

# **Habitat Mapping for Aquatic Species at-Risk on Military Installations using GPS-based Underwater Video**

**DOD Legacy Project No. 15-776  
Contract No. HQ0034-15-2-0012**

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University of Tennessee

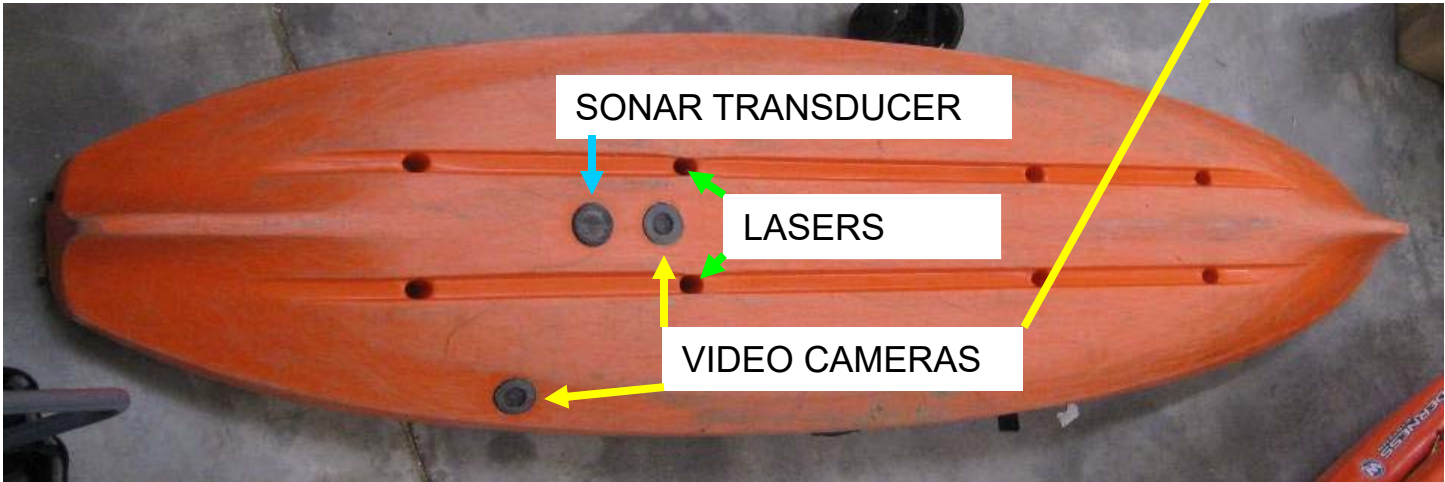
Support from:

Ken Oristaglio

MTC Fort Pickett - Environmental

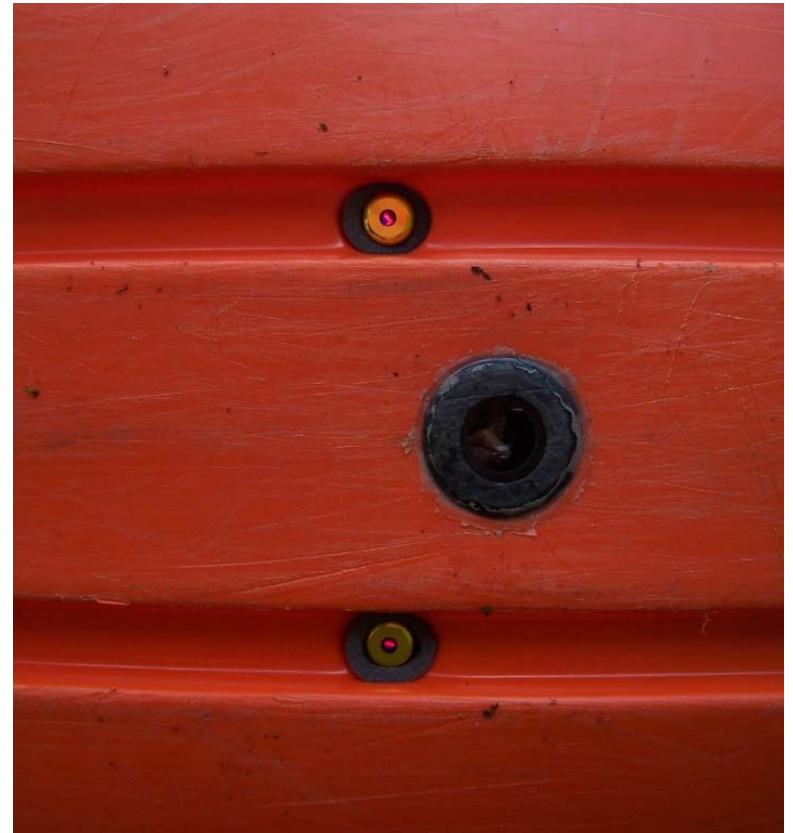
# Objectives

- Habitat mapping for Roanoke logperch and the Atlantic pigtoe on Nottoway River at Fort Pickett using kayak-based Underwater Videomapping System
- Other – Snorkel mapping (SCUBA mapper)
  - Streambank erosion mapping
  - Water quality mapping





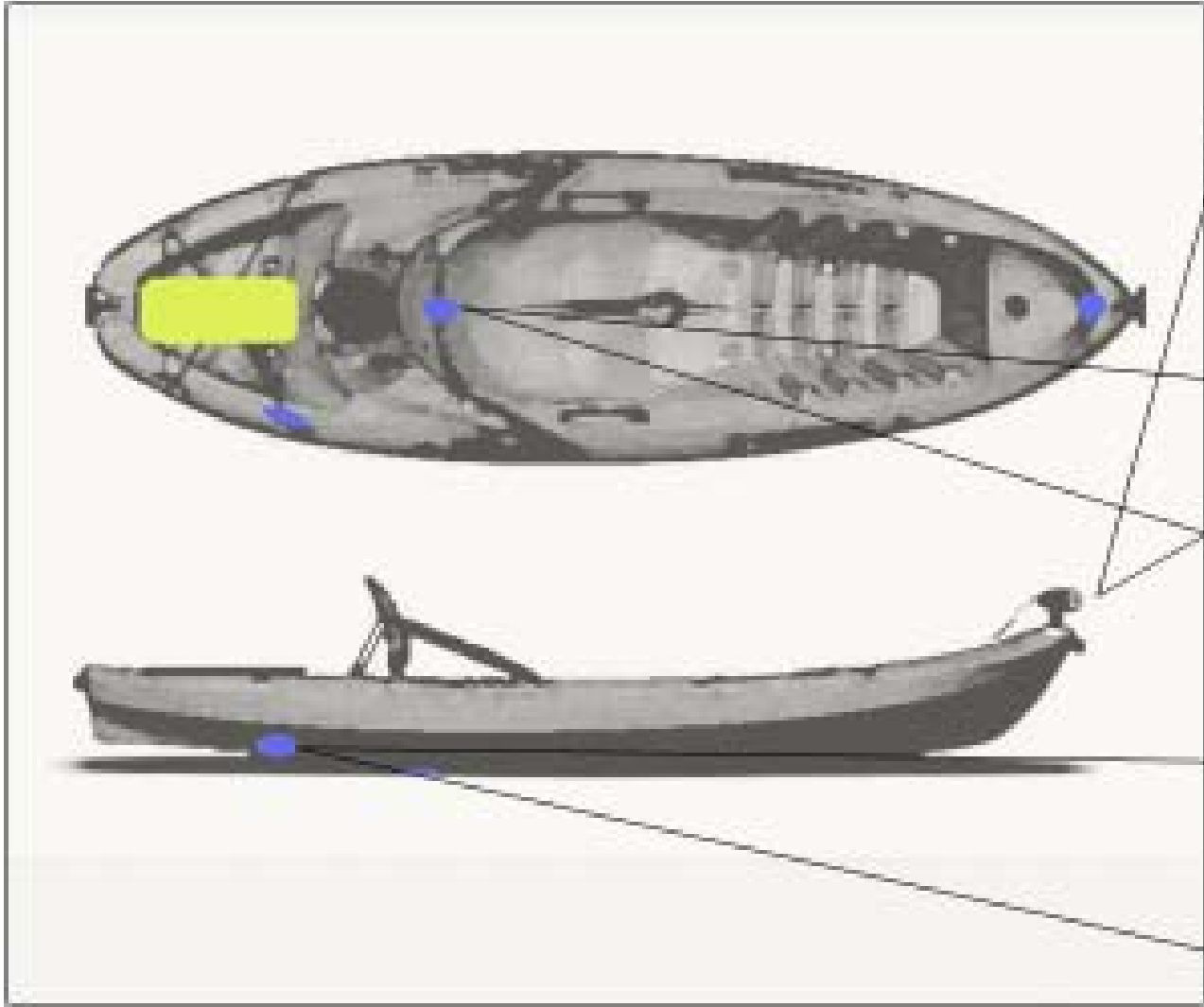
Instrumented kayaks floating the river thalweg.  
GPS and depth sonar



Flush-mounted  
underwater camera and lasers



Above water camera






## Georeferenced Above Water Image



# GIS Attributes Defined

- GPS Position
- Depth
- Substrate
- River Characteristic
- Embeddedness
- Substrate Heterogeneity
- River Width (new)
- Streambank Vegetation and Cover (new)

Flow Characteristics of the River		
habitat parameter	description	example pictures
pool	Areas characterized by smooth undisturbed surface, generally slow current, and deep enough to provide protective cover for fish (75 to 100% deeper than the prevailing stream depth).	 <p>Lat: 36.350826 N Lon: 84.730981 W UTC: 05 Apr 2004 19:45:00</p>
riffle	Area characterized by broken water surface, rocky or firm substrate, moderate or swift current, and relatively shallow depth (usually less than 18 inches). Shallow section in a stream where water is breaking over rocks, wood, or other partly submerged debris and producing agitation.	 <p>Lat: 36.509337 N Lon: 84.634953 W UTC: 14 Jun 2004 19:13:41</p>
run	Fast-moving section of a stream with defined thalweg and little surface agitation. Runs are deeper than a riffle and shallower than a pool.	 <p>Lat: 36.326184 N Lon: 84.783725 W UTC: 05 Apr 2004 16:01:54</p>

EPA river characteristics



Microsoft Excel - SC.xls

File Edit View Insert Format Tools Data Window Help Adobe PDF

heading

A57 A=A1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
57	NAME	bedrock	boulder	cobble	gravel	sand	clay	total	embeddedness	laser cm	detritus	muck-mud	marl	aquatic veg	notes
58	9	0	10	75	5	10	0	100		18.8 cm					
59	9A	0	0	60	40	0	0	100		20.8 cm					

Ready

File and Folder Tasks

- Rename this file
- Move this file
- Copy this file
- Publish this file to the Web
- E-mail this file
- Delete this file

Other Places

- SC
- My Pictures
- My Computer
- My Network Places

Details

9.jpg  
 JPEG Image  
 Dimension: 640 x 480  
 Size: 154 KB  
 Date Modified: Yesterday  
 February 05, 2005, 8:10 PM

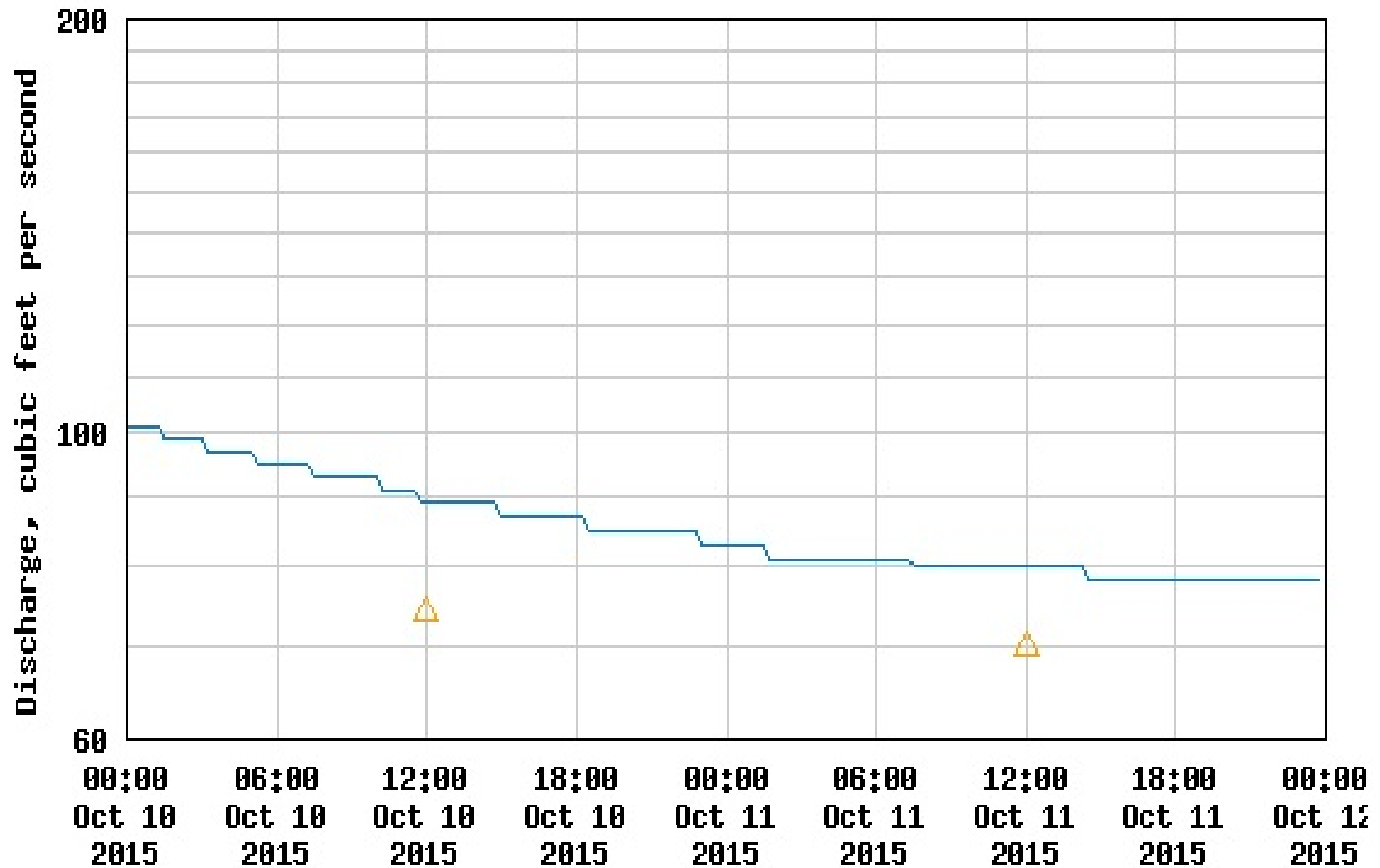
Lat: 36.3250( 2 N Lon: 84.78 608 W UTC: 0 i Apr. 2004 3:51 :29 PM 9 UTK

Substrate classification viewing

9.jpg 9A.jpg 9B.jpg 9C.jpg 9D.jpg 9E.jpg 9F.jpg 9G.jpg 9A.jpg

# Discharge Rate – 80 to 95 cfs

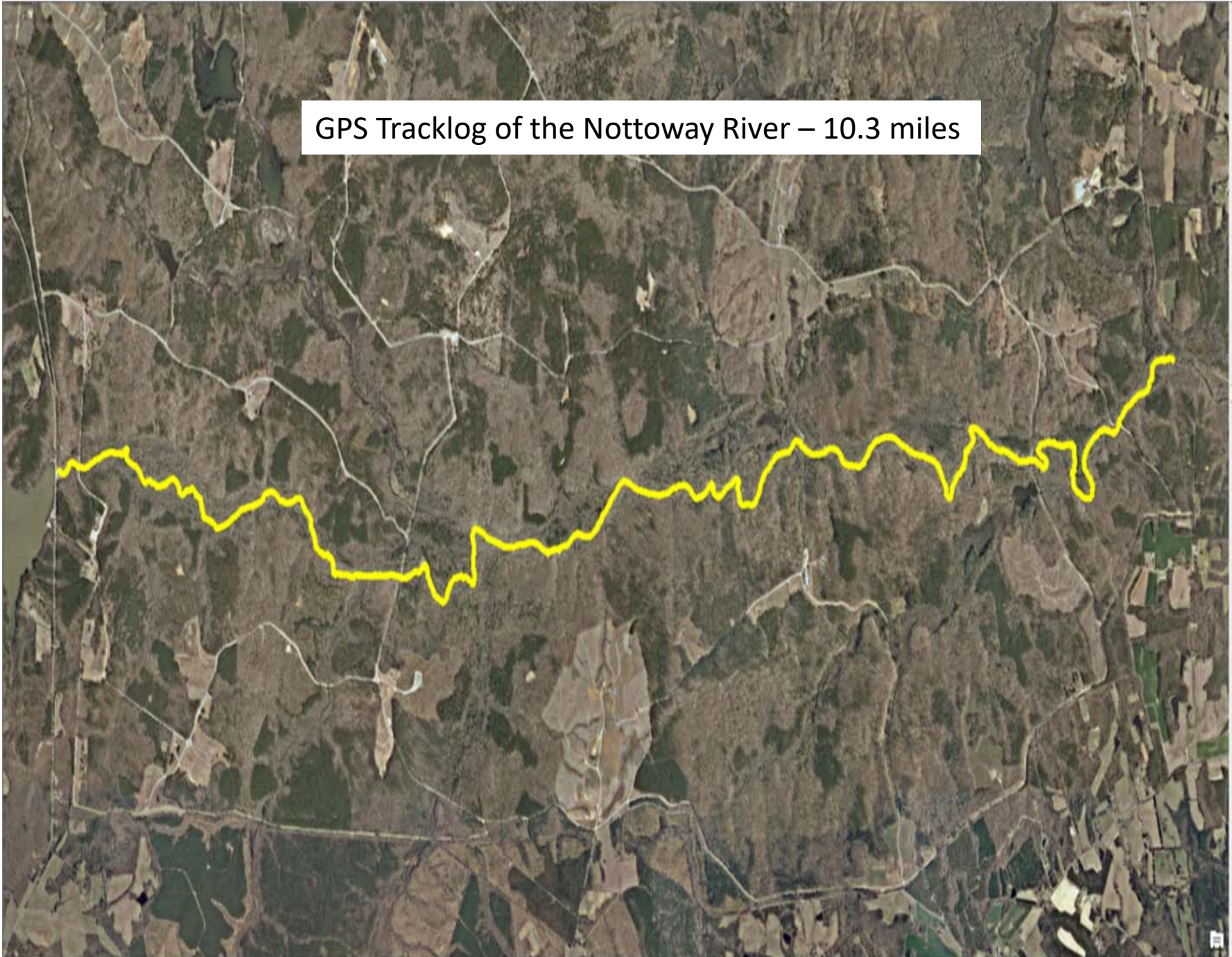
USGS 02044500 NOTTOWAY RIVER NEAR RAWLINGS, VA



---- Provisional Data Subject to Revision ----

△ Median daily statistic (65 years) — Discharge

GPS Tracklog of the Nottoway River – 10.3 miles

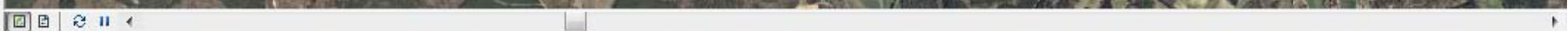
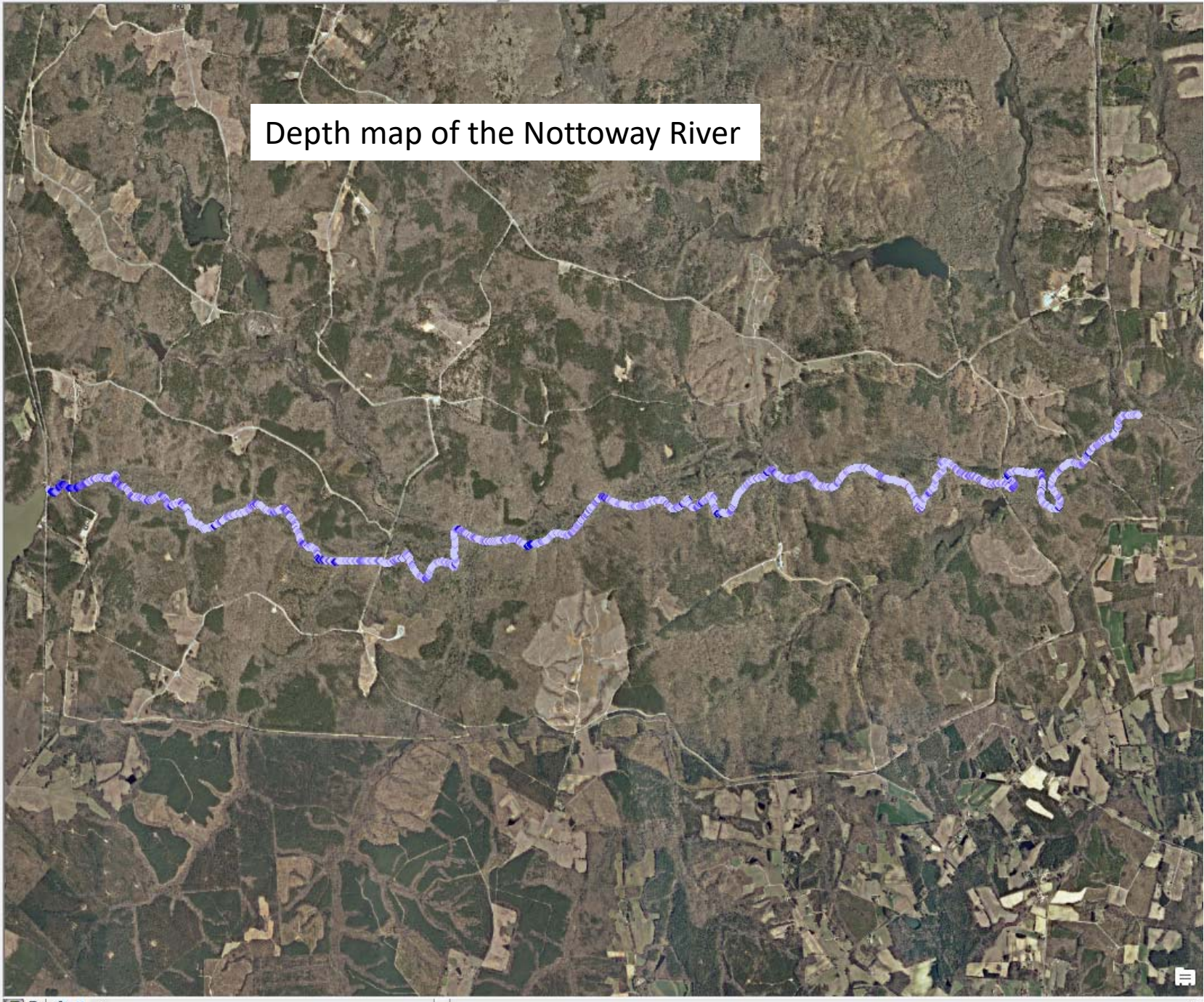




**Layers**

- F:\Nottoway\Octob
- Good\_Habitat
- Nottoway
  - Depth\_ft
    - 0.0 - 2.0
    - 2.1 - 3.0
    - 3.1 - 4.0
    - 4.1 - 5.0
    - 5.1 - 10.0
- World Imagery

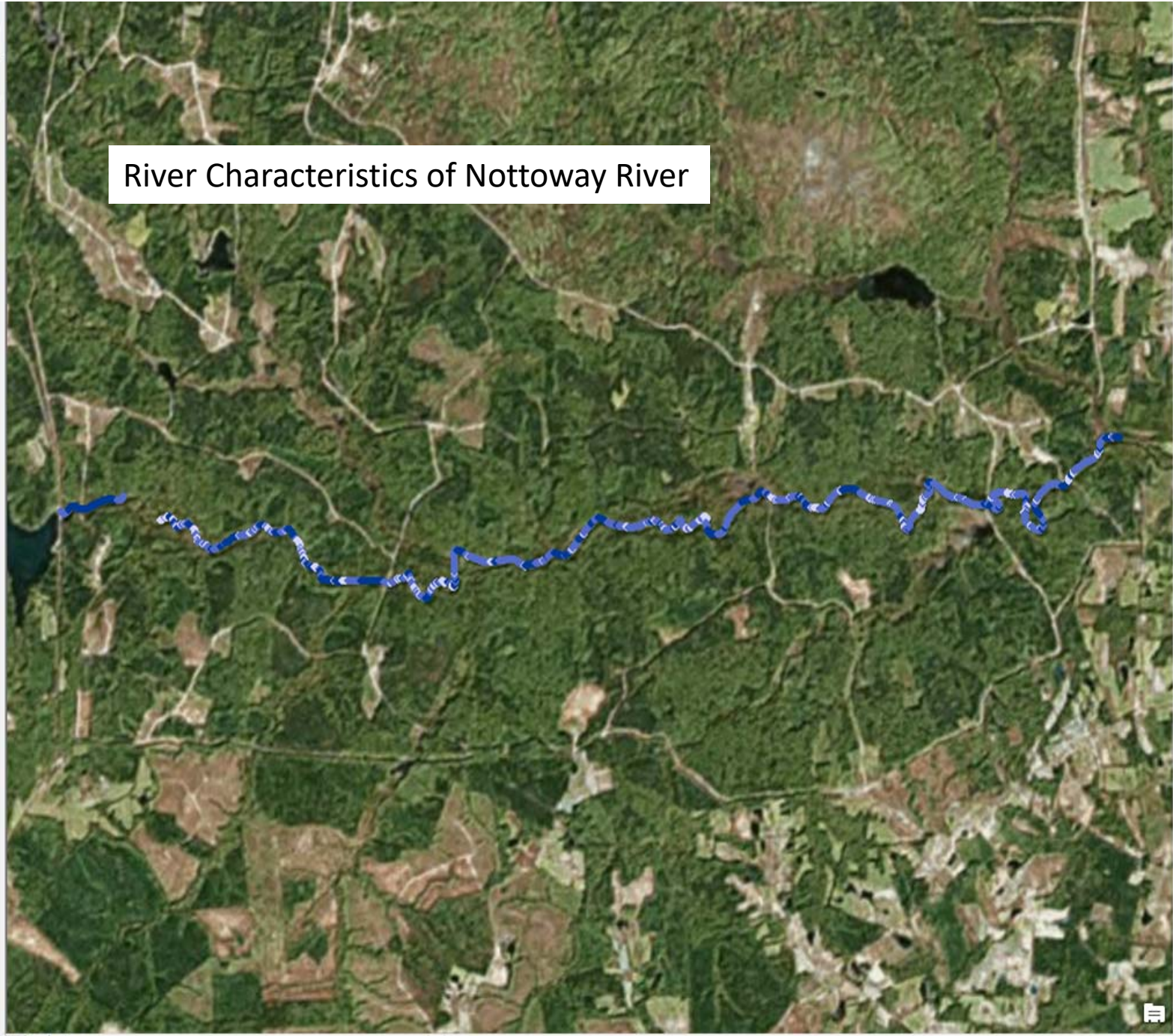
# Depth map of the Nottoway River





- Layers
  - F:\Nottoway\October 2015\An
    - Nottoway
      - River\_Char
        - POOL
        - RUN
        - RIFFLE
  - World Imagery

# River Characteristics of Nottoway River



GIS Attributes for Optimal Habitat:

Depth  $\leq$  4 feet

Substrate = gravel

River Characteristic = riffle or run



Roanoke logperch (NANFA, 2016).

FID	Shape *	Lat	Lon	Right_Stre	Depth_ft	River_Char	Substrate
1824	Point	36.98914	-77.95122	HIGH	2.35	RIFFLE	Gravel
1825	Point	36.98914	-77.95122	HIGH	2.29	RIFFLE	Gravel
1826	Point	36.98914	-77.95121	HIGH	2.09	RIFFLE	Gravel
1827	Point	36.98914	-77.95121	HIGH	2.13	RIFFLE	Gravel
1828	Point	36.98914	-77.95121	HIGH	2.13	RIFFLE	Gravel
1829	Point	36.98914	-77.95121	HIGH	2.8	RIFFLE	Gravel
1830	Point	36.98914	-77.95121	HIGH	2.37	RIFFLE	Gravel
1831	Point	36.98914	-77.95121	HIGH	1.5	RIFFLE	Gravel
1832	Point	36.98914	-77.95121	HIGH	1.33	RIFFLE	Gravel
1833	Point	36.98914	-77.9512	HIGH	1.44	RIFFLE	Gravel
1834	Point	36.98914	-77.9512	HIGH	1.44	RIFFLE	Gravel
1835	Point	36.98915	-77.9512	HIGH	1.86	RIFFLE	Gravel
1836	Point	36.98914	-77.95119	HIGH	2.02	RIFFLE	Gravel
1837	Point	36.98914	-77.95119	HIGH	1.73	RIFFLE	Gravel
1838	Point	36.98914	-77.95118	HIGH	1.87	RIFFLE	Gravel
1839	Point	36.98914	-77.95118	HIGH	2.78	RIFFLE	Gravel
1840	Point	36.98914	-77.95118	HIGH	2.63	RIFFLE	Gravel
1841	Point	36.98914	-77.95118	HIGH	2.98	RIFFLE	Gravel
1842	Point	36.98914	-77.95117	HIGH	2.72	RIFFLE	Gravel
1843	Point	36.98914	-77.95117	HIGH	1.43	RIFFLE	Gravel
1844	Point	36.98914	-77.95117	HIGH	2.43	RIFFLE	Gravel
1845	Point	36.98914	-77.95116	HIGH	2.3	RIFFLE	Gravel
1846	Point	36.98914	-77.95116	HIGH	2.31	RIFFLE	Gravel
1847	Point	36.98914	-77.95115	HIGH	2.31	RIFFLE	Gravel
1848	Point	36.98914	-77.95115	HIGH	2.58	RIFFLE	Gravel
1849	Point	36.98914	-77.95114	HIGH	2.56	RIFFLE	Gravel
1850	Point	36.98914	-77.95114	HIGH	2.37	RIFFLE	Gravel
1851	Point	36.98914	-77.95113	HIGH	2.39	RIFFLE	Gravel
1852	Point	36.98914	-77.95112	HIGH	2.59	RIFFLE	Gravel
1853	Point	36.98914	-77.95111	HIGH	1.98	RIFFLE	Gravel
1854	Point	36.98914	-77.9511	HIGH	1.46	RIFFLE	Gravel
1855	Point	36.98914	-77.95109	LOW	1.98	RIFFLE	Gravel
1856	Point	36.98913	-77.95108	LOW	1.98	RIFFLE	Gravel
1857	Point	36.98913	-77.95106	LOW	2.58	RIFFLE	Gravel
1858	Point	36.98913	-77.95106	LOW	2.71	RIFFLE	Gravel
1879	Point	36.98919	-77.95098	LOW	2.07	RIFFLE	Gravel
1880	Point	36.9892	-77.95098	LOW	2.45	RIFFLE	Gravel
1881	Point	36.9892	-77.95099	LOW	2.65	RIFFLE	Gravel
1882	Point	36.98921	-77.95099	LOW	2.65	RIFFLE	Gravel
1883	Point	36.98921	-77.95098	LOW	2.62	RIFFLE	Gravel
1884	Point	36.98921	-77.95097	LOW	2.47	RIFFLE	Gravel
1885	Point	36.98922	-77.95097	LOW	1.96	RIFFLE	Gravel
1886	Point	36.98922	-77.95097	LOW	1.82	RIFFLE	Gravel
1887	Point	36.98923	-77.95097	LOW	2.93	RIFFLE	Gravel
1888	Point	36.98924	-77.95096	LOW	2.78	RIFFLE	Gravel
1889	Point	36.98925	-77.95095	LOW	2.78	RIFFLE	Gravel
1890	Point	36.98925	-77.95094	LOW	1.37	RIFFLE	Gravel
1891	Point	36.98925	-77.95094	LOW	2.03	RIFFLE	Gravel
1892	Point	36.98926	-77.95093	LOW	2.03	RIFFLE	Gravel
1893	Point	36.98926	-77.95093	LOW	1.44	RIFFLE	Gravel
1894	Point	36.98926	-77.95092	LOW	1.44	RIFFLE	Gravel
1895	Point	36.98927	-77.95091	LOW	1.44	RIFFLE	Gravel
1896	Point	36.98927	-77.95091	LOW	1.44	RIFFLE	Gravel
1897	Point	36.98927	-77.95089	LOW	1.44	RIFFLE	Gravel
1898	Point	36.98927	-77.95088	LOW	1.44	RIFFLE	Gravel

Select by Attributes

Enter a WHERE clause to select records in the table window.

Method : Create a new selection

"FID"  
"Lat"  
"Lon"  
"Time"  
"UTC"

= <> Like  
> >= And  
< <= Or  
% ( ) Not

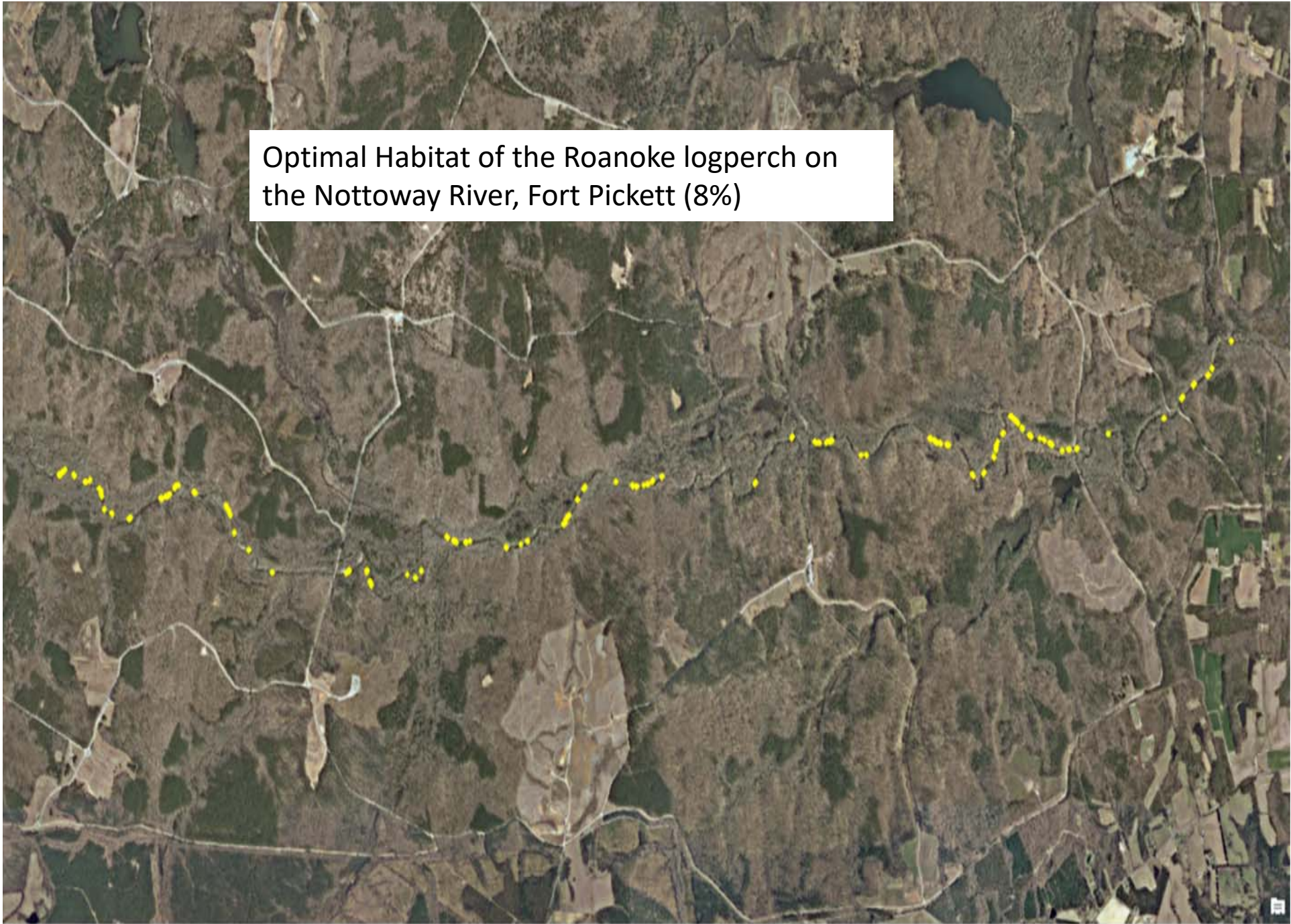
is Get Unique Values Go To:

SELECT \* FROM Nottoway WHERE:  
("Substrate" = 'Gravel' AND "Depth\_ft" <3.0 AND "River\_Char" = 'RUN') OR ("Substrate" = 'Gravel' AND "Depth\_ft" <3.0 AND "River\_Char" = 'RIFFLE')

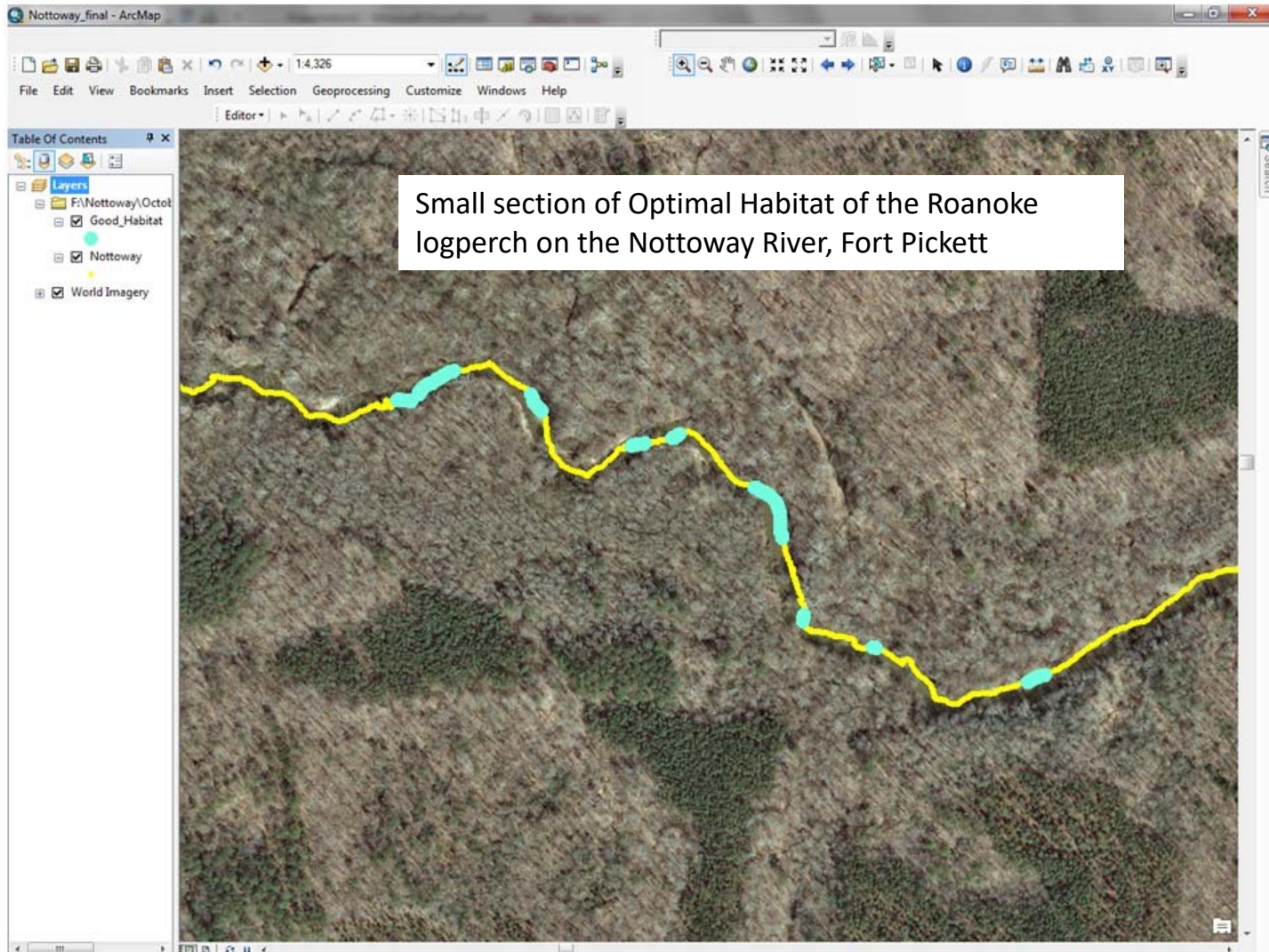
Clear Verify Help Load... Save... Apply Close

ArcGIS search criterion for optimal habitat for the Roanoke logperch

Optimal Habitat of the Roanoke logperch on  
the Nottoway River, Fort Pickett (8%)







GIS Attributes for Optimal Habitat:

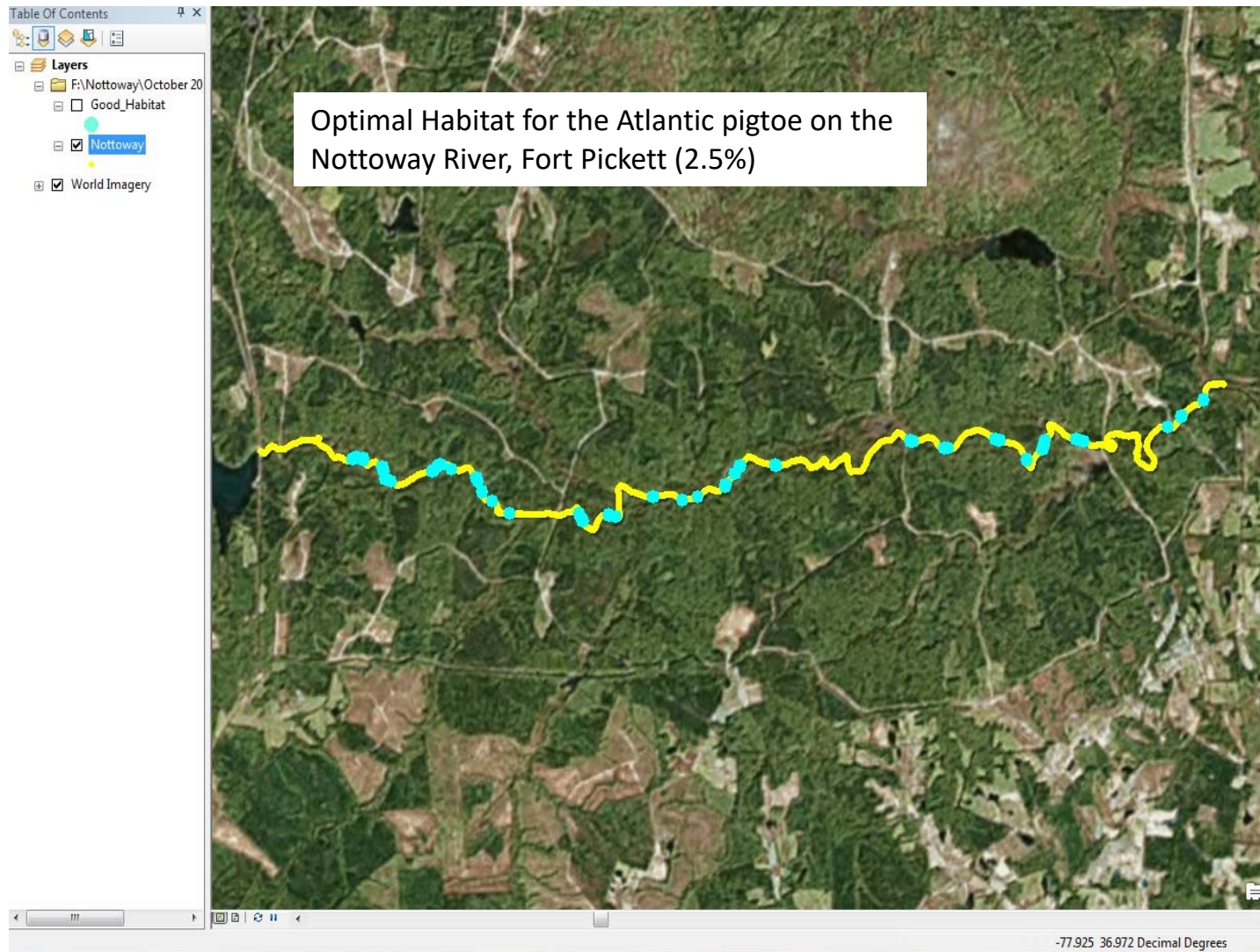
Depth  $\leq$  4 feet

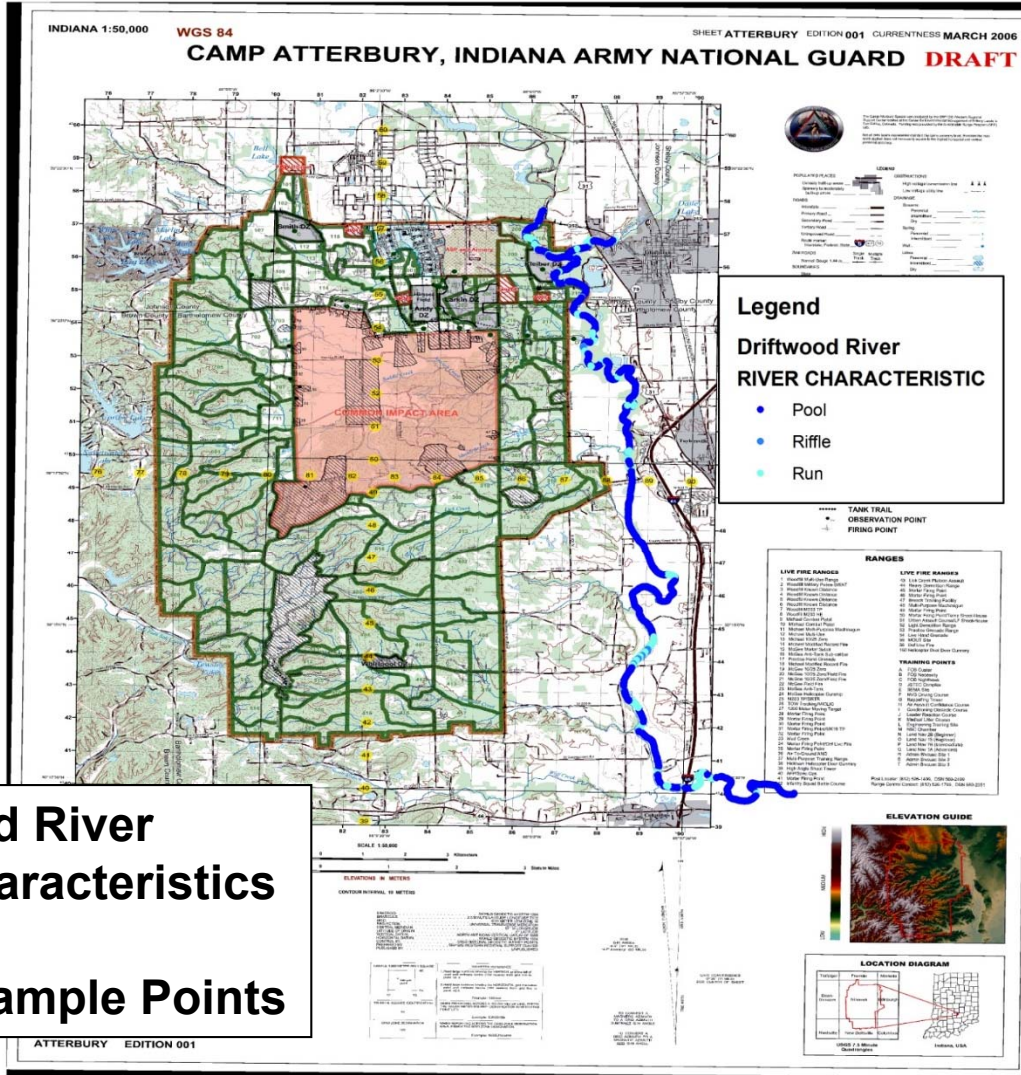
Substrate = gravel

River Characteristic = riffle



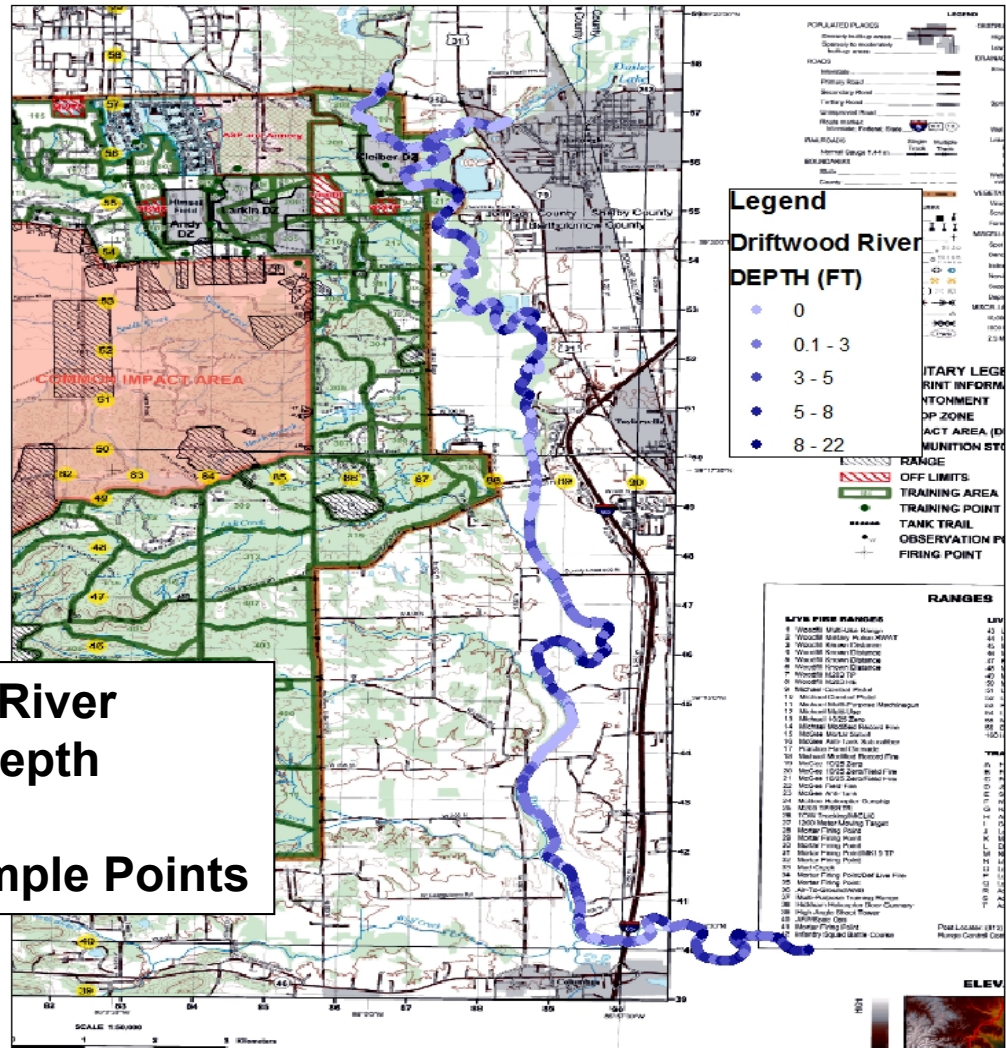
Atlantic pigtoe (Laurent, 2016)



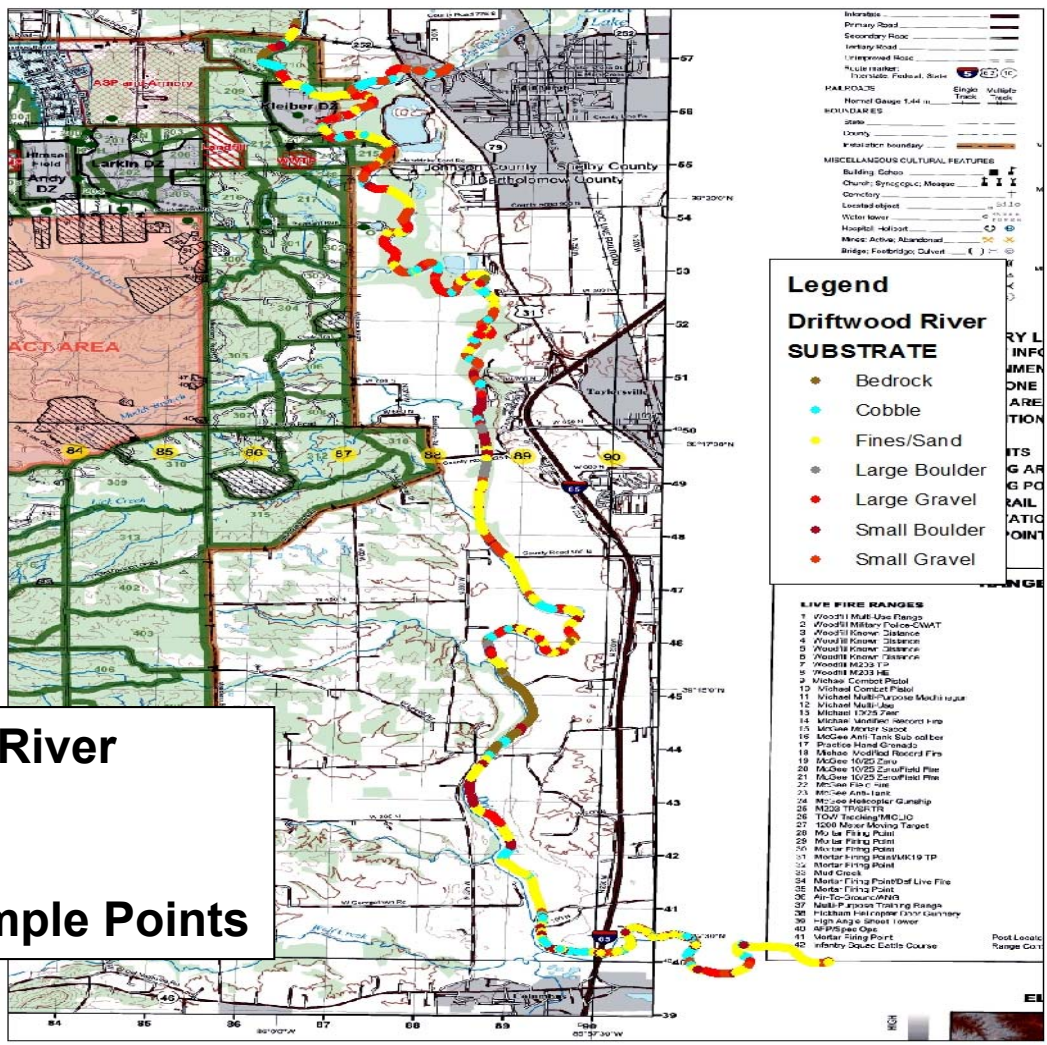


**Driftwood River**  
**River Characteristics**  
**20 mile**  
**38,503 Sample Points**

**Driftwood River  
Thalweg Depth  
20 mile  
38,053 Sample Points**



**Driftwood River  
Substrate  
20 mile  
38,053 Sample Points**



## Species at Risk Habitat Maps

- Rayed Bean (*Villosa fabalis*) mussel
- Develop Optimum Habitat Criteria



## Rayed Bean (*Villosa fabalis*) Habitat Criteria

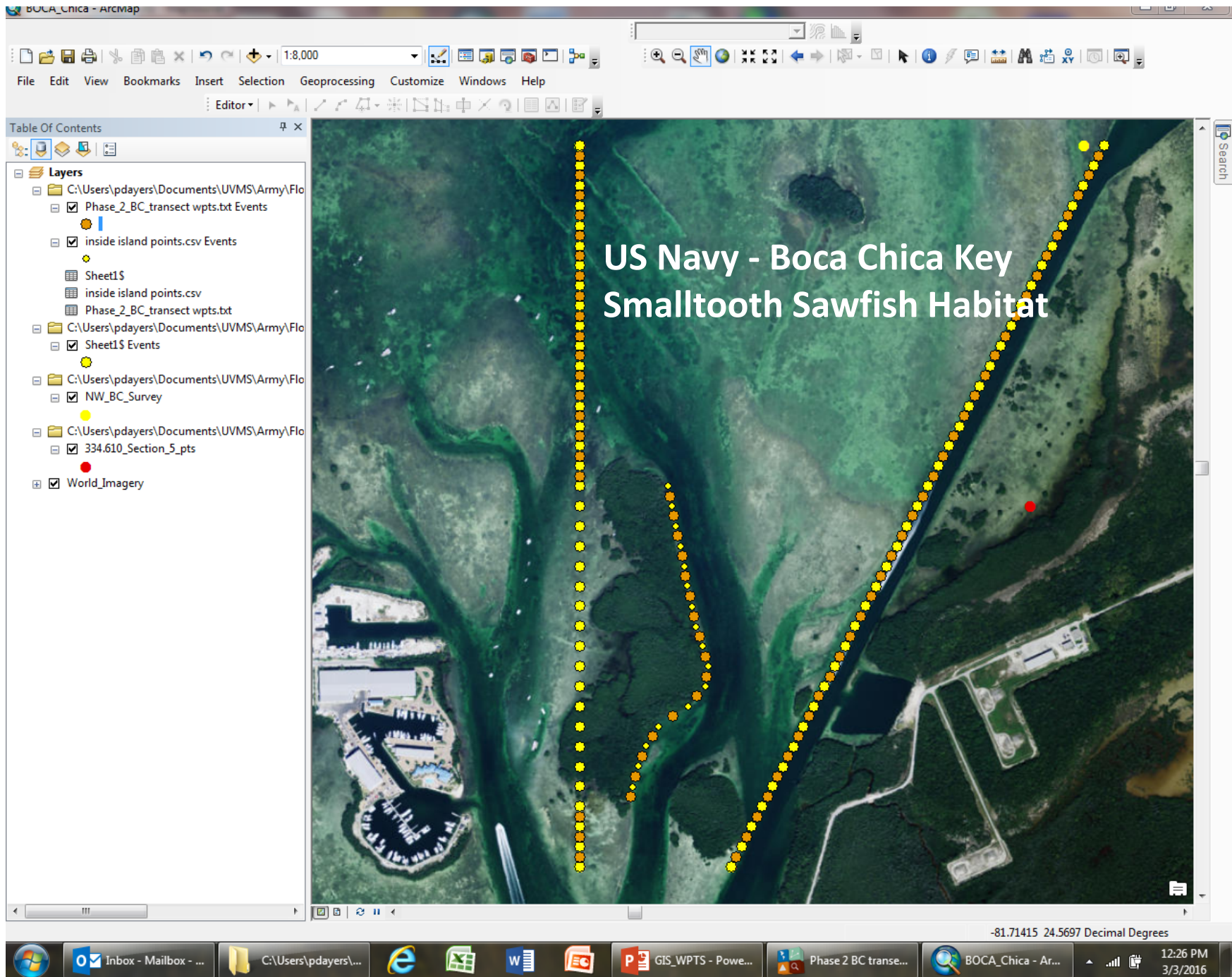
- primarily found in small, shallow rivers
- usually about 4 feet in depth or less
- in and near riffles/runs
- usually found deeply buried in sand and gravel substrates
- often in and around aquatic vegetation

### Search

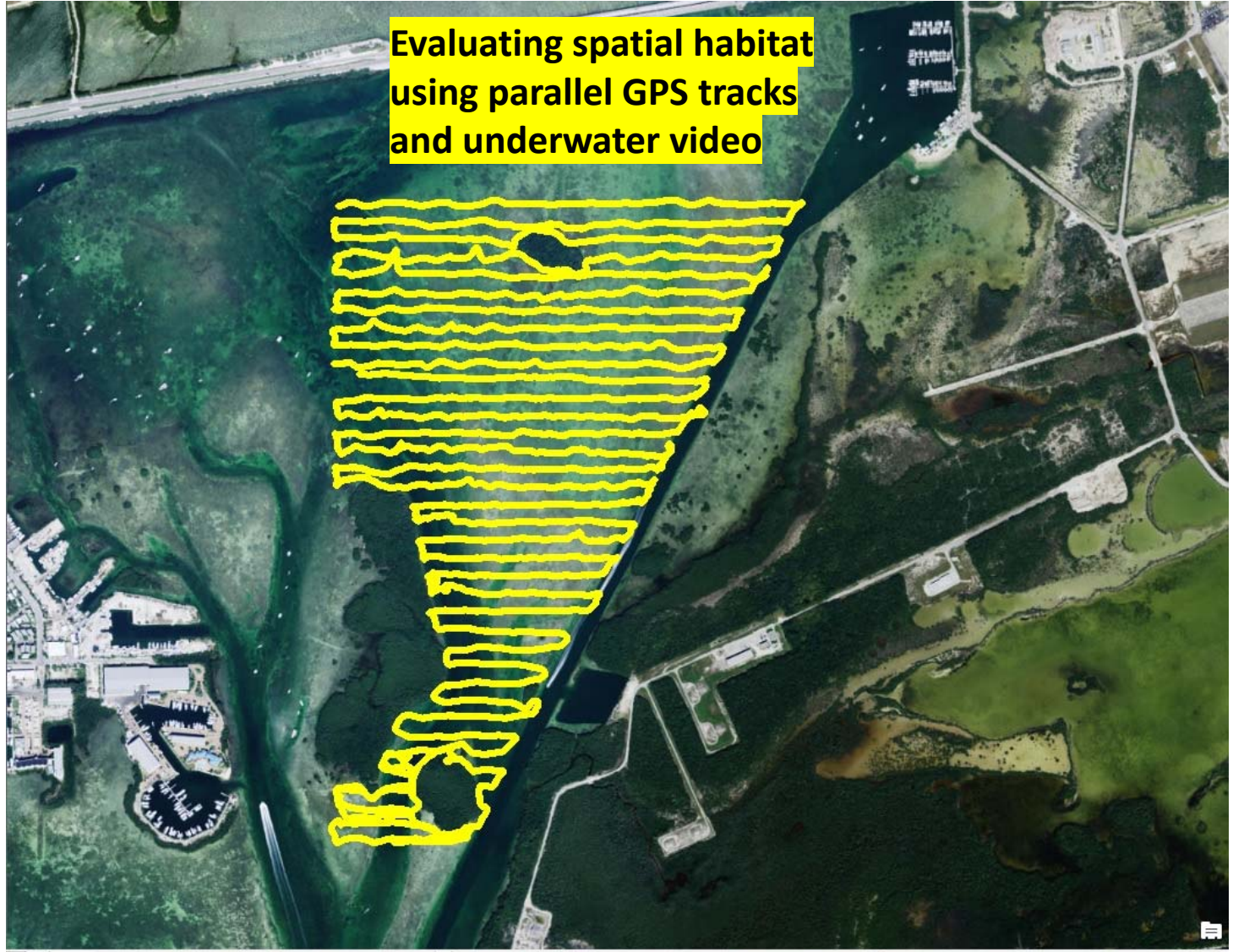
- (Depth  $\leq$  4 feet)
- River Characteristic = riffle/run
- Substrate = sand or gravel







Evaluating spatial habitat  
using parallel GPS tracks  
and underwater video



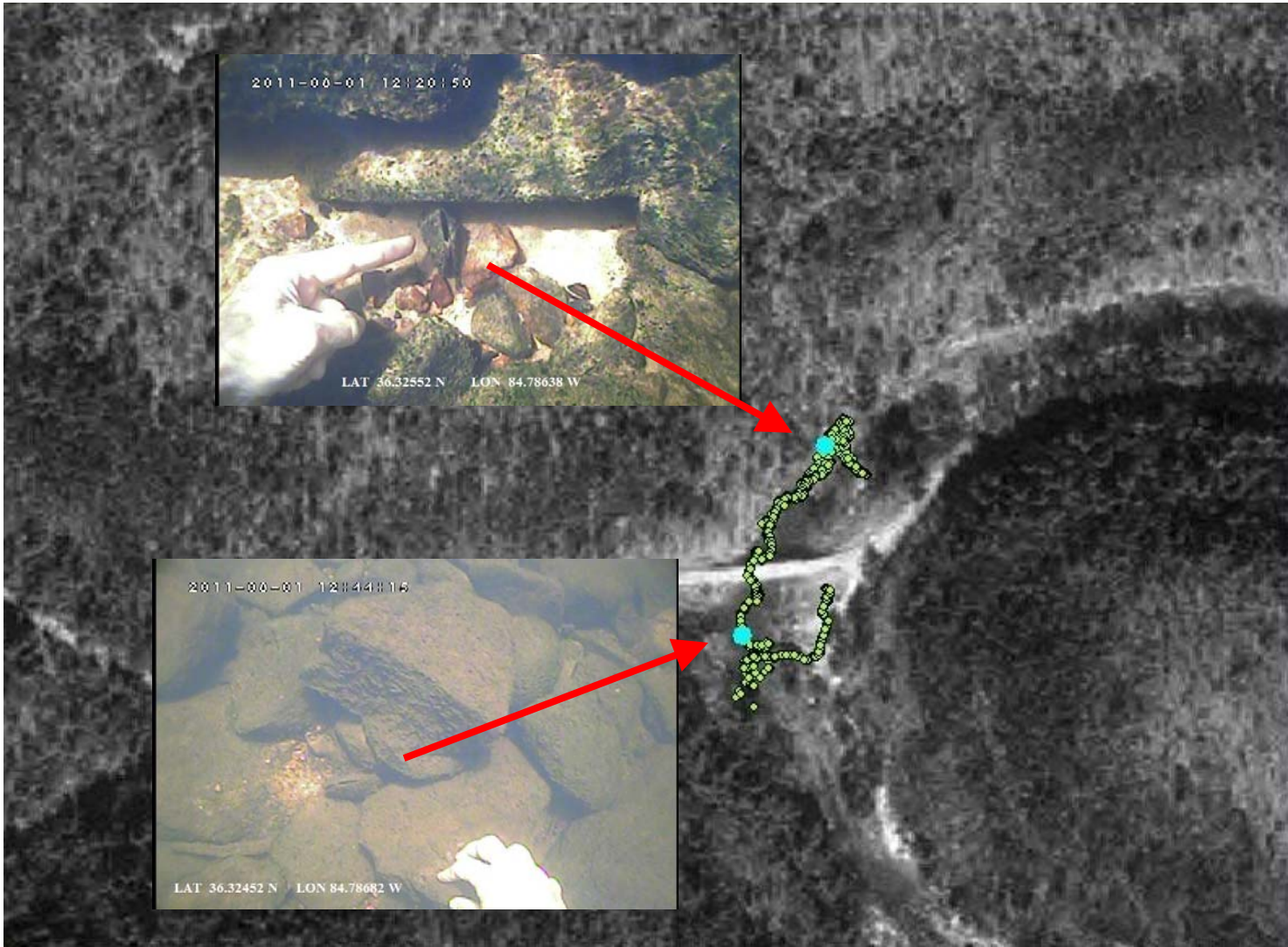
## GPS-based Snorkelmapping System for species identification and population monitoring



Liquid Image Video Mask and Garmin 64csx GPS Receiver

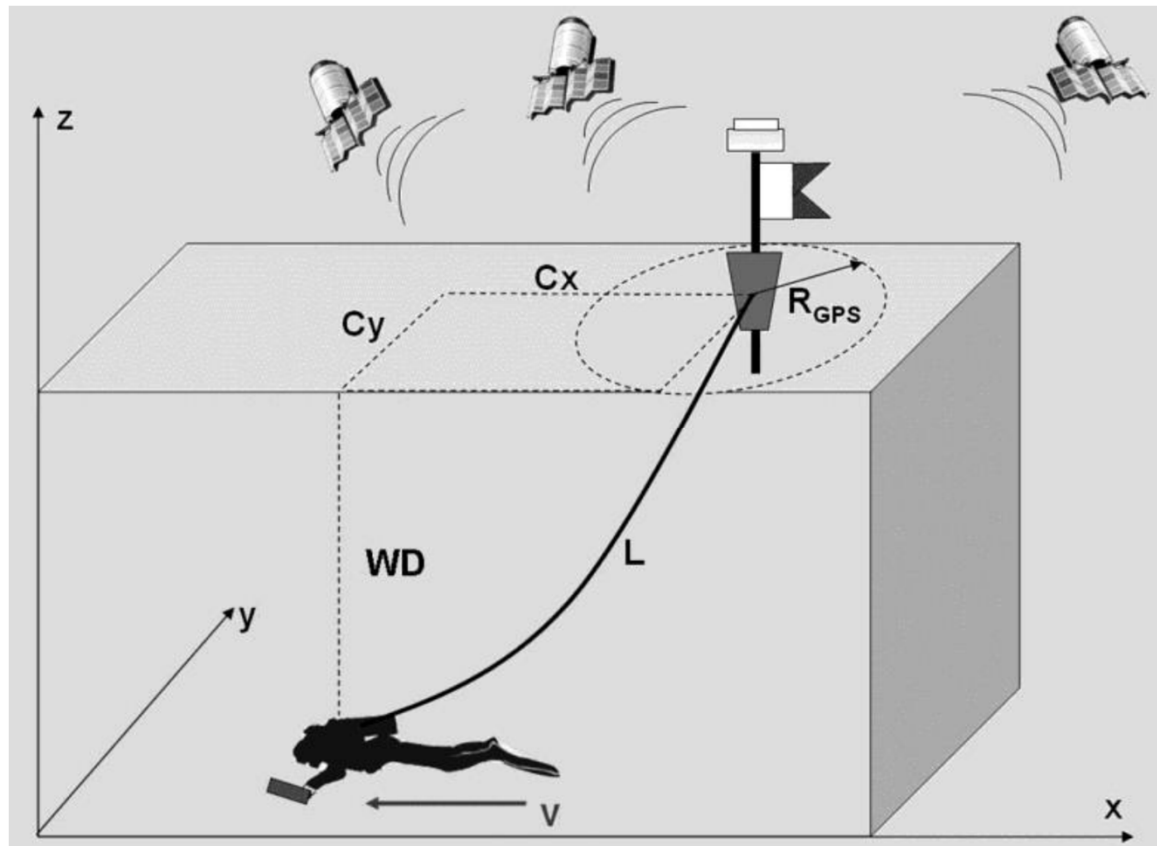
# Acquiring Georeferenced Snorkel Video





# SCUBA Mapper under development

GPS-based SCUBA diver tracking system for georeferencing underwater video for coral reef monitoring





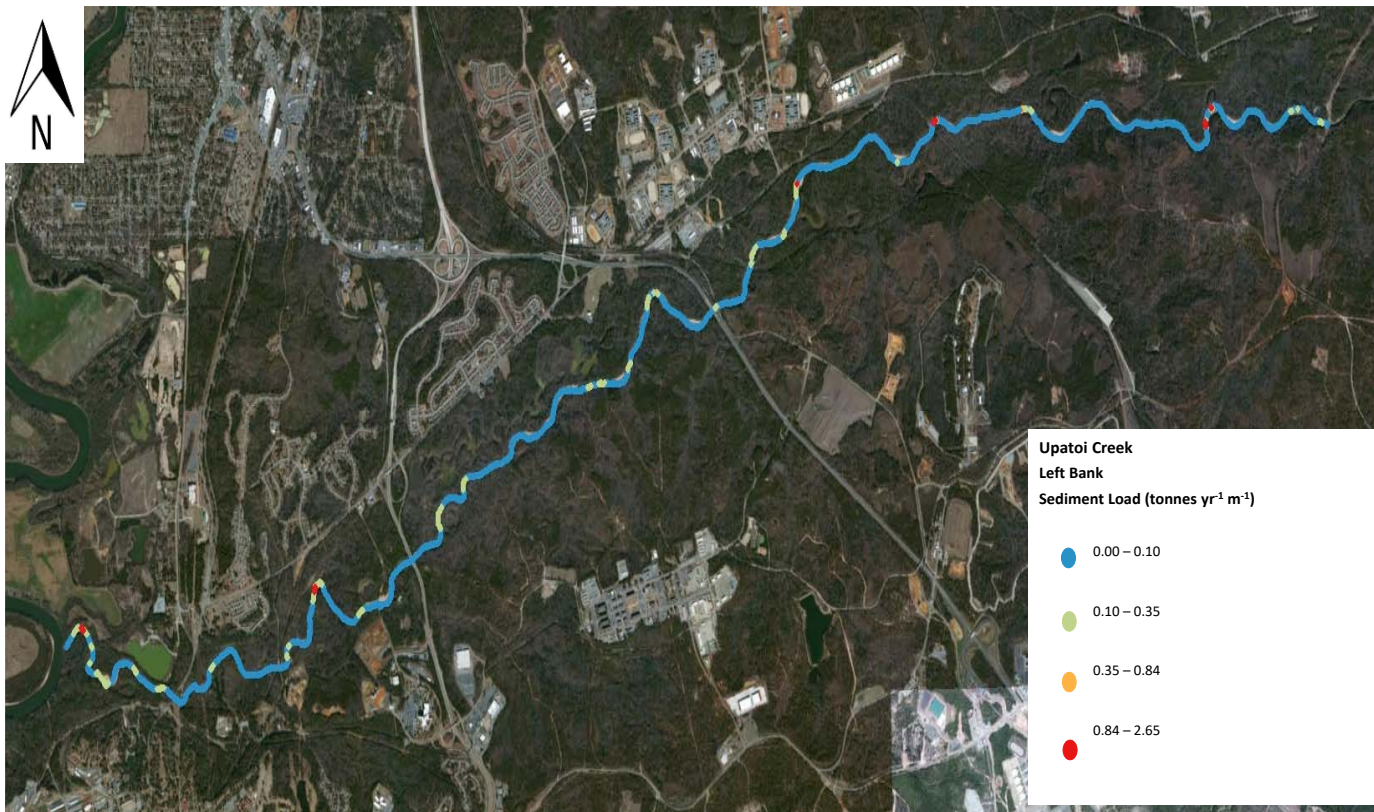
**Bank Angle = 6.95, Bank Height = 7.5, Surface Protection = 9, Riparian Diversity = 9**

Bank Angle (deg)					Bank Height (ft)								Surface Protect (Avg. %)				Riparian Diversity			
	0 - 60	61 - 80	81 - 90	> 91		0-1ft	1ft-3ft	3ft - 6ft	6ft-9ft	9ft-12ft	12ft-18ft	>18ft	100-56	55-30	29-15	< 14	Optimal	Sub Opt	Marginal	Poor
=2.45	=4.95	=6.95	=9									=2.45	=4.95	=6.95	=9	=2.45	=4.95	=6.95	=9	

**Use EPA BANCS technique to determine streambank erosion rates**



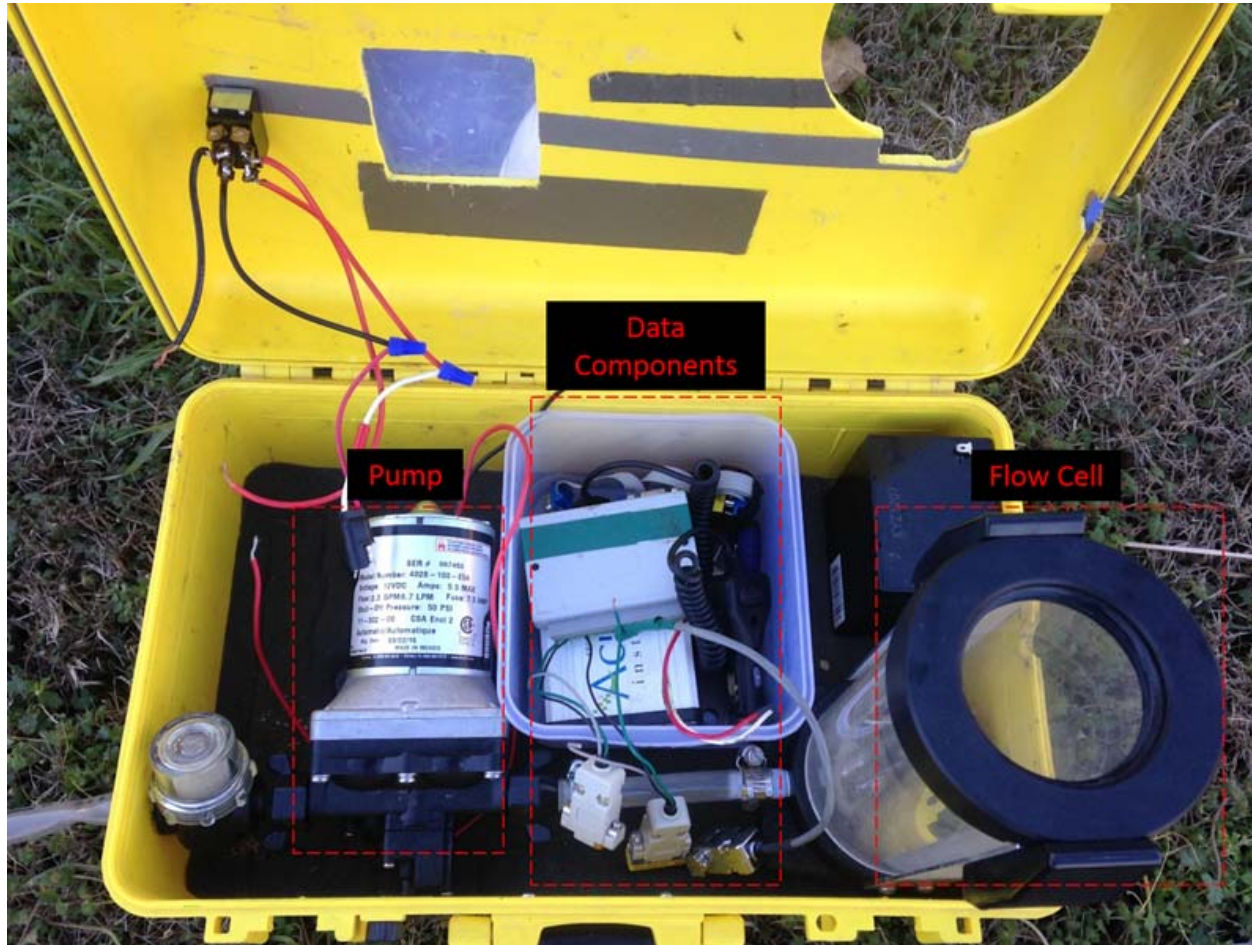
## Fort Benning Upatoi Creek – Streambank erosion sediment mapping for TMDL's



## Evaluating Geospatial Water Quality



# Flow cell and data recorder for YSI Sonde



# Water Quality Mapping (GPS and YSI Sonde)



# GPS (Trimble or Garmin18)

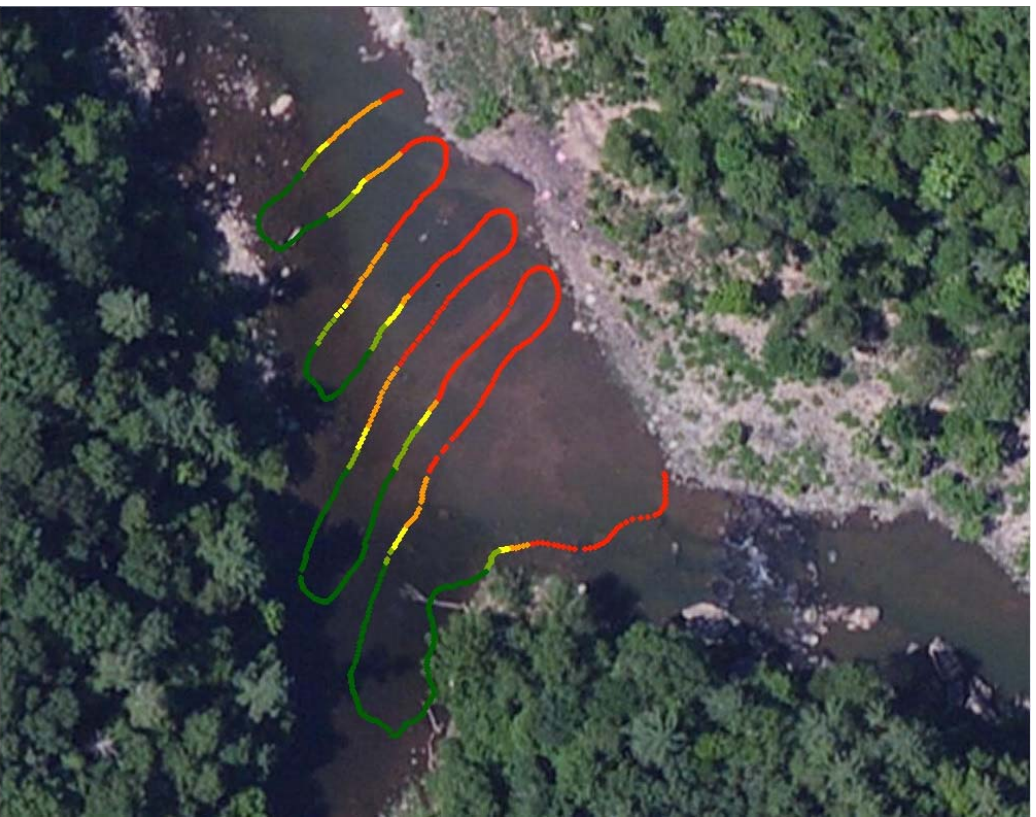
## SBAS, 1-3 m accuracy

### YSI (6920-V2) Temp, pH, EC, DO, Turbidity, TC95<7sec

- \$GPRMC,165541,A,3557.3281,N,08351.2315,W,001.8,043.8,020617,005.0,W\*7B
- \$GPGGA,165541,3557.3281,N,08351.2315,W,2,09,1.5,250.4,M,-31.9,M,,\*7F
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- \$GPGGA,165544,3557.3292,N,08351.2303,W,2,08,1.5,250.2,M,-31.9,M,,\*78
- \$YSI,1,17.25,5,176,18,7.53,203,0.3,212,7.26\*7E
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- \$YSI,1,17.25,5,176,18,7.53,203,0.4,212,7.25\*7A

Table Of Contents

- Layers
  - C:\Users\pdayers\Documents\U
    - Confluence WQ
      - EC  $\mu$ mhos/cm
        - 50 - 59
        - 60 - 78
        - 79 - 99
        - 100 - 121
        - 122 - 135
      - Confluence WQ
        - pH
          - 7.52 - 7.60
          - 7.61 - 7.68
          - 7.69 - 7.77
          - 7.78 - 7.84
          - 7.85 - 7.94
  - World Imagery



## **Benefits of Kayak-based Videomapping**

- Cover large areas (10 miles/day) - continuous
- Non-intrusive, no access required
- Allow for virtual video access in GIS
- Permanent historical video database, evaluate change
- The advantage of video mapping every foot of stream is that 1) the total population estimates can be made, and 2) the locations of optimal habitat can be identified and managed
- Evaluate habitat, streambank erosion, water quality.

# Transfer plan for mapping aquatic habitat for Species at-Risk using the underwater video mapping system

- Document prepared in final report
- Site specific – based on need
- Contract or in-house or USACE
- Field data collection (GPS, video, sensor)
- Use GIS specialist (on site or CEMML)
- As simple as GPS and GoPro (or smartphone)



Questions?

email: [ayers@utk.edu](mailto:ayers@utk.edu)

