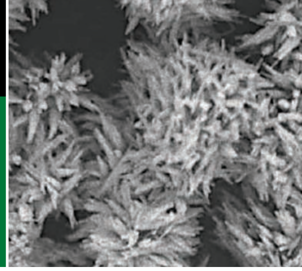

LETTERS

edited by Jennifer Sills

Concerns About Extrapolating Right Off the Bat

IN THEIR POLICY FORUM "ECONOMIC IMPORTANCE OF BATS IN AGRIculture" (1 April, p. 41), J. G. Boyles *et al.* address how a decline in bats might affect agricultural returns in the United States. The decline of bats due to factors such as disease and wind farm development is certainly an important issue, and one deserving of policy attention. However, as a motivation for conservation, the ad hoc calculation of the economic importance of bats to agriculture has serious flaws.

We would not be able to estimate the total value of cropland across the United States based only on an extrapolation of the per-acre value of cotton in Texas. Factors such as the mixture of crops and their yields, production costs, market prices, and pests all vary greatly across the United States. Similarly, each of these variables plays a crucial role in influencing the economic value of pest control services provided by bats. Additionally, basic natural history tells us that the distribution, abundance, and feeding ecology of bats across widely varying ecosystems is likely to result in substantially different pest control values. By ignoring this variation, the authors' approach to calculating the economic value of bat pest services is tantamount to calculating the nation's gross national product based on a country-wide extrapolation of steel production in Pittsburgh. Boyles *et al.*'s extrapolation results in the remarkable claim that the value of pest regulation by bats is roughly 50% of the total crop value in states such as Montana, Oklahoma, West Virginia, and Wyoming. Yet the predominant crop in the latter two states—hay—is a crop that *Helicoverpa zea* (the pest for which the original bat service values were calculated) does not affect.

In the past 15 years, numerous advances in the science of measuring, mapping, and valuing ecosystem services have been made (*1*–*3*). Unfortunately, Boyles *et al.*'s study ignores these advances and perpetuates most of the early errors that ecologists and economists have attempted to overcome, such as ad hoc value transfers and confounding marginal and total values. The loss of bats is an important policy issue and one we need to take seriously, but studies on the economic value of biodiversity and ecosystem services that can inform decision-making are those that follow state-of-the-art methods in ecosystem service science.

In decline. Little brown bat with white-nose syndrome.

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Response

WE APPRECIATE THE COMMENTS BY FISHER AND Naidoo regarding our recent effort to provide a first estimate of how much the disappearance of bats could cost the agricultural industry in the United States. Their critique focuses on the fact that variation in agricultural and ecological systems across the United States will lead to geographic variation in the economic value of bats. We agree with this point, so much so that we explicitly addressed it in the Supporting Online Material (SOM) that accompanied our paper, as follows: "Such estimates…will vary by location because of biological and monetary differences in crop yield, their respective insect pests, use of chemical pesticides, and variation in the density and composition of bat assemblages."

Fisher and Naidoo argue that our methods may lead to unrealistic estimates of the value of bats compared to the market value of crops in some states. They focus their argument on states with low per-acre crop value (Montana, Oklahoma, West Virginia, and Wyoming); however, our estimates of pest-control services for bats were based on data from a state in roughly the middle of the distribution of value-per-acre for agriculture in the United States (*1*). In addition, our estimates were likely conservative for other reasons mentioned in the SOM. Our goal in this exercise was to impress upon both the public and policy-makers the magnitude of the problem and the importance of conserving bat populations that confront two new threats—unprecedented mortality from white-nose syndrome, and the high mortality when bats encounter wind turbines. This exchange emphasizes the paucity of data and prior economic research on ecosystem services provided by bats (*2*).

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CREDIT: MARVIN MORIARTY/U.S. FISH AND WILDLIFE SERVICE

Published by AAAS

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Shedding Light on Solar Fuel Efficiencies

IN THEIR REVIEW "COMPARING PHOTOSYNthetic and photovoltaic efficiencies and recognizing the potential for improvement" (13 May, p. 805), R. E. Blankenship *et al.* compare the conversion efficiency of photosynthesis with that for production of hydrogen by photovoltaics and subsequent water electrolysis (PV-EL). They conclude that the latter technology is more efficient, but also point out ongoing and future research directions that could lead to substantial conversion efficiency increases in plants and microorganisms. We agree that careful analysis of current limitations for a system is valuable as a guide to researchers working on solutions to bottleneck problems. However, using a single figure of merit may discount other important considerations, and could prematurely identify technology winners and discourage research in other promising areas.

In addition to potential improvements in efficiency that are difficult to quantify for an emerging technology, other parameters are important. For example, the Review compared the products of the two systems—hydrogen in the case of PV-EL and energy-rich organic molecules for photosynthesis—on the basis of their combustion enthalpies. This approach ignores other differences between the fuels, such as the amount of energy that can usefully be extracted as well as processing and storage requirements. The Review also overlooked the manifold ancillary costs associated with disparate fuels that must be factored into a complete engineering-economic analysis of solar fuels production.

Furthermore, the Review compares only indirect and semi-indirect solar fuels production. It is informative to broaden the analysis to include the rapidly expanding research field of direct solar fuel production by artificial photosynthetic (APS) systems (*1*–*4*), which do not require intermediate energy carriers such as electricity, NADPH/ATP, or biomass. The efficiency of primary light capture and electron transfer steps in photosynthesis is very high. Losses related to further metabolism and life processes, such as the photosynthetic dark reactions, can be avoided in synthetic systems. The Review discusses viable approaches to organism engineering for increasing efficiency, such as making use of near-infrared photons. In synthetic systems, such improvements can be incorporated directly into assembly design.

An engineering-economic analysis of solar fuels requires that the increased design complexity of APS be offset by improvements in fuel production efficiency. APS obeys the same fundamental efficiency limitations as PV-EL. Because fewer energy transduction steps are involved, however, direct processes in integrated systems have the potential to reduce losses and decrease overall costs. We believe that the most important research challenge in coming years is the successful construction of a direct artificial system for efficient solar fuel generation.

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Crash Course in Injury-Prevention Research

THE NEWS FOCUS STORY "CAR-CRASH EPIdemiologist pushes systemic attack on bad driving" (R. Stone, 6 May, p. 657) tells the story of Jin Huiqing's "fateful decision" in the mid-1980s to study traffic casualties in China and alludes to his brave research into "uncharted territory." His work may have been the first of its kind in China, but the history of car-crash epidemiology precedes Jin by at least 30 years.

In the 1930s, human factors engineering became an essential element in developing U.S. aircraft carriers. Ross McFarland was an academic scientist who worked with the Navy and Air Force on preventing pilot errors (*1*). After the war, McFarland, at Harvard, attracted a cohort of young physicians and scientists to injury-prevention research. The field was based on the premise that unintended injuries, especially car crashes, are not random events. Like any disease, they have highly predictable agents, hosts, and environments. Hence, they are preventable.

William Haddon Jr. may be McFarland's best-known student. Haddon's 1964 textbook on accident research became a classic in injury prevention (*2*). In 1966, he started the National Highway Traffic Safety Administration. Haddon's epidemiological approach to seat belt legislation and other automobile safety standards made him both a favorite and a target of the automobile industry (*3*, *4*).

The "three lines of defense" against traffic accidents attributed to Jin Huiqing in the News story are remarkably similar to Haddon's work (*5*, *6*). The use of public policy to control injuries also precedes Jin Huiqing's work by at least 25 years (*7*, *8*).

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CORRECTIONS AND CLARIFICATIONS

Reports: "*Nod2* mutation in Crohn's disease potentiates NF-κB activity and IL-1β processing" by S. Maeda *et al.* (4 February 2005, p. 734). The mice with a specific "knockin" mutation (*Nod*$^{2293\mathit{9iC}}$) in the *Nod2* locus described in this report were recently found to contain a duplication of the 3′ end of the wild-type *Nod2* locus, including exon 11, which was targeted by the mutation. This genetic duplication, whose exact borders are not clear in the absence of genomic sequencing, lies outside of the region analyzed in detail in Maeda *et al*. The authors are not sure how and when this duplication occurred, as the mouse line used now in their laboratory originated from a derivative of the original strain reported in the paper. They do not doubt the results reported in the paper but are working to recreate a knockin mutant strain without such a duplication, so as to confirm the report's findings in a second genetic model. The conclusion described in Maeda *et al*. that the NOD2 protein controls the production of IL-1β has been validated in at least in two subsequent studies [L. C. Hsu *et al*., *Proc. Natl. Acad. Sci. U.S.A.* **105**, 7803 (2008) and S. R. Ali *et al*., *Immunity* 10.1016/j.immuni.2011.04.015 (published online 15 June 2011)]. The authors have also validated that the knockin mutation introduced into the NOD2 locus, leading to the generation of a truncated protein lacking its last 33 amino acids, augments caspase 1 activation and potentiates the processing of pro-IL-1β to IL-1β.

Letters to the Editor

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