A Look at the Future of Streamgaging

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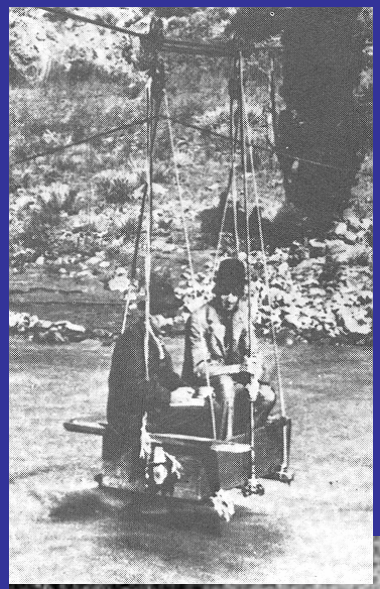
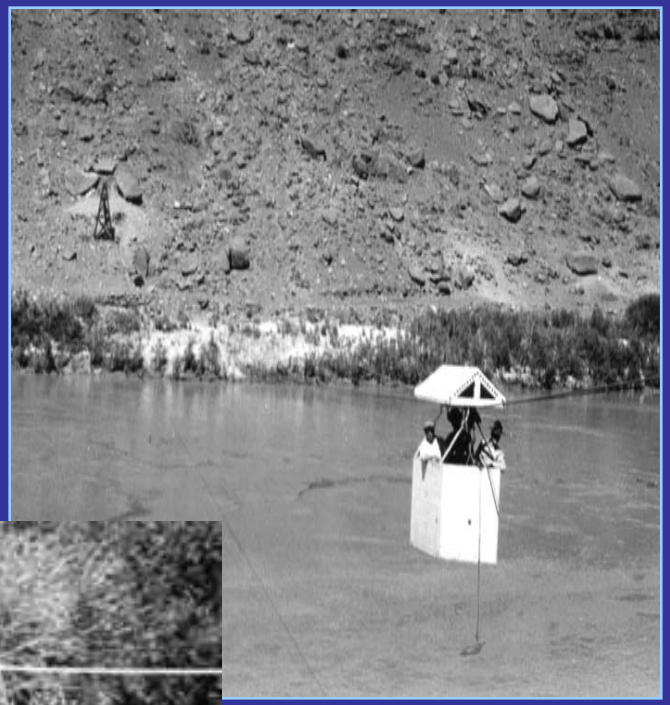
Measurement of Discharge Through the Years

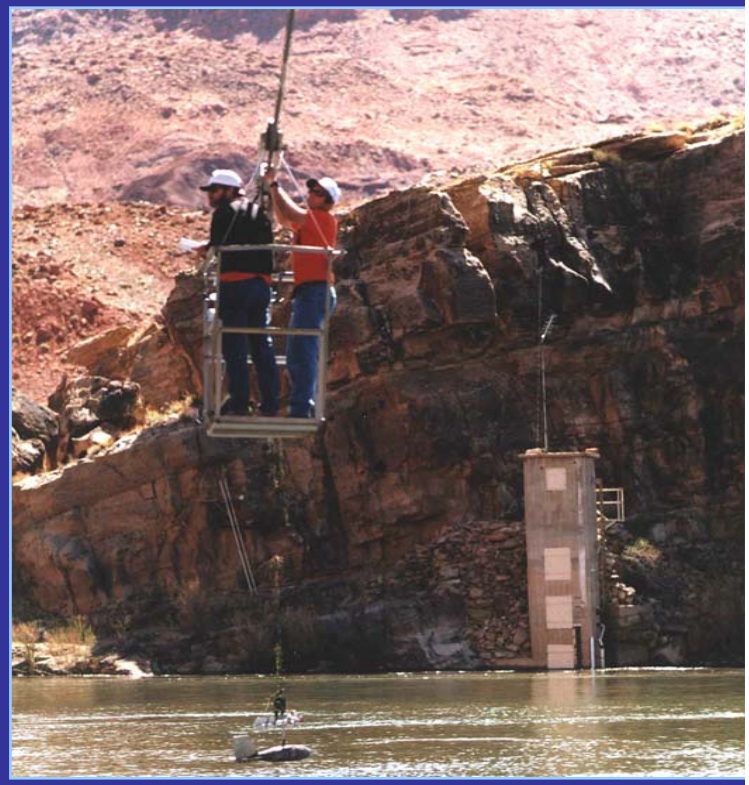
1890



1923

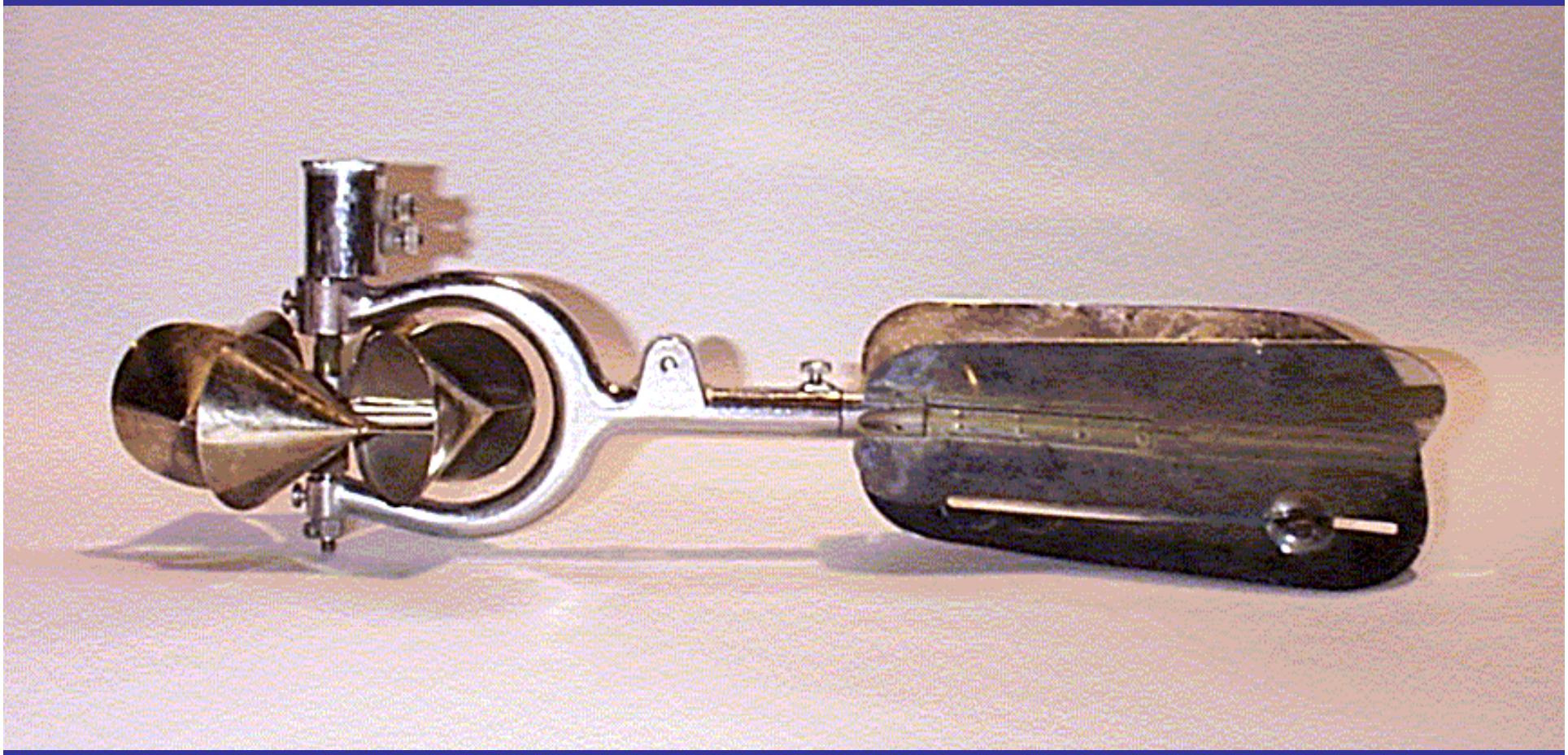


1996

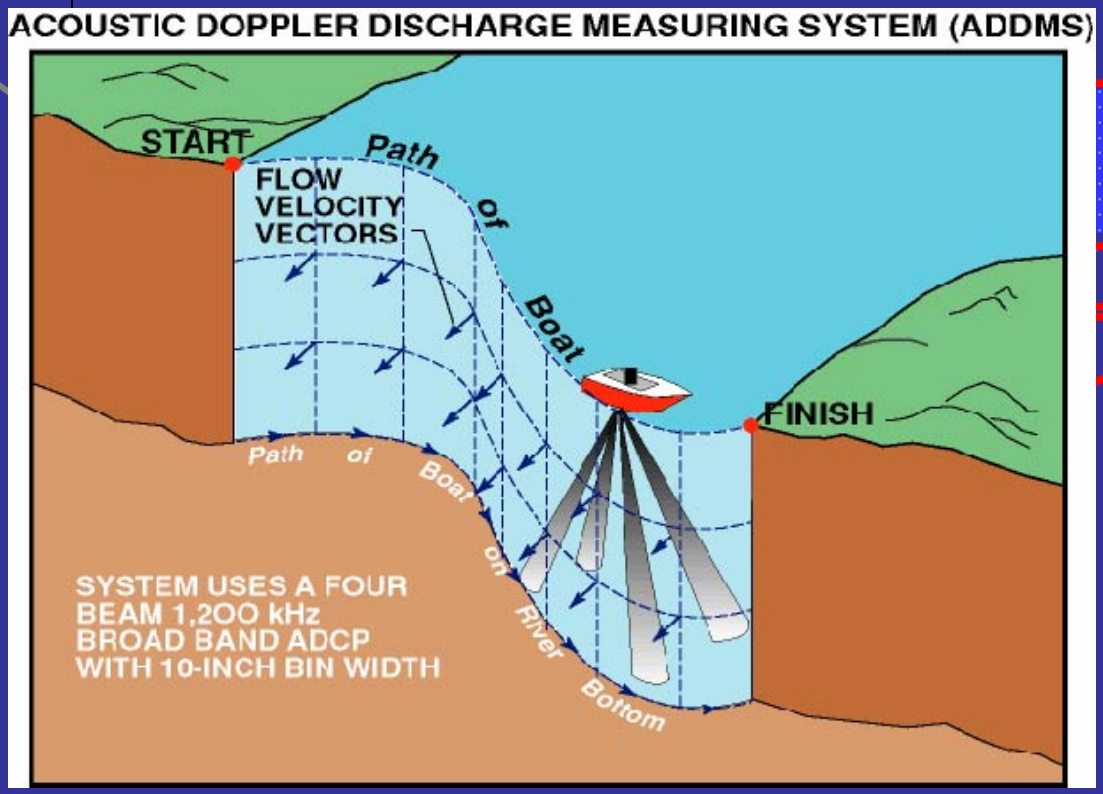


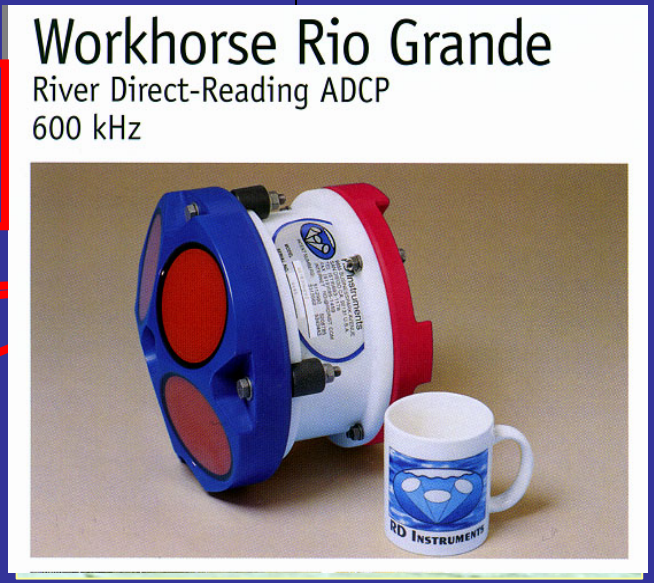
Colorado River at Lees Ferry

AA-Price Current Meter

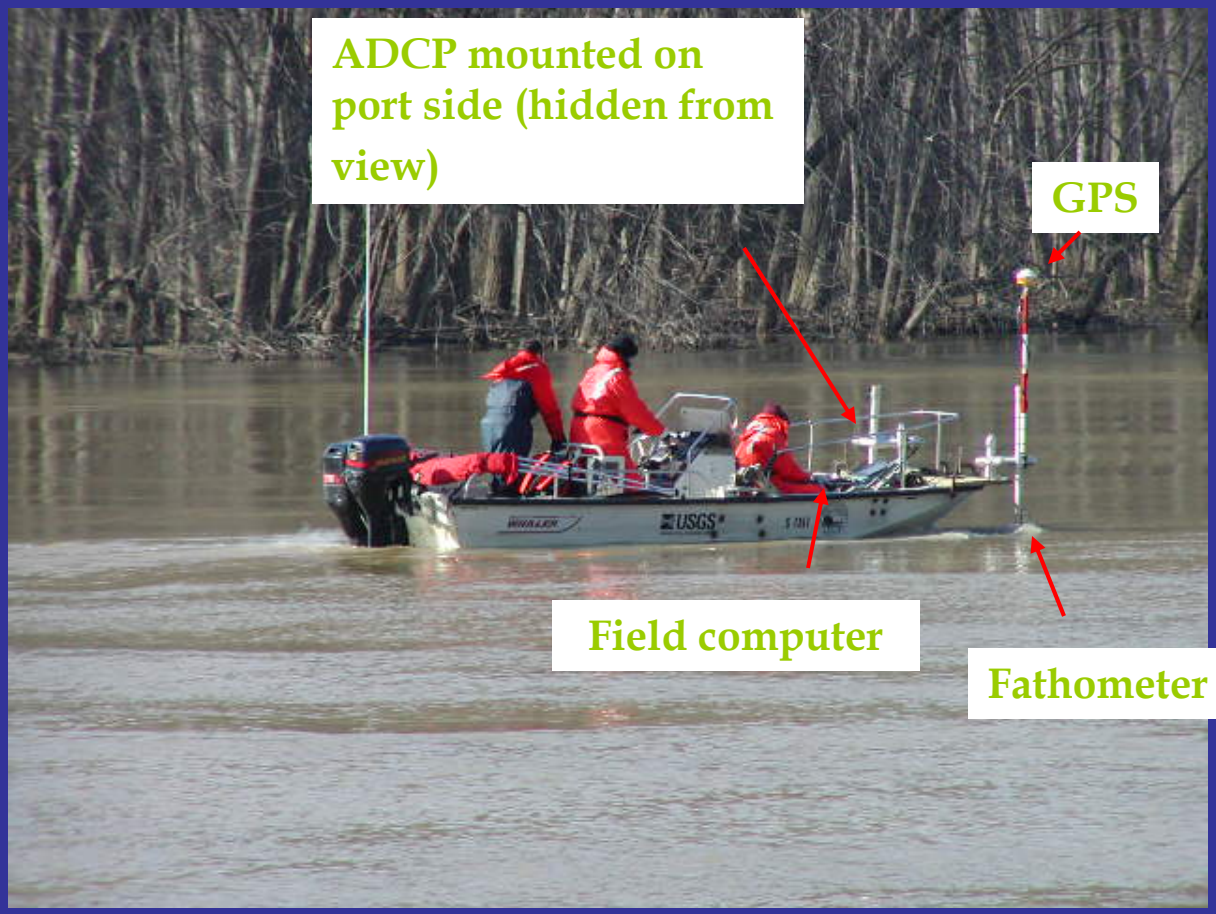


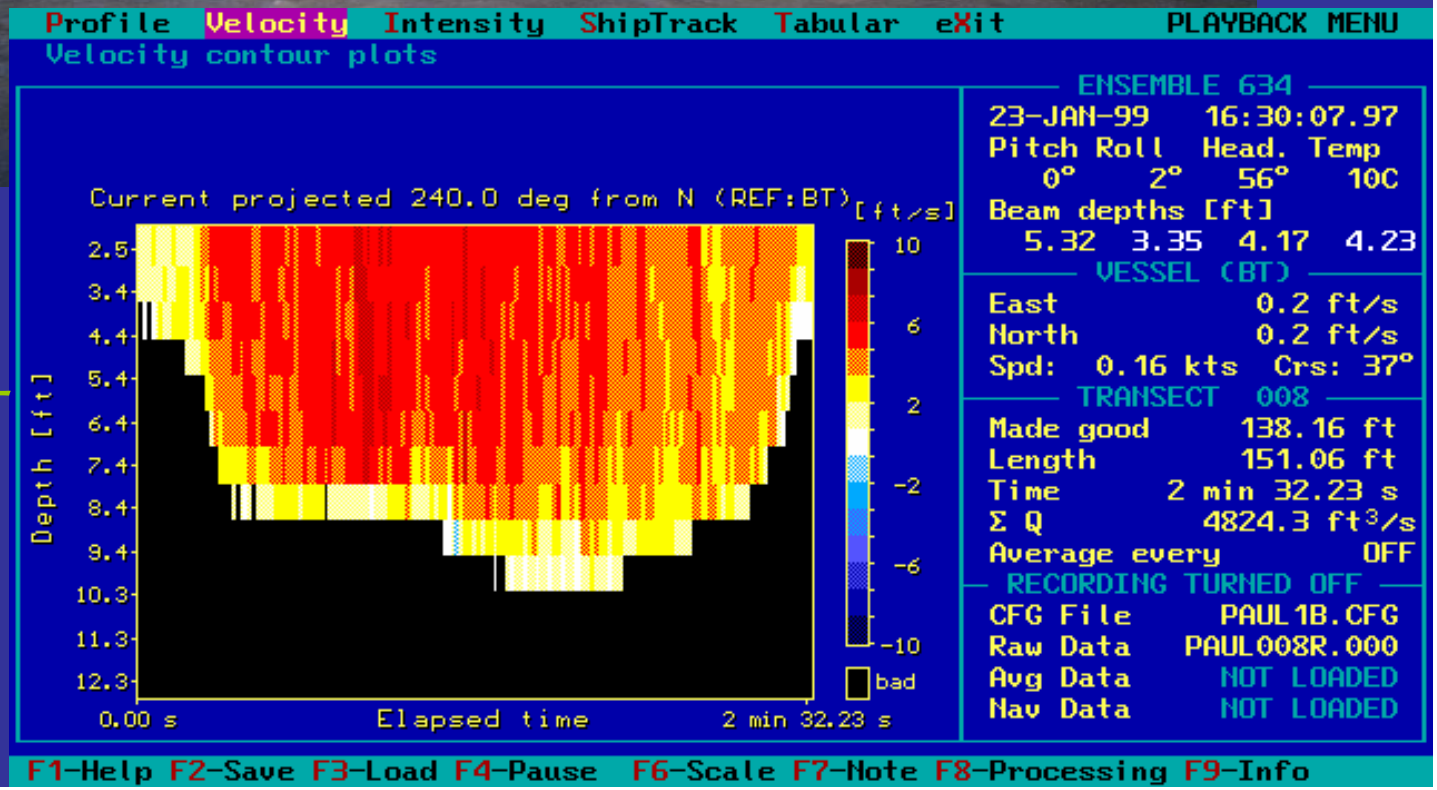
For past 15 years, new technology has enabled 3-D water velocity to be determined in depth cells as small as 1 cm at a sampling frequency from 5 to 12 hertz as the Acoustic Doppler Current Profiler (ADCP) traverses the stream.





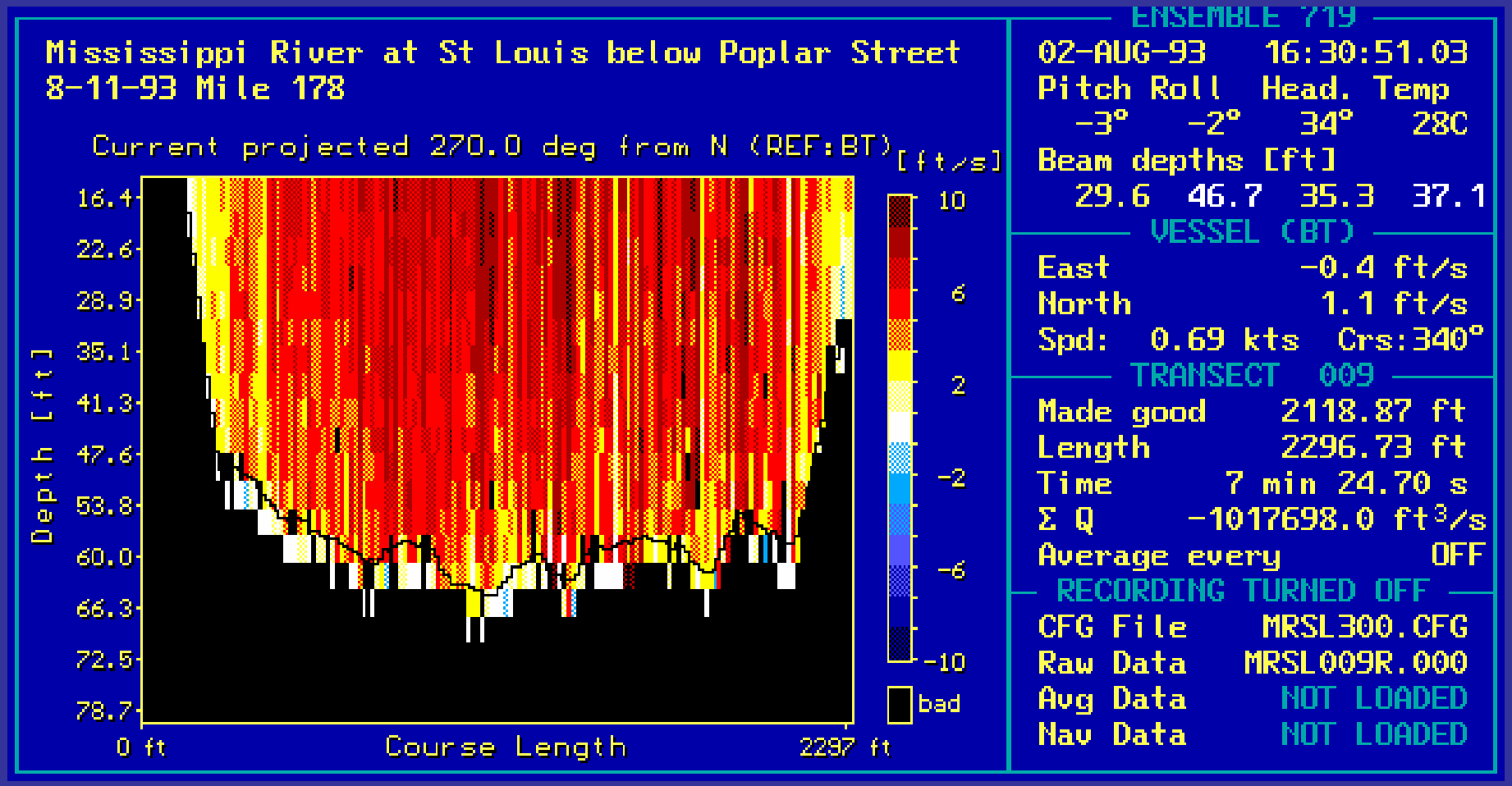
ADCP Discharge Measurements





Velocity Cross-section plot

Discharge Measurement

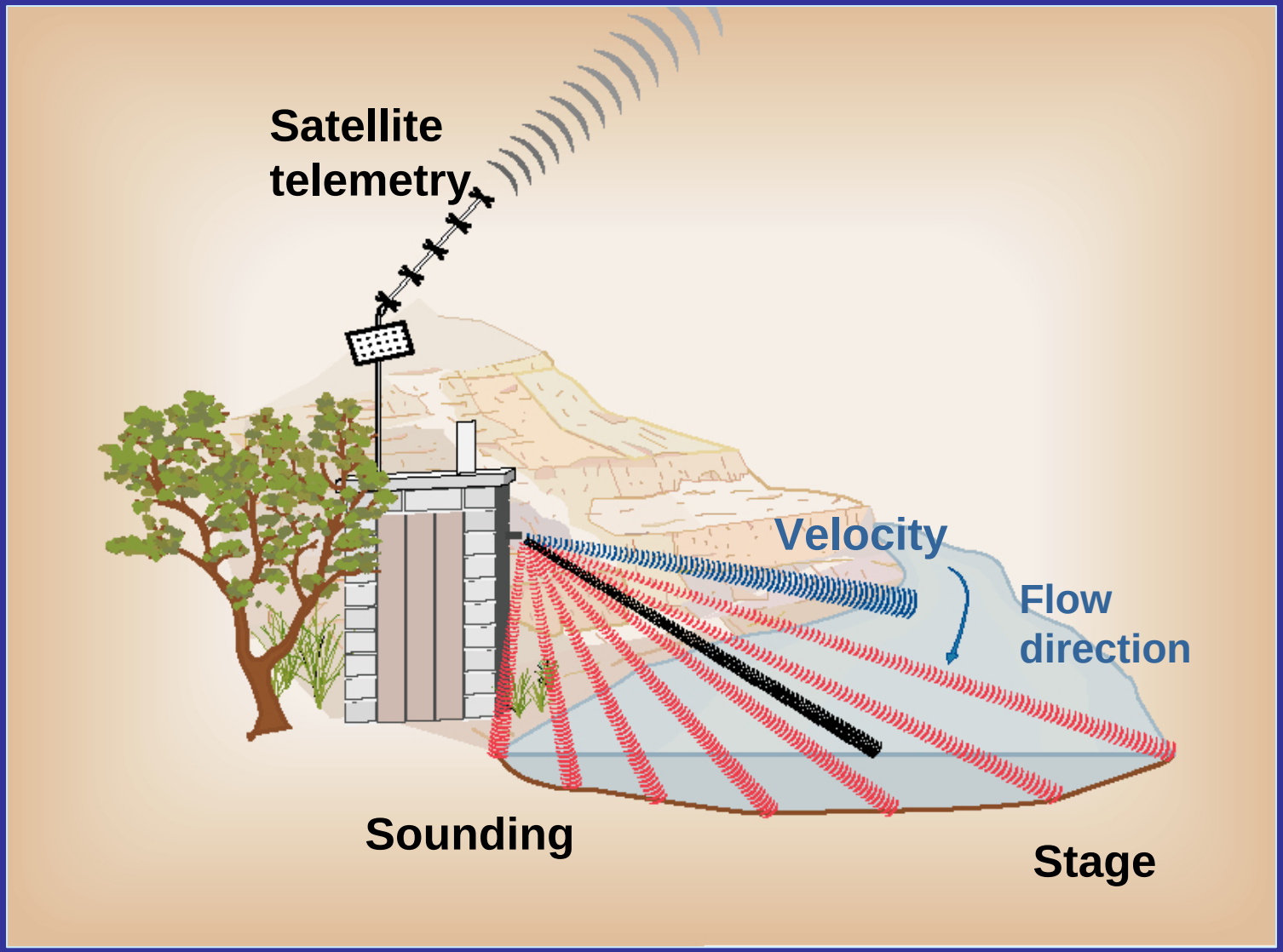


Acoustic Doppler Velocimeter

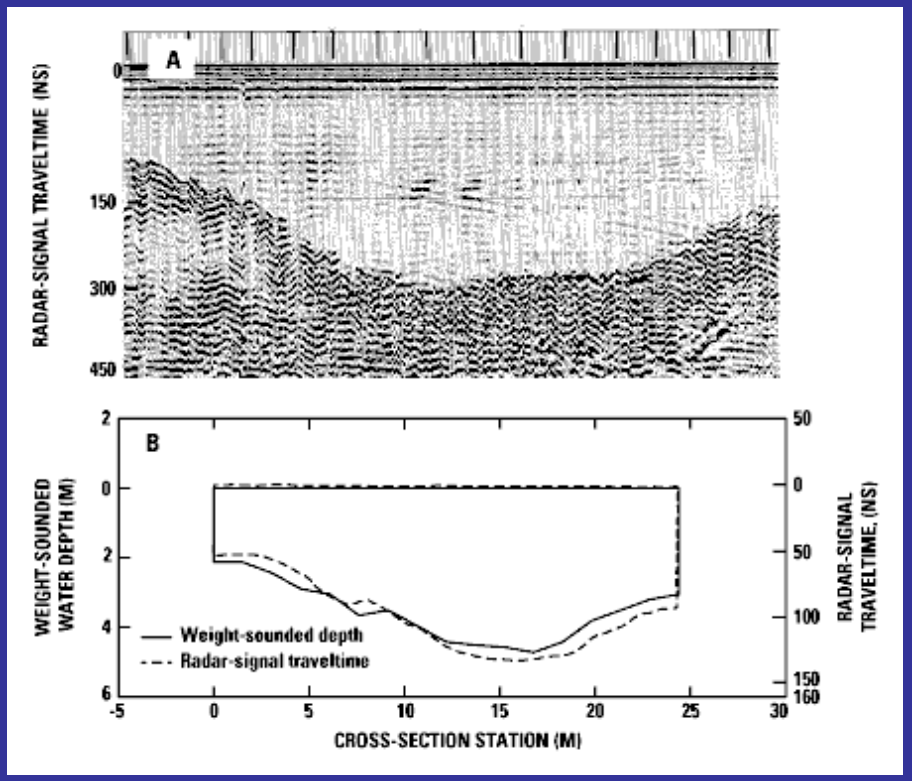
SonTek FlowTracker attaches to top-setting wading rods and has an automatic discharge computation program.

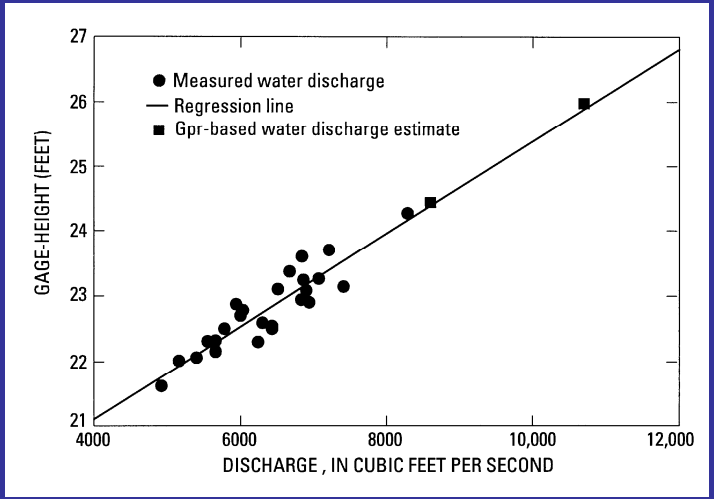
So…what is the future?

Non-Contact Measurement of River Discharge



GPR Testing
Muddy River, WA, 1996





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Non-contact Discharge Experiment on Skagit River, WA - April 21, 1999

Surface-velocity data-collection

Channel cross-section data collection using GPR; checked with ADCP

Microwave Doppler Radar

- Uses Bragg scattering from short waves produced by surface turbulence
- In absence of current, shift is precisely known
- Doppler shift is positive or negative, depending on direction of streamflow
- Downstream flow imparts an added Doppler shift, which can be measured
- Collects velocity data in ~ 7.5 m x 10 m cells

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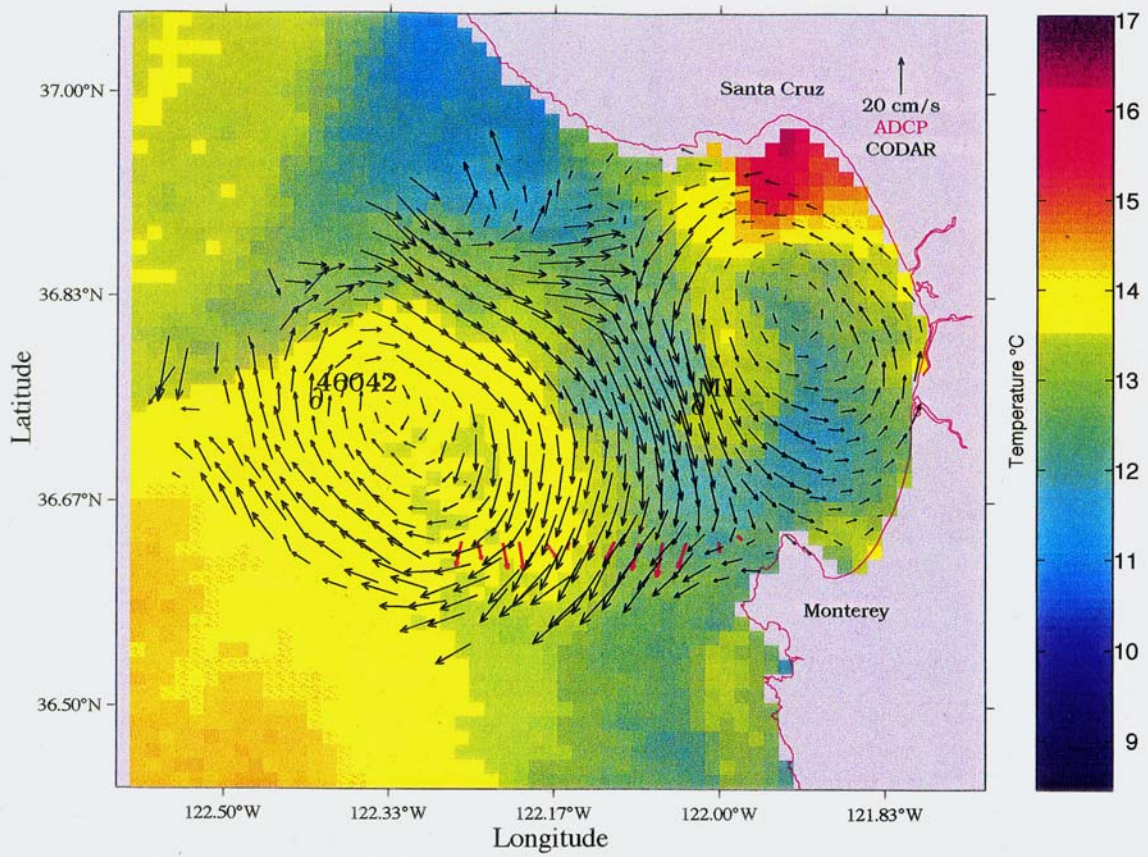
Radar-derived surface-current vectors, Monterey Bay, CA

From: Remotely sensed surface currents in Monterey Bay from shore-based HF radar (CODAR), Jeffrey D. Paduan and Leslie K. Rosenfeld, *J. Geophys. Res.*, vol. 101, no. C9, pp. 20,669 - 20,686.



Average radar-derived surface-current vectors for the period 0900 UT August 6 to 0700 UT August 7, 1994 (black arrows); average VM-ADCP vectors for the period 1016 UT August 6 to 0524 UT August 7, 1994 (red arrows), shown with uncorrected AVHRR Channel 4 surface temperatures at 0300 UT August 6, 1994.

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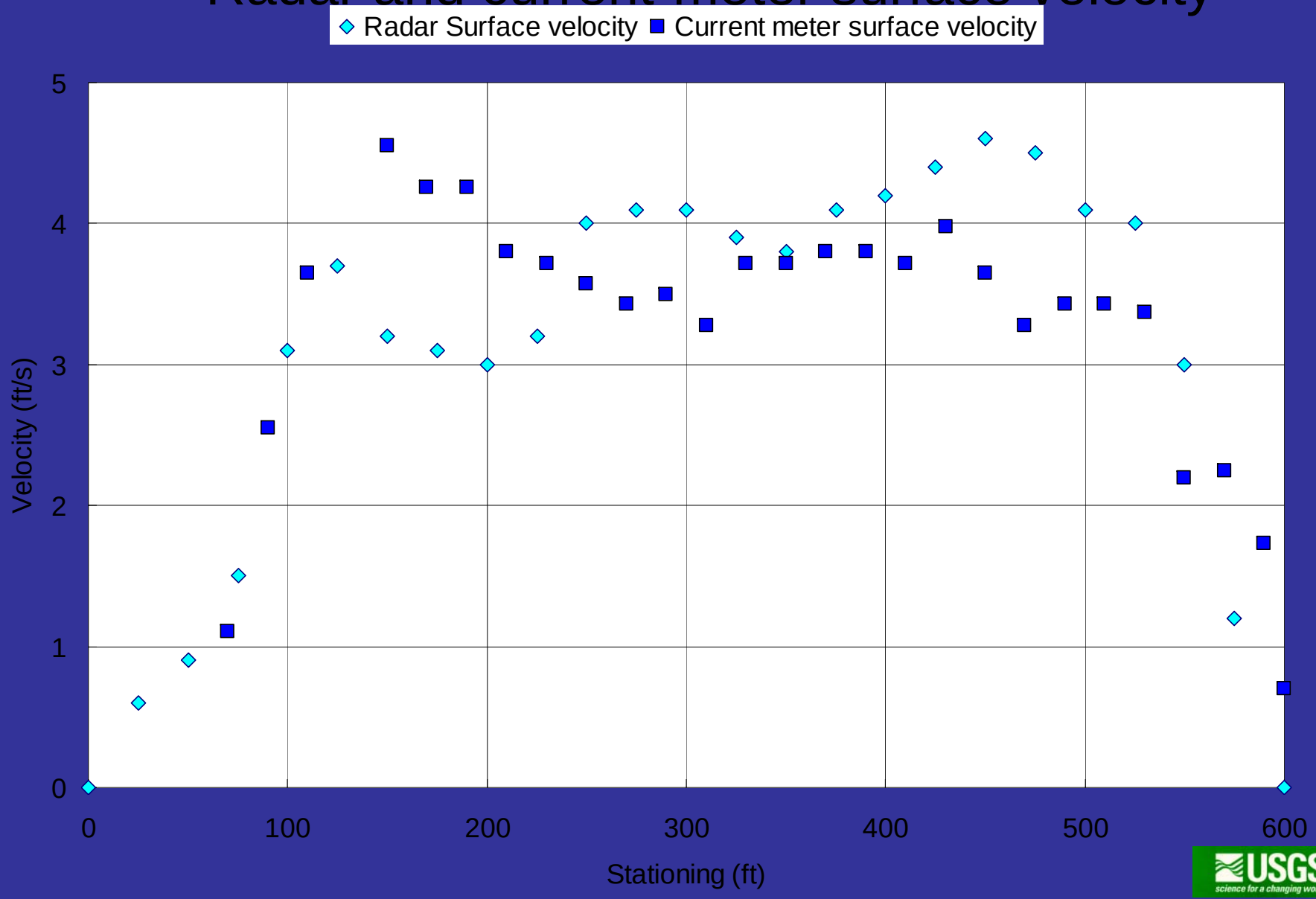
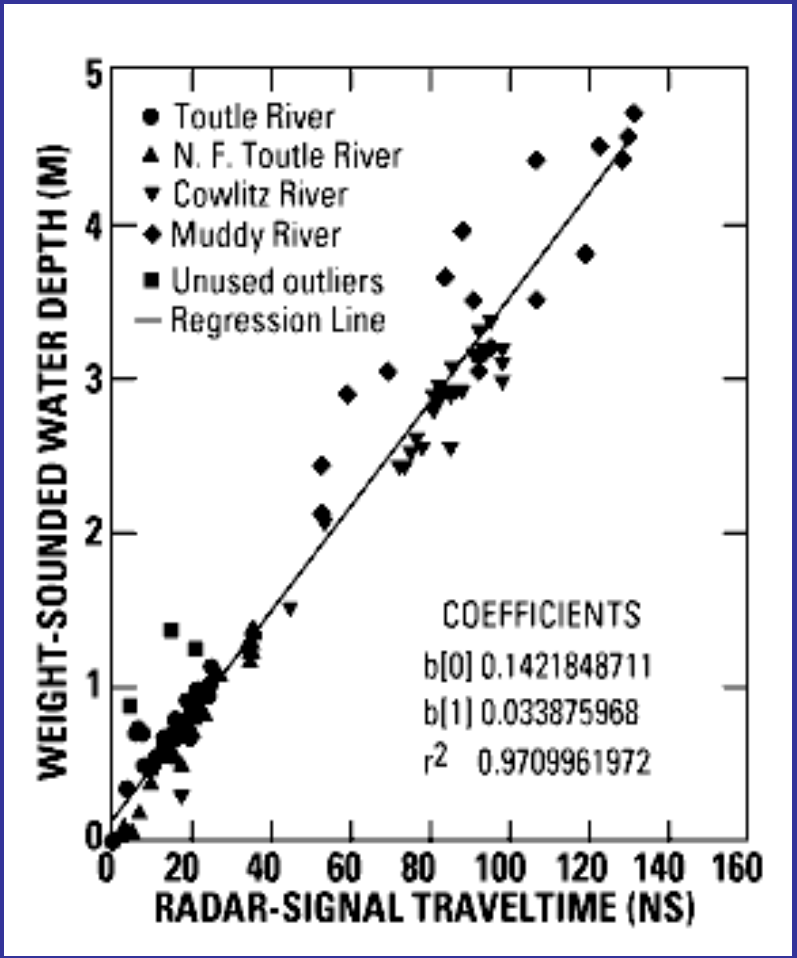
Non-contact Discharge Experiment:
Radar and current-meter surface velocity



With GPR, velocity of radar waves in impure fresh water must be converted to distance (depth)

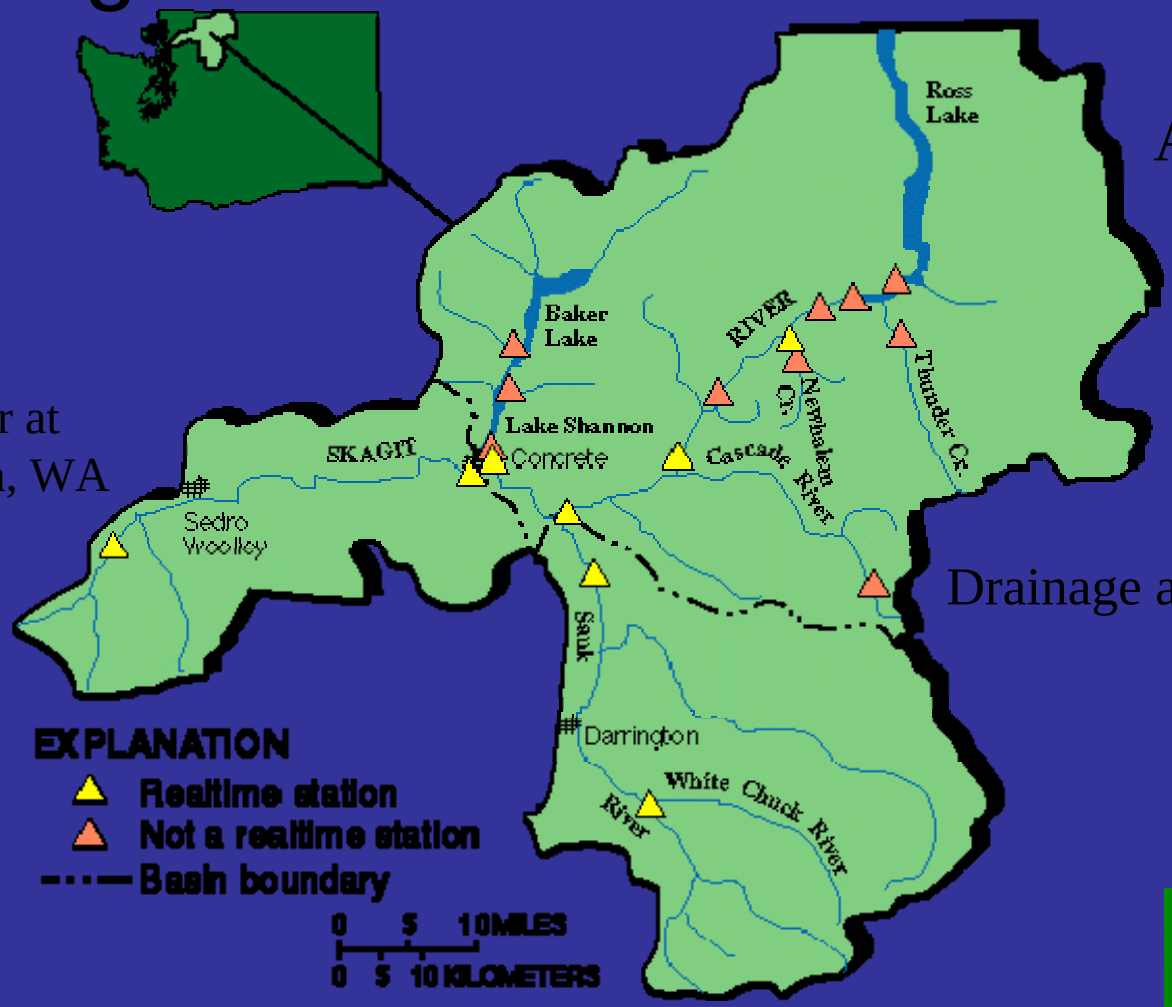


- Evaluated in flows with Q_s ± 10,000 mg/l
- Conductivity > 1,000 mS/cm can absorb all energy
- Test site conductivity always < 100 S/cm
- Average radar signal traveltime is 0.04 m/ns

Hydro21 Non-contact discharge experiment: Skagit River at Mount Vernon, WA

April 21, 1999

Skagit River at Mount Vernon, WA



Drainage area = 8,000 km^2

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Why Skagit River at Mount Vernon, Washington ?

- USGS gaging station with continuous record from 1940
- Close to WRD offices in Tacoma and Portland; close to Univ. of Washington
- Gaging station has cableway for suspending GPR antenna
- Site has clear riverbank for sending and receiving radar signals
- NWS flood-forecast location for 30,000 downstream floodplain occupants

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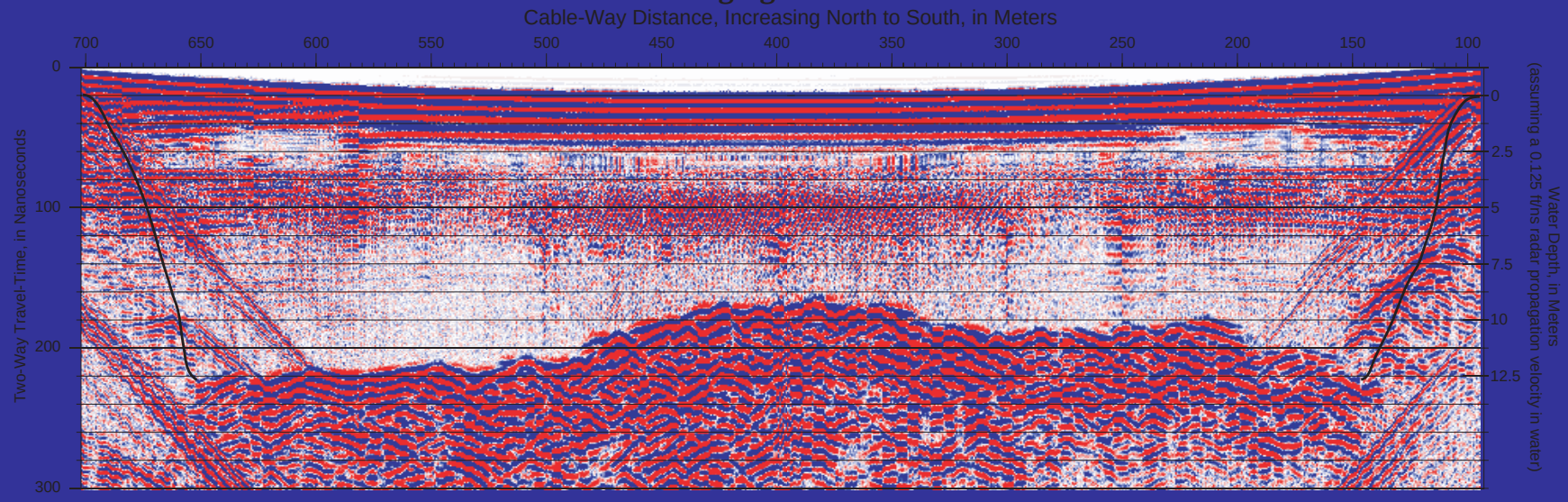
Non-contact Discharge Experiment, Skagit River at Mount Vernon, WA

Skagit River, I-5, Washington
U.S. Geological Survey
Stream Gaging Station 12000500



100 MHz GPR river-bottom reflection record
Collected with antennas suspended from a cable car
First non-contact stream discharge measurement
Conducted April 21, 1999
Hydro 21 committee

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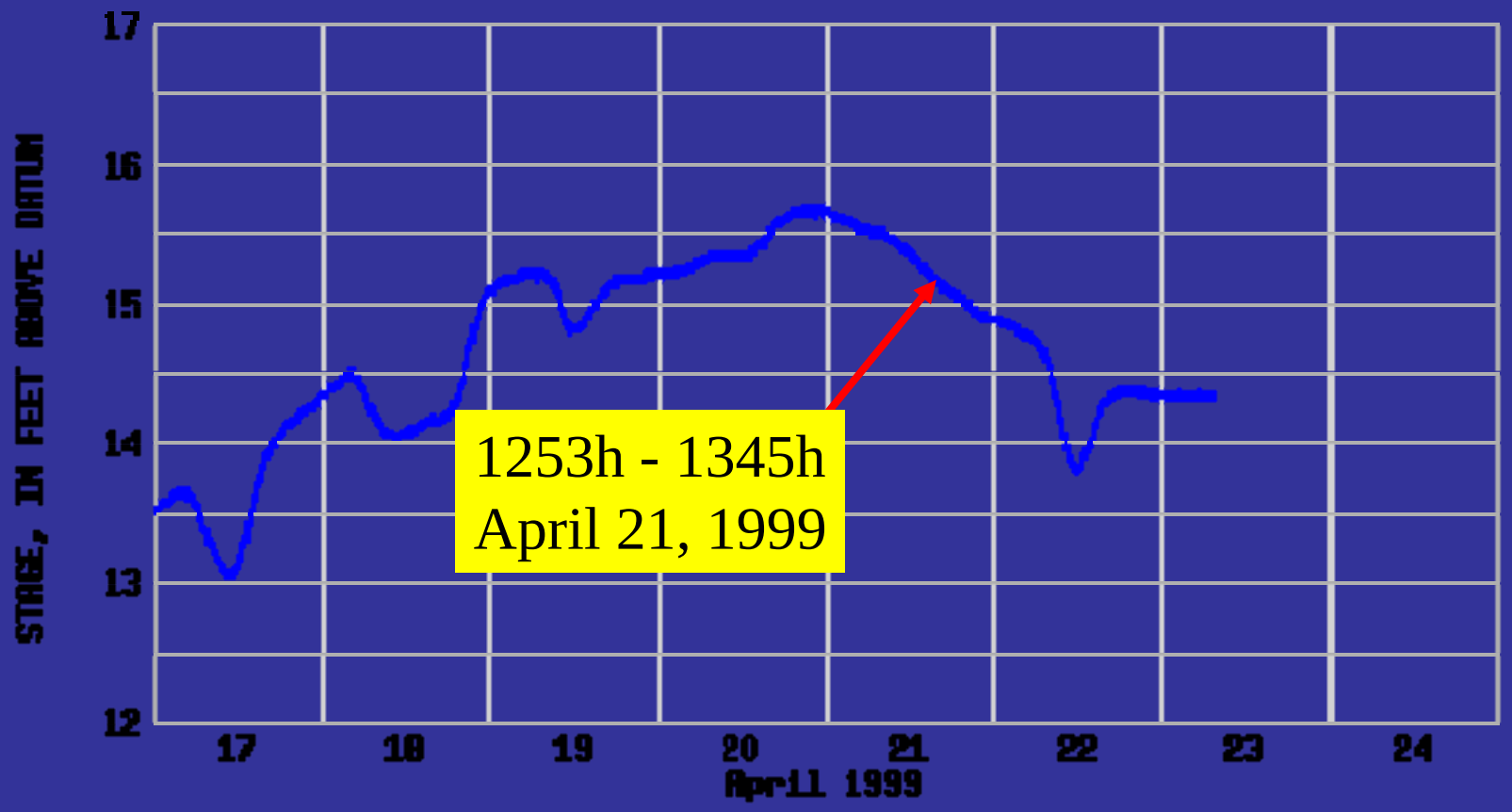
Stage record for Skagit River, WA Non-contact discharge experiment



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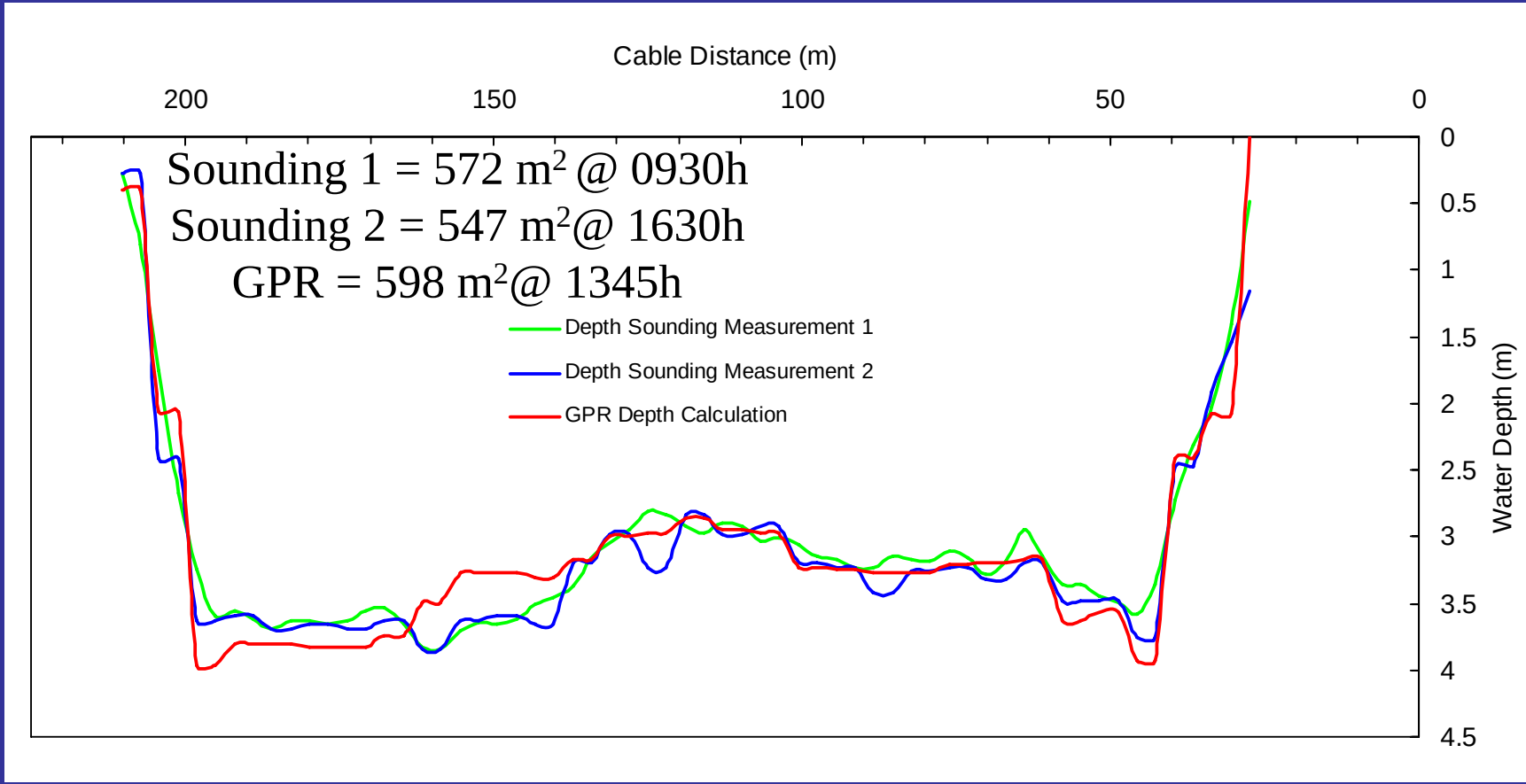
GPR Derived Cross-section Compared to Two Sounding-Weight Measurements



Assumes average radar travel-time = 0.04 m/ns

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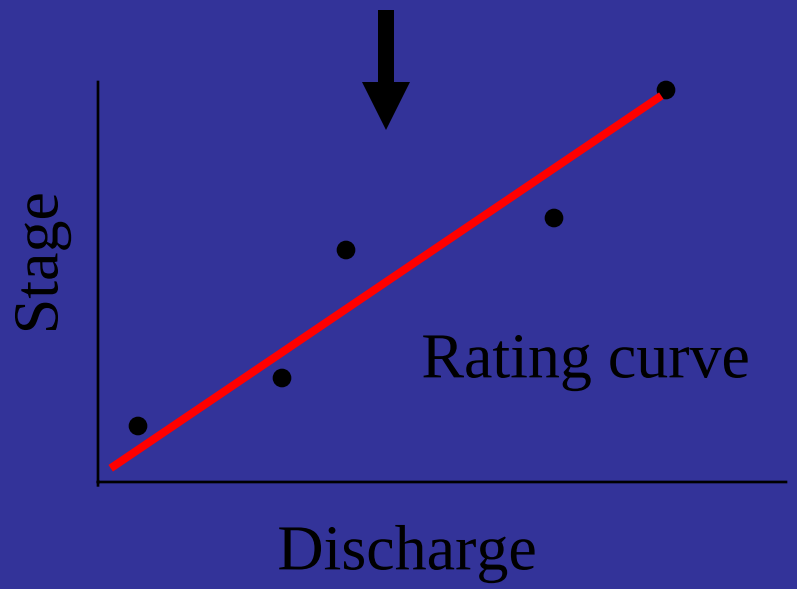
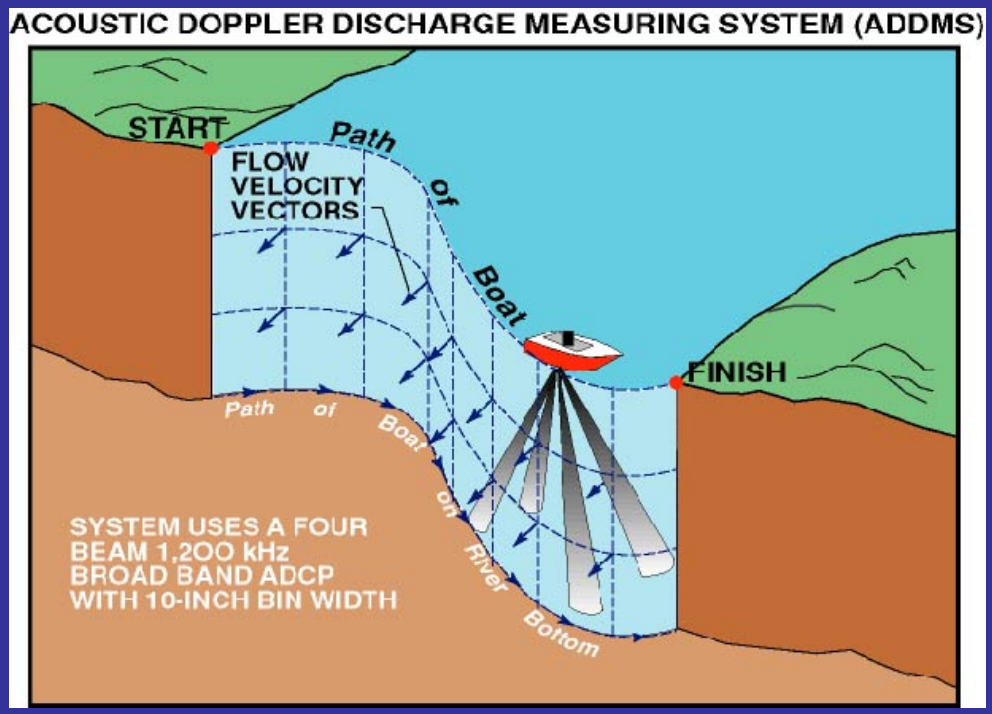
Results Tested Against Accepted Technologies





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Results

Method	Time	Discharge (m^3/s)	Discharge from rating curve (m^3/s)
ADCP	1042	526	527
	1130	521	524
	1156	511	521
	1252	525	518
	1300	517	518
	1312	523	515
	1316	514	515
Mean		**520**	**520**
Current meter	1630	527	504
Non-contact radar	1253	518	518
	1305	517	518
	1339	520	515
Mean		**518**	**517**

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