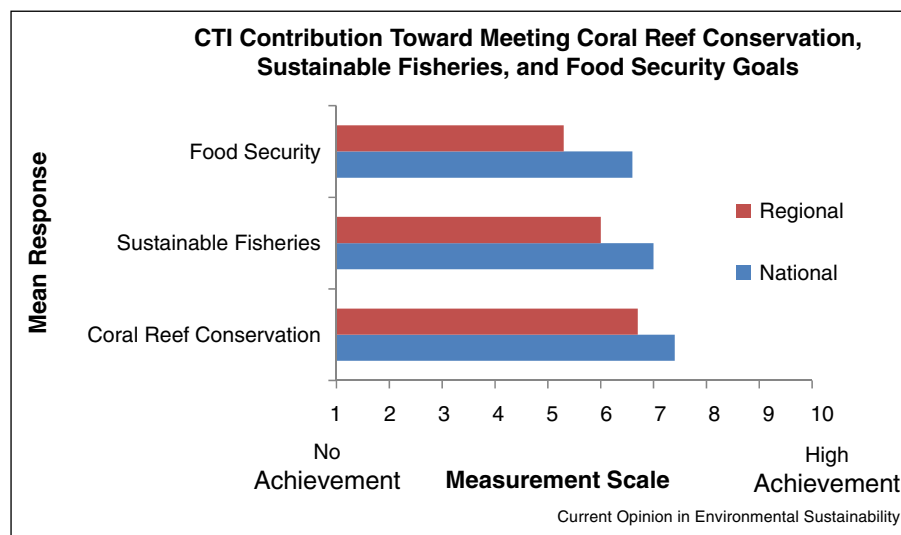
Increased capacity

Strengthening institutional capacity to achieve CTI-CFF goals (e.g., the establishment of a regional MPA system) was one of the main objectives of the USCTI. This was an important component of CTI-CFF and associated activities supported by USCTI, given that throughout much of the CT6, capacity for key management activities to improve resource condition (e.g., MPA enforcement, implementation of climate change adaptation activities, designing integrated fisheries management plans) is lacking. Specific activities to help achieve this goal occurred on many levels, from trainings at project sites and at national levels to topical regional exchanges (REXs), multi-day meetings where individuals from the CT6 and technical experts worked together toward implementing CTI-CFF's main goals. At the community level, one documented indicator of increased capacity was community perception of MPA enforcement. Enforcement can be a major factor in promoting

the success of small-scale fisheries management and community-based management programs [34,35] and is often an important component of both social (e.g., improved compliance, community support for an MPA) and ecological (e.g., improvements in fish and coral condition) MPA success [36,37]. MPAs are common but not generally well enforced in the region according to national informants (Figure 4). National informants were asked to describe the level of MPA enforcement in their country using a five-point scaled question, ranging from (1) never happens to (5) always happens. There are significant differences between countries ($H(5) = 19.597$, $P = 0.001$, $n = 145$). Philippine responses were significantly higher (indicating higher occurrence of enforcement) than those from Indonesia ($U = 357.0$, $P = 0.036$), Solomon Islands ($U = 280.0$, $P < 0.001$), Timor-Leste ($U = 296.0$, $P = 0.044$), and Papua New Guinea ($U = 180.0$, $P = 0.001$). Malaysia responses were also significantly higher than those from Solomon Islands ($U = 123.5$, $P = 0.009$) and Papua New Guinea ($U = 78.5$, $P = 0.016$).

While enforcement is inconsistent, based on responses to a binary (yes/no) question regarding MPA enforcement ($n = 135$), 85% of national informants report improvements in MPA enforcement over the last five years. The strong perception of improved MPA enforcement is a likely indication that the CTI-CFF and USCTI are having a positive impact.
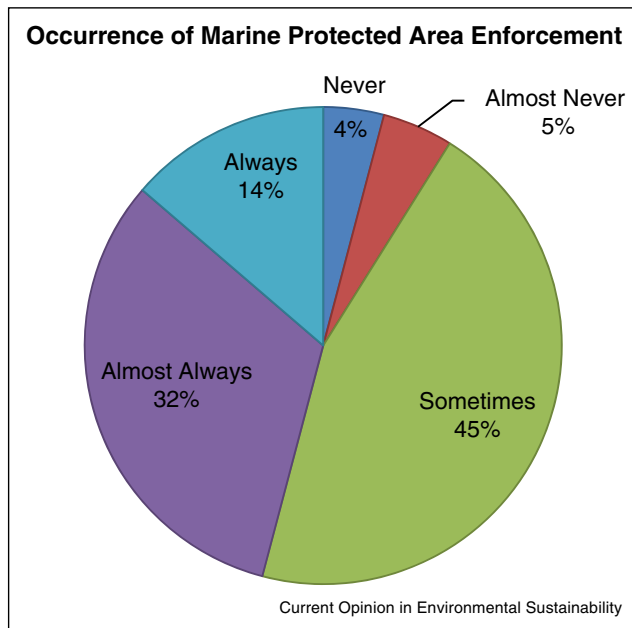
Another desired outcome of the USCTI was to increase regional and national capacity to catalyze and strengthen marine and coastal management throughout the CT. Capacity building, processes wherein individuals have opportunities to strengthen skills, knowledge, and relationships

Figure 3

CTI Contribution Toward Meeting Coral Reef Conservation, Sustainable Fisheries, and Food Security Goals

Impacts of CTI-CFF according to national and regional informants ($n = 166$, Regional and National).

Occurrence of Marine Protected Area Enforcement

Current Opinion in Environmental Sustainability

MPA enforcement effectiveness (*n* = 145, National informants).

to promote goal realization, are essential to improving management of marine resources; however, for a five-year program, the challenge of developing capacity in a short period of time is tremendous [38]. The difficulty of creating sustained improvements in capacity was a theme many informants discussed. One senior U.S. government informant noted that building capacity requires timelines and adaptability that may contradict the orthodoxies of the U.S. government and bilateral projects.

"Growing capacity takes time. . .. You have to train them, bring them up to speed on some of the substance of what they were doing. I think that many consultants and many governments are too impatient and too driven by a narrowly defined set of outcomes that are well-intentioned but really get in the way of meaningful progress."
Jane Lubchencho, NOAA Administrator in 2013

Another major challenge respondents highlighted was the complexity of designing a regional program for six countries with divergent political and cultural contexts, as well as differing levels of capacity.

"It's very hard to deliver something that responds to the needs of all the individual countries. I think this should have been acknowledged in the beginning. . .the (different) level of capacity and understanding of management and issues to do with food security."
NGO employee from CT6 country

Recognizing this, the USCTI sought to foster leadership and increase institutional capacity to improve marine management in a way that created a consistent vision across all countries with room for national adaptation [39]. The REXs were one of the main tools the USCTI used to accomplish this. The REXs offered ongoing opportunities for participants from across the CT6 to meet their regional peers and learn about successful management practices that had been applied in other countries. In the social network surveys, respondents (*n* = 123; 49% response rate) were participants in REXs on climate change planning, EAFM, and/or MPAs, and were asked the question, 'If you have questions about CTI-related issues (e.g., MPAs, climate change planning, fisheries management) who do you go to?' The full network (Figure 5) had 198 nodes and 328 ties with isolates (individuals who did not nominate any other individuals and were also not nominated by any individuals) removed. The network was characterized by low density (0.007), indicating that only 0.7% of possible ties that could exist in the network were present [40]. In the network diagram, nodes are sized by in-degree centrality, a measure of who is highly sought after as a source of information and calculated by counting the number of individuals in the network who nominated a given actor [40,41]. (See Pietri *et al.* for a full description of the REX network [42••].)

The connections formed between countries in the CT6 demonstrate considerable progress toward strengthening learning networks. In general, for large-scale environmental collaborations, exchanging ideas and disseminating knowledge are recognized as key network functions [43–46]. Notably, when respondents were asked if they had known the individual they nominated prior to participating in CTI-CFF, for individuals nominated from different countries, 74% of respondents indicated they had not known the nominee prior to participating in the REXs, demonstrating that new connections are directly attributable to the USCTI and the REXs.

The REX network is dominated by a few highly central individuals, the two most central of whom are from the United States and involved with the USCTI. The centrality of regional partners highlights the reliance of this network on USCTI partners and their strength as technical advisors. However, there are also individuals within the CT6 who are central to the network, including members of the regional secretariat (the body responsible for coordinating and overseeing CTI-CFF activities), national government employees in the Solomon Islands and the Philippines, and NGO staff in Timor-Leste. Though a potential weakness of a network with a few central individuals is that power and influence are not equally distributed throughout the network [47], the prominence of CT6 representatives in the network demonstrates that the USCTI program helped empower local leaders. Multiple individuals in

Figure 5
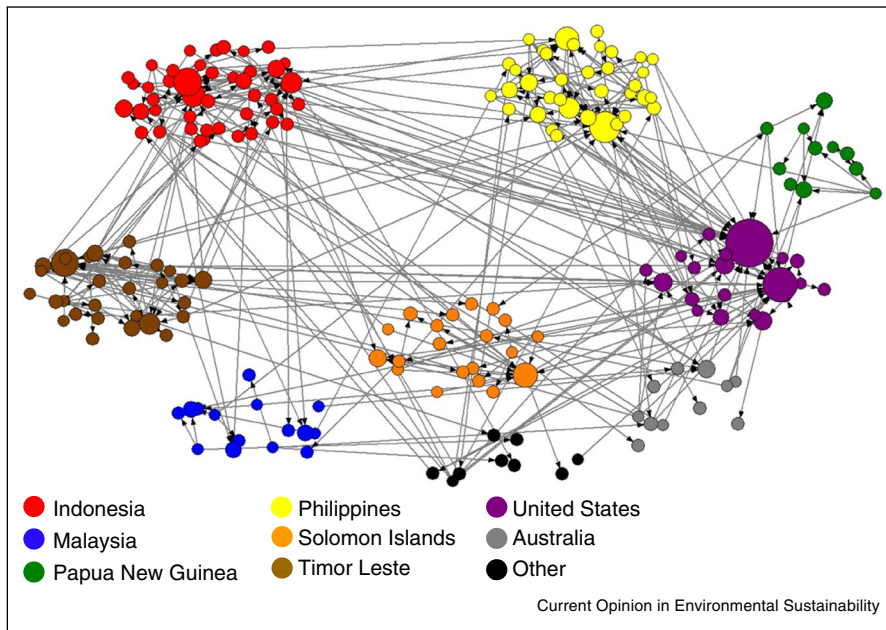
The REX network, with isolates removed (198 nodes, 328 ties) and nodes sized by in-degree centrality, the number of individuals who nominated a given actor (from Pietri *et al.* [42••]). The network is clustered by country to show the cross-country links the REXs fostered.

the CT6, including managers in the Philippines, Solomon Islands, and Indonesia, emerged as central individuals in the analysis. For instance, one of these individuals was a national manager from the Solomon

Islands (Figure 6). This actor was the sixth most central actor in the entire network and sought after by respondents within country, as well as regional partners. Notably, at the start of the REXs this actor was younger

Figure 6
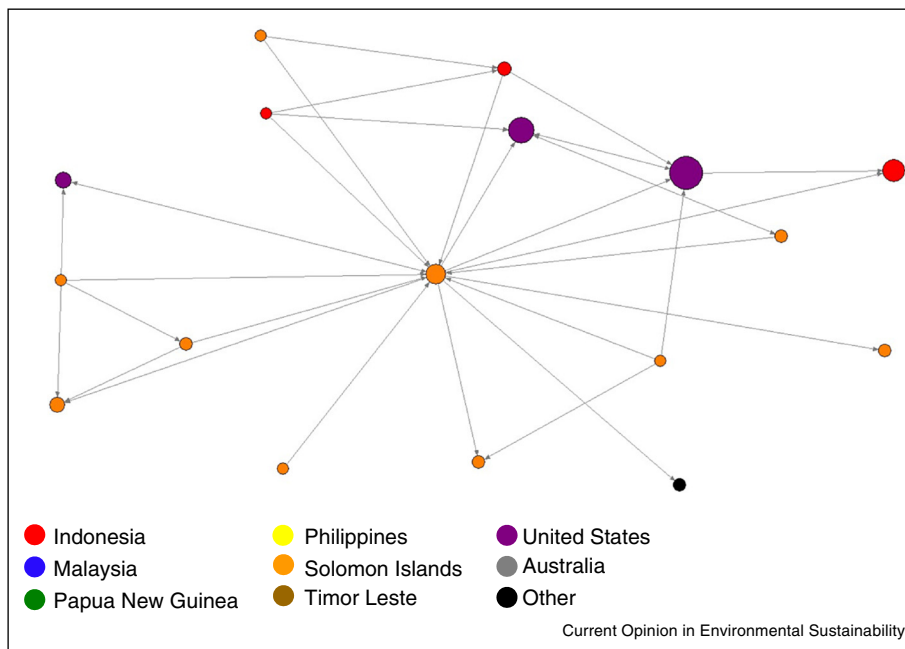
Ego network for a central actor from the Solomon Islands. Nodes are sized by in-degree centrality in the entire network.

and had low seniority in his/her management agency; prior to participating in CTI-CFF and USCTI activities, this actor had not participated in a regional forum like CTI-CFF. In interviews, however, informants highlighted how this actor had matured through participation in the REXs and had become an important regional player. These results suggest that other REX participants now view this individual as an important bridging actor who helps connect the Solomon Islands to the larger CT region and helps regional partners connect to those in the Solomon Islands. Individuals like this central Solomon Islands actor who serve as a bridge and connect subgroups are often key to a network's success by allowing the network to share information more efficiently and rapidly [48,49]; in the case of CTI-CFF, these types of actors can help ensure information is shared among and beyond network participants, thus further strengthening capacity.

The prominence of CT6 individuals in the REX network demonstrates a theme echoed in interviews: the USCTI contributed to empowerment of historically marginalized people in the CT region. Most notably, interviews highlighted that the creation of social networks and mentoring relationships empowered women from the CT6. A number of the central individuals in the network analysis were women from the CT6, and during interviews, multiple respondents stressed the strong bonds before women throughout the CT6 and the mentoring opportunities gained through participation in the REXs:

"At the regional level, I learned leadership. I got a lot of mentoring at the regional level. . .. I'm inspired by women in this forum. I've learned a lot, like women can play a great role in leadership. . .. I come from a background where women are not so much considered."

CT6 national government policy maker

Despite the positive benefits of the REXs, some informants also noted they were expensive and time-consuming. Given that the USCTI program held its last REX on MPAs in June 2014 and is not planning currently to provide further funds for REXs, the fiscal, personnel, and time costs of the REXs are an important point for CTI-CFF coordinators to consider when planning for potential continuation of the network and its activities.

Improved governance

An important projected result of the USCTI was to improve governance (e.g., by strengthening coordination on marine management between local and national levels of government within the CT6) at the national and regional level in the CT6 and strengthen platforms for marine and coastal management. Given the socio-political diversity of the CT6 — as well as vast differences in culture, institutional arrangements, centralization of policy making, and experience with integrated planning [7,20] — this was a complex task. Improved collaborative relations between relevant institutions have the potential to foster vertical and horizontal integration, which can improve ocean governance. However, as one informant highlighted, achieving vertical integration is often a difficult task.
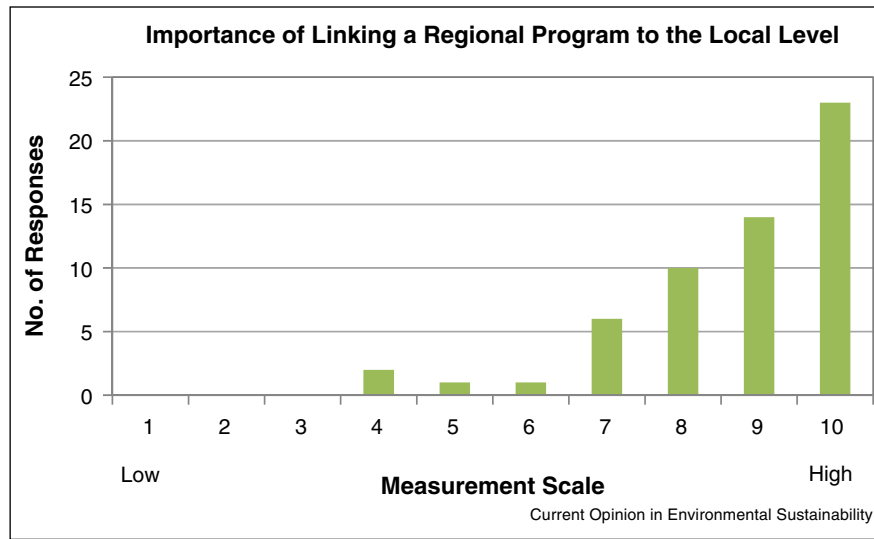
"I think for those who thought we were going to have perfect vertical integration, it's almost impossible. Because there're just too many layers, especially when

Figure 7
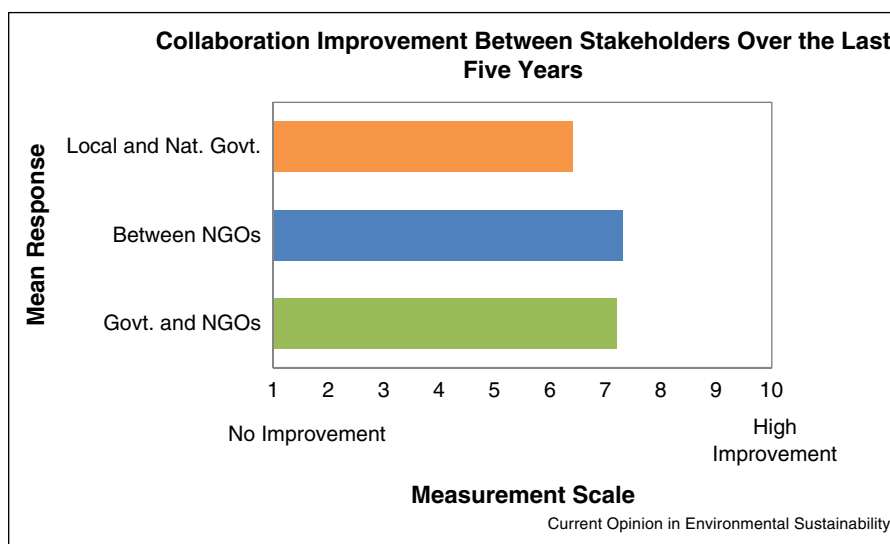
Improvement in collaboration between CTI institutional stakeholders (local and national government (n = 145); between NGOs (n = 62); and government and NGOs (n = 169)).

Figure 8

National and regional respondents were queried on the importance of linking regional program activities to the local level ($n = 58$).

you're targeting regional to national. I mean even between national and local, it's often a big disconnect in the larger countries. And then to go from regional to local seems like a real stretch…."

NGO employee from non-CT6 country

To evaluate participant perceptions regarding institutional collaboration, we asked respondents to indicate how collaboration between local and national government agencies, between NGOs, and between government agencies

and NGOs had changed over the last five years using a ten-point scaled questions, where '1' implied no improvement and '10' high improvement. Improvements in collaboration between institutional stakeholders over the last five years were detected, indicating modest progress in increasing vertical integration (Figure 7).

To evaluate perceived importance of vertical integration, respondents were asked how important they believed it was to link regional actions to the local level using ten-point scale questions, where '1' signified low importance

Figure 9
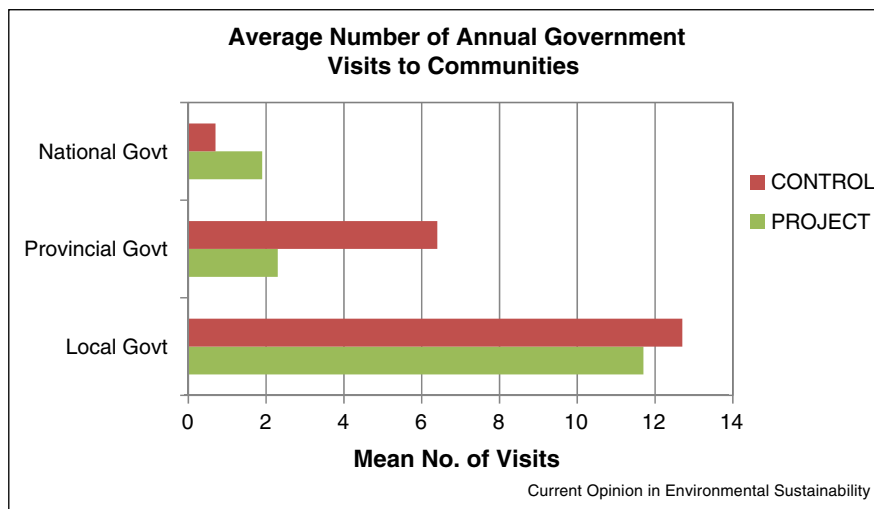
Community leader responses to the average number of visits by government officials in their communities ($n = 67$).

and '10' signified high importance. Both regional and national respondents believed it was important to link regional program activities to local level action — a form of vertical integration (Figure 8). Linking regional activities to the local level is often cited as a crucial element to the success of regional environmental initiatives [7,50,51]. This suggests respondents placed high value on vertical integration.

Despite the belief of national and regional respondents about the importance of linking regional and local activities and respondent perceptions of modest improvements in vertical integration, evidence suggests that integration is still incomplete. Community leaders in both control and project sites were asked how many times they were visited by national, provincial and local government officials in their communities. The mean number of visits was compared for responses from control and project communities (Figure 9). Project communities were not statistically different from control communities ($P > 0.05$, t-test) for: National visits (Project, $n = 48$, Control, $n = 19$); Provincial visits (Project, $n = 49$, Control, $n = 18$), and Local visits (Project, $n = 41$, Control, $n = 18$). These results highlight an opportunity to improve vertical integration strategies throughout the CT6, though achieving vertical integration may be an ongoing challenge that will require continued support, especially by national governments.

Conclusions

Surveys and interviews of thousands of informants from various levels of society clearly demonstrate that the USCTI program had a significant positive impact in the CT region. The USCTI was innovative on a number of fronts. Progress was made in terms of both process and outcomes — essential ingredients to sustained environmental management programs [52,53]. There are modest indications that social and ecological conditions are improving in project sites across the region. Improvements in fisheries, MPAs, and climate change policies are evident and documented elsewhere [24**]. Survey results indicate that there remain, however, challenges to improve governance via vertical integration — a process that is highly valued, a potentially important factor in program success, and will require ongoing attention both within the CT6 and regionally.

One of the most significant achievements of the USCTI is the creation of learning networks at various levels within the CT region. Social network analysis and interviews clearly document the progress toward and value of the regional and in-country networks that have been fostered by the REXs [42**]. Currently, the regional communication network, as measured, mainly involves individuals from the United States and the CT6, but importantly, the network contains multiples leaders from within the CT6. The role of female leaders in these networks is apparent

and is contributing to the ongoing empowerment of women who participate in the CTI-CFF. Investment in REXs and peer-to-peer mentorship opportunities should be maintained to further the tangible capacity building opportunities of the learning network, though maintaining this network will require additional outside funding or internal contributions and coordinators from the CT6.

Our results suggest that in addition to improvements in social and ecological conditions and capacity, a CT regional identity is emerging. The tangible excitement expressed by informants during interviews regarding program outcomes and future opportunities illustrates that there is motivation throughout the CT region to continue collaborating toward CTI-CFF's ambitious goals. However, with the close of the USCTI in 2014, CTI-CFF is transitioning to the next phase of its development, with a focus on carefully considering how to best sustain its momentum and activities. Due to its scale, CTI-CFF is likely to continually need some degree of external financial and technical support. Potential pathways exist for support of CTI-CFF's regional and national functions internally, through member country contributions, and through attracting additional support from outside partners. Some regional development partners, like the Asian Development Bank and government of Australia, are already supporting CTI-CFF, though this support differs in scope and scale from USCTI. CTI-CFF now faces numerous challenges as it searches to build upon its early successes and continues to work toward its overarching goal of improved management and protection of the region's valuable marine resources.

In addition to the novel nature of the USCTI and its impacts, the LP represents a relatively unique interdisciplinary, applied research project that was co-designed by USCTI leadership and academics. Upon review of LP goals presented in the introduction, one can reflect on the utility of one such integrated, time-bound assessment. LP and USCTI partners agreed upon LP goals and priorities through a series of planning meetings and regular communication during implementation. While collaborative planning and implementation were central to LP success, it was also important that LP leadership ultimately maintained control over data collected, analysis, and interpretation of results. The division of responsibility between LP lead researchers and USCTI partners ultimately improved the objectivity of the project and findings. However, the short time frame (6 months) created challenges for LP implementation. It precluded the collection of primary environmental monitoring data and also created stress within LP team and, on occasion, between the LP team and USCTI partners who were juggling multiple responsibilities. This experience suggests that such data-intensive assessments should have been initiated earlier in the USCTI.

Overall, the co-design process and collaborative spirit of the LP allowed it to collect a large body of information from a diverse range of informants in a relatively short time frame and provide important documentation of the achievements and challenges of USCTI. Using multiple assessment tools and identifying explicit LP goals allowed for the triangulation of findings and the tailoring of research methods to informant type. For example, it is not culturally appropriate to expect a senior Asian official of a national agency to respond to a structured survey. The survey invitation would likely be ignored. Rather, a confidential, semi-structured interview is more appropriate. In this analysis, quantitative and qualitative information, from unique sources, were used to provide a detailed and balanced assessment of topics.

The LP involved a multi-national team of researchers, some who had little prior formal training in survey deployment. Formally trained social scientists and program evaluators developed the research instruments and design, but many junior team members remarked at how they benefitted personally and professionally through involvement in the LP. Some graduate student assistants from CT6 countries subsequently used LP-related assessment tools in their personal research. North American assistants are now involved in follow-on evaluations for donors who wish to invest in the CTI.

LP findings that identified USCTI strengths and areas for improvements have been disseminated to NGO partners and donors involved in the CTI. World Wildlife Fund hosted a seminar in Washington D.C. at which LP findings were presented to approximately 80 donor, NGO, and academic representatives. It is not clear whether LP findings have been directly translated into CTI-CFF policies — partly because it is beyond the scope of the LP to assess whether recommendations were implemented. But, the LP final report and this manuscript have generated considerable interest from USAID and other donors who support the CTI. The outcomes generated through the USCTI, demonstrate the potential benefits and possibility of progress within the CTI-CFF's large scale experiment in marine governance, and point to ways in which regional programs can create positive social, ecological, capacity-building, and governance impacts.

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