

A master chief quartermaster teaches a midshipman to take a sextant sight. The same skills that found ships in 1800 still back up the satellites today. *1

NAVIGATION / REFERENCE

GPS Coordinates & Coastal Navigation

A practical, plain-language guide to positions, charts, compasses and cross-checks for owners, crew and working mariners.

Your chartplotter shows a position to a few feet, but the numbers only help if you know what they mean, where they came from and when they can be wrong. This guide starts with how sailors found their way before satellites, then walks through latitude and longitude, coordinate formats, why a minute of longitude is not a mile, why we use knots, datums, true versus magnetic north, and how to prove your GPS is telling the truth.

AT A GLANCE

Latitude & longitude Latitude runs north–south; longitude runs east–west. Learn both before trusting either.	**Minutes and miles** 1′ of latitude ≈ 1 nautical mile everywhere. 1′ of longitude is about 0.76 nm in Long Island Sound.
Knots, not mph Charts measure in nautical miles, so speed in knots makes the arithmetic simple.	**Datums** Set the plotter to WGS 84 for NOAA charts. Old NAD 27 positions can be off by 25–50 m.
True vs magnetic Variation changes with place and year. Old magnetic courses go stale.	**Cross-check** Depth, bearings, radar ranges and buoys should all agree with the GPS.

*General guidance only. Always follow vessel manuals, current regulations and the judgment of the vessel's master. * See photo & reference credits.*

How Our Forefathers Found Their Way

For most of history, navigators combined four things: a compass for direction, a way to measure speed, a clock (often a sand glass) for time, and a lead line for depth. Speed × time gave distance run, and plotting each leg from a known start gave an estimated position. This is **dead reckoning**, and it is still the backbone of good navigation when electronics fail.

Latitude was the easy half. The height of Polaris above the horizon is close to your latitude (within about a degree, refined with almanac corrections). By day, the sun at local noon also gives latitude, but it takes a calculation: the navigator measures the sun's height at its highest point and combines it with the sun's **declination** for that date from the almanac, since the sun moves about 23.4° north and south of the equator through the year. Longitude was the hard half, because it depends on time: the earth turns 15° each hour, so finding longitude means knowing the exact time at a reference place (Greenwich) while at sea. Errors in longitude wrecked ships for centuries.

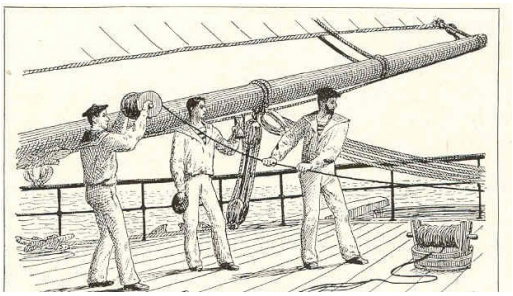
Year	Milestone
1574	William Bourne gives the first printed description of the chip log for measuring speed[1]
1731	John Hadley demonstrates the reflecting quadrant (octant), forerunner of the sextant[2]
1757	John Bird builds the first sextant, which can measure the larger angles needed for lunar distances[3]
1759–62	John Harrison's H4 sea watch is completed and on its trial voyage to Jamaica loses only about 5 seconds[4]
1767	The Board of Longitude publishes the first Nautical Almanac, with Moon tables for finding longitude by lunar distance[2]
1957–2010	LORAN-C radio navigation serves U.S. waters until the U.S. signal is ended on February 8, 2010[5]
1995	GPS reaches full operational capability; Selective Availability (deliberate error) is switched off in 2000[18]

Where the Word "Knot" Comes From

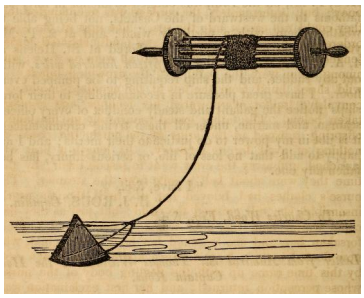
The chip log was a wooden board, weighted to float upright, tied to a line wound on a reel. A sailor threw it astern and let the line run out while a shipmate turned a small sand glass. Knots were tied in the line at equal spacing, and the number of knots that ran out before the sand emptied was the ship's speed, "so many knots." Later practice spaced the knots 47 ft 3 in apart and used a 28-second glass[1].

> **THE ARITHMETIC THAT STILL WORKS**
>
> 47.25 ft ÷ 28 seconds × 3,600 seconds per hour ≈ **6,075 feet per hour**, almost exactly one nautical mile (about 6,076 ft). One knot on the line meant one nautical mile per hour, and that is still the definition of a knot today. The nautical mile has been fixed at exactly 1,852 metres since 1929.

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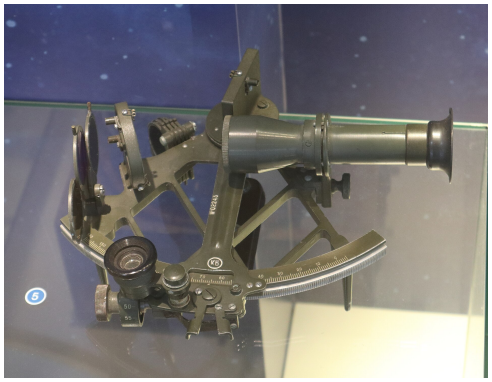
Seamen "heaving the log": one man holds the reel, one the sand glass, one pays out the line. *2



A chip log, from an 1835 engraving: the weighted wooden "chip" and its line. *3



Harrison's H4 marine timekeeper. Accurate time at sea solved the longitude problem. *4



A marine sextant. It measures the angle between a star or the sun and the horizon. *5

Latitude and Longitude in Plain English

Picture the earth wrapped in a grid. **Latitude** lines (parallels) circle the earth like rungs on a ladder and tell you how far north or south of the equator you are, from 0° to 90°. **Longitude** lines (meridians) run from pole to pole and tell you how far east or west of Greenwich, England you are, from 0° to 180°. Every degree is split into 60 minutes (′) and every minute into 60 seconds (″) or into decimal minutes.

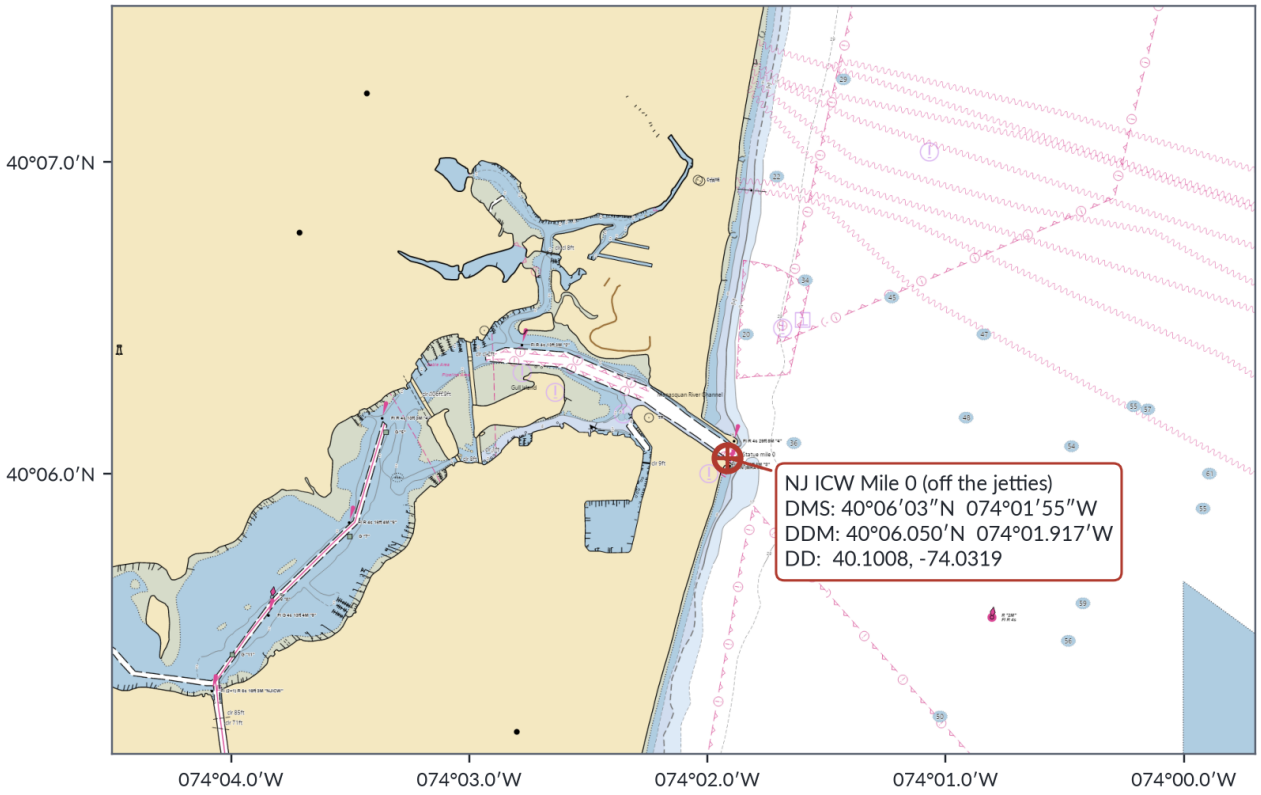
- On the U.S. East Coast you are always **north** latitude and **west** longitude.
- Latitude is always written first: 40°06′N, 074°02′W.
- In decimal-degree form, west longitude is a **negative** number (-74.03). Drop the minus sign and your waypoint lands in Central Asia.
- On a paper chart, latitude is read on the left and right borders and longitude on the top and bottom borders.

Coordinate Formats: Same Place, Three Ways

The point below is Mile 0 of the New Jersey Intracoastal Waterway, which the U.S. Coast Pilot places off the outer ends of the Manasquan Inlet jetties[13]. All three lines describe exactly the same spot. Mixing formats is one of the most common waypoint errors.

Format	Example	Where you see it
DMS — degrees, minutes, seconds	40°06′03″N 074°01′55″W	Coast Pilot, Light List, older logbooks and survey records
DDM — degrees, decimal minutes	40°06.050′N 074°01.917′W	Default on most marine chartplotters and GPS units
DD — decimal degrees	40.1008, -74.0319	Phones, Google Maps, websites, spreadsheets

To convert: seconds ÷ 60 = decimal minutes (03″ ÷ 60 = 0.050′). Decimal minutes ÷ 60 = decimal degrees (6.050′ ÷ 60 = 0.1008°). Going the other way, multiply the decimals by 60.



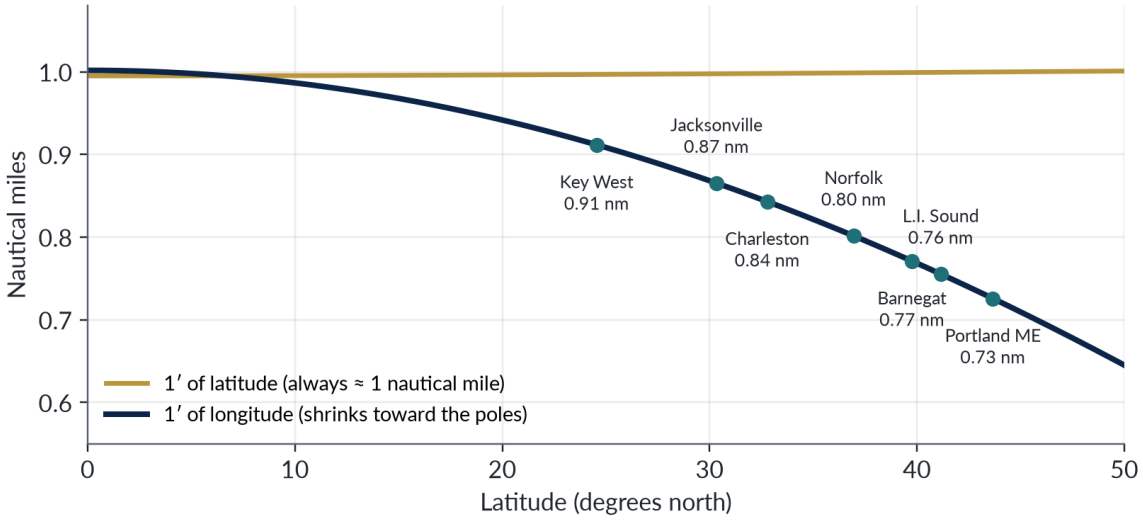
NOAA chart data near Manasquan Inlet, N.J., with a one-minute grid. The NJ ICW Mile 0 position lands right at the jetty ends, where the chart prints "Statute mile 0." Chart image for illustration only, not for navigation. *6

Digits shown	Latitude precision	Practical meaning
0.1′ (DDM)	about 608 ft	Good enough to find a harbor, not a slip
0.01′ (DDM)	about 61 ft	About a boat length or two
0.001′ (DDM)	about 6 ft	Finer than ordinary GPS accuracy
0.0001° (DD)	about 36 ft	Four decimal places in decimal degrees

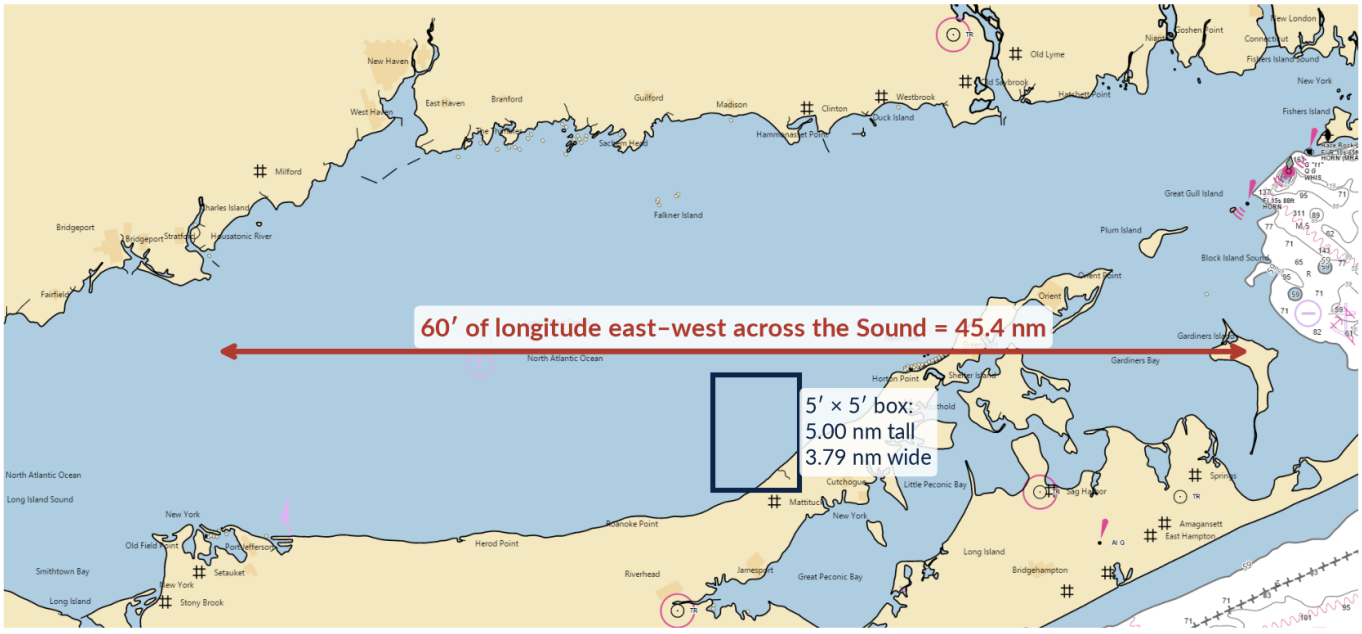
*General guidance only. Always follow vessel manuals, current regulations and the judgment of the vessel's master. * See photo & reference credits.*

Why a Minute of Longitude Is Not a Mile

The nautical mile was built from the earth itself: one minute of **latitude** is about one nautical mile anywhere on earth. Meridians of **longitude**, however, squeeze together as they head toward the poles, so the east–west distance covered by one minute shrinks. At the equator it is about 1.0 nm. Off Key West it is about 0.91 nm, off Barnegat 0.77 nm and in Long Island Sound about 0.76 nm.



Length of one minute of latitude and of longitude by latitude, with East Coast reference points (computed on the WGS 84 ellipsoid).



*Long Island Sound runs east–west. A run of 60 minutes of longitude across the Sound is only about 45 nm, not 60. The 5′ × 5′ box is a true square of minutes, yet it is noticeably wider in minutes than in miles. Chart image for illustration only. *7*

Why it matters. When you run north or south along the coast, from Cape May toward Florida, every minute of latitude you change is about one mile run, so counting minutes gives a fair distance check. When you run east or west, as in Long Island Sound, Block Island Sound or along the south shore of Long Island, counting minutes of longitude as miles

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overestimates the distance by roughly a quarter. The rule on a paper chart is simple: **always measure distance on the latitude scale** (the side border), at about the same latitude as the leg you are measuring, and never on the longitude scale across the top or bottom.

Knots, Not Miles per Hour

A knot is one nautical mile per hour: 1.852 km/h, or about 1.15 statute mph. Charts, radar ranges, the Light List and passage distances are all in nautical miles, so a speed in knots plugs straight into the chart. Speed in mph forces a conversion every time, and that is where mistakes creep in. A boat making 20 knots is doing about 23 mph; plan a 40 nm run at "40 mph" and you will be late and short on fuel.

Formula	Example
Distance = Speed × Time	12 kn × 1.5 h = 18 nm
Time = Distance ÷ Speed	45 nm ÷ 15 kn = 3 h
"60 D Street": 60 × D = S × T (T in minutes)	60 × 6 nm = 12 kn × T, so T = 30 min
Convert	nm × 1.15 = statute miles; statute miles × 0.87 = nm

One exception to know: distances along the Intracoastal Waterway are in **statute** miles so they match the small-craft charts; all other distances are nautical[13,14]. NJ ICW Mile 0 is at Manasquan Inlet and the Atlantic ICW mileage starts at Norfolk, Virginia. Convert before you work out an arrival time from the ICW mile markers.

Also remember that the GPS shows **speed over ground (SOG)**, while the paddlewheel log shows **speed through the water (STW)**. When they differ, the cause may be current, but it may also be **leeway** (wind pushing the boat sideways) or instrument error: an uncalibrated or fouled paddlewheel, or a poor GPS fix. Because both are only speeds, comparing them shows just the along-track part of any current. A cross-current can set you well off your track while barely changing SOG. To find the real **set and drift**, compare course over ground with your heading, or plot your dead-reckoning position against a fix; the line from DR to fix is the combined effect of current and leeway. Use SOG for arrival times and STW to judge how the boat and engines are performing.

How GPS Works and How Good It Is

GPS satellites broadcast precise time signals. Your receiver compares signals from several satellites and works out how far away each one is, then solves for the single point where those distances meet. Under open sky, the government reports that a smartphone is typically accurate to within about 4.9 m (16 ft)[6], and the civil service standard is 8 m or better 95% of the time worldwide, with well-designed receivers often doing 3 m or better[7]. That is the accuracy of your position. The chart underneath it may be far less accurate, especially in areas surveyed long ago.

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Datums: The Hidden Setting Behind Every Position

A latitude and longitude only mean something when you know which model of the earth they are measured on. That model is the **datum**. The old North American Datum of 1927 (NAD 27) used the Clarke 1866 ellipsoid with its starting point at Meades Ranch, Kansas. NAD 83 uses the GRS 80 ellipsoid and is earth-centered[8]. The shift between them runs from roughly 10 to 100 m across the country[9].

Location	NAD 27 → NAD 83 shift (computed with NOAA NADCON grid)
Portland, ME	about 42 m
New Haven, CT	about 40 m
Barnegat Inlet, NJ	about 38 m
Norfolk, VA	about 34 m
Charleston, SC	about 26 m
Miami, FL	about 48 m

- NOAA charts use NAD 83, which for navigation is treated as equivalent to WGS 84. The two agree at about the 1–2 m level[10].
- **Leave the plotter on WGS 84** when using NOAA charts. Change it only if you are entering positions from an old chart or list in a different datum, and then change it back.
- A waypoint taken from a 1970s NAD 27 chart and typed into a WGS 84 plotter can be off by 25–50 m on the East Coast. That is enough to put you on the rocks beside a narrow inlet.
- Depths on NOAA charts refer to Mean Lower Low Water (MLLW), and most bridge clearances to a high-water datum. Vertical datums matter as much as horizontal ones[12].
- NOAA is modernizing the National Spatial Reference System. A new frame, NATRF2022, will replace NAD 83, with official release expected in 2027[11].

FROM THE SURVEYOR'S SIDE — CAPT. TOM ERTLE, PLS

On land, surveyors rarely work in latitude and longitude. We use **State Plane Coordinate Systems**, flat grids in feet or metres (northings and eastings) designed for each state so measurements on the ground stay accurate. Those numbers look nothing like a GPS position and should never be typed into a chartplotter. The lesson carries over to the water: **always ask what datum and what format a position is in before you trust it.** Capt. Tom is a licensed land surveyor in several states, where datums and coordinate conversions are part of the profession, and the same check belongs before the first waypoint goes into a plotter.

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Artist's view of a GPS Block IIF satellite. About two dozen or more are in orbit at any time. *8



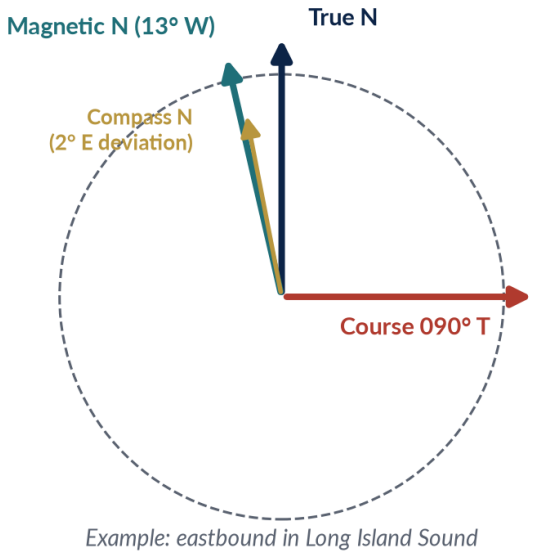
A small Garmin chartplotter. Check its position format and datum settings before entering waypoints. *9

Plotting and Entering Waypoints

01	Confirm the plotter's **position format** (usually DDM) and **datum** (WGS 84) before entering anything.
02	On a paper chart, read latitude on the side border and longitude on the top or bottom border, using dividers from the nearest printed grid line.
03	Enter latitude first and check **N** and **W**. Read the numbers back aloud, digit by digit, to a second person if you can.
04	Look at the waypoint on the chart at a large scale (zoomed in). It should sit exactly where you meant it to.
05	Do not put waypoints **on** buoys, rocks or jetty ends. Offset them into safe water; other boats aim for the same buoys.
06	Zoom in along every leg of the route and look for land, shoals, wrecks, pots and bridges the line crosses. A route that looks clear zoomed out often is not.
07	Name waypoints so they make sense ("MANASQ-SEA"), and record the route and positions in the log as a paper backup.

True North, Magnetic North and Your Compass

True north is the direction to the geographic North Pole; chart grid lines and GPS course over ground are based on it. A compass needle points to **magnetic north**, which is somewhere else entirely and slowly moves. The angle between them at your location is **variation** (land surveyors call it declination). On the East Coast it is west variation, about 13° W in Long Island Sound and about 7° W off Jacksonville. Your boat adds its own error, **deviation**, caused by engines, steel, speakers and electronics near the compass. Deviation changes with the boat's heading and is recorded on a deviation card.



Example: eastbound in Long Island Sound

T — **True 090°**
Course off the chart (true)

V — **Variation 13° W**
Add West going down

M — **Magnetic 103°**
Magnetic course

D — **Deviation 2° E**
Subtract East going down

C — **Compass 101°**
Steer this on your compass

"True Virgins Make Dull Companions"

Going down: add West

Going up: add East

Converting a true course from the chart to the course to steer on the compass, using the TVMDC memory aid.

Where to find variation. The compass rose on a paper chart has an outer ring (true) and an inner ring (magnetic). The center prints the variation, the year it applied and the annual change. Electronic charts and plotters calculate it from a world magnetic model.

Plotters and headings. Most plotters let you show bearings and headings as True or Magnetic, often with an automatic variation setting. A fluxgate heading sensor or autopilot compass is magnetic by nature; GPS course over ground is true. If the plotter is set to True and the helmsman steers by a magnetic compass, the two will disagree by the full variation — about 13° in Long Island Sound. Decide which reference the boat uses, set every display the same, and say it out loud at the crew briefing: "all courses magnetic."



A marine steering compass. Keep phones, tools and speakers away from it. *10

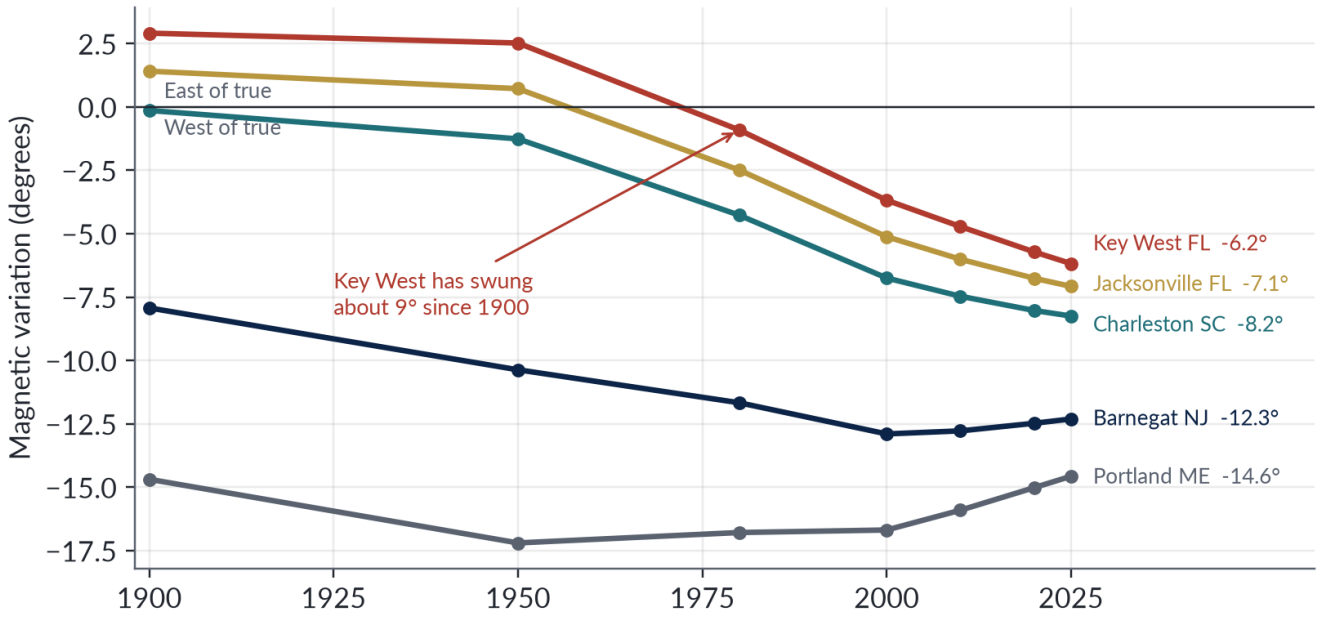


Compass adjusting on a ship: correcting magnets reduce deviation, and what remains goes on the deviation card. *11

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Why an Old Magnetic Course Goes Stale

Magnetic north wanders because the earth's molten core is always moving. Variation at any one place changes a few minutes of arc every year, and over decades that adds up. A course written as "steer 185° magnetic" in an old log or cruising guide was correct for that year only. Values below are from the NOAA World Magnetic Model and the International Geomagnetic Reference Field[15].



Magnetic variation from 1900 to 2025 at five East Coast locations (IGRF model). Negative values are west variation.

Location	Variation, late 2026	Yearly change	Location	Variation, late 2026	Yearly change
Portland, ME	14.5° W	5.2′ toward E	Norfolk, VA	10.8° W	about steady
Boston, MA	13.9° W	4.3′ toward E	Cape Hatteras, NC	11.0° W	0.6′ toward W
New Haven / L.I. Sound	13.0° W	3.0′ toward E	Charleston, SC	8.3° W	2.8′ toward W
Barnegat Inlet, NJ	12.3° W	1.9′ toward E	Jacksonville, FL	7.2° W	3.9′ toward W
Cape May, NJ	11.8° W	1.2′ toward E	Key West, FL	6.3° W	5.6′ toward W

A real example. In 1980 variation at Key West was about 0.9° W. Today it is about 6.3° W. A route laid out on magnetic bearings in 1980 and steered unchanged today would be about 5.4° off. Over a 20 nm leg that puts you nearly **2 nm** from where you meant to be, enough to miss a channel entrance or find a reef. Since 1900 the variation at Key West has swung about 9°. Further north, Portland's variation grew from 14.7° W in 1900 to 17.2° W in 1950 and has since come back to about 14.6° W.

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CAPTAIN'S RULE FOR COMPASS COURSES

Lay every course **true** from the chart, then apply **this year's** variation and your own deviation. To update an old compass rose, multiply the printed annual change by the number of years since the printed date and add it to the variation. Or simply look up today's value on the NOAA magnetic field calculator[15].

Why Your Electronics Don't Always Agree

What you notice	Usual reason	What to do
Two plotters show slightly different positions	Different GPS sources on the network, or antennas mounted in different places	Pick one primary GPS source and set antenna offsets
Heading and COG differ by several degrees	Current and wind (set and drift), or one shows magnetic and one true	Normal underway; check both use the same reference
Flybridge and lower helm disagree on bearing	Each station set to its own True/Magnetic or north-up/head-up mode	Match units and modes on every display
Boat icon sits on land at the dock	Chart survey age or chart offset, not GPS error	Trust your eyes and depth; report chart errors to NOAA
Variation differs by a degree between brands	Older world magnetic model built into firmware	Keep software updated; check against NOAA
Phone and plotter disagree by 10–30 ft	Phone GPS accuracy, or a different datum or format in an app	Use the marine unit; check the app's settings
Speed on log and GPS differ	Current (STW vs SOG), or an uncalibrated paddlewheel	Calibrate the log on a slack-water run

On a multi-station boat, such as a Grady-White with flybridge monitors and a networked Raymarine Axiom, every screen can carry its own settings. Before a passage, walk to each station and confirm the same datum, position format, bearing reference, units and chart.

Cross-Checking Your GPS Position

GPS signals are weak, and they can be lost, jammed or spoofed. U.S. maritime advisories urge vessel operators to plan for degraded GPS and to verify position by all available means[16]. A prudent navigator proves the GPS right several times every hour:

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01	**Depth check.** Compare the sounder with the charted depth, allowing for tide and transducer depth. A big mismatch is a warning.
02	**Visual bearings.** Take hand-bearing compass bearings on two or three charted objects (a lighthouse, a water tower, a point of land) and plot where they cross.
03	**Radar ranges.** Set the radar's range marker (VRM) on a charted headland or breakwater and compare the distance with the chart.
04	**Buoy check.** As you pass a numbered buoy, confirm its number and color match the chart and the plotter.
05	**Dead reckoning.** Write position, course, speed and time in the log at least hourly. If the GPS quits, you can still estimate where you are.
06	**Second receiver.** Carry an independent handheld GPS with spare batteries. If two receivers disagree, slow down and work out why.

If you suspect interference, note the time, position and what each device did, and report it to the Coast Guard Navigation Center[17].

Buoys, the ICW and Charts That Can Be Wrong

U.S. waters use the IALA Region B lateral system, remembered as **Red Right Returning**: when returning from sea, entering a harbor or heading upstream, keep red marks on your starboard (right) side and green marks to port. Red nuns and daymarks carry even numbers, green cans and daymarks odd numbers, and the numbers increase from seaward. Where there is no obvious "from sea," the conventional direction of buoyage runs clockwise around the continent: southerly along the Atlantic coast, westerly along the Gulf and northerly up the Pacific coast[19].

Red Right Returning



Red nuns (even numbers) to starboard, green cans (odd numbers) to port. Numbers increase as you come in from sea.

Intracoastal Waterway marks



Yellow triangle
Keep on your STARBOARD side



Yellow square
Keep on your PORT side



Yellow triangle on a green mark
Still keep to STARBOARD: the yellow symbol rules

Applies southbound on the Atlantic ICW (New Jersey toward Florida), westbound on the Gulf ICW. Northbound, reverse it. Where the ICW crosses an inlet channel, the inlet colors follow Red Right Returning from sea, while the yellow symbols tell the ICW boater which side to pass.

Left: Red Right Returning in a channel from sea. Right: Intracoastal Waterway yellow symbols, which tell the ICW boater which side to pass regardless of the mark's color or number.

*General guidance only. Always follow vessel manuals, current regulations and the judgment of the vessel's master. * See photo & reference credits.*

On the Intracoastal Waterway, marks also carry a yellow symbol. A **yellow triangle** is passed on your starboard hand and a **yellow square** on your port hand, regardless of the mark's number, color or light, when traveling southbound on the Atlantic ICW (westbound on the Gulf). A horizontal yellow band only identifies the mark as ICW and gives no side information[20]. Northbound, reverse it. Where the ICW crosses an inlet or river channel, the same buoy can serve both: follow its color if you are in the inlet channel and its yellow symbol if you are on the ICW.

Charts, even the newest electronic charts, can be wrong. NOAA notes that chart depths come from the latest available survey, which may be quite old; about half the depths on NOAA charts come from surveys before 1940[21]. The Coast Pilot warns that improved channels shoal, especially along the edges, and that buoys may not properly mark shoals because the shoals or the buoys have shifted[22]. Inlets and shallow ICW stretches can change with a single storm season, and buoys get moved to follow the water.

- Update electronic charts before every passage and check the Coast Guard **Local Notice to Mariners** for your area.
- Treat the chart as a starting point. Follow the buoys you can see, but question any buoy that does not match the chart or the depth sounder.
- Watch the water: color changes, breaking or standing waves and boats already aground often mark a shoal before the chart does.
- Slow down in unfamiliar inlets and skinny ICW stretches, set a shallow-water alarm, and know the state of the tide.
- Report chart discrepancies to NOAA so the next boater benefits.

> **FROM CAPT. TOM'S EXPERIENCE**
>
> Capt. Tom has run into shoaling over charted depths and channel marks moved from where the chart showed them. The chart and plotter said one thing and the water said another. A watchful eye on the water, the sounder and the buoys is what prevents a grounding or worse.

Other Navigation Systems at a Glance

System	Strengths	Limitations
GPS and other satellite systems (GLONASS, Galileo, BeiDou)	Worldwide, all-weather, very accurate; modern receivers use several systems at once	Weak signals; can be jammed or spoofed; depends on power and antenna
SBAS / WAAS correction	Improves accuracy and warns of bad satellite data	Still a satellite system; same vulnerabilities
Paper chart and magnetic compass	No power needed; the ultimate backup	Needs practice; chart corrections must be kept up
Radar	Independent of GPS; ranges and bearings to land and targets	Interpretation takes skill; misses low and small targets
AIS	Names, course and speed of equipped vessels	Not all boats carry it; positions come from their GPS
Depth sounder	Simple, independent check against the chart	One line of position, not a fix
Celestial (sextant)	Fully independent of electronics	Needs clear sky, a horizon, tables and practice
LORAN-C	Was a reliable land-based backup	U.S. signal terminated in 2010[5]

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Terms and Acronyms

Term	Meaning	Term	Meaning
Bearing	Direction from you to an object, in degrees true (T) or magnetic (M).	**MLLW**	Mean Lower Low Water, the reference level for NOAA chart depths.
COG / SOG	Course over ground / speed over ground: actual track and speed from GPS.	**NAD 27 / NAD 83**	North American Datums of 1927 and 1983.
Datum	Earth model and reference that a coordinate is measured on (NAD 27, NAD 83, WGS 84).	**Nautical mile (nm)**	Exactly 1,852 m (about 6,076 ft); about 1′ of latitude.
DD, DDM, DMS	Decimal degrees; degrees and decimal minutes; degrees, minutes and seconds.	**Red Right Returning**	Keep red marks to starboard when returning from sea or heading upstream.
Dead reckoning (DR)	Position worked out from known course, speed and time since the last fix.	**Set and drift**	Direction and speed of the current pushing the boat.
Deviation	Compass error caused by the boat itself; changes with heading.	**State Plane (SPCS)**	Flat grid coordinate systems used by land surveyors; not for chartplotters.
Fix	A position found from two or more independent lines of position.	**STW**	Speed through the water, measured by the boat's log.
GNSS	Global Navigation Satellite System: GPS, GLONASS, Galileo, BeiDou.	**TVMDC**	True, Variation, Magnetic, Deviation, Compass: the order for converting courses.
GPS	Global Positioning System, operated by the U.S. Space Force.	**Variation (declination)**	Angle between true and magnetic north at a place and year.
Heading	The direction the bow points, which may differ from COG.	**WAAS / SBAS**	Satellite-based augmentation that improves GPS accuracy and integrity.
Knot (kn)	One nautical mile per hour.	**Waypoint (WPT)**	A stored position used to build a route.
Leeway	Sideways drift of the boat caused by wind.	**WGS 84**	World Geodetic System 1984, the datum GPS works in.
LNM	Local Notice to Mariners; weekly Coast Guard chart and buoy changes.	**WMM / IGRF**	World Magnetic Model / International Geomagnetic Reference Field.
LOP	Line of position: a line you know you are somewhere on.		

CAPTAIN'S NOTE

Electronics make navigation easy, but they also make it easy to stop thinking. Before departure, set the datum and units on each display, lay the route true, check this year's variation, and keep a written DR plot going. When the GPS, the depth, the compass and the view out the window all agree, keep going. When they do not, slow down until they do.

*General guidance only. Always follow vessel manuals, current regulations and the judgment of the vessel's master. * See photo & reference credits.*

Further Reading & Official Sources

[1] University of New Brunswick, International Hydrographic Review — history of the log and the knot — https://journals.lib.unb.ca/index.php/ihr/article/download/26967/1882519725

[2] Royal Observatory Greenwich — Hadley's quadrant and the sextant — https://www.royalobservatorygreenwich.org/articles.php?article=1290

[3] Smithsonian, Time and Navigation — first sextant, 1757 — https://timeandnavigation.si.edu/timeline2/1000

[4] Royal Museums Greenwich — Harrison's clocks and the longitude problem — https://www.rmg.co.uk/stories/time/harrisons-clocks-longitude-problem

[5] Federal Register — Termination of the U.S. LORAN-C signal (2010) — https://www.federalregister.gov/d/2010-83

[6] GPS.gov — GPS accuracy — https://www.gps.gov/gps-accuracy

[7] GPS Standard Positioning Service Performance Standard (2020) — https://www.gps.gov/sites/default/files/2025-07/2020-SPS-performance-standard.pdf

[8] NOAA National Geodetic Survey — Datums FAQ — https://geodesy.noaa.gov/datums/faq.shtml

[9] NOAA NGS — NADCON (Professional Surveyor article) — https://www.ngs.noaa.gov/TOOLS/Professional_Surveyor_Articles/NADCON.pdf

[10] NOAA NGS — National Spatial Reference System (NAD 83 and WGS 84 agreement) — https://www.ngs.noaa.gov/PUBS_LIB/NatlSpatial.pdf

[11] NOAA Ocean Service — NSRS modernization update (Nov. 2026) — https://oceanservice.noaa.gov/news/nov26/ngs-mount-rushmore.html

[12] NOAA VDatum — tidal and vertical datums — https://vdatum.noaa.gov/docs/datums.html

[13] NOAA U.S. Coast Pilot 3, Ch. 5 — NJ Intracoastal Waterway mileage — https://nauticalcharts.noaa.gov/publications/coast-pilot/files/cp3/CPB3_C05_WEB.pdf

[14] NOAA U.S. Coast Pilot 4, Ch. 12 — Atlantic ICW mileage in statute miles — https://nauticalcharts.noaa.gov/publications/coast-pilot/files/cp4/CPB4_C12_WEB.pdf

[15] NOAA NCEI — Magnetic field calculators (WMM and IGRF) — https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml

[16] U.S. Maritime Administration — Advisory 2026-015, GPS disruptions — https://www.maritime.dot.gov/msci/2026-015-global-us-maritime-advisory-updates-resources-and-contacts

[17] USCG Navigation Center — GPS problem report — https://navcen.uscg.gov/contact/gps-problem-report

[18] FAA — Existing navigation capabilities assessment (GPS operational history) — https://www.faa.gov/sites/faa.gov/files/uas/advanced_operations/upper_class_etm/ETM_NAV_Existing_Capabilities_Assessment.pdf

[19] eCFR, 33 CFR Part 62 — U.S. Aids to Navigation System (lateral marks, conventional direction of buoyage) — https://www.ecfr.gov/current/title-33/chapter-I/subchapter-C/part-62

[20] eCFR, 33 CFR 62.49 — Intracoastal Waterway identification — https://ecfr.gov/current/title-33/section-62.49

[21] NOAA Office of Coast Survey — How accurate are nautical charts? — https://nauticalcharts.noaa.gov/updates/how-accurate-are-nautical-charts/

[22] NOAA U.S. Coast Pilot 2, Ch. 1 — General information (channels, buoys, chart accuracy) — https://nauticalcharts.noaa.gov/publications/coast-pilot/files/cp2/CPB2_C01_WEB.pdf

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*3 Example of a Chip log, 1835 - tragedyofseasors01ellm 0242.jpg — Charles Ellms. License: Public domain. Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Example_of_a_Chip_log,_1835_-_tragedyofseasors01ellm_0242.jpg

*4 Harrison H4 chronometer.jpg — Colonel Warden at en.wikipedia. License: CC BY-SA 3.0. Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Harrison_H4_chronometer.jpg

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