1. No River Presentations today – Please see new schedule

2. Flexibility with field work – we will evaluate bank erosion on the farm that we visited last lab to help us develop a total erosion picture for sheet/rill, gully and bank erosion.

3. We will also develop a farm plan for this area including a riparian buffer, potential stream bank stabilization practices and waterways, etc (future labs)

4. Discuss Stream Channel Evolution & Equilibrium Models

5. Tests will be returned on Thursday
This Morning

This Afternoon
Partly Cloudy
SSW 15-25 mph
49 F – 9.5 C
Skunk River at Ada Hayden Park

Delay our stream channel/floodplain lab
Where have we studied to date?
• Now concentrate on assessing hydrologic conditions of landscapes
• Develop gully, field, stream and watershed level remedial actions to address problems
Deeply incised, sediment choked channels – Why?
Overgrazed Pastures – compacted, low infiltration rates

Southern Iowa
Rathbun Watershed

Runoff Concentrates

Grass can’t hold, nick point – gully starts
Major Cantilever Failure

Left unchecked – classic gully develops
Cropfield Gully
Since Last Fall’s Harvest
Gullies Flowing Through the Forest in a Rain Event
Gullies Flowing Into the Stream Channel during a Rain Event
Channel Response to Changing Watershed Hydrology

50 cm
20+ in
Since Thanksgiving
How do we fix?

Need to fix uphill, upstream, small order watersheds
Another Landowners Way of Stopping A Gully Nick Point!
It Even Filters the Water!
Photos from the Register's archive

From 1966: Here's the caption that ran with this photo in May, 1966: "This line of junked cars along a bend in the Iowa River south of Iowa City were placed there at least 15 years ago, according to the State Conservation Commission, by a farmer trying to control erosion of his cornfield by the river. Such river-bank junkyards have been utilized along several other streams with the approval of the Conservation Commission."
Examples of Conservation Practices

- Grass Waterways
- Drop Structures
- Buffers/Filters
- Terraces
Targeted Field & Riparian Conservation Practices

Story we will focus on now
Replacing Perennial Plants With Annual Crops Has Reduced Soil Quality

Infiltration Rates Were 2-5 in/hr Now 0.5-1.5 in/hr

Leads To Rapid Storm Runoff - Flooding
Channel Modifications

Create Unstable Channels - Flooding
Wetland Drainage & Tile - Stormflow - Flooding
Urban Areas: Impervious Surfaces
Rapid Storm Runoff - Flooding
Climate Change May Increase Runoff & Flooding Problem

2008 Precip: 34.7 in/yr
2030 Precip: 35.5 in/yr
2095 Precip: 54.4 in/yr

How climate change could affect Iowa

IOWA'S FUTURE CLIMATE | WORLD GREENHOUSE GAS EMISSIONS

WHAT IOWA'S CLIMATE MIGHT BE LIKE
By 2030, Iowa summers could resemble those of Kansas in terms of average temperature and rainfall. By the end of the century, Iowa's summer climate could generally be more like what northwest Mississippi is today. Winters also could change, but less drastically — becoming something like current-day northern Kansas by the end of the century.

KEY:
- Current
- Summer by 2030
- Summer by 2095
- Winter by 2095

IOWA WEATHER NOW...
Average high: 59.8°  Average low: 40.5°
Average precipitation: 34.7 inches
*Based on data from Des Moines area, 1971-2000

AND LATER...
1. Average high: 65.4°  Average low: 43.3°
   Average precipitation: 35.5 inches
   *Based on data from Topeka, Kan., and surrounding area, 1971-2000
2. Average high: 72°  Average low: 53.2°
   Average precipitation: 54.4 inches
   *Based on data from Memphis, Tenn., and surrounding area, 1971-2000

Source: Union of Concerned Scientists

Source: National Weather Service
Summary Of Agricultural/Urban Alterations

- Land clearing
- Tiling
- Wetland drainage
- Channelization
- Urban impervious surfaces
- Storm sewers

- Increased surface & subsurface runoff (tiles)
- More sediment loss & leaching
- Lower water tables

- Higher & more frequent peak flows
- More flooding
- More channel incision
- Decreased base flow/(increase/tile)
- More intermittancy of small streams
Bear Creek Watershed - Example of What Happens

Channel Evolution
Incision, Elongation, Widening

Stormflow & Flooding
Historical Alterations of Stream Discharge Patterns in Agricultural Ecosystems

After Menzel, 1983
Stream flow is described by a hydrograph.
US Geologic Survey responsible for Stream Gaging
1. 7,000 gaging stations across US
2. Electronic data loggers transmit data to satellites every 15 minutes
3. 12 volt batteries charged by solar panels
4. Satellite data transmitted to Maryland then Carson City, Nevada
5. Data automatically sent to USGS websites after software manipulation
Skunk River at Ada Hayden Park
Material Transfer in Watersheds
Hillslope and Channel Connections

Hillslope Processes
Mass Movements & Erosion

- Slump
- Mass Movements
- Soil Creep
- Litterfall
- Dissolved Load
- Bed Load
- Suspended Load
- Surface Erosion
- Solution Transport

Channel Processes
Hillslope Processes Produce

- Colluvial deposits
- Dissolved transport
- Suspended transport
- Bedload transport

Channel Processes

Alluvial deposits

Channel Responses

Modifications
Channel Size factor of:
- Qs = sediment discharge
- D50 = sediment particle size
- Qw = streamflow
- S = channel slope

Channel Equilibrium all are in balance
If one factor changes readjustments will occur

From Rosgen (1996), from Lane, Proceedings, 1955.
Published with the permission of American Society of Civil Engineers.
Schumm, Harvey and Watson

Channel Evolution Model

<table>
<thead>
<tr>
<th>Stage</th>
<th>Channel Evolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Stable</td>
</tr>
<tr>
<td>II</td>
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</tr>
<tr>
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<td>IV</td>
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- **Very Important Concept**
- Channel responds to changes in discharge & sediment load

**Q = discharge** (Q_2 means discharge that occurs at least once every 2 years)

**h = bank height**

**hc = bank height at time of bank collapse**

\[ Q = \text{discharge (Q}_2\text{ means discharge that occurs at least once every 2 years)} \]

\[ h = \text{bank height} \]

\[ hc = \text{bank height at time of bank collapse} \]
Channel Flow Dynamics

Channel Features

Run – fast smooth flow

Riffle – shallow, turbulent flow

Bend – deep pool

Island – point bar

Riparian Zone

Thalweg
Formation of a terrace

Initiated by change in flow regime or base point level (Disturbance)
**Very Important Concept**

Channel responds to changes in discharge & sediment load

Q = discharge ($Q_2$ means discharge that occurs at least once every 2 years)

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### Channel Evolution Model

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<td>$h &lt; h_c$</td>
<td>$h = hc$</td>
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*Widening* $h = hc$

*Q* = discharge ($Q_2$ means discharge that occurs at least once every 2 years)

*Very Important Concept*
Floodplain Features

- oxbow lake
- clay plug
- chute
- oxbow
- meander scrolls
- natural levee
- splay
- backswamp
Levee Formation (Hanlon soil)
Simon

Channel Evolution Model
Stable, Incision, Widening, Stabilizing, Stable

Stable – Stage I
Incision – Stage II
Widening – Stage III
Slab Failure
Erosion With Rilling and Gullying
Pop-out Failure
Cantilever Failure
Channel Evolution Model

Stage I
Stable

Stage II
Incision
(Headcutting)

Stage III
Widening

Stage IV
Stabilizing

Stage V
Stable

(h < h_c)

(Headcutting)

(h = h_c)

(h = h_c)

(Terrace_1)

(Terrace_2)

(after Svyhum, Harvey, Waterman)
Swenson Farm

Determine Present Condition

Erosion Estimation Project

Develop a Farm Plan To Reduce Stream Sediment Load
What do we have to know to determine amount of bank erosion?

- Eroding length
- Bank height
- Widening rate
- Soil density
Need Volume of Soil Lost & Density

- Length
- Widening Rate
- Height
- Density – 90 lbs/ft$^3$
### Bank Erosion Categories Based on 2/3 of the Vertical Bank Fitting Criteria

**Page 5 – Erosion and Sediment Delivery**

<table>
<thead>
<tr>
<th>(Recession Rate) Widening (ft/yr)</th>
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<td>0.06 - 0.2</td>
<td>Moderate</td>
<td>Bank is predominantly bare with some rills and vegetative overhang. Some exposed tree roots, but no slumps or slips.</td>
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<td>Severe</td>
<td>Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads and trails. Channel cross-section becomes more U-shaped as opposed to V-shaped</td>
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Very Severely Eroding Bank – Use 0.6 ft or 7 inches for Annual Widening Rate
## Bank Erosion

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Measure Length & Height of Eroding Banks

Keep Track of Total Eroding Bank Length
One team on either side
Keep track of total length
Location of each eroded bank

Groups 1 & 2
Groups 3 & 4

Groups 5 & 6
Groups 8 & 9

Groups 7 & 10
Groups 11 & 12
Leave From the Loading Dock at 3:10 pm
One team on either side
Keep track of total length
Location of each eroded bank
Height, Length & widening rate (ft)
Groups 1 & 2
Groups 3 & 4

Start at Bridge
End at Big Gully
Groups 5 & 6
Groups 8 & 9

Start at Big Gully
End Midway between Bends
Start Midway between Bends
End at Fence Line

Groups 7 & 10
Groups 11 & 12