Stressor Identification for Impaired Streams in Mississippi

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The Mississippi Department of Environmental Quality (MDEQ) monitors streams throughout the state and regularly collects biological samples to assess stream health. When streams are found to be biologically impaired, a stressor-identification process is often needed to determine the causes of impairment. Thus, the U.S. Geological Survey Lower Mississippi-Gulf Water Science Center, in cooperation with MDEQ, has developed a framework for use as a decision-support tool to identify stressors in biologically-impaired streams in Mississippi.

Stressor-Identification Framework

The stressor-identification framework involves six key steps:

1. Define the impairment
2. List the candidate causes of impairment and develop a conceptual model
3. Compile all relevant data
4. Evaluate the data
5. Identify probable causes of impairment using a strength- of-evidence approach
6. Produce a report of results

Step 1 – impairment can be defined by describing the geographic, environmental, and temporal scope of the impairment. Definition may include basic watershed and stream reach information and details of biological metrics from the biological samples that were used to list the site as impaired.

Step 2 – potential sources of stress are identified within the watershed, including human practices such as agriculture, mining and water withdrawals, and features such as roads, impoundments, and wastewater discharge sites. In a conceptual model (fig. 1), sources of stress are linked through causal pathways (intermediate causes) to the possible proximal stressors that directly produced the observed biological outcomes or effects.

Step 3 – data are compiled from a variety of sources including reconnaissance surveys, water-quality monitoring, discrete and continuous hydrologic observations, landcover geospatial data, and other natural resources databases. Types of information can include habitat assessment scores, sediment particle-size percentages, biological metrics, and landcover metrics. Data from the impaired site as well as nearby non-impaired sites are compiled in this step for analysis in step 4.

Teoc Creek, Carroll County, Miss. (photo by Matt Hicks, U.S. Geological Survey)

Step 4 – data are evaluated based on two main categories: 1) data from the impaired site, and 2) data from other places. Data from the impaired site may include information about abiotic conditions and biological community metrics or taxonomic traits collected at the time of sampling that resulted in the impaired listing. Data from the impaired site are compared to water-quality standards and criteria, data from nearby non-impaired comparator sites and other benchmarks or target values. Data from other places may include biological effects based on stressor-response relationships from regional studies. Stressor-response relationships may be visualized as scatterplots of abiotic and biotic data and as box and whisker plots of biological metrics arranged by quartile groupings of a range of environmental data (figs. 2 and 3). Comparisons for all lines of evidence are scored using a summary sheet based on strength-of-evidence to support each potential cause of impairment.

Step 5 – results from step 4 are synthesized and integrated to reach a conclusion for each probable cause based on the overall weight of evidence. The conclusion considers data quality, quantity, and scores from step 4. This step may result in identification of likely causes of impairment, along with elimination of some candidate causes and identification of future data needs to strengthen confidence in the results.

Step 6 – a report is produced summarizing the results of the previous steps and may be presented to stakeholders and decision makers. Documentation and consistent application of the previous steps are critical in developing the report.

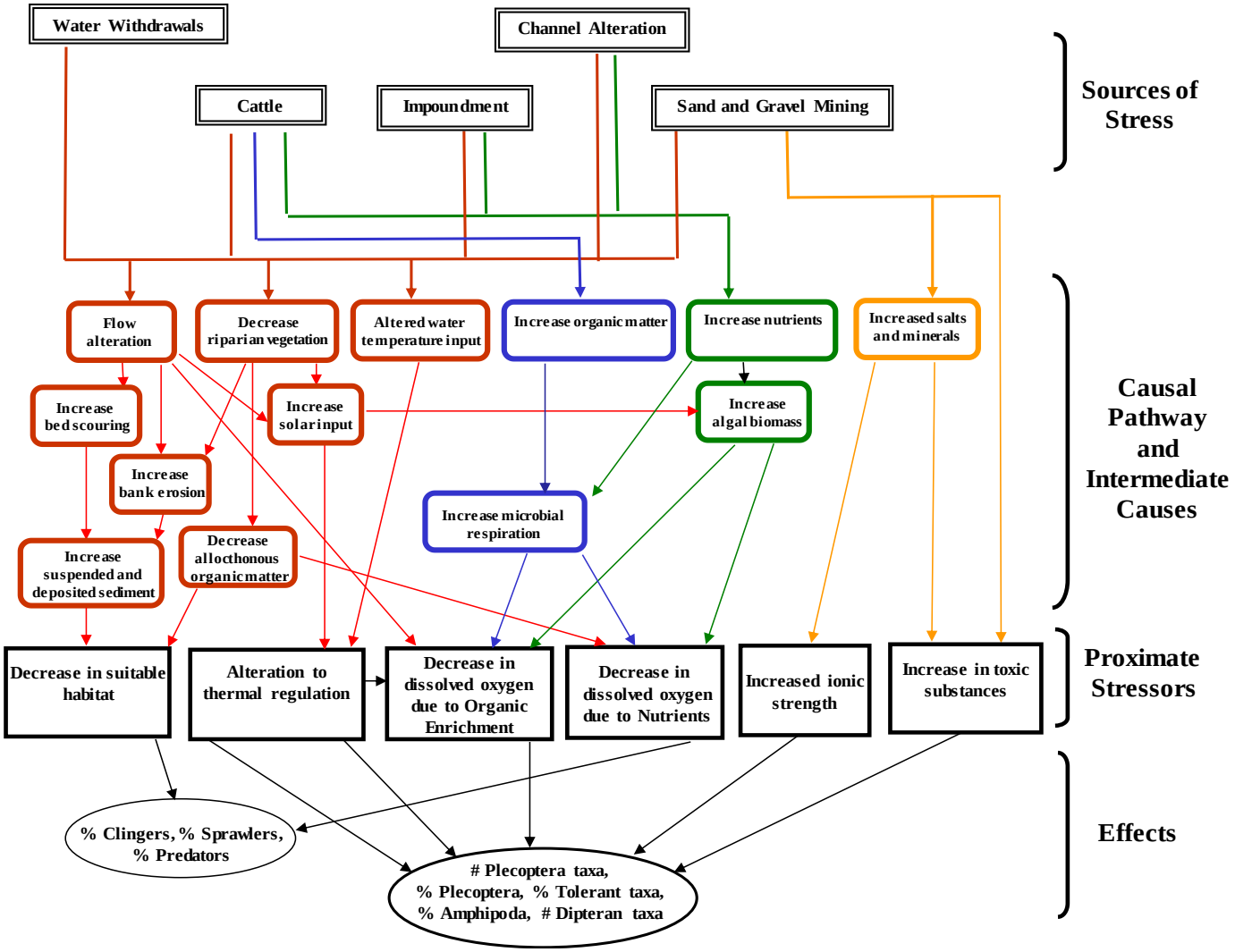

Figure 1. Example of a conceptual model linking potential sources of stress within a watershed to intermediate causes and proximate stressors which produce observed biological effects.

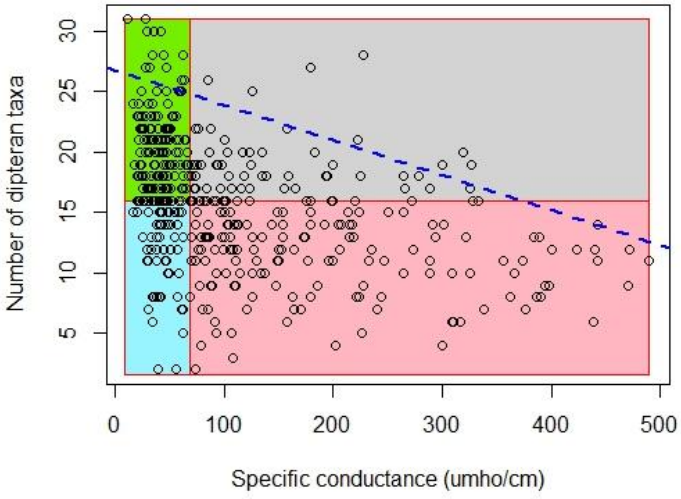

Figure 2. Example of a scatterplot divided into quadrants using median values of a physical variable (the proximate stressor being evaluated) and a biological response. The blue dashed line represents the 90th percentile quantile regression line.

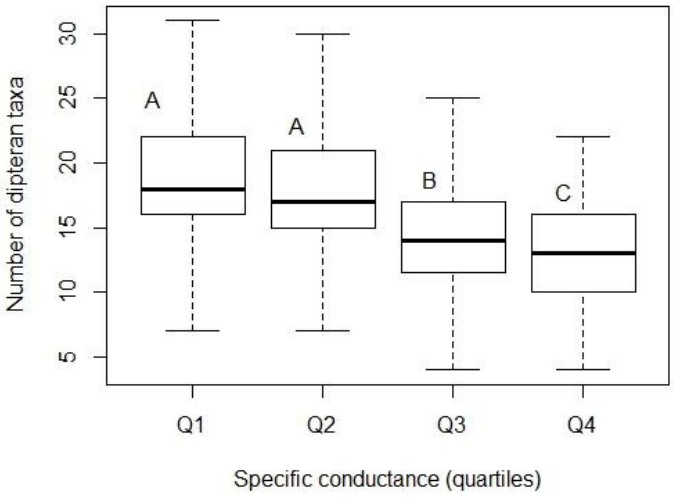

Figure 3. Example of boxplot for visualizing four quartiles of the physical variable (proximate stressor) with associated biological response.

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