Color plate 1

Color Figure 1. This wetland in Doolittle Prairie, Story County, Iowa, exemplifies how remnant biodiversity complements water quality in the Corn Belt. Photo credit: J.A. Dowdell
Color Figure 2. Economist Steve Polasky and avian ecologist Kathryn Freemark Lindsay, contributors to Part 2 of this book, work together in Iowa’s Buck Creek watershed to imagine how the future landscape could remain productive and profitable for agriculture and improve water quality and enhance native biodiversity at the same time. Photo credit: D. Hellekson

Color Figure 3. This riparian buffer along Bear Creek in Boone County, Iowa, shows how new land covers that protect water quality can also enhance biodiversity. It is part of an Iowa State University research experiment. Photo credit: J.A. Dowdell
Color Figure 4.  An aerial view of baseline conditions in north central Buck Creek watershed, at the future site of the bioreserve proposed in Scenario 3. Under baseline conditions, farmers noticed that the existing pasture and stream banks were suffering from erosion and needed to be improved. They gave this landscape an average rating of 2.10/5.00.  Photo credit: R.C. Corry.

Color Figure 5.  Scenario 3 in Buck Creek watershed in 2025. This formerly eroding pasture dissected by the upper reaches of Buck Creek was designated a permanent bioreserve with a wide wooded riparian buffer under Scenario 3, which emphasizes enhanced biodiversity. The bioreserve is buffered by best management practices that are designed to enhance biodiversity, including strip intercropping with perennial prairie strips, which could be harvested for native plant seed, as assumed in Chapter 7 or for biofuels. In addition, the upstream bioreserve detains and infiltrates storm water, relieving downstream flooding. The landscape is highly varied in land cover; wildlife is abundant; and recreational opportunities are available on the trails and bioreserves, as described in Chapter 4. There are fewer farmers than in Scenario 2, but many of the farmsteads are inhabited by nonfarmers. The public finds this landscape particularly appealing for recreation and rural living opportunities and is willing to pay for public benefits from environmentally beneficial practices. Farmers gave this landscape a rating of 3.28/5.00.  Simulation credit: R.C. Corry
**Color Figure 6.** The baseline landscape in Walnut Creek watershed, Story County, Iowa, where highly productive soils and efficient tile drainage have allowed more than 80 percent of the watershed to be used for corn and soybean row crop agriculture. Less than 1 percent of the land was enrolled in the CRP in 1994 (the baseline year). This landscape reflects trends since 1970—larger fields and larger, fewer farms. Conventional production technology is used, and livestock operations are moving toward concentrated animal feeding operations (CAFOs), primarily in a few areas of the state. Iowa farmers gave this an average rating of 3.22 / 5.00 to indicate their preferences for the future of the people of Iowa. Photo credit: R.C. Corry

**Color Figure 7.** Scenario 1 in Walnut Creek watershed in 2025 emphasizes increased commodity production and converts more land to corn and soybean fields in bigger fields. Precision agriculture and conservation tillage are pervasive. Livestock are concentrated in CAFOs in a few areas of the state, but not in this watershed. Even fewer farms and less woodland remain. Rural population losses continue at previous rates, with small towns and community institutions at risk. Average rating by Iowa farmers: 2.66/5.00. Simulation credit: M. Sundt.
**Color Figure 8.** Scenario 2 in Walnut Creek watershed in 2025 emphasizes improved water quality and incentivizes adoption of perennial cover crops for rotational grazing, which is fenced from nearby streams. A wider stream buffer includes off-channel floodplain wetlands. Precision farming and tile drainage supplement the rotational grazing technology, but tile drainage is detained before entering streams. More farms and more woodland remain. Rural population stabilizes with some nonfarm residents and more farmers remaining. Community institutions are stable. Iowa farmers gave this image an average rating of 3.56/5.00.

Simulation credit: M. Sundt.

**Color Figure 9.** Scenario 3 in Walnut Creek watershed in 2025 emphasizes enhanced biodiversity by setting aside some land in a permanent riparian woodland bioreserve and by adopting new enterprises and practices that incorporate perennial strips within row crop agriculture. It also includes organic production targeted to a biodiversity zone that connects and buffers bioreserves and stream corridors. Livestock are concentrated in CAFOs in a few areas of the state, but not in this watershed. There are fewer farms, but a larger rural population because more nonfarm families want to live in this high-amenity landscape. Small towns and community institutions are thriving. This was rated highest of all the images shown to Iowa farmers, with a mean score of 3.78/5.00.

Simulation credit: M. Sundt.
Color Figure 10. An aerial view of the Buck Creek watershed baseline landscape. This rolling, more erodible watershed had more land in woodland, pasture or hay, and more land enrolled in the Conservation Reserve Program (CRP) in 1994—about 16 percent. Conventional production technology is used. Livestock operations are moving toward CAFOs, primarily in areas of the state outside Buck Creek watershed, where grazing continues on the rolling terrain. Noting its susceptibility to erosion, Iowa farmers gave this baseline landscape an average rating of 2.53/5.00. Photo credit: R.C. Corry

Color Figure 11. Scenario 1 in Buck Creek watershed in 2025 emphasizes increased commodity production and converts more highly productive land from perennial cover, including the CRP, to corn and soybean fields. Even fewer farms and much less woodland remain. Precision agriculture and conservation tillage are used pervasively, but farmers voiced their concerns about erosion and water quality, especially in comparison with the flat landscape of the Walnut Creek watershed. Livestock are concentrated in CAFOs in a few areas of the state, but there are none in this watershed. Rural population losses continue at previous rates, and small towns and community institutions are disappearing. In this scenario, the public sees the landscape as boring, but perceives this form of agriculture as safe. The scenario assumes that the public is not particularly concerned about environmental effects, and continues to be willing to pay commodity subsidies. Iowa farmers gave this landscape their lowest average rating: 1.47/5.00. Simulation credit: R.C. Corry.
Color Figure 12. Scenario 2 in Buck Creek watershed in 2025 emphasizes improved water quality and incentivizes more widespread adoption of perennial cover crops for rotational grazing, which is fenced from nearby streams. Woodlands are maintained for grazing and livestock shade as well. Steeper working lands near streams are in pasture or hay and a wider stream buffer includes off-channel floodplain wetlands. Grazing livestock enterprises lead to the need for more farms and farm buildings than in Scenarios 1 and 3. The public finds the variety of land cover and grazing livestock appealing, and the landscape is attractive for recreation and tourism. The public sees environmental benefits from the mixed grain and livestock enterprises and is willing to pay for subsidies. Simulation credit: R.C. Cory.
Color Figure 13. Scenario 1 in west central Walnut Creek watershed, where the tile-drained, highly productive soils are well suited to corn and soybean production. Because the number of farms decreases by 50 percent in Scenario 1 compared with the baseline, there is no visible farmstead in this landscape. This simulation was not included in the Iowa farmer interviews (Chapter 6).

Simulation credit: R.C. Corry

Color Figure 14. Scenario 2 in west central Walnut Creek watershed leads to adoption of some mixed-grain livestock farming with rotational grazing. Farmers are assumed to employ perennial cover as pasture or hay near streams to meet water quality standards. Compared with Scenarios 1 and 3, more farmers and farmsteads are needed to manage the rotational grazing enterprises, and a farmstead is seen in the distance in this simulation. This simulation was not included in the Iowa farmer interviews (Chapter 6).

Simulation credit: R.C. Corry
Color Figure 15. Scenario 3 bioreserve in west central Walnut Creek watershed, where wetland soils led to this bioreserve being designed to include several types of wetland habitats. Because this bioreserve is located on the watershed boundary (see Color Figure 43), it may enhance habitat connectivity and patch size if it is adjacent to a bioreserve in the adjacent watershed. This simulation was not included in the Iowa farmer interviews (Chapter 6). Simulation credit: R.C. Corry.
**Color Figure 16.** This cornfield (under Scenario 1 in Buck Creek watershed) on productive soils with more rolling terrain shows how the emphasis on commodity production in Scenario 1 extends cultivation to lands that might have been enrolled in the CRP or in pasture under baseline conditions. Noting the healthy appearance of the corn crop, farmers rated this landscape 3.06/5.00. Simulation credit: R.C. Corry.

**Color Figure 17.** Under the land allocation model for Scenario 2 in Buck Creek watershed, the same field is used for pasture in rotational grazing (described in Chapter 4). Pasture and hay as perennial cover contribute to improved water quality (Chapter 7), and the public is likely to find this landscape attractive. This simulation was not included in the Iowa farmer interviews (Chapter 6). Simulation credit: R.C. Corry.
Scenario 3 in Buck Creek watershed brings perennial strip intercropping with prairie strips to this field. This innovative practice was developed for Scenario 3 based on the Iowa State University field experiments in strip intercropping (described in Chapter 4). Although farmers were concerned that managing the strip pattern could be time-consuming, they consistently noted that the strip pattern with prairie grasses suggested good stewardship, and they gave this landscape high ratings—an average of 3.75/5.00.

Simulation credit: R.C. Corry
Color Figure 19. This field demonstrates strip intercropping of corn, soybeans, and oats as it has been implemented by Iowa farmers in experiments with Iowa State University. Seeing good stewardship here, farmers rated this landscape an average of 3.75/5.00, tying with the average rating for Color Figure 18, which also showed strip intercropping. Photo credit: R. Cruse

Color Figure 20. Prairie remnants were recognized as a native ecosystem and seen as attractive by most of the farmers interviewed. Farmers often spoke about the need to maintain some land for habitat or for biodiversity. They rated this landscape highly: 3.66/5.00.
Color Figure 21. Many farmsteads and a variety of land cover types currently characterizes the upper reaches of Buck Creek watershed, shown in this photograph. Appreciating the number of farmsteads and the diversity of land covers, farmers rated this landscape 3.62/5.00. Photo credit: R.C. Corry

Color Figure 22. This riparian corridor restoration along Bear Creek, Story County, Iowa, is part of a cooperative field experiment conducted by Iowa State University. Farmers recognized its water quality and habitat values, but some were unenthusiastic about managing land they perceived as floodplain. Its average rating was 3.47/5.00. Photo credit: T. Isenhart
Color Figure 23. This pasture in Buck Creek watershed was viewed critically by farmers, who noticed where it showed signs of erosion, overgrazing, or lack of care. Farmers rated this landscape 3.16/5.00. Photo credit: J.I. Nassauer

Color Figure 24. Rolling fields of row crops in Buck Creek watershed led farmers to comment on tillage and planting practices for conservation. Some farmers thought this land was being managed properly, but a few thought more appropriate conservation practices could have been used. On average, farmers rated this landscape 3.12/5.00. Photo credit: R.C. Corry
Color Figure 25. Many farmers viewed this small wetland surrounded by cultivated land critically for its poor weed management. Farmers rated this landscape 2.66/5.00. Photo credit: USDA NRCS

Color Figure 26. Farmers had mixed feelings about this CAFO, wondering whether there was enough land nearby to spread manure without causing pollution and mentioning their concerns about offensive odors. At the same time, they noted the financial pressures and rewards that might lead to adoption of CAFO technology. On average, however, the farmers rated this landscape as one of the least desirable for the future of the people of Iowa at 1.84/5.00. Photo credit: J.J. Nassauer
Color Figure 27. In this photograph, farmers noticed residential development surrounded by farmland. They also viewed the uneven color and texture in the row crops as indicating poor management or poor soils for production. Most farmers saw both as undesirable, and this landscape had the lowest average rating: 1.84/5.00. Photo credit: J.I. Nassauer
Color Figure 28. Geographic distribution of the CRP is shown in this map and discussed in Chapter 3.
Source: Maps created by the U.S. Department of Agriculture (USDA) Economic Research Service (ERS)

Color Figure 29. Watersheds eligible for the Conservation Security Program (CSP) in 2006 are shown in this map and discussed in Chapter 3.
Source: Maps created by the USDA ERS
**Color Figure 30.** This map shows the baseline (1994) land cover of Walnut Creek watershed, one of two Iowa study watersheds for the Corn Belt futures project (Chapter 4). Dark green indicates woodlands, which occur almost exclusively along Walnut Creek.

**Color Figure 31.** Past habitat of Walnut Creek watershed as inferred from soil characteristics

*Note: Dark blue indicates the pervasiveness of wetland ecosystems in the watershed before tile drainage for agriculture.*
Color Figure 32. Low relief of Walnut Creek watershed topography
Source: U.S. Geological Survey (USGS)

Color Figure 33. High productivity of Walnut Creek watershed soils (see Chapter 4)
Past habitat of Buck Creek watershed shows prairie uplands with pervasive woodlands along lower stream reaches and steeper slopes. Wetland habitats were relatively rare in Buck Creek watershed compared with Walnut Creek.

Color Figure 34. Baseline (1994) land cover of Buck Creek watershed; pervasive perennial cover as pasture or CRP on steeper slopes.

Color Figure 35. Past habitat of Buck Creek watershed shows prairie uplands with pervasive woodlands along lower stream reaches and steeper slopes. Wetland habitats were relatively rare in Buck Creek watershed compared with Walnut Creek.
**Color Figure 36.** High relief of Buck Creek watershed topography compared with Walnut Creek watershed.

**Color Figure 37.** Soil productivity of Buck Creek watershed is highest along stream bottoms and on the uplands. Erosive slopes appear as pink on this map.
Color Figure 38. Scenario 1 emphasizes increased commodity production in 2025. In Buck Creek watershed, some land cover previously in CRP or pasture is converted to row crops, and much land previously in woodland is converted to cultivation.

Color Figure 39. Scenario 1 emphasizes increased commodity production in 2025. In Walnut Creek watershed, land cover is similar to the baseline condition (Color Figure 30), but woodlands on highly productive soils have been converted to row crops. Precision agriculture also creates some less productive patches not in row crops.
Scenario 2 emphasizes improved water quality. In Buck Creek watershed, working lands in perennial cover extend over much of the watershed. Rotational grazing pasture and hay are dominant land covers. Woodlands have been maintained for grazing. A wider stream buffer with the stream fenced from livestock is also apparent, shown in dark green.

Scenario 2 emphasizes improved water quality. In Walnut Creek watershed, working lands in perennial cover are located along the stream, where some rotational grazing pasture and hay occur, and where woodlands remain for grazing. A wider stream buffer with the stream fenced from livestock is also apparent, shown in dark green. Perennial cover patches identified by precision agriculture dot large productive corn–soybean fields.
Color Figure 42. Scenario 3 emphasizes enhanced biodiversity in 2025. In Buck Creek watershed, a bioreserve that combines dry prairie and savannah ecosystems is visible in the north. The watershed is dominated by perennial strip intercropping practices (indicated by light green). A combination of riparian vegetation and upland woodlands occurs in a wide stream buffer (indicated by pink and dark green on the map).

Color Figure 43. Scenario 3 emphasizes enhanced biodiversity in 2025. In Walnut Creek watershed, two bioreserves are established—one that represents wetland ecosystems in the west, and another along the stream corridor that represents riparian ecosystems. Perennial strip intercropping practices (indicated by light green) and organic crops (light yellow) occur in a biodiversity target zone that links the stream corridor and wetland reserve in this watershed. Because of its productive soils, much of this watershed remains in a corn–soybean rotation under the land allocation model for Scenario 3 (Chapter 4).
Color Figure 44. Farmer ratings of three alternative scenarios and the baseline landscape in Buck Creek watershed are described in Chapter 6. Mean area-weighted ratings of all land covers are based on farmer ratings of images. (Bold type indicates scenario number or name; numbers in parentheses indicate area-weighted ratings).
Farmer ratings of three alternative scenarios and the baseline landscape in Walnut Creek watershed are described in Chapter 6. Mean area-weighted ratings of all land covers are based on farmer ratings of images. (Bold type indicates scenario number or name; numbers in parentheses indicate area-weighted ratings).
Color Figure 46. In the Walnut Creek watershed, breeding site occupancy for the tiger salamander in (a) the baseline and (b) Scenario 3. Red indicates sites that were unoccupied and blue indicates sites that were occupied during model years 50 to 100. In the baseline, ditches comprised the majority of habitat for this species, and most are unoccupied. In Scenario 3, most of the habitat occurred in wetlands within the prairie/wetland bioreserve and was occupied.
Color Figure 47. Species richness map of native vertebrates for the existing landscape of both watersheds.
Color Figure 48. Species richness change maps of native vertebrates for the alternative futures and the past compared to the baseline for Buck Creek watershed, described in Chapter 13.
Color Figure 49. Species richness change maps of native vertebrates for the alternative futures and the past compared to the baseline for Walnut Creek watershed, described in Chapter 13.
Color Figure 50. Nitrate yields from the sub-basins of the Mississippi River Basin are shown here and described in Chapter 15.

Notes: 1 = Upper Ohio, 2 = Lower Ohio, 3 = Upper Missouri, 4 = Lower Missouri, 5 = Upper Mississippi, 6 = Middle Mississippi, 7 = Arkansas, 8 = Lower Mississippi, 9 = Red and Ouachita Basins are identified by bold numbers. Source: Modified from Goolsby et al. (1999)

Color Figure 51. Total nitrogen yields from the sub-basins of the Mississippi River Basin are shown here and described in Chapter 15.

Notes: 1 = Upper Ohio, 2 = Lower Ohio, 3 = Upper Missouri, 4 = Lower Missouri, 5 = Upper Mississippi, 6 = Middle Mississippi, 7 = Arkansas, 8 = Lower Mississippi, 9 = Red and Ouachita Basins are identified by bold numbers. Source: Goolsby et al. (1999)
Spatial distribution of nitrate yields is highly varied among smaller watersheds, as described in Chapter 15. Among the highest yields are from the Skunk River watershed in Iowa, the location of the two Corn Belt futures study watersheds described in Part 2.

Note: Basins are identified by bold numbers. Source: Modified from Goolsby et al. (1999)