Headwater Stream Survey Protocol - Repeat Surveys

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Equipment

Required

1. Retractable tape measure (metric or standard)
2. Field notebook (waterproof recommended)
3. Survey flags (500-1000 flags recommended)
4. Slick and durable rope, cut to a length of 5 m
5. Continuous tracking GPS (can use a free smartphone app)
6. Camera (can use phone camera)

Optional

1. Rubber boots (highly recommended)
2. Laser range finder for wide streams
3. Waders for deep streams
4. Long transect tape (e.g. 50 m)
5. Flow probe for water velocimetry

Flagging channel networks:

Flag stream channel networks so that stream measurements are equally spaced. It is easiest to flag channel networks during wet conditions when the active stream network extends far up into the channel network.

1. Turn on GPS tracking to help with channel network map digitization
2. Start at the top of the channel network and move downstream, being sure to flag all connecting tributaries.
3. Working in pairs, use the rope to measure 5-m intervals along the thalweg. At each measurement site, stake a survey flag securely and well outside of the channel.
4. While staking flags, create a data table and a map of the flag locations in the notebook. See examples below.
5. Keep in mind that as the stream network expands and contracts, previously unidentified stream segments may come into existence. Flag these new streams and add them to your data table and map.
6. Aim to flag >500 locations (shoot for 1000 if possible), and try to work your way down into the stream network so that you're flagging fairly wide streams (e.g. >5 ft, >2nd stream order). Flag all channels above a given point in the channel network.

Surveying streams:

1. Turn on GPS tracking and record start and ending times of stream survey in notebook.
2. At each flagged site, measure stream width perpendicular to the thalweg. Record measurement in columns labeled with a "w". Give dry steams a width of "0".
3. For multichannel flow (i.e. a stream island), measure each stream width and sum the widths together. If there are some dry sections along the width transect (e.g. a rock in the measurement, braided stream, grass or a tree, etc.), then you can make an estimate on how much of the stream is dry. So a very braided width measurement could read: 64 cm, 50% dry. Record this in columns labeled with a "d"
4. Take lots of photos to document stream conditions. Take at least one representative photo of average stream conditions that can be used in a publication.
5. Digitize measurements and stream network maps while the survey is still fresh in your memory.

Miscellaneous Notes

What is a stream? A stream is defined as flowing water within a channel, including transient channels formed by leaf litter or other debris. If there is no channel, we consider the water feature to be overland flow and not a stream.

What is a channel? A channel is a roughly concave geomorphic feature carved by streams. Sometimes channels contain flowing water and sometimes they are dry.

Selecting a catchment: We recommend carefully scoping out headwater catchments in Google Earth to get an idea of scale, conditions, and accessibility. We targeted the headwaters of the trunk stream within a basin (the stream with the most accumulation area going upstream).

Watershed recommended attributes:

1. Safe and lawful access to the entire stream network within a watershed.
2. Stream networks that are gauged or have downstream gauges nearby with at least daily discharge records. A long flow archive is also a plus.
3. Easy access by road to the headwaters of the network. We strongly recommend starting at the headwaters or drainage divide and work your way downstream, walking up any tributaries you cross.
4. Try to sample drainages that have a few tributaries draining into them. Dendritic style. This allows us to look at higher order streams, which is useful in comparing this work to biogeochemical applications.
5. Avoid selecting stream networks to survey that have streams that flow through bushes/dense underbrush.

Other tips for surveying streams:

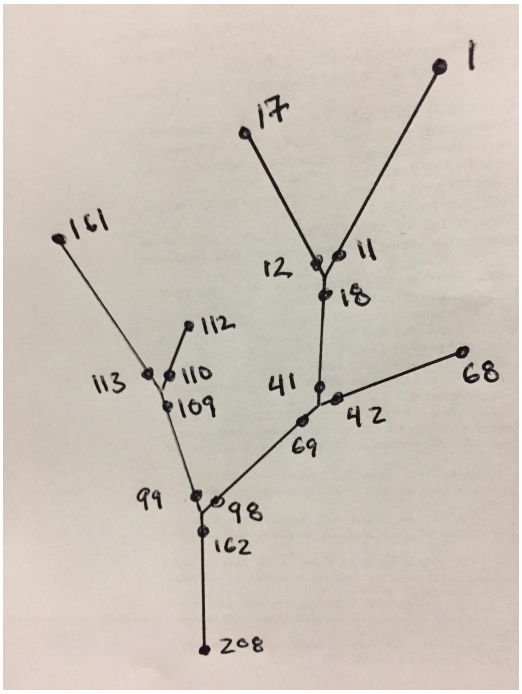
1. Do not include stagnant pools that are not flowing in stream surveys.
2. Survey streams when discharge is not dramatically changing
3. If a tributary with flowing water doesn't connect to the stream network at the surface, figure out where it would most likely connect (e.g. the steepest path down the hill to the next stream) and connect it there in your table and in your stream network diagram. These places where you are connecting together flowing channels but do not have any surface water should have a width of zero.
4. If there are multiple channels but there isn't an island and it looks like the ground water is coming from the hillside and not just hyporheic flow then consider, call it a tributary and label it as a new segment in your stream network map.
5. Quantify measurement error by surveying the same stretch of measurement sites repeatedly during a short time period.

Example data table:

site ID	dnstrm ID	notes	w001 (in)	d001	w002 (in)	d002 (in)
1	2		5		9	10
2	3	replaced flag on survey 002	8		13	
3	4		0		3	20

Rows are measurement sites and columns are measurement times

Example map:



Numbers correspond to the ID of most upstream & downstream survey locations along each stream segment