What's New in Hydroacoustics

The latest in equipment, policies, procedures, and common issues

November 2014

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National Coordinator for Hydroacoustics
USGS Water Mission Area

HydroAcoustics USGS

What's New?

- Instruments and Methods
  - Moving Boat
  - Mid-section
  - Index Velocity
  - Field forms & database issues
  - Sediment Acoustics
- OSW Support
  - Web pages / Forums
  - Training

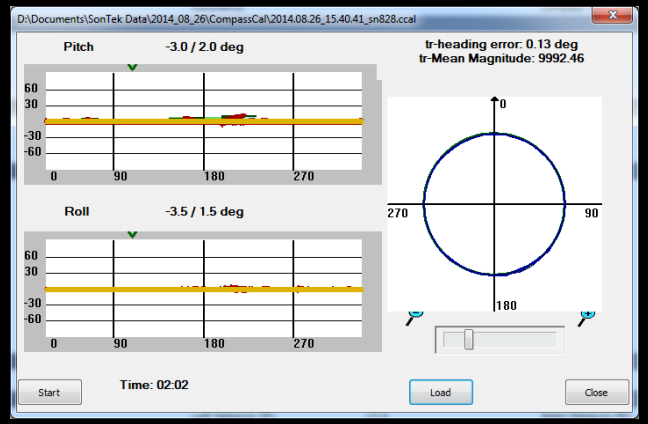
Moving Boat ADCP Measurements

M9 Compass Modifications

- 2011-2013: USGS testing (>2 years) identified various compass calibration problems.
- Feb. – Aug. 2014: SonTek developed a solution that involved hardware (moving compass, new magnetometer) and software changes.
- Aug. 2014: Two USGS M9s modified and returned to USGS for testing
- USGS Testing Results
  - Calibration & user feedback is much improved.
  - Testing wasn't wholly conclusive; but seemed to support the stated compass accuracy (± 2 degrees).
- Oct. 2014: SonTek "released" M9 compass modification. Involves factory recall.
- Nov. 2014: OSW Note 2015.05.

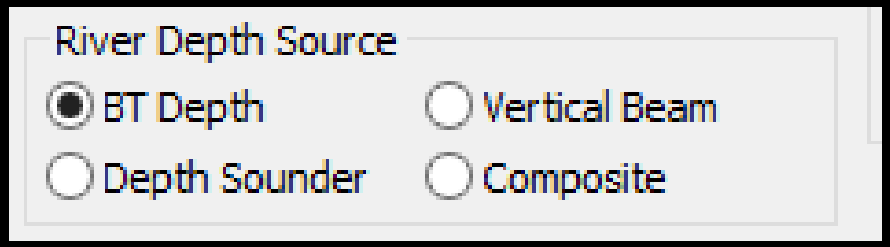
M9 Compass Modifications Recall Process

1. Schedule return of M9 to SonTek
2. Run and record RSMatrix before repair
3. When M9 is returned, run RSMatrix again and collect a comparison measurement
4. Submit RSMatrix results and comparison Qm to SharePoint site (see OSW Note 2015.05)
5. A sample of repaired M9s will be tested at HIF. HIF will notify offices.
6. Webinar coming!



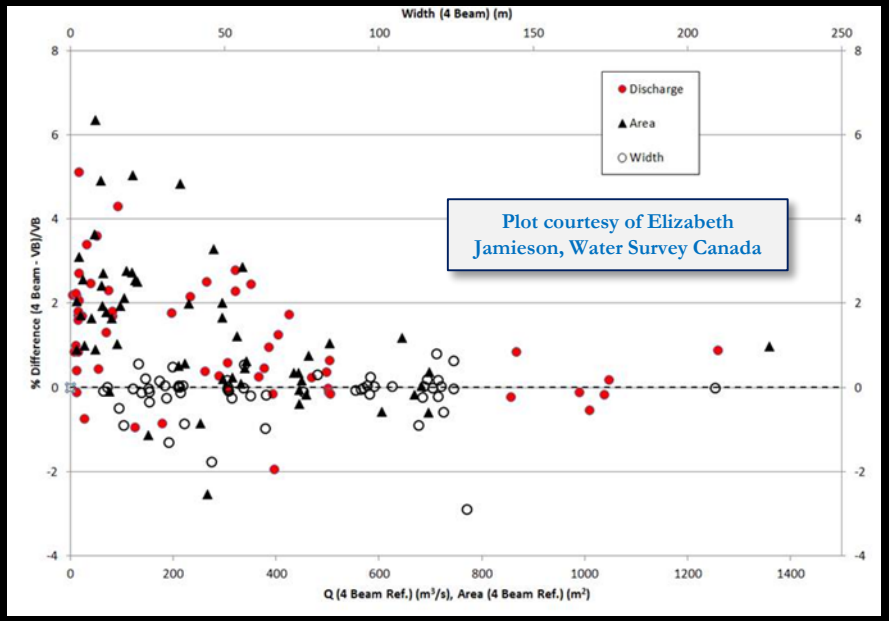
TRDI RiverRay Vertical Beam

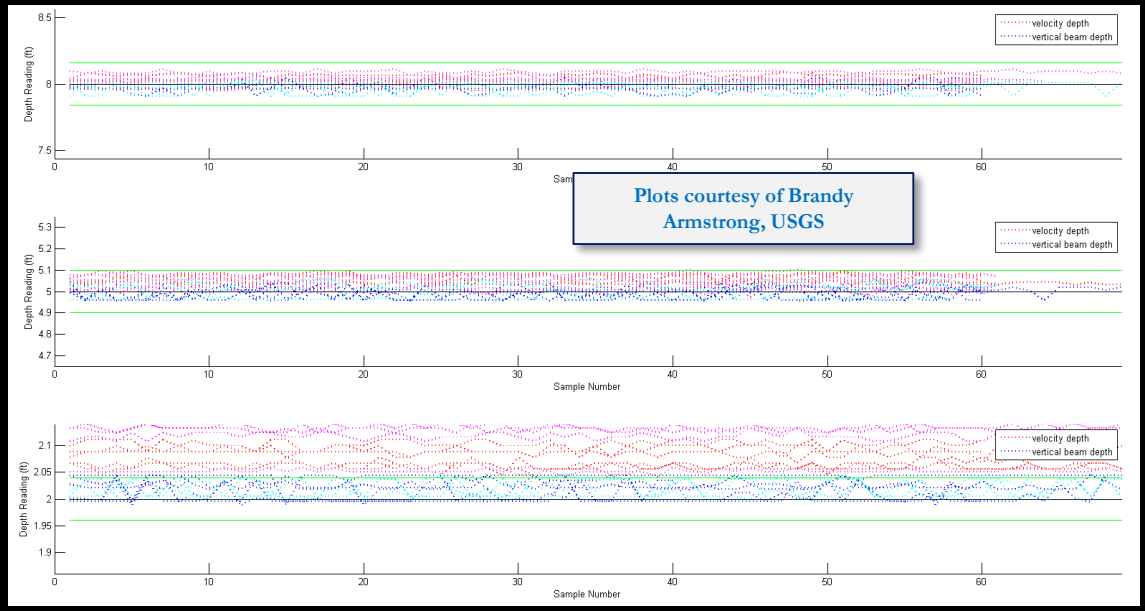
- TRDI added a 600 kHz vertical beam to the RiverRay (for depth measurement only).
- Software modified to support vertical beam, 4-beam bottom-track depths, echo sounder or composite
- Test plan created for evaluating efficacy of VB (on web site)



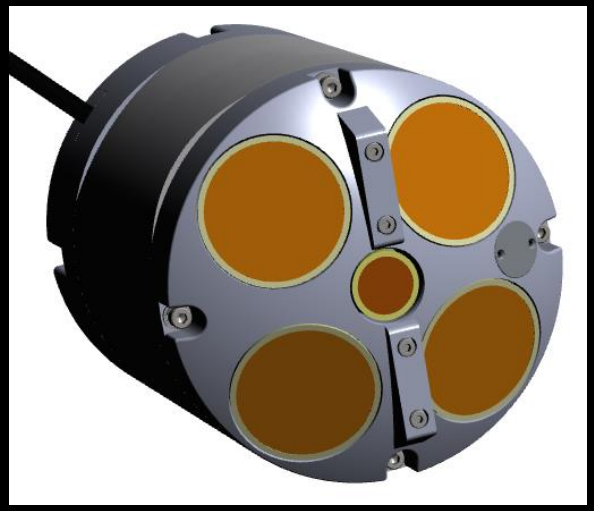
RiverRay Vertical Beam

- Some **preliminary evidence** of discharges computed with the VB are less than discharges computed using 4-beam weighted average. OSW is investigating!
- Submit comparison Qms to SharePoint!





TRDI RiverPro ADCP



- 5 acoustic beams; four 1200 kHz 20-degree beams and one 600 kHz vertical beam.
- Vertical beam: depth & velocity
- Auto-adaptive configuration
- Embedded GPS for geo-referencing data collected.
- Manual configuration for advanced users ($$)
- RSSI can be calibrated for use in sediment acoustics ($$)

TRDI RiverPro ADCP

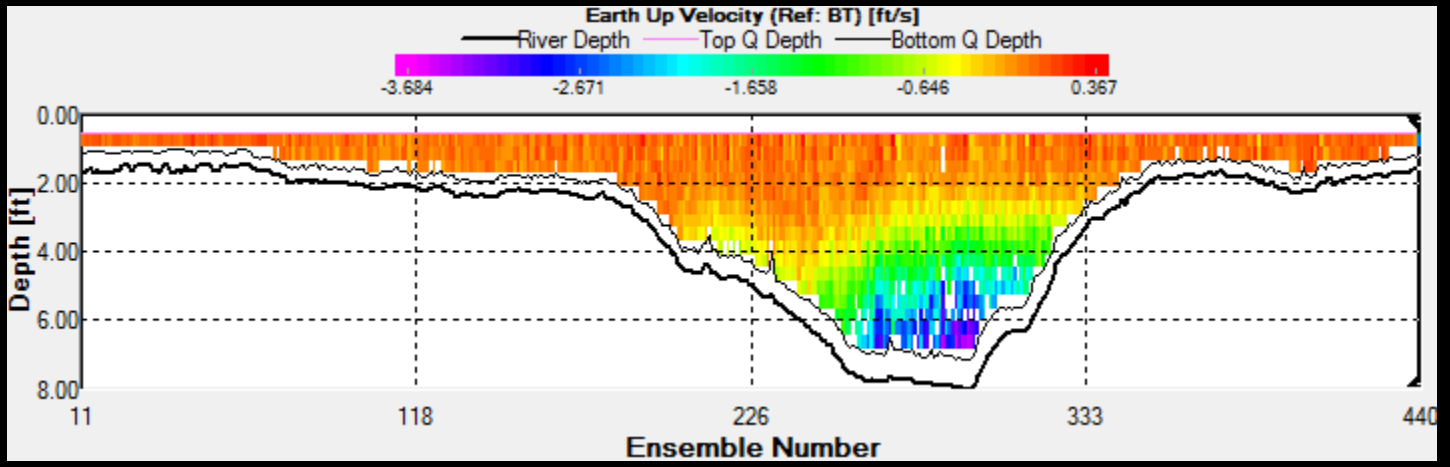
- The RiverPro will fit into the RiverRay float, allowing users to swap ADCPs, reducing the need to purchase and transport a second float.
- Possible Rio Grande conversion. No details yet.
- 1 RiverPro purchased by OSW (but not delivered); No formal test results yet.

StreamPro Site-specific Interference

>PT3

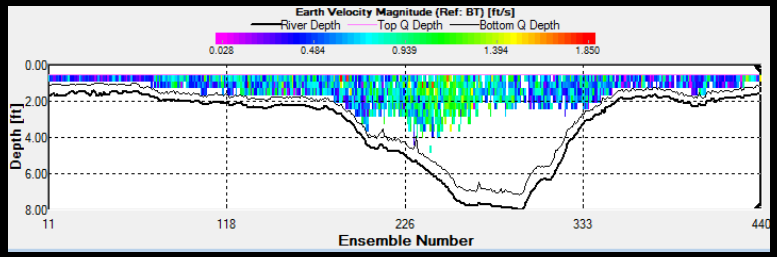
Mag (%)	Lag	Bm1	Bm2	Bm3	Bm4
	0	100	100	100	100
	1	78	71	72	76
	2	80	74	75	80
	3	88	83	81	86
	4	81	76	78	83
	5	84	80	80	81
	6	86	78	81	86
	7	82	78	79	81
Sin Duty(%)		46	45	48	46
Cos Duty(%)		49	49	49	46
RSSI (counts)		84	90	91	91

- USGS has evidence of site-specific electromagnetic interference (EMI).
  - PT3 test results: RSSI do not decrease to 15% or less by lag 3
  - Error and vertical velocities increase with depth and are larger than expected.



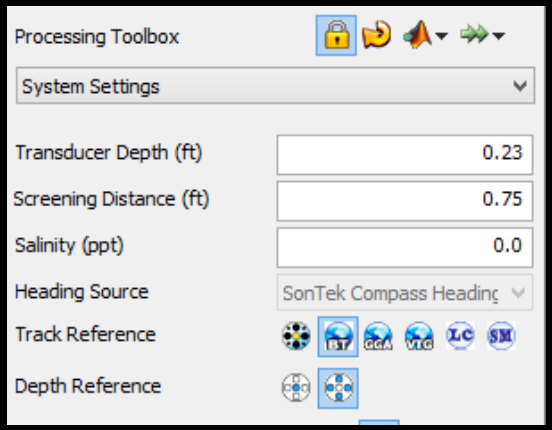
StreamPro Site-specific Interference

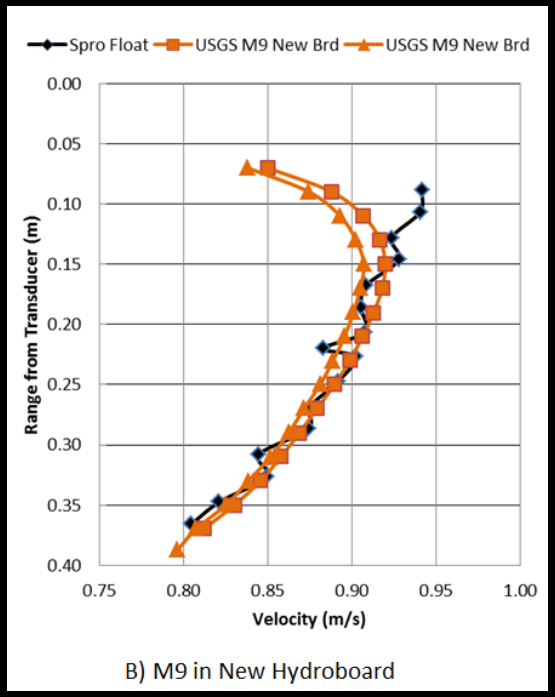
- StreamPro more susceptible because of cable between transducer and electronics
- Lower backscatter sites more susceptible
- Reasonable values for the WT Up and WT Error thresholds can usually screen out erroneous data – but may screen out a significant amount of data
- Solutions:
  - Move measuring section (substantial distance). If still present, don't use StreamPro
  - TRDI working on hardware shielding for new and existing StreamPros



Identification of Flow Disturbance Bias

- OSW Tech Memo 2014.01 requires use of 16 cm screening distance. In RSLive, must enter value = (ADCP depth + 16 cm).
  - Analysis by OSW of comparison measurements submitted by WSCs indicated a velocity bias in M9 data.
  - OSW used field experiments and 3-D numerical simulations to determine 16 cm distance and to confirm our findings.
- New RSLive software will automatically screen data, provided a special file is loaded properly. Guidance coming!



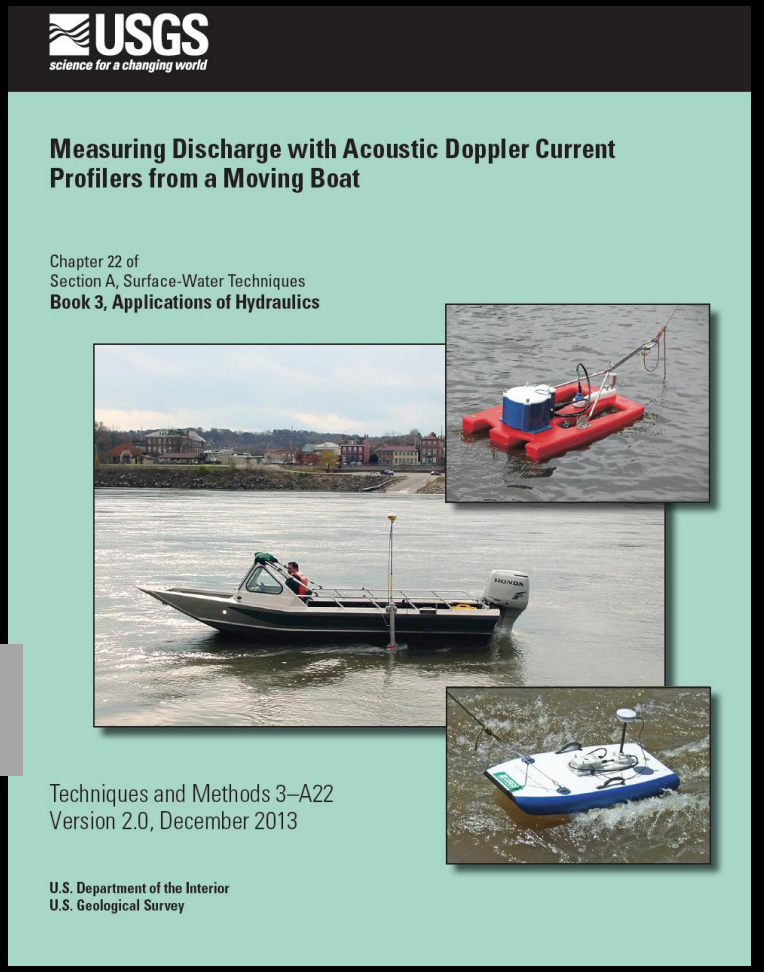


B) M9 in New Hydroboard

Moving-boat ADCP T&M Revised!!

Watch the Webinar!!
Read the Report!!

http://hydroacoustics.usgs.gov/training/webinars.shtml
http://pubs.usgs.gov/tm/3a22/



Significant Updates and Changes

Significant Updates and Changes

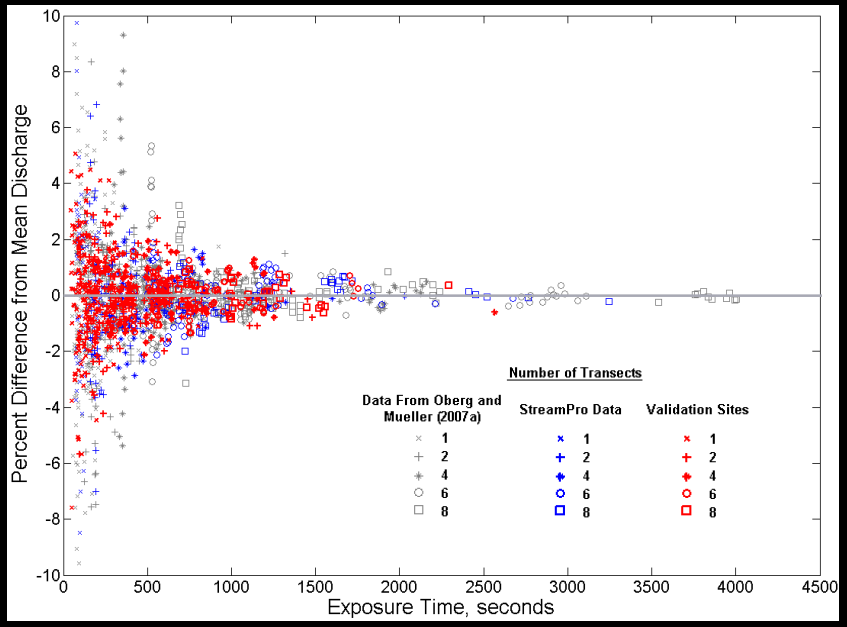
The list below contains information on the important updates and changes in this revision when compared to the original publication (2009). The list is not exhaustive, but is intended to highlight differences of interest to the majority of those that perform moving-boat ADCP discharge measurements.

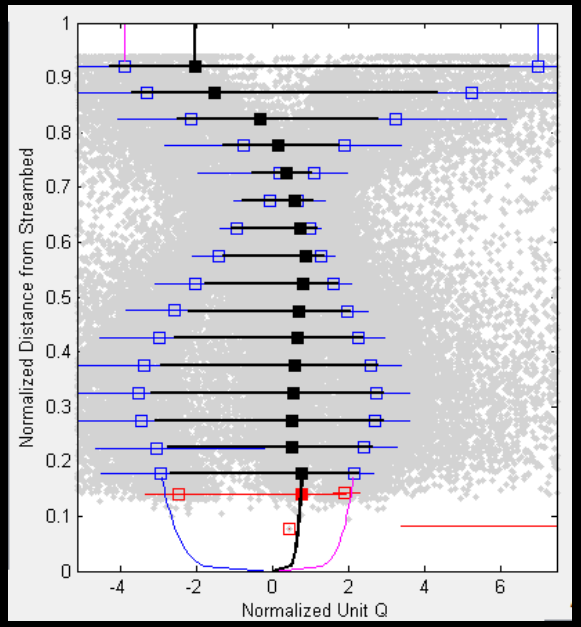
- Discussion of Instruments – Updated descriptions of instruments including signal processing, frequency, and transducers (p. 2).
- Data Management – Added that all aspects of data management must follow agency policy and be documented in the office's surface-water quality-assurance plan. Encourages scanning of paper measurement notes to an electronic file (p. 3).
- Training – Added that training must comply with agency required training standards and highly encourages additional training in order to stay current (p. 4).
- Unmeasured Areas in a Profile – Added discussion of blanking distances for additional instruments (p. 6).
- Configuration and Characteristics – Added characteristics for additional instruments (p. 7).
- Testing Requirements and Procedures – Added section describing when an instrument must be tested and a matrix of quality-assurance test requirements (p. 10).
- Transformation Matrix Check – Added description of methods for verifying that the correct transformation matrix is stored in the ADCP (p. 11).
- Instrument History Log – Added a discussion on the importance of logging instrument quality-assurance tests (p. 12).
- GPS Requirements and Specifications – Added specific precision requirements needed for the GPS data output and a discussion of VTG limitations (p. 12).
- Manned Boats – Added discussions of tethered boats used from a manned boat (p. 13).
- Tethered Boats – Added discussions about why to avoid wading with a tethered boat across the stream, recommendations of unmanned cableways, safety considerations, and use of tethered boats in high velocity situations (p. 14).
- Remote-Controlled Boats – Added concern of potential effect of motors and batteries on the compass (p. 18).
- Other Equipment – Added electronic field notes (p. 18).
- Variation in Speed of Sound with Depth – Added discussion that so[illegible] software can correct the vertical velocity or depth for changes in the speed of sou[illegible] array ADCPs horizontal velocities are unaffected by changes in speed[illegible] vertical velocity and depth are still dependent on correcting the speed
- Water Temperature – Clarified that ADCP temperature comparisons are[illegible] assurance only and should not be released to the public when not using [illegible] that meets USGS water temperature field measurement standards (p. 22).
- Salinity – Set minimum bounds when salinity is expected to be sampled t[illegible] thousand (p. 22).

http://pubs.usgs.gov/tm/3a22/

Exposure Time – Review Policy

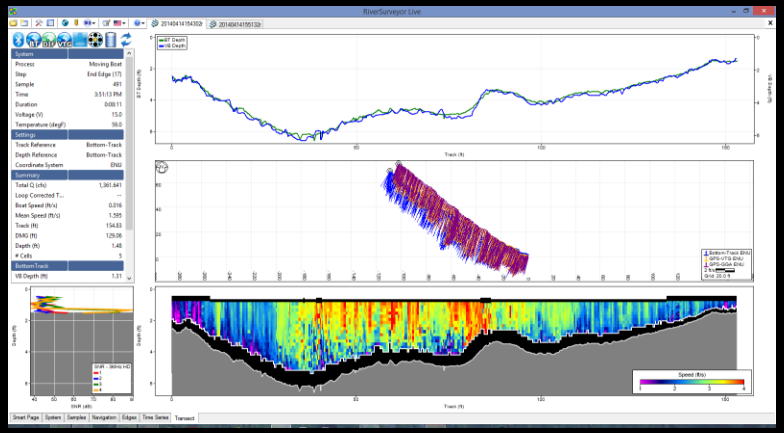
- Applies to steady flow conditions only!!
- Best practice: Obtain more transects – may reduce uncertainty. (Rating of ADCP Qms)
- More transects at a faster, but more uniform boat speed may yield better measurements.





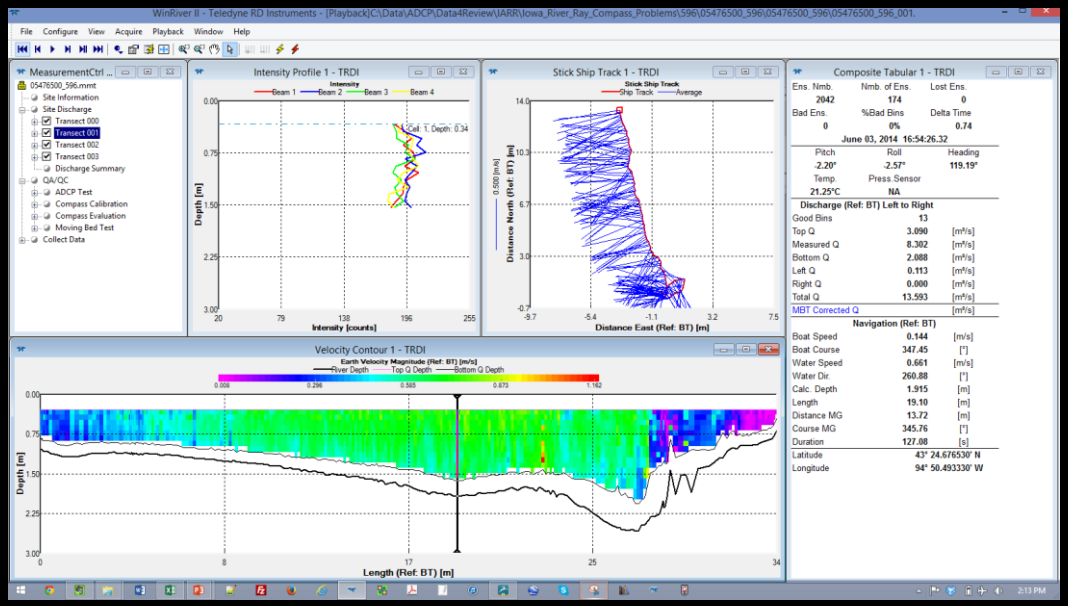
RS Live Updates

- RiverSurveyor Live Versions to use:
  - M9s with compass retrofit will require version 3.80+
  - M9s with new PCMs require version 3.70+
  - For everyone else, version 3.60 is recommended for now.
  - Once we get more broad experience with 3.80, might recommend it to all, assuming it is stable and works well.



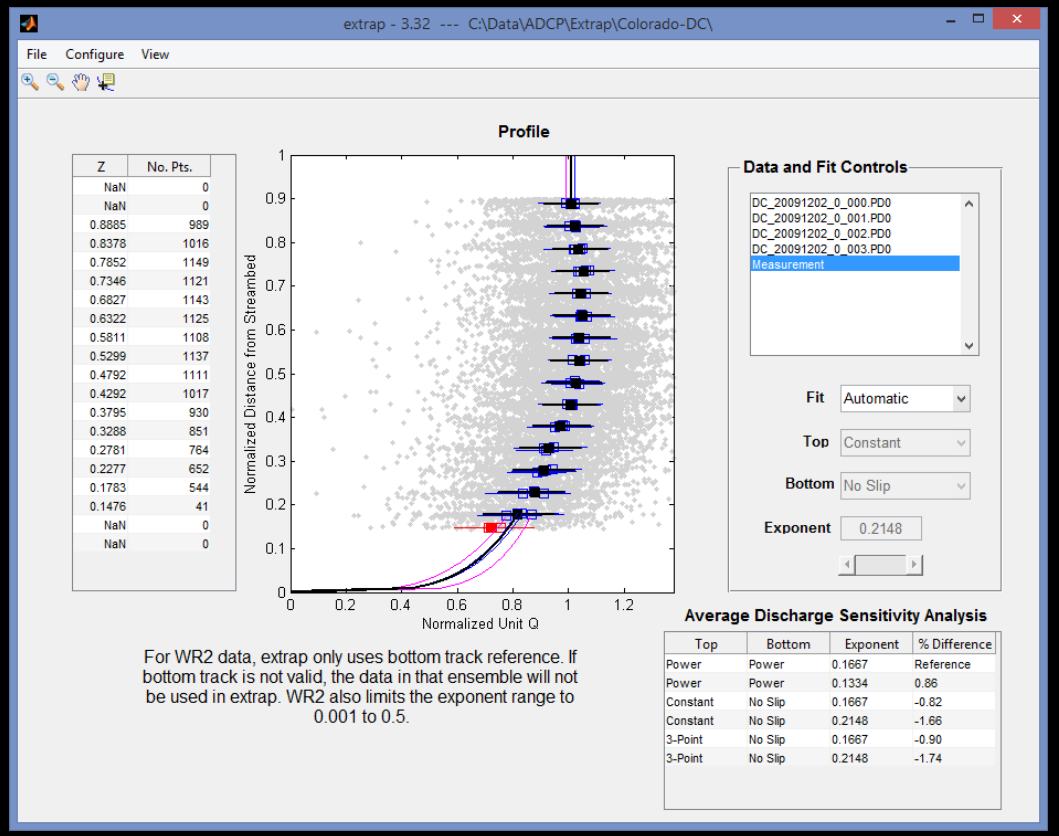
WinRiverII Updates

- WRII was updated to support Loop and Stationary MBTs some time ago.
- Recommended version is 2.12. Version 2.15 will be required when RiverPro begins to be used.



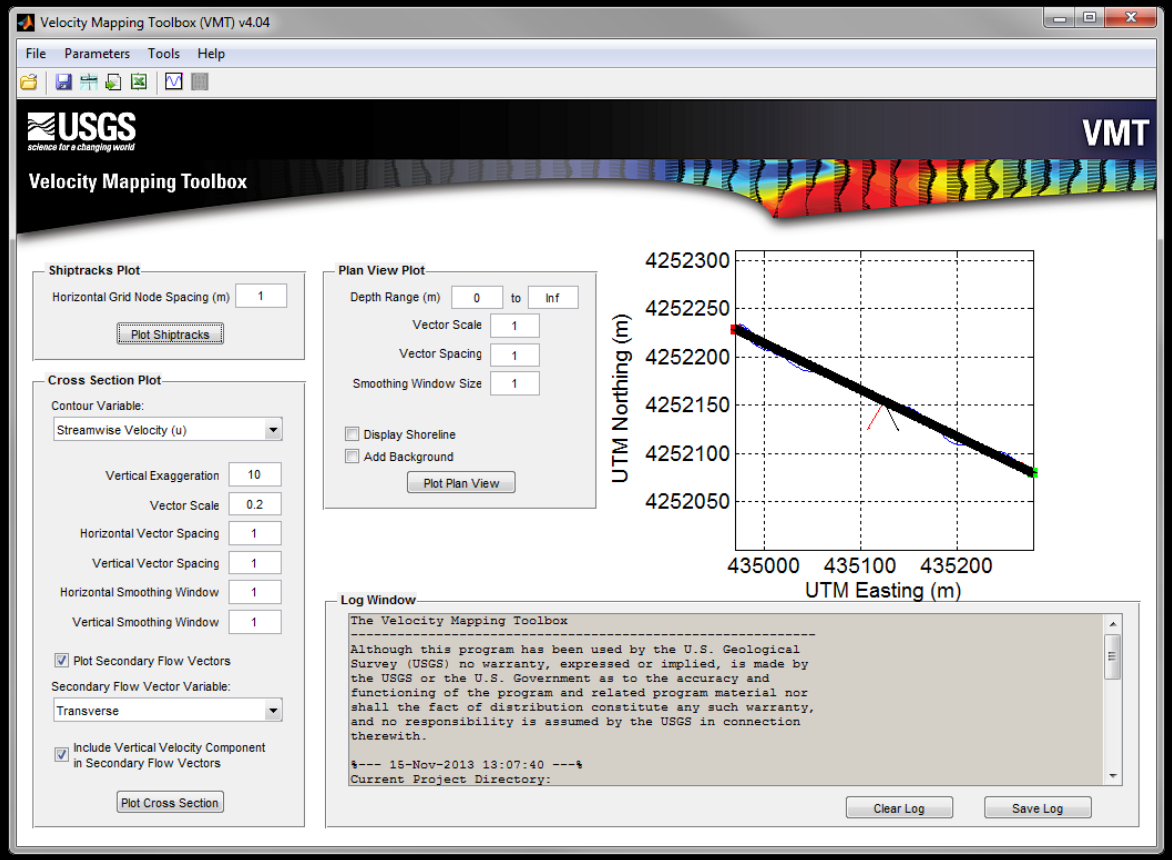
Extrap

- Make sure that you are using it!
- Watch the podcast/online training!!
- Some possibility that it will find it's way into vendor software.

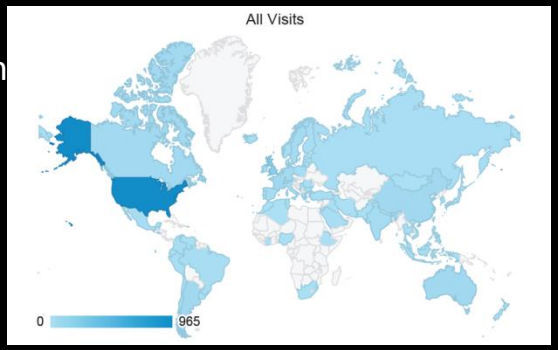


Velocity Mapping Toolbox (VMT)

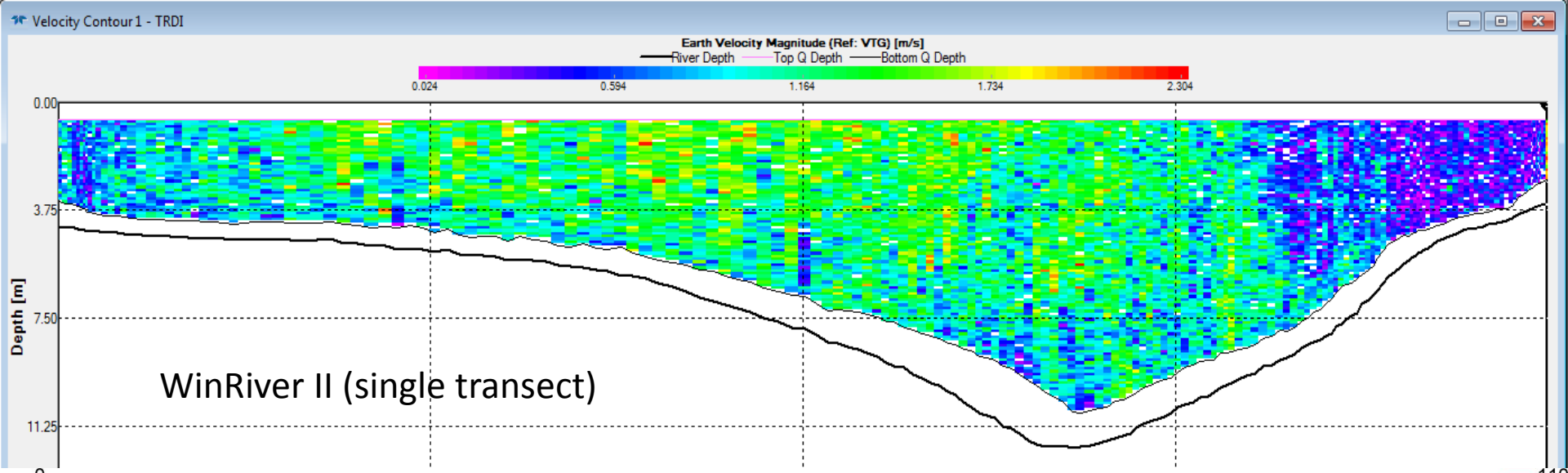
- Makes powerful post-processing and visualization tools accessible to ADCP users
- Generates figures that effectively communicate our data to cooperators and the public
- Is freely available

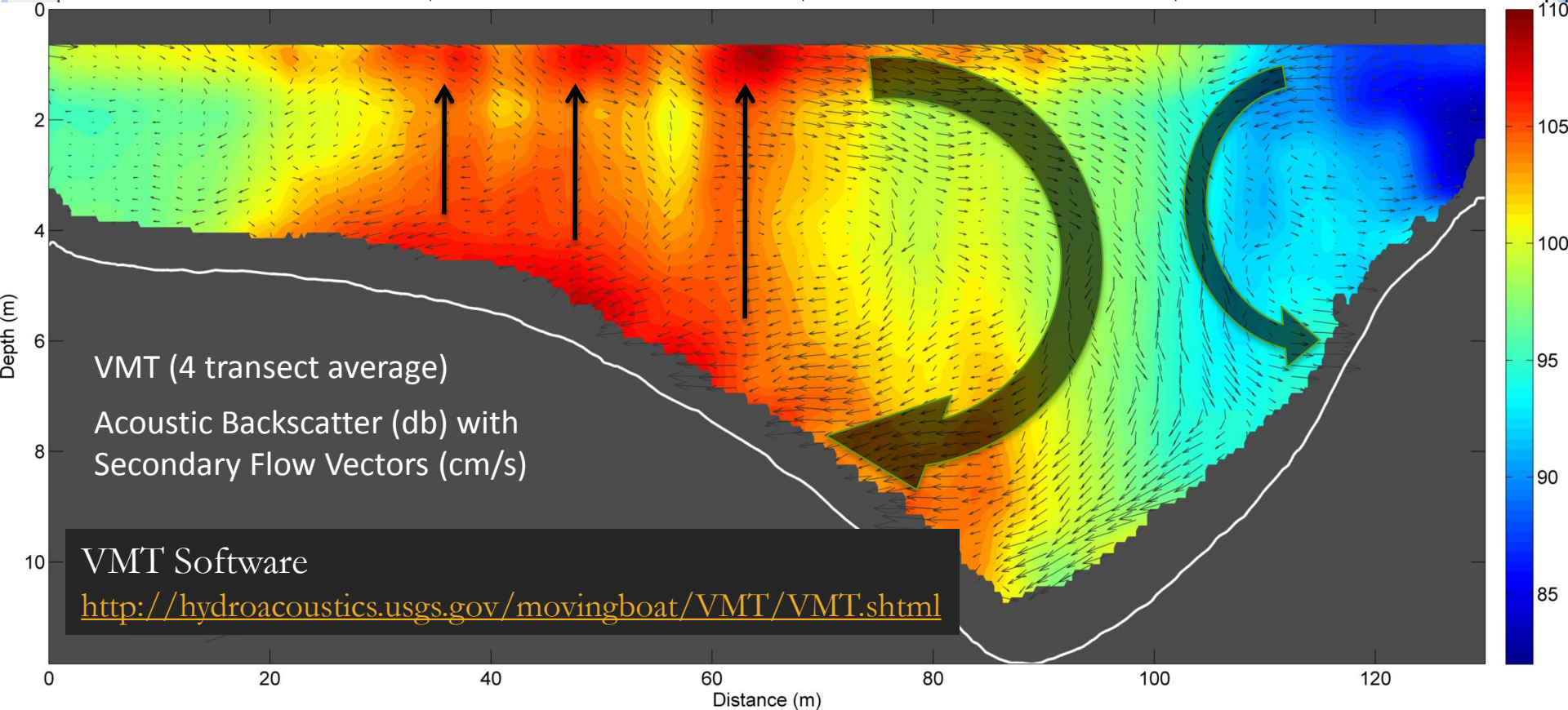


Currently VMT has over 690 users from numerous countries
(based on downloads from Nov. 2012 to Dec. 2013)



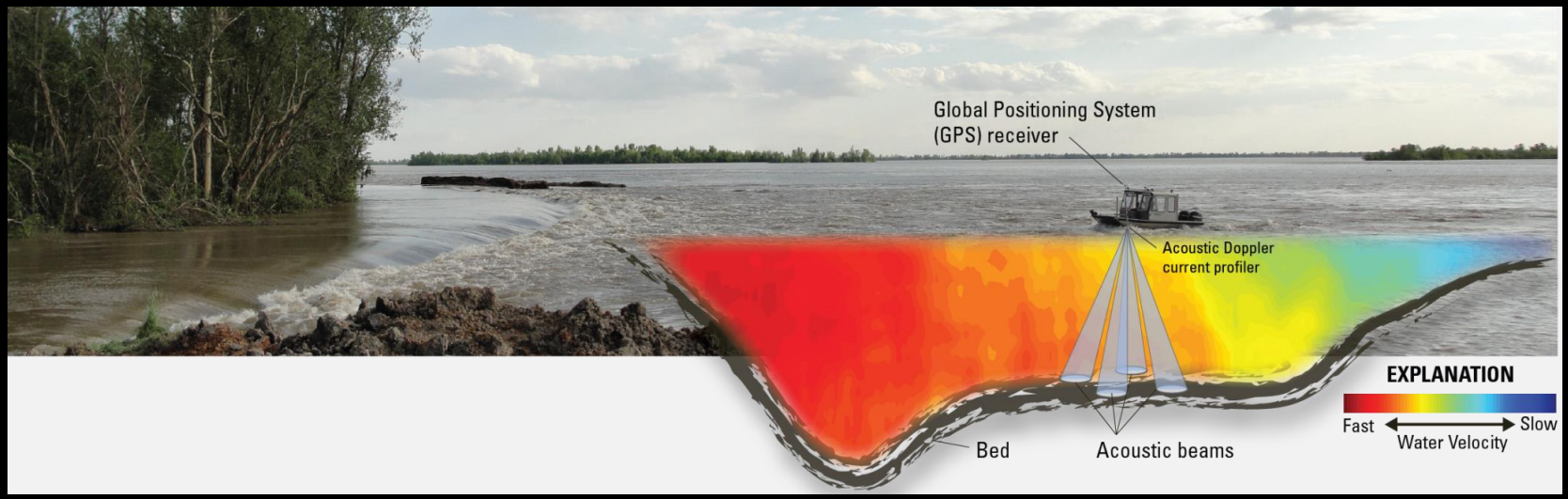
We currently average 20-30 downloads per day
(1-2 per day until Nov. 2013)


Velocity Contour 1 - TRDI
Earth Velocity Magnitude (Ref: VTG) [m/s]
River Depth
Top Q Depth
Bottom Q Depth
0.024
0.594
1.164
1.734
2.304
0.00
3.75
7.50
11.25
Depth [m]
WinRiver II (single transect)


VMT (4 transect average)
Acoustic Backscatter (db) with
Secondary Flow Vectors (cm/s)
VMT Software
http://hydroacoustics.usgs.gov/movingboat/VMT/VMT.shtml
Depth (m)
Distance (m)
0
2
4
6
8
10
0
20
40
60
80
100
120
110
105
100
95
90
85

VMT Updates

- Support for RiverRay ADCP added
- Limited support for M9
- Routines to compute longitudinal dispersion coefficients
- Batch processing and custom file builder tools



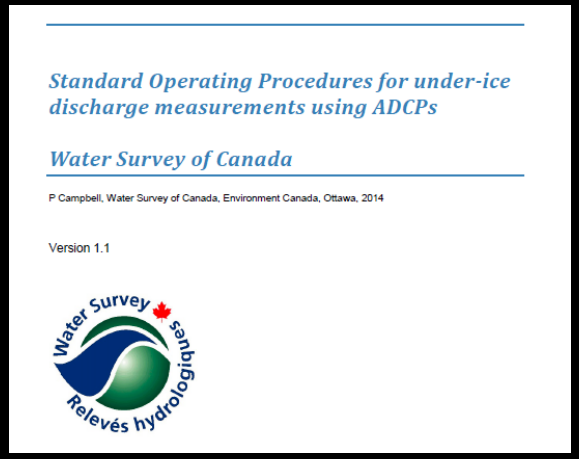
Mid-Section Measurements

Midsection ADCP Measurements

- When to use it
  - Check measurements
  - When bottom track is invalid
  - GPS data are unavailable or invalid
  - Ice-covered streams
- Teledyne-RDI
  - ~~WinRiver II SxS~~ | ~~StreamPro Handheld SxS~~
  - SxS Pro
- SonTek M9 and S5
  - RiverSurveyor Stationary Live
  - RiverSurveyor Stationary Live Mobile (On phone w/Bluetooth PCMs)

Ice Qms

- Past 3 winters, data from SiteVisit indicate that as many as 60% of ice Qms were made with acoustics devices.
- Interim techniques for flow measurements under ice have been drafted by Water Survey Canada with USGS input. USGS is recommending following their guidelines



Standard Operating Procedures for under-ice discharge measurements using ADCPs

Water Survey of Canada

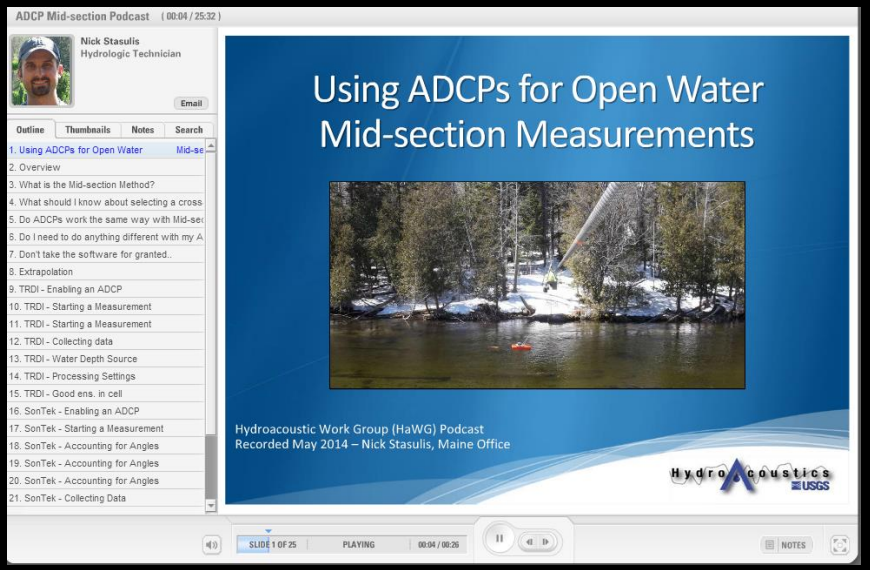
P Campbell, Water Survey of Canada, Environment Canada, Ottawa, 2014

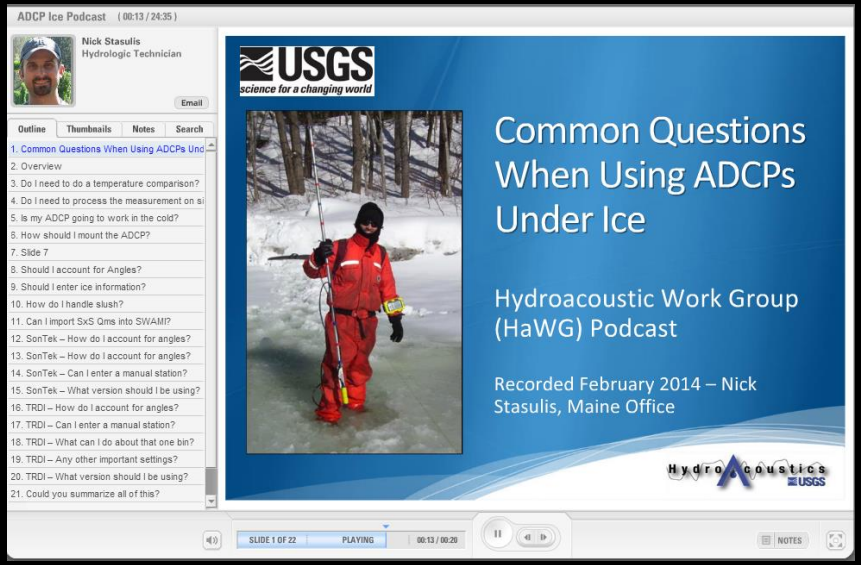
Version 1.1

Water Survey Relevés hydrologiques

Mid-section Reminders

- Flowtracker ADVs
  - View the Flowtracker webinar – available at hydroacoustics.gov.
- Training for mid-section measurements
  - Using ADCPs for Open Water Mid-Section Measurements
  - Using ADCPs Under Ice (Podcast)





Index Velocity Method

SonTek ADVMs - iQ series (iQ Plus)

Index Velocity ✓ Internal Q computation ⊘

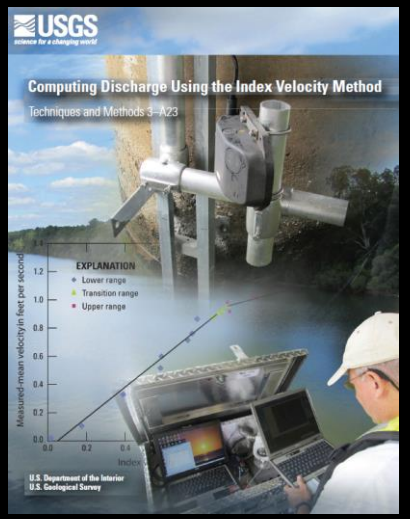
- Replacement for Argonaut SW
- Complete re-design; includes SmartPulse HD "mode"
- Two "streamwise" beams and two skewed beams
- One vertical beam for depth
- Tested conducted by HIF;
  report in review.

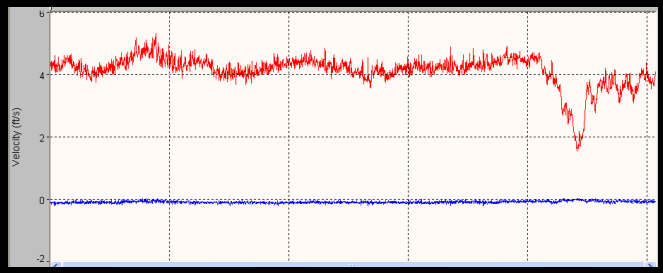
SonTek ADVMs - SonTek SL series (3G)

- Includes SmartPulse HD
- Same transducer configuration; electronics based on iQ
- New software for configuration
- Limited field evaluations in FL/ID WSCs
- HIF testing underway

Index Velocity Methods

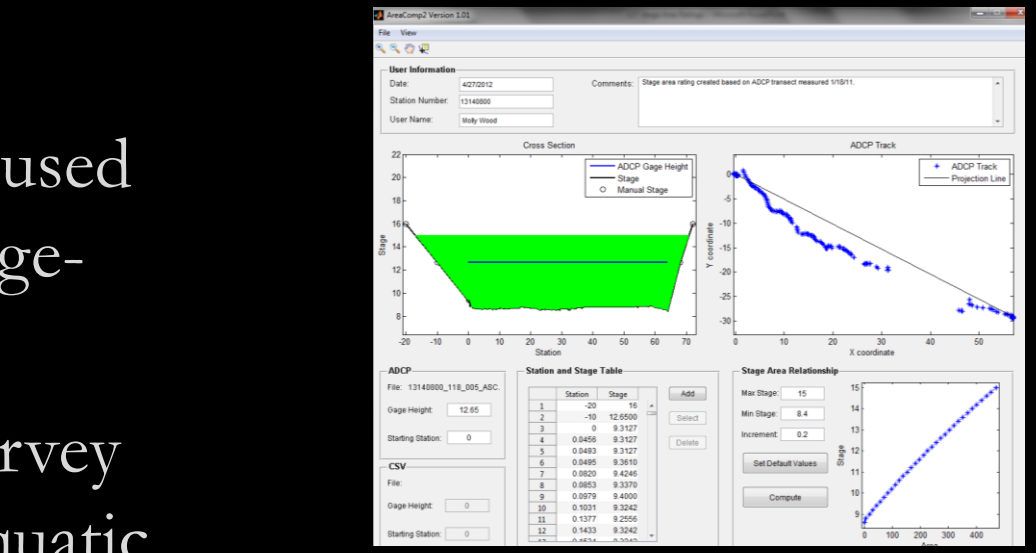
- Read and use the T&M
- Index-velocity rating template (on forum)
- TEL prereq for Index Velocity Class being developed
- OSW Memo 2014.08: Requires that data gaps are "filled in" in NWIS by loading the 1-minute data collected during Qms into NWIS.
- Draft of an OSW memo on minimum requirements for documenting index-velocity and stage-area ratings

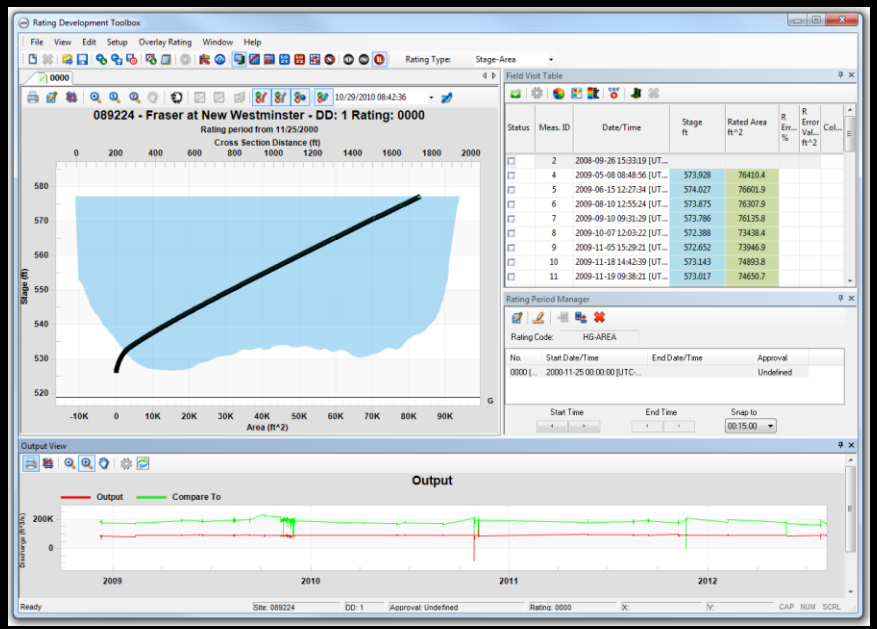




Index Velocity Software

- AreaComp2 should be used for development of stage-area ratings.
- Working with Water Survey Canada (WSCa) and Aquatic Informatics to develop and test an Index Velocity Rating Tool

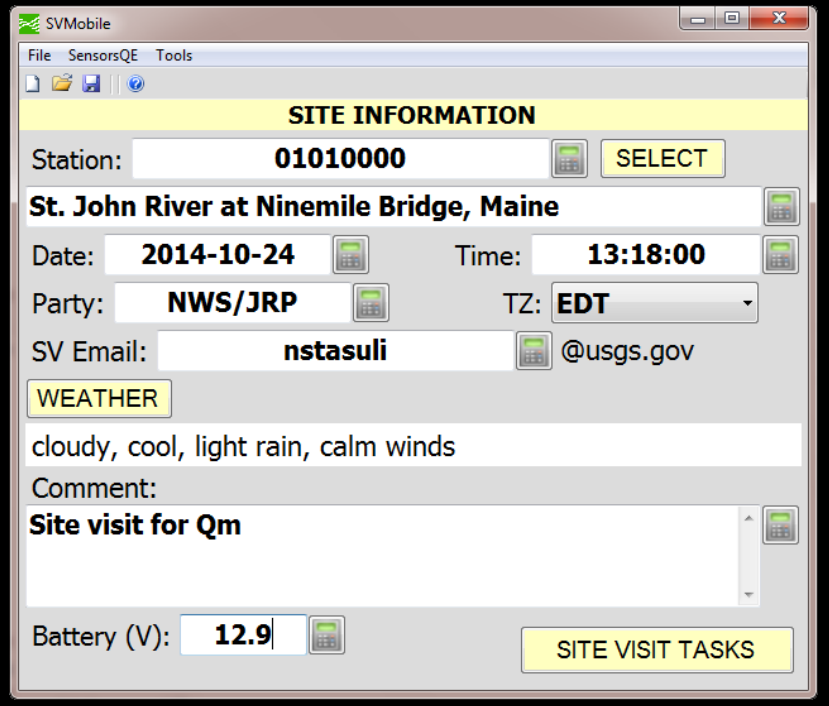




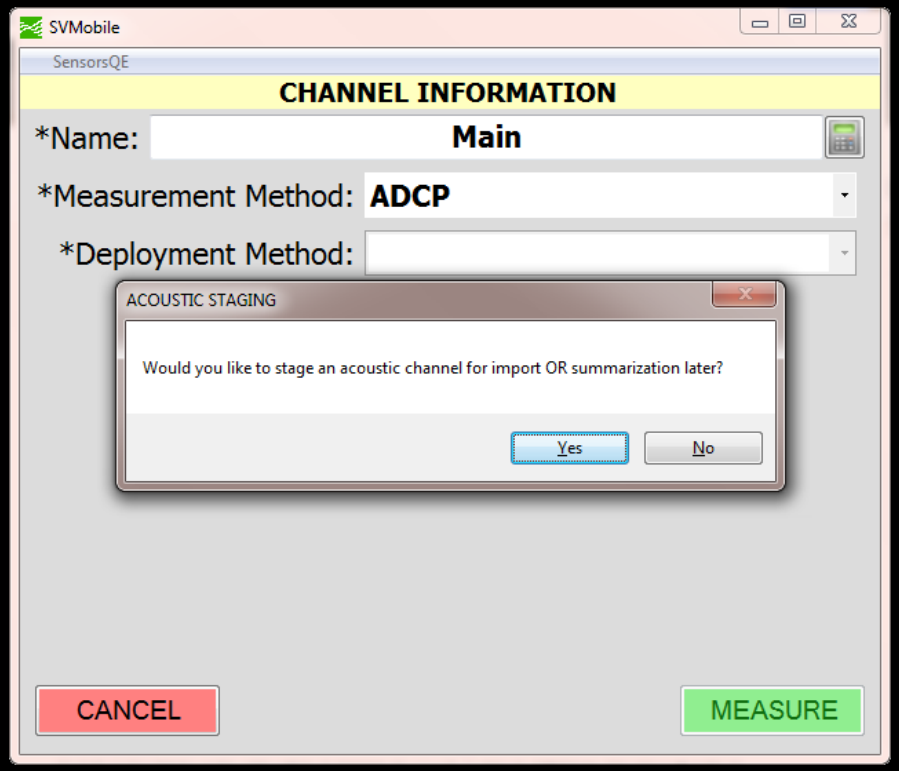
Field Forms & Database Issues

Electronic Notes - SVMobile

- OSW Memo 2014.07 requires the use of SWAMI/SVMobile
- SVMobile is used on PC for inspections, Qms and station levels
- Replaces SWAMI
- Can import measurement data

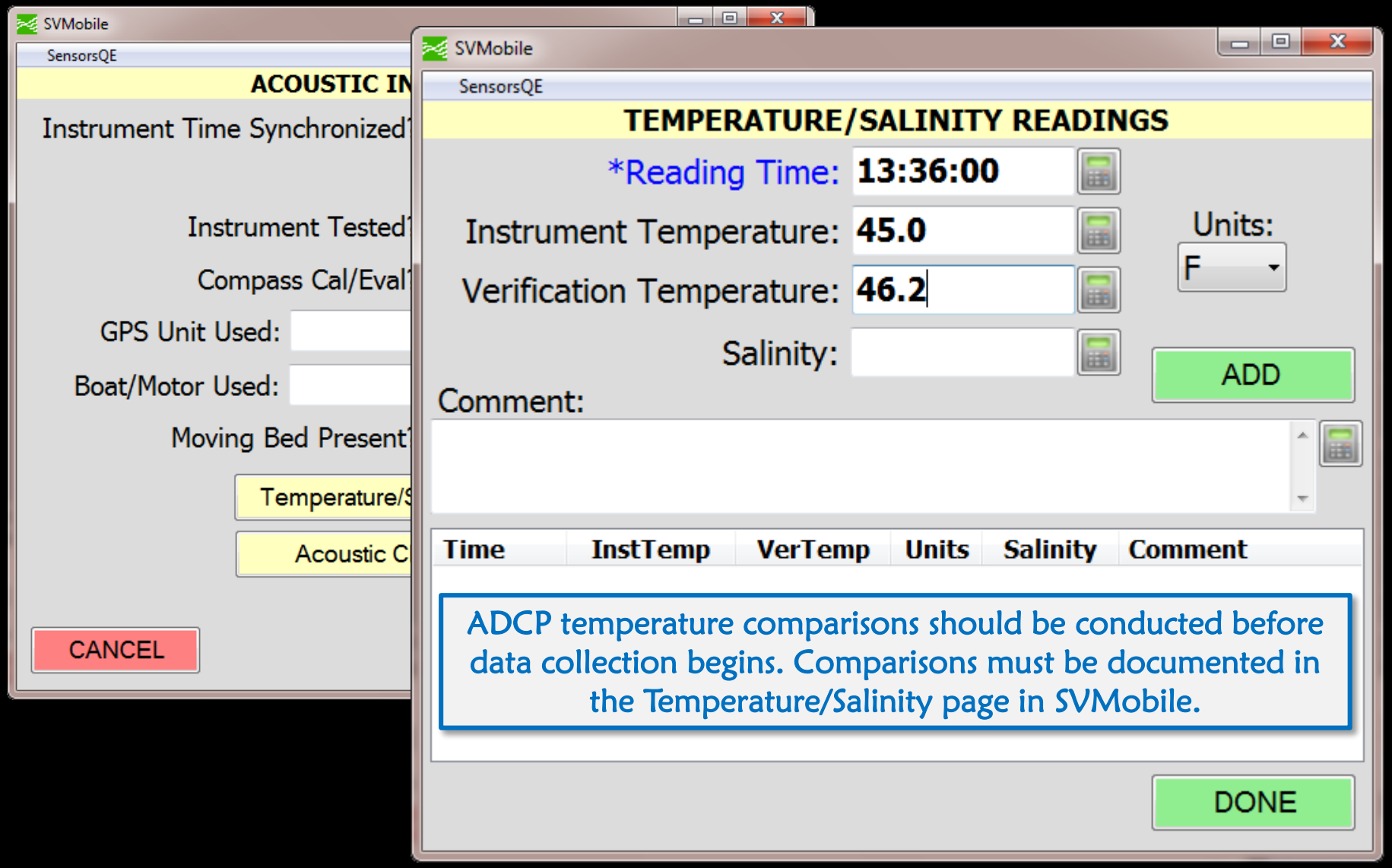


SVMobile – Staging ADCP Measurements



- 'Staging' allows pre-measurement tests and notes during Qm to be documented before Qm is finished

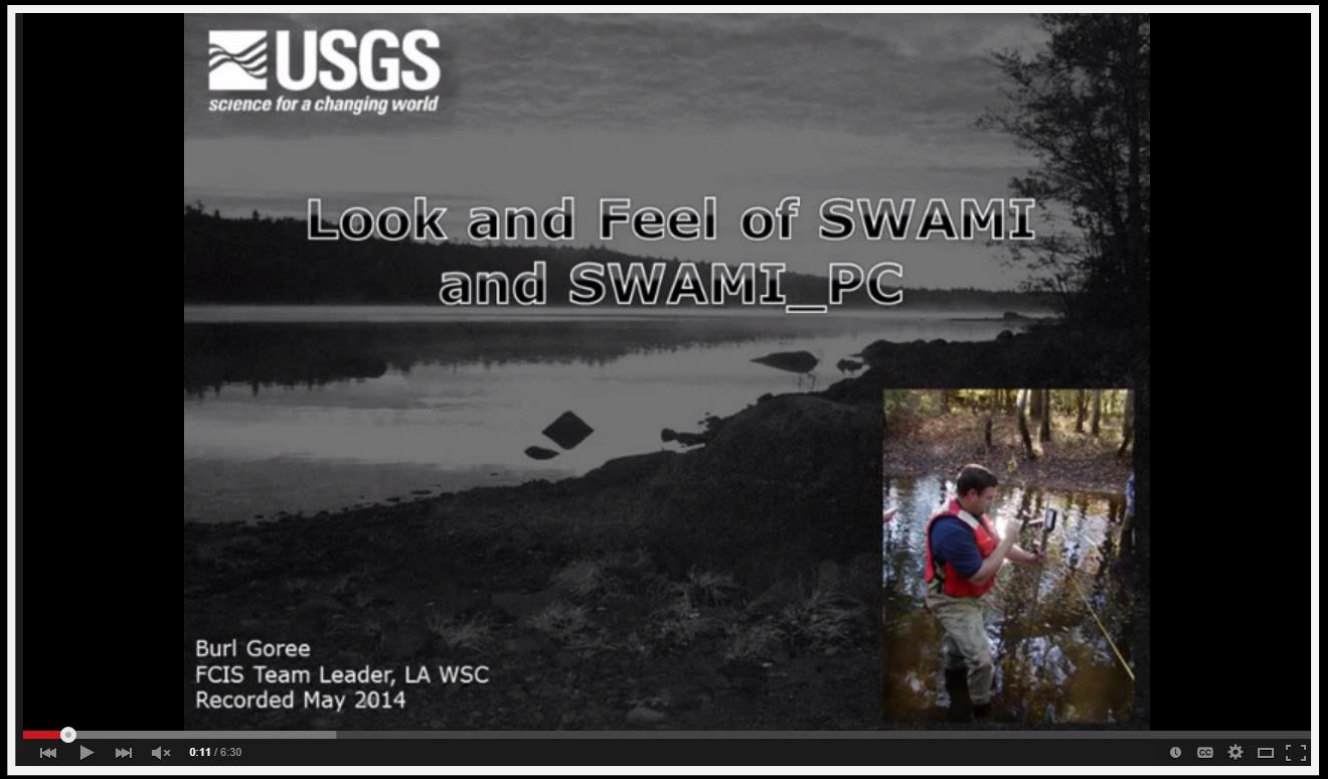
SVMobile – Temperature Comparison



SVMobile and HA Measurements

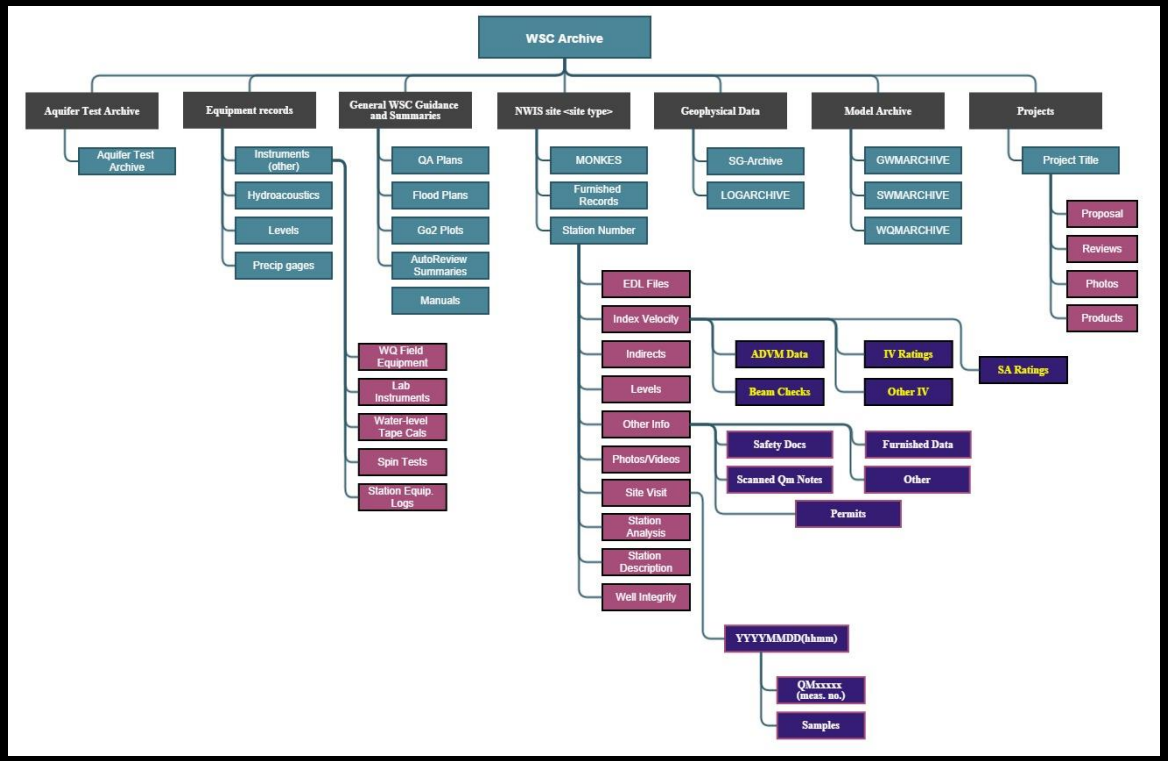
- Watch videos available on USGS HydroTube:

http://www.usgs.gov/humancapital/ecd/hydrotube/hydrotube-swami.html



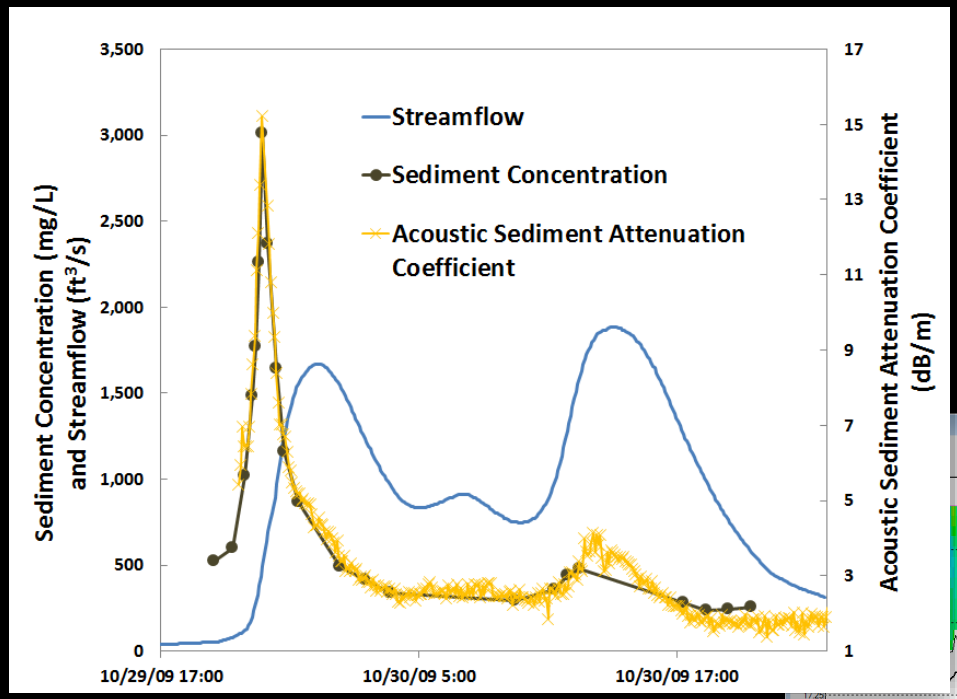
Electronic Data Archival

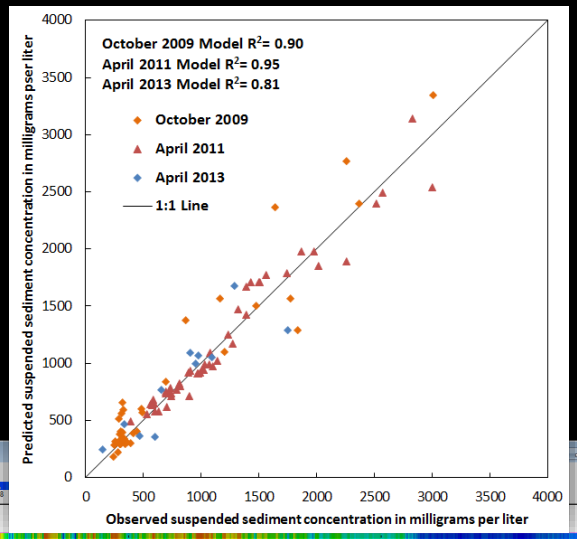
- Draft OSW Note has been prepared
- Final tweaks of "recommended" archival structure being made. Contact: Jim Kolva, OSW

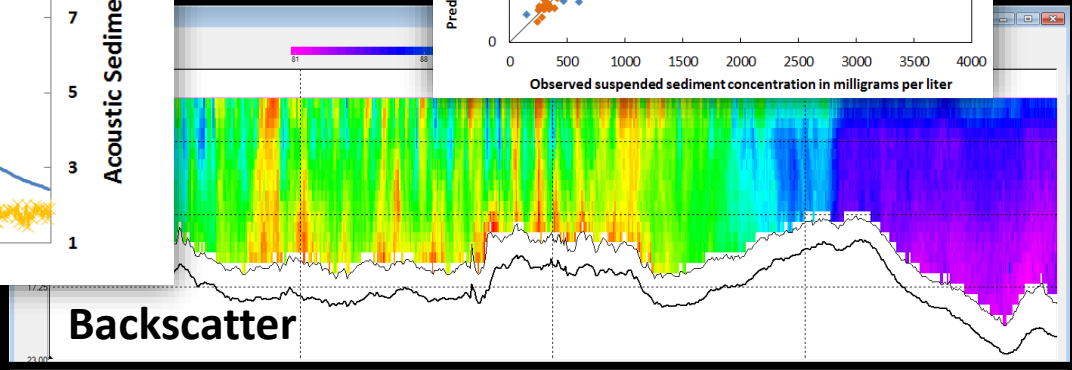


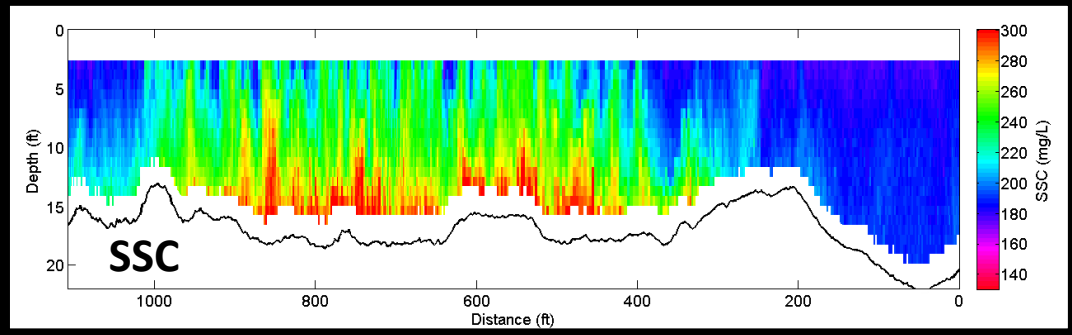
Sediment Acoustics

Estimating Suspended Sediment Concentrations



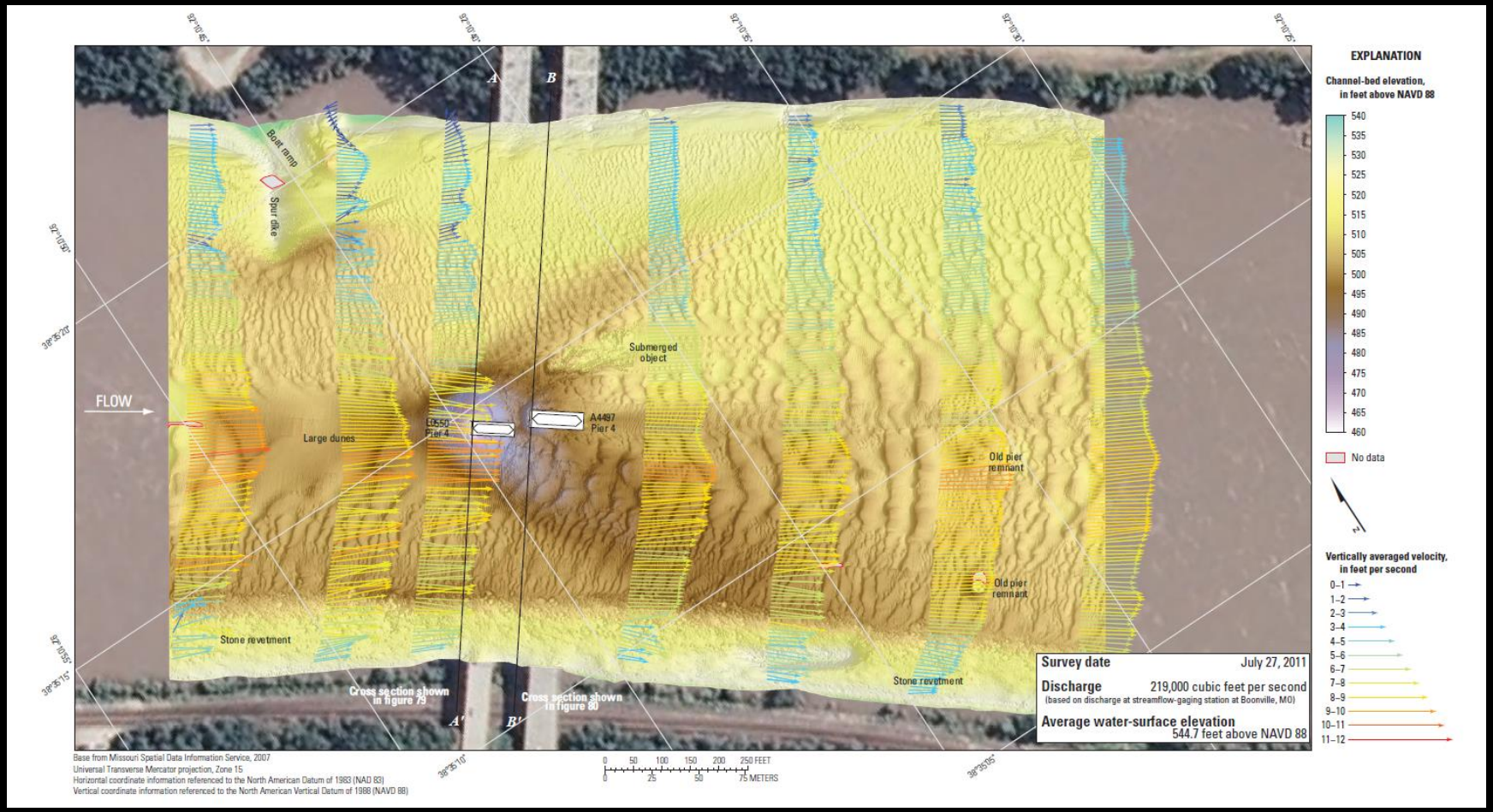






SALT
Sediment Acoustic Leadership Team

MBES and ADCP: Missouri River at US Highway 54



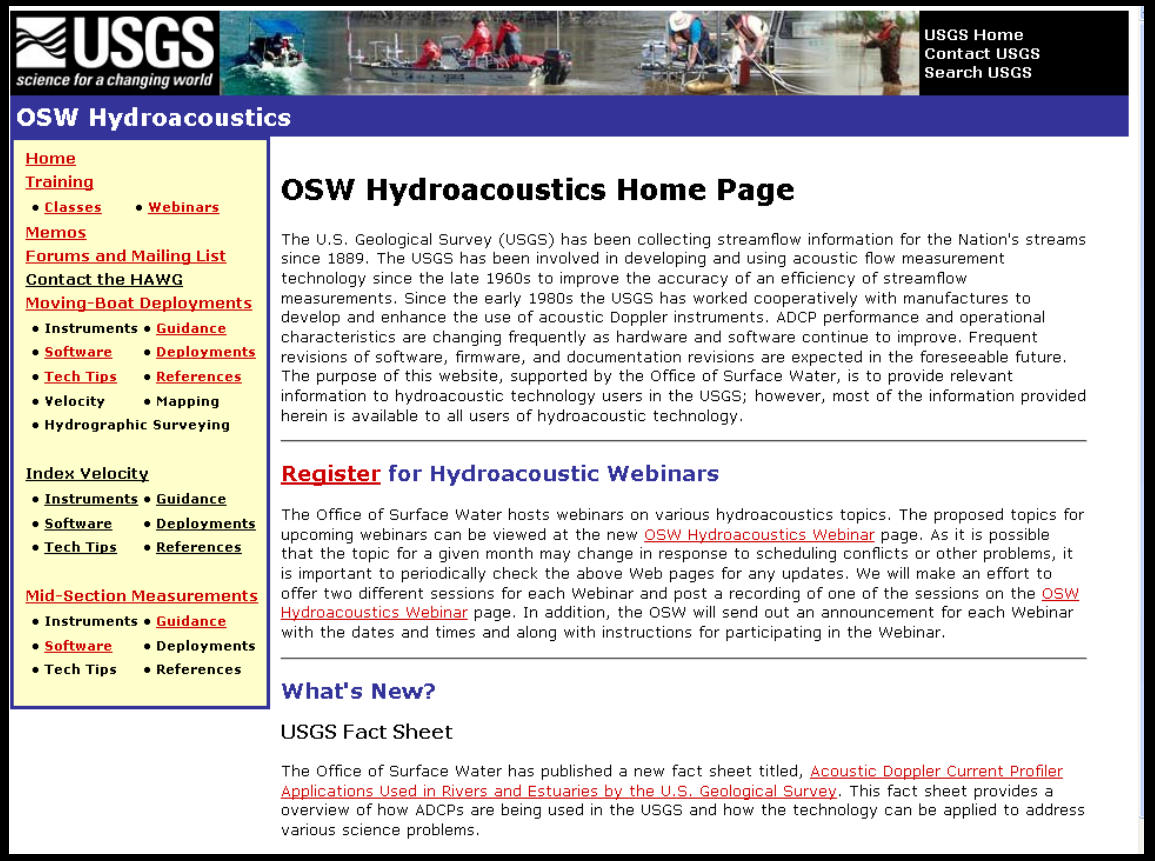
From: USGS SIR 2012–5204; (R. Huizinga)

OSW Support Activities

OSW Hydroacoustics Website

- Moved to a new server. Had some 'hiccups'. Most things working now.
- Mailing list is no longer working. Alternative???

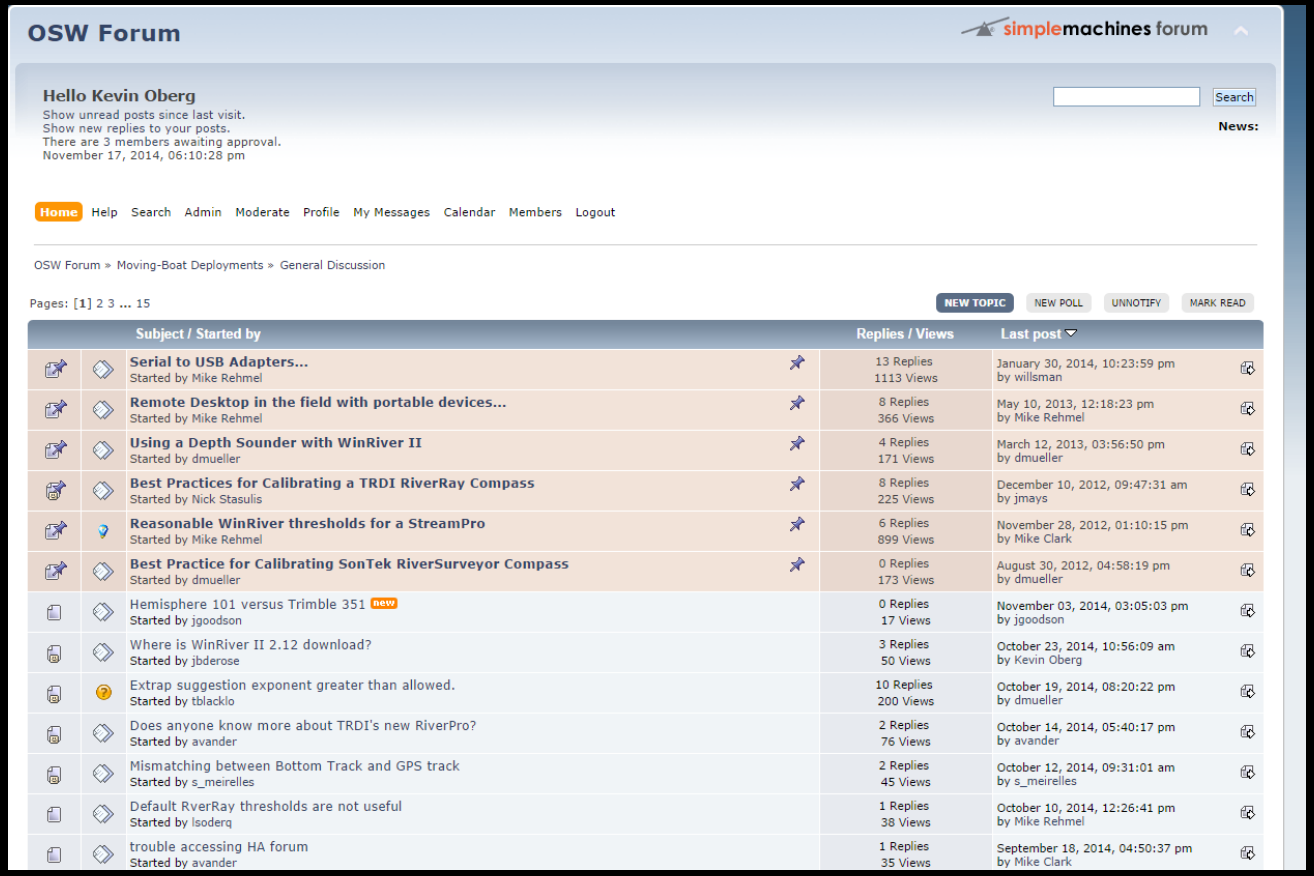
http://hydroacoustics.usgs.gov



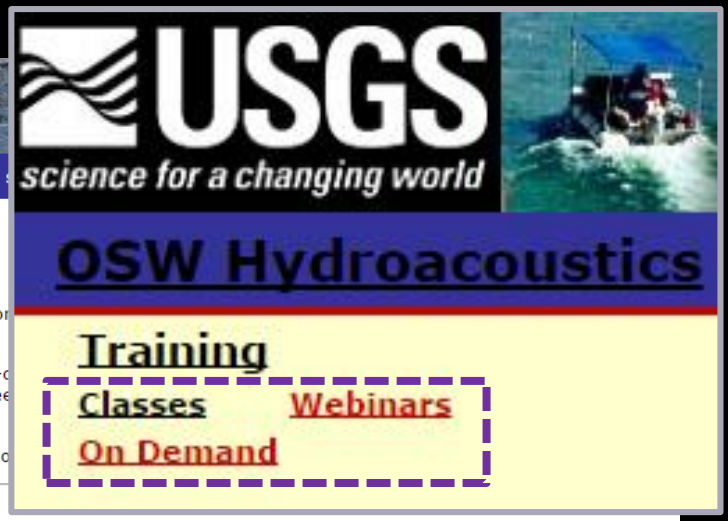
Hydroacoustics OSW Forum

- Ask
- Search
- Read
- Answer
- Software

http://hydroacoustics.usgs.gov/forum



On Demand Section under Training



Field Support/Development – Training

- Week-long class schedule is on hydroacoustics.gov; Open for registration in DOI Learn.
- 2-day refresher ADCP class offered in WSCs. If interested in class for 2015, Data Chief or Field Office Chief should contact Mike Rehmel
- Working to address increased demand for Index Velocity class
- Trained **311** students in 2014!!

Summary of Hydroacoustics Reviews

- Scanned OSW Technical Review reports for two review cycles, 2007-2009 & 2010-2012;
  - Major recommendations
  - Recommendations in Hydroacoustics section(s)
  - "Important" HA issues identified or referred to throughout the report
- Findings summarized in report: "*Issues, Improvements, and Opportunities in Hydroacoustic Practices from OSW Technical Reviews, 2007-2012*"

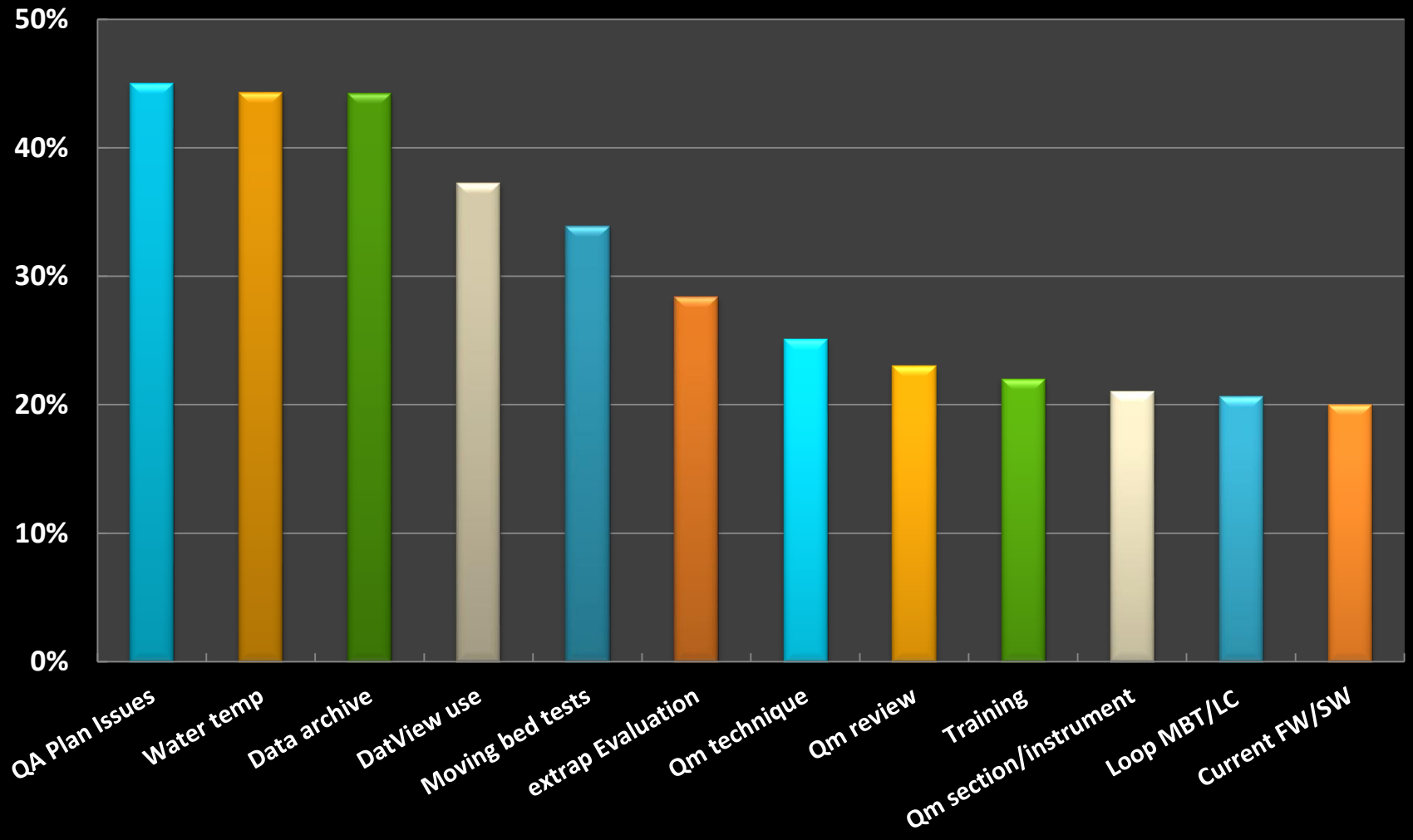
http://water.usgs.gov/usgs/osw/dist.rev.html

Categorized HA Issues

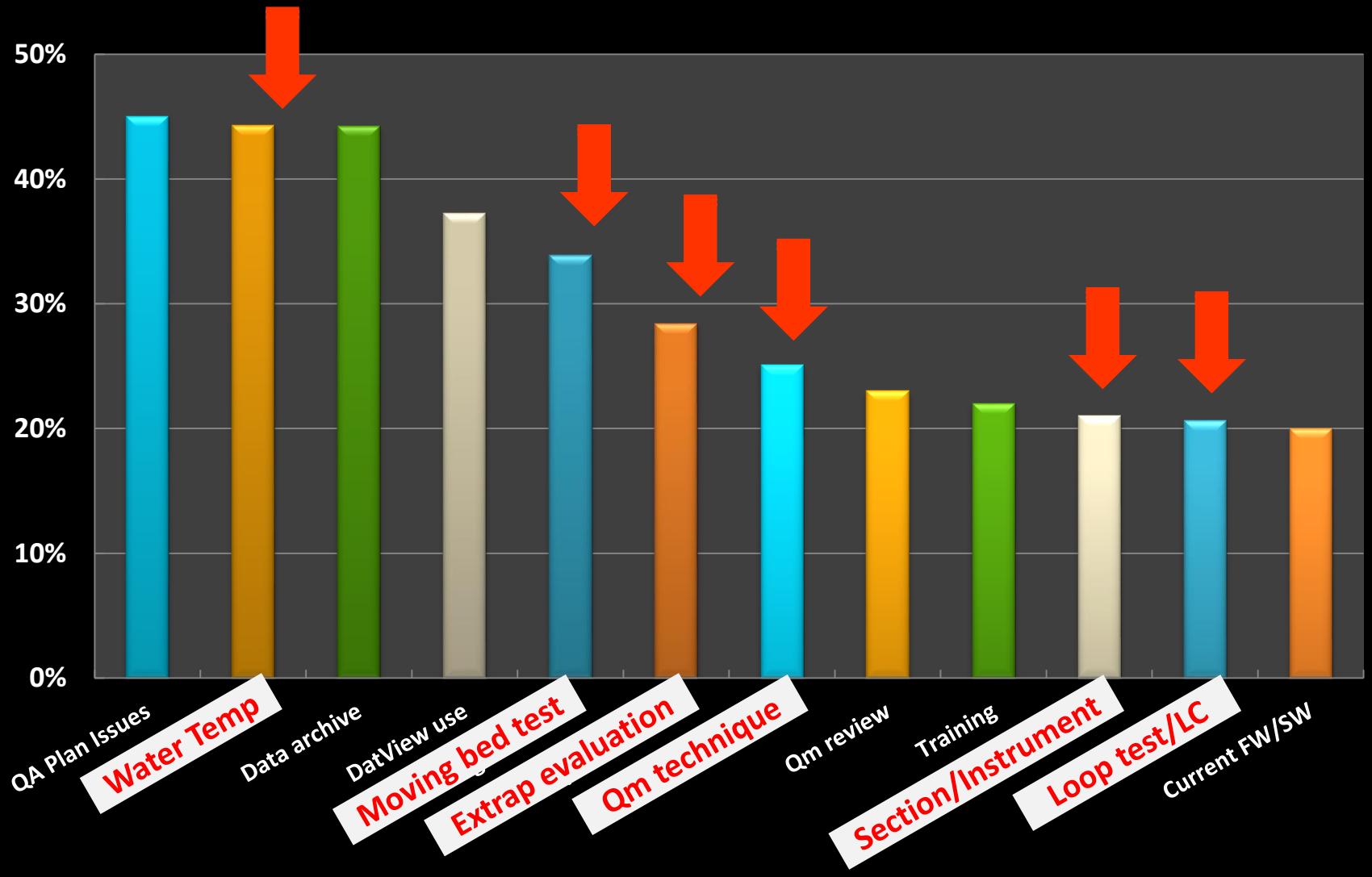
Issue	Category	Issue2	2012	2011	2010	To	49	2007-2009	2007-2010
Water temperature not being measured/recorded	General	Water temp	7	8	15	30	61%	14	
Problems with electronic data storage (no plan, inconsistent use, etc)	General	Data archive	9	10	9	28	57%	16	
Use DatView software for reviewing Flowtracker Qms	Flowtrackers	DatView use	6	8	11	25	51%	12	
Integration of Hydroacoustics into QA Plan or related QA plan issues (needs	General	QA Plan Issues	7	7	9	23	47%	22	
Evalu									
Movi									
Perfc									
Fill o									
Meas									
Lock									

Category	Issue2	2012	2011	2010	Total	49
General	Water temp	7	8	15	30	61%
General	Data archive	9	10	9	28	57%
Flowtrackers	DatView use	6	8	11	25	51%
General	QA Plan Issues	7	7	9	23	47%
ADCPs	extrap Evaluation	9	6	5	20	41%
ADCPs	Moving bed tests	7	6	6	19	39%
ADCPs	Comparison Qms	5	5	7	17	35%
General	Incomplete notes	2	5	9	16	33%
General	Qm technique	2	7	6	15	31%
ADCPs	Lock measurements	5	4	4	13	27%

Top Twelve Issues, 2007-2012



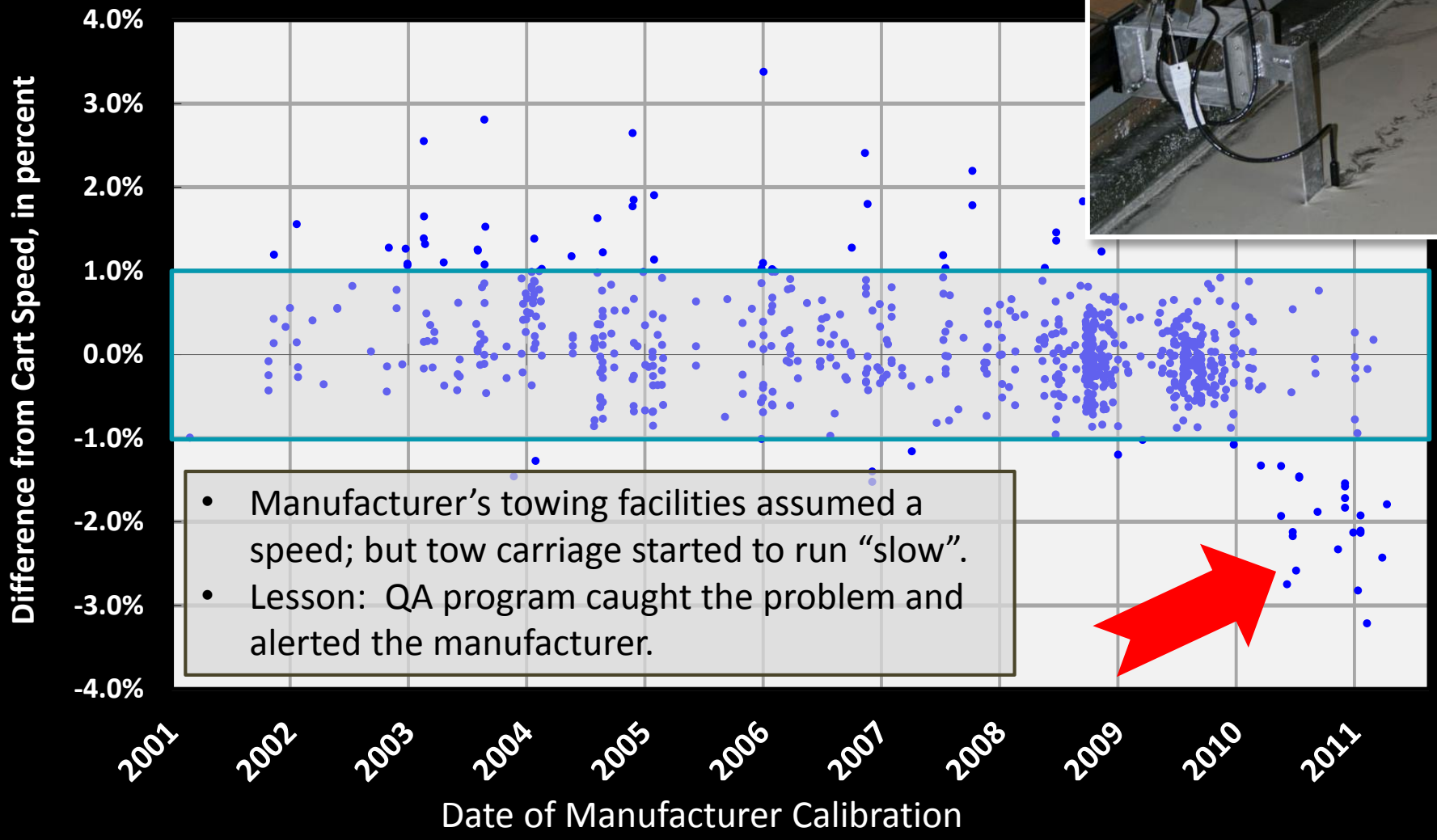
Top Twelve Issues, 2007-2012



Suggested actions

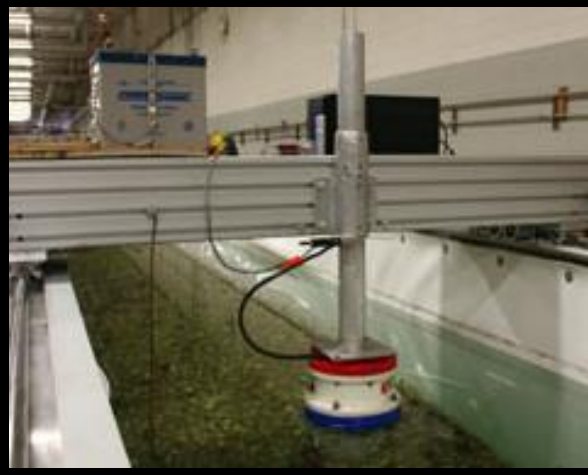
Review Issue	OSW Actions	WSC Actions
Moving bed tests incorrect or not done	Encourage increased compliance in training, webinars, and OSW reviews. Consider development of tool for WSCs to periodically sweep and flag measurement files for absence of moving bed checks Continue to enhance QA checks in LC and SMBA	Remind staff of the requirement to do MBTs. Institute procedures (such as independent measurement review) to insure compliance.
Failure to consider proper choice of extrapolation method	Encourage increased use of extrap by means of podcasts, webinars, training classes, and OSW reviews.	Make extrap available to all users. Require use of extrap before leaving gage, after a discharge measurement.

Flowtracker Testing



- Manufacturer's towing facilities assumed a speed; but tow carriage started to run "slow".
- Lesson: QA program caught the problem and alerted the manufacturer.

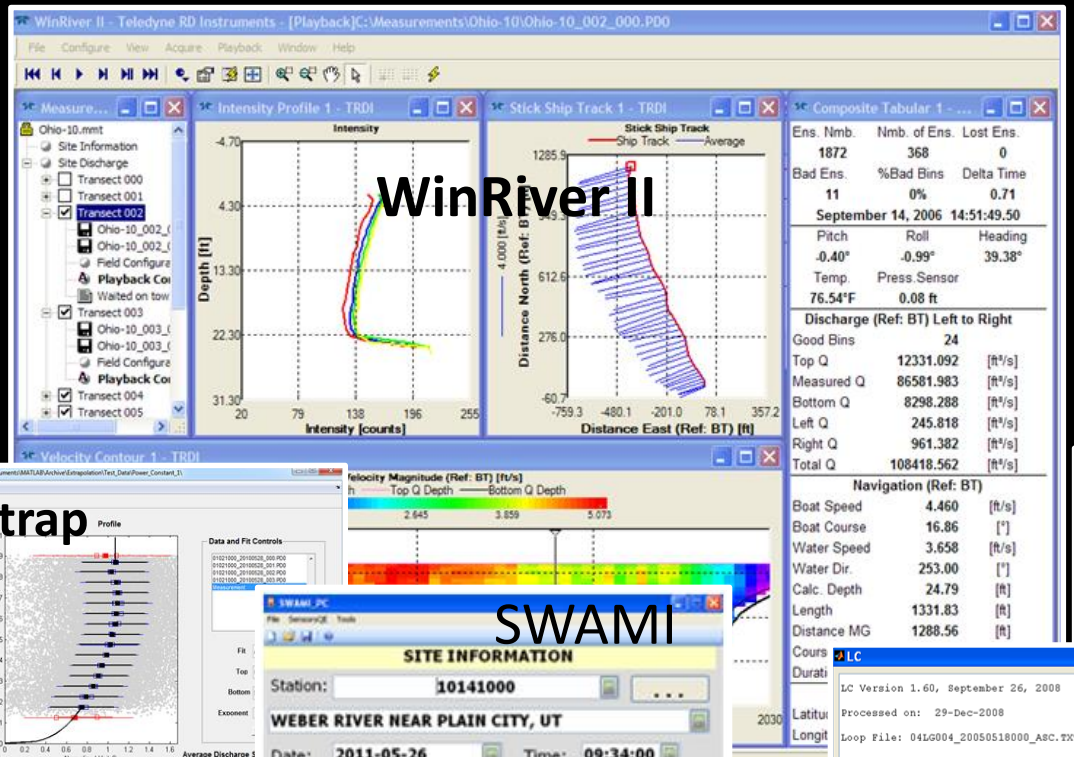
ADCP QA Program

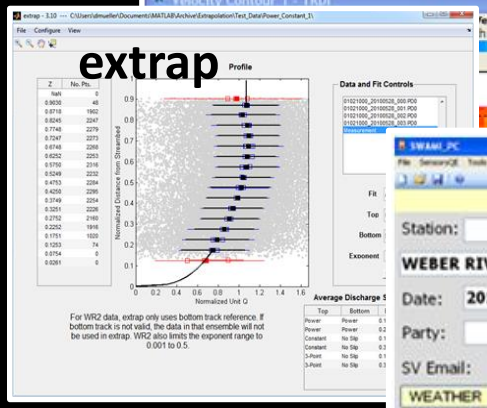


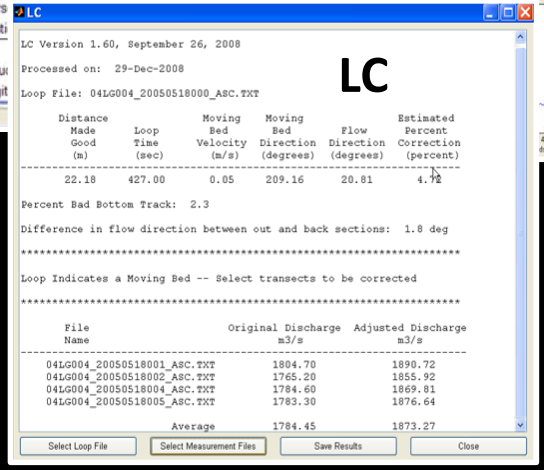
- OSW Technical Memo 2014.04
  - Established ADCP QA/QC Program
  - Every ADCP tested on 3-year cycle
  - Start with StreamPros
- What do initial testing results indicate?
  - 9% failure rate to date (54 SPros)
  - Incorrect beam transformation matrices?? Most older SPros

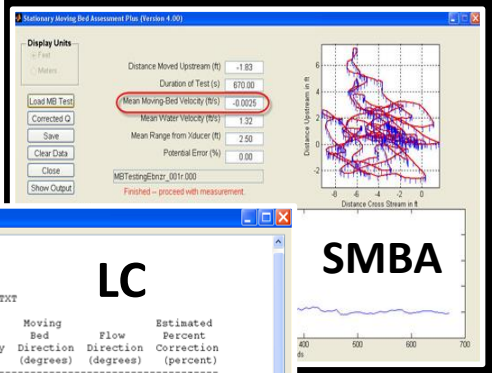
OSW 2014.04 States: *In addition to AQA checks on existing ADCPs, all new ADCPs purchased directly from the manufacturer and/or meters sent to the HIF or the manufacturer for repair, must be AQA checked in the HIF-HL before being placed into service for the first time or back in service. Meters purchased through the HIF will be AQA checked as part of the HIF's standard QA/QC process.*

Need to Standardize Qm Processing





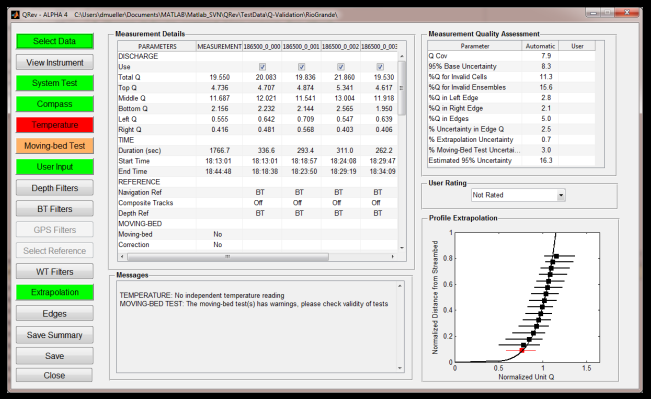




- Sometimes USGS has waited years for enhancements or fixes.
- We would like to have ONE method for discharge computation that allows for standardized processing for all ADCPs

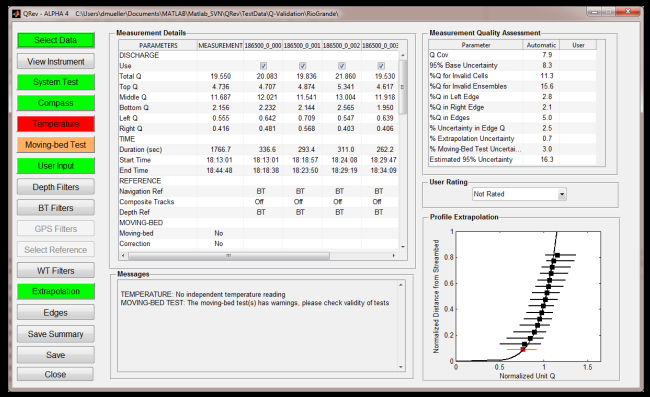
Solution? QRev Software

- USGS standard processing algorithms: Apply the same algorithms to data, independent of ADCP manufacturer
- Use the best interpolation methods with available data to estimate values for invalid data
- Automate data quality evaluation
- Automate data uncertainty estimation

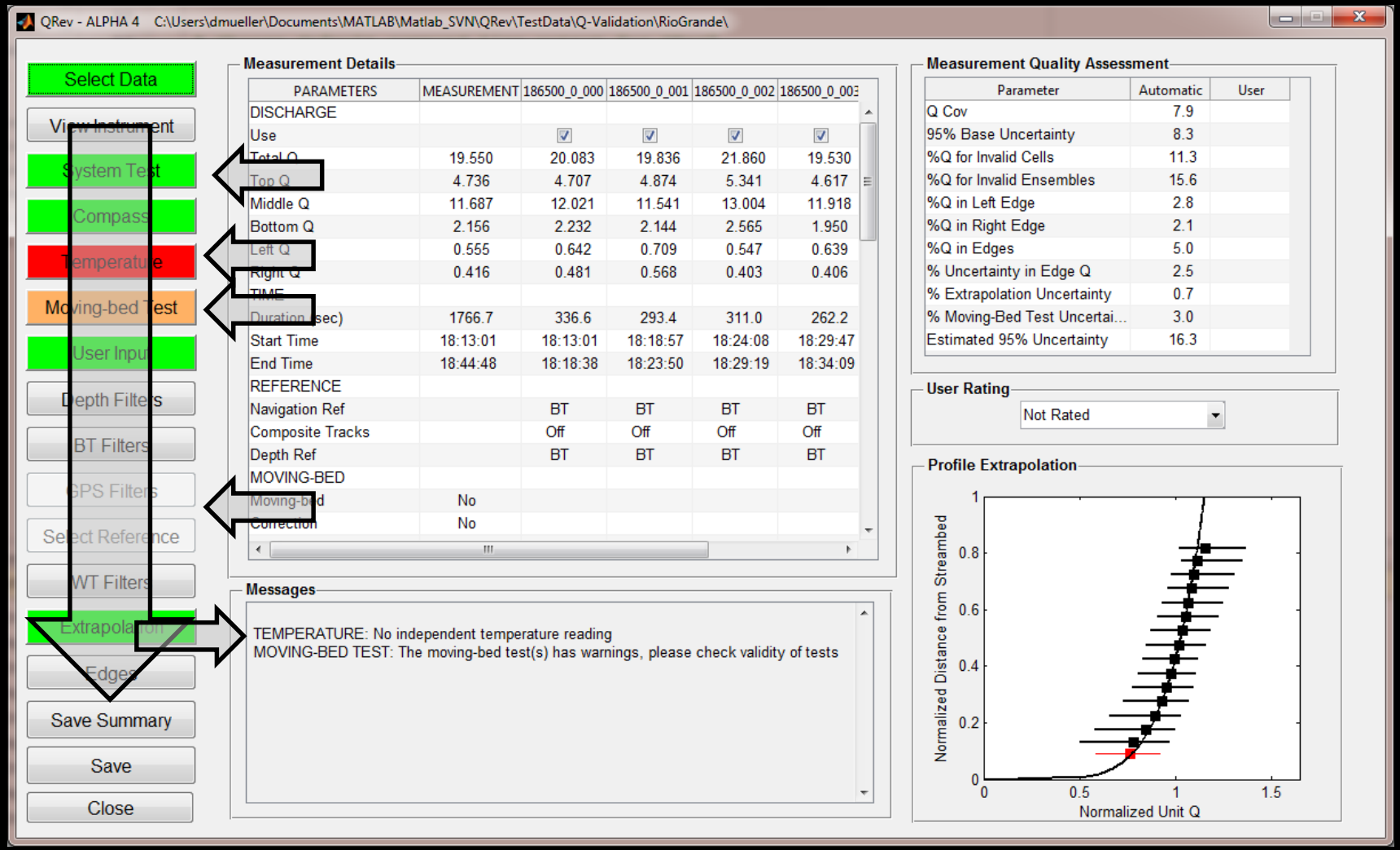


QRev – Goals

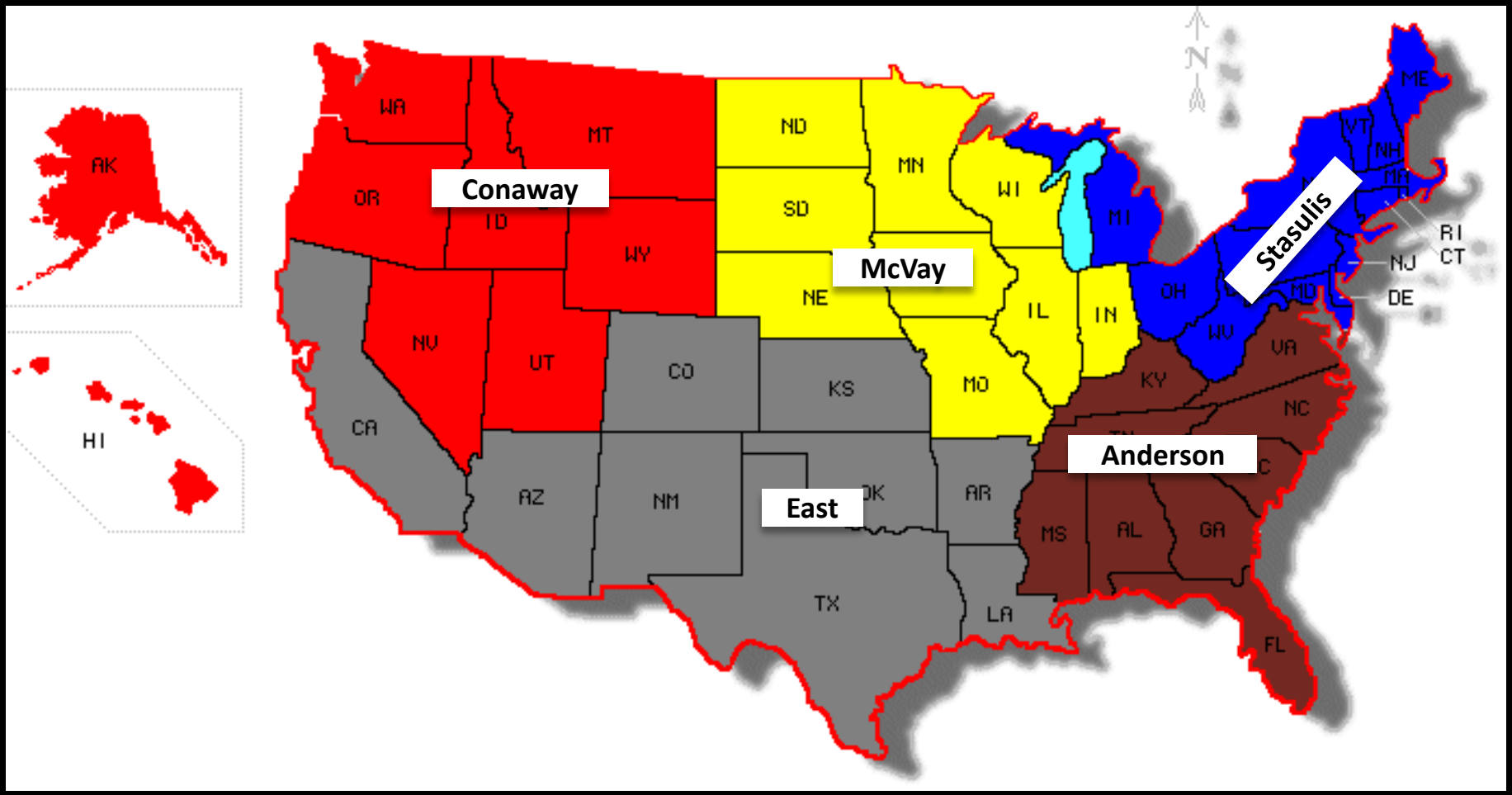
- Process both SonTek and TRDI data
- Use consistent algorithms for discharge computation
- Use best available data
- Have a logical workflow
- Automate data quality review and feedback
- Provide manual overrides
- Issue specific dialog windows
- Feedback to user on uncertainty
- Make it “tablet friendly”



QRev (Alpha Testing)



Hydroacoustic Work Group Rotational Members



Thanks!