Deep-sea drilling threatens cold seep ecosystems.

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Deep risks from offshore development

Brazil's government is reopening bidding rounds for deep-sea oil and gas exploration after 4 years of economic and political turmoil. According to its ambitious 4-year plan (*1*), through which the government expects to profit from licenses and production royalties, Brazil will lease hundreds of offshore areas for exploration in depths below 200 m. Allowing such exploration will substantially expand the offshore industry in regions that are of biological and ecological relevance for deep-sea conservation (*2*).

In deep-sea basins within Brazil's exclusive economic zone, where more than 70% of the current offshore oil production is concentrated, there is already substantial overlap between leased areas and vulnerable marine ecosystems, including cold-water corals and submarine canyons (*3*). Other vulnerable ecosystems, such as cold seeps, are poorly reported even in basins where there is biological and geophysical evidence for their presence (*4*, *5*). The spatial overlap and depth distribution of pockmarks within oil fields suggest that seeps may be common in areas currently offered on bidding rounds. As a result, the planned expansion of offshore leasing areas will increase the impacts of the offshore oil industry from the Amazon to the Southern Atlantic basins (*6*) if political and legal frameworks are not developed to offer better management of industrial activities.

The industrialization of the deep sea requires global action to protect vulnerable marine ecosystems (*7*). Strategic management and conservation actions, including avoidance and protection of deep-sea ecosystems into marine protected area networks, would prevent impacts from the offshore oil and gas industry and could be easily adapted from other industrial activities such as deep-sea mining (*8*). Drilling companies are already required by contract to invest 0.5 to 1% of their gross income in research and development (*9*); there should also be a legal framework to direct research to high-quality scientific baselines of deep-sea ecosystems across Brazil's continental margin, which would help to define conservation goals and monitoring demands. This new legal framework for the offshore industry would be similar to the current international demands with which Brazil will have to comply in order to pursue its mining claims in the South Atlantic (*10*, *11*). It is time to add the conservation of deep-sea vulnerable ecosystems to Brazil's offshore agenda, allying scientific and societal demands for sustainable use of natural resources and positioning the country toward deep-sea conservation in the South Atlantic.

Angelo F. Bernardino[1]* and Paulo Y. G. Sumida[2]

[1]Departamento de Oceanografia, Universidade Federal do Espirito Santo, Vitoria, ES 29075-910, Brazil. [2]Instituto Oceanográfico, Universidade de São Paulo, São Paulo, SP 05508-120, Brazil.
*Corresponding author.
Email: angelo.bernardino@ufes.br

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Culturally inclusive STEM education

In their Policy Forum "Without inclusion, diversity initiatives may not be enough" (15 September, p. 1101), C. Puritty *et al.* suggest that institutions must foster a "culture of inclusion aimed at equity and social justice." However, the failure of long-standing efforts to effect substantial change reflects a deeper issue: the widespread cultural belief that science is neutral, objective, and apolitical. Although it is true that science aims for objectivity, social and cultural values affect who gets to do science, what questions are addressed, and who benefits from research. Fewer National Institutes of Health (NIH) grants are awarded to black scientists (*1*) and to female scientists (*2*) relative to their white male counterparts; biomedical research is biased toward diseases afflicting white men (*3*). The idea that science is separate from social and cultural issues is flawed and alienates women and underrepresented minorities (*4*). To diversify science, we must systematically incorporate culturally inclusive practices into higher-education science, technology, engineering, and mathematics (STEM) classrooms.

STEM curricula should emphasize the methodological and statistical practices that shape our standard scientific explanations, such as analyzing who is a part of the sample population and to whom scientific findings truly generalize. A discussion of how unrecognized bias in scientific studies results in structural racism and socially biased public policies demonstrates the importance of critical analysis while creating an inclusive class environment. Integrating socially and culturally relevant examples into STEM education (*5*) and incorporating community- and project-based learning increases student motivation and confidence—key factors in improving persistence of underrepresented minorities (*6*). These techniques have been shown to increase critical thinking skills, interest in the subject, and persistence in all students, including minorities (*7*).

Opportunities abound to relate scientific subject matter to social and cultural issues. In an undergraduate physics classroom, for example, students may work with a local business to analyze solar power needs, helping them learn about the technology in the context of its benefits and limits for society. In a computer science course, students might work with a local library to expand its community impact. A general chemistry course can integrate socially relevant examples such as the Flint water crisis (*8*) or the huge societal implications of the minute structural differences between crack and cocaine. In a biology course, a discussion of Henrietta Lacks integrates an important racial and bioethical issue into a class on stem cells (*9*). Culturally sensitive classrooms can help to mitigate the effects of the primary barriers to underrepresented minority students' success, which include feeling like they do not belong in a predominantly male, white, and cisgendered field; faculty or peers undermining their intellectual capacities through implicit stereotyping (*10*); the unsupportive "weeding out" culture of many STEM disciplines ("Helping less-prepared students excel," A. Sessoms, Letters, 18 August, p. 654); and the focus on the individual rather than the community (*4*).

Despite the evidence of their success (*7*), culturally inclusive teaching practices are not systematically used across the STEM curriculum in higher education. We thus recommend a major pedagogical shift in STEM education that will require broad faculty buy-in and institutional support. To facilitate the use of culturally relevant STEM teaching materials at a large scale throughout undergraduate STEM education, such syllabi should be archived in repositories housed by professional societies, and textbook programs should shift STEM teaching beyond the traditional approach. Faculty training is also critical. Faculty learning communities can facilitate discussion, foster reflection, provide an opportunity to research pedagogical practices in a collaborative environment, and lead to successful development of culturally relevant course material (*11*).

Amanda J. Zellmer[1]*and Aleksandra Sherman[2]*
[1]Department of Biology, Occidental College, Los Angeles, CA 90041, USA. [2]Department of Cognitive Science, Occidental College, Los Angeles, CA 90041, USA.
*Corresponding author. Email: zellmer@oxy.edu; asherman@oxy.edu

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Incentives for Galápagos protection

In their Letter "Illegal fishing on the Galápagos high seas" (29 September, p. 1362), J. J. Alava and F. Paladines highlight the importance of compliance with international laws to protect the high seas but do not suggest strategies to ensure such compliance. Ecuador has a spotty history when it comes to protecting natural resources. Former president Rafael Correa recently relaxed fishing regulations pertaining to shark bycatch in the Galápagos Islands (*1*), and China finances the development of hydropower in exchange for drilling rights to vast oil reserves under Ecuador's rainforest (*2*). In this context, it is especially important to establish financial incentives to ensure both compliance with and enforcement of environmental laws.

With private financial contributions from global development institutions such as the World Bank, the Global Environment Facility, and the United Nations Environment Program, Ecuador could channel funding toward payments for ecosystem services and integrated ocean planning as well as enforcement and monitoring. Market mechanisms such as cap-and-trade, conservation markets, and mitigation payments could also deliver cash and provide incentives (*3*). Economic incentives and private financing could stimulate innovation in sustainable fishing gear, seafood traceability, and accountability.

Global collaboration is needed for high-seas governance to establish financial mechanisms that shift economic incentives to align conservation and economic benefits (*4*). An infrastructure for effective governance also provides a mechanism to deter illegal fishing activity by ensuring that the risks and penalties associated with noncompliance are high. The proposed Eastern Tropical Pacific Marine Corridor represents a promising approach to foster shared stewardship of shared marine resources between Costa Rica, Panama, Colombia, and Ecuador (*5*). Technologies such as remote sensing via satellites could be used broadly to monitor the high seas, collect important data, and enforce protected areas. Engaging private-sector partners skilled in the provision of these technologies will facilitate the implementation of marine spatial planning approaches.

The ocean provides goods and services worth trillions of U.S. dollars annually (*6*), providing ample market opportunities for the public and private sectors to invest in sustainable marine activities. Steep penalties [e.g., (*7*)] will deter some of the illegal fishing in the Galápagos and beyond, but without incentives, current illegal practices and unsustainable fishing will continue to threaten fragile and valuable marine ecosystems.

Leah R. Gerber[1]* and Diego Quiroga[2]
[1]Center for Biodiversity Outcomes and School of Life Sciences, Arizona State University, Tempe, AZ 85281, USA. [2]Galapágos Science Center, Universidad San Francisco de Quito, Quito, Ecuador.
*Corresponding author. Email: leah.gerber@asu.edu

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TECHNICAL COMMENT ABSTRACTS

Comment on "Persistent effects of pre-Columbian plant domestication on Amazonian forest composition"

Crystal H. McMichael, Kenneth J. Feeley, Christopher W. Dick, Dolores R. Piperno, Mark B. Bush

Levis *et al*. (Research Articles, 3 March 2017, p. 925) concluded that pre-Columbian tree domestication has shaped present-day Amazonian forest composition. The study, however, downplays five centuries of human influence following European arrival to the Americas. We show that the effects of post-Columbian activities in Amazonia are likely to have played a larger role than pre-Columbian ones in shaping the observed floristic patterns.

Full text: dx.doi.org/10.1126/science.aan8347

Response to Comment on "Persistent effects of pre-Columbian plant domestication on Amazonian forest composition"

André Braga Junqueira, Carolina Levis, Frans Bongers, Marielos Peña-Claros, Charles Roland Clement, Flávia Costa, Hans ter Steege

McMichael *et al*. state that we overlooked the effects of post-Columbian human activities in shaping current floristic patterns in Amazonian forests. We formally show that post-Columbian human influences on Amazonian forests are indeed important, but they have played a smaller role when compared to the persistent effects of pre-Columbian human activities on current forest composition.

Full text: dx.doi.org/10.1126/science.aan8837

ERRATA

Erratum for the Research Article "Observation of the Wigner-Huntington transition to metallic hydrogen" by R. P. Dias and I. F. Silvera, *Science* **357**, eaao5843 (2017). Published online 18 August 2017; 10.1126/science.aao5843

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