Developing Synoptic Human Stressor Indicators for Assessing the Ecological Integrity of Freshwater Ecosystems – Literature Review

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Project Period

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Variables used in Human Stressor Index and associated ranks

	Relative Ranks			
Metric	**1**	**2**	**3**	**4**
Number of Introduced Species	1	2	3	4-5
Percent Urban	0-5	5-10	11-20	>20
Percent Agriculture	0-25	26-50	51-75	>75
Density of Road-Stream Crossings (#/mi²)	0-0.24	0.25-0.49	0.5-0.9	≥1
Population Change 1990-2000 (#/mi²)	-42-0	0.1-14	15-45	>45
Degree of Hydrologic Modification and/or Fragmentation by Major Impoundments	1	2 or 3	4 or 5	6
Number of Federally Licensed Dams	0	1-9	10-20	>20
Density of Coal Mines (#/mi²)	0	1-5	6-20	>20
Density of Lead Mines (#/mi²)	0	1-5	6-20	>20
Density of Permitted Discharges (#/mi²)	0	1-5	6-20	>20
Density of Confined Animal Feeding Operations (#/mi²)	0	1-5	5-10	>10

Some problems with HSI

- Treats all stressors equally
  - Weighting (ex., 3xUrban vs. 1xAg)
- Does not account for magnitude, temporal and spatial considerations
  - Unsure if this can be accounted for
- Does not account for differences in the principal ecological effects
  - Develop separate stressor indices? (flow regime, physical habitat, energy sources and relations, water quality, biotic interactions)

What is biological integrity?

- The capability of supporting and maintaining a balanced, integrated, and adaptive community that has good diversity and resiliency. In other words, it is a system that can withstand an assault and recover

  (Karr et al. 1983).
- The five components that affect stream biota are:

  Flow regime

  Physical habitat

  Energy sources and relations

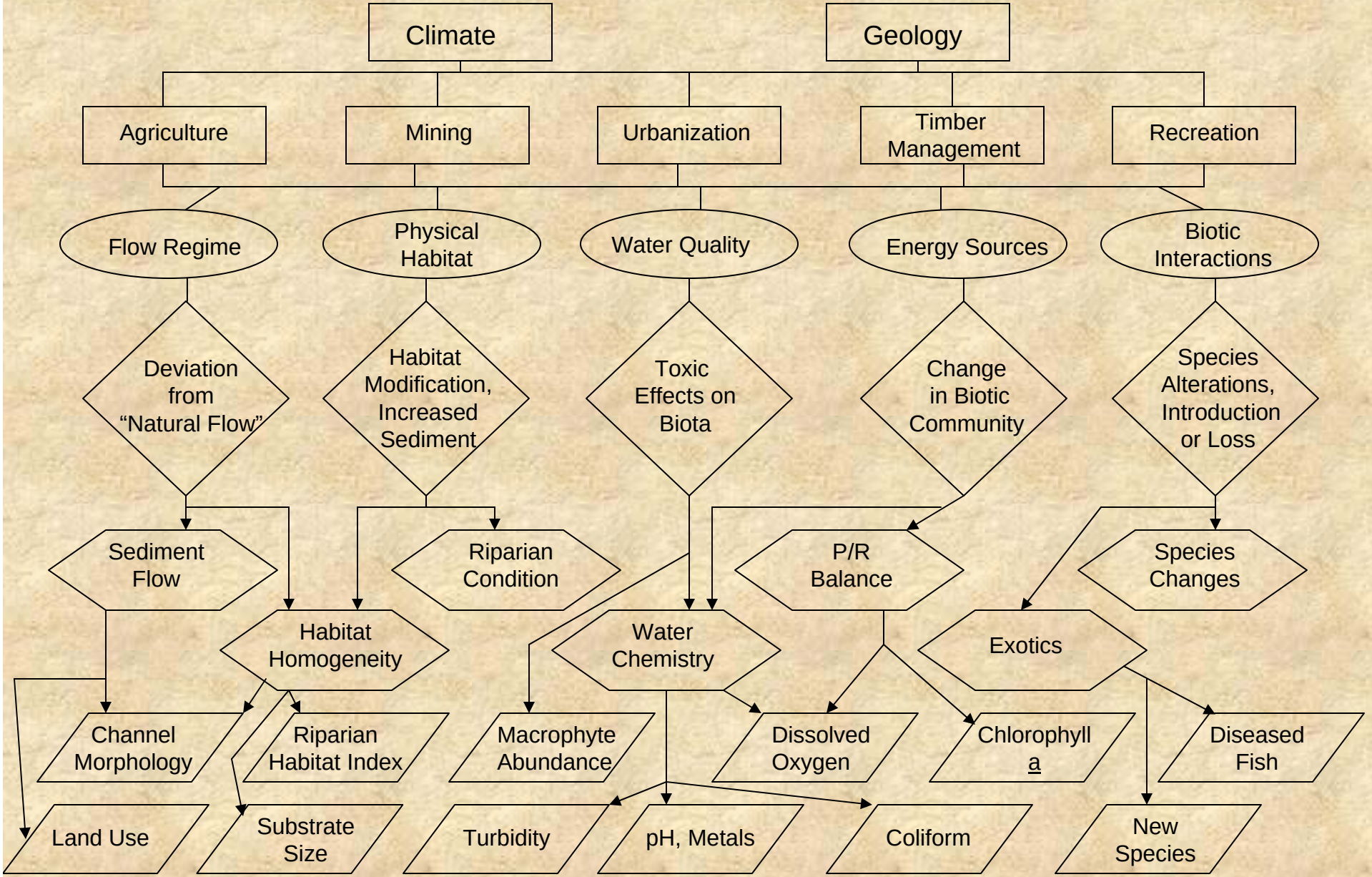
  Water quality

  Biotic interactions

Goals of the literature review

- Document the effects of land use stressors on the five components of biological integrity
- Look for data on the weighting of stressors to compare with the weightings developed from your professional judgment
- Look for data to assign possible threshold levels
- Look for data on spatial or temporal effects

OZARK RIVER MODEL



Principal ecological effects based on the survey results

Pasture and rangeland					
Level of influence	Flow regime	Physical habitat	Energy sources	Water quality	Biotic interactions
Low	X	X	X		X
Medium				X	
High					

Major reservoirs					
Level of influence	Flow regime	Physical habitat	Energy sources	Water quality	Biotic interactions
Low					
Medium					
High	X	X	X	X	X

Weighting the stressors

Use information developed from similar research efforts.

- Mattson and Angermeier. 2007. Tennessee river basin – Ecological risk index based on frequency and severity of 12 major stressors (land use)
- USEPA. 2006. U.S. — uses invertebrate indices to rank direct stressors such as total N rather than indirect stressors such as land use
- Bressler et al. 2006. Mississippi – uses a stressor gradient and invertebrate abundance to assign tolerance values
- Stranko et al. 2005. Maryland — uses fish abundance to predict probable direct and indirect stressors
- Snyder et al. 2005. Maryland — linked land use data to IBI fish and invertebrates to predict stream health. Examined clumpiness and connectivity of urban impacts
- McBride and Booth. 2005. Washington — developed Physical stream condition index using GIS and physical habitat. Examined spatial effects (subwatershed, buffer and local)

Stressors of interest

- **Water management**
- Dams and major reservoirs
- Headwater dams
- Dispersal barriers and low head dams
- Channelization
- Water withdrawal
- Flow diversions
- Recreational use
- Navigation
- **Human habitation**
- Impervious surface
- Population density
- Stormwater systems
- On sight waste water treatment plants (include septic tanks)
- NPDES (municipal, agricultural and industrial discharges)
- Sludge (underground injected)
- Landfills
- Golf courses
- Power lines
- Superfund sites
- Toxic releases
- Hazardous waste haulers and handlers
- Military sites

- **Transportation**
- Rail yards (fuel and coal dust)
- Airports
- Road salt applications
- Roads: paved and graveled
- Road crossings
- Salt scars
- Oil and gas wells
- Pipelines
- **Agriculture**
- Pasture/range land
- Row crop agriculture
- Ranging livestock
- CAFOs
- Artificial drainage
- Former grain storage facilities (Carbon tetrachloride)
- **Mining**
- Upland mining (lead, cadmium, zinc)
- Instream gravel and sand mining

- Resource Conservation and recovery act locations
- Introduced species

Methods

- Multiple Endnote libraries developed for past research projects looking at various land use effects on streams and rivers (>6,500 citations)
- Current Contents for latest peer-reviewed literature (urban+river/urban+stream=1,858 hits)
- Google Scholar for latest gray-literature such as EPA reports (urban+river/urban+stream=45,700 hits + impact = 34,200 hits)

Completed sections

Water management

- Dams and major reservoirs
- Headwater dams
- Dispersal barriers and low head dams
- Channelization
- Water withdrawal
- Flow diversions
- Recreational use
- Navigation

Agriculture

- Pasture/range land
- Row crop agriculture
- Ranging livestock
- CAFOs
- Artificial drainage
- Former grain storage facilities (Carbon tetrachloride)

What have we found?

- Detailed information on the effects of various land use activities on the five components of biological integrity
- Weighting of the stressors has been done by other groups. The resultant weightings may not work for this region, but we may incorporate their methods into our work
- Threshold data is available for urban impacts and some agricultural practices but not much information on other stressors
- Past land use may have an impact (but GIS data is not readily available)
- There is no consensus on the most appropriate spatial scale (watershed, local) for detecting stressor effects
- Knowledge of the land use within the riparian buffer is critical in determining the level of impact of various agricultural activities esp. animal production because land use in the buffer has a disproportionate effect on the stream

Slide 12

KED7 Scott what words do you prefer I use to describe the different spatial levels. I think I've seen you use local. Should segment-shed be in here?

Kathy Doisy, 1/18/2007

Stressors in need of citations

- Salt scars
- Hazardous waste haulers and handlers
- Toxic releases
- Sludge
- Golf courses
- NPDES
- Power lines
- Airports
- Rail yards
- Military sites

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