How to Sail in Shifty Wind

Wind shifts are annoying but they provide more opportunity for gain than anything else. Wind is never constant. This is not news to sailors, who are constantly dealing with shifting wind and wave to maximize performance. On this page, we’ll discuss wind shifts and how to extract maximum performance from them. Another important but less understood phenomenon – wind shear – is discussed (here).

Wind shifts occur at all time scales – from seconds to days. By definition, wind shifts of less than the reaction time of the boat can be ignored. Shifts on a time scale much longer than the race are also only of academic interest. We’re interested in shifts with a time scale from say 10 seconds to the length of the race (hours to days).

The Long Race – Optimal Routing

Optimal routing is commonly used on long distance races. This technique uses weather prediction (in the form of GRiB files) and polar curves to determine the fastest path to the finish line. GRiB files generally predict wind every 3 hours on a grid 30 miles on a side. If your race is on a scale commensurate with the GRiB, you should certainly consider doing an optimal route to set strategy. If possible, the route should be redone during the race to factor in actual present position and changes in forecast.

For the smaller scale, prediction is less important than knowing the current conditions and how local knowledge will affect them.

Sailing fast – Targets

The most fundamental technique for optimal sailing up and down wind is the Target Boatspeed idea. Polar curves allow you to determine the boat speed at which your Vmg is maximized. There is good reason to use boatspeed and not Vmg to set the optimum sailing point (see the discussion here). This technique implicitly sets the true wind angle to be sailed. If the wind shifts, heading changes the same amount to as to maintain target boat speed (and therefore, true wind angle).

Changes in true wind speed affect the shape and magnitude of the polar curve, and therefore both target boat speed and true wind angle. But in general, sailing targets means sailing a fixed true wind angle (as determined by target boat speed) relative to the wind direction.

Targets themselves say nothing about wind shifts. When shifts are added to the mix, there are techniques to get extra performance beyond targets alone (see The Wally).
Being in the right place – Lateral position

![Diagram of lateral position and shift](image)

Winning a boat race doesn't depend only on speed. Cunning plays an important role too. When sailing upwind, if the wind doesn't shift and two boats have the same performance, they can be said to be even when they are on the same "ladder rung", a line perpendicular to the true wind. In the figure, Green and Red are even because they are on the same ladder rung. When the wind shifts 10º to the left, Green is suddenly 25% of the lateral separation ahead of Red, and didn’t have to sand a single bottom to do it. This mechanism is why being on the “right side of the fleet” is so very, very important.

So how do you know the wind is going to shift left instead of right? By playing the percentages. By observing wind direction, you get a feeling that the average is, say 225º and gain a sense of how shifty the breeze is. Then, because wind always oscillates (more or less depending on the weather pattern), you will know that when the gauge reads 230º, the wind is 5º right, and you can expect it to go left in a while. You can also read the wind shear tea leaves (see Understanding Shear).

In addition to tacking, lateral separation can be manipulated by pinching in the headers and footing in the lifts (doing the Wally – see below). If you don’t overdo it, Vmg isn’t affected much, but lateral separation can be changed a lot. If you’re headed and pinch, your separation is reduced on the boats to to the favored side and simultaneously increased on those to the unfavored side. When the wind shifts, you suffer less damage from the favored boats and gain extra on the unfavored boats.

Shifts on the small scale – Doing the Wally

When the wind will oscillate at least 1 cycle before you get to the windward (or leeward) mark, then your objective is to make the best speed up (down) the AVERAGE wind direction, not the present wind direction. This change in perspective moves the little squares on the polar depending on where the present wind is relative to the average wind.

In the figure, the wind is shifted 10º right from average, moving the Vmg points. This means that the optimum Vmg point has a faster than standard Target on the lifted tack and lower than standard Target on the headed tack. This change actually makes your Vmg HIGHER than standard, because the curve rotates up relative to the Vmg point on the rotated polar. Therefore, if you Wally (sail the faster target speed when lifted and the slower target when headed), two things happen:

- You go upwind (up the average wind) faster than you would if you just sailed to your basic target speed.
Your separation automatically moves in the right direction to reduce damage from boats on the favored side, and increase gain on boats on the unfavored side.

Why not just tack? There may be tactical or strategic considerations, but more importantly, tacking costs distance to weather. If the shift is too quick or too small, you won’t make up for the loss. Wallying gains distance to weather and Vmg when you can’t or shouldn’t tack.

**How to Wally AND tack**

Let’s say you’re sailing in an oscillating northwest wind with shifts lasting long enough to allow tacking.

1. As the wind starts to lift above mean, you begin to foot. The greater the lift, the more the foot.
2. When the lift hits maximum, you’re going your maximum foot.
3. As the wind swings back to mean, you begin to return to your target speed.
4. When the wind hits the mean, you’re at target speed, and you tack onto the new favored board.
5. Repeat.

There are two advantages to doing this:

1. You’re always going faster upwind than you would if you just sailed your targets.
2. Your lateral separation automatically changes so you gain more on those on the unfavored side and lose less to those on the favored side when the wind shifts back.

**Medium to large scale – Vmc sailing**

What about non-upwind/downwind sailing, like in distance races? In the figure, you can see that bearing off below the rhumbline increases your speed toward the mark.

Of course, the disadvantage of Vmc sailing is that you go off rhumbline, and will eventually have to get back. In the upwind case, you can tack. But in the offwind case, you cannot. If the mark is days away, the wind will likely change and allow you to consolidate back to the rhumbline. If the mark is minutes away, maybe no Vmc sailing. If the mark is in between, it depends on circumstances.

Whether or how much to Vmc sail depends on your knowledge of the future. If you have a GRIB file, and you trust it, you will be able to determine whether or how much to stick your hide out. If the wind is going to shift enough to tack, or at least enough to get you back to the rhumbline, then you can Vmc with confidence.
Measuring Wind, and Understanding Wind Shear

Understanding wind shear and gradient

Wind shear... it's that mysterious quality of the wind that can make or break your strategy in a race. Many people measuring wind refuse to believe in the existence of wind shear, never mind its effects on sail trim. Much has been written on wind shear, especially here at Ockam. We have a clear understanding of it's importance.

It is a very real phenomenon that can be seen in sail trim (especially jib cars) and the wind information from an Ockam system. Many other instrument systems for measuring wind cannot reliably display the angle offsets that provide clues as to the presence of wind shear due the the method of calculating the wind solution, so many people refuse to believe its existence. The moment of epiphany for the Ockam system’s ability to detect shear came back when the America’s Cup was still in Newport, and it was a Block Island Race Week year. One syndicate was using SODAR to image the wind field prior to the warning signal. They also had the Ockam system installed. Several boats racing at Block Island (13 miles south of the Rhode Island coast) also had Ockam instruments. The boats with Ockam systems were seeing absurd tack-to-tack differences in wind angles, and the users were declaring them “useless pieces of junk.” However, the SODAR was imaging vertical wind shear at the same time. It dawned upon the shore crew analyzing the data that the tack-to-tack differences in wind angles were due to the effects of wind shear! After a little more examination of the data over many sailing days, it was determined to be a real effect. The crews who were able to recognize the existence of vertical wind shear went on to gain a tremendous advantage in racing.

Short of using a SODAR, how can the ordinary person see wind shear? One of our customers has come up with a simple but ingenious device to demonstrate the absence or presence of vertical wind shear. He calls it the "Shear-O-meter". It requires hauling a line up the mast without sails present, so it is most useful just before the race.

During a race, it’s not practical to drop sails to check for shear. Also, some boats leave the harbor with the main already up to reduce problems out on the water. Here is the method for Determining Shear while racing.

There is also an atmospheric mirage phenomenon called a Fata Morgana. The conditions that produce Fata Morgana are also ideal for producing vertical wind shear! Chances are, if you can see a Fata Morgana mirage, then there will be vertical wind shear. The conditions that form a superior mirage also tend to produce shear, although it may not be as pronounced. An inferior mirage indicates conditions opposite those that tend to produce vertical shear, but they are rarely seen over water. The absence of these optical phenomena does not indicate the absence of vertical wind shear. Their presence indicates the presence of the atmospheric structure that strongly promotes vertical wind shear – stratified surface layers with laminar flow.
The Wally

Gain from wind shifts without tacking

The Wally is a technique for gaining advantage of wind shifts when you can't or shouldn't tack. When should you not tack?

The Wally was invented in Fremantle where the wind shifts were regular, but too short to exploit (there were also significant tactical reasons not to tack).

The basic idea is that when the wind shifts back and forth at least once during a leg, you should change your objective to maximizing Vmg up or down the average wind instead of the current wind. This change of perspective always increases your speed to weather or downwind relative to maximizing Vmg on the current wind. And it also pumps your lateral separation in such a way that wind shifts always help you and hurt them. See Lateral Separation.

Since there is no cost involved, you should always Wally when you are not tacking

Performance improvement

Here you see a polar rotated to align with the wind shift. The standard target points also rotate but there are new target points maximizing Vmg up the average wind. On the lifted tack wally targets are faster than target speed, and on the headed tack they are slower. In both cases you will notice that your Vmg (up the average wind) is better than standard targets. Thus, no matter whether you are in a lift or header, Wallying increases your Vmg relative to standard target speed.

The performance component of wallying is typically worth about 5 seconds per mile.

If you are so inclined, the method for calculating Wallys is discussed here. However, there is also another reward to wallying; pumping your lateral separation. The gain by manipulating lateral separation can be as much as 10% of lateral separation.
Everybody talks about them, but what are they?

What are Polars anyway? Ever hear someone talking about hitting their targets at the post-race party, and wonder why they were shooting at people? They're not trying to shoot the competition, they're just using polar plots of the boat's performance to judge how they are performing against the boat's potential in the conditions.

Many people are familiar with polars as the table and graph documents that detail the boat's performance in a variety of wind speeds at wind angles from dead downwind all the way up to in irons (at least the good polars cover this range). It's not very convenient to whip out some sheets of paper while racing, so the better instrument systems (Ockam included) can compute and display polar performance information on the fly. This may seem like overkill to win a race, but all the best racing programs use polars. To paraphrase a recent sailing forum post: “How do you recognize people who use polars? They're standing up front with the trophy in their hand.

I'll not go into the nitty-gritty details of plotting polars – that's covered pretty well elsewhere. However, there are a few important details that are worth noting.

First, everyone should be aware that polars use true wind angles and speeds. This is what the boat "sees" as the basis for its speed, as true wind is independent of the boat’s motion through the water (unlike apparent).

Almost all polar sets, or at least the initial model runs, assume optimal conditions. This means that there is no accommodation for bad sails, bad trim, bad driving, bad weather, or bad luck. If you have old sails, it should be pretty obvious that you will not be reaching your polar targets. For those people inexperienced with the use of polars, it may not be as obvious that bad weather will also prevent you from reaching your polar targets. If you have to reef, or if you are pounding through waves, the boat will not be driving to its potential speed for the given wind speed.

A boat isn't precluded from having more than one polar file. Many high-end programs will have the initial prediction file from the designer as a basis for starting measurement, and then also build a file from observed performance.

One aside: building a polar file from observed performance can be difficult since it's hard to winnow out bad data. Performance analysis is typically done off the boat much after the race, so it can be hard to determine when the boat is responsible for a particular data point, or if an external factor is at work (e.g., bad helming, collision avoidance, weather, etc.).

A good alternative polar file built from observed data can provide a way to compensate for weather and sea state. It takes a lot of concerted effort by the person doing the analysis and a large data set in a wide range of environmental conditions to provide a good foundation for analysis. Some boats also have multiple rig or sail configurations that strongly affect performance, and require separate polar files for different configurations.

Another detail that should be obvious, but really isn't: you need good instruments to use polars effectively. Your instruments must measure the boat and its environment accurately and precisely to give you a good idea of the actual performance. This means that you must have instruments with reproducible results, and
must have any measurement errors corrected (i.e., calibrate the instruments). The more astute reader will have realized that since true wind is the basis for polar performance, then good calibration of the instrument system is a must. Some instrument systems have no capability for calibration, and are completely unsuitable for using polars. Imagine driving a car with a speedometer that worked differently each time you drove – bad instruments are like that. It’s pretty impossible to know how well you’re doing from day to day if you don’t have reproducible results.

It may not be completely obvious, but GPS-based SOG should NOT be substituted for speed through the water! “Why?” you ask… SOG does not take into account any current. Those of you who have sailed in foul current (such as The Race in Long Island Sound) know how frustrating it is to trim the sails perfectly in good wind, only to make 1.0 knot headway over the ground. Now imagine if your polar performance was based off SOG. Assuming you have decent wind speed and a good point of sail, the polar performance would show you making some paltry low percentage of your expected performance! There would be much gnashing of teeth, since it seems like you’re doing everything correctly and not making any speed. However, if you use speed through the water, it will at least show that you are making the best speed through the water possible for the wind conditions. The Race is an extreme example, but it illustrates the point that current can significantly affect your speed over ground, thus rendering SOG a poor indicator of performance.

Resolving wind speed and angle to predicted performance can be a problem if you have a very coarsely granulated polar file. In the past, the Ockam system required very strict data ranges to provide polar information through the 037 Performance Index. Wind angles had to be provided from dead downwind (180 degrees), all the way up to extreme pinching (ideally around 15 degrees) in 2 degree increments. Winds speeds were provided from 0 to 25 knots in 0.5 knot increments. These rather strict requirements were due to the limited processing power of electronics back then. Remember when 33 MHz processors with 16-bit buses were the leading edge for PCs? More powerful processors have opened the door to better functionality; the more powerful processor in the Ockam T1 has loosened the requirements for the polar files. It can interpolate values with far less data points than before. However, the polar file shouldn’t be too sparse on data points if any sort of accuracy is desired. Data points every 10 degrees and 5 knots are a good minimum standard for the T1 processor, but higher data resolution is always better. Areas of the performance plot that have large changes in a small region should have data point higher resolution to capture the predictions accurately.

For most instances of simple performance comparisons, polar plots that cover the range from close-hauled to dead down wind will suffice. When using VMC sailing and Wally, having more information past close-hauled becomes important. VMC sailing becomes especially important when going to a mark that is not directly in line with the wind (typically some sort of distance race). It becomes even more important if the wind is shifting over time, such as is found in almost every distance race. The performance information for the region above close-hauled allows computation of the possible VMC benefit of sailing both above and below the rhumbline. This allows comparison of the distance advantages between sailing on a conventional rhumbline course and sailing off the rhumbline (either above or below) at the fastest VMC speed. Without the data above close-hauled, possible advantageous sailing is eliminated from the calculus of the fastest route! That would be like only allowing your trimmers to adjust sails while on only one tack, and hobble you from your possible best performance.

Sailing with polar performance comparison can induce a lot of headache, and has a pretty steep learning curve. Many people simply don’t have the time to fully comprehend all the nuances of using the performance analysis with their instrument systems. However, many of the more common functions can be easily incorporated into the tactician’s tool kit with a little study and practice.
Wind shear and gradient changes the way you trim your sails

How to determine shear? Wind shear is always present. Determining how much there is will improve sail trim and performance, and offer a clue about future wind shifts.

Shear is best determined by tacking upwind in full racing mode. Shear is half the sum of true wind angle on the two tacks. When shear is present, boatspeed and heel angle will be lower on the tack in the direction of the shear, and higher on the other tack.

This confirms that it's shear and not sensor alignment. You can also use the 'ShearOmometer' before you go sailing.

Your instruments tell you how to determine shear

(The following example uses the readings shown in the figure).

- Shear is +5º. \((52º+(-42º))/2=+5º\). Plus means to the right.
- Boatspeed is down 0.25 knots on port tack and up 0.25 knots on starboard, as would be expected for positive shear.
- Mean boatspeed is 7.02 which is 0.10 knots below target. This is probably due to a combination of less efficient sailplan due to shear, and higher than average gradient. In any case, you know that your new targets will be down 0.10 knots, modulated by 0.25 knots due to shear.
- Effective wind direction is 225º as determined from heading on the two tacks.

Note that wind direction is 5º right of your effective wind direction, and doesn’t change tack-to-tack because of shear.

It is very important to determine shear, targets and sail trim before the start of the race, so the information can be used right off the line. Since shear tends to predict future wind, it offers a clue about which side of the fleet to favor. This could be trumped by local knowledge.

This is also a good time to get an idea about how shifty and puffy the wind is. Shiftness will affect your decision about how conservatively to call the layline (see Approaching the Mark).

On the windward legs, shear and targets should continue to be monitored for changes.
Sailing lateral separation

Lateral separation pumping leverages wind shifts into big gains when sailing

When sailing lateral separation is crucial. Being “On the wrong side of the shift” means that if you are to the right of your competition and the wind shifts left (or vice-versa), you lose distance to weather. It has nothing to do with how fast you are, it depends on your lateral separation.

A 5º shift gains or loses about 9% of your separation

You can manage (pump) your lateral separation by tacking or Wallying. However, most of the time, tacking is inadvisable (see Break-even tacking). But much of the time, you can safely Wally and gain by pumping your lateral separation (in addition to the gain of the Wally itself).

You will need an accurate real-time wind direction readout to do this properly.

Pumping your sailing lateral separation; How it works

This is why you hear the saying Foot to the header. And the Wally tells you exactly how much to foot.

(1) Green is in a lift (favoring Red) so he foots, increasing lateral separation at no cost in \( V_{mg} \), in preparation for the right shift to follow. Footing the amount advised by the Wally technique will increase lateral separation while actually gaining \( V_{mg} \) up the average wind. You could foot faster to increase lateral separation faster with only a small loss in \( V_{mg} \).
(2) When the lift ends, Green has increased lateral separation.

(3) When the opposite shift happens, Green is ahead due to the increased separation. Now he pinches in the header so the lateral separation gets smaller, in preparation for the next left shift. The Wally also has an optimum pinching value, and you could also pinch more.

You never hear Pinch to the lift, but it’s equally valid. Keep this to yourself. Since the gain depends on lateral separation, a number can’t be assigned to it, but it can be big. Gain or loss is 2% of lateral separation per degree of shift. In other words, a 5º shift is like a 10% of separation gain!

**Super-pumping lateral separation**

You can actually pump separation more than normal if the situation requires it. As you remember, optimal Wallying produces a bit of gain to weather. You can trade in that extra Vmg and pinch or foot more than optimal to change sailing lateral separation a lot faster without losing Vmg.

**The match racing perspective – Hyper-Pumping**

For boat-on-boat, best Vmg becomes almost irrelevant. It doesn’t matter if you finish in the middle; the idea is to beat your arch enemy. And for this, sailing lateral separation is the tool of choice. The idea of hyper-pumping is to change separation by tacking instead of merely Wallying.

When you Wally, the separation rate is about 10% of boatspeed, and there is no DLw to contend with. If you tack, separation rate is about 140% of boatspeed, but there is the DLw issue to contend with. All separation pumping works downwind as well, and there is less DLw (DLd in this case) to worry about.

If this discussion interests you, please register to receive a more detailed presentation on the Wally, tacking and sailing lateral separation.
Calculating Wally

How to calculate Wally

The Wally is a technique for gaining advantage of wind shifts when you can’t or shouldn’t tack (read the overview). And yes, there are times and conditions where you shouldn’t tack (see Break-even tacking).

In this exercise we will use the Ockam37 polar as an example. If you would like to follow along, you can download it from here.

Vmc Angle

The Wally function uses the Ockam polar function VmcAngle which gives the angle of maximum Vmc at any true wind angle. Upwind and downwind targets are merely special cases of the Vmc Angle at 0° and 180° true wind angle respectively.

As you can see from the diagram, for a 10° shift, the fast-wally will be the max Vmc at a true wind angle 10° greater than normal, while the slow-wally is at a true wind angle 10° less than normal.

Calculating the Wally in 12 knots true

Now, using the Ockam37 at 12 knots we will calculate the Wallys.

- Find the normal target angle and speed
  - Vmc Angle(12 kt, 0°) is 39.3°. This is the normal upwind target angle in 12 knots.
  - Boatspeed(12 kt, 39.3°) is 7.434 knots. This is the normal upwind target speed in 12 knots.
  - Vmg is 7.434*Cos(39.3°) or 5.752 knots.
- Find the fast-wally (at +10° Vmc Angle).
  - Vmc Angle(12 kt, +10°) is 31.1°. True wind angle is base angle + Vmc Angle, or 41.1°.
  - Boatspeed(12 kt, 41.1°) is 7.603 knots.
  - Fast-wally is therefore (7.603 – 7.434) or +0.169 knots.
  - If you weren’t wallying, your Vmg up the average wind would be 7.434*Cos(29.3°) or 6.483 knots.
  - By walling, your Vmg up the average wind is 7.603*Cos(31.1°) or 6.510 knots; +0.027 knots. That doesn’t sound like much, but you are also lateral separation pumping.
- Find the slow-wally (at -10° Vmc Angle).
  - Vmc Angle(12 kt, -10°) is 39.6°. True wind angle is base angle + Vmc Angle, or 29.6°.
  - Boatspeed(12 kt, 29.6°) is 6.525 knots.
  - Slow-wally is therefore (6.525 – 7.434) or -0.909 knots.
  - If you weren’t wallying, your Vmg up the average wind would be 7.434*Cos(49.6°) or 4.818 knots.
  - By walling, your Vmg up the average wind is 6.525*Cos(39.6°) or 5.028 knots; +0.210 knots (+4.3% or 35 seconds/mile). Yes. Slow-wally is very effective.
  - For some boats, going a knot slow is a challenge. But, if you can handle it, you will be gaining a lot. And the Lateral Separation pumping at -9.7° true wind angle difference will be quite rewarding. Otherwise pinch as much as you can get away with.
The Wally plot

The complete Wally graph for the Ockam37 looks like this.
Approaching the Mark

Be on starboard at the mark
- Approaching the mark on port means having to give way to everybody else on starboard.
- You have to turn 90 degrees further, which is very bad for boatspeed.

Full speed at the mark
- Rounding a mark at less than full speed makes you vulnerable to being passed.
- If somebody tries to squeeze between you and the mark, you can pass them.

Don’t overstand or tack too soon
- Overstanding (going beyond the layline) is not optimum sailing, although, if not overdone, the damage is less than some people think. And there are tactical reasons to do it, if warranted.
- Tacking short of the layline is very bad. When you realize you aren’t going to make it, you’ll either have to pinch or take 2 short tacks which cost several boat lengths to weather and speed at the mark. And you’ll have to do it in heavy traffic.
- Use Time to the Laylines to determine where the layline is. When heading toward the starboard layline, ‘Stbd Layline’ counts down. When it reaches 0, you’re there.
- ‘Port Layline’ tells you how long you will be on starboard before you get to the mark.

Pick the best point to intersect the starboard layline (‘Port Layline’ reading)
- If you hit the layline too far from the mark, wind shifts will move the line and you may be short or overstand.
- If you hit the layline less than a couple of minutes from the mark, you won’t be able to get up to speed, and the crew won’t have enough time to prepare for rounding.
- Your close-by enemies to port will have to go behind you or tack short. The ones to starboard can force you into that situation. You should have lateral separation of 5-10 boatlengths from the starboard enemy so you will have clear air on the layline.

Be ready for eventualities
- Sometimes the mark isn’t where it’s supposed to be.
  - You can use Opposite Tack to check whether the layline is where it’s supposed to be.
  - If Opposite Tack points to the mark when you’re on the layline, things are OK.
  - If it doesn’t, you have a decision to make.
- Adjust your tack onto the layline depending on expected wind shift.
  - When you tack for the mark, you’re committed. If the wind subsequently shifts, you have a problem (headers being much worse). Be aware of the current shift when you decide to tack.
  - The Shift display shows the current wind direction relative to average.
- Positive numbers mean the wind is right (meaning an eventual header), so you should go beyond the layline so you won’t come up short when it happens.
- Negative numbers mean the wind is left (meaning an eventual lift), so you might tack short so you’ll be lifted onto the layline when it happens.
- How much should you spin the intersect? About 2% of the Port Layline reading times the average shift expected over the starboard run to the mark.
- Where are you in the shift cycle, and how big a shift can you expect? The Stats display includes a shift item giving the average size of the wind shifts (over the last hour).
- Overstanding is better than tacking short.
Break-even tacking

Break-even tacking

Everybody knows you should tack on a header. The problem is that tacking includes a penalty – distance lost to weather (DLw – see Tack Analysis). Your DLw first needs to be paid back before your tack is a gainer. And that depends on the amount and duration of the shift. You gain to weather while the wind is a lift, and the bigger the shift, the faster you gain and the less time the shift has to last. If the shift peters out before you make back your DLw, you will lose. Break-even tacking (the BET) describes the minimum conditions under which you will gain by tacking.

The break-even line is how much distance you lose in a tack. OS5 includes a tool to automatically record, analyze and display your tacks. With this tool, you can find out how much DLw you actually have. See Tack Tracker.

If shift conditions and your DLw fail to meet the minimum conditions, you can still gain from the shift without tacking by doing the Wally.

Tacking serves several purposes

- Point you to where you need to go.
  - Tacking on the layline
  - Moving to one side of the course because of a wind or current advantage there.
  - Position yourself advantageously relative to your competition.
- Consolidate your lead by covering the fleet.
- Set you on starboard for right-of-way advantage.
- Avoid obstacles or boats with the right-of-way.

The decision to tack for these situations is not discretionary.

Take advantage of wind oscillations

However, most of the time, you are where you want to be and going the direction you want to go. In this case, the tacking decision is to take advantage of oscillating wind. Tacking carries with it a certain amount of risk and penalty with a hoped for reward at the end. The more you know about the risk vs. reward, the more likely you are to make the right decision (see Wind Statistics).

In this discussion, the wind is shifting left and right but its average direction remains constant. In this kind of condition it is a lot faster to maximize your Vmg up the average wind direction rather than the shifted wind direction. This is the principle behind the Wally.
Tack vs. Wally scenarios

The performance perspective
Most of the time you are fleet racing. Your objective is getting around the course as fast as possible. Your metric is best Vmg upwind with as little loss to weather (DLw – see Tack Analysis) as possible.

The match racing perspective
Sometimes though, there is somebody you have to beat. It doesn’t matter whether you finish in the middle, you must beat this guy. Your objective is sticking it to him and to hell with the rest of the fleet. In this case, pumping your lateral separation relative to him is a big gainer, and may trump your tack/wally decision (see Lateral Separation).

Tack or Wally? How do you decide?
We are going to relate speed differences to rating numbers (see How to Calculate Seconds per Mile).

The advantage of Tacking
Here we see 2 boats on port. Green Machine detects a small shift and tacks onto starboard. Dead Red doesn’t notice and keeps going, bearing away to the new wind because his telltale tells him to.

Notice that Green’s Vmg up the average wind increases while Red’s decreases. The equivalent straight-line boatspeed advantage is considerable:
A 5° shift is equivalent to about 1 knot of boatspeed or 100 seconds/mile!

The disadvantage of tacking
- Distance lost to weather (DLw). All tacks carry a loss, and blown tacks are always a possibility. The expected gain needs to pay back this loss before it becomes one.
- The hoped-for wind shift peters out before you make back your tack loss.
You certainly shouldn’t tack if you won’t make up for the DLw. So how do you decide this?
- The first thing is to know what a tack will cost you. See Tack Analysis and Tack Score for guidance on this.
- The second thing is deciding how big the shift is and how long it is likely to last. The bigger and longer the shift, the safer it is to use it.
How to calculate seconds per mile

In sailboat racing rating is given in seconds per mile. When deciding how much difference in rating a speed advantage is, it is convenient to be able to convert between a speed difference and a rating difference. This gives a handy yardstick to decide if a particular change is worth its cost.

So exactly how do we convert speed gain into seconds per mile? In the figure, Green is covering a mile 6 seconds faster than Red. This makes Red’s rating 6 seconds/mile less than Red’s.

**Seconds per mile formula:**

\[
\frac{Sec}{Mile} = \frac{3600 \Delta}{Vs(Vs + \Delta)}
\]

Vs is base boatspeed
\(\Delta\) is the speed difference

**Straight-line speed advantage for a Vmg difference**

When there is a Vmg difference, the boatspeed equivalent is higher. For a given gain in Vmg, the boatspeed is about 140% faster. The exact amount is \(1/\cos(Bt)\) where Bt is the true wind angle.

This speed difference to rating function is used in many situations where you need to make tactical decisions, for instance;