Graduate Students and Knowledge Exchange with Local Stakeholders: Possibilities and Preparation

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ABSTRACT

Tropical biologists are exploring ways to expand their role as researchers through knowledge exchange with local stakeholders. Graduate students are well positioned for this broader role, particularly when supported by graduate programs. We ask: (1) how can graduate students effectively engage in knowledge exchange during their research; and (2) how can university programs prepare young scientists to take on this partnership role? We present a conceptual framework with three levels at which graduate students can exchange knowledge with stakeholders (information sharing, skill building, and knowledge generation) and discuss limitations of each. Examples of these strategies included disseminating preliminary research results to southern African villages, building research skills of Brazilian undergraduate students through semester-long internships, and jointly developing and implementing a forest ecology research and training program with one community in the Amazon estuary. Students chose strategies based on stakeholders' interests, research goals, and a realistic evaluation of student capacity and skill set. As strategies became more complex, time invested, skills mobilized, and strength of relationships between students and stakeholders increased. Graduate programs can prepare students for knowledge exchange with partners by developing specialized skills training, nurturing external networks, offering funding, maximizing strengths of universities in developed and developing regions through partnership, and evaluating knowledge exchange experiences. While balancing the needs of academia with those of stakeholders is challenging, the benefits of enhancing local scientific capacity and generating more locally relevant research for improved conservation may be worth the risks associated with implementing this type of graduate training model.

Abstracts in Spanish and Portuguese are available at http://www.blackwell-synergy.com/loi/btp.

TROPICAL BIOLOGISTS ARE EXPLORING WAYS to expand their role as researchers of tropical systems. Scientific discoveries of recent decades have generated a wealth of knowledge in tropical ecology and have laid the foundation for a broader mission to assist in conservation and management of those systems. To achieve this, tropical scientists are now asked to integrate social sciences with biological knowledge, engage civil society in the research process, and link science to policy and action (Bawa *et al.* 2004). This is a tall order. Nonetheless, some developed- and developing-country scientists have embraced this broader goal, seeking to partner with stakeholders (*i.e.*, local resource users, conservation practitioners, sovereign governments) also concerned with the processes and products of tropical research. These scientists may be aware that much of the scientific knowledge generated about tropical ecology is published in English-language journals by scientists housed in nontropical, and only select tropical, institutions (Stocks *et al.* 2008, Sunderland *et al.* 2009), with little to no dissemination of research results to local resource managers (Shanley & Gaia 2002, Shanley 2006, Shanley & López 2009). One group of researchers who seem particularly enthusiastic to take on this broader role, forge partnerships, and exchange knowledge with stakeholders is graduate

students. Perhaps because they are less encumbered by conventional academic incentive structures that might preclude engagement in less-recognized outreach activities (Shanley & López 2009), graduate students are exploring how to communicate with and learn from local stakeholders (Ewel 2008).

Graduate programs in tropical biology and conservation have an important role in preparing the next generation of scientists to build partnerships and exchange knowledge with local stakeholders during the research process. Such preparation during formative graduate years can establish the attitudes, skills, and knowledge that build confidence and allow conservation scientists and practitioners to embrace a more collaborative approach. This requires working in teams, and facilitating knowledge exchange and social learning among diverse societal actors (Wondolleck & Yaffee 2000, Shackleton *et al.* 2009)—useful preparation as graduates confront the elaborate set of management and policy issues that will be present throughout their careers (Jacobson 1990, Cannon *et al.* 1996, Clark 2001, Knight *et al.* 2008).

In this paper, we describe ways that graduate students have integrated knowledge exchange with local people into their research projects and discuss approaches adopted by one program to help prepare students for this challenge. Specifically, we ask: (1) how can graduate students effectively engage in knowledge exchange during their research; and (2) how can university programs prepare young

scientists to take on this partnership role? We first present a conceptual framework of different knowledge exchange strategies and their application by graduate students during field research. We then synthesize lessons learned and offer guidelines to make knowledge exchange an integral part of academic research and training in conservation of tropical ecosystems. We draw heavily on the University of Florida's (UF) Tropical Conservation and Development (TCD) Program as one model for this type of graduate training. TCD is a graduate certificate program that complements disciplinary academic training and supports graduate students in building professional skills and relationships with local stakeholders by emphasizing: (1) interdisciplinary, problem-oriented research approaches and evidence-based problem solving; (2) skills and leadership capacity to bridge theory and practice; and (3) collaborative network linkages between academics and practitioners involved in the day-to-day realities of tropical conservation and development (Kainer *et al.* 2006). Although we use examples and insights from the TCD program, we recognize that innovative programs at other universities engage in similar and complementary strategies.

KNOWLEDGE EXCHANGE FRAMEWORK AND FIELD APPLICATION

We refer to knowledge exchange as the sharing, use, and generation of information through methods appropriate to the context, audience, and communication objective. Useful frameworks for knowledge exchange are typically drawn from the fields of communication and education. We distilled one developed by Monroe *et al.* (2007) to create a knowledge exchange pyramid that outlines how graduate students can exchange knowledge with local stakeholders during research (Fig. 1). The pyramid represents three levels of knowledge exchange from simplest to most complex: (1) information sharing; (2) skill building; and (3) knowledge generation. The pyramid structure shows how these strategies build on each other, with greatest feasibility of graduate student engagement at the base level.
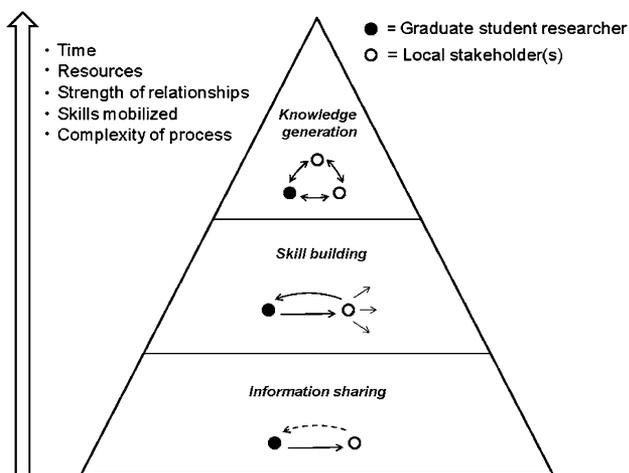

FIGURE 1. Knowledge exchange pyramid: conceptual framework of strategies for knowledge exchange between graduate student researchers and local collaborators.

Strategies farther up the pyramid may require greater time investment, increased emphasis on relationship cultivation, and an expanded set of skills. In this section, we present the theory underlying each knowledge exchange strategy, demonstrate how the strategy has been applied by TCD graduate students during field research, and critically assess its limitations.

INFORMATION SHARING.—Information sharing forms the pyramid base (Fig. 1). As the foundation of knowledge exchange, information sharing describes a primarily one-way transmission of ideas where stakeholders interpret information based on how it is presented (Shannon & Weaver 1949). The student is responsible for tailoring the information to the language, education, culture, and interests of the recipients so that the information is transferred most appropriately (Freire 1970, Jacobson 1999). The simplest tools for information sharing are presentations, brochures, posters, and dissemination of research results in an audience-appropriate format. These tools are appropriate when time is limited, specific facts need to be shared, and information is not controversial (Monroe *et al.* 2007). If a student's goal in information sharing is to change attitudes, the process will be more effective if stakeholders are given a more active role in interpreting the information presented to them (Freire 1970). Community forums, presentations allowing discussion time, and short workshops can be highly effective ways to encourage such active engagement (Monroe *et al.* 2007).

Information sharing by graduate students often focuses on dissemination of research results to local stakeholders. One example involved UF graduate students, a TCD faculty member, African conservation practitioners, and rural communities in southern Africa. The students and practitioners reported preliminary survey results to over 350 participating villagers from 11 community-based organizations during 6-wk periods in 2007 and 2008. These findings, which assessed villagers' access to information about local wildlife management and their perspectives on wildlife population trends, were presented orally within a week of survey implementation. The quick turn-around allowed community members to interpret the information and verify survey data before final analysis. To attract as many villagers as possible, presentations were given in outdoor venues, used local languages, included meals, and were carefully planned to avoid conflict with other community activities. Presenters used both verbal and graphic methods to display the most salient survey results, and encouraged questions about potentially controversial content. During information sharing, the research team was conscious of audience composition and varying ability to understand and interpret scientific information. Both researchers and community members benefited from the information sharing. It directly enhanced the quality of the team's research as they validated preliminary survey data and gained a richer understanding of the reasons behind the findings. Villagers, in turn, were given the opportunity to visualize individual and community responses, identify issues they wanted to address further, and express their interpretation of results. An enduring impact of the exchange occurred in one community that subsequently implemented their own information sharing policies: use of local radio to announce wildlife management meetings where critical decisions would be

made, distribution of paper copies of management reports to all community members, and creation of posters to convey information about wildlife resources.

Other examples of information sharing by TCD graduate students include a photo book of forgotten indigenous basket weaving patterns presented to an indigenous group in Brazil (Athayde *et al.* 2009); geo-referenced maps indicating community land uses that were returned to the participating community-based organization in Namibia (A. Gaughan, Pers. comm.); and research results from a multidisciplinary group of student and professional researchers presented to policy-makers, universities, and communities in a traveling 'knowledge exchange train' in southwestern Amazonia (Mendoza *et al.* 2007).

Results dissemination is a critical, yet relatively simple, means of including local communities in research projects (Kainer *et al.* 2009); yet, there are precautions and potential drawbacks with this and other information sharing strategies (Shanley & Laird 2002). Most importantly, the effectiveness of information sharing is contingent upon the student's understanding of the context and audience. While seemingly obvious, use of appropriate language and choice of media (*e.g.*, illustrations, stories, pamphlets, theater, video, power point) to reach diverse audiences, along with follow-up after information sharing activities, can help avoid confusing or controversial interpretations of information. Graduate students may have limited time to prepare audience-appropriate information sharing activities or to follow up with local stakeholders, and may lack experience using nontechnical language or media other than posters or power point in communicating scientific findings.

SKILL BUILDING.—The second pyramid level (Fig. 1) encourages stakeholders to use knowledge to develop new skills. It builds on information sharing by incorporating behavior change tools from adult learning (Kolb & Fry 1975) and social marketing (McKenzie-Mohr & Smith 1999), which emphasize using existing skills as a starting point, demonstrating new skills to prove their feasibility, and providing constructive feedback. Applying these ideas in our context, skill building is a strategy where graduate students work with stakeholders as partners to practice specific skills important for tropical biology and conservation, including data collection and analysis, grant writing, or manuscript preparation. In addition to knowing the context, audience, and basic presentation techniques, skill building suggests that as the graduate student introduces new skills, he or she should allow time for the recipient partner to practice the skill, receive constructive feedback, and reflect on how it fits into the partner's previous knowledge and skill set (Monroe *et al.* 2007). During skill building, the graduate student concurrently reflects on improving his or her technical and communication skills, and ideally gains new skills from the partner.

Graduate students can engage in skill building both within and outside the academic setting during field research. While undergraduate students from tropical universities commonly work as field assistants on graduate projects, the experience is often limited to data collection and could be expanded to promote greater research skill development. During PhD fieldwork on tropical seedling ecology and management in the Brazilian Amazon, one TCD graduate student collaborated with a local university biology professor to respond to undergraduate requests for internships in plant ecology. They created locally accessible greenhouse and laboratory research projects for seven biology interns and one senior student's thesis. The semester-long internships provided undergraduates with hands-on training in ecological research, including experimental design, greenhouse and laboratory methods (*e.g.*, seed germination and seedling growth experiments), and data analysis. While these concepts had been introduced in the undergraduate biology education, learning-by-doing helped them develop research skills. The graduate student guided the internships and student thesis project, and worked with undergraduates in small groups allowing them to practice skills and teach each other, while providing constructive feedback. Local university biology professors played a critical advisory role in orienting internships, and their encouragement of these activities provided an incentive for undergraduate participation. The skill building was mutually beneficial: undergraduate students gained extra laboratory experience and guidance, while the graduate student obtained baseline and pilot data complementary to her fieldwork. Co-advising undergraduates with faculty also allowed the graduate student to develop mentoring skills.

Other examples of TCD students engaged in skill building during field research include: workshops and field guides developed to train Brazilian loggers in taxonomic identification of timber species (Baraloto *et al.* 2005, 2007; Rockwell *et al.* 2007); professional Bolivian forestry researchers mentored in manuscript preparation; and workshops on dynamic landscape simulation modeling, participatory scenarios development, and carbon markets conducted with policy-makers and nongovernmental research organizations, among other stakeholders, in the Brazilian Amazon (C. Stickler, pers. comm.).

Skill building activities will almost certainly require more time, resources, and preparation on the part of the graduate student than information sharing. A common challenge to engaging in skill building with local partners is cultivation of required skills by the graduate students themselves. It may be difficult to find a match between skills that graduate students have to offer and those desired by stakeholders confronting particular conservation problems. Also, more formal training activities may necessitate that graduate students navigate rules, regulations, and protocols of local partner institutions. Finally, rapid graduate student turnover may impede long-term integration of skills into conservation and resource management practices, as partners may not have the necessary incentives or resources to advance or apply skills learned. Skill building by graduate students may yield better results if integrated into broader, long-term efforts by tropical-country partners.

KNOWLEDGE GENERATION.—Knowledge generation, at the pyramid apex (Fig. 1), includes stakeholders as partners in the creation of knowledge, intended to result in more accurate information, appropriate decisions, and sustainable policies and behaviors (Allen 2000, Keen *et al.* 2005, Guijit 2008). The methods and goals of knowledge generation are mutually developed between graduate student and stakeholder partner with the student facilitating the process. Facilitation requires techniques that build an atmosphere

of trust and openness to ensure a diversity of inputs and knowledge verification (Kaner 1998). Common examples of knowledge generation include action research and multistakeholder processes. Action research incorporates potential research users in some or multiple aspects of the research process to address a significant problem (Reason & Bradbury 2001, Arnold & Fernandez-Gimenez 2008). This is a suitable strategy when specific research questions are not predetermined, and both graduate students and partners wish to build knowledge around mutual interests. A multistakeholder process is an approach for making decisions with broad consensus where information to be shared is controversial (Hemmati 2001, Keen *et al.* 2005). Multistakeholder processes can be useful in addressing complex conservation problems where there are diverging interests among stakeholder groups. Both action research and multistakeholder processes require a considerable amount of time and reflection to facilitate equitable knowledge sharing and manage conflict among diverse actors.

Action research was used by a Brazilian TCD graduate student and one community in the Amazon estuary to explore the ecology of tree species that sustain local livelihoods. The project goal was to jointly develop guidelines on best forest management practices through collaborative ecological research, training, and integration of scientific results with local insights. It began in 2005 when the student was a professional researcher with a regional research NGO and later became the basis for her graduate work. Community members were engaged at all stages of the research and training program: setting research priorities, selecting research species (in which the seed-oil producing species Andiroba *Carapa guianensis* was most important), and mapping forest types and species distributions. A subset of the community (local monitors) had greater participation, acting as volunteers to collect data, participating in research skill building activities, and disseminating results to their community. Community participation permitted a much larger sample size of trees and continued high-quality data collection throughout the year. Research results demonstrated that Andiroba seeds could be more intensively harvested without negatively affecting population persistence. Current logging of this same species, however, proved ecologically unsustainable. After assessing these findings and similar results of other local species, community members organized themselves to discuss resource use strategies and take action. As a consequence, community members: (1) dramatically reduced high-impact harvesting of timber and palm heart species; (2) initiated efforts to market a range of nontimber forest product species; (3) attested to modest increases in income and welfare; and (4) became more interested in the ecological research process. Between the project's second and third year, the number of local monitors grew from 8 to 20 and diversified to include youth, women, and community leaders. Training modules on disseminating results culminated in community-organized meetings that also included leaders from neighboring communities, in which local monitors independently presented research findings. Even without the graduate student's presence, the community developed and delivered a locally based strategy to share their findings with other communities throughout the region who were also struggling to improve their forest-based livelihoods while sustaining their resource base.

Because of the complexity of multistakeholder processes, it may be particularly challenging for graduate students to become involved in this strategy for knowledge generation. One TCD student, however, with long-term ties to the Maya Biosphere Reserve of Guatemala, focused his doctoral research on a multistakeholder process for dialogue and consensus building regarding conservation and development of the ancient archaeological site, El Mirador. As a formal member of the roundtable facilitation team, the student fostered collaborative learning and decision making through multicriteria decision analysis, cognitive mapping, simulation modeling, and conflict management. In less than a year and a half, the roundtable: (1) implemented an interinstitutional environmental security plan; (2) designed and began construction of reserve infrastructure; (3) made significant investments in community organization and governance; and (4) completed the reserve's master plan.

Knowledge generation to address real-world conservation and resource management problems demands an exceptionally high investment of time and energy by graduate students and partners, as well as institutional support and communication with academic advisors. Graduate students may need to manage challenging group dynamics, such as divergent interests, unequal distribution of power and access to resources, and conflict (Kaner 1998). Not all students are equipped with the ability to recognize and navigate through group disagreements, nor should they always take on such responsibilities. Also, even when action research and multistakeholder processes are collaborative and well facilitated, criticism that only a sector of the stakeholder community is involved can lead to rivalry, conflict, and misuse of generated information. Finally, students may risk losing direction in the research process as they attempt to satisfy the diverse needs of different stakeholder groups. For this reason, graduate committees may not afford students the flexibility to conduct research that lacks predetermined research questions to be refined during fieldwork according to stakeholder needs. Despite these concerns and criticisms, knowledge generation processes can be the most successful in furthering tropical biology research and decision making because they involve local partners early in the process (Keen *et al.* 2005).

GUIDELINES AND STRATEGIES FOR EFFECTIVE KNOWLEDGE EXCHANGE

The success of each knowledge exchange strategy depends on the quality of its implementation and fit to the context of the field site. Students in the above examples chose strategies based on the interests of local stakeholders, their research goals, and a realistic evaluation of their capacity and skill set. Each example demonstrates distinct strategies for knowledge exchange with local collaborators. As strategies became more complex, time invested, skills mobilized, and strength of relationships between students and stakeholders increased. In general, by diversifying their role during field research and reflecting on their experiences, graduate students involved in knowledge exchange reported improved communication skills, enhanced quality and relevance of research, and increased self-confidence and professionalism. There was anecdotal evidence that local partners also benefited from the exchanges by contributing to

interpretation of research results as exemplified by the southern Africa example, developing research skills in the case of the Brazilian undergraduates, and in the action research example, helping generate scientific knowledge and applying findings to tropical forest management.

The TCD program provided an important institutional umbrella within which these graduate students conducted knowledge exchange with local stakeholders (Kainer *et al.* 2006). Results of a 2004 program evaluation showed that most TCD students (82%; $N = 44$) perceived that participation in the program enhanced their communication skills, increased the local relevance of their research (82%), and promoted collaboration with tropical-country partners (84%). TCD alumni ($N = 171$) responses to a 2008 survey also highlight the benefits of communication skills training. Training in conflict management, facilitation, and participatory tools was the second most perceived long-term benefit of the TCD program after research training. When asked to free-list how TCD training could be more relevant to pressing needs in conservation and development, the most common response after understanding global climate change was learning to encourage dialogue between groups with diverse and competing interests. Inspired by our reflections on the TCD program, the following guidelines and strategies first address how graduate students can engage in knowledge exchange with local stakeholders, and then how faculty and academic programs in tropical and nontropical countries can prepare and support students in doing so (Table 1).

CRITICAL ASSESSMENT OF STUDENT RESOURCES AND SKILLS.—Prospective students interested in working with local stakeholders can seek institutions, graduate programs, and mentors amenable to expanding the scope of research to include knowledge exchange. Taking time to evaluate one's own capacity, as well as cultivate desired skills and attitudes, is helpful for developing sound and feasible knowledge exchange strategies. Depending on the context and strategy chosen, graduate student researchers may need to develop presentation skills, practice active listening, facilitate groups, or manage conflict. Nonnative speakers may need to attain high proficiency in the host-country language. Attitudes of flexibility, open-mindedness, commitment, and humility can go a long way toward building important relationships that foster effective communication. Time and funding allocated to these endeavors can be integrated into research planning. For example, a budget line for partnership building activities can be reserved for when spontaneous opportunities arise in the field. Doctoral students are particularly well positioned to engage in more complex strategies since they may be able to dedicate more time and more easily integrate partners and partner needs in their fundraising efforts.

CULTIVATING RELATIONSHIPS WITH PARTNERS.—Time invested by graduate students to establish and develop collaborative relationships is often well spent. While preparing for research, potential stakeholder partners can be identified based on existing networks or interested parties. Early in the research process, reflection and, when possible, negotiation between graduate student goals and local stakeholder needs can help guide student selection of

TABLE 1. *Guidelines and strategies for integrating knowledge exchange with local stakeholders into graduate research and training.*

Strategy	Benefit
For graduate students	
Seek appropriate graduate programs and mentors	Provides institutional base and support
Reflect on capacity for knowledge exchange	Allows choice of appropriate knowledge exchange strategy
Communicate, negotiate, and adapt research and training goals with needs of local collaborators	
Develop appropriate skills (*e.g.*, language, presentation, active listening, teamwork, group facilitation)	Increases student capacity for effective knowledge exchange with local stakeholders
Cultivate attitudes of flexibility, open-mindedness, commitment, humility	
Budget time and funding for knowledge exchange activities	Ensures inclusion of knowledge exchange in research
For faculty and academic programs	
Validate knowledge exchange	Builds student confidence and ability for knowledge exchange in research
Bring together diverse group of students from variety of academic disciplines and countries, and with different language and cross-cultural skills and experiences	Demonstrates benefits of knowledge exchange among diverse individuals
	Builds future professional network
Offer courses that model collaborative teaching and provide skills training	Provides opportunities for students to learn and practice knowledge exchange
Encourage student-led initiatives, seminars, poster-sessions outside of classroom	Creates spaces that promote synergies, cross-student learning, sharing of contacts and networks, and cultivation of relationships
Interact with communications or education departments, or extension groups	Improves tools for knowledge exchange
Set groundwork for external networks	Allows student to build on collaborative relationships with local stakeholders
Fund exploratory research, internships, dissemination of research results, field grants that include knowledge exchange, practitioner experiences	Encourages and, in some cases, enables knowledge exchange
Cultivate partnerships between universities in developing and developed regions	Maximizes strengths for institutionalizing knowledge exchange
Evaluate knowledge exchange with graduate students and local stakeholders through written evaluations, discussion groups, and meetings	Allows for understanding dual benefits of knowledge exchange and ways in which it can be improved

information sharing, skill building, or knowledge generation. It may be necessary to perform tasks ancillary to dissertation work to attain acceptance, trust, and relevance with stakeholders, even though this can distract students from their original lines of research. Depending on the type of knowledge exchange carried out, graduate research may take longer. In some cases, the knowledge exchange may not be outlined in the initial research proposal, but emerge naturally during fieldwork. In all cases, clear communication and adaption of goals and methods throughout the research process can help ensure that all parties' objectives are thoughtfully considered and, hopefully, met.

LEARNING ENVIRONMENT AND CULTURE OF COLLABORATION.—Knowledge exchange can be encouraged in the graduate program through faculty support for collaborative learning, specialized coursework, and student-led initiatives. Faculty validation of graduate student engagement with local stakeholders in research can be very important for improving students' self-confidence while helping them reach beyond the academic incentive system that discourages many scientists from engaging in such knowledge exchange (Shanley & López 2009). Since graduate students will learn as much, if not more, from their peers as from their mentors, bringing together a diverse group of students from a variety of natural and social science disciplines, tropical and nontropical countries, with different language and cross-cultural skills and experiences can be a highly effective demonstration of the benefits of knowledge exchange. The graduate program can help create spaces that promote cross-student learning, sharing of contacts and networks, and cultivation of relationships that are invaluable for future professional networks.

Graduate programs can offer courses that explicitly build knowledge exchange skills, as well as those that allow students to experience cross-disciplinary learning and use various educational approaches to demonstrate effective knowledge exchange techniques. For example, conceptual courses (ideally team-taught by both biophysical and social scientists) that attract students from diverse disciplines can use practical case studies, present biological and social perspectives on tropical conservation, and strategically use teaching methods that foment peer-to-peer cross-disciplinary learning. TCD has developed a series of leadership courses, including conflict management, group facilitation, policy advocacy, and green entrepreneurship, which build upon theories of collaboration and have students practice new skills. All courses can require students to work in teams and emphasize critical reflection on their learning experiences.

Additional skill-building and leadership opportunities for knowledge exchange can be promoted outside the classroom through student-led initiatives, service learning opportunities, formal seminars, and poster sessions. For example, student-led seminar series and workshops can be implemented with faculty encouragement and feedback. TCD is experimenting with a new service learning course that allows students to earn credit while developing a collaborative project under faculty supervision. The formal credits may provide greater incentives for students to refine knowledge exchange skills and attend to negotiated partner needs. Finally, interaction with and advice from communication and ed-

ucation departments or extension groups may be helpful in developing useful tools for knowledge exchange.

NURTURING NETWORKS.—Faculty and institutional support can be helpful in setting the groundwork for external relationships that could foster knowledge exchange. Although some students have or are able to develop their own network of tropical collaborators, faculty can generate and maintain long-term local partnerships, communicate existing regional networks to students, and plug students into these networks as appropriate. Consultation with experienced local practitioners and academics may help graduate students develop and execute appropriate knowledge exchange strategies in the field. Longer-term partnerships can ameliorate rapid turnover of graduate students by maintaining continuity of research and knowledge exchange over time. To promote positive long-term collaborations, faculty can encourage formal or informal agreements with partners to outline expectations, maintain transparency, and avoid conflicts over miscommunication.

FUNDING.—The act of prioritizing limited program funds to knowledge exchange makes a strong statement to students about the expectations and importance of this activity for academic development. Support for internships can provide students first-hand experience working with collaborators to build skills and possibly set the stage for future partnership. Seed monies for preliminary research can be linked to explicit assessment and negotiation of partner needs with student research interests. Funds can be made available to return research results, including outreach publications in the appropriate language or seminars and workshops. Delivering preliminary results to local stakeholders toward the end of field data collection, while with its cautions, can occur at almost no additional cost to the student.

REGIONAL DIFFERENCES IN ACADEMIC CONTEXTS.—Academic programs in both developing and developed regions can institutionalize knowledge exchange with local stakeholders. Some fundamental characteristics, however, may contribute to differences in knowledge exchange capacity and logistics. For example, universities that are close to tropical research sites can more easily foster and maintain long-term partnerships with local stakeholders, and students may have more intimate understanding of regional problems in tropical biology and conservation. Conversely, it may be more difficult for universities in developing regions to secure funding and create incentives for faculty and students to engage in knowledge exchange outside the university. While universities in developed regions may more easily secure funding to institutionalize knowledge exchange and may have more departmental freedoms in doing so, it can be difficult for faculty and students in these programs to respond to local needs in designing research. Formal partnerships between universities in developing and developed regions may offer ways to mutually maximize strengths.

EVALUATION OF KNOWLEDGE EXCHANGE.—Integrating knowledge exchange into graduate student research and training is an adaptive learning process that could benefit from evaluation. While we have

focused largely on the reflections of graduate students, it is also important to provide opportunities for stakeholders to critically reflect on their experiences with knowledge exchange. Exploring the dual benefits and limitations of partnerships can inform strategies for improvement. During fieldwork, graduate students can ask for formal or informal feedback from recipient partners as to the effectiveness and perceived benefits of knowledge exchange activities. Academic programs can request feedback from graduate students and partners through written evaluations, focus groups, or meetings.

CONCLUSION

Graduate students and the future of tropical biology and conservation would benefit from institutional incentives that encourage knowledge exchange with local stakeholders. Research conducted by graduate students constitutes a considerable portion of research in tropical biology and conservation. As such, graduate students may also be interested in heeding recent calls for scientists to be more accountable to society. Many graduate students are enthusiastic about this topic and have opportunities to develop skills at an early career stage through information sharing, skill building, or knowledge generation with local stakeholders. Graduate programs in which collaborative research is the norm provide important platforms from which students can experiment with knowledge exchange in their research. There are challenges to balancing the needs of academia with those of local stakeholders, overloading an already dense graduate program, and creating expectations that not all students will be able to meet. Yet the benefits of enhancing local scientific capacity for improved conservation and generating research that is better grounded, more robust, and more responsive to local needs may be worth the risks associated with setting up this type of graduate training model.

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