ELEVATION SURVEYS

Massachusetts Department of Fish and Game
Division of Ecological Restoration
Invested in Nature and Community

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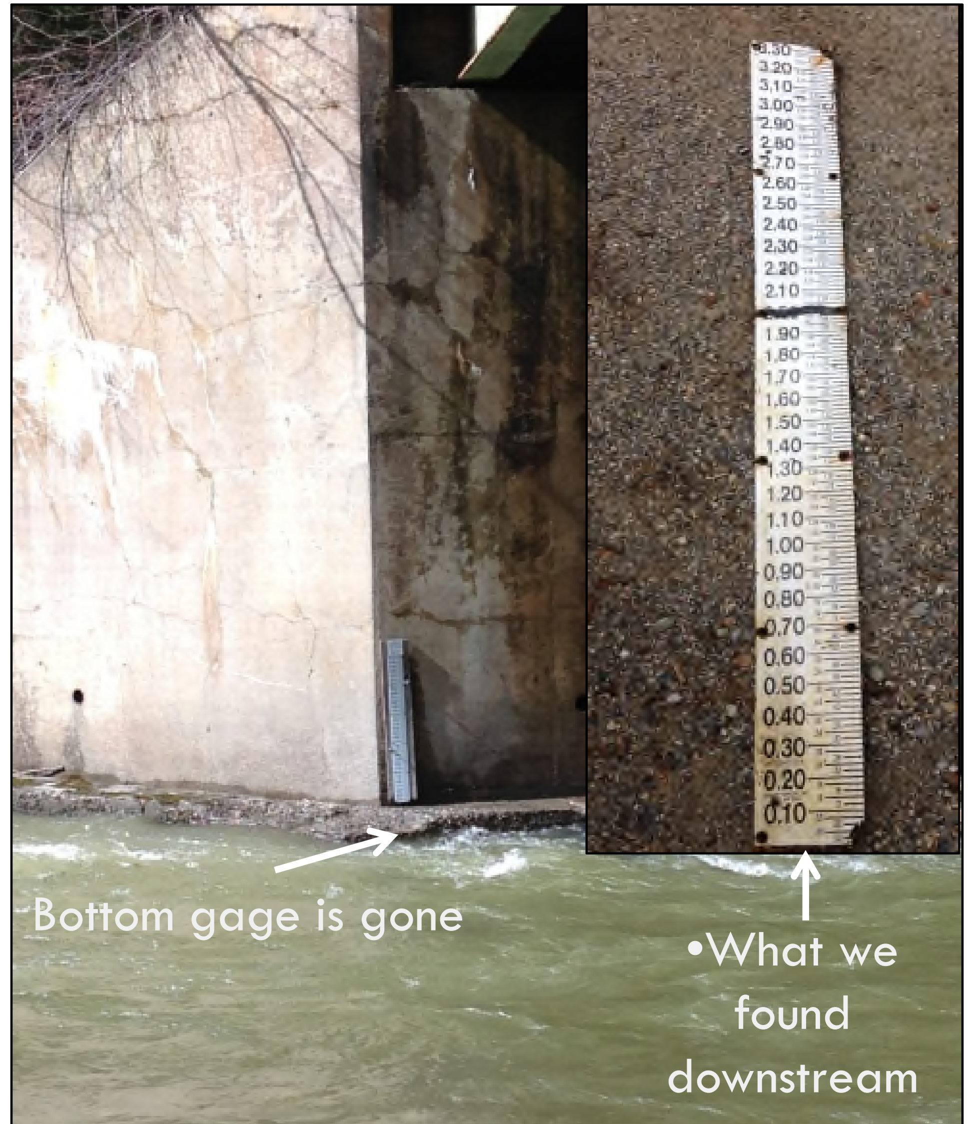
Elevation Surveys - Outline

- Importance and frequency of elevation surveys
- Benchmarks
- Equipment
- Set up
- Measuring elevation
- Calculating elevation
- Good reference material
- Questions?

Importance of elevation surveys

- Why do we need to do elevation surveys?
- Staff gages and transducers can move
  - High spring flows
  - Debris in stream
  - Vandalism
  - Ice
- Movement of equipment impacts data
- If elevation is measured regularly, movement can be detected and quantified and data corrected

Importance of elevation surveys



Frequency of elevation surveys

- At least once a year, more often if movement is suspected (especially for equipment installed in streambed)
  - Preferably in Spring after ice melt, spring flows
  - After flood events

Tip: May be easier to survey in spring before trees leaf out

Benchmarks

- What is a benchmark?
  - Reference point of survey
  - Will likely need to establish new benchmarks
  - Can assign a relative elevation (e.g. 100ft) if actual elevation is unknown
- Good benchmarks – prominent and easy to relocate, unlikely to move, accessible at a variety of flows
  - Existing structure – bridge, storm drain
  - Rebar - driven most of the way into ground
  - Boulder - highest point or other prominent spot
    - Accessible during most flows
  - Tree - drive long nail/spike into tree
    - Choose a large, relatively straight and healthy tree
    - No large branches that inhibit ability to hold stadia rod
    - Away from stream banks/potential erosion

Benchmarks

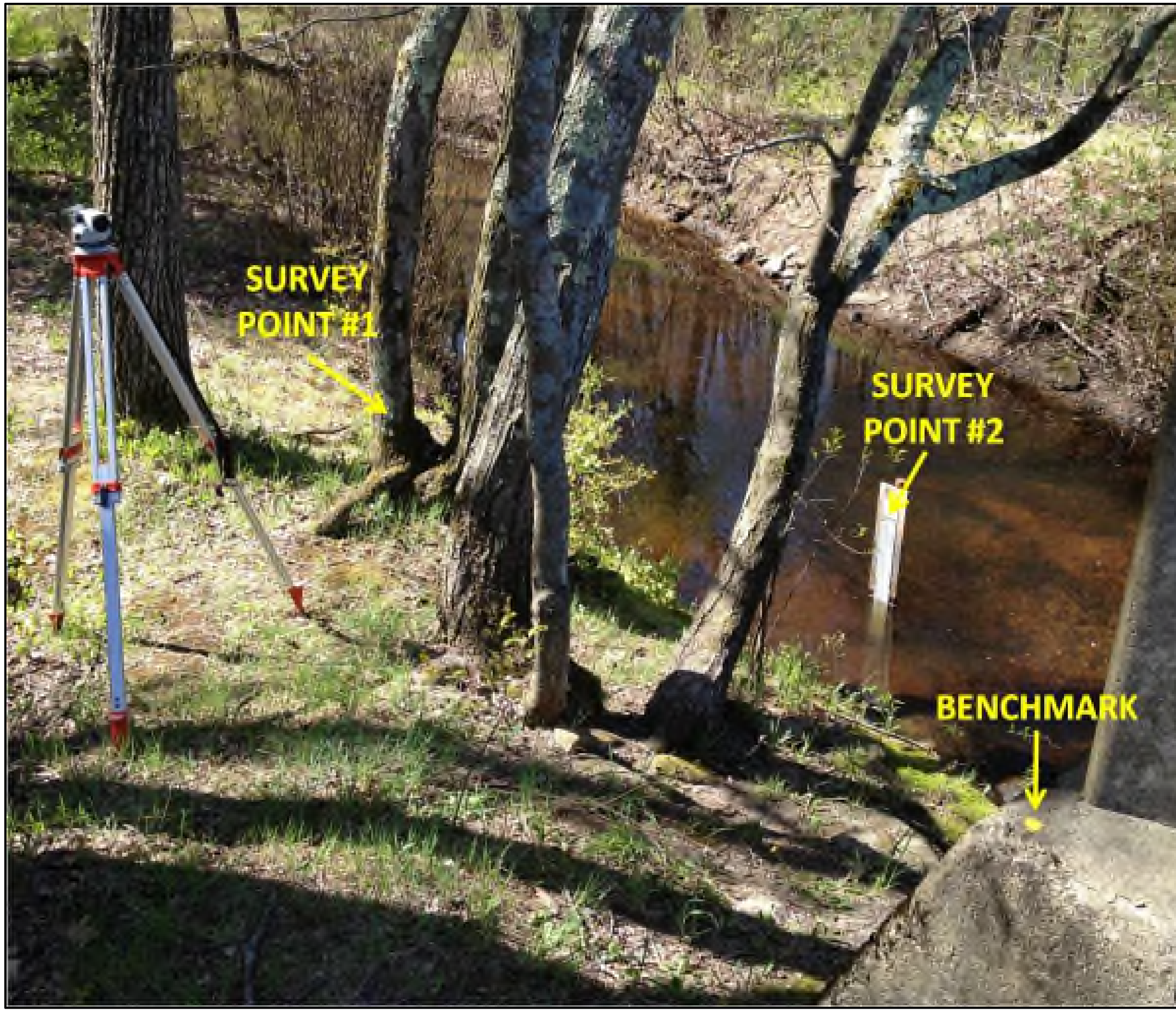
- Do I need multiple benchmarks?
  - Yes, benchmarks can move, become vandalized, washout
  - Multiple benchmarks allow you to track movement of equipment as well as movement of benchmarks
- Benchmarks should be easily visible from location of equipment (staff gage, transducer)
- Benchmarks should be independent of each other (e.g. not all on a bridge, not all on the same tree)
- Mark benchmarks with bolt, flagging tape or paint

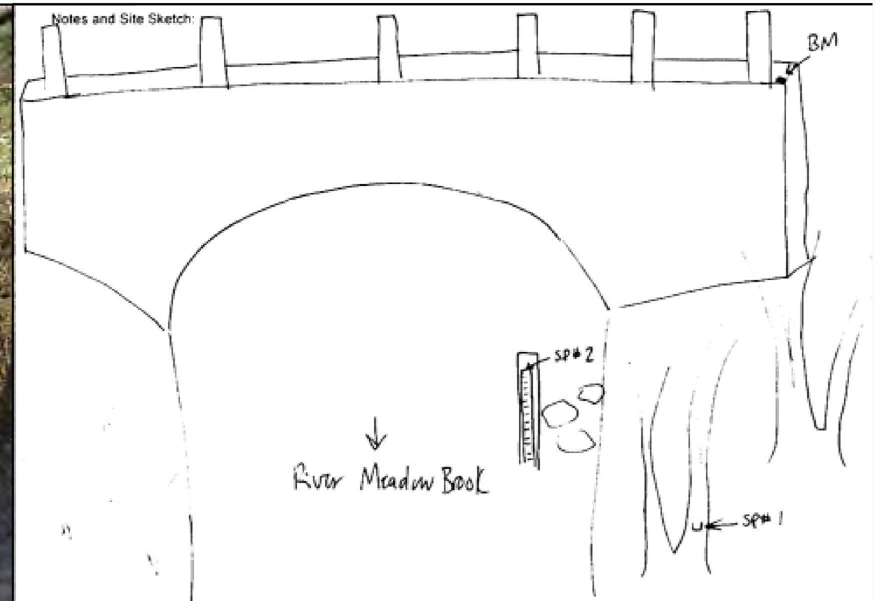
Benchmarks

Once benchmarks are established and marked:

- Create a site drawing that notes all survey points, include detailed descriptions of survey points
- Photo document all benchmarks Document location of benchmarks with GPS
- Determine if certain seasons will be best for conducting surveys (e.g. does it need to be before leaf-out)

Benchmark documentation examples





#	Survey Point
BM	River left corner of bridge next to white post on bridge, marked in yellow, Downstream end of bridge corner
1	U-nail in branched tree, River left, immediately downstream of gage, ~2 ft off ground
2	Top of gage
BM	River left corner of bridge next to white post on bridge, marked in yellow, Downstream end of bridge corner

Equipment

- To perform an elevation survey you need:
  - A level (typical ones include a laser level or auto level)
  - Tripod
  - Stadia Rod, with rod level
  - Datasheet
  - Two people

Example of a laser level

Example of an auto level, tripod and stadia rod

Set up – Tripod and level

1. Set up tripod in a location where you can view all benchmarks and survey points
   - Extend tripod legs fully
   - Make tripod as stable and level as possible
2. Attach level to tripod and level it
   - Attach level using screw on tripod, finger tighten
   - Use foot screws to center the level bubble
   - When level, rotate 90^0 and re-level (if necessary). Repeat until you are able to rotate 360^0 with it staying level

Set up – Tips

- To center level bubble, turn the foot screw that is opposite bubble location until it moves. Switch foot screws as bubble moves around until it is centered
- If you are having difficulty leveling the survey equipment, turn all foot screws back down and start over fresh making sure that the tripod is as level as possible

Measuring Elevation

1. Person 1 (P1) hold stadia rod on top of benchmark. Rod must be level.
2. Person 2 (P2) aim level at stadia rod.
   A. Look through level and find stadia rod, focus view field until you can clearly read rod.
   B. Read elevation at which crosshairs in level cross the stadia rod. Crosshairs can be adjusted using knob on side of level
   C. Record this elevation as the starting backsite (B.S.)
3. P1 hold stadia rod on survey point #1. Rod must be level.
4. Repeat Step 2. Record this elevation as the foresite (F.S.).
5. Repeat Step 4 for additional survey points (including the top of the staff gage and transducer)
6. Closeout survey by re-measuring benchmark (repeating Steps 1 and 2). If final B.S. does not match starting B.S. (within 0.01 ft), repeat survey.

Reading a stadia rod

Typically measured in tenths of feet (or meters)

Each line is 0.01 ft apart (or 0.01 m)

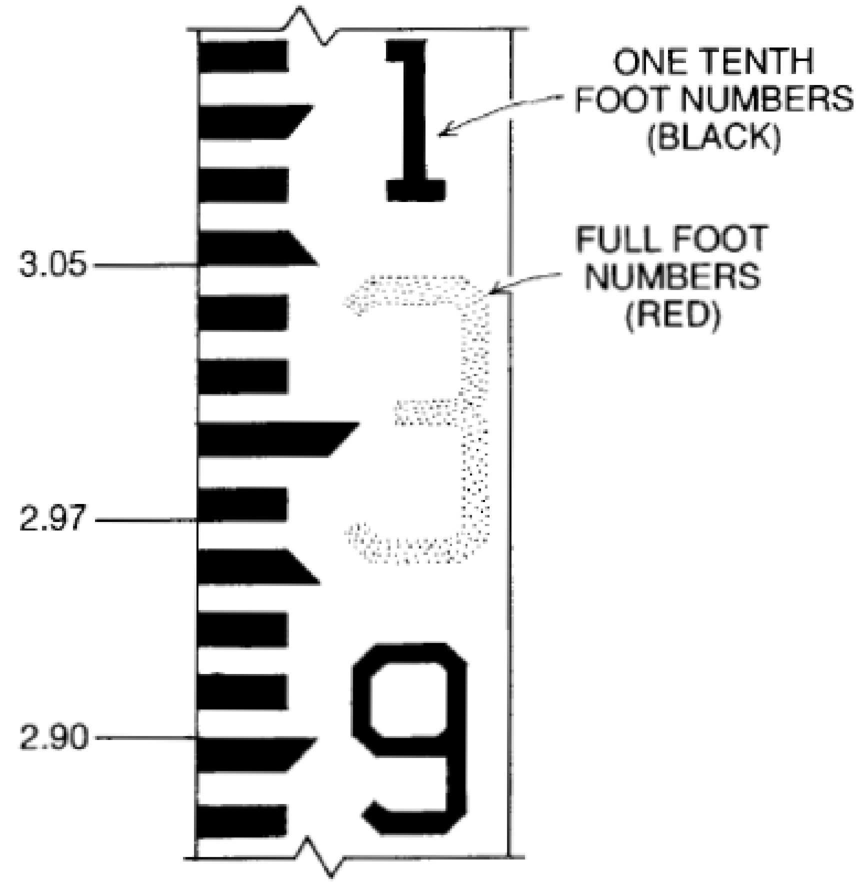


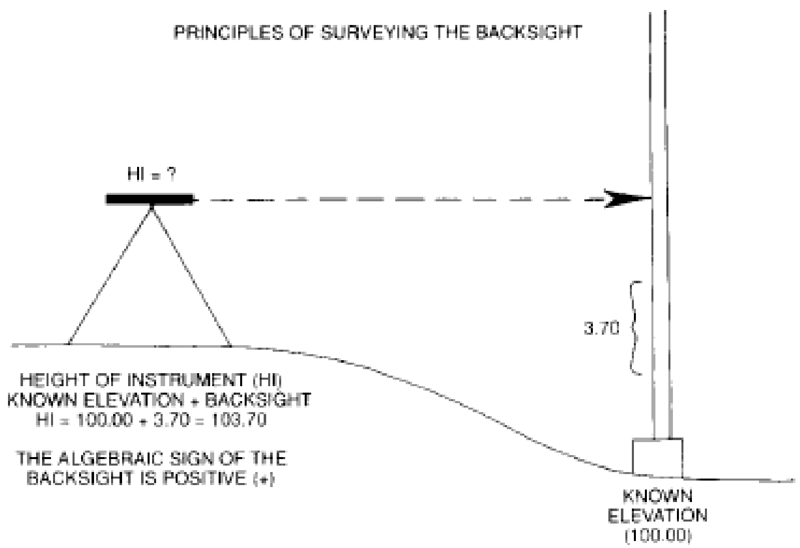
Image from Harrelson et al. 1994

Calculating Elevation

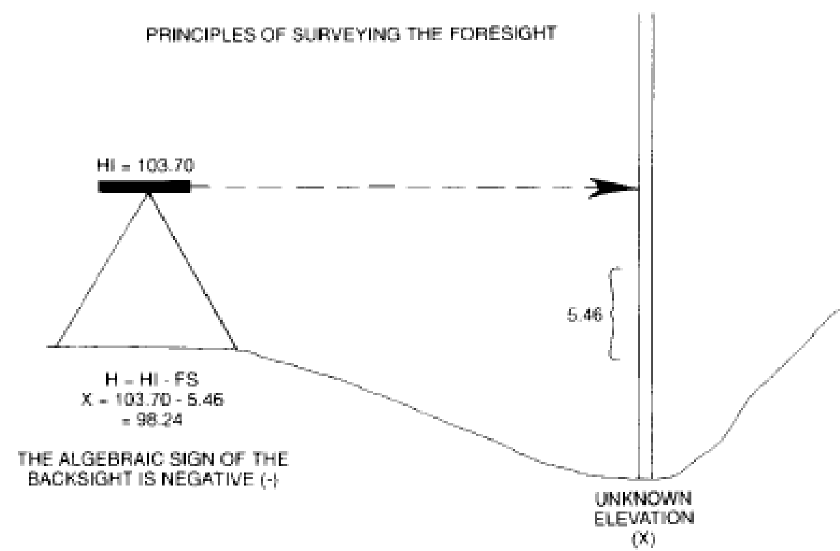
Height of instrument (H.I.) = Backsite (B.S.) + Elevation of benchmark (B.M.)

Elevation of survey point = H.I. – Foresite (F.S.)

*Elevation of benchmark is usually a relative elevation (e.g., 100 feet)



Surveying the backsight
(or distance above benchmark of known elevation*)



Surveying the foresight
(or distance above object of unknown elevation)

Images from Harrelson et al. 1994

Datasheet example

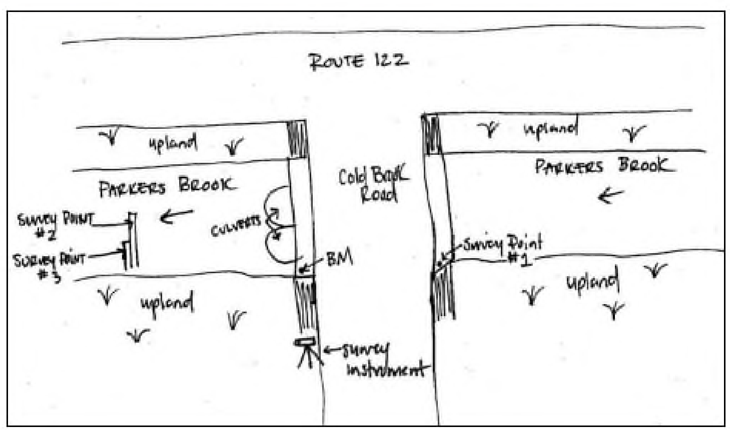
#	Survey Point	Benchmark	12/5/12	5/30/13	9/25/13	3/19/14	3/30/15	3/29/16
			100	100	100	100	100	100
BM	River left corner of top of downstream side of bridge on corner closest to river, marked in yellow	x	3.85	4.30	3.91	4.58	4.61	3.13
1	River left corner of top of upstream side of bridge on outer corner closest to road, marked in yellow		3.83	4.27	3.89	4.55	4.59	3.11
2	Top of 3.33 ft gage		9.87	10.26	9.89	10.57	10.61	9.10
3	Top of transducer PVC housing		12.13	12.56	9.91	10.59	10.64	9.13
BM	River left corner of top of downstream side of bridge on corner closest to river, marked in yellow	x	3.85	4.30	3.91	4.57	4.62	3.13
	Elevation of gage using BM		93.98	94.04	94.02	94.01	94.00	94.03
	Elevation of gage using SP#1		93.96	94.01	94.00	93.98	93.98	94.01
	Elevation of top of transducer housing		91.72	91.74	94.00	93.99	93.97	94.00
	Difference between BM and SP#1		0.02	0.03	0.02	0.03	0.02	0.02
	Difference between beginning/end BM readings		0.00	0.00	0.00	0.01	-0.01	0.00

Table title: RIFLS Site Survey Summary Sheet - Parkers Brook at Cold Brook Road

Notes

12/5/12 - 3.33 ft Gage and transducer installed

9/25/13 - Removed Global Waters transducer and replaced with Onset Hobo (10387395). Transducer cable length from top of loop to top of cap = 2.50 ft, top of loop is 0.04ft below top of PVC



Final thoughts and tips

- Levels are sensitive pieces of equipment. Treat it with care and always store in appropriate box and on a flat surface.

  'When transporting instruments, protect them from impact and vibration. (When you have the choice of allowing your friend, your dog, or your level to ride on the seat, choose the level. Secure it in place with the seat belt.)' (Harrelson et al. 1994)

- Elevation surveys are very important if you are collecting water level data! They can save you time and energy and prevent loss of data.

Reference material

USDA United States Department of Agriculture

Forest Service

Rocky Mountain Research Station

General Technical Report RM-245

Stream Channel Reference Sites:

An Illustrated Guide to Field Technique

Cheryl C. Harrelson

C. L. Rawlins

John P. Potyondy

USGS science for a changing world

Levels at Gaging Stations

Chapter 19 of
Section A, Surface-Water Techniques
Book 3, Applications of Hydraulics

Techniques and Methods 3–A19

U.S. Department of the Interior
U.S. Geological Survey

Questions?

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