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Sustainability science and education in Haiti and Puerto Rico

Ciencia y educación en sostenibilidad en Haití y Puerto Rico

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ABSTRACT

This paper reports on the results of a workshop in Haiti and Puerto Rico to capture what priorities may be important to build sustainability sciences and education. In 2015, approximately 35 individuals attended all or part of the workshop at each location. Participants included academic leaders, university faculty, secondary school teachers, representatives of non-profit organizations, and university and high school students. Haitian participants called attention to the need for reforestation training, systemic solutions for waste management, and sustainable marine resources management. In Puerto Rico, participants called for more training to link civic engagement with sustainable development, social determinants of health, and programming on tsunami preparation and recovery. Members of both workshops asked for sustainability science and education advances in renewable and alternative energy development, general disaster and climate change impact preparedness (e.g. drought), and sustainable agriculture. Haitian and Puerto Rican participants also shared the view that engaging sustainability requires higher educational institutions to partner with communities, primary and secondary school teachers, policy-makers, and especially young persons, to reinforce the values of sustainability, and collectively work across sectors to learn through trial and error together.

KEY WORDS: Sustainability sciences, education, Haiti, Puerto Rico, transdisciplinarity

RESUMEN

El presente artículo reporta los resultados de un taller en Haití y Puerto Rico el cual identifica qué prioridades pueden ser importantes para construir ciencias de la sostenibilidad y educación. En 2015, aproximadamente 35 personas asistieron a todos o parte del taller en cada ubicación. Los participantes incluyeron académicos, líderes, profesores universitarios, profesores de secundaria, representantes de organizaciones sin fines de lucro, y estudiantes universitarios y de secundaria. Los participantes haitianos llamaron la atención sobre la necesidad de formación en reforestación, soluciones sistémicas para la gestión de residuos y gestión sostenible de recursos marinos. En Puerto Rico, los participantes pidieron más capacitación para vincular el compromiso cívico con el desarrollo sostenible, determinantes sociales de la salud y programación sobre preparación para tsunamis y recuperación. Los miembros de ambos talleres pidieron ciencia para la sostenibilidad y avances de educación en energías renovables y desarrollo de energía alternativa, preparación para desastres naturales e impacto del cambio climático (por ejemplo, sequía) y

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agricultura sostenible. Los participantes haitianos y portorriqueños también compartieron su visión de que comprometer la sostenibilidad requiere que las instituciones de educación superior se asocien con las comunidades, maestros de escuelas primaria y secundarias, formuladores de políticas, y especialmente jóvenes, para reforzar los valores de la sostenibilidad, y trabajar colectivamente en todos los sectores para aprender juntos a través de prueba y error.

PALABRAS CLAVE: Ciencias de la sostenibilidad, educación, Haití, Puerto Rico, transdisciplinaridad

INTRODUCTION

The question of how to teach sustainability is important across the world as educational institutions continue to recognize the context-sensitive and site-specific approaches needed to address climate change, biodiversity loss, desertification, sustainable livelihoods, and the historical and continuing relationships among health, food and energy security, social justice and the renewability of ecosystems. Higher education institutions can help promote sustainability as a core strategy for progress, and offer courses and programs to teach transdisciplinary approaches to integrate policy and science into sustainability. This paper reports on two workshops with stakeholders in Haiti and Puerto Rico held in 2015 to address: 1. *What should be the goals of the sustainability sciences?*; 2. *What should be the goals of sustainability education?*; and 3. *What are the strategies and tactics to achieve these goals?* This paper summarizes the responses in the workshops to these questions, and offers a few specific recommendations regarding advancing sustainability science and education in Haiti and Puerto Rico, and several broader suggestions about how the process carried out in Haiti and Puerto Rico could be integrated into sustainability planning across the Americas.

The sustainability sciences include the biophysical, socio-cultural, and interdisciplinary sciences, and sustainability education includes both formal and informal learning at the higher education level, as well as experiential and service learning related to sustainability. There are currently many universities with interdisciplinary sustainability academic programs at the undergraduate and graduate level such as the University of Alberta (Canada), Arizona State University (United States), and Stockholm University (Sweden).

The emergence of sustainability as a subject of university education and research is not new. The United Nations has called on higher education institutions to address environmental and development issues for many years, and designated the years 2005-2014 as the Decade of Sustainable Development (Sterling 2010). More recently, the United Nations has urged educational institutions and all sectors of society to address 17 Sustainable Development Goals (SDGs), with support from 193 world leaders (UNESCO 2017). Scholars have described a wide range of approaches to teaching sustainability in higher educational institutions (Sipos et al 2008; Tilbury, 2011, Wals, 2009; Wright 2013).

While higher education institutions around the world are engaged in sustainability initiatives, there is a significant lack of guidance on how such institutions can effectively plan for and implement these initiatives in ways that are distinctive to national cultures and higher education institutions, affordable within financial constraints, and forward looking (Clark et al 2011). In Haiti, the role of universities as solution providers for sustainable development has been mostly ignored by the public and private sectors, as well as international stakeholders. In Puerto Rico, higher education is far more accessible to the population, although government austerity measures leave higher educational institutions significantly underfunded.

The Haiti and Puerto Rico workshops were part of a larger Sustainability Sciences and Education Project sponsored by the American Association for the Advancement of Science (AAAS), Clemson University, the University of Alberta, the recently formed Haitian Association for the Advancement of Science and Technology (HAAST) and the Caribbean Division of the AAAS. These workshops had three main objectives: 1) provide stakeholder-driven guidance on future directions of sustainability initiatives at Haitian and Puerto Rican higher education institutions, 2) foster communication and collaboration amongst institutions with similar sustainability goals within Haiti and Puerto Rico, and 3) help build capacity for sustainability leadership in Haiti and Puerto Rico.

Background on host countries and workshops

Haiti, as it has so often been in its history, is at a crossroads. Rebuilding from the devastating 2010 earthquake, the people and institutions of Haiti are working to find new strategies for economic and social development, new solutions for old problems such as inadequate infrastructure, and new opportunities for creating a sustainable and prosperous Haiti. Puerto Rico also faces an uncertain economic and environmental future, especially with its current recovery efforts from Hurricane Maria in September 2017. When the workshop occurred, Puerto Rico was already coping with outmigration trends, inadequate funding of public services (including public higher education), and challenges to the growth of employment opportunities. Climate change, sea-level rise, energy and potable water availability, and continuing risks from hurricanes, also create uncertainties and challenges. Both Haiti and Puerto Rico are now in the midst of long term recovery efforts related to the 2017 Hurricanes Irma and Maria that will even further limit higher education capacity, whilst increasing the importance of sustainability and resilience training.

The workshop in Haiti was conducted on 6 May 2015 at the Hotel Montana, Petion-ville, Haiti, and in Puerto Rico on 12 September 2015 at the University of Puerto Rico in San Juan. The workshop in Puerto Rico was hosted by Caribbean Division of the AAAS during its 2015 Annual Meeting at the University of Puerto Rico Medical Sciences Campus. The theme of the Annual Meeting was "Attaining Sustainability Through Science and Education." Approximately 35 individuals attended all or part of the workshop at each location. Participants included academic leaders, university faculty, secondary school teachers, representatives of non-profit organizations, university and high school students, and others.

The authors of this paper facilitated the discussions. In Haiti, the workshop was conducted in French and English, with simultaneous translation, and recorded on video, whereas in Puerto Rico, the workshop was conducted in Spanish and English, with simultaneous translation. One facilitator took notes summarizing participants' comments while the other led a discussion. After introductions and an overview of sustainability science and education at each location, the discussions (each lasting approximately 90 minutes in Haiti, 30 minutes for each question in Puerto Rico) were organized into three sessions linked to three key questions:

1. What should be the goals of the sustainability sciences in Haiti/ Puerto Rico?

2. What should be the goals of sustainability education in Haiti/Puerto Rico?

3. What are the strategies and tactics in Haiti to achieve these goals in Haiti/Puerto Rico?

The workshops concluded with a brief summary of the discussions and a description of next steps. After the workshop was completed, all comments by participants were reviewed and placed with the responses to one or more of the three questions. In some cases, a response made during a particular discussion session was more appropriate to a different question session, and was placed in that session for analysis.

The workshop results have several limitations. First, the time allowed for each question limited the breadth and depth of the discussion. Second, the results are dependent upon the individuals and mix of institutions represented in the workshop; a different set of participants might provide different results. Third, the concepts of sustainability science and sustainability education were relatively new to some participants, limiting their opportunity to provide comment. Given the small percentage of students who enter higher education in Haiti, significant concern and interest was expressed about sustainability education at primary and secondary levels. In Puerto Rico, participants were more focused on sustainability education in post-secondary institutions.

The results represent the guidance of a broad set of stakeholders in higher education and research and can provide useful insights into advancing sustainability science and education within Haiti and Puerto Rico. The links between primary, secondary, and post-secondary education made by our participants illustrated the opportunity to ladder, or build upon previous learning and skill development, in a much more deliberate fashion across the Americas. High school education for a student in Haiti, for example, may call for more hands-on experience in sustainability projects due to the fact fewer students can afford higher education. Participants' expressed deep appreciation for the opportunity to speak to the experiments and lessons they had learned, in situ, that could inform a more targeted approach to transdisciplinary teaching, research and collaboration in their countries. Across the Americas there may be opportunity for academic leaders, university faculty, secondary school teachers, representatives of non-profit organizations, university and high school students to share their experiences, ideas, and organizational abilities to enrich sustainability education.

Much of the material in this paper is drawn from two American Association for the Advancement of Science reports in which the authors summarized the workshop results (Krogman and Machlis, 2016; Machlis and Krogman 2016).

Workshop results

Goals of sustainability sciences

1. What should be the goals of the sustainability sciences in Haiti?

There are three general overarching themes that emerged from the participants' statements at the workshop. First, the sustainability sciences in Haiti should focus on the protection and sustainable use of the fundamental natural resources of the country. Among these are water, land (especially arable and forested land), and marine resources. A suggestion was made to create a national inventory of the land of Haiti that identifies lands that cannot be cultivated due to drought or deforestation, and lands that hold the potential for successful reforestation. Enthusiasm was demonstrated around science that informs farming that is less labor-intensive and more ecologically sustainable, due to the health issues associated with manual farm implements, and the soil erosion and nutrient depletion currently reducing agricultural productivity. Similarly, many participants were interested in sustainability science that could inform incentives and community collaborative approaches that arrest deforestation and improve the longer-term outcomes of reforestation. Interest was also expressed in enhanced marine science that identifies medicinal and edible plant and food harvest possibilities.

A second expressed goal for the sustainability sciences is to create higher education opportunities to directly address Haiti-specific sustainable development. Participants spoke of the unique history, geography, and demographic trends (e.g. majority of population is young or of child bearing age) in Haiti that call for sustainable development initiatives informed by distinct Haitian needs. In particular, participants called for greater science and scholarship in risk management, disaster preparedness, and enhancing resiliency for Haiti. Country-specific research could be conducted on:

- alternative energy development (solar, biogas, waste product energy),
- pollution abatement and waste management, particularly in regards to recycling science and practice (e.g., reuse of plastics, using waste to make other products, potentially involving robotics),
- building termite-resistant homes,
- efficient and affordable transportation for people across Haiti,
- communication technologies that would foster these sustainable development initiatives above, and
- most importantly, identify places of high risk, in terms of potential disaster and climate change impacts, and the ability for communities to prepare, adapt, and make improvements in these high-risk areas.

Participants felt that the sustainable development needs of Haiti should emerge from communities across Haiti, and specifically engage and integrate community members in needs assessments, experimental and demonstration projects, test-applications, and partnerships to implement and evaluate interventions. They also felt the accumulated knowledge should be made public and easily accessible.

Participants felt that a third goal of sustainability science in Haiti should be to create a partnership between higher education, scientific research, and public policy. Essential to this task, some participants held, is the need to re-establish a reliable Haitian Census. Participants expressed concern about the absence of a current and longitudinal analysis of the demographics and conditions of the Haitian population, rendering many development efforts in Haiti poorly informed about their target populations. Participants also suggested the development of research centres to more effectively build collaborations between higher education institutions, and among Haitian researchers and the global academy of scientists who work in Haiti, the government, non-governmental organizations, the private sector, and communities.

What should be the goals of the sustainability sciences in Puerto Rico?

Among the Puerto Rican participants there was high interest around promoting an interdisciplinary approach to complex problems that affect the future of Puerto Rico. Participants identified key topic areas for the sustainability sciences in Puerto Rico, including:

- sustainable development,
- social determinants of health,
- healthy communities,
- sustainable agriculture, and
- renewable energy.

Participants felt that one of the goals of the sustainability sciences in Puerto Rico should be to train students to understand the data needed to examine complex problems, how to integrate different data sets, apply appropriate statistics, and use the findings of such research to address current challenges. For the sustainability sciences to succeed in Puerto Rico, participants suggested that there needs to be a government-

provided solid base of funding to support sustainability research and to support university laboratories.

Some of the participants held that the high reliance on external funds from the US-based National Science Foundation and the National Institutes of Health inhibits the ability to carry out research on broader sustainability topics such as integral health and sustainable economic development for Puerto Rico. One option offered was a government-supported research cooperative to give secure funding to basic research that supports the sustainability sciences.

For several participants, effective sustainability science in Puerto Rico requires student and researcher engagement with community challenges, problem-based learning, and experiments. These applied trial-and-error experiences could help transform Puerto Rican society toward a more sustainable future through more sustainable designs, practices, policies, and civic involvement.

Goals of sustainability education

2. What should be the goals of sustainability education in Haiti?

There were two theme areas for responses to goals of sustainability education in Haiti. First, educational efforts should be increased in the areas of risk management, disaster-preparedness, and approaches and designs for recovery and resilience. This training was seen as part of education that places content about risks, disasters, and resiliency as pedagogy on *systems* and systemic thinking about linkages among multiple elements, such as the stages of preparation, disaster event, and recovery over time. Participants suggested interdisciplinary systems training could help explain the interacting factors of shelter, water, farming, food, technology, transportation, and support for governance, human health, communication, education, and employment. Such system-focused curriculums would also address agriculture-environmental connections, climate change, energy, reforestation, tourism, public policy, governance, and cultural barriers to sustainable development.

Secondly, participants felt that the goal of sustainability education should be to connect higher education institutions to communities as well as international research programs working on similar issues, through the research centres described above and study centres in communities. For example, such study centres could be places for secondary students to participate in learning experiences (e.g., "Reforestation Days") or a research project initiated by a Haitian university. The study centres could also be a place for community teachers to attend workshops (for example, on the basics of the scientific method or on models for sustainable development) led by a Haitian higher educational institution. Participants suggested the scientific training of teachers in Haiti is weak, and continuing education in this area is needed. They also felt that continuing education of teachers is needed to nurture student curiosity, enthusiasm, and awareness of the role of science in civic well-being, and to better prepare students for careers in science that require higher education.

In general, greater cooperation and exchange between higher educational institutions and communities could potentially foster transdisciplinary, cross-sector, experimental, experiential, and proactive learning. Participants felt that secondary and post-secondary students need this kind of learning to understand the importance and application of knowledge and skills and to contribute to Haiti's development. Several participants suggested that students and faculty in higher educational institutions can be far more effective if they have direct experience working with communities, in order to learn about in situ priorities (e.g., improving farmer livelihoods) for sustainable development and gain the skills of developing specific solutions for Haitian communities.

Consistent emphasis was placed by participants on the high proportion of Haitian students who will not attend a higher educational institution, and hence the importance of learning opportunities for primary and secondary teachers and their students, and more broadly community members. Participants felt that students need to understand their own potential to combine a variety of skills in the trades, and the related opportunities for entrepreneurship, to help build and improve Haiti's infrastructure and develop small-scale businesses. Issues addressed in Haiti exist in many other developing countries, and locally developed solutions can and should be exportable and usable elsewhere. Many participants held that entrepreneurial opportunities exist in waste recycling, energy/electricity development, and reforestation.

One participant expressed concern about the barrier of language for students capable of pursuing a higher education but who only speak Creole, given that French is the primary language in which higher education is delivered. Greater creativity in teaching sustainability education in Creole and teaching French in rural areas may be required to effectively reach the broader Haitian population.

What should be the goals of sustainability education in Puerto Rico?

Participants at the workshop called for a set of "holistic education" programs that provide investigation opportunities linked to action. According to some participants, the key question to be addressed in sustainability education, is "How can science be integrated into action?"

Some participants held that science and its application must be demonstrated in communities and engage community members, e.g. through a range of activities, including (for example):

- trials in sustainable farming,
- community gardening,
- models for greater civic engagement,
- converting empty spaces in Puerto Rico to other fruitful uses,
- building and installing solar cells and transformers in communities,
- and tsunami preparation.

Enthusiasm was expressed around the way informal teaching methods in the community and applied science can increase public interest in science and basic science understanding in fundamental ways. For example, one professor shared his experience of teaching chemistry to 700 students by tying concepts of polymers, physics and lights to waste management and recycling.

Civic engagement was seen as an especially important part of sustainability education because of the importance of self-reliance and in-country leadership, given Puerto Rico's distinctive history of colonialism and challenges to self-organization around collective problems. Thus, critical thinking pedagogy is also an important part of sustainability education in Puerto Rico.

Strategies and tactics to achieve sustainability sciences and education goals

3. What are the strategies and tactics in Haiti to achieve these goals?

Several themes emerged from the discussion of strategy and tactics in Haiti. Many participants (including the student representatives) reported that developing significant opportunities for life-long learning was the foundation for long-term sustainability in Haiti. Participants stated that sustainability can and should be integrated into the curriculum early, "even in primary school" and definitely in

secondary and higher education. Importantly, the values of empathy, solidarity, and collaboration were seen as essential elements to impart on young persons, to help create motivation and interest in subjects (from science to civics) relevant to Haitian sustainability. Building student interest, skill, and confidence in solving local problems had strong support amongst participants. Teaching "how to learn" and training students "to keep them learning" were seen as important strategies.

In addition to this expanded view of sustainability education, there were several institutional strategies proposed. One was to ensure that the "systems perspective" is part of the curriculum, so that students can better understand the key linkages between environment, economy, society, and culture. This necessarily requires interdisciplinary coursework and teachers skilled in systems thinking. While participants felt that the systems perspective could and should be integrated into sustainability education and research at all levels, there was specific interest in developing a sustainability certificate for higher education students, modeled after the certificate program at the University of Alberta.

A third theme was the importance of higher education investing in applied research at the local level, to help Haitians solve problems and advance sustainability. Participants recommended that university students, even at the beginning of their training, could and should be engaged in problem-solving research. Further, advanced students (particularly for PhD students) should conduct research that is relevant to Haitian needs, applied to Haitian problems, and communicated to Haitian decision makers. Reducing current course loads to create opportunities for hands-on research was seen as an important strategy.

For faculty, this emphasis on systems-level science and applied research suggested several important strategies and tactics. With the heavy teaching loads carried by Haitian faculty, creating opportunities for student and faculty research may benefit from informal collaboration. Participants also asserted that they would benefit from formal partnerships focused on sustainability science with universities outside Haiti, external scientists and international students.

What are the strategies and tactics in Puerto Rico to achieve these goals?

Participants had widely varied views on strategies and tactics to achieve sustainability science and education goals for Puerto Rico. Some were optimistic in advancing sustainability in Puerto Rico; others were pessimistic about the possibility for change. One area of agreement was that a significant values shift was required, and that values associated with environmental care and sustainable practices needed to be imparted throughout Puerto Rican society. Recent drought and climate change offered opportunities to link a shift in values to Puerto Rico's future. (We suspect this shift in values toward sustainability is even stronger as Puerto Rico rebuilds its energy and potable water systems after Hurricane Maria.) Participants asserted that education—both formal for young persons and informal for adults—needed to include valuing nature, and that tactics such as social media campaigns and demonstration projects (such as community gardens) should be part of this effort.

A second key theme was that strategies should include formal collaborative agreements with other Caribbean countries (including Cuba) that would encourage:

- community education in sustainability and sustainable practices,
- formal school and university sustainability curriculums (including courses, certificates, and degrees as appropriate),

- exchange programs in sustainability, focused on faculty, students, and community groups,
- national, regional, and local meetings to share best practices in sustainability, with broad use of social media to disseminate ideas and practices, and
- funding for sustainability initiatives, including support from world organizations and matching funds from other countries.

Participants also cautioned that action is important, and that resistance to change must be overcome if sustainability is to become integral to Puerto Rico's future.

DISCUSSION

The different goals and strategies voiced at the workshops on Haiti and Puerto Rico illustrate the need for country-specific sustainability science and education development. Participants called for support for research in the specific sustainability challenges for their people and land. For example, Haitian participants called attention to the need for reforestation training, systemic solutions for waste management, and sustainable marine resources management. In Puerto Rico, participants called for more training to link civic engagement with sustainable development, social determinants of health, and programming on tsunami preparation and recovery. Members of both workshops identified as important sustainability science and education advances in renewable and alternative energy development, general disaster and climate change impact preparedness (e.g., drought), and sustainable agriculture. Haitian and Puerto Rican participants also shared the view that engaging sustainability requires higher educational institutions to partner with communities, primary and secondary school teachers, policy-makers, and especially young persons, to reinforce the values of sustainability, and collectively working across sectors to learn through trial and error together.

This research corroborates a recent Organization of the America's publication (OAS, nd) on Environmental Sustainability in the Americas. In that policy brief, the authors hold that the key sustainability issues common across the Americas include: 1) issues of access to technology and know-how, and access to natural resources, especially for the poor; 2) ensuring the sustainability of water resources; 3) mitigating natural hazard risk; 3) reducing land degradation; and 4) reducing economic, social and environmental vulnerability. Using these topics in workshops to then generate country-specific content for transdisciplinary curriculums and programs may be a useful approach across the Americas.

CONCLUSIONS AND RECOMMENDATIONS

The project directors (who served as facilitators for the workshops) reviewed the workshop comments and from the above discussion, developed several general recommendations for higher education institutions in Haiti and Puerto Rico.

Haiti

1. Haitian sustainability policy and practice can be informed by policies and practices in other countries (such as the US, Canada, and developing countries confronting similar problems) but should be distinctively Haitian and derived from local community engagement.

2. Sustainability science in Haiti should be fully integrated into sustainability education; i.e., learning about sustainability should include research experiences at all levels of Haitian education.

3. Sustainability sciences and education in Haiti should include applied biophysical science, socioeconomic science, and interdisciplinary science, and focus on systems-level understanding and the protection and sustainable use of Haitian natural resources.

4. Haitian higher education institutions should consider partnering with universities outside Haiti to develop a primary-secondary-undergraduate curriculum proposal to promote sustainability education in Haiti.

5. In collaboration with select universities in the US and Canada, a certificate program in sustainability should be developed appropriate to Haiti, including distance learning where most effective.

Puerto Rico

1. Puerto Rican universities should empower their faculty, staff, and students to advance sustainability policies and practices both within the institutions as well as in broader Puerto Rican society. This includes both sustainability research (including studies of environmental values within Puerto Rico society) and education both within the curriculum and through outreach to Puerto Rico's citizens.

2. The integration of sustainability into youth education (including environmental values and sustainable practices) should be made a national and institutional priority, and student learning can be leveraged to engage adults and broader Puerto Rican society.

Across the Americas, there is a great need for partnership in sustainability research to offset the inequities and variabilities in research capacities of institutions, and to enrich transboundary, cross-cultural learning about diverse approaches to address sustainability challenges. A common theme among the voices in our study, and likely applicable elsewhere, is the need for sustainability thought and practice to be mainstreamed across the primary, secondary and post-secondary curriculum, where social, natural and physical sciences are all applied to in-country sustainability challenges.

Puerto Rico and Haiti represent just two distinct cultures and educational systems, but the approach described here has potential elsewhere. As sustainable development and sustainable economies, environments, and cultures become critical benchmarks of human progress, the role of higher education institutions around the world in researching and teaching sustainability must increase in visibility and effectiveness. In doing so, thoughtful consideration of the views of stakeholders—including both educators and students as well as citizens and institutional leaders—can help guide how universities can become agents of change.

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Gary Machlis is University Professor of Environmental Sustainability at Clemson University. From 2008-2017 he served in the Obama administration as the first scientist appointed as science advisor to the director of the National Park Service. His research interests include conservation, urban ecology, humanitarian response to environmental crises, the politics of science, and the future of sustainability. His recent work includes the co-authored books *The Structure and Dynamics of Human Ecosystems: A Model for Thought and Action* (Yale University Press, 2017), and *The Future of Conservation in America: A Chart for Rough Water* (University of Chicago Press, 2018). Dr. Machlis has worked internationally on a variety of projects, from giant panda conservation in China to rebuilding scientific capacity in Haiti after its devastating earthquake. Along with Naomi Krogman, he is at work on a book about sustainability, entitled *Desolation Row: Sustainability for the Forgotten*. In 2010 he was elected a Fellow of the American Association for the Advancement of Science.