Field trial of the Flying Fox,

A Portable Remote-Controlled Towing System for Tethered Boats

Jan. 4, 2012

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Introduction:

Hydrological Services has recently developed the Flying Fox, a remote-controlled towing system. Using a hand-held control (figure 1), the Flying Fox is designed to tow floating or suspended items across a straight span of rope. It was designed with tethered boats and ADCP measurements in mind, and that is the USGS's primary interest in exploring this product's potential. It may also be possible to use the Flying Fox for other water monitoring needs, such as sending a water quality sonde across an otherwise inaccessible cross-section.

On January 4, 2012, the Flying Fox prototype was used at the White River near Buckley, Washington across a cobble/boulder channel approximately 113 ft wide (area 368 ft^2, maximum depth 4.61 ft, maximum velocity 9.01 ft/s) flowing at 1,680 ft^3/s with a rough surface and surface velocities between 5 and 8 ft/s (figure 2).

Trial setup:

The trial site chosen was a cross-section that was un-wadable but which had opposite-bank access. From the left bank (looking downstream) a 0.22 blank-cartridge dummy launcher (figure 3) was used to shoot a buoy, with pull line attached (figure 4) , across the channel. Once a technician waiting on the opposite shore (right bank) retrieved the dummy and line, the pull line was then cut back at the launching site (left bank) and tied in to the leading end of the blue span rope (8 mm dia.) provided by the vendor. The opposite shore (right bank) technician then pulled the span rope across the channel and tied it off around a tree. Finally, the left bank end of the span rope was manually stretched taught and fastened to a small (2" width strap) come-along, which was secured around a tree 1 ft further shoreward (figure 5).

The Flying Fox was fitted to the approximately 140 ft long span rope (figure 6) and then the rope was brought up to the final desired tension using the come-along. A Teledyne RDI RiverRay ADCP boat was tethered to the Flying Fox (figure 7) and used to make a discharge measurement. Six transects were made, as well as a stationary moving bed test. The Flying Fox & ADCP operation occurred from the left bank.

Pros:

The Flying Fox facilitates smooth, consistent ADCP boat control by running at a dialed-in speed, without the jerks sometimes inherent in hand-pulling a boat across a tag line. Also, when a slower speed was desired in an attempt to get better data across a rough spot, the Flying Fox speed dial and read-out on the hand control was utilized.

Once set up, the Flying Fox facilitated as many transects as necessary with relative ease. A limiting factor in obtaining the necessary number of transects might be remaining battery power in the Flying Fox, but we did not run in to this when deciding to run the last two of the six transects. Because of the ease of running additional transects with the Flying Fox, verification transects are more likely to be made when called for.

Concerns:

(Note: Suggestions to remedy these concerns follow in the "Suggestions" section. Also, see the "Notes" section for how Hydrological Services is addressing some of these concerns.)

Tensioning capacity: On larger spans, a larger come-along is needed to ease the process of fastening the span rope to the optimum tension. The small 2" width strap did not have much take-up capacity, so that on our span of 140 ft, effectively fastening the span rope to the come-along took a few trials.

Potential loss of instrumentation: It is unknown how much force the set-up can withstand before the Flying Fox would be pulled off of the line spanning the channel. Of particular concern is what may happen should the tethered boat dive, suddenly exerting an exponentially larger force on the rope to pulley/pin connections. With the current set-up, we were unable to think of a way to attach a non-rigid safety cable or back-up line to the Flying Fox or to the ADCP equipment to protect against equipment loss should the Flying Fox come off of the span rope.

Battery power: We had adequate Flying Fox battery voltage for one measurement that included 22 minutes of exposure time and one stationary moving bed test. However, when done with our measurement, the Flying Fox battery would have needed to be recharged prior to another measurement. It is unknown how quickly the Flying Fox might recharge and technicians may make multiple ADCP measurements in one work day. Running voltage was roughly 1 V less than standing voltage. Prior to beginning, our standing voltage was at a full charge of 12.6 V (beginning running voltage 11.6 V). After six transects (total exposure time 1,340 seconds) our standing voltage was 12.0 V (running voltage 11.0 V). Finally, after running the Flying Fox out to mid-channel for a stationary moving bed test the standing voltage was 11.7 V (running voltage 10.5 V). During our trial the voltage seemed to drop more quickly near the end of the measurement.

Size of tether-attachment hole: Carabineers are the quickest / simplest way to attach a tether rope to a span rope or motor. The hole for this purpose at the bottom of the Flying Fox was big enough for a small carabineer, but would not accommodate a slightly larger standard size carabineer (figure 6).

Suggestions:

Tensioning mechanism: Since any come-along will be limited in its capacity to further tension a span rope, a method is needed to initially attach the span rope to the come-along at close to the desired tension. Feeding the rope through a climbing ascender attached by carabineer to the come-along (figure 8) will allow the rope to be fastened first (through the ascender) and then tightened to the maximum of the technician's strength. At this point the Flying Fox can be fitted to the span rope and the final desired tension can be reached by watching the motor current on the hand-held and using the come-along.

Safety catch: A rigid ring, similar to a locking carabineer, extending forward perpendicularly off of each 'ear' of the Flying Fox would provide a safety catch should the Flying Fox pulleys be pulled off of the span rope. The rings would be installed around the span rope at the same time as the Flying Fox is being installed on the span rope. Such a modification may not be needed if simply attaching a carabineer through each ear and around the span rope accomplishes the same thing. This latter suggestion would need to be tested to insure that the moveable carabineers did not interfere with the leading edge of the forward pulley.

Battery: A possible solution to making battery power last for a whole work day is to power the unit from a rechargeable battery pack, similar to those used on power drills. As power on one battery pack ran low, it could be switched out for one with a full charge.

Additional set-up suggestions:

Were the tethered boat to dive and stay submerged, a backup stop (knots/carabineers .. something large enough to not run through the safety catch) on the slack end of the rope coming out of the ascender is needed so that if the line were cut (shoreward of the ascender, along the come-along strap) any Flying Fox safety catches would run along the span rope to the end and then pendulum to one side of the channel or be in a position to be pulled in.

Notes:

The Flying Fox we tested was the original prototype. Its maximum speed was 0.67 ft/s. Prior to our trial we were told that the following improvements are already planned in to the manufacturing of the Flying Fox:

- maximum speed ~1.5 ft/s.
- At running voltage of 10V the handheld will sound an alarm, alerting the user to use the remaining battery power to bring the boat to shore.
- Although not the default, if the purchaser asks they may have the option to have a forward/backward toggle switch that only needs to be pushed once (and not held) to initiate and continue the forward motion of the Flying Fox.

After discussing our trial with Hydrological Services, they have done the following (per 1/17/2012 conference call between Mark Bryant, Ken Frasl, and Peter Ward,CEO, Hydrological Services):

- Tested the security of the Flying Fox: They found that once it is on the span rope with the pins in place that it will not come off of the rope, even with a large force applied.
- Are developing an attached retrieval line that would uncoil / recoil along the main span (to keep it out of the water) as the Flying Fox moved out / back in.
- Are developing an exchangeable battery for the Flying Fox.

Figure 1. The Flying Fox hand-held remote control


Figure 2. Measurement cross-section on the White River, approximately 1000 ft above the USGS gaging station 12099200, White River above Boise Creek at Buckley, WA


Figure 3. A 0.22 blank-cartridge dummy launcher


Figure 4. Pull line (20 lb. workload and 200 lb. tensile strength, available at most electrical supply stores) was fastened to the buoy, launched across the channel, and then used to pull the blue span rope across.

Figure 5. Span rope is connected by a carabineer to the come-along, which is secured around a tree.


Figure 6. The Flying Fox installed on an optimally-tensioned span rope

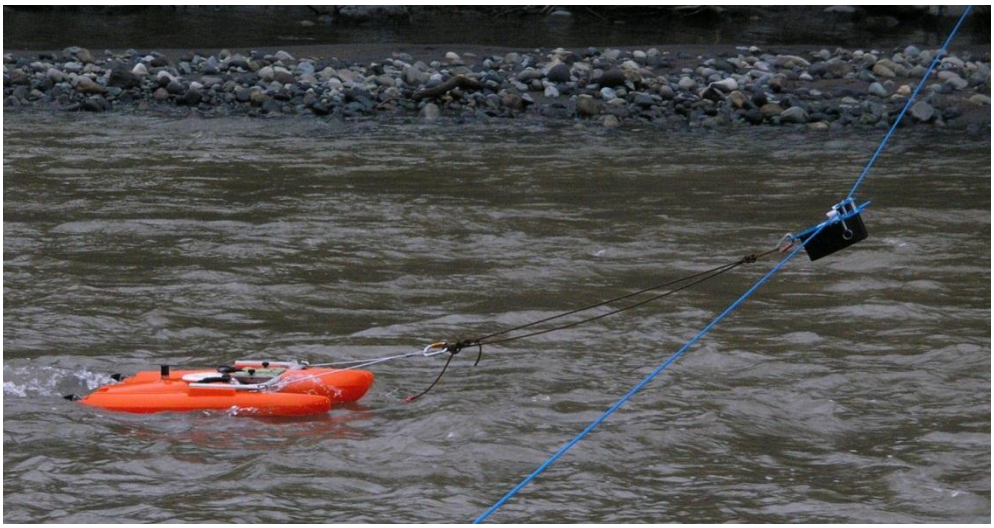
Figure 7. Teledyne RDI RiverRay ADCP tethered to the Flying Fox mid-channel

Figure 8. Climbing ascender