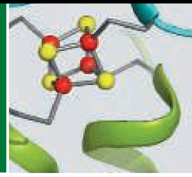

LETTERS

edited by Jennifer Sills

Working the Crowd

THE NEWS FOCUS STORY BY J. TRAVIS ("SCIENCE BY THE MASSES" 28 March, p. 1750) describes the application of crowd-sourcing in research and development. This approach consists of gathering a mass of people to seek out new ideas or solutions, and paying profits to seekers and solvers. A related idea is crowd-funding, a bottom-up model of financing used for various purposes, from software development to political campaigns.

We suggest crowd-funding as a possible strategy to cope with the lack of investments in research, as well as to increase democratization in the sciences. Projects seeking funding could be stored in an online repository. Each project would include a description of its objectives, duration, and requested contribution. Investors (either people or funding agencies) could decide which projects to fund.

For such a service to be successful, several challenges would need to be addressed: (i) Evaluating the quality of the proposals. To assist (nonspecialist) investors in deciding the awarding of contributions (and to audit thereafter), a peer-review procedure could be used. (ii) Potential for fraud. Fraud could be prevented by implementing a reputation system (*1*) and by indicating the scientific track record of the proponent. (iii) Intellectual property management. Intellectual property issues could be managed by allowing proponents to choose the appropriate level of protection of their ideas—for example, by using Creative Commons licenses (*2*). (iv) Investor rewards. Investors could be motivated by the prospect of earning shares (for profit-making research programs) or by the acknowledgment of their contribution (for nonprofit research programs).

Public investing. Allowing the public to invest in research may help alleviate the funding shortage.

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Southern Ocean Not So Pristine

THE REPORT "A GLOBAL MAP OF HUMAN impact on marine ecosystems" (B. S. Halpern *et al.*, 15 February, p. 948) provides a timely overview of anthropogenic effects on even the farthest reaches of Earth's oceans. However, we contend that, for at least one region, using data from only the past decade leads to misleading results.

A widespread perception exists that waters south of the Antarctic Polar Frontal Zone—i.e., the Southern Ocean (SO)—are still nearly pristine (*1*, *2*). In fact, the northern portion of the SO saw virtually all cetacean populations removed long ago (*3*), and in subsequent years (1960s to 1980s) the largest stocks of demersal fish in the Indian Ocean and Scotia Sea/Atlantic Ocean sectors were also fished to commercial extinction (*4*, *5*). Historically exploited fish species and cetaceans show little signs of recovery in the SO, and recent legal commercial fishing activity has been correspondingly low (*6*). It is thus no surprise that the modeling used by Halpern *et al.* shows little anthropogenic impact in these sectors apart from that of climate change. The authors acknowledge that accounting for current illegal, unregulated, and unreported fishing in these waters might show increased human impacts. The additional consideration of historical data should cause Halpern *et al.* to temper their conclusion that for the world's oceans "large areas of relatively little human impact remain, particularly near the poles."

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Diminishing Sea Ice

IN THEIR USEFUL REPORT, "A GLOBAL MAP OF human impact on marine ecosystems" (15 February, p. 948), B. S. Halpern *et al.* wrote that "large areas of relatively little human impact remain, particularly near the poles." They failed to take into account sea-ice diminishment, which may already be responsible for substantial local, regional, and global effects (*1*, *2*).

Arctic and Antarctic sea-ice ecosystems, together covering 7% of Earth, comprise "one of the largest biomes on Earth" (*3*), providing

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habitat for many species, from epontic algae to ice-dependent pinnipeds. Recent sea-ice diminishment has been a consequence, in part, of human greenhouse-gas production, indicating that sea ice may also be viewed as an anthropogenic driver of change (*4*, *5*), which will predictably have cumulative and synergistic effects on shelf seas, neighboring ecosystems, and regional to global climate.

Over Beringia (the combined shelves of the Bering and Chukchi seas), diminishment of sea ice may have already reached a "tipping point" (*6*). Multiple effects are apparent. Sea ice provides breeding, feeding, and molting habitat for polar pinnipeds; ribbon seals and Pacific walruses are being considered for threatened or endangered status under the Endangered Species Act. Polar bears have already been designated as "threatened." Ecosystem effects, such as diminished productivity (*7*) and loss of walrus mixing of benthic sediment important to its structure and chemical exchanges (*8*), are also probable. Socioeconomic effects include the relocation of Alaskan coastal villages due to shore erosion, and losses of critical resources on which indigenous subsistence hunters depend, with cascading impacts on hunting practices, knowledge systems, and cultures (*9*, *10*). Commercial species are also impacted by a shift from an Arctic to a sub-Arctic ecosystem (*11*).

Sea ice should not be omitted from consideration in such efforts as this mapping effort exemplifies.

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Response

A KEY MOTIVATION FOR OUR RESEARCH WAS to counteract the tendency to focus on single activities or single ecosystems when assessing the state of the oceans. Because we mapped cumulative impacts of 17 different stressors on 20 ecosystems, cumulative impacts diverge substantially from expectations for single stressors or ecosystems in most locations. Our global map is particularly valuable because it allows different areas of the planet to be compared using the same currency. The poles, while not pristine, are areas of little cumulative impact relative to the rest of the world's oceans according to our model.

Blight and Ainley suggest that our maps for the Southern Ocean are misleading because they do not reflect current or historical levels of fishing. Had data for historical fishing been available globally and included, many key areas of the world's oceans (e.g., waters around Europe, Asia, and North America) would likely have also looked much worse on our map, keeping the patches of blue near Antarctica in the lowest category of human impact. Moreover, the nine stressors not related to commercial fishing and climate change are inarguably lower in the poles than elsewhere. Consequently, our results are conservative, not misleading.

Ray *et al*. highlight a key challenge in mapping human impacts to marine ecosystems at the global scale: capturing dynamic processes on a static map. Sea ice is clearly an important ecosystem, but its extent shows strong seasonal and annual variation, far more than any other ecosystem, precluding a clear solution for where to place it on the map. Ray *et al*. also point out that the loss of sea ice is an important driver of change, but habitat loss and resulting species extirpations are problems shared by many ecosystem types (e.g., mangroves). Future efforts to refine our maps would benefit from incorporation of dynamic processes and may be able to better include historical data when conducted at local or regional scales.

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Microscopy for Life Scientists

IN THE REPORT "HIGH-RESOLUTION SCANning x-ray diffraction microscopy" (18 July, p. 379), P. Thibault *et al*. described the technique of scanning x-ray diffraction microscopy (SXDM) and their achievement of 70-nm resolution. The implications of this work for life scientists were underemphasized.

The development of SXDM comes from the physics community, but it has the most to offer to the life science community, where the inability to image live cells and tissues beyond the limitations of the light microscope is a constant frustration. If SXDM achieves its potential resolution of below 10 nanometers on live material, it will result in a revolution. In addition to refining their technique, I hope Thibault *et al*. will start to apply their existing technique to live biological tissues with inherent periodicity (such as muscle or cornea), where it already has the potential to provide unique information.

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Archaeology Without Borders

I READ WITH INTEREST THE LATEST UPDATES, problems, and progress in the archaeological research in the neighboring countries of India and Pakistan (Special News Focus section, "Unmasking the Indus," 6 June, p. 1276). However, I was saddened to note the researchers' apathy about the international border that prevents the free flow of information between sides. Sites in this area are not just important to India and Pakistan; these are precious global heritage centers marking the triumph of human civilization and evolution of human ingenuity and progress.

The international community should come together and work as a consortium to facilitate easy access to information for all who research these sites, regardless of nationality or location. It is important for all of us to understand our shared heritage and to preserve it for future generations to learn and appreciate.

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TECHNICAL COMMENT ABSTRACTS

Comment on "A Global Map of Human Impact on Marine Ecosystems"

Michael R. Heath

Halpern *et al*. (Reports, 15 February 2008, p. 948) integrated spatial data on 17 drivers of change in the oceans to map the global distribution of human impact. Although fishery catches are a dominant driver, the data reflect activity while impacts occur at different space and time scales. Failure to account for this spatial disconnection could lead to potentially misleading conclusions.

Full text at www.sciencemag.org/cgi/content/full/321/5895/1446b

Response to Comment on "A Global Map of Human Impact on Marine Ecosystems"

Kimberly A. Selkoe, Carrie V. Kappel, Benjamin S. Halpern, Fiorenza Micheli, Caterina D'Agrosa, John Bruno, Kenneth S. Casey, Colin Ebert, Helen E. Fox, Rod Fujita, Dennis Heinemann, Hunter S. Lenihan, Elizabeth M. P. Madin, Matt Perry, Elizabeth R. Selig, Mark Spalding, Robert Steneck, Shaun Walbridge, Reg Watson

Our results provide an important first step toward a full assessment of how human activities act cumulatively to affect the condition of the oceans. Fisheries (and climate change) impacts are some of the hardest to map and measure accurately. Consequently, species-specific considerations and fine-scale analyses should be left to more nuanced regional-scale replicates of our mapping framework.

Full text at www.sciencemag.org/cgi/content/full/321/5895/1446c

CORRECTIONS AND CLARIFICATIONS

Brevia: "Auxin gradients are associated with polarity changes in trees," by E. M. Kramer *et al*. (20 June, p. 1610). E. M. Kramer should have been affiliated with both Bard College at Simon's Rock, Massachusetts, and the Centre for Plant Integrative Biology at the University of Nottingham, UK.