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Study Highlights Landscape Simplification and Insecticide Use

A new UC Santa Barbara study that analyzed U.S. Department of Agriculture (USDA) Census of Agriculture data spanning two decades (1987-2007) shows that the statistical magnitude, existence, and direction of the relationship between landscape simplification — a term used for the conversion of natural habitat to cropland — and insecticide use varies enormously year to year.

While there was a positive relationship in 2007 — more simplified landscapes received more insecticides — it is absent or reversed in all previous years. The findings were published in the Proceedings of the National Academy of Science (PNAS).

The author, Ashley E. Larsen, a Ph.D. candidate in the Department of Ecology, Evolution and Marine Biology, built on an earlier study published in PNAS by extending the temporal dimension of that analysis. That study found a strong positive relationship between landscape simplification and insecticide use when examining 2007 data for seven midwestern states. Larsen's results also showed 2007 was positive, with increased land area in cropland leading to increased cropland treated with insecticides. But in 2002 and 1997, there was no statistically significant relationship; 1992 was negative (increased cropland but decreased insecticides); and 1987 was generally negative, but sometimes depending on the model specification used.

According to Larsen, the increase in agricultural production over the past four to five decades has corresponded to massive changes in land use often resulting in large scale monocultures separated by small fragments of natural land. Ecological theory suggests that these simplified landscapes should have more insect pest problems due to the lack of natural enemies and the increased size and connectivity of crop-food resources.

"There is a debate currently in ecology about what the most efficient land use policy for agricultural production is," said Larsen. "Some think that complex landscapes are better, that they have minimal effect on the environment, in which case we'd need to grow over a larger area. Others think that we should grow in a concentrated area and preserve what isn't in agricultural production. This land sparing-land sharing debate is getting a lot of attention. My study results don't support either land sharing or land sparing. They just show that we don't really understand how either of those policies will affect insecticide use."

Larsen used USDA county-level data for 1987, 1992, 1997, 2002, and 2007 as well as from the National Agricultural Statistics Service Cropland Data Layer for 2007 for the same seven Midwestern states as the earlier PNAS analysis –– covering more than 600 counties in Iowa, Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. She performed a single-year cross-sectional analysis for each year followed by a fixed effects analysis for all years together. She then compared fixed effects models with year, county, and year- and county-fixed effects. County-fixed effects control for unobserved effects, such as the soil quality unique to each county, and year effects control for year shocks, such as droughts shared by all counties in the study region.

With just county-fixed effects, the analysis showed a strong negative relationship between landscape simplification and insecticide use. When year-fixed effects were included, that relationship dropped to . Including both year- and county-fixed effects, the relationship remained and similar to the year-only model, indicating that year effects are very important.

"It would be very difficult to inform policy questions, such as land sparing or land sharing in terms of insecticide use, if the relationship between landscape simplification and insecticide use flip flops year to year," concluded Larsen. "These varied results make it hard to say a complex landscape is better or a simplified landscape is better. My next step would be to try to unlock what's behind that variation."

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