

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

John Rousmaniere, September 18, 2012

Concern about safety on the water is hardly new, but it has taken on urgency in the wake of five accidents (four of them fatal) since June 2011, including the loss of a young sailor entrapped in a capsized Club 420 at Annapolis, Md. In response to that accident, and to provide information and photographs for instructional materials, volunteers recently conducted three days of on-water tests of dinghy safety methods and equipment in California and New York.

On July 13, Chuck Hawley (chair of U.S. Sailing's Safety-at-Sea Committee and a safety-at-sea seminar moderator) and five other volunteers tested capsize recovery methods with a Flying Junior and a RIB at the Stockton, Cal., Sailing Club.

On August 27-28, Timmy Larr (a member of the National Faculty of U.S. Sailing's Training Committee), myself (author of a report on the Annapolis accident, a member of the Safety-at-Sea Committee, and a safety seminar moderator), and more than a dozen other volunteers conducted trials with 420s and powerboats at the State University of New York Maritime College, Ft. Schuyler, N.Y., and American Yacht Club, Rye, N.Y.

The volunteers participated as individuals, not in official capacities. We have a broad range of experience in sailing, training, and rule-making in boats of many kinds, from dinghies to ocean racers. These tests were meeting grounds where we compared our knowledge outside the narrow "silos" of our specialties and experiences, and looked at safety concerns through fresh eyes.

Participants came away with hard data and preferences concerning a number of questions, including: "What is the best way to rescue entrapped sailors?" "What is the minimum weight for bringing a 420 back from a turtle?" "How helpful is it to add buoyancy to the top of the mast?" "Which boat-righting methods work with different types of powerboats?" "How do we handle disabled or helpless sailors?"

Contents

- 1. Recovering people in the water, 2**
- 2. Righting dinghies from capsize and inversion, 7**
- 3. Sailor entrapment, 13**
- 4. Recommendations, 19**
- 5. Acknowledgments, 20**

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

1. Recovering People in the Water

Techniques and equipment for recovery of a person in the water, with and without a second rescuer and special equipment, were tested using a hard-sided whaler-type boat at SUNY Maritime and a RIB with a T-top at American Yacht Club. The testers observed several standard safety rules: Rescuers should evaluate the situation before taking action. A rescuer should not go into the water (that puts another life at risk and adds to the rescuers' problem). A person in the water must not be near an engine, whether or not it is turned on. Instructions should be simple, clear, and timely.

1.1 Rescues without Special Equipment



Tests of the vertical life jacket lift, vertical under arm lift, and the leg and arm roll were held with a whaler-type boat and a RIB, with one or two rescuers.

1.1.A Vertical life jacket lift. One or two rescuers in the boat lean over the rail, grasp the straps of the life jacket of the victim, “bounce” the victim down and up three times, and pull decisively upward, keeping the victim in column as long as possible to relieve strain, and then into the boat. “Bouncing” employs the life jacket’s buoyancy to launch the victim upwards as the

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

rescuer starts to lift. The life jacket may be inflatable or foam, but it must be a close fit and should have thigh or crotch straps. There was no indication of damage to life jackets.

This method was easy to explain and understand, and crews were impressed by its effectiveness. It was not always successful. A single 155-lb. rescuer retrieved a 230-lb. swimmer, yet a 125-lb. rescuer was unable to rescue a 120-lb. swimmer. A second rescuer may be required depending on the first rescuer's ability and the swimmer's weight and condition. As with each of these methods, technique can be as important as strength.

1.1.B Vertical underarm lift. One or two rescuers in the boat lean over the rail, grasp the victim's armpits or arms, and pull decisively upward, keeping the victim in column as long as possible. Because there are reports of separated shoulders or other injuries on the part of the victim, this technique was conducted with care. Two postures were tried: victim's back to the boat and victim's face to the boat. With a RIB, the victim reported that both postures were comfortable. With the whaler-type, the face-to posture was comfortable but the back-to posture was painful.

This method was also fast, effective, and easy to explain and understand. It should be done with care. A second rescuer may be necessary.

1.1.C Leg and arm roll. The victim lies horizontal alongside the boat, head toward the bow, and lifts the upper arm and leg over the rail. One or two rescuers grab the arm and leg and roll the victim over the rail into the boat. The small rescuer who was unable to perform the life jacket lift on a 120-lb. person was successful with the leg and arm roll

Awkward as it looks, this method is easy to explain and simple to use. The swimmer needs a hand-hold to grab, which may be difficult with a RIB's smooth tube. A second rescuer may be necessary.

1.1.D Crossed-arms hoist. The victim faces the boat with arms crossed and hands at the hip. Each of the two rescuers grasps a hand and turns the victim in the water while lifting and pulls the victim up and into the boat with back to the boat.

This relatively complicated technique was difficult to master and employ.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

1.2 Rescues with Special Equipment



A throw bag is accurate and carries upwind. A swim ladder was tested.

1.2.A Throw bag. Contact often must be quickly made with a distant swimmer or boat. With a little practice, a buoyant throw rope in a bag (\$50) can be accurately tossed a considerable distance upwind.

This device was not tested at New York but has been proven at safety-at-sea trials. A large loop may be needed in the rope's end for swimmers to grab or place over their bodies.

1.2.B Swim ladder. A sturdy folding swim ladder (\$100) hung over the side and worked well. The victim sometimes required assistance.

The choice of ladder is important. To be effective with a shallow-hull boat, a ladder must be rigid (not a rope ladder), have deep steps so the person's legs can be extended, and hang vertically, which requires stand-offs high enough to press against the topsides.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



The Lifesling was tested with and without straps that were added to keep the swimmer horizontal.

1.2.C Lifesling and hoisting tackle. Designed and well proven as a crewoverboard rescue device for sailboats, the Lifesling (\$125) was hoisted from a RIB T-top with a 5:1 tackle. In some tests the Lifesling was fitted with improvised straps to keep the swimmer horizontal.

To serve as a hoist, the T-top must be strong and securely mounted in the boat. A slippery hoisting line and the RIB's confined area made the rescue awkward. Timmy reported considerable discomfort, some of which might have been eased by partially deflating the inflatable life jacket once she was in the Lifesling.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



With the parbuckle attached to the rail, a pull on the line rolls the weighted bunt, and the swimmer in it, up to the boat.



The victim (a dummy) is positioned in the parbuckle and rolled up to and over the rail.

1.2.D Markus MOB Rescue-net parbuckle. The parbuckle is one of few devices that permit horizontal rescue of a helpless victim without putting another person in the water (which risks a second life). Because it reduces the change in pressure that comes from a vertical lift, it may well be the preferred recovery device for people suffering from hypothermia.

Originally used to bring logs onboard commercial vessels, a parbuckle is a cloth or webbing bunt secured to the rail and extended several feet out into the water. Rescuers pull the victim onto the bunt, then haul on the bunt's outer edge to roll the victim to the boat's side and then up to and over the rail. In tests at safety-at-sea trials with larger sail and powerboats, of parbuckles did not function well due to the high topsides and stanchions.¹

¹ Report of the 2005 Crew Overboard Rescue Symposium at Sausalito, Cal., organized by John Connolly, Chuck Hawley, Karen Prioleau, John Rousmaniere, and Ruth Wood).

<http://www.boatus.com/foundation/findings/COBfinalreport/>

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

The parbuckle's bunt must be weighted so it sinks spontaneously under the victim. The bunt should be webbing so it self-drains and victims do not feel they are drowning (webbing also allows the bunt to be used as a Jacob's ladder). The attachment to the rail must be firm; sag may spill the victim. The Markus MOB FRC Rescue-net (\$1,300) tested in the New York trials meets these requirements, and is conveniently stowed in a long pouch on the rail or inside the cockpit.

The Rescue-net parbuckle was very effective when tested in a RIB using both a human and a dummy (it was not attempted in a whaler-type boat). Because the parbuckle and its technique are unfamiliar to most sailors, training and practice are strongly recommended. Its cost is relatively high, but because this device offers a range of valuable capabilities it should be considered for assignment to at least one safety boat.

2. Righting Dinghies from Capsize and Inversion (Turtling)

Quickly righting a turtled boat is a valuable skill at any time, and especially when sailors may be under the boat. In its reports on its 2005 study of 44 entrapments in capsized dinghies, Great Britain's Royal Yachting Association stated, "The most effective rescue of a trapped sailor is to right the boat as rapidly as possible," and "no technique was faster than the basic one using leverage from sailors to right the boat."²

Righting a turtled boat is not easy. "The hardest thing is to get from turtle to capsized," says Russ O'Reilly, SUNY Maritime's racing coach. An upsidedown boat is extremely stable, and the centerboard offers very little leverage to right the hull.

Another concern is that a turtled boat may be invisible to other crews. Even the 100-foot *Rambler* was not seen by passing boats after her capsized in the 2011 Fastnet Race.

Once a 420 or similar boat is at the normal capsized position with the hull on its side, the horizontal centerboard is an effective lever and a relatively small sailor should be able to right it. Even if the crew cannot right the boat from a normal capsized, the hull and sailors are visible to other boats.

² "Dinghy Entrapments," RYA, 2009, <http://www.rya.org.uk/coursestraining/resources/tresources/Pages/dinghyentrapments.aspx>. "RYA Research into Dinghy Entrapments," March 2005, <http://www.rya.org.uk/sitecollectiondocuments/training/Web%20Documents/RYA%20Training/Training%20centres/Dinghy/TRA%20Entrapments%20report.pdf>

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



This 175-lb sailing instructor was able to right a 420 from a turtle, but not a 155-lb. instructor.



The young sailors at American YC put 230 lb. or more on the centerboard by piggybacking.

2.1 Self-rescue of a turtled boat. In its 2005 report on entrapment, the Royal Yachting Association concluded, “The fastest reliable rescue technique which worked for all boats was found to be two heavy sailors aboard the inverted boat, pulling on the centre board. Nearly all boats could be righted consistently inside 35 seconds in a range of conditions.”³

How much weight is “heavy”? To find out, in the New York tests sailors of different weights attempted to right turtled 420s. Rob Crafa, Director of SUNY Maritime’s Waterfront Programs,

³ “RYA Research into Dinghy Entrapments.”

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

who weighs 230 lb. (the boat's weight), quickly got a 420 upright singlehanded. Pairs of 420 sailors whose total weight was around 240 lb. also had little trouble when they both pulled on the centerboard or piggybacked, with one sailor hanging off the board and the second hanging off the first sailor's back.

Working down the weight ladder, a 175-lb. sailing instructor, Kevin Broome of American YC, succeeded in getting a turtled 420 upright singlehanded. Yet another instructor who weighs 155 lb., Russ O'Reilly of SUNY Maritime, was unable to do it even when he exerted a series of hearty jerks and pulls on the board.

Occasionally a well-practiced, athletic small sailor can do the job. A 125-lb. American YC sailor, Molly Robertson, succeeded in righting a turtled 420 in the New York tests. At Stockton, 138-lb., 5'9" 18-year old Patrick Tara righted a turtled Flying Junior in about a minute.

A crew or sailor weighing about 200 pounds or more should be able to right a Club 420 from a turtle except in extreme conditions. Technique is important; sailors should practice self-righting. If only one sailor is available, people in safety boats should be prepared to go into the water and assist in righting a boat in which there may be an entrapment. Obviously, every aspect – including hand signals, securing the rescue boat, radio procedures, and recovering the people – must be thought through, planned, and practiced.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

2.2. Powerboat-assisted righting methods. Several methods of righting a turtled boat using a powerboat have been proposed. Two of them – the corkscrew and rollover – were tried in the California and New York trials with varying success. They might be used when sailors are not available or unable to right the boat, or when the mast is stuck in the bottom. Both methods put a heavy load on the dinghy and the towing line. These methods are not as easy to explain as others we tested, and they require training and practice.



**A 420 is righted in less than five minutes
at SUNY Maritime using the rollover method.**

2.2.A The rollover method brings the boat upright by turning it over with a line running from the powerboat across the bottom of the turtled boat, forward of the centerboard, to the dinghy's chain plate on the far side. The powerboat pulls while attempting to keep the line perpendicular to the hull. The moving water lifts the sails and the hull follows.

This method succeeded at Stockton and SUNY Maritime. At American YC, the bow tended to align with the tow and the boat was not fully righted.

2.2.B The corkscrew method was developed to right a boat whose mast is stuck in the bottom, but it has also been used with other turtled boats. One end of the dinghy's painter is secured around the mast, led through a ring or other fairlead on the bow, and secured to the powerboat's bow or stern. The powerboat pulls away from the dinghy with the helm hard over. As the dinghy

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

spins, its sails fill with water and lift. People experienced with this technique say that its success is boat specific.

At Stockton and New York, the corkscrew method was attempted when the dinghy mast was not stuck in the bottom, but without any success. Some dinghies lacked bow fairleads. All boats yawed around. There are concerns about trying this method and the rollover with the crew near the boat.



At Stockton (here) and New York, the dinghies sometimes yawed or followed the powerboats rather than lying beam-to.

2.2.C Problems with powerboat-assisted methods. The mixed success of these methods stimulated speculation about causes. Among the factors suggested were tidal current, water accumulation in the mast, water accumulation in the 420s' bows (Flying Juniors have a forward air tank), differences in hardware, and whether to pull the dinghy bow-to-bow or stern-to-bow. In other tests of the corkscrew, it has helped to rig a secondary line to the transom to keep the dinghy perpendicular to the tow line.

Chuck Hawley reported that the only righting method that always worked at Stockton was self-righting. He said the following about the corkscrew and rollover:

1. You have to have a way to keep the sailboat from yawing. Could be a bridle (slow) or putting the righting line aft of the centerboard. This could damage the centerboard trailing edge or cut the tow line.
2. The force on the rescue boat is such that it cannot maneuver easily after there is tension on the towline. A towing post would be a big advantage, and it also reduces the need to

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

maneuver the boat in reverse when there are sailors in the water. It's very easy to forget where the lines, kids, boats, etc. are when you're trying to line things up.

3. Bow-to has better visibility, but stern-to has much better power (no news, but it was reinforced).
4. The rescuers may inadvertently pull the dinghy away from the crew.
5. The drag of the individuals clutching the dinghy produces unexpected yaw.
6. The dinghy re-inverts quickly after coming up to 90 degrees.
7. The watertight integrity of the mast makes a big difference.

3. Sailor Entrapment

The most serious concern with any capsize is that a sailor might be trapped in or under the hull. This was the cause of the fatality in the June 2011 accident at Annapolis.⁴ The factors at play include buoyancy, turtling, and entrapment by the rig. An on-shore reenactment of the Annapolis accident clarified these factors.

3.1 Prevent, delay, or slow turtling. One of the most vivid teaching points of these tests is that a normal capsize, with the boat lying on its side, usually is relatively safe, with righting often requiring just one person. Turtling presents more challenges. This is not a new discovery. In 2005 the Royal Yachting Association report said this on its opening page:

The biggest risk results from complete inversion of the boat with the sailor tangled or stuck underneath. The probability of an incident seems unaffected very much by the conditions, since a number of incidents were recorded in light winds.

The speed of inversion can increase the risk: some designs invert faster than others, but most will invert quickly if capsized to windward whilst sailing downwind.⁵

Two of the four inversions reported in the review of the Annapolis accident occurred on runs in light to moderate conditions.

⁴ The Annapolis accident report is at <http://about.ussailing.org/AssetFactory.aspx?vid=16941>

⁵ "RYA Research into Dinghy Entrapments," March 2005.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



Water streams out of a 420's mast.

3.A Leaking masts. One consequence of capsizes and especially turtling is that hollow aluminum masts leak and lose buoyancy. Russ O'Reilly at SUNY Maritime estimated that a dry 420 mast weighs 25 lb. and has considerable buoyancy, but when filled with water it weighs as much as 75 lb. and has little or no buoyancy. Efforts have been made to fill masts with foam, but there are reports that the foam breaks up. Masts also lose buoyancy when they pick up mud or sand.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



This masthead flotation device (“floatie”) is secured to the headboard by the halyard.

3.B Masthead buoyancy. Some sailing organizations address the inversion problem by adding buoyancy at the top of the mast or mainsail. Pixels, MC Scows, and Hobie Cats are among the classes that require foam aloft in headboards or pull-on foam covers. Junior sailing and other training programs employ similar devices or improvise flotation by hanging empty bottles from the masthead or wrapping upper shrouds in Noodle foam tubes.

The Severn Sailing Association loaned one of its masthead flotation devices for the New York trials. The “floatie,” as it was dubbed by the sailors at American Yacht Club, is slipped over the mainsail’s headboard and secured with the main halyard through cringles that align with the sail’s. Approximately 2 feet wide and 2 feet long at its greatest dimensions, the floatie has Dacron-encased foam 2.5” in thickness. The device weighs 4 lb. According to Joel Labuzetta (SSA’s former sailing director) the North Sails floatie cost about \$160. SSA uses it in sailing classes and on all boats racing Club 420s in the winter sailing program where, according to Labuzetta, the sailors did not voice objection since the floatie has little or no effect on sail shape and, in any case, was required on all boats.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



A 420 at SUNY Maritime with a “floatie” remained at this attitude until the test ended after seven minutes.

In the first test we conducted of the floatie, in SUNY Maritime’s marina we rigged it on a Collegiate 420 and laid the boat over in a normal 90-degree capsized. Only the top of the mast, just above the floatie, was submerged when the boat was laid over. According to ranges and other visual aids, the mast was in the same position at the same attitude seven minutes later.



In choppy water a 420 with the floatie remained in a normal capsized with just the tip of the mast submerged, even when a sailor climbed on the sail.

At American Yacht Club, two Club 420s, one with the floatie and the other without, were capsized simultaneously alongside each other. The boat with the floatie settled on its side while the other boat’s mast submerged until the boat turtled. The floatie-equipped boat was up and

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

sailing half a minute after the capsize. The other crew meanwhile struggled to bring their boat first to a normal capsize, then upright.

The sailors (who weighed in the 120- to 135-lb. range) attempted to sink the floatie by sitting lying in the top of the mainsail, with no success. One of the sailors eventually asked me, with obvious exasperation, “Can we take off the floatie now? We can't turtle!” (A team effort eventually forced that boat into a turtle.)

This masthead flotation device was very effective and had small effect on sail shape. Because entrapment is most likely to occur in a turtled boat, ways to prevent, delay, or slow turtling really should be considered.

3.C Entrapment by the rig. The young sailors at American Yacht Club wore “pinnies” (tight-fitting Lycra shirts) pulled over their life jackets and harnesses to prevent accidental snags with the rigging. They reported that some regattas bar pinnies because they are may be used to disguise illegal life jackets.

By all accounts pinnies are effective. Their use should be encouraged.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment



As this 125-lb. teenage sailor moves forward, she cannot avoid brushing against the trapeze wire, its tackle, and the taut shock cord securing them that is led up from the inboard side of the air tank.

3.D Reenacting the Annapolis accident. Following up on a recommendation in the report on the 2011 Annapolis accident, I asked the sailors at American Yacht Club to recreate that accident using a Club 420 on a dolly on shore. With the other five sailors looking on, one of the girls suited up in her life jacket with a trapeze harness.

She followed the accident scenario: (1) The crew moved forward to douse the spinnaker. (2) Her trapeze harness hook accidentally snagged the metal bale at the lower end of the trapeze wire. (3) The boat jibed accidentally and turtled. (4) The crew was caught under the boat and the instructor and other crew were unable to retrieve her in time.

(1-2) As our sailor moved forward, the front of her trapeze harness, including the hook, brushed against the trapeze wire and its attachments, all of which were held well inboard from the rail by taut shock cord running through a fairlead on the inward slope of the air tank. These attachments were a small block and tackle for adjusting the height of the trapeze, the bale at the end of the tackle, and the shock cord itself. Asked how hard it would be to accidentally hook onto the bale, she replied that it would more likely for her harness hook to snag the shock cord or tackle. She and the others indicated that accidental snags like these are common.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

(3) Simulating an accidental jibe, we swung the boom across the cockpit. The boom vang was set up hard, as it usually is in Club 420s because they use vang sheeting. The boom and vang pressed against the sailor's back and pushed her forward and down until her face lay on the foredeck, facing outboard toward the rail. Without a vang release close at hand, the pressure could not be relieved until the steerer, aft, released the vang, or until the boom hits the water.

The sailors indicated that they are sometimes trapped during a jibe by the vang. They described the forward part of the cockpit as "the triangle of death." Taken aback by this description, I followed up on its history with a young sailor who told me that it originated before the Annapolis accident.

Several parts of the boat can obstruct or snag the sailor. Alternative arrangements should be tested.

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

4. Recommendations

1. Several methods for lifting a sailor from the water without special equipment are effective. Technique is important, so these methods must be practiced.
2. The parbuckle or an alternative method for a horizontal recovery would be a good rescue device to have on a race course, with trained personnel, for the rescue of injured, hypothermic, or otherwise helpless sailors.
3. Our tests reinforce the Royal Yachting Association's observation that a decisive way to address entrapment is to immediately right the boat by putting weight on the centerboard. U.S. Sailing and other organizations should consider establishing this as doctrine.
4. Powerboat-assisted righting is suitable for certain situations, but is complicated by several factors, not all of which are clear. More testing should be done.
5. A high priority should be placed on preventing or delaying turtling. Because ability and athleticism vary from sailor to sailor, it may not be enough to count entirely on boat-handling skills to keep boats upright. A well-proven method is to place buoyancy aloft in dedicated or improvised flotation devices. While this is widely acknowledged, the equipment does not appear to be widely employed, even with novice sailors. U.S. Sailing and other organizations should consider establishing policies for equipment and use.
6. *"A seaman laboring under an undue sense of security becomes at once worth hardly half his salt."* (Joseph Conrad) Safety and seamanship require constant attention and review at all levels, from the deck to the board room. For example, in distance racing, U.S. Sailing, the International Sailing Federation, and organizers of races conduct annual, systematic, public evaluations of practices, equipment, and rules, taking into account developing technology and recent experiences. That is a good model for any sport.

John Rousmaniere

Tests of Sailor Retrieval, Capsize Recovery, and Entrapment

5. Acknowledgments

Photographs in this report were taken by Raleigh Barnes, Chuck Hawley, Elizabeth Hale Rodriguez, Brendan Rogers, and John Rousmaniere.

Stockton Sailing Club, Stockton, Cal. (July 13, 2012)

Event director: Paul Tara. Demonstrators: Patrick Tara, Michael Scott. Sailors: Little Bear Lundegard, Chris Canete. Observer/Photographer: Chuck Hawley (Safety-at-Sea Committee).

State University of New York Maritime College, Ft. Schuyler, N.Y. (August 27, 2012)

Event director: Timmy Larr. Demonstrators: Rob Crafa, Russ O'Reilly, Joe Sullivan. Observers: John Rousmaniere (Safety-at-Sea Committee); Pam Toner and Bob Whittredge (Junior Sailing Association of Long Island Sound). Photographer: Brendan Rogers.

American Yacht Club, Rye, N.Y. (August 28, 2012)

Event director: Timmy Larr. Powerboat demonstrators: Rob Asma, Kevin Broome, Timmy Larr, Joe Sullivan. Sailboat demonstrators: Taegan Blackwell, Walter Florio, Emily Quirke, Aisling Quirke, Clara Robertson, Molly Robertson. Observers: Matthew Marion, Bob Whittredge (Junior Sailing Association of Long Island Sound); John Rousmaniere (Safety-at-Sea Committee). Photographers: Raleigh Barnes (also demonstrator), Alison Brett, Elizabeth Hale Rodriguez, Brendan Rogers.