

# Development of Extensible Electronic Field Forms for Ecological Data Collection

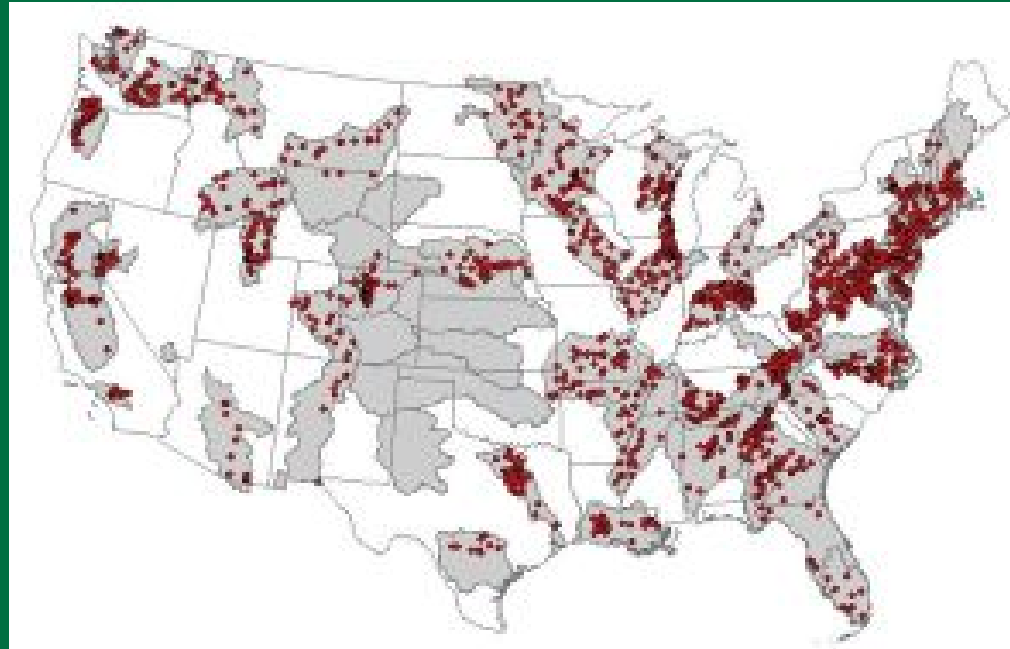
**Mitchell A. Harris (Illinois)**

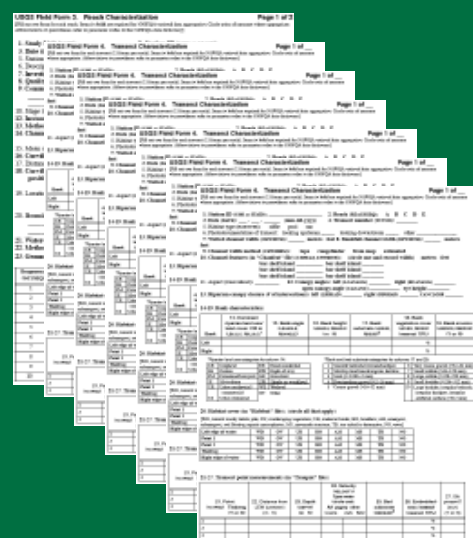
**Peter M. Ruhl (Reston)**

**Sean R. Allen (Eagle Vision Software Technologies, Inc.)**

# National Water-Quality Assessment Program (NAWQA) Biological Sampling

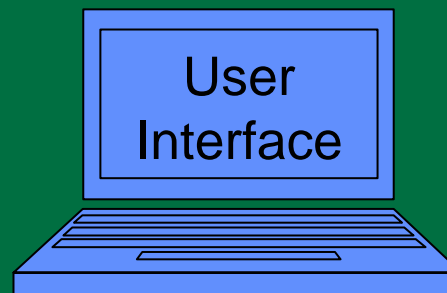
- 6000 reach habitat and fish community samples since 1994
- Data stored in the Biological Transactional Database (BioTDB)
- Served to public in the NAWQA Data Warehouse



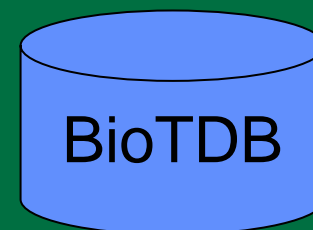


Manual  
Data Entry

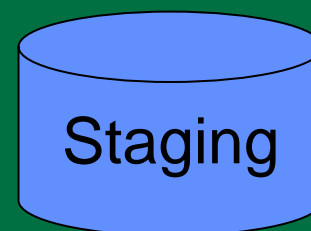
- Record field data
- Review for completeness



Review  
Data Entry



Data  
checks



Transfer

Automated  
upload



# Selected User Requirements

- 2. No limitation on sequence of data entry
- 4. Data entry status information easily displayed/accessible
- 5. Save an incomplete data set (“coffee break function”), flag as incomplete
- 6. Enforce relational integrity
- 7. Run error/validation checks
- 11. Must be legible, especially for "senior " biologists
- 13. Ability to configure default measurement units for various "parameters" units configuration page
- 14. Require units for each data element

# Hardware: Advantages

## Large-screen (Tablet)

- **screen size**
- flexibility, adaptability
- users are familiar with operating system
- synchronizing between mobile OS and Tablet OS not necessary

## Small (Pocket PC)

- device size
- submersibility
- instant on/off
- ruggedness
- battery life
- nonvolatile flash memory (contrast to hard drive)
- lower entry price for rugged, submersible unit

# Biological Electronic Field Forms (BioEFF)



## News

[Version 1.0](#) is available now.

## BioEFF Users

- [Users Guide](#)
- [Download, Installation, Comments](#)
- Field Computers
  - Loaner Equipment
    1. [Getac CA 27 Ruggedized Slate Computer](#)
    2. [Panasonic CF18 Toughbook](#)
    3. [Panasonic CF18 Toughbook Number 2](#)
  - [Buyers' Corner](#)
- [Version History](#)

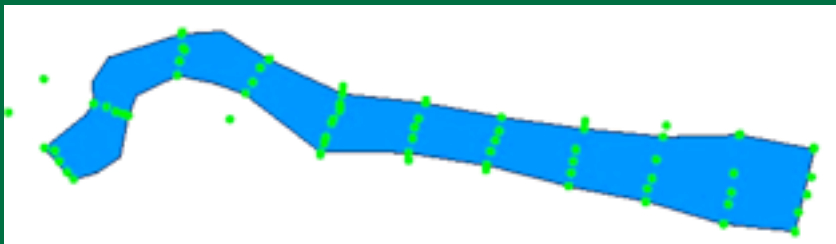
## Developers and Managers

[Project Charter](#)

[Project Management Home](#) – limited access

[Issues List](#) – limited access

[Project Development \(June\)](#) – limited access



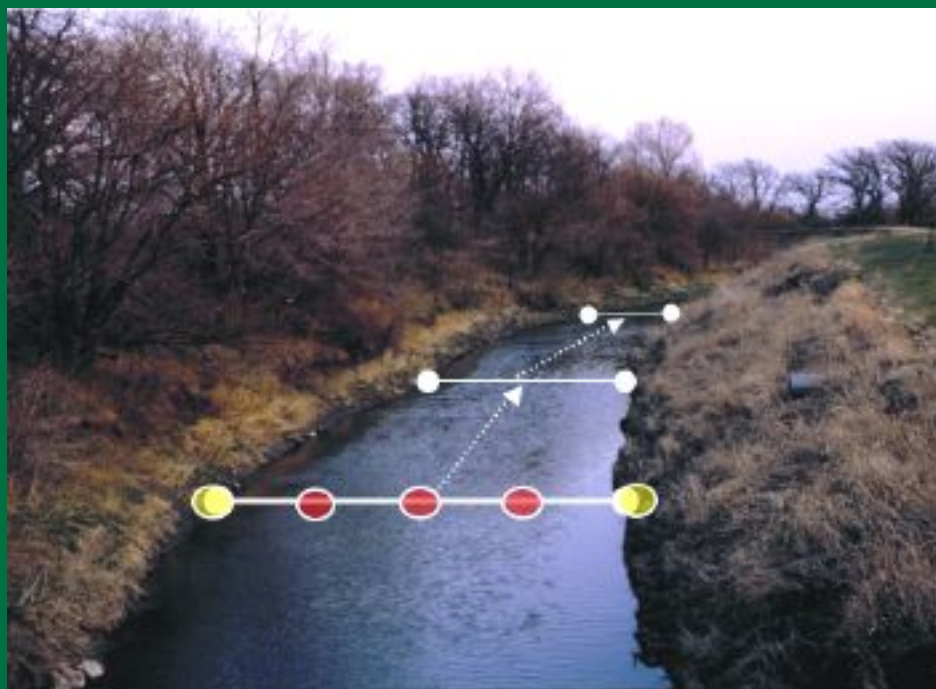
Reach (1)



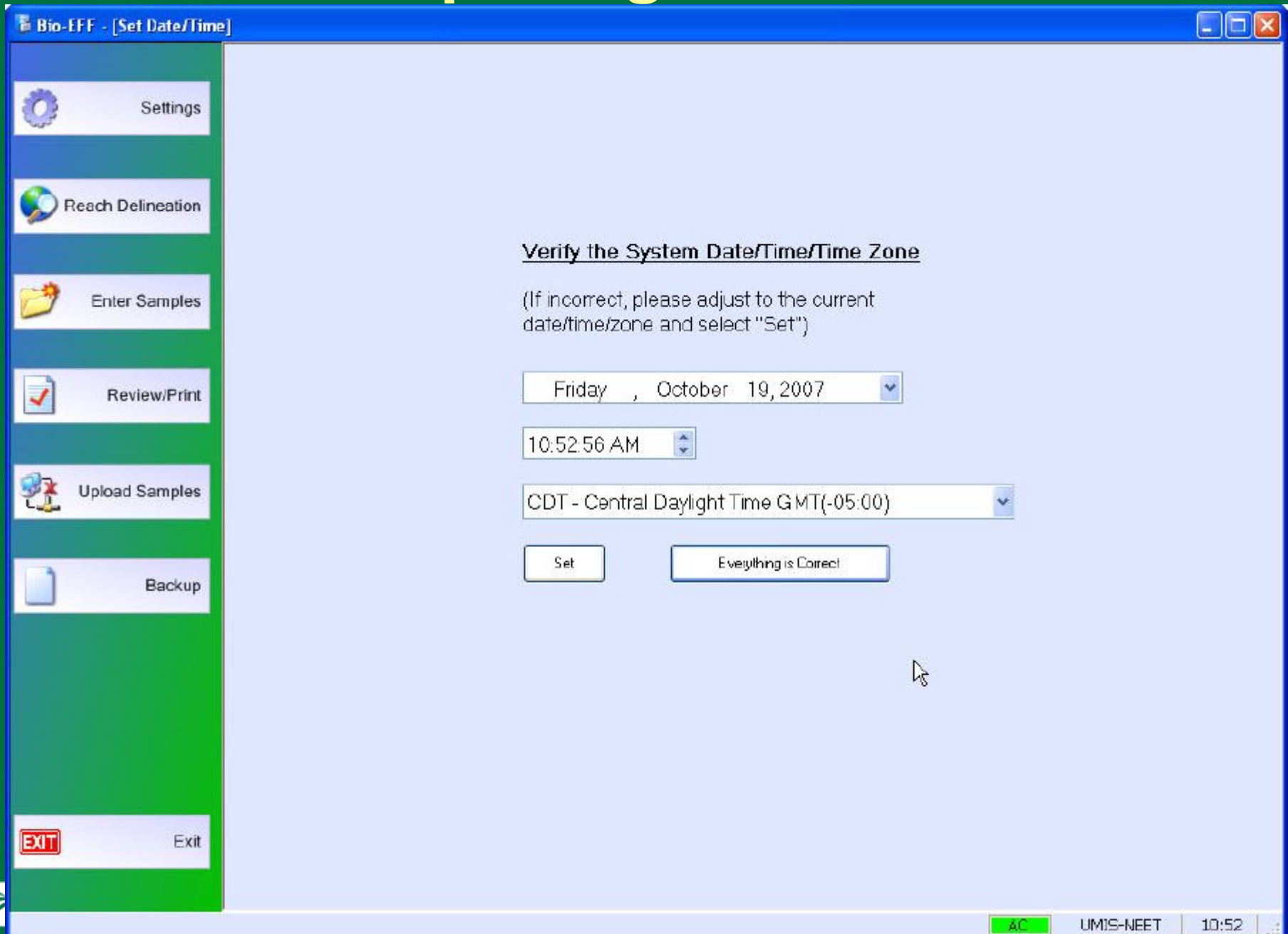
Transect (11)



Transect Point (5)



# Opening Screen





# Navigation and Data Entry

- **2. No limitation on sequence of data entry**
  - Navigation features
- **4. Data entry status information easily displayed/accessible**
  - Colors
  - Review
- **5. Save an incomplete data set (“coffee break function”), flag as incomplete**

Station: REDEYE RIVER AT HILLVIEW, MN

Date: 08/08/2007

13.42

15.48

Set End Time

STAID: 05244409

Reach: A

Edit

Collectors: J.Greene A. Berg

Reach

GCU 1

Photo Doc

Site Sketch

Transect 5

Channel Feature 1

Trans Point 3

1

2

3

4

5

\*

Save Sample

Save Defaults

Cancel

Transect 5

Transect Point #

1 2 3 4 5 \*

Delete TP

Transect Point Data

NC

Pointtype In Stream

X

NC

Thalweg Yes No

X

NC

Distance from LEW Rmk 5 ft

X

NC

Depth Rmk ft

X

NC

Velocity Rmk 0.08 ft/sec Acoustic Doppler Velocimeter

?

X

NC

Bed substrate 3 - Sand (> 0.062 - 2 mm)

X

NC

Embeddedness (nearest 10%) 100 %

?

X

NC

Silt present Yes No

X

NC

Macrophytes or Macroalgae (nearest 10%) 40 %

?

X

Habitat Cover Present

NC

WD - Natural woody debris Yes No

X

NC

BD - Boulders Yes No

?

X

NC

OV - Overhanging vegetation Yes No

X

NC

MS - Manmade structure Yes No

X

NC

UB - Undercut banks Yes No

X

NC

AM - Aquatic macrophytes Yes No

X

Set remaining to 'No'

Too turbid to determine

# Navigational Controls and Data Entry Form Status

The image displays a software interface for data entry, featuring four vertical panels. Each panel contains a list of items with associated status indicators (radio buttons, colored boxes, and numbers). The first panel on the left has a 'Save Sample' button, a 'Save Defaults' button, and a 'Cancel' button. The second panel shows a 'not started' section with 'GCU 5', a 'partial' section with 'GCU 5', and a 'complete' section with 'GCU 5'. The third and fourth panels show various items like 'Reach', 'GCU 1', 'Photo Doc', 'Site Sketch', 'Transect 3', 'Channel Feature 2', 'Trans Point 1', and 'Trans Point 3', each with a corresponding status indicator. The status indicators are represented by radio buttons, colored boxes (yellow for 'not started', green for 'partial', and white for 'complete'), and numbers (1-7) in colored boxes (yellow for 'not started', green for 'partial', and white for 'complete').

**Panel 1 (Left):**

- Reach (Radio button)
- GCU 7 (Radio button)
- Photo Doc (Radio button)
- Site Sketch (Radio button)
- Transect 3 (Radio button)

**Panel 2:**

- not started: GCU 5 (Radio button)
- partial: GCU 5 (Radio button)
- complete: GCU 5 (Radio button)

**Panel 3:**

- Reach (Radio button)
- GCU 1 (Radio button)
- Photo Doc (Radio button)
- Site Sketch (Radio button)
- Transect 3 (Radio button)
- Channel Feature 2 (Radio button)
- Trans Point 1 (Radio button)

**Panel 4:**

- Reach (Radio button)
- GCU 1 (Radio button)
- Photo Doc (Radio button)
- Site Sketch (Radio button)
- Transect 3 (Radio button)
- Channel Feature 1 (Radio button)
- Trans Point 3 (Radio button)

**Buttons:**

- Save Sample
- Save Defaults
- Cancel



Settings



Reach Delineation



Enter Samples



Review/Print



Upload Samples



Backup



Exit

## Review/Validate/Print/Delete Samples

STAID	Reach	Date	Time	Project	Status
<b>Habitat</b>					
05243200	A	08/13/2007	11:16	UMIS-NEET	Validated
05244409	A	08/08/2007	13:42	UMIS-NEET	In Progress
05245295	A	08/08/2007	08:12	UMIS-NEET	Validated
05265696	A	08/14/2007	07:33	UMIS-NEET	Validated
05267185	A	08/16/2007	10:49	UMIS-NEET	Validated
05267930	A	08/17/2007	07:13	UMIS-NEET	Validated
05272951	A	08/07/2007	10:12	UMIS-NEET	Validated
05284690	A	08/09/2007	07:47	UMIS-NEET	Validated
05284945	A	08/09/2007	13:00	UMIS-NEET	Validated
05287690	A	08/10/2007	08:23	UMIS-NEET	Validated
05338955	A	08/20/2007	09:47	UMIS-NEET	Validated
05340280	A	08/20/2007	13:43	UMIS-NEET	Validated
05340962	A	08/21/2007	08:24	UMIS-NEET	Validated

## Data Check Details:

## Problem

Transect Point MISSING Data, Transect: 5, Transect Point: 3

# Data Input

- 13. Ability to configure default measurement units for various "parameters" units configuration page
- 14. Require units for each data element



# Input Types

Habitat Cover Present

NC	WD - Natural woody debris	<input type="radio"/> Yes <input type="radio"/> No		NC	BO - Boulders	<input type="radio"/> Yes <input type="radio"/> No	
NC	OV - Overhanging vegetation	<input type="radio"/> Yes <input type="radio"/> No		NC	MS - Manmade structure	<input type="radio"/> Yes <input type="radio"/> No	
NC	UB - Undercut banks	<input type="radio"/> Yes <input type="radio"/> No		NC	AM - Aquatic macrophytes	<input type="radio"/> Yes <input type="radio"/> No	

NC	Bed substrate	
NC	Embeddedness (nearest 10%)	
NC	Silt present	
NC	Macrophytes or Macroalgae (nearest 10%)	

Habitat Cover Present

NC	WD - Natural woody debris	<input type="radio"/> Yes <input type="radio"/> No	
NC	OV - Overhanging vegetation	<input type="radio"/> Yes <input type="radio"/> No	
NC	MS - Manmade structure	<input type="radio"/> Yes <input type="radio"/> No	

1 - Smooth bedrock/concrete/hardpan

2 - Silt/clay/marl/muck/organic detritus

3 - Sand (> 0.062 - 2 mm)

4 - Fine/medium gravel (>2 - 16 mm)

5 - Coarse gravel (>16 - 32 mm)

6 - Very coarse gravel (>32 - 64 mm)

7 - Small cobble (>64 - 128 mm)

8 - Large cobble (>128 - 256 mm)

9 - Small boulder (>256 - 512 mm)

10 - Large boulder, irregular bedrock/hardpan (>512 mm)

Habitat type Run

Wetted channel width Rmk 25 m Rangefinder

Bankfull channel width Rmk 30 Rangefinder



Habitat type Run

Wetted channel width Rmk 25 m Rangefinder

Bankfull channel width Rmk 30 Rangefinder



# Data Entry Features

**Stream Center**

At the midpoint of the transect, face downstream and point a compass parallel to streamflow.

NC	Aspect	Rmk	*	NC	Eye height	Rmk	m	
NC	Canopy angle LB	Rmk	*	NC	Canopy angle RB	Rmk	*	

NC	Depth	Rmk	m		
NC	Velocity	Rmk	m/sec	Acoustic Doppler Velocimeter	
NC	Bed substrate	2 - Silt/clay/marl/muck/organic detritus			
NC	Embeddedness (nearest 10%)		%		
NC	Silt present	<input type="radio"/> Yes <input type="radio"/> No			

NC

NA - Non Applicable

NC

EQ - Equipment Problem

NC

LI - Location Inaccessible

NC

OT - Other

NC

TB - Too turbid

NC

<Clear>

NC	Wetted channel width	Rmk	m	Rangefinder	
NC	Bankfull channel width	Rmk	m ft	Rangefinder	

NC	Velocity	Rmk	m/sec	Acoustic Doppler Velocimeter	
NC	Bed substrate			Acoustic Doppler Velocimeter	
NC	Embeddedness (nearest 10%)		%	Pygmy	
NC	Silt present	<input type="radio"/> Yes <input type="radio"/> No			

AA  
Marsh-McBirney  
Estimate

# Other Features

- **Margin notes**
- **Site sketch**



# Margin Notes

Bio-EFF - [Enter Habitat Sample]

Home Backup Margin Notes Other Samples:

Station: SHELL RIVER Margin Notes RTON, MN Date: 06/13/2007

STAID: 05243200 Reach: A Edit Collectors: J. Greene A. Berg

Eraser Page 1 of 4 Clear Print

Reach

GCU 1

Photo Doc

Site Sketch

Transect 1

Reach Data

NC	Quality of habitat sampling effort	Excellent
NC	Channel modification	Not Modified
NC	Mean channel width	Rmk 33
NC	Distance between transects	Rmk 66
NC	Water-surface gradient	Rmk 0.0012
NC	Thalweg gradient	Rmk 0.00
Habitat sampling comments		Sampling

View Reach Delineation

Save Sample

Save Defaults

Cancel

RTH

1 Depth: 1.02'  
Velocity: 0.70 ft/sec.

2 depth: 0.75'  
velocity: 0.45 ft/sec.

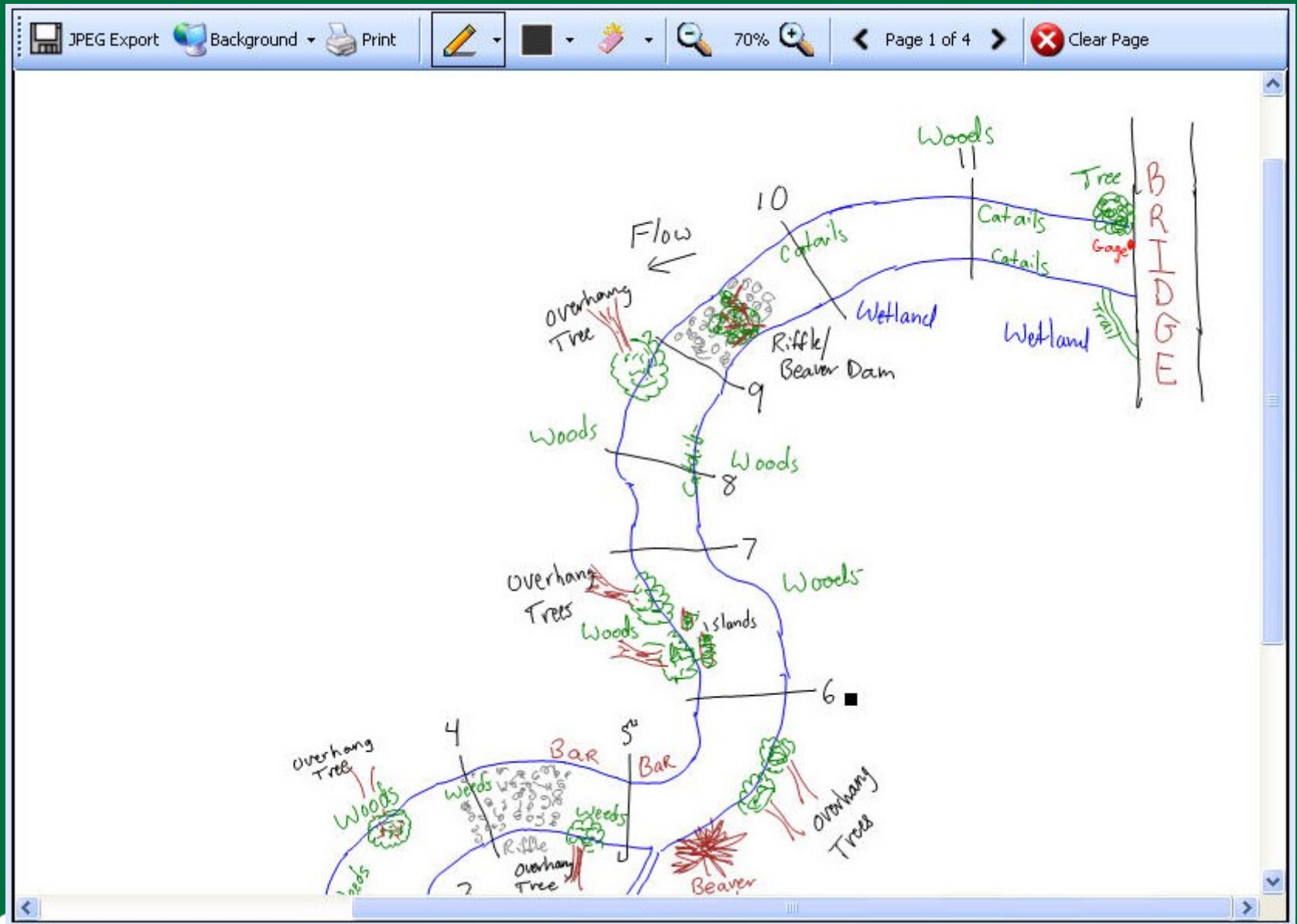
3 depth: 0.95'  
velocity: 0.30 ft/sec.

4 depth: 0.72'  
Velocity: 0.15 ft/sec.

5 depth: 0.61'  
velocity: 0.60 ft/sec.

AC UMIS-NEET 10:57

# Site Sketch



# Configure Default Options

User In

Ink th

Ink to

Col

E

F

I

C

E

Lo

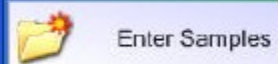
Bio-EFF - [Configure Defaults]



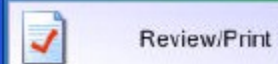
Settings



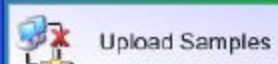
Reach Delineation



Enter Samples



Review/Print



Upload Samples



Backup



Exit

## Configure Default Options

### User Interface

Ink thickness



Ink to Text delay



Ink entry test

### Colors

Background



Text bg



Foreground



Incomplete



InkPopup



Group



Button bg



Save as "My Scheme"

### Load Color Schemes

Office

Field

My Scheme

### Defaults

Default number of Transect Points

### Project Maintenance

Manage Station List

### System

Version: 1.0.1.0

Auto Backup Drive Preference

\* NO DRIVES AVAILABLE\*

Auto Backup Interval

 mins

Adjust Date/Time

Check For New Version

### Power Status

AC

Battery: True

Not charging

97%

# Design & Extensibility

- Programmed in VB.Net
- Microsoft Access backend databases
  - Static
    - Display, placement of form elements
    - Parameter domain, range, help
    - Domain lists
  - Data
    - Field-entered data
- What do we mean by “Extensible?”
  - designed to rapidly accommodate changes
  - modifiable for other collection protocols



# Extensibility by Design

Field : Table

	Display Name	Long Name	Control Type	Field Length	Control Width	Mid	Data Type	Preferred Unit	Pref	Min	Max	Can Have Remark	No NC Flag	Help Desc
+	Bed substrate		lookup				text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	BQ - Boulders		checkbox		370	8	boolean			0	0	<input type="checkbox"/>	<input type="checkbox"/>	Habitat cover present within one m
+	Canopy angle LB		textbox	3	370	85	integer			0	180	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Canopy angle RB		textbox	3	370	85	integer			0	180	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Canopy closure	RB Riparian can	textbox	4	345	8	integer			0	17	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Canopy closure	LB Riparian can	textbox	4	345	8	integer			0	17	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Canopy closure DS	Canopy closure	textbox	4	370	7	integer			0	17	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Canopy closure US	Canopy closure	textbox	4	370	7	integer			0	17	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Channel Feature Type		lookup	5	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Channel Feature Width		textbox	5	370	85	decimal	m		0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Channel Features		checkbox		370	8	boolean			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Channel modification		lookup	10	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Channel Width Method		lookup	10	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Curvilinear distance from reference to reach		textbox	6	370	85	decimal	m		0	0	<input type="checkbox"/>	<input type="checkbox"/>	Distance upstream is negative and
+	Curvilinear distance from reference to band		textbox	6	370	85	decimal	m		0	0	<input type="checkbox"/>	<input type="checkbox"/>	Distance upstream is negative and
+	Curvilinear reach length		textbox	6	370	85	decimal	m		0	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Distance along thalweg
+	Dec. % Potential Radiation		textbox	4	370	7	decimal			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Dec. Megajoules/m2/day		textbox	4	370	7	decimal			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Depth		textbox	6	370	85	decimal	m		0	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Description	Upstream boundary	textbox	255	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	Describe the type of boundary mar
+	Description	Downstream boundary	textbox	255	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Distance between transects		textbox	6	370	85	decimal	m		0	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Reach length divided by "number o
+	Distance from LEW		textbox	6	370	85	decimal	m		0	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
+	Dominant riparian land use	Upstream boundary	lookup	345	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Dominant riparian land use	Downstream boundary	lookup	345	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	Downstream Photodocumentation		textbox	20	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	DS datum		lookup	6	370	85	text			0	0	<input type="checkbox"/>	<input type="checkbox"/>	
+	DS latitude		textbox	14	370	85	decimal			-90	90	<input type="checkbox"/>	<input type="checkbox"/>	
+	DS longitude		textbox	14	370	85	decimal			-180	180	<input type="checkbox"/>	<input type="checkbox"/>	

Record: 1/1

Database tables control much of the layout and data elements display

- Sections > groups > controls
- Display name, type, remarks, minimum, maximum, help message....

# Extensibility Tradeoffs

- Initial development time
- Within field enforcement (range and data type enforcement, help, remarks, methods)
- Completeness validation
- Tradeoff: to preserve flexibility, more difficult vs. shortcuts & between field data checking (compared to fixed forms where you know what fields will be on the form)

# Field experience

- **Users like the interface and the electronic forms**
  - Learning curve if user already familiar with paper forms
  - Data entry went well
- **Users identified bugs and forms improved over the summer**
- **Many ideas for new features**
- **Uncomfortable middle stage after data collected, but before data uploaded**
- **Handling backup and archiving files**

# Lessons Learned

- **Get feedback from users early and often**
- **User interface is only the first step**



# Future Plans

- *Resource, interest permitting*
- Further deployment **reach habitat** forms
- Add **fish** community forms
- User configuration

