

This is NOT the official Troop 166 Sailing Rig. Bill has that, but he's at camp, so this will have to do.

When we go on long canoe trips, each canoe has the opportunity to be rigged for sailing. Sailing is highly recommended because sailing a canoe is a) fun, and b) much less work than paddling when the wind is at your back. The rig we use is not a lanteen (triangular) rig like you see on most canoe sailing web sites. Using a lanteen/fore & aft sailing rig requires sailing skills that (for the most part) our boys do not have yet. Thus using such a rig presents a higher probability of spontaneous swimming opportunities. Swimming in Lake Roosevelt is fun, but we like to plan our swimming sessions, and we generally wait until we get into camp so that we can organize our swimming parties and supervise them better. Spontaneous swimming also usually involves getting all your gear wet too, which can have unpleasant consequences for sleeping bags and food.

### Keep It Simple

Our rig is a rectangular or "square" sail supported on a 'yard' that is raised on a mast that is held in a bracket that is mounted in front of the bow paddler. When we sail, the Bowman raises the sail and holds the sheets (the ropes attached to the lower corners of the sail), and the stern paddler keeps his paddle in the water to steer and act as a (sort of) keel. If we have proper wind conditions and everyone brings their sails, we will practice sailing on the August 8<sup>th</sup> trip down Lake Washington. This type of rig does well sailing before (in the same direction as) the wind. We do not (often) try to 'beat' or sail against the wind. Unless you add 'dagger boards' or a 'lee' board it is hard to sail a canoe across the wind because they simply blow sideways. If you want to add one to your rig, your canoe will slide sideways far less – but they are not necessary for sailing with the wind – so we generally don't bother. If you want to know a lot more about sailing canoes, Google the phrase "canoe sailing rig" and you will find thousands of pages on this subject.

### Making a Sailing Rig

Each pair of paddlers is responsible for outfitting their canoe with its necessary equipment such as their own paddles and pfd's, a spare paddle and a spare pfd, sponges, bailers, bow and stern lines, AND a mast, a bracket, and a sail. Some canoes- notably Grumman canoes- come with brackets, and some people already have sails – so they have less work to do in preparing for the trip. Most of the canoes DO NOT have brackets, and unless the paddlers have been on a long term canoe trip before, it is unlikely that they have a sail. A good option is to call around to the troop alumni and see if you can find a sail tucked in someone's garage or basement. We will try to collect an inventory of 15 or so alumni sails for future outings – but as of today, we only have a few and they are all spoken for. Please consider donating the one you are about to build to the Troop locker after the trip.

So if you don't have one, and you can't borrow one, you will need to make one. It isn't hard. Catherine Noonan and I made one two years ago in about two hours. The *square sail* is the oldest type of sail. It is rectangular and is held up by a horizontal spar called the *yard*, that is attached to the mast in a fashion that allows the yard to be raised, lowered and turned both in the vertical and the horizontal plane. The complete rig has 4 parts so in making your sail you will need to make:

1. The Sail
2. The Mast
3. The Yards
4. The Mounting Bracket

So let's begin.

## Really Simple Way

You will need a twin sized FITTED bed sheet (A good strong one, not a worn out one), about 20 grommets and a grommet tool, and some 1/8" parachute cord. Make the yards as described below. And tie the sail to the yards with 9-12" pieces of the cord. You need a mast, clamps, sheets and a halyard as described below also. This next part just makes a quick and dirty sail.

Punch the grommets through the long edges of the sail about 12" apart, and then tie loops with the cord. Make sure you use water knots or some other knot that will never come undone. A fitted sheet will act like a spinnaker and fill out in a good wind. Double the edge of the sheet over and punch through two layers to make your grommets hold better. Use the corner grommets to tie the corners of the sail to the ends of the yard. (see below). Make sure one grommet is in the exact middle of the top yard, and run your halyard through that hole and tie a double look around the middle of the yard.

Some have used the rain fly from a tent. That works too.

## Another more complicated Really Simple Way.

Construct your sail from a tarp using duct tape, pvc pipe, parachute cord or 3/16 inch braided nylon cord, and clear vinyl. There are several photos of one constructed like this at the end of this document. You have to decide if you want to add grommets to a 6 X 8 tarp for reefing or use a 5 X 7 tarp. A 6 X 8 sail can overwhelm a canoe in a strong wind, so being able to shorten the length is important. In a light wind the 6 X 8 sail will go faster.

Materials: 6 X 8 foot tarp or 5 X 7 foot tarp, choose your color. Two 10 foot lengths of 3/4 or 1 inch ID schedule 40 PCV pipe. Duct tape of your color choice. If you can find waterproof duct tape, get that. 50 feet of rope. Either parachute cord or 3/16 inch braided nylon cord. Don't get twisted cord- get braided. Three to four square feet of clear vinyl for a window so you don't hit a submerged rock and the bowman gets some of the view. Seattle Fabric has some as does the UW Bookstore in the Art Supplies, maybe a hardware store too. One Large bottle of Contact cement.

Tarp: Consider these purchase points.

- Look for grommets made from rust-proof brass or aluminum
- Reinforced corners provide additional resistance to tears
- Choose UV-resistant tarps if you plan to use them outdoors extensively. If not available, any tarp will do as the sail's UV exposure is quite limited- 10 to 12 hours a year. If the UV resistant tarps are the heavy silver ones, don't buy it. Stick to the lighter tarps.

Study the photos at the end of this document for the how to construct.

Stretch out the tarp on a flat surface. Place the clear vinyl centered on the tarp or with a slight bias towards the bottom (allow room for reefing grommets if needed). Mark the corners on the tarp. Remove the vinyl and mark new corners 2 - 3 inches diagonally in from the corners you just drew. Place the vinyl back on the tarp and ensure the area to be cut is smaller than the vinyl. Remove the vinyl and cut the tarp along the lines connecting the **inner** corners. Place contact cement on the overlap area of the vinyl then attach the vinyl. Tape down the edges of the vinyl with duct tape. On the **other** side of the tarp, put duct tape one half on the tarp and one half on the vinyl. When you construct your sail, the inside of the sail- the part facing you- should be the side with the over lapping vinyl so the wind pushes on the side of the overlap.

Eat your donut.

Lay out the tarp and pipe. Cut the length of the pipe with at most 1 to 2 inches beyond the end grommets of the tarp on **each side**. Line up the tarp with the pipe making sure the pipe sticks out equally from the end grommet

on **both** sides. Mark where the grommets are and drill a hole in the pipe using a 3/16 or 1/4 inch drill bit. Cut short lengths of the rope to tie a small loop. Pass through the loop a length of rope which spans the length of the pipe allowing extra to tie it off on both ends. As you tie each loop, use the rope as a spacer and make it tight against the tarp and pipe. (study the photos). Where the photo shows a carabineer on the inside bottom edges of the sail, you can use that or tie another loop here to attach the sheets. ( The rope the bowman holds to control the sail.)

REEFING: If you chose a 6 X 8 tarp, make reefing points. Mark two spots 4.5 to 5 feet down from the top and 2 to 4 inches in from the sides. Mark 2 more spots equal distance between these so you have four in all. Cover both sides with duct tape. Install a small grommet where you put the duct tape. Use a small length of rope, 6 to 10 inches. On one end of the rope, tie a knot large enough so it won't go through the hole. Put the rope through the reefing holes and tie a knot on the other end. To reef your sail, roll it up and tie it off.

The photos show a tarp sail with end caps on the PVC pipe. Since the sail will be in the water at some point and the pipe needs to drain, they aren't needed and it might be better without them.

You made a sail, eat your donut. You'll need the strength for the next task.

You must make a mast, clamps, sheets and a halyard as described below.

**More Complex But Way Cooler**

Two colors of rip-stop nylon cloth and some thread and grommets are about \$30 at Seattle Outdoor Fabrics on Aurora or Hancock fabrics.

**Materials List**

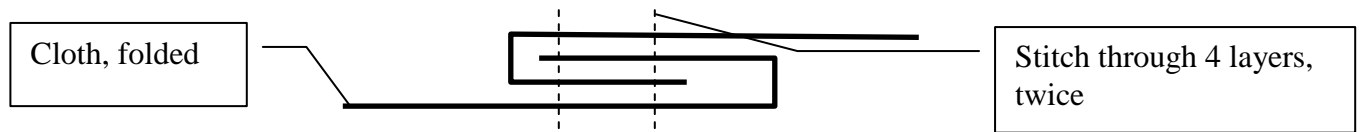
4-5	Yards of rip-stop nylon or equivalent. Sheets will do, but they don't last as long.	Hancock fabric store, etc.
1	Nylon or Dacron thread, grommets & grommet tool	Ditto
50'	1/8" parachute cord	Lowes, Home Depot, etc.
1	8' long by 1 1/2" thick hand rail or closet pole	Ditto
1	1/2" brass eye or small pulley	Ditto
2	10' 3/4" PVC plastic pipe	Ditto
1	8' long by 3/4" by 4" wide fir board	Ditto
1	Short piece of fir 2x4	(if you can't find one, buy a whole 2x4)
8-10	2" stainless steel wood screws	Ditto
2	3-4" "C" Clamps	Ditto
1	1/2 Pint can of poly urethane or spar varnish and a cheap brush you can throw away	
	Milk, donuts, and other forms of refreshment	

**The Sail**

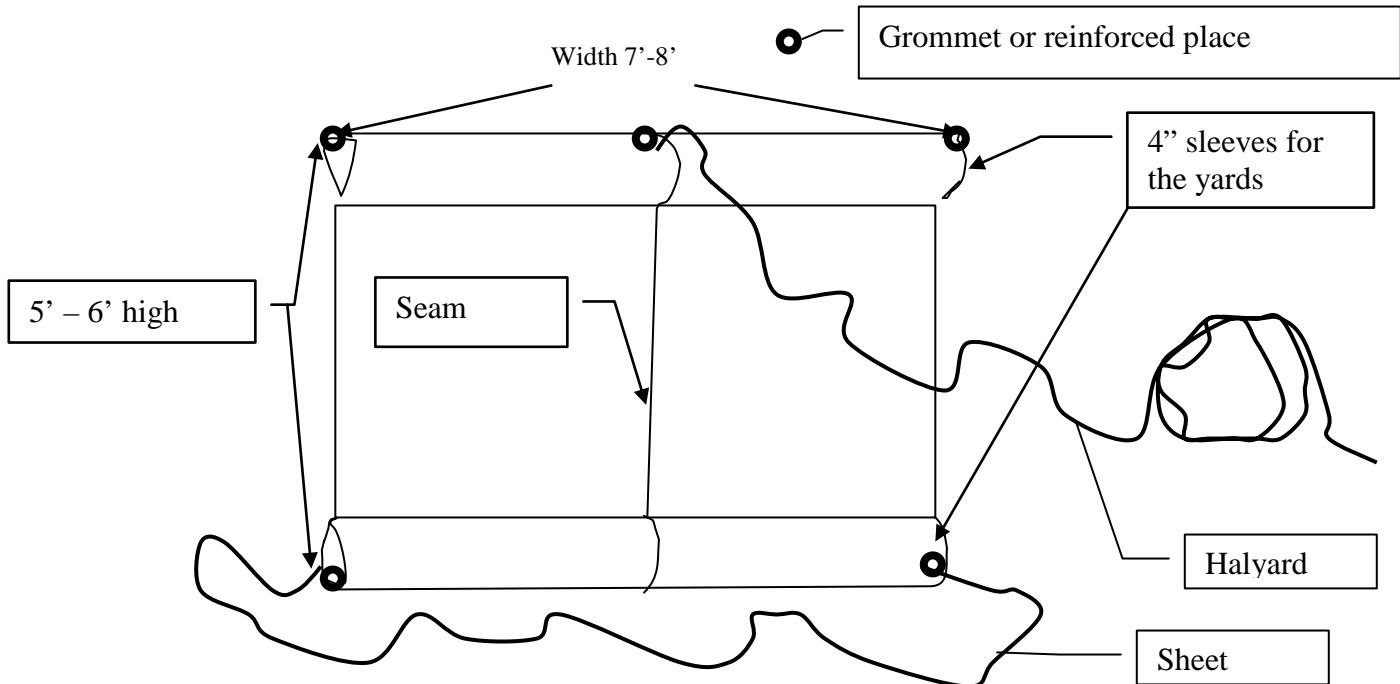
I have used strong bed sheets, nylon cloth, and sail cloth. Bed sheets are the worst alternative because even a new one can fail with surprising ease in a strong wind, and they get really heavy when they are wet. Fabric stores and camping stores sell 5' wide, rip-stop nylon cloth in an array of colors that works very well. I also went to a sail loft on Lake Union and asked for a ripped sail from a racing yacht and got a huge hunk of nylon sail cloth that worked quite well. Nylon or Dacron thread is stronger and it won't shrink. The wind can be quite strong, so the sail must be strong enough to accept a lot of pressure and not rip or unravel.

You can make a piece of cloth large enough for a sail by cutting two pieces from the 5' bolt that are 7' long and sewing them together along their long edge to make one large piece of cloth. Overlap the cloth so that you are sewing through four layers, and then run at least two lines of stitching down the length to ensure that it is strong

enough. Cut off the excess and hem the sides, and you will end up with a piece of cloth about 8' wide – which is fine. My most recent sail making experiment resulted in a bright yellow and green sail that looks cool.



Hem the sides, and make 2"- 4" sleeves at the top and bottom to accept the yards (see diagram). Your finished rectangle should be about 5-6' high and 8' wide. If you make it 6' in length, provide for 'reefing' to shorten it to 4-5'. See above in the tarp sail section.



If you have the tools, reinforce the cloth, and put grommets in the outside corners of the sleeves and in the middle of the top sleeve, otherwise just reinforce the cloth (before you stitch up the sleeves) in those points and poke a hole through each one. These reinforced places will be what you use to fasten the sail to the yards, and haul it up and down the mast. You can reinforce by just taking a 4" wide strip of cloth and folding it over a few times and stitching it in place firmly. Poke the hole in the middle of the reinforcing.

There. You just made a sail. Have a donut.

### Yards

The yards are the horizontal 'beams' that the sail is suspended from. You can get by with only one yard at the top as long as you have sheets (lines) tied to the lower corners. People who have thought about this more than I have believe that having a yard on the bottom of the sail makes it more efficient – and results in more power to move the canoe. I made my sails with yards on the top and the bottom.

I use 3/4" PVC pipe for my yards, but you can use wood or bamboo poles too. Cut the pipes to be about an inch longer than your sail is wide. Then drill a 1/8" hole in the end about 1/2" from the very end of each yard. The hole in the middle of the top sleeve of the sail should end up right in the middle of the sail.

Now slide the yards into the sleeves at the top and bottom of the sail. Take four 9" pieces of 1/8" parachute cord and thread them through the holes in the ends of the yards, and tie them through the grommets at the ends

of the sleeves. Now your sail is fastened to the yards and they won't slip out. Wind power pushing on the sail will be transferred evenly along its width. Thread another piece of parachute cord through the hole in the middle of the top sleeve and around the middle of the top yard and back out the hole. Tie it tightly enough so that it is hard to work another length of parachute cord underneath it. You will use this loop in a minute to tie on the halyard (the rope used to haul the sail up the mast) to the yard. Use knots like water knots for these ties.

Take about 15' of 1/8" parachute cord for your halyard and slip it under the loop in the middle of the top yard, and tie it securely. For a sheet, take about 20' of parachute cord and tie one end of it to the left end of the bottom yard, and the other end of the sheet to the right end of the bottom yard. You use 'sheets' to control the sail. Be sure to fuse the ends of the parachute cord in a flame when you cut them so they don't fray.

### **Mast**

Get an 8' long (roughly) 1 1/2" round wooden pole (a hand rail or closet pole from Lowes will do fine). Sand it and coat it with polyurethane or spar varnish to protect it and avoid splinters, and install a small pulley or a 1/2" brass eye at the top to pull the halyard through. Fasten a small cleat at the bottom of the mast at about 2 feet from the base of the mast. The cleat should be on the opposite side of the mast from where you fastened the pulley or eye.

There, now you have both a mast and a finished sail. Have another donut.

### **Mounting Bracket**

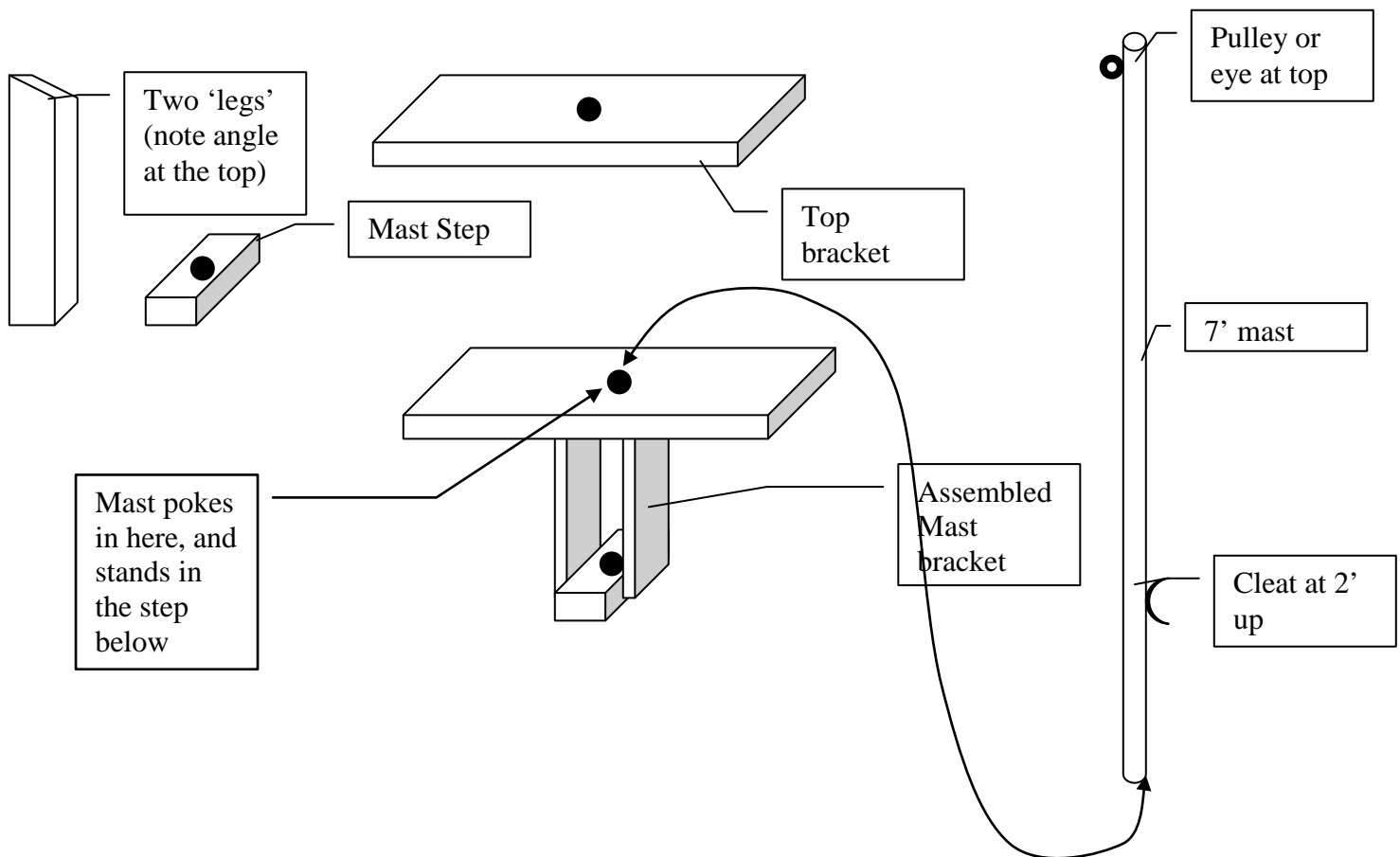
If this is your canoe, you can permanently fix the sail bracket to the canoe. I'll assume that this is not your canoe, and that this is a temporary job.

The mast is mounted by standing it up and running it through a hole in a board that is fastened to the gunwales in the bow compartment at a right angle to the keel. The bottom of the mast rests in a block with a hole in it called the mast step.

To make the top bracket, cut a board that is about 3/4" thick and 4 feet wide to a length that is about 2 inches longer than the width of the canoe at the position you will be mounting it at the bow of the canoe. The board will be resting across the gunwales, about 8-12" aft of the bow deck of the canoe. In a Grumman Canoe there is a 'step' block mounting plate riveted to the bottom of the hull on the keel. The board should be positioned directly over that bracket. Drill a hole through the top bracket (board) in the very middle of the board. The hole should be about 1/8" bigger in diameter than the thickness of your mast. If you have a 1 1/2" mast, make the hole about 1 5/8" to 1 3/4" in diameter. Take a block of wood about 2"x4"x8" and drill an identical hole in it to serve as the mast step. Sand and coat both pieces of wood when you coat the mast (above). In a Grumman canoe with a mast step bracket, you bolt your step block to the bracket. In a boat you don't own, you can mount it by fastening it with two vertical members running down to the bottom of the boat from your top bracket.

Place your top bracket across the gunwales and use a small "C" clamp on either side to clamp it to the gunwale. When it is clamped in the position you want it in, measure the distance from the bottom of the bracket to the bottom of the boat. Because the gunwales will be sloping upwards toward the peak of the bow, the distance from the front edge of the bracket to the bottom of the canoe will be slightly longer than the distance to the bottom from the back edge. Cut two boards from the same material as your top bracket. One end of each board will be cut at a square angle to its axis, and the other end will be cut at a slight angle so that the lengths of each are the same as the distance from the front and back edges of the bracket to the floor of the canoe. You now have two 4" wide, 3/4" thick boards that are square on one end, and slightly angled on the other end. Coat them with polyurethane or varnish before you assemble them.

Now mount the step block between them at the square end as shown in the diagram below. When you stand it up, the step block should be on the bottom, with the two 'legs' sticking up vertically from the ground. The top edges should be angled, with the high side of each board oriented the same way. Stainless screws work best for this because the wood will be getting wet and the screws will rust if you don't. Now mount this "U" shaped thing to the bottom of the top bracket so that the hole is in the middle between the two legs.



The entire assembly will mount securely to the gunwales with two small "C" clamps. You can also make a step assembly that looks like a flat Capital "T", with a hole for the mast step in the bottom of the T. This works in a fully loaded canoe because all the gear is sitting on the middle of the T and the top of the T and thus holds it down to the bottom so the mast step doesn't move.

Have another donut, drink a glass of milk too. You have earned it, and your son owes you big time.

**Sailing Tips**

We will teach you how to use this thing during the merit badge class, but there are a few things to keep in mind.

Keep your weight **LOW**. In rough water or windy conditions, you want your weight really low, so the bow paddler should sit on the bottom of the boat (on the spare pfd to keep your bottom from getting quite so wet), and the stern paddler should kneel. Pack heavy stuff low in the canoe and light stuff on top to keep the overall center of gravity as low as possible. Make sure **EVERYTHING** (yes your water bottle too) is tied in. Good

sailers capsize too. Also, people who make sails out of materials that don't float well can lose their sails. We recently had one really nice nylon sail sink to the bottom of Lake Washington because someone used aluminum yards. Metal does not float.

The bowman raises and lowers the sail, and works the sheets to control the sail. He should practice before he gets out into the middle of a lake and needs to do this for real. Put the mast next to your hip with the top of the mast nearest to you. Loosen up the sail from the sheets and halyard, and make sure nothing is tangled. Then lay the sail across your lap, and make sure the top yard (with the halyard tied to it) is on top, and the bottom yard (with the sheets tied to its ends) is on the bottom. Run the halyard through the pulley or eye at the top of the mast, and put the loose end of the halyard on the bottom next to you – but don't let it get tangled with the sheets. You should have about 7' of halyard on either side of the eye or pulley so that when you 'step' the mast, the sail can remain on the deck.

Place the sail (with the top yard on top) in front of the hole where the mast will be inserted, and make sure the sheets are behind the hole (near you). Swing the mast up, holding onto the loose end of the halyard, and insert it into the hole. Make sure the sail stays on the bow, and does not get filled with wind yet. Turn the mast so that the halyard runs from front to back. When you pull the sail up it should be in front of the mast, and the halyard should not be wrapped around the mast.

Now check to make sure that the sail is not tangled, that it is in front of the mast, and that the sheets are behind the mast where you can grab them quickly.

Now haul the sail up the mast quickly, and tie the halyard off on the cleat – which should be facing you. Haul it up all the way, as far as it will go, and tie it securely to the cleat.

The sail will be flapping around, but the sheets should be readily accessible because they are on your side of the mast. Now grab the sheets, and pull them in to tighten up the sail. Slide down so that you are sitting on the spare pfd on the bottom of the canoe. Keep your weight low. You should be sailing now, and if the wind is strong, you will pick up speed very fast. The bowman needs to stay awake and control the sheets so that the sail doesn't swing around and capsize the canoe.

The stern man keeps his paddle in the water at all times, and uses it to steady the boat and to steer. It also acts a little like a keel. **The stern man must keep the canoe facing down wind all the time, and into rough seas.** If the bow man gets tangled up, it is really important to keep the boat off the shore and pointing down wind so you don't get blown onto the shore or capsized. Give the bowman time to get things set up right. If you need help, call a more experienced canoe over to help you get started before they raise their sail. Sailing is fun but you need to watch it.

Note: the edges of the vinyl is where the duct tape is.  
The white in the window is the duct tape on the other side.





