pensive than the traditional two-piece foul weather suits. Also, in many cases, they are warmer, longer lasting, and drier.

- Hiking boots. The old sneaks are great for kicking around in, but when it comes time to jump in the straps, your ankles and arches will love you forever if you buy a pair of sailing hiking boots.
- Full-fingered gloves. The traditional sailing gloves with all five fingers cut off can cause more pain than wearing no gloves at all. The stubby fingers slip down and bunch at the bottom, and nothing protects the critical outside of your fourth and fifth fingers, which do all the work. Full-fingered gloves with maybe just the thumb and forefinger cut off are the most comfortable.
- And for those cold, wet days, there's no substitute for a wool hat, wool socks, and drysuit or wetsuit. The wetsuit should be the Farmer John style (one-piece, long legs, no sleeves).

Preparation on the Water

- Start the race with no water in the bilge or tanks. The crew should keep the boat bailed and sponged dry up to the last possible second.
- If you're using the automatic bailers, close them for the final minute while you're luffing before the start, and open them again just as you begin to accelerate.
- Sailing around before the start, keep a slight heel so waves can't wash over your windward side as easily.
- Check all double-ended controls. If the first reach will be a windy, tight one on starboard, be sure to have plenty of excess tail on your starboard vang, traveler, and cunningham controls.
- Put all your loose things (tool bags, lunch, sail bags, foul weather gear, etc.) into one large sail bag and tie it into the boat.
- Carry plenty of short pieces of spare line, basic tools, a knife, a few shackles, some spare battens, and anything else you feel you may need.
- In a keelboat carry a weed stick. A long ski pole with a towel wrapped at one end works well. Just put it in the water ahead of your keel and the force of the water will push it down the leading edge.

CHAPTER 29

There Is No Lee-Bow Effect

ONE OF THE MOST fascinating and timeless controversies in our sport is over what effect current has on how we sail and race our boats. Beginning in early 1979, Peter Isler and I filled hours of time debating the effects of current, and it wasn't until mid-1980 that he finally parted my clouds and shook me loose from years of misconceptions and incorrect assumptions. Here then is my understanding of the effects of current, substantiated by several of my more mathematically-clever friends.

What Is Current?

Current is the physical movement of the water. Often the entire body of water moves, as in a river or tidal region, but frequently just the surface layer of water moves, as when swept by the wind.

How Can We Determine the Current?

The information we need is: in what direction and at what speed will the current be moving at a given location and time? In tidal regions, tide charts tell us the times and height of low and high tide, but they don't give us specific information on current. In the fourth hour of a six-hour cycle, how fast is the current moving? Nearing low tide, when does the current actually start flooding (coming in)? After high tide, where does the ebb (going out) begin? Many regions have current charts and tables. Ask the locals or at the nearby marine store. The current is further affected by high and low atmospheric pressure, the phase of the moon, the strength and duration of the wind, the topography of the bottom, and the amount of rainfall or snow run-off in the area.

With over 30 feet of snow in the mountains north of San Francisco Bay the winter of 1982, local sailors reported that the currents were much stronger and less predictable that summer.

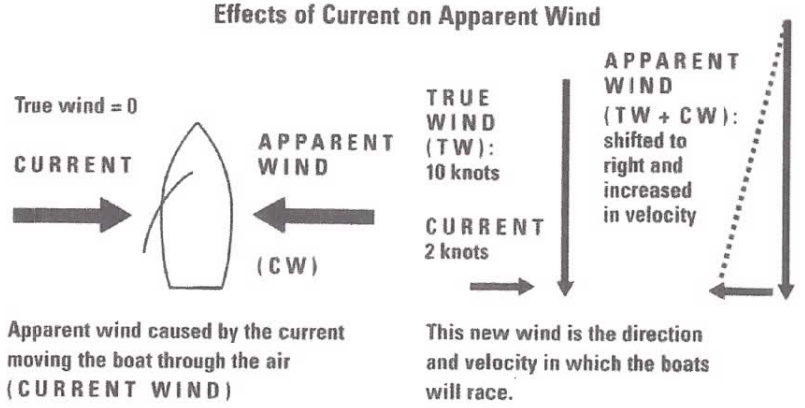
After studying the charts and tables and talking to the locals, go out and take your own measurements. The best current stick is one that protrudes only a couple of inches above the water's surface (to reduce the effect of the wind), and sinks to the level of your centerboard or keel. A weighted plastic tube works well, but in the clutch a sponge does the trick. Drop it in next to a buoy and start your watch. When it has drifted a boat-length, check the time and direction it moved. Using r = d/t, you will know the strength and direction of the current.

Check the current all over your racing area. Bring a small buoy if there aren't many already out there. If you're measuring current several days in advance of a regatta, remember that the current cycle often changes. Using your tables, determine the predicted direction and strength for your race day. Then find what time that same direction and strength occurs the day you're going out, measure it at that time, and check your findings against the table. Also observe all lobster pots, buoys, and anchored boats for clues on current. Finally, notice the water's surface. When the current is aligned with the wind, the water will appear extra smooth; when opposing the wind, the water will appear rough and choppy.

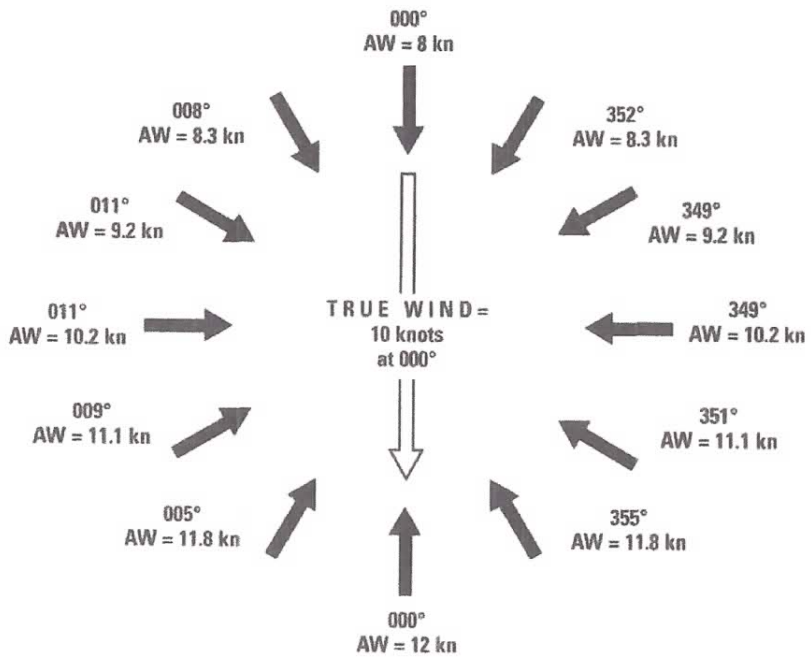
How Does the Current Affect Our Apparent Wind?

This is the most difficult aspect to conceptualize, but once understood it solves the mysteries surrounding current. As Peter says, imagine a stick floating down a river. Whether it's angled parallel or perpendicular to the direction of the current, it is still being moved at the same speed and direction down the river. If you go out on the river on a floating boat when there's no wind, and the current is from the south at two knots, what will the boat feel? Two knots of wind from the north.

Now the true wind picks up to ten knots and you look at your instruments. The wind direction and strength they read will be the combination of the two knots of current created wind and the ten knots of true wind. The



This chart shows changes in apparent wind angle and velocity (as noted) due to different angles of current (black arrows). The true wind is 10 knots from the north (000°). The current strength is 2 knots. As an example, if the current was from the east (the three o'clock position) the resulting apparent wind (true wind plus current wind) would be from a direction of 349° at a strength of 10.2 knots.



result is one wind direction and strength (true plus current wind) in which you will sail. Now you put up your sails and begin sailing. The apparent wind your boat now feels is the combination of the true plus current wind and the headwind your boat is creating by its forward motion. It's important to remember here that no matter how fast or in which direction you are moving, the current speed and direction remain constant (assuming the current itself doesn't change), and therefore its effect on the boat's apparent wind will always be present and constant (diagram previous page).

Should the Current Affect the Way We Sail Our Boats?

Assuming that we're sailing in constant current direction and strength, NO! As we've determined, the direction and strength of the current created wind is the same no matter at what angle the boat is aiming or at what speed it is moving. The presumption of the lee-bow effect is that if you are sailing directly into the current you can pinch slightly, putting the current on your leeward bow, and the current will push you up to weather. This is obviously false because the only direction the current can move you is in the direction it is going (the stick on the river).

The presumption of those who believe that in current a boat will have a different apparent wind direction and strength on opposite tacks, is that on one tack the boat will be slowed more by the current than on the other. The extreme example is when port tack takes you right into the current, and starboard tack takes you across it. The illusion is that on port tack it would seem that the boat is still going forward toward the wind, but that on starboard the boat is being swept away from the wind by the current. Therefore, the apparent winds must be different on the two tacks. The fallacy here, though, is that the judgment of going toward the wind and being swept away are made in reference to fixed objects such as the mark, an anchored boat, or land. In reality, both boats are being affected equally by the current and the wind "sees" both boats in the same way. In other words, if you were following the race in a motorboat and were in the ocean where you couldn't see any land for reference, the boats would look identical on either tack, and in fact you would have no clue that there even was current unless you knew from charts or perhaps from the surface condition of the water. Put another way, if you're sailing on a boat with apparent wind strength and direction instruments, they'll read the same on both tacks because the boat is affected in the same way by the current on either tacks (the stick in the river again). Stan Honey's numerical model and Dave Dellenbaugh's geometric model, found at the end of this chapter, are both proofs of this phenomenon, and they look at the two boats both from the reference frame of the water (i.e. as the wind "sees" the boats, or as you would floating in another boat) and from the reference frame of land (i.e. watching from the bottom, an anchored boat, or on shore).

How Does the Current Affect Our Racing Strategy and Tactics?

The current has a definite effect on our race around the buoys (because the buoys are fixed to the bottom), and in some places, like Charleston, S.C. or San Francisco Bay, the current is often more of a race-determining factor than windshifts. Race committees must remember to determine the wind direction before anchoring. Often they'll anchor and then take wind readings, which of course will not determine the wind direction and strength in which the sailboats are sailing. Using the diagram showing the effects of current on apparent wind for reference, if the RC anchors in one knot of southerly current, then sets the starting line perpendicular to the true wind which is west, which end is favored? The right-hand end, because the new true plus current wind is shifted right. Fortunately, because our sailboats are not anchored, when we shoot the wind the current's effect is automatically built in, so we see only one wind direction (true plus current wind). So in current, don't determine the favored end by judging the angle of the flags on the line.

Before the start, especially in light air, always stay on the up current side of the line. Never allow yourself to get down current unless absolutely necessary. This often requires paddling or motoring until your preparatory signal to get up current. Also, get excellent line sights through both ends of the line. (Go outside one end, sight through both ends, and see what shore object lines up with the starting marks.) In current, always watch the land behind fixed objects to see how you're drifting. To arrive at a mark you cannot aim at the mark. Instead, aim up or down until the land stays constant behind the mark.

On the start put all faith in your line sight, and sail in whatever direction and speed keeps you lined up. You'll be amazed at how useful the land sight is.

If the current is pushing you downwind away from the line, avoid the left-hand end completely! Set up earlier on starboard and remember that the more you slow down, the farther you'll be set from the line. Stay up there using your line sights. If the current is flushing the fleet over the line, stay away from the right-hand end. Practice timed runs to get a feeling for how far to hang back and when to break for the line. In current pushing you from left to right, again avoid the right-hand end, and consider a port tack approach, especially if the left end is at all favored. And in right to left current, the left end is a devil's trap. Plan a middle to right end start.

Once you've started you will undoubtedly have a game plan based on all your info on the wind, the different currents over the course, and your tactics for the race. If you know you are in bad current headed for better current, you might consider footing slightly to get out of the adverse current faster. Likewise you might pinch a bit to stay in favorable current longer.

But no matter what the current is, it will change your laylines to the windward mark. In general, try to take the up current tack first, i.e. in a left to right current across the course, go on starboard tack first. This minimizes the risk of overstanding. Near the mark, plan to tack onto starboard well short of the mark and go to the port tack layline, again to insure against overstanding. Finally, if you're close to making the mark on starboard, you can often pinch, slowing the boat and allowing the current more time to move you the little bit needed to the right relative to the mark.

For more accuracy in determining laylines in current, Brad Dellenbaugh has a good idea. Before the start, pass right next to a buoy going close-hauled on starboard and sail for a minute. Then take a bearing back to the mark and write down its reciprocal. Then, assuming similar current at the windward mark, when the mark bears your number, you'll be on the layline.

On the reaches (and at all marks) immediately locate the mark and watch the land behind it. When the land holds constant behind it, you are sailing on the shortest possible course to it. If you expect the current to set you more to leeward ahead, be sure to work extra high early, etc. On the run again in general, sail the up current tack first. Using Brad's method (sailing by the buoy

on your optimum downwind angle before the start) will help you call the laylines. Also, with the current at all aft, those marks come flying up to you, so start your spinnaker take-down and mark rounding preparation early. Finally, when rounding marks in current watch the land behind the mark. The tendency is to watch only the mark, which will always result in a less than ideal "swing wide-cut close" type of rounding.

RACING IN CURRENT adds a great new dimension to sailing. Do your homework so you know what the direction and strength of the current will be throughout the race. Remember, for optimum speed through the water, you should not sail your boat any differently just because you are in current; but also keep in mind that the current will definitely affect your tactics, especially in regard to lay-lines, rhumb lines, marks, and your strategy when the current varies in different places on the course.

NUMERICAL MODEL *by Stan Honey*
GEOMETRIC MODEL *by Dave Dellenbaugh*

Assumptions:

1. True wind with respect to land blows from 000° at 5 knots. (AZ)
2. Current flows from 030° at 1 knot. (AB)
3. Boats tack through 73.79° and sail at 2 knots. (This angle is chosen so that the port tack boat, sailing in the combined true wind/current wind, is headed directly into the current.)

In Reference Plane of Water:

Wind (ref. water) = Wind (ref. ground) (AZ) plus Water (ref. ground)
Wind (ref. water) = 000° at 5 knots plus 030° at 1 knot (AB)
Wind (ref. water) = 353.10° at 4.16 knots (BZ)

This is now the wind in the reference plane of the water. The boats symmetrically tack about this heading; they head 030° on port tack (ZK) and 316.21° on starboard tack (ZC). *Diagram 1 (next page)*

Both boats are moving through the water at the same speed: 2 knots. Since both boats (port and starboard) sail the same angle with the wind

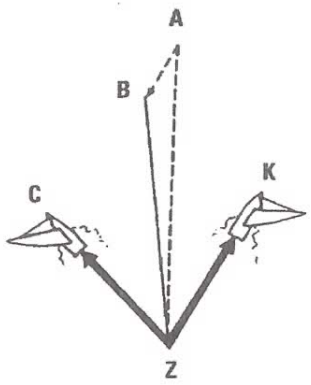


Diagram 1

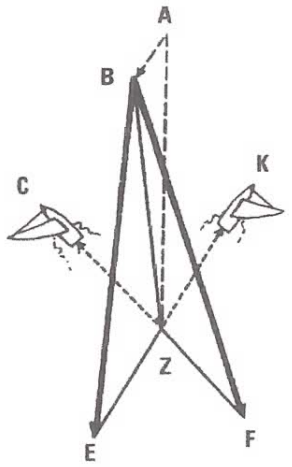


Diagram 2

(ref. water), and both boats sail at the same speed through the water, then by simple trigonometry, both tacks have exactly the same apparent wind: 5.89 knots (BE on port, BF on starboard). *Diagram 2*

In Reference Plane of Land:

Port-tack boat

Movement (ref. land) = Movement (ref. water) plus current (ref. land)

Movement (ref. land) = 030° at 2 knots (ZK) minus 030° at 1 knot (JK)

Movement (ref. land) = 030° at 1 knot (ZJ)

Apparent wind = Boat movement (ref. land) plus true wind (ref. land)

Apparent wind = 030° at 1 knot (ZH) plus 000° at 5 knots (AZ)

Apparent wind = 004.87° at 5.89 knots (AH)

Starboard-tack boat

Movement (ref. land) = Movement (ref. water) plus current (ref. land)

Movement (ref. land) = 316.21° at 2 knots (ZC) minus 030° at 1 knot (CD)

Movement (ref. land) = 287.05° at 1.97 knots (ZD)

Apparent wind = Boat movement (ref. land) plus true wind (ref. land)

Apparent wind = 287.05° at 1.97 knots (ZG) plus 000° at 5 knots (AZ)

Apparent wind = 341.36° at 5.89 knots (AG)

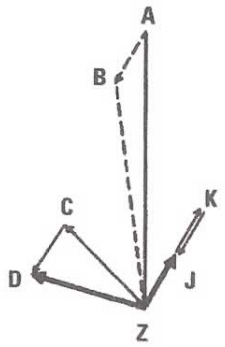


Diagram 3

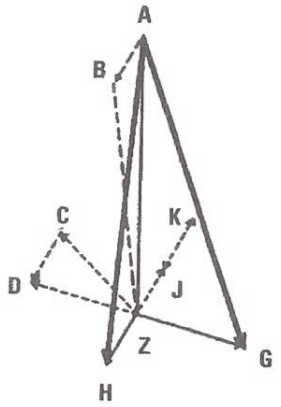


Diagram 4

Notice that the port tack boat is slower over the bottom and at a closer angle to the wind, but the strength and direction of the apparent wind felt on each boat is still exactly the same. *Diagrams 3 and 4*