Supporting Online Material for

Economic Importance of Bats in Agriculture

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Other Supporting Online Material for this manuscript includes the following:
(available at www.sciencemag.org/cgi/content/full/332/6025/41/DC1)

Table S2. County-level data. [as an Excel file]

Supplementary Online Material

Estimating the agricultural value of bats in the Continental United States

We use Cleveland *et al*.'s (*S1*) avoided-cost economic analysis of the value of Brazilian free-tailed bats (*Tadarida brasiliensis*) to cotton agriculture in south-central Texas as the baseline for our extrapolations. Avoided-costs are those not incurred by society because these mammals are part of the ecosystem (*S1*). Estimates include the value of cotton crops that would have been lost in the absence of bats and the reduced use of pesticides because of bat predation on crop pests. Using three different scenarios (low, medium, high) for egg and small larvae survival for the cotton bollworm (*Helicoverpa zea*), the main insect pest of cotton in the region, Cleveland *et al*. (*S1*) estimated the value of bats to agriculture at $12.1/acre (assuming low egg/larval survival in *H. zea* and no decrease in pesticide applications because of bats), $74.1/acre (assuming moderate egg/survival rates and the need for one less pesticide application because of bats), or $172.5/acre (assuming high egg/larval survival and the need for two fewer pesticide applications because of bats). Because of ambiguity in the original reports about the year in which each of the parameter estimates was based, these values were not adjusted for inflation and the estimates of the value of bats are probably conservative.

To estimate the value of bats to the agricultural industry of each county in the United States, as well as each state and the continental United States as a whole (Tables S1 and S2), we extrapolated these values to the total amount of harvested cropland in 2007 as reported in the *2007 Census of Agriculture* (*S2*). Such estimates of the value of bats to agriculture 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. An economic assessment of bats was possible in south-central Texas for two reasons. First, Brazilian free-tailed bats, the dominant species in the local bat assemblage, roost in large numbers in relatively few sites; thus, population sizes can be estimated with a relatively high degree of confidence. In other parts of North America, the sizes of summer bat populations are mostly unknown. However, an additional 41 species of insectivorous bats occur in the United States and Canada, with most areas occupied by about 4 to 10 species (*S3*). Second, the energetic needs and diet of Brazilian free-tailed bats in this region has been studied extensively, allowing for an estimation of the quantity of insects that each bat consumes. It is important to note, however, that the estimates by Cleveland *et al*. (*S1*) do not include the economic value of other bat species in this region, another reason why our estimates are conservative. Also, the crop pest modeled by Cleveland *et al*. (*S1*), *H. zea*, is a widespread, polyphagous agricultural pest known regionally as the cotton bollworm, corn earworm, or tomato fruitworm (depending on the crop of interest), and bats likely feed on the adult moth stage of this species in other areas as well. Future research should be conducted in other regions of the United States and throughout the world to estimate the economic value of bats to agriculture. Thus, we strongly encourage this work so that our estimates can be further refined and validated. Our estimates make it clear that the economic value of bats to agriculture may be quite large, emphasizing that there are substantial economic benefits to conserving bat populations.

References

S1. C. J. Cleveland *et al.*, *Front. Ecol. Environ.* **4**, 238 (2006).
S2. U.S. Department of Agriculture, *2007 Census of Agriculture: United States Summary and State Data*, vol. 1, *Geographic Area Series* (AC-07-A-51, USDA, Washington, DC, 2009).
S3. S. R. Humphrey, *J. Mamm.* **56**, 321-346 (1975).

Table S1. Estimated annual avoided-cost value of bats per state based on the assumption that bats provide $74.1/acre of services to agriculture (*S1*) and on the relative value of those benefits compared with the published market value of all crops produced. The amount of harvested cropland and the market value of crops sold are taken from the 2007 USDA Census of Agriculture (*S2*).

State	Harvested land (acres)	Estimated value of bats (U.S.$)	Market value of crops sold (U.S.$)	Proportion of market value
Alabama	1,994,743	147,810,456	676,987,000	0.22
Alaska	30,772	2,280,205	24,749,000	0.09
Arizona	832,406	61,681,285	1,913,014,000	0.03
Arkansas	7,367,068	545,899,739	2,900,973,000	0.19
California	7,633,173	565,618,119	22,903,021,000	0.02
Colorado	5,888,926	436,369,417	1,981,399,000	0.22
Connecticut	136,833	10,139,325	401,372,000	0.03
Delaware	409,468	30,341,579	210,635,000	0.14
Florida	2,112,129	156,508,759	6,256,228,000	0.03
Georgia	3,390,437	251,231,382	2,142,270,000	0.12
Hawaii	103,120	7,641,192	429,916,000	0.02
Idaho	4,225,786	313,130,743	2,324,789,000	0.13
Illinois	22,611,443	1,675,507,926	10,876,415,000	0.15
Indiana	12,108,940	897,272,454	5,319,019,000	0.17
Iowa	23,799,380	1,763,534,058	10,343,585,000	0.17
Kansas	19,886,655	1,473,601,136	4,887,212,000	0.30
Kentucky	5,057,883	374,789,130	1,404,769,000	0.27
Louisiana	3,342,048	247,645,757	1,604,647,000	0.15
Maine	393,738	29,175,986	326,573,000	0.09
Maryland	1,246,603	92,373,282	629,303,000	0.15
Massachusetts	153,993	11,410,881	364,481,000	0.03
Michigan	6,859,081	508,257,902	3,329,928,000	0.15
Minnesota	19,267,018	1,427,686,034	7,048,913,000	0.20
Mississippi	4,223,708	312,976,763	1,668,028,000	0.19
Missouri	12,980,113	961,826,373	3,494,938,000	0.28
Montana	9,163,867	679,042,545	1,273,721,000	0.53
Nebraska	18,169,876	1,346,387,812	6,843,325,000	0.20
Nevada	504,311	37,369,445	219,341,000	0.17
New Hampshire	99,520	7,374,432	106,467,000	0.07
New Jersey	415,542	30,791,662	851,653,000	0.04
New Mexico	1,009,683	74,817,510	553,140,000	0.14
New York	3,651,278	270,559,700	1,561,927,000	0.17
North Carolina	4,188,658	310,379,558	2,606,279,000	0.12
North Dakota	22,035,717	1,632,846,630	5,038,521,000	0.32
Ohio	9,991,007	740,333,619	4,109,722,000	0.18
Oklahoma	7,650,080	566,870,928	1,187,625,000	0.48
Oregon	3,037,261	225,061,040	2,976,087,000	0.08
Pennsylvania	3,942,079	292,108,054	1,869,706,000	0.16
Rhode Island	19,325	1,431,983	55,602,000	0.03

South Carolina	1,551,670	114,978,747	798,490,000	0.14
South Dakota	15,278,709	1,132,152,337	3,383,497,000	0.33
Tennessee	4,226,440	313,179,204	1,147,786,000	0.27
Texas	19,174,301	1,420,815,704	6,565,576,000	0.22
Utah	964,702	71,484,418	372,396,000	0.19
Vermont	433,074	32,090,783	99,262,000	0.32
Virginia	2,544,997	188,584,278	858,301,000	0.22
Washington	4,387,169	325,089,223	4,754,898,000	0.07
West Virginia	692,003	51,277,422	78,308,000	0.65
Wisconsin	8,884,628	658,350,935	2,669,326,000	0.25
Wyoming	1,536,240	113,835,384	213,808,000	0.53
Total	309,607,601	22,941,923,234	143,657,928,000	0.16

Table S2. Estimated annual avoided-cost value of bats per county based on the assumption that bats provide $12.1, 74.1, or 172.5/acre of services to agriculture (*S1*). The amount of harvested cropland is taken from the 2007 USDA Census of Agriculture (*S2*). Note that county level data on acres of cropland harvested are not available for a small number of counties, so the estimates based on state level data are slightly higher than the cumulative total based on county level data.

See Excel spreadsheet: **County-level data**