



How Academia can Contribute to Biocultural Conservation

FOR EXTERNAL REVIEW

November 16, 2023

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PRESENTATION

The Tropical Conservation and Development Program ([TCD](#)) at the University of Florida (UF) has a long history of working collaboratively with communities, practitioners, and other local organizations to bridge academic and practical ways of knowing and contribute to effective implementation of conservation linked to human well-being. Notable examples include MERGE and Working Forests in the Tropics. A recent major TCD project on [Governance and Infrastructure in the Amazon \(GIA\)](#) demonstrated the lead role that forest and riverine peoples play in effective protection of the landscapes where they live and have sovereign rights. They have done this from time immemorial, not as “conservationists” but inherently to their way of life and conception of themselves.

In dialogue with GIA partners, especially community leaders, about how to build on the project’s first phase, we got a clear message that they did not see themselves as “beneficiaries” of knowledge and training provided by academia, but as partners in a reciprocal exchange of knowledge and experiences (“*diálogo de saberes*”). Embedded in this discussion was a challenge to equalize power relations between forest communities and outside supporters, including academia (Sabo et al. in prep.). In response, we convened thematic working groups and a “Voices from the Forest” workshop to integrate academic and Indigenous worldviews and create a shared vision of conservation ([video](#), [project concept](#)).

This trajectory aligned us with the emerging field of biocultural conservation, and motivated TCD and the GIA team to deepen our conceptual understanding of biocultural conservation, learn about its implementation in practice, and assess needs and opportunities for academia to effectively contribute to biocultural conservation. Over the past year, with support from the Gordon and Betty Moore Foundation and the UF Office of Research, a working group of UF/TCD faculty and students conducted an extensive review of academic literature; reviewed and consulted leading academic programs; reviewed past TCD programs and interviewed TCD alumni. Finally, to assess specific needs and opportunities in the Amazon region, we consulted leaders of Indigenous community organizations, NGOs who work closely with communities, and regional academic programs.

This report explores how universities can work in partnership with “front-line conservationists” to enhance their effectiveness for long-term impact. It provides general lessons, guidance and recommendations for how academic programs can effectively support a biocultural approach to conservation. Our point of departure is the TCD literature review on “Biocultural conservation: conceptual understanding and practical implications” (Fonseca et al. in prep.). An internal follow-up document provides specific recommendations for how UF/TCD can apply these practices in the Amazon-Andes region. These reports are presented as a point of departure to assess possible future actions and collaborations among the academic community, practitioners, community leaders, and funders. We look forward to feedback and continued discussion.

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EXECUTIVE SUMMARY

The purpose of this paper is to provide analysis and recommendations on how academia can contribute to effective Biocultural Conservation in practice. We start from **two fundamental premises of biocultural conservation** (Fonseca et al. in prep):

- *Interdependence of biological and cultural diversity. Effective conservation requires integrated conservation strategies across biophysical and cultural realms (knowledge systems, spirituality, language).*
- *Indigenous (or community) agency and empowerment. Local communities with sovereign territory and a strong sense of identity, place and social integration are the key protagonists of biocultural conservation.*

Biocultural approaches can expand existing conservation frameworks by identifying and honoring the relationships between people and other parts of nature, offering actions based on conservation priorities and cultural values aligned with local priorities (Maffi 2010; Gavin et al. 2015). Rather than breaking the relations between people and other parts of nature, there is the need to include a larger range of worldviews, knowledge, and values that capture place-based relationships that support social–ecological systems over the long term (Sterling et al 2017; Reyes-Garcia et al. 2022).

Since academia is not a direct implementer of biocultural conservation but can play a supporting role, we consider how academia can support **5 key strategies for the implementation of biocultural conservation**¹:

- *Indigenous (or community) empowerment and agency*
- *Collaboration and partnership*
- *Knowledge*
- *Territorial/resource/species management*
- *Rights and Governance*

Effective implementation of biocultural conservation is based on empowerment and agency by Indigenous (and other traditional) communities. Furthermore, these groups can be supported through appropriate partnerships; knowledge production and application is an important contributing factor; communities implement biocultural conservation through territorial and resource management; and governance is the key factor that enables or limits this local action.

Both conceptual and practical considerations highlight empowerment and agency of local communities. The role of academia must be seen as supporting these “front line conservationists,” with implications for the nature of collaborative relationships, the focus and approach to knowledge, and the purpose and goals of their activities. **Our fundamental premise is that**

¹ As identified by a literature review on how to effectively implement biocultural conservation, Fonseca et al. in prep.

academia must incorporate and address the needs and interests of potential community partners.

Academia is primarily engaged with production and dissemination of knowledge. The foregoing considerations emphasize that knowledge must be co-constructed and thus transdisciplinary. Furthermore, the way that academia works interactively with Indigenous and traditional communities must be productive for all and contribute to both short and long-term outcomes. Synthesizing these considerations, we propose a **framework of three key dimensions of an academic approach to biocultural conservation:**

1. *Collaborative:* Foster partnerships and collaboration to leverage resources, expertise and networks; awareness and addressing of power relationships. In the case of academia, fundamentally addressing relational power calls for co-designing and co-implementing research, education and capacity activities.
2. *Transdisciplinary knowledge:* Recognition, dialogue and integration of plural (academic and non-academic) forms of knowledge, worldviews, and ways of knowing.
3. *Impact oriented:* Address the needs of local communities, aiming for positive outcomes in the present while also increasing capacity for the future.

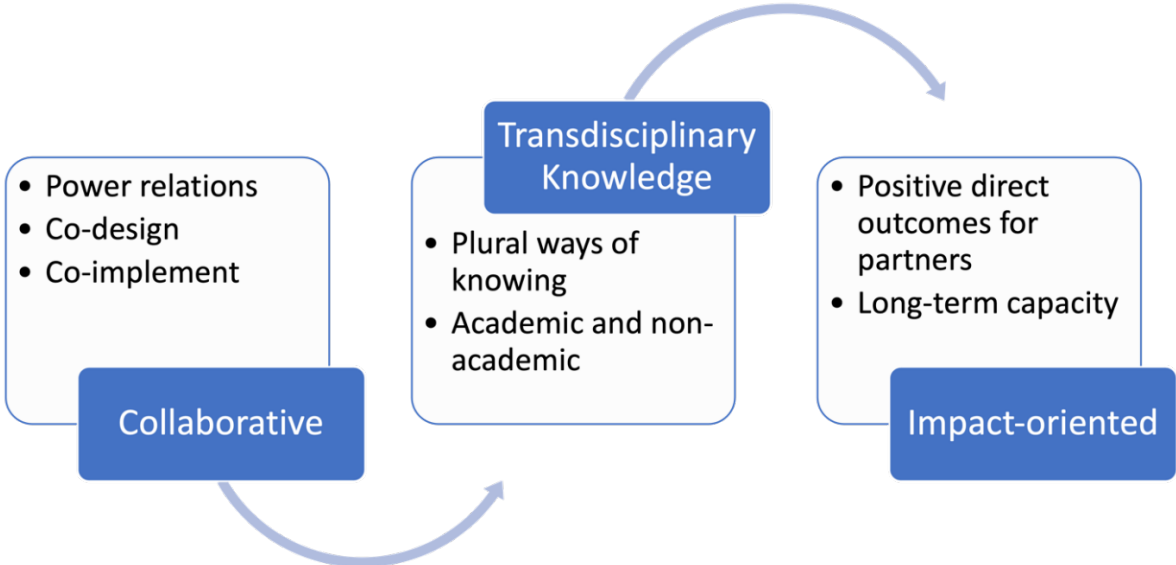


Figure 1: THEORY OF CHANGE for an academic approach to Biocultural Conservation. Academia works in partnership with Indigenous (and other local) communities; they co-produce knowledge; and this knowledge contributes to impact in terms of governance, territorial management, and/or capacity for long-term impact on governance and territorial management.

To effectively contribute to biocultural conservation requires academia to fundamentally rethink the way that research, education, and training are carried out: investing in partnerships, delegating power, rethinking forms of knowledge, and reframing goals. We recognize the institutional and structural obstacles to such transformative change, but cite many positive examples of effective practices and approaches, and recognize that incremental change can also make a positive contribution. This paper provides an in-depth review of a wide range of

literature and experiences (9 academic articles, 6 toolkits and programmatic guidelines, 8 leading academic programs in the field of biocultural conservation, and 5 prior UF/TCD programs) with diverse perspectives and examples on how academia can incorporate these principles into their approach and activities.

We present an analysis of lessons learned and best practices that emerge from this review, following the three key dimensions of collaboration, transdisciplinarity, and impact-orientation. We find that collaboration calls for building trust and long-term relationships, addressing relational power with specific strategies for transparency and co-designing and co-implementing research, education, and capacity-building activities. Transdisciplinarity calls for proactively engaging with and learning from Indigenous and traditional knowledge, engaging with elders as teachers and mentors, co-production of knowledge, and place-based and experiential learning. Guidelines for being Impact-oriented include:

- Recognize that impact has multiple pathways, including capacity-building
- Prioritize and reward impact-oriented knowledge generation and capacity-building strategies
- Conceptualize scientists as interveners, and build capacity to engage with the public and participate in policy and decision-making processes
- Envision research application as a social process that engages science, not a scientific process that engages society
- Focus on impact throughout the process, not only on application of results

Advancing in these dimensions requires development of specific interpersonal and professional skills that are not commonly taught in schools and universities, including cultural proficiencies, negotiation, communication, leadership, empathy and listening.

To consider how UF/TCD can apply these practices in the Amazon-Andes region, we consulted UF partners from academia, NGOs and community organizations in Colombia, Ecuador, Peru, Bolivia and Brazil about their interests and vision for potential future collaboration with UF/TCD. The approaches and recommendations from this report can be applied to the specific needs and opportunities identified in the Amazon-Andes region through an integrated set of activities that include:

- Structured **teaching content** on specific dimensions of biocultural conservation, as well as related “soft skills” needed by practitioners.
- **Participatory research** aimed at documenting and solving specific challenges of biocultural conservation that communities are facing.
- Hands-on, real-world, solution-oriented **application projects** that integrate learning and knowledge with ongoing practice and agendas.
- Working groups for cross-site, cross-sector **exchange and synthesis**.

Effective implementation of this program in partnership with community organizations, NGOs, and regional universities could contribute to current efforts and long-term capacity for biocultural conservation on 11 million hectares of forests and riverine corridors in Indigenous Territories, protected areas, and municipalities.

I. INTRODUCTION

A. Wicked Problems and Transformational Education

As global changes are continuously affecting urban and rural livelihoods, ecosystems, and biodiversity, humanity must find solutions for ever-more complex and uncertain “wicked” challenges. These can occur at multiple scales, but include global challenges such as climate change, loss of biodiversity and ecosystem services, poverty and socio-environmental justice. “Wicked” problems are characterized by being embedded in dynamic, complex systems with many non-linear interdependencies (Game et al 2014) and are further complicated by the fact that multiple stakeholders have different values, interests and perceptions of the problem and the solution. This leads to (i) outcomes that are valued differently across society; (ii) differential benefits and burdens; (iii) scientific uncertainty; (iv) interactions that are uncontrolled in space or time; and (v) an urgency to act despite such uncertainty (NSF 2018; Stern 2005).

If we intend to successfully tackle these grand challenges, then our approaches to scientific practice and education must account for these wicked realities. Kawa et al. (2021) call for a “wicked science” that produces wicked solutions to these wicked problems, and to rethink the role of academia and the structure of graduate education. To embrace complex systems, academics must look beyond their respective fields and collaborate with diverse research teams from multiple disciplines. Furthermore, they must also be “transdisciplinary” i.e. engage directly with diverse stakeholders and integrate multiple forms of knowledge. Just and equitable transdisciplinary research methods and partnerships are key to this concept of “wicked solutions.”

Engaging in complex situations with diverse stakeholders and worldviews requires engagement by students, decision-makers, community representatives, citizens and society in general. The role of universities is crucial here, as higher education can shape students’ views about distinctive stakeholders, strengthen values for improved collaboration and problem-solving, and prepare citizens and leaders who can take action to address these complex challenges. This applies to both knowledge generation and education at multiple levels: undergraduate, graduate, continuing education, training and extension.

Interdisciplinary and transdisciplinary programs are progressively more frequent in higher education (Pennington et al. 2019). They connect researchers of different disciplinary backgrounds (multidisciplinarity), or researchers and other stakeholders with plural ways of thinking and knowing (transdisciplinarity) to explore distinctly identified problems of shared interest and understanding. Innovative new academic programs are needed to build on these experiences and generate knowledge systems and skills to tackle this complexity and work towards transformative change.

Transformational education promotes "a more expansive way of thinking and consideration of diverse perspectives," allows for greater willingness to question assumptions and explore new ideas, promotes collaborative learning experiences, sharpens critical thinking and problem-solving skills (Journal of Transformative Education). It is not just informational but aims to deepen understanding, foster integrative thinking and action, and shift moral and spiritual values toward an ethos of caring for one another as well as land, water, and resources.

To put these ideas into practice, future professionals need to have both deep disciplinary training and the necessary soft skills to collaborate effectively with diverse teams of researchers and stakeholders. At the core of collaborative practice lies careful planning and preparation, along with the determination to build strong interpersonal relationships and cultural awareness for productive engagement with stakeholders (Huntington et al. 2011). Diverse interpersonal and professional skills to collaborate successfully with complex teams with a stake in a specific problem or issue include negotiation, strategic communication through different modalities, respectful collaboration, ethics, multi-lingual proficiency, and using a systems-thinking approach that considers roles, interests, and perspectives of stakeholders. Surveys, interviews and focus groups of TCD alumni demonstrate that newly formed young professionals are demanding new, improved, disciplinary training and transdisciplinary skills needed to embrace an uncertain and complex future (see reports by Gouveia 2023, Jordão and Montero 2023).

B. Applying Wicked Science and Transformational Education to Biocultural Conservation

This paper explores how these innovative approaches for science and education can be applied to biocultural conservation. For over thirty years, the University of Florida Tropical Conservation and Development Program (TCD) has excelled in training future leaders on the problems and solutions of tropical development through interdisciplinarity, collaborative research, and capacity-training. TCD has a robust history bridging theory and practice to advance biodiversity conservation, sustainable resource use, and human well-being in the tropics and elsewhere (<https://uftcd.org/>). TCD is now interested in exploring how it can better respond to the wicked problem of biocultural conservation (BCC).

Based on our literature review and conceptual understanding of biocultural conservation (Fonseca et al. in prep.), we identify **two fundamental premises of biocultural conservation**:

- *Interdependence of biological and cultural diversity. Effective conservation requires integrated conservation strategies across biophysical and cultural realms (knowledge systems, spirituality, language).*
- *Indigenous (or community) agency and empowerment. Local communities with sovereign territory and a strong sense of identity, place and social integration are the key protagonists of biocultural conservation.*

Biocultural approaches can expand existing conservation frameworks by identifying and honoring the relationships between people and other parts of nature, offering actions based on conservation priorities and cultural values aligned with local priorities (Maffi 2010; Gavin et al. 2015). Rather than breaking the relations between people and other parts of nature, there is the need to include a larger range of worldviews, knowledge, and values that capture place-based relationships that support social-ecological systems over the long term (Sterling et al. 2017; Reyes-Garcia et al. 2022). Reyes-Garcia et al. (2023) reflect on the importance of adopting biocultural conservation as a guiding framework for assessing academia's role in invoking transformative change. The biocultural conservation approach, or community-based conservation in general, promotes

individual and collective choices that can move political will toward protecting and enhancing the biocultural conservation vision.

Our literature review of academic experiences and research aimed at the implementation of biocultural conservation (Fonseca et al. in prep.) identified **5 emergent themes for the implementation of biocultural conservation:**

- *Indigenous (or community) empowerment and agency*
- *Collaboration and partnership*
- *Knowledge*
- *Rights and Governance*
- *Territorial/resource/species management*

Communities are embedded within multi-scalar legal, policy, economic and governance systems, and biocultural conservation is a long-term process. Therefore, the needs and opportunities for academia to contribute to biocultural conservation are wide-ranging, calling for bi-directional and multi-directional linkage and collaboration between academia, communities, local government, regional and national governments to address biophysical, sociocultural and governance challenges.

Both conceptual and practical considerations of biocultural conservation highlight empowerment and agency of local communities. The role of academia must be seen as supporting these “front line conservationists,” with implications for the nature of collaborative relationships, the focus and approach to knowledge, and the purpose and goals of their activities. **Our fundamental premise is that academia must incorporate and address the needs and interests of potential community partners.**

Academia is primarily engaged with production and dissemination of knowledge. The foregoing considerations emphasize that knowledge must be co-constructed and thus transdisciplinary. Furthermore, the way that academia works interactively with Indigenous and traditional communities must be productive for all and contribute to both short and long-term outcomes.

Synthesizing these considerations, we propose a **framework of three key dimensions of an academic approach to biocultural conservation:**

1. *Collaborative:* Foster partnerships and collaboration to leverage resources, expertise and networks; awareness and addressing of power relationships. In the case of academia, fundamentally addressing relational power calls for co-designing and co-implementing research, education and capacity activities.
2. *Transdisciplinary knowledge:* Recognition, dialogue and integration of plural (academic and non-academic) forms of knowledge, worldviews, and ways of knowing.
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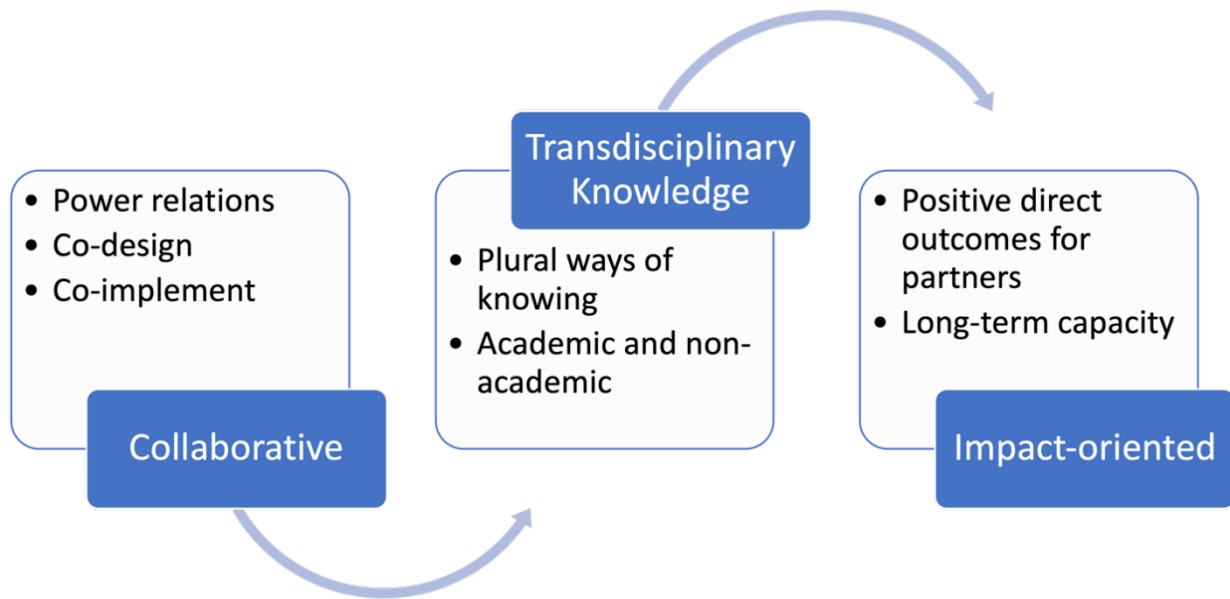


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We use this framework to structure our analysis and presentation of principles, new approaches, and best practices for how we can incorporate a biocultural approach into academia to effectively contribute to addressing Biocultural Conservation as a potential solution to the interconnected challenges of climate change mitigation, biodiversity protection, and socioenvironmental justice.

In the following section, we review a wide range of literature and experiences that provide diverse perspectives and examples on how academia can incorporate these principles into their approach and activities. We conclude this report with an analysis of lessons learned and best practices that emerge from this review, following the three key dimensions of transdisciplinarity, collaboration and impact-orientation (section III).

In a subsequent internal report, we explore how UF/TCD could apply the findings and recommendations of this study in the Amazon-Andes region. As further input, we consulted UF partners from NGOs and community organizations in Colombia, Ecuador, Peru, Bolivia and Brazil about their interests and vision for potential future collaboration with academia, and university partners from the Amazon region about their interests and challenges for addressing this agenda. We then present an integrated set of activities that illustrate how the approaches and recommendations from this report can be applied to the specific needs and opportunities for biocultural conservation on 11 million hectares of forests and riverine corridors in Indigenous Territories, protected areas and municipalities.

II: REVIEW OF EXPERIENCES TO LEARN FROM AND BUILD UPON

We consulted many sources of information on strategies and approaches for academia to support biocultural conservation:

- Academic literature on applied research and collaboration, in particular articles which present sets of principles relevant to research, collaboration, and impact in partnership with local actors.
- Guidelines and toolkits for effective partnerships with communities, especially those that were community-led.
- Review and consultations of leading academic programs that focus on biocultural conservation (mainly from North America).
- Experiences of prior UF programs such as Managing Ecosystem and Resources with Gender Emphasis (MERGE), Working Forest in the Tropics (WFT) and Governance and Infrastructure in the Amazon (GIA).
- A consultation of TCD alumni regarding how their UF education contributed to effective conservation and development practice, plus opportunities for improvement.

In this section we summarize approaches and lessons from each source, as a basis for the synthesis of overall findings and recommendations for academia to contribute to biocultural conservation that is presented in section III. We organize our review and analysis according to our framework of three dimensions for academia to contribute to biocultural conservation, *collaboration, transdisciplinary knowledge, and impact orientation*.

A. Review of Academic Literature

We conducted an extensive literature review of 52 academic articles and six websites that address academia's interactions with communities and other stakeholders in the broad context of sustainable development. We selected eight articles that present guiding principles and best practices that could be applied to biocultural conservation, and assess how these contribute to the collaborative, transdisciplinary, and impact-oriented dimensions of applied research and knowledge production (Table 1).

We begin our assessment with Keahey (2020) who provides an interdisciplinary toolbox of methods for research and action based on sustainable development participatory action research. Participatory action research (PAR) provides an effective framework for relating different knowledges, conducting interdisciplinary and international research collaborations, and linking quantitative and qualitative research paradigms. For example, involving local-expert knowledge to attain transdisciplinary understanding, PAR scholars must share power, reconcile different attitudes toward truth, handle the complexity of collecting data across multiple scales, and work with grassroots to innovate solutions to complex problems.

HIGHLIGHTED GUIDING PRINCIPLES - KEAHEY 2020:

- Integrate different knowledge systems
- Work with marginalized communities to reclaim their values and beliefs
- Equalize power imbalances (co-researcher partnerships)
- Share what is learned together in an engaging format

Norström et al. (2020) present a set of four comprehensive principles for high-quality knowledge co-production in sustainability research: (1) context-based; (2) pluralistic; (3) goal-oriented; and (4) interactive. Using these principles, the authors provide practical guidance on how to engage in co-productive practices, and how to evaluate quality and success. Knowledge co-production begins with a collaborative stage of trust building and problem framing (based on specific social, economic, and ecological contexts), through knowledge generation, to a phase of exploring the practical impacts of the process. Co-production methods tend to generate more than just knowledge; for example, they develop capacity, build networks, foster social capital, and implement actions that contribute to sustainability.

This approach echoes some of the principles of participatory action research (PAR), including integrating the concepts of action and reflection throughout the process. The approach promotes co-designing research questions and activities with community members, recognizing and respecting the skills, knowledge, and value that the community members add, identifying and addressing power imbalances, working with the community to generate benefits for the participants, and ensuring that the research generates actionable findings that can lead to positive changes in the communities.

HIGHLIGHTED GUIDING PRINCIPLES - NORSTRÖM ET AL. 2020:

- Co-production processes should be contemplated and placed within the specific social, economic, and ecological contexts in which they are rooted.
- Co-production of knowledge must clearly recognize multiple ways of knowing and doing.
- Knowledge co-production is problem-focused and benefits from openly defined and meaningful goals and changes shared among participants.
- Co-production requires frequent interactions among participants throughout the process.

Krystalli et al. (2021) talk about four interrelated principles to improve the process of conducting applied research — (1) respectful; (2) relevant (3) right-sized; and (4) rigorous, consistent with the standards and best practices of the disciplines, methodologies, and methods in question. These authors also rely on PAR principles, as well as participatory “human-centered” design (IDEO 2012), co-design, and co-creation approaches. They introduce a framework that incorporates these principles and address the ethical and methodological dilemmas that may occur in the process of its application. For example, how to gain insight into how humans experience the research process, since applied research goes beyond how humans affect land, environment, and resources. The fundamental element of reflexivity is a key component here, questioning one’s assumptions and perspectives.

HIGHLIGHTED GUIDING PRINCIPLES – KRYSTALLI ET AL. 2021:

- Applied research is respectful toward all engaged in the research process
- Applied research is relevant to research participants, decision-makers, and key stakeholders.
- Applied research is right-sized and rigorous.
- Applied research is a process that needs to be reflected on in terms of one’s footprint, assumptions, and perspectives.

The principles laid out by Haelewaters et al. (2021) are meant as a counterpoint to what is known as helicopter science, also called parachute science or colonial science (Putz 2022; Giller 2020; Minasny and Fiantis 2018; de Voss, 2020). These terms denote the dominance of the Global North approach to science. For example, Burivalova and Rayadin (2022) emphasize the power imbalances derived from the hegemony of English in scientific literature, funding disparities, unequal access to information, differing priorities and research cultures. Consequences include lack of proper research acknowledgements to local scientists, field researchers and assistants; even worse, research may remain unavailable to local communities and others who contributed substantially.

To counterbalance helicopter science, Haelewaters et al. (2021) suggest 10 simple rules for better, collaborative, and non-colonial science between the Global North and the Global South. Most of the principles are categorized under collaborations and partnerships and provide relevant guidelines to be used within any practices of research and collaboration. Several other authors provide further insight and reflection on fair and productive collaboration. For example, Prescott and Stibble (2020) bring in the term of “true partnership” that is guided by principles of sharing, trust, equality, reciprocity, ownership, and respect. For Halbreich et al. (2019), shared visions, agendas, and priorities are also key components for successful global partnerships.

In terms of the impact-oriented dimension, a notable strategy mentioned is the incorporation of capacity building components. Furthermore, biocultural conservation practitioners specifically emphasize critical, reflexive, and decolonial practice (de Vos, 2022). This requires pluralistic approaches and negotiation of power structures in relationships among collaborators.

HIGHLIGHTED GUIDING PRINCIPLES - COLLABORATIVE AND NON-COLONIAL SCIENCE BETWEEN THE GLOBAL NORTH AND GLOBAL SOUTH – HAELEWATERS ET AL. 2021:

- Promote equal, open, synergistic, mutually beneficial, and meaningful collaboration
- Set co-creation of research as a priority
- Abide by local written and unwritten rules
- Be respectful for the local land and people
- Be ethical and fair about publications and authorship
- Foster local dissemination of research considering local language and local media

Chambers et al (2021) present an analysis of six modes of co-production defined by how the purpose of co-production is framed, how power is conceptualized, how politics is approached, and how impact pathways are theorized. The first mode, “researching solutions,” calls for a more “investigative method” for practical scientific knowledge production to influence policies and interventions. Mode 2 addresses “empowering voices” of marginalized actors and including greater social diversity and initiatives of local and Indigenous communities. Mode 3, “brokering power,” intends to find common ground with powerful actors by promoting dialogue to achieve solution actions to challenging problems. Similarly, Mode 4, “reframing power,” deals with powerful actors but intends to advance power to benefit marginalized social actors and in some way alter practice and policy. Mode 5, “navigating differences,” focuses on exploring conflicts and reframing perspectives, through relating together, learning and empowerment. Finally, Mode 6, “reframing agency” aims to provide safe spaces for engaged, impact-motivated actors.

The framework presented by Chambers seeks to cultivate flexibility and reflexivity that enables researchers and practitioners to plan as well as improvise what action is required in their situation. For example, Chambers puts forward the term ‘co-productive agility’ as an evolving element fundamental for directing conflicts into transformations. Co-productive agility describes the disposition and capability of diverse actors to iteratively participate in reflexive dialogues to find consensus on shared ideas and actions that would not have been possible otherwise. It depends on knowledge production within processes of change to continuously identify, relocate, and navigate tensions and opportunities. Co-productive agility offers various options to transformation: (1) uplifting marginalized agendas in ways that maintain their integrity and broaden struggles for justice; (2) questioning dominant agendas by embracing power in ways that challenge assumptions, (3) navigating conflicting agendas to actively transform interwoven practices and structures; and (4) exploring diverse agendas to foster learning and mutual respect for a plurality of perspectives.

This frame of analysis inspires researchers and societal actors for more reflexive co-production design and practice, based on relating together, learning and empowerment, and generating practical knowledge to change and influence practices and policies.

HIGHLIGHTED GUIDING PRINCIPLES – CHAMBERS ET AL. 2021:

- Research solutions
- Empower voices
- Broker and reframe power
- Navigate differences
- Reframe agency

Toomey et al. 2016b emphasize the need to reframe the current understanding of the research-implementation gap. Rather than producing the “best available evidence” to fill “a gap” they conceptualize impact as a continuous social and policy process (see also Pullin et al. 2004). For these authors, scientific research is a socioeconomic activity loaded with power relations, cultural understandings (or misunderstandings), social interactions, and political consequences. Values, knowledge, and behaviors are to be acknowledged, understood, and given due recognition during the process of conducting research. They highlight research as “a social process that engages science, not a scientific process that engages society.” This directly points to the importance of thinking about who is involved in the production of knowledge and what knowledge is produced. The conceptualization laid out by Toomey et al. (2016) can be linked to biocultural conservation since it provides a framework for adapting research to have direct relevance to outcomes that can be implemented by partners. The framework incorporates diverse ways of “knowing and doing,” and in turn calls for a focus on thinking and skills that enable practitioners to address these complexities and challenges.

HIGHLIGHTED GUIDING PRINCIPLES – TOOMEY ET AL. 2016B:

- Identify and understand by whom and for what knowledge is produced
- Reconceptualize the research-implementation gap
- Implement conservation as a social process that engages society, not as a scientific process that engages society

Gavin et al. (2015) clearly explain the meaning of biocultural approaches as those that start and build on place-based cultural perspectives, recognize feedback between ecological state and human well-being, and embrace values, knowledge, and needs. Implementing a biocultural approach and translating theory into practice involves respect for knowledge and practices, traditional lands, self-determination, and strong working relations based on trust and open communication.

HIGHLIGHTED GUIDING PRINCIPLES – GAVIN ET AL. 2015:

- Recognize the existence of multiple knowledge systems
- Respect the right to self-determination
- Respect traditional lands, territories, and resources
- Respect local knowledge and practices
- Create equitable sharing of benefits, cost, and power
- Vest human resources and capacities
- Establish long-term relation-building
- Maintain strong working relations based on trust, accountability, and open communication
- Foster social learning
- Build inclusive governance
- Develop conflict management and communication skills
- Establish functioning innovative institutions (transfer of power)
- Create context-specific conservation (social-political)

Table 1. Principles for achieving collaboration practices, knowledge generation, and impact: A literature review

Sources	Collaboration	Transdisciplinary Knowledge	Impact-Oriented
Keahey 2020 Sustainable Development participatory action research	Equalize power imbalances	Integrate different knowledge systems	Develop sustainable solutions
	Establish fully collaborative co-research partnerships with grassroots co-investigators	Work with marginalized communities to recover their values, traits, beliefs, and arts.	Diffuse and share what is “learned together in an understandable and engaging format”
	Remain receptive to counternarratives that support struggles for justice and transcend elitist vision		Incorporate arts for action
Norström et al. 2020 Knowledge co-production	Develop interactive collaboration	Focus on context-based co-production	Emphasize problem-focused and goal-oriented solutions
		Create pluralistic knowledge	
Krystalli et al. 2021 Applied research	Be respectful toward participants, data collectors, implementing partners, and all others engaged in the research process		Generate actionable findings
	Be right sized in terms of the footprint of the data collection activities		Produce research relevant to participants, decision-makers, and other key stakeholders
Haelewaters et al. 2021 Collaborative non-colonial science	Establish “win-win” collaboration and equal partnership		Incorporate a capacity-building component
	Communicate actively with the Global South to initiate meaningful collaboration		
	Establish collaborations that are synergistic and mutually beneficial		
	Prioritize co-creation of research ideas		
	Abide by local written and unwritten rules. Be respectful. Show culturally appropriate behavior, engagement, and respect for the local land and people		
	Recognize and embrace differences in working culture		
	Instill non-colonial collaborative research practices early on		
	Use local infrastructure		
	Be ethical and fair about publications and authorship		
Make research available through local dissemination considering local languages and local media			

Prescott and Stibble 2020 True Partnership	Share vision, agreed as much as possible by stakeholders		
	Share goals and priorities		
	Be a system leader, a person who catalyzes collective leadership, “who has the ability to think, lead and act beyond organizational boundaries”		
Halbreich et al. 2019 Partnership well-being	Find common denominators, shared vision, agenda, and priorities	Build operational implementation and sustainable interdisciplinary partnerships	Follow leadership that leads to concrete action
	Establish convincing and achievable goals	Build coalitions of professional specialists in multiple areas of expertise	
Chambers et al. 2021 Reflexive co-production design and practice	Relate together	Reframe agency	Empower marginalized voices, supporting initiative of local and Indigenous communities
	Build trust across power differentials	Foster learning for a plurality of perspectives	Research solutions and empower research knowledge
	Broker and reframe power, through dialogue with powerful actors and marginalized communities	Create safe spaces to allow the expression of different forms of knowledge	Create reflexive dialogue for learning
	Navigate differences, connect diverse stakeholders to explore conflict and reframe problems		Influence practice and policies
	Engage in multi-scale, long-term action and supportive funding arrangements		
Toomey et al. 2016b Research Implementation Gap		Identify and understand by whom and for what knowledge is produced.	Reconceptualize the research-implementation gap
			Implement conservation as a social process that engages science, not as a scientific process that engages society
Gavin et al. 2015 Actions and preconditions	Create equitable sharing of benefits, cost, and power	Recognize the existence of multiple knowledge systems	Foster social learning
	Vest human resources and capacities	Respect the right to self-determination	Build inclusive governance
	Establish long-term relation building	Respect traditional lands, territories, and resources	Establish functioning innovative institutions (transfer of power)
	Maintain strong working relations based on trust, accountability, and open communication	Respect local knowledge and practices	Develop conflict management and communication skills
			Create context-specific conservation (social-political)

B. Guides and Tools to Support Just and Productive Partnerships

The foregoing review of academic literature, mostly from the Global North, aspires for improved research and collaboration so that science and conservation is based on equitable partnerships that address on-the ground priorities, benefit all parties involved, and result in positive research, learning and conservation outcomes. Achieving equitable conservation partnerships requires practices that build trust and long-term commitment, fully acknowledging that partnerships are built, earned, and maintained, not assumed and handed over. To further learn how to implement these practices, we identified and reviewed a set of operational frameworks meant to guide such partnerships (Table 2).

Examples from local communities that have addressed unequal partnerships and come up with rules and approaches for respectful interactions with researchers include the [San Code of Research Ethics](#) and the [Institutional Review Board of the Cherokee Nation](#) (Putz 2022). The San Code of Ethics is a response to a publication on the first human genome sequence from Southern Africa published in Nature without properly complying with ethical requirements and free, prior and informed consent (Schuster et al. 2010). The Cherokee Nation aims to ensure protection of the rights and welfare of tribal members involved in research projects. These measures should ensure collective permission for research, acknowledge and embrace Indigenous core values, and guide how to approach local communities.

Other guides and tools have been developed as practical resources for high impact multi-stakeholder partnerships. For example, the [Scotland Malawi Partnership](#) is a large and diverse coalition of organizations and individuals that has curated a living resource of “[Partnership Principles](#)” guided by an ambition for “dignified partnerships.” Each principle includes references to academic articles, research reports, or template project tools to support further reflection and inquiry.

[Nesta](#), the UK-based innovation foundation, have produced a “[Partnering Toolkit](#)” (Tennyson, 2011) that guides how knowledge should be constructed, translated, and spread for multiple audiences.

With a more critical approach, the Power Awareness Tool (The Spindle 2020) developed by Partos, a Dutch NGO network, focuses on analyzing the power dynamics in partnerships across geopolitical and sector contexts. Furthermore, the Commission for Research Partnerships with Developing Countries (KFPE) produced a guide for researchers considering or planning to engage in fair and equal partnerships towards common goals. The KFPE’s guide for Transboundary Research Partnership is intended to provide recommendations for knowledge generation, mutual trust building and learning, and shared ownership. KFPE’s guide includes 11 Principles and seven Questions (Stöckli et al. 2018). The seven questions are designed to support implementing the 11 principles effectively, trigger debate, and acknowledge driving forces that hinder or enable partnerships such as faith and cultural customs, discourses, research facilities, financial and physical security, and access to technologies. In addition, the principles should facilitate a better translation of scientific knowledge into benefits for society. Using links to animations and further references, this resource offers a much more inclusive and plural perspective on partnerships and

has been cited frequently in funding calls in Europe as a resource to support the development of funding proposals.

The Kūlana Noi'I research standards developed by the University of Hawai'i, He'eia National Estuarine Research Reserve, and the local non-profit Kua'āina Ulu 'Auamo (Braddock and Gregg 2021) are a great example of how to promote collaborative, mutually beneficial knowledge exchange between researchers, natural and cultural resource professionals, and the communities who care for and rely on local resources. The Kūlana Noi'i, or research standards, provide guidance on how researchers can build and sustain more effective partnerships and long-term relationships with communities. While representing a uniquely Hawaiian perspective, these standards address a common disconnect between institutional research initiatives, resource managers, and community stakeholders. The guidelines include a summary of best practices and patterns that have been successful at the community and research levels collected from insights of the KUA Research Committee, Moloka'i Climate Change Collaboration, and a literature review of other collaborative research efforts in Native Hawaiian, Native American, and Aboriginal Canadian communities (Kūlana Noi'i 2021). The Kūlana Noi'i standards include: respect for people and place, reciprocity between researchers and community members, self-awareness of intentions and power of individuals and institutions, transparent and inclusive communication, maintaining a long-term focus, community engagement and co-production of knowledge, community ownership and access to knowledge, and accountability to the Kūlana Noi'i.

Table 2. Principles for achieving collaboration practices, knowledge generation, and impact: A review of Guides and Tools for just and productive partnerships (Encouraged by local organizations and global foundations)

Reference	Collaboration	Transdisciplinary Knowledge	Impact-Oriented
San Code of Research Ethics	<p>Provide early identification of research useful to the community</p> <p>Jointly develop the design, content, methodology of all aspects of the research</p> <p>Develop culturally appropriate plan to share benefits, agreed by all relevant stakeholders</p> <p>Carry out pre-publication consultation</p> <p>Request community assent and individual consent for the use of knowledge or material</p> <p>Compensate local communities and researchers for support</p> <p>Undertake research upholding the high regulatory standard of own country even if non-existent in local setting</p>		Provide post-publication feedback to the community
Institutional Review Board of the Cherokee Nation	<p>Ensure collective permission for research</p> <p>Refrain from using a pan-Indian design or a checklist approach of cultural adaptations</p> <p>Commit to sustained process of relationship building, cross-cultural learning, and reciprocity</p> <p>Get a tribal sponsor who will support the scientific research activities</p> <p>Learn the historical context of research of Native communities and the role of research in the specific tribe</p>	<p>Acknowledge and embrace Indigenous core values</p> <p>Acquire in-depth knowledge and understanding of the cultural and political dynamics of the tribe</p> <p>Acknowledge each tribe as their own sovereign nations with their own unique governments, traditional practices, and culture</p>	<p>Research must align with the agendas of the tribe or contribute to an under-researched need for its people</p> <p>Tribe will have data ownership over any collected data</p>

The Scotland-Malawi Partnership	Plan and implement together Behave appropriately and leave no one behind Respect, create trust and mutual understanding Be transparent and accountable Be effective and reciprocal Articulate a clear shared purpose	Reflect on power, ownership, and influence to ensure equity	Focus on sustainability Plan long-term Mitigate against unintended harm Build capacities
Partnering Toolkit” (2011) (Tennyson, 2011)	Identify clear opportunities for both parties to benefit Make equitable contributions to the partnership Build transparent, equitable and open relationships Ensure acceptable level of risk Find a facilitation guru, ensure diversity of input		
A Guide for Transboundary Research Partnerships 11 Principles and 7 questions Guide for equal and fair partnerships	Set the agenda together/Why work in partnership? Clarify responsibilities/What form of collaboration? Account to beneficiaries /Which foci and priorities? Promote mutual learning/Who to involve? Enhance capacities/Where to create relevance? Share data and networks/When to consolidate outcomes? Fairly share authorship, publication, patents, other products		Disseminate and apply results into relevant and meaningful outcomes Secure outcomes by long term support and funding

<p>Eight Central Themes of the Kūlana Noi'i. (Research Standards)</p> <p>Braddock and Gregg 2021</p>	<p>Be reciprocal rather than extractive in relationships</p> <p>Instill self-awareness and capacity: Intentions, power, and value to the place</p> <p>Build communication: Be inclusive, transparent, and open</p> <p>Promote co-learning and co-development of methods, strategies, goals/objectives, and outputs/outcomes adaptable to local place, people, climate, resources, and needs for community engagement and co-review</p> <p>Respect knowledge ownership and provide access</p> <p>Identify problems and adjust the research to meet principles for improved accountability</p>	<p>Respect, understand, acknowledge, and honor local culture, traditions, knowledge, and wisdom</p>	<p>Maintain a long-term focus: research should contribute positively to their care of place</p>
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C. Review and Consultation of Leading Academic Programs on Biocultural Conservation

We explored innovative education, research, and non-degree training at leading academic programs in biocultural conservation to document and learn from their experiences and practices. Saavedra (2023) provides a systematic review of these programs based on interviews, publications, and web sites. Here we present a brief overview of selected programs and consider how these programs address the three dimensions of our framework for how academia can contribute to biocultural conservation: collaboration and partnership, transdisciplinary knowledge, and impact-oriented results (Table 3).



University of North Texas/Sub-Antarctic Biocultural Conservation Master’s Program. This is a research-education-conservation program led by Dr. Ricardo Rozzi, and is a partnership between University of North Texas, Universidad de Magallanes, Chile and others. Dr. Rozzi is a prolific author on biocultural conservation

who emphasizes impact-oriented academic research and education (Rozzi 2013, Rozzi et al. 2006, Rozzi et al. 2018). The program produces many [publications](#) on biocultural conservation with special emphasis on the Sub-Antarctic region. Collaboration between participating universities and implementation activities by the Sub-Antarctic Biocultural Conservation Program ensures program impact based on interdisciplinary research on integrated biological and cultural aspects by a network of academic collaborators and an interregional dialogue between the Northern and Southern hemispheres.

Key elements that contribute to program effectiveness for advancing biocultural conservation – University of North Texas:

Collaboration	Strengthen respectful North-South collaboration Provide mentorship program Create network of collaborators Benefit from motivated expertise onsite (Ricardo Rozzi)
Transdisciplinary Knowledge	Provide course work related to biocultural conservation Generate different forms of knowledge in partnership with an outside university Require practical mandatory research experience
Impact-oriented	Develop innovative and creative forms of knowledge dissemination for different audiences



Colorado State University Master Leadership Program is a 1.5 year-long Master’s program which includes coursework and a collaborative, multidisciplinary, solution-based capstone project. The Program also offers a variety of extracurricular activities to foster experiential and project-based learning such as an immersion week when students forego classes and have the opportunity to immerse in a topic, meet experts, stakeholders, and/or carry out fieldwork. This professional program is solution oriented. The course work prepares students to work as “consultants” and the capstone project is the platform to apply the knowledge and skills learned.

Key elements that contribute to program effectiveness for advancing biocultural conservation – Colorado State University:

Collaboration	Provide exposure to diverse stakeholders Cohort-based learning community that supports network building, collaboration and learning
Transdisciplinary Knowledge	Offer interdisciplinary curriculum Access to cross-cultural experiences Provide experiential and project-based learning
Impact-oriented	Capstone project that is solution-oriented



SUNY College of Environmental Science and Forestry M.S., M.P.S. and Ph.D. in Indigenous Peoples and the Environment are led by the renowned professor and writer

Dr. Robin Wall Kimmerer who co-developed the program and its courses emphasizing braiding together traditional western science and Indigenous knowledge and perspective (see her best-selling and award-winning 2013 book [Braiding Sweetgrass](#)). Students in this program work in close collaboration with ESF Center for Native Peoples and the Environment, with a focus on biocultural restoration. The program has a formal agreement between the Center and the [Haudenosaunee Environmental Task Force](#), composed of delegates chosen by each of the Haudenosaunee Nations who are committed to identifying environmental problems in their communities and working to find solutions. SUNY ESF partnered with the A.P. Sloan Foundation in 2019 to create The Sloan Indigenous Graduate Partnership (Sloan Scholars, or SIGP Scholars) to support Indigenous graduate students as Indigenous environmental scientists pursuing STEM degrees.

Key elements that contribute to program effectiveness for advancing biocultural conservation - SUNY:

Collaboration	Benefit from motivated expertise onsite (Robin Kimmerer) Work in close collaboration with The Haudenosaunee Environmental Task Force
Transdisciplinary Knowledge	Integrate traditional Western science and Indigenous knowledge and perspectives Provide transdisciplinary approach with the Haudenosaunee Nation Offer interdisciplinary and biocultural coursework
Impact-oriented	Support Indigenous graduate students via partnership Solution-oriented focus on biocultural restoration Involved in advancing land rights and empower Indigenous Nations



University of Guelph Master of Conservation Leadership (MCL) is a 2-year hybrid Master’s program featuring biocultural conservation. Courses in the program involve learning from Indigenous elders or organizations. This program works in close collaboration with Conservation through Reconciliation Partnership, an NGO co-led by five Indigenous leaders and two academics from University of Guelph (Drs. Robin Roth and Faisal Moola), who are also leading the professional Master’s graduate program. The MCL Program uses a pedagogy called [“Two-Eyed Seeing”](#) (a concept created by Albert Marshall, Reid et al. 2020), and focuses on place-based education. In Mi’kmaq Elder Albert Marshall’s words, Two-Eyed Seeing or Etuaptmunk refers to “learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of western knowledges and ways of knowing – and learning to use both of these eyes together for the benefit of all.”

Key elements that contribute to program effectiveness for advancing biocultural conservation – University of Guelph:

Collaboration	Collaborate with Conservation through Reconciliation Partnership (CRP)
	Benefit from on-site expertise (Robin Roth and Faisal Moola)
	Promote an ethical and equitable program
	Develop Indigenous-led conservation initiatives
Transdisciplinary Knowledge	Provide training on relationship-building and negotiation
	Generate knowledge with Indigenous elders as learning component and transdisciplinary work with CRP
	Apply Two-Eyed Seeing Pedagogy
Impact-oriented	Offer placed-based education and courses that integrate biocultural conservation
	Integrate Indigenous students
	Train students as leaders
	Integrate solution-oriented projects



University of Hawai'i. Biocultural conservation training at the University of Hawai'i is dispersed across different departments/programs. Dr. Christopher Dunn (now at Cornell University) led the effort to establish a Center for Biocultural Studies at the University of Hawai'i which culminated in the [Biocultural Initiative of the Pacific](#), “a knowledge center and network linking scholars, instructors and students who share the common goal of thinking holistically to enhance understanding of biocultural systems.” The [Hawai'i Institute of Marine Biology \(HIMB\)](#) at the University of Hawai'i is leading important biocultural efforts. HIMB houses the [He'eia National Estuarine Research Reserve](#) that works to implement biocultural restoration of key habitats for future generations.

Key elements that contribute to program effectiveness for advancing biocultural conservation – University of Hawai'i:

Collaboration	Use network of collaborators Benefit from motivated expertise onsite (Eleonor Sterling (deceased) Christopher Dunn (former) and Rachel Dacks)
Transdisciplinary Knowledge	Offer biocultural systems - knowledge generation Establish Center for Biocultural Studies Integrate Indigenous knowledge in research, policy and decision making
Impact-oriented	Establish Biocultural Initiative of the Pacific as a space for learning and collaboration Train students in professional development and Indigenous leaders Conduct solution driven research



Terralingua

Terralingua is an NGO that carries out an integrative program of research, education and outreach, policy-relevant work, and on-the-ground action. Founded in 1996 by Luisa Maffi and David Harmon, their goal is to bring about a profound shift in human values to make sustaining biocultural diversity a primary societal goal acknowledging a just, equitable, sustainable world in which the biocultural diversity of life is valued, protected, and perpetuated for generations to come. [Terralingua](#) has engaged in a variety of projects to increase understanding of biocultural diversity and has developed tools to assess, document, and conserve it. They support Indigenous Peoples' and local communities' efforts to maintain and revitalize their ancestral languages, cultures, and connections with the land; have contributed to international policy; and raise awareness of biocultural diversity through educational initiatives and outreach publications, such as Landscape Magazine.

Key elements that contribute to program effectiveness for advancing biocultural conservation - Terralingua:

Collaboration	Create network of collaborators Benefit from motivated expertise onsite (Luisa Maffi) Promote multidisciplinary collaboration
Transdisciplinary Knowledge	Promote the integration of multiple ways of knowing
Impact-oriented	Use diverse media for promoting understanding and appreciation of world's biocultural diversity Support effort of Indigenous people to maintain their culture and language Promote and develop biocultural diversity curriculum



Field Museum of Chicago, Keller Science Action Center houses an interdisciplinary team of biologists and social scientists dedicated to translating museum science into action for conservation and the quality of life of local people. The team creates long-term strategies for integrating conservation, sustainable livelihoods, and local well-being through the implementation of rapid biological and social inventories grounded in a biocultural approach. The team provides the scientific support, including co-creation of “life plans” with local stakeholders, to protect areas of high biodiversity that local people and communities also want to keep healthy for future generations. They have been able to protect 28.9 million hectares in 22 years.

Key elements that contribute to program effectiveness for advancing biocultural conservation – Field Museum:

Collaboration	Foster empowerment	Create commitment
	Promote participation	Adopt inclusion
	Take decisions based on culture	
Transdisciplinary Knowledge	Integrate museum scientists with community knowledge and expertise	
Impact-oriented	Co-produce life plans for well-being of communities and nature	
	Translate museum science into action for conservation and quality of life of local people	
	Capacity-building for local stakeholders	
	Share rapid inventory data for conservation and management	



The Intercultural Maya University of Quintana Roo, Mexico (UIMQRoo) is the seventh of eleven intercultural universities established in

areas with high concentrations of Indigenous populations in Mexico. The intercultural model brings together the Western scientific knowledge of conventional universities and the Indigenous knowledge of Mexico’s various ethnic groups to expand possibilities for equitable and sustainable development (Schmelkes 2009). The underlying theoretical assumption of the UIMQRoo educational model is that there are different forms of learning and thus different systems of knowledge construction (Aguilar Pérez and Ortega Pérez 2008). Their coexistence and interaction provide a legitimate space to generate new knowledge and strategies for addressing local and global challenges. Trans-disciplinary collaborations are based on three distinct approaches to incorporating Indigenous knowledge. *Sabios locales* (local wise persons recognized by the community for their knowledge) act like faculty members; they participate in teaching and collaborate in student and faculty-led research. *Abuelos(as) tutores* (mentoring elders) are selected by each new student to guide him or her in learning the Maya language and appropriate behavior in community settings. University professors who teach Maya consider the opinion of *abuelos(as) tutores* in assigning grades. Finally, students receive training in the Maya language, in which the local culture constructs its knowledge, as well as two years of English as the international language of scientific communication. A cornerstone of the model is the Community Linkages Course, in which students apply insights and knowledge gained through the lens of interculturality to work on sustainable development projects in rural communities (often their own); students can adopt a participatory action research methodology or a conventional academic approach. Project development is a collaborative process in which students, faculty, and community members share their respective experiences and expertise to ensure that the projects address local needs and challenges. These field experiences are often incorporated into teaching or further research. The UIMQRoo educational model has positive effects on sustainable development and resource management policies and practices in the region. For more in-depth insights please refer to Burford et al. (2012).

Key elements that contribute to program effectiveness for advancing biocultural conservation UMIQRoo:

Collaboration	<p>Mandate Maya language - reflects knowledge, value, and culture Include community leaders as academic committee members Collaborate with "sabios locales" in teaching and research Establish mentoring system by elders as guiding force</p>
Transdisciplinary Knowledge	<p>Apply <i>Ka´anan Kax</i>, Indigenous ejido principle of care of the forest for future use Use different systems of construction of knowledge and forms of learning based on active local knowledge input Foster practical experience through sustainable management projects in rural communities Develop transdisciplinary collaboration between faculty members</p>
Impact-oriented	<p>Follow community perception of environmental changes in Ejido natural resource management and strategic decisions Recognize Indigenous heritage by law Institutionalize the Intercultural University System Translate academic research projects into real conservation projects and policies</p>

Table 3. Practices of leading academic programs on biocultural conservation for collaboration practices, knowledge generation, and impact

Program	Collaboration	Transdisciplinary Knowledge	Impact-Oriented
University of North Texas/Sub-Antarctic Biocultural Conservation Master’s Program.	Strengthen respectful North-South collaboration	Provide biocultural conservation coursework	Develop innovative and creative forms of knowledge dissemination for different audiences
	Provide student mentorship program to create North-South dialogue	Generate different forms of knowledge in partnership between universities from US and Chile, plus local NGOs and communities	Production of scientific knowledge useful to the South
	Create network of collaborators	Require practical research experience in the Global South	
	Motivated expertise onsite (Ricardo Rozzi)		
Colorado State University/Master Leadership Program	Work closely with a network of practitioners and organizations throughout the program	Provide experiential and project-based learning	Offer program that is solution-oriented: students produce a final applied project
	Cohort-based learning community, that supports network building, collaboration, and learning	Interdisciplinary curriculum	
		Cross-cultural experiences (cohort, course work, field trips, experiential Friday)	
College of Environmental Science and Forestry SUNY Indigenous Peoples and the Environment	Community learning and collaboration (Sloan seminar, mentorship, social gatherings, community service, etc.)	Integrate traditional Western science and Indigenous knowledge and perspectives in a cross-cultural context	Support Indigenous graduate students via A.P. Sloan Foundation partnership
	Motivated expertise onsite (Robin Kimmerer)	Provide transdisciplinary approach with the Haudenosaunee Nation	Solution oriented, focus on biocultural conservation and restoration
	Work in close collaboration with The Haudenosaunee Environmental Task Force	Offer interdisciplinary and biocultural coursework	Actively involved in advancing land rights and models of land conservation that support and empower Indigenous Nations

University of Guelph / Master of Conservation Leadership	Collaborate with CRP	Transdisciplinary work by collaborating with the Conservation through Reconciliation Partnership (CRP)	Elevate the voices of Indigenous communities by collaborating with CRP
	Motivated expertise on site (Robin Roth and Faisal Moola) and elders	Generate knowledge with Indigenous elders as learning component	Train students as leaders for the future of conservation. Each student receives help from a Leadership Coach.
	Develop Indigenous-led conservation initiatives	Apply Two-Eyed Seeing Pedagogy	Final project is solution-oriented
	Promote an ethical and equitable program	Offer placed-based education in partnership with First Nations elders	Integrate Indigenous students
	Train for partnership-building and negotiation	Include curriculum and tools with Indigenous and Western perspectives	
University of Hawai'i Center for Biocultural Studies	Use network of collaborators with local communities, federal and state government	Offer biocultural systems knowledge generation	Established space for learning, exchange and collaboration through Biocultural Initiative of the Pacific
	Collaborate with faculty and students interested in biocultural diversity	Establish Biocultural Initiative of the Pacific to link faculty and students	Professional development of students to conduct culturally respectful research
	Motivated expertise onsite (Eleanor Sterling) (deceased), (Christopher Dunn (past). Rachel Dacks, Kawika Winter, and many others	Integrate Indigenous knowledge in research, policy and decision making	Train the next generations of Indigenous and local communities for leadership roles in Hawaii Conduct solution driven research (e, g, biocultural estuarine restoration)
Terralingua	Create worldwide network of collaborators and donors	Publish articles on biocultural diversity that promote the integration of multiples ways of knowing	Use diverse media for promoting understanding and appreciation of world's biocultural diversity
			Promote public education on biocultural diversity
	Presence of motivated expertise and leader onsite (Luisa Maffi)		Develop biocultural diversity curriculum for secondary education
	Invite for contribution to a magazine promoting multidisciplinary collaboration		Support effort of Indigenous people to maintain or recover their language and culture

Field Museum of Chicago	Long-term engagement and partnership building	Co-production of knowledge between academic experts and local communities	Contribute to protected areas establishment through scientific evidence, community mobilization and technical support to government
	Foster empowerment		
	Promote participation		
	Empower local communities to improve or sustain their quality of life		
	Adopt inclusion		
Enable local communities to make decisions based on culture and aspirations	Share rapid inventory data and data implications for conservation and management		
		Capacity-building for local stakeholders to develop and implement quality of life plans	
		Develop reflection and create commitment	
Intercultural Maya University of Quintana Roo, Mexico	Mandate Maya language - language reflects knowledge, values, and concept of culture	Apply Ka'anax, Indigenous ejido principle of care of the forest for future use	Follow community perception of environmental changes in Ejido natural resource management and strategic decisions
	Include community as committee members for academic activities	Use different systems of construction of knowledge and forms of learning based on active local knowledge input	Academic research projects translate into real conservation and sustainable management policies
	Collaborate with "sabios locales" in teaching and research	Foster practical experience, inclusion of sustainable projects in rural communities	Institutionalize the Intercultural University System
	Establish mentoring system by elders as guiding force	Develop transdisciplinary collaboration between faculty members	Recognize Indigenous heritage by law Translate academic research projects into real conservation and sustainable policies

D. Lessons from Previous TCD programs

The Tropical Conservation and Development Program ([TCD](#)) is a research and training program housed at the University of Florida's Center for Latin American Studies. TCD provides interdisciplinary courses and other spaces for learning and exchange among students, faculty and practitioners. The TCD certificate requires coursework in natural science and social science, interdisciplinary "core courses" that address conservation and development from a multi-scalar socioecological systems perspective, and professional skills such as communication, leadership, conflict management and group facilitation. In addition, TCD faculty and students interact with communities and practitioners to learn from their experiences and perspectives and produce and disseminate knowledge that is relevant and useful for policy and practice.

In addition to the overall TCD program, various specific programs from recent decades offer reflections and experiences relevant to the three dimensions of our framework for academia to contribute to biocultural conservation. These are described below, and summarized in Table 4.

Managing Ecosystems and Resources with Gender Emphasis ([MERGE](#)) was a collaborative network of universities and international and local NGOs that during the 1990s pursued a strategy of mutual learning and action focused on gender, community participation, and natural resource management in Peru, Ecuador and Brazil. The MERGE strategy used gender analysis to approach diversity in community-based conservation efforts. For the most part, the growing recognition of women's important roles in grass-roots projects was then not yet reflected in strategies to influence policy, institutions, and organizational partnerships for conservation and development. The MERGE strategy had three dimensions: (1) a conceptual framework that combined attention to gender, participatory approaches with local communities, and resource management, within particular contexts and embedded in cross-scale social and ecological systems; (2) an action plan that included applied research, training and training-of-trainers, policy and project implementation, monitoring and follow-up, networking, and documentation of results in case studies; (3) partnerships among organizations, from which they learned about diversity and conflict through a dense and rich collaborative learning approach, and which fostered personal, methodological, and institutional change. From the beginning, the central philosophy of MERGE was to build towards a partnership among equals, respecting and learning to deal with diversity. While sharing common interests and goals, each organization defined its own objectives and activities, and controlled its own funds. This arrangement helped to avoid tensions related to competition over resources and allowed to pool resources in creative ways. MERGE served as a convener and facilitator of exchanges among partner organizations of different kinds and at different levels of activity, in different locations and moments, involving a wide variety of organizations and individuals in an often-unpredictable process of learning together. One goal of this convening role was to strengthen connections among organizations that could work together at different levels, and draw on their experiences to promote a process of collective learning. As difficult as this process often was, strengthening these partnerships increased the potential for measurable impacts and for longer-term mutual learning, and fostered a greater commitment to incorporating gender analysis into natural resource management projects that work with local communities.

Key program elements we can learn from MERGE program for advancing biocultural conservation:

Collaboration	<ul style="list-style-type: none"> Created partnership among equals Established networking Fostered committment Strengthened partnerships Diversified community-based conservation efforts
Transdisciplinary Knowledge	<ul style="list-style-type: none"> Provided a strategy of mutual learning on gender, community participation, and natural resource managment Applied research Developed participatory approaches
Impact-oriented	<ul style="list-style-type: none"> Action plan for applied research, training, and training of trainers Action plan for policy and project implemenation, monitoring and follow-up Action plan for networking and documenting results of case studies Achieved methodological and institutional change Created space for knowledge exchanges and collective learning

Integrative Graduate Education and Research Traineeship (IGERT) was an NSF-wide training program intended to educate U.S. Ph.D. scientists with the multidisciplinary backgrounds and technical, professional, and personal skills needed for the career demands of the future. The program was intended to catalyze collaborative research that transcends traditional disciplinary boundaries. UF's [Working Forests in the Tropics IGERT](#) built on strengths of TCD to construct a model for how doctoral research and training can effectively and ethically contribute to solving critical problems facing tropical forests. The research goals were to (1) analyze tradeoffs and complementarities among working forest options; (2) clarify how biophysical, social, economic and political constraints and their interactions influence the effectiveness of different kinds of working forests for conservation and development; and (3) measure the impacts of capacity-building interventions designed to improve forest management and promote conservation. The training program included (1) cross-disciplinary requirements, with courses in ecology, social science, history/culture of the research regions, and language proficiency; (2) integrative coursework, including Interdisciplinary Research Methods, Leadership and Communication Skills, Tropical Conservation and Development, and Land-Use/Land-Cover Analysis; (3) practicum activities such as a Working Forests Clinic, a Working Forests seminar and a field course; and (4) complementary learning/teaching opportunities, including site visits within the four regions, annual conferences, retreats and workshops, a WFT student group, internships, service as mentors, and sharing research results with stakeholders. In terms of impact, WFT did (1) foster research that was more responsive to real world problems due to interdisciplinary training and strong partner linkages; (2) provide a better match between knowledge and skills developed by graduates and job market demands; and (3) develop a network of effective leaders, trained for the challenges of conservation and intensified use of tropical working forests.

Key program elements we can learn from the WFT-IGERT Program for advancing biocultural conservation:

Collaboration	<p>Taught collaborative research</p> <p>Required and supported language proficiency</p> <p>Trained leadership and communication skills</p> <p>Fostered site visits, retreats, workshops and internships with communities and practitioners</p> <p>Provided mentorship</p> <p>Created partnership linkages</p>
Transdisciplinary Knowledge	<p>Established innovative graduate education and training model on tropical working forests for conservation and development</p> <p>Cross-disciplinary course and language proficiency requirements</p> <p>Provided integrative course work via interdisciplinary research methods and communication skills</p>
Impact-oriented	<p>Engaged stakeholders in dissemination of research results</p> <p>Created a network of effective leaders</p> <p>Trained leaders for collaborative and transdisciplinary practice</p>

The Governance and Infrastructure in the Amazon project (GIA) was established in the Fall of 2018 to create, strengthen, and implement a pan-Amazon Community of Practice and Learning (CoP-L). The GIA CoP-L provided a forum for social learning and analysis about the challenges and strategies for reducing threats to protected areas and other lands from poorly planned infrastructure projects. GIA is a polycentric network of key stakeholders from grassroots organizations, academia, NGOs, and government in Bolivia, Brazil, Colombia, and Peru. GIA prioritized graduate students with pre-existing personal experiences and relationships in the Amazon region; this was a key factor for building the GIA network, facilitating dialogue and reflection with partners, and finalizing products. Overall, GIA produced more than [50 products](#) which included both academic research and analysis, and products with format and language designed for dissemination to communities. GIA demonstrated the importance of both learning from and contributing to (information and capacity) partner organizations' infrastructure governance strategies. GIA learned to base this work on (1) community engagement from defining research topics to data gathering and analysis; (2) recognition and respect for grassroots ontologies, epistemologies, timing, and knowledge; and (3) community autonomy and co-ownership of research products.

Key elements we can learn from the GIA program for advancing biocultural conservation:

Collaboration	<p>Benefitted from graduate students' local experience and knowledge to play key roles in building the network</p> <p>Provided mentorship from and for partners</p> <p>Engaged in dialogue and reflections with community leaders and practitioners</p> <p>Engaged community in research process</p> <p>Practiced recognition and respect for grassroot culture</p> <p>Promoted knowledge, communication, and collaboration</p>
Transdisciplinary Knowledge	<p>Developed forum for social learning and analysis</p> <p>Promoted polycentric network of key stakeholders</p>
Impact-oriented	<p>Established Community of Practice and Learning</p> <p>Action-oriented, addressing partners' needs</p> <p>Community-oriented co-ownership of products</p> <p>Built capacity-training for infrastructure governance strategies</p>

GIA Upper Madera Community of Practice: Within the GIA project, the [Upper Madera Community of Practice and Learning](#) was an exemplary model for networking that featured the active participation of grassroots stakeholders in planning, capacity building, research as co-production of knowledge, knowledge exchange, and collective action. It included five universities (3 in Bolivia, 1 in Brazil, and 1 in the US), four NGOs (all in Bolivia), three grassroots organizations (1 Bolivia, 1 Brazil, one binational), and eleven communities (7 in Bolivia and 4 in Brazil), and focused on the experiences and needs of communities impacted by proposed and actual large hydroelectric dams. Local communities in the Upper Madera prioritized access to scientific knowledge about the impacts of dams, as well as building capacity in skills and strategies to confront proponents of dams. Conversely, universities, researchers and NGOs with relevant expertise have limited access to those communities and their pre-existing knowledge. GIA brought these actors together to strengthen ties based on mutual trust and respect, co-construct a joint agenda of activities, and generate and disseminate co-produced knowledge in various formats aimed at decisionmakers and local communities. Crucial to this evolution was an emphasis on including diverse stakeholders, processes to encourage broad participation, reflection on past experiences, and trust-building exercises (Arteaga 2021). A particularly effective academic component was engagement of the regional university in Pando, Bolivia (UAP) to generate and share knowledge via student field research, thesis development, and synthesized strategic product generation, including videos, protocols, communication strategies for political advocacy, and booklets. The substantive products reflected the co-produced knowledge based on needs and priorities of the Upper Madera COP-L. These were translated into a useful and practical form accessible to local communities and grassroots organizations that provide guidelines for collective action.

Key elements from the GIA Upper Madera Community of Practice and Learning that we can learn from for advancing biocultural conservation:

Collaboration	<ul style="list-style-type: none"> Created mutual trust and respect Applied tools to encourage broad participation Provided mentorship Created spaces for dialogue and reflection Co-constructed a joint agenda Developed networking
Transdisciplinary Knowledge	<ul style="list-style-type: none"> Built a transdisciplinary community of practice and learning Implemented transdisciplinary thesis research Included active participation of grassroots stakeholders Followed a participatory action research knowledge co-generation model
Impact-oriented	<ul style="list-style-type: none"> Provided access to scientific knowledge Built capacity Co-produced knowledge in diverse formats Encouraged political advocacy

E. TCD Alumni

Through a survey, interviews and a focus group with TCD alumni, we inquired about knowledge and experiences they gained while studying at TCD that helped them engage and collaborate with local communities, form effective partnerships, and influence conservation and development policy and practice; what skills were most relevant for application in their professional careers; and what else they wished they would have learned (see Table 4a). Complete reports are available upon request (Gouveia 2023; de Jordao and Montero 2023).

Social skills such as facilitation, negotiation, consensus-building, presentation tools, and public communication were the most frequently cited as critical to their professional careers post-graduation. Alumni highlighted that they would have liked more practical, hands-on training during their TCD education on these as well as other “soft skills” such as setting goals and agendas to have efficient meetings, active listening, facilitating workshops and discussions, working in international groups to develop research, writing funding proposals and working in interdisciplinary teams.

Furthermore, with a view to conservation and development impact, TCD alumni expressed interest in converting interdisciplinary knowledge into public policy and influencing politicians and decision-makers. Key skills include how to frame and infuse research into the policy-making process, and tools to change mindsets and make people more prone to conserve and restore.

TCD alumni expressed interest in in-service and continuing education, both as learners and trainers. Suggested topics included Indigenous languages and cosmology, non-western knowledge systems, novel strategies for working with communities, climate change vulnerability and climate justice, communication skills for multiple audiences and media types, presentation skills, storytelling, impact narrative development, policy-oriented seminars/classes, research for policy change, interdisciplinary political ecology 2.0 master classes on decolonization, social movements and biocultural conservation, data management, and MBA-type content or approach.

Key research, professional and practitioner practices and skills prioritized by TCD alumni:

	Learn novel strategies for collaboration, negotiation, and facilitation
Collaboration	Develop decision-making skills, research, ethics, and project management techniques
	Learn systems analysis and data management
	Learn participatory research methods
Transdisciplinary Knowledge	To learn, or to be exposed to, non-western knowledge systems
	Learn Indigenous language and cosmology
	Hands-on experience for transdisciplinary learning
Impact-oriented	Learn strategic communication for advocacy
	Learn policy-oriented research for policy change

Table 4. Experiences and practices of TCD programs related to collaboration practices, knowledge generation, and impact.

Program	Collaborative	Transdisciplinary Knowledge	Impact-Oriented
TCD program general	Work in teams and groups	Research and training program to advance biodiversity conservation, sustainable resource use, and human well-being in the tropics	Return research results to communities and other stakeholders
	Provide coursework on collaboration, leadership, and conflict management	Creates spaces for informal and formal activities to support collective learning about cutting-edge thinking and practical issues of conservation and development	Communicate in non-academic formats such as posters, folders, workshops, social media, videos, radio
	Collaborate with communities and other stakeholders on research and practicum activities	Grants interdisciplinary certificate that requires natural science and social science disciplinary courses, professional skills course, and core interdisciplinary courses	
		Reflect critically on student's own perspectives and actions	
UF MERGE program	Created partnerships among equals Strengthened partnerships Facilitated networking Fostered commitment	Provide a strategy of mutual learning on gender, community participation and natural resource management	
	Searched for shared vision while respecting organizations' independence	Implemented applied research	Diversified community-based conservation efforts
	Led participatory approaches	Created space for knowledge exchange and collective learning	Action plan for policy and project implementation, monitoring and follow-up
			Action plan for networking and documenting results of case studies
		Achieved methodological and institutional change	

WFT - IGERT	Taught collaborative research	Innovative graduate education and training model on tropical working forests for conservation and development	Engaged stakeholders in dissemination
	Provided mentorship		Established network of effective leaders
	Created partnership linkage		
	Trained in leadership and collaboration	Cross-disciplinary course requirements	Trained leaders for collaborative and transdisciplinary research
	Required and trained in language skills	Integrative course work: Interdisciplinary research methods, communication skills	
	Fostered site visits, retreats, workshops, and internships		
Required language and integrative coursework			
GIA	Benefitted from graduate students' key roles for building the networks	Created a forum for social learning and analysis	Capacity training for infrastructure strategies of partner organizations
	Provided mentorship	Built a polycentric network of key stakeholders	Academic/analytical and community-oriented co-ownership of products
	Engaged in dialogue and reflection		Action-oriented, addressing partner's needs
	Engaged community in research process		Community of practice and learning with practitioners and community leaders as well as regional universities
	Created respect for community autonomy		
	Practiced recognition and respect for grassroots culture		
	Emphasized knowledge communication and collaboration		

GIA-Upper Madera-COP-L	Created mutual trust and respect	Built transdisciplinary community of practice and learning	Established community of practice and learning- Upper Madeira
	Co-constructed a joint agenda	Had active participation of grassroots and stakeholders	Built capacity of local students and faculty, NGO, and community professionals
	Provided mentorship	Implemented transdisciplinary thesis research model	Co-produced knowledge in diverse formats
	Built networking	Participatory action research knowledge co-generation model	Encouraged political advocacy
	Applied tools to encourage broad participation, reflection, and trust-building		Provided access to scientific knowledge (substantive and strategic)
	Created spaces for dialogue and reflections		
Fostered community engagement			

Table 4a. Needs and priorities expressed by TCD Alumni

Program	Collaborative	Transdisciplinary Knowledge	Impact-Oriented
TCD alumni	Learn novel strategies for collaboration, facilitation, and negotiation skills	To learn, or to be exposed to non-western knowledge systems	Learn negotiation skills
	Develop decision-making skills, research ethics, and project management techniques	Learn Indigenous language and cosmology	Learn strategic communication for advocacy for higher impact
	Learn system analysis and data management	Hands-on experience for transdisciplinary learning	
	Learn participatory research methods		

III. ANALYSIS OF LESSONS LEARNED AND RECOMMENDED PRACTICES

A. Overview

We have reviewed 29 perspectives and experiences that provide valuable insight into how academia can contribute to biocultural conservation (Tables 1 through 4). In this final section, we synthesize these findings into a comprehensive set of recommendations and strategies. Since academia is not a direct implementer of biocultural conservation but can play a supporting role, it is important to begin this analysis with consideration of the findings of our previous study on key strategies for implementation of biocultural conservation. Fonseca et al. (in prep., summarized in section I.B above) found that empowerment and agency by Indigenous (and other traditional) communities are the point of departure for effective implementation of biocultural conservation. Furthermore, these groups can be supported through appropriate partnerships; knowledge production and application is an important contributing factor; communities implement biocultural conservation through territorial and resource management; and governance is the key factor that enables or limits this local action.

Thinking about how these considerations align with the three dimensions of our framework for how academia can contribute, we see that: **partnership and collaboration is the foundational strategy that sets the stage; knowledge is the substantive area where academia can contribute; and impact can be conceived as either directly supporting territorial management or governance, or enhancing capacity for Indigenous agency and empowerment that enable territorial management and governance over the long term.**

These three dimensions are both overlapping and sequential. Partnership is a pre-requisite for transdisciplinary knowledge, and both should be oriented towards impact. Thinking of such a sequence frames a **theory of change: academia works in partnership with Indigenous (and other local) communities; they co-produce knowledge; and this knowledge contributes to impact in terms of governance, territorial management, and/or capacity.**

Our analysis produced a rich set of lessons and good practices for each dimension of our framework, but it also calls attention to the overlap and synergy among them. The core principle that emerges for transdisciplinary knowledge is that it be co-constructed; co-production of knowledge is both a form of partnership and a way of knowing that aims for impact. And being impact-oriented inherently requires that there is concrete benefit for all parties, which is an intrinsic feature of true partnership.

In the sub-sections below, we discuss main findings and recommendations for each dimension of our framework, in the order that they appear in our theory of change: partnership, transdisciplinary knowledge, and impact. We conclude with final considerations of how to integrate the three dimensions into a comprehensive program.

B. Partnership and Collaboration

While we did not set out to do a quantitative analysis, it is striking that there were many more guidelines or recommendations about how to promote collaboration than about transdisciplinary knowledge production or impact orientation (an average of 5 guidelines per experience about

collaboration, versus 2.4 for transdisciplinarity and impact). How to carry out equitable partnerships was most emphasized in the guidelines and toolkits (Table 2) but was also highly emphasized in the academic literature (Table 1) and TCD experiences (Table 4)². This supports our conclusion that collaboration and partnership is foundational to the other dimensions of our framework for how academia can contribute to biocultural conservation.

Equal partnerships are challenging and complex (Olssen 2016). The pressures of research funding, institutional agendas, and the geopolitics of knowledge and language tend to reinforce inequalities between academic institutions from the Global North and local partners from the Global South. Collaboration therefore calls for fundamentally addressing relational power with specific strategies to co-design and co-implement research, education, and capacity activities away from inappropriate colonial research structures. New forms of collaboration and engagement require devoting time to build meaningful partnerships beyond university walls, then investing in the establishment of long-term collaborative processes with those partners. Yet reward systems and incentives of academic institutions are not necessarily aligned with these priorities; consequently, carrying out constructive partnerships will require recognizing and addressing such structural challenges (Perry et al. 2022).

Recommendations and guidelines emerging from the academic literature and programmatic toolkits (Tables 1 and 2) indicate that successful adoption of collaborative partnerships requires groups to willingly share power and to maintain strong working relations based on respect, trust, transparency, accountability, and open communication. They emphasize transparent and inclusive communication to clarify responsibilities and priorities, navigate conflict and differences, considering shared goals, empowering marginalized voices, and communicating with diverse stakeholders. Furthermore, collaborative work needs to be relevant to partners, local communities, and decision-makers, which provides an important link to the concept of being impact-oriented.

Leading academic programs in the field of biocultural conservation (Table 3) emphasize as crucial the creation of a network of partners and collaborators, and development of the skills to create and cultivate those partnerships. The presence of motivated leaders with the vision to guide, inspire, and carry out these programs was frequently cited as a strategic factor. Continuous, long-term engagement to build trust and establish relationships is yet another key element of creating productive partnerships, and it is notable that academic programs co-located with Indigenous populations, such as in Canada and Hawai'i, have been particularly successful in building these long-term relationships. This finding is reinforced by literature review of academic studies on effective implementation of biocultural conservation (Fonseca et. al. in prep.) which shows high frequency of research deeply engaged with local communities, including co-authorship and abstracts in Indigenous languages, in New Zealand, Australia, Hawai'i, Mexico and Canada, i.e. places co-located with Indigenous populations.

An important implication of these observations is that while Amazonian universities are not yet leaders in biocultural conservation, they have an opportunity to benefit from being co-located with Indigenous cultures. By engaging closely with these front-line actors, they can contribute to the long-term effectiveness of biocultural conservation in this region. They would do well to emulate

² The review of academic programs also showed a plurality of guidelines for partnerships, but nearly as many on forms of impact and means of transdisciplinary production (Table 3).

the strategies and approaches exemplified by these currently leading programs, such as spaces for cross-cultural learning in both classwork and fieldwork, mechanisms for diverse stakeholders to provide input to their programs, and exchanges with local ‘elders/*sabios*’ for teaching and mentoring.

Because this dimension calls for engagement with diverse stakeholders, development of specific interpersonal and professional skills, including cultural proficiencies, are particularly significant. These sets of skills need to consider normative aspects, inequalities, politics and power, and work more directly across the interface of science and practice (Fazey et al. 2018). These practical skills still are not extensively taught in university curricula, but TCD has highly relevant expertise and experience in this area. TCD alumni emphasize the importance for their professional effectiveness of practical training in negotiation, communication, leadership, empathy and listening, and call for broader training and continuing education for professionals.

HIGHLIGHTED GUIDING PRINCIPLES – PARTNERSHIP AND COLLABORATION:

- Aim for continuous, long-term relationships
- Invest time to build trust, especially early in relationships
- Create opportunities for cross-cultural learning and exchange
- Adapt academic reward systems to prioritize equitable and collaborative research, teaching and extension that meet local needs
- Recognize power relationships and explicitly commit to addressing them through co-design and co-implementation of research, education and training programs
- Maintain transparent and inclusive communication about goals, interests and decision-making processes, with monitoring and accountability
- Invest in professional skills such as service leadership, listening, empathy, and negotiation

C. Transdisciplinary Knowledge

A transdisciplinary approach to biocultural conservation is based on partnering with Indigenous and local communities to transform the culture of knowledge production by recognizing multiple ways of knowing and doing. Sources of knowledge such as Indigenous knowledge complement and extend academic scientific knowledge. Expanding the diversity of stakeholders involved in the scientific process is both a significant input to and output from transdisciplinary research. Given the key role of governance in biocultural conservation, this should include not only communities but government and others who have significant influence on policy and decision-making. Furthermore, a growing body of evidence demonstrates that co-produced knowledge is more likely to be socially relevant, publicly accepted, and used in decision-making than knowledge produced by traditional academic research (Wyborn et al. 2019). The development of co-production and new forms of collaboration must therefore be recognized as a best practice for researchers and institutions (Beyond Academy 2022).

Guidelines and recommendations for transdisciplinary knowledge production from the academic literature (Table 1) focus on plurality, co-production, co-planning, co-design, and co-implementation of research processes. Achieving pluralistic co-production calls for bringing together people from different sectors and groups to generate knowledge and promote change. It requires building trust, working out power differentials, and creating a variety of spaces where

different forms of knowledge can be expressed. The academic literature on transdisciplinarity also emphasizes essential core values of respect for culture, people, traditional lands, and worldviews. These findings are consistent with the programmatic guidelines and toolkits (Table 2) which emphasize respect for local culture (Kūlana Noi'i) and reflection on power issues to ensure equity (the Scotland-Malawi Partnership).

The approach to knowledge-production that emerges from these sources has been recognized in the literature under the rubric of “co-production”: a strategy to produce knowledge, action, and societal change collaboratively and iteratively by linking researchers with varied stakeholders (Wyborn et al. 2019). Indeed, co-production is part of an evolving cluster of related approaches such as collaborative governance (Sorrentino et al. 2018), social learning (Norström et al. 2022; Lemos et al. 2018; Slater and Robinson 2020), co-design (Page et al. 2016), transdisciplinarity and participatory action research (Knapp et al. 2019; Harvey et al. 2019). Other similar terms include participatory research, mode-2 science (Nowotny et al. 2003), civic science, citizen science, post-normal science, joint knowledge production, action research, and community-engaged scholarship (Beyond Academy 2022). For co-production processes to be successful, all participants must embrace a collective understanding of the many different needs, concerns, and beliefs of the different social groups.

Unsurprisingly, the greatest breadth and depth of guidelines and recommendations on transdisciplinary knowledge comes from the academic programs that are leaders in this field (Table 3). These programs are designed to provide the necessary skills to: establish transformative actions in amplifying and representing the voices of different cultures (Gavin, Colorado State University, personal communication); build reciprocal relationships with communities (Dacks, University of Hawai'i, personal communication); and grapple with their own history of occupation and colonial science (Dunn, Cornell University, personal communication).

Key themes that emerge from these experiences are an emphasis on consultation and dialogue, an interdisciplinary curriculum, and integration of Indigenous knowledge by being experience-based and place-based. Teaching students about Indigenous cosmology and language while integrating non-western knowledge systems opens minds and generates different ways of knowing. Programs like the University of Hawai'i, the University of Guelph, and SUNY have successfully advanced in this direction. Interestingly, learning about Indigenous languages and cosmologies was a demand that emerged from interviews of TCD alumni who work in diverse fields and not only on biocultural conservation.

We see the model of intercultural education by UIMQRoo as exemplary for how to promote dialogue and equal relations between an Indigenous and a society dominated by Western values. The term "intercultural education" has been used in Latin America for decades to refer to educational systems that seek mutual exchange between different bodies of knowledge while perceiving them as equal in status (e.g., science is not privileged over IK). An intercultural education initiative here entails productive two-way dialogue generating something novel at the interface between IK and science (Schroder 2006). The intercultural education model provides guiding principles for universities to restructure their programs toward an anti-colonial approach to conservation, embracing the biocultural approach and giving new meaning and value to research embedded in nature.

HIGHLIGHTED GUIDING PRINCIPLES – TRANSDISCIPLINARY KNOWLEDGE:

- Recognize and respect multiple ways of knowing and doing
- Pro-actively engage with and learn from Indigenous and traditional knowledge, beliefs and ways of thinking
- Co-produce knowledge through joint planning, design and implementation of research with communities, government and other decision-makers
- Produce and disseminate knowledge that addresses and contributes to communities' agendas and challenges related to territorial management and governance
- Adopt techniques of inter-cultural education such as place-based and experiential learning and engaging with elders as teachers and mentors

D. Impact-Oriented

The key question that this paper seeks to address is how academia can contribute to effective implementation of biocultural conservation. Given that academia does not act directly in territorial management or governance, it is clear that academia inherently has a “support” role. The diverse perspectives and visions reviewed herein (Tables 1-4) converge on two main avenues of potential impact: knowledge and capacity-building. Furthermore, our sources emphasize that knowledge must be relevant to actors and decision-makers, and must be made available to them in suitable formats and in a timely fashion.

Linking transdisciplinary academic approaches to transformative changes for biocultural conservation can be facilitated by carrying out applied research that recognizes Indigenous peoples and local communities' (IPLC) rights and agency in biodiversity policy, and which recognizes and supports Indigenous communities' leading role in managing the protected areas where many live (Massarella et al. 2022). As such, there is a need for culture-rooted programs that understand and provide solutions that include IPLCs determining and executing local, regional, and global biodiversity policy (Forest Peoples Programme et al. 2020).

While relevance and dissemination are minimal pre-requisites for research impact, it is essential to address the enduring challenges for research results to ultimately be put into practice. For example, Chambers et al. (2022) point out that the meaning and outcomes of co-production are still vague. Various authors suggest monitoring impacts occurring within (and not just after) co-production processes to ensure adaptive learning, while recognizing complex and unpredictable impact pathways (Wyborn et al. 2019; Norström et al. 2022; Page et al. 2016).

Change processes are complex, and there is still limited understanding of how to implement change. Success and change can take many forms, from changes in policies and practices, to changes in attitudes and perceptions. It is important to recognize multiple impact pathways and cross-scalar interactions between local action and macro policies and governance (Newig et al. 2019; Schneider et al. 2019). An important task for transformation research is to produce evidence and enhance learning about the actions and solutions that lead to desirable social, cultural, ecological, and economic futures. Experimenting with change processes, such as through local and context-specific actions, projects and initiatives, is therefore a critical part of transformation research (Evans et al. 2015).

Learning about change requires more than identifying potential solutions: it also requires knowing “how to implement changes.” The “how to” question is the most important question on the role of academia. For example, to what extent and through what mechanisms can we show evidence for impact generation? The process of impact generation is highly complex and existing frameworks still struggle to account for this complexity. Research conducted by Schneider et. al. (2019) identified three generic conceptualizations of impact generation mechanisms:

- (a) producing knowledge about systems, target processes, and transformation for more informed and equitable decision-making;
- (b) fostering social learning for collective action; and
- (c) enhancing competencies for reflective leadership.

They conclude that the most promising pathways to impact are long-term, adaptive processes that combine elements of the three impact generation mechanisms.

Within conservation science, the “research-implementation gap” is often assumed to be primarily a question of knowledge dissemination; this affects how conservation scientists structure and conduct their research, how collaboration is performed and operationalized, who is involved, and how impact is assessed (Toomey et al. 2016b). A good way to supersede this linear conceptualization is to think in terms of “wicked science and complex systems” (scientifically complex, non-linear, and intensely influenced by human values and preferences -- described in Section I). If academia can internalize the concept of “wicked science” during the complete research process, scientists will be better positioned to understand the complex nature of the problems and their causes.

To address this challenge, scientists need to reconceptualize the research-implementation gap as a space that requires more collaborative partnerships based on a more inclusive and open understanding of for whom and for what purpose knowledge is produced. Research-practice or knowledge-action spaces represent an important first step toward reconceptualizing a diversity of ways of knowing and doing. As an alternative to a linear, knowledge-deficit-based model of scientific impact, Toomey et al. (2016b) recommend embedding conservation science within collaborative social and decision-making processes involving the arenas where policy scenarios and grassroots action play out (Clark 2002). This reframing identifies conservation as a social process that engages science, not a scientific process that engages society (Balmford & Cowling 2006; Adams & Sandbrook 2014). This statement is crucial, as it provides the necessary recognition of social spaces, and more specifically of Indigenous peoples and local communities’ (IPLC) rights and agency (Massarella et al. 2022), and provides a right direction for implementing biocultural conservation.

Scholars have voiced their concern over the process of impact evaluation and metrics that reinforce instrumental, stereotyped knowledge production, and emphasize that these metrics benefit certain types of researchers, typically those from Western contexts (Laing et al. 2018), missing the meaning of impact at the partnership level. There are multiple ways to produce results and outputs for research to have impacts on wider society. Impact should be visualized as something that occurs not only at the end stages of research, but throughout the process – thus the need to examine the multiple spaces where the practice of impacting takes place. The programmatic guidelines that we reviewed (Table 2) call for a focus on impact not in terms of “results,” but throughout the processes of research and learning, capacity-building, long-term planning, funding, and impact measurement. Furthermore, while it is crucial to focus on production of research work that is

solution-oriented and useful to local communities, building capacity for long-term impact is just as essential. If partnerships facilitate the co-creation of knowledge, then the process of impact could involve a joint process of identification and resolution of impact measures. As such, the contributions of the work and the conceptions of impact would reflect the plurality of knowledge, value systems, and logics that the partnership draws together (Perry et al. 2022).

Inherent in these considerations is acceptance of a role, as identified in the academic program consultation (Table 3), of “scientists as interveners” and “research as practice.” Research through practice is where the act of practice itself becomes the research (Hope 2016). Here the emphasis is more towards developing the practice rather than the epistemic knowledge about that practice. Thinking is then embodied in the artifact that emerges, such as a process or tool for change. We need to continue to focus on examples of work at the interface of academia and practice and the growing trends towards more impact-driven knowledge, “transformation research,” co-creation of outcomes from research and practice, and greater engagement of researchers in interventions seeking to enact change. This will require that we acknowledge the world of politics, values, and ethics that characterize societal change, work with academic and practical forms of knowledge, and embrace creativity, imagination, and innovation as forms of knowledge production.

Scientists should acknowledge engagement with the public while doing research, and recognize capacities and the complex relations that already exist in the various spaces and places in which scientists and the public interact. To pursue transformation research, academia likely needs to view the generation of new knowledge, learning, and action as being more closely intertwined. Transformation research places greater emphasis on research as a reflective practice (Ison 2010) and focuses on creating change from within the system being studied rather than viewing it as an external problem (O’Brien 2013). Reflexivity is a fundamental source of innovation and important for managing complex, collaborative, and action-oriented research (Fazey et al. 2018).

Conceptualizing research as being “from within” enables the goal to focus on social improvement as opposed to primarily knowledge production which dominates research that is viewed as being conducted from the outside (Fazey et al. 2018). It places considerable emphasis on the need for researchers to be more cognizant of the role of their own underlying assumptions that shape the nature of the questions posed and to continually reflect on their role and influence in the processes of research and change.

Midgley (2000 p.113) describes “intervention” as the “purposeful action by a human agent to create change,” where action is influenced by knowledge, including perceptions and implicit understandings, as well as conscious and unconscious motivations, values, morals, ethics and norms, and behavioral habits. Science can thus be understood as an active process of intervention, either directly in practice or more indirectly through the generation of knowledge. If researchers agree to this role, the proposed “impact oriented” dimension would become mainstream and transformational.

TCD alumni who are now conservation and development practitioners, researchers and teachers call attention to the need for fundamental skills to address the enduring obstacles embedded in policy frameworks and conservation and development models that would enable progress toward biocultural sustainability: facilitation, negotiation, public communication, and consensus-building tools among others (Table 4). Including more policy-oriented courses and emphasizing facilitation,

negotiation, and strategic communication skills should be consistent with recognizing Indigenous and local groups' need to be integrated into decision-making, and facilitate actions based on ecological conservation priorities and cultural values while aligning with local priorities (Büscher and Fletcher 2019, 2020; Merçon et al. 2019).

HIGHLIGHTED GUIDING PRINCIPLES – IMPACT ORIENTED:

- Prioritize and reward impact-oriented knowledge generation and capacity-building strategies
- Conceptualize scientists as interveners, and build capacity of scientists and others to engage with the public and participate in policy and decision-making processes
- Envision research application as a social process that engages science, not a scientific process that engages society
- Focus on impact from partnership, knowledge, and capacity-building throughout the process, not only on application of results
- Prioritize production of knowledge from within complex systems of biocultural conservation
- Recognize research-as-practice as a legitimate way of conducting academic science
- Recognize that impact has multiple pathways, including capacity-building

E. Final Considerations

For academia to effectively contribute to biocultural conservation requires fundamentally rethinking the way that research, education, and training are carried out: investing in partnerships, delegating power, rethinking forms of knowledge, and reframing goals. It calls for a profound effort to teach practitioners, policymakers, funders, and the public about the value of biocultural diversity for sustaining life on earth and achieving truthfully sustainable development that supports the nexus between nature and culture (Sterling et al. 2017). Foremost, this requires change in partnership practices, promoting justice and fairness in the production, bi-directional exchange and sharing of knowledge. It also requires transcending disciplinary structures and augmenting research impact.

A great challenge is how academia can translate and apply these guides and tools within their own institutional contexts to achieve cultural and institutional changes. Fundamental transformation needs to be initiated by a commitment to change among individuals capable of reflecting on the requirements for, and consequences of, integrating the normative dimension of sustainable development into research and education. First, at the institutional level, a strategically managed niche needs to be established for the work of transdisciplinary groups, and the success of their work should be measured not only by the number of peer-reviewed publications but by new criteria that the group will develop. Second, this group needs to perceive itself as a learning collective and be prepared to address the question of how science can live up to the expectation of having a transformative role by interacting productively and respectfully with others, especially those who are at the front lines of implementing biocultural conservation.

The institutional and structural obstacles to making such changes are severe, and while transformational change is desirable, incremental change can also make a positive contribution.

The principles and practices presented in this report offer a road map for long-term transformation but can be implemented gradually and incrementally, building on current strengths, and addressing gaps and weaknesses. Faculty can specifically help by:

- 1) committing to tackling socially relevant research problems;
- 2) developing research collaborations that go beyond the walls of the academy;
- 3) communicating research in modalities other than peer-reviewed academic literature; and
- 4) teaching interdisciplinary skills alongside specialized disciplinary training.

Diverse academic networks already exist that work toward making universities friendlier places to do interdisciplinary research with real-world impact by fostering engaged leadership and promoting action-oriented scholarship (Beyond the Academy 2022). The academic programs presented here (section II.C) are inspirational models. They represent positive examples of best practices emphasizing respect, diversity, collaboration, and many other meaningful and creative elements (see Saavedra 2023 for more detailed descriptions). They are exemplary as they build on place-based cultural perspectives embracing values, knowledge, and needs, and reconceptualizing education's role rooted in cultural, Indigenous knowledge.

Similarly, TCD's decades-long trajectory is commendable (section II.D). TCD has already tested several applied research models and currently benefits from an integrated network of grassroots organizations, NGOs, and regional partner universities in Latin America, and highly experienced and engaged students from the Amazon region, ready to facilitate networking and knowledge exchanges. The core challenge is to integrate academic research and program development with external engagement beyond academia.

Despite the difficulties, the need for change is urgent. We are in a global crisis related to climate change and biodiversity. Indigenous people now oversee, use, and occupy lands that hold approximately 80 percent of the planet's biodiversity (Brondizio and Le Tourneau 2016). We strongly believe that academia can and must contribute to addressing the challenges embedded in current policy frameworks and conservation and development models (Diaz et al. 2019). Thus, there is strong justification, as noted by Gavin et. al. (2015), to overcome limitations and use a biocultural conservation perspective for education, research, and training to engage and implement transformative change.

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