Soda Butte Creek, Yellowstone National Park

Researcher links toxin deposition with stream morphology using BoundarySeer™ software

Information

Soda Butte Creek enters Yellowstone National Park near Cooke City, Montana, after flowing past a Superfund site contaminated with heavy metals. These metals concentrate in stream sediments, which can be toxic to plants, insects and fish that contact them and humans, such as fisherman, that contact stream-dwelling animals.

W. Andrew Marcus, Ph.D., of Montana State University has been studying the transport and fate of heavy metals in Soda Butte Creek. Metals are known to concentrate in fine-grained sediments, which accumulate where stream waters slow. Thus, Marcus hypothesized that stream morphology, by varying the rate of the stream's flow, controls local heavy metal deposition rates—with more accumulation of heavy metals in pools than in rapids.

Researcher Andrew Marcus holds stream rocks covered by orange iron oxides from the metals in the water.

Analysis

Field crews mapped Soda Butte Creek, classifying it into areas with specific morphological features (such as riffles, pools, and glides). They then collected bed sediment samples from 9 locations in each morphology type, 350 samples, and tested the heavy metal concentration in each sample.

Using BoundarySeer, Marcus identified two types of boundaries for copper and vanadium concentrations: areas of similar metal concentrations (areal boundaries) and areas of local change (difference boundaries).

Marcus then used BoundarySeer to overlap the metals boundaries with the stream morphological types identified by the field crews.

For more information, see BoundarySeer Analysis Details on the reverse side.

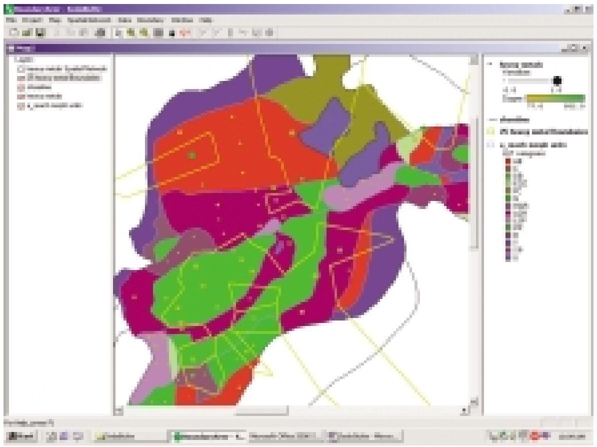
Insight

BoundarySeer provided a way to verify the field results. It found that the trained field crews successfully identified many heavy metal deposits. The confirmation of these locations by BoundarySeer has provided a powerful hypothesis-testing tool for Marcus, and provided the research team with guidance on where to collect future sediment samples for assessment and modeling of environmental risk.

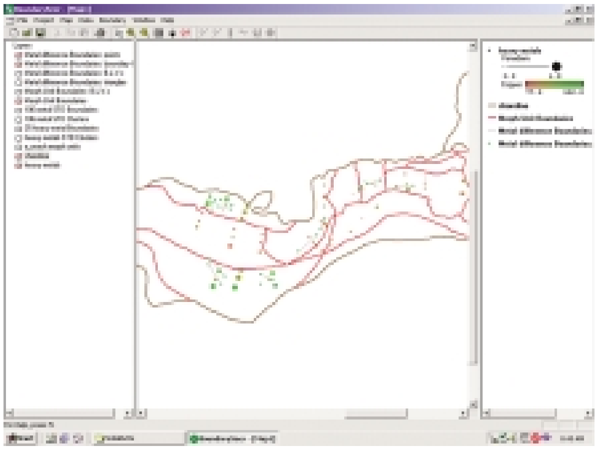
Perhaps even more important, BoundarySeer identified numerous boundaries in heavy metal concentrations that did not correspond to features that could be easily identified by field crews. This has led to generation of entirely new hypotheses and provided explanations for the factors that control toxin exposure for plants, fish and humans.

BoundarySeer™ Analysis Details

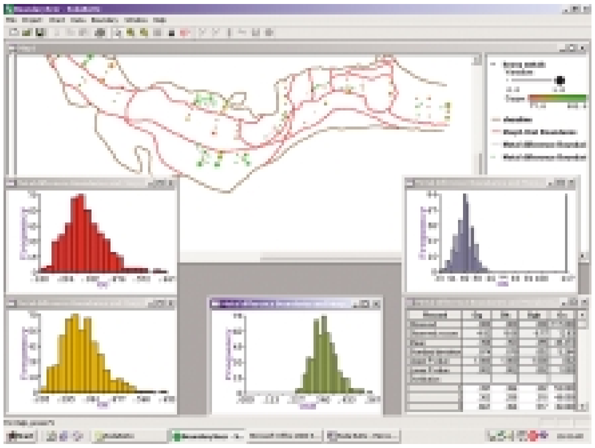
1) Exploratory Visualization
BoundarySeer produced histograms, scatterplots, and maps of the heavy metal concentrations. Locations high in copper (green on the map) were also high in vanadium (large circles).



2) Boundary Delineation
BoundarySeer defined areal boundaries for heavy metal concentrations (outlined in yellow). As you can see, these boundaries do not coincide well with those for stream morphology (shown as colored polygons).



3) Exploratory Visualization
Difference boundaries in heavy metals reflect local scale variation. These boundaries did associate with the stream morphology types.



4) Overlap Analysis
Overlap statistics support the pattern shown in 3). Areas with high levels of change in metals concentrations do coincide significantly with some of the stream morphology boundaries.

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