Science's
COMPASS
LETTERS SCIENCE & SOCIETY POLICY FORUM BOOKS *ET AL.* PERSPECTIVES REVIEWS

Closing of the National Tritium Labeling Facility

THE CIRCUMSTANCES REGARDING THE National Institutes of Health's (NIH's) decision to close the National Tritium Labeling Facility (NTLF) are disturbing (News of the Week, "Tritium lab to close after loss of NIH funds," by J. Withgott, 2 Nov., p. 977). As a resident of Berkeley, California, and a scientist working in nuclear medical imaging at Lawrence Berkeley National Laboratory, I know that the NTLF has long been the target of a small but vocal group of antinuclear activists, the Committee to Minimize Toxic Waste, who say that any exposure to radiation, however small, is dangerous. I believe that the actual danger is negligible and that the results of the numerous inspections and accident analyses that have been performed at the insistence of this group support this conclusion.

NIH's stated reasons for closure, "low publication rates, inadequate service to NIH grantees, and failure to fill a safety position," according to Withgott's article, are unconvincing and inconsistent with the excellent scores the facility received during the peer-review process. The closure was precipitous and outside the normal funding cycle, suggesting unusual circumstances. It seems unlikely that the NIH had any significant concerns about the public safety threat posed by the NTLF, as the response of a scientific body to a safety concern would have been open fact finding. I can only conclude that NIH closed the NTLF to mollify an extremely small number of people.

An organizational chart posted on NIH's Web site (*1*) states that "The National Institutes of Health seeks to accomplish its mission by…exemplifying and promoting the highest level of scientific integrity, public accountability, and social responsibility in the conduct of science." In its recent dealings with the NTLF, the NIH deserves low marks in each of these categories.

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References and Notes
1. The chart is available from http://www.nih.gov/about/.

Letters to the Editor

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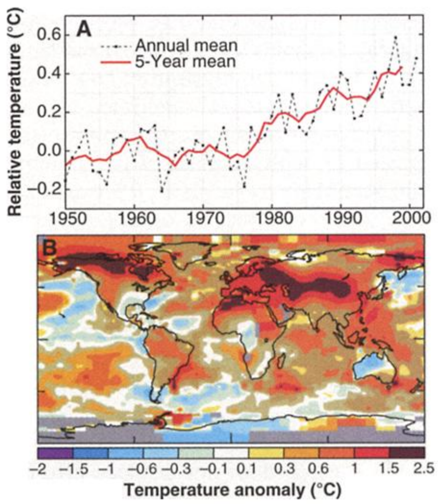
Global Warming Continues

THE SECOND WARMEST GLOBAL SURFACE temperature in more than a century of instrumental data (*1*) was recorded in the 2001 meteorological year (December 2000 through November 2001) (see panel A). The calendar year 2001 will also be the second warmest year on record, as the 11-month temperature anomaly exceeds that in the next warmest years (1990 and 1995) by almost 0.1°C. For our analysis, we used recently documented procedures for data over land (*1*) and for sea surface temperatures (*2*).

The global warmth in 2001 is particularly meaningful because it occurs at a phase of the Southern Oscillation in which the tropical Pacific Ocean is cool (see panel B). The record warmth of 1998, in contrast, was bolstered by a strong El Niño that raised global temperature 0.2°C above the trend line (see panel A).



(A) The global annual surface temperature relative to 1951–1980 mean based on surface air measurements at meteorological stations and satellite measurements of sea surface temperature. (B) Temperature anomaly for December 2000 through November 2001.

Global surface air warming over the past 25 years is ~0.5°C, and in the past century is ~0.75°C (*1*). The recent surface warming contrasts with warming of only ~0.1°C in the troposphere over the past 22 years (*3*); however, surface and tropospheric warmings are similar over the past 50 years (*4*). The greatest warm anomalies in 2001 were in Alaska-Canada, in a band from North Africa to Central Asia, and in the Antarctic peninsula (Palmer Land). The Indian and Western Pacific oceans were unusually warm, continuing a trend of recent decades (*1*).

The North Atlantic Ocean is notably warmer than the 1951–1980 climatology. Unusually cool conditions of recent decades, which were centered in Baffin Bay and extended south and southeast of Greenland (*1*), have given way to warm anomalies in the past 5 years.

Overall, the 2001 temperature extends the unusual global warming of recent decades. This warming is considered to be a consequence of anthropogenic greenhouse gases (*5*), and thus the high 2001 temperature will likely invigorate discussions about how to slow global warming.

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Minimizing Effects of CO_2 Storage in Oceans

THE POTENTIAL NEGATIVE BIOLOGICAL AND environmental impacts of sequestering carbon dioxide (CO_2) in the ocean by means of ocean fertilization (*1*) or direct CO_2 injection (*2*) are discussed in a Policy Forum and Perspective, respectively, in *Science*'s 12 October issue. However, the oceans already serve as a repository of anthropogenic CO_2, ingassing and storing ~2 picograms of carbon per year, an amount that could potentially have significant consequences for marine biota (*3*). The issue, therefore, is to reduce CO_2 emissions or their impacts in ways that provide a net environmental benefit. It remains to be shown if the negative consequences of the purposeful ocean CO_2 sequestration strategies are real and worse than other alternatives. Should the environmental and climatic effects of unmitigated CO_2 release to the atmosphere make CO_2 sequestration a necessity, the potential of the oceans for such a repository should not be ignored.

One way to avoid some of the negative chemical and biological effects of ocean CO_2 storage would be first to react waste CO_2 with water and a carbonate mineral (e.g., limestone) to form dissolved bicarbonate (*4*) for release into the sea. This would simply speed up part of Earth's natural carbon cycle (carbonate weathering), which is already central in modulating atmospheric CO_2, but over geologic time scales (*5*). The addition of alkalinity to the ocean resulting from this enhanced bicarbonate production would also help to buffer ocean acidification attributable to anthropogenic CO_2 from the atmosphere (*3*). In any case, there are other ways to diminish the impact of our energy economy on the environment (*6*), and it would be shortsighted not to evaluate our options carefully.

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Response

WE ARE FACED WITH SERIOUS DECISIONS concerning alternative strategies to mitigate climate warming. One such alternative is the purposeful sequestration of CO_2 in the ocean, with potentially severe environmental consequences. Rau and Caldeira justify this approach by pointing out that the oceans already act as a reservoir for CO_2 via passive diffusion from the atmosphere with associated impacts on some shallow-living organisms. However, the fact that human activities already unintentionally compromise the oceanic environment does not justify large-scale, purposeful interference with ocean ecosystems, as Chisolm *et al.* pointed out in their Policy Forum (12 Oct., p. 309). Our criticism of direct injection is not an endorsement of business-as-usual CO_2 emissions (Perspectives, "Potential impacts of CO_2 injection on deep-sea biota, 12 Oct., p. 319). It is well accepted that continued atmospheric accumulation of CO_2 is affecting Earth's climate. The acidification of surface waters through passive diffusion of atmospheric CO_2 is but one of a suite of problems associated with continued emissions. The challenge is to cure the root causes of atmospheric CO_2 accumulation, to reduce greatly or eliminate fossil fuel emissions through the development of alternative clean energy sources, rather than treating the symptoms.

The risks of direct injection to the deep ocean biota are real. The physiological mechanisms outlined in our Perspective are well characterized and suggest that large-scale sequestration, through deep-sea injection, would result in massive mortality of deep-sea organisms with potential disruption of the biogeochemical cycles dependent on their metabolism. The physiological capacity to buffer and compensate for ambient pH excursions is 10 to 100 times less in deep- compared with shallow-living organisms. Thus, direct CO_2 injection, in our estimation, is worse for marine biota than continued acidification of surface waters through passive atmospheric input. However, precise physiological thresholds and the spatial and temporal extent of the disruption to complex ecosystems cannot yet be predicted.

Rau and Caldeira's suggestion to react waste CO_2 with carbonate would minimize the perturbations in pH in the ocean relative to direct injection of CO_2 (although the associated elevation in seawater CO_2 partial pressure could still lead to physiological impairment in marine organisms). As such, it should be explored more fully. We also point out the need for careful definition of the spatio-temporal extent of direct CO_2 injection and additional biological data on deep-sea organisms, so long as such research does not displace efforts to reduce emissions through conservation, increased efficiency, and alternative energy.

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Taxonomists' Requiem?

THE NEED TO DOCUMENT AND UNDERSTAND the world's natural history, with the sixth great mass extinction caused by *Homo sapiens* seemingly on the way (*1*), is greater than ever, as J. McCarter and co-authors discuss in their Essay "Safeguarding the world's natural treasures" (*Science*'s Compass, 7 Dec., p. 2099). And we agree that museums and other centers of excellence on biodiversity matters have a prime role to play in objectively assessing the history and future of biological diversity.

Scientists today have the will and the technological means to quickly catalog the world's fauna and flora (*2*); however, young biologists are hardly encouraged to enter the narrow but rather competitive field of pure taxonomy because the possibilities to pursue an academic career are jeopardized by the current publication system. Indeed, description of new species and revisions at family or generic level are critical to provide a reliable estimate of biodiversity (*3*), yet this research is seldom validated in terms of the widely (mis)-used impact factor system, and this is especially true for taxonomists working with certain invertebrate groups.

Taxonomists have identified about 1400 species of sea cucumbers in the class Holothuroidea.

As an illustration, consider the papers published by the "big five" (*4*) holothurian taxonomists of the last century: 84% of their papers were published in journals with no impact factor at all, 15% were published in journals with an impact factor less than one, and only 1% appeared in journals with an impact factor higher than one. On the other hand, research relying on the work laid down by these taxonomists regularly appears in scientific journals with an impact factor comparable to that of *Science*.

Only if the publication system deters this malaise and promotes taxonomic and faunistical works will more scientists be attracted to taxonomy. Indeed, Robert May's bricks and cement (*5*) are necessary for constructing a solid building, but let's make sure we

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