Journal of Conservation Planning Vol 6 (2010) 21 — 35

Socioeconomic patterns of American farmland preservation funded by the Farm and Ranch Lands Protection Program

David M. Stoms, Gregory DeAngelo

***David M. Stoms**
Associate Researcher
Donald Bren School of Environmental Science and Management
University of California Santa Barbara, CA 93106-5131 USA
stoms@bren.ucsb.edu
Phone: (805) 893-7655
http://www.biogeog.ucsb.edu/people/stoms/stoms.html

Gregory DeAngelo
Department of Economics
University of California Santa Barbara, CA 93106-9210 USA
deangelo@econ.ucsb.edu
Phone: (585) 329-0424

*Corresponding author

ABSTRACT: Since 1996 the federal Farm and Ranch Lands Protection Program (FRPP) has supported local programs to preserve their farmland by providing matching funds to "eligible cooperating entities." This paper analyzes where those funds have been distributed and then asks what kinds of communities choose to preserve farmland (i.e., become eligible cooperating entities) and which do not? And how widespread is farmland preservation likely to become in the near future? To answer these questions we compiled historical county-level spatial data on demographics, economics, agricultural, and GIS-based growth pattern statistics to characterize counties that have implemented farmland preservation programs as represented in FRPP allocations. Statistical models determined the probability that a county has received funding and predicted the level of funding. Applying the regression coefficients to contemporary data then forecast the level of funding expected in the coming decade if sufficient funds are available; that is, where current socioeconomic conditions now match the historic conditions that favored preservation at the initiation of the FRPP. The most significant variables of FRPP activity in counties were a combination of socioeconomic factors for the county as a whole (per capita income, population growth in the preceding decade), agricultural factors (area of farmland, direct sales of products to individuals in dollars), and a synthetic GIS-based index of sprawl. Although FRPP cannot distribute funds based on predicted "demand", prospective farmland preservationists may be inspired to act if they see that their county has characteristics similar to those that have already succeeded in meeting FRPP eligibility criteria.

Keywords: agricultural conservation easements, Farm and Ranch Lands Protection Program, land trusts, urban growth, sprawl, local food movement

INTRODUCTION

Preserving farmland from urban conversion is expanding rapidly in the United States to protect many social values (Machado et al. 2006). The most common method of preserving farmland is for an organization to purchase the development rights from the land owner who retains the remaining rights, such as the right to farm (Daniels and Bowers 1997). An agricultural conservation easement (ACE) that retires development rights is appended to the property deed in perpetuity. Because the development rights constitute only a portion of the total rights associated with property, their purchase price is less than the full market value of the property (Plantinga and Miller 2001). In practice, 905,468 hectares (2.2 million acres) of American farmland have been placed under agricultural conservation easement at a cost of $4.1 billion (American Farmland Trust 2009a and b), and the rate has been accelerating (Sokolow and Zurbrugg 2003).

The pattern of agricultural conservation easements is far from uniform across the nation. Local communities face a complex array of social, economic, environmental, and public health issues. In densely-populated regions such as the Mid-Atlantic (Delaware, Maryland, New Jersey, Pennsylvania), New England (Vermont, Massachusetts), and California (Bowers 2005, Sokolow and Zurbrugg 2003), farmland preservation has risen to a level of public concern for officials or civic groups to act, even with the daunting price tag. In the central part of the nation, the Southeast and the Mountain West, it has generally remained a lower priority. What makes some communities preserve farmland while others do not? Is there a difference in their demographic characteristics or the nature of their agricultural sector? In areas with vast amounts of farmland or where urban pressure is negligible, we might not expect concern to reach a level sufficient to motivate action relative to all the competing demands for public attention (e.g., energy, water quality, jobs, and health care).

Programs that purchase development rights (PDR) include private non-profit conservancies or land trusts, special agricultural districts, and county or state agencies. At the national level, the federal Farm and Ranch Lands Protection Program (FRPP) provides matching funds to qualified PDR programs but does not hold easements itself. Since 1996, FRPP has provided matching funds to "eligible cooperating entities" for the purchase of agricultural conservation easements. To become eligible, a program must be run by a Federally-recognized Indian Tribe, State, unit of local government, or (since the 2002 Farm Bill) a non-governmental organization that has demonstrated capacity to purchase and manage ACEs for the purpose of limiting conversion to non-agricultural uses of the land (Farm and Ranch Lands Protection Program 2007). In addition to the eligibility of the entity or program, the land to be protected must also meet specific criteria. Not all potentially eligible farmland preservation programs have received FRPP funding, whether by failing to apply or to be selected. The number of potential programs that have not participated in FRPP is unknown, but we believe that the programs that have received funding constitute a strong representative sample of those who are actually preserving farmland by acquiring easements.

FRPP has been in operation for over a decade, so it is timely to review where its funds have been allocated and identify the factors associated with those places. Our premise is that conservation activity in a period reflects conditions in the preceding period. Our objectives were to identify which historical characteristics best predict the probability of FRPP activity from 1996 through 2007 in the 3109 counties of the 48 conterminous states (i.e., the lower 48) and then to project future demand for FRPP funding based on current conditions. In particular, the study addresses the following questions:

- ⇒ Is farmland PDR activity in counties more affected by the level of variables (e.g., population, housing density) or by their rate of growth in the preceding time period?
- ⇒ Are more complex indices that incorporate spatial pattern of urban growth better predictors than the raw census data?

⇒ Is FRPP activity related more to characteristics of the county as a whole (e.g., per capita income, housing density), to those of its agricultural sector (e.g., farm area, market value of crops), or to the interaction between farms and towns (e.g., direct sales to individuals)?

BACKGROUND

A few studies have looked at what motivates communities to choose to preserve farmland through PDR programs. Kline and Wichelns (1994) found that citizens in counties or towns in Pennsylvania and Rhode Island were more likely to vote for statewide referenda to finance farmland PDR programs if population and land values were increasing rapidly. In Pennsylvania, counties with higher percentage of farmland were less likely to vote in favor, apparently because they perceived less pressure to act. Feather and Barnard (2003) examined both the factors associated with the creation of farmland PDR programs and their level of activity. Limiting their analysis to seven northeastern states with the most active farmland PDR programs, they found that creation of programs was positively and significantly associated with income and agricultural land density. The change in agricultural land density was not significant. The level of activity was also positively associated with these covariates and with changes in agricultural land density and urban influence (related to population density). Based on these results, the authors concluded that both a level of prosperity and population pressure (demand side) and a critical mass of farmland (supply side) are required to promote the creation of farmland PDR programs. They speculated that future farmland PDR programs would most likely appear in rapidly-growing areas that are losing open space, such as Florida.

The two studies summarized above only analyzed farmland preservation in a few states where it was already intensively practiced. More recently, Poor and Brule (2007) modeled the relationship between area of land preserved (as a percentage of the area of the county) and socioeconomic indicators for all counties in the entire conterminous United States. Their dependent variable was the area preserved, including both open space and FRPP. Because they were interested in social equity issues, they added covariates for the percentage of African-Americans, unemployment rate, and median age to the demographic, economic, and agricultural variables. As with previous studies they found that open space/ farmland preservation was positively related to income, housing and farmland values, and population growth rate. Note that Poor and Brule used predictor variables from the same period to predict preservation activity from 1996-2004.

METHODS

Farmland Preservation Data

FRPP records data on the transactions they fund, including the date, name and type of entity, acres, dollars contributed by FRPP and Total Appraised Fair Market Value, and the county where the parcel occurs. We obtained a spreadsheet from FRPP of all transactions from 1996 through July, 2007. To model the relationship of farmland preservation to socioeconomic variables, we chose to aggregate transactions to the county-level summed over the entire time period. For each county then we derived the total number of parcels preserved, their total area, and the total payments by FRPP. Because results were similar for these three metrics of FRPP activity, we only report the results for total FRPP payments (adjusted to year 2000 dollars). Where the number of parcels was greater than zero, we also labeled the county as having a PDR program, otherwise that programs were absent. As noted above, there will inevitably be some false negatives in the data set, where qualified programs have not received FRPP funding, but there should be no false positives. Aggregating to county-level provides a common spatial framework for analysis with data from the US Census, the Census of Agriculture, and other national data sets. We also limited the analysis to the counties in the 48 conterminous states because Alaska and Hawaii are so unique and had extremely few transactions.

Socioeconomic Predictor Variables

The variables selected to predict FRPP activity represent both state and rate variables representing demographic and agricultural factors from the time period preceding the FRPP funding (Table 1, page 25). State variables represent the relative magnitude of some attribute of interest, such as population density or farm area in a county, at the latest point in time. Rate variables are calculated changes in state variables between two recent data collection times. Population growth rate from 1980-1990 or farmland loss from 1987-1992 are examples. Local communities may respond more urgently to preserve farmland when they perceive an increase in pressure on agriculture (Kline and Wichelns 1994). We presumed that there is a lag between the time conditions arise that raise the concern for farmland preservation to a sufficient level for citizens to act and the time that programs reach the status as an eligible entity under FRPP's guidelines. Consequently we compiled predictor variable data for the time period preceding the activity of the FRPP, rather than data from the FRPP period as Poor and Brule (2007) did.

Demographic variables

Based on previous work that found PDR program creation and level of activity were associated with high per capita income and rapid population growth (Kline and Wichelns 1994, Feather and Barnard 2003), we compiled county-level data from the U. S. Census and elsewhere. Housing density can be a better predictor of environmental impacts than population (Theobald 2005), so density in 1990 and growth rate of housing from 1980-1990 were compiled by county. In addition to direct counts of population (converted to density by dividing by the area of the county), we used the Population-Interaction Index (U. S. Department of Agriculture Economic Research Service 2005), which models the potential interaction between urban residents and agricultural lands. The PII process uses a gravity model approach to calculate a value at each grid cell of the population surrounding it, weighted by the distance to each neighboring cell. The mean cell value in 1990 for each county was used to quantify this variable. We believed that the PII-based variable might be better at representing the spatial arrangement of farmland relative to urban populations than basic population density. PII captures the pressure from dense urban populations, but much of the loss of prime farmland is due to low density rural and exurban sprawl. Theobald (2005) defined a Landscape Sprawl metric (LS) that measures the degree of impact. LS is based on a combination of three criteria for edge or continuity of development, accessibility or travel time, and land consumption. All three criteria are derived from housing density. High values of LS occur with low housing densities near agricultural lands that are far from urban core areas. Theobald (2005) generated a GIS raster map of LS for 1980 using housing density data from the U. S. Census and provided downloadable tables of county averages (http://www.ecologyandsociety.org/include/getdoc.php?attachment=1077).

Agricultural variables

Some studies found that the amount of farmland and land values influenced the likelihood of farmland PDR programs (Feather and Barnard 2003, Poor and Brule 2007). We therefore included data from the USDA Census of Agriculture on farm land area in 1992 and its density as a fraction of the county land area, its loss from 1987 to 1992, average farm size, and land value per acre. Agricultural importance was measured by the market value of crops and by the value of food sold directly to individuals. The latter is related to the increasing importance of locally-grown food to American consumers and provides a rationale for preserving local farmland. USDA provides other sources of funding for farmland conservation, such as the Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP). We expected that the payments to farmers in each county through the CRP and WRP programs would be negatively

TABLE 1 Variables used for modeling presence (or level) of FRPP funding in U. S. counties. The term "year" in the variable names stands for the year represented for the retrospective (circa 1990) or prospective modeling (circa 2000). All monetary data were indexed to year 2000.

Variables for predicting past activity	Variables for predicting future activity	Variable name	Data Source
Dependent variables			
FRPP Presence 1996-2007 (Yes = 1, no = 0)		frpp_presence	USDA-FRPP data
FRPP Funds ($ of FRPP funds indexed to the year 2000) 1996-2007		frpp_money	USDA-FRPP data
Independent variables			
Demographic data			
Per capita income 1990 ($ per person)	Per capita income 2000 ($ per person)	pc_inc_year	US Census
Population density 1990 (people per sq. km)	Population density 2000 (people per sq. km)	pd_year	US Census, calculated as Pop_year / Land area in county
Population growth rate 1980-1990 (%)	Population growth rate 1990-2000 (%)	pd_grow~year	Calculated as (Pop1990 – Pop1980)/Pop1980 * 100 or (Pop2000 – Pop1990)/Pop1990 *100
Housing density 1990 (housing units per sq. km)	Housing density 2000 (housing units per sq. km)	hd_year	US Census, calculated as HU_year / Land area in county
Housing growth rate 1980-1990 (%)	Housing growth rate 1990-2000 (%)	hd_grow~year	Calculated as (HU1990 – HU1980)/HU1980 * 100 or (HU2000 – HU1990)/ HU1990 *100
Population-Interaction Index 1990	Population Interaction Index 2000	pii_year	(U. S. Department of Agriculture Economic Research Service 2005)
Landscape Sprawl Index 1980	Landscape Sprawl Index 2000	land_sprawl_year	(Theobald 2005)
Agricultural data			
Farm area 1997 (hectares)	Farm area 2002 (hectares)	farmhect_year	Census of Agriculture
Agricultural density 1997 (%)	Agricultural density 2002 (%)	ad_year	Calculated as Farm_area_year / Land area in county * 100
Land value of land and buildings 1992 ($ per hectare)	Land value of land and buildings 2002 ($ per hectare)	lv_doll_year	Census of Agriculture
Market value of crops 1992 ($1000)	Market value of crops 2002 ($1000)	mv_crop_year	Census of Agriculture
Food sold directly to individuals 1992 ($1000)	Food sold directly to individuals 2002 ($1000)	direct_sales_year	Census of Agriculture
CRP&WRP payments 1992 ($1000)	CRP&WRP payments 2002 ($1000)	crp_year	Census of Agriculture

associated with FRPP activity because they take environmentally sensitive land out of agricultural production.

These covariates were used to model the probability of actual FRPP activity in the period 1996-2007. As we also wanted to forecast the potential pattern of activity for the coming decade, we compiled the same county data (Table 1, page 25) from the 2000 US Census, 2002 Census of Agriculture, the Population Interaction Index 2000, and the 2000 Landscape Sprawl Index, and for rate variables we calculated the change from the previous data point.

Statistical Modeling

We tested whether the spatial pattern of farmland PDR activity appears to be associated with socioeconomic covariates. In particular, a logit regression was implemented to compute the probability that a county had received FRPP funding between 1996 and 2007. In this case, the dependent variable was the Frpp_presence, which had a 0 (no funding) or 1 (funding) value. To model the level of total FRPP spending in counties, an ordinary least squares regression was conducted with Frpp_money as the dependent variable.

The logit regression equation takes the form:

$$FRPP_i = X'_i \beta + \varepsilon_i$$

Where $FRPP_i$ is a binary variable that denotes the absence ($FRPP_i=0$) or presence ($FRPP_i=1$) of FRPP-funding for conservation easements in count $_i$, X'_i is a vector of covariates (Table 1, page 25), β is a vector of coefficients, and ε_i is the error term that is distributed logistically over (0,1). The vector of covariates includes variables characterizing demographics, agricultural activity, natural amenities, and land ownership in each county. Patterns may be influenced by fixed effects that occur because of where the county is located but not accounted for in the independent variables. Therefore we included a set of dummy variables for the state in which a county is located to control for fixed effects. Our purpose was to determine the model with the best goodness of fit that would accurately predict the locations of FRPP activity as a proxy for farmland PDR programs nationally.

The level of FRPP funding was analyzed as a function of the predictor variables through an ordinary least squares regression. It is possible that a county might be influenced by decisions from neighboring counties, creating a spatial dependence in the data. To test for this potential spatial dependence, robust and spatially dependent standard errors were calculated from the elements of the variance-covariance matrix for both the logit and linear regressions (Conley 1999). This was accomplished by choosing a spatial bandwidth around both the x- and y-coordinates of the county centroids. We selected a bandwidth of 100 km (60 miles) based on a long commuting distance to urban centers from their rural neighbors. Choosing a larger bandwidth did not substantially impact the results of the standard errors, so we only report on this single width. We did not include an autoregressive term directly in the models, but some spatial dependence was probably captured by using the fixed effects of the dummy variables for states.

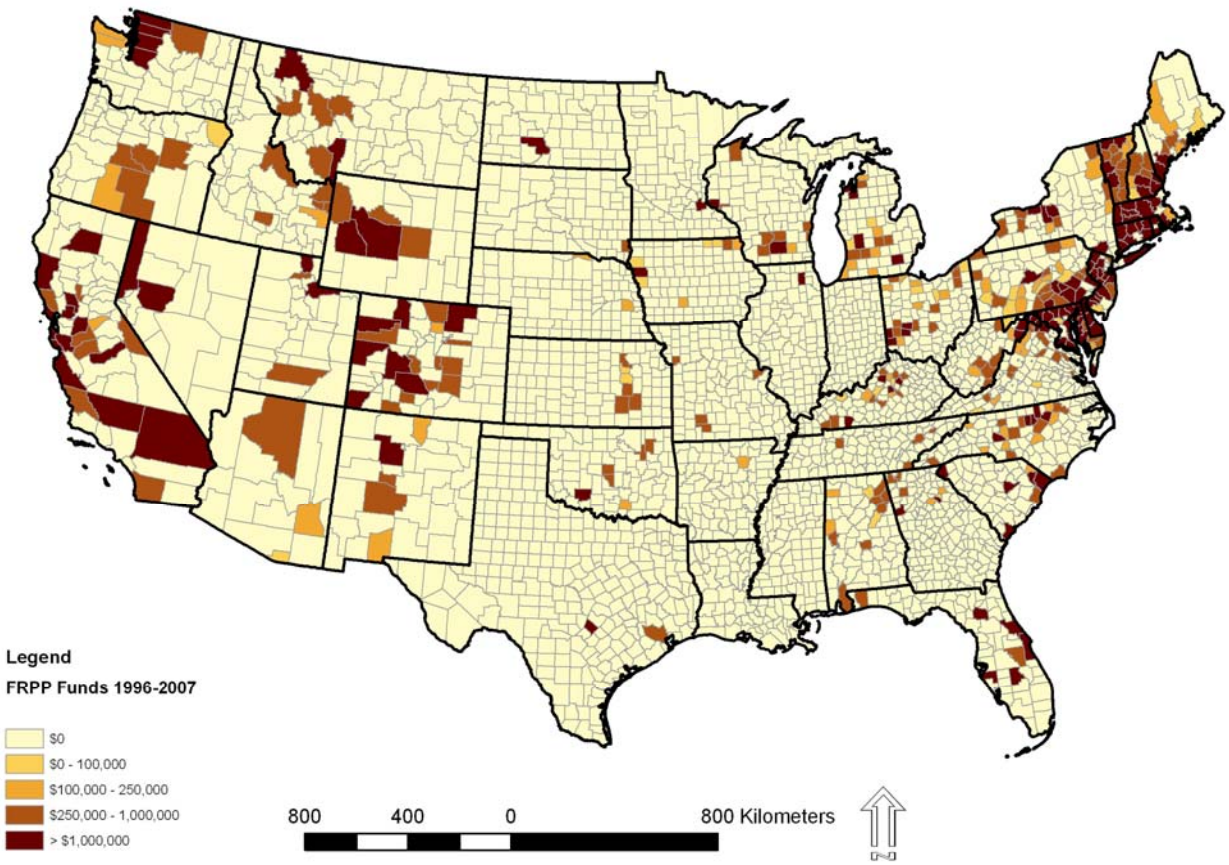
The analysis of recent FRPP activity was used to identify a model of variables with significant marginal effects on the probability of funding (logit) or the level of funding (least squares regression) for a county. The model coefficients were then applied to the predictor data from the most recent time period (circa 2000, Table 1, page 25, second column) to predict where demand for FRPP funds may arise in the near future. The premise for this is that conditions at the start of a time period, or changes in conditions just preceding it, determine the activity during that period.

RESULTS

FRPP Activity

Between 1996 and 2007, FRPP funded 2,648 transactions in the 48 conterminous states, totaling 210,000 hectares at a federal share of $520 million. Those transactions took place in 403 of the 3109 county or city units (Figure 1). Forty-six of the 48 states were represented; only Mississippi and Louisiana received no FRPP funds in this period. Arkansas and South Dakota had only a single transaction each, whereas Maryland, New Jersey, Pennsylvania, and Vermont in the northeast had over 200 transactions apiece. These states also had some of the largest acreages of farmland preserved, joined by Colorado and Montana that had fewer transactions but involved larger parcels. California, Maryland, North Carolina, Ohio, and Pennsylvania had transactions in at least 20 counties within their borders. Counties with more than 10,000 acres in easements funded in part by FRPP occurred primarily in the West—Colorado, Montana, and Oregon—plus Vermont and Kentucky. FRPP's greatest activity in terms of number of parcels (82) and funds ($11.2 million) occurred in Fayette County in Kentucky's famed Bluegrass equestrian region. The most land (7,388 hectares) was funded in Gallatin County, Montana, near Yellowstone National Park.

FIGURE 1 Map of FRPP activity by county, 1996-2007, in federal dollars of funding.



All counties with major agricultural PDR programs (as listed in Sokolow and Zurbrugg 2003) received funding from FRPP during this period with a few exceptions. For example, the Land Trust of Napa County in California's wine country only acquires easements by landowner donations and therefore had no need of FRPP funds. The other false negatives in the database, counties with well-known programs without FRPP funds, include the TriValley Conservancy in California's Alameda County, San Juan County, Washington, and Virginia Beach City, Virginia. These programs are funded locally through development fees on new home construction, property transfer tax, or a dedicated portion of the property tax, respectively.

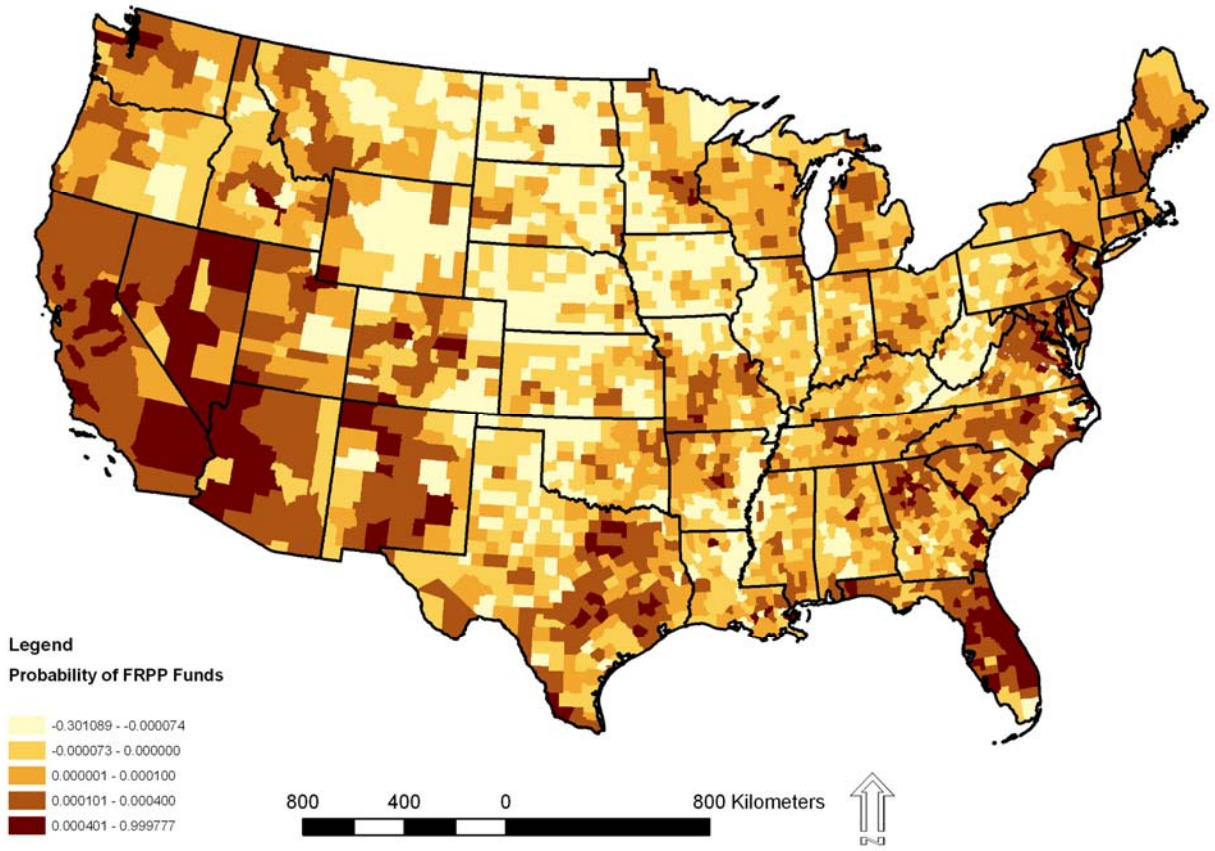
Predicting Recent FRPP Activity from Historical Socioeconomic Variables

Logistic modeling was performed to predict the likelihood that a county would have received some FRPP funding between 1996 and 2007. The independent variables with the strongest positive marginal effect on the probability of FRPP funding are direct sales of farm products to individuals, the Land Sprawl Index for 1980, per capita income, the area of farmland in the county, and the rate of population growth during the 1980s (represented by the lowest p values in Table 2). Strong negative effects were found for the funds received from other Farm Bill programs such as the CRP and WRP and the density of farmland (as a percentage of the county). The probability of a PDR program receiving FRPP funding according to the logistic model is shown in Figure 2, page 29. Many of the high probability counties are seen in parts of Florida, eastern Texas, and the Southwest, which actually received little funding (Figure 1, page 27), The Great Plains region in general had low probabilities, which is consistent with the observations. The standard errors did not change substantially when adjusted for spatial dependence, perhaps because some spatial dependence was already captured in the state fixed effects.

TABLE 2 Results of logistic regression modeling of presence of FRPP funding in U. S. counties. Pseudo r^2 = 0.1862.

Variable	Coefficient	Std. Error	z	P > |z|	95% Conf. Interval	
pc_inc_90	.0001311	.0000186	7.05	0.000	.0000947	.0001676
pd_1990	-.0020808	.0039894	-0.52	0.602	-.0099	.0057383
pd_grow~1990	.0368758	.0181509	2.03	0.042	.0013007	.0724508
hd_1990	-.002531	.0090011	-0.28	0.779	-.0201728	.0151108
hd_grow~1990	-.0574267	.0343221	-1.67	0.094	-.1246967	.0098434
pii_1990	.0007869	.0005185	1.52	0.129	-.0002295	.0018032
land_sprawl_80	.0038988	.0005015	7.77	0.000	.0029159	.0048817
farmhect_97	1.28e-06	3.82e-07	3.34	0.001	5.28e-07	2.03e-06
ad_97	-.0049405	.0021914	-2.25	0.024	-.0092357	-.0006454
lv_doll_92	.0000141	.0000137	1.03	0.303	-.0000127	.0000409
mv_crop_92	1.05e-06	7.35e-07	1.43	0.151	-3.86e-07	2.50e-06
direct_sales_92	.0019594	.0002317	8.46	0.000	.0015053	.0024135
crp_92	-.0004548	.0001721	-2.64	0.008	-.0007921	-.0001176
constant	-5.295312	.3273384	-16.18	0.000	-5.936884	-4.653741

FIGURE 2 Map of probability of FRPP funding, 1996-2007, from logistic regression model.



We also conducted an ordinary least squares regression of the continuous variables of FRPP activity (number of transactions or parcels, number of hectares preserved, and dollars of federal funding). Results were similar for all three models so only the results for dollars of FRPP funding are reported here. The most significant predictor variables were very similar to those for the logistic regression. Significant positive effects on funding were found for direct sales to individuals, per capita income, hectares of farmland, and the Land Sprawl Index (Table 3). Strong negative effects were related to CRP/WRP funding. CRP and WRP are Farm Bill programs that fund retirement of marginal farmland to enhance soil, water, and wildlife habitat. It makes sense that the government would not be heavily funding farmland retirement and preservation in the same locations. Less significant were population growth rate (positive) and housing growth rate (negative). Figure 3a, page 31, shows the predicted level of FRPP funding by county for 1996-2007. Counties with high predicted funding more closely match the actual funding in Figure 1, page 27, with low predictions throughout the Great Plains and the southeast. The linear regression model greatly underpredicted funding in parts of Colorado, the west coast, the northern Rocky Mountains, and New England (i.e., counties received more funding than predicted by our model, Figure 3b, page 31). Primary areas that received less than predicted include south Florida, parts of the western states, and in states bordering the Great Lakes. Total predicted funding summed to $510 million, just slightly less than the actual funding level. Three of the agricultural variables (land value, market value of crops, and direct sales to individuals) showed effects of spatial dependence, with large increases in their adjusted standard errors.

TABLE 3 Results of ordinary least squares regression modeling of level of FRPP funding in U. S. counties. $r^2 = 0.1882$.

Variable	Coefficient	Std. Error	t	P > |t|	95% Conf. Interval	
pc_inc_90	26.95382	4.842143	5.57	0.000	17.45977	36.44787
pd_1990	-789.4116	483.8625	-1.63	0.103	-1738.127	159.3041
pd_grow~1990	2533.368	1288.825	1.97	0.049	6.351949	5060.384
hd_1990	1327.886	858.8647	1.55	0.122	-356.1016	3011.873
hd_grow~1990	-7590.782	3703.964	-2.05	0.041	-14853.19	-328.3715
pii_1990	96.01981	78.71039	1.22	0.223	-58.30871	250.3483
land_sprawl_80	383.5465	114.2532	3.36	0.001	159.5288	607.5642
farmhect_97	.1746426	.0472388	3.70	0.000	.0820209	.2672643
ad_97	-34.47508	24.80051	-1.39	0.165	-83.10177	14.15162
lv_doll_92	10.51566	5.934955	1.77	0.077	-1.121082	22.15241
mv_crop_92	.9570545	.6420585	1.49	0.136	-.3018383	2.215947
direct_sales_92	841.9112	145.3415	5.79	0.000	556.9382	1126.884
crp_92	-44.4349	16.84943	-2.64	0.008	-77.47179	-11.39801
constant	-477,004.5	69,400.83	-6.87	0.000	-613,079.6	-340,929.4

FIGURE 3a

Map of predicted FRPP funding activity, 1996-2007, from linear regression model

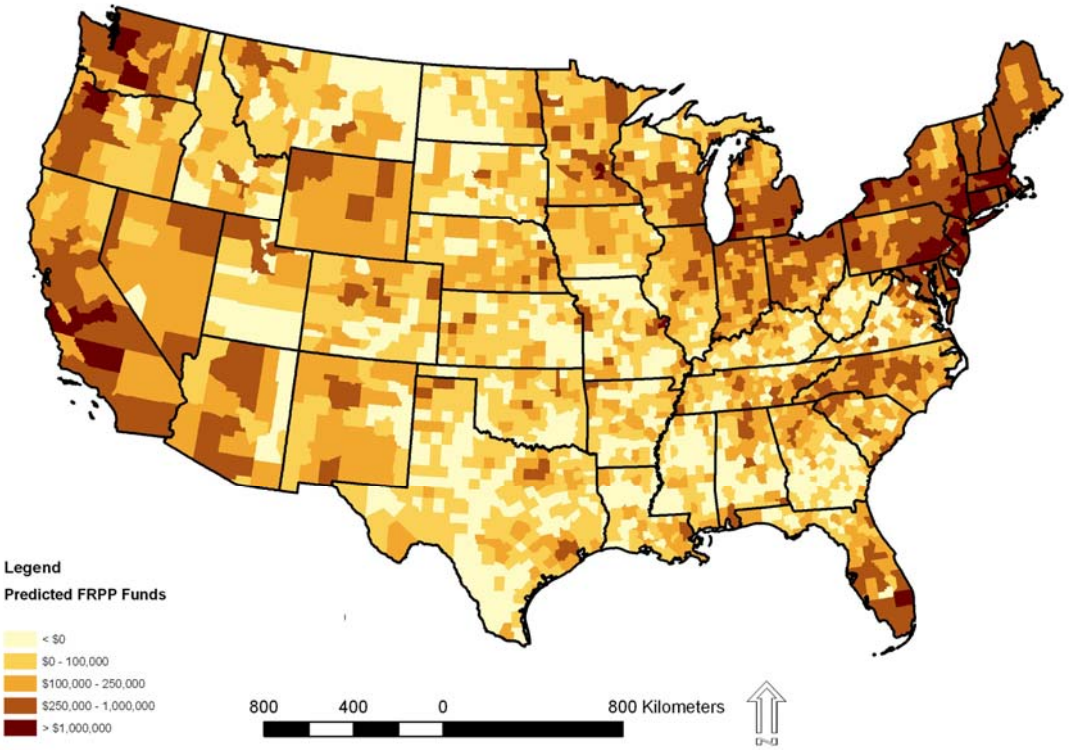
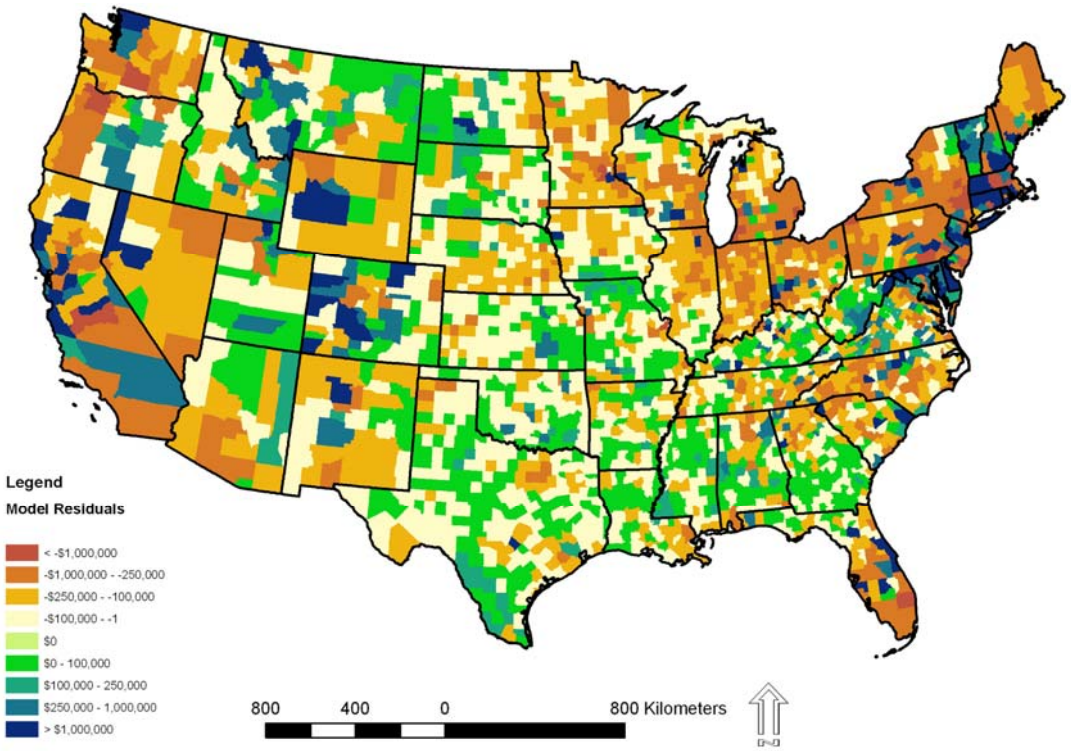


FIGURE 3b

Map of residuals (observed funding minus predicted).



Forecasting Future Activity from Recent Socioeconomic Variables

The socioeconomic and agricultural predictor variables change over time. In general, population and housing density increases in most places, while farm area tends to decline. Assuming the relationships between these variables and the level of FRPP funding are constant, we would expect the predicted level of funding in the next decade to respond to the changes in predictor variables in the 2000 census, the 2002 census of agriculture, and synthesized variables. Therefore, we multiplied the regression coefficients (Table 3, page 30) by the more recent values of predictor variables to forecast future funding levels (Figure 4a, page 33). As Figures 3a and 4a use the same legend, we can see at a glance that most areas are predicted to have higher funding from FRPP in the next decade, assuming more funds are available. Areas where high levels of future funding were forecast include the West Coast, Colorado, Florida, the Mid-Atlantic, New England, and the Great Lakes (Figure 4a, page 33). Comparing the forecasted funding map with the predicted historic funding map county by county (Figure 4b, page 33) identified much of California and a few counties in Massachusetts and Connecticut as having the greatest predicted increase in funding in the future. Areas in the Great Plains, that had low predictions to begin with, south Florida, and some western counties, showed a decrease in predicted funding. Total forecast funding would more than double over the actual and predicted historic levels, totaling $1.2 billion.

DISCUSSION AND CONCLUSIONS

FRPP is directed by Congress to be reactive to bottom-up petitions for funding, so the program cannot proactively use statistical modeling such as presented here to distribute funds to areas of perceived demand. Rather our results provide some insights into the general conditions associated with cooperating entities. Our results are partially consistent with findings of the few previous studies. In particular, higher per capita income was a major predictor of farmland preservation as shown previously in the most active states (Feather and Barnard 2003) and nationally (Poor and Brule 2007). The same subset of predictor variables proved to be significant in both the logistic and linear regression models of the presence or level of FRPP funding, respectively. Both models found significant positive effects of per capita income, the Land Sprawl Index, area of farmland, and direct sales of crops to individuals, and negative effects of CRP/WRP payments to farmers. Population and housing density that others found important (Kline and Wichelns 1994, Feather and Barnard 2003, Poor and Brule 2007) were not very significant predictors in our study. Their growth rates, however, were moderately significant, with housing growth rate negatively related to FRPP. The GIS-based Land Sprawl Index (Theobald 2005) provided a richer spatial interpretation than the purely statistical information from the census. Generally, the Population-Interaction Index, agricultural density, land value of farmland, and the market value of crops were not very significant. Thus a county supporting a farmland preservation program would tend to be prosperous with an active local food movement, while having lots of farmland experiencing the effects of sprawl, as quantified by low housing densities near agricultural lands far from urban core areas. In other words, a combination of socioeconomic indicators characterizing the county as a whole plus some indicators of the agricultural sector of the county best predicted FRPP activity. The strong relationship of FRPP with direct sales of crops to individuals is a new insight that had not been analyzed before. If the local food movement continues to grow, we might expect to see increasing demand by urban dwellers to preserve (some types of) nearby farmland and turn to FRPP for assistance in financing agricultural conservation easements.

FRPP activity is relatively modest compared to other forms of conservation (Table 4, page 34). The mammoth Conservation Reserve Program that retires environmentally sensitive farmland has 70 times more land under term contracts than FRPP has helped protect. The land protected by land trusts is more than five times

FIGURE 4a

Map of forecasted FRPP funding activity, 2008-2019, based on linear regression coefficients.

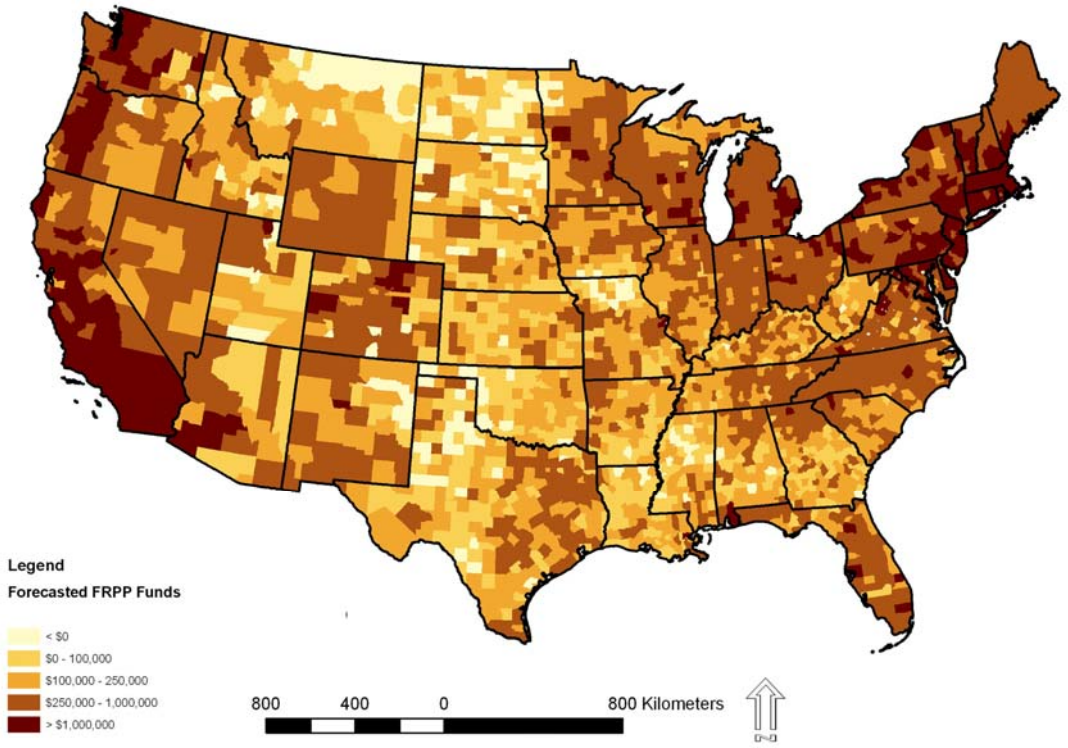
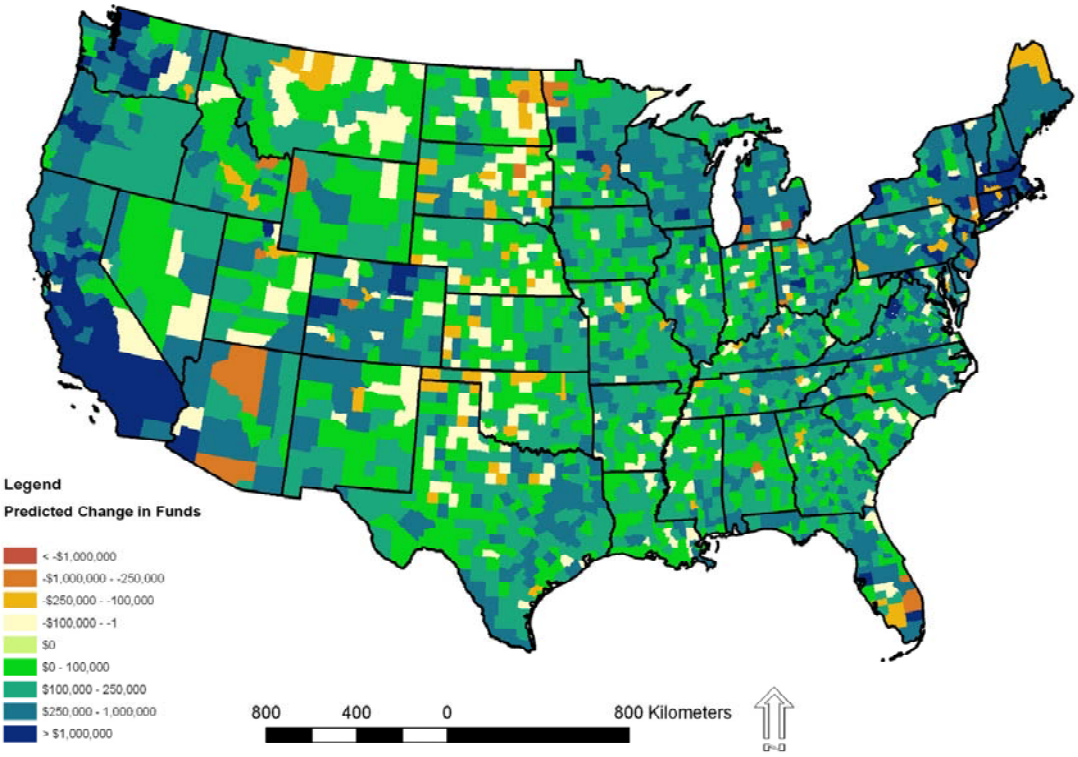


FIGURE 4b

Map of change in predictions from funding period to future period (i.e., map 4a minus map 3a).



as much as the total area of farmland preserved, although there is some amount of overlap. Nevertheless, FRPP has contributed to roughly one-quarter of all farmland preserved in the United States and has helped hundreds of land trusts and governmental programs across the nation.

TABLE 4 Comparison of area protected by FRPP funding relative to other conservation efforts.

Program	Area protected (ha)	Source
Farm and Ranch Lands Protection Program (FRPP)	210,226	FRPP data
All farmland	905,468	American Farmland Trust - Farmland Information Center (2009a and b)
All land trusts	4,813,809	Aldrich and Wyerman (2006)
Conservation Reserve Program (CRP)	14,887,038	United States Department of Agriculture, Farm Service Agency (2008)

This study suggests several potential lines of future research. Our modeling assumed linear relationships between covariates and FRPP activity. We suspect that the emergence of farmland preservation programs may not occur until threshold values of predictors, or tipping points, are reached. Therefore applying a non-linear approach such as generalized additive models to our data may improve the prediction accuracy. Classification and regression tree modeling might tease out regional differences in relationships that may be obscured when all counties are analysed collectively. This variation can be seen in the types of agricultural land preserved with the help of FRPP funds, from horse farms in Kentucky, to ranchland in the mountain west, to prime farmland elsewhere. The 2002 Farm Bill changed the definition of cooperating entities to allow non-governmental organizations to participate, whereas 22 states had not participated until that point (Robert Glennon, personal communication). Analyzing the FRPP data for pre- and post-2002 might provide additional insights about how the program has evolved. As mentioned in the beginning of the paper, farmland preservation competes with other social programs including other forms of land conservation. One intriguing political economy question is whether the degree of land conservation in a county (open space, public land, and nature reserves) reinforces or competes with farmland preservation efforts. On the one hand, having a large proportion of land in some form of permanent protection might make communities more familiar and comfortable with the strategy of farmland preservation to achieve social goals. Alternatively, other conservation could reduce the sense of urgency since so much land was already protected. Compiling these additional data could provide greater insights into the motivations of communities to rise to the need to preserve farmland.

Our modeling has identified counties that did not receive funding so far from FRPP but that have similar conditions to those who did (or are becoming like them). Some of these locations could become eligible cooperating entities in the near future, and indeed some are already forming farmland preservation programs. Fresno County, California, is a prime example. As of 2007, FRPP had supplied no funds for agricultural conservation easements in this county. Our modeling predicted a funding level of $1.6 million for the historical period, with a projected five-fold increase to more than $8 million in the future, primarily due to a large increase in reported direct sales of crops to individuals. Stakeholders in Fresno County are in fact investigating mechanisms to preserve farmland including financing for conservation easements (American Farmland Trust 2008). Perhaps all some other communities lack is the emergence of an effective champion to catalyze others to act. If some of these potential champions see from our data that their county is similar to others that have already succeeded in meeting FRPPs eligibility criteria, they may be inspired to take on the challenge of preserving their local farmland from urban expansion. The good news is that the 2008 Farm Bill authorized an increase in FRPP funding up to $743 million through 2012.

ACKNOWLEDGEMENTS

This project was supported by National Research Initiative Grant no. 2005-35401-15320 from the USDA Cooperative State Research, Education, and Extension Service Rural Development Program to Dr. Frank Davis. We are grateful to Frank Davis and our project advisory group (Tim Duane, Julie Gustanski, Ralph Heimlich, Pete Roussopoulos, Rita Schenck, and Al Sokolow) for their encouragement to pursue this study and for valuable advice. We thank Bob Glennon, FRPP Manager, for compiling and providing their transaction data and for helpful comments on a draft manuscript. We also thank David Theobald for sharing his sprawl data. Our colleague Nick Parker provided insights to get us started and helped with the data preparation.

LITERATURE CITED

Aldrich, R. and J. Wyerman. 2006. 2005 National Land Trust Census Report.

American Farmland Trust. 2008. *Model Farmland Conservation Program for Fresno County*. Report to the Report to the Council of Fresno County Governments.

American Farmland Trust - Farmland Information Center. 2009a. *Fact Sheet: Status of Local PACE Programs.*

American Farmland Trust - Farmland Information Center. 2009b. *Fact Sheet: Status of State PACE Programs.*

Bowers, D. 2005. Farmland Preservation Report. 15(5). Bowers Publishing, Inc. Street, MD.

Conley, T. G. 1999. Gmm estimation with cross sectional dependence. *Journal of Econometrics* 92, 1-45.

Daniels, T. and D. Bowers. 1997. *Holding Our Ground: Protecting America's Farms and Farmland.* Washington, Island Press.

Farm and Ranch Lands Protection Program. 2007. Fiscal Year 2007 Announcement of Program Funding, USDA Natural Resources Conservation Service.

Feather, P. and C. H. Barnard. 2003. Retaining open space with purchasable development rights programs. *Review of Agricultural Economics* 25: 369-384.

Kline, J. and D. Wichelns. 1994. Using referendum data to characterize public support for purchasing development rights to farmland. *Land Economics* 70: 223-233.

Machado, E. A., D. M. Stoms, F. W. Davis and J. Kreitler. 2006. Prioritizing farmland preservation cost-effectively for multiple objectives. *Journal of Soil and Water Conservation* 61:250-258.

Plantinga, A. J. and D. J. Miller. 2001. Agricultural land values and the value of rights to future land development. *Land Economics* 77: 56-67.

Poor, P. J. and R. Brule. 2007. An investigation of the socio-economic aspects of open space and agricultural land preservation. *Journal of Sustainable Agriculture* 30: 165-176.

Sokolow, A. D. and A. Zurbrugg. 2003. *A National View of Agricultural Easement Programs: Profiles and Maps -- Report 1*. DeKalb, Illinois, American Farmland Trust and Agricultural Issues Center.

Theobald, D. M. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. *Ecology and Society* 10: 32. [online] URL: http://www.ecologyandsociety.org/vol10/iss1/art32/.

U. S. Department of Agriculture, Economic Research Service. 2005. URL: http://www.ers.usda.gov/Data/PopulationInteractionZones/. Accessed September 23, 2008.

United States Department of Agriculture, Farm Service Agency. 2008. Conservation Reserve Program: Summary and Enrollment Statistics FY 2007.