**Appendix A. Supplementary Material for Chennault et al., *PEWI: An Interactive Web-based Ecosystem Service Model Designed for a Broad Public Audience***

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# **Table S1. Watershed Area**

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Notation** | **Rule** | **Value** |
| Grid cell area |  | Area of individual grid cell, *j*, in subwatershed *i* |  |
| Subwatershedarea |  | Sum of *mi* grid cell areas, *Aij*, in subwatershed *i* |  |
| Watershed area |  | Sum of *n* \* *mi* grid cell areas, *Aij*, in the watershed |  |

# **Table S2. Weather Type and Percent Frequency Distribution of Annual Precipitation Values**

| **Precipitation (*pr*)**  **(cm yr-1)** | **Weather Type** | **Frequency** |
| --- | --- | --- |
| 62.4 | Dry | 5% |
| 71.6 | Dry | 15% |
| 77.2 | Normal | 15% |
| 81.7 | Normal | 15% |
| 87.2 | Normal | 15% |
| 92.6 | Wet | 15% |
| 114.6 | Wet | 5% |

# **Table S3. Topographic Relief Rangesa**

| **Topographic relief (tr)** |
| --- |
| 01% |
| 1 2% |
| 2 5% |
| 5 9% |
| 9 14% |
| 14 18% |

a (Miller et al., 2010)

# **Biodiversity Module Details**

The biodiversity model in PEWI presents a relative measure indicating how well a landscape pattern maintains habitat suitability at the watershed scale for native species (Fischer et al., 2006), based upon landscape configuration and composition (Fahrig et al., 2011). We developed the biodiversity model to reflect habitat suitability for a suite of native species, with emphasis on native bird species due to the relatively greater scientific understanding of this taxon compared to others.

The importance of biodiversity on the landscape scale is important to humans because, according to Robertson et al. (2014), it “affects the capacity of agriculture to deliver ecosystem services, especially those related to biocontrol and water quality” (p. 4). To provide one example of how biodiversity supports ecosystem services, research and experimentation conducted by Costamagna and Landis (2006) at the Kellogg Biological Station Long Term Ecological Research site shows the importance of ladybird beetles in controlling soybean aphids, which in turn reduces the risk of decreased crop production. Details for each component of the biodiversity calculation follow.

PEWI users receive between 0 and 10 biodiversity points annually, with 10 indicating a PEWI landscape that best maintains habitat quality. The biodiversity score breaks down into five calculations with associated rules to form a point system (Table S4). The landscape composition component calculates the percent area of natural vegetation land-use types and land-use types with high diversity and low input relative to conventionally row-cropped systems. Calculations of landscape composition and configuration include stream buffering and wetland percent area and strategic location. Together, the biodiversity score calculations account for the effects of land-use type, land management, and landscape pattern on native species habitat (Fischer et al., 2006).

PEWI also provides users with an index to evaluate all indicators on a relative basis. To assign an index score for biodiversity, PEWI converts biodiversity points to the index score on a straight-line basis with scores ranging between 0, the lowest score attainable in PEWI, and 100, highest score attainable in PEWI. For example, 5.5 biodiversity points in PEWI equals an index score of 55 out of 100.

The first biodiversity calculation in PEWI considers landscape composition of more natural (non-crop, less managed) vegetation. Fisher et al. 2006 presented 10 guiding principles for biodiversity in agricultural landscapes. They concluded that placing large areas into native vegetation “tends to support higher biodiversity than structurally simple or degraded vegetation” (p. 81). More recently, ecologists studying biodiversity in suburban and rural landscapes have developed and tested countryside biogeography frameworks that predict the ability of agricultural landscapes to support biodiversity, if managed appropriately for habitat and if species have access to proximate reserve areas of native vegetation such as forests (Mendenhall et al., 2014). We classified three land-use types offered in the PEWI model as structurally complex, more natural vegetation: conservation forest, prairie, and wetland. Users receive between 0 and 4 biodiversity points based on the amount of the watershed in natural vegetation (Table S4).

Fischer et al. (2006) noted that “a matrix that has a similar vegetation structure to patches of native vegetation (i.e. that has a low contrast) will supply numerous benefits to ecosystem functioning” (p. 81). Additionally, less natural perennial land uses may provide habitat for different species, particularly when, as Fahrig et al. (2011) described, “production areas have structural similarities to extant natural areas in the same landscape” (p. 107). Accordingly, in addition to natural vegetation, we allocated biodiversity points to agricultural land-uses that better support wildlife richness and abundance compared to conventionally row-cropped systems. To conceptualize our model, we adapted to PEWI a framework that categorizes suitability of agricultural bioenergy landscapes to support wildlife richness and abundance according to two gradients: levels of agricultural inputs and plant diversity (Schulte et al., 2013). Like Schulte et al., (2013), we categorized land use as supporting low or high diversity and as using low or high inputs. Additionally, we designed the PEWI biodiversity model to award points for each land use with high-diversity and/or low-input land uses relative to a conventional row-cropped system. The point system has a hierarchical structure that awards greater overall points to land-use types that incorporate relatively higher diversity and lower inputs.

The second biodiversity calculation considers the percent area in the three more natural land uses and three high-diversity land uses. We included the three land-use types in the first biodiversity calculation as natural vegetation, and three additional land-use types offered in the PEWI model as high-diversity: conventional forest; mixed fruit and vegetables; and rotational grazing. Users receive between 0 and 1.5 biodiversity points for this calculation (Table S4).

The third biodiversity calculation considers the percent area in the three more natural land uses; three high-diversity land uses; three low-diversity, high input land uses; and three low diversity, low-input land uses. Natural vegetation and high-diversity land uses are identical to land uses from the first and second biodiversity calculations. The addition of three low-diversity, high-input land uses and three low diversity, low-input land uses represent land-use types that are not as beneficial as any of the six land-use types in the second calculation. Nevertheless, these land-use types rank higher in the matrix than conventional row-cropped systems. The additional low-diversity, high-input land uses include: conservation corn, conservation soybean, and permanent pasture. We selected conservation corn and conservation soybean for inclusion in this category because we defined management practices for conservation row crops to include winter cover crops, no-till, and grassed waterways, and/or buffers. Low diversity, low-input land uses include: grass hay, herbaceous perennial bioenergy, and short-rotation woody bioenergy. Users receive between 0 and 1.5 biodiversity points for this calculation (Table S4).

The fourth biodiversity calculation in PEWI subdivides into two calculations: percent area in wetland and strategic placement of wetlands. Wetlands provide invertebrate and amphibian habitat, with prairie pothole wetlands being especially important for birds (Best et al., 1995; Hunter Jr., 2005). Users receive between 0 and 1.5 biodiversity points for wetlands (Table S4).

The fifth biodiversity calculation in PEWI is percent of buffered stream. Based on Fischer et al.'s (2006) principle that stream buffers protect sensitive aquatic ecosystems and that corridors connect patches of natural vegetation, users receive between 0 and 1.5 additional biodiversity points based upon the percent of stream-adjacent cells placed in one or more land uses that function as a stream buffer and corridor for native species (Table S4). Streams and riparian areas provide habitat for diverse and abundant wildlife, and land managers can use strips of vegetation in these zones to protect against agricultural runoff and conserve these sensitive ecosystems (Hunter Jr., 2005). To receive points for buffering, users must create stream buffers using the following land-use types: conservation corn, conservation forest, conservation soybean, conventional forest, grass hay, herbaceous perennial bioenergy, mixed fruit and vegetables, prairie, rotational grazing, short-rotation woody bioenergy, and wetland. We assume conservation corn and conservation soybean best management practices include stream buffering.

# **Table S4. Biodiversity Points**

| **Calculation** | **Land-use Type** | **Metric** | **Points** | **Thresholds** |
| --- | --- | --- | --- | --- |
| Natural vegetation | Conservation forest  Prairie Wetland | Percent of watershed area | 0.0 | Less than 10% area |
| 1.0 | At least 10%, less than 25% area |
| 2.0 | At least 25%, less than 50% area |
| 3.0 | At least 50%, less than 100% area |
| 4.0 | 100% area |
| Natural vegetation and other high diversity land uses | Conservation forest Conventional forest Mixed fruits and vegetables  Prairie Rotational grazing Wetland | Percent of watershed area | 0.0 | Less than 10% area |
| 0.5 | At least 10%, less than 50% area |
| 1.0 | At least 50%, less than 100% area |
| 1.5 | 100% area |
| Natural vegetation, and comparatively high-diversity and/or low-input land uses\* | Conservation corn† Conservation forest Conservation soybean† Conventional forest  Grass hay Mixed fruits and vegetables Prairie Rotational grazing, Short-rotation woody bioenergy  Switchgrass  Wetland | Percent of watershed area | 0.0 | Less than 10% area |
| 0.5 | At least 10%, less than 50% area |
| 1.0 | At least 50%, less than 100% area |
| 1.5 | 100% area |
| Wetland | Wetland | Percent of watershed area and strategic location | 0.0 | Less than 5% area and less than 50% of strategic wetland locations in wetland land-use type |
| 0.5 | At least 5% area and at least 50% of strategic wetland locations in wetland land-use type |
| 1.0 | At least 5% area and at least 75% of strategic wetland locations in wetland land-use type |
| 1.5 | At least 5% area and 100% of strategic wetland locations in wetland land-use type |
| Stream buffer | Conservation corn‡, Conservation forest Conservation soybean‡ Conventional forest Grass hay Mixed fruits and vegetables  Prairie  Rotational grazing Short-rotation woody bioenergy  Switchgrass Wetland | Percent of stream-adjacent cells | 0.0 | Less than 10% stream-adjacent cells |
| 0.5 | At least 10%, less than 50% stream-adjacent cells |
| 1.0 | At least 50%, less than 100% stream-adjacent cells |
| 1.5 | 100% stream-adjacent cells |
| \*In this calculation, PEWI awards up to 1.5 biodiversity points for land uses that include natural vegetation and other high-diversity land uses, as well as both low-diversity, high-input and low-diversity, low-input land uses that provide higher diversity support and require fewer inputs than conventionally row-cropped systems.  †We selected conservation corn and conservation soybean for inclusion in this category because we defined management practices for conservation row crops to include winter cover crops, no-till, and grassed waterways, and/or buffers.  ‡We assume conservation corn and conservation soybean best management practices include stream buffering. | | | | |

# **Wildlife Module Details**

The game wildlife model in PEWI, similar to the biodiversity model, presents a relative measure indicating how well a landscape pattern maintains habitat quality for game species based upon landscape configuration and composition (Fahrig et al., 2011). Game species include deer, ducks, turkey, pheasant, quail, and sport fish. Users receive between 0 and 10 game wildlife points annually, with 10 indicating a PEWI landscape that best maintains game habitat quality. Although the game wildlife index is similar to the biodiversity index, we adjusted it to reflect less sensitivity to need for natural habitats and greater need to reach a minimum threshold area for land-use types that support each game species. The game wildlife score breaks down into six calculations (Table S5). The first two calculations consider the percent area of more natural land-use types and land-use types with high diversity and low input relative to conventionally row-cropped systems. The remaining calculations consider the percent area in conservation forest, grassland, and wetland, as well as the percent of stream buffered. Together, the game wildlife score calculations account for the effects of land-use type, land management, and landscape pattern on native species habitat (Fischer et al., 2006).

PEWI also provides users with an index to evaluate all indicators on a relative basis. To create an index score for game wildlife, PEWI converts game wildlife points to the index score on a straight-line basis with scores ranging between 0, the lowest score attainable in PEWI, and 100, highest score attainable in PEWI. For example, 5.5 game wildlife points in PEWI equals an index score of 55 out of 100.

Similar to biodiversity calculations, we considered land-use type suitability for game wildlife habitat along two gradients: agricultural inputs and level of plant diversity (Schulte et al., 2013). The first game wildlife calculation considers the percent area in the three more natural land uses and three high-diversity land uses. We classified the three land-use types as natural vegetation: conservation forest, prairie, and wetland, and three additional land-use types offered in the PEWI model as high diversity: conventional forest; mixed fruit and vegetables; and rotational grazing. Users receive between 0 and 4.0 game wildlife points for this calculation (Table S5).

The second game wildlife calculation considers the percent area in the three more natural land uses; three high-diversity land uses; three low-diversity, high input land uses; and three low diversity, low-input land uses. Natural vegetation and high-diversity land uses are identical to land uses from the first game wildlife calculation. The addition of three low-diversity, high-input land uses and three low diversity, low-input land uses represent land-use types that are not as beneficial as any of the six land-use types in the first calculation. Nevertheless, these land-use types rank higher in the matrix than conventional row-cropped systems. The additional low-diversity, high-input land uses include: conservation corn, conservation soybean, and permanent pasture. We selected conservation corn and conservation soybean for inclusion in this category because we defined management practices for conservation row crops to include winter cover crops, no-till, and grassed waterways, and/or buffers. Low diversity, low-input land uses include: grass hay, herbaceous perennial bioenergy, and short-rotation woody bioenergy. Users receive between 0 and 1.5 game wildlife points for this calculation (Table S5).

The third game wildlife calculation in PEWI is percent area in conservation forest. Forests provide important habitat for game wildlife, including nesting birds (Best et al., 1995; Hunter Jr. and Schmiegelow, 2010). Incorporating at least some forest into an agricultural landscape supports game wildlife including northern bobwhite quail, wild turkey, and white-tailed deer (Brennan, 1999; McRoberts et al., 2014). Users receive between 0 and 1 game wildlife points; more specifically, a user receives 1.0 point when placing at least five percent of the watershed in conservation forest.

The fourth game wildlife calculation in PEWI is percent area in grassland. Incorporating at least some grassland into an agricultural landscape supports game wildlife including northern bobwhite quail and ring-necked pheasant (Brennan, 1999; Giudice and Ratti, 2001). Users receive between 0 and 1 game wildlife points; more specifically, a user receives 1.0 point when placing at least five percent of the watershed in a combination of herbaceous perennial bioenergy, prairie, and/or rotational grazing (Table S5).

The fifth game wildlife calculation in PEWI is percent area in wetland. Prairie pothole wetlands are important for birds, especially water nesting bird species Best et al. 1995; Hunter 2005. Incorporating at least some wetland into an agricultural landscape supports game wildlife such as mallards (Drilling et al., 2002). Margins of wetlands also provide good winter habitat for ring-necked pheasants (Giudice and Ratti, 2001). Users receive between 0 and 1 game wildlife points; more specifically, a user receives 1.0 point when placing at least five percent of the watershed in wetland (Table S5).

The sixth game wildlife calculation in PEWI is percent of buffered stream, and users receive between 0 and 1.5 game wildlife points (Table S5), based on principle that stream buffers protect sensitive aquatic ecosystems and that corridors connect patches of natural vegetation. To receive points for stream buffering, users must create stream buffers using the

following land-use types: conservation corn, conservation forest, conservation soybean, conventional forest, prairie, rotational grazing, and wetland. We assume conservation corn and conservation soybean best management practices include stream buffering.

# **Table S5. Game Wildlife Points**

| **Calculation** | **Land-use Types** | **Metric** | **Points** | **Thresholds** |
| --- | --- | --- | --- | --- |
| Natural vegetation and other high diversity land uses | Conservation forest Conventional forest Mixed fruits and vegetables  Prairie Rotational grazing  Wetland | Percent of watershed area | 0.0 | Less than 10% area |
| 1.0 | At least 10%, less than 25% area |
| 2.0 | At least 25%, less than 50% area |
| 3.0 | At least 50%, less than 100% area |
| 4.0 | 100% area |
| Natural vegetation and comparatively high-diversity and/or low-input land uses\* | Conservation corn† Conservation forest Conservation soybean† Conventional forest  Grass hay Mixed fruits and vegetables Prairie Rotational grazing  Short-rotation woody bioenergy  Switchgrass  Wetland | Percent of watershed area | 0.0 | Less than 10% area |
| 0.5 | At least 10%, less than 50% area |
| 1.0 | At least 50%, less than 100% area |
| 1.5 | 100% area |
| Conservation forest | Conservation forest | Percent of watershed area | 0.0 | Less than 5% area |
| 1.0 | At least 5% area |
| Grassland | Prairie  Rotational grazing Switchgrass | Percent of watershed area | 0.0 | Less than 5% area |
| 1.0 | At least 5% area |
| Wetland | Wetland | Percent of watershed area | 0.0 | Less than 5% area |
| 1.0 | At least 5% area |
| Stream buffer | Conservation corn‡ Conservation forest Conservation soybean‡ Conventional forest  Grass hay  Mixed fruits and vegetables  Prairie  Rotational grazing Short-rotation woody bioenergy  Switchgrass  Wetland | Percent of stream-adjacent cells | 0.0 | Less than 10% stream-adjacent cells |
| 0.5 | At least 10%, less than 50% stream-adjacent cells |
| 1.0 | At least 50%, less than 100% stream-adjacent cells |
| 1.5 | 100% stream-adjacent cells |
| \*In this calculation, PEWI awards up to 1.5 game wildlife points for land uses that include natural vegetation and other high-diversity land uses, as well as both low-diversity, high-input and low-diversity, low-input land uses that provide higher diversity support and require fewer inputs than conventionally row-cropped systems.  †We selected conservation corn and conservation soybean for inclusion in this category because we defined management practices for conservation row crops to include winter cover crops, no-till, and grassed waterways, and/or buffers.  ‡We assume conservation corn and conservation soybean best management practices include stream buffering. | | | | |

# **Table S6. Carbon Sequestration Rates by Land-use Type**

| **From Annual Row Crop Types\***† **to:** | **Measured Unit** | **PEWI Land-use Types** | **Values (Mg ha-1 yr-1)** |
| --- | --- | --- | --- |
| Forestsa | Total biomass and soils | Conservation forest, Conventional forest |  |
| Incorporation of cover cropsa | Soils | Conservation corn, Conservation soybean |  |
| Perennial grasslanda | Soils | Prairie |  |
| Pasture or hay landa | Soils | Grass hay,  Permanent pasture, Rotational grazing |  |
| Prairie potholesa | Soils | Wetland |  |
| Short-rotation woody cropsa | Total biomass and soils | Short-rotation woody bioenergy |  |
| Switchgrassb | SOC, 0-15 cm soil depth‡ | Switchgrass |  |
| Corn-soybean-alfalfa rotationb | SOC, 0-15 cm soil depth‡ | Alfalfa |  |
| a (Fissore et al., 2010)  b (Al-Kaisi et al., 2005)  \* Conventional corn, Conventional soybean, Mixed fruits and vegetables.  † Availability of published empirical data presented challenges in estimating carbon sequestration values for PEWI, so we incorporated expert knowledge suggesting no increases in carbon sequestration for the Mixed fruits and vegetables land-use type relative to annual row crop systems (Cynthia Cambardella, USDA Agricultural Research Service, personal communication, 2014).  ‡ Al-Kaisi et al. (2005) reported soil organic carbon (SOC) content increases during a 10-year period compared with initial SOC content; measurements were taken at the 0-15 cm soil profile (p. 642). | | | |

# **Gross Erosion Module Details**

The Erosion Control model in PEWI uses the 2004 Iowa Phosphorus Index (P-Index) guidelines (Mallarino et al., 2005; USDA NRCS, 2004a) to inform calculations of water erosion. P-index guidelines define gross erosion as rill and interrill erosion, ephemeral gully erosion, and classical gully erosion. PEWI provides estimates for rill and interrill erosion based on the Revised Universal Soil Loss Equation (RULSE; Renard et al., 1997). Because RUSLE does not consider ephemeral gully erosion, we incorporated statewide estimates for Iowa (USDA NRCS, 1997).

PEWI quantifies Gross Erosion as the amount of soil loss per year in the watershed from ephemeral gully erosion, rill erosion, and interrill erosion (Table S7). High Gross Erosion translates to low Erosion Control, and thus a low index score, and vice versa. The two subcomponents in the Gross Erosion calculation are RUSLE, which describes rill and interrill erosion, and ephemeral gully erosion. The RUSLE soil loss calculation takes the product of five factors: rainfall erosivity factor (R), soil erodibility factor (K), slope length steepness factor (LS), cover management factor (C), and practice support factor (P) (Renard et al. 1997, Table S7). Rainfall erosivity, R-factor, estimates account for climate effects on erosion. Typically, RUSLE calculations use a static R-factor value set for a location or region based on historic average storm erosivity values. PEWI instead varies R-factor values by annual precipitation levels, according to an equation provided by (Renard and Freimund, 1994). We selected this model to emphasize the relationship between climate variability and interannual differences in erosion rates.

Soil erodibility, K-factor, accounts for soil susceptibility to erosion, or as USDA Agricultural Handbook 703 (Renard et al., 1997) states, the “ease with which soil is detached by splash during rainfall or by surface flow or both” (p. 68). The measurement unit for the K-index is the rate of soil loss per unit of rainfall erosivity. ISPAID (Miller et al., 2010) provides K-factor values for each soil type, which we incorporated within PEWI. For slope length-steepness, LS-factor, estimates we assumed a relationship between slope steepness, S-factor, and slope length, L-factor, similar to values that Iowa NRCS Technical Note 29 (USDA NRCS, 2008a) presented in a plot entitled “Slope length related to slope gradient” (p. 5).

We derived cover management, C-factor, values based on estimates for Squaw Creek Watershed in Boone, Hamilton, Story and Webster Counties, Iowa (Wendt, 2007). Cover management depends not only on current year land use but also on prior year land use. We assumed in the erosion model that the hypothetical year 0 land-use configuration consisted of 100% conventional corn. We calculated practice support, P-factor, as the product of a contour subfactor and a terrace subfactor. We assumed that only conservation corn and conservation soybean land-use types incorporate contouring and terracing, and only at downhill slopes greater than 2%. We selected contour subfactors for 10-year EI (storm intensity) equal to 80 and low (1-3”) ridge or oriented roughness height, and assumed median row grades for each downhill slope category, as well as terrace subfactors (USDA NRCS, 2002; Table IIIe). We selected closed outlet terrace values for PEWI, which vary based on horizontal terrace intervals that we set equal to Iowa NRCS terrace standards recommendations on maximum terrace spacing for each slope category (USDA NRCS, 2008b).

Ephemeral gully erosion is an active area of research still proceeding towards generalization (Bennett and Wells, 2019). We created a simple ephemeral gully erosion model for PEWI, in which we modified annual erosion estimates of 6.7 Mg ha-1 for Iowa (USDA NRCS, 1997) upward by 50% to 10.1 Mg ha-1 for conventional annual row-crop practices, and downward by 50% to 3.4 Mg ha-1 for conservation annual row-crop practices (Thomas Isenhart, Iowa State University, personal communication). The 50% upward and downward adjustments reflect directionally accurate models based our understanding of the effects of conservation practices on ephemeral gully erosion. Annual Gross Erosion rates in PEWI range from 0.04–137 Mg ha-1.

# **Table S7. Gross Erosion**

| **Description** | **Notation** | **Rule** | **Possible Values** |
| --- | --- | --- | --- |
| Gross erosiona |  |  |  |
| Gross erosion index |  |  |  |
| Gross erosion ratea |  |  |  |
| RUSLE rill and interrill erosion rateb\* |  |  |  |
| Ephemeral gully erosion ratec |  | Land-use types:, Conventional corn, Conventional soybean, Mixed fruits and vegetables |  |
| Land-use types: Alfalfa, Conservation corn, Conservation soybean |  |
| Land-use types: All others |  |
| Rainfall erosivity factord |  |  |  |
| Soil erodibility factore |  | Soil series in Des Moines Lobe: Boone County (*B*); and Southern Iowa Drift Plain: Jasper County (*J*) |  |
| Slope length steepness factorb† |  | Land-use types: Alfalfa, Conservation corn, Conservation soybean, Conventional corn, Conventional soybean, Mixed fruits and vegetables |  |
| Land-use types: Permanent pasture, Rotational grazing |  |
| Land-use types: All others | 1 |
|  |  |  |
|  |  |  |
| Cover management factorf |  | Conventional corn preceding annual row crop: |  |
| Conservation corn preceding annual row crop: |  |
| Conventional soybean or mixed fruits and vegetables preceding annual row crop: |  |
| Conservation soybean preceding annual row crop: |  |
| All land-use types except Conventional corn, Conservation corn, Conventional soybean, Conservation soybean, and Mixed fruits and vegetables preceding annual row crop: |  |
| Any land-use type preceding the following land-use types: |  |
| Support practice factorbg |  | Land-use type: Conservation corn, Conservation soybean |  |
| Land-use type: All others | 1 |
| Contour subfactorg |  |  |  |
| Terrace subfactorg |  |  |  |
| Terrace intervalh |  |  |  |

a (USDA NRCS, 2004a)

b (Renard et al., 1997)

c (USDA NRCS, 1997)

d (Renard and Freimund, 1994)

e (Miller et al., 2010)

f (Wendt, 2007)

g (USDA NRCS, 2002)

h (USDA NRCS, 2008b)

\*We converted RUSLE factors between SI units and US customary units using USDA Agricultural Handbook 703 (Renard et al., 1997; Table A-2).

†RUSLE instructions (Renard et al., 1997) suggested to modify estimates of soil loss with contouring when the slope length, L-factor, exceeds the critical slope length at which contouring fails and permits rill erosion. For PEWI, we defined critical slope lengths based upon Iowa NRCS USLE Erosion Prediction (USDA NRCS, 2002; Table IIIa), which resulted in no L-factors exceeding critical lengths.

# **Nitrate Pollution Control Module Details**

Nitrate Pollution Control within PEWI is the indexed inverse of the annual mean nitrate-N concentration levels in surface water from the outlet of the model watershed, where low levels of concentration correspond to high levels of control and vice versa. The calculation for watershed annual mean nitrate-N concentration averages subwatershed nitrate-N concentration, weighted by subwatershed area proportional to watershed area. Because we restricted nitrate-N concentration to a minimum of 2 mg L-1 in line with data on fully perennial systems (Randall et al., 1997), subwatershed nitrate-N concentration, in mg L-1, equals the maximum of: 2 or 100 multiplied by the product of: 1) precipitation multiplier,2) strategic wetland multiplier, 3) row crop multiplier, a weighted average by grid cell area proportional to subwatershed area; and 4) conservation row-crop multiplier (Table S8). Mean annual nitrate-N concentration in PEWI ranges from 2–29.54 mg L-1. PEWI also generates a map for users to evaluate the percent contribution of each subwatershed to the overall watershed nitrate-N concentration (Fig. 4). PEWI calculates the percent contribution of each subwatershed as the product of subwatershed nitrate-N concentration and the ratio of subwatershed area to watershed area (Table S8).

Mean nitrate-N concentration estimates are based on Schilling and Libra's (2000) conclusion that watershed size impacts the relationship between the percent of the watershed in row crops and the expected nitrate-N concentrations in surface water. Specifically, they found approximate nitrate-N concentration by multiplying the percent area in row crops by 0.14 mg L-1 for subwatersheds. As such, considering the PEWI watershed size we used 14% for a row-crop multiplier for subwatersheds in PEWI nitrate model calculations (Schilling and Libra 2000). The PEWI nitrate model simplifies land use into two categories, annual row crop or perennial vegetation. Because Schilling and Libra (2000) did not explicitly consider factors within perennial vegetation systems that have potential to elevate nitrate-N concentration levels, PEWI scenarios with a large percentage of land-use types such as pasture, alfalfa, hay, or bioenergy crops in a subwatershed may underestimate concentration levels (Chennault, 2014).

To calculate subwatershed nitrate-N concentration, we assigned a 14% or 0% row-crop multiplier to each grid cell in PEWI, dependent on annual or perennial land-use type, and weighted each grid cell’s multiplier by the area of the grid cell as a percent of the subwatershed area. Calculating concentration using the row-crop multiplier produces a baseline nitrate-N concentration based on land use. Other factors—climatic cycles and management decisions—alter this baseline by reducing or temporally redistributing nitrate-N release into surface water. We accounted for these factors in the model by creating three additional multipliers.

Users can alter baseline contribution of each grid cell row-crop multiplier by selecting a conservation row crop—conservation corn or conservation soybean—instead of a conventional row crop. The conservation multiplier reduces baseline concentration of a grid cell by either 31% or 39%, depending on the Major Land Resource Area (MLRA) to which a grid cell belongs—the Des Moines Lobe (103) or Southern Iowa Drift Plain (108C), respectively(IDALS et al., 2017). In the Des Moines Lobe grid cells, the conservation multiplier equals 100% minus a 31% cover crop reduction, totaling 69% or 0.69. In PEWI we assumed that two land-use types, conservation corn and conservation soybean, incorporate cover crops as a management practice. For those land-use types, we apply a nitrate-N reduction factor based on Iowa Nutrient Reduction Strategy (NRS) estimates in which a winter cereal rye cover crop exhibits a 31% mean reduction in nitrate-N concentration (IDALS et al., 2017). To calculate the conservation multiplier for the Southern Iowa Drift Plain grid cells, we added together the effect of each of the two practices, 31% cover crop reduction plus a 7% edge-of-field buffer reduction, and subtracted from 100%, totaling 62% or 0.62 (IDALS et al., 2017). While the Iowa NRS science team estimated a 91% concentration reduction from the water that flows through the soil below the buffer, they noted that this percentage accounts for an overall reduction of 7% because only a very small portion of the water moves through the active buffer zone. In the model, we assumed conservation best management practices include adoption of edge-of-field buffers only in the Southern Iowa Drift Plain grid cells, which is consistent with land-use practices in the region (Brown and Schulte, 2011).

The precipitation multiplier represents the effects of interannual patterns of precipitation on mean nitrate-N concentrations in surface water. Randall and Mulla (2001) cited three previous studies to establish a relationship between precipitation and annual flow-weighted nitrate-N concentration (Randall, 1998; Randall et al., 1997; Randall and Iragavarapu, 1995). These studies illustrated climate cycles of dry years with relatively low concentrations and buildup of residual soil nitrate-nitrogen, followed by wet years with very high concentrations and transport and delivery of residual soil nitrate-nitrogen to streams. Elevated concentrations returned to baseline levels in subsequent years of normal and above-normal precipitation.

Using the five data sets from these studies we created precipitation multipliers in the PEWI nitrate model for each of the climate cycles highlighted by Randall and Mulla (2001). We used their descriptions of precipitation levels in each year as dry, normal, above-normal, and wet to label their data from each year in relationship to one of four climatic cycles: (a) dry year, (b) initial wet or above normal precipitation year after a dry year, (c) initial normal precipitation year after a dry year, or (d) background year (i.e., any year not falling into the first three groups). Next, for each data set we calculated the mean of the reported mean flow-weighted annual nitrate-N concentration values within each climate cycle group. We indexed the calculated mean of each climate cycle group as a percentage of the background climate cycle group mean. Finally, we calculated the mean of indexed values for each climate cycle group across all five data sets. This resulted in multipliers of 0.86 for dry year, 2.11 for an initial wet or above normal precipitation year after a dry year, 1.69 for a normal precipitation year after a dry year, and 1.00 for background years. To assign multipliers in the PEWI model, we classified PEWI’s seven precipitation levels as dry, normal, or wet (Table S2).

The final factor to reduce baseline nitrate-N concentration, the strategic wetland multiplier depends on whether the user places the wetland land-use type on predefined strategic wetland locations. We created a static strategic wetland data set in PEWI, visible as a physical feature map. The map helps users to identify optimal locations for restoring a wetland, which we based upon physiographic features of the watershed. Twenty strategic wetland locations exist in PEWI, and we assigned subwatersheds containing at least one strategic wetland a potential nitrate-N concentration reduction of 52% (IDALS et al., 2017).

# **Table S8. Nitrate-N Concentration**

| **Description** | **Notation** | **Rule** | **Possible Values** |
| --- | --- | --- | --- |
| Watershed  nitrate-N concentration |  |  |  |
| Nitrate pollution control index |  |  |  |
| Subwatershed nitrate-N percent contribution |  |  |  |
| Precipitation multipliera |  | Dry: Precipitation current year ≤ 71.6 cm |  |
| Normal after dry: Precipitation current year = 77.2 cm, 81.7 cm, or 87.2 cm; and Precipitation prior year ≤ 71.6 cm |  |
| Wet after dry: Precipitation current year ≥ 92.6; and Precipitation prior year ≤ 71.6 cm |  |
| Background: All other climate cycles |  |
| Wetland multiplierb |  | At least one strategic wetland in the subwatershed with wetland land-use type |  |
| No strategic wetland locations in the subwatershed with wetland land-use type |  |
| Row crop multiplierc |  | Land-use types: Conservation corn, Conservation soybean, Conventional corn, Conventional soybean, Mixed fruits and vegetables |  |
| Land-use types: Alfalfa, Conservation forest, Conventional forest, Hay, Switchgrass, Permanent pasture, Prairie, Rotational grazing, Short-rotation woody bioenergy, Wetland | 0.00 |
| Conservation row crop multiplierd |  | Land-use types in Des Moines Lobe: Conservation corn, Conservation soybean |  |
| Land-use types in Southern Iowa Drift Plain: Conservation corn, Conservation soybean |  |
| Land-use types: Alfalfa, Conservation forest, Conventional corn, Conventional forest, Conventional soybean, Hay, Switchgrass, Permanent pasture, Prairie, Rotational grazing, Short-rotation woody bioenergy, Wetland |  |
| a (Randall and Mulla, 2001)  b (Thomas Isenhart, Iowa State University, personal communication, 2013)  c (Schilling and Libra, 2000)  d (IDALS et al., 2017) | | | |

# **Phosphorus Pollution Control Module Details**

Phosphorus Pollution control is reported as the indexed inverse of annual in-stream phosphorus loading in PEWI. The calculation incorporates three phosphorus delivery pathways to surface waters: phosphorus bound to sediment and moving with erosion dissolved phosphorus moving with surface water in runoff, and dissolved phosphorus moving with subsurface water (USDA NRCS, 2004a). Pollution control is calculated for each grid cell, and values are summed to yield watershed annual in-stream phosphorus delivery (Table S9). We used the Iowa Phosphorus Index (P-Index) as the bases for our calculations and selected index parameter values based on Iowa NRCS Technical Note 25 (USDA NRCS, 2004a), Iowa Nutrient Reduction Strategy (IDALS et al., 2017) and expert consultation (Matthew Helmers and Thomas Isenhart, Iowa State University, personal communication).

The erosion component is the product of five parameters: gross erosion, sediment trap factor or sediment delivery ratio, buffer factor, enrichment factor, and soil test phosphorus (STP) erosion factor USDA (USDA NRCS, 2004a). Gross erosion provides estimates of total rill and interrill erosion using RUSLE (Renard et al., 1997) and ephemeral gully erosion, based on Iowa statewide estimates USDA (USDA NRCS, 1997). Detailed explanations of RUSLE subcomponent calculations are described with the module on Gross Erosion. Sediment delivery ratio converts gross erosion into sediment yield and “represents the efficiency of the watershed in moving soil particles from areas of erosion to the point where sediment yield is measured” (USDA NRCS 1998; p. 6). Using USDA NRCS (1998) equations for each Iowa landform region in PEWI, we estimated sediment delivery ratio as a function of drainage area (Tables S9, S10). The Iowa P-Index sets the buffer factor equal to 0.5 for vegetative buffers that meet the USDA NRCS Practice Standard 393 for a filter strip (USDA NRCS, 2004a).

The runoff component of the Iowa P-Index measures phosphorus delivery with water runoff (USDA NRCS, 2004a). The runoff component consists of the product of a runoff factor, precipitation, and the sum of STP runoff factor and P application factor (Table S9). Our calculation uses runoff factor values converted from USDA NRCS (2004b) Runoff Curve Numbers (RCN, Table S11). Next, PEWI uses each modeled year’s precipitation level to calculate that year’s hypothetical P-Index value. The third runoff subcomponent, STP runoff factor, represents the concentration of dissolved phosphorus in runoff based on soil test P values. The P application factor depends on P2O5 application rate and method of application (USDA NRCS, 2004a).

The subsurface drainage component of the Iowa P-Index consists of the product of precipitation, a flow factor, and an STP drainage factor (USDA NRCS, 2004a). The P-Index again uses precipitation and STP concentrations to determine factor values. The flow factor takes on a value of 0.1 if subsurface flow is present, with 10% representing the observed average annual precipitation percentage that flows through the subsurface in Iowa; otherwise flow factor takes on a value of zero (Mallarino et al., 2005).

# **Table S9. Phosphorus Delivery to Stream**

| **Description** | **Notation** | **Rule** | **Possible Values** |
| --- | --- | --- | --- |
| Phosphorus delivery to streama |  |  |  |
| Phosphorus control index |  |  |  |
| Iowa P-Indexa |  |  |  |
| Erosion componenta |  |  |  |
| Runoff componenta |  |  |  |
| Subsurface drainage componenta |  |  |  |
| Buffer factorab\* |  | Land-use typ0065s: Conservation corn, Conservation forest, Conservation soybean, Conventional forest, Grass hay, Switchgrass, Prairie, Wetland, Short-rotation woody bioenergy |  |
| Land-use types: all others |  |
| Gross erosion ratea |  |  |  |
| Sediment delivery ratioc |  | Grid cells in Des Moines Lobe: |  |
| Grid cells in Southern Iowa Drift Plain: |  |
| Enrichment factora |  | Land-use types: Conventional corn, Conventional soybean, Mixed fruits and vegetables | 1.1 |
| Land-use types: All others | 1.3 |
| Soil test P erosion factord |  |  |  |
| Soil test P concentratione† |  | Soil series in Des Moines Lobe |  |
| Soil series in Southern Iowa Drift Plain |  |
| Runoff factora‡‼ |  |  |  |
| Precipitation factora |  |  |  |
| Soil test P runoff factord |  |  |  |
| P application factord |  |  |  |
| P application rate, as P2O5efghi‡§¶ |  | Des Moines Lobe with land-use types: Conservation corn, Conventional corn |  |
| Southern Iowa Drift Plain with land-use types: Conservation corn, Conventional corn |  |
| Des Moines Lobe with land-use types: Conservation soybean, Conventional soybean |  |
| Southern Iowa Drift Plain with land-use types: Conservation soybean, Conventional soybean |  |
| Land-use type: alfalfa |  |
| Land-use types: Permanent pasture, Rotational grazing |  |
| Des Moines Lobe with land-use type: Grass hay |  |
| Southern Iowa Drift Plain with land-use type: Grass hay |  |
| Land-use type: Mixed fruits and vegetables |  |
| Land-use types: All others |  |
| Time and method factorbd∥ |  | Land-use types: Conservation corn, Conservation soybean, Grass hay, Permanent pasture, Rotational grazing |  |
| Land-use types: Alfalfa | 0.9 |
| Land-use types: Conventional corn, Conventional soybean, Mixed fruits and vegetables |  |
| Land-use types: All others | 0 |
| Flow factoraj |  | ISPAID soil map series meeting conditions for one of the following options:  Option 1   * Slope range no greater than 5%; * Drainage class of 60, 65, or 70 (Poor, Poor-Very poor, or Very poor); * Subsoil group of 1 or 2 (Clay less than 40%)   Option 2   * Permeability code no greater than 35 or equal to 58, 72, or 75 (Coarse texture subsoil/substrate) |  |
| Soil map series: All others |  |
| Soil test P drainage factord∫ |  |  |  |
| a (USDA NRCS, 2004a)  b (Matthew Helmers and Thomas Isenhart, Iowa State University, personal communication, 2014)  c (USDA NRCS, 1998)  d (Mallarino et al., 2005)  e (IDALS et al., 2017)  f (Goolsby et al., 1999)  g (Jacobson et al., 2011)  h (Laboski et al., 2006)  I (Sawyer et al., 2008)  j (Miller et al., 2010)  \*We assumed conservation corn and conservation soybean include vegetative buffers.  † Major landform region area (MLRA) Bray-1 P, Mehlich-3 average STP values; (IDALS et al., 2017).  ‡Runoff Curve Number (*RCNij*) estimates (Table S11).  ‼Runoff factor equation takes 50% of observed weighted average percent of runoff in Iowa for RCN levels of 50, 60, 70, 80, 90, and 95, to account for approximately 50% of observed rain events in Iowa that fall below the limit for production of runoff (Mallarino et al., 2005).  §Yield rates for alfalfa (*YBij*[*Alfalfa*])(Table S17); and green beans (*GBY*), and squash (*SQY*) (Table S19).  ¶Seasonal utilization rate (SU) and average daily intake (DI) (Table S18).  ∥For conservation corn, conservation soybean, grass hay, permanent pasture, and rotational grazing land-use types, we assumed surface application with no incorporation. For conventional corn, conventional soybean, and mixed fruits and vegetables land-use types, we assumed management across the watershed with two methods occurring in equal proportion: surface application with no incorporation and incorporating within one week (Matthew Helmers and Thomas Isenhart, Iowa State University, personal communication, 2014). For alfalfa, we assumed an intermediate value between conservation and conventional row crop land-use types.  ∫All possible soil test P (STPij) values in PEWI have values less than 100; thus soil test P drainage only takes on the value of 0.1 ppm. | | | |

# **Table S10. Sediment Delivery Ratio (SDR) by Iowa Landform Region and Drainage Area, from Iowa NRCS Erosion and Sediment Deliverya**

| **Hectares** | **SDR1** | **SDR2\*** | **SDR3** | **SDR4\*** |
| --- | --- | --- | --- | --- |
| 0.4 | 97.0 | 94.0 | 88.0 | 80.0 |
| 4.0 | 84.5 | 68.0 | 44.0 | 25.5 |
| 25.9 | 75.0 | 50.0 | 25.0 | 10.0 |
| 40.5 | 73.0 | 47.0 | 23.0 | 9.0 |
| 404.7 | 65.0 | 35.0 | 17.5 | 6.0 |
| 4,046.9 | 57.0 | 26.0 | 13.0 | 4.0 |
| a (USDA NRCS, 1998)  \*“SDR 2” represents Southern Iowa Drift Plain and “SDR 4” represents Des Moines Lobe. | | | | |

# **Table S11.** **Runoff Curve Numbersa**

| **Land-use Type** | **Topographic relief** | **Hydrologic Group** | **Flow Factor** | **Value** |
| --- | --- | --- | --- | --- |
| Alfalfa |  | A | - | 58 |
| B | - | 72 |
| C, D, B/D | > 0 | 72 |
| C | 0 | 81 |
| D, B/D | 0 | 85 |
| Alfalfa |  | A | - | 55 |
| B | - | 69 |
| C, D, B/D | > 0 | 69 |
| C | 0 | 78 |
| D, B/D | 0 | 83 |
| Conservation corn  Conservation soybean |  | A | - | 64 |
| B | - | 74 |
| C, D, B/D | > 0 | 74 |
| C | 0 | 81 |
| D, B/D | 0 | 85 |
|  | A | - | 61 |
| B | - | 70 |
| C, D, B/D | > 0 | 70 |
| C | 0 | 77 |
| D, B/D | 0 | 80 |
| Conservation forest  Conventional forest  Short-rotation woody bioenergy | - | A | - | 30 |
| B | - | 55 |
| C, D, B/D | > 0 | 55 |
| C | 0 | 70 |
| D, B/D | 0 | 77 |
| Conventional corn  Conventional soybean  Mixed fruits and vegetables | - | A | - | 72 |
| B | - | 81 |
| C, D, B/D | > 0 | 81 |
| C | 0 | 88 |
| D, B/D | 0 | 91 |
| Grass hay  Switcgrass | - | A | *−* | 30 |
| B | - | 58 |
| C, D, B/D | > 0 | 58 |
| C | 0 | 71 |
| D, B/D | 0 | 78 |
| Permanent pasture | - | A | *−* | 68 |
| B | - | 79 |
| C, D, B/D | > 0 | 79 |
| C | 0 | 86 |
| D, B/D | 0 | 89 |
| Prairie  Wetland | - | A | *−* | 30 |
| B | - | 48 |
| C, D, B/D | > 0 | 48 |
| C | 0 | 65 |
| D, B/D | 0 | 73 |
| Rotational grazing | - | A | *−* | 49 |
| B | - | 69 |
| C, D, B/D | > 0 | 69 |
| C | 0 | 79 |
| D, B/D | 0 | 84 |

# **Table S12. Sediment Delivery to Stream**

| **Description** | **Notation** | **Rule** | **Possible Values** |
| --- | --- | --- | --- |
| Sediment delivery to streama |  | (see Tables S7, S9, S10) |  |
| Sediment control index |  |  |  |
| a (USDA NRCS, 2004a) | | | |

# **Table S13.** **Crop and Livestock Production**

| **Yield Type** | **PEWI Land-use Types** | **Possible Values** |
| --- | --- | --- |
| Alfalfa hay (*Medicago sativa* L.)\* | Alfalfa | 028,800 *Mg* |
| Cattle\*† | Permanent pasture Rotational grazing | 04850 *animals* |
| Corn grain (*Zea mays* L.)‡ | Conventional corn Conservation corn | 030,600 *Mg* |
| Grass hay\* | Grass hay | 0 *Mg* |
| Switchgrass (*Panicum virgatum* L.)‼ | Switchgrass | 0 *Mg* |
| Mixed fruits and vegetables§ | Mixed fruits and vegetables | 024,000 *Mg* |
| Short-rotation woody biomass¶ | Short-rotation woody bioenergy | 053,400 *Mg* |
| Soybeans (*Glycine max* (L.) Merr.)‡ | Conservation soybean Conventional soybean | 09500 *Mg* |
| Wood∥ | Conservation forest Conventional forest | 02540 |

\*See Table S17.

†See Table S18

‡See Table S16.

‼ See Table S21.

§See Table S19.

¶See Section 2.2.4.7.

∥See Table S20.

# **Table S14.** **Yield**

| **Description** | **Notation** | **Rule** | **Values** |
| --- | --- | --- | --- |
| Yield |  |  | *Varies by Yield Type*\* |
| Yield index |  |  |  |

\*See Table S15.

# **Table S15. Yield Type Precipitation Factor at Different Precipitation Levels**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Land-use Types** | **Precipitation (cm) Factors *YP*** | | | | | | |
| 62.4 | 71.6 | 77.2 | 81.7 | 87.2 | 92.6 | 114.6 |
| Conservation corn  Conservation soybean  Conventional corn  Conventional soybean | 0.75 | 0.90 | 1.00 | 1.00 | 1.00 | 0.90 | 0.75 |
| Alfalfa  Grass hay  Permanent pasture  Rotational grazing  Switchgrass | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 |
| Mixed fruits and vegetables | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.90 | 0.75 |
| All others | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

# **Table S16.** **Yield Base Rate: Corn and Soybeana**

| **County** | **ISPAID Soil Type** | **Yield Base Rate *YBij* (Mg ha-1 year-1) \*** | |
| --- | --- | --- | --- |
| **Corn** | **Soybean** |
| **Boone County** | Clarion 138B |  |  |
| Buckney 1636 |  |  |
| Canisteo 507 |  |  |
| Coland 135 |  |  |
| Nicollet 55 |  |  |
| Okoboji 90 |  |  |
| **Jasper County** | Downs 162D2 |  |  |
| Gara-Armstrong 993E2 |  |  |
| Ackmore-Colo 5B |  |  |
| Tama 120C2 |  |  |
| Tama 120B |  |  |
| Muscatine 119 |  |  |
| Nodaway 220 |  |  |
| a (Miller et al., 2010) \*To convert between bushels in ISPAID and metric units, we used approximate relationships of 56 lb bu-1 of corn and 60 lb bu-1 of soybeans (Johanns, 2013) to derive factors of 0.0254 and 0.0272 Mg bu-1, respectively. | | | |

# **Table S17. Yield Base Rate: Alfalfa and Grass Haya**

| **County** | **ISPAID Soil Type** | **Yield Base Rate *YBij* (Mg ha-1 year-1)** |
| --- | --- | --- |
| **Boone County** | Clarion 138B |  |
| Buckney 1636 |  |
| Canisteo 507 |  |
| Coland 135 |  |
| Nicollet 55 |  |
| Okoboji 90 |  |
| **Jasper County** | Downs 162D2 |  |
| Gara-Armstrong 993E2 |  |
| Ackmore-Colo 5B |  |
| Tama 120C2 |  |
| Tama 120B |  |
| Muscatine 119 |  |
| Nodaway 220 |  |
| a (Miller et al., 2010) | | |

# **Table S18.** **Yield Base Rate for Cattle**

| **Description** | **Notation** | **Rule** | **Possible Values** |
| --- | --- | --- | --- |
| Cattle supported yield base ratea |  |  |  |
| Seasonal utilization ratea |  | Land-use type: Permanent pasture |  |
| Land-use type: Rotational grazing |  |
| Average daily intakea |  | 3% of live bodyweight |  |
| Grazing season length\* |  | April 15 – November 1 |  |
| a (USDA NRCS, 2008c)  \*Most respondents in a survey of Iowa beef production reported a grazing season of April 15 through November 1 (Iowa Beef Center, 2007). | | | |

# **Table S19. Yield Base Rate: Mixed Fruits and Vegetables**

| **Description** | **Notation** | **Rule** | **Possible Values** |
| --- | --- | --- | --- |
| Mixed fruits and vegetables yield base rate\* |  |  |  |
| Grape yieldab |  | - |  |
| Green bean yieldc |  | - |  |
| Squash yieldc |  | - |  |
| Strawberry yieldc |  | - |  |
| Soil texture multiplierc |  | Fine sandy loam | .00 |
| Silt loam |  |
| Loam | 0 |
| Clay loam, Mucky silt loam, Silty clay loam | 0 |
| a (Delate and Friedrich, 2004)  b (Post and Robinson, 1995)  c (Taber, 2008)  \*We allocated one-quarter of each mixed fruits and vegetable grid cell to each of the four crops. | | | |

# **Table S20.** **Yield Base Rate: Wooda**

| **County** | **ISPAID Soil Type** | **Yield Base Rate *YBij* (m3 ha-1 year-1)\*** |
| --- | --- | --- |
| **Boone County** | Clarion 138B | .60 |
| Buckney 1636 |  |
| Canisteo 507 |  |
| Coland 135 |  |
| Nicollet 55 | 1.02 |
| Okoboji 90 |  |
| **Jasper County** | Downs 162D2 | .60 |
| Gara-Armstrong 993E2 | .43 |
| Ackmore-Colo 5B |  |
| Tama 120C2 | .60 |
| Tama 120B | .60 |
| Muscatine 119 | 1.02 |
| Nodaway 220 | .60 |
| a (IDNR and USDA NRCS, 2007) \*Yield Base Rate figures are for conventional forest. We apply a 30% reduction factor for conservation forest wood yield. | | |

# **Table S21.** **Yield Base Rate: Switchgrassa**

| **County** | **ISPAID Soil Type** | **Yield Base Rate *YBij* (Mg ha-1 year-1)** |
| --- | --- | --- |
| **Boone County** | Clarion 138B | 5.77 |
| Buckney 1636 | 4.39 |
| Canisteo 507 | 5.65 |
| Coland 135 | 5.65 |
| Nicollet 55 | 6.25 |
| Okoboji 90 | 4.39 |
| **Jasper County** | Downs 162D2 | 4.39 |
| Gara-Armstrong 993E2 | 4.39 |
| Ackmore-Colo 5B | 4.81 |
| Tama 120C2 | 5.29 |
| Tama 120B | 6.31 |
| Muscatine 119 | 6.61 |
| Nodaway 220 | 5.83 |
| a(Emily Heaton, Iowa State University, personal communication, 2014) | | |

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