Methods for building community-engaged partnerships in ecotoxicology

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ABSTRACT:

Background: Ecotoxicology provides powerful tools to characterize the nature and effects of pollution, which can be impactful when used in community-engaged research (CEnR). However, academic researchers are often insufficiently informed about the communities in which they conduct research. Researchers are not usually from or familiar with the cultural nuances of these communities, which is problematic for the strength of community-engaged projects. CEnR in ecotoxicology integrates local ecological knowledge and cultural understanding of communities with academic disciplines. Our ecotoxicological investigations of the health effects of pesticides, perchlorate, and toxic metals among residents of the Sonora-Arizona border involve direct collaboration among university researchers and local community groups.

Objectives: We created a protocol for establishing and maintaining community-university partnerships to address ecotoxicological effects of pollution. Our step-by-step process fosters genuine research relationships, leading to better outcomes for the affected communities.

Methods: We compiled information collected by our team members through qualitative interviews and group discussions. Using integrated perspectives, we created research protocols for sustainable and equitable partnerships in community-based ecotoxicology. The steps illustrate effective practices for beginning, building, and bolstering such partnerships.

Conclusions: Ecotoxicology projects require expertise from an array of fields. Investigators approach projects with different background knowledge, training, and experiences. In effective partnerships, each group adds significant value to the overall project, whether that contribution is technical proficiency, local knowledge, or cultural wisdom. These partnerships require trusting relationships and suit organizations committed to long-term collaborations. Our approach offers a replicable model for transdisciplinary teams seeking to conduct meaningful, collaborative

ecotoxicology research.

KEYWORDS: Environmental Health, Community-Based Participatory Research, Community

health partnerships, Community health research, Power sharing, Process issues, Ecotoxicology

INTRODUCTION:

First coined in the 1960s by Jean-Michel Jouany and René Truhaut, "ecotoxicology" is the aptly named intersection of ecology and toxicology, combining the studies of the relationships between the environment and its inhabitants with the corresponding health effects of these interactions.[1-5] Since then, the field has steadily uncovered associations between environmental contamination and human or animal health outcomes. Unfortunately, with almost 200 million substances registered in the Chemical Abstracts Service (CAS) system, approximately 350,000 chemicals or chemical biproducts in the global marketplace, and new chemical compounds being synthesized daily, it is impossible to adequately research, review, and regulate even a minority of environmental toxicants.[6-10] The production of chemicals is not strictly regulated but instead guided primarily by market forces, which are driven by consumer choices and corporate profits.[11] This has led to toxic chemical exposures throughout the world, especially for marginalized populations, which typically lack the economic and political resources to challenge polluters.[12-16]

One way to address this imbalance is to create community-engaged research (CEnR) projects that integrate the resources of community members, academic researchers, and community-based agencies or grassroots organizations (Figure 1).[17, 18] CEnR provides a path for ecotoxicology research in action,[19] exploring ways to improve the health of a community, defined by MacQueen et al.[20] as, "...a group of people with diverse characteristics who are linked by social ties, share common perspectives, and engage in joint action in geographical locations or settings." CEnR collaborations improve the likelihood that decisions are made without recourse to assumptions about the population; this is accomplished by incorporating a community's understanding of their health and wellness through, for example, funds of knowledge, which

emphasizes that people intuitively understand their surroundings through their experiences,[21, 22] or community resilience, where individuals or collectives organize to internally assess and address external threats to their well-being.[23-25]

Varying degrees of community engagement are possible. The most involved is community-driven research, where the community leads all aspects of the research, and partners are invited to assist on projects as consultants.[26-28] In community-based participatory research (CBPR), the research question and agenda are created by the community and supported by researchers.[26, 29-31] At the other end of the continuum, community representatives have little influence or decision-making power throughout the research process.[32]

Our Community Partnerships and Parent Study

Yuma County, Arizona is an important agricultural area,[33] and community members expressed concerns regarding potentially elevated concentrations of agrochemicals in their local environment.[19, 34] Residents were also concerned about possible exposures to various sources of toxic metals and perchlorate.[19, 34] Beginning in 2016, community members in Yuma County partnered with local health organizations, university researchers, and social advocacy groups to investigate the health effects from exposures to environmental contaminants on residents and local wildlife. The partnership stemmed from a Community Action Board (CAB), organized by community leaders and organizations who invited academic researchers to attend discussions related to their environmental exposures. Academic researchers from Northern Arizona University and the University of Arizona were contacted by community members and agreed to support the community with human, wildlife, and environmental sample and data collection, laboratory and statistical analyses, report building, and communication efforts. The research was designed under the One Health framework, which involved simultaneous analysis of human,

animal, and environmental health (Figure 2).

The Regional Center for Border Health (RCBH), the Yuma Regional Medical Center (YMRC), and Campesinos Sin Fronteras (CSF, "Farmworkers Without Borders") served as our primary community partners. RCBH provides health services for border residents from low-income households who commonly face obstacles to accessing healthcare. RCBH is a 501 (c) 3 non-profit organization with offices throughout Yuma County.[35] YRMC is a hospital that is available to all Yuma residents and visitors.[36] As an advocacy organization, CSF provides social and economic services, such as healthcare, education, counseling, and housing, to farmworkers with moderate or low incomes.[37] Community health workers, or *promotoras*, at CSF coordinate care for laborers who experience socio-economic or health-related problems.

Border community members may harbor mistrust of academic researchers due to historical perceptions of exploitation, lack of transparency, or failure to benefit the community directly.[38] Limited access to information regarding environmental health services may hinder community outreach efforts.[39] The academic researchers and community partner staff members involved in our project used several methods described in this paper to overcome these barriers, streamline the research process, and strengthen the study. After preliminary conversations and a thorough literature review, the community-university partnership decided to use a combination of approaches from ecotoxicology, epidemiology, social sciences, chemistry, and biology to determine if associations exist between environmental contaminants and human or other animal health outcomes, with the ultimate goal of developing effective interventions, if needed.[19, 34]

Study Objectives

CEnR partnerships, such as the one described above, provide a practical avenue for scientific inquiries to achieve tangible public benefits. Mutually supportive collaborations create

synergistic relationships, which can foster commitments to long-term or additional projects that actively promote public health and other benefits for the affected communities.[31, 40] Research partnerships that share a united message can significantly impact the communities they hope to serve.[41, 42] However, the potential exists for these relationships to hinder progress if trust wanes and resentments grow, which can happen for several reasons.[43] Given these challenges, we provide the current protocol, which integrates the One Health framework with CEnR principles to effectively promote resilience in community-based ecotoxicology research.

In our collaborative research project, we developed a comprehensive protocol for establishing and maintaining effective community-university partnerships in ecotoxicology research. Specifically, our objectives were to create a systematic approach for building genuine research relationships that yield better outcomes for communities affected by environmental pollution, to provide a step-by-step process for fostering collaborative research partnerships that integrate local ecological knowledge with academic disciplines, and to develop a flexible process that can guide researchers and community partners in creating sustainable and equitable research collaborations. By documenting our partnership's development and creating a generalized protocol, we describe a structured, respectful approach to research that prioritizes local knowledge and collaborative decision-making, addresses common challenges in CEnR, and provides a practical guide for other transdisciplinary teams.

METHODS:

We employed a systematic, multi-phase approach to develop our protocols (Appendix A), utilizing three primary methods: 1) internal team interviews, 2) a literature review, and 3) collaborative, reiterative refinement of the outlined steps. The protocol development process involved synthesizing information from these multiple sources, with a particular focus on U.S.-

Mexico border communities and methodological approaches that could be adapted to ecotoxicology research. Our final protocol was designed as a flexible process to serve as a comprehensive guide that researchers could adapt to their specific research needs.

We used responses from previously conducted internal interviews with five of our community partner leaders, described in detail by Baldwin et al.,[19] to determine which details were important to include in our recommendations. Using thematic analyses, Baldwin et al. categorized transcriptions of the interviews as one of four components of the CBPR conceptual logic model[44, 45]: 1) Context; 2) Group Dynamics/Equitable Partnerships; 3) Intervention and Research; and 4) Outcomes. We reconsidered these interviews under the lens of positive reviews regarding partnership success and looked for areas of improvement based on negative experiences or feedback. The interviews were considered evaluative by the Northern Arizona University Institutional Review Board, which reviewed and approved the overall study (project number 1167230–14) and did not require additional approval.

We completed a literature review focused on environmental health-related projects, community-based research projects, and community-university partnerships to supplement the findings from our internal interviews. Because recommendations for community engagement in ecotoxicology research are rapidly evolving, we sought the most relevant, appropriate, and up-to-date suggestions for methods to build community-university-organization partnerships. We compared population demographics, project type, and any discussion of challenges and accomplishments to determine relevancy and relationships to our study. We prioritized more recent articles, as the methods for viable community-engagement are continuously advancing, and older publications may already be dated in recommendations or language. The resulting steps were then presented to the group, including community partners, to validate initial

recommendations and to allow for additional input and perspectives. After each presentation, we incorporated the team's feedback and reshared the updated steps until we reached a final unanimous agreement.

Here we present a protocol for building effective and lasting relationships through CEnR within ecotoxicology research and beyond. The protocol outlines five stages of CEnR: pre-partnership, partnership building, partnership growth, partnership maintenance and sustainability, and post-partnership. The processes can be used to identify areas where discussions are needed or where training may be necessary. Although not every step applies to all CEnR projects, this protocol can be a general guide for considering the most appropriate options for a particular study. A flowchart illustrating general steps for CEnR projects in ecotoxicology is presented in Figure 3.

DISCUSSION:

Practical Implications and Challenges

Translational ecotoxicology can facilitate improved health outcomes by recommending and implementing relevant preventative measures, interventions, and remediation programs conducted in concert with community decision-making. However, traditional research models often inadvertently marginalize community partners. Additionally, conventional approaches occur only after the onset of illness or disease and tend to have accessibility, applicability, and feasibility issues,[46-49] which might be avoided through proactive prevention and remediation efforts. We sought to create a more horizontal organizational structure where each partner's expertise was equally valued. Our resultant protocol was built from the lessons learned, best practices, and key findings gleaned from our approach and experiences working as a transdisciplinary team on an ecotoxicology research project in Yuma County. By combining

academic research methodologies with local ecological and cultural knowledge, we developed more nuanced and contextually relevant research strategies.

Successful translational projects can ease the burden of the decision-making process for the affected population by providing information and tools needed to make an informed judgement. Project partners collaboratively develop intervention options that effectively control exposures to contaminants of concern. Decisions about which, if any, recommended interventions are implemented are left up to the community and exist within the constraints of funding opportunities, options for legal recourse, and public policies. Our partnership in Yuma County revealed that effective community-university collaborations can significantly transform research methodologies and provide space for innovative community health interventions. For example, our team recently developed and disseminated a collection of *fotonovelas* (comic books) that present pesticide exposure prevention techniques, which CSF shared with Yuma farmworkers and their families.[50] CEnR projects build capacity for ongoing and inter-generational resilience, with experiences that can be applied to other similar issues that exist or arise.[51, 52] CEnR increases the capacity for sustainable change through the adoption of prolonged interventions.[43]

Properly utilized CEnR methods in ecotoxicology projects can result in elevated recruitment rates (particularly for those populations that are disproportionately impacted), multiple collaborative projects, an emphasis on community empowerment and social solidarity, improved environmental justice and resource distribution, and reduced health disparities.[53-55] CEnR projects can simplify the transition from laboratories to homes by placing advocates, such as *promotoras*, between the two domains, giving voice to both the research and the community.[56] On the other hand, while community-driven research fosters inclusion, it can extend project

timelines due to the iterative nature of decision-making.

Difficulties within partnerships can manifest in several ways. Typically, obstacles arise from misunderstandings, assumptions, and unrealistic expectations.[57] When communication is insufficient, issues can appear at any stage of an applied research project, which can impede successful completion. If issues are not adequately addressed in a timely manner, they tend to compound. Academics and policy makers have historically made decisions based primarily on empirical evidence, which is slow to be compiled, often incomplete, and usually provides superficial or biased information, in part due to lack of community involvement.[58] This can lead to years of misguided efforts, expenditure of significant funds, and failed projects.

Although our project in Yuma County is ongoing, we have taken steps to complete initial evaluations of the partnerships.[19] Using interviews of key informants, the team conducted a qualitative review of the collaborations, as well as a quantitative analysis of the research process.[19] Comments were generally positive from all groups, with respectful articulations of successes and difficulties occurring within the project. For example, one participant from CSF noted, "Listening to each other and respecting each other as equal partners and valuing the information that each brings makes a big difference. You guys know a lot about research, but you don't know about my community, you don't know about the things we live on a daily basis, the challenges, so that makes me an expert on my own issues."[19, 22]

Several frameworks are available to assess partnerships and projects. One approach to performing quick and informal evaluations of the partnership is through a strengths, weaknesses, opportunities, and threats (SWOT) analysis.[59] Reflexivity provides another approach.[60] For longitudinal partnerships, the Reach, Efficacy, Adoption, Implementation, and Maintenance (RE-AIM) framework, which evaluates the participation, effectiveness, acceptance, execution, and

long-term use of the project by and for the community, can be used to assess progress and identify obstacles within projects.[61, 62] It is important to consider which model may be most appropriate for a project and to complete the chosen assessment fully.

<u>Lessons Learned</u>

CEnR in ecotoxicology leads to recommendations for interventions designed to minimize exposures to toxicants to protect human, animal, and environmental health, often with a focus on vulnerable areas.[63] Interventions should be useable, culturally appropriate, geographically relevant, as simple as possible to implement, effective, and linguistically understandable (both in terms of language and word choice).[64] Having a community voice in the planning, development, data collection, and dissemination stages of these projects can eliminate the guesswork for how to meet these requirements while simultaneously building community support. In their quest for scholasticism, researchers can become inflexible and pedantic, insisting on interventions that correspond to the highest statistical difference in some predetermined outcome, regardless of how feasible or appropriate those interventions might be for the affected community.[65] Many applied research projects have failed due to misconceptions or misinterpretations about the community and their ability to weigh risks and make decisions about their own health and environment.[57]

A critical component of CEnR is the development of community-approved research aims and methodologies. Researchers who develop projects based on externally-perceived problems often attempt to implement interventions that ultimately fail because of the lack of community buy-in.[66] Community input from the beginning and throughout the project improves the complex and dynamic relationships among partners, leading to greater efficiency and prospects for success.[67] For example, shorter turn-around times for reporting results back to community partners can be

attained from teams that work effectively with the community, which in turn leads to greater community support.[19] As co-owners of the project, each group, including the community members, contributes something significant that is crucial for success.[67] As outlined in our protocol, community partnerships that form to tackle ecotoxicological issues through research projects should commit to long-term mutual growth, from pre-partnership communications through post-partnership relationships.

Multiple perspectives arising from a transdisciplinary team help to eliminate unintended consequences of CEnR projects, which is critical given the real-world implications for communities.[68, 69] Additionally, diversity of viewpoints within the research team enhances credibility and dependability.[43, 70] CEnR projects seek objective answers to questions posed from a community perspective, which together establishes credibility. By approaching questions from a variety of directions, the likelihood of reaching accurate and appropriate conclusions (demonstrating dependability) will improve.[71] However, a team with mixed skill sets and backgrounds can lead to skewed power dynamics, and therefore the division of labor should be regularly reassessed and renegotiated. For example, a member of CSF, the community-based organization on the Yuma project team, shared frustrations regarding a perceived lack of awareness about the importance of their roles, stating, "Sometimes community groups aren't understood as well as clinics, universities, etc. We need to be seen as equal partners and see what training is needed to bring us up to speed with other partners..."[19] This sentiment underscores the idea that expertise is multifaceted and context-dependent.

As the project progresses, some changes may be unavoidable. The addition or loss of team members, the modification of project goals leading to a shift in required expertise, or the possibility of missed time due to illness or other leave can result in a loss of institutional

knowledge. While CEnR is reliant on interpersonal relationships, many of the steps outlined will mitigate common challenges associated with personnel changes. Team leaders need to employ modesty and effective communication skills while re-examining partnership roles.[57] Meeting minutes, ongoing training, and open communication are examples of processes that contribute to stability while creating a confirmable, transferable, and repeatable project that can serve as a model for communities facing similar challenges. As such, CEnR principles are difficult to apply to short-term projects that do not have sufficient time to build strong rapports that can withstand common challenges.[57, 67]

Mutual training related to the unique expertise of the project partners is a critical aspect of CEnR, as it will foster a deeper understanding and respect while elucidating the often-unspoken institutional knowledge of each partner.[67] Overlapping skillsets can improve each person's capacity to present and discuss the research with participants and community members in a more holistic manner, and alleviate disruptions due to personnel changes. Overlapping skillsets also help to ensure that shared duties can be performed systematically and therefore limit errors or bias in data collection.[17] Furthermore, mutual training improves the capacities of each organization to conduct new CEnR projects.

CONCLUSIONS:

In undertaking CEnR, we must re-define what it means to be an expert. Personal experiences affect and are affected by societal experiences, and culture, language, politics, and environment can modify behaviors.[72] Following the standards for CEnR is a reiterative process that can provide quality control, systematic evaluations, and improved outcomes for applied research.[43] Using the protocols presented in Appendix A can help prevent saviorism while producing meaningful results for a community searching for answers.[73]

ACKNOWLEDGMENTS:

REFERENCES:
1.   Truhaut R. Dangers de l'ere chimique. *Pure and Applied Chemistry*. 1969;18(1):111-128.
2.   Jouany J-M. Nuisances et écologie. *Les Actualités Pharmaceutiques*. 1971;69:12-22.
3.   Vasseur P, Masfaraud J-F, Blaise C. Ecotoxicology, revisiting its pioneers. *Environmental Science and Pollution Research*. 2021;28(4):3852-3857.
4.   Butler GC. Principles of Ecotoxicology. New York, NY: John Wiley & Sons; 1978.
5.   Ramade F. Introduction à l'écotoxicologie : Fondements et applications: Lavoisier; 2007.
6.   von Hippel FA. Green Chemistry: Terry Collins. *Science History Podcast*. 2020;Episode 29:https://sciencehistory.libsyn.com/episode-29-green-chemistry-terry-collins.
7.   Jolliet O, Huang L, Hou P, Fantke P. High throughput risk and impact screening of chemicals in consumer products. *Risk Analysis*. 2021;41(4):627-644.
8.   Li D, Suh S. Health risks of chemicals in consumer products: A review. *Environment International*. 2019;123:580-587.
9.   American Chemical Society. CAS Registry 2022 [Available from: https://www.cas.org/cas-data/cas-registry.
10.   Wang Z, Walker GW, Muir DCG, Nagatani-Yoshida K. Toward a global understanding of chemical pollution: A first comprehensive analysis of national and regional chemical inventories. *Environmental Science & Technology*. 2020;54(5):2575-2584.
11.   Czarnezki JJ, Fiedler K. The neoliberal turn in environmental regulation. *Utah L Rev*. 2016:1.
12.   Yeich S, Levine R. Participatory research's contribution to a conceptualization of empowerment. *Journal of Applied Social Psychology*. 1992;22(24):1894-1908.
13.   Oppong JR, Harold A. Disease, Ecology, and Environment. In: Brown T, McLafferty S, Moon G, editors. A Companion to Health and Medical Geography. Malden, MA: Wiley-Blackwell; 2010. p. 81-95.
14.   Sexton K, Adgate JL. Looking at environmental justice from an environmental health perspective. *Journal of Exposure Analysis and Environmental Epidemiology*. 1999;9(1):3-8.
15.   Gilles M. Class warfare: The disappearance of low-income litigants from the civil docket. *Emory Law Journal*. 2016;65(6):1531-1568.
16.   Cushing L, Morello-Frosch R, Wander M, Pastor M. The haves, the have-nots, and the health of everyone: The relationship between social inequality and environmental quality. *Annual Review of Public Health*. 2015;36(1):193-209.
17.   Israel BA, Eng E, Schulz AJ, Parker EA. Methods for Community-Based Participatory Research for Health. 2nd ed. San Francisco, CA: Jossey-Bass; 2012.
18.   Israel BA, Schulz AJ, Parker EA, Becker AB. Review of community-based research: Assessing partnership approaches to improve public health. *Annual Review of Public Health*. 1998;19(1):173-202.
19.   Baldwin JA, Trotter RT, Remiker M, Buck CL, Aguirre A, Milner T, et al. A community-engaged approach to environmental health research: Process and lessons learned. *Progress in Community Health Partnerships: Research, Education, and Action*. 2021;15(4):533-540.
20.   MacQueen KM, McLellan E, Metzger DS, Kegeles S, Strauss RP, Scotti R, et al. What is community? An evidence-based definition for participatory public health. *American Journal of Public Health*. 2001;91(12):1929-1938.
21.   González N, Moll LC, Amanti C. Funds of Knowledge: Theorizing Practices in Households, Communities, and Classrooms. Mahwah, New Jersey: Routledge; 2006.

22. Torres E, von Hippel FA. Stories of Community Engaged Research: Health Impacts of Environmental Contamination in the Yuma, Arizona Region. *Southwest Health Equity Research Collaborative (SHERC)*. 2022:https://nau.edu/sherc/cec-video-series-2-video-1-frank-von-hippel-and-emma-torres-health-impacts-of-environmental-contaminants-in-the-yuma-arizona-region/.

23. Reams MA, Irving JK. Applying community resilience theory to engagement with residents facing cumulative environmental exposure risks: Lessons from Louisiana's industrial corridor. *Reviews on Environmental Health*. 2019;34(3):235-244.

24. Rotarangi S, Russell D. Social-ecological resilience thinking: Can Indigenous culture guide environmental management? *Journal of the Royal Society of New Zealand*. 2009.

25. Hobman EV, Walker I. Stasis and change: Social psychological insights into social-ecological resilience. *Ecology and Society*. 2015;20(1).

26. Israel BA, Eng E, Schulz AJ, Parker EA. Methods in Community-Based Participatory Research for Health. San Francisco, CA: Jossey-Bass; 2005.

27. Pandya RE. Community-Driven Research in the Anthropocene. In: Dalbotten D, Roehrig G, Hamilton P, editors. Future Earth—Advancing Civic Understanding of the Anthropocene. Hoboken, New Jersey: American Geophysical Union and John Wiley & Sons, Inc.; 2014. p. 53-66.

28. McElfish PA, Kohler P, Smith C, Warmack S, Buron B, Hudson J, et al. Community-driven research agenda to reduce health disparities. *Clinical and Translational Science*. 2015;8(6):690-695.

29. Hillerdal C, Knecht R, Jones W. Nunalleq: Archaeology, climate change, and community engagement in a Yup'ik village. *Arctic Anthropology*. 2019;56(1):4-17.

30. NIH. Principles of Community Engagement 2nd ed. Force CCEKFCT, editor. Washington, D.C.: Dept. of Health & Human Services, National Institutes of Health, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, Clinical and Translational Science Awards; 2011.

31. Springer MV, Skolarus LE. Community-based participatory research. *Stroke*. 2019;50(3):e48-e50.

32. Buchanan DR. Autonomy, paternalism, and justice: Ethical priorities in public health. *American Journal of Public Health*. 2008;98(1):15-21.

33. Yuma County Chamber of Commerce. Local Industry 2021 [Available from: https://www.yumachamber.org/local-industry.html.

34. Trotter R, Baldwin J, Buck CL, Remiker M, Aguirre A, Milner T, et al. Health impacts of perchlorate and pesticide exposure: Protocol for community-engaged research to evaluate environmental toxicants in a US border community. *JMIR Research Protocols*. 2021;10(8):e15864.

35. Erikson J. The Regional Center for Border Health: A model of health-care collaboration. Arizona Telemedicine Program Blog. 2016.

36. YRMC. Yuma Regional Medical Center - About Us 2023 [Available from: https://www.yumaregional.org/About-Us.

37. CSF. Mission and Vision: Campesinos Sin Fronteras; 2023 [Available from: https://campesinossinfronteras.org/about-us/mission-and-vision/.

38. Westdahl S. Voices Unheard in Environmental Justice Panel and Documentary Preview at the Wonder House SXSW23. In: Harrison M, editor.: Landmark Stories; 2023.

39.   Ceballos RM, Knerr S, Scott MA, Hohl SD, Malen RC, Vilchis H, et al. Latino beliefs about biomedical research participation: A qualitative study on the U.S.–Mexico border. *Journal of Empirical Research on Human Research Ethics*. 2014;9(4):10-21.

40.   Balazs CL, Morello-Frosch R. The three Rs: How community-based participatory research strengthens the rigor, relevance, and reach of science. *Environmental Justice*. 2013;6(1):9-16.

41.   Lawson HA. Pursuing and securing collaboration to improve results. *Teachers College Record*. 2003;105(11):45-73.

42.   Kelley-Quon LI, Crowley MA, Applebaum H, Cummings K, Kang RJ, Tseng C-H, et al. Academic-community partnerships improve outcomes in pediatric trauma care. *Journal of Pediatric Surgery*. 2015;50(6):1032-1036.

43.   Wallerstein N, Duran B. Community-based participatory research contributions to intervention research: The intersection of science and practice to improve health equity. *American Journal of Public Health*. 2010;100 Suppl 1(Suppl 1):S40-S46.

44.   Wallerstein N, Duran B, Oetzel JG, Minkler M. Community-Based Participatory Research for Health: Advancing Social and Health Equity: John Wiley & Sons; 2017.

45.   Belone L, Lucero JE, Duran B, Tafoya G, Baker EA, Chan D, et al. Community-Based Participatory Research Conceptual Model: Community partner consultation and face validity. *Qualitative Health Research*. 2016;26(1):117-135.

46.   McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, et al. The quality of health care delivered to adults in the United States. *New England Journal of Medicine*. 2003;348(26):2635-2645.

47.   Woolf SH. The meaning of translational research and why it matters. *Journal of the American Medical Association*. 2008;299(2):211-213.

48.   Rayner G. Conventional and ecological public health. *Public Health*. 2009;123(9):587-591.

49.   Payyappallimana U. Role of traditional medicine in primary health care. *Yokohama Journal of Social Sciences*. 2010;14(6):57-75.

50.   Slagle AE, Hippel1 FAv, Cruz L, Torres F, Morey O, Rincon L, et al. Fotonovelas for farmworkers and their families: Evitando los riesgos en casa. *Progress in Community Health Partnerships: Research, Education, and Action*. Forthcoming 2025.

51.   Ahmed SM, Palermo A-GS. Community engagement in research: Frameworks for education and peer review. *American Journal of Public Health*. 2010;100(8):1380-1387.

52.   Theron LC. Community-researcher liaisons: The pathways to resilience project advisory panel. *South African Journal of Education*. 2013;33(4):1-19.

53.   Julian McFarlane S, Occa A, Peng W, Awonuga O, Morgan SE. Community-based participatory research (CBPR) to enhance participation of racial/ethnic minorities in clinical trials: A 10-year systematic review. *Health Communication*. 2021:1-18.

54.   Flicker S. Who benefits from community-based participatory research? A case study of the Positive Youth Project. *Health Education & Behavior*. 2008;35(1):70-86.

55.   Chen Y-W, Milstein T, Anguiano C, Sandoval J, Knudsen L. Challenges and Benefits of Community-Based Participatory Research for Environmental Justice: A Case of Collaboratively Examining Ecocultural Struggles. *Environmental Communication*. 2012;6(3):403-421.

56.   Ingram M, Sabo SJ, Gomez S, Piper R, de Zapien JG, Reinschmidt KM, et al. Taking a community-based participatory research approach in the development of methods to measure a

community health worker community advocacy intervention. *Progress in Community Health Partnerships: Research, Education, and Action*. 2015;9(1):49-56.

57.   Lazarus S, Duran B, Caldwell L, Bulbulia A. Public Health Research and Action: Reflections on Challenges and Possibilities of Community-Based Participatory Research. In: Maddock J, editor. Public Health: Social and Behavioral Health. Rijeka, Croatia: InTech; 2012. p. 309-324.

58.   Quarles van Ufford P. Knowledge and Ignorance in the Practices of Development Policy. In: Hobart M, editor. An Anthropological Critique of Development: The Growth of Ignorance. 1st ed. London, UK: Routledge; 1993. p. 135 –160.

59.   Leigh D. SWOT Analysis. Handbook of Improving Performance in the Workplace. 1-3. San Francisco, CA: Pfeiffer; 2009. p. 115-140.

60.   Gilbert A, Sliep Y. Reflexivity in the practice of social action: From self-to inter-relational reflexivity. *South African Journal of Psychology*. 2009;39(4):468-479.

61.   Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health*. 1999;89(9):1322-1327.

62.   Gaglio B, Shoup JA, Glasgow RE. The RE-AIM framework: A systematic review of use over time. *American Journal of Public Health*. 2013;103(6):e38-e46.

63.   Walker CH, Hopkin SP, Sibly RM, Peakall D. Principles of Ecotoxicology. 3rd ed. Boca Raton, FL: Taylor & Francis Group; 2006.

64.   Dana RH. Understanding Cultural Identity in Intervention and Assessment. Thousand Oaks, CA: SAGE publications; 1998.

65.   Buchanan DR, Miller FG, Wallerstein N. Ethical issues in community-based participatory research: Balancing rigorous research with community participation in community intervention studies. *Progress in Community Health Partnerships: Research, Education, and Action*. 2007;1(2):153-160.

66.   Waugh PD, Knight J, editors. Lessons learned from ten years of water projects at Engineers Without Borders-USA. World Environmental and Water Resources Congress 2013: Showcasing the Future; 2013.

67.   McCloskey DJ, Aguilar-Gaxiola S, Michener JL. Principles of Community Engagement. 2nd ed. US Department of Health and Human Services, National Institutes of Health, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, Awards CaTS, editors. Washington DC: DIANE Publishing Company; 2011.

68.   Blackwell GW. Multidisciplinary team research. *Social Forces*. 1954;33(4):367-374.

69.   Ledford H. How to solve the world's biggest problems. *Nature*. 2015;525(7569):308-311.

70.   Dolwick Grieb S, Eder MM, Smith KC, Calhoun K, Tandon D. Qualitative research and community-based participatory research: Considerations for effective dissemination in the peer-reviewed literature. *Progress in Community Health Partnerships: Research, Education, and Action*. 2015;9(2):275-282.

71.   Quinn G, Restine LN. Interdisciplinary teams: Concerns, benefits, and costs. *Journal of School Leadership*. 1996;6(5):494-511.

72.   Kilanowski JF. Breadth of the socio-ecological model. *Journal of Agromedicine*. 2017;22(4):295-297.

73.   Heitkemper EM, Thurman W. Social justice informatics: A critical approach for the future. *Nursing Outlook*. 2022.

74.   D'Alonzo KT. Getting started in CBPR: Lessons in building community partnerships for new researchers. *Nursing Inquiry*. 2010;17(4):282-288.

75.   Pike H. Acceptable Risk: Regulatory Aspects. In: Khan FI, Amyotte PR, editors. Methods in Chemical Process Safety. 4: Elsevier; 2020. p. 303-319.

76.   Calow P, Forbes VE. Does ecotoxicology inform ecological risk assessment? *Environmental Science and Technology*. 2003:146-151.

77.   Braunschweiger P, Goodman KW. The CITI program: An international online resource for education in human subjects protection and the responsible conduct of research. *Academic Medicine*. 2007;82(9):861-864.

78.   Papadopoulos I, Lees S. Developing culturally competent researchers. *Journal of Advanced Nursing*. 2002;37(3):258-264.

79.   Minkler M, Blackwell AG, Thompson M, Tamir H. Community-based participatory research: Implications for public health funding. *American Journal of Public Health*. 2003;93(8):1210-1213.

80.   Becker AB, Israel BA, Allen III AJ. Strategies and Techniques for Effective Group Process in CBPR Partnerships. Methods in Community-Based Participatory Research for Health. San Francisco, CA: Jossey-Bass; 2005. p. 69-94.

81.   CDC. Sample Memorandum of Understanding Template: Centers for Disease Control and Prevention; N.D. [Available from: https://www.cdc.gov/cancer/ncccp/doc/samplemoatemplate.doc.
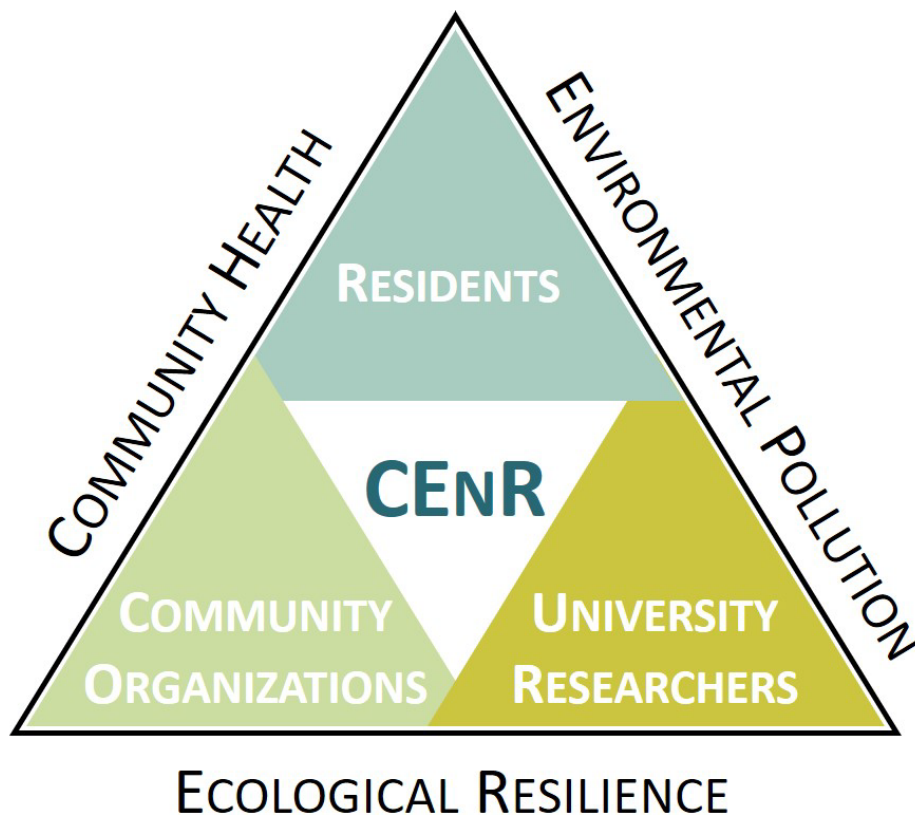
Figure 1: Components of CEnR Partnerships in Ecotoxicology. Each organization contributes their own unique skills to the project, all of which are necessary to understand the complexities of environmental pollution, community health, and ecological resilience.

Figure 2: The One Health Framework. One Health recognizes that human health, animal health, and environmental health are inextricably connected. The One Health framework naturally lends itself to community-engaged ecotoxicology research. Figure created by Paul Akmajian and Ann Garn.
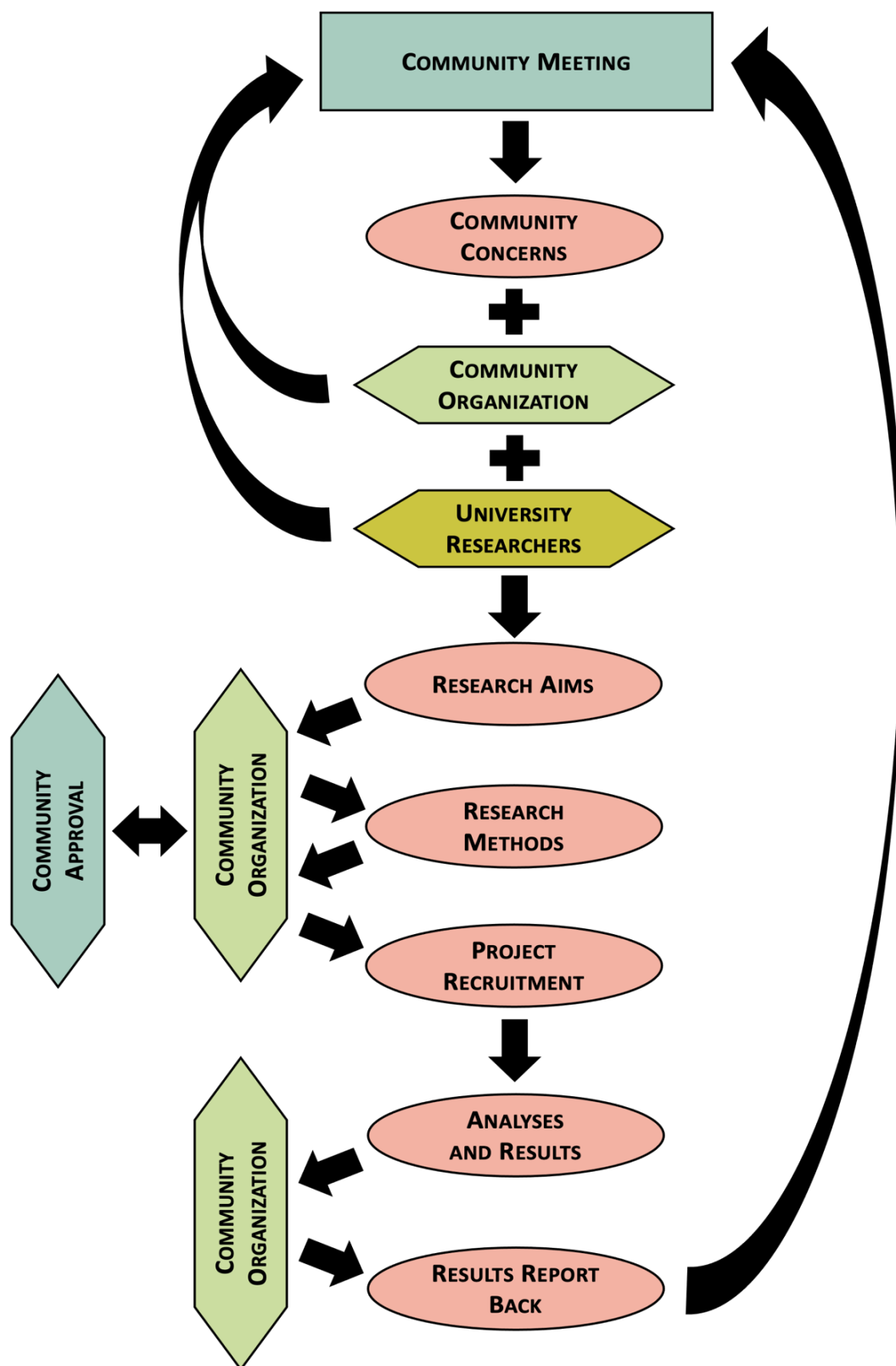
Figure 3: Project Flow Chart for CEnR. From project development to dissemination of results, CEnR tends to be an iterative process that involves regular community participation.

Appendix A:
Protocol for building and maintaining community-university partnerships in ecotoxicology community-engaged research projects.

PROTOCOL:

1. **Pre-Partnership**

    1.1. Create a Community Action Board (CAB). The coalescing of a CAB or equivalent group of affected community members is a natural starting point to discuss concerns about perceived environmental hazards and associated ecological effects or adverse health outcomes. Many communities will already have active CABs, which are usually comprised of five to ten members who regularly attend meetings to represent their community or organization.[74] Meetings can be formal or informal, are usually open to the public, and typically include an agenda with time allotted to speakers for updates, followed by questions and answers and/or open discussions. Leaders are often well-known to the community and can accurately represent its ecological needs.[74]

    1.2. Formulate a list of community concerns through discussion. Members should come to an agreement about their concerns and outline questions and ideas about how to address the issue(s).

        1.2.1. For example, community members may identify areas with potential sources of environmental contamination through environmental mapping exercises that include land use changes, clustered areas of communities with related adverse health outcomes, or other community narratives.

Honan, J.K., von Hippel, F.A., Moreno Ramírez, D., Baldwin, J.A., Trotter II, R.T., Remiker, M., Beamer, P.I., Aguirre, A., Milner, T., Torres, E., Buck, C.L. (2025) Methods for building community-engaged partnerships in ecotoxicology. *Progress in Community Health Partnerships*. (Forthcoming.)
21 April 2025.

Researchers can then use the maps to pinpoint areas for environmental assessment or interventions.

1.2.2. Discuss the idea of "acceptable risk"[75] within the CAB. Communities may assess their risks differently than would researchers, who are trained to use governmental regulations and guidelines as a basis for risk interpretation and management.[76]

1.3. Contact organizations, such as non-governmental organizations (NGOs) or local health departments, who may be able to provide additional resources to address community concerns.

2. Partnership Building

2.1. Establish common questions and core objectives among community members and research partners as an important early step to building a sustainable partnership. For a project to be most effective, explicit and achievable goals should be developed that are acceptable for both academic and community partners.[19] Project goals and methods should be usable, culturally appropriate, geographically relevant, cost effective, simple, practical, and clear.

2.1.1. Obtain community approval of the study aims. This step is critical. The project must focus on helping to resolve a health or environmental issue that is significant to the community. Having a project that focuses on a topic for which community members have a personal connection leads to stronger commitments and therefore better outcomes.[19]

2.1.2. Be clear and realistic about the concern, the hypotheses, and the expected result(s). This will provide a baseline whereby local needs can be integrated with research efforts.[19, 34]

2.1.3. Assemble a multifaceted project. The field of ecotoxicology lends itself to projects with multiple related objectives, including in human, animal, and environmental health.

2.2. Provide a venue for CAB members to meet and present information about the issue and its relevance to the community. These meetings can be facilitated to articulate needs and expectations.

2.3. Allow each potential partner to present their relevant capabilities and fit with respect to the expressed needs of the community. These can include traditional or Indigenous ecological expertise, technical knowledge, cultural and regional understanding through funds of knowledge, fund-raising experience, equipment or other resource availability, communication and outreach ability, and perhaps most importantly, time commitments.

2.4. Create an inter- and transdisciplinary team. In ecotoxicological studies, expertise in toxicology, analytical chemistry, developmental biology, physiology, ecology, environmental science, public health, anthropology, medicine, engineering, economics, behavioral science, biostatistics, communication, exposure science, epidemiology, risk assessment, implementation science, political science, and/or environmental law may all play important roles. The inclusion of NGOs or other local/community-based organizations as equal partners is beneficial and often

necessary, because they can act as sources of local knowledge and advocacy and improve recruitment efforts.[53] Participants are typically more trusting of information coming from someone inside the community.[22]

2.4.1. Collaboratively select new team members. Each partner group should provide input, with teamwork skills being a priority characteristic.

2.4.2. If possible, include academic researchers who are from the community where the research is taking place.

2.5. Conduct preliminary consultations regarding the purpose and design of the emerging project. Partners can begin considering how subsequent research protocols may be developed. Records should be kept of these initial conversations, as they will provide a reference point for community needs, a direction for additional goal setting, and a foundation for future cooperative activities.[19, 34]

2.6. Prioritize concerns using a ranking system (Table 1). Based on the list created in step 1.2, the issues can be organized by overall importance to the community, expected time to completion, potential impacts from interventions, or another agreed upon factor. For example, during the Yuma project development, community partners expressed concerns about exposure to pesticides, toxic metals, and perchlorate. Based on available resources and timeline to completion, we rank ordered these as: 1) perchlorate, 2) toxic metals, and 3) pesticides. Each of these has associated environmental, human, and animal health impacts and opportunities for interventions.

2.7.   Prepare a Memorandum of Understanding (MOU) or similar document before beginning the project. A template for an MOU can be found on the Center for Disease Control and Prevention (CDC) website.[81] This should clarify roles and responsibilities for each party and help to establish boundaries for the division of labor. This will also ensure that ownership of data is clearly delineated, that expectations are reasonable, that contact information is available should future questions arise, and that a process exists to replace key personnel should they leave the project.

2.8.   Establish research methods before project recruitment begins. Methods should be developed and revised through discussions and literature reviews until agreed upon by all parties. All methods involving vertebrate animals must be approved by an Institutional Animal Care and Use Committee (IACUC) and all methods involving humans must be approved by an Institutional Review Board (IRB), or potentially multiple IRBs if required by participating groups and institutions, before the project is initiated. Additional authorities, such as the local health department, may need to be consulted prior to beginning a project, depending on the unique nature of the community. Additionally, sampling permits may be required by government agencies, Tribes, or landowners.

2.9.   Incorporate mechanisms and time to complete IACUC and IRB training into the project.[77] Although ecotoxicology researchers are accustomed to completing these types of trainings prior to beginning work, community partners may not be. All members of the research team must comply with and understand research ethics.

2.10.   Complete cultural competency training, including awareness, knowledge, and sensitivity, to ensure accountability and responsibility to the community members from the research team.[78]

2.11.   Establish participation guidelines for CAB meetings. Researchers should regularly attend these meetings to learn about and better understand the community they plan to serve.

2.12.   Openly discuss funding, when culturally appropriate. Proposals can be prepared by both researchers and community partners, and the proposed budget should be acceptable for all members. Financial challenges for community-engaged research include the tendency for funding organizations to prioritize support for traditional academic research over non-profit or community-based projects,[79] as well as the common pay differentials between the groups. A preliminary step towards a fair distribution of funds can include budgeting more time for the community partners than the academic researchers, such that both organizations receive equal budget allocations for personnel. We employed this budgeting method for our Yuma study. Funds may also support relevant certification opportunities for community organization members.

3.   **Partnership Growth**

3.1.   Schedule regular meetings that are hosted by each organization on a rotating basis. Each group should take a turn creating the agenda and sharing preparatory materials with the group. Speaking time should be equitably distributed, with time

saved for questions and discussions. *Note: Equitable does not always mean equal. Time allotments should be based on the needs of the content and process.*

    3.1.1.   Attend meetings in person, when possible. Email is convenient but does not adequately facilitate the bonds necessary to sustain long-term relationships. When using video-capable online meeting platforms, turn on cameras to allow for virtual face-to-face interactions. Bonus points are given for hosting meetings at locally owned restaurants or other appropriate locations within the community.

    3.1.2.   Maintain meeting minutes. These should be accessible to all team members as a reference with the opportunity to edit the minutes for accuracy after each meeting. Jargon should be defined in the notes.

3.2.   Collectively create a timeline with assigned tasks (Table 2). Honor set dates and activities as much as possible. While flexibility from all partners is required, as modifications to the timeline are expected, repetitive delays can be tedious and discouraging, leading to feelings of resentment.

3.3.   Develop formal training sessions pertaining to the processes and protocols for each organization. Members of the other institutions can learn about the work related to each portion of the project. The amount of time dedicated to each training session should depend on previous experience of the trainees.[19] Prior to the commencement of our Yuma project, partners participated in training sessions that covered project goals, processes for recruiting and consenting participants, collection and storage of biological samples, and health survey administration.

The training, which focused on systematic data collection through adhering to set protocols, was held on-site in the partners' preferred language of Spanish.[19]

3.4. Allocate time to learn about each other.[80] Oftentimes, organizations involved in community work will take part in multiple projects simultaneously or will have conducted projects successfully to completion, similar to academic researchers. Learning about these additional activities will increase each partner's understanding of the visions and objectives of the other groups.

   3.4.1. Consider language in all communication. For team members who do not belong to the community with which the research is engaged, it is important to learn about preferred language that is culturally and socially appropriate and accessible, both for discussing the research in academic settings, and for community-based interactions, such as during study recruitment or while reporting results. Not only will this help to prevent miscommunication, but it also signifies respect for the community members.

3.5. If possible, engage in community activities outside of the project. This will simultaneously help expand understanding of the community's unique experience while increasing name and face recognition within the community to improve trust.[74] For example, in our Yuma project, some of the university researchers joined the community partners to participate in a cultural and health fair called "El Día del Campesino" (The Day of the Farmworker), an all-night event to serve the needs of migratory farmworkers.

4. **Partnership Maintenance and Sustainability**

4.1. Establish a culture that allows for a free flow of information among organizations, discussing not just what actions are being taken, but how and why. This can help minimize or eliminate misunderstandings among the members while also providing informal training on the processes that each group uses in their respective fields of expertise. Discussions should be timely, open, and honest without hostility or judgment.

4.2. Minimize modifications to methodologies after data collection has begun. Logistics are difficult when working in larger groups, but changes to certain activities, while sometimes unavoidable and necessary, can create barriers to access and limit trust within the community, particularly for health-related projects.[19, 22]

4.3. Complete formal, systematic assessments of the partnerships regularly through monitoring and evaluation of research context, group dynamics, interventions, and outcomes.[19, 34] Assessments can be done through interviews, focus groups, onymous or anonymous surveys, or other ways that best fit the project. Dolwick et al.[70] provide a framework for assessment of CEnR, including a platform for obtaining feedback from collaborators. An initial evaluation of our project partnerships with CSF, RCBH, and YRMC was conducted by Baldwin et al.[19]

4.3.1. Include questions in these evaluations regarding the suitability of the project topic, effectiveness of training, partner involvement, impacts on

local environmental or health policies, and future development of the research.[19]

    4.3.2.   Review quantitative results for trends, outliers, or unexpected outcomes. Qualitative results can be coded and thematically analyzed to look for common experiences.[19] This will help to illuminate effective tactics and areas for improvement.

    4.3.3.   Modify the project based on the results of these internal questionnaires. Any changes should be considered and discussed together before implementation.

4.4.   Review informed consent documents for cultural and linguistic sensitivity before implementing or disseminating them to the community (e.g., surveys, infopackets, public announcements, recruitment flyers, reports). Use simple but accurate language to describe any ecotoxicology concepts related to the project. Community partners must give final approval before use.

5. Post-Partnership

5.1.   Conduct a final evaluation of the research group at the end of the study. Partners should reflect on and discuss what worked well and what did not, whether or not the original goals were realized, and ideas for other community work based on ongoing needs. Ideas for improvement should be shared and used for continuing work.

5.2.   Share information about the organizations with other groups in your area of expertise. This will help to grow the available resources for community advocacy

and resilience by allowing bilateral outreach and networking (e.g., the academic institutions can reach out to NGOs to provide assistance in developing new community-engaged ecotoxicology projects). For example, a researcher from Northern Arizona University had previously collaborated with a leader of CSF and was therefore able to kickstart the partnership for our current Yuma project.

5.3.   Preserve community ecotoxicology narratives. Communities should have a systematic way to document and disseminate data, results, and other information for their historical records. Communities can return to their archives to access these data for use in longitudinal or comparative ecological analyses.

5.4.   Whenever possible, maintain contact with community members. As populations change with time, through arrival or departure of residents, aging of community members, or evolutions in cultural norms and habits, the results of prior research may become less relevant, and interventions that were previously implemented can become ineffective or inappropriate, used less over time, or simply be forgotten. In order to create more sustainable relationships with longer-lasting impacts, communication should be routinely maintained.

Table 1: Example Ranking System for Prioritizing Community Concerns. While communities may have multiple problems that need to be addressed, the ranking system can target areas of high need where researchers and community organizations can provide expertise within an acceptable timeframe. The ranking system can illuminate areas of highest impact for community-engaged research in ecotoxicology.

	Concern 1	Concern 1	Concern 1
Known Human or Animal Health Risk Rating	High	Low	Medium
Human or Animal Exposure Risk Rating	Low	Medium	High
Uncertainty Rating	Low	Medium	Medium
Potential Ecological Impact	Low	Low	High
Feasibility Rating	High	Medium	Medium
Community Ranking	Low	Medium	High
Initial Judgement of Status Quo	Acceptable	Acceptable	**Unacceptable**
Priority Number (Rank)	3	2	1

Table 2: Example Template for a Project Timeline for Assigning Tasks. Creating and adhering to an agreed upon timeline can help communities keep realistic expectations and hold researchers and community workers accountable for their individual tasks, especially those that are necessary to complete before moving to the next step in the research project.

	Task	Assigned To	Start Date	Expected End Date	Actual End Date
PHASE 1					
Needs Assessment					
Literature Review					
PHASE 2					
Methods Development					
Community Outreach					
PHASE 3					
Participant Recruitment					
Lab Preparation					
PHASE 4					
Data Collection					
Model Development					
PHASE 5					
Data Analysis					
Initial Participant Feedback					
PHASE 6					
Final Report					
Interventions / Health Recommendations					
Results Report Back (Individual/Community)					
Final Focus Groups					