Tools for Jurisdictional Determinations of Headwater Streams in Appalachia

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Why is this important?

- **Headwater Streams and Isolated Wetlands at Risk**
- ***Rapanos* v. *United States* and *Carabell v. United States* (consolidated into one ruling:**
  - ***Rapanos* v. *United States*, US 126 S. Ct. (2006), questioned the federal authority to protect headwater streams as jurisdictional waters under the Clean Water Act**

Why is this important?

- **Joint Guidance issued by USACE and US EPA on Jurisdictional Determinations (2007)**
  - **Determining Relatively Permanent Waters (RPW) from Non-Relatively Permanent Waters (Non-RPW)**
  - **RPW= intermittent/perennial streams flowing >3 months**
  - **Non-RPW= ephemeral (non jurisdictional unless it can be shown to provide a "significant nexus" to TNWs)**

HISS

- Headwater Research by EPA ORD-Cinci (2003-2005)

  Field manual (2006)

  2 Publications; 1 in review, more to come

  -Physical indicators

  -Hydrological indicators

  -Biological Indicators

Field Operations Manual for Assessing the Hydrologic Permanence and Ecological Condition of Headwater Streams

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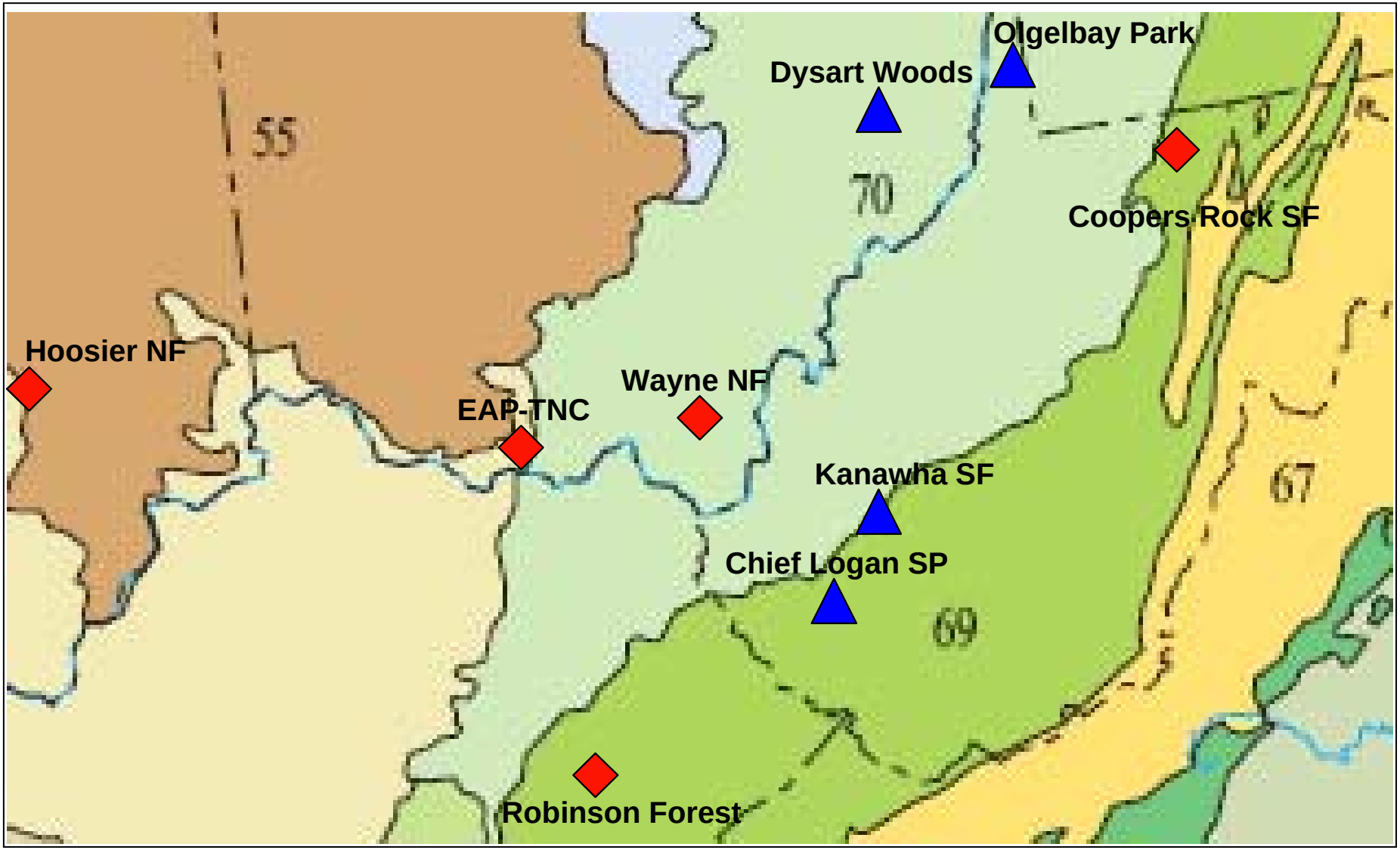
Ephemeral-Intermittent-Perennial
(3-4 streams per study area)

Flow category verified with spring and summer data collection, 4 mo. water sensors

Regional Observations on RPWs



HISS DATA
Example Physical Variables
(Fritz et al. 2008)

Variable	Description
DA[1]	Drainage area (ha)
EL[1]	Elevation (km)
VS[1]	Mean valley slope (%)
VW	Valley width (m)
CD[1]	Channel density (km^{-1})
CS[1]	Channel slope (%)
FED	Frequency of erosional-depositional sequences
PRE	Proportion of erosional habitat
BFW[1]	Median bankfull width (m)
BFD[1]	Median bankfull depth (m)
BFWCV[3]	Bankfull width coefficient of variation (%)
BFDCV[3]	Bankfull depth coefficient of variation (%)
INSTABILITY	Index of streambed tractive force
$W:D_{BF}$[3]	Mean bankfull width : bankfull depth
ER	Mean entrenchment ratio
SUBTRATE[4]	Median substrate size class (mm)
SINUOSITY	Number of bends per 30m reach
SUBSTRATECV[1]	Substrate size coefficient of variation (%)
PBR[5]	Proportion of bedrock
DBR	Mean depth to bedrock (m)
MAXP[1]	Maximum pool depth (m)
WW[3]	Median wetted width (m)

NC Stream ID Form (V. 3.1)

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date:	Project:	Latitude:
Evaluator:	Site:	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	County:	Other *e.g. Quad Name*:

A. Geomorphology (Subtotal = _____)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal =)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = _____)				
20[b]. Fibrous roots in channel	3	2	1	0

OH HHEI Form

Primary Headwater Habitat Evaluation Form

HHEI Score (sum of metrics 1, 2, 3) : ☐

SITE NAME/LOCATION _____

_____ SITE NUMBER _____ RIVER BASIN _____ DRAINAGE AREA (mi^2) _____

LENGTH OF STREAM REACH (ft) _____ LAT. _____ LONG. _____ RIVER CODE _____ RIVER MILE _____

DATE _____ SCORER _____ COMMENTS _____

NOTE: Complete All Items On This Form - Refer to "Field Evaluation Manual for Ohio's PHWH Streams" for Instructions

STREAM CHANNEL MODIFICATIONS: ☐ NONE / NATURAL CHANNEL ☐ RECOVERED ☐ RECOVERING ☐ RECENT OR NO RECOVERY

1. SUBSTRATE (Estimate percent of every type of substrate present. Check *ONLY* two predominant substrate *TYPE* boxes (Max of 32). Add total number of significant substrate types found (Max of 8). Final metric score is sum of boxes A & B.

TYPE		PERCENT	TYPE		PERCENT
☐☐	BLDR SLABS [16 pts]	_____	☐☐	SILT [3 pt]	_____
☐☐	BOULDER (>256 mm) [16 pts]	_____	☐☐	LEAF PACK/WOODY DEBRIS [3 pts]	_____
☐☐	BEDROCK [16 pt]	_____	☐☐	FINE DETRITUS [3 pts]	_____
☐☐	COBBLE (65-256 mm) [12 pts]	_____	☐☐	CLAY or HARDPAN [0 pt]	_____
☐☐	GRAVEL (2-64 mm) [9 pts]	_____	☐☐	MUCK [0 pts]	_____
☐☐	SAND (<2 mm) [6 pts]	_____	☐☐	ARTIFICIAL [3 pts]	_____

Total of Percentages of Bldr Slabs, Boulder, Cobble, Bedrock _____ (A) ☐

SCORE OF TWO MOST PREDOMINATE SUBSTRATE TYPES:

(B) ☐ TOTAL NUMBER OF SUBSTRATE TYPES:

2. Maximum Pool Depth *(Measure the maximum pool depth within the 61 meter (200 ft)* evaluation reach at the time of evaluation. Avoid plunge pools from road culverts or storm water pipes) (Check *ONLY* one box):

- ☐ > 30 centimeters [20 pts]
- ☐ > 22.5 - 30 cm [30 pts]
- ☐ > 10 - 22.5 cm [25 pts]
- ☐ > 5 cm - 10 cm [15 pts]
- ☐ < 5 cm [5 pts]
- ☐ NO WATER OR MOIST CHANNEL [0 pts]

COMMENTS _____ MAXIMUM POOL DEPTH (centimeters): ☐

3. BANK FULL WIDTH (Measured as the average of 3-4 measurements) (Check *ONLY* one box):

- ☐ > 4.0 meters (> 13') [30 pts]
- ☐ > 3.0 m - 4.0 m (> 9' 7" - 13') [25 pts]
- ☐ > 1.5 m - 3.0 m (> 9' 7" - 4' 8") [20 pts]
- ☐ > 1.0 m - 1.5 m (> 3' 3" - 4' 8") [15 pts]
- ☐ ≤ 1.0 m (≤ 3' 3") [5 pts]

COMMENTS _____ AVERAGE BANKFULL WIDTH (meters) ☐

HHEI Metric Points

Substrate Max = 40 ☐

A + B

Pool Depth Max = 30 ☐

Bankfull Width Max=30 ☐

Statistical Analysis

- HISS dataset (IN,OH,KY,WV)
  - 21 least-disturbed streams (78 sites)
- Discriminant Function Analysis (DFA)
  - Similar to MANOVA but pick groups *a priori*
    - RPW *(intermittent and perennial)*
    - Non-RPW *(ephemeral)*
- Ran **Stepwise** DFA on all physical variables in dataset

Stepwise DFA Results

"IN"

Variable		F-to-remove	Tolerance
11	Chan Den	21.29	0.683362
28	SP Frq Er:Dep	9.17	0.682545
33	OH HHEI	5.94	0.832985
34	NCDWQ SI	21.35	0.806500
41	SP W:D	9.97	0.785994
43	SP PrDRY	56.48	0.742680
46	SP Wt-Wd CV	6.87	0.765639

"OUT"

Variable		F-to-enter	Tolerance
8	DA	0.04	0.484371
10	EL	0.09	0.762151
12	VW	0.72	0.867998
13	VS	0.45	0.522384
14	CS	0.06	0.391970
15	BFW	2.75	0.511290
16	BFD	0.16	0.680040
17	DEP	0.01	0.838502
18	SINUOSITY	0.38	0.783578
19	SUBSTRATE	1.92	0.720616
20	SUBSTRATECV	0.19	0.919028
21	PBR	1.94	0.779263
22	ER	1.30	0.928131
23	W:DBF	0.19	0.739288
24	BFWCV	0.61	0.788954
25	BFDCV	0.00	0.914890
26	INSTABILITY	1.84	0.742297
27	SPRPRE	0.17	0.643656
32	RHA	0.53	0.634310
35	SPRMAXP	0.28	0.684674
36	SUMMERCANOPY	1.86	0.877766
37	SPRVEL	0.59	0.690135
38	SPRQ	1.40	0.497493
39	SPRDEPTH	1.04	0.573795
40	SPRWIDTH	0.14	0.737966
44	SPRDEPTHCV	1.17	0.858918
45	SPRVELCV	0.41	0.393921
47	SPRWDWATERC	2.31	0.486651
48	SUMMERDEP	1.78	0.782668

	NRPW	RPW	%correct
NRPW	18	0	100
RPW	1	58	98
Total	19	58	99

Jackknifed classification matrix

	NRPW	RPW	%correct
NRPW	18	0	100
RPW	1	58	98
Total	19	58	99

Wilk's lambda= 0.090 Approx.F= 100.120 df= 7,69
p-tail= 0.0000

"IN"

Variable	F-to-remove	Tolerance	
OH HHEI	46.33	0.971588	
NCDWQ SI	23.01	0.971588	

Classification matrix (cases in row categories classified into columns)

	NRPW	RPW	%correct
NRPW	17	1	94
RPW	0	59	100
Total	17	60	99

Jackknifed classification matrix

	NRPW	RPW	%correct
NRPW	17	1	94
RPW	0	59	100
Total	17	60	99

Eigenvalues

2.926

Canonical correlations

0.863

Cumulative proportion of total dispersion

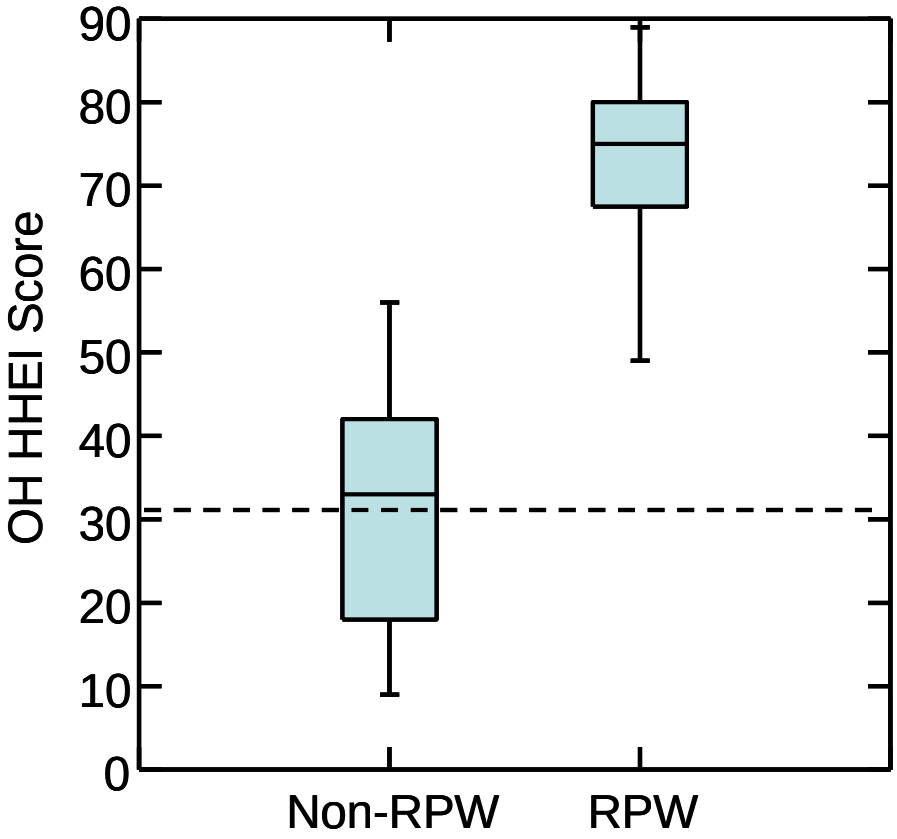
1.000

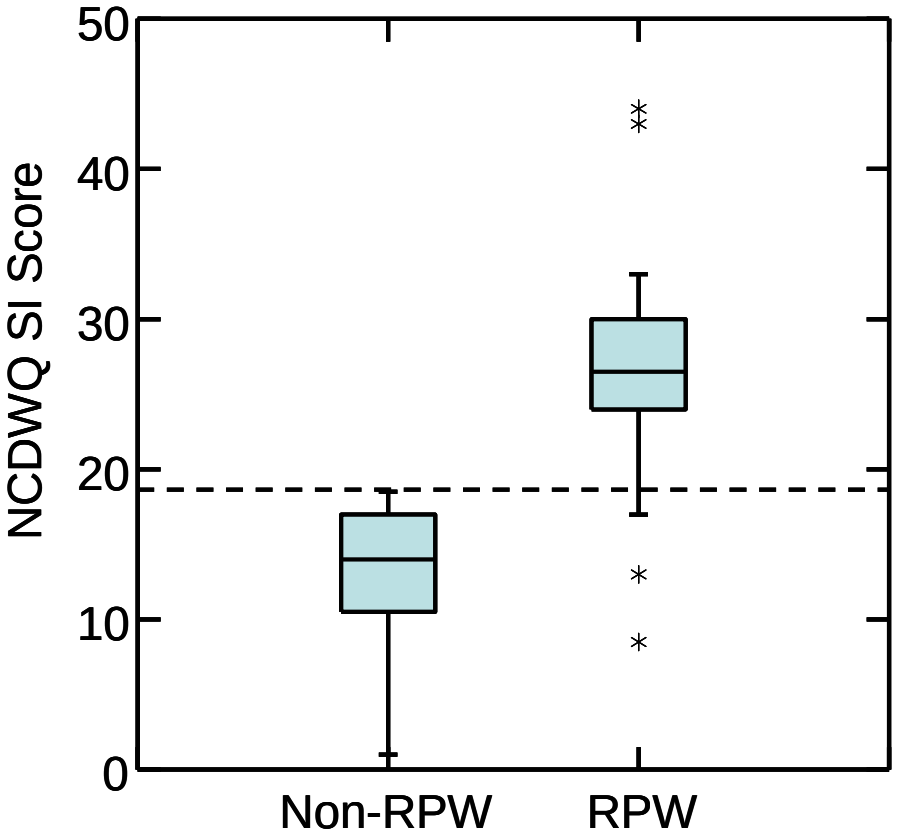
Wilks' lambda= 0.255

Approx.F= 108.244 df= 2, 74 p-tail= 0.0000

DFA Results

HISS dataset (IN,OH,KY,WV)

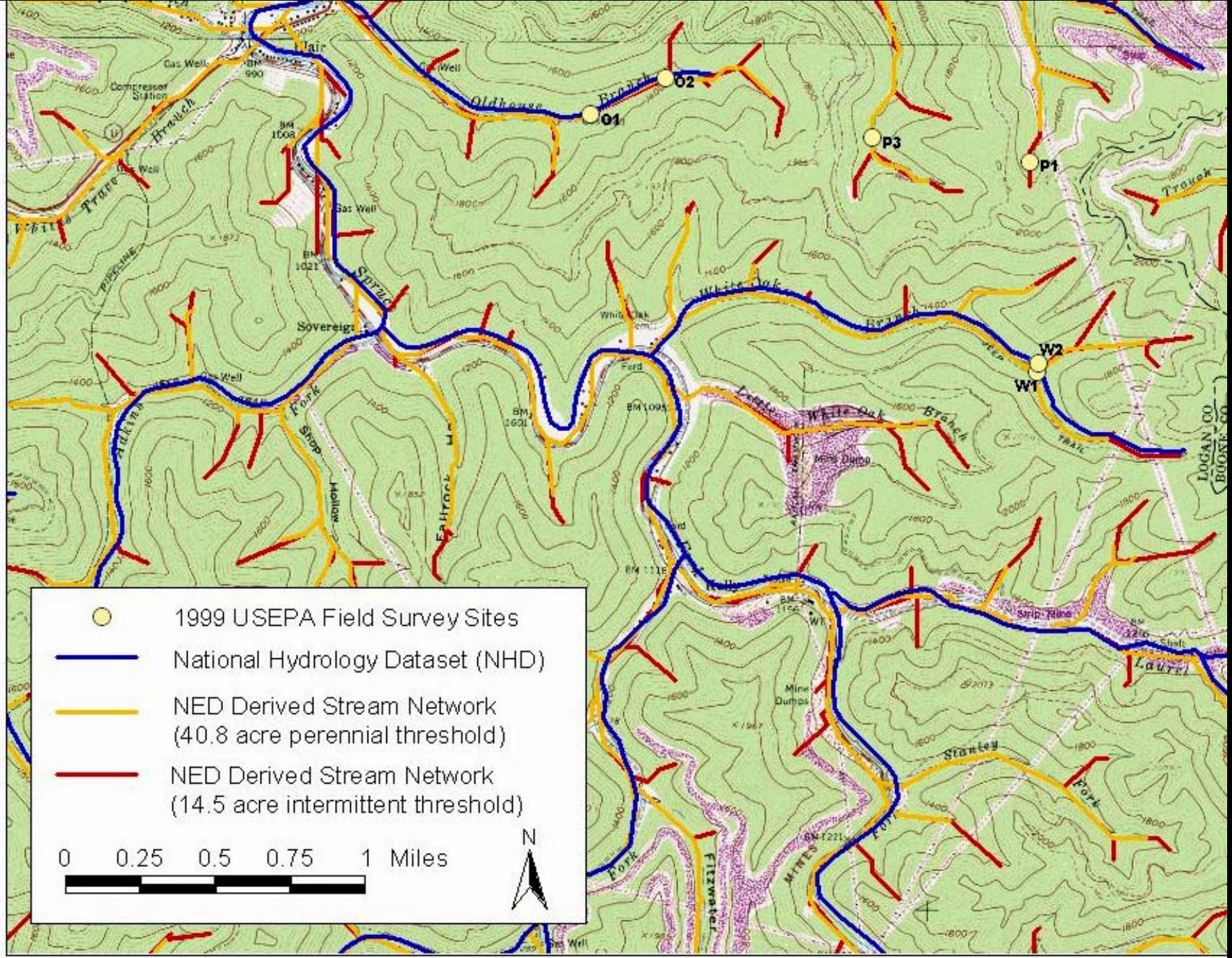




Ave. Watershed Size of RPW Cutoff

Location	n	Catchment Area (acres)	Source
Robinson Forest (KY)	3	10.4	Fritz (unpub.)
Robinson Forest (KY)*	8	12.5*	Svec et al. 2005
E. Kentucky other (KY)*	5	19.8*	Svec et al. 2005
Coopers Rock SF (WV)	4	20.6	EPA R3 (unpub.)
Upper OH Valley WV/OH/PA	19	5.3	B. Stout (unpub.)
Hoosier NF (IN)	1	6.1	Fritz (unpub.)
EAP–TNC (OH)	4	18.8	Fritz (unpub.)
Wayne NF (OH)	2	5.7	Fritz (unpub.)
WV MTM Region (WV)	36	14.5	Paybins 2003
NC Mountains (NC)	36	5.1	NCDWQ (unpub.)

*Considered "ephemeral" by authors (a priori) but all flowed for >50% duration over both 13 mo. and 24 mo.



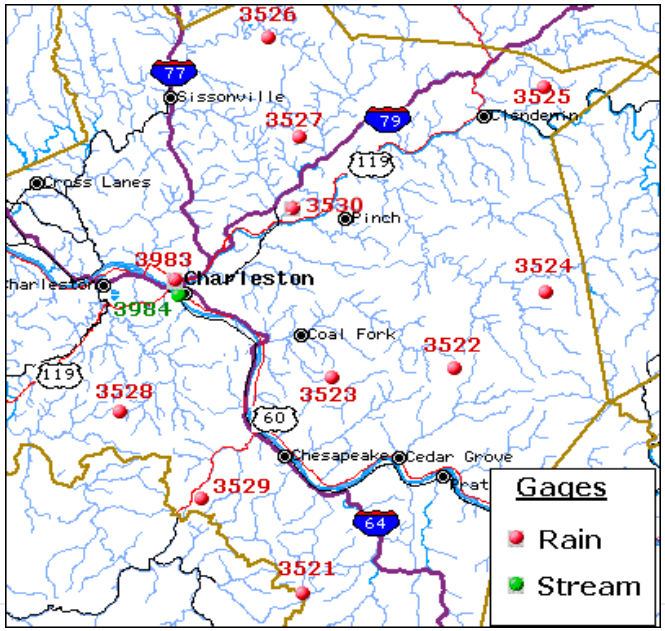
EPA R3 GIS SIG1217 HCHILDERS 02/06/03 MAP# 1957.

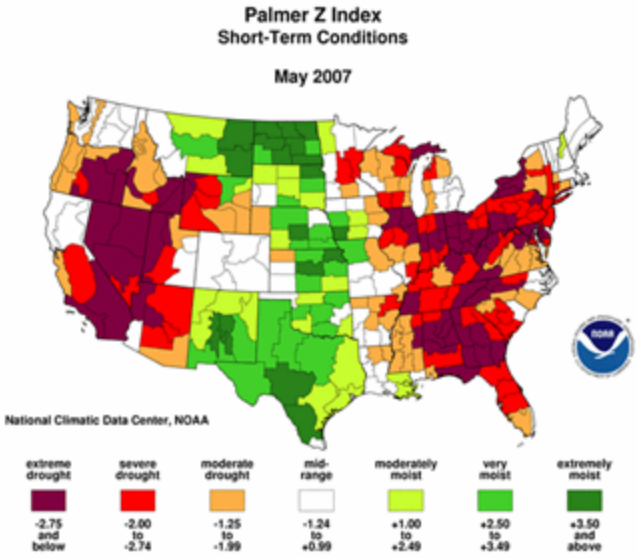
Procedure

- Desktop
  - Web Precipitation Archives
  - Calculate Drainage Area of Project Area
- Field Data
  - NCSI and OH HHEI forms
  - 15 min search and ID of obligate benthos
    - Salamanders, (mosses/liverworts?)

Precipitation Archives

- http://www.afws.net/
  IFLOWS
- http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/zimage.html
  Palmer Drought Index
- http://www.srh.noaa.gov/rfcshare/precip_analysis_new.php
  NOAA estimated precipitation imagery

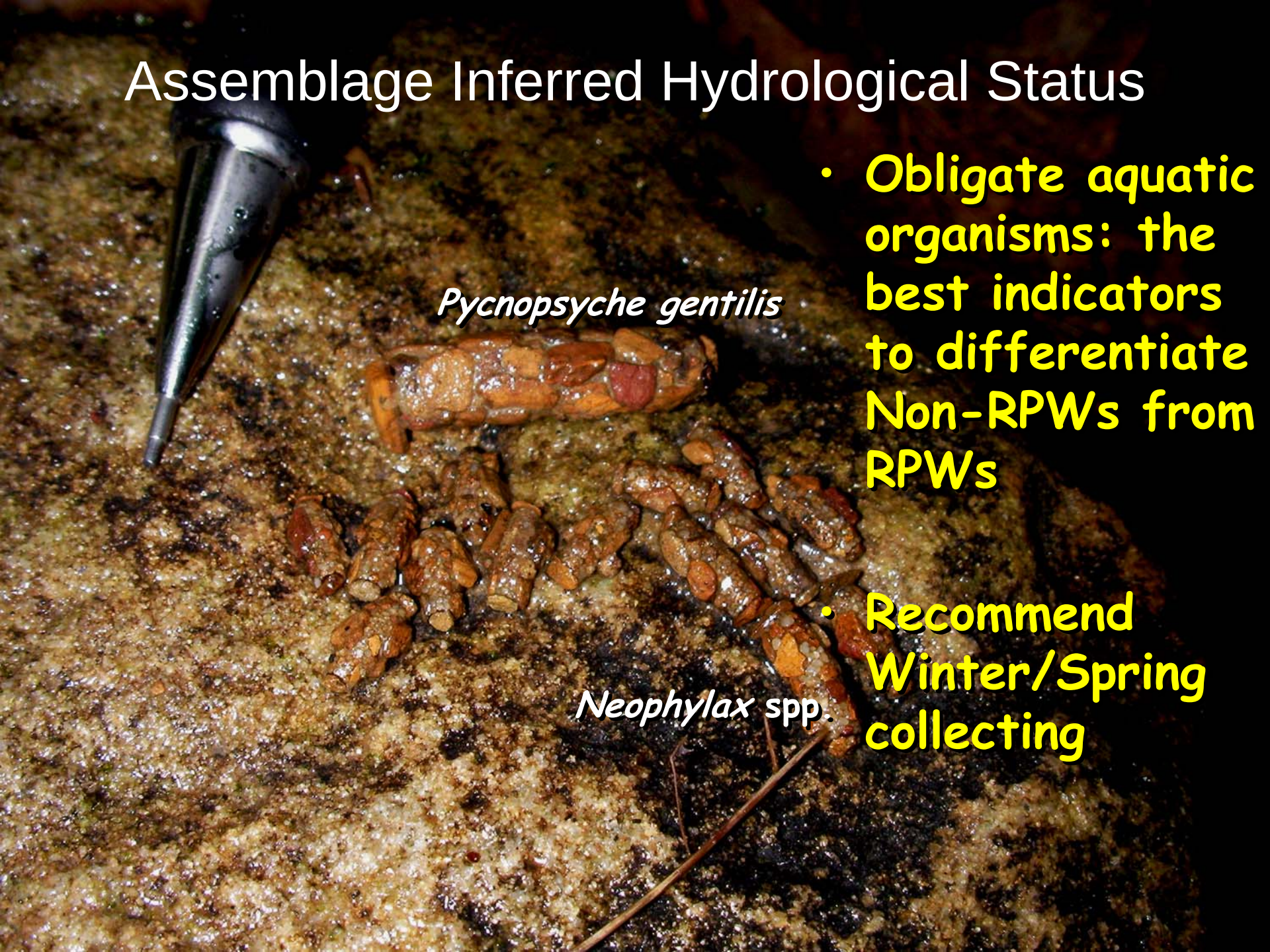




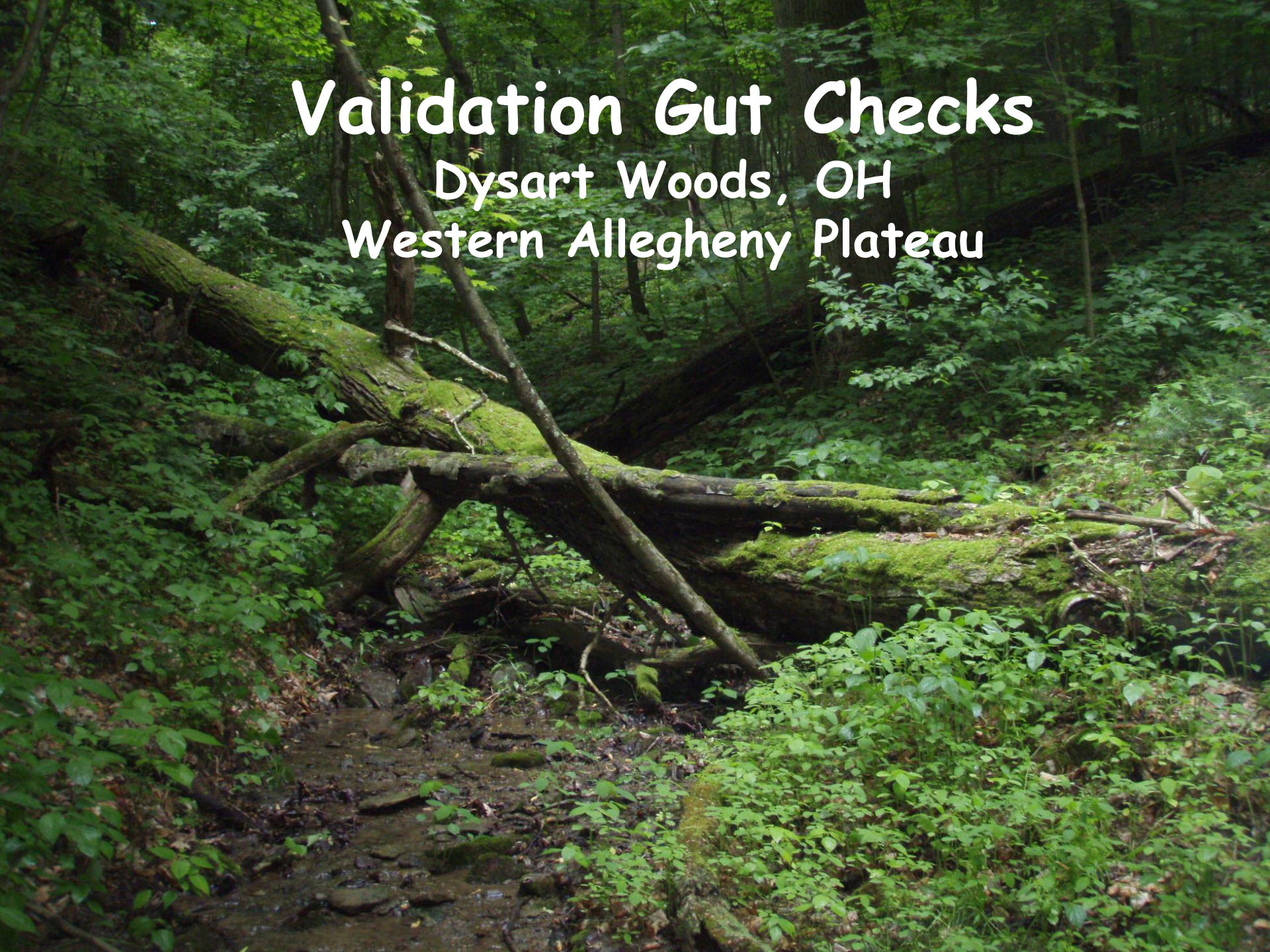
Macroinvertebrates In Dry Sediments (summer months)

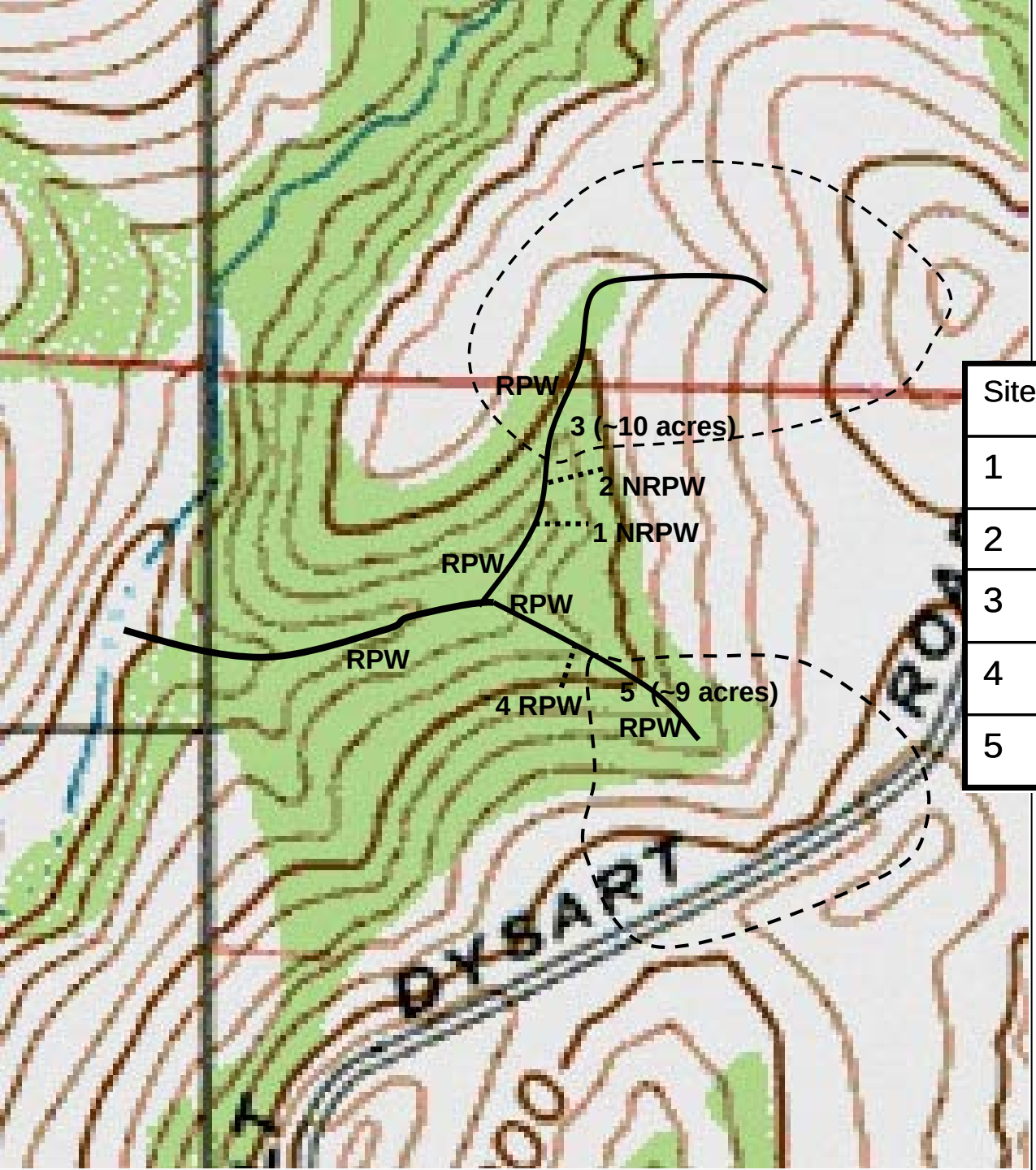
- Caddisflies (>6 mo.)
  - *Neophylax* pre-pupae and cases
  - *Pycnopsyche gentilis*
  - *Rhyacophila* and *Glossosoma* pupae
  - *Homoplectra* larvae in dry retreats
- Tipulidae
  - *Tipula*
- Megaloptera
  - *Nigronia*

Assemblage Inferred Hydrological Status



- **Obligate aquatic organisms: the best indicators to differentiate Non-RPWs from RPWs**
- **Recommend Winter/Spring collecting**


Validation Gut Checks
Dysart Woods, OH
Western Allegheny Plateau



Moderate Drought

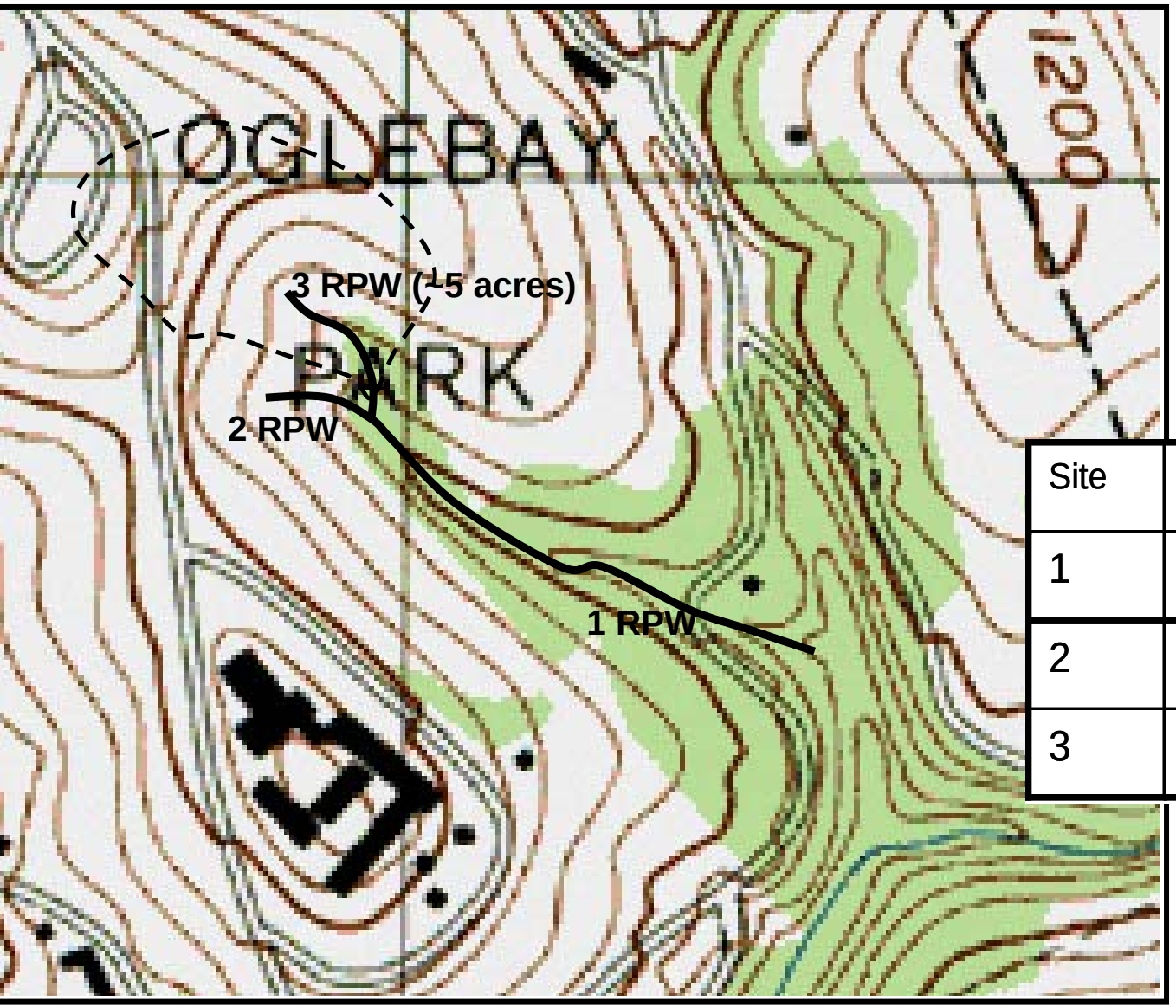
Belmont Co., OH

July 3, 2007

Site	NCSI	OHHEI	Benthos?
1	13	31	No
2	17.5	18	No
3	31	51	Yes
4	19	39	Yes
5	30.5	52	Yes


Dysart Site 4 RPW

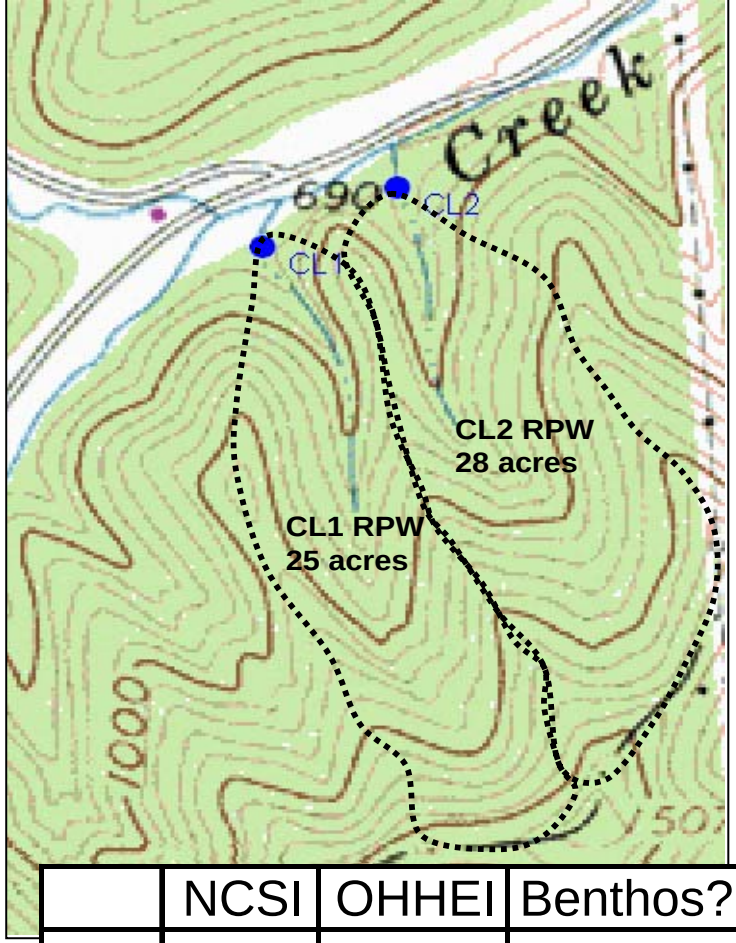

Dysart Site 1 N-RPW

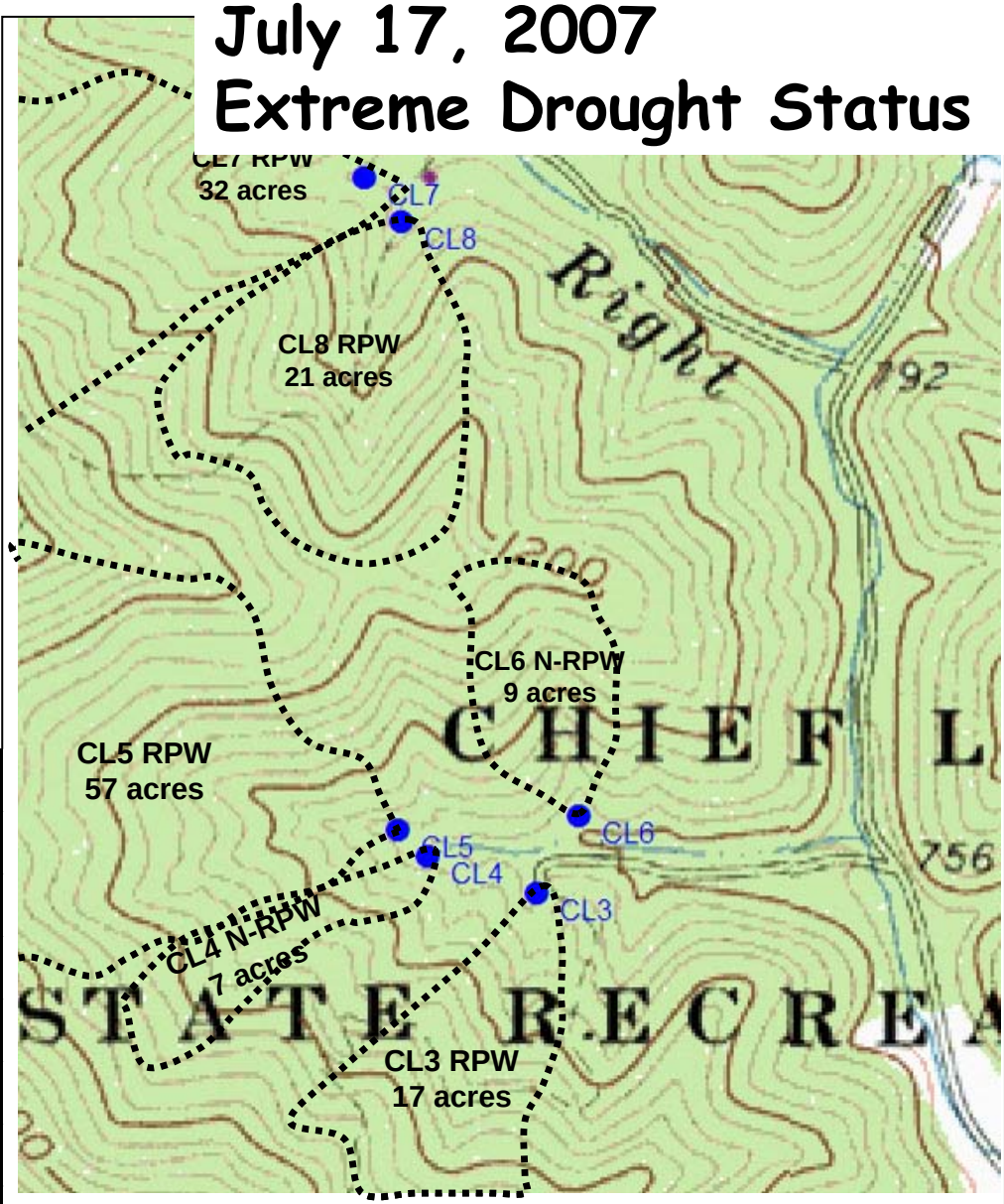


Oglebay Park
Ohio Co., WV
July 3, 2007
Moderate Drought

Site	NCSI	OHHEI	Benthos?
1	ND	ND	Yes
2	ND	ND	Yes
3	23.5	32	Yes

Logan County, WV
July 17, 2007
Extreme Drought Status

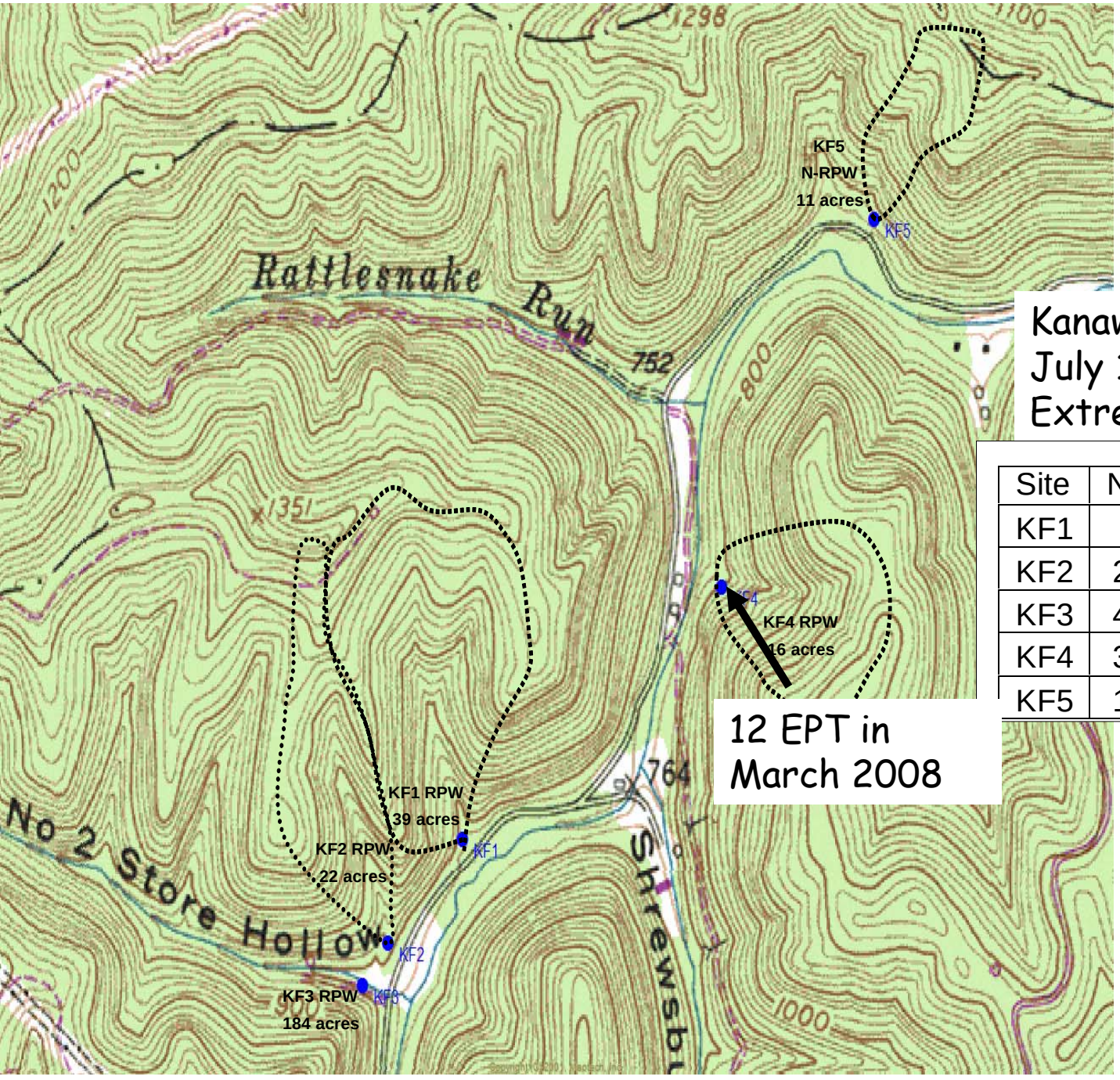




	NCSI	OHHEI	Benthos?
CL1	25.5	47	yes
CL2	30	53	yes
CL3	26.5	47	yes
CL4	18	31	no
CL5	31.5	69	yes
CL6	18.5	30	no
CL7	24.5	42	yes
CL8	23	32	yes


Site CL3 RPW


bed aggradation at mouth
(lower 15-20 m)

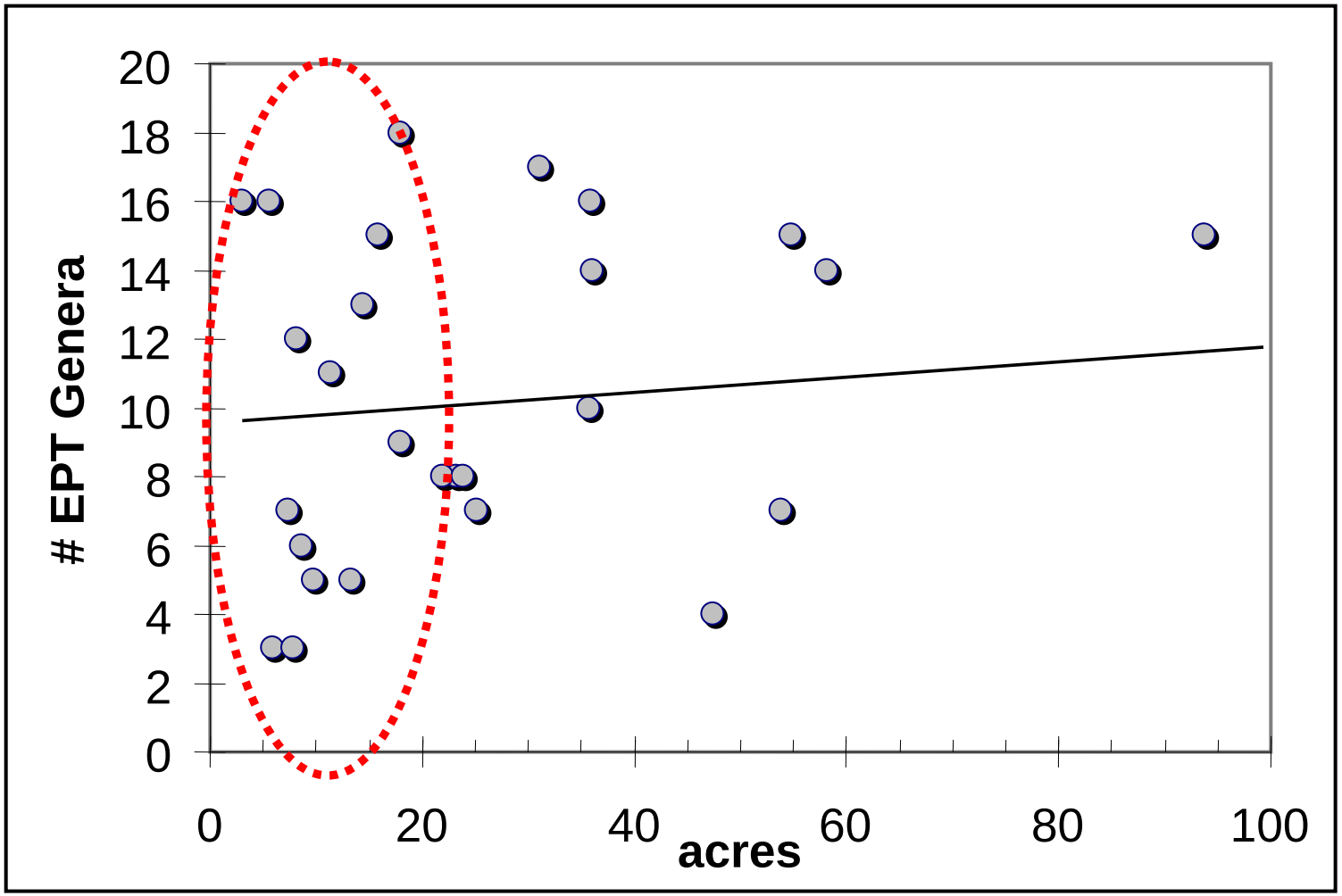


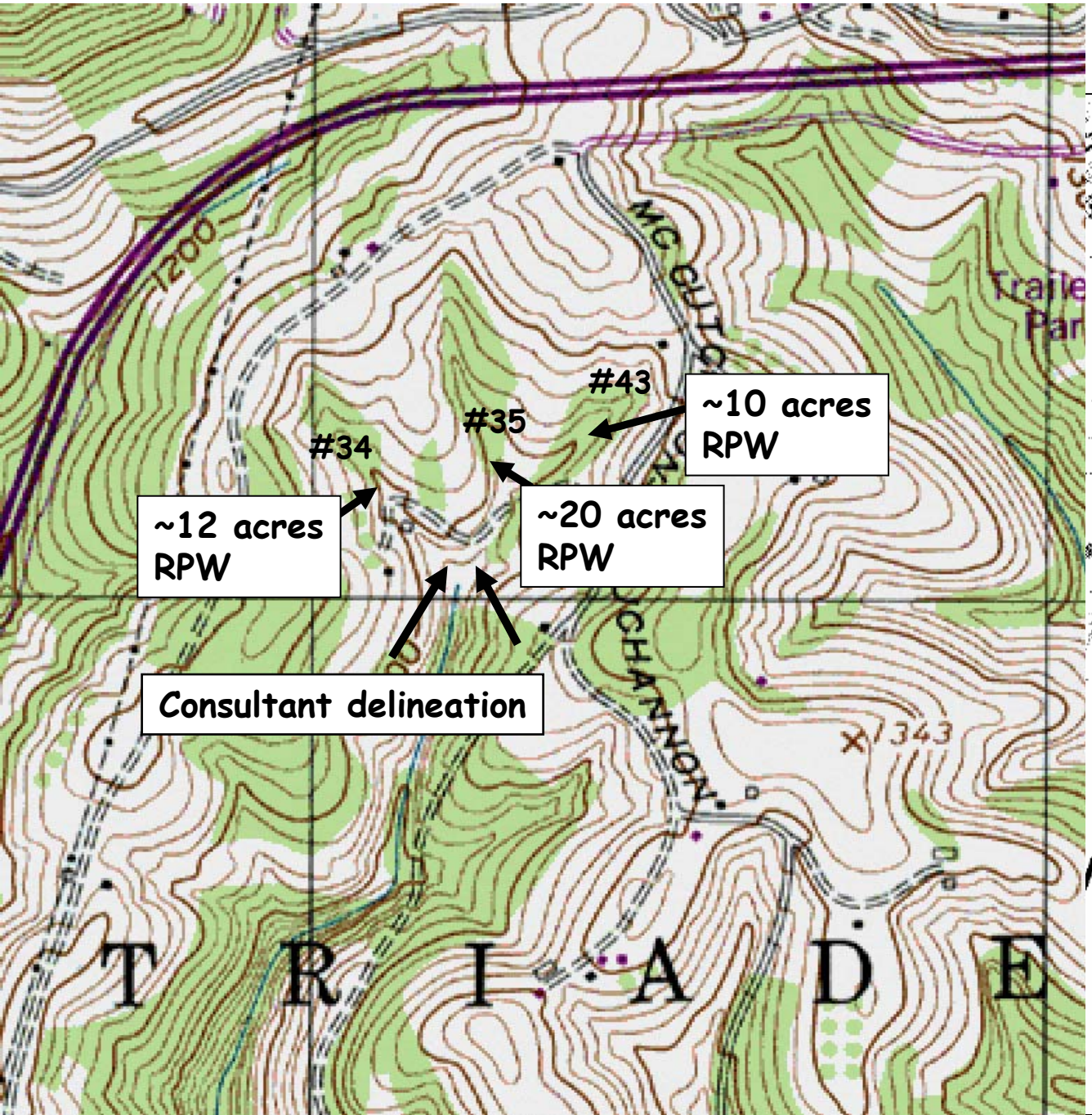
Kanawha SF, WV
July 16, 2007
Extreme Drought Status

Site	NCSI	OHHEI	Benthos?
KF1	25	43	yes
KF2	27.5	33	yes
KF3	40.5	80	yes
KF4	30.5	65	yes
KF5	19.5	36	no

12 EPT in
March 2008

WV Cen App/Ridge &Valley Ecoregions Feb-June 2008





"The Highlands"
Ohio Co., WV
October 2007
Moderate Drought

Site	NCSI	Benthos ?
43	23.5	Yes

Wheeling Intelligencer Nov. 10, 2007


Questions?