QUANTIFYING STREAM STRUCTURAL PHYSICAL HABITAT ATTRIBUTES USING LIDAR AND HYPERSPECTRAL IMAGERY

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Abstract

Structural physical habitat attributes include indices of stream size, channel gradient, substrate size, habitat complexity and cover, riparian vegetation cover and structure, human disturbances and channel-riparian interaction. These habitat attributes will vary naturally even in the absence of human disturbances according to their ecological setting.

Light Detection and Ranging (LIDAR) is an airborne laser system that provides information on topography, as well as height and structure of vegetation and other ground features. LIDAR-derived digital elevation models (DEMs) at 1 meter (~39 inches) horizontal and 0.3 meter (~12 inches) vertical resolution allow for the measuring of approximate channel dimensions (width, depth), slope, channel complexity (residual pools, volume, morphometric complexity, hydraulic roughness), riparian vegetation (height) dimensions of riparian zone, anthropogenic alterations and disturbances, channel and riparian interaction, and for detailed hydrologic and sedimentation modeling at the watershed to sub-basin levels.

Hyperspectral imagery is comprised of narrow spectral bandwidths (1-5nm) with a continuous spectrum in the visual to near infrared portion of the electromagnetic spectrum. Hyperspectral imagery offers the advantages of high spectral and spatial resolution allowing for the detection and identification of riparian vegetation and natural and anthropogenic features not possible with satellite imagery. High resolution remote sensing provides unique capabilities in detecting a variety of features (e.g., vegetation type, sedimentation, water column constituents, potential sources of non-point source pollution) and indicators of environmental health and condition. When combined, or fused, these technologies comprise a powerful geospatial data set for assessing and monitoring environmental characteristics and condition.

Figure 1. Stream Reach Transects

Figure 2. Stream Reach Transect A

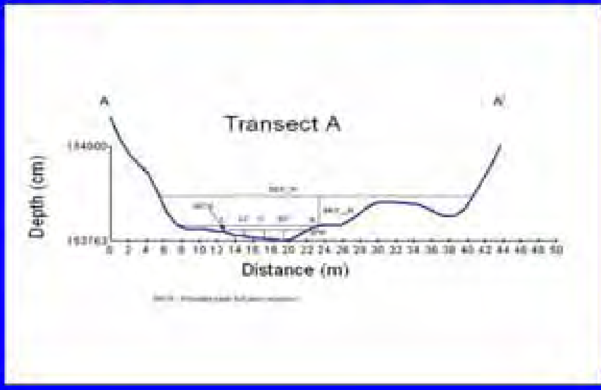

Figure 3. Stream Reach Transect H

Figure 4. Watershed Morphology and Invasive Species Classification: Humboldt River, NV

Riparian Vegetation

Canopy cover is essential for moderating stream temperatures, providing habitat and an indicator of potential aquatic community presence.

Hyperspectral imagery integrated with LIDAR data can determine vegetation type (e.g., native plants, noxious, invasive species), structure, height and distribution.

Stream Dimensions

Streams are dynamic and subject to relatively rapid change in channel shape. To determine the integrity of the fish habitat, it is important to measure:

- wetted width
- bankfull height and width – highest flow achieved during a major storm event
- thalweg depth – deepest part of the channel
- depth cross-sections, and
- flow rates as indicators of stream size.

The stream longitudinal profile and cross-sections (see Figure 2 and 3) provide a measure of the stream's dimensions.

Conclusions: High resolution RS: Advantages

There are multiple advantages to hyperspectral & LIDAR data

- 100% coverage of the ground surface to approximately 1 meter (~3 feet) pixel resolution.
- Spatially accurate within several inches using corrected Differential Global Positioning System (DGPS).
- Covers larger areas than a single stream reach assessment.
- Narrow, contiguous spectral bands in hyperspectral imagery allows better discrimination of vegetation types, land cover and water clarity.
- Measures canopy height and density, riparian width and fragmentation.
- Can measure channel form and reveal subtle changes in topography and bathymetry.
- Can be used to develop quantitative water quality indicators.

Major advantage is the cost to benefit relative to high density ground sampling to cover the same land area.