Identifying biophysical controls on stream ecosystem health in developing watersheds

ReNeWS
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“Urban Stream Syndrome”

- Consistent ecological degradation of streams draining urbanizing watersheds.
- Urbanization typically quantified by:
  - % total impervious cover (TI)
  - % effective impervious cover (EI)
- Degradation documented in systems with <5% TI.
- Similar degradation due to agricultural development.
- Measured by macro-invertebrate taxa scores.

“Urban Stream Syndrome”

Feature	Consistent response	Inconsistent response	Limited research
Hydrology	↑ Frequency of overland flow ↑ Frequency of erosive flow ↑ Magnitude of high flow ↓ Lag time to peak flow ↑ Rise and fall of storm hydrograph	Baseflow magnitude	
Water chemistry	↑ Nutrients (N, P) ↑ Toxicants ↑ Temperature	Suspended sediments	
Channel morphology	↑ Channel width ↑ Pool depth ↑ Scour ↓ Channel complexity	Sedimentation	
Organic matter	↓ Retention	Standing stock/inputs	
Fishes	↓ Sensitive fishes	Tolerant fishes Fish abundance/biomass	
Invertebrates	↑ Tolerant invertebrates ↓ Sensitive invertebrates		Secondary production
Algae	↑ Eutrophic diatoms ↓ Oligotrophic diatoms	Algal biomass	
Ecosystem processes	↓ Nutrient uptake	Leaf breakdown	Net ecosystem metabolism Nutrient retention P:R ratio

Walsh et al., 2005

“Urban Stream Syndrome”

J. N. Am. Benthol. Soc., 2005, 24(3):602–612

Meyer et al.

Stream ecosystem function in urbanizing landscapes

J. N. Am. Benthol. Soc., 2005, 24(3):706–723

Walsh et al.

The urban stream syndrome: current knowledge and the search for a cure

J. N. Am. Benthol. Soc., 2009, 28(4):1080–1098
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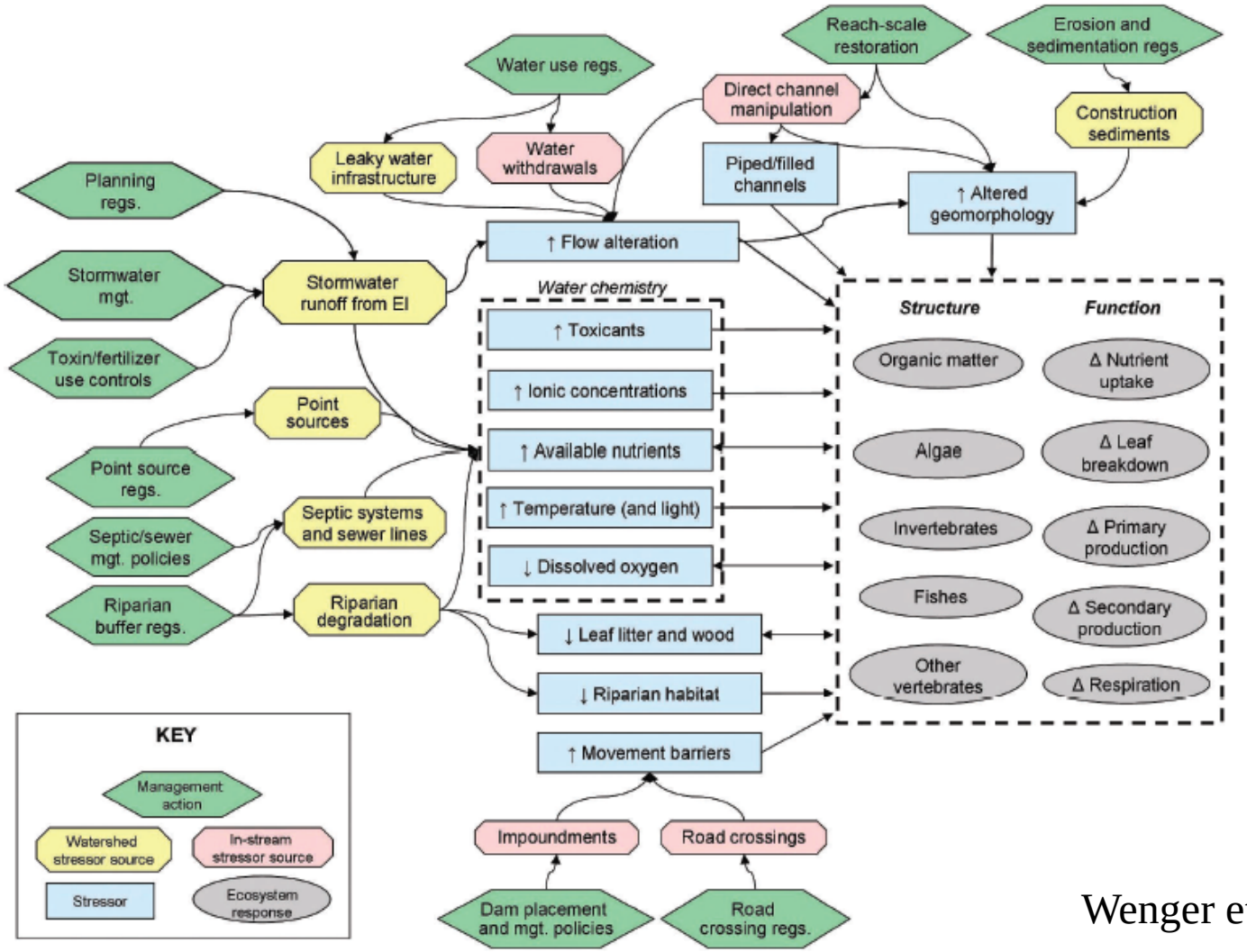
Twenty-six key research questions in urban stream ecology: an assessment of the state of the science

Seth J. Wenger[1,17], Allison H. Roy[2,18], C. Rhett Jackson[3,19], Emily S. Bernhardt[4,20], Timothy L. Carter[1,21], Solange Filoso[5,22], Catherine A. Gibson[6,23], W. Cully Hession[7,24], Sujay S. Kaushal[5,25], Eugenia Martí[8,26], Judy L. Meyer[9,27], Margaret A. Palmer[5,28], Michael J. Paul[10,29], Alison H. Purcell[11,30], Alonso Ramírez[12,31], Amy D. Rosemond[13,32], Kate A. Schofield[14,33], Elizabeth B. Sudduth[15,34], AND Christopher J. Walsh[16,35]

Questions, Part I
ecosystem structure and function



Wenger et al., 2009

Questions, Part II
ecosystem management

- How do we prioritize ecosystem preservation:
  - What economic and societal benefits do streams provide?
  - What are realistic goals for different levels of development (TI)?
  - How do we predict future given climate change, infrastructure aging, population growth, etc.?
  - What management actions are most cost-effective?

Modeling Needs

- Scales:
  - Cross-system modeling to synthesize sparse data from multiple locations.
  - Targeted modeling to better understand biophysical processes.
- Integration:
  - Climate, hydrologic models.
  - Water quality, ecological models.
  - Economic models.
- Direct/indirect benefits:
  - Direct benefits to urban streams.
  - Indirect benefits downstream.