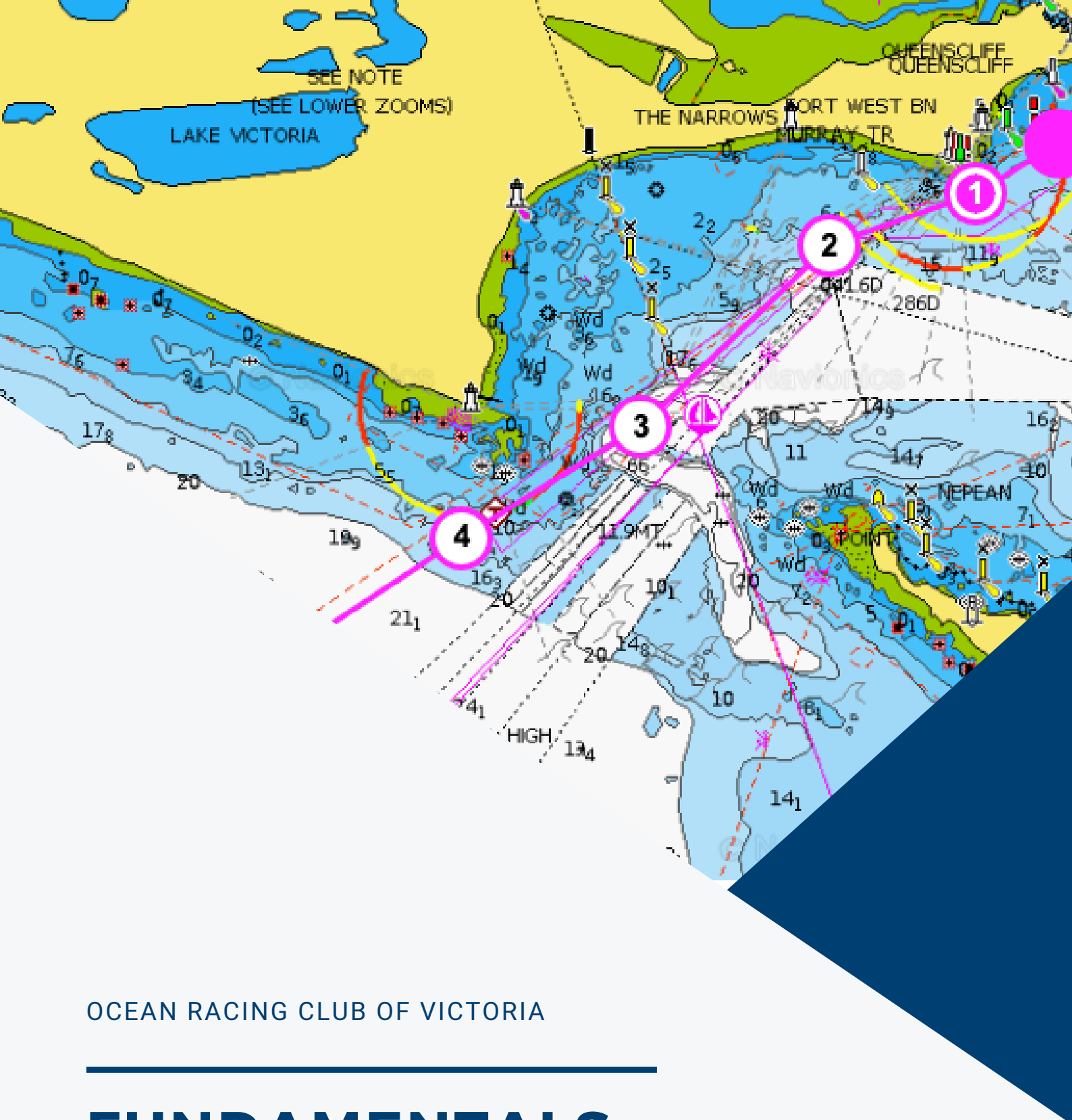


OCEAN RACING CLUB OF VICTORIA

FUNDAMENTALS OF NAVIGATION

SESSION 1

ORCV
OCEAN TRAINING

ORCV
OCEAN TRAINING

Introductions

- **Instructors**
  - Justin Brenan
    - justin.brenan@orcv.org.au
  - Past Commodore Ray Shaw
    - ray.shaw@orcv.org.au
- **Moderator**
  - Simon Dryden

House rules & explanation

- The sessions will go for approximately 2 hours including presentations, chats and exercises
- There will be a 10 min break in the middle

- **Teams – protocols and tools (Moderator to Explain)**
- Chat bar
- Raise hand
- Audio and Video selections
- Polls
- Quiz's

4

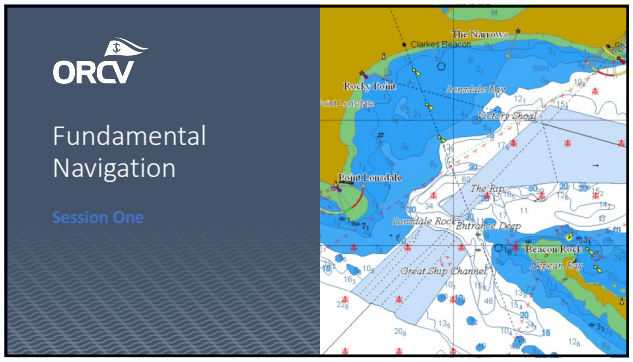
Navigation definition

- **Navigation** - the process of monitoring and controlling the movement of a vessel safely from one place to another.

6

Course objectives

- The Fundamental Navigation Course introduces the core concepts and skills required for safe yacht navigation in 5 sections
- navigation basics
- use of paper charts – now being phased out so what do you do instead
- electronic charts
- navigating with GPS and chart plotters
- good practice for safe navigation
- These are building blocks for our Intermediate Navigation course

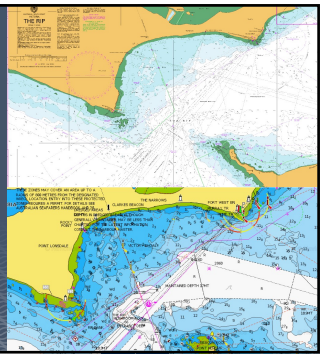


Fundamental Navigation – session one outcomes

- To provide an understanding of navigation theory and systems such that participants will be able to:
- understand common navigation terms, including the ability to interpret a nautical chart
- Use both paper and electronic charts
- calculate bearings and plot positions
- recognise nearby risks and visual references
- plan simple passage routes

10

Navigation Fundamentals



Essential Requirements for Safe Navigation

- You need……
- to know your current position on the globe
- the direction in which you are moving and speed.
- a good chart – where is the land, how deep is the water – relative to my position

- Sounds simple but its been a 500 year quest. For yachts:-
  - GPS and chart plotting technology now largely addresses the first 2 requirements
  - Chart quality and user errors are currently the weakest links.

12

The Global Positioning Grid

- Our positioning grid was developed 500 years ago and reflects the technology of the past when:
  - boat positions North and South of the equator were determined by celestial sightings – measuring the elevation of sun and stars
  - for East – West positions, time was critical (earth's rotation)
- The navigators had their work cut out for them since:
- the earth is not round,
- clocks were not reliable
- the earth is inclined so the stars being observed move north and south as the year progresses
- sightings subject to numerous errors – refraction, height above water,

Latitude and Longitude

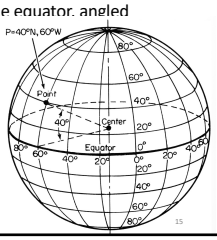
- We define our position by:-
- **Parallels** of Latitude
  - Rings around the globe **parallel to the equator** spaced through 180 degrees
    - 90 degrees north and 90 degrees south of the equator
- **Meridians** of longitude
  - Each meridian is half of a great circle around the globe - running from North Pole, through the equator to South Pole
  - Spaced through 360 degrees (east 180 [+] and west 180 [-] from Greenwich)
- This grid system incorporates a time - distance dimension
  - 15 degrees of earth's rotation = 1 hour of time (360 degrees/24 hours=15)
    1 degree of longitude = 4 minutes
  - Each degree along a meridian (and other great circles) = 60 Nautical miles
-

14

Latitude & Longitude

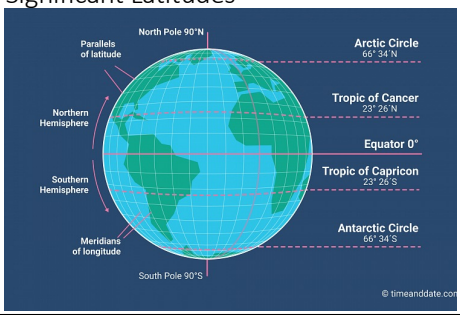
- Parallels of Latitude – lines running parallel to the equator (north or south) angled from the polar axis. Each degree is 60 nautical miles.
  - The 40 degree arc shown is 2400 nautical miles
- Meridians of Longitude – perpendicular to the equator, angled around the globe (360 degrees but counted from Greenwich.
- Tradition units were used Degrees, Minutes,
- But be careful reading your GPS:
  - It will also offer
  - Degrees, Minutes. decimal minutes
  - or Degrees, decimal degrees

  i.e. 40° 26' 46"
  or 40° 26.77'
  or 40.4461



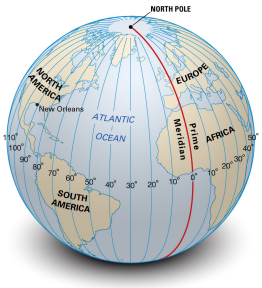
15

Significant Latitudes



16

Significant lines of Longitude



FACTS ABOUT LINES OF LONGITUDE

- Are known as meridians.
- Run in a north-south direction.
- Measure distance east or west of the prime meridian.
- Are farthest apart at the Equator and meet at the poles.
- Cross the Equator at right angles.
- Lie in planes that pass through the Earth's axis.
- Are equal in length.
- Are halves of great circles.

© Encyclopædia Britannica, Inc.

17

Significant lines of Longitude

- 0° Prime Meridian runs through Greenwich and is "Zulu time". That is how we set the world time
- 180° is the International date line (after adjustment to avoid unnecessarily "splitting countries")
- This is where, if you are traveling from west to east across the line, you would go back in time to the previous day

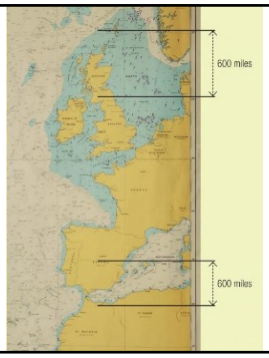
18

What is a Nautical Mile?

- The Nautical Mile was standardised at an International Convention at 1852 meters
  - This differs slightly from the theoretical definition (1 minute of arc) - earth isn't round and the theoretical length varies by some 20m depending on latitude
- Note that a minute of longitude is only a nautical mile at the equator - the distance covered by one degree of longitude decrease towards the poles because the meridians converge at the poles.
- Accordingly, you should not use the longitude scale of your chart to measure distance.

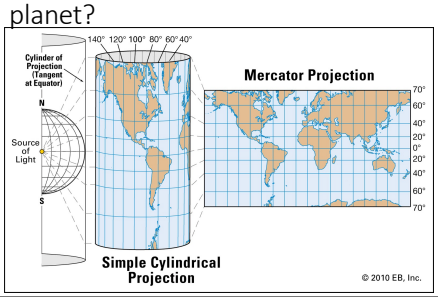
19

Measuring Distance on a chart



20

How are flat charts made of our round planet?



21

Advantages of Mercator Charts

- Parallels and meridians on the Mercator chart are straight and perpendicular to each other
  - The grid lines on a Mercator chart run true north and true south
- It became the standard map projection for navigation because of its unique property of representing any course of constant bearing as a straight segment.
- The disadvantage is that land masses are distorted

22

Quick Quiz 1

23

Navigation Basics - Review

- Major global lines
- Latitude
- Longitude
- Measurements
- Mercator charts

24

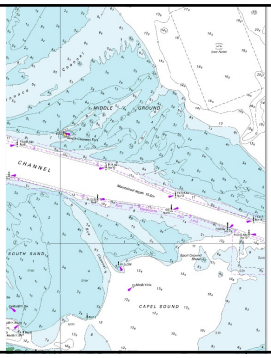
ORCV
OCEAN TRAINING

ORCV

Chart Basics

Chart Basics

- Depth – Metres
- ZOC ~ Zone of Confidence
- Lights
- Leads
- Channel Markers
- Traffic Separation Schemes
- Tides
- Features
- Admiralty Chart 5011



26

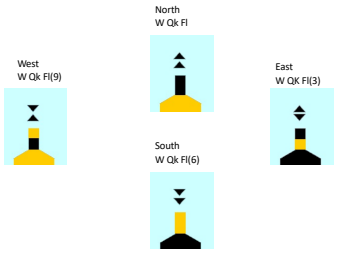
Reading Lights from chart

- eg West Channel Pile
- Fl.WR.6s 14 / 11M
- Fl = Light type
- WR = Color (White Red)
- 6s = cycle period (6 sec)
- 14 & 11 = v s (Nm)

Description	Characteristic	Chart Abbreviation
Alternating		Alt. R.W.G.
Fixed		F.
Flashing		Fl.
Group flashing		Gp Fl.(2)
Occulting		Occ.
Group occulting		Gp Occ(3)
Quick flashing		Qk.Fl.
Very quick flashing		V.Qk.Fl.
Isophase		Iso.
Morse		Mo.(letter)

27

Cardinal Marks

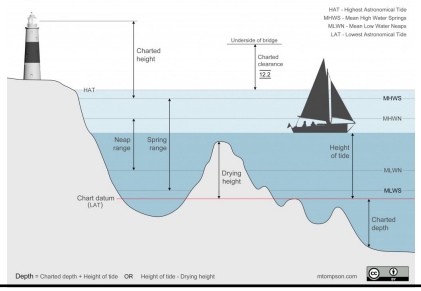


28

Other Key Marks

29

About tides and depth



30

Multitude of Sources for Tide Predictions

- We recommend

Australian Government Bureau of Meteorology — http://www.bom.gov.au/australia/tides/

NAVIONICS A Garmin Brand — https://www.navionics.com/

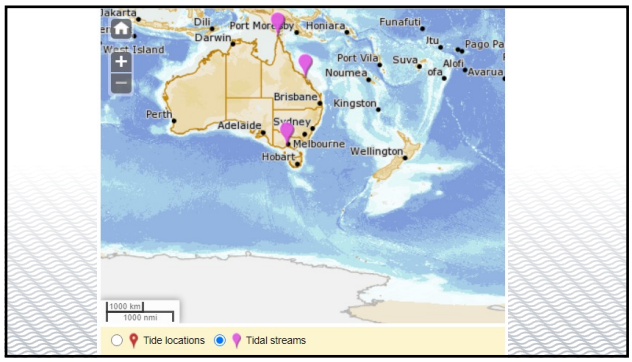
31

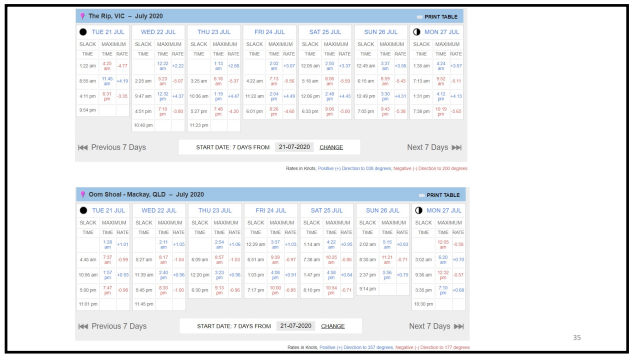
Mornington, VIC – July 2020 — PRINT TABLE

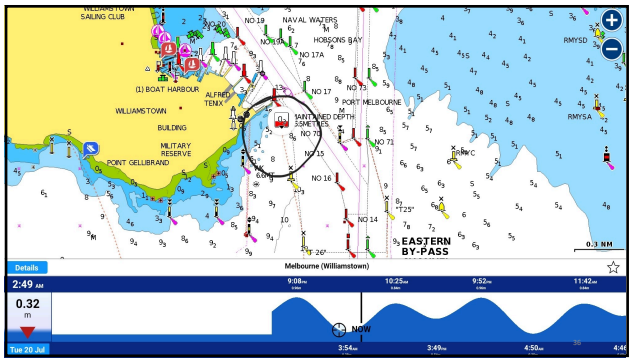
TUE 21 JUL	WED 22 JUL	THU 23 JUL	FRI 24 JUL	SAT 25 JUL	SUN 26 JUL	MON 27 JUL
HIGH 1:38 am 0.80 m	HIGH 2:38 am 0.79 m	HIGH 3:36 am 0.78 m	HIGH 4:32 am 0.78 m	LOW 12:05 am 0.41 m	LOW 12:46 am 0.38 m	LOW 1:30 am 0.35 m
LOW 9:02 am 0.22 m	LOW 9:49 am 0.18 m	LOW 10:34 am 0.16 m	LOW 11:16 am 0.17 m	HIGH 5:28 am 0.79 m	HIGH 6:22 am 0.79 m	HIGH 7:17 am 0.79 m
HIGH 4:22 pm 0.88 m	HIGH 5:00 pm 0.87 m	HIGH 5:32 pm 0.85 m	HIGH 6:03 pm 0.85 m	LOW 11:58 am 0.20 m	LOW 12:39 pm 0.24 m	LOW 1:21 pm 0.29 m
LOW 10:05 pm 0.56 m	LOW 10:45 pm 0.50 m	LOW 11:25 pm 0.46 m		HIGH 6:36 pm 0.87 m	HIGH 7:11 pm 0.90 m	HIGH 7:47 pm 0.93 m

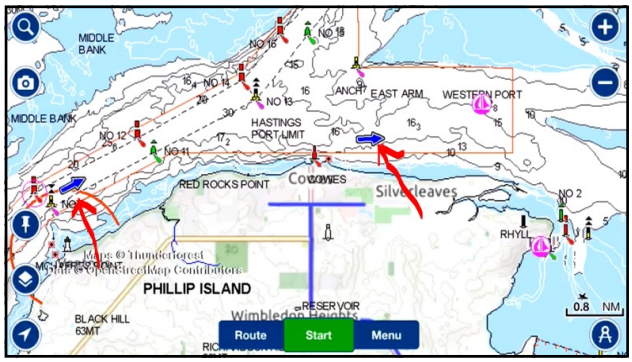
Point Lonsdale, VIC – July 2020 — PRINT TABLE

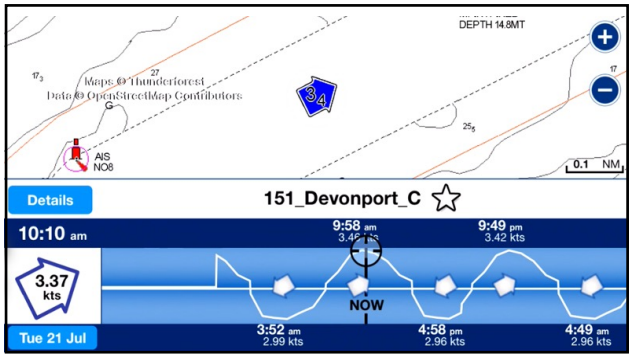
TUE 21 JUL	WED 22 JUL	THU 23 JUL	FRI 24 JUL	SAT 25 JUL	SUN 26 JUL	MON 27 JUL
LOW 5:20 am 0.43 m	HIGH 12:10 am 1.39 m	HIGH 1:05 am 1.44 m	HIGH 1:57 am 1.49 m	HIGH 2:46 am 1.53 m	HIGH 3:35 am 1.55 m	HIGH 4:25 am 1.56 m
HIGH 12:40 pm 1.59 m	LOW 6:11 am 0.38 m	LOW 6:59 am 0.35 m	LOW 7:45 am 0.34 m	LOW 8:31 am 0.35 m	LOW 9:18 am 0.40 m	LOW 10:06 am 0.47 m
LOW 6:07 pm 0.93 m	HIGH 1:29 pm 1.65 m	HIGH 2:14 pm 1.70 m	HIGH 2:56 pm 1.73 m	HIGH 3:35 pm 1.73 m	HIGH 4:14 pm 1.71 m	HIGH 4:52 pm 1.68 m
	LOW 6:56 pm 0.85 m	LOW 7:42 pm 0.76 m	LOW 8:27 pm 0.67 m	LOW 9:13 pm 0.58 m	LOW 9:59 pm 0.50 m	LOW 10:45 pm 0.43 m


Jakarta
Dili
Darwin
Port Moresby
Honiara
Funafuti
Port Vila
Noumea
Suva
Brisbane
Kingston
Perth
Adelaide
Sydney
Melbourne
Hobart
Wellington
Tide locations
Tidal streams


The Rip, VIC – July 2020
PRINT TABLE
TUE 21 JUL
WED 22 JUL
THU 23 JUL
FRI 24 JUL
SAT 25 JUL
SUN 26 JUL
MON 27 JUL
Previous 7 Days
START DATE: 7 DAYS FROM 21-07-2020 CHANGE
Next 7 Days
Oom Shoal - Mackay, QLD – July 2020
PRINT TABLE
Previous 7 Days
START DATE: 7 DAYS FROM 21-07-2020 CHANGE
Next 7 Days


SAILING CLUB
NO 19
NAVAL WATERS
HOBSONS BAY
NO 17A
NO 17
NO 73
(1) BOAT HARBOUR
ALFRED TEMX
WILLIAMSTOWN
PORT MELBOURNE
MAINTAINED DEPTH
BUILDING
MILITARY RESERVE
POINT GELLIBRAND
NO 71
NO 15
NO 16
NO 14
EASTERN BY-PASS
RMYSD
RMYSA
0.3 NM
Details
Melbourne (Williamstown)
2:49
0.32
m
NOW
Tue 20 Jul





More on tides

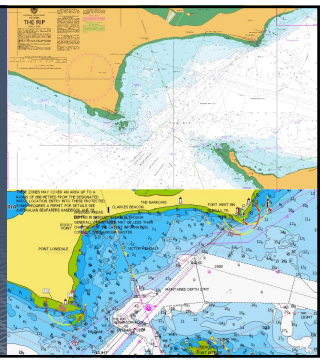
- More detailed information on tides is discussed in the intermediate course
- If you are not participating in the intermediate course, it is highly recommended that you become very familiar with tides and currents
- ORCV – fundamental navigation resource page
- https://www.orcv.org.au/fundamental-navigation

39

ORCV
OCEAN TRAINING

ORCV

Paper Charts



A general word of caution

- Charts are good and getting better with each update but they are not 100% accurate or continuously updated.
- The world has moved from lead lines to sonar arrays
- and
- from sextants and hand bearings to GPS
- but the chart you are using may not have been made with the benefit to today's technology

41

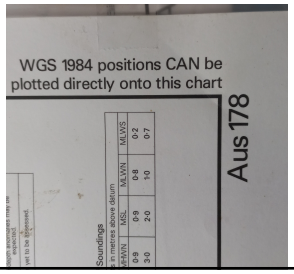
Information in Paper Charts

- Paper charts contain quite a lot of information
- Colour coded depth sones and depths
- Scale
- Chanel marks and lights
- When the chart was made
- When it was updated with "Notices to Mariners"
- Note the Datum, chart and GPS need to match
- Information about the chart's reliability – Zones of Confidence or Chart Properties
- Notes and information on Hazards

42

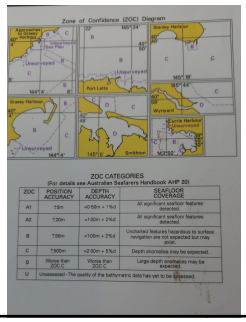
ORCV
OCEAN TRAINING

Things to look for



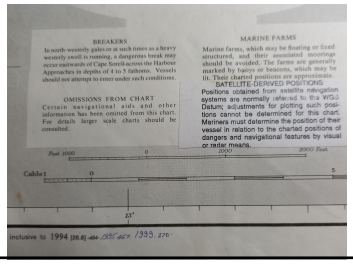
43

Zones of Confidence "ZOC"



44

Other useful Information….



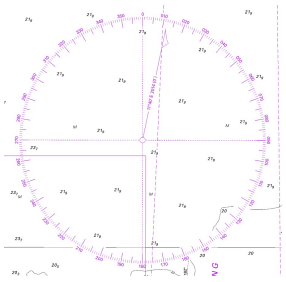
Breakers at entrance to Macquarie harbour…. don't attempt to enter when…

GPS positions cannot be plotted on this chart…… (if you do you will run into the groin)

45

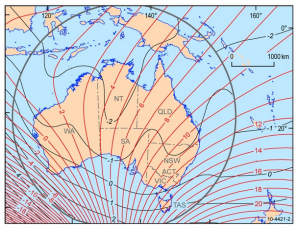
Compass

- Charts show “True” direction
- Compasses show “Magnetic” direction
- The difference is “magnetic variation” (declination)
- If the declination is East, "compass is least". So, if you want to head due north steer less than 360 magnetic
- Magnetic variation varies across the globe



46

Magnetic variation Australia



Declination, Australian Geomagnetic Reference Field model 2010 at 2010.0

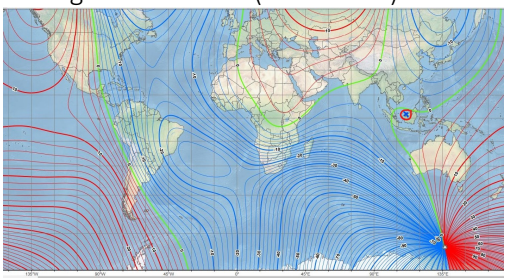
Declination angle (°)

Annual rate of change of declination (°/year)

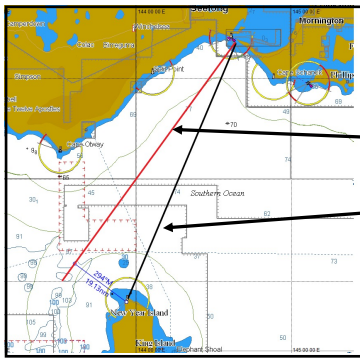
AGRF model area

47

Magnetic variation (declination)



48



True / Magnetic

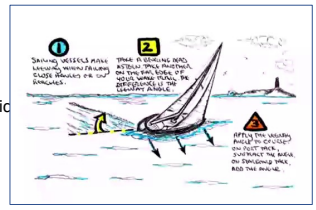
203˚ MAGNETIC bearing from Port Phillip Heads to King Island

- 203˚ TRUE bearing from Port Phillip Heads to King Island

49

Leeway

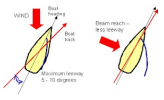
- How can we Estimate it?
- How can we Measure it?
- How can we Apply it to predic



50

Leeway

- Leeway – estimate typically 5 to 10° (for a yacht when the wind is forward of the beam)
- Measure
- Sight wake with hand compass
- Use GPS course over ground vs compass heading.
- Predict:
- Wind from Port side: Water track - Leeway angle = course to steer.
- Wind from Starboard side: Water track + Leeway



51

Leeway

- A handy thing to remember is that;
- 5 degrees is roughly 5/60 or 1/12 meaning that for every 12 miles forward you slip one mile to leeward.
- 3 degrees is roughly 3/60 or 1/20 so then for every 20 miles forward, one mile slipped to leeward.
- You get the idea! Works best for small angles

52

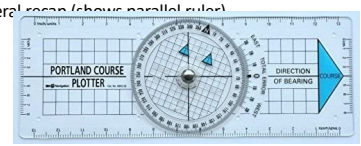
Plotting

- Note scale on Lat/Long
- To plot a position on to a chart:
- Mark desired latitude on side scale (pencil)
- Use parallel ruler or Portland Plotter to transpose to approx. location
- Do similar with longitude, where lines cross is your position
- To read off a position from a

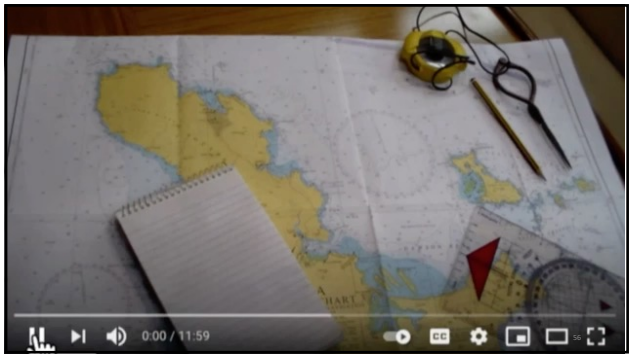
54

Plotting

- We are now going to show you three short videos:-
- Plotting a position using a Portland Plotter and
- Using dividers to measure distance
- Using a Portland Plotter to take a bearing
- A general recap (shows parallel ruler)

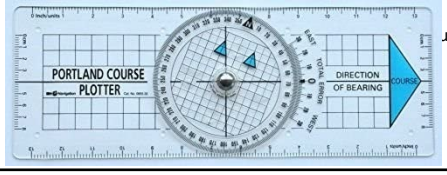


55



Discussion

- It's a simple 3 step process with the Portland Plotter
- Put the plotter, pointing in the right direction along the line you wish to sail
- Turn the dial so that the grid on the dial lines up with the Latitude grid on the map



u can use to

57

Discussion (plotting position)

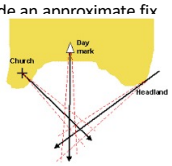
- In that video he was using a norther hemisphere chart so latitudes increase as you go up the chart towards the North Pole.
- In our waters the opposite is true.... latitude increases as you move south.

59

Multi point fix

- If you can take a bearing to two or more (ideally three) landmarks that are on your chart (for two points, at 90 degrees, three points, 60 degrees between each)
- Where they converge will provide an approximate fix

triangu



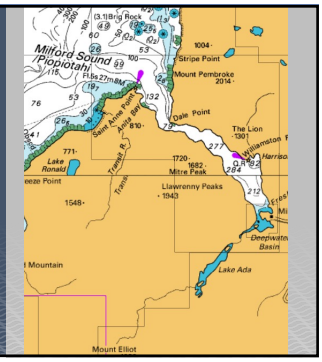
estimated

61

Exercise 1

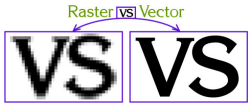
62

Electronic Charts



Electronic chart types

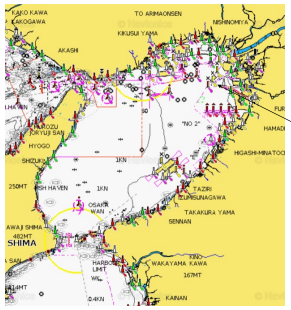
- **ENC**
  - Electronic Navigational Chart
  - Vector
  - S-57: S63(encrypted) and in a few years S-101
  - ONLY official charts can be called ENC
- **RNC**
  - Raster Navigational Chart
  - Essentially a photocopy - georeferenced
- **C-map & Navionics**
  - Vector charts similar to ENC's but seamless

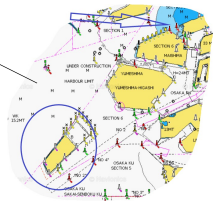


Why should you have more than one source ?

Why should they be up to date ?

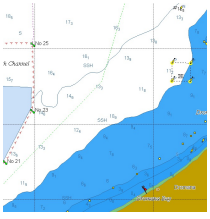
64

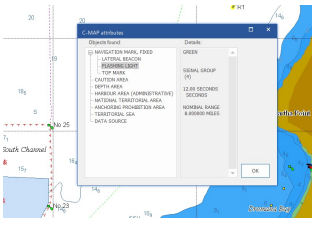




65

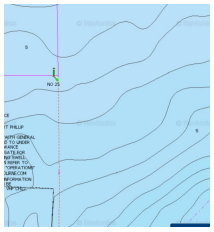
C-map

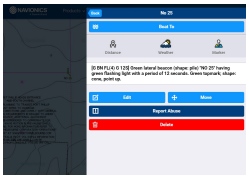




66

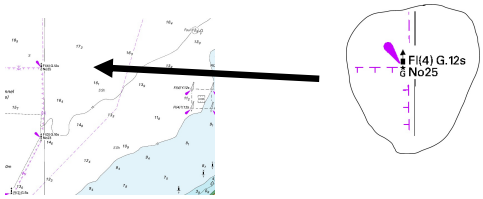
Navionics





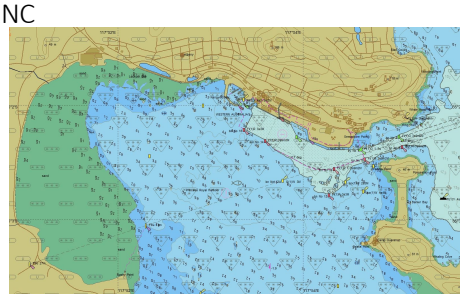
67

RNC



68

ENC



69

ENC and the Phase out of Paper Charts

- The Australian Hydrographic Office is phasing out paper charts – partly due to cost, also needs of commercial shipping, update capacity and ability to display more information on ENC.
  - The AS requirement for Paper charts will also be dropped
  - ENC charts not published in Android so the change will cause some inconvenience for sailors
  - The following recording provides a good insight into the need for improved information display.

  - **Cut down version of mikes talk here**

70

Exercise 2

71

Exercise 2 solution

72

Exercise 2 solution

Fundamental Navigation Homework

Exercise 1

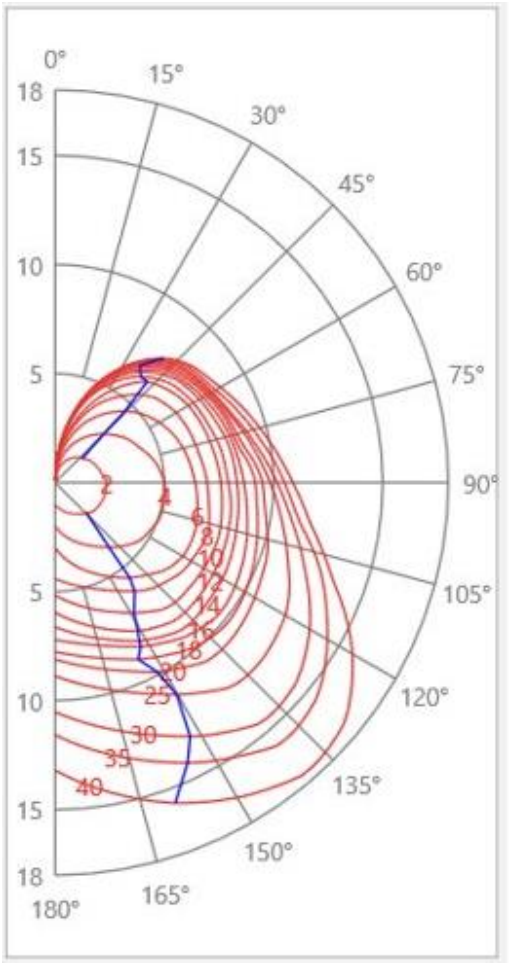
You are entering the Apollo Bay race; you have the locations of all the marks. You must now enter these waypoints in your Navionics. Then make a route using those waypoints. Take screen shot of the whole course then a magnification of the start and finish. Email those pictures to training@orcv.org.au

Latitude	Longitude	Location	Leave to
S38 16.409	E144 40.145	Drapers Reef	Starboard
S38 16.90	E144 38.90	ORCV A	Port
S38 17.95	E144 37.74	ORCV B	Port
S38 18.50	E144 36.80	ORCV C	Port
S38 45.362	E 143 40.734	Mark AB	Port
S38 45.206	E143 40.988	Finish Mark	Between
S38 45.362	E143 40.734	Finish Mark	Between

Exercise 2

You are leaving from you pen at the RYCV and you are going to the start of the Apollo Bay Race. Use the automatic routing function on Navionics.

1. Carefully exam the route and screen shot the any issues that you find on the route.
2. The start of the race is Saturday 31st July at 7am take the weather into account and determine what time you should leave using the boat polar below. If you have to motor you boat motors at 6 knots.
3. What effect will the tide through West Channel effect you timing
4. Email your answers to training@orcv.org.au



Question 3

Please do a “reverse multi-point fix” using the measuring device in your Navionics App to find the bearing and distance of the points given below from the position 37deg 59.047min S, 144deg 53.021min E.

The points are:-

- The South Cardinal Mark off Ricketts point
- Point Cook
- Prince George Bank (off the Bellarine Peninsular)

ORCV is dedicated to promoting ocean sailing, growing its participation, providing sea safety programs and value to our members.

Support the ORCV by joining as a member
www.orcv.org.au/join

Learn more about the ORCV Programs

Racing Calendar
Safety & Sea Survival Courses
Weather Courses
Navigation Courses
Bowman Course
Other Courses
Membership
plus more

Follow us on

ORCV Office 3 Aquatic Drive Albert Park VIC 3206
orcv@orcv.org.au