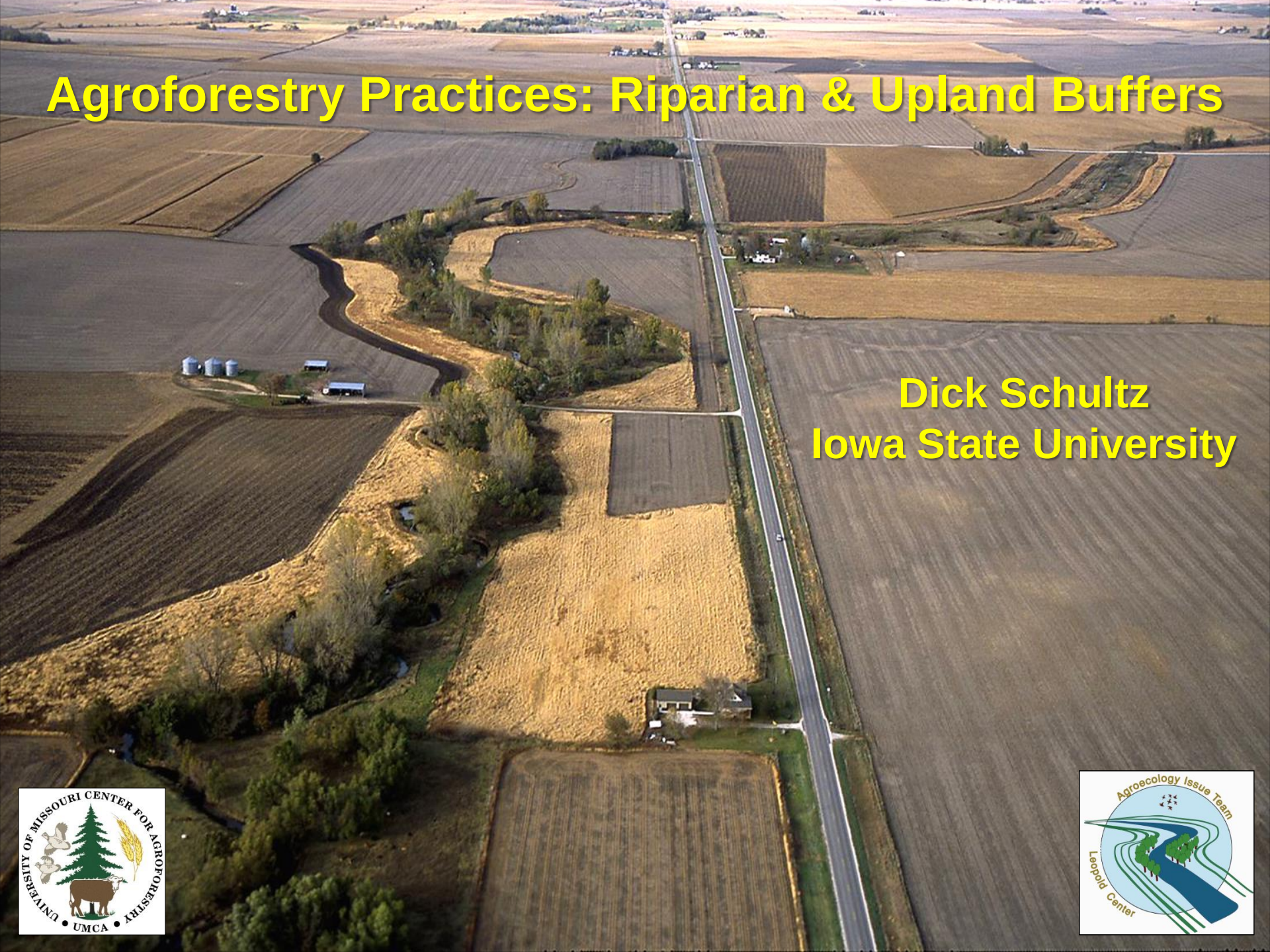
Agroforestry Practices: Riparian & Upland Buffers

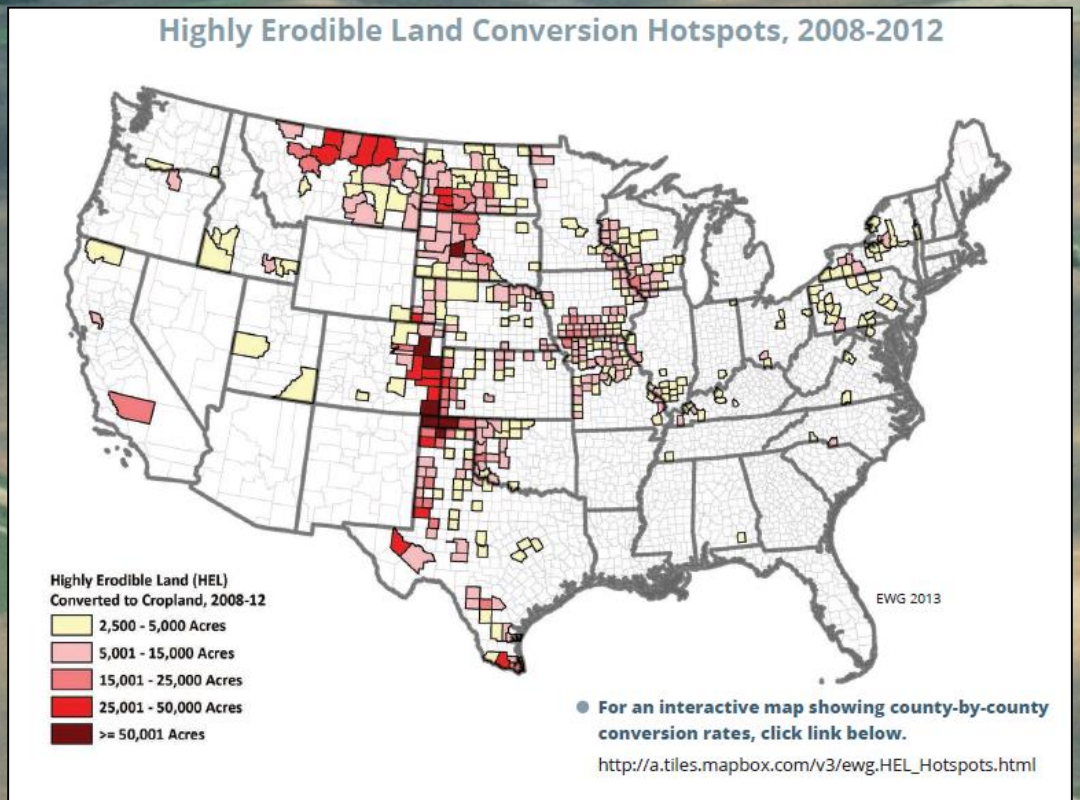


Dick Schultz
Iowa State University


Outline:
Why do we need buffers – what is the problem?
What do buffers do – why do we love them?
What can't buffers do – what other practices work with them?
What are the barriers/constraints to more adoption?
4 year old Riparian Forest Buffer

The Problem: Continued loss of perennial plant cover – replaced by major expanses of annual row crops – larger fields – fence rows gone.

2012 Report by Environmental Working Group: 23.6 million acres of grassland, wetland & shrub-land converted to row crops between 2008-2011.



Why Do We Need Buffers?

Gully Erosion Since Last Fall's Harvest – Delivers A Lot Of Sediment


Gullies Flowing Into the Stream
Through Narrow Forest Strips
Deliver Sediment & Phosphorus


Planting Right to the Edge Provides
Direct Access to the Channel
Photo by T. Schultz

Unprotected Banks Collapse & Erode

40-80% of sediment in the stream may come from bank erosion

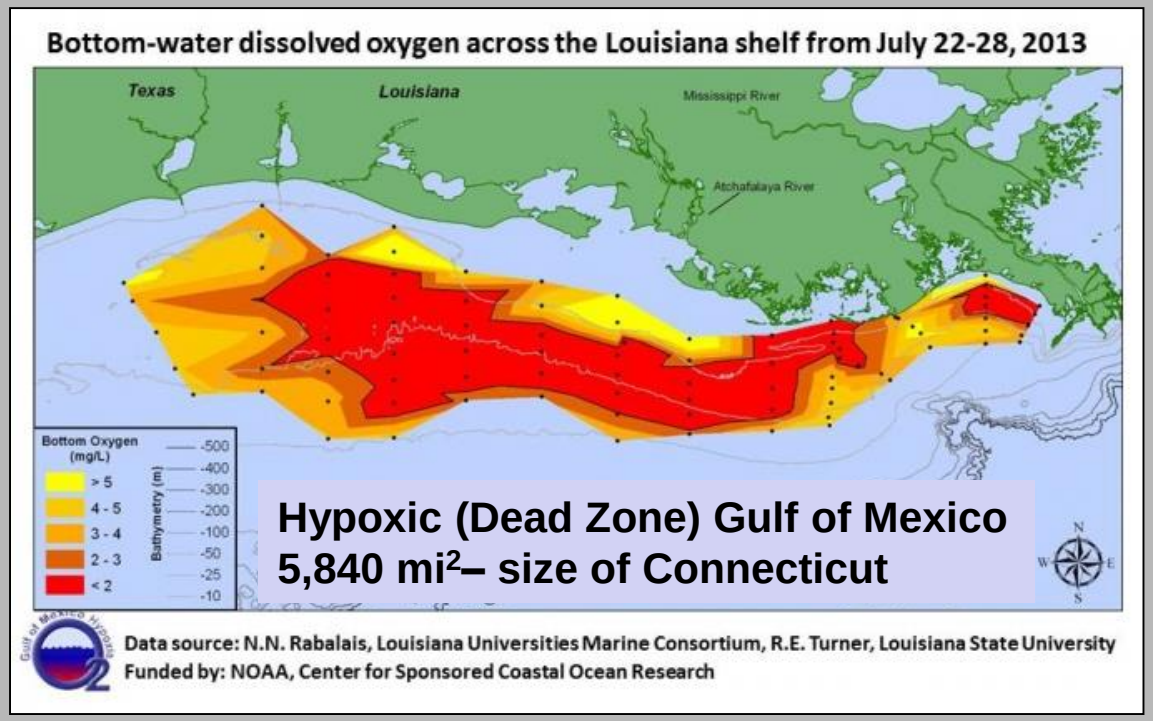
Riparian Zone Grazing Accelerates Bank Erosion & Increases Sediment & Nutrient Loading - Reduces Water Quality


Mass Wasting
Bank Failure
NREM 407/507 Field Exercise
Watershed Management
How much soil/sediment do these 2 blocks represent?
4 ft
10 ft
9 Tons of Sediment
20 ft
5 ft
18 Tons of Sediment

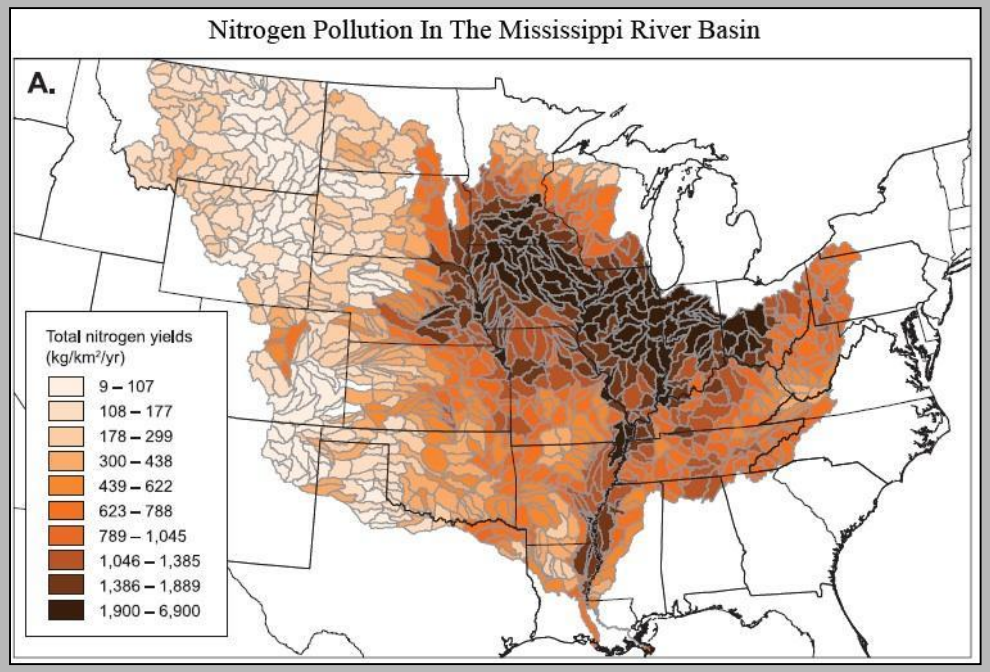
Channels Incise & Are Sediment Choked With High N & P & Aquatic Ecosystems are Dead

Most Midwestern Streams Are Badly Polluted

Flow into Missouri & Mississippi Rivers To The Gulf



More than 2X the size of 1,900 square mile goal set by Gulf of Mexico/Mississippi River Watershed Nutrient Task Force.

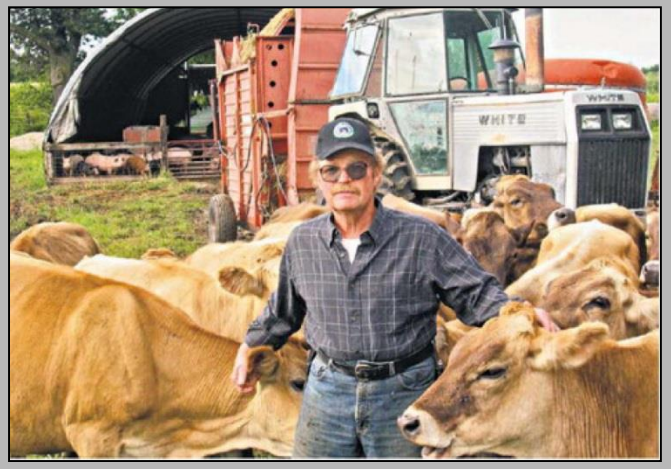


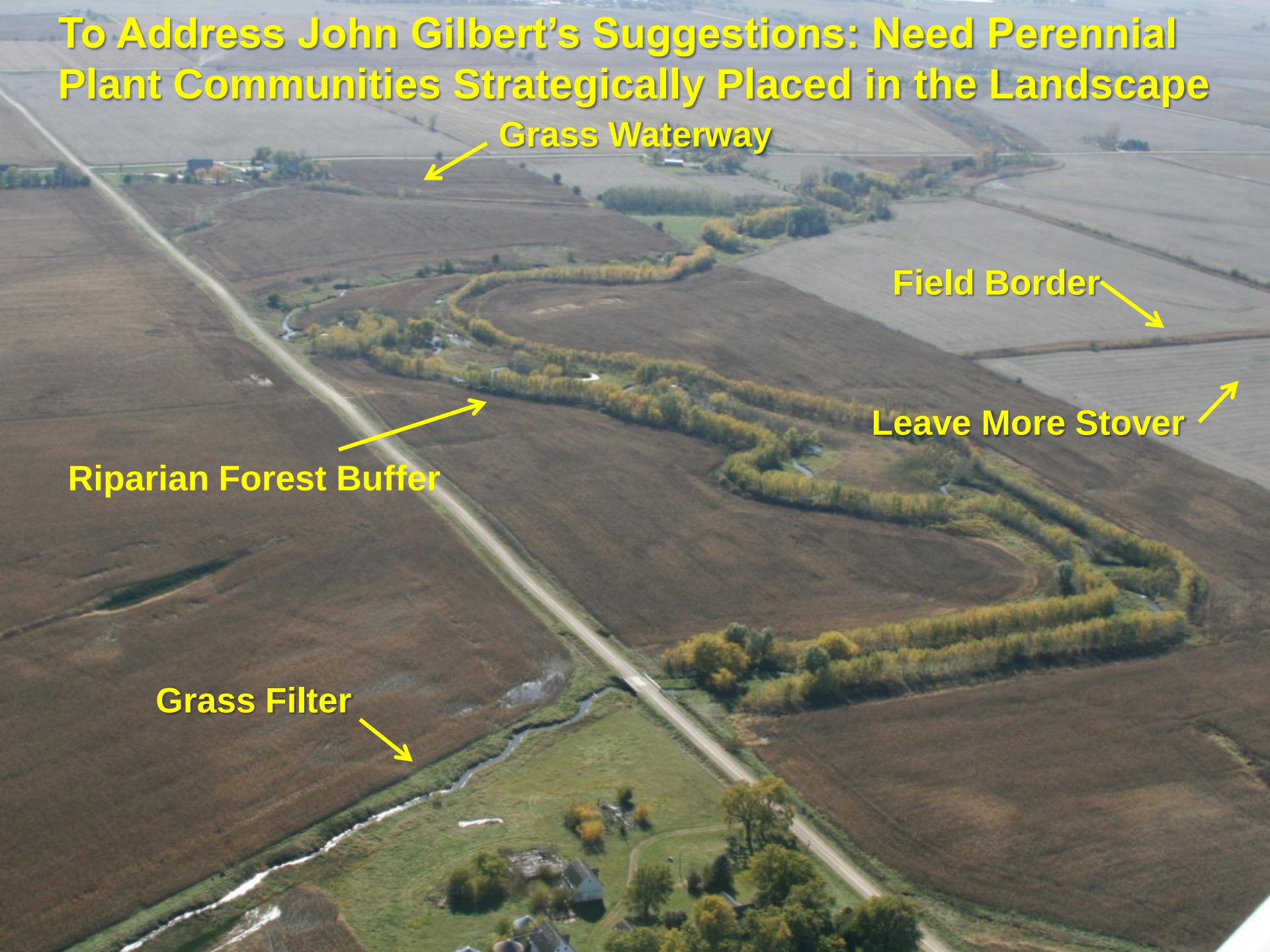
Different Views of the Real Cost of Agriculture

(Des Moines Register: July, 2013)

"The American farmer of today is the model of efficiency and productivity, single-handedly feeding 155 people. …… our weekly trip to the supermarket ensures us the safest and most reliable food supply in the world. We have the highest quality and greatest choices while paying the least of any global culture ……" Bruce Rastetter, president of the Iowa Board of Regents & CEO of a diversified, international agribusiness.

"…. Our current situation is not sustainable. We cannot continue to treat our soils like dirt. .. We know what we need to do: cover our soils year-round and reduce tillage, slow water movement and increase infiltration and regenerate our soil organic matter." John Gilbert – Dairy farmer in central Iowa.




To Address John Gilbert's Suggestions: Need Perennial Plant Communities Strategically Placed in the Landscape
Grass Waterway
Field Border
Leave More Stover
Riparian Forest Buffer
Grass Filter

Also Use In-Field Buffers & Cover Crops

In-field buffers in Missouri

Prairie Strips in Iowa

Photo credit: Anna MacDonald

Riparian Forest Buffer Design Objectives

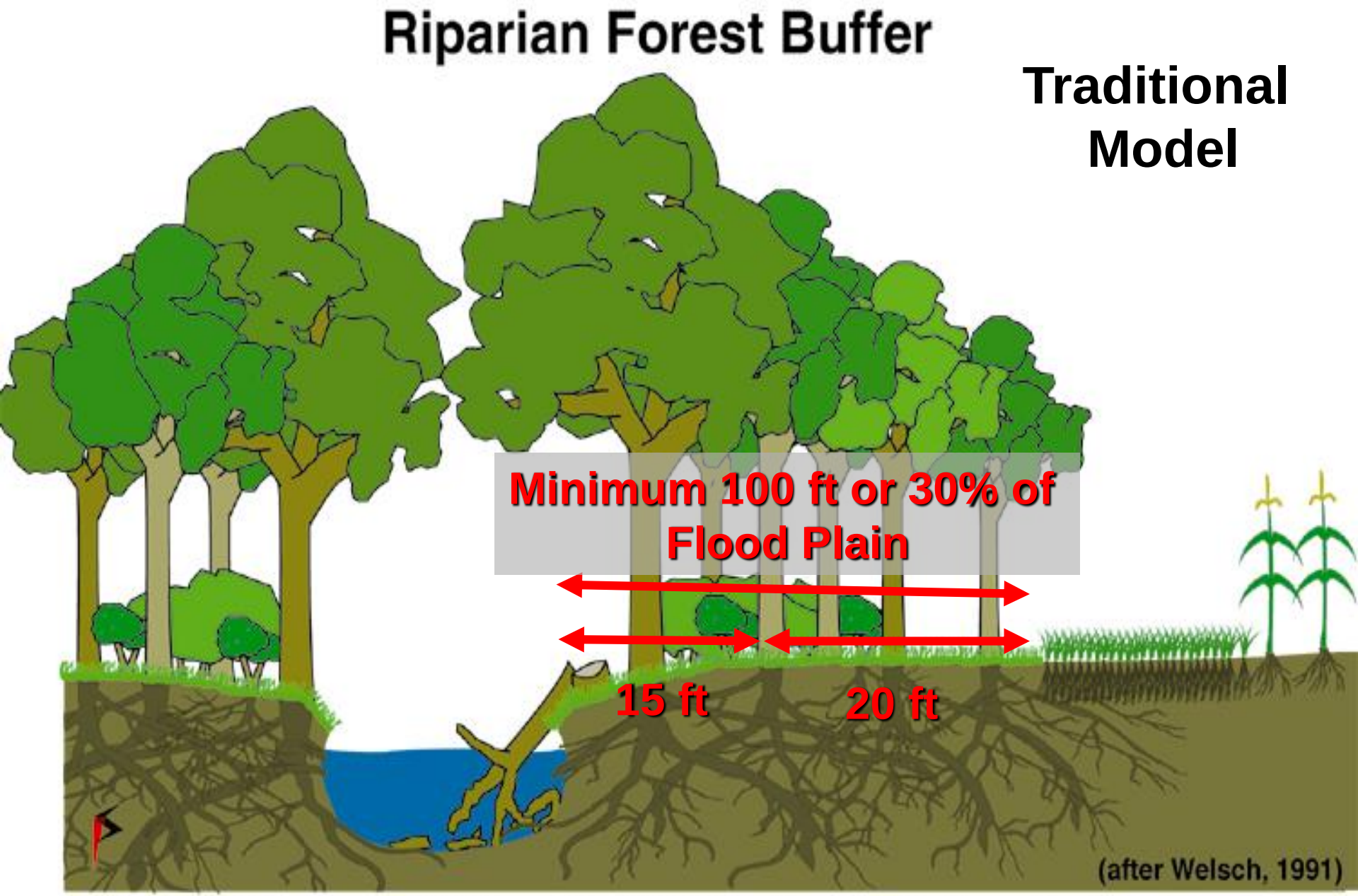
- Create shade to lower water temperatures to improve habitat for aquatic organisms
- Provide a source of detritus and large woody debris for aquatic & terrestrial organisms & create wildlife habitat & wildlife corridors
- Reduce excess amounts of sediment, organic material, nutrients, & pesticides in surface runoff & reduce excess nutrients & other chemicals in shallow ground water flow

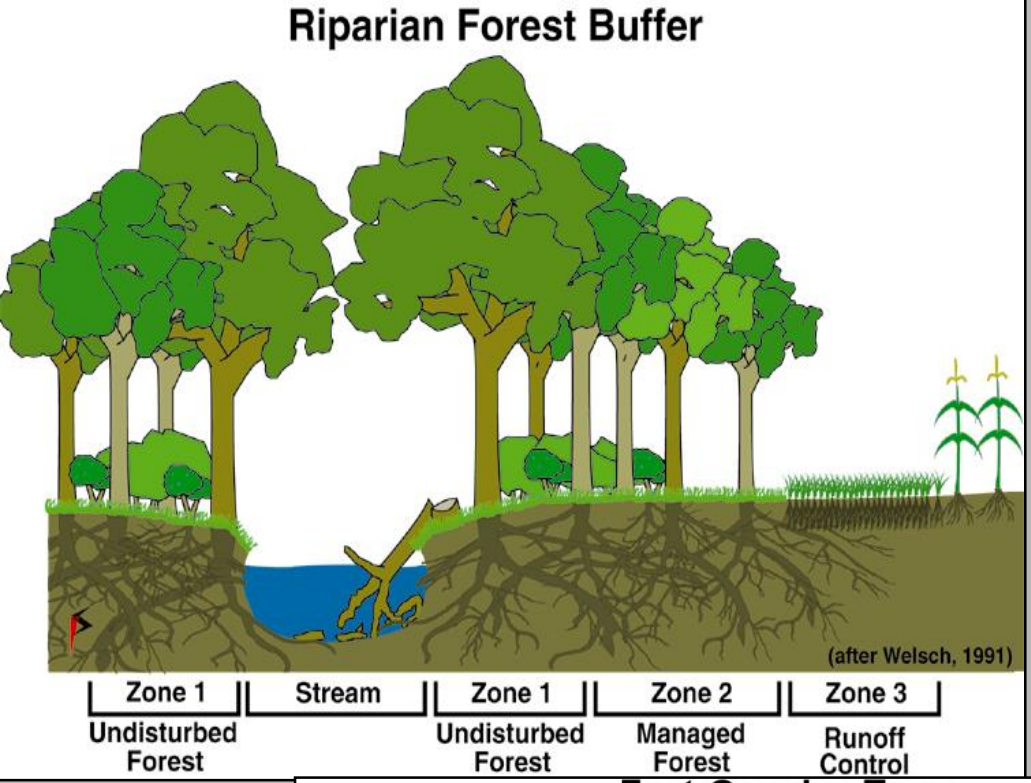
Riparian Forest Buffer Design Objectives

- Mitigate flooding damage by trapping large debris & water-borne sediment, slowing flood waters & lowering flood peaks.
- Restore natural riparian plant communities
- Increase carbon storage in plant biomass & soils
- Provide a harvestable crop of timber, fiber, forage, fruit or other crops consistent with other intended purposes

Riparian Forest Buffer

Traditional Model

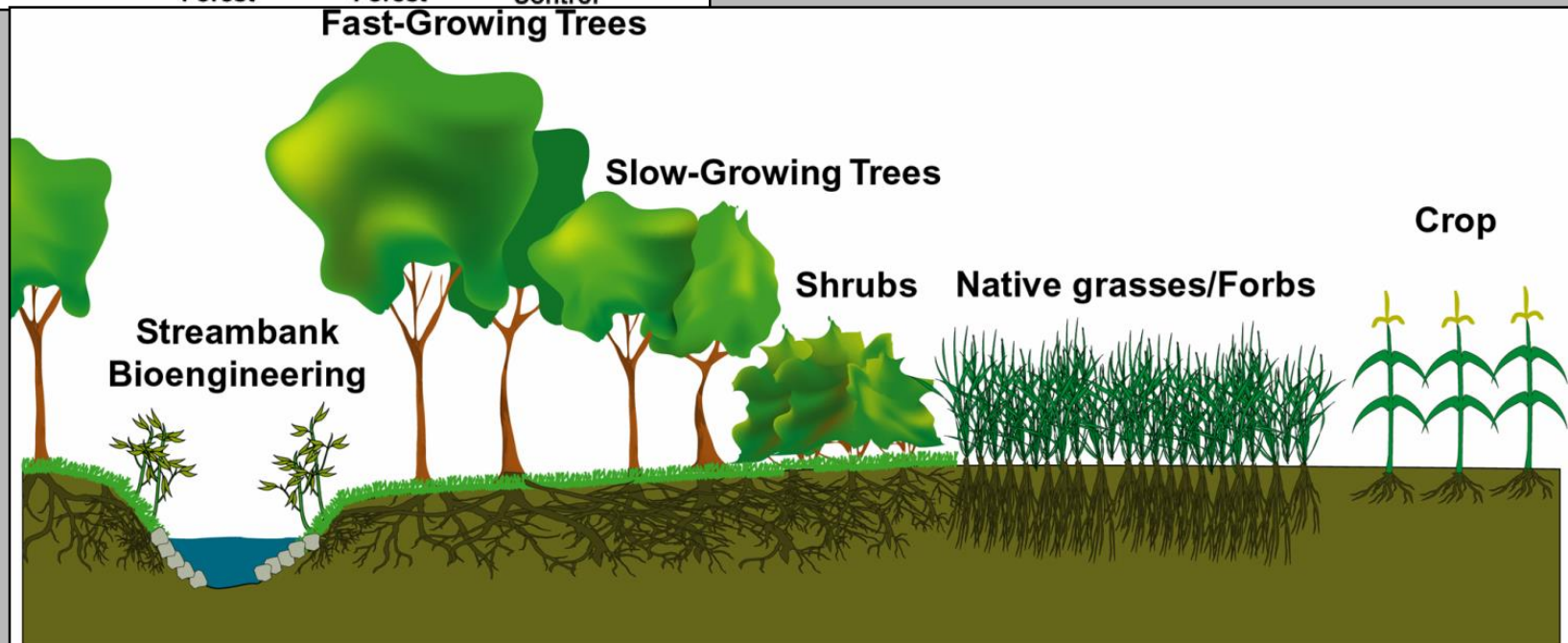




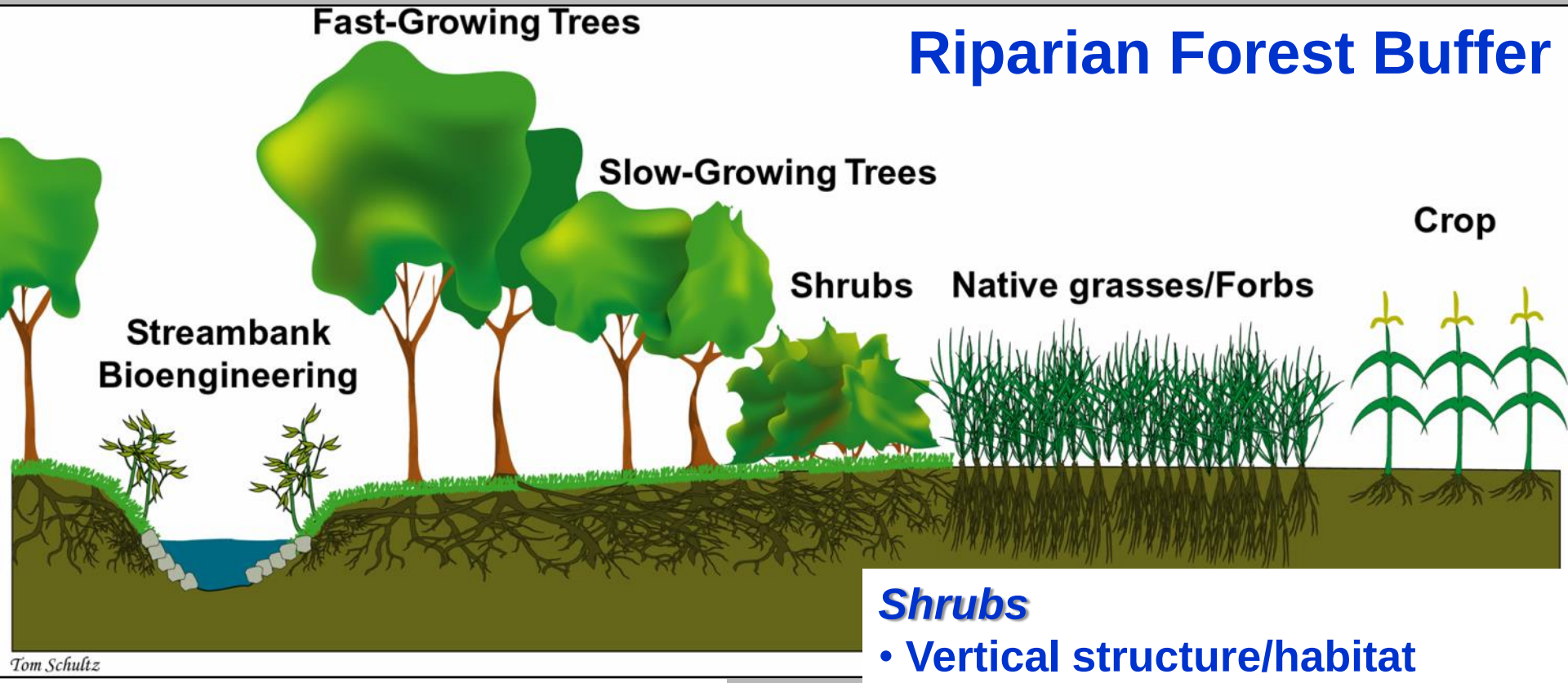
Traditional Model

3 Zone vs 2 or 3 Zone

Modified Corn Belt Model



Riparian Forest Buffer



Trees

- Vertical structure/habitat
- Improve soil infiltration/tilth
- Standing nutrient storage
- Intercept subsurface pollutants
- Carbon storage
- Strong woody roots/banks
- Stream shading/in-stream food

Shrubs

- Vertical structure/habitat
- Multiple-stems – trap debris
- Woody roots
- Little stream shading

Native Grasses

- Wildlife habitat/cover/forage
- Sediment removal from runoff
- Improve soil infiltration/tilth
- No stream shading/ detritus
- Keep out invasive species

Riparian Forest Buffer Now Does Not Include Grass Filter

Since the majority of the area must now be planted to trees/shrubs re-enrollment requires that: 1) the area previously planted to grass now be planted to trees/shrubs, or 2) re-enroll only the tree/shrub portion (landowner might then convert grass strip back to row crops)

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

RIPARIAN FOREST BUFFER

(Ac.)

CODE 391

DEFINITION

An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

PURPOSE

- Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms.
- Create or improve riparian habitat and provide a source of detritus and large woody debris.
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Reduce pesticide drift entering the water body.
- Restore riparian plant communities.
- Increase carbon storage in plant biomass and soils.
- Mitigate flooding damage by trapping large debris and water-borne sediments, slowing flood waters and lowering flood peaks.
- Provide a harvestable crop of timber, fiber, wildlife forage, fruit or other crops consistent with other intended purposes.
- Create riparian habitat and corridors for wildlife.
- Provide room for water courses to establish geomorphic stability.

CONDITIONS WHERE PRACTICE APPLIES

Riparian forest buffers are applied on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands. They are not applied to stabilize stream banks or shorelines. It should not be applied to small cold water trout streams.

The riparian forest buffer will be most effective when used as a component of a total resource management system including nutrient management, pest management, and erosion runoff and sediment control practices.

CRITERIA

General Criteria Applicable to All Purposes

The riparian forest buffer shall be positioned appropriately and designed to achieve sufficient width, length, vertical structure/density and connectivity to accomplish the intended purpose(s).

It must be wide enough to achieve the purpose and minimally 40 feet measured horizontally on a line perpendicular to the water body beginning at the normal water line, bank-full elevation, or the top of the bank as determined locally.

Dominant vegetation will consist of existing, naturally regenerated, or seeded/planted trees and shrubs suited to the soil and hydrology of the site and the intended purpose(s). Use locally grown native species. Plantings will consist of two or more species with individual plants suited to the seasonal variation of the site's moisture status. No single species will

NRCS, IA
August 2007

With Forest Buffers Alone Concentrated Flow Can Pass Through Almost Unimpeded Forming Gullies

Forest Buffer with No Grass Filter

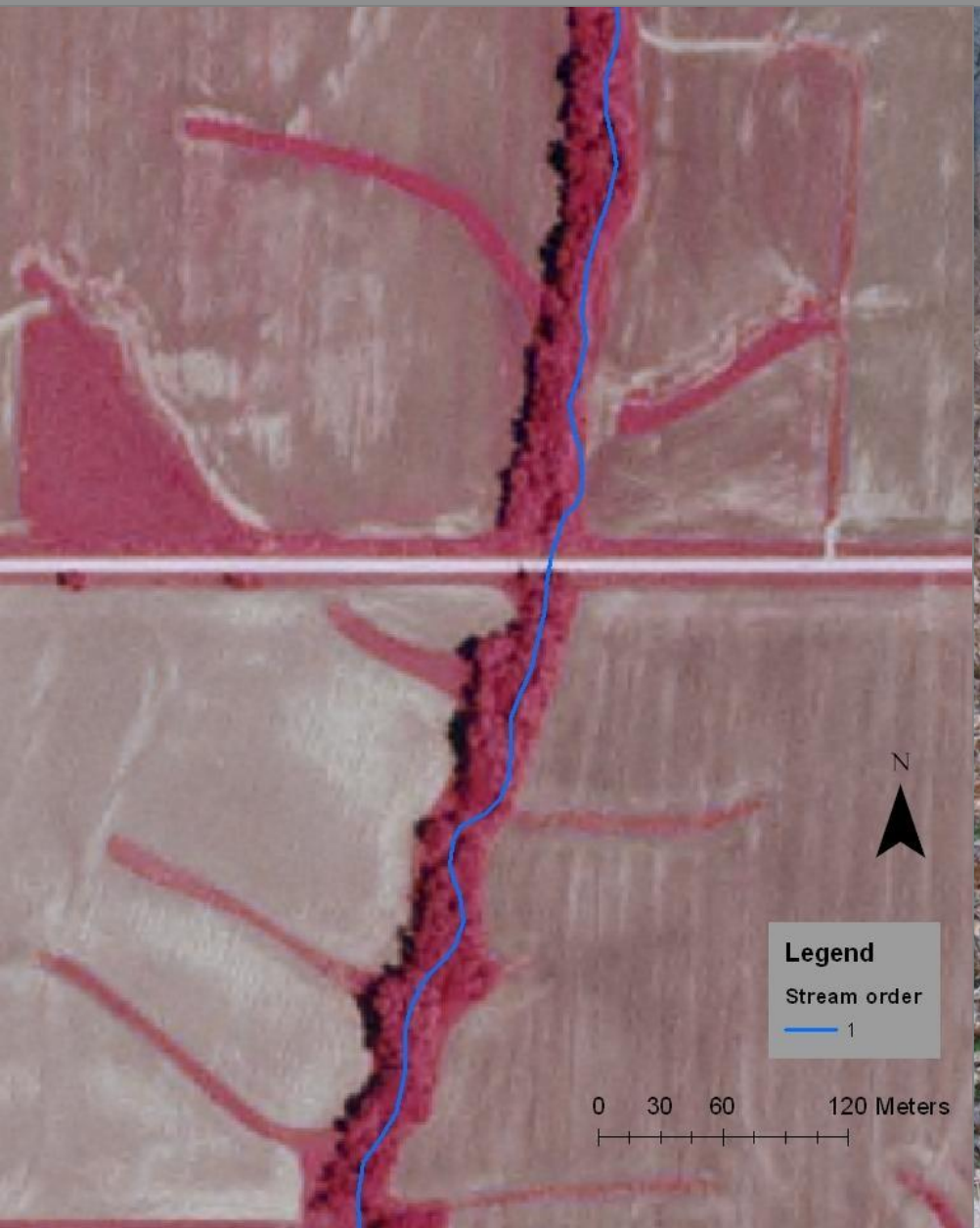
Forest Buffer with Grass Filter Traps
100% of Surface Runoff Sediment


700 Trees per Acre
17% Grass Cover
Surface Runoff


350 Trees per Acre
87% Grass Cover
No Surface Runoff

Grass Waterways Used to Stop Annual Development of Ephemeral Gullies – Carry Water Without Sediment Load

Many Grass Waterways End At A Forest Only Buffer - 21 of 39 waterways surveyed had classic gullies passing through them



A well-managed grass filter can be control gullies or consider thinning forest to allow more perennial ground cover to grow.

More Buffer Design Considerations:

Constraints of the site – depth of channel incision – depth to water table, rate of widening

Constrained by FSA/NRCS Specifications

Market opportunities & landowner objectives

- Farmers with large corn/bean operations need less intensive, longer term woody plants & wildlife habitat
- Farmers with diversified crops can diversify more with berries & nuts

Design Considerations - Market Opportunities

Decorative florals (2-3 years; dogwoods, pussy willow)

Nut trees (5-15 years; hazel nuts, walnut, pecan)

Fruit trees, berries (3-5 years; apple, raspberries)

Shrubs for jellies, etc.

Mushrooms in tree strips

Biomass & timber (15-40 years, cottonwood, walnut)

Examples of Species Suitable for Riparian Plantings

Trees

Cottonwood
Sycamore
Willow
Silver Maple
Walnut/ Pecan
Shellbark Hickory
Swamp White Oak
Red Oak
Burr Oak
River Birch
Hackberry

Shrubs

Redosier Dogwood
Silky Dogwood
Gray Dogwood
American Plum
Persimmon
American Cranberry Bush
Chokecherry
Nanking Cherry
Crabapple
Paw Paw
Ninebark
Hazel


Persimmon


©Nancy
Asian Pear


Cornelian Cherry


Aronia Berry


Chinese Che


Elderberry

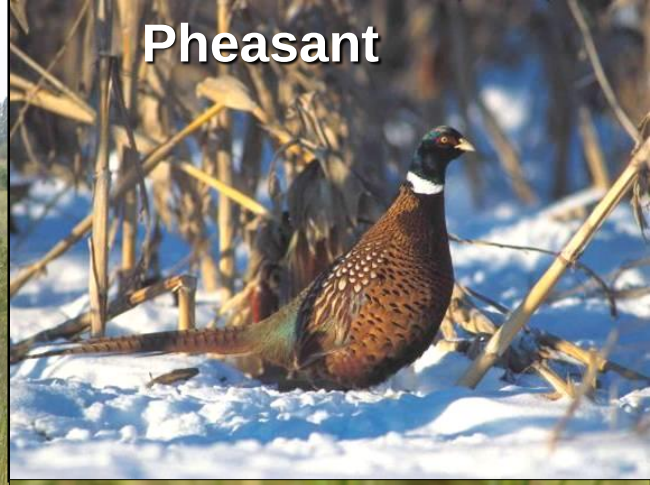

Paw paw


Kiwi

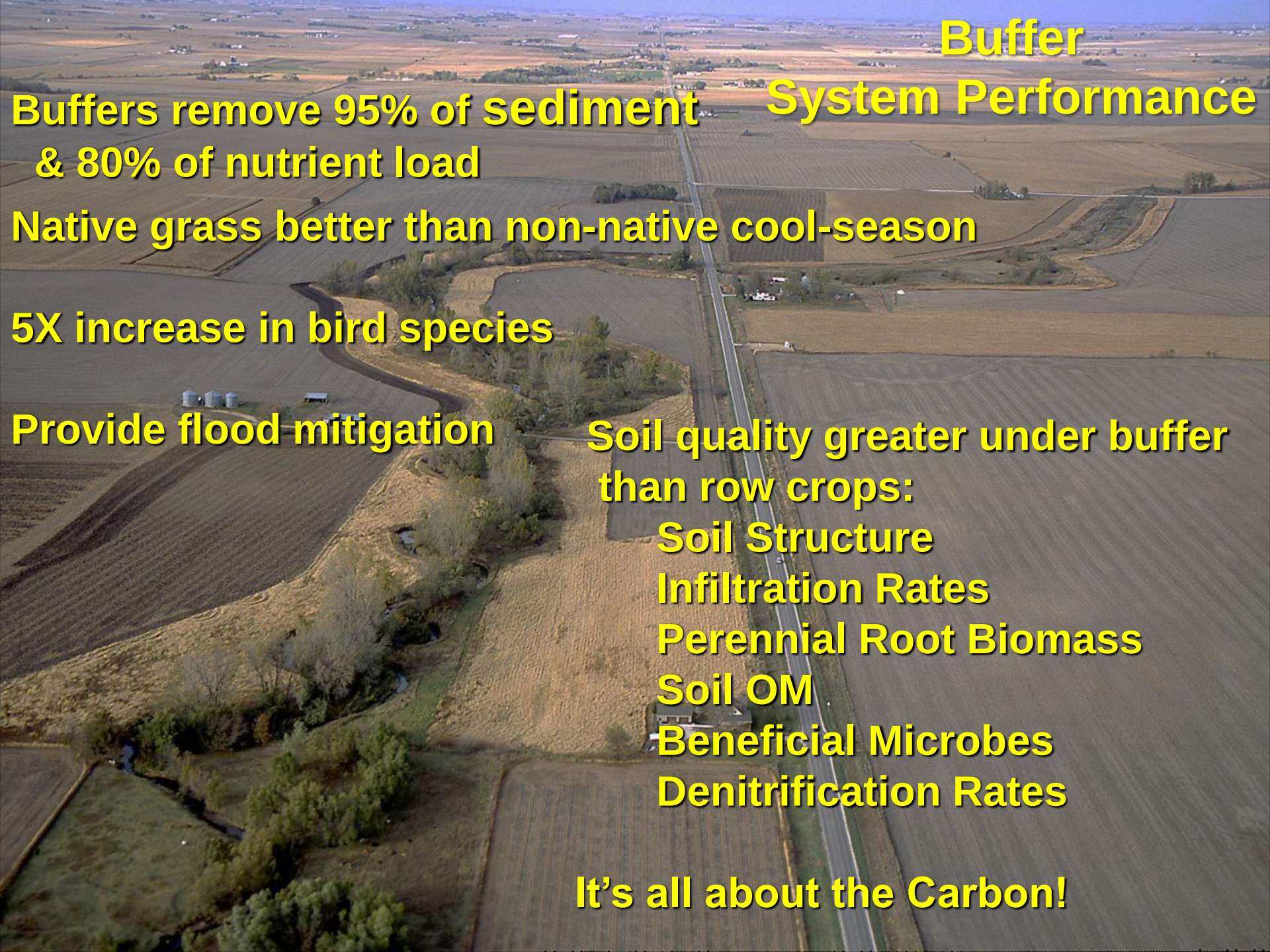

Goji berry


Woody Component For Biomass/Timber
Thin & prune to maintain groundcover
& improve tree quality & remove nutrients

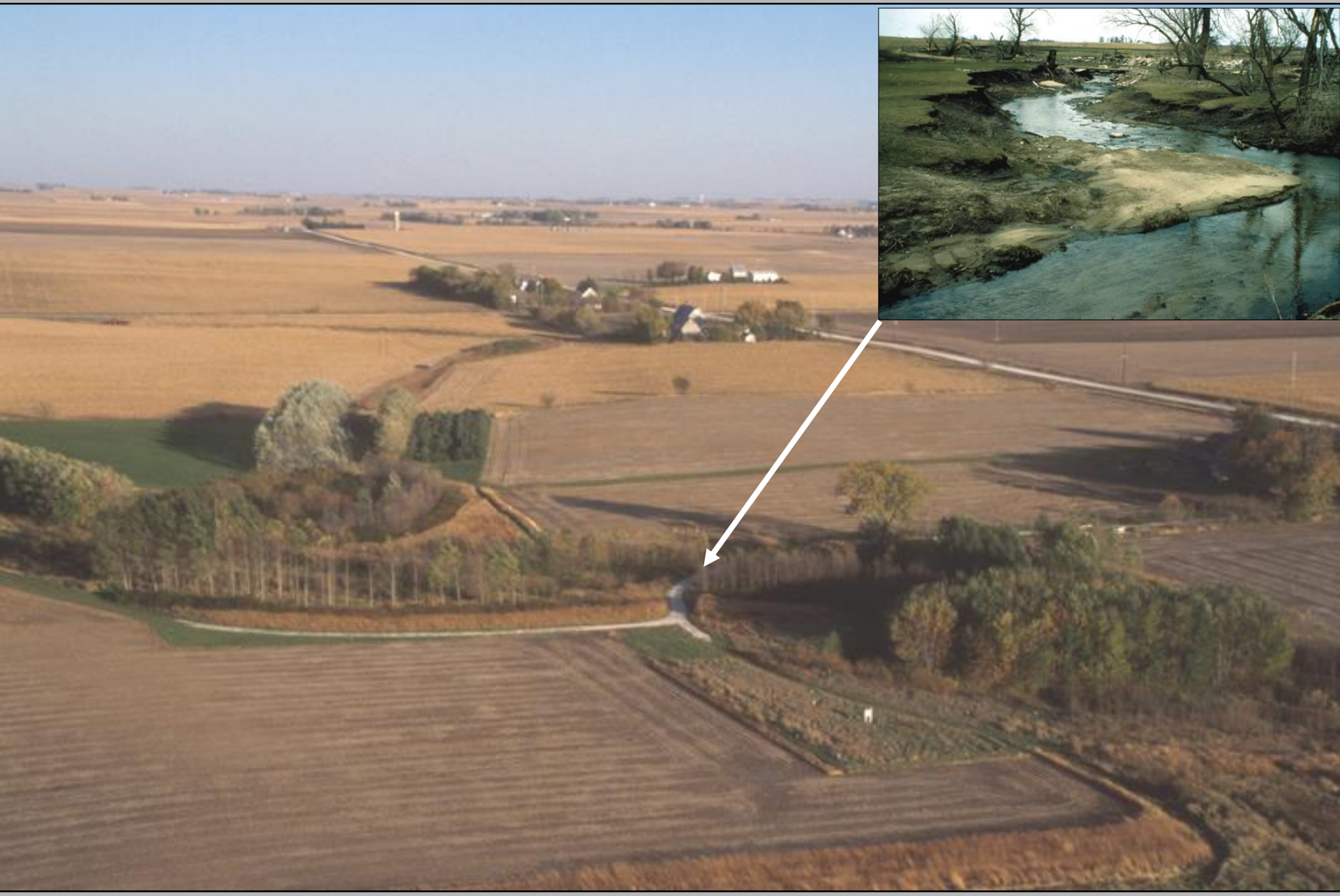
Design - Upland Bird Habitat



Design - Forest Game Habitat


Buffer
System Performance
Buffers remove 95% of sediment
& 80% of nutrient load
Native grass better than non-native cool-season
5X increase in bird species
Provide flood mitigation
Soil quality greater under buffer than row crops:
Soil Structure
Infiltration Rates
Perennial Root Biomass
Soil OM
Beneficial Microbes
Denitrification Rates
It's all about the Carbon!

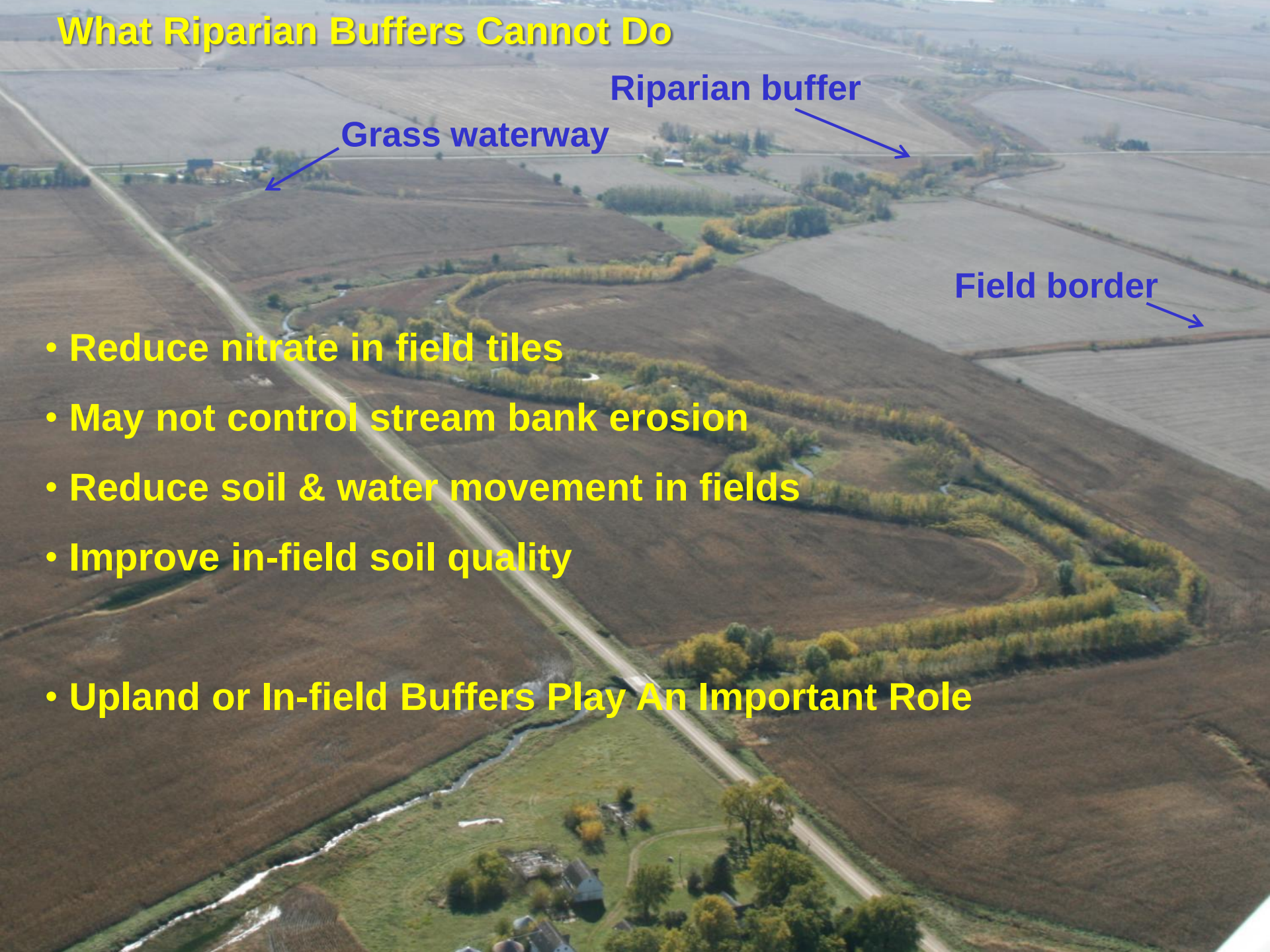
Riparian Forest Buffer Success



Riparian Forest Buffer Success

Riparian Forest Buffer Success

What Riparian Buffers Cannot Do



- Reduce nitrate in field tiles
- May not control stream bank erosion
- Reduce soil & water movement in fields
- Improve in-field soil quality

- Upland or In-field Buffers Play An Important Role

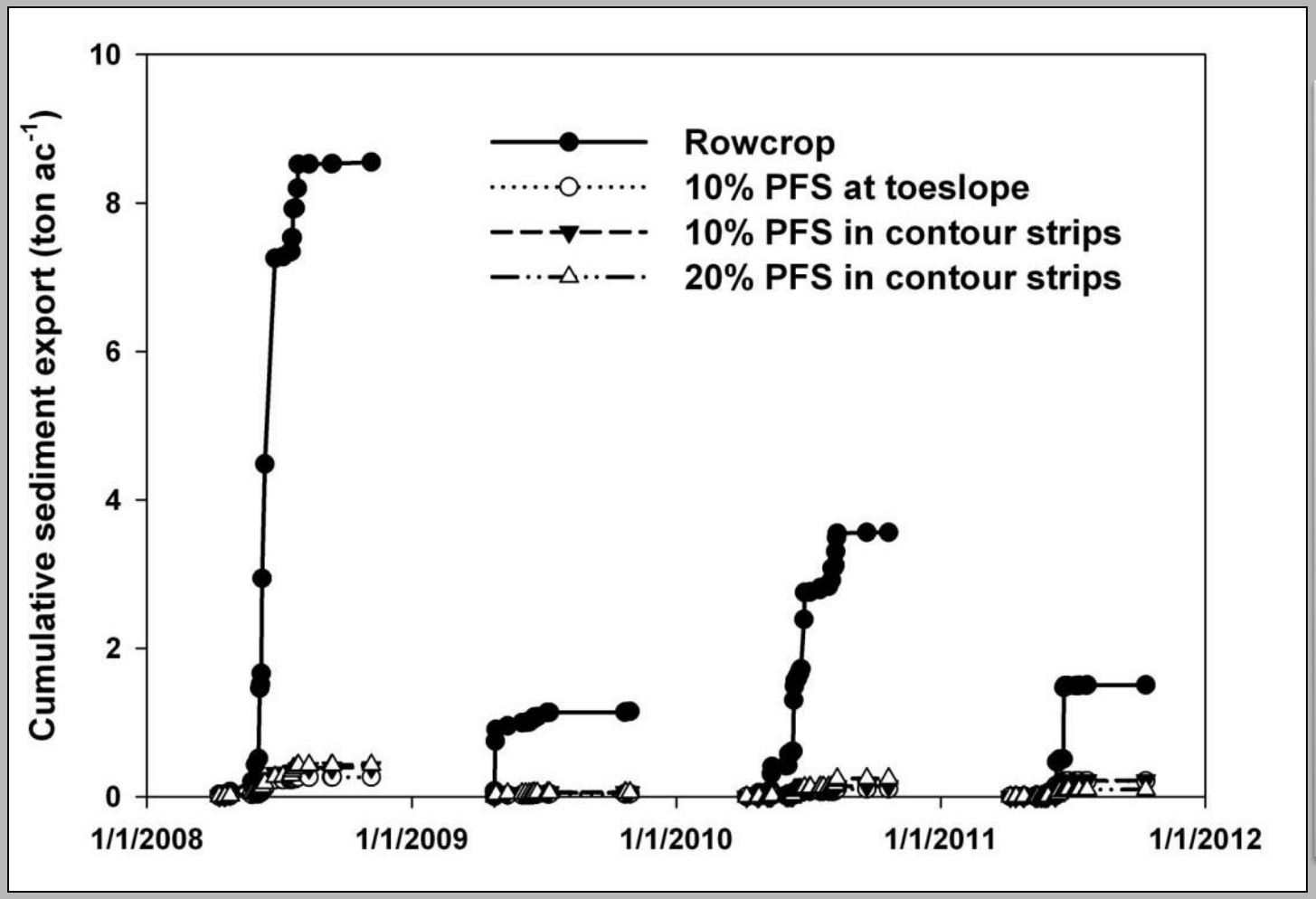
UMCA Buffer Research On Upland Buffers

- Grass buffers reduce herbicide transport up to 80% from surface runoff
- Native grasses better than non-native cool season
- Switchgrass 80% reduction of atrazine in soil in 25 days
- In-field agroforestry practices reduce field runoff by 16%
- Soil erosion by 25%

In-Field Buffers
Row-crops with Prairie Strips at Neal Smith Wildlife Refuge - ISU

Website: PrairieStrips.Org

Sediment Loss in Runoff (2008-2011)

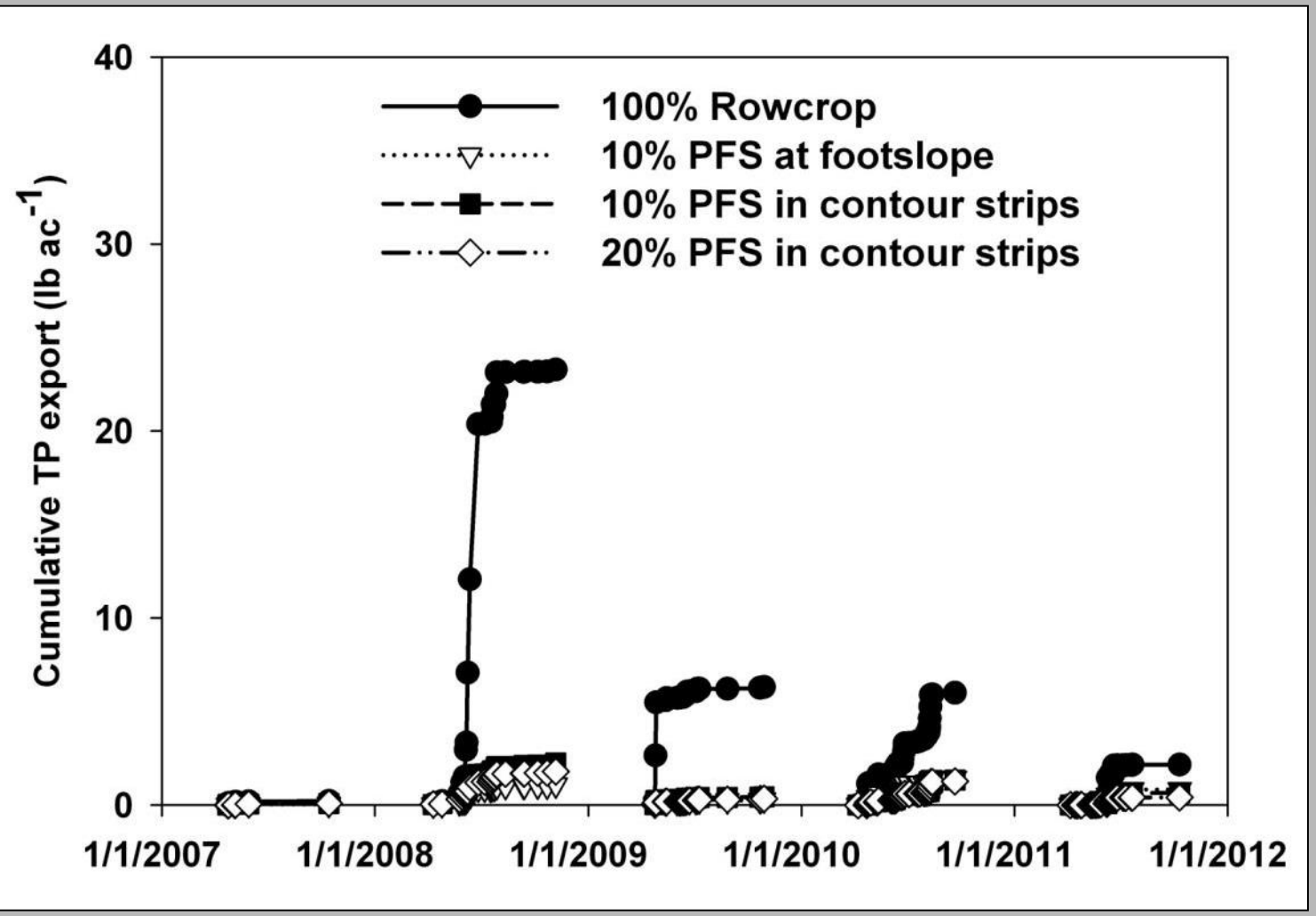


>95% Reduction in sediment export from watersheds with prairie filter strips.

No-till practices alone were not sufficient to limit sediment loss from all-crop watersheds.

Helmers et al., 2012, J. Env. Qual.

Sediment Loss in Runoff (2008-2011)



>90% Reduction in TP export from watersheds with prairie filter strips

Helmers et al., in review

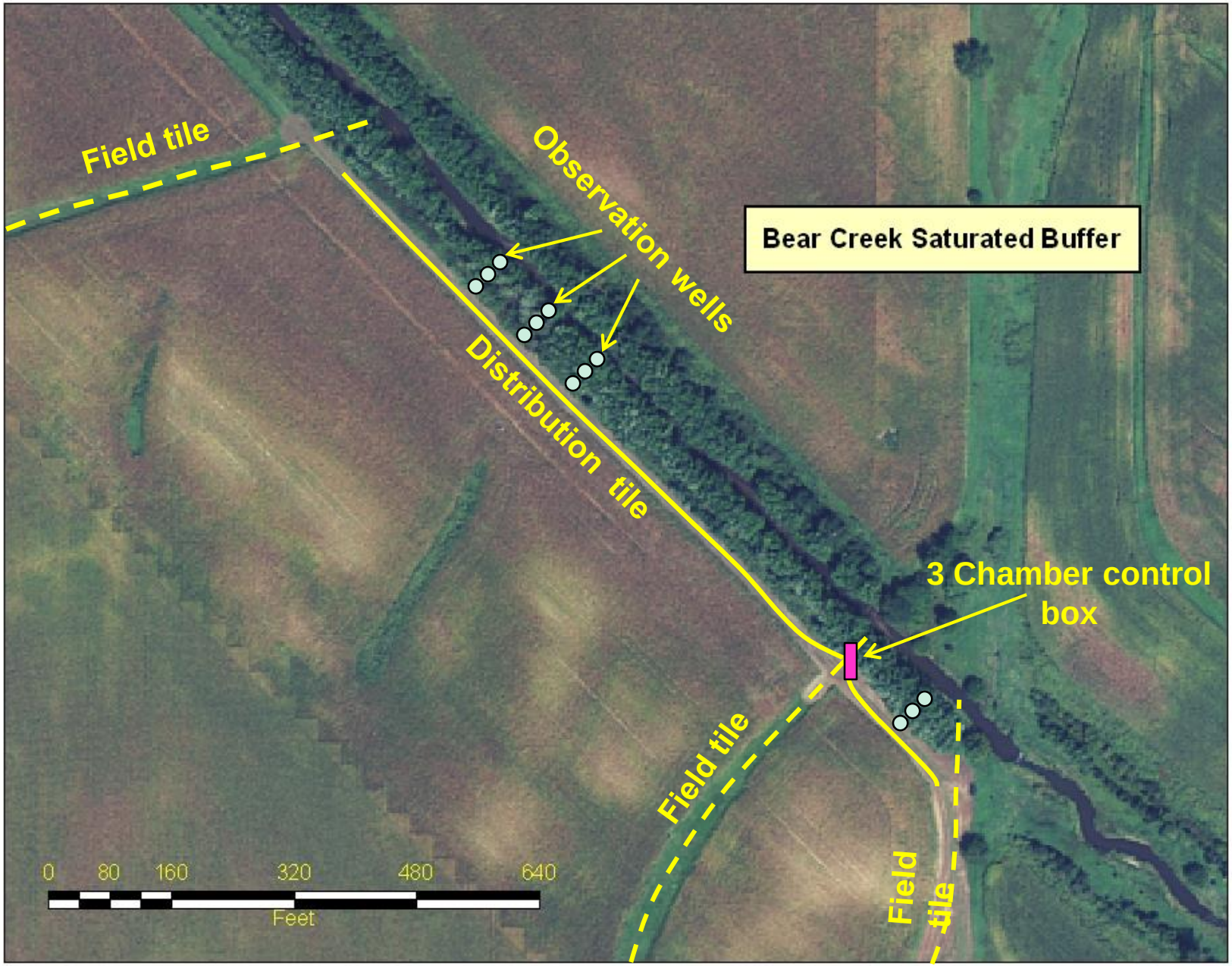
Tiles Pass Under Buffers Without Any Treatment Alternatives for Tile-drained Landscapes?

CREP Wetland

Bioreactor

Saturated Tile Buffers

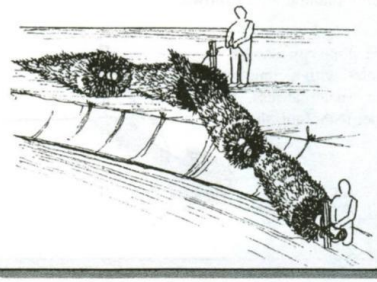
Control Box


Field tile
Observation wells
Bear Creek Saturated Buffer
Distribution tile
3 Chamber control box
Field tile
Field tile
0 80 160 320 480 640
Feet

Buffers Are Not Very Effective At Stabilizing Deeply Incised Stream Banks - Bank Erosion – 40-80% of Sediment in Streams

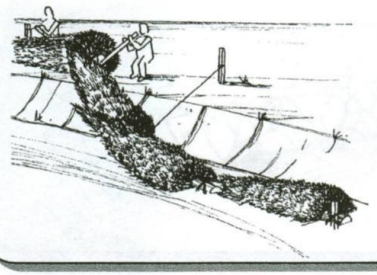
Bioengineering Methods

Lower revetment into stream and fasten end of revetment to a t-post placed at toe of bank.



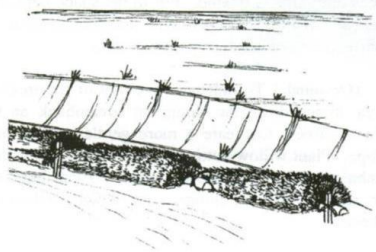
Step Three: Begin Placement

Lever the rest of the revetment into the stream, temporarily securing the revetment to the t-posts.



Step Four: Final Placement

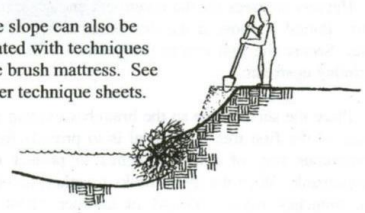
Pound t-posts next to the revetment and secure revetment to posts with wire.



Step Five: Final T-post Placement

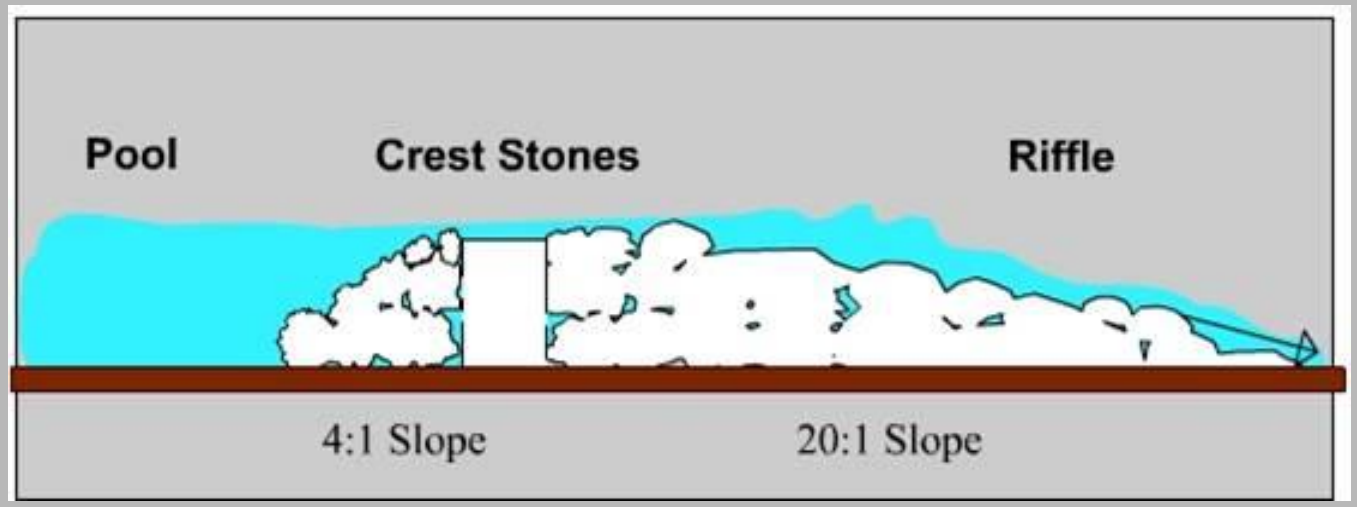
Streambank can be knocked down on to the revetment. Slope should be seeded with grass and planted with willows.

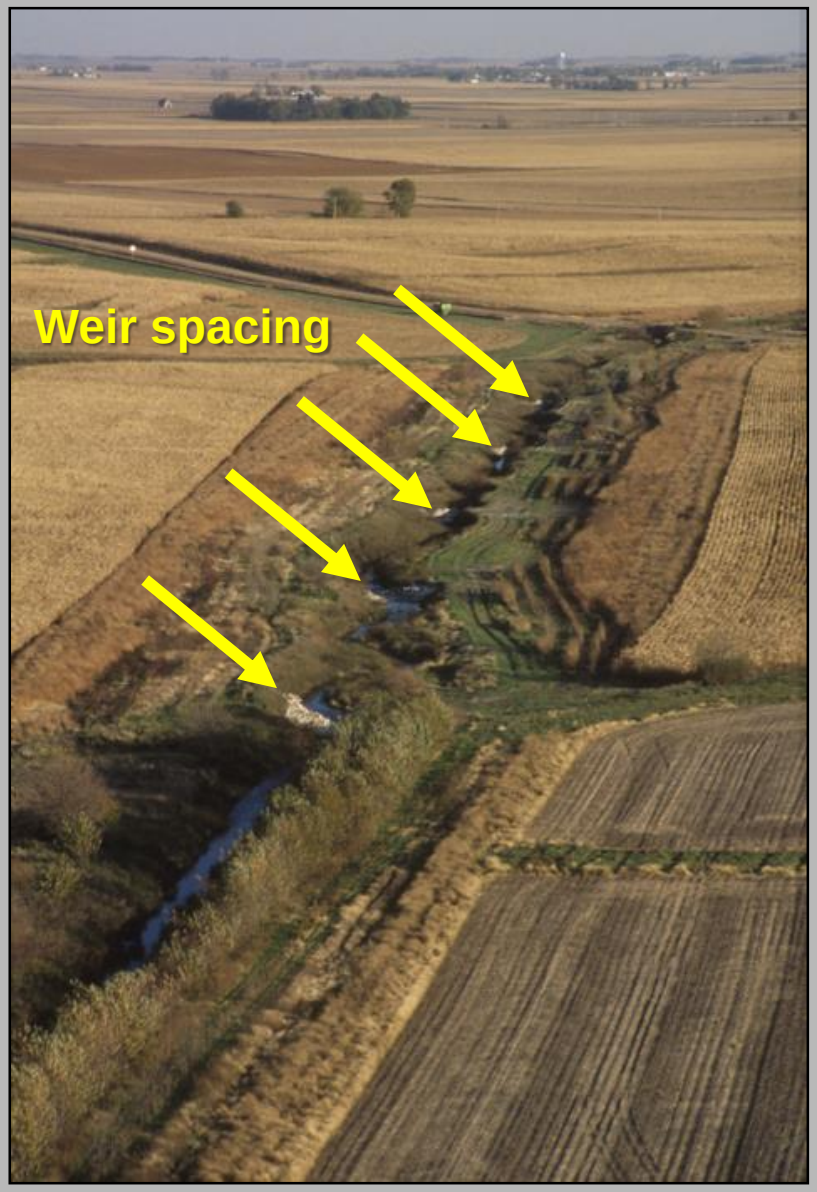
The slope can also be treated with techniques like brush mattress. See other technique sheets.



Step Six: Optional Bank Shaping

Boulder Weir (Riffle Structure)





Weirs spaced about 300 ft apart. Total length of one weir about 75 ft.

Riparian Grazing Solutions

- Fencing narrow corridor along stream may be sufficient
- Establish 3 dense shrub rows: wild plum, dogwood, ninebark & remove fence

Constraints to Adoption

Volunteer Adoption Does Not Work

Must not treat soil like dirt

Streams should be valued as more than drainage ditches

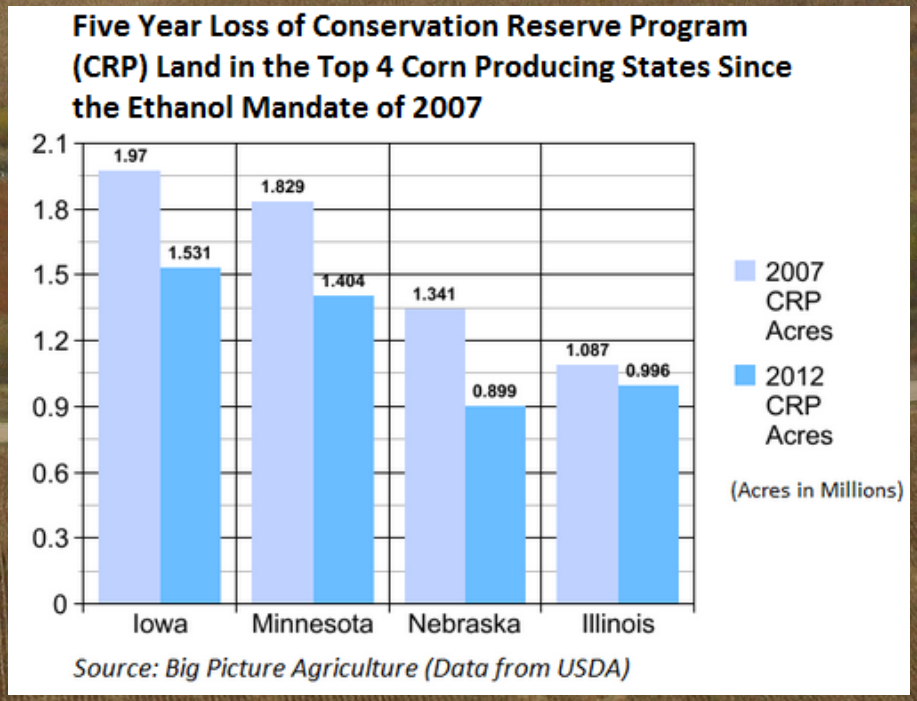
CRP acres being lost for row crops

Not enough flexibility in standards

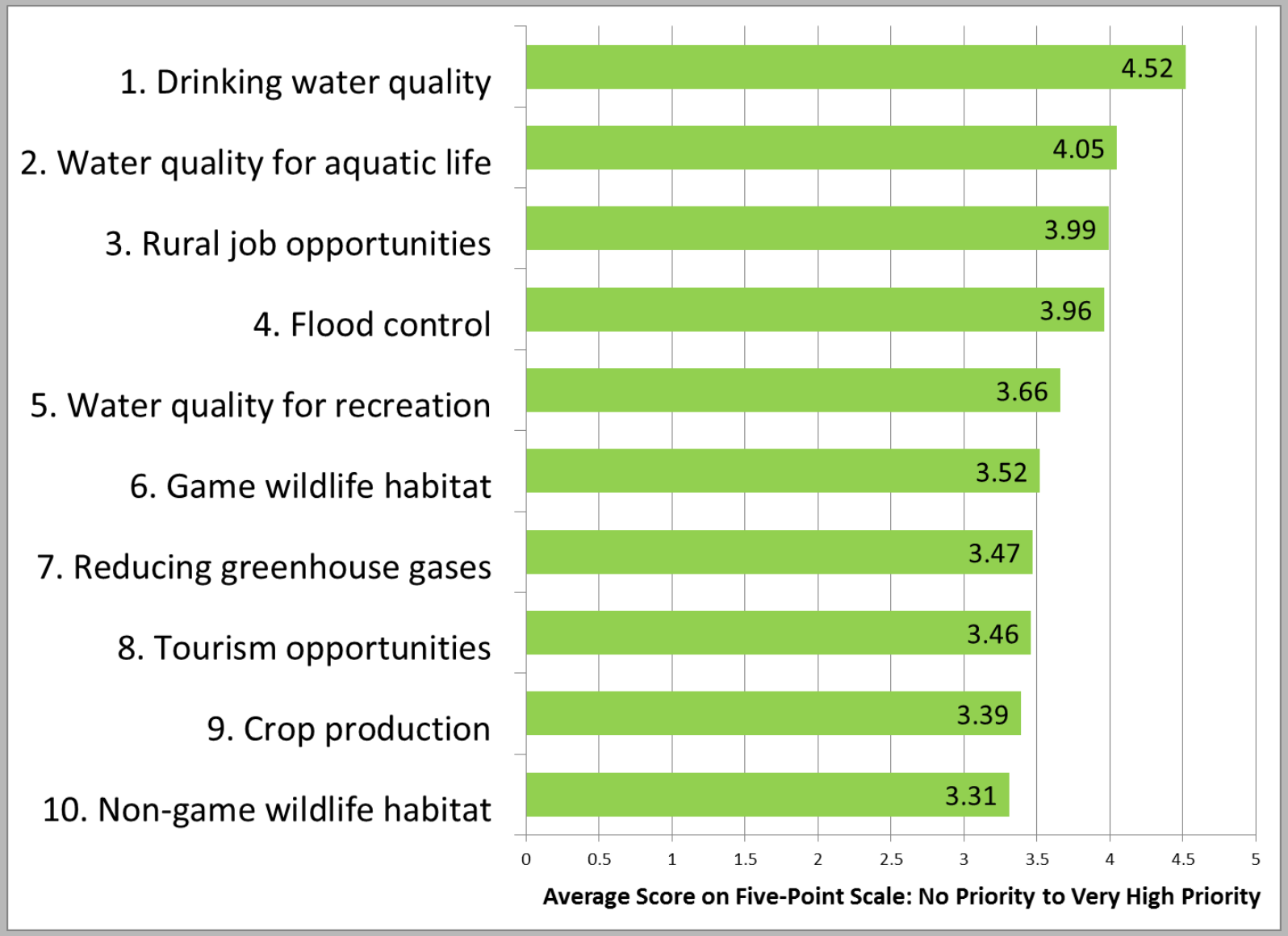
Rewritten standards are flawed

Climate change challenges buffers

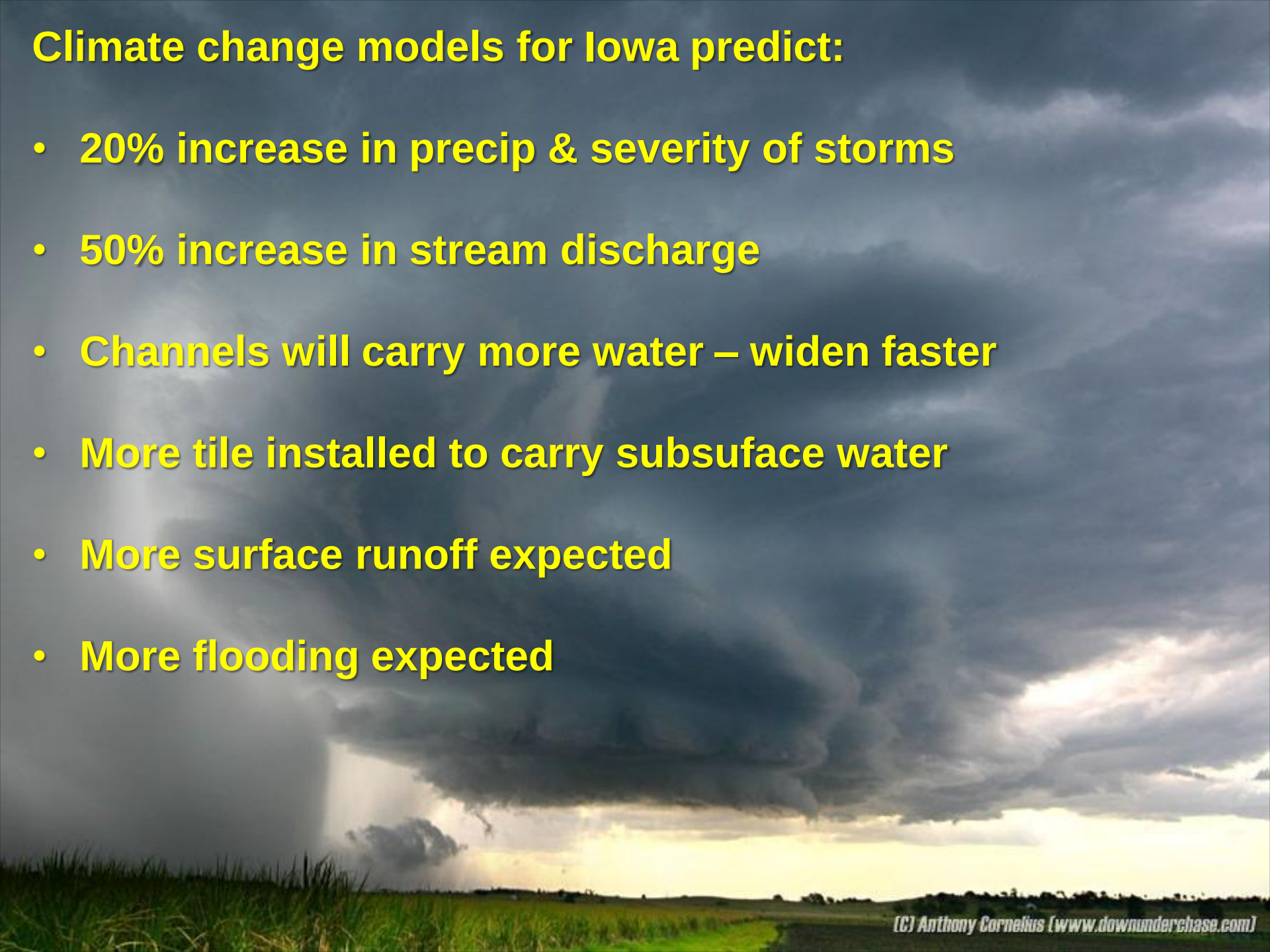
Early Adopters Have Volunteered



General public's Top 10 priorities for what agriculture should provide – Agroforestry can provide many of these

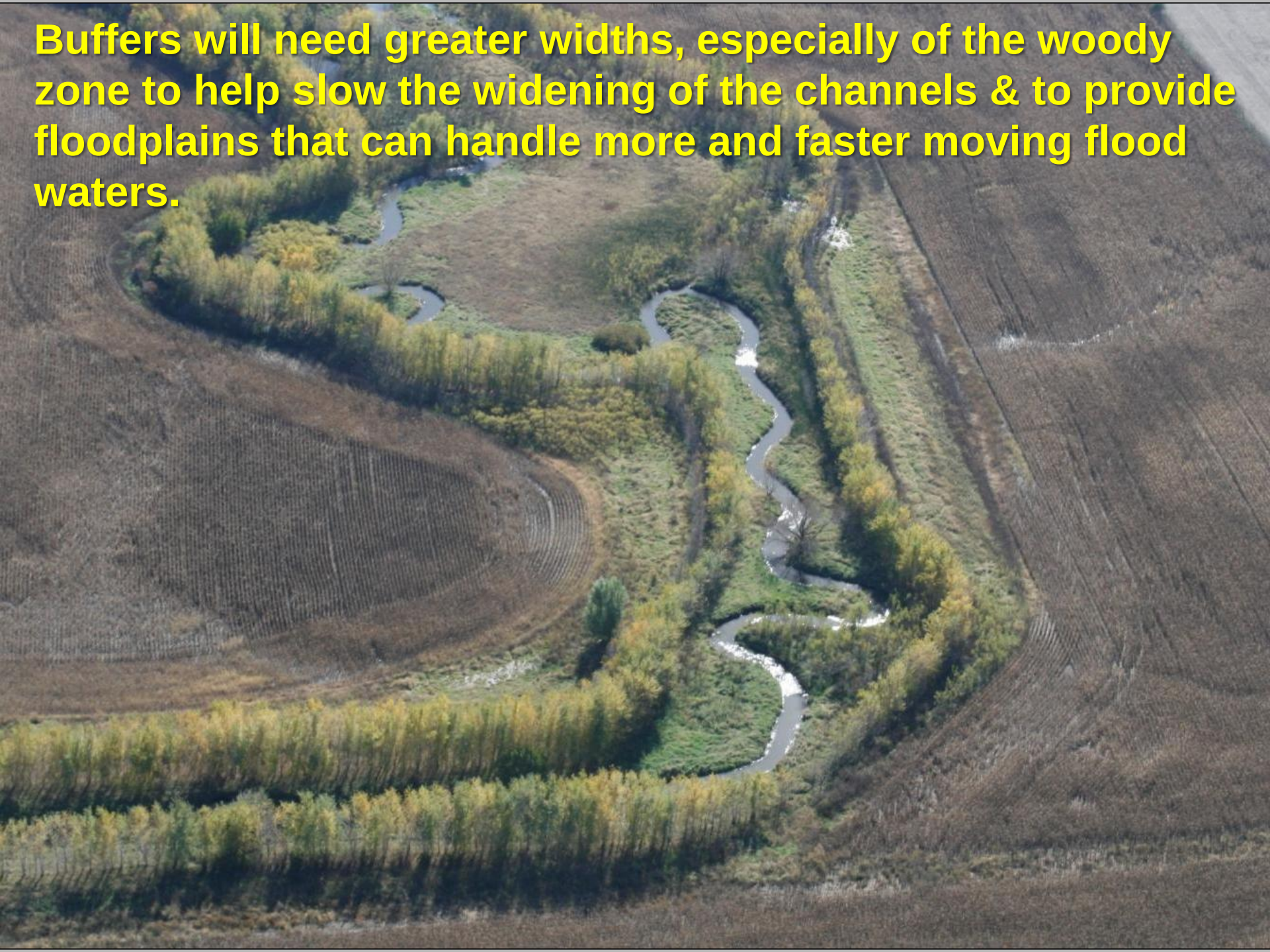


J.G. Arbuckle and J. Tyndall, unpublished data


Climate change models for Iowa predict:
• 20% increase in precip & severity of storms
• 50% increase in stream discharge
• Channels will carry more water – widen faster
• More tile installed to carry subsuface water
• More surface runoff expected
• More flooding expected
(C) Anthony Cornelius (www.downunderchase.com)

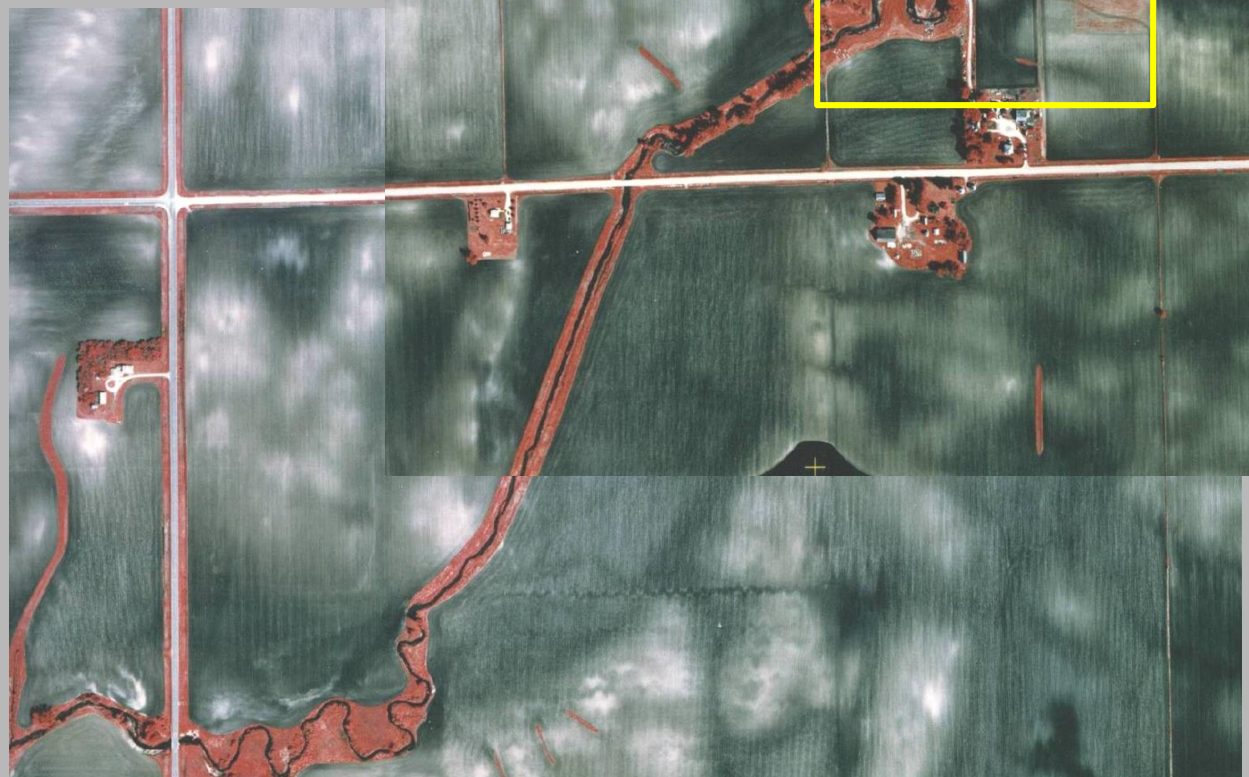
Added Runoff Results in Accelerated Bank Erosion & Sediment & Nutrient Loading

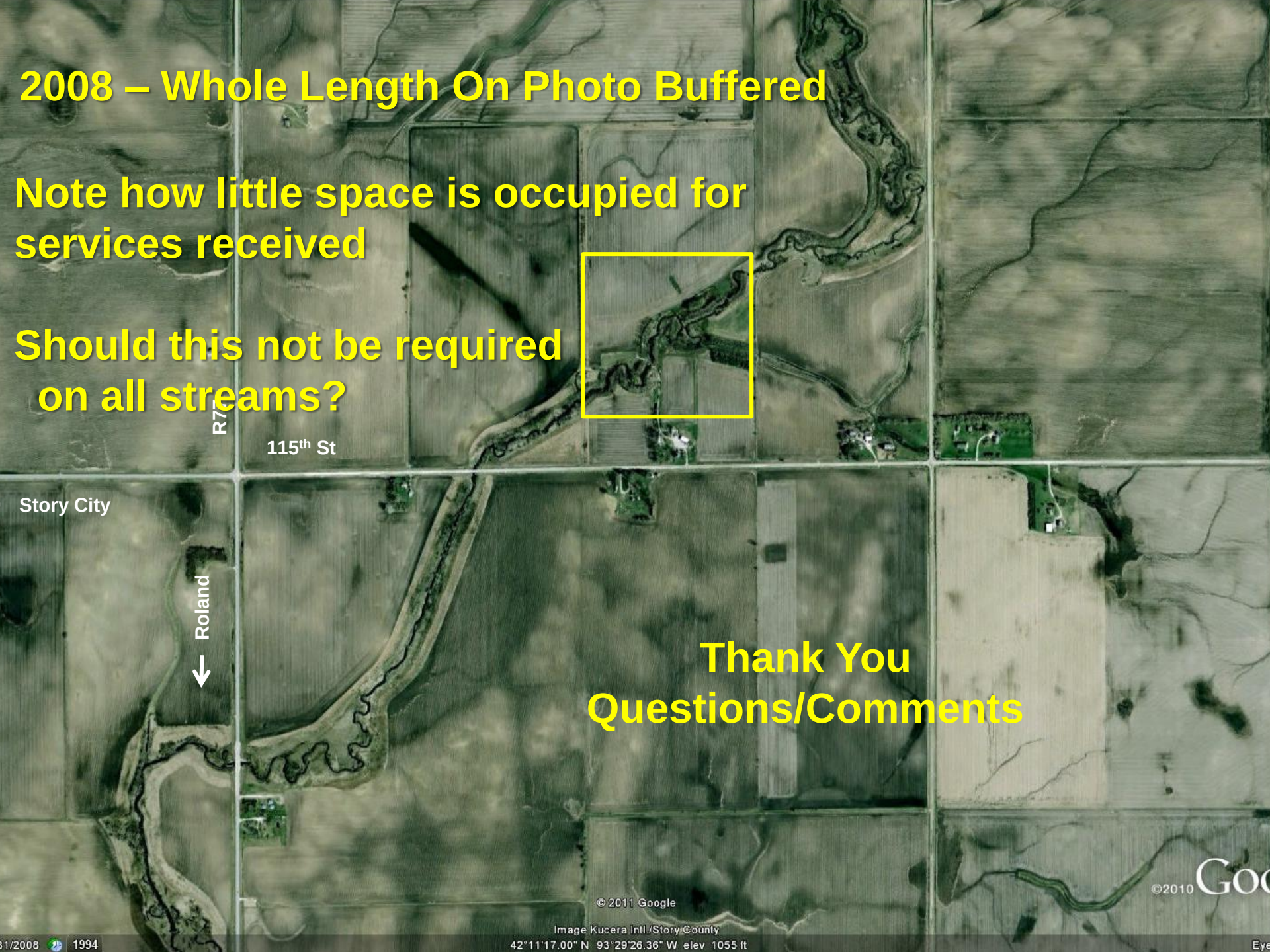

Channel Evolution Model
Stage
I
Terrace1
Q2
h < hc
Stable
II
Q10
h > hc
Incision
(Headcutting)
III
+Q10
h = hc
IV
+Q10
h = hc
Stabilizing
V
Terrace2
Terrace1
Floodplain
Q2
h < hc
Stable
(after Svhumm, Harvey, Watson, 19


Buffers will need greater widths, especially of the woody zone to help slow the widening of the channels & to provide floodplains that can handle more and faster moving flood waters.

Bear Creek 1992

Note Size of Riparian Area




2008 – Whole Length On Photo Buffered
Note how little space is occupied for services received
Should this not be required on all streams?
R7
115th St
Story City
Roland
Thank You
Questions/Comments
© 2011 Google
Image Kucera Intl./Story County
42°11'17.00" N 93°29'26.36" W elev 1055 ft
©2010 Goo