

## NORTH SAILS FAST COURSE MAINSAIL

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### Mainsail Trim

By nature, a mainsail is the most durable and flexible sail in any inventory. It has to cover an incredible wind range, which means stretching into almost every shape possible.

While the mainsail provides a good bit of power, it also has a lot to do with the boat's directional control. The sail helps to steer the whole sailplan, functioning a lot like a trim tab on a keel or a flap on an aeroplane wing.

In particular, the aft part of the main, the leech, is an important influence on the directional tendency of the boat. A closed or tight leech "kicks" the airflow to windward, creating a large side force to leeward at the stern of your boat. This creates weather helm and tends to push the bow to windward (See below).

Similarly, an open or twisted leech allows the air to flow easily off the mainsail without developing as much sideways force (See below). So you feel less windward helm.

(**Animation 1** closed leech – open leech)

### Mainsail trim procedure

In the last edition of the Fast Course book, this chapter included an extensive trim loop diagram to explain mainsail trimming. The loop cycle was helpful for some people, but quite confusing for most. For this reason, we dropped it. However, we found the basic five-step trim procedure very helpful, and we have expanded on it here. The main point of the loop cycle was that trimming the main is not such a simple matter. Whenever you adjust a control, it has a primary effect, but also many secondary effects. Therefore, the mainsail trimmer must have a well-rounded knowledge of just about everything covered in this book, as well as a methodical approach to the task. What's exciting about trimming the main is that it's a job where you can learn a great deal. The following procedure offers a good, solid approach to mainsail trimming. The five basic steps are:

1. Set twist with mainsheet tension.
2. Set depth with mast bend and outhaul tension.
3. Set draft position with luff tension.
4. Set helm balance with traveller position.
5. Fine-tune the total power of the main with the above controls

### STEP 1: Set twist with mainsheet tension.

We learned in "The Basics" that twist refers to the changes in a sail's chordlines from bottom to top. A sail needs to be twisted because of wind gradient, which moves the apparent wind aft as you get higher off the water.

(**Animation 2** mainsails twist is controlled by the mainsheet)

On a mainsail, twist is controlled by the amount of mainsheet tension (see right), as well as the amount of vang. The mainsail leech is our best indicator of how much the sail is twisted. The front of the main is certainly a poor measure of twist because it sits in the confused airflow of the slot and directly behind the mast's turbulence.

To set proper twist, trim the mainsheet until the top batten is parallel to the boom. If you have a long top batten, your goal is to make its aft end parallel to the boom. Using the angle of the top batten isn't exactly measuring twist (because the angle of the batten is different than the angle of the chordline), but it's a good guide.

(**Animation 3** leech too tight – leech too loose)

When the sheet is eased, the main has a very twisted shape, with the top batten falling off to leeward (see below). As you trim the sheet, the top batten angle narrows until it is parallel with the boom. Trimming harder will take away all the twist, close the upper leech, and make the top batten poke to windward (see below).

The best average setting for the top batten on everything from Lasers to 12 Metres is parallel to the boom. This is one of the golden rules of mainsail trim.

(Animation 4 flowing - stalled)

With the batten in this position, the top batten telltale should stream aft between 50 and 90% of the time (see right). This telltale, attached to the aft end of the top batten and extending 8 to 10 inches beyond the leech, indicates whether the upper leech is stalling. When the leech is stalled, the telltale curls around to leeward of the main (see right). Twisting the main more will open up the leech and re-establish flow.

### When to bend the rule.

Rules, of course, were made to be broken. On a masthead boat, you can sometimes trim the sheet hard enough to tighten the upper leech and poke the top batten slightly to windward. This is fastest in medium air and smooth water, when you can point high and maintain speed. This works with a masthead rig because the full hoist genoa steers the airflow around the lee side of the upper leech and reduces the danger of stall. On a fractional rig, the upper mainsail has no genoa to steer flow, so its upper leech may need to be opened up slightly by easing the sheet. There are a number of times when you may want to twist the main enough to let the top batten fall off slightly to leeward. In a chop, after tacks and in light air, ease the sheet to open up the leech slightly and prevent stall.

## STEP 2: Set depth with mast bend and outhaul tension.

MAINSAIL - Target depths and draft positions						
APPARENT WIND (Knots)	LOWER STRIPE		MIDDLE STRIPE		UPPER STRIPE	
	Depth	Position	Depth	Position	Depth	Position
3-6	14-15%	45%	15-16%	45%	16-17%	45%
5-12	12%	50%	14-15%	50%	15-16%	50%
10-18	10%	50%	12-13%	50%	13-14%	50%
16-26	8-9%	50%	11%	50%	11%	50%
24-30	9%	50%	10%	50%	10%	50%

These numbers are general targets only. Even with the best sail-measuring tools, it is typical to have errors plus/minus 1-2 percent for depth and plus/minus 2-3 degrees for draft position.

(Animation 5 Mast bend affects mainsails depth)

The depth of a sail is important for performance, especially with the main, which must change shape radically to cover a wide wind range. The primary means for adjusting depth in the upper two-thirds of the main is mast bend. Bending the mast moves the luff away from the leech, which does several things simultaneously – it flattens the sail, opens the leech and moves the draft aft (see right).

As we'll explain in the chapter on "Mast Tuning," there are many ways to control how much the mast bends. These include adjusting the partners and mast step for pre-bend, tensioning the backstay, runners, jumpers, vang and so on.

The lesson of the trim loop was that bending the mast changes more than just the depth of the main. If you want a flat main that maintains the same twist and draft position as you had before, you'll have to make two adjustments.

- First, trim the mainsheet. Bending the mast brought the mast tip closer to the end of the boom, which allowed the leech to twist more open.
- Second, pull harder on the cunningham. When the mast bent, it pulled all the fullness out of the front of the sail and left you with a draft-aft shape. The cunningham will reintroduce curvature to the luff (see below).
- A well-behaved main should "blade out" when the mast reaches maximum bend (see below). With the sheet trimmed hard and cunningham tight, the depth of the main should be reduced to about 8%. This shape, ideal for heavy wind and flat water, will stream quietly behind the mast without flogging or creating drag.
- If the bend of the mast exceeds the sail's designed luff curve the shape of the main will go a step beyond blading out. In this case, the mainsail shape inverts as the leech falls away from a hinge created by the long diagonal creases. You'll see large overbend wrinkles running from the clew toward the middle of the mast (see below).

(Animation 6 Bending the mast ...)

Inverting the main a bit sometimes works in heavy wind when you really need to depower. In general, however, an inverted main will hurt pointing because the leech is not firm. So if you see overbend wrinkles, ease the backstay or tighten the checkstays/runners to straighten the mast.

Mast bend is sometimes necessary in very light air as well as in heavy air. For aerodynamic reasons, slow-moving air remains attached to a flat, open leeched sail more readily than to the deep sail that intuition suggests. Since there isn't

enough wind power to bend the mast in light air, many mains will be too full. You have to artificially "pre-bend" the mast with rig tension (as described in Mast Tuning) until mainsail depth drops to about 14 or 15%.

## **Outhaul**

(Animation 7 Ease the outhaul ...)

The best way to control depth in the lower third of the main is with the outhaul. Basically, the tighter the outhaul, the flatter the bottom of the sail (see below). If the waves are big for the wind, ease the outhaul slightly to give more power. If the waves are small for the wind, as in an offshore breeze, pull on the outhaul to flatten the sail and reduce drag.

Besides depth, the outhaul also changes the tightness of the lower leech. Easing the outhaul adds depth to the foot, which in turn closes the lower leech. Conversely, tightening the outhaul opens the lower leech. You can see this change by sighting forward from the backstay, or by looking at the angle of the lower batten from under the boom.

The tighter the lower leech, the more windward helm you have. That's why it makes sense to tension the outhaul in heavy air to open the leech and reduce helm. If you have a flattening reef, this flattens the foot even more than maximum outhaul tension.

## **STEP 3: Set draft position with luff tension.**

Once you've set the overall depth of the sail, the next step is to position the area of maximum draft. In most wind conditions, your goal is to locate the draft about 50% of the way from luff to leech. This is usually done with cunningham tension.

The cunningham applies tension to the luff of the main, and this controls draft position. Tighten the cunningham to move the draft forward; ease it to let the draft move aft (see below). In general, the more you bend the mast, the tighter you need to pull the cunningham to get the draft in the right place. You'll also have to pull the cunningham harder on an older main, because a sail's draft moves aft with age.

(Animation 8 Medium Cunningham)

In light air, keep the cunningham quite loose. A few "speed wrinkles" along the lower luff won't hurt. Remember you're using the cunningham to control draft position, not make the sail look pretty. In light air, you may even have to lower your main halyard (especially downwind) to get the proper luff tension.

## **Step 4: Adjust helm balance with traveller position.**

The traveller controls the angle of the mainsail to the boat's centreline and to the wind (see below). Because of this, it has a large effect on helm. The helmsperson must continually let the mainsail trimmer know how the main feels, so the trimmer can adjust the traveller as needed. Again, 3 to 5 degrees of windward helm is your goal.

(Animation 9 Adjusting the traveller ...)

When adjusting the traveller, you almost never want to pull the traveller so much to weather that the boom angles to windward of centreline. It's tempting to try this when you're looking for more helm in light air, but it usually stalls the main. On the other extreme, don't ease the traveller to leeward so much that the genoa backwinds the entire main. This may be necessary for a short time to ease helm, but it means you need to depower.

The trimmer must continuously fine-tune the traveller to keep the boat on her feet and the helm in the groove. Just remember to keep an eye on boatspeed to help you find the fastest settings.

The relationship of the mainsheet to the traveller is sometimes hard to understand. Consider the following analogy: When you move the genoa lead aft, you twist the genoa. This is what happens when you ease the mainsheet; it twists the main. Moving the jib lead inboard narrows the genoa's angle to the centreline. The same thing happens when you trim the traveller; it narrows the main's angle to the centreline.

Note: On many boats, adjusting the traveller automatically changes the mainsheet tension, and not always for the better! Ideally, you should set up the traveller so you can play it without affecting mainsheet tension.

## **Step 5: Fine-tune the total power of the main with the above controls.**

The final step in mainsail trim is continual evaluation of the sail's power. The main trimmer must keep track of the boat's heel angle, speed and pointing ability, and how the mainsail may be affecting each.

To get an idea of how to do this imagine that you are sailing upwind in medium air with the main at its most powerful setting. Gradually the wind strengthens. Sooner or later, the main will need to be de-powered, first by flattening it with mast bend and foot tension, later by lowering the traveller in the gusts, and eventually by reefing. How quickly should you depower the main?

The most obvious indication of over-powering is your angle of heel. This is something all crewmembers can feel. Heel isn't necessarily your best guideline, however. Boatspeed and the amount of windward helm are actually more sensitive and accurate indicators.

When you think you might be over-powered, use the following boatspeed test to gauge mainsail power. Lower the traveller until most of the main is luffing, and watch the knotmeter for at least a minute. If your speed increases without an appreciable loss in pointing ability you are overpowered.

Depower by blading out the main. If the main is already as flat as possible (without inverting), put in a reef or change headsails. Once again, check the knotmeter to confirm that your speed is greater after the change than before it.

Another way of testing mainsail power is to measure the rudder angle required to sail in a straight line. We said before that the goal in mainsail trimming is to achieve about 3 to 5 degrees of windward helm. If you have more than this, you are overpowered.

Depower the mainsail by bending the mast, opening the leech, easing the sheet, dumping the traveller, and reefing if necessary. These adjustments are simply changing the total power being exerted by the mainsail. Since most of the main's power is side force, adjusting the amount of this power affects windward helm. You have to get windward helm down into the acceptable range.

## **Mainsail Shape**

To measure your main's depth and draft position, draw chord lines between the ends of the draft stripes. Then measure the shapes as explained in "The Basics.". Note that twist is shown by the difference in angle between chordlines.

## **When your main gets old**

Not everyone can afford a brand new main every season. Most people are racing with mains that are two, three or four years old. Many of these sails don't look too great. You may not be able to teach an old dog new tricks, but can you make an old sail go faster?

### **Trimming tips**

(Animation 10 Growing old shape)

As mainsails age, they generally get tighter leeched, draft-aft and fuller (see right). This means you should compensate with the following:

- Use more mast bend to remove bagginess from the middle of the sail.
- Use more cunningham to pull the draft forward.

Be careful not to over-trim the main sheet (which would make the leech even tighter).

### **Batten retrofit**

There are several ways you can breathe more racing life into your weathered main. One of these is to have your sailmaker retrofit to the longest possible battens. A major reason that mainsails lose their shape is because batten flogging breaks down the material at the inboard ends of the battens. Extending the battens into the low-load area of the sail can do wonders for that wrinkled, baggy look.

### **Re-cut**

Another suggestion is to take photos of your main in action, and show these to your sailmaker. Often he can perform a face-lift that will move some of the draft from the back to the front again.

### **Sail care**

Treat your main well so it will stay fast as long as possible. Don't let it flog, and be sure to fold well after each day sailing.

## **Battens**

(Animation 11 Battens too stiff)

The rule change to permit longer battens for racing mains was a significant step forward for sail durability. Because the inboard batten ends now extend into the less-loaded area of the sail, the main flogs less and keeps its fast racing shape longer than ever before.

From a speed point of view, battens should support the roach (extra area in leech beyond a straight line from clew to headboard) without distorting sail shape. This means they must be very stiff at their outboard end. At the same time they must be quite flexible up forward, where they enter the more curved area of the sail.

Use stiffer battens (in the top one or two pockets) in heavy air to take curvature out of the leech. They are too soft if they allow a lot of curvature in the upper leech or fail to control the lower leech in strong winds (see below). Battens in the bottom two pockets should be very stiff (you can tape two together if necessary).

Use softer top battens in light air to avoid a hard edge at the forward end of the battens. The battens are too stiff (see below) if they create a kink running from the inboard end of one batten to the inboard ends of the other battens.

## Leech cord

The leech cord should be set just tight enough to eliminate flutter. This may mean you get a slight hook in the leech. This is more unsightly than significant. It's better to reduce flutter, which destroys the sailcloth and tends to get worse with age.

## Recording optimal sail settings

Every mainsail has certain trim adjustments and settings that seem to make it go as fast as possible. Whenever you feel like you're going fast, notice how you have the sail trimmed. Your ultimate goal is to create a reference chart for each of your mains that will give you good target settings for each variable. See below for an example:

### Mainsail trim Card:

Make a copy of the chart above for your mainsail. Then set a goal to keep track of your fast settings and fill in the chart as shown below. Each time you race, review the chart of the main you are using before the start. This will give you good starting adjustments. Change the numbers in your chart(s) as you discover faster settings. (Remember settings will differ widely between boats.)

Mainsail	Light Air	Medium	Heavy Air
North K/M 98			
Wind Range (knots apparent)	0-12	12-20	20+
Top Batten (angle to boom)	Parallel	Parallel	Slightly Open
Outhaul (inches from band)	2"	Max	Max
Cunningham	None	Little	Hard
Depth (% at mid stripe)	15%	13%	11%
Draft Position (% at mid)	50%	50%	50%
Backstay Tension (% of max)	50%	75%	95%
Boom Position	Centreline	Centreline	Traveller Eased
Battens	Soft Top 2	Soft Top 1	Stiff
Rudder Angle	3°	4°	5°

## Mainsail - Genoa interaction

We just described an extensive procedure for trimming the main, focusing somewhat on the back of the sail. It's obvious, however, that the main doesn't function in a vacuum. All you have to do is move forward a bit to see that it interacts greatly with another important sail called the genoa. The area that separates the main from genoa is called the slot. The width of the slot (see below) is controlled by a number of different factors:

- Traveller position
- Mainsail depth
- Sideways mast bend
- Genoa lead angle
- Genoa sheet tension
- Mainsheet tension.

### (Animation 12 Slot Width)

When you adjust these controls, you are fine-tuning the interaction between genoa and main. In medium and heavy air, your goal is to set up the main so its forward section "lifts" (shows the first backwind) evenly from boom to headboard, at the same time as the genoa's windward telltales lift. Ease the traveller to induce lifting, then readjust the sheet as follows: If the top lifts before the bottom, the sail is too twisted, so trim the mainsheet. If the bottom lifts before the top, ease the mainsheet to induce more twist. Lots of backwind in the mainsail means that the slot is too narrow. Correct this by:

- Easing the jib sheet slightly
- Trimming the main
- Flattening the main
- Changing to a headsail with less LP
- Moving the genoa lead outboard and/or back
- Making sure the mast doesn't sag to leeward in the middle.

## Downwind

Most of the principles we've talked about apply for downwind trim as well as upwind. Your goal is still to keep air flowing over the main as much as possible. Watch the upper batten telltale, and try to keep it streaming. The only time this won't work is when you're on a run, where the sail is stalled most of the time.

### Mainsheet

Downwind the sheet controls the overall angle of the main and has very little to do with adjusting twist. Ease the sheet until the front of the main almost luffs. It can be helpful to put a telltale half way up the sail and a couple feet aft of the mast, so you know when the back of the main stalls.

### Vang

The vang is not used much upwind except on smaller boats that vang-sheet in heavy air. Downwind, however, you must use the vang to control leech tension (twist) because the mainsheet no longer pulls down.

One of the biggest mistakes that sailors make is over-vanging the main in lighter air. Often the weight of the boom provides plenty of leech tension; use the vang only when it gets windier to keep the upper batten parallel to the boom.

### Sail depth

In general, you want a fuller main shape downwind than up wind. This means you should ease the outhaul, cunningham and backstay when you go around the windward mark. In light air, you may have to drop the halyard slightly as well. One exception is an overpowered reach, when you want to depower the main as much as possible to reduce helm.

**Don't forget about the main when you turn the corner and set the chute. Keep the sheet eased as far as possible, and adjust the vang so the top batten is parallel to the boom.**