Chapter 4

Environmental Characteristics of Economically Marginal Cropland

Agricultural production, particularly cultivated crop production, can affect the environment in many ways. But is the extensive margin of cultivated crop production more susceptible to soil erosion or nutrient loss than average cropland? These agri-environmental problems have been a major focus of U.S. agri-environmental policy over the past two decades. We also examine whether changes in cultivated cropland could be affecting habitat that is important to imperiled species of birds and other wildlife. Imperiled species are those classified by NatureServe as either “critically imperiled” or “imperiled” at the national level, receiving a Global Conservation Status (G) rank of 1 or 2, respectively. These data are the most comprehensive measure of U.S. biodiversity conservation status (see Appendix C).

We analyze the relationship between soil productivity, environmental sensitivity, and land use at both the local and national levels. At the local level, we compare differences from averages by Crop Reporting District (CRD). Most States have between six and nine CRDs, which are multicounty areas used by USDA for data-gathering purposes. When environmental sensitivity varies widely at that local level, focusing on small geographic areas ensures that local differences are not averaged out, as they could be in national averages. We look at differences from national averages to capture broader inter-regional differences. For example, wind erosion occurs mostly on semi-arid regions of the Northern and Southern Plains. But at a local level, land may be quite similar in terms of erodibility. Finally, available data are not always sufficient to capture local variations in environmental sensitivity. In these cases, comparisons against national averages are necessary, even if local variation is significant.

Lands With Low Soil Productivity Are More Vulnerable to Erosion Damage

We measure the soil’s sensitivity in terms of erosion using the erodibility index (EI) and the estimated average annual rate of soil erosion. The EI is defined by the ratio of *inherent erodibility* to the *soil loss tolerance*. Inherent erodibility for a given soil is the rate of erosion (tons per acre per year) that would occur on land that was continuously clean tilled throughout the year.[1] The soil loss tolerance is the rate of soil erosion that can occur without significant long-term productivity loss. Thus, while the erodibility index is independent of land use and management, it measures the fragility of the soil in terms of erosion, capturing both the potential of a soil to erode and its resistance to erosion damage.

Actual levels of soil erosion depend greatly on land use and management, making comparisons across different land uses difficult. On land in culti-

[1]Wischmeier and Smith (1978) and Skidmore and Woodruff (1968) provide detailed descriptions of the estimation of inherent erodibility for rainfall erosion and wind erosion, respectively.

vated crop production, soils are frequently exposed to the erosive forces of rainfall and wind, and tend to erode more quickly than land in continuous grass or tree cover. However, meaningful comparisons can be made across lands of different soil productivity levels that are, nonetheless, devoted to the same land use. Average annual rates of erosion are estimated (for NRI data points) using the Universal Soil Loss Equation (USLE; Wischmeier and Smith, 1978) and the Wind Erosion Equation (WEE; Skidmore and Woodruff, 1968).

At the local (CRD) level, lands with lower soil productivity do tend to be more inherently erodible for wind and, especially, rainfall (fig. 4.1, top row). Low-productivity land (SRPG 0-33) is, on average, 40 percent more susceptible to rainfall erosion than the CRD average, while high-productivity land (SRPG 67-100) is 25 percent less erodible. The critical factor behind these differences is the steepness of slopes. On steeply sloping land, water runs off quickly, often carrying soil with it. Topography can also affect soil productivity as the loss of soil and nutrients through surface runoff can result in higher input costs and reduced soil depth. In the SRPG index, slope reduces the overall soil productivity score.

For wind erosion, low-productivity land is, on average, 34 percent more erodible than the CRD average, while high-productivity land is 18 percent less erodible. At a local level, differences in wind erodibility derive from differences in climate (prevailing winds) and the susceptibility of the soil to wind erosion. At a national level, differences in wind erosion are primarily due to regional differences in climate; land in more arid regions is more likely to be eroded by wind.

At a national level, the relationship between soil productivity and erodibility is similar to that observed at the local level, but more pronounced for both rainfall and wind erosion (fig. 4.1, second row). For example, wind erodibility ranges from 62 percent above the national average for lands with low productivity to 47 percent below the national average for lands with high soil productivity.

Potential crop yields also tend to be lower on highly erodible cropland (HEL).[2] Average potential crop yields for HEL range from 77 percent (for oats) to 82 percent (for hay) of non-HEL yields (table 4.1).[3] This suggests that, on average, HEL is about 20 percent less productive, than non-HEL in the same CRD. Still, the productivity of HEL varies considerably. In some CRDs, potential yields on HEL are substantially above—close to double for alfalfa hay—those for non-HEL (maximum yield ratio, table 4.1). In other CRDs, potential yields on HEL are a third or less of those on non-HEL (minimum yield ratio, table 4.1). Despite this variation, at the national level, the highest potential yields always occur on non-HEL for the crops examined.

Soil Productivity and Nutrient Losses

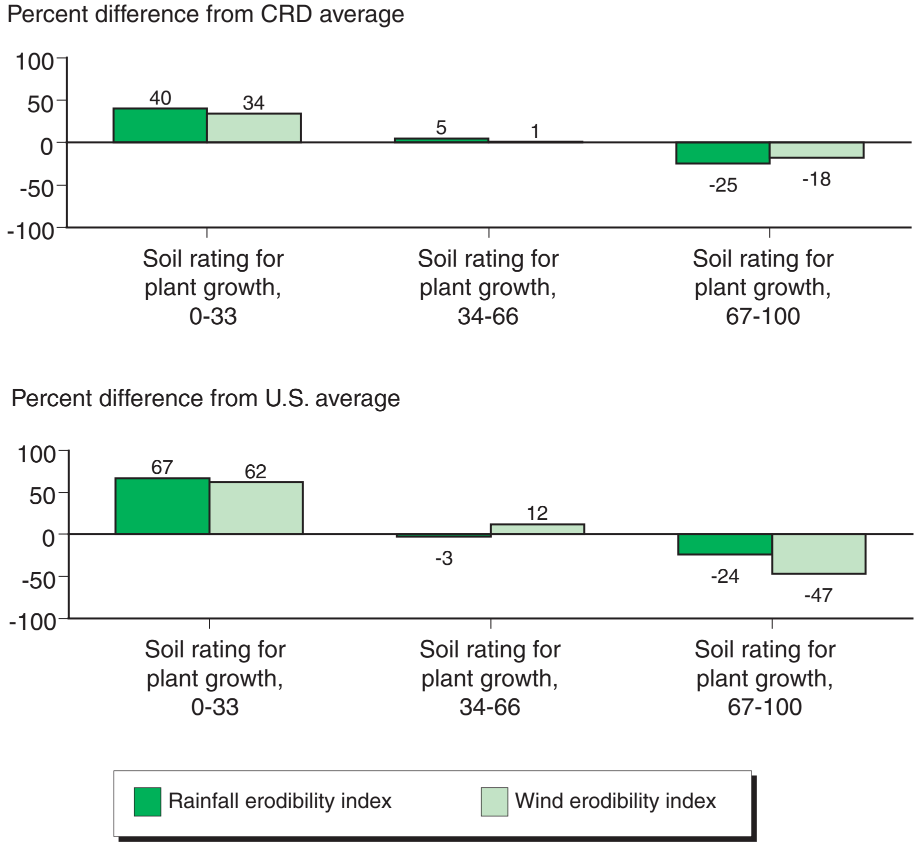
Nutrient runoff depends on both the inherent characteristics of land (including climate) and the way it is used and managed. Lands in crop production tend to have higher rates of nutrient loss because they receive

[2]Highly erodible land (HEL) has an erodibility index (EI) of 8 or more.

[3]Using a Geographic Information System (GIS), estimated yields and HEL designations are overlaid with CRD boundaries to estimate the ratio of yields on HEL and non-HEL land within each CRD. Estimated yields are from Soil Survey Geographic (SSURGO) data, the most up-to-date source of yield and soils information available. We are limited to crop reporting districts that have yield estimates for both HEL and non-HEL, but we have over 200 observations for each of these crops: alfalfa hay, corn, oats, soybeans, and wheat.

Figure 4.1

Erodibility index relative to local and national averages, by land quality classification



Notes: Point-level data are compared with the average for each Crop Reporting District (CRD) and for all agricultural and forest land in the United States. A CRD is a multicounty area defined for data gathering purposes by USDA's National Agricultural Statistics Service (NASS). The soil rating for plant growth is an index of soil productivity based on many biological, chemical, and physical soil properties as well as topography and climate. In 1997, land with SRPG estimates of 0-33, 34-66, and 67-100 comprised 38, 44, and 18 percent of the private agricultural and forest land in the contiguous 48 States.

Source: ERS analysis of 1997 National Resources Inventory and Soil Survey Geographic data.

more fertilizer and, because of tillage, are more susceptible to nutrient transport from rainfall runoff and soil erosion. No indicator of inherent susceptibility to nutrient loss exists. But meaningful comparisons can be made among lands that are in the same use but vary in soil productivity.

Potential nitrogen and phosphorus losses to water are simulated using the Environmental Policy Integrated Climate Model (EPIC) and matched with land-use and soil information from the NRI and SSURGO data sets, respectively. EPIC is a crop biophysical simulation model that is used to estimate the impact of management practices on pollution discharged at the field level (Mitchell et al., 1998). It uses information on soils, weather, land use, and land management practices—including fertilizer rates—and produces estimates of resulting erosion and nutrient loss to the environment (as well as other indicators). Land use and management practices used in the EPIC

Table 4.1
Comparison of average crop yields on HEL and non-HEL, by soil survey unit

Crop	Average non-irrigated yield: All land	Average non-irrigated yield: Highly erodible land (HEL)	Ratio of HEL to Non-HEL yields[1]: Average	Median	Standard deviation	Min.	Max.	No. of observations
Alfalfa hay	3.7	2.7	0.82	0.79	0.22	0.27	1.95	215
Corn	89.2	67.5	0.78	0.76	0.19	0.28	1.62	320
Oats	65.3	47.4	0.77	0.76	0.22	0.33	1.70	222
Soybeans	36.0	28.2	0.78	0.76	0.17	0.33	1.32	219
Wheat	31.5	22.3	0.78	0.78	0.21	0.33	1.73	201

[1] Ratios are for non-irrigated yields within a soil survey unit, a geographic area cutting across counties. Average values are weighted by the amount of cropland within each soil survey unit. Highly erodible land (HEL) is land with an erodibility index (for either rainfall or wind erosion) of 8 or more.

Source: ERS analysis of Soil Survey Geographic (SSURGO) Data set. SSURGO is the most detailed level of soil mapping conducted by USDA's Natural Resources Conservation Service.

management files are based on existing land use, cropping patterns, and management practices for highly erodible (HEL) and non-highly erodible (NHEL) land in 45 farm production regions (see appendix B for details).

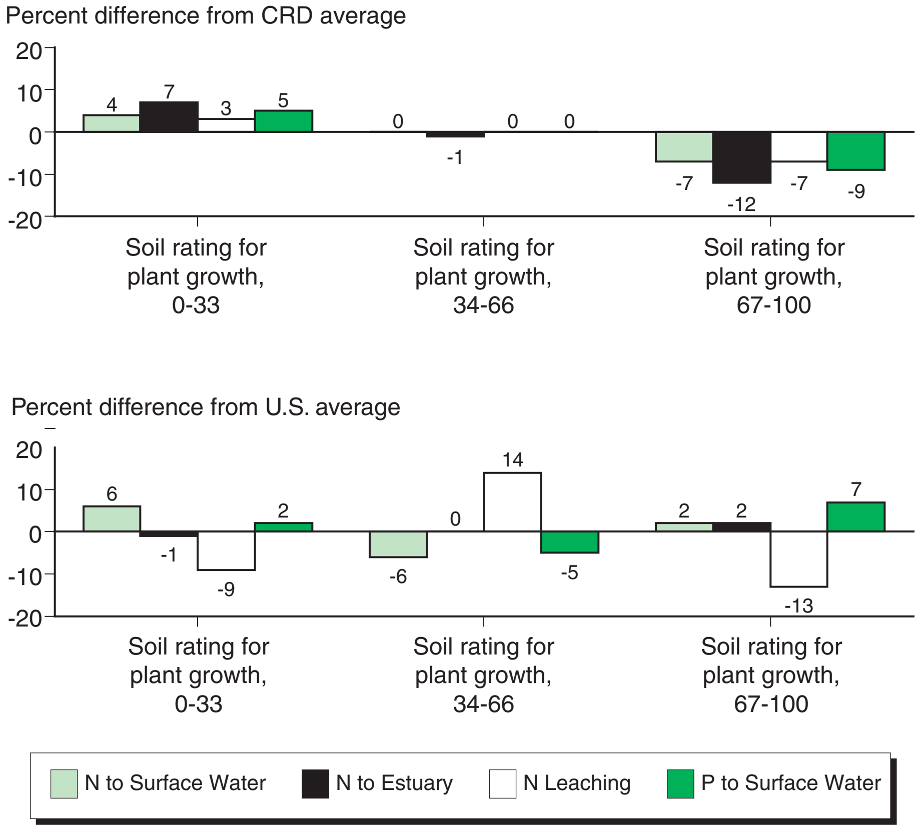
At the local (CRD) level, the potential for nutrient loss to water increases as land quality (SRPG) declines (fig. 4.2, top row). For low-productivity land (SRPG 0-33), potential nutrient losses exceed CRD averages by 3 to 7 percent for all four nutrient loss categories (nitrogen loss to surface water, nitrogen loss to estuaries, nitrogen leaching to groundwater, and phosphorus loss to surface water). On high-productivity land (SRPG 67-100), losses are 7 to 12 percent less than CRD averages for all categories. Potential nutrient loss is very close to CRD averages on medium-productivity land (SRPG 34-66). However, these results are based on environmental modeling in which local variation is limited. Within CRDs, differences in nutrient loss are driven by differences in soil erodibility. Higher erodibility is often associated with lower soil productivity and greater nutrient transport with soil. Also, the available data do not generally capture variations in nutrient applications and cropping patterns within local areas.

At the national level (fig. 4.2, bottom row), differences in nutrient loss across productivity classes are not as uniform as at the local level. Nitrogen loss to surface water is highest (6 percent above average) on low-productivity land but lowest (6 percent below average) on medium-quality land. Nitrogen leaching to groundwater is highest on medium-quality land (14 percent above average), but 9 and 13 percent below average on the other land classes. Nitrogen surface runoff and nitrogen leaching appear to have an inverse relationship: when surface runoff is high, leaching is low and vice versa. Nitrogen runoff to estuaries varies only slightly since this is as much a function of location as soil characteristics. Finally, phosphorus runoff is lowest for lands with medium soil productivity (5 percent below average) and highest for lands with high soil productivity (7 percent above average).

The pattern of nutrient loss across land quality classes may be the product of offsetting trends in inherent susceptibility to nutrient loss and nutrient application. As soil productivity declines, erodibility and land

Figure 4.2

Nutrient runoff potential for cultivated cropland relative to local and national averages, by land quality classification



Notes: Point-level data are compared with the average for each Crop Reporting District (CRD) and for all agricultural, forest, or other rural land in the contiguous United States. A CRD is a multicounty area defined for data gathering purposes by USDA's National Agricultural Statistics Service (NASS). The Soil Rating for Plant Growth (SRPG) is an index of soil productivity based on many biological, chemical, and physical soil properties as well as topography and climate. In 1997, land with SRPG estimates of 0-33, 34-66, and 67-100 comprised 38, 44 , and 18 percent of the private agricultural and forest land in the contiguous 48 States.

Source: ERS analysis of 1997 National Resources Inventory, Soil Survey Geographic data, and nitrogen (N) and phosphorus (P) indicators based on the Environmental Policy Integrated Climate model.

slope tend to increase, potentially increasing the proportion of applied nutrients that are lost to the environment. Because the crop yield potential is generally lower for less productive lands, these lands may receive more fertilizers than higher quality lands so as to compensate for the lower productive capacity of the soil. Alternatively, the relative benefits and costs of fertilizer applications could imply that these lands receive less fertilizer than higher quality lands, reducing the size of the overall pool of nutrients from which runoff can occur. Even if the nutrient pool is smaller, lower crop yields also imply that the crop uses fewer nutrients, perhaps leaving just as much "excess" nutrient, which is susceptible to runoff and leaching.

Our analysis until now has uncovered three relationships:

- Less productive croplands are those most likely to lie on the extensive margin.
- Lands that are less productive for crop production also tend to be more environmentally sensitive in terms of potential erosion damage.
- Less productive lands are often more environmentally sensitive in terms of potential nutrient loss locally and sometimes nationally (although the evidence is not as strong as for erodibility).

Cropland Converted to Other Uses More Prone to Erosion Damage and Nutrient Loss

Rainfall Erosion. Lands that transitioned between cultivated crops and a less intensive land use tend to have a greater potential for erosion damage than land that was cultivated in both 1982 and 1997.[4] At the local level, where variation in rainfall erosion can be large, land that was cultivated in 1982 and 1997 had, on average, a rainfall erodibility index (EI) that was 20 percent lower than the CRD average. Land that shifted to less intensive uses, particularly to CRP, was generally more prone to erosion damage than the CRD average (fig. 4.3). High erodibility on CRP land is not surprising; erodibility is an important factor in CRP eligibility criteria and selection. Similar patterns are observed for land that started out as uncultivated cropland and grazing/forest/other land (fig. 4.3). Similar relationships between rainfall erodibility and land use also emerge on a national scale (fig. 4.4).

Comparisons of estimated erosion rates (rather than the erodibiliy index) across different extensive margin lands can also be made by looking at erosion rates for the year when the land entering/leaving cultivated crops was in cultivation.[5] Land that moved from cultivated crops to another, less intensive use between 1982 and 1997 had relatively high 1982 erosion rates compared with land that stayed in crop production over that period (table 4.2). Land in cultivated crops in both 1982 and 1997 had an average rainfall erosion rate of 4.04 tons/acre/year (TAY), while land moving to uncultivated crops, CRP, or grazing/forest/other uses had erosion rates of 5.08, 5.97, and 6.18 TAY. Land that moved to cultivated crop production from less intensive uses had 1997 rates of rainfall erosion that were roughly equal to or higher than those for land that was cultivated in both 1982 and 1997 (table 4.2). Land cultivated in both years had a 1997 average erosion rate of 3.06 TAY while the 1997 rates on land that moved from uncultivated crops and from grazing, forest, and other uses were 2.99 TAY and 4.34 TAY.

Wind Erosion. For wind-erodible soils, the erodibility index is also higher for land at the extensive margin of cultivated crop production than for land in cultivated crops in both 1982 and 1997. At the local level, however, differences are much smaller than differences for rainfall erodibility (fig. 4.3). Land that was cultivated in 1982 and 1997 was less prone to damage from wind erosion (EI 2 percent below the CRD average) than was transitioning land (EI 4-12 percent above average). Land that moved to cultivated crop production from another use also had higher potential for wind erosion damage than land cultivated in

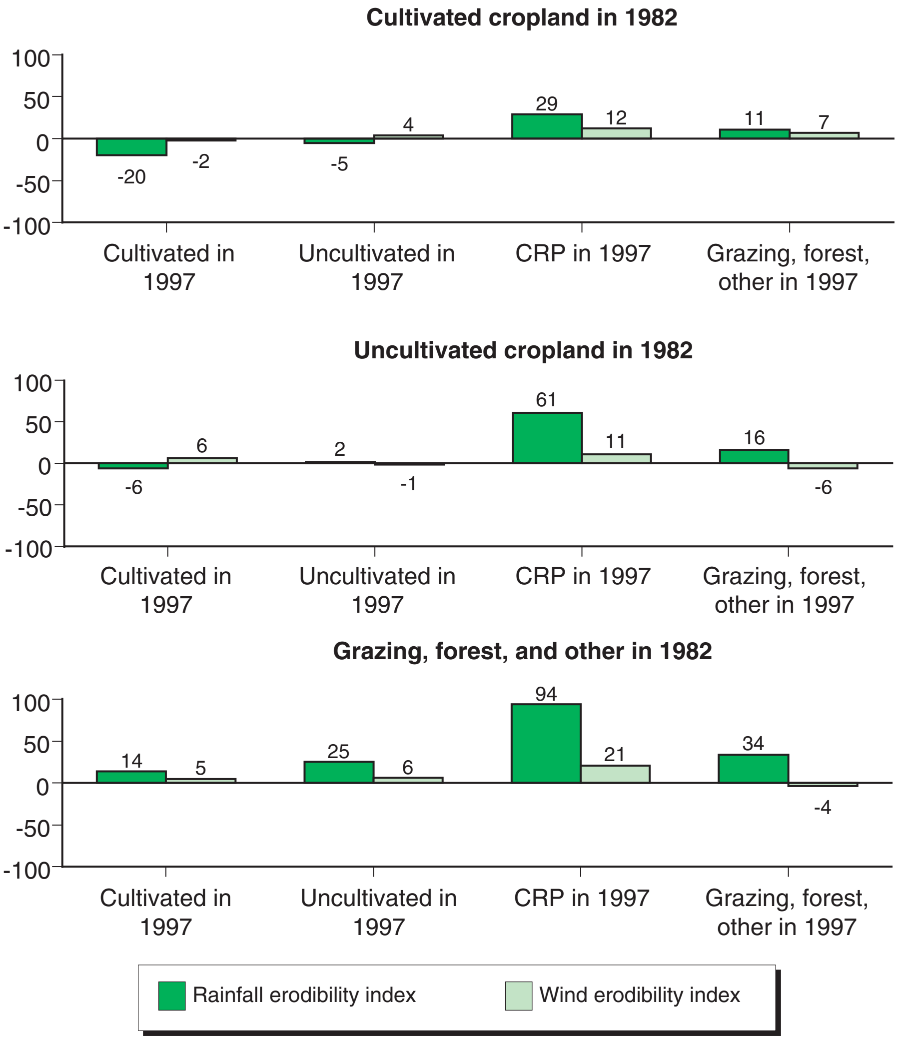
[4]As noted previously, we compare lands transitioning and remaining in cultivation over the 1982-97 period so as to obtain the maximum number of observations of lands transitioning at some point over that period. Comparing lands changing over shorter 5-year periods would capture some lands that shifted out of cultivation and then returned to crop production from 1982 to 1997, but would reduce the overall observations of transitioning lands. Because our group of lands that remained in the same use from 1982 to 1997 includes some lands that transitioned but then reverted back to the starting use, the actual differences in the a characteristics of transitioning and no-transitioning lands are likely to be somewhat greater than our estimates imply.

[5]As land use changes, particularly between cultivated cropland and other less intensive uses, erosion rates change dramatically. Thus, erosion rate change due to land-use change does little to indicate the erodibility of extensive margin land relative to other cultivated cropland. Moreover, soil erosion generally declined between 1982 and 1997 (see table 4 in Claassen et al., 2004), further reducing the usefulness of "before" and "after" comparisons.

Figure 4.3

Erodibility index relative to local averages, by land use and land-use change category

Percent difference from CRD average



Note: Data for each NRI point are compared with the average for each Crop Reporting District (CRD). A CRD is a multi-county area defined for data gathering purposes by USDA's National Agricultural Statistics Service.

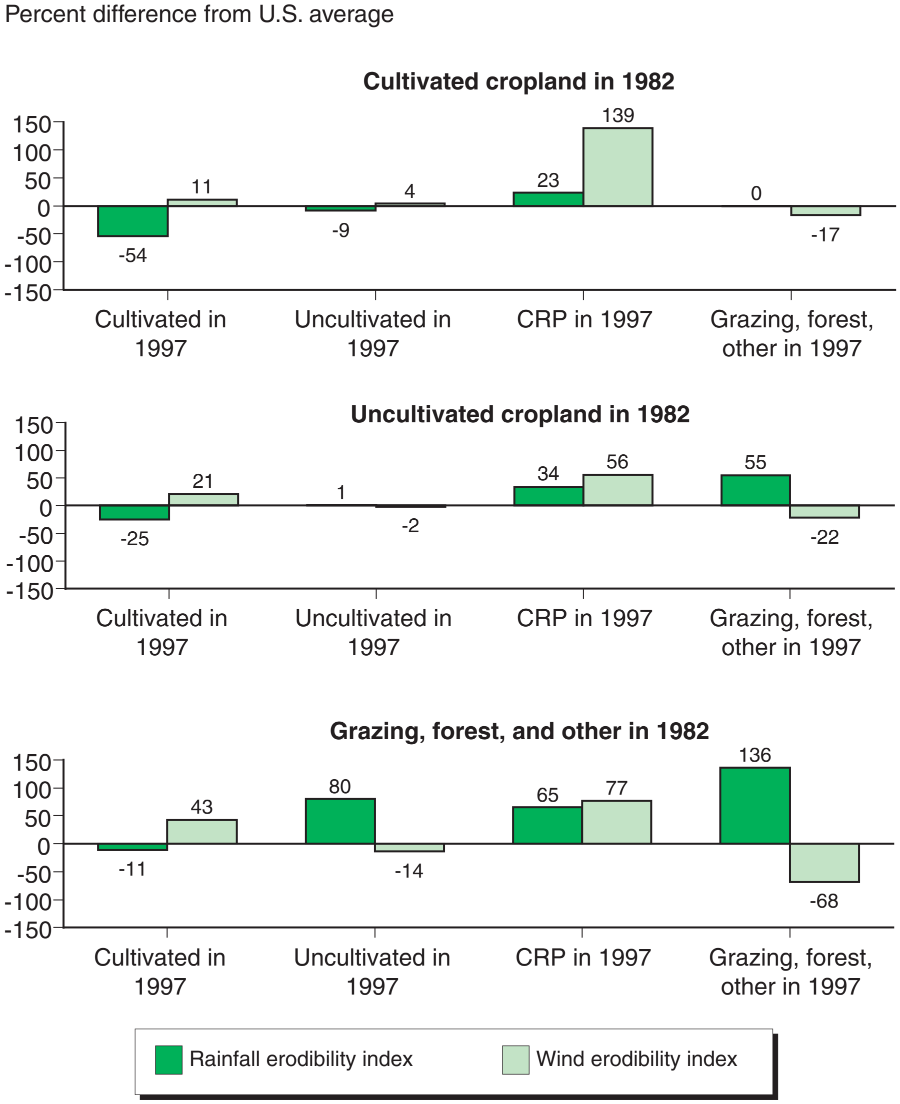
Source: ERS analysis of 1997 National Resources Inventory data.

both 1982 and 1997 (fig. 4.3). At the national level, results for wind erodibility are mixed. The wind erodibility index on land that was cropped in 1982 and 1997 (EI 11 percent above national average) is lower than on land that moved from cultivation to CRP (EI 139 percent above national average). On the other hand, land that moved from cultivated crops to uncultivated crops (EI 4 percent above national average) and to grazing, forest, and other uses (EI 17 percent **below** national average) had a lower erodibility rating (fig. 4.4).

Estimated wind erosion rates also yield mixed results regarding the environmental sensitivity of land at the extensive margin of cultivated crop production. The average 1982 wind erosion rates on land converted from cultivated

Figure 4.4

Erodibility index relative to national averages, by land use and land-use change category, 1982 and 1997



Note: Point-level data are compared with the average for all private land in agricultural, forest, or other rural uses in both 1982 and 1997. In 1982, the area of cultivated cropland, uncultivated cropland, and grazing, forest, and other uses comprised 26 percent, 3 percent, and 70 percent of private agricultural and forest land in the contiguous 48 States. In 1997, the area of cultivated cropland, uncultivated cropland; CRP, and grazing, forest, and other uses comprised, respectively, 23, 4, 2, and 71 percent of private agricultural and forest land in the contiguous 48 States (table 2.1).

Source: ERS analysis of National Resources Inventory data.

crops to less intensive uses, except CRP, appear to be lower than the average rate on land that was cultivated in 1982 and 1997 (table 4.3). The average 1997 erosion rate for uncultivated cropland that moved to cultivation was 2.03 TAY, versus 2.51 TAY for land cultivated in both 1982 and 1997.

Nutrient Loss. Comparisons of the potential nutrient losses to water between land remaining cultivated and land moving out of or into cultivated crops can also be made by focusing on years in which lands were cultivated. In general,

Table 4.2

Rainfall erosion, by land use and land-use change category (tons/acre/year), 1982 and 1997

1982 land use	1997 land use: Cultivated cropland	1997 land use: Uncultivated cropland	1997 land use: Converation Reserve Program	1997 land use: Grazing, forests, and other rural land
Cultivated cropland	4.04[1] / 3.06[2]	5.08 / 0.77	5.97 / 0.36	6.18 / 0.34[3]
Uncultivated cropland	0.75 / 2.99	0.60 / 0.52	1.37 / 0.50	0.86 / 0.40[3]
Grazing, forests, and other rural land	0.33[3] / 4.34	0.66[3] / 0.81	0.62[3] / 0.46	0.13[3] / 0.10[3]

[1]1982 erosion rates are in the upper left corner of each cell. Erosion rates for rainfall (sheet and rill erosion) are computed using the Universal Soil Loss Equation (USLE).

[2] 1997 erosion rates are in the lower right corner of each cell.

[3] Erosion rate is for pasture only. NRI does not report erosion rates for rangeland, forest, and other rural land.

Source: ERS analysis of National Resources Inventory (NRI) data.

Table 4.3

Wind erosion, by land use and land-use change category (tons/acre/year), 1982 and 1997

1982 land use	1997 land use: Cultivated cropland	1997 land use: Uncultivated cropland	1997 land use: Converation Reserve Program	1997 land use: Grazing, forests, and other rural land
Cultivated cropland	3.45[1] / 2.51[2]	2.21 / 0.25	7.57 / 0.33	2.33 / 0.07[3]
Uncultivated cropland	0.48 / 2.03	0.33 / 0.16	0.68 / 0.03	0.21 / 0.10[3]
Grazing, forests, and other rural land	0.08[3] / 2.85	0.09[3] / 0.15	0.15[3] / 0.14	0.01[3] / 0.01[3]

[1]1982 erosion rates are in the upper left corner of each cell. Erosion rates for wind are computed using the Wind Erosion Equation (WEQ).

[2] 1997 erosion rates are in the lower right corner of each cell.

[3] Erosion rate is for pasture only. NRI does not report erosion rates for rangeland, forest, and other rural land.

Source: ERS analysis of National Resources Inventory (NRI) data.

land moving between cultivated crops and a less intensive use had higher potential for nutrient loss (when cultivated) than land that persisted in cultivation in both 1982 and 1997.

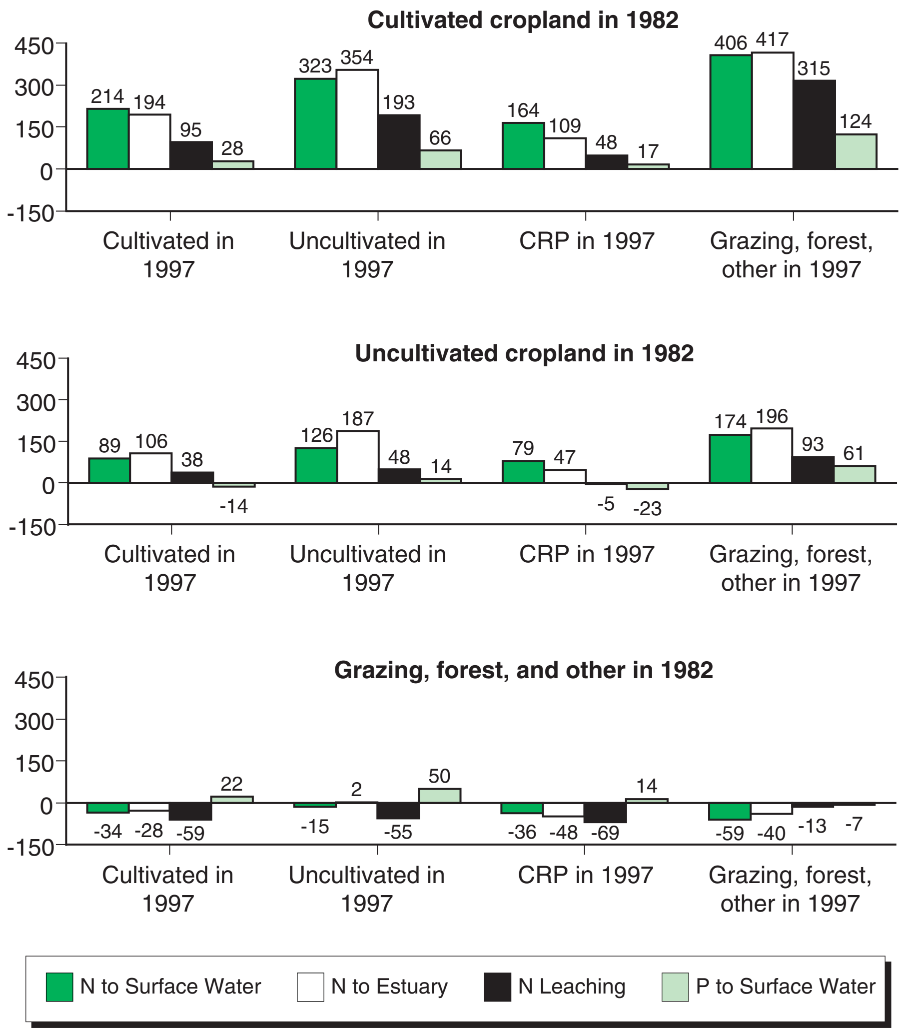
Differences are largest for land that moved from cultivation in 1982 to uncultivated crop production or grazing, forest, and other use in 1997 (fig. 4.5).[6] For example, nitrogen runoff to surface water is 214 percent above the national average for land cultivated in 1982 and 1997, but 323 percent above average for land moving to uncultivated crops and 406 percent above average for land moving to grazing, forest, and other uses. Cultivated lands have potential nutrient losses far above the national average because uncultivated lands (the majority of the land base) receive minimal nutrient applications. CRP land appears to be less susceptible to nutrient loss than other lands moving out of cultivation, possibly because the program tends to attract lands with low soil productivity, where nutrient application rates may be lower. Moreover, CRP

[6]Because of data limitations, comparisons are made only to national averages.

Figure 4.5

Potential (1982) nutrient runoff levels, by land use and land-use change categories

Percent difference from U.S. average



Notes: Point-level data are compared with the average for all private land in agricultural, forest, or other rural uses in both 1982 and 1997. Because grazing, forest, and other uses is the largest land-use category, lands in cultivated and uncultivated cropland in 1982 are generally significantly above average in terms of potential nutrient runoff levels. In 1982, the area of cultivated cropland; uncultivated cropland; and grazing, forest, and other uses comprised 26, 3, and 70 percent of the private agricultural, forest, and other rural land in the contiguous 48 States (table 2.1).

Source: ERS analysis of National Resources Inventory data and nitrogen (N) and phosphorus (P) indicators based on the Environmental Policy Integrated Climate model.

land is drawn heavily from arid regions where factors driving nutrient loss—rainfall runoff and rainfall-based soil erosion—are less intense.

Land shifting to cultivated crops from another use also appears to be more susceptible to nutrient loss than land cultivated in 1982 and 1997 (fig. 4.6). For example, estimated potential nitrogen runoff on land converted from uncultivated crops was 288 percent above the national average, versus 239 percent for lands in cultivation in both 1982 and 1997.

Lands Moving In and Out of Cultivation Generally Associated With More Imperiled Species

Erosion and nutrient runoff are indirect indications of how changes in cultivated cropland affect environmental quality and ecosystem health. Also potentially affected is the number of wildlife species at risk of extinction. Previous studies, mainly in the ecology literature, have studied the relationship between land use and wildlife indicators by focusing on a species group, such as birds (O'Connor et al., 1999), or particular habitat types (Hof et al., 1999). Dobson et al., (1997) find a positive relationship between the level of agricultural activity and the density of endangered plants, mammals, birds, and reptiles at the State level. However, their results could reflect the geographic distribution of species and agriculture relative to climate and other factors, rather than the effect of agriculture on species endangerment.

We examine the location of cultivated cropland changes relative to imperiled species counts based on the conservation status assessments in NatureServe's Natural Heritage data set (see Appendix C). These data provide the most comprehensive indication of biodiversity hot spots in the United States (Ehrenfeld et al., 1997).[7] Our species indicator is the number of species in each watershed that are considered to be imperiled throughout their ranges. Hence, these data cannot be used to measure the effects of land-use change on the health of species populations. The presence of an imperiled species in a watershed could reflect the fact that local land-use changes and other conditions in that watershed (or neighboring watersheds) are threatening the survival of that species. On the other hand, the NatureServe measure may simply provide an indicator of the hospitality of a region to species that are imperiled at the national level: the higher the count, the more hospitable that region is to these species given that the species is present in that area. We focus on counts of imperiled vertebrate animal species, imperiled plant species, imperiled birds, and imperiled fish and mollusk species.

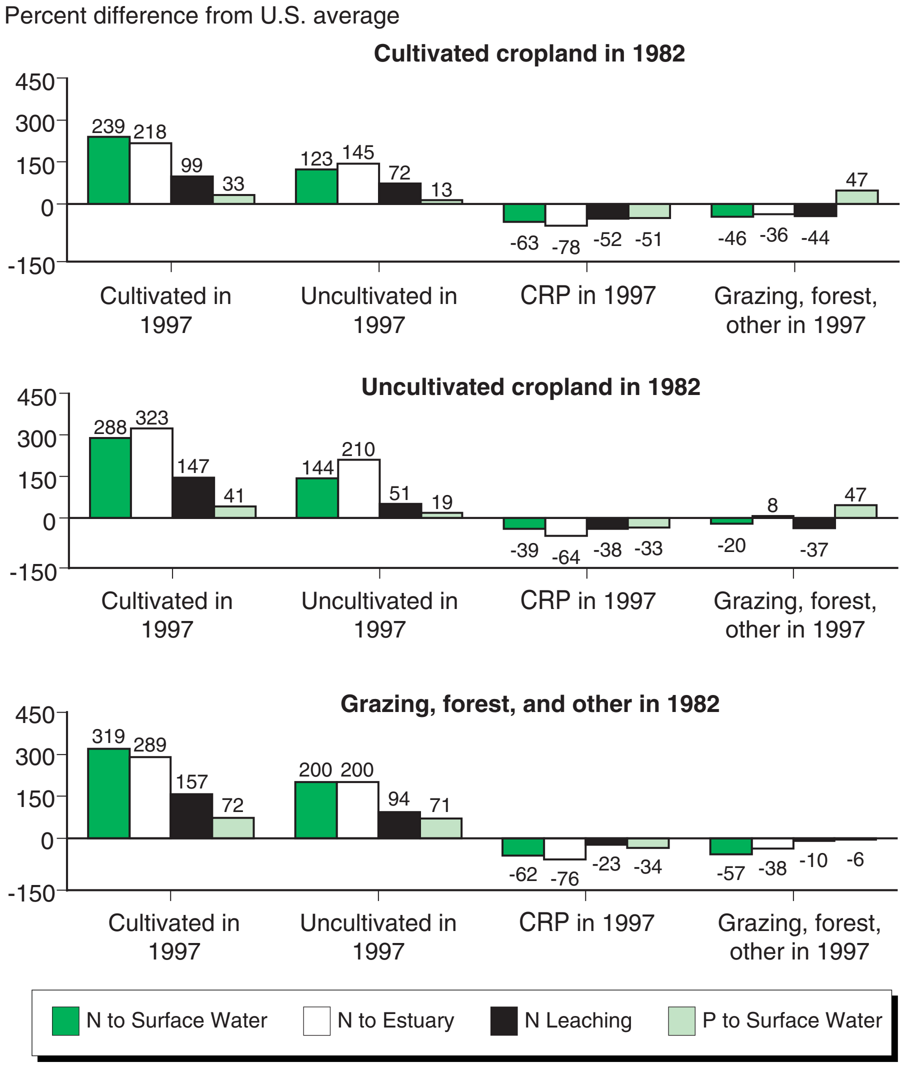
Conversion of native prairie to cropland and runoff of sediments and agricultural chemicals are reported to be the major threats to species in the Northern Great Plains and in the rivers and streams of the Southeast (WWF, 2005a; 2005b). The Prairie Pothole region of the Northern Great Plains is an important breeding ground for migratory waterfowl, including more than half of North America's duck population (Kantrud, 1993). The count of imperiled bird species is also one of the most sensitive indicators of biodiversity in a region (Dobson et al., 1997), while counts of imperiled fish/mollusks could indicate the effect of agricultural sediment and chemical runoff on aquatic ecosystems.

On a national scale, cultivated croplands that moved to uncultivated cropland are located in areas with more imperiled species (in all four groups) than lands that remained in cultivated crops or that transitioned to cultivation from uncultivated crops (fig. 4.7, top row). Cultivated croplands that transitioned to grazing, forest, and other rural uses are located in areas with high counts of imperiled vertebrate animals, plants, and fish/mollusks but lower counts of imperiled birds (37 percent below the national average). Lands that moved to

[7]These data may overcount the existence of imperiled species by counting occurrences based on information predating the Natural Heritage program that have since disappeared. On the other hand, the data may generally undercount the existence of very rare species given the difficulty in identifying their occurrences.

Figure 4.6

Potential (1997) nutrient runoff levels, by land use and land-use change categories



Notes: Point-level data are compared with the average for all private land in agricultural, forest, or other rural uses in both 1982 and 1997. Because grazing, forest, and other uses is the largest land-use category, lands in cultivated and uncultivated cropland in 1997 are generally significantly above average in terms of potential nutrient runoff levels. In 1997, the area of cultivated cropland, uncultivated cropland, CRP, and grazing, forest, and other uses comprised 23, 4, 2, and 71 percent of private agricultural, forest, and other rural land in the contiguous 48 States (table 2.1).

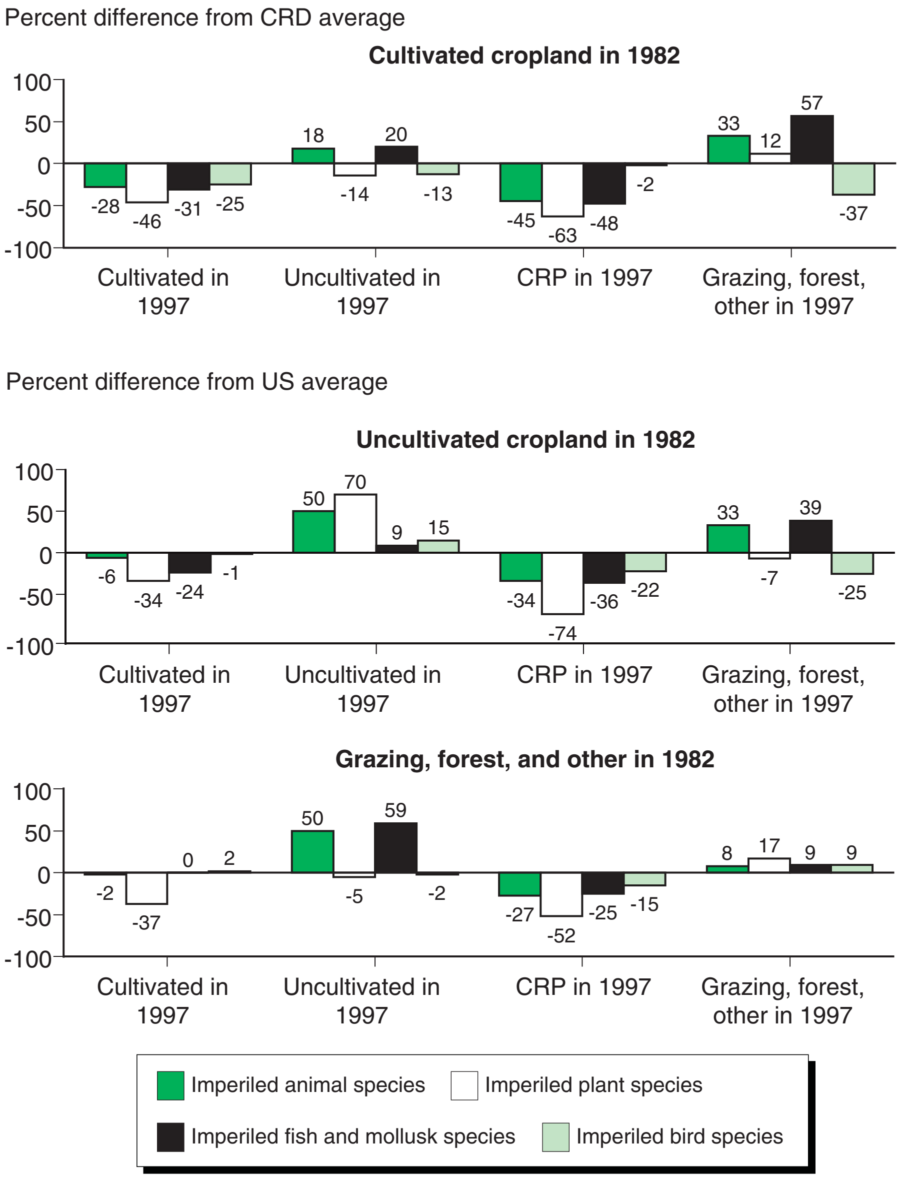
Source: ERS analysis of National Resources Inventory data and nitrogen (N) and phosphorus (P) indicators based on the Environmental Policy Integrated Climate model.

cultivated crops had higher counts in all imperiled species groups than lands that remained in cultivation (fig. 4.7, left-hand column).

The generally negative association between imperiled species counts and cropland transitioning to and from cultivation has various possible interpretations. If the indicator reflects the effect of land use on species imperilment, the observed patterns could suggest that crop cultivation is more favorable for species health, compared with transitions to pasture and forest,

Figure 4.7

Counts of imperiled species, by land use and land-use change categories



Notes: Imperiled species include those classified by NatureServe as either “critically imperiled” or “imperiled” at the national level, receiving a Global Conservation Status rank of 1 or 2, respectively.

Point-level data are compared to the average for all private land in agricultural, forest, or other rural uses in both 1982 and 1997. In 1982, the area of cultivated cropland, uncultivated cropland, and grazing, forest, and other uses comprised 26, 3, and 70 percent of private agricultural and forest land in the contiguous 48 States. In 1997, the area of cultivated cropland, uncultivated cropland, CRP, and grazing, forest, and other uses comprised 23, 4, 2, and 71 percent of private agricultural, forest, and other rural land in the contiguous 48 States (table 2.1).

Source: ERS analysis of National Resources Inventory and NatureServe Natural Heritage data.

grazing, and other uses. Conversely, because the presence of an imperiled species may indicate the hospitality of a local region to a species that is nationally imperiled, the results could also indicate that areas with cultivated cropland tend to be relatively inhospitable for species in general, compared with areas with uncultivated cropland and grazing, forest, and other uses. Although the imperiled species counts reveal associations, these data are insufficient to infer any causal relationships between land-use changes and particular species groups.

Lands converting to CRP (versus remaining in cultivation) tend to be in watersheds with higher counts of imperiled birds but lower counts of other imperiled species. If the species count reflects a region's hospitality for a species, cropland retirement through CRP may well benefit birds more than continued crop cultivation. Or particular bird species may simply take to the regions in which CRP lands are located. Either interpretation is consistent with the fact that habitat protection for imperiled species is an explicit CRP objective and incorporated into USDA's environmental criteria for enrolling land.

Overlaying the species indicators with 1982-97 NRI data on movements of land to and from cultivated cropland reveals many areas with high (low) amounts of extensive margin changes and low (high) counts of imperiled vertebrate animal and plant species (figs. 4.8a and 4.8b). While there is a concentration of cultivated cropland change and imperiled species in the Central Valley of California, no systematic broad-scale relationship is evident between animal/plant species imperilment and the extensive margin of cultivated crop production.[8]

If imperiled species are affected by land-use change, then it may be useful to relate local imperiled species counts to local land-use change. Watersheds with high counts of imperiled birds coincide with areas experiencing changes in the extensive margin of cropland in the Northern Great Plains and Prairie Gateway (fig. 4.9a). These are also areas with the highest concentrations of CRP enrollment. The Appalachian region has high counts of imperiled fish and mollusks (fig. 4.9b) but did not experience particularly high levels of cultivated cropland change. Areas where high levels of cultivated cropland changes overlap with imperiled fish/mollusks are the Central Valley of California, areas along major rivers, and some parts of the Southern Seaboard. To the extent that agricultural runoff poses threats to wildlife, policies that affect land-use changes in these areas might merit special examination. However, other regions with high (low) counts of imperiled fish and mollusk species have low (high) changes in cultivated cropland. Thus, no consistent relationship is apparent between changes in cultivated cropland and imperiled fish/mollusk counts.

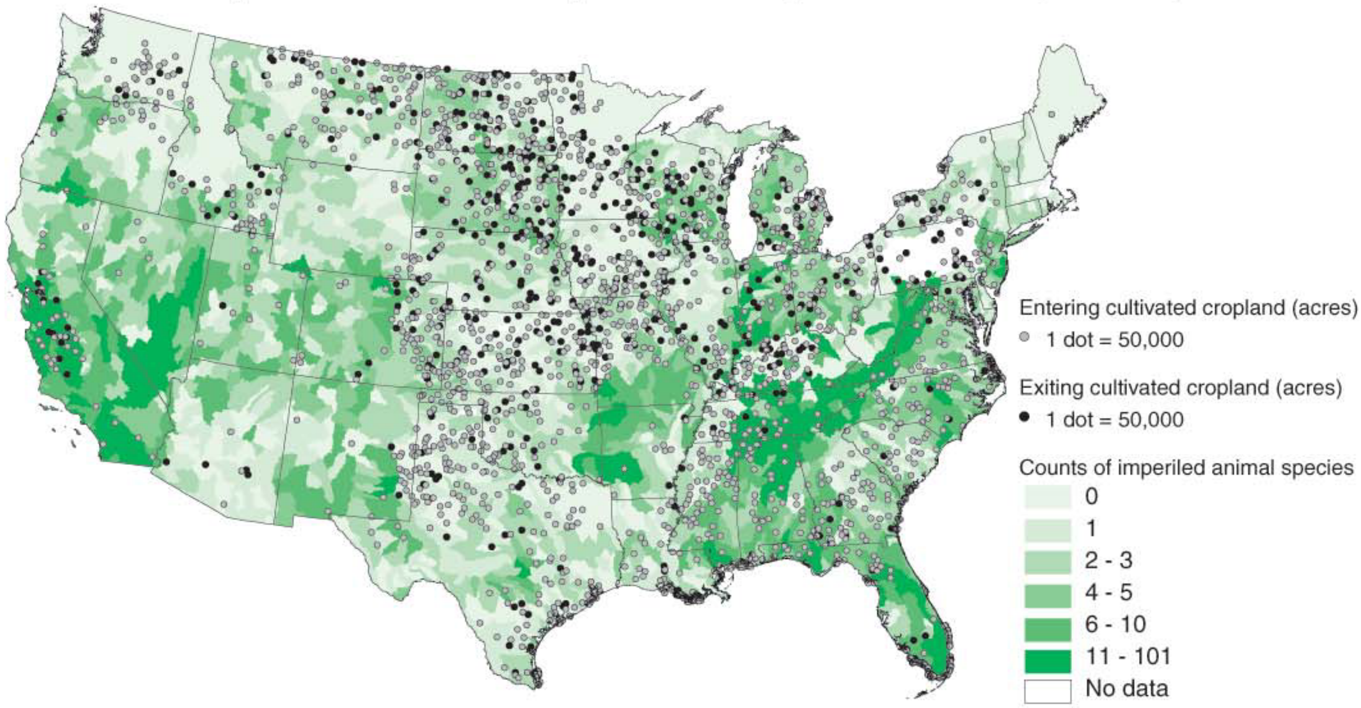
Conclusion

Environmental outcomes depend on land use and land management as well as on the physical characteristics of the land itself and location (e.g., proximity to water). We find that lands transitioning between cultivated cropland and less intensive uses are more prone to rainfall and wind erosion damage than other cropland, both at the national and local level. Except for lands entering CRP, lands at the extensive margin of cultivated cropland are also

[8]Regression analyses did not reveal statistically significant relationships between occurrences of imperiled species and measures of land use and land-use change at the watershed level. The lack of a relationship may be due to the crudeness of the NatureServe data, which obscures variations in the imperilment of particular species across the country. More systematic relationships between cropland changes and the occurrence of imperiled species could emerge through regional analyses, as the factors affecting species may well be different in different regions. For example, while conversion of grasslands might be an important threat to birds in the Midwest, conversion of croplands to urban development could be the principal threat to wildlife in California and Florida.

Figure 4.8a

Counts of total imperiled vertebrate animal species and changes in cultivated cropland area, 1982-97

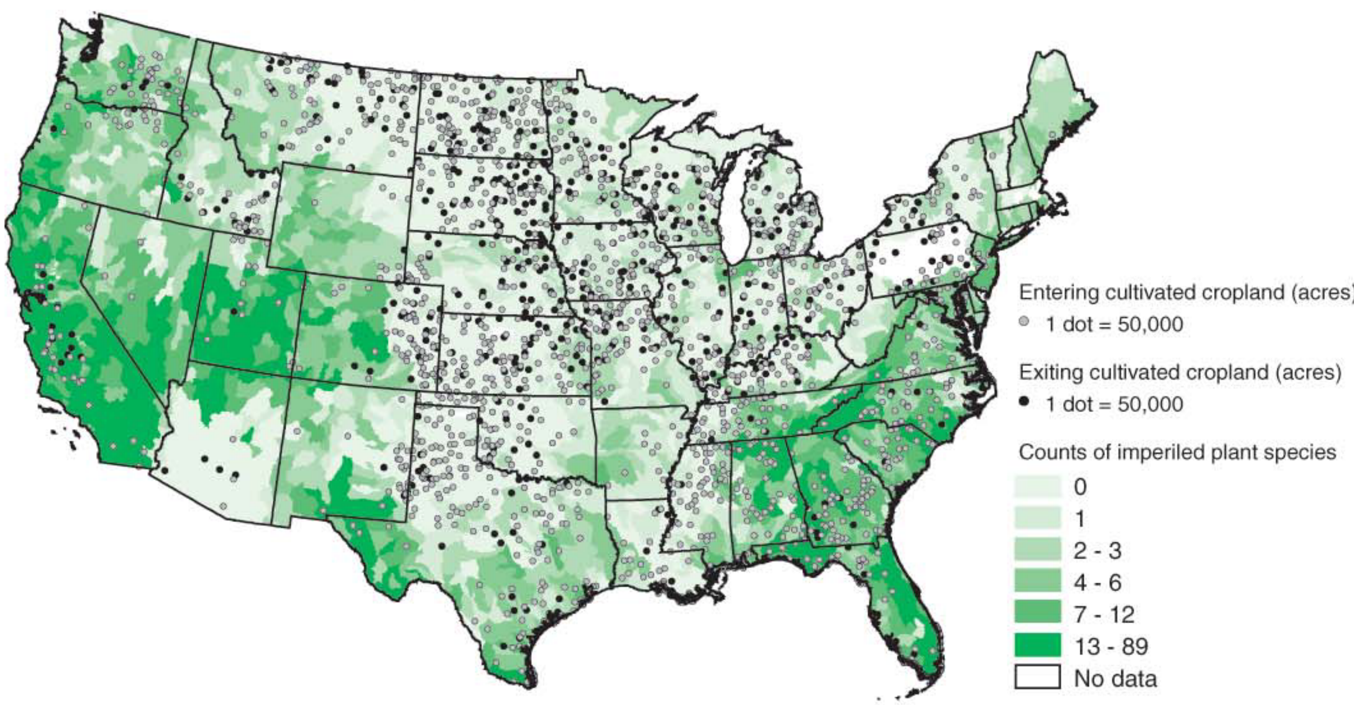


Note: Imperiled species include those classified by NatureServe as either "critically imperiled" or "imperiled" at the national level, receiving a Global Conservation Status (G) rank of 1 or 2, respectively. Size of dots is not proportional to actual land area. Location of dots is assigned randomly within watersheds and may vary slightly across maps.

Source: ERS analysis of National Resources Inventory (NRI) and NatureServe Natural Heritage data.

Figure 4.8b

Counts of total imperiled plant species and changes in cultivated cropland area, 1982-97

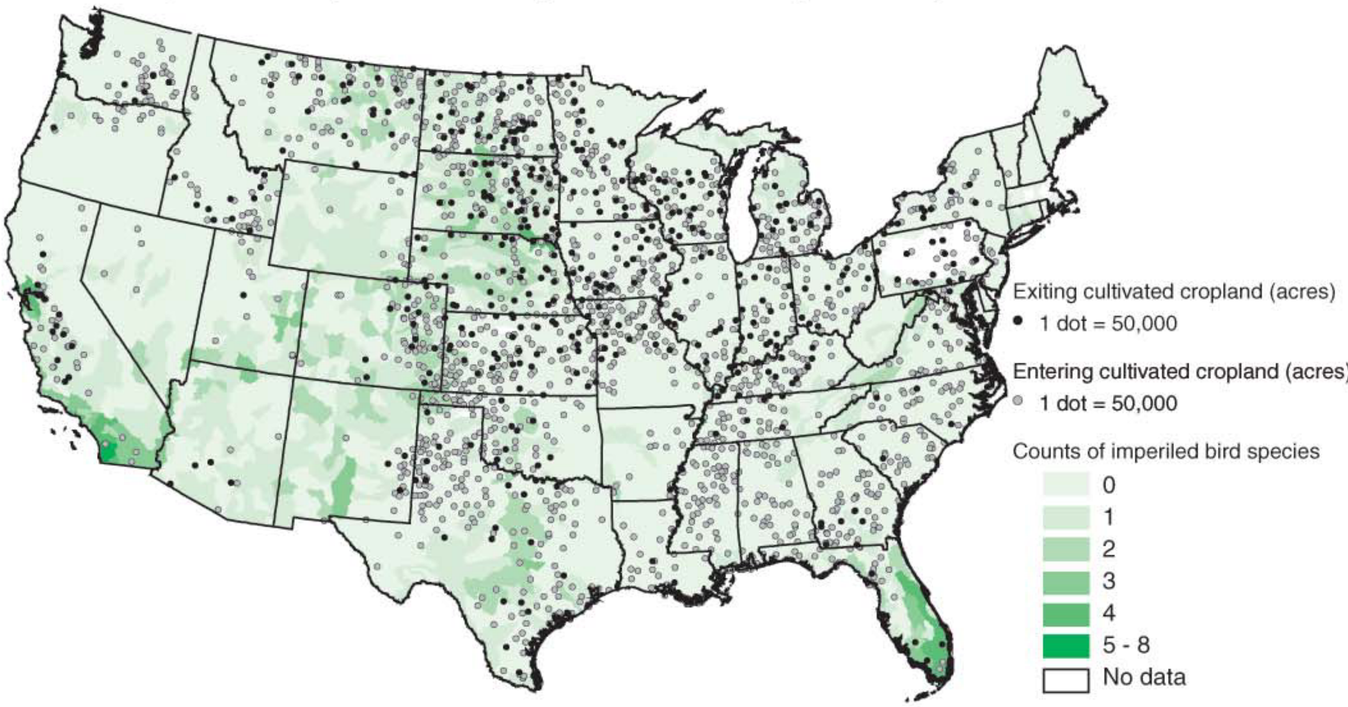


Note: Imperiled species include those classified by NatureServe as either "critically imperiled" or "imperiled" at the national level, receiving a Global Conservation Status (G) rank of 1 or 2, respectively. Size of dots is not proportional to actual land area. Location of dots is assigned randomly within watersheds and may vary slightly across maps.

Source: ERS analysis of National Resources Inventory (NRI) and NatureServe Natural Heritage data.

Figure 4.9a

Counts of imperiled bird species and changes in cultivated cropland area, 1982-97

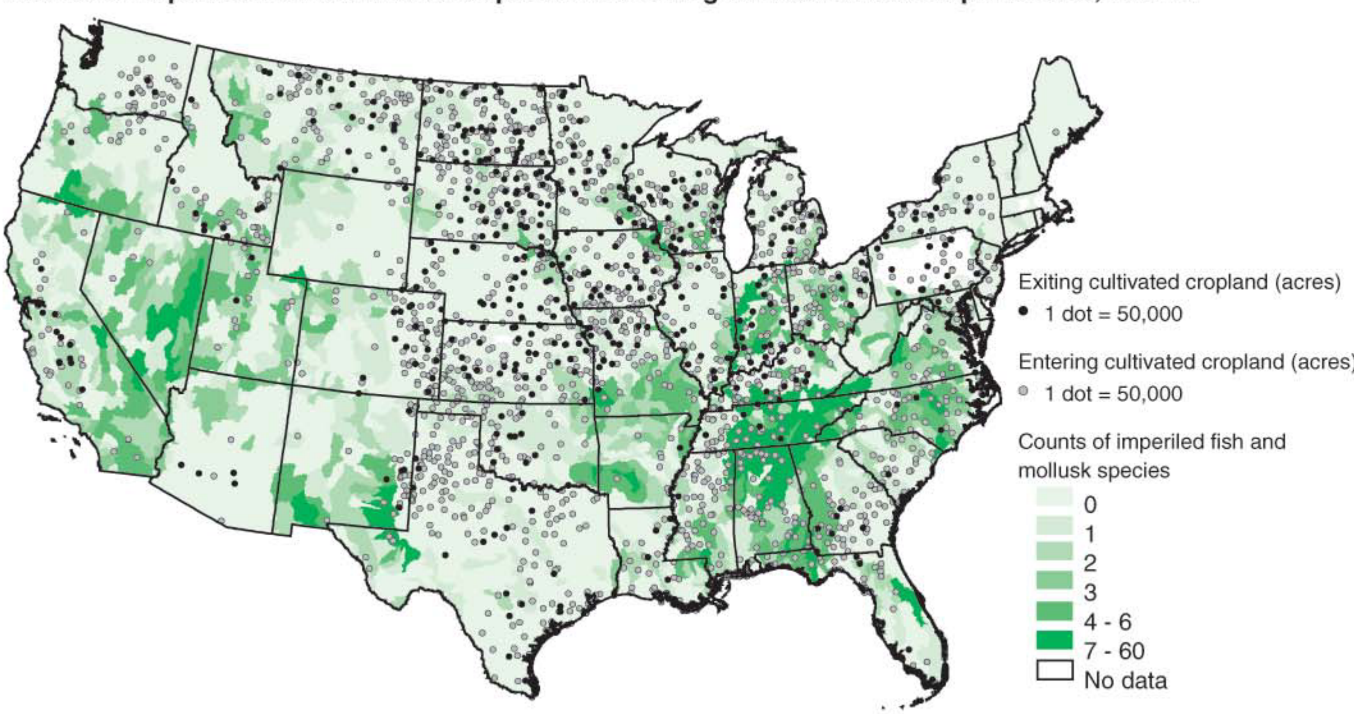


Note: Imperiled species include those classified by NatureServe as either "critically imperiled" or "imperiled" at the national level, receiving a Global Conservation Status (G) rank of 1 or 2, respectively. Size of dots is not proportional to actual land area. Location of dots is assigned randomly within watersheds and may vary slightly across maps.

Source: ERS analysis of National Resources Inventory (NRI) and NatureServe Natural Heritage data.

Figure 4.9b

Counts of imperiled fish and mollusk species and changes in cultivated cropland area, 1982-97



Note: Imperiled species include those classified by NatureServe as either "critically imperiled" or "imperiled" at the national level, receiving a Global Conservation Status (G) rank of 1 or 2, respectively. Size of dots is not proportional to actual land area. Location of dots is assigned randomly within watersheds and may vary slightly across maps.

Source: ERS analysis of National Resources Inventory (NRI) and NatureServe Natural Heritage data.

associated with higher levels of potential nutrient loss than are cultivated croplands that did not change use.

To the extent that particular land-use changes affect particular types of species, a comparison of the location of extensive margin lands and of areas with high counts of imperiled species could help target conservation policies or shape government policies that affect land use. Except for CRP enrollments, land in cultivated crops moving to and from less intensive uses is in areas with higher overall counts of imperiled animal and plant species. Nevertheless, due to the nature of the imperiled species indicator, we cannot infer any causal relationships between land-use changes and the imperilment of species.

The data on cropland transitions from 1982 to 1997 suggest that croplands with lower soil productivity, which are more likely to be at the extensive margin, may be more environmentally sensitive in terms of erosion and potential nutrient loss. Based on soil productivity, lands with lower crop growth potential are more susceptible to damage from erosion than are more productive lands. While greater erodibility contributes to nutrient loss potential, we lack sufficient data on nutrient applications by lands of different quality to reach definitive conclusions on the relationship between soil productivity and nutrient loss.

Lands enrolled in the CRP tend to be different than other lands at the extensive margin of cultivated cropland. CRP lands are located in areas with more erodible land and higher concentrations of imperiled birds (but lower counts of other imperiled species) than other cropland. Again, it is difficult to make direct comparisons of CRP lands to other lands in the same region in terms of nutrient loss or species. Broadly speaking, CRP-heavy areas do not appear to be areas where land characteristics and cropping practices combine to produce above-average nutrient losses.