Swiftwater and Flood Boat & Rope 'Systems'

Part 6 in our on-going series on updating training and technology for swiftwater and flood rescue

By Jim Segerstrom

When the Tuolumne County, California, Sheriff's Search and Rescue Team was formed in 1975 virtually the first "discipline" we addressed was river rescue. The unique mixture of commercial whitewater guides and climbers lead to early discussions about lines across the river. After all, getting a rope across the river seemed such a logical thing to do! And reflecting on early river rescue training and calls around North America, there seemed to be an emphasis on, somehow, getting a line across before doing anything else!

This emphasis on cross-river rope systems is firmly ingrained in the psyches of rescue teams that even new documents like the National Fire Protection Administration's published document #1006, the "standards" for rescue technician, requires that a "swiftwater" technician be able to build "tyroleans" across a river!

Time and experience however have proven the opposite. The requirement for cross-river systems on actual swiftwater operations is relatively low. More often such "systems" come into play for either river searches or for evacuating stranded people from one side of the river to the other. The early applications of mountaineering river crossings involving rescuers clipped to ropes stretched parallel to the current soon proved more theoretical than practical, and in a couple of instances fatal. Thus, the "absolute" dictums: "Never tension an in-water crossing line at right angles to the current," and "Never hard tie or clip in to a fixed rope in current," came into being.

(Note: Post-Katrina there has some been limited discussion about the difference between an "evacuation" and a "rescue." Some pundits, including your author, argue that counting assisting victims from the tops of their houses as water rescues is inaccurate. A "water rescue" involves assisting someone in peril of injury or drowning from the water, or from a "situation" in which there is a chance that they might be injured or drown if they end up in the water. An "evacuation" involves taking someone from one "place" to another. Granted, some of the evacuations in New Orleans were urgent ones; and some of the people trapped in the attics of houses or bed-bound qualify as rescues. The helicopter hoists at Boscastle were rescues, since anyone going in the water would likely have drowned; whereas in New Orleans most of the victims were sitting on their roofs surrounded by water less than 4 feet deep and not moving. But better definitions are in order.)

As mentioned, cross-river rope systems do have application: They are used for setting boats in a particular spot for river searches. They have been used to manage downstream safety during river events and swiftwater rescues and also at the base of dams and weirs. And most often they are built for simple transportation and evacuations.

"First, Get the Line Across"

River rescue books and articles galore feature that simple statement as the first instruction. In some instances it may as well read, "first launch a rocket to Mars." That simple task often takes a disproportionate amount of time, simply because the rescue team hasn't determined their options before and prepared accordingly. A vast array of options and devices exist, as I detailed recently in an article for a stateside rescue magazine. Devices range from the obvious to the obscure, including the excellent ResQmax compressed air line gun. (www.rescuemax.com) and other various purpose-made line guns, down to a home-made "mortar," manufactured from sewer pipe, and the bizarre "potato gun," made from PVC pipe, powered by hair spray, and so popular with American delinquents of all ages! (Simply "google" the expression "potato gun," and stand back.) We have also used a variety of arborist's devices and bean bag launchers that are used for training hunting dogs.

In the "simple is better" category a combination of the Life Safer rescue disc, (www.life-safer.com) and the REACH from the opposite bank, (www.crosslinesolutions.com) has extended our basic rope crossing capabilities over 140 feet on several occasion. We have also experimented with a variety of catapults, cross-bows, tear gas launchers shooting cola cans, and other ad hoc devices.

Suffice it to say that everything written after this point is COMPLETELY dependent on what has been written up to this point!

Get the line across the river!

THE SIMPLEST TYROLEAN

My definition of a "tyrolean" is a tensioned line from point to point. That means that a cross-river tyrolean can be 600 feet in the air, or 6 inches, and still meet the definition.

For the sake of simplicity and ease of use any time we can avoid making such a "system" a "life line" it is worth doing, and requires significantly less effort. A "lifeline" situation is created, according to many rope rescue experts, when the failure of the system will lead to injury or death of someone on the system.

This definition in turn has lead to strict dictums regarding doubled ropes, redundant anchors, backed-up knots, and tandem prusik hitches. As the result, building a tyrolean has gone from an exercise to a project, sometimes taking hours to complete. In the U.S. fire service all of these strictures must be in place if the human "load" is going to be more than a dizzying 8 feet off the ground!

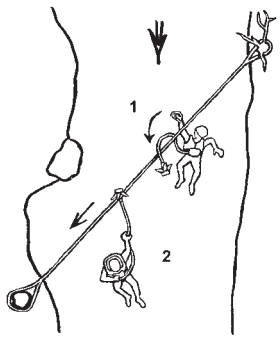
The first point to note is that providing you don't use a toothed ascender ***the rope won't break if we over-tension it. Ever.***

The second point is that the ropes in the vast majority of river rescue applications will NOT be "lifelines." If they break, (and I hope you get film of that because I'd like to see it,) the worst that can happen is that the boat and passengers will go off down the river!

Those two points simplify things indeed.

Once the rope is across we next determine the location of the best available anchors, and the direction the water is moving, the "current

vector." Remember, the water CARVES the turns; it doesn't follow the channel. Thus the current may actually be moving at angles to the banks. Having determined anchors and direction of flow the rescue team can then set up a basic tensioned rope, ideally at 45 degrees, or less, to the current. We started calling this the "tensioned diagonal traverse." It is based on a river crossing method first demonstrated to us when we were teaching an instructors course to cadre at the U.S. Marine Corps Mountain Warfare Training Center in Bridgeport, California. Their technique involved fully equipped



marines clipping into the rope with a carabiner at their waists. The technique was guaranteed to get the troops across even if some arrived on the far bank fully submerged!

We adapted the technique so that we could slide across, either by ourselves, on a river rescue board, or attached by the "cow's tail" on the swiftwater rescue jacket, while holding on to a patient. ***(See title pic)*** The rope is anchored on the far side, ideally with a simple tensionless hitch, and then tensioned with a simple 3 : 1 mechanical advantage system, just using carabiners and prusiks, the same gear carried by most whitewater and climbing guides, or with smooth profile cams as shown in the title pic. Once everyone is across, the far side unties the "no knot" hitch so that the last person can break down the carabiners and prusiks and swing back across holding on to the end of the rope.

The system certainly can be used for mountaineering stream crossing, but prudence suggests just holding on to the rope, and if one falls to go down the line hand over hand to the far side.

Building this system provides technical practice, and has some good applications, and so the tensioned diagonal line has been part of the course since the 1980s.

When instructors in Los Angeles tried to adopt it as a back-up system in the high-speed flood channel system, they ran into problems. First was hooking in. The rescue swimmer had just a moment to hook on as he went under the rope at speeds in excess of 25 miles per hour. The cure was the use of larger "ladder" carabiners or the large, billed "Sky Hook," used for helicopter rescue.

The next was the pull exerted at high speed if they did hook in. The best solution for this problem was to use a longer rope and tension it at an angle of 30 degrees or even less.

The worse problem was almost impossible to overcome. Most of the flood channels have vertical walls. So if the swimmer was able to hook in and deal with the pressure while sliding down the fixed line, he would end up hitting the wall and stopping. At that point water pressure takes over and it is virtually impossible to pull someone out.

USING A BOAT

The solution was to use an inflatable boat. The resulting "system" simply involves the boat on a pulley. Crew-members stay to the back, downstream end of the boat, to keep the nose from burying.

Rescuers on the upstream simply hang on to the rope, lowering or pulling upstream using gloved hands for power. No friction device is used. If the drag on the boat is severe more rescuers are added.

The boat crew signals to position the boat in relation to the victim coming down stream, either right or left-up the rope or down. As soon as the victim is alongside the boat, the upstream rescuers simply let the rope run free. The boat is then moving down the line at nearly the same speed as the current, thus reducing the drag on the swimmer and allowing the rescuers to pull the victim into the boat. The boat goes up against the wall with the victim in the boat, who can then be extricated by rope or

A variation of a *Tensioned Diagonal* used in conjunction with second rope at water height and with tension and control provided by rescuers at each end. The webbing helps maintain an easily grabbed form. Once captured, the victim is moved down the diagonal to the far bank .

ladder up the wall.

This "system" has proven so adaptable that it works as a great downstream protection system at virtually any situation where a line can be strung across the channel.

THE TWO-POINT AND FOUR-POINT ROPE SYSTEM

The first "system" widely taught and this is a complete no-brainer: a boat with either two or four ropes attached to it, two upstream, and, if necessary, two downstream. I first saw it when I took one of the earliest classes taught by Dive Rescue International in 1976, and it pre-dated even that program, being used for river rescue in Ohio and Pennsylvania prior to that.

The Two/Four Point is simple to set up; but a challenge to manage effectively. It works best in a straight-side channel with few obstructions, up to hard Class II.

It also works well in narrow low head dams and weirs. A self-bailing inflatable raft, such as the Oceanid RDC (photo above) is HIGHLY recommended, since a non-bailing raft or a rigid boat that somehow fills with water is impossible to hold even in slow currents.

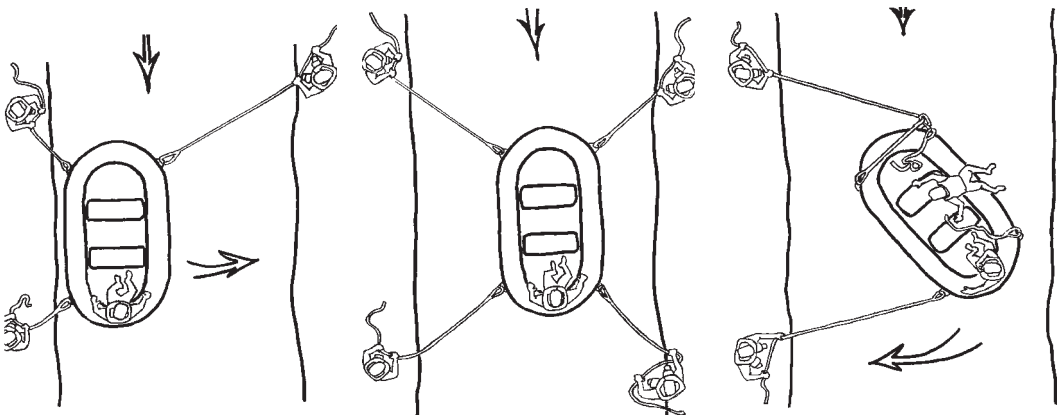
The places it doesn't work are more numerous-Class III whitewater, with lots of midstream obstacles; turns in the channel, and widths greater than 200 feet.

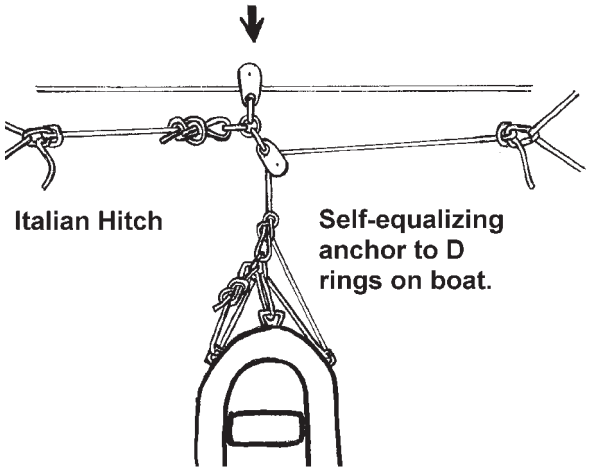
I generally teach the Two/Four Point as follows:

1. First you get a line across the river …(and so forth.)
2. Once there are at least two people on the far bank, the boat, with all lines pre-tied, can then be pulled across the channel. At least one additional passenger can go in the boat. Note: As the boat approaches the bank it will be downstream, so, for the first "trick," in order to pull it to the bank it is often necessary for one person to stand fast while the other walks down the line, "vector pulling" the boat to the bank. Fig 1
3. The boat is then pulled back and forth until there are enough people on each corner, the larger numbers being on the upstream lines.
4. At this point the second "trick" is management of the ropes, the opposite corners pulling against each other in order to keep the boat straight to the current. Fig 2.
5. The boat can then be pulled up or downstream, into the eddy on the downstream of a car for instance, in order to affect a rescue.

Breaking the system goes just in reverse except for one small "finesse" move at the end.

a. Rescuers from the far side downstream rope are recovered first.
b. Excess rescuers from the far side upstream rope are then brought back.
c. For the final "trick," while one rescuer on the far side holds the boat, the other moves the rope from the near side to the far side of the upstream end of the boat. When the boat is pulled by both ropes it will automatically assume the correct ferry angle and swing to shore. Fig3





THE HIGHLINE TYROLEAN WITH BOAT ON TETHER

A number of "tyroleans" involving a boat have developed over the years, and all of them work just fine. Like the 2 and 4 point system, highlines involving boats have their own pros and cons.

Tyroleans with boats don't need to involve anything like the amount of redundant safety measures so beloved by rope "specialists" around the world, since, if the tyrolean rope should part due to the catastrophic loads put on it by a self-bailing raft and one or two people, (yes, I am being facetious,) the worst than can happen, as mentioned earlier, is that the boat will go off down the river.

A Cautionary Tale : With that thought in mind, a cautionary tale for all you readers who love complex rope systems. This story falls into the category of "kids don't try this at home," or "near misses you won't read about anywhere else:"

A few months ago, in a city in the eastern part of the United States whose name will go unmentioned, there was an USAR task force that decided to get into the swiftwater rescue business without the benefit of seeking outside expertise or commercial training. After all, as USAR members, they had been imbued with all knowledge. It was necessary only to send one or two members to somebody else's course, and then apply that information to create their own, "unique and special" in-house program. [ED: Jim's undisguised skepticism highlights a very valid concern we've always had with 'cascade training', particularly within fire services and we will be looking at this subject in the next issue.] Additionally they chose to buy a couple of specialized sled-style inflatable rescue boats, since one of the departments close to them used those boats, and that department was recognized as one of the nation's best at swiftwater rescue boat operations. Note: They bought the same boats but, again, didn't get any specialized training in their use.

Moving to a nearby power plant where the cooling water channel had been adapted years ago as a kayak training course and which was also used for local swiftwater rescue classes, and using a diagram in a popular flip-chart rescue book, they built their high line tyrolean with boat on tether system.

Using a truck for an anchor on one side they tensioned the line using tandem prusiks on both sides. The tandem prusik system for holding tension is particularly beloved in the U.S. since it is supposed to provide shock absorption and warning in case the rope is over-tensioned. All of this concern has grown from a series of tests conducted in Canada several years ago where it was proven, (at least to the satisfaction of those conducting the tests,) that dropping a piano 1 meter on a single rope, and trying to catch the fall with a Gibbs ascender, would cause catastrophic rope failure. However, tandem prusik loops would prevent such a horrible outcome. So now rope systems in the U.S. fire service are festooned with prusik loops.

In any event, having built the system they attached the rescue sled, with its motor on the transom, to the control point rope, loaded it up with four rescue team members-a collective weight of around 1000 pounds, and pulled it up through the final rapid on the race course using other team members for straight muscle power.

Then they attempted to lower the boat back through the rapid, again using hand power, with the tandem prusiks as "back-up."

As they started the lower the upstream end of the boat was pushed below the surface and the boat rapidly filled with water, adding at least another 2 to 3,000 pounds of weight. The firefighters attempting the lower couldn't hold it and the tandem prusiks grabbed the rope. More water went into the boat increasing the weight still more.

As the vehicle acting as an anchor started crawling towards the edge of the channel, the prusiks simultaneously exploded and de-sheathed the main line and the control line, and the boat flipped, trapping one of the team members in the ropes underneath in the middle of the rapid. Finally, and fortunately, the entire system failed, including the attachment points on the boat, and it washed downstream into calm water, leaving a number of rope rescue "experts" shuffling their feet in the dirt, whistling, and looking up into the trees.

This incident actually happened. The moral is that using ropes in each rescue environment requires thorough training in the hazards of that environment FIRST.

The tyrolean with a boat attached requires technician-level competencies in both rope and swiftwater. If not practiced regularly such systems can take some time to deploy, and anchors and applications should be pre-planned in potential rescue locations.

However, on the plus side, with such competencies in place and concerns addressed, the tyrolean with a boat can be set up over distances of several hundred feet, requires less people to manage, can be run in water up to Class V, in significant gradients, on turns in the river, and with multiple mid-stream obstructions.

The simplest system goes together as follows:

1. First get a line across the river, (here we go again.)
2. Next attach two ropes to that "messenger" line and send them across. The two ropes are sent for two reason, if successful, one will act as the tyrolean line and the other will act as the far side control line. And if one line drops, we still have a line across the river.
3. Ideally, the far side anchor should be as simple as possible. I favor a tensionless hitch around a tree or post.
4. The tyrolean line is tensioned using, for instance, a Figure 8 or autolock to hold the tension, and a "piggy back" system to tension the rope. (Picture above) Using a Figure 8 or autolock allows an easy release of tension on the highline if necessary. Notice, so far we haven't used a prusik loop.
5. Meanwhile other rescuers rig the movable control point to the tyrolean line, made up of two pulleys, three carabiners, and either an "O" ring, a webbing loop, or a rigging plate as a gathering point. Additionally, the rig plate, (in this case the Pelzl Paw) or an "O" ring keeps carabiners from side-loading when the control point is pulled along the tyrolean line. Because of the "legs" coming off of it, this movable control point has long been referred to as "the octopus."
6. The up and down control line is rigged to the nose of the point on a load-sharing system, either using webbing, or the end of the rope, as illustrated.
7. Unlike some systems this one does not have separate lines for back and forth and up and down. Instead the near side control line does both. By taking in and playing the two lines out at the same rate the boat can be kept in the same position relative to the banks.
8. Friction on the two control lines is handled by using Munter hitches.
9. If the current is too slow to keep the boat downstream relative to the high line, (remember, there is VERY little drag created by an inflatable boat,) or if working up into a dam or falls, or if rescuers wish to "lock off" the boat in a single position for a river search, one or two downstream control lines can be added to keep the boat positioned. (Illustration)
10. The system can be broken down two ways:
    a. All lines except the highline can be pulled back to the near side, and end of the tyrolean line can be attached to the boat, which is then swung to the near shore, or
    b. All lines and the boat can be recovered and the last line sent back "clean," (no knots) with the last rescuers swimming back or returning by another route.

Of the "systems" listed, the two and four point goes together the quickest, with the tensioned diagonal next and the highline with boat taking the longest, if the rescue team doesn't practice adequately. Successively however, the systems are more exacting, the highline with boat being the easiest for skilled river.
rescuers to use.

In the next segment of this series we will unhitch the boat from the ropes and go forth to make the rescue with paddles, oars, and motors, a definite escalation of risk. TR