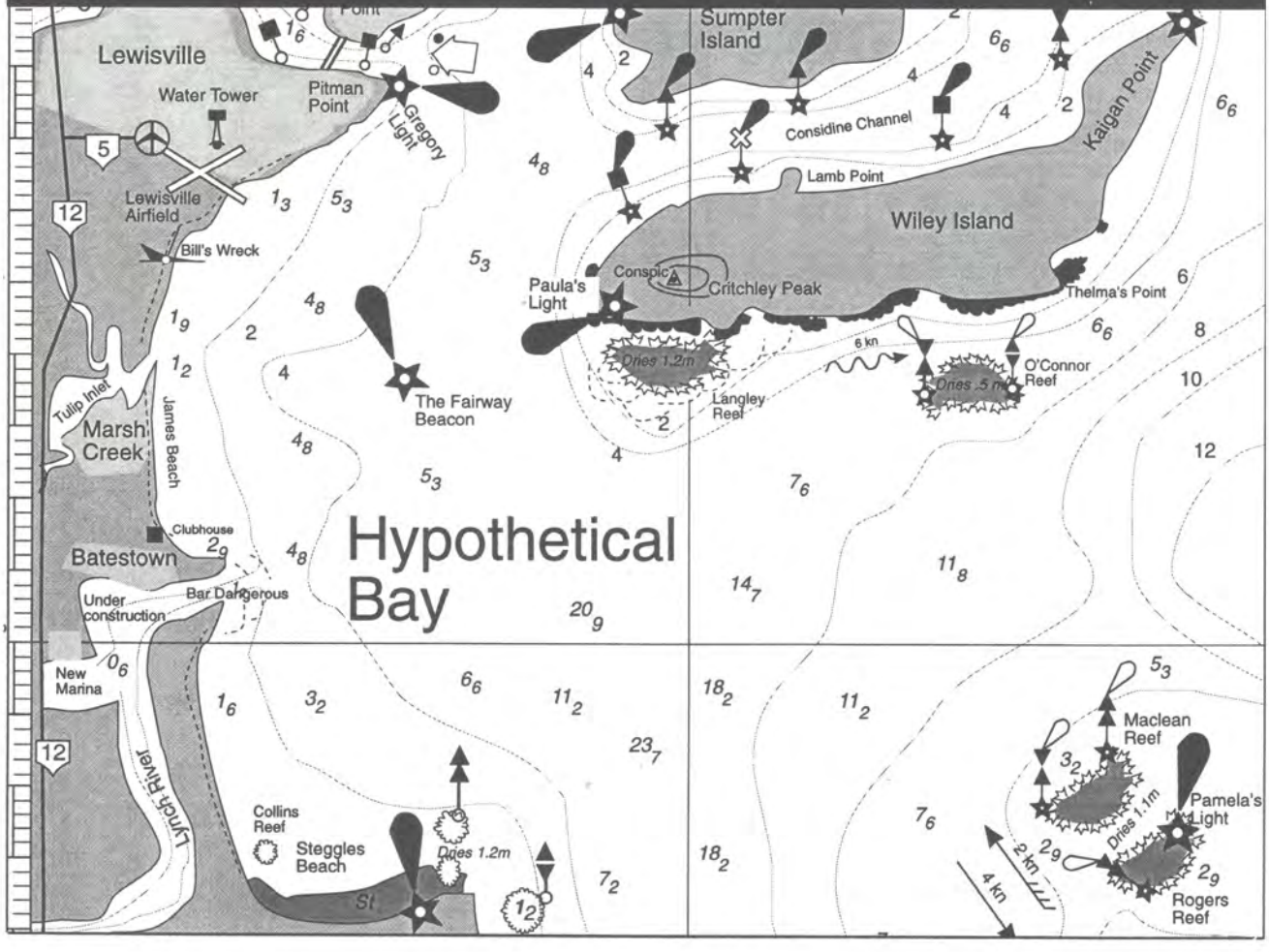
Classroom Navigation Workbook

A student workbook for Mathematics Students



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Wet Paper

CONTENTS

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Additional Wet Paper Resources

Also by the same publisher:

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INTRODUCTION

Navigation is the art of directing a vessel at sea and can be as simple as paddling a surf ski over a sandbank or as complicated as driving an ocean liner around the world.

The following terms are to be used with this workbook and for more meaningful ones, it is suggested you refer to a standard navigation textbook.

TERMS USED

Buoys, beacons and marks

Buoys, beacons and marks are the road signs of the sea used by navigators to prevent collisions.

They vary in shape, size and colour and sometimes carry lights so they can be seen at night.

Buoyage system

Buoyage system refers to how buoys beacons and markers are interpreted by mariners.

Compass points

Compass points refer to variations of north, south east or west. For example, east of north is North East and is expressed as NE.

Compass

A compass is an instrument that has a series of compass points and numbers arranged in a 360° circle to show where magnetic north is.

Chart

A chart is a piece of paper that shows the contours of the sea and distinctive features useful for mariners when navigating.

Dead reckoning

Dead reckoning (DR) - plotting a course by using only speed, distance and time to work out your position.

Dividers

Dividers are instruments used to measure the distances on a chart.

Fix

Fix - finding the bearings of conspicuous objects and using them to find positions at sea.

Hypothetical Bay

Hypothetical Bay is an imaginary chart, produced for this booklet so you can learn about navigation.

Knots

Knots - a measurement of speed at sea. One knot = one nautical mile per hour = 1.852 km/hr.

Longitude

Longitude - a meridian drawn from North to South.

Latitude

Latitude - a meridian drawn East to West.

Magnetic variation

Magnetic variation is the angle between true north and magnetic north.

Mercator projection

A mercator projection is where meridians are drawn as straight vertical lines on a map.

Hypothetical Bay is a Mercator Projection.

Meridian

Meridian - a line drawn on a chart.

Nautical mile

Nautical mile - the distance of one minute of latitude. One degree = 60 nautical miles or 1852 metres.

Ortho-photographic map

Orthophotographic map - sometimes used by Government Department to make maps from aerial photographs.

Parallel rules

Parallel rules are instruments used with the compass rose on a chart.

Projection

Projection - the method used to show a map on a flat surface.

Set squares

Set squares are instruments that can be used as a substitute for parallel rules and can be used with the compass rose.

SUGGESTIONS

You should get out of the classroom and onto a river or sheltered waterway to see real buoys, beacons and markers. There are many field study centres, environmental education centres or local charter or ferry boats that can help you.

If the skippers have the required maritime qualifications and the vessel has a current certificate of survey, see if you can take a half day excursion out to sea and use a real chart to apply the skills you learn here.

SKILLS

This workbook provides the opportunity for students to learn how to:

- write basic definitions and terms used in navigation
- construct a compass rose and its compass points
- describe the principles of a hand bearing compass
- take a bearing using a hand bearing compass
- draw significant symbols used on a chart
- determine latitude, longitude and nautical miles
- calculate distance, speed and time on a chart for dead reckoning
- use a compass rose to calculate a bearing
- calculate compass conversions from true and magnetic
- draw a line of position to determine a position at sea using a cocked hat
- find a position at sea using a chart, known bearings and the compass rose
- lay off and plot a safe course at sea
- construct some common buoys, beacons and marks from simple materials
- use your local chart
- chart your oval
- practice at using a real chart
- go on an excursion to practice skills at sea

EXERCISE 1
CLASSROOM CHARTS

METHOD

1. Use your pencil and ruler to make a map of your room in the space in Figure 1.2.

   Draw in the desks and mark in conspicuous features such as the door, wall clock, blackboard and where you are sitting.
2. Using the circle in Figure 1.2 as a guide, mark in classroom North with a capital N and write 0° beside it.
3. Now mark in 10°, 20°, 30° to 360° around the circles as shown in Figure 1.1. You have now made a compass rose.
4. On the inside of the circle mark off the compass points:

   NE, E, SE, S, SW, W, NW to match numbers you have just marked.
5. Take the orienteering compass, place it in front of you away from the metal parts of the desk and find magnetic north.
6. Now mark this on your compass rose as magnetic north.

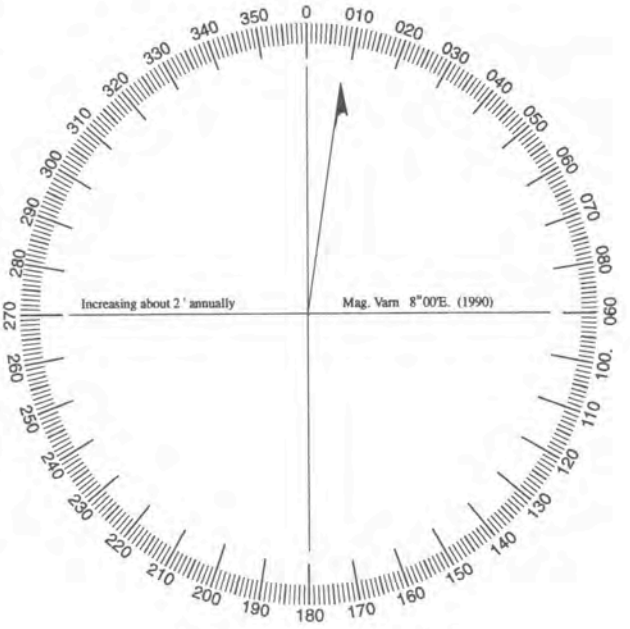


Figure 1.1 A compass rose

QUESTIONS

1. How many degrees difference is there between Classroom North and Magnetic North? Give a reason for this difference.

2. From where you are sitting, what is the approximate compass point position of the following conspicuous points in your classroom? Give your answer in compass points.

   a. Right hard corner of the blackboard.

   b. Door.

   c. Clock.

MATERIALS AND EQUIPMENT (PER GROUP)

Equipment required

- pencil, ruler and rubber
- orienteering compass

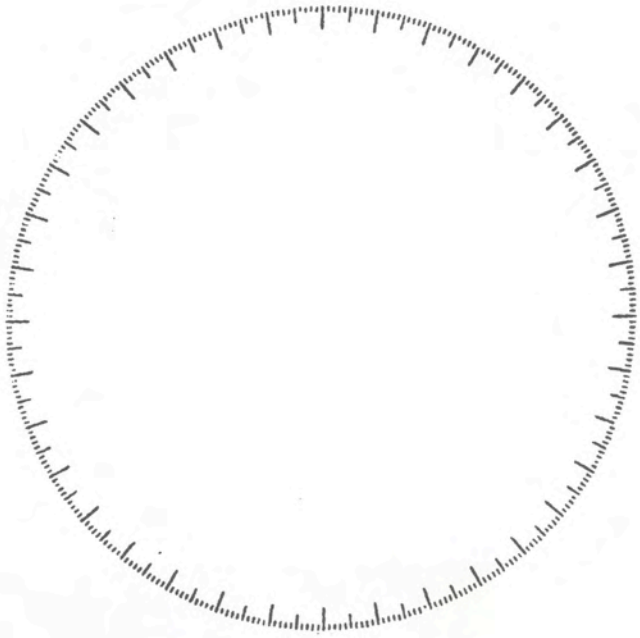


Figure 1.2 Your classroom chart

Exercise 2
Make a simple compass

Safety warning

Satay sticks have a sharp end and should not be put up to the eye.

Use the handbearing compass at arms length as shown in Figure 2.2.

Method

1. Fix the orienteering compass on the cardboard with sticky tape as shown in Figure 2.2.
2. Make two holes in your cardboard as shown in Figure 2.2 so that they line up to the north and south of the compass.

   Now push one satay stick through one hole at the north end and fix with tape.

   Repeat for the other satay sick at the south end.
3. Take the third satay stick and fix it to the other two half way up as shown in Figure 2.2.
4. Use the home made handbearing compass at arms length as shown in Figure 2.2.
   a. Take bearings on the corners of the room or other conspicuous points around the classroom and record them in the Table in Figure 2.3
   b. Use the good quality compass, as shown in Figure 2.1, to compare your accuracy.
5. Using your classroom plan, see if you can find your position using your handbearing compass.

Questions

1. What problems do you have with this simple type of compass?

2. How have these problems been overcome using a good quality hand bearing compass?

Figure 2.1 A good quality hand-bearing compass

Materials and equipment (per group)

Equipment required

- three satay sticks
- orienteering compass
- cardboard sheet (approximately 200 mm x 200 mm)
- sticky tape

(per class)

- good quality, hand-bearing compass as shown in Figure 2.1

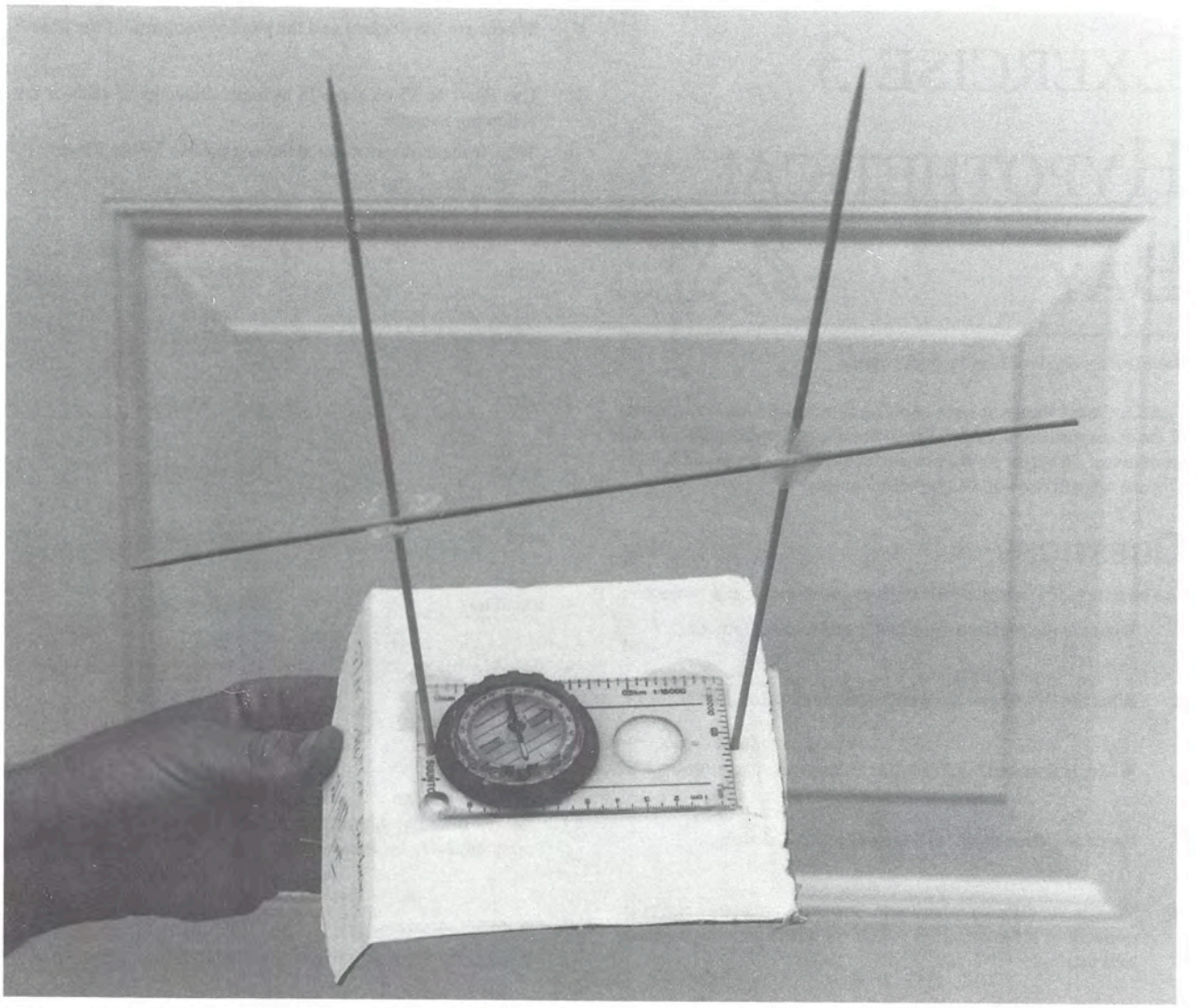


Figure 2.2 A simple hand-bearing compass made from satay sticks, an orienteering compass, sticky tape and a piece of stiff cardboard.

Position in room	Bearing from hand bearing compass

Figure 2.3 Results

Exercise 3
Hypothetical Bay

Based on an original idea by Bob Moffatt

There are many things to learn about navigation. To navigate outside of the classroom requires skills and knowledge that come later in this set of notes. However for the present let us look at how to use a *chart*. The one we will use will be Hypothetical Bay.

Questions

Use an atlas to find a map of Australia showing a mercator projection.

1. What are the northern most and southern most latitudes?
2. What are the eastern most and western most longitudes?
3. Where is Greenwich? What line of longitude passes through it?
4. Name any three places the equator passes through.
5. What is the difference between a mercator projection and other projections of the world? (e.g. Find out what a gnomic projection tells us.)
6. Look carefully at the latitudes and longitudes of Hypothetical Bay.
   a. Is the bay in the Northern Hemisphere or Southern Hemisphere (refer to Figure 3.1)?
   b. Off what continental shelf is the bay located?
   c. How big is the bay approximately in kilometres?

Look carefully at Hypothetical Bay opposite and answer the questions below.

7. List any six chart features that are not found on a map.
8. Where are the deepest and the shallowest parts of the chart?
9. Use Exercise 13 on page 28 to make drawings of each of the following features:
10. What is the depth of water at the entrance to Jensen River?

- wreck
- direction of buoyage
- light
- water tower
- sectored light
- special mark
- hill
- rocky headland
- airport
- breaking waves
- coral reef
- stony beach
- sounding
- mangrove area
- sounding line
- starboard lateral unlit mark
- beacon
- sandy beach

11. What is the difference between pilotage and buoyage? Use your textbook index to write a definition of each.
12. What is the depth of water in Claridge Inlet?
13. Who is a pilot and what does he or she do at sea?
14. Where is Thelma's Point?
15. What is found in Watson Swamp?
16. Describe the coastline features around the mouth of Lynch River?
17. Name any three hills over 500 m.
18. Name the two islands in the bay.
19. What is the speed of the ebb tide off Maclean Reef?
20. What is the sea floor made of in Perry Shoals?
21. What is the speed of the current between Wiley Island and O'Connor Reef?
22. What is the sea floor and surrounding coastline made of around Langley Reef?

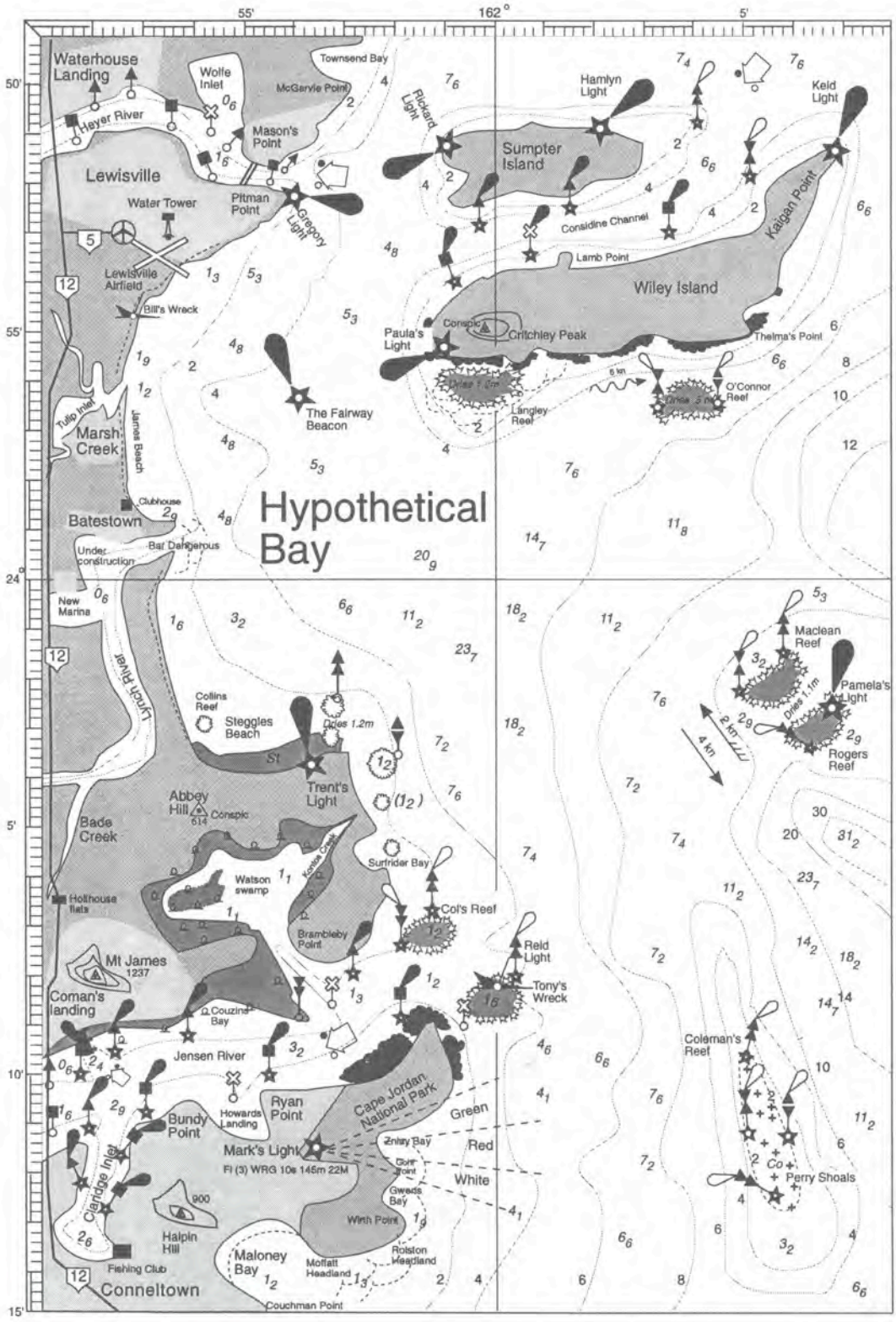


Figure 3.1 Where in the world is Hypothetical Bay?

Answers

1. approx. 80°S to 49°S
2. 112°E to 153°E
3. England; 0°E
4. Galapagos Islands, Borneo, Colombia.
5. A mercator projection is where meridians are drawn as straight vertical lines on a map. Hypothetical Bay is a Mercator Projection. A gnomic projection is where great circles are drawn as straight lines. Figure 2.1 is gnomic projection.
6. a. Southern
   b. East Australian
   c. approx. 30km
7. beacons, reefs, set and drift of tide, lateral markers, cardinal markers, direction of tidal flow
8. deepest is south of Rogers Reef, shallowest is Wolfe Inlet and Lynch River
9. Students to draw symbols.
10. 1.2 metres
11. pilotage is the term used to describe the means by which skippers use a series of buoys beacons and markers to enter and leave ports; buoyage is the system of marking these buoys, beacons, and markers.
12. 2_6
13. A pilot is a person who knows the local channel very well and operates a pilot boat which is located in a harbour and whose job is to navigate large vessels safely into the harbour.
14. 162°5'N, 23°54'S
15. mangroves
16. sand spit, bar
17. Halpin, Abbey, Mt James
18. Sumpter, Wiley
19. 4 knots
20. sand, coral
21. 6 knots
22. coral, rock

EXERCISE 4 LATITUDE, LONGITUDE AND NAUTICAL MILES

Notes: In these early exercises the compass rose has been left off the map of Hypothetical Bay. A nautical mile is one minute of latitude.

QUESTIONS

Use a ruler to find the latitude and longitude of the following places. Remember lines of latitude run down from the equator and lines of longitude run east or west of Greenwich as shown in Figure 4.1 below.

1. Find the latitude and longitude of the following points:
   a. Gregory Light
   b. Paula's Light
   c. Rogers's Light
   d. Tony's Wreck
   e. Fishing Club on Claridge Inlet
   f. Airport at Lewisville
   g. Rickard Light
   h. Hamlyn Light
   i. the mouth of Kontos Creek
   j. Ryan Point
   k. the peak of Halpin Hill

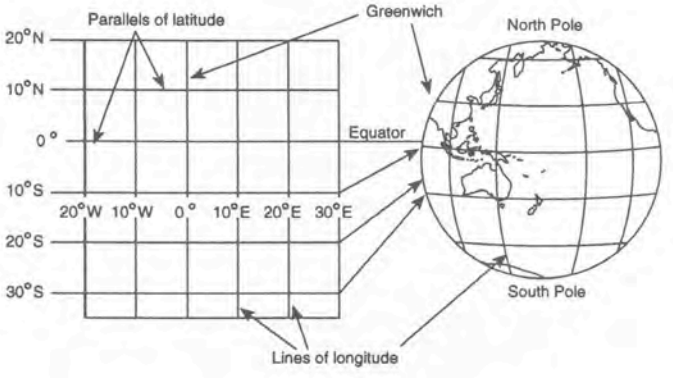
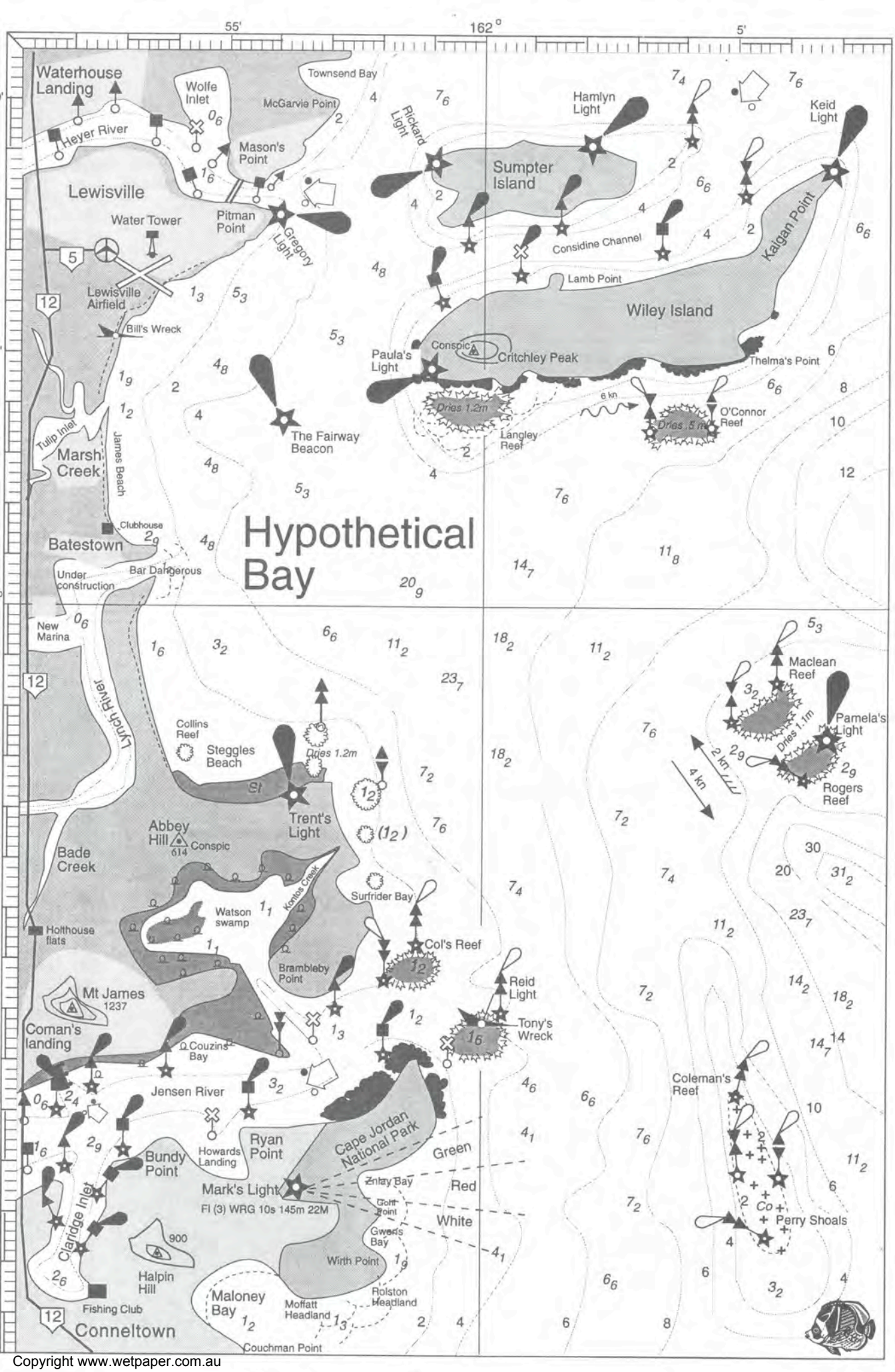


Figure 4.1 Latitude and longitude

2. Name the charted features at the following positions of latitude and longitude.
   a. 23° 54' S, 161° 53' E
   b. 23° 52' S, 161° 56' E
   c. 24° 02' S, 162° 06' E
   d. 24° 11' S, 161° 54' E
   e. 24° 02.5' S, 162° 06.8' E
   f. 24° 11.6' S, 161° 56.2' E
   g. 24° 6.6' S, 161° 51.2' E
3. Find two features at different latitudes but the same longitude.
4. Find two features at different longitudes but the same latitude.
5. What is the safest navigable distance between the following places for a deep draft vessel?
   a. Gregory Light and the Fairway Beacon
   b. the Fairway Beacon and Trent's Light
   c. Gregory Light and Keid Light
   d. Keid Light and Maloney Beach
   e. The north mark on Maclean Reef and Bundy Point in Jensen River.
   f. the Southern Mark on Perry Shoals and Waterhouse Landing
6. Calculate the size of the following places:
   a. Watson Swamp
   b. the new marina in Lynch River
   c. Roger's Reef
   d. Wiley Island



EXERCISE 5
DISTANCE, SPEED AND TIME

METHOD

This exercise allows you to practice using the nautical mile to determine speed and time.

Remember one knot is equal to one nautical mile per hour.

Worked examples

a. How fast am I travelling if I cover 100 Nm in 5 hours?

S = D/T = 100 Nm/5 hrs = 20 Nm/hr or 20 knots

b. How far can I travel in 2 hours and 30 minutes, if I am travelling at 10 knots?

D = S x T = 10 knots x 2.5 hrs = 25 Nm

c. How long is it going to take me to travel 75 Nm of my boat travels at a constant speed of 10 knots?

T = D/S = 75 Nm/10 Nm per hr = 7.5 hrs = 7 hrs and 30 minutes

QUESTIONS

1. How far can I travel in 10 hours if I am travelling at 9 knots?

2. How far can I travel in 6 hours at a constant speed of 4 knots?

3. For 2 hours I travel at 10 knots, and for the next 3 hours my boat can only make 5 knots. How far have I travelled?

4. My boat travels 10 Nm in two hours. How fast did she go?

5. I left harbour at 7 a.m. and travelled 5 Nm by 10 a.m. How well did my speed boat perform?

6. If I set out in my sailing boat at 10.30 a.m. and reached my destination at 2 p.m. after travelling 35 Nm, what was my average speed for the trip?

7. How long did it take a mariner to travel 20 Nm at an average speed of 5 knots?

8. Your sailing boat is travelling at 4 knots and your navigator predicts 32 Nm to go. How many hours will it take to reach your destination?

9. How far is it from the fishing club in Conneltown to the 4 m line off Col's reef? My boat can do 6 knots and draws 2.9 m. When can I leave the fishing club on the morning of 4 January and how long will it take to get to Col's reef? Use the tide tables in Figure 4.1 to help you.

10. How far is it from the port mark at the mouth of Heyer River to Lamb Point on Wiley Island?

11. *Wet Paper I* leaves the new marina on Lynch River at 0800 hrs and travels to 24° 01'S, 161° 59'E. She can do 25 knots, but a 15 knot S/E is blowing and she can only make 12.

    a. How long will she take to get there?

    b. Whales have been spotted off Thelma's Point. Can *Wet Paper I* make it in time for lunch? Show all working.

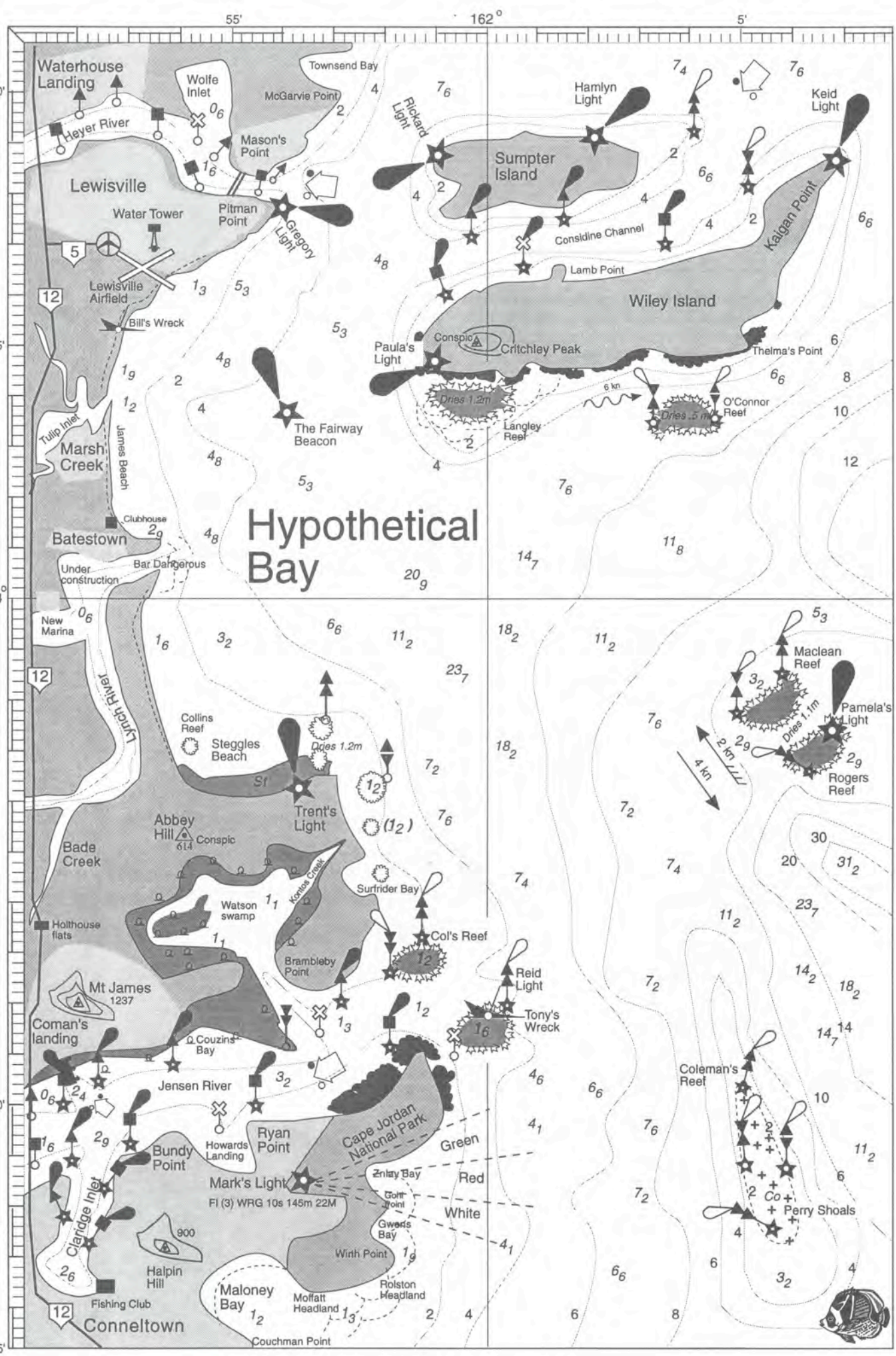
12. Another vessel, *Whyamber*, can make 5 knots and travels from the same marina. How long will she take?

13. If you were running a coach company and wanted to tap into the growing market of whale watching tourists from Hypothetical Bay, and your cousin has a restaurant at Marsh Creek, what bus schedule would you draw up for your operation? Lewisville airport can take direct flights from Tokyo and Sigatoka.

Tide tables for Jensen River

Date	Time	m	Date	Time	m
Jan1	0221	0.99	Jan 4	0221	0.95
	0515	2.32		0515	2.32
	1424	0.51		1424	0.54
	2101	2.55		2101	2.66
Jan 2	0252	1.15	Jan 5	0221	1.99
	0535	2.22		0515	3.32
	1452	0.49		1424	0.71
	2133	2.58		2101	3.55
Jan 3	0321	0.99			
	0715	2.32			
	1524	0.51			
	2201	2.55			

Figure 5.1 Tides for Jensen River



EXERCISE 6
USING THE COMPASS ROSE

The compass rose allows us to navigate at sea. As there are no road signs, traffic lights or highways, the chart has a compass rose which allows us to go safely from place to place. Read pages 99 – 101 of the first edition of *Marine Studies or your Maths book,*

METHOD

Obtain two 90^0 set squares (or parallel rules) and complete the following tasks on the Hypothetical Bay chart.

1. 'Walk' the instruments from the top of the chart to the bottom, keeping the sides parallel.
2. 'Walk' the squares from one corner to the other, keeping the bases parallel.
3. Place one of the squares so that the hypotenuse lies over the Fairway Beacon and Paula's Light. Draw a light line between the two (remember that you will have to rub out all lines at the end of the exercise).
4. Now place the side of the other square opposite the side of the first square.

   Slide the second set square down the page until the hypotenuse of the second square is over the centre of the compass rose (as shown in Fig. 21 *Marine Studies first edition).*
5. The bearing from Paula's Light to the Fairway Beacon can now be read from the number of degrees shown on the compass rose. What did you get? Discuss with your teacher the level of accuracy required in this exercise.

QUESTIONS

For each of these exercises, draw a faint line on the chart opposite using either your squares or parallel rule. In each case, use your instruments to read off the following true bearings on the chart. In the next exercise we will look at errors in the compass you are using.

Give the true bearings for the following:

- From Rickard Light to Gregory Light
- From Trent's Light to the Fairway Beacon
- From Trent's Light to Critchley Peak
- From Hamlyn Light to McGravie Point
- From Trent's Light to Paula's Light
- From the 20.9 sounding to the clubhouse

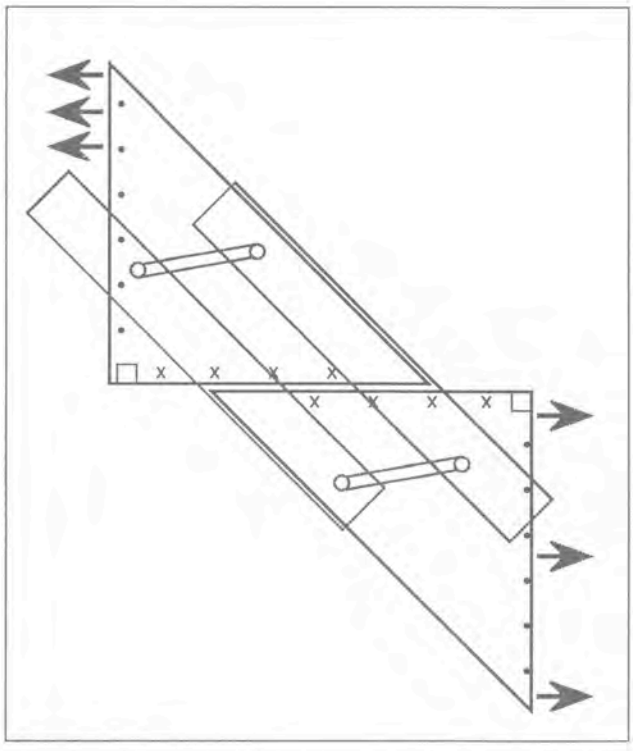


Figure 6.1 Walking a pair of set squares is the same as using a pair of parallel rules

- From the Fairway Beacon to the Water Tower at Lewisville Airport
- From The Clubhouse to Critchley Peak
- McGarvie Point to Critchley Peak
- Hamlyn Light to Lamb Point on Wiley Island

MATERIALS AND EQUIPMENT (PER GROUP)

Equipment required

- pair of 90^0 set squares or parallel rules
- HB pencil and HB rubber
- copy of *Marine Studies or maths book*

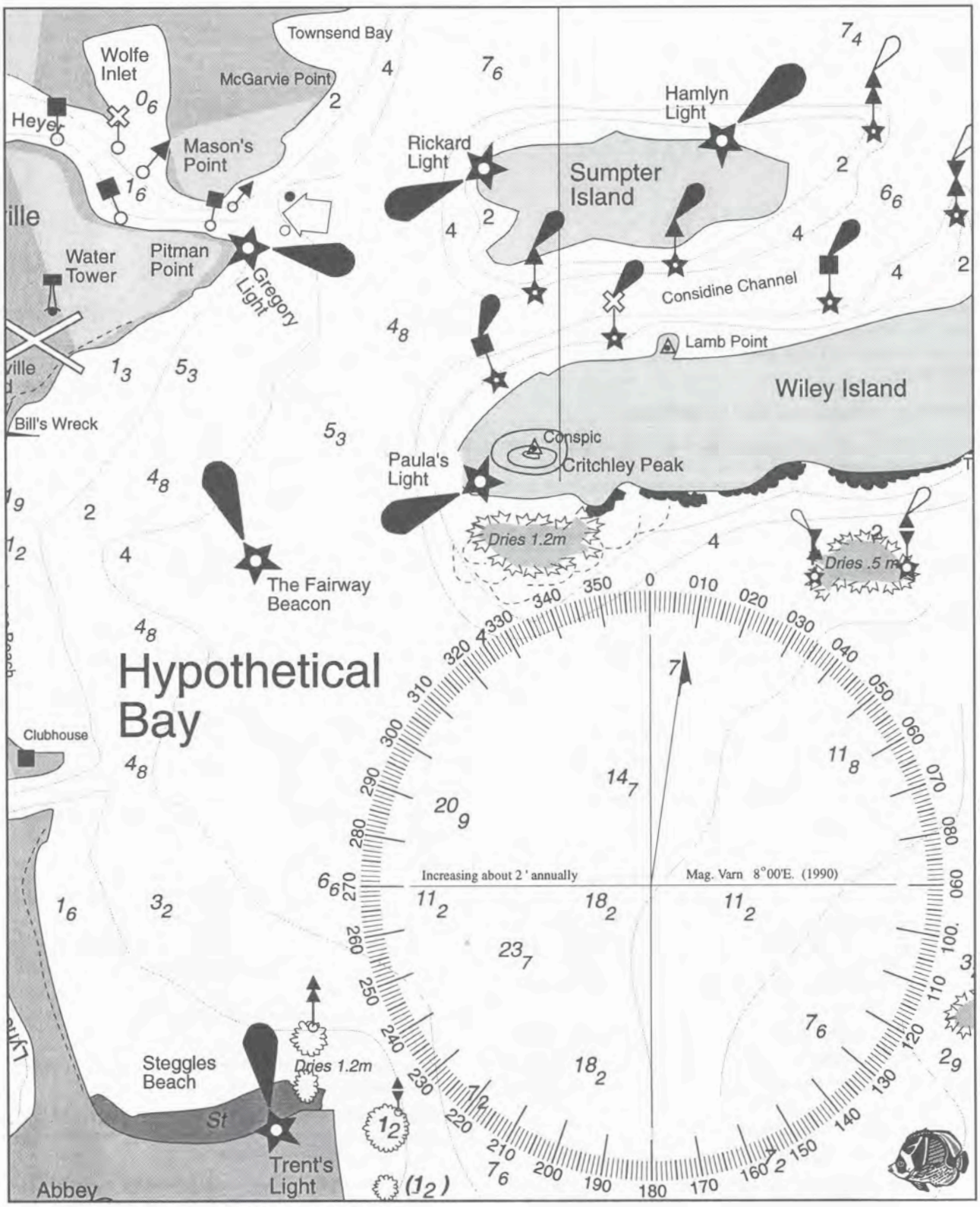


Figure 6.2 Hypothetical Bay with compass rose added

EXERCISE 7
DOING COMPASS CONVERSIONS

In a perfect world, geographic north and magnetic north would be the same. All ships compasses would always point to true north and any bearings you took with your hand-bearing compass would be relative to true north.

Errors in compasses due to variation

In any location, the earth's magnetic field is at an angle to the meridians of longitude, and so your compass (either steering or hand-bearing) does not point to the true north of the longitude lines on the chart.

We end up with three types of angular bearing:

1. **True bearings**

   These are relative to true north and are taken off the compass rose on the chart or measured with a protractor against the grid lines of the chart. These are usually written with a T after the angle, e.g. 32°T means an angle of 32° to the true north of the chart.

2. **Compass bearings**

   These are relative to the earth's magnetic field lines in the area, and are read off the hand bearing compass or the steering compass. Usually written with a C after the angle, e.g. 165°C means an angle of 165° to the earth's magnetic field in that area.

3. **Variation**

   This is the local *variation* (for the particular year). It is taken off the compass rose information on your chart, and is always given in the direction of east or west to indicate which way the magnetic field lines are pointing as well as how far, e.g. 8° east in our Hypothetical Bay example as shown opposite (in 1990, but will be still closer to 8° than 9° until 2005).

   You can look up variation in the index of your textbook to locate the magnetic north pole in Hudson Bay Canada.

4. To convert between true and compass bearings we use the rule:

   Error East - Compass Least

   Error West - Compass Best (best means the bigger number)

   - The word Error is used here to mean variation error. Later on it will include deviation error and combined error.
   - Figure 7.1 shows some examples of conversion.

Conversions of compass bearings to true bearings

When you make an observation with a hand-bearing compass, and transfer it to a chart as an LOP (line of position), you have to convert a compass bearing to a true bearing to be able to plot it off the compass rose on the chart.

Example

1. Suppose you are out on Hypothetical Bay somewhere to the north of Trent's Light and east of Batestown. You are looking through your hand-bearing compass at Critchley Peak as shown in Figure 7.2.
2. The hand-bearing compass is reading 30°C. Because of the 8°E variation, you need to add 8° to get 38°T before you may plot your line of position on the chart. (Error east, compass 30° is less than 38°T).
3. See Figure 7.3.
4. Note. Two LOPs will fix your position on the chart, and three LOPs will not only fix your position, but also the size of your cocked hat will tell you how accurate or reliable the bearings were (see exercise 8).

Conversions of true bearings to compass bearings

When you draw a line on a chart to indicate where you want your boat to go — that is a course to steer, you read off the chart the true bearing of the course to steer.

Before the skipper can start moving the boat, this must be converted to a compass course to steer, so you know what numbers to be reading on the steering compass.

Example

1. You have just come out of Heyer River, and want to go straight to the clubhouse at Batestown.
2. On the chart you have drawn the course (see Figure 7.3) and with your parallel rule have found from the compass rose that the course is 210°T.

   Now you must subtract the 8°E to get the compass course to steer of 202°C.

   Error east, compass of 202° is least/less than 210°. (You yell to the helmsperson to steer 202° by the compass).
3. Note that once you have your course to steer marked on the chart, you can use it for deduced reckoning, better known as *dead reckoning* or simply DR.

   You simply measure along your course the distance you have travelled from your log, or your speed x time calculations.

   This is where you would be if there were no current, drift or errors in your steering ability.

   It gives a good idea of your approximate position so you can identify objects and use them for LOPs to fix your position.

Example	a.	b.	c.	d.	e.
True bearing	40°T	85°T	243°T	5°T	356°T
Variation (error)	8°E	5°W	10°E	10°E	12°W
Compass bearing	32°C	90°C	233°C	355°C	8°C

In example d. think of 5°T as 365°T before you subtract the 10°.

In example e. 356° + 12° = 368°, which becomes 8°C.

Figure 7.1 Example of compass conversions

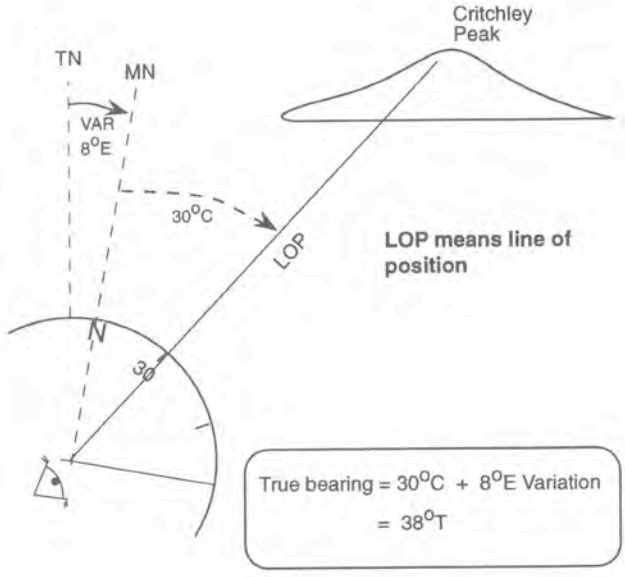


Figure 7.2 Eye looking through hand-bearing compass at Critchley Peak

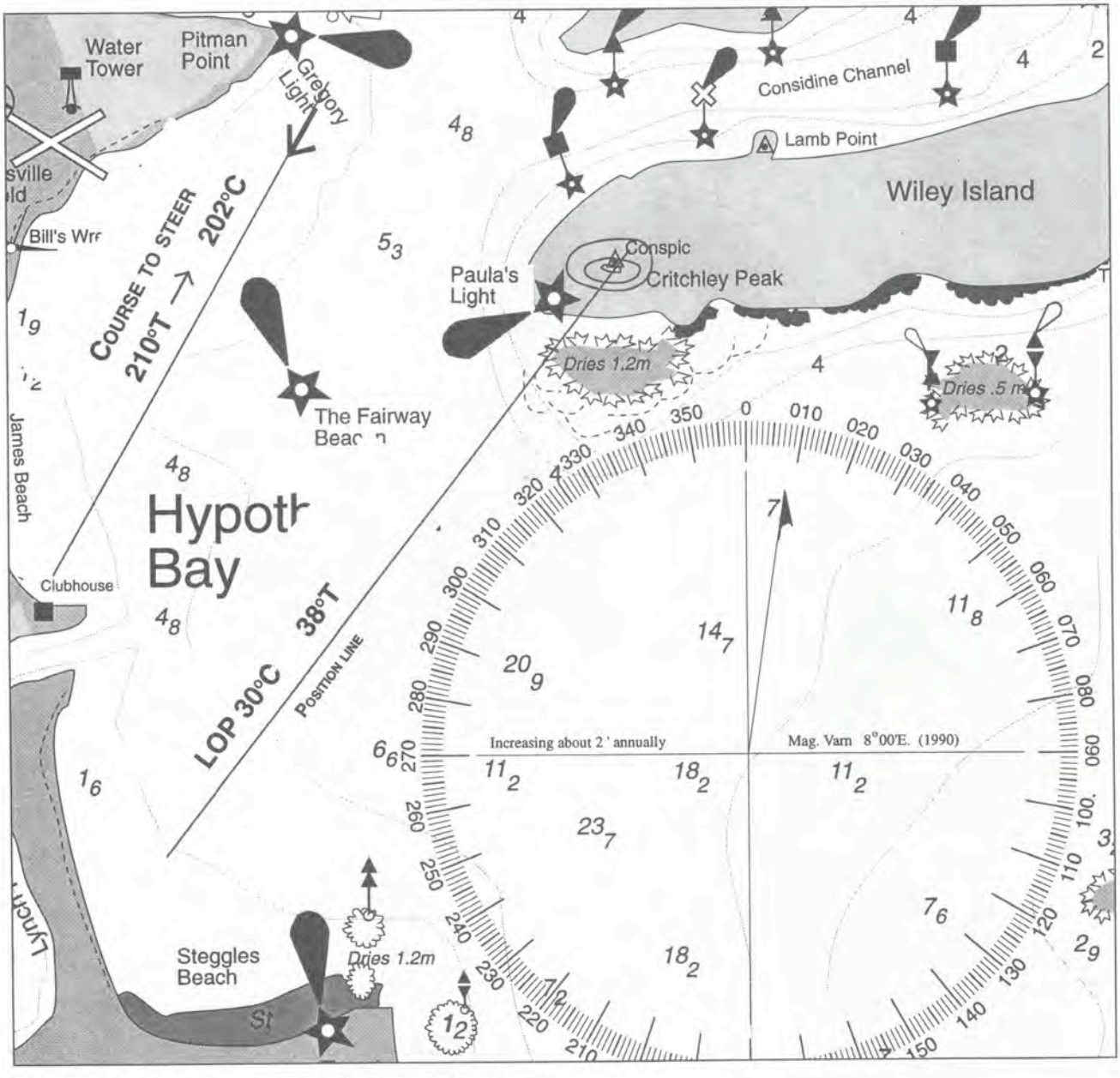
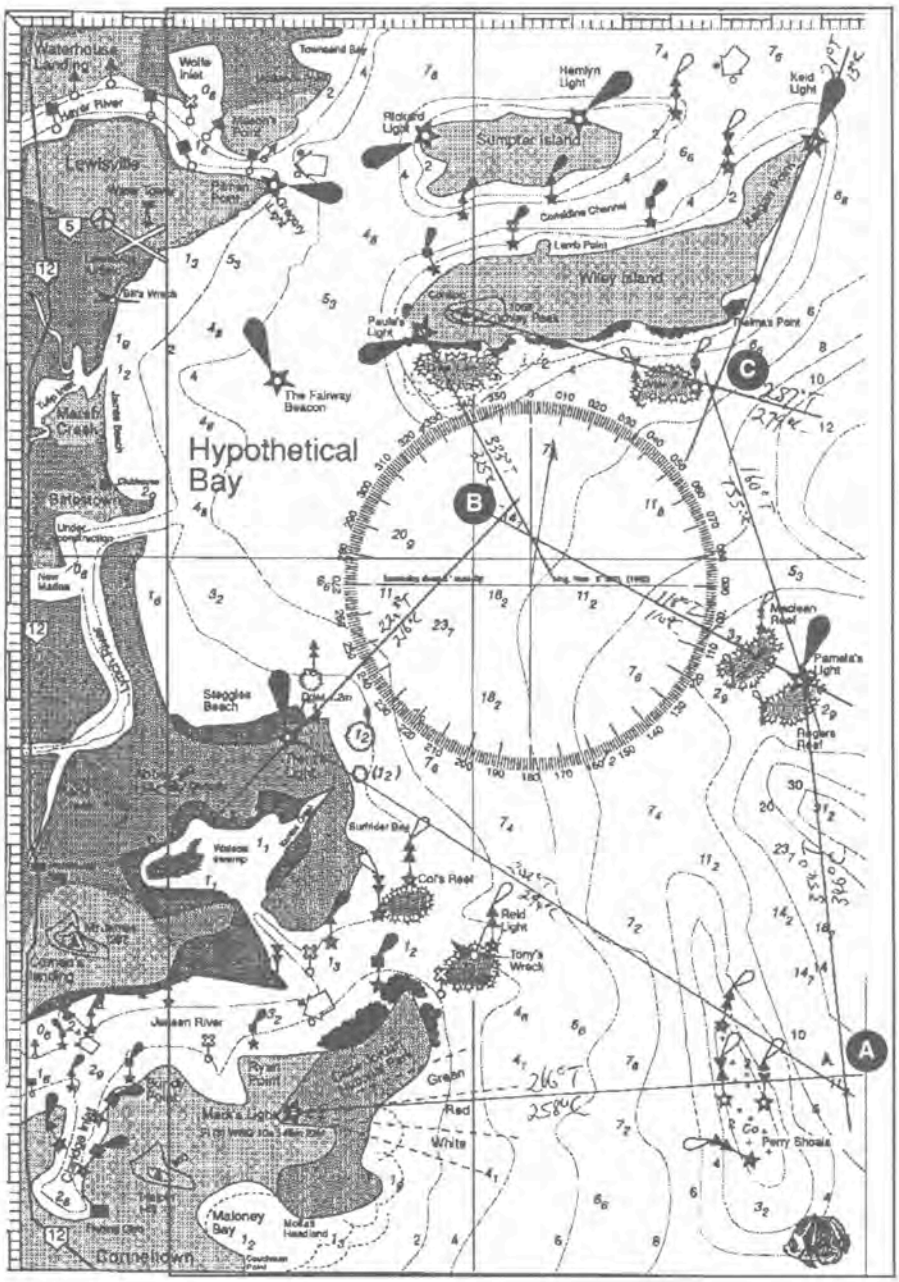


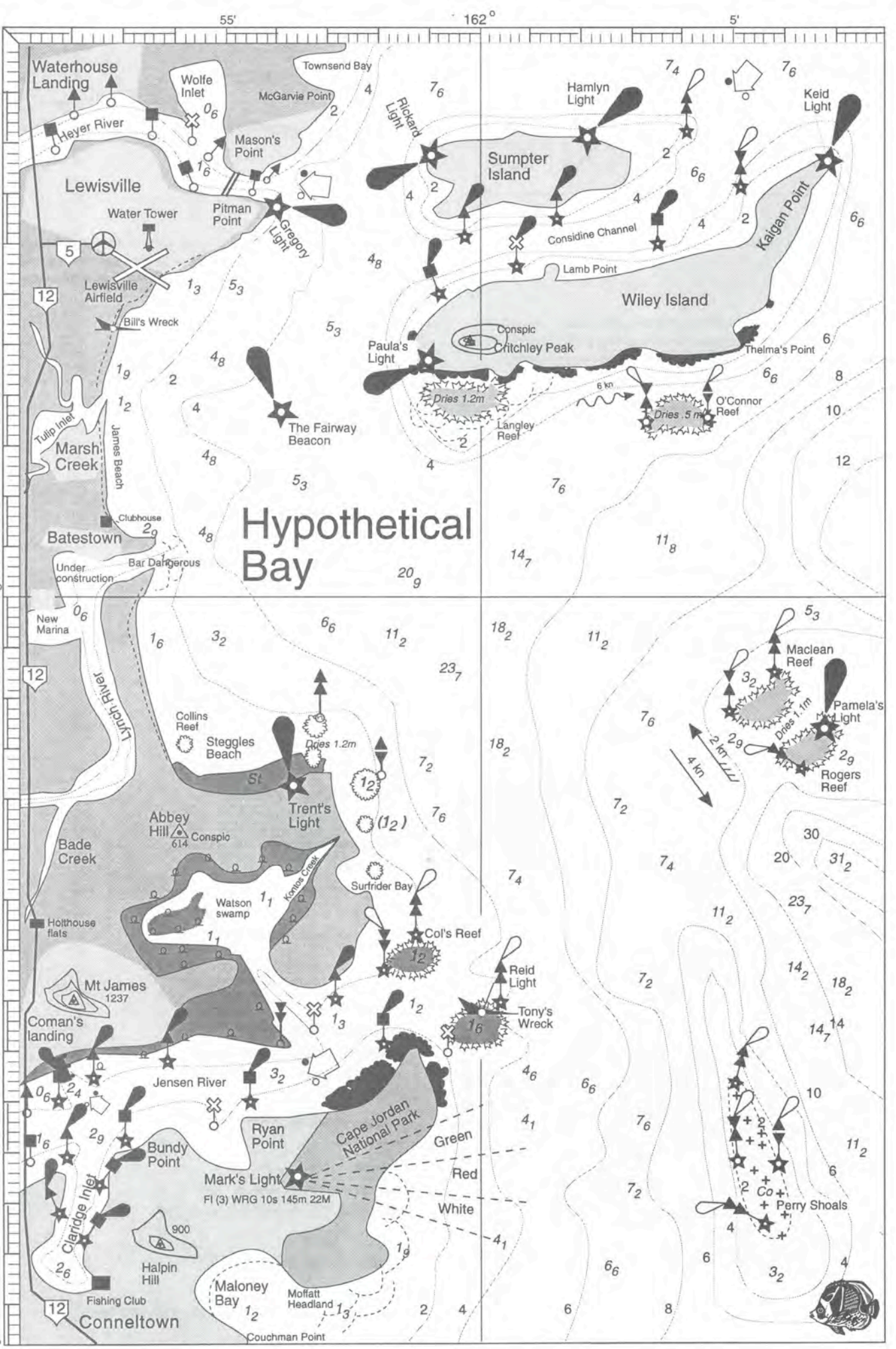
Figure 7.3 Conversion from compass to true and vice versa

QUESTIONS

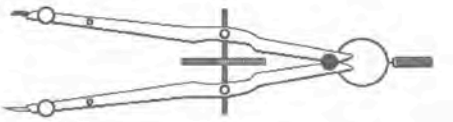
1. Calculate the compass course to steer to go between the following places:
   a. Fairway Beacon to Gregory Light
   b. Gregory Light to Rickard Light
   c. Batestown Clubhouse to northern tip of Maclean Reef
   d. Pamela's Light to Keid Light
   e. Keid Light to Hamlyn Light

2. Draw in LOPs for the following hand bearing-compass observations. Each set of three gives a cocked hat position fix.
   a. Mark's Light 258°C, Trent's Light 294°C, Pamela's Light 346°C
   b. Trent's Light 216°C, Paula's Light 325°C, Pamela's Light 110°C
   c. Critchley Peak 279°C, Keid Light 13°C, Pamela's Light 155°C





Exercise 8
Position fixing



Its nice to know where you are and this exercise lets us use our chart to find out where we are.

Method

Having travelled out for 45 minutes from the marina in Lynch River, the skipper of *Wet Paper I* wants her first mate to plot their position. She takes three bearings, as follows, using a hand-bearing compass.

Bearing 1 to Pamela's Light CB =88°C

Bearing 2 to Trent's Light CB = 163°C

Bearing 2 to Mt James CB = 202°C

These convert using error east compass least rule.

Step 1 Do conversion for bearing 1

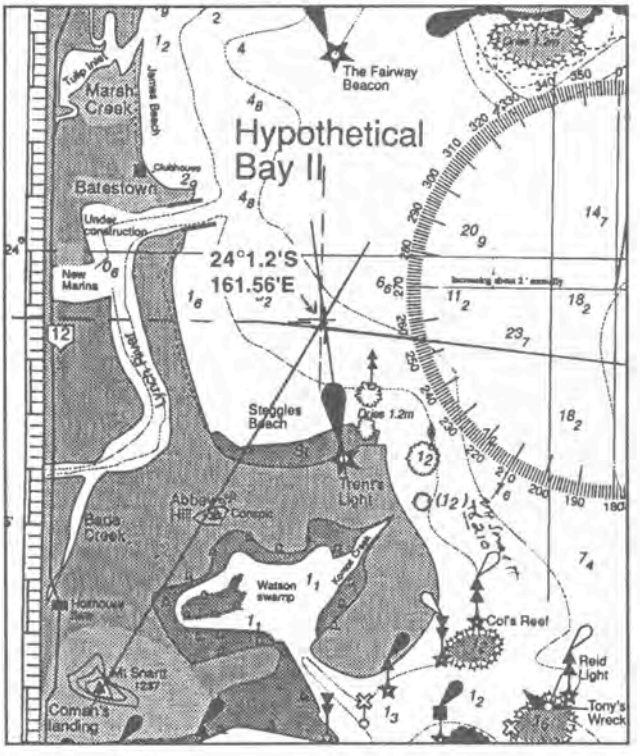
To Pamela's Light CB =88°C TB = 96°T

Step 2 Place rule or square on compass rose from the centre to Pamela's light.

Step 3 Walk rule or square to Pamela's Light and draw a line back towards the mainland.

Step 4 Do conversions for bearings 2 and 3 respectively and repeat as described in steps 2 and 3.

Step 5 Shade in your cocked hat as described in your textbook.



Questions

Find the latitude and longitude of the following positions and mark them on your chart. Check your answer with the suggested answer given. Note all bearings have been made with a hand-bearing compass.

1. Position A.
   Bearing to Pamela's Light 20°
   Bearing to Mark's Light 257°
   Bearing to Trent's Light 314°

   (Suggested answer 24°11' S, 162°02'E)
2. Position B.
   Bearing to Pamela's Light 20°
   Bearing to Paula's Light 147°
   Bearing to Reid Light 72°

   (Suggested answer 24°7'S, 162°04'E)
3. Position C.
   Bearing to Halpin Hill 178°
   Bearing to Mt James 306°
   Bearing to Trent's Light 013°

   (Suggested answer 24°10' S, 161°54'E)
4. Position D.
   Bearing to Keid Light 358°
   Bearing to Pamela's Light 175°
   Bearing to Critchley Hill 263°

   (Suggested answer 23°55' S, 162°07'E)
5. Position E.
   Bearing to Pamela's Light 357°
   Bearing to Trent's Light 281°
   Bearing to Paula's Light 320°

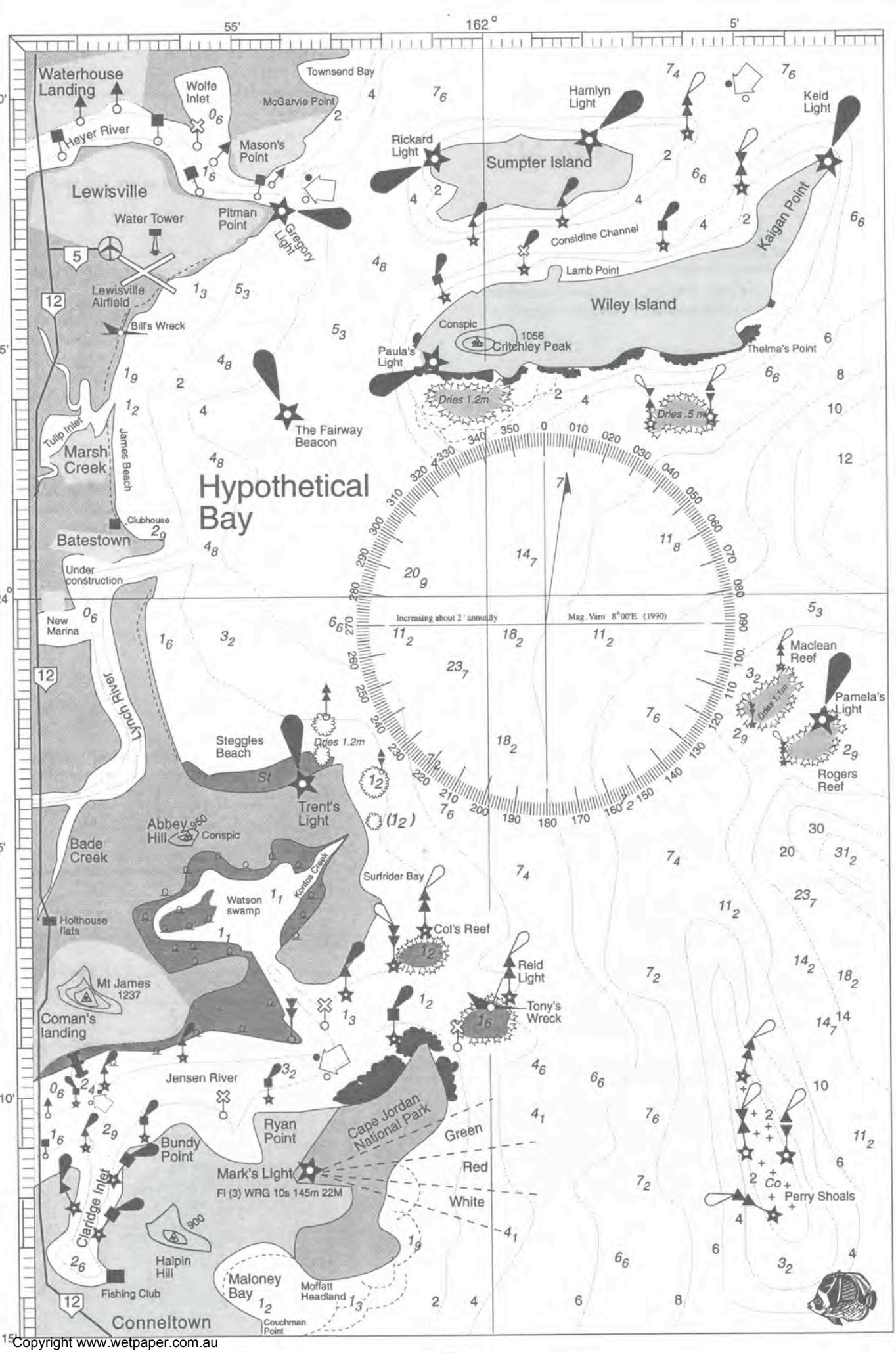
   (Suggested answer 24°07' S, 162°06'E - you are on the beach)
6. Position F.
   Bearing to Halpin Hill 302°
   Bearing to South Cardinal Mark Perry Shoals 74°
   Bearing to Mark's Light 20°

   (Suggested answer 24°14' S, 161°55'E)
7. Position F.
   Bearing to Trent's Light 242°
   Bearing to Fairway Beacon 310°
   Bearing to Clubhouse at Batestown 285°

   (Suggested answer 24°02' S, 162°01'E)

Note

It is not good practice to take bearings along the 180° line



EXERCISE 9
LAYING OFF AND PLOTTING

Which course do you steer , how long will it take to get there and are you on course? This exercise lets you practice the skills in laying off and plotting a course.

METHOD

A day's outing and whale watching is planned off Thelma's Point. You live at Waterhouse Landing and are planning the trip.

From Gregory Light, you decide to go around Paula's Light and Wiley Island Reef as shown in the chart of Hypothetical Bay opposite.

1. You decide to avoid all water below 4 metres and draw four lines with changes in direction at A, B, C and D (as shown).
2. You calculate your distances in nautical miles for each course and the total distance. You figure you can make at least 10 knots and so decide that this is safe for the day.
3. Using your parallel rule and compass rose, you find the true course from Gregory Light to point A is 153°T.

   This converts to 145°C (Error east, compass least)
4. You will need to know when you are at point A. From the chart you find that it is 6 miles from Gregory Light.

   At 10 knots, this will take 0.6 hours, or 36 minutes, give or take a bit depending on currents, etc. and instrument error. (Your speedo might be slightly out).
5. From the chart you can see that Critchley Peak should be on your port beam quarter when you are at A, if you stayed on your intended track.

   It is far more reliable to use a hand-bearing compass reading, so on the chart you find that the bearing of Critchley Peak should be 25°T, which is 17°C when you are at point A.

On the day

1. The day has come and you have your chart ready with the planned course marked in. You pass Gregory Light at 9 a.m. and so immediately mark it on the chart.
2. At 9.30 you are not sure of what you are looking at on your port beam, so calculate your DR position on the chart.

   Since your boat is travelling at 10 knots and it is 30 minutes since you passed Gregory Light, you should be 5 miles along your track.

   You mark this in as your 9.30 DR position, which gives you a better idea of what you should be able to see.
3. As you should have only about a mile to go to point A, you get your hand-bearing compass ready, and take a bearing on Critchley Peak. The reading is 22°C, so you are not yet up to point A.
   - Over the next few minutes, the compass bearing of Critchley Peak will decrease, and when it gets to 17°C, you know you are at point A and can alter course to point B.

QUESTIONS

1. Lay off a course from position A to position D as outlined in the figure opposite.
   a. How far is it from A to B, B to C and C to D ?

   b. What are the true bearings from B to Critchley Peak and Paula's Light?

   c. When you are supposed to be at position C, what compass bearings should you get on Critchley Peak and Keid Light?

   d. What compass course should you steer from A to B? You propose to make 10 knots, what is your ETA at position B?

   e. What is your compass course from B to C?

   f. What is your compass course from C to D?

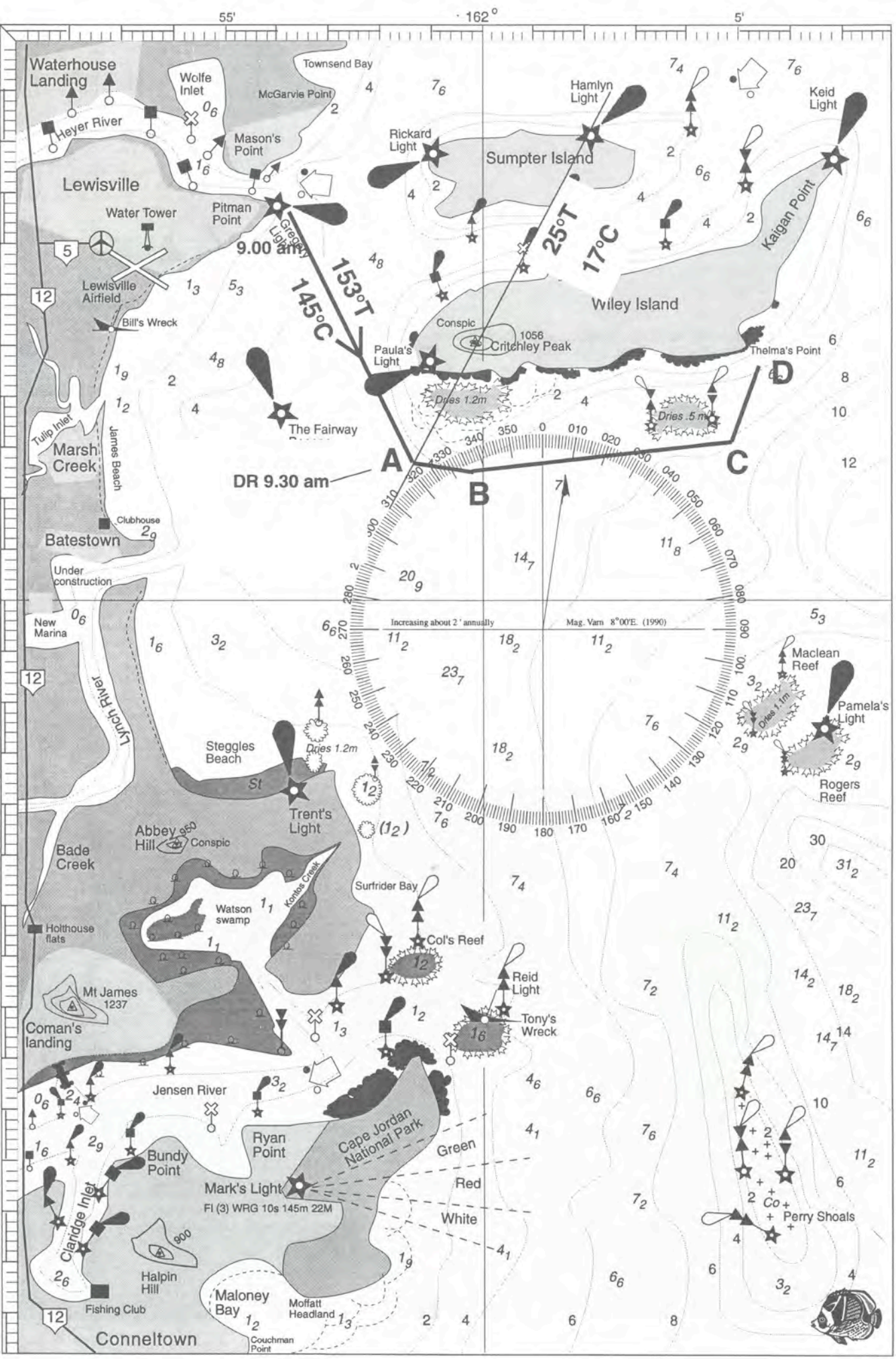
2. A fishing trip is planned to Rogers Reef from the Fishing Club at Connelltown. Lay off a compass course from midway between the two reefs at the entrance to Jensen River to Rogers Reef. You plan to leave at 0800 hrs.
   a. You can make 12 knots. Estimate your ETA at Rogers Reef.

   b. The fishing is lousy and you stay for only one hour. Avoiding all water below 4 m, plot the shortest course to the marina in Lynch River.

   c. When you pass Maclean Reef Light, what compass course do you steer?

   d. You make 6 knots, what is your ETA at the marina?

   e. You left the fishing club in the morning. How far have you travelled during the day?



EXERCISE 10 BUOYAGE SYSTEMS

METHOD

Based on an exercise devised by the Marine Studies teachers and Don Reid of Gympie High School

1. Study the photo in Figure 10.1 and with the assistance of your industrial arts department, construct a series of models that represent lateral and cardinal marks.

   The models could be used as follows:

   - As a small ship simulator — any harbour or shipping channel in Australia can be modelled from a chart and students steer a model boat through the course. Adverse conditions could be simulated by spraying salt water around the room or using a large fan for a bit of fun.
   - before going on camp, Don uses the models to show students the navigation channels and types they will encounter. The class then discusses out of bounds areas, fishing or bait gathering spots.
   - Don's classes use the models to set up a model harbour.

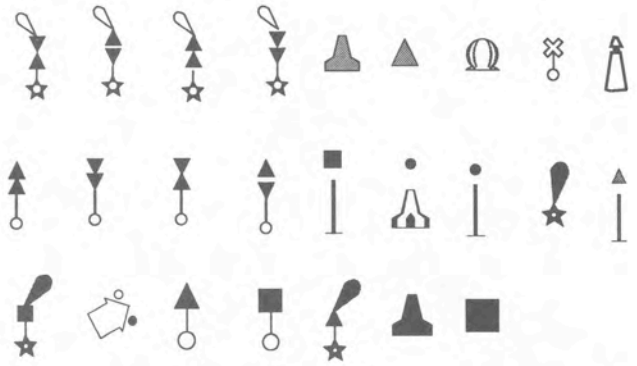


Figure 10.2 Chart symbols that could be used in this exercise

RESEARCH ASSIGNMENT

Time passes in Hypothetical Bay and as the population of Holthouse Flats and Batestown increases, the community decides on a new ecotourism project. Lynch River, Bade Creek and Watson Swamp are dredged and land adjacent filled for future developments as shown in Figure 10.3. Soundings are taken and you have the job of erecting a buoyage system.

1. Make a copy of Figure 10.3 and use the chart symbols in Figure 10.2, as well as any others you may feel appropriate, to plan a buoyage system for the new marina, airport and harbour town development.
2. Use a pencil first to plan the exercise and then ink and colour in your markers.
3. Decide where lights would be appropriate and where a lateral system would best serve the boating public.

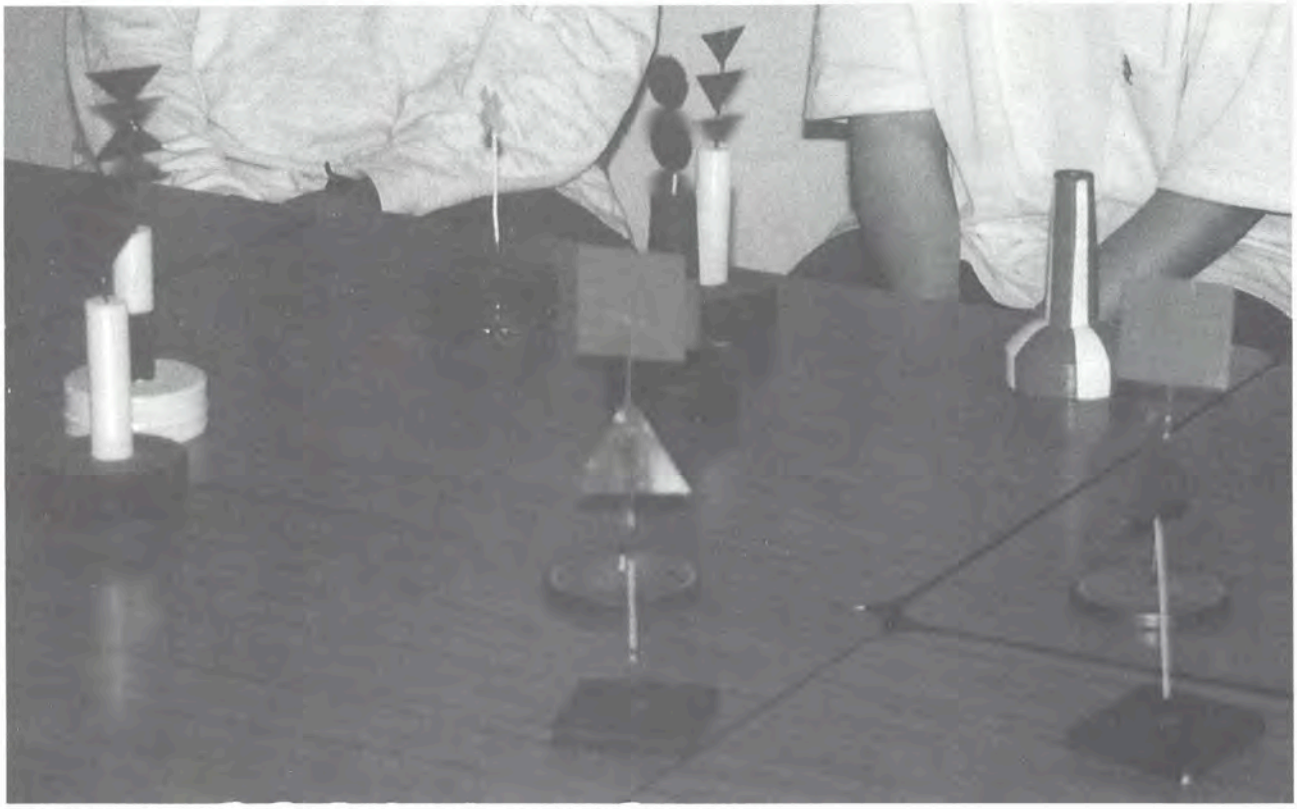


Figure 10.1 Model buoyage marks (Models courtesy Gympie State High School)

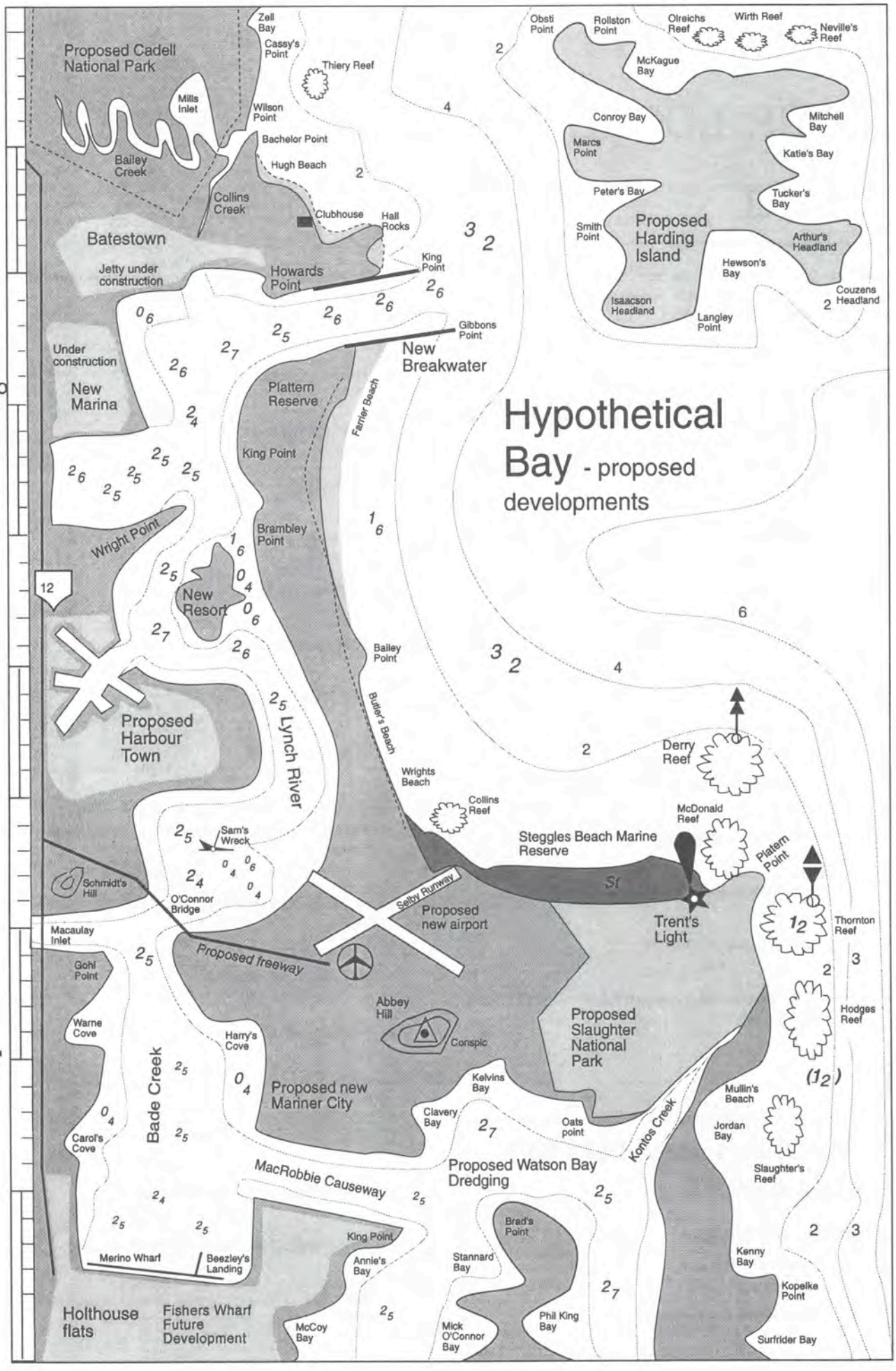


Figure 10-3 Hypothetical Bay proposed developments

EXERCISE 11
YOUR LOCAL CHART

When you look at charts for the very first time they look quite complicated. This activity seeks to introduce you to some chart features that don't occur on a map.

Later activities will help you use the chart.

METHOD

1. Look carefully at the map and then at the chart and write a list of 10 differences between the chart and the map.
2. Record these in your notebook, giving your reasons for the differences.

QUESTIONS

1. What is the deepest section of water on the chart?
2. What is the most northerly point on the chart?
3. Why does a chart need latitude and longitude?
4. What date was the chart prepared?
5. Is there a scale on the chart and if so what scale is used?
6. What are the main shipping lights nearest the local port?
7. What is the main degree of longitude and latitude?
8. Is the chart in fathoms or metres?
9. If you had to navigate a ship into port, why would you use a chart rather than a map?

MATERIALS AND EQUIPMENT (PER GROUP)

Equipment required

- chart of the local area
- map of the local area
- copy of book *Marine Studies*

10. Locate the photographs of the navigation marks in your textbook and make labelled drawings of the following.
    - Starboard lateral mark
    - Port lateral mark
    - Port hand floating can
    - Starboard mark on pole
    - Port mark on pole
    - North cardinal mark
    - South cardinal mark
    - East cardinal mark
    - West cardinal mark
11. Select a venue for an overnight stay on your chart, noting:
    a. What time should you leave to arrive three hours before sunset?
    b. Will tides affect your trip? If so, what times will affect the trip?
    c. How far are you going?
    d. What type of boat will you be in?
    e. What types of forecast will cancel your trip ?
    f. How much fuel will you need?
    g. What will be your first compass course?
    h. How many course changes will you be making?
    i. What type of buoyage system (if any) is shown on your chart?

EXERCISE 12
CHART YOUR SCHOOL OVAL

Based on an original exercise by Bob Critchley, Bowen SHS (reproduced with permission).

MATERIALS AND EQUIPMENT (PER GROUP)

Equipment required

- assistant to record bearings
- good hand bearing compass
- 100 m tape
- drawing board, T square, A3 paper
- copy of compass rose, glue, scissors

RESEARCH PROJECT

This exercise allows you to practice you skills without getting wet.

1. Decide on five to eight easily identified objects to include on your chart. Don't clutter the chart up with unnecessary features.
2. Lay out 100 m of tape parallel to the line of the objects.

   Think of them as landmarks on a shoreline and include only one or two on the other side of the oval as islands.
3. From each end of the tape, record accurate bearings (to 0.5° precision), of each of the selected objects and the line of the tape measure.

   Convert all bearings to true using the variation on the compass rose you have selected to paste onto the chart.
4. If you are confident, prepare the following exercises:
   a. Plan a course distance, speed and time as accurately as you can to travel from the library, to the animal shed then the goal posts. Now walk the course with a trundle wheel to see how accurate you were.
   b. Place a peg in the ground with a Mars Bar and give the latitude and longitude for the class to find the bar.
   c. Plot a new object on the chart. You have just discovered a new fishing spot called cricket pitch. Use your instruments to plot the new location
5. On the drawing board, using a scale of 1 cm = 10 m, draw in lightly the base line.

   From each end, draw in the LOP of each object and plot the object.
6. Add the compass rose and position it as accurately as you can.
7. Add the artificial latitude and longitude scale using your local latitude and longitude.

   Make 1' of latitude 1 cm long.
8. Put a warning on the chart that the 1' = 10 m is artificial and would normally be 1 nautical mile.

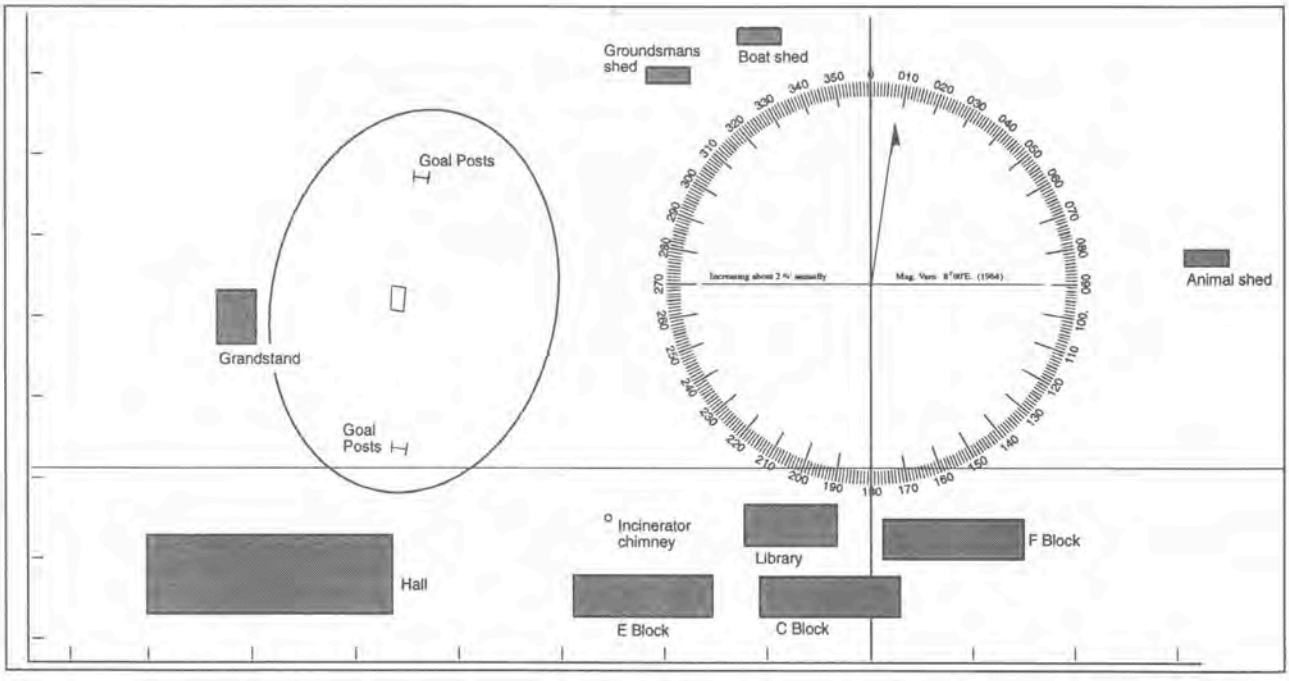


Figure 12.1 An example of a chart of a school oval

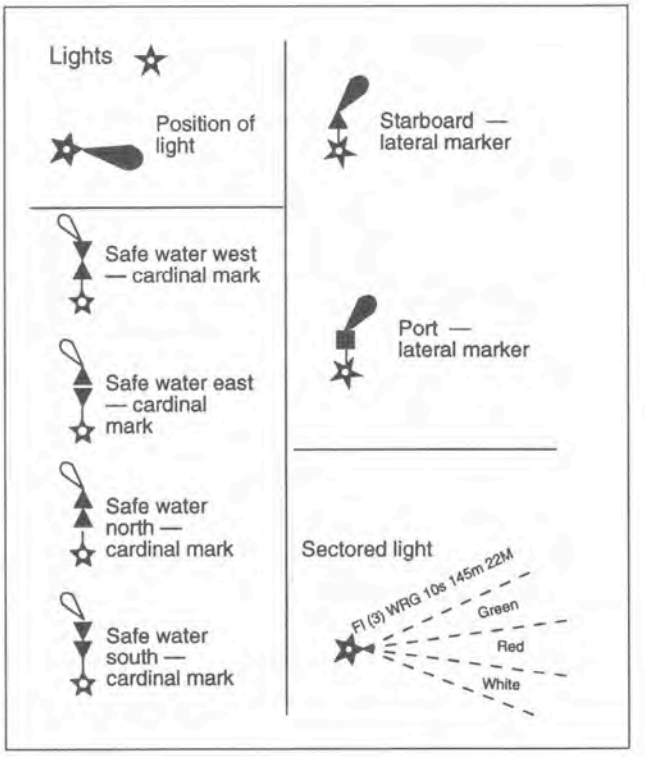
EXERCISE 13
YOUR OWN CHART

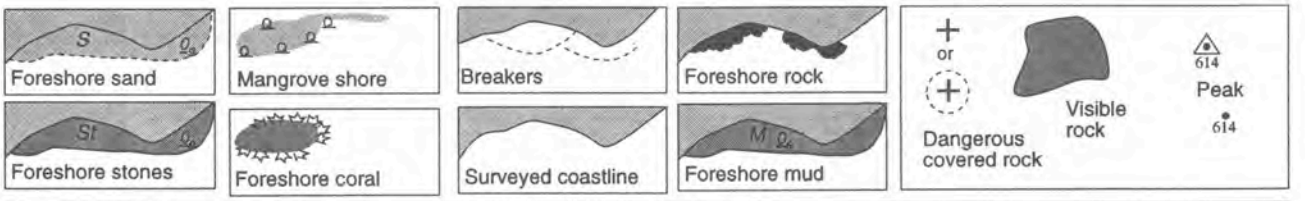
PROJECT

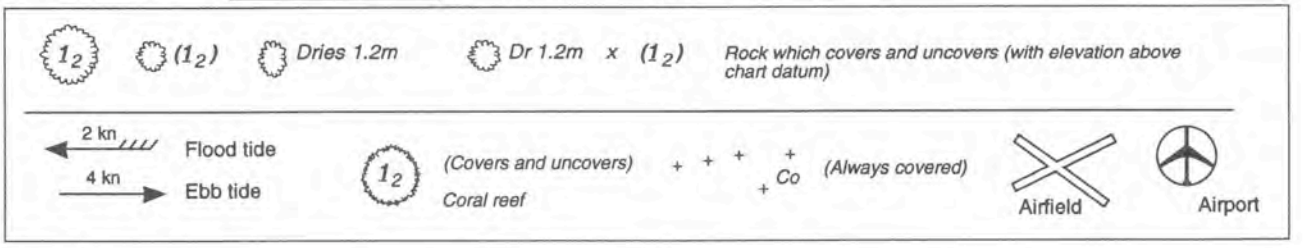
Make up a hypothetical bay of your own using the symbols on this page.

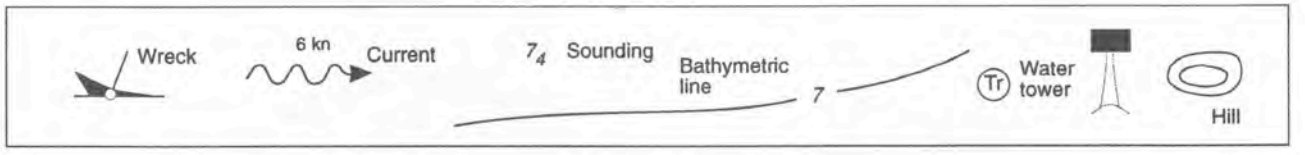
Additional references

Charts and chart symbols and maritime buoyage system, published by the Hydrographer of the Navy, 1982, Commonwealth of Australia.









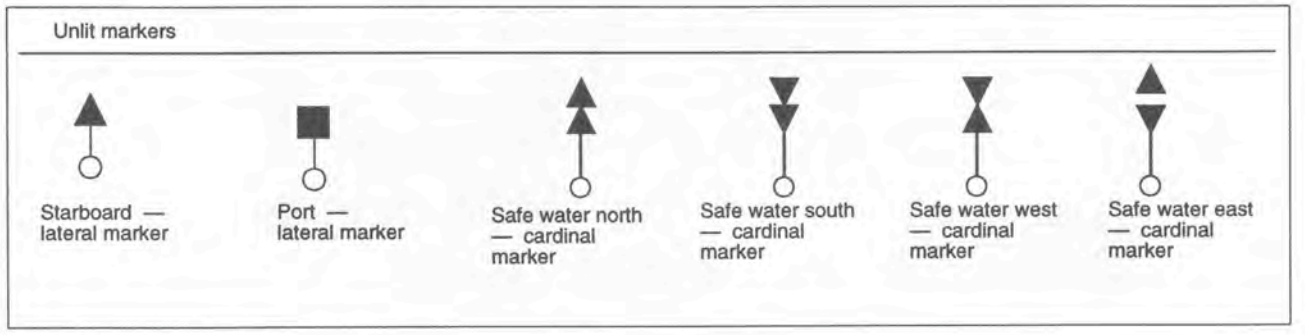


Fig 13.1 Common chart symbols

EXERCISE 14
CHARTWORK

Cape Hillsborough Channel courtesy Hydrography Service for the Navy, exercises prepared by Bob Critchely, Bowen SHS. Reproduced with permission.

Notes

1. This exercise refers to the chart portion reproduced on pages 30-31.
2. Variation for 1993. No Deviation.
3. Work in soft lead pencil.
4. Leave all your working on the chart. Written answers to be done on a separate sheet and attached to chart.
5. All distance to within 0.1 mile, and all angles to 0.5°.
6. Your teacher may have prepared a chart and overlays with all the solutions is in the room so you can check your progressive working.
7. The numbers at the bottom of the page are page numbers and are not lines of longitude. The longitude is 148°E.
8. 1 fathom = 1.83 metres.

QUESTIONS

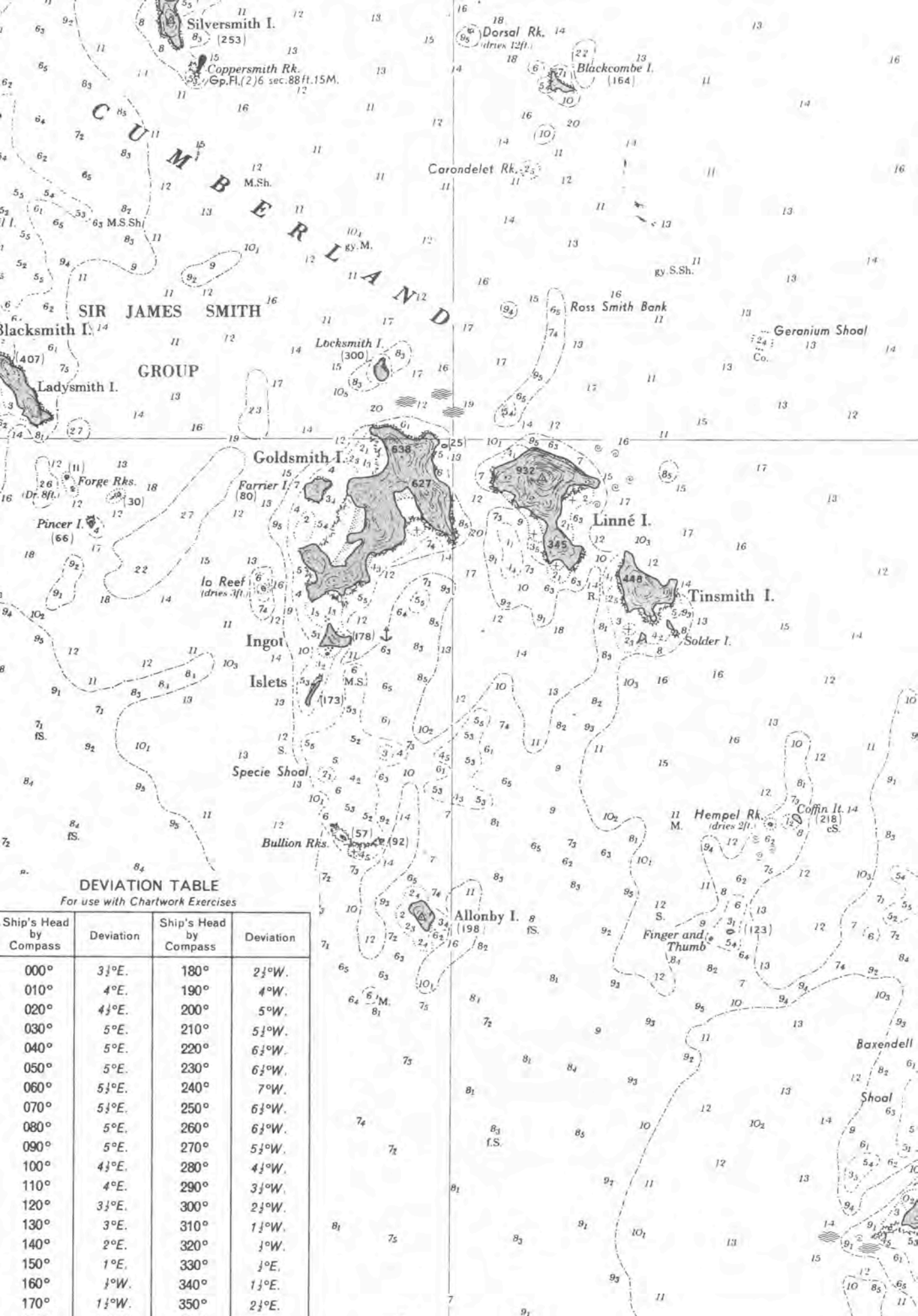
This exercise uses the A3 Version 5169 B on pages 192-193 and variation 1994 - nearest degree.

1. What are the latitude and longitude of the following points?
   a. Hempel Rock
   b. Coppersmith Rock Lighthouse
   c. Hill 670 Cockermouth Island.

2 You are at the anchorage at Maryport Bay, Brampton Island, in position 20°48' S 149°16' E. Mark this on your chart as position A and answer the following questions.
   a. What is your magnetic variation to the nearest whole degree?
   b. You want to go to Coffin Island. What compass course will you steer?
   c. How far is it from position A to Coffin Island?
   d. How long will it to take to arrive at Coffin Island if you travel at 6 knots?
   e. After you have been travelling for half an hour, what will be your DR position? Mark this on the chart as position B.
   f. You are worried about what you can see and decide to fix your position. You take the following bearings:
      Allonby Island Hill 198 273°
      Brampton Island Hill 323 131°
      Tinsmith Hill 448 340°
      Plot this position and mark it on the chart as position C.
   g. What are the rocks you can see in front of you?
   h. How do you account for the change in position from point B to point C?
   i. If the error in your position from B to C is caused only by current, how fast was the current flowing? Which direction was it flowing?

3. a. You are anchored near Geranium Shoal. Locksmith - S (southern tips of Locksmith Island) is in transit with Ladysmith - S. You also have Allonby Island Hill 198 in transit with Tinsmith Island - SE. Mark this position as position D.
   b. What is the latitude and longitude of point D?
   c. How far are you from Geranium Shoal?
   d. What course would you steer to arrive at the shoal?
   e. How long will it take you to get there at 6 knots?
   f. It is now a 3 m tide. What will your Metric Depth sounder read as you find the shoal?

Space for working



DEVIATION TABLE

For use with Chartwork Exercises

Ship's Head by Compass	Deviation	Ship's Head by Compass	Deviation
000°	3½°E.	180°	2½°W.
010°	4°E.	190°	4°W.
020°	4½°E.	200°	5°W.
030°	5°E.	210°	5½°W.
040°	5°E.	220°	6½°W.
050°	5°E.	230°	6½°W.
060°	5½°E.	240°	7°W.
070°	5½°E.	250°	6½°W.
080°	5°E.	260°	6½°W.
090°	5°E.	270°	5½°W.
100°	4½°E.	280°	4½°W.
110°	4°E.	290°	3½°W.
120°	3½°E.	300°	2½°W.
130°	3°E.	310°	1½°W.
140°	2°E.	320°	½°W.
150°	1°E.	330°	½°E.
160°	½°W.	340°	1½°E.
170°	1½°W.	350°	2½°E.
180°	2½°W.	000°	3½°E.

LLSBOROUGH CHANNEL

FROM SURVEYS BY THE ROYAL AUSTRALIAN NAVY to 1960
with additions from Colonial-Admiralty Surveys to 1885

Whitsunday Peak Lat. 20°16′06″.04S. Long. 148°57′17″.275E.

Underlined figures express, in Feet, Drying Heights above Chart Datum.
All other Heights are expressed in Feet above Mean High Water Springs.
For abbreviations see Catalogue and Index of Australian Charts and Admiralty Chart 5011.

SOUNDINGS IN FATHOMS
(Under Eleven in Fathoms and Feet)

NATURAL SCALE
1 : 100,000 (at Lat. 20° 30′ S.)
Projection Mercator

Increasing about 2¾′ annually Mag. Var 8°00′ E. (1964)

Steff Rk.
Silloth Rks.
Cockermouth I.
406
670
CHANNEL
Devereux Rk.
(dries 15ft.)
Helvellyn Rks.
384
457
gy.M.Sh.
gy.M.
f.S.
R.

Wet Paper

Marine Education