Protocols for Measuring Water Level & Streamflow

National Water Quality Monitoring Conference
Field Protocols Workshop

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The views expressed in this presentation are those of the author and they do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency or other collaborating agencies

Office of Research and Development
Air, Climate and Energy Program, National Center for Environmental Assessment

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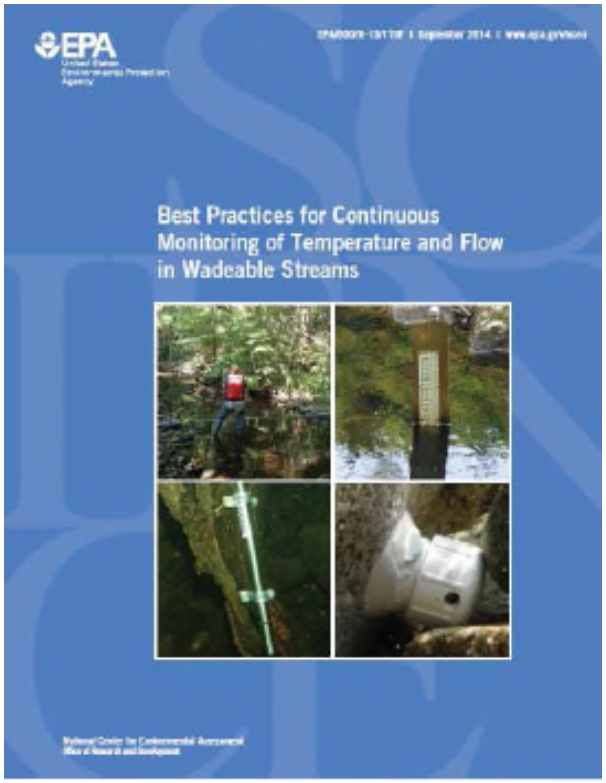
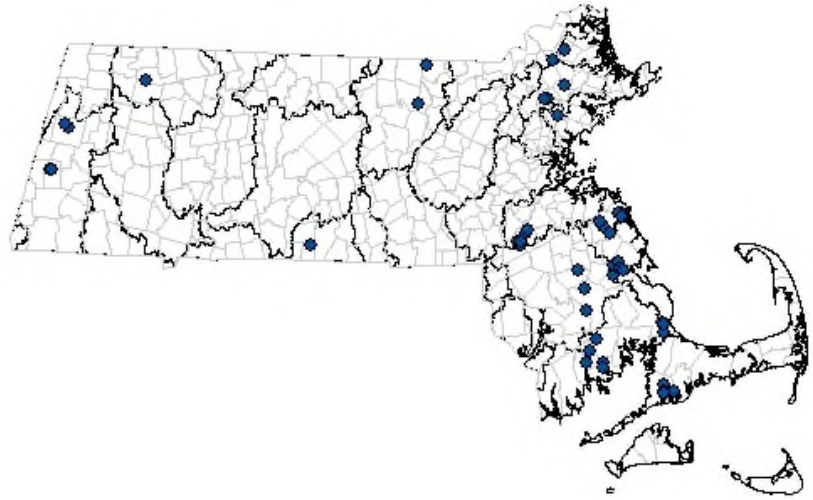
Hydrology - outline



- Streamflow program in Massachusetts
- Measuring streamflow: an overview
- Measuring stage (water level)
  - Site selection
  - Equipment
  - Installation
  - Maintenance & documentation
  - Data retrieval and QA/QC
- Measuring discharge (streamflow)
  - Equipment
  - Techniques
  - Documentation & maintenance

Streamflow gaging in Massachusetts



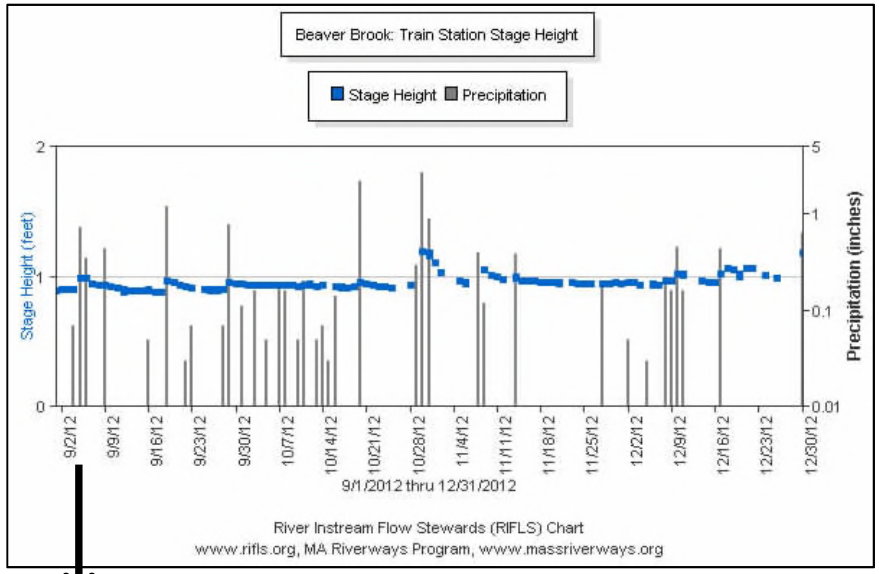
State funded streamflow restoration program started in 2002

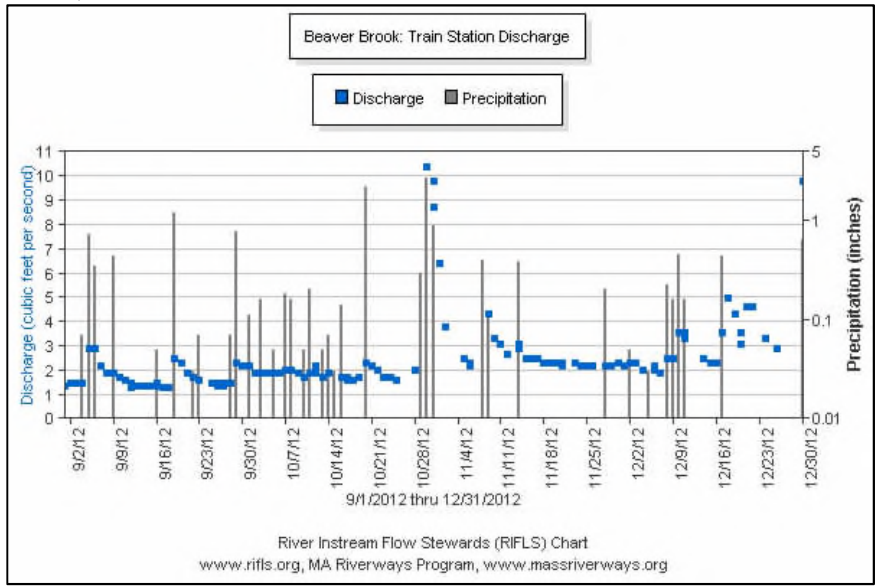
- Initial focus on low-flow

- Volunteers read staff gages, staff build rating curves
- Transducers installed at most sites
- QAPP, USGS technical guidance
- Two staff
- Major costs
  - Travel
  - Equipment

Measuring streamflow: an overview

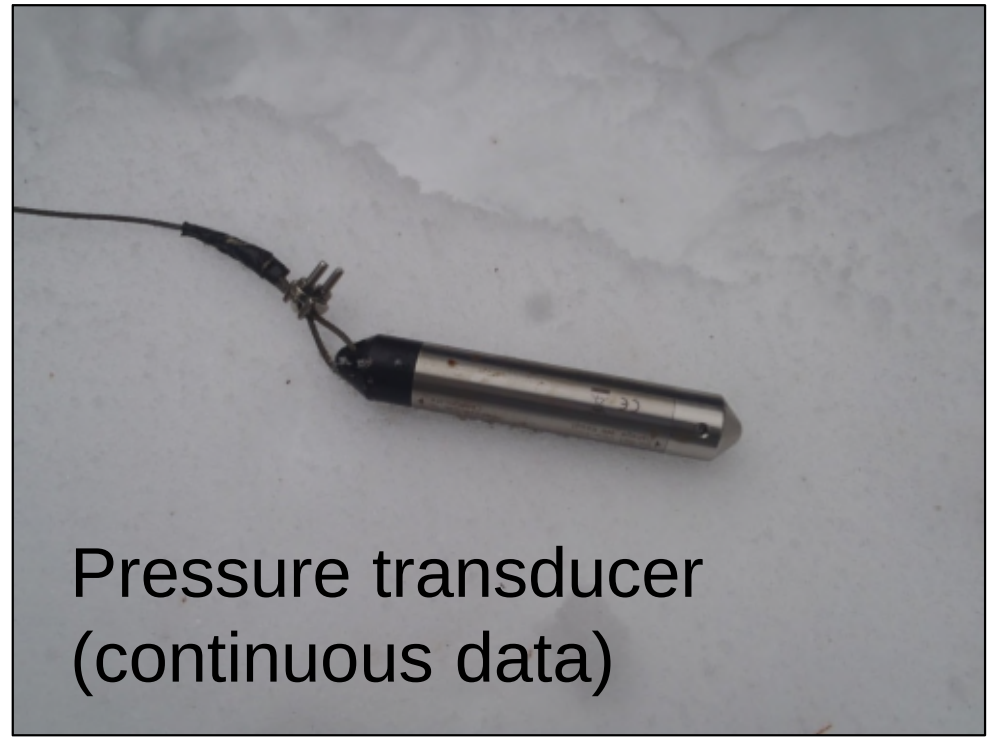
1. Measure stage at a fixed point
   - Staff gages
   - Pressure transducers
2. Relate stage measurements to discharge (streamflow).



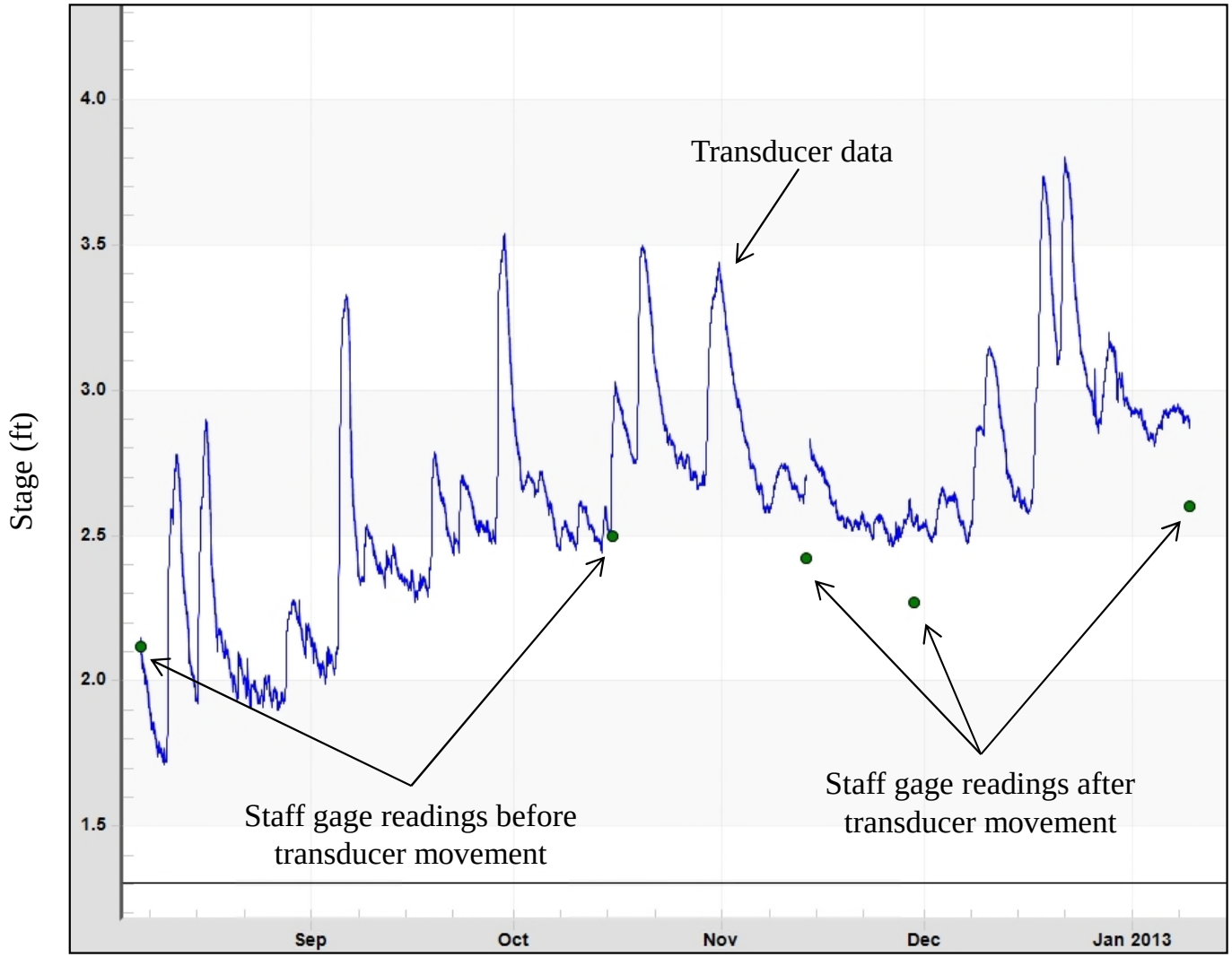


Measuring water level

Staff gage
(discrete data)


Pressure transducer
(continuous data)

Staff gage allows check of pressure transducer data



Pressure transducers

Vented vs. non-vented transducers

A)

B)

C)

D)

Many different equipment options

Accuracy is a function of the operational range of the transducer

Characteristic	Pressure Transducer
Durable	yes
Submersible/waterproof	yes
Programmable start time and date	yes
Minimum accuracy	≤0.015ft
Precision	±0.005%
Temperature range	-5 to 37˚C
Stage range	Sufficient for the expected variation in stage at the site
Memory	Sufficient to last between site visits
Battery life	Sufficient to last between site visits

Vented pressure transducers

Pros

- Does not need to be removed from the stream to download
- Data are automatically corrected for barometric pressure

Cons

- Maintenance of the vented cable
  - Desiccant
  - Damage to cable
- Cable lengths are fixed
- Higher visibility than non-vented transducers

Non-vented pressure transducers

Pros

- Data loggers are internal
  - Less visible than vented transducers
- No vented cable or desiccant
  - Less maintenance

Cons

- Must deploy a second pressure transducer to collect barometric pressure
  - Data must be corrected post-download
- Transducer must be removed from the stream to download data

Site selection

- Pool with downstream control
- Underwater during low flows
- Avoid sites with excessive vegetation, unstable banks or streambed, beaver activity
- Nearby locations to measure discharge (low and high flows)
- Safe and accessible

If appropriate site conditions are not present where biologic sampling is taking place you can install anywhere upstream or downstream of the sampling as long as there is no water entering or leaving the stream

Staff gage installation

United States Environmental Protection Agency

Fixed object

- May be more stable in high flow, high gradient & rocky streams
- Objects may include bridges, boulders, weirs

Streambed

- Best in high order streams with lower flow and limited debris
- Must be able to drive a pole/stake into streambed

Transducer Installation

Key considerations
- Should remain submerged when stream flowing
- Deeper pools may reduce ice impacts
- Calm pools yield less noisy data

Three methods
- Staff gage board
- Fixed object
- Streambed

Installing data logger for vented transducers & barometric transducer

Key considerations with data logger/transducer:

- Install in PVC housing for protection
- Should be above potential flood/snow line
- Should be relatively hidden to discourage vandalism

Maintenance

Basic Maintenance

- Clean gage and transducer
- Clear leaf litter and debris from control
- Change batteries and desiccant (if necessary)

Gage readings

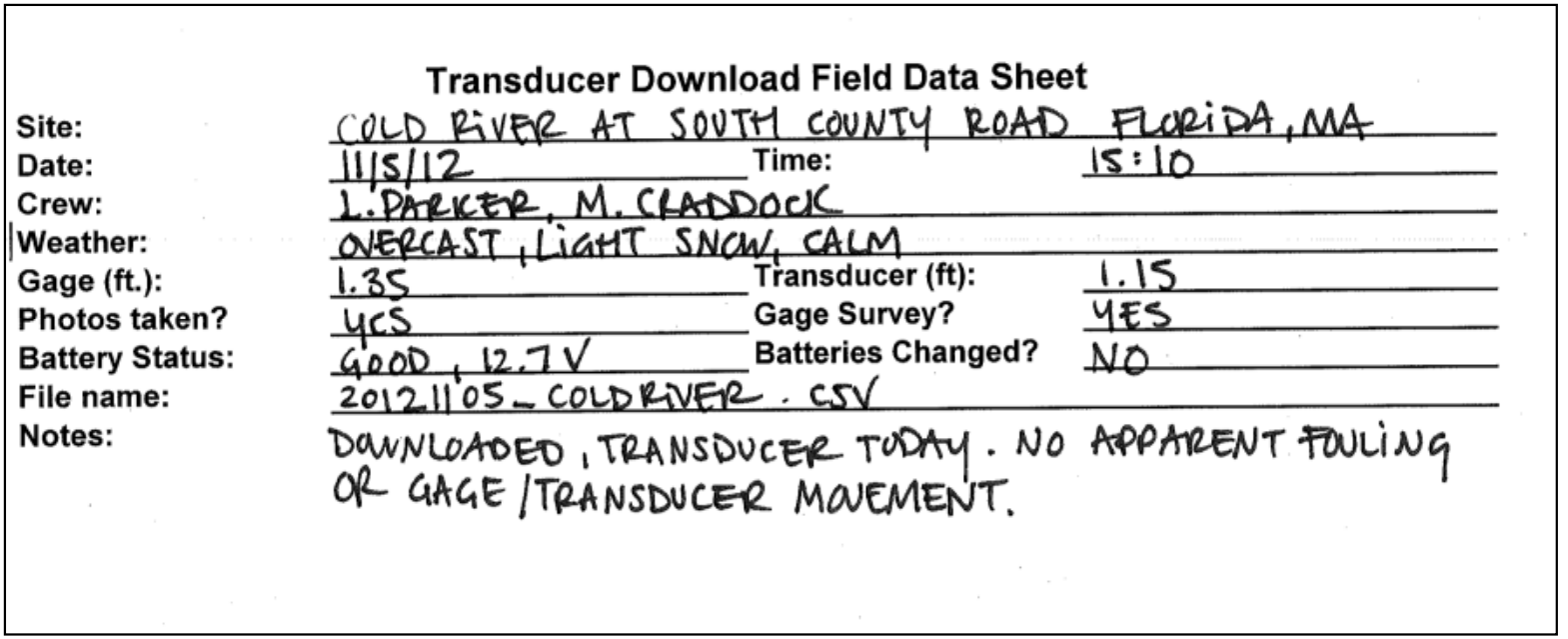
Elevation surveys

Elevation Surveys

- Important tool for detecting movement of transducers and staff gages
- Conduct surveys yearly after high spring flows/ice out or if movement is suspected
- Can use results to correct transducer data if movement is detected

Documentation

- Photos: gage, upstream, downstream (including control), & anything unusual at every site visit.
- Date, time, stage (from transducer and staff gage), battery status at every transducer download.
- Any changes to the calibration or location of the transducer.



Transducer Download Field Data Sheet

Site:	COLD RIVER AT SOUTH COUNTY ROAD FLORIDA, MA		
Date:	11/5/12	Time:	15:10
Crew:	L. PARKER, M. CRADDOCK		
Weather:	OVERCAST, LIGHT SNOW, CALM		
Gage (ft.):	1.35	Transducer (ft):	1.15
Photos taken?	YES	Gage Survey?	YES
Battery Status:	GOOD, 12.7V	Batteries Changed?	NO
File name:	20121105_COLDRIVER.CSV		
Notes:	DOWNLOADED, TRANSDUCER TODAY. NO APPARENT FOULING OR GAGE/TRANSDUCER MOVEMENT.		

Data retrieval, QA/QC

- Frequent downloads minimize data loss
- Download approach varies based on transducer type
- QA/QC

Relating stage to discharge

Stage data on its own does not give quantitative information about the magnitude of streamflow

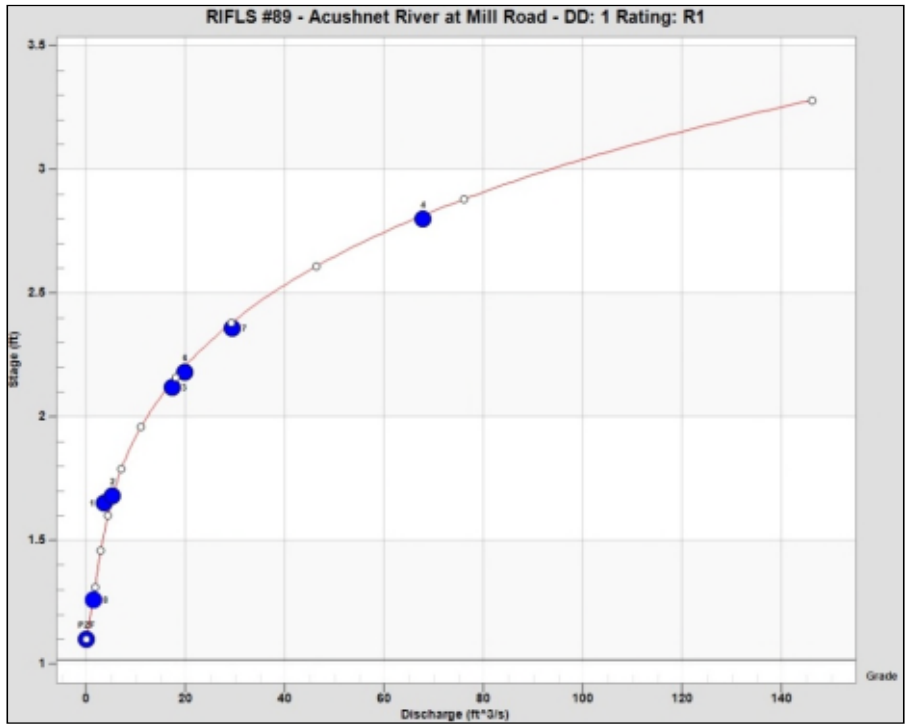
Establishing a relationship between stage-discharge allows you to:

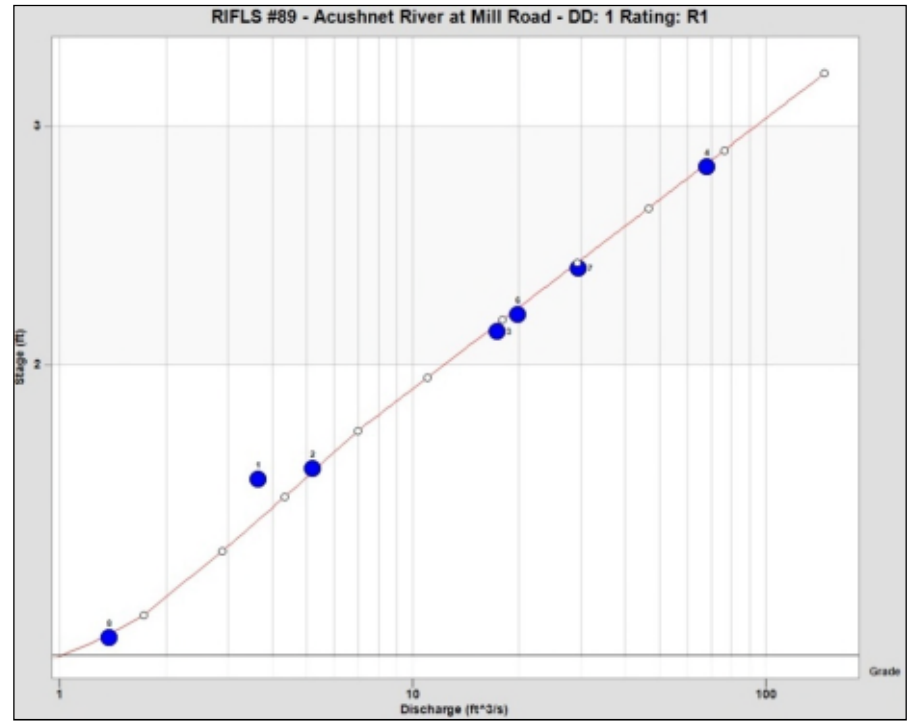
- Compare data from year to year
- Compare data from stream to stream
- Know the magnitude of streamflow – key attribute that may change with changing climate

Stage-discharge rating curve

Make discharge measurements over a wide range of flows

Plot stage vs. discharge and draw a curve through it – can estimate streamflow at a range of stages





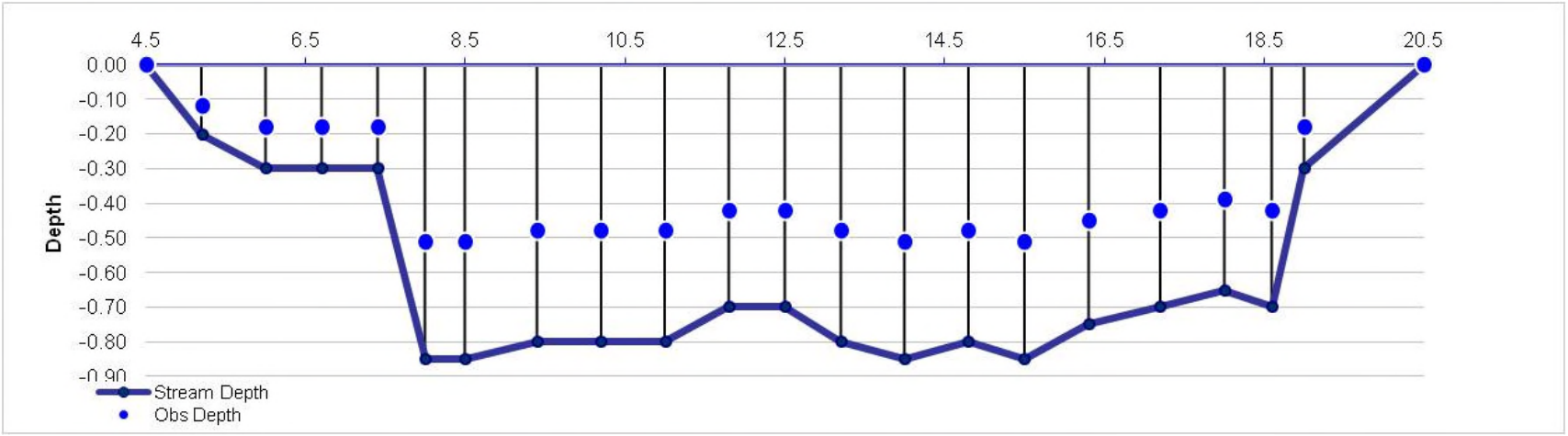
Flow measurement

Equipment
- Flow meter
- Wading rod
- Measuring tape and stakes

Documentation
- Meter QA/QC
- Staff gage reading before and after measurement
- Notes on transect, control, gage pool, etc.
- Photos: gage, upstream, downstream (including control)

Flow measurement techniques

- Good cross-section
- At least twenty measurements, no more than 5% of flow should pass through a segment
- Paired measurements



Rating curve maintenance

Check rating curve:

- Annually (at an absolute minimum),preferably seasonally
  - Leaf buildup
  - Vegetation
  - Ice impacts
- After major storms
- After other channel-changing activities (bridge, culvert replacement)

Questions?

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