Using Subwatershed Prioritization for Developing Management Strategies: Case Studies from Maryland and Georgia

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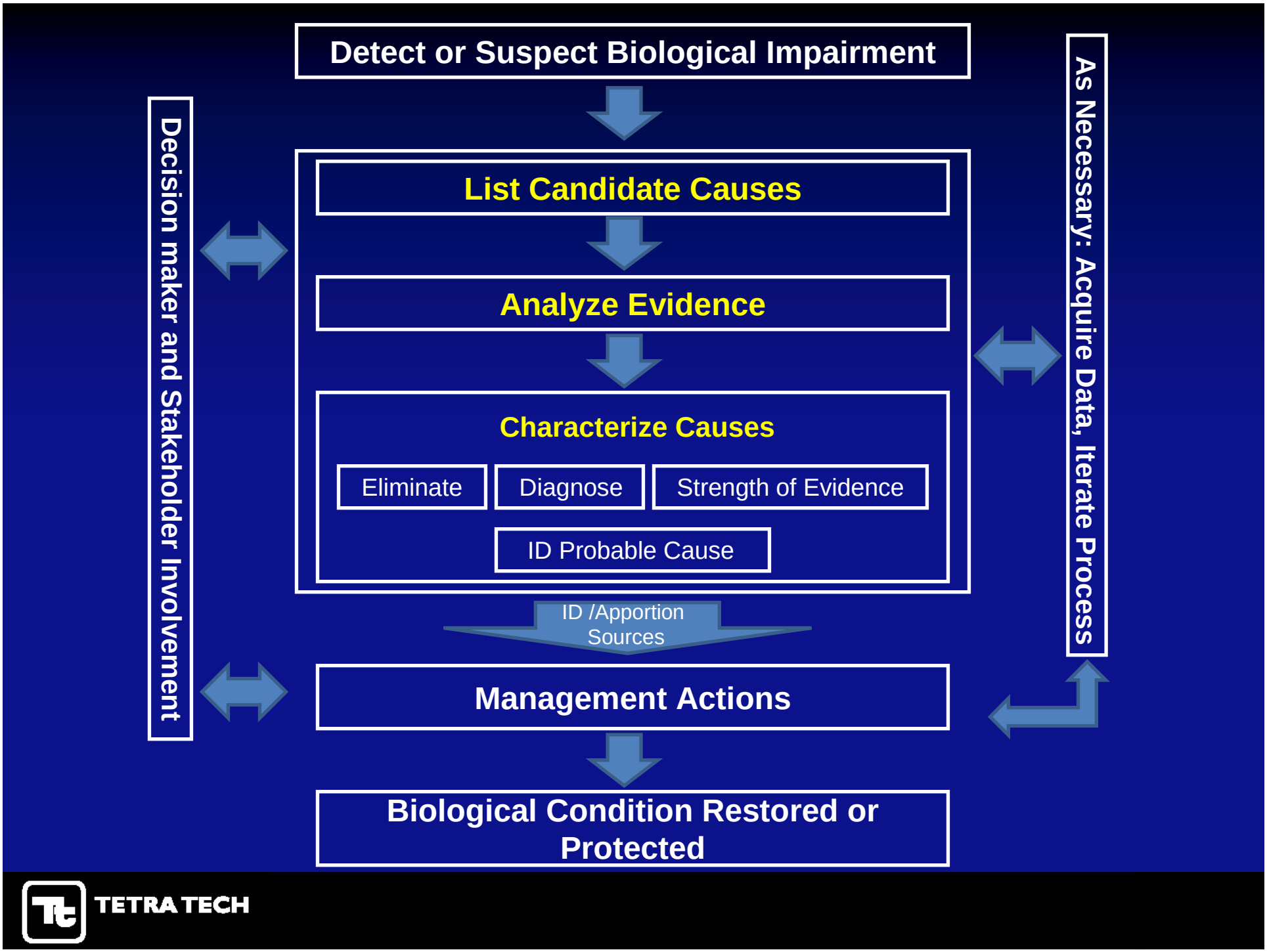
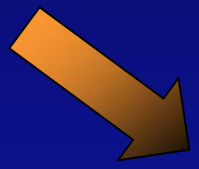

Detect or Suspect Biological Impairment
List Candidate Causes
Analyze Evidence
Characterize Causes
Eliminate
Diagnose
Strength of Evidence
ID Probable Cause
ID /Apportion Sources
Management Actions
Biological Condition Restored or Protected
Decision maker and Stakeholder Involvement
As Necessary: Acquire Data, Iterate Process

Linkages

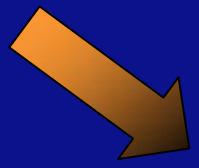
Sources

Land use/land cover, impervious surface, industrial outfalls, transportation corridors, disturbed soils, forest removal, etc.



Stressors

Low dissolved oxygen, low pH, reduced organic detritus, high water temperature, elevated frequency of scouring flows, elevated cadmium, increased sediment mobility, etc.



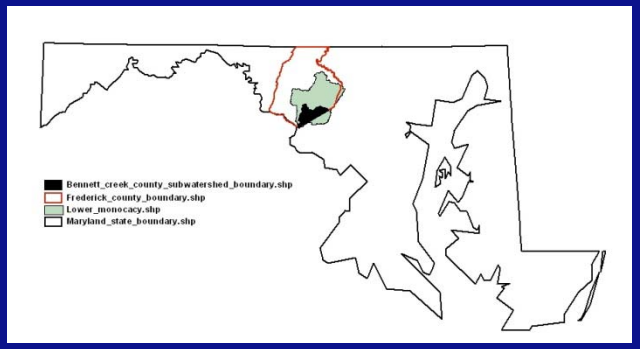
Responses

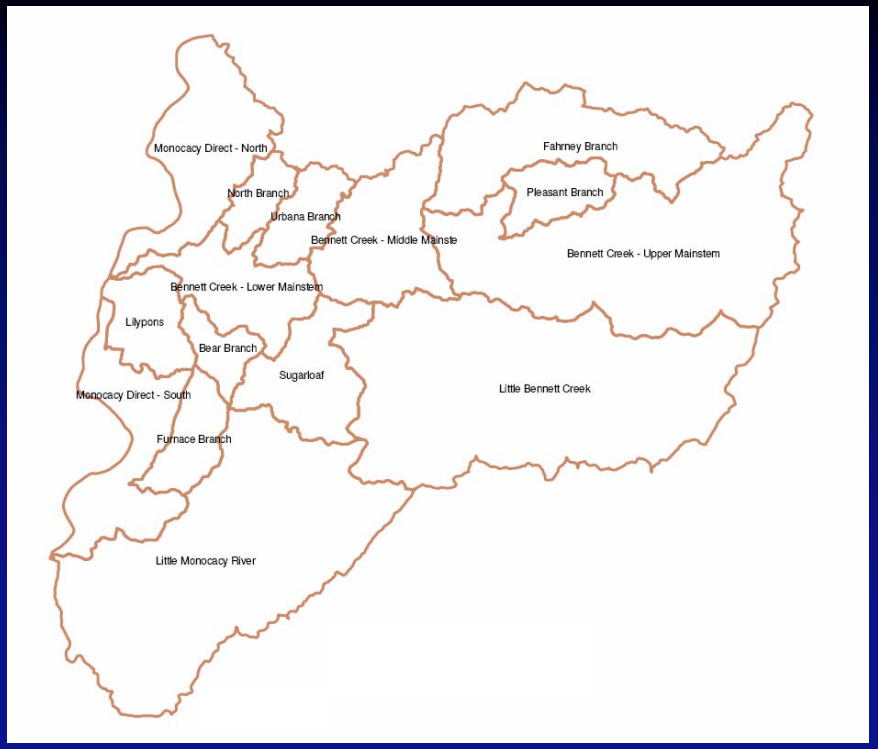
Degraded biological conditions, decreased biological diversity, local extirpation of threatened and endangered species, reduced fish standing crop, diminished native species, increased invasives, etc.

Bennett Creek Watershed

Bennett Creek Watershed

- ~ 85 mi^2 drainage area/15 subwatershed
- 46% forested; 39% agricultural land cover
- Zoning ordinances preserve : Ag - 50%; resource conservation - 30%; residential -15%; industrial - 5%





Primary Objectives

- Identify watershed and stream restoration opportunities
- Propose monitoring designs specific to individual stressors that BMPs or other retrofit activities are intended to reduce

Data Availability

- Potential stressor sources
  - Land use/land cover, permitted NPDES discharges, stormwater infrastructure
- Potential stressors
  - Physical (physical habitat quality [visual-based], particle size distribution [pebble count], selected geomorphic variables
  - Water chemistry (grab samples [pH, conductivity, nutrients, ANC, SO_4])
  - Field chemistry (water temp, DO, conductivity, and pH)
- Response variables (biology)
  - Indexes of Biological Integrity (benthos and fish)
  - Aquatic vegetation, reptiles/amphibians, mussel observations

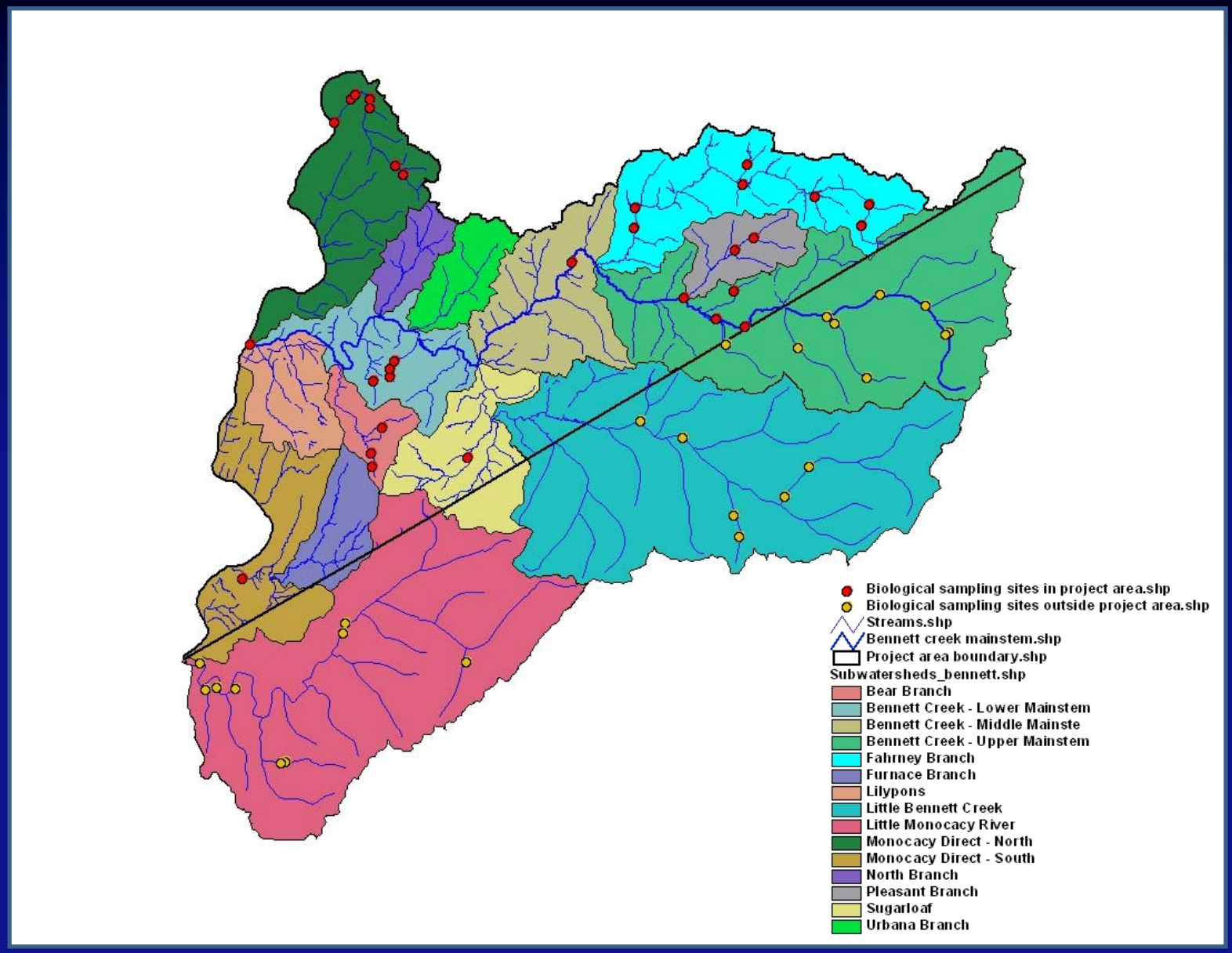
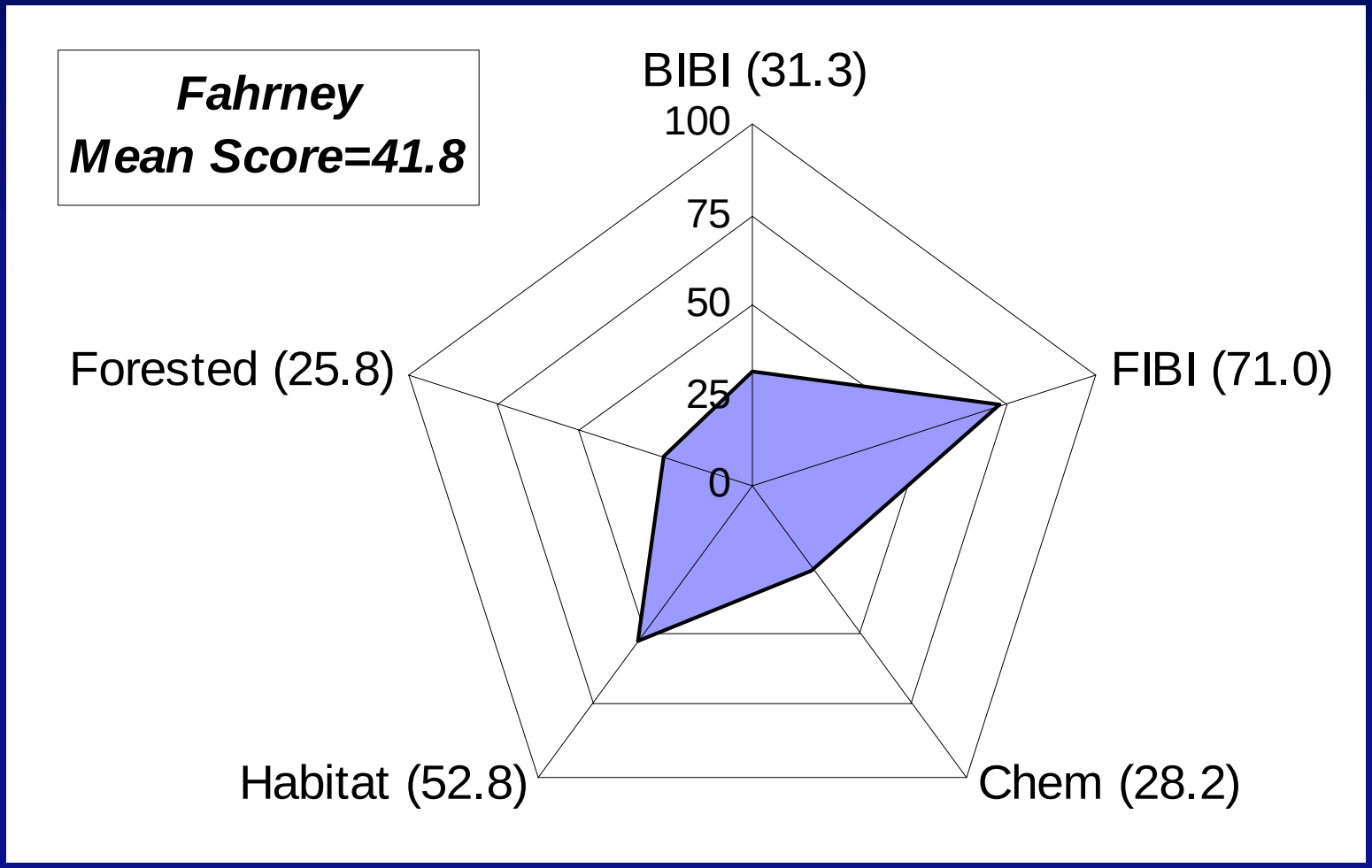

Biological sampling sites in project area.shp
Biological sampling sites outside project area.shp
Streams.shp
Bennett creek mainstem.shp
Project area boundary.shp
Subwatersheds_bennett.shp
Bear Branch
Bennett Creek - Lower Mainstem
Bennett Creek - Middle Mainste
Bennett Creek - Upper Mainstem
Fahrney Branch
Furnace Branch
Lilypons
Little Bennett Creek
Little Monocacy River
Monocacy Direct - North
Monocacy Direct - South
North Branch
Pleasant Branch
Sugarloaf
Urbana Branch

Table 13-1. Summary of the data available in each tier of subwatersheds (this only includes sites within the project area)

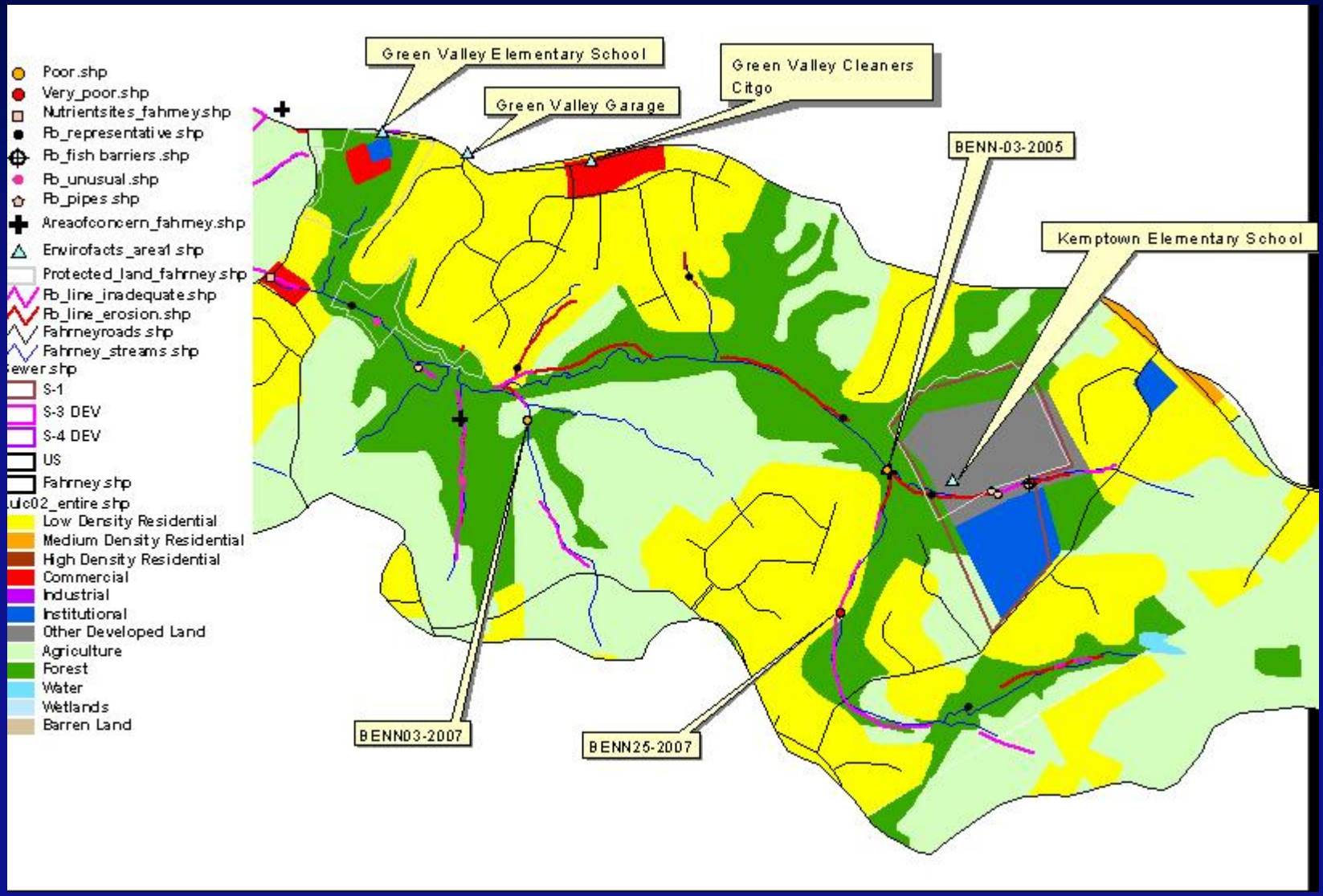
Data Availability

Tier	Subwatershed	# of Biological Sampling Sites		# of nutrient survey sites	SCA data	# of priority restoration sites
		Random	Targeted			
1	Monocacy Direct-North	5	2	0	no	0
	Fahrney	4	3	3	yes	6
	Bennett Ck -	4	1	3	no	0
	Bennett Ck -	3	0	3	no	0
	Bear	2	1	1	yes	1
2	Bennett Ck - Middle Mainstem	1	0	0	no	0
	Monocacy Direct-South	1	0	1	no	0
	Sugarloaf	1	0	1	no	0
3	Pleasant Branch	0	3	1	yes	10
	Urbana	0	0	1	yes	3
	North	0	0	1	yes	3
4	Furnace Branch	0	0	0	no	0
	Lilypons	0	0	1	no	0
	Little Bennett	0	0	0	no	0
	Little Monocacy River	0	0	0	no	0

Star Plot - Fahrney Branch



Fahrney Branch



Most Probable Stressors/Sources Causing Biological Impairment

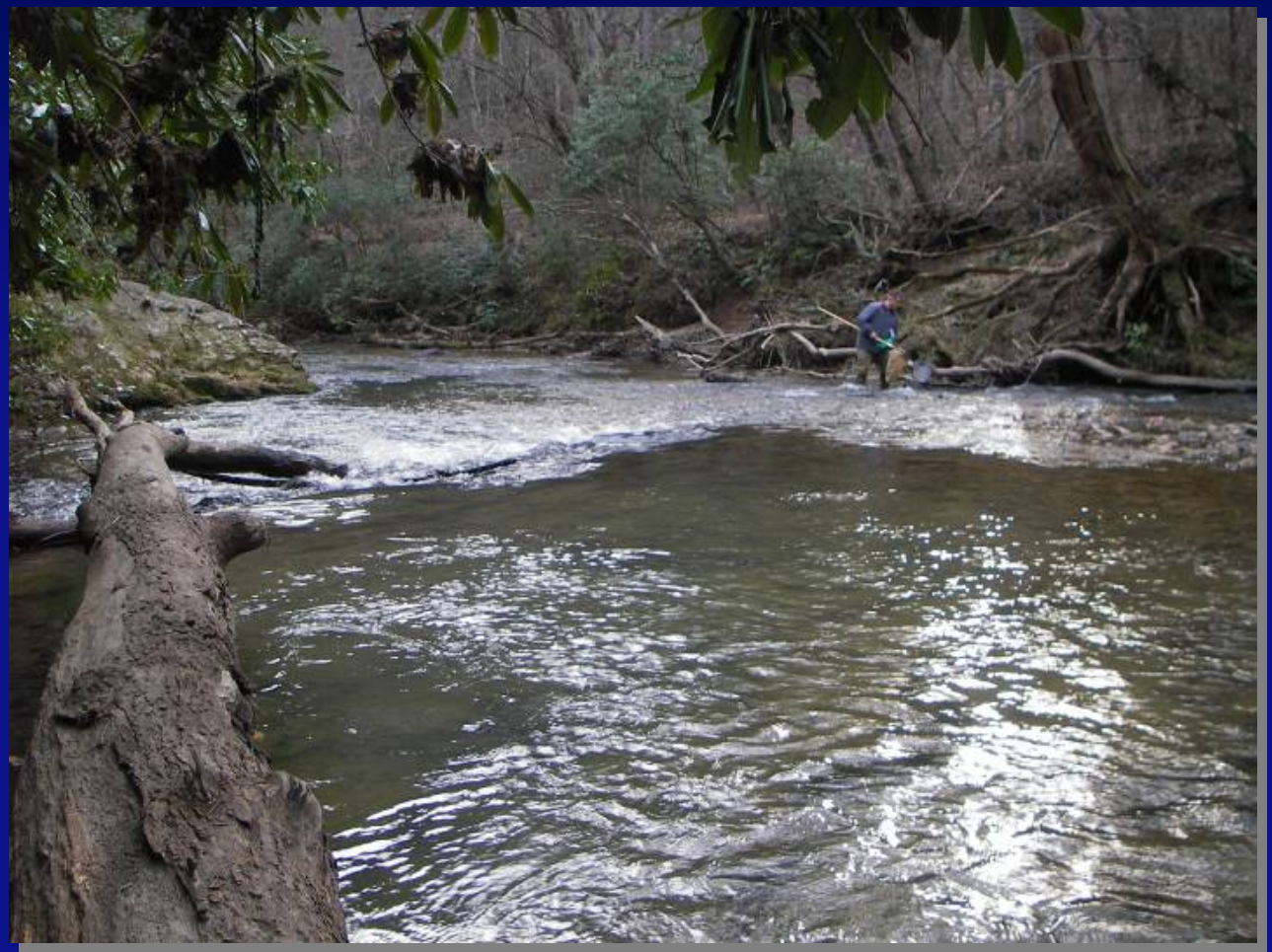
Stressors

- Nutrient enrichment
- Habitat degradation
- Excess sediment and turbidity

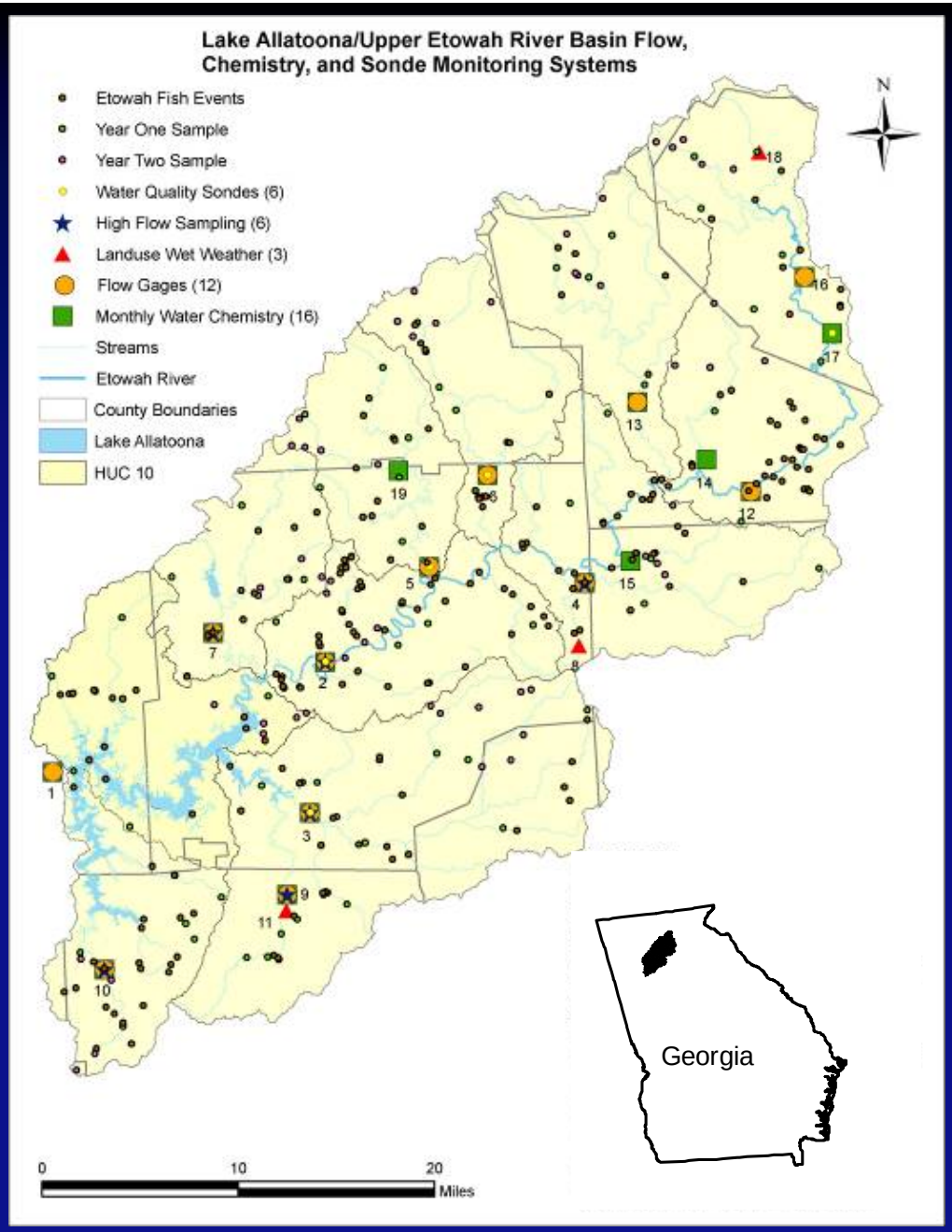
Stressor Sources

- Multiple reaches of inadequate riparian buffer and accelerated erosion
  - livestock access to streams
  - Row crop agriculture

Etowah River Watershed

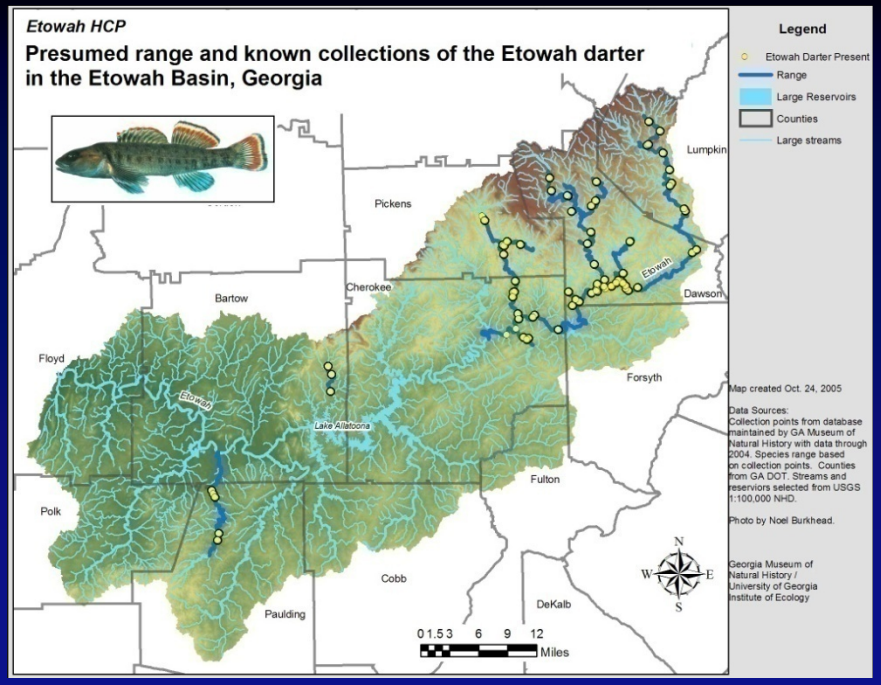


Lake Allatoona/ Upper Etowah River Watershed



- ~1,120 mi^2 drainage area
- Dominated by forested land cover (~68%)
- Bounded on lower end by the USACE-operated Lake Allatoona Dam

- Lake Allatona/Upper Etowah River Partnership –7 counties/ 3 water authorities / USACE
- 5 year rotating subwatershed design – HUC 12s. Targeted data.
- Resulting data are complimentary to the developing Habitat Conservation Plan (HCP)

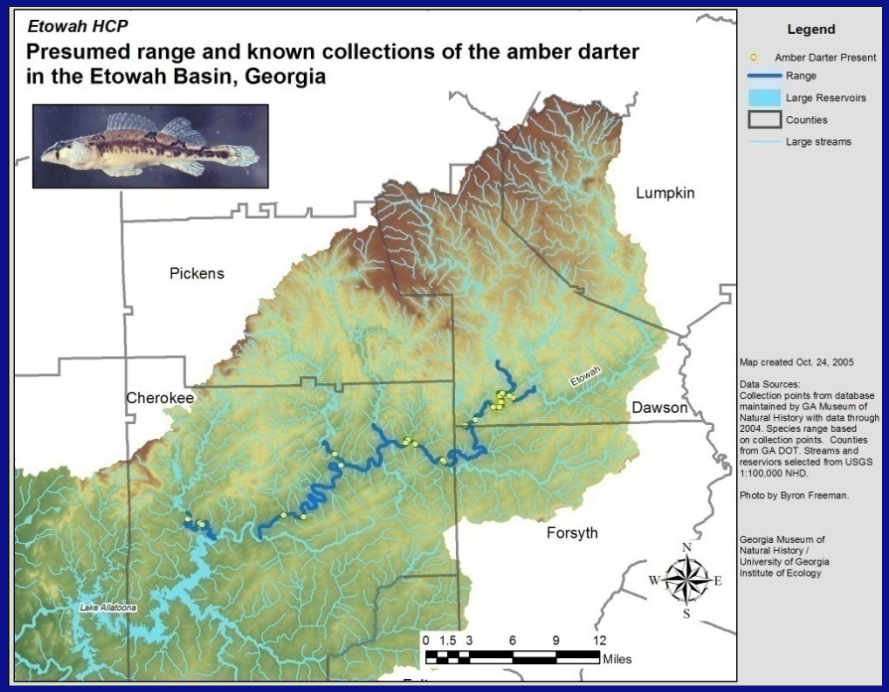


State Listed

- Coosa madtom (E)
- holiday darter (T)
- bridled darter (R)
- freckled darter (E)
- Coosa chub

Federally Listed

- Etowah darter (E)
- amber darter (E)
- Cherokee darter (T)

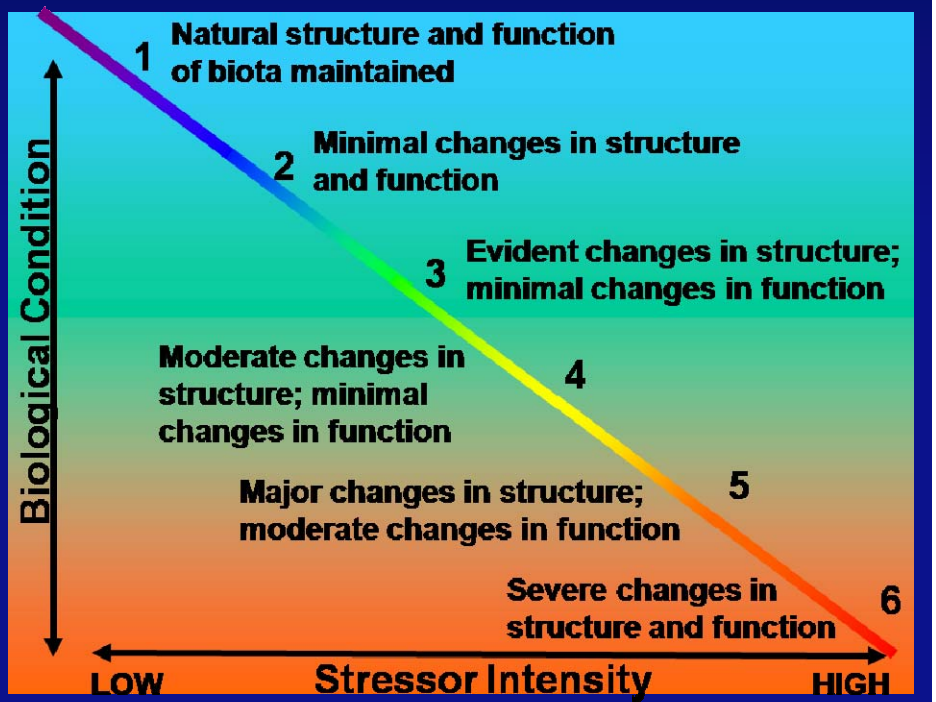


Data Availability

DATA	ORIG	# SITES	SITES PER HUC/COMMENTS
Benthic macro-invertebrates	Tt	~130	variable (9 to 24) will add Y3 sites
Fish	UGA/DNR	~220	variable (9 to 64)
In situ Water Chemistry	Tt	~130	variable (9 to 24) will add Y3 sites
RBP - Habitat	Tt	~130	variable (9 to 24) will add Y3 sites
RGA - Habitat	Tt	~130	variable (9 to 24) will add Y3 sites
Land use	Tt	~130	Digitized catchment of each site
Sediment	Sponsors	19	monthly collection plus 6 high flow measurements per year
Nutrients	Sponsors	19	monthly collection plus 6 high flow measurements per year
Hydrology	USGS	12	15 min readings and daily flows
Historical Data	various	~200	historical WQ and sediment data collected before year 2000

Prioritization Approach

- Response Indicators Include:
  - HUC10 watershed score (SWEIA)
  - Biological condition (MMI)
  - # of sites rated as “very good” or “good”
  - Fish (RTE species)
  - Fish (# of native species)
- Chemical, physical, hydrologic, and land use indicators NOT used in BCG scoring



SWEIA – Adjusted Rank Score

	315010401	315010402	315010403	315010404	315010405	315010406	315010407	315010408	315010409	315010410	
	7	88	65	74	108	50	36	102	48	20	
	22	35	92	37	54	85	45	101	103	90	
	30	10	33	66	59	71	105	12	57	60	
	26	9	16	69	25	49	62	6	96	79	
	21	4	27	80	67	46	56	47	86	104	
	19	24	39	51	64	53	68	72	95	100	
	32	5	52	55	58	107	63	98	106	28	
	14	29	61	70	43	93	13	81	99	97	
	78	75	84		44	94	82	41			
	18		77		109	42		76			
	23		38		34			8			
	15							1			
	17							31			
	73							40			
	11							89			
	2							87			
	3							83			
								91			
Ri	411	279	584	502	665	690	530	1066	690	578	5995
Score (Z)	0.0685571	0.0465388	0.0974145	0.0837364	0.1109258	0.1150959	0.088407	0.1778148	0.1150959	0.0964137	1
N(max)	42	24	36	24	36	30	24	54	24	24	318
N(sampled)	17	9	11	8	11	10	9	18	8	8	109
% sampled	0.4047619	0.375	0.3055556	0.3333333	0.3055556	0.3333333	0.375	0.3333333	0.3333333	0.3333333	0.342767
AdjRi	1015	744	1911	1506	2176	2070	1413	3198	2070	1734	17837
Adj Score (Zadj)	0.0569042	0.0417111	0.1071369	0.0844312	0.1219936	0.1160509	0.0792174	0.1792902	0.1160509	0.0972137	1
Rank of AdjR	2	1	6	4	9	7	3	10	7	5	

SWEIA – Final Ranking

	HUC 10s									
	315010401	**315010402**	**315010403**	**315010404**	**315010405**	**315010406**	**315010407**	**315010408**	**315010409**	**315010410**
Just MMI and Fish	0.32085404	0.214377823	0.29765682	0.233562662	0.285085895	0.277387028	0.199310912	0.604522337	0.271475579	0.33007898
	8	2	7	3	6	5	1	10	4	9
Just MMI & Avg Fish	0.18887911	0.128044436	0.202396835	0.15899695	0.203539752	0.196718967	0.139264135	0.391906288	0.193763242	0.213646319
	4	1	7	3	8	6	2	10	5	9
MMI	0.05690419	0.04171105	0.10713685	0.084431238	0.121993609	0.116050905	0.079217357	0.179290239	0.116050905	0.097213657
	2	1	6	4	9	7	3	10	7	5
Native Fish	0.13659136	0.08212694	0.071154142	0.077885354	0.04988474	0.100015368	0.060181343	0.169663439	0.084800984	0.119625019
	9	5	3	4	1	7	2	10	6	8
HUC Ranked RTEs	0.12735849	0.090539832	0.119365828	0.071246069	0.113207547	0.061320755	0.059912212	0.255568658	0.07062369	0.113240304
	9	5	8	4	6	2	1	10	3	7

	315010401	315010402	315010403	315010
	183	125	169	
	87	82	24	
	115	138	69	
	100	60	183	
	215	201	13	
	24	183	38	
	69	125	2	
	45		138	
	183		125	
	183		69	
	169		24	
	169		4	
	125		158	
	60		158	
	201		100	
	100		100	
	38		13	
	24		38	
	82		69	
	69		10	
	12		138	
	138		13	
	53		1	
	7		13	
	158		125	

					115		87	138			
					2		183	201			
					87		138				
					115		201				
					24		169				
Ri	4419	914	1958	1680	576	5954	875	2671	2658	3347	25052
Score (Z)	0.1763931	0.03648411	0.07815743	0.06706051	0.02299218	0.23766566	0.03492735	0.10661823	0.10609931	0.13360211	1
N(max)	42	24	36	24	36	30	24	54	24	24	318
N(sampled)	41	7	28	14	11	52	10	25	22	19	229
% sampled	0.97619048	0.29166667	0.77777778	0.58333333	0.30555556	1.73333333	0.41666667	0.46296296	0.91666667	0.79166667	0.720126
AdjRi	4527	3134	2517	2880	1885	3435	2100	5769	2900	4228	34788
Adj Score (Zadj)	0.13013108	0.09008854	0.07235254	0.08278717	0.05418535	0.09874095	0.06036564	0.16583305	0.08336208	0.12153616	
Rank of AdjR	2	5	8	7	10	4	9	1	6	3	
Raw Rank	2	8	6	7	10	1	9	4	5	3	

5	73	53											
3	99	63											
1	92	107											
2	98	103											
1	106	95											
4	77	79											
1	109	15											
9	102	100											
1													
4													
3													
1													
0													
4													
5													
3													
0													
6													

Ri	593	199	713	372	495	580	379	1293	756	615	5995	R_T	
Score (Z)	0.0989158	0.0331943	0.1189324	0.0620517	0.0825688	0.0967473	0.0632193	0.2156797	0.1261051	0.1025855	1		
N(max)	42	24	36	24	36	30	24	54	24	24	318		
N(sampled)	17	9	11	8	11	10	9	18	8	8	109		
% sampled	0.4047619	0.375	0.3055556	0.3333333	0.3055556	0.3333333	0.375	0.3333333	0.3333333	0.3333333	0.342767		
AdjRi	1465	531	2333	1116	1620	1740	1011	3879	2268	1845	17808	adjRt	
Adj Score (Zadj)	0.0822664	0.0298181	0.1310085	0.0626685	0.0909704	0.0977089	0.0567722	0.2178235	0.1273585	0.1036051	1		
Rank of AdjR	4	1	9	3	5	6	2	10	8	7			
	6	1	8	2	4	5	3	10	9	7			

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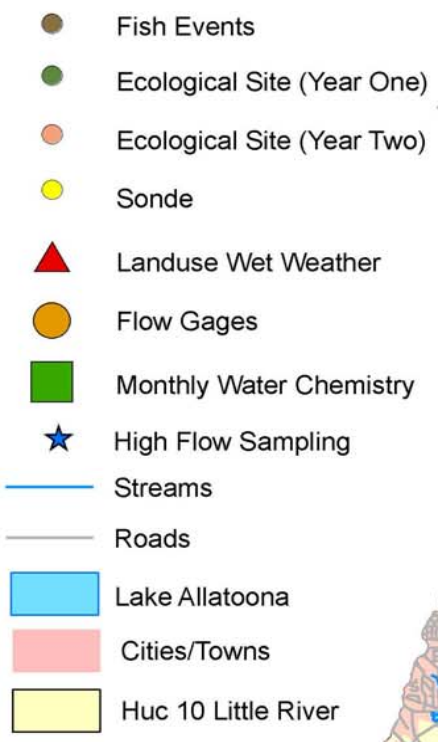
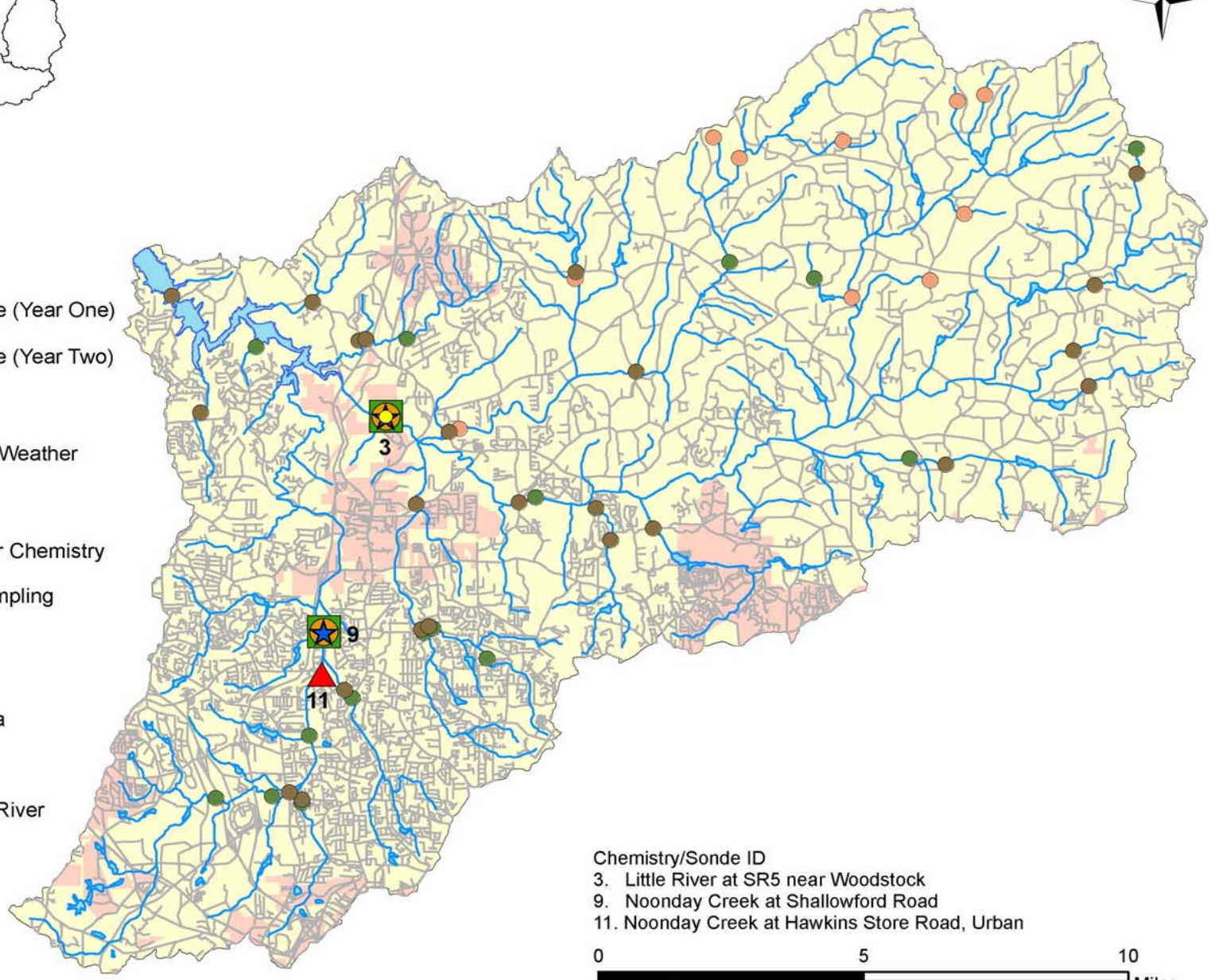
BCG Placement of HUC10 Watersheds

Little River (0315010408)





Little River Results

- Biological Condition (Response Indicators)
  - SWEIA Rank – 10th
  - Overall “poor” rating
  - 18 sites (9 “poor”, 5 “fair”, 3 “good”, and 1 “very good”)
  - 160 taxa of benthic macroinvertebrates (cumulative)
  - 41 native fish species, and one Federal RTE (Cherokee Darter)

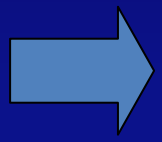
Little River Results

- Biological Condition (Response Indicators)

- Most Probable Stressors
  - Bedded and suspended sediment
  - Nutrients
  - Metals
  - Flashiness of Flow
  - Water Temperature

Little River Results

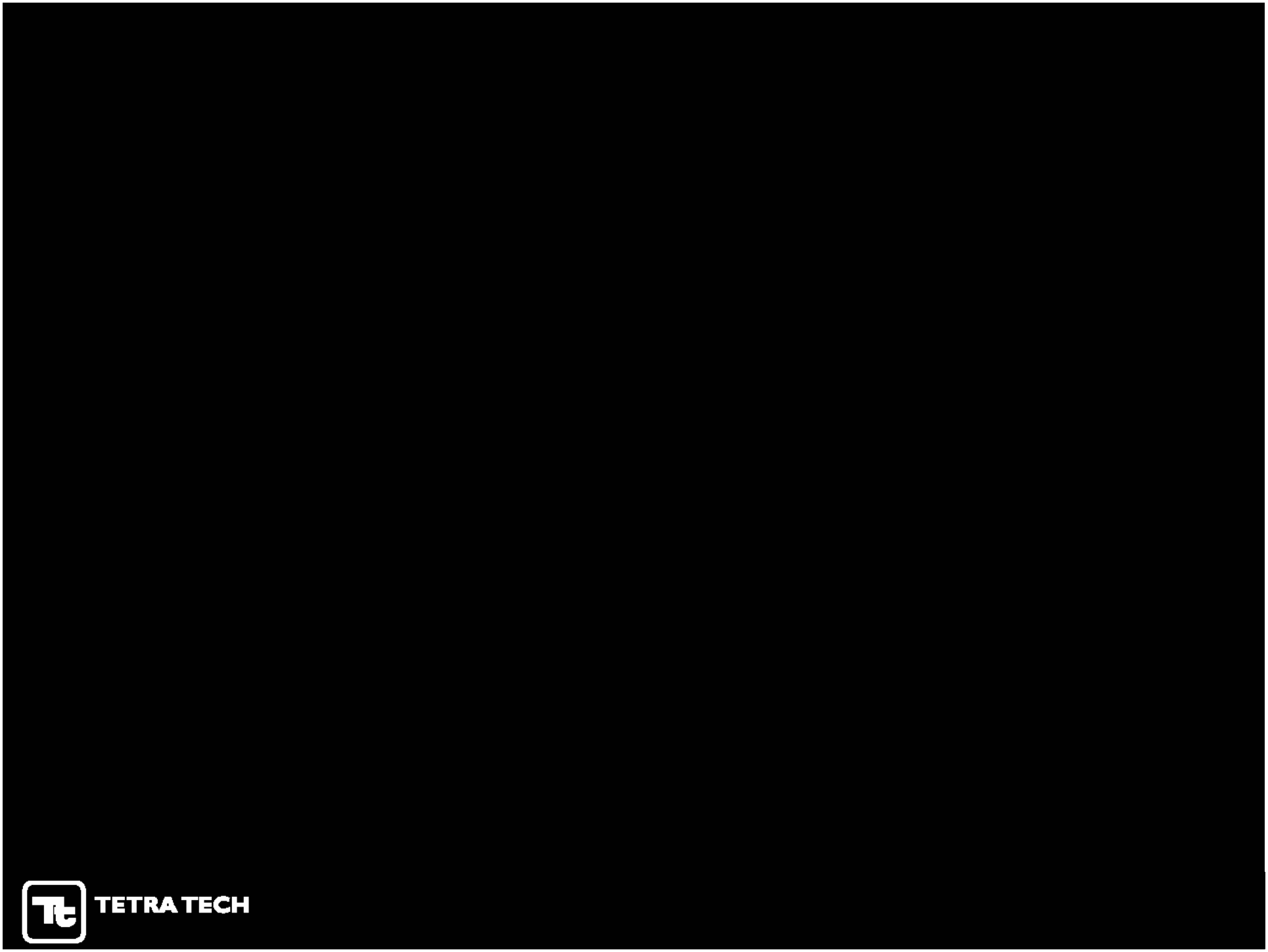
- Biological Condition (Response Indicators)
  - Most Probable Stressors



- Most Probable <u>Stressor Sources</u>
  - Storm water outfalls (impervious surface)
  - Channel Instability, mass wasting
  - Transportation Corridors

Next Steps

- Further assessment of stressor / biology relationships
- Design and evaluate proposed BMPs to reduce /eliminate stressors
- Monitor effectiveness of BMP implimintation.



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