High Definition Stream Surveys: A New Method to Managing Rivers and Streams

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As water resource professionals, we are often tasked with balancing the needs of people with the needs of nature. While these requirements often appear to conflict, justifiable compromises may be found which sustain economically viable and environmentally beneficial long-term solutions. The High Definition Stream Survey (HDSS) method provides water managers with an integrated suite of stream corridor information to support effective decision-making. By employing advances in automation and technology, HDSS enables the continuous collection of geo-referenced imagery with instream, streambank, water quality, and bathymetric data over long reaches. HDSS delivers to managers and stakeholders more data, faster and at lower cost as compared to traditional methods. As a result, the HDSS platform transforms featureless blue lines on a map into data-rich, 1-meter resolution GIS layers representing numerous instream and streambank parameters. These parameters can be combined in informative ways to create powerful decision-support tools allowing for a new holistic approach to river and stream management.

Effective management is critical to maintaining long-term viability of rivers and streams which supports the growing needs of human society without compromising the integrity of the waterway. Traditionally, aquatic resource managers were required to make management decisions based on few short sample sites (several 100 m) within a stream system. Conditions at these sites were then extrapolated to represent an entire stream. It was typical to make management decisions on entire streams with data representing less than 5% (and in many cases <1%) of the overall stream. Using HDSS, we now collect measures of stream conditions consistently throughout the stream system. No longer are we extrapolating data to "guess" conditions in miles and miles of unsurveyed stream, instead we now have high-quality data to accurately prioritize management actions throughout the stream.

The obvious benefits of HDSS are its speed, versatility and ability to capture the data required to address a nearly endless suite of issues in a single survey. When compared to traditional stream survey methods, the HDSS method is *fast*. For example, we surveyed 125 miles of the Duck River, TN in only 7 days with a two-person crew. Complete survey coverage of such a long stretch of river would not have been feasible using other stream survey

HDSS dashboard provides the viewer with a continuous 27-mile assessment of the Collins River allowing for a thorough understanding of river conditions. Included in the dashboard are high definition videos recorded directly in front of and under the boat (underwater) and left and right bank, a map that identifies the current location, date, time, GPS coordinates, depth under the boat, and sidescan sonograph.

methods. The HDSS approach is *versatile*. The method can be used in dry artificial drainages, intermittent streams, wadeable creeks and boatable rivers. The results of the surveys can integrate with multiple different models and support numerous management needs. The HDSS method provides *better data*. While traditional survey methods may require separate surveys for habitat suitability, streambank condition or impact assessment, a single HDSS survey would address the data needs for all of those requirements and more. Most importantly, achieving these improvements in speed, versatility and application using HDSS actually *costs less* than traditional survey approaches, an important consideration in a time of diminishing budgets for resource management needs.

By rapidly gathering continuous stream corridor information, the HDSS approach is applicable to answering a wide range of management questions. In our experience, certain questions typically arise when river and stream management issues are discussed. We have all likely heard or asked one or more of these questions:

- How do we get the best information to our watershed planning group to make effective and informed decisions?
- Do we have a list of the priority problem areas (complete with pictures and location) within our river system?
- What is the cost/benefit analysis of possible mitigation actions to comply with permit requirements?
- What are the environmental impacts of alternative project scenarios?
- Where is suitable habitat for species of concern found in the river system?

With HDSS, we now have the answers. The examples below highlight the applications and benefits of the High Definition Stream Survey technique and how it has helped to address the needs of local, state, federal, and private institutions in answering these typical management questions.

How do we get the best information to our watershed planning group to make effective and informed decisions?

A broad watershed planning group concerned with Big Canoe Creek in Northern Alabama included federal (The U.S. Fish and Wildlife Service), state (Alabama Department of Conservation and Natural Resources and Geological Survey of Alabama), non-profit (The Nature Conservancy, the Coosa Riverkeepers and Friends of Big Canoe Creek), and local landowners. They planned to remove Goodwin's Mill Dam from the Big Canoe Creek to eliminate a barrier to fish and mussel movement. Given the high cost of dam removal and subsequent stream restoration, it was important to document stream conditions before and after the dam removal to ensure that improved habitat conditions resulted. One problem when attempting to document changes resulting from dam removal using traditional transect surveys is that the changes to the stream can occur over a broad area upstream and downstream from the removal site. This makes determining the placement and number of transects extremely subjective. More transects over a wider area likely will document changes more effectively, but this comes with a high cost to the monitoring budget. To solve this problem, the HDSS method was used to document pre- (2013) and post- (2016) barrier removal conditions. Each HDSS survey collected data for both streambanks and instream conditions along three miles of stream, centered on the dam site. Given the rapid data collection capabilities of HDSS, field data collection was completed in less than ½ day for each survey. HDSS data was used to delineate habitat type, substrate type and embeddedness, depth, bank full depth, bank angle and height, bank erosion potential, and riparian diversity. These parameters were used to document trends in sediment movement, stream geometry, and habitat conditions by comparing pre- and post-removal conditions. The results were used to not only show improvements from this dam removal project, but also to help planners predict impacts for future projects. This project highlights the strength of the HDSS approach to efficiently gather a wide range of river corridor information to support a range of stakeholder needs.

Do we have a list of the priority problem areas (complete with pictures and location) within our river system?

The Paint Rock River is one of Alabama's most biologically diverse aquatic systems. The Nature Conservancy (TNC) and Tennessee Valley Authority (TVA) teamed up to help protect and restore this Alabama jewel. Due to fiscal limitations and the extensive area of interest, prioritization was necessary to ensure that areas in greatest need of protection and restoration were identified. The HDSS approach was used to efficiently gather high resolution, geo-referenced data over 53 continuous miles

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The versatile HDSS platform allows it to be used in small rivers using boats, to shallow streams using a backpack.

of the Paint Rock River and its tributaries in three days. HDSS survey data was used to continuously assign bank condition scores and habitat type (pool, riffle, run). Bank condition scores were prioritized, highlighting the ten best areas in need of protection and the ten worst areas in need of restoration. Decision support tools, developed from the HDSS data, and geo-referenced, high-definition video were layered onto GIS maps to clearly communicate the issues to and among the stakeholders. TNC and TVA used the HDSS prioritization to select and restore habitat that met their criteria for greatest need. HDSS also provided managers and stakeholders with baseline data and video of bank conditions that are reviewable in the future for conservation action. This project highlights the strength of the HDSS approach to collect the data at a longitudinal scale necessary to prioritize and support your management action at a fraction of the cost and time as traditional methods.

What is the cost/benefit analysis of possible mitigation actions to comply with permit requirements?

Many municipalities have permit requirements associated with municipal stormwater sewer systems (MS4). Part of an MS4 permit includes documenting the problem areas to identify and address issues that may be contributing to stream impairments. There are several survey methods to conduct "stream walks," but most are slow and only focus on documenting problems. We have used the HDSS approach to rapidly gather all important stream information throughout a municipality's waterways. The HDSS geo-referenced data collection platform can be mounted on backpacks for surveying shallow or dry waterways and on small boats to survey deeper stream segments. This flexibility allows for the collection of consistent resolution data on any sized natural stream or man-made drainage. The results of the data collection can be used to document both sewer outfalls and stream conditions in a single survey. By documenting the type, extent, and severity of the problems, we can estimate the cost and potential ecological lift gained by the action. For the city of Athens, TN, we were able to document priority areas for trash cleanup (inexpensive), streambank restoration (moderately expensive) and possible dam removal (most expensive) to allow the city meet permit requirements and budget for different management actions. In addition to meeting permit requirements, the high-definition video allowed city managers to view and better understand problem areas without needing to visit the difficult-to-access stream locations. Overall, the HDSS was a well-suited and successful approach for cost/benefit analyses on future management cases.

What are the environmental impacts of alternative project scenarios?

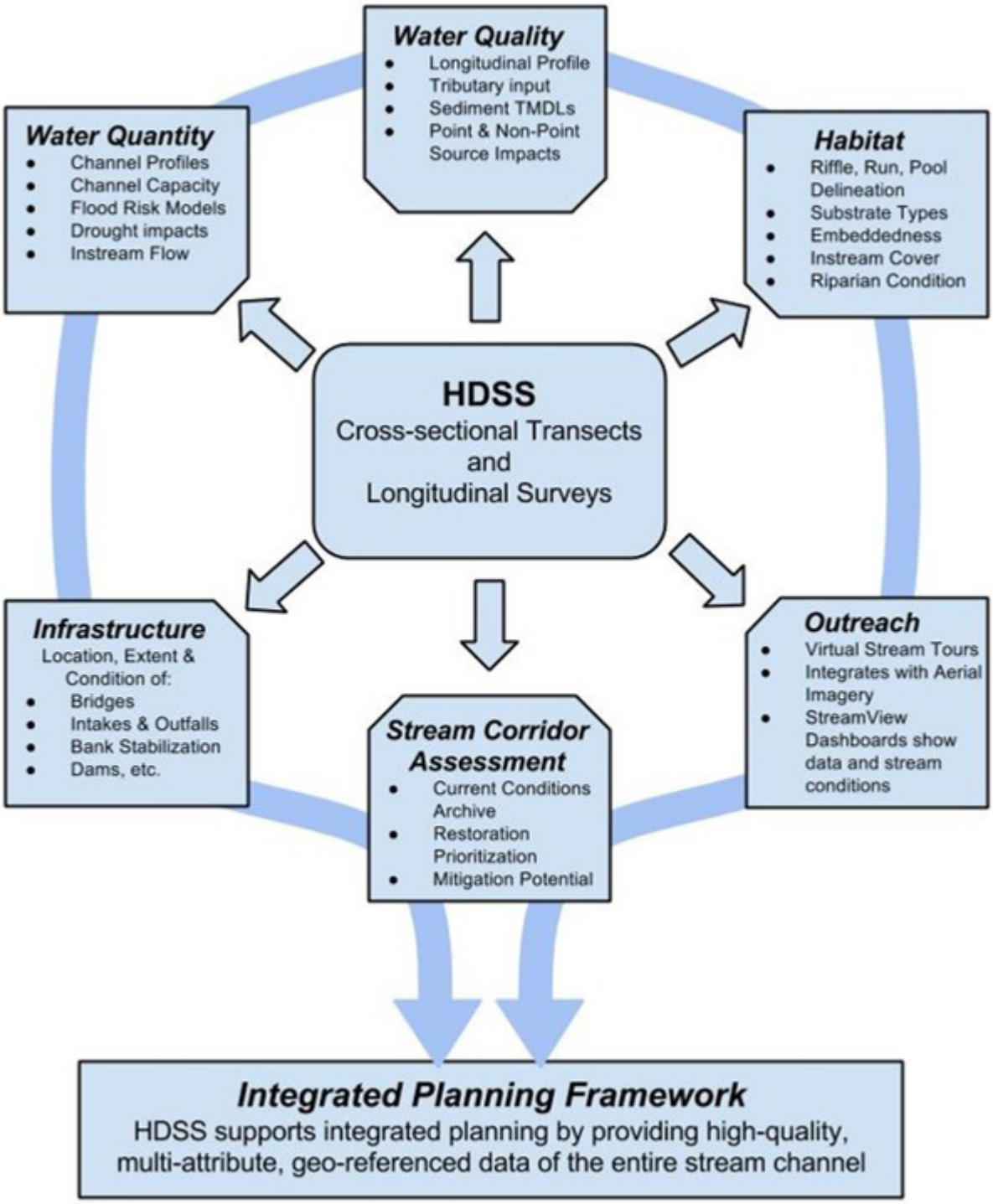
The Ala Wai Canal is an artificial waterway created in 1928 which drains streams that run through central and east Honolulu, HI, to the ocean. Damage from flood events lead to the development of the Ala Wai Canal Flood Mitigation Project. The goal of this US Army Corps of Engineers (USACE) project was to reduce the risk of flooding within the Manoa area of Honolulu. The project was focused on holding back or diverting peak flood flows to lessen the impact of a flood event and was expected to have an impact on aquatic habitat of native Hawaiian stream animals. The HDSS platform was used to survey long stretches of Manoa, Palolo and Makiki streams in the Ala Wai watershed from sea level to the upper reaches in order to document stream channel conditions. This data was integrated into the Hawaiian Stream Habitat Assessment Procedure (HSHEP) model to quantify the impact of mitigation scenarios on native species habitat. HDSS fieldwork uncovered problems such as barriers to fish migration, failing retaining walls, and point-source pollution locations while also documenting the location and extent of suitable habitat for native stream species. HDSS delivered the necessary data for subsequent models to address cost/benefits of different mitigation scenarios and allowed for the selection of actions that were less costly to the public and resulted in much larger fish habitat improvements. This project highlights how collecting a wide range of data using the HDSS approach consistently throughout multiple streams in a watershed improved scenario testing and environmental impact decision-making.

Where is suitable habitat for species of concern found in the river system?

Cold water releases from the Center Hill Dam support a high-quality trout fishery and recreational paddling opportunities (kayaks and canoes) in the lower portion of the Caney Fork River, TN. The USACE manages the flow releases from Center Hill Dam to support power production and flood control. The USACE planned to upgrade its generation capacity at Center Hill Dam, and as a result, may change the volume and duration of the generation flows from the dam. The Cumberland Chapter of Trout Unlimited (TU), Tennessee Wildlife Resource Agency (TWRA), and Tennessee Department of Environment and Conservation (TDEC) were concerned about the potential negative effects of the flow changes and were seeking ways to improve water quality, trout habitat and fishing success for anglers.

The HDSS platform was used to collect continuous, geo-referenced data on 27 miles of the Caney Fork River corridor downstream of Center Hill Dam to its confluence with the Cumberland River. HDSS data was captured on both riverbanks, depth, water quality, habitat type and bottom characteristics of the river channel. Concurrent with HDSS data collection, electrofishing surveys were conducted, allowing habitat availability (HDSS data) to be tied with habitat use (electroshocking data). Data captured during this survey allowed for the development of habitat suitability models for trout as well as suitability models for fishing access (wading and boat), supporting both management applications and recreational angler needs. HDSS data provided TU, TWRA and TDEC with complete documentation of river corridor conditions, information on the trout population, prioritized locations for trout enhancement projects, and fishing maps to improve angler success. This project highlights how HDSS results can be used to document the distribution and extent of fish habitat and also help prioritize management actions to improve habitat conditions.

Knowing which management actions are most important is made easier when you have clear, comprehensive documentation of the current conditions within your entire stream system. The HDSS technique can be deployed to collect better data, providing stronger support for the most appropriate management action and making you more successful at protecting and improving your streams and rivers. ◆



HDSS allows for a single survey to gather information for numerous user groups for multiple applications. HDSS documents infrastructure for permits, precise bathymetry measurements for water quantity and quality modeling, and habitat parameters to prioritize mitigation work and protect and conserve aquatic resources.

To find out more about the HDSS approach and its applications, please visit our website at TruttaSolutions.com