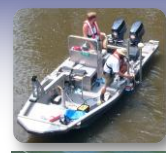
Velocity Field Surveys: Instrumentation, Gear, and Measurement Tips

Deployment Methods

Manned boat

- Pros
  - Efficient
  - High Mobility
- Cons
  - requires a good boat operator
  - Only possible in larger rivers



Tethered boat

- Pros
  - High precision
  - Works in small rivers and streams
- Cons
  - Limited cross sections
  - Low mobility, low efficiency

Deployment Methods

Remote control boats

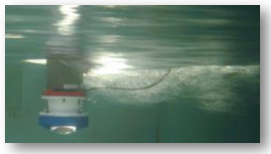
- Pros
  - Moderate mobility
- Cons
  - Limited sites/applications
  - NAV Precision can be poor (unless automated or very experienced user)

Autonomous Underwater Vehicles (AUVs)

- Pros
  - Good precision
  - Moderate Mobility
  - Efficient
- Cons
  - Limited sites/applications
  - Preprogramming necessary
  - No real time data viewing on some

Boat Mounts

- Location of mount can impact measured data
- Flow disturbance dependent on mount, boat hull and flow



Instrumentation: ADCP

TRDI Rio Grande

- Most widely used in USGS
- 600 kHz and 1200 kHz
  - also 300 kHz workhorse

While useful for discharge measurements, *MANY* TRDI StreamPros are currently NOT a good option for velocity mapping.

Why?

Instrumentation: ADCP

TRDI Rio Grande Recommendations and Limitations

Recommendations and Limitations		
Rio Grand Model >	1200/1200ZH	600
Blanking Distance (WF)		
All Modes	0.82 ft (25 cm)	0.82 ft (25 cm)
Minimum Depth Cell (Bin) Size		
Mode 1	0.82 ft (25 cm)	1.64 ft (50 cm)
Mode 5 or 11	0.16 ft (5 cm)	0.33 ft (10 cm)
Mode 12	0.16 ft (5 cm)	0.33 ft (10 cm)
Maximum Profiling Range		
Mode 1 or 12	65 ft	230 ft
Mode 5 or 11	13 ft	26 ft
Mode 5 or 11 with WZ3	22 ft	42 ft
Maximum Relative Velocity		
Mode 1 or 12	32 ft/s	32 ft/s
Mode 5 or 11	~2.3 ft/s	~3.3 ft/s
Mode 5 or 11 with WZ3	< 2.3 ft/s	< 2.3 ft/s
Approximate Velocity Standard Deviation		
Mode 1, WV175	*Bin Size: 0.82 ft* SD: 0.43 ft/s	*Bin Size: 1.64 ft* SD: 0.43 ft/s
Mode 5/11	*Bin Size: 0.16 ft* SD: < 0.03 ft/s	*Bin Size: 0.33 ft* SD: < 0.03 ft/s
Mode 12, WV175, 10 subpings	*Bin Size: 0.82 ft* SD: 0.13 ft/s	*Bin Size: 1.64 ft* SD: 0.13 ft/s
	Bin Size: 0.33 ft SD: 0.33 ft/s	*Bin Size: 0.82 ft* SD: 0.30 ft/s
	Bin Size: 0.16 ft SD: 0.16 ft/s	*Bin Size: 0.33 ft* SD: 0.49 ft/s

Instrumentation: ADCP

Sontek River Surveyor ADP

Recommendations and Limitations

ADP Frequency (kHz)	Profiling Range [min. – max.] (ft)	Cell Size [min. – max.] (ft)	Blanking Distance [minimum] (ft)	Max. Bottom Tracking Depth (ft)
500	10 - 394	3.3 – 39.4	3.3	443
1,000	3.9 - 131	0.82 – 16.4	2.3	131
1,500	3.0 - 82	0.82 – 13.1	1.3	98
3,000	2.0 - 20	0.49 – 6.6	0.66	33

ADP Frequency (kHz)	Ping Rate (Hz)	Cell Size (ft)	Single Ping Std. Dev. (ft/s)	1-Second Std. Dev. (ft/s)	5-Second Std. Dev. (ft/s)
500	4.5	1.64	3.08	1.44	0.66
500	4.5	3.28	1.54	0.72	0.33
1,000	12	0.82	3.08	0.88	0.39
1,000	12	1.64	1.54	0.46	0.20
1,500	9	0.82	2.07	0.69	0.30
1,500	9	1.64	1.02	0.33	0.16
3,000	20	0.49	1.71	0.39	0.16
3,000	20	0.82	1.02	0.23	0.10

About New Profilers

New profilers from Sontek and TRDI use variable bin size, mode and frequency (Sontek only)

These new features, while useful, cause complications for VMT and data from these instruments is not currently supported in version 2.4b (testing new code)

Why? --Variable bin sizes, variable frequency (backscatter issues), etc.

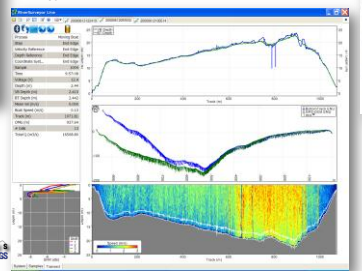
Instrumentation: SonTek M9 & S5

M9

- 9-beam 3-frequency profiler
- 4 beams at 1 Mhz
- 4 beams at 3 Mhz
- 1 beam @ 500 kHz (depth)
- Nominal velocity profiling range: ~0.3 m – 30.0 m
- Vertical beam range: 0.2 - 80m

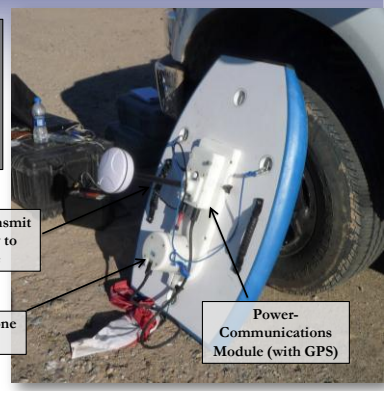
S5

- 5-beam 2-frequency profiler
- 4 beams at 3 Mhz
- 1 beam @ 1 MHz (depth)
- Nominal velocity profiling range: 0.3 m – 5.0 m (BT)
- Vertical beam range: 0.20 – 15 m



Integrated System-Radios, GPS, Float

System sold as an integrated package including float, radios, ADCP, GPS, etc.



Instrumentation: TRDI RiverRay

- Flat face Phased array - 600 kHz
- 30-degree beams (larger unmeasured area)
- Evaluation ongoing
- Flat face = less flow disturbance

Instrumentation: GPS

- GPS is required for accurate velocity mapping (can't correct for moving bed without)
- Configurations
  - Basic GPS (not recommended)
  - Differential GPS (Better)
    - Sub-meter accuracy on many units with WAAS or Omnistar (e.g. Trimble Ag132)
  - Real-Time Kinematic (RTK) GPS (Best)
    - High accuracy (<10 cm), but high cost
    - Requires the user to set up a separate base station on shore (or access virtual BS network)

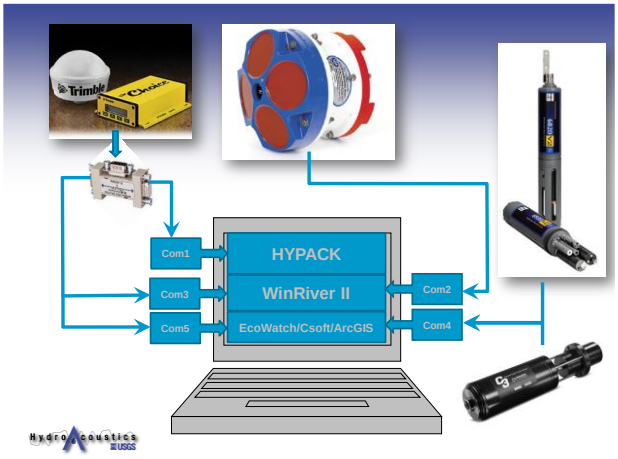
Instrumentation: Ancillary Sensors

- **Single Beam Echo Sounder**
  - Useful for simultaneous bathymetric mapping of study reach (higher accuracy than ADCP)
  - Multibeam surveys also an option, but typically requires a second boat
- **Temperature and Conductivity Sensors**
  - Required to check ADCP thermistor
  - Profiles may also be required in stratified water bodies (for speed of sound calculations)
  - Can also use separate speed of sound probe (but does not allow on-site comparison with ADCP thermistor

Instrumentation: Ancillary Sensors

- **Multiparameter Sonde**
  - Useful for simultaneous mapping of basic water quality
    (especially useful at confluences or outfalls where water quality may differ)
- **Fluorometer**
  - Tracer (dye) transport data can significantly strengthen analysis & understanding
    (e.g. power plant intake/outfall transport time)

Manned Boat Integrated Surveys



Gear

Quatech
Serial Expresscard, 4 Port, PCIE Based

Manufacturer Part# QSPXP-100

- Provantage.com
- $237

RS232 Splitter

Manufacturer Part# 9PMDS

- B & B Eelectronics
- $64

USB 2-Port Serial Adapter **$42**

HIF Stk. No. 7011527

The 2-port USB serial adapter with 3' USB extension cable instantly adds 2 serial communications ports when plugged into a USB port. The adapter is automatically detected and installed.

HIF Stk. No.	Product Name
7011527	USB 2-Port Serial Adaptor

Real Time Data With EcoWatch

Tips

- Set wiper interval on sonde to 60 min (else interrupts data)
- Spiking may occur
  - Start a new file if persistent
- Orient probes down if possible (sunlight can contaminate turbidity sensor)
- Start data collection on sonde last
- Have plenty of batteries
- SYNC YSI clock with CPU clock

Alternatives:

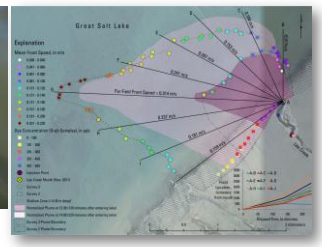
- Bring GPS into YSI 650 handheld directly
- Only text readout
- GPS data written to file directly (on 650 only and no data merging required)
- Requires special cable (YSI 6115)

Field Cable to Computer
HIF # 6104050
P/N 6095
Connects to field cable

Real Time Data With ArcGIS10

Turner CFINS ArcGIS extension

- Allows C3 data to log and display in ArcGIS in realtime (e.g. dye plume mapping)
- GPS merged automatically



Field Computer & Software

- Laptop PC (windows)
  - Accessories
    - DC power supply or inverter
    - USB-to-Serial adapters
    - RS232 Splitters & Cables
    - Screen Shade
- Software
  - WinRiver II
  - Hypack or similar
    - Used for navigation along plan lines
    - Logs depth sounder data
  - GeoMag
    - Magnetic variation calculator (difference between magnetic north and true north)

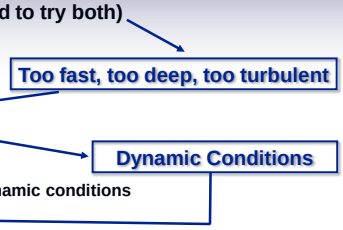
Measurement Tips

Keys to a Successful Velocity Survey

- Good results are highly dependent on
  - Instrument configuration
  - Boat navigation, speed, and control
  - Measurement location
  - Good planning

Rio Grande Water Modes (In Priority Order)

- Mode 5/11 (often need to try both)
  - Low instrument noise
  - Small bins
  - Limited application
- Mode 12
  - High-ping rate
  - Small bins
  - Potential errors in dynamic conditions
- Mode 1
  - Robust mode
  - Highest instrument noise
  - Limited bin sizes

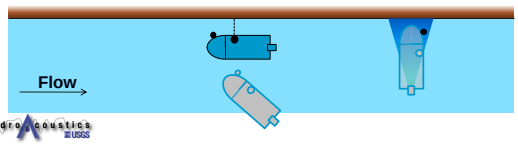


Boat Control

- Keep boat speed constant and slow
  - The slower, the better (more data, better data)
  - Slower boat speed = more man-hours (tradeoff)
- Follow plan lines at all times when possible
  - Especially important when averaging transects in variable topography

Boat Control

- Don't reverse at edges
  - Will push water by the ADCP resulting in velocity spikes at banks
- Treat edges like a discharge measurement
  - Measure edge distance when possible (can do more with ADCP data)
  - "Square-Up" and hold position when possible

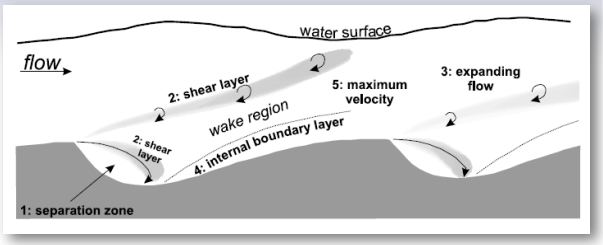


Stationary Time Series

- Consider where to measure (what are you after?)
- Consider how long to measure
  - Is there an inherent timescale associated with the process you want to measure?
- Do whatever is necessary to SAFELY remain stationary
  - Anchor, hold-position, use a tag line, etc.

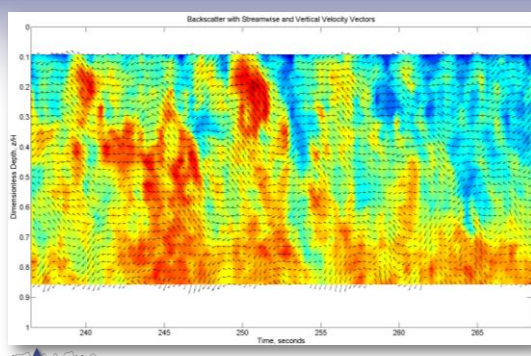
Confluence Dynamics and Flow over Dunes

Flow over Dunes



Best, J. (2005), The fluid dynamics of river dunes: A review and some future research directions, J. Geophys. Res.

Velocity and Backscatter - Lee



Questions?