Exploring scale-dependent responses to urbanization in northwestern Vermont

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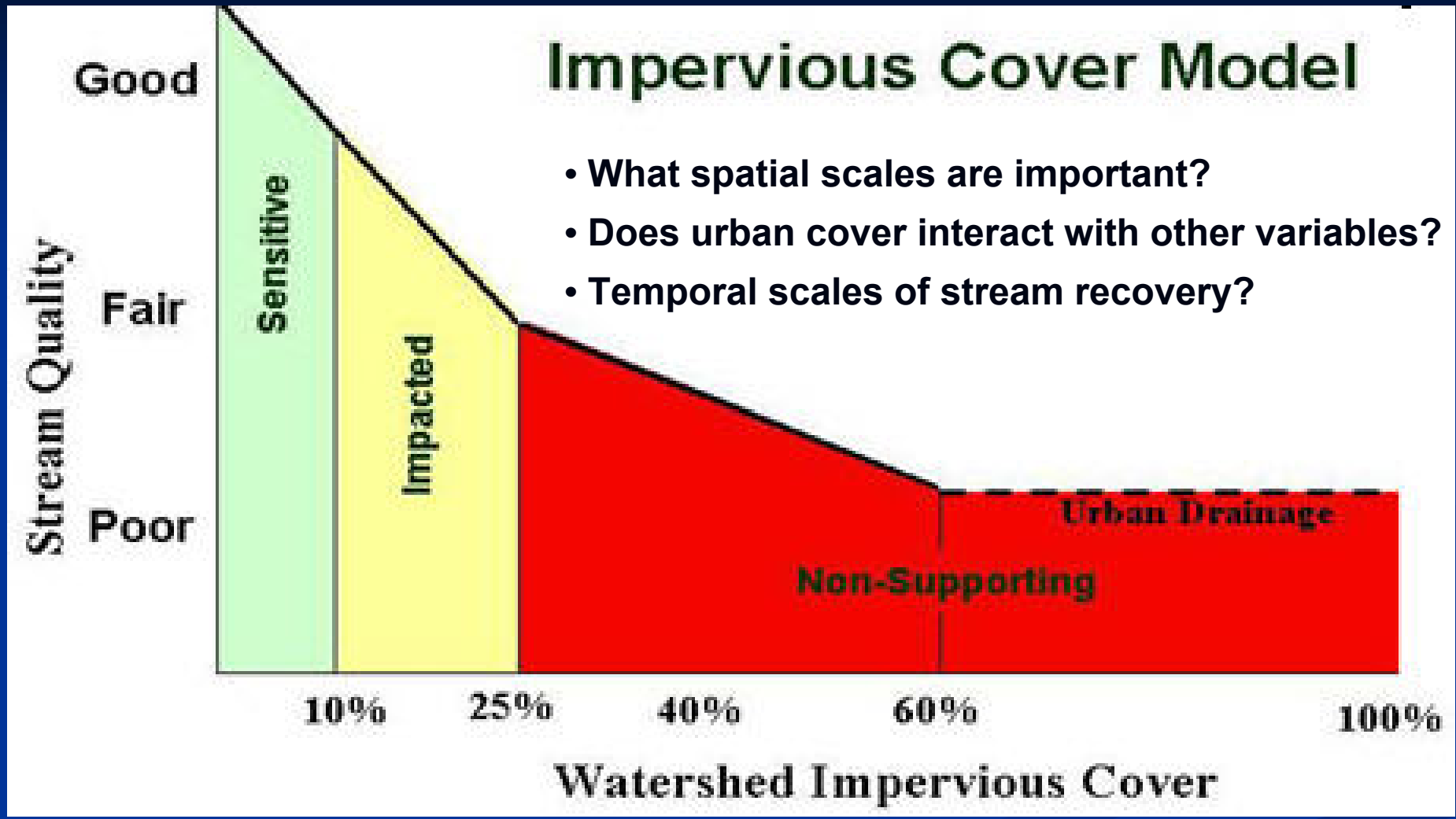
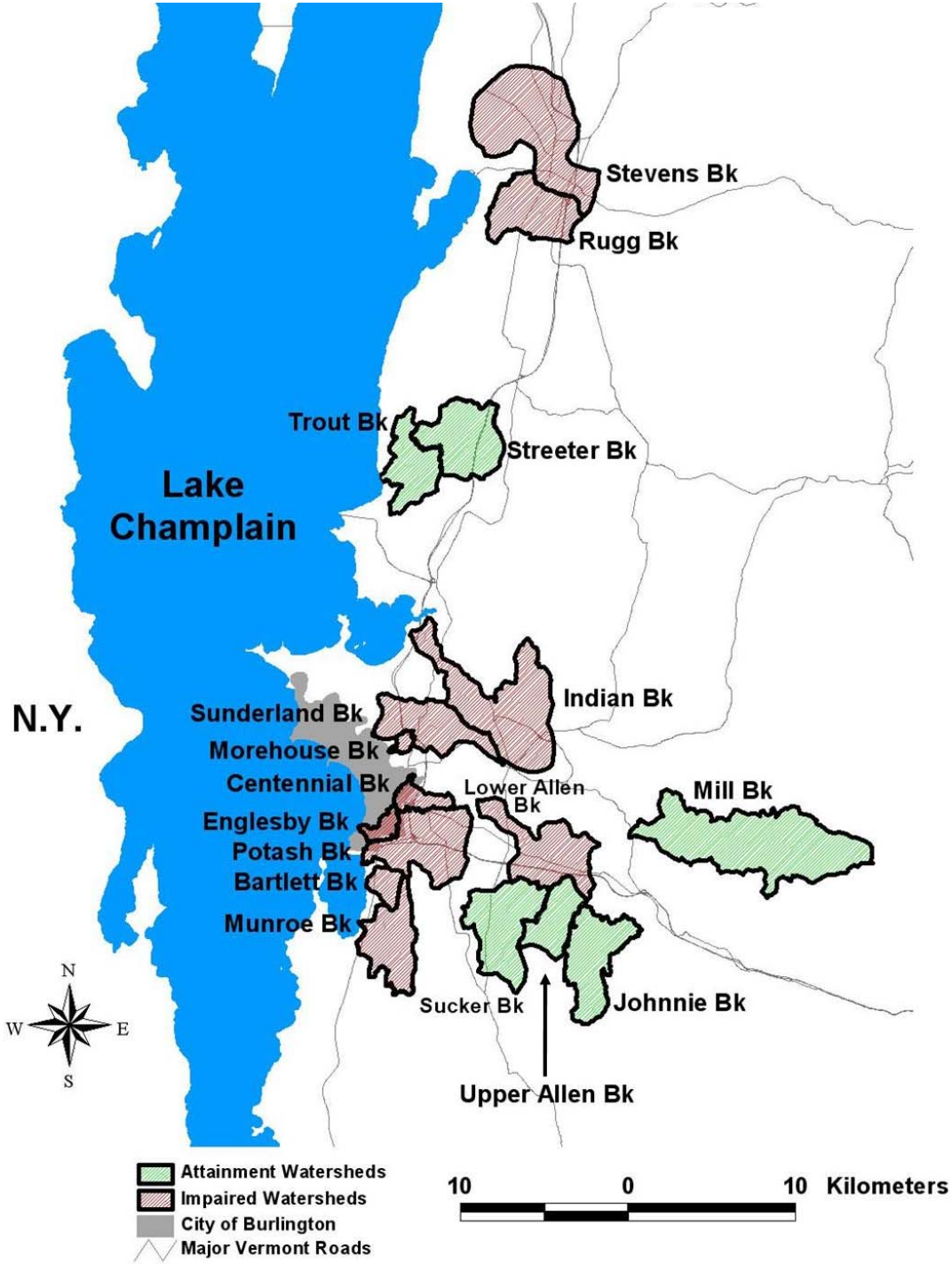


Source: CWP (Center for Watershed Protection). 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph:39-49.

UVM-VTANR Project Objectives:

1. Complete Phase I and II assessments for streams in spring and summer 2005
2. Develop a research project with data specific to the stormwater impacts and the evolving needs of the Stream Geomorphic Assessement (SGA) protocol
   - **Spatial scale-dependent responses to urbanization**
   - **Temporal scale of macroinvertebrate response**


Stevens Bk
Rugg Bk
Trout Bk
Streeter Bk
Lake Champlain
N.Y.
Sunderland Bk
Morehouse Bk
Centennial Bk
Englesby Bk
Potash Bk
Bartlett Bk
Munroe Bk
Indian Bk
Lower Allen Bk
Mill Bk
Sucker Bk
Johnnie Bk
Upper Allen Bk
N
W
E
S
Attainment Watersheds
Impaired Watersheds
City of Burlington
Major Vermont Roads
10
0
10
Kilometers

Watershed Type	Watershed Name	Drainage Area (km^2)	Watershed Elevation (m)*	Relief Ratio† (m/km)	TIA	Dominant Land Uses
Urban (Impaired)	Allen Bk (lower)	29.1	100	10	7.2%	Residential, Agricultural, Forested
	Bartlett Bk	2.7	46	11	15.8%	Residential, Agricultural, Forested
	Centennial Bk	4.0	64	14	30.4%	Residential, Commercial, Forested
	Englesby Bk	2.7	61	26	26.9%	Residential, Commercial
	Indian Bk	31.3	100	8	8.4%	Residential, Commercial, Forested
	Morehouse Bk	1.2	55	33	31.9%	Residential, Commercial, Industrial
	Munroe Bk	13.9	59	11	6.6%	Residential, Agricultural, Forested
	Potash Bk	18.4	62	6	20.4%	Residential, Commercial, Forested
	Rugg Bk	15.7	87	11	7.5%	Residential, Agricultural, Forested
	Stevens Bk	38.2	105	13	8.3%	Residential, Agricultural, Forested
	Sunderland Bk	14.3	53	4	15.0%	Residential, Commercial, Forested
Rural (Attainment)	Allen Bk (upper)	10.2	189	15	2.6%	Forested, Agricultural
	Johnnie Bk	17.0	191	31	1.1%	Forested, Agricultural
	Mill Bk	42.6	255	38	1.5%	Forested, Agricultural
	Streeter Bk	17.4	77	9	3.9%	Forested, Agricultural
	Sucker Bk	19.3	156	28	2.5%	Forested, Agricultural
	Trout Bk	12.2	60	9	1.7%	Forested, Agricultural

* Mean elevation for channel network (meters above mean sea level)

† Watershed elevation change divided by watershed length (Dunne and Leopold, 1978)

SGA Phase I – GIS & Remote Sensing

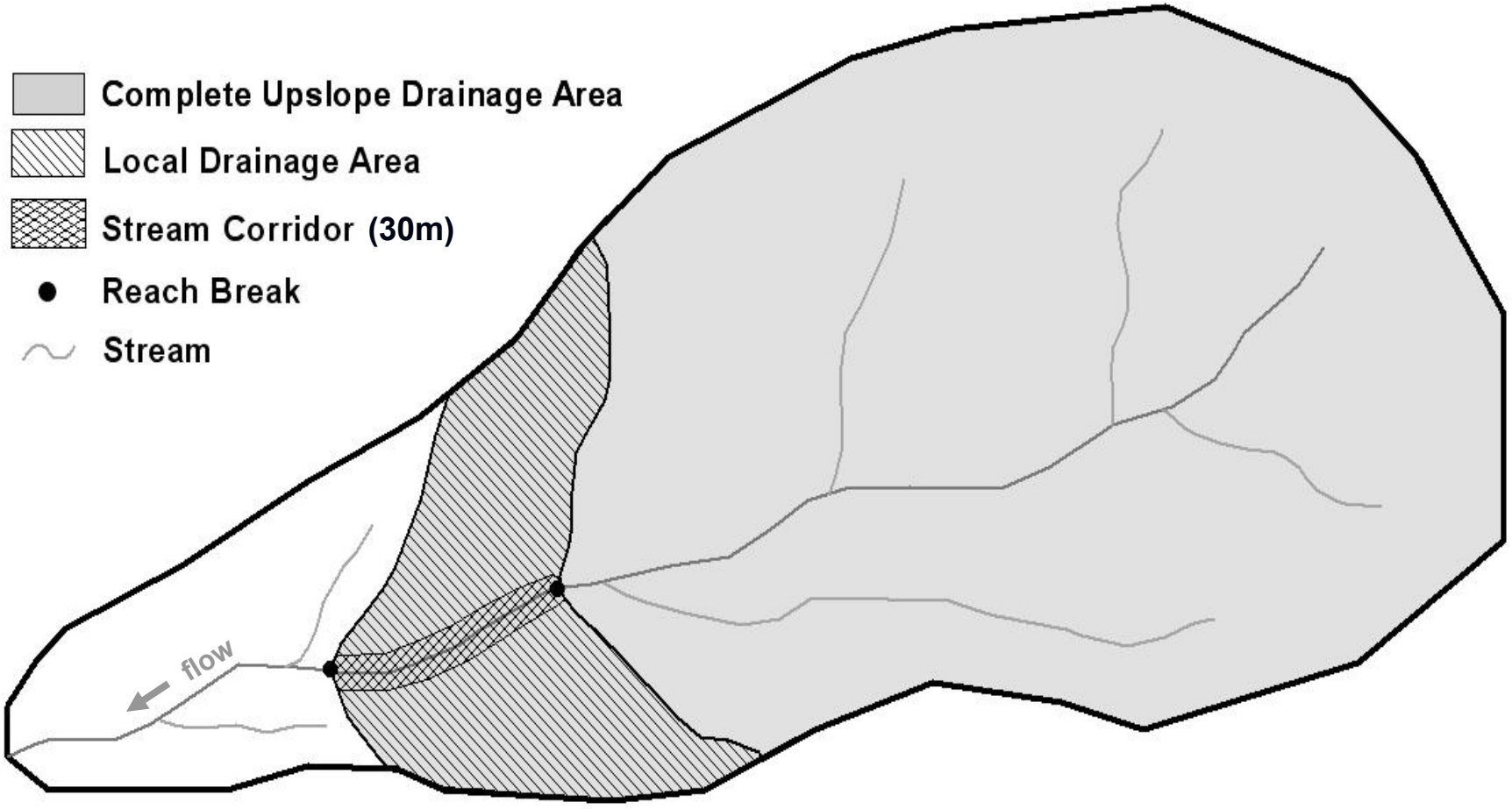
- Slope and Sinuosity
- Soil Types
- Buffer Width
- Valley Geometry
- Preliminary Stream Type
- Man-made drainage
- Total Impervious Area (TIA)

SGA Phase II - Field Measurements:

- Cross-Section Geometry (1-3 measurements per reach)
- Bank erosion dimensions
- Substrate sampling (pebble ct.)
- Buffer & corridor conditions
- Main channel culverts & stormwater outfalls
- RGA & RHA for current geomorphic and aquatic habitat conditions
- Results from VTANR Biomon-itoring Program (since 2000)

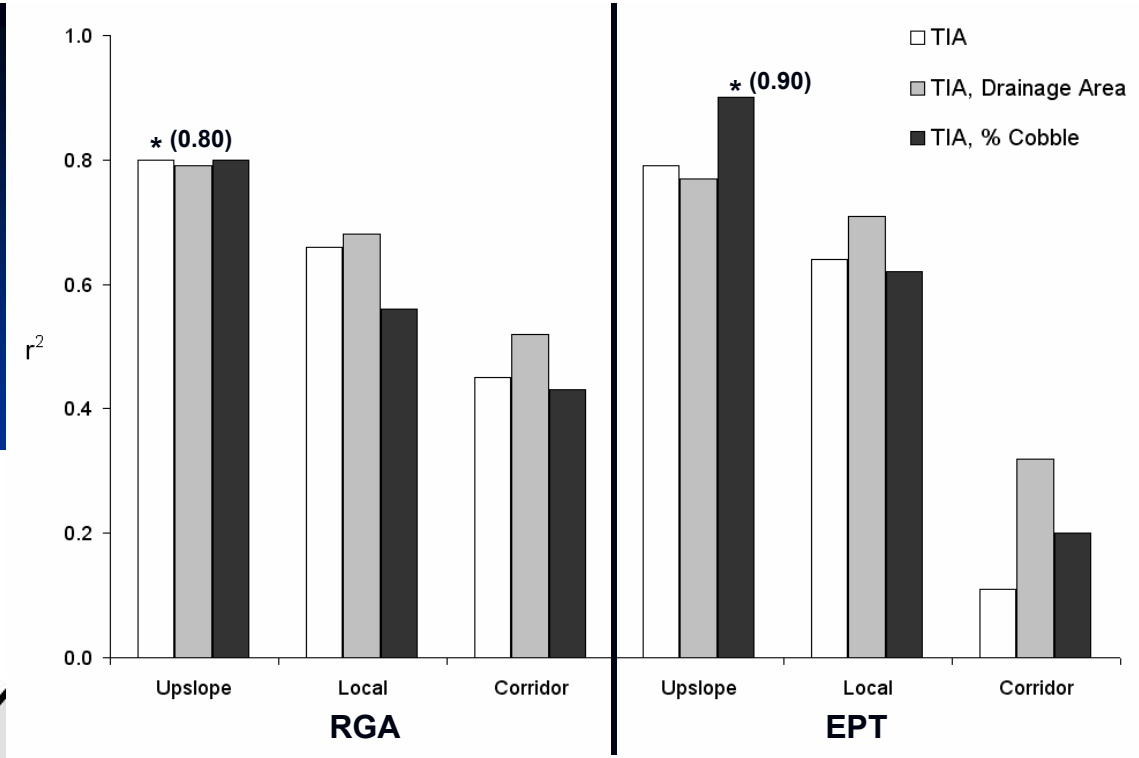
Effect of Total Impervious Area (TIA) at Multiple Spatial Scales:

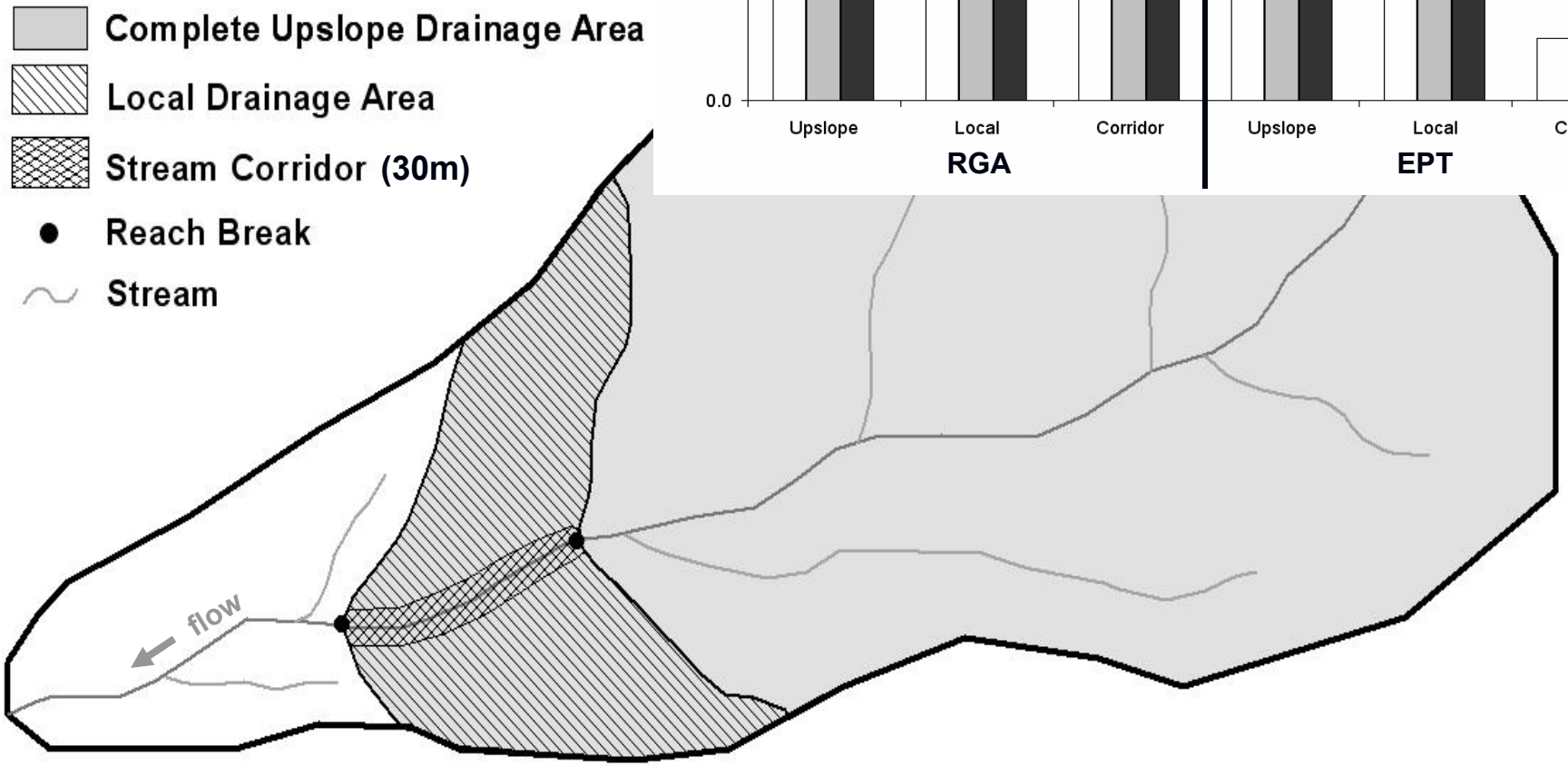
- Independent high-gradient reaches from each watershed (n = 17)
- Simple and multiple linear regressions using other natural watershed variables



Results:

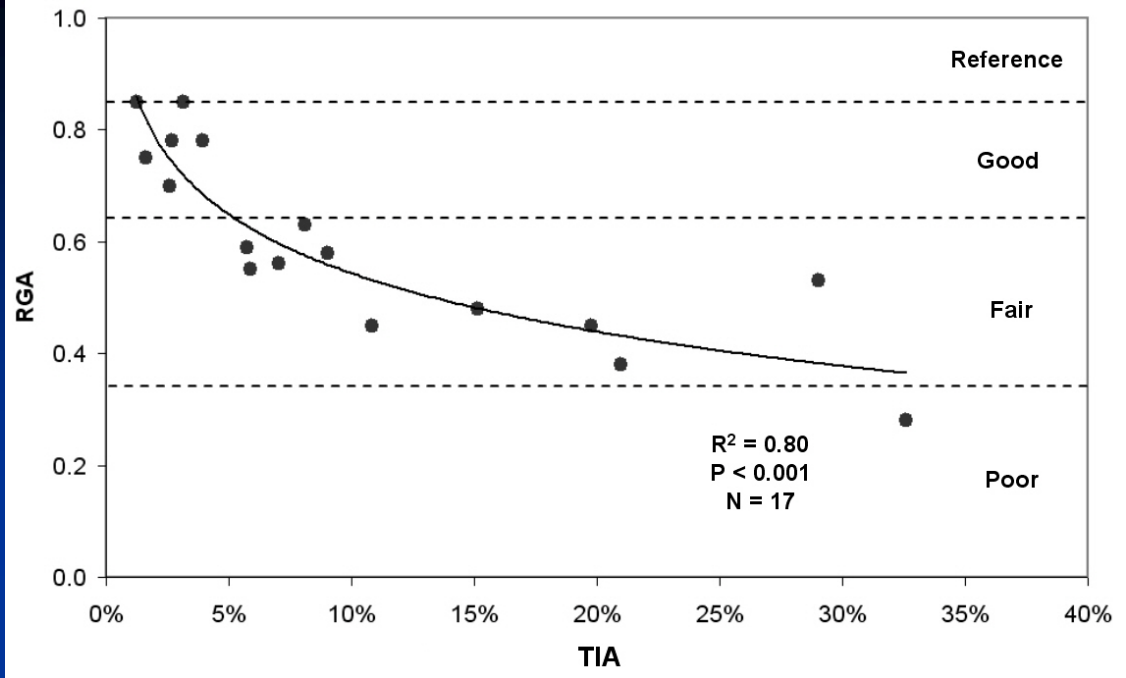
- TIA highly correlated between scales ($p < 0.01$)
- Watershed TIA best predictor
- TIA alone is often best predictor

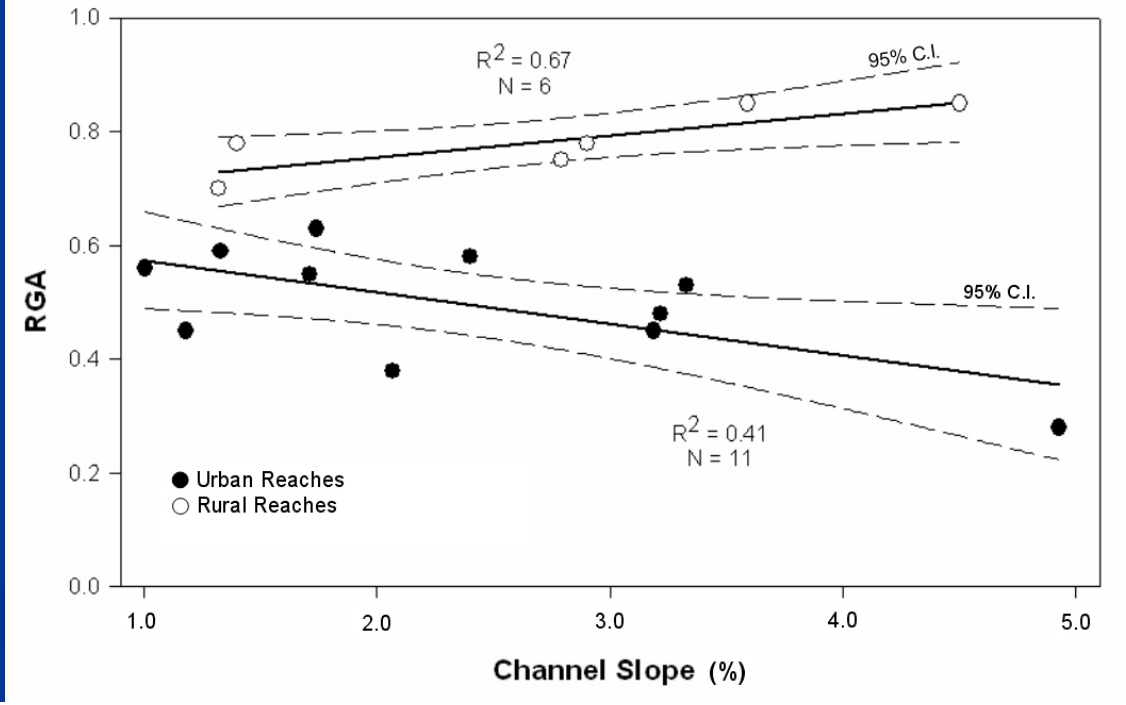




Response of High-Gradient Reaches to Upslope TIA:

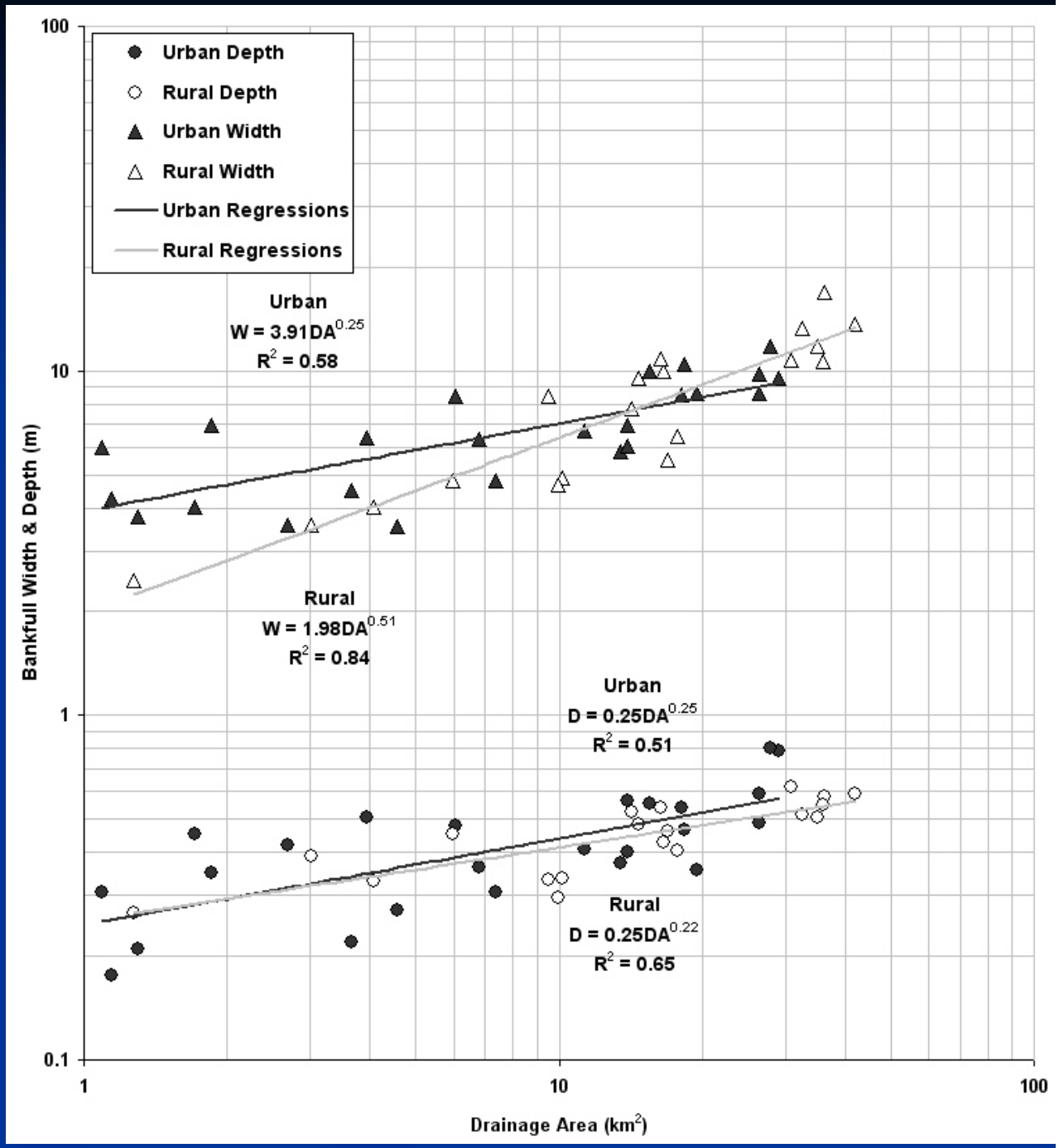
- **~5% TIA threshold**
- **no significant change at TIA > 10%** (n = 6; p = 0.48)
- **channel slope and drainage area interacts with TIA (ANCOVA; p < 0.05)**





Response of High-Gradient Reaches to TIA:

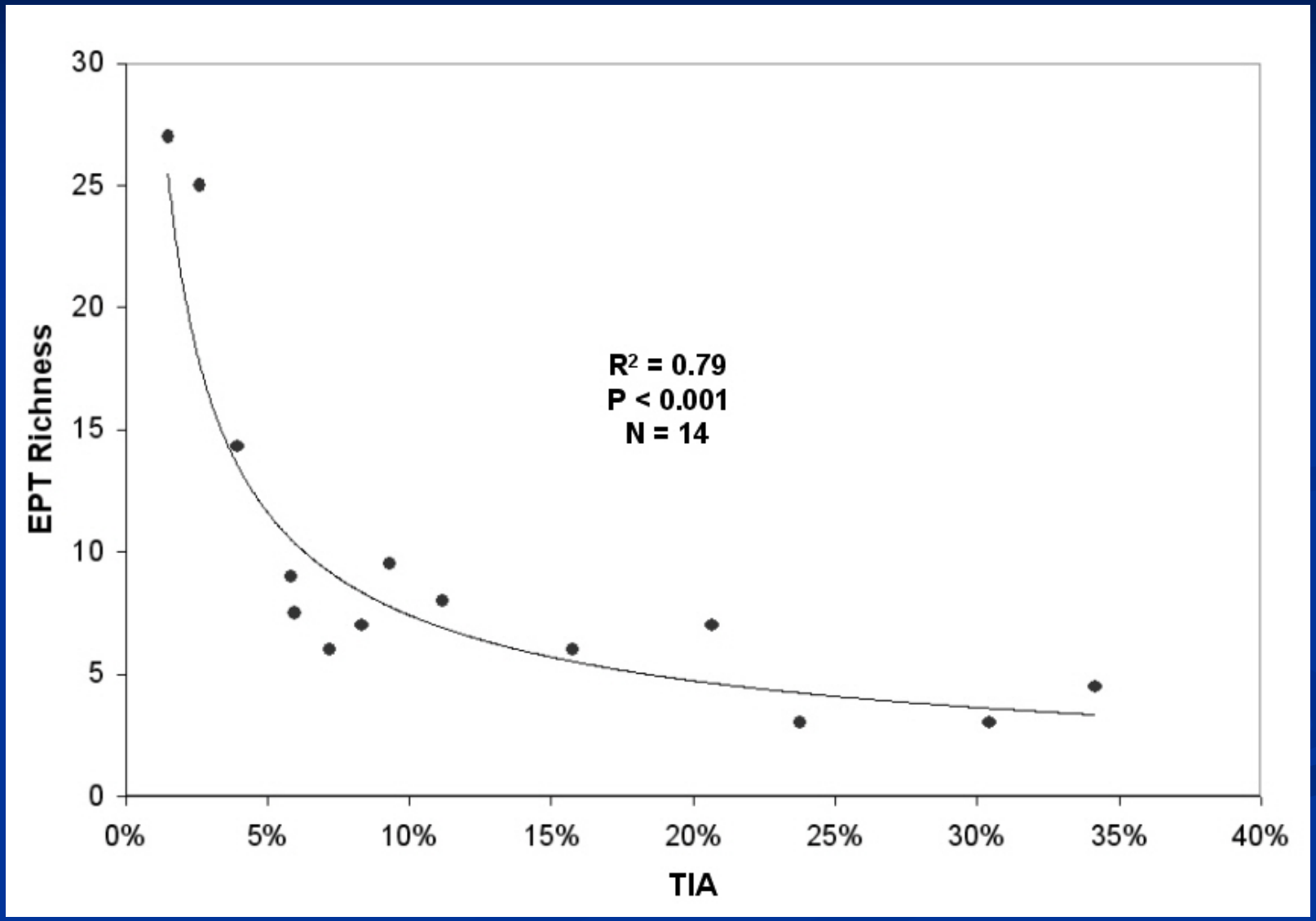
- **drainage area interacts with TIA (ANCOVA; p = 0.001)**
- **Steep, headwaters reaches are most susceptible to urban impacts and rapid channel widening**



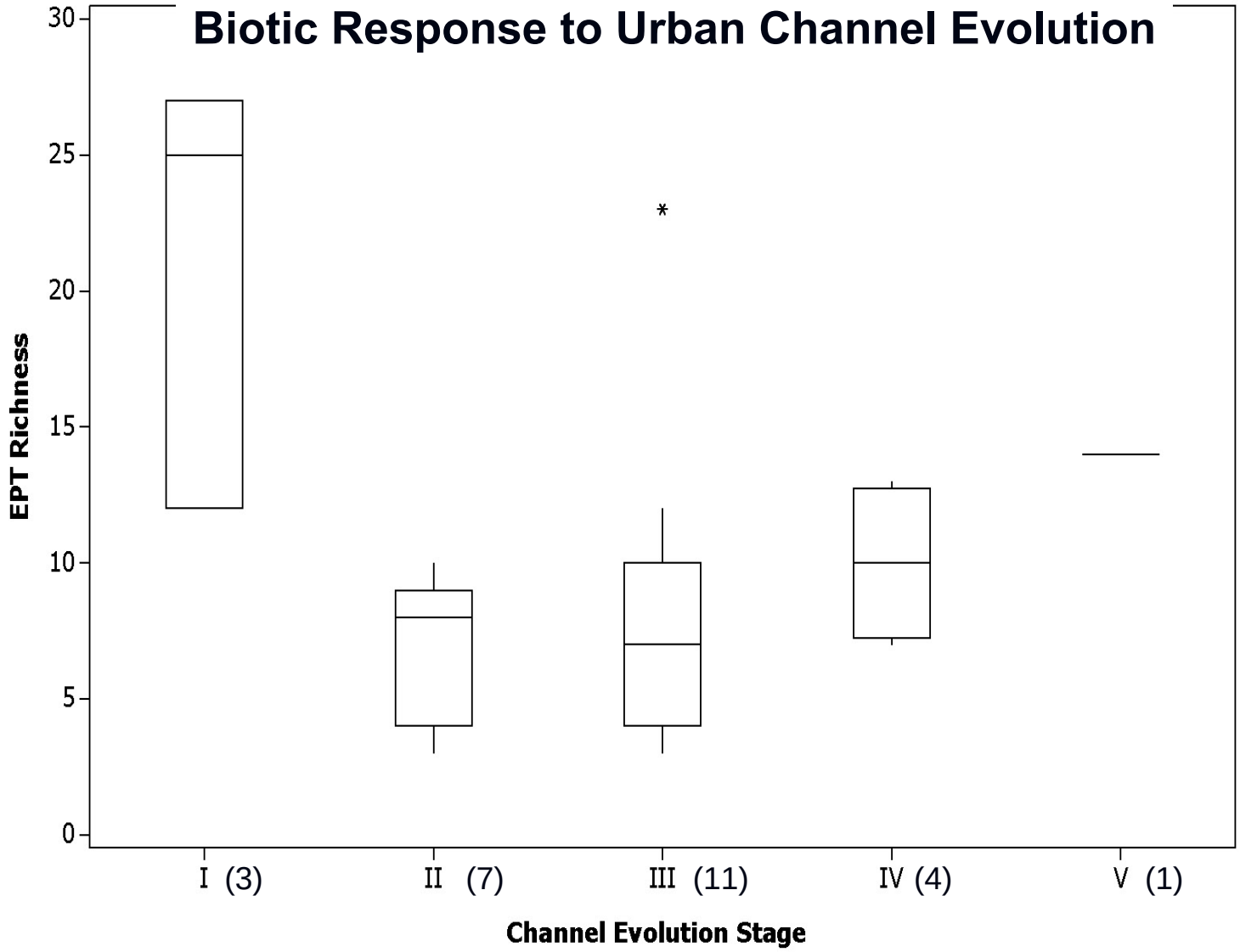
Temporal Scale of Urban Impacts on Biotic Communities:

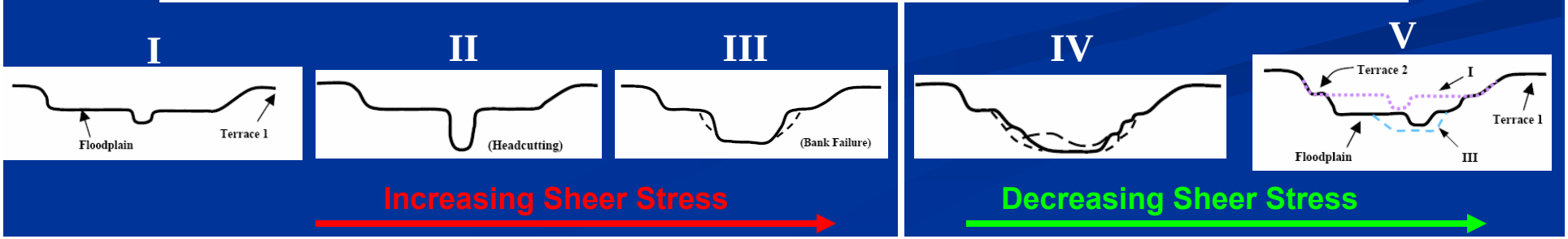
- Can we make inferences about the temporal scale of biotic recovery using channel evolution stage observations?
- Can biotic communities recover following natural or human-induced channel restoration?

Biotic Response at 5% TIA in High-Gradient Reaches

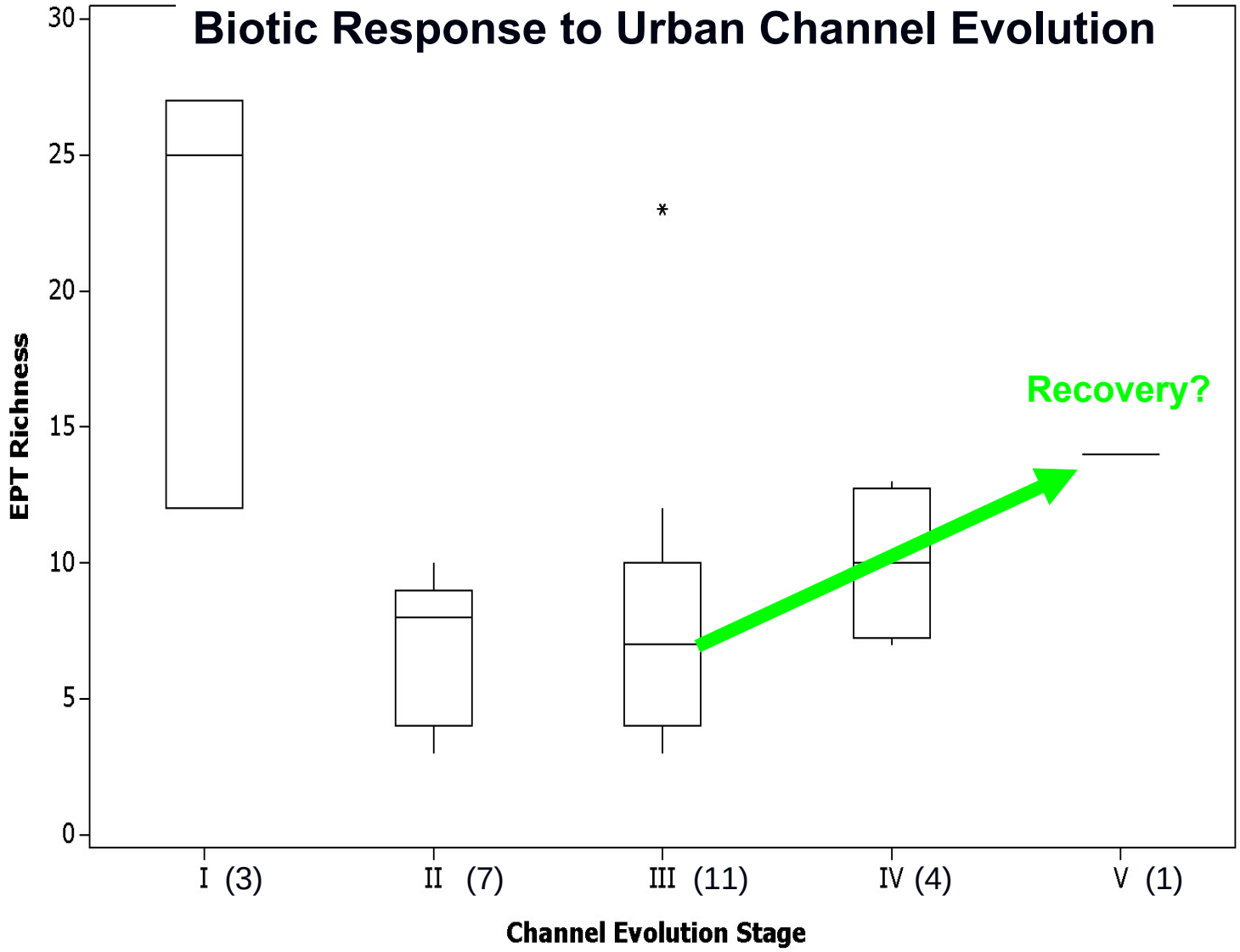


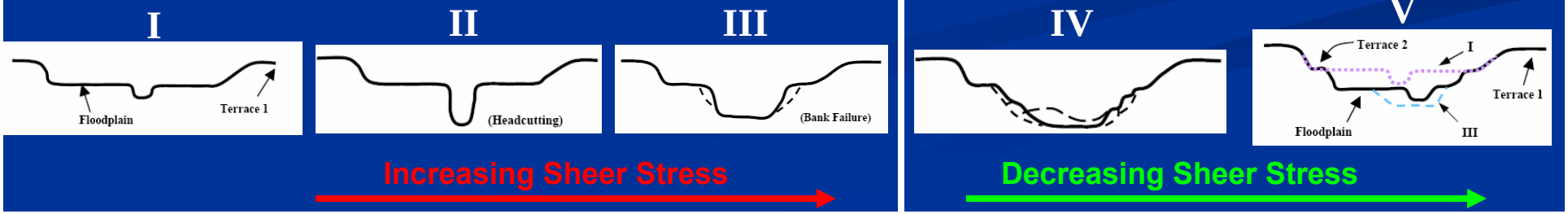
Biotic Response to Urban Channel Evolution





Biotic Response to Urban Channel Evolution





Summary & Conclusions:

- Watershed TIA has greatest influence on stream conditions in northwestern Vermont (5% threshold)
- High-gradient, headwaters channels are more sensitive to the impacts of urbanization than lower-gradient reaches
- Recovery of biotic communities following incision-dominated channel adjustment processes may be especially dependent on the recovery of dynamic equilibrium conditions

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