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Summary

On 1 December 1992, while engaged in a navigational training exercise off the north-west coast of Flinders Island, Bass Strait, the Australian Maritime College training ship Wyuna struck a submerged object while navigating the passage between North and Mid Pasco Islands.

The Wyuna sustained damage to bottom plating and internal structure, which resulted in diesel fuel oil and sea water flooding the engine-room bilge.

There were no injuries caused by the incident, but diesel oil was pumped overboard from the engine-room bilge.

After the situation was stabilised, the Wyuna was able to return to its base at Beauty Point.

Sources of information

Wyuna: Master, Second Officer, Chief Engineer and Watch Students.

Mr Allen Wheatley, Killiecrankie Enterprise, Flinders Island.

Hydrographic Office, RAN

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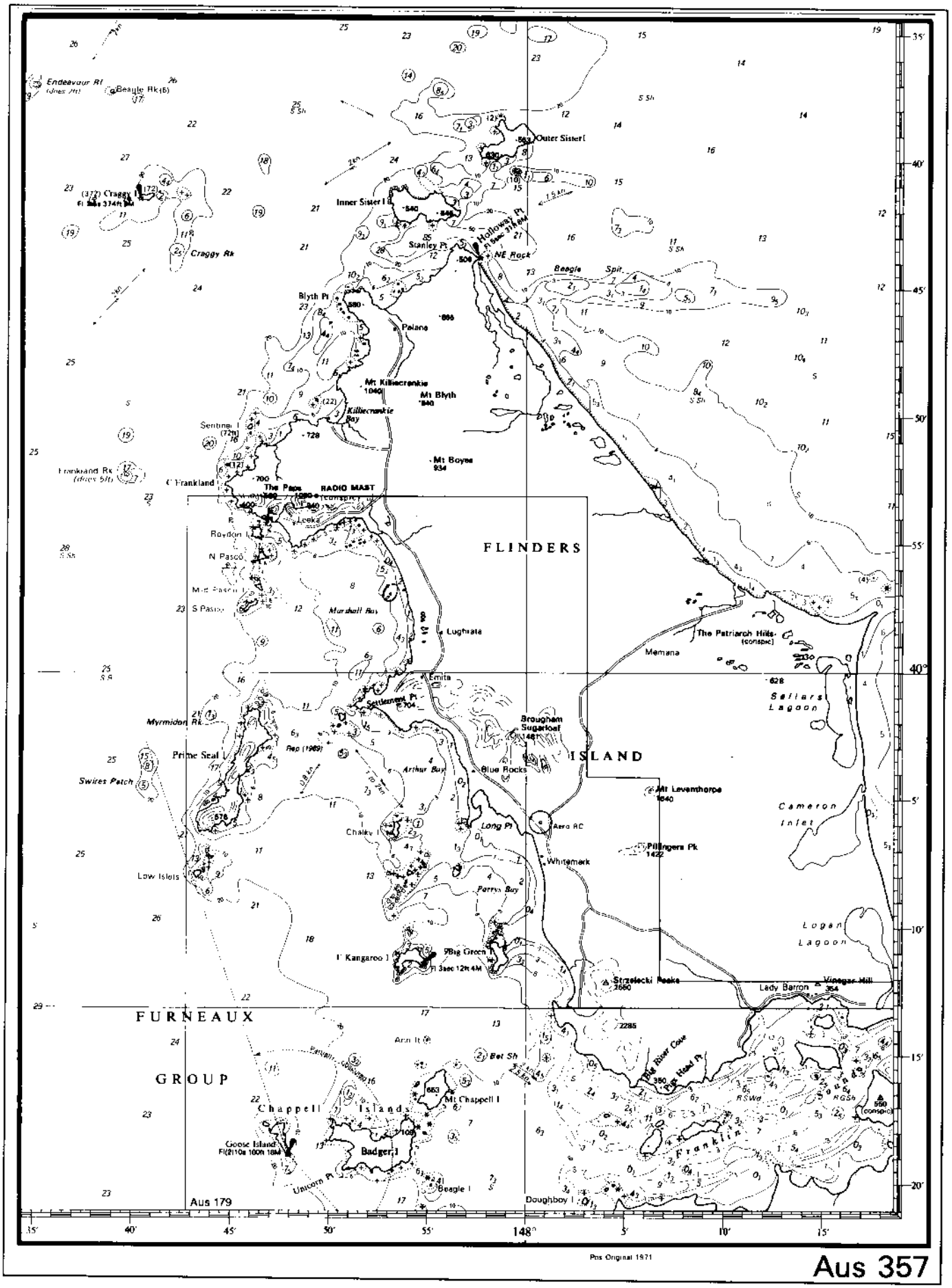
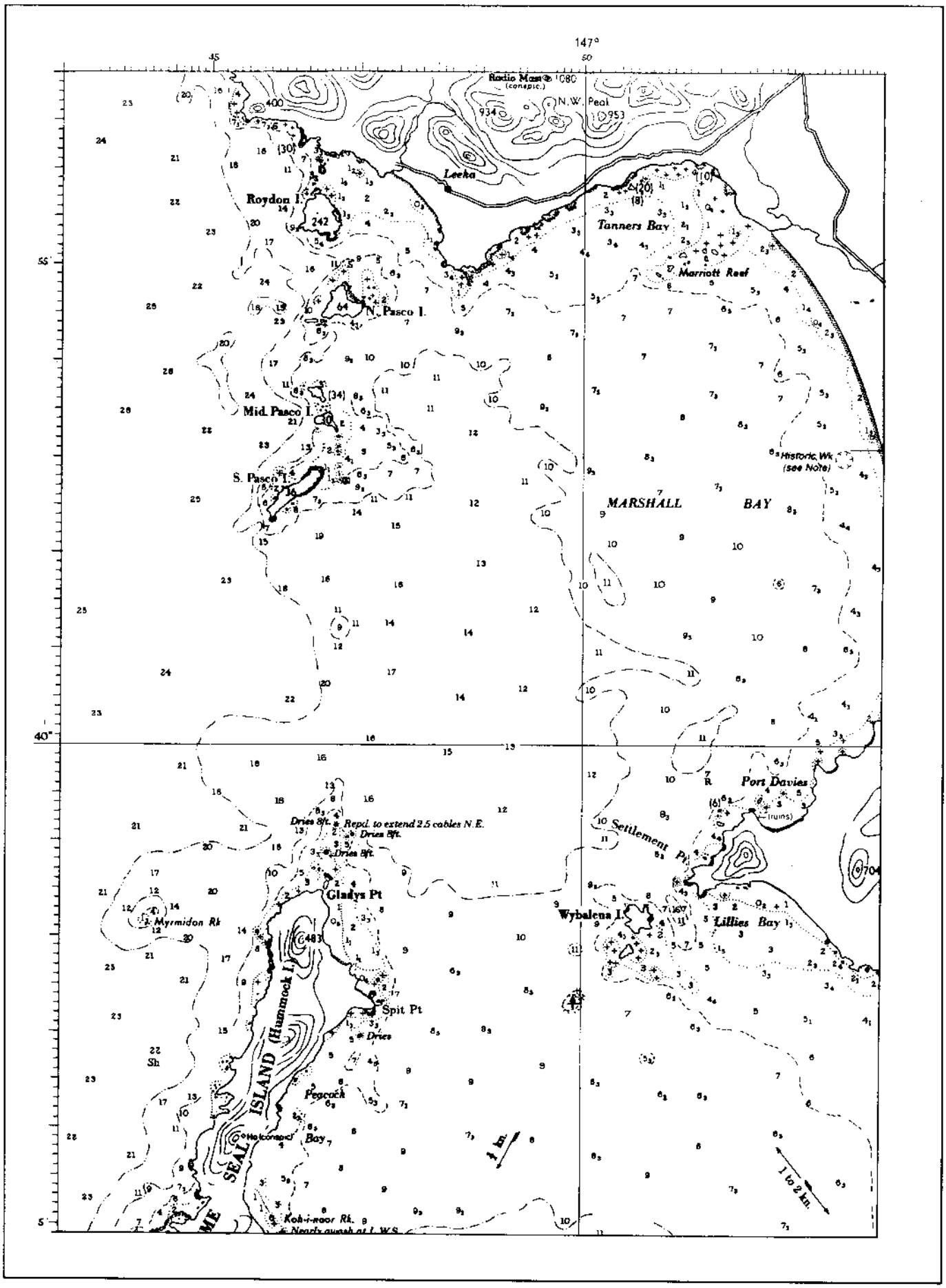


Part of Chart AUS 357 - Reduced showing Flinders Island, Bass Strait



Part of Chart AUS 179 - Showing Pasco Islands

BACKGROUND

The Wyuna was built in Glasgow in 1952 as a pilot vessel for the Port Phillip Sea Pilots, to operate off Port Phillip Heads. The ship, 85m in length, is of rivetted steel construction and is powered by twin diesel-electric motors driving two propellers.

In 1981 the Wyuna was withdrawn from pilotage service and was presented to the newly created Australian Maritime College, located near Launceston, Tasmania. It was refurbished as a training ship, to provide practical seagoing experience to the nautical and engineering students attending the college.

The Wyuna is normally staffed by a master, a mate and a second mate; a chief engineer, a second engineer and a third engineer, all of whom perform instructing/teaching functions during their watch-keeping periods. A number of tutors are also carried to conduct classroom studies. Students make up the rest of the crew and where a senior student is carried, that student may be appointed third mate for the cruise.

Training cruises are normally of either one day, or one week's duration. During the longer cruises, the Wyuna operates in the Bass Strait and off the east coast of Tasmania, and occasionally off the south coast of Tasmania, the weather being the predominant determining factor.

Students undertaking any particular cruise are divided into groups and sub-groups, for allocation of duties, and either two or three cadets will be detailed to each bridge watch, as part of their training. Training includes not only celestial navigation, but also inshore, radar navigation, for which narrow passages between small islands are ideal, and therefore frequently used.

Due to the vagaries of the weather in the Bass Strait and around Tasmania, cruises are not pre-planned in any detail, the area of cruising being left entirely to the discretion of the master.

A new master, one having had nine years command experience on Australian ships, had been appointed to the ship on 1 June 1992; a new second mate had been appointed to the ship on 6 April 1992.

THE INCIDENT

On the morning of Monday, 30 November 1992, a group of 19 second year Diploma of Nautical Science students joined the Wyuna at Beauty Point, for a one-week training cruise. The cruise was to provide them with practical experience in both offshore and coastal navigation, including radar parallel indexing and pilotage techniques.

The Wyuna cleared from Beauty Point at 1000, two students having been assigned to each bridge watch. As the weather was fine and calm, on clearing Low Head at the entrance to the Tamar River, the Master decided to proceed to the north-east, to conduct coastal navigation exercises on the west coast of Flinders Island. The Master had conducted two previous cruises in that particular area and had found the passages between the small off-lying islands to be ideal for parallel indexing purposes.

To facilitate the students taking evening star sights, the course was altered to the west in the late afternoon, in order to be well clear of the land and so provide a clear, all-around horizon. The Master's intention was then to conduct night-time radar navigation exercises around the Furneaux Group of Islands. He decided that the Wyuna would pass between Goose and Badger Islands, then northwards, to pass between Settlement Point and Prime Seal Island, into Marshall Bay, then out through the passage between North and Mid Pasco Islands.

The Master took over the bridge watch at 2000 and on completion of star sights, at around 2130, course was altered to the east and shaped to pass to the south of Goose Island. As the Wyuna approached Goose Island the student understudying the watch officer utilised parallel indexing, navigating the ship south of the island, then altering course to port, to 359 degrees true, to navigate the passage between Goose Island and Badger Island.

The 12-4 watch, comprising the Second Mate and two students, took over the watch as the Wyuna cleared the passage between Goose and Badger Islands, the Master leaving instructions that the ship was to maintain the 359 degree track up to the Pasco Islands, where course was to be altered to 292 degrees, to pass between North Pasco and Mid Pasco Islands. Completely satisfied with the competence and ability of the Second Mate to navigate the ship safely, the Master did not ask to be called for the passage out through the Pasco Islands.

At the commencement of the 12-4 watch, the Second Mate allocated duties to the two students, bearing in mind that the Wyuna would be navigating the Pasco passage during the third hour of the watch. As the ship was clear of the Goose Island passage, steering was conducted in the automatic mode, releasing the student not understudying the officer to carry out various tasks from the student task book. The Second Mate, in line with his normal practice, took the students through the procedures for setting up and tuning the radar, ensuring that they were satisfied with its performance.

At 0035, when in a position with East Kangaroo Island bearing 074 degrees at 3.8 miles, course was adjusted to 002 degrees, to make allowance for a slight westerly set. The watch progressed normally, the visibility was good, the sea was calm, and the ship made good a speed of 8.25 knots.

In a position south-east of Spit Point (Prime Seal Island) course was readjusted at 0141 to 357 degrees, to make allowance for an easterly set. However, the ship continued to be set to the east and at 0215, when in a position with Settlement Point bearing 146 degrees at 2.9 miles, course was altered to 350 degrees, to make good a course of 352 degrees. This amended course would take the ship to the predetermined course alteration point for the commencement of the passage between North and Mid Pasco Islands. At this time the student understudying the officer began a parallel indexing exercise and shortly afterwards the other student was put on the wheel, to enable him to get used to the steering before the commencement of the transit of the passage.

At 0226, with Mid Pasco Island bearing 279 degrees at 1.7 miles, the order was given for hard a'port the wheel, to bring the ship on to the course of 292 degrees. With the Radar switched to the "3 mile" range, parallel index lines were set up on the radar reflector screen, three cables either side of the 292 degree heading. On such a heading, the gap presented between North and Mid Pasco Islands is six cables; thus it was intended to maintain the ship in the middle by keeping the radar images of both islands just touching the parallel index lines.

Once steadied on the 292 degree heading, the ship was found to be south of the intended track, indicated by the echo of Mid Pasco Island being inside the port-hand parallel index line. The course was adjusted to 300 degrees, to bring the ship back on to the desired track. At 0238, the student plotted the ship's position on the chart, which indicated that the Wyuna was still about one cable to the south of the course line laid down on the chart.

The sea was still calm, causing no sea clutter, although tide rips abaft the beam showed up on the screen as small areas of clutter. The radar presented a clear picture, with good definition, all the islands being well defined. The echo sounder digital readout was indicating depths of 27m to 30m, rather more than the depth indicated on the chart, which was 9 to 10 fathoms (16m to 18m).

Copy of Part of Chart AUS 179 in use by "Wyuna" at time of Incident

As the ship came back on to the track line, as indicated by the parallel indexing, and in a position with the north-east point of Mid Pasco Island on the port beam, the course was altered to 292 degrees. Soon after, the ship was found to be slightly north of the track, towards North Pasco Island, indicated by the echo of North Pasco Island just impinging on the parallel index line. To offset this, the student at the wheel was told to steer 288 degrees, and then, as his response was slow, he was instructed to alter to 285. At this stage the western point of Mid Pasco Island was just abaft the port beam.

Shortly after this order for a course of 285, at a time placed at 0244, the ship juddered, there were scraping sounds, the ship heeled over to starboard and also veered to starboard. As the ship righted itself further judders were felt.

The Second Mate stopped the engines immediately and sent one of the students to call the Master. The student, on returning to the bridge, plotted the ship's position using the GPS satellite navigator co-ordinates, this position indicating that the ship was about one cable south of the course line and about three cables out beyond the line of the islands. Using the radar, the Second Mate fixed the ship's position at 0252, this position indicating that the ship was two cables to the south of the course line and 3.5 cables beyond the line of the islands.

The Master had been woken by the movement, but had thought it to be the result of a swell. However, on being called by the student he went straight to the bridge, where the Second Mate drew his attention to the radar, to show him the ship was right on track.

The Master's immediate conclusion was that the radar, in some way, "had to be wrong"; there was not a large rock in the middle of the passage and therefore the ship must have passed too close to Mid Pasco Island. He immediately read the coordinates off the GPS satellite navigator, at 0256, and plotted the ship's position on the chart, which indicated that the ship was now two cables to the south of the course line and almost six cables beyond the line of the islands.

The Master was concerned for the safety of the ship, not knowing what damage had been sustained. He detailed the Mate to sound the ship's tanks, laid a course of 090 degrees on the chart, back through the Pasco passage, and gave the appropriate helm orders to conduct a Williamson turn.

The Chief Engineer had been awoken by the impact and had gone to the engine-room, where he was immediately aware of a strong smell of diesel oil. This was traced to diesel oil welling up from No. 11 port double-bottom tank, underneath the main electric control board for the ship's electric engines. The Chief Engineer reported to the Master, while the latter was in the process of executing the Williamson turn. Word was also received that water was entering the engine room through fractured bottom plates.

Although reluctant to do so, in case there was indeed a rock in the middle of the passage, the Master felt that it was necessary to proceed back through the passage, in order to get the Wyuna close to a sandy beach in case it was necessary to carry out a beaching, to prevent foundering.

As he needed to use the engines, the Master was greatly concerned that the diesel oil under the main electrical control board presented an explosion/fire hazard. He therefore ordered the Chief Engineer to pump the oil overboard, this being commenced at 0307. Soon after, the engineers also started the fuel oil transfer pump, pumping from No. 11 port double-bottom tank to other tanks. However, this action was stopped at about 0445, when it was discovered that only water was being pumped into the other tanks.

Speed was built up to 7.5 knots, the maximum the Master considered prudent under the circumstances, and the Third Mate detailed to fix the ship's position at six-minute intervals. The Wyuna passed safely back through the Pasco passage and was brought to anchor, at 0418, three cables off the beach in Marshall Bay.

Advice of the bottom contact and of the diesel oil being pumped overboard was sent to the Maritime Rescue Coordination Centre in Canberra at 0600.

The engineers were not only able to control the level of oil/water in the engine room bilge, but were eventually able to lower the level and partially plug some of the fractures, thus reducing the ingress of water. The suction pipe from No. 11 port double-bottom tank was found to have been set up, which had caused the flanged collar at the tank top to fracture in a number of places. Ingress of water from these fractures around the suction pipe indicated that all of the oil in the tank, approximately 17 tonnes, had been displaced by sea water.

After a full assessment of the situation and consultation with the ship's officers, the Master decided to weigh anchor and proceed back to Beauty Point. The Wyuna arrived safely back at its berth in Beauty Point at 1900 on Tuesday 1 December 1992.

COMMENT

The Australian Maritime College, as owner of the Wyuna, provides no written instructions or guidelines for the Master of the Wyuna regarding the areas in which he should conduct the training cruises. The area of operation is left entirely to the discretion of the Master.

Because of the type of training carried out during cruises, the Wyuna frequently operates in waters close inshore and amongst islands, areas not normally frequented by vessels other than fishing vessels and pleasure craft.

The previous Master, who had commanded the Wyuna for about 10 years, had not ventured into the waters around the Pasco Islands. However, the new Master had taken the ship through the passage between North and Mid Pasco Islands on two previous occasions without mishap, the first during daylight hours, when no indications of rocks were sighted. He was, therefore, confident that the passage was safe.

Published information on the Pasco Islands available to the mariner is contained in the Admiralty Australia Pilot Volume II and on the navigation chart Aus 179 Plans in Banks Strait and Furneaux Group - Approaches to Prime Seal I. Anchorage and Franklin Sound.

The Admiralty Australia Pilot Volume II contains a brief description of the islands, but makes no reference to the passages between the islands. However, it would be unusual for an Admiralty Pilot to contain information on rocks that were not depicted on the navigation chart.

Chart Aus 179, under the plan title Approaches to Prime Seal I. Anchorage and Franklin Sound, bears the notation "Surveyed by Commr. D. A. T. Gale, D.S.C., R.A.N., H.M.A.S. Warrego, 1953 Soundings in hairline are from earlier and imperfect surveys". No information is given on the earlier surveys, but inspection of the other plans on the chart indicate British Admiralty Surveys of 1874–7. The H.M.A.S. Warrego survey was of the approaches to Lady Barron, at the southern end of Flinders Island.

All the soundings on the plan Approaches to Prime Seal I. Anchorage and Franklin Sound north of East Kangaroo Island are "hairline" and, therefore, from earlier surveys. As all the depth figures are printed in identical type and there is no contrast with "normal" print, it is not obvious to the "untrained" eye that the print is in hairline.

On chart Aus 179, the minimum depth indicated in the passage between North and Mid Pasco Islands is 8 fathoms 3 feet (15.54m), mid-way between the two islands.

The area of the Pasco Islands was surveyed by Staff Commander H.J. Stanley, R.N. in 1877 and by Commander R.F. Hoskyn, R.N., in H.M.S. Myrmidon, in 1886–7. The soundings would have been obtained by handlead, in all probability from an open boat, such as a cutter or whaler. The area in which the 8.5 fathoms sounding was located was surveyed by Commander Hoskyn, and from the survey chart it is evident that a closer network of soundings was carried out around that point, but without locating any rocks.

Although the early surveys conducted by officers of the Royal Navy were very accurate, obstructions could well lie undetected between the actual lines and points of soundings.

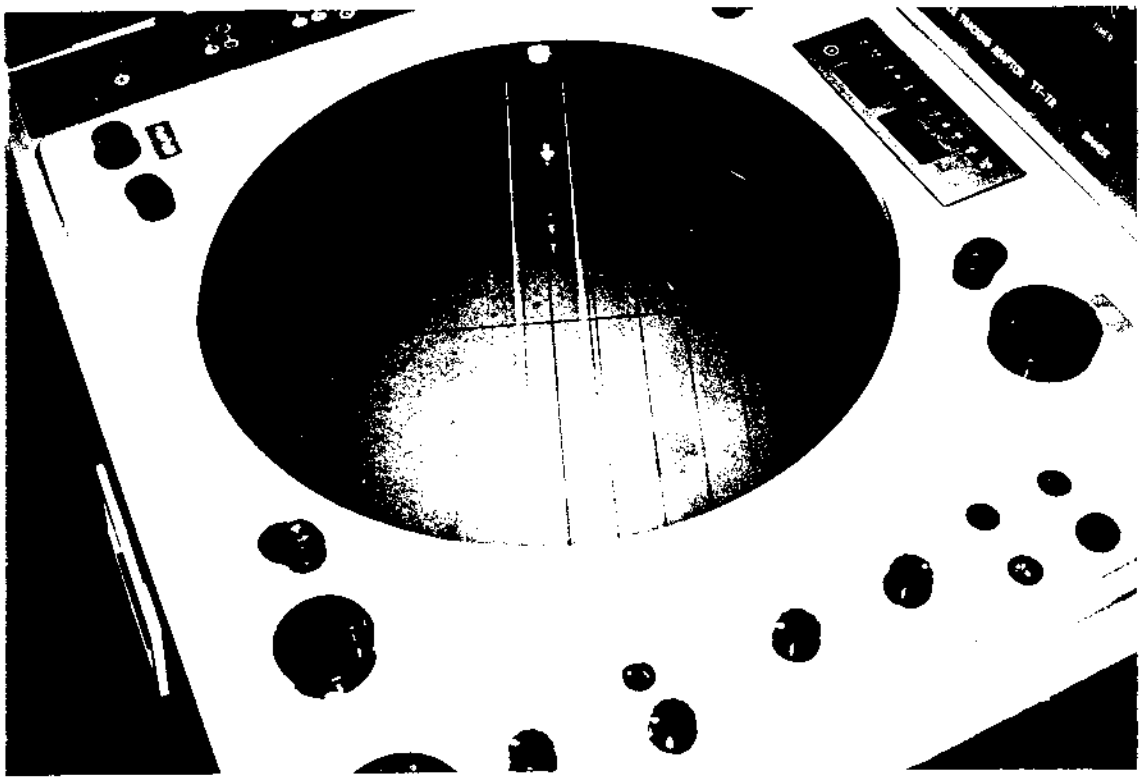
In the area around the Pasco Islands soundings appear to have been taken about every 500 feet (152.4m) along a line of survey, but the distance between the lines of survey varied a great deal. It is very important that mariners bear this in mind when navigating in areas that have not been surveyed more recently, with more modern equipment. A paper on chart reliability, published by the Hydrographer RAN in 1972, advised mariners that in most coastal surveys closest spacing of lines is 200 to 400m and that obstructions of a lesser dimension could go completely undetected. However, with modern hydrographic techniques, side sonar and airborne laser, there is less chance of isolated dangers going undetected.

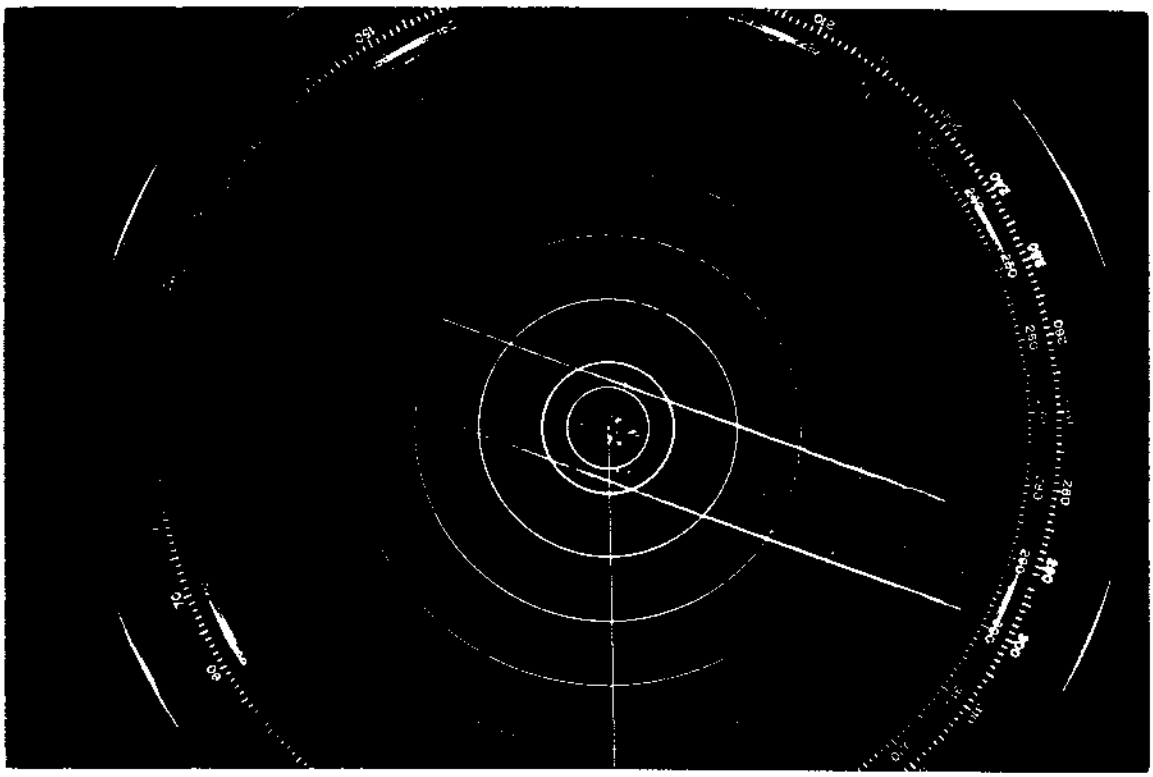
It is considered that neither the Master nor the Second Officer realised that the soundings in the areas through which they were proceeding were in "hairline", or appreciated the full significance of that fact.

At the time of the incident, the Officer of the Watch and the student were conducting a parallel indexing exercise and had set up parallel lines on the radar reflector screen, three cables both to port and to starboard of the intended track. By adopting a double parallel index approach, they would have been alerted immediately the Wyuna strayed off track by the echo of one or other of the islands encroaching within the relevant parallel index line. In fact the course had been altered from time to time in order to keep the ship on, or close to, the intended track—the purpose of the exercise. Both the Officer and the student were satisfied that the Wyuna was on the intended track, mid-way between the two islands and it is accepted that this was so.

It is, therefore, considered that the Wyuna struck an uncharted obstruction in the middle of the passage between North and Mid Pasco Islands.

When the Master arrived on the bridge immediately after the incident, the Second Mate showed him the radar and confirmed that the ship had been on track. The Master, in choosing to ignore this in favour of the experience of the two previous, trouble-free passages, made an erroneous assumption that the ship had in fact been to the south. This assumption seemed to be confirmed when he plotted the ship's position as given by the GPS, which placed the ship two cables to the south of the intended track.





Parallel Index Lines set up on "Wyuna" Radar as for Passage between North & Mid Pasco Islands

Chart Aus 179 is based on Clarke (1858) (the spherical model in use at the time the chart was drawn), whereas GPS positions are based on the World Geodetic Datum. A note under the title of the plan advises "Positions obtained from satellite navigation systems are referred to World Geodetic System 1972 Datum (WGS 72); they should be moved 0.11 minutes SOUTHWARD and 0.03 minutes EASTWARD to agree with this chart". All the GPS positions plotted on chart Aus 179 should, therefore, have been adjusted accordingly, meaning that the Wyuna, once clear of the passage, was even further south, by 1.1 cables.

The tide was flooding at the time of the incident and the indications are, from the tidal arrows shown on the chart, that the main stream of flood tide seaward of the Pasco Islands is from north to south. The series of GPS positions plotted after the incident support this, but this did not appear to cause the Master to reconsider his first assessment, that the radar information was wrong.

The Master's concern, because of the flooding in the engine room, was to get the ship close to a sandy beach as quickly as possible, in case it was necessary to beach the ship to prevent it from sinking. The nearest suitable sandy beach was in Marshall Bay and the shortest distance to the beach, from the position that the Master had plotted, was by way of the passage through which the ship had just come. From the position plotted on the chart at 0306, however, this distance was 7.2 miles, whereas the distance to the beach by a route south of South Pasco Island was only a little over one mile greater.

In performing a Williamson turn and then taking the ship back through the same passage, although on an intended different track and despite the two previous safe passages, the Master risked striking the same submerged object a second time. However, the passage was renegotiated safely.

The initial flooding of the engine room tank tops was by diesel oil, this oil issuing beneath the main engines' electrical controls. To get close to the sandy beach the Master needed to run the engines.

When the Chief Engineer entered the engine-room he was immediately aware of a strong smell of diesel, therefore hydrocarbon gases were being generated, with the possibility of an explosive mixture being present, or developing in the vicinity of the main engine electrical controls. These electrical controls are of the original design, with contact breakers, which are prone to arcing. The Master, who had served for many years on oil tankers, considered, quite reasonably, that the diesel oil fumes around the electrical controls posed a real threat of explosion and the oil itself a threat of ensuing fire.

The Master's orders to the Chief Engineer, to pump out the oil as quickly as possible, the quickest disposable means being to pump the oil overboard, were quite reasonable, the safety of the ship and the lives of those on board being paramount. It is considered that the Master's concerns for the safety of the ship, both from the foundering and explosion/fire points of view, and his orders therefore to pump the diesel oil in the bilge to overboard were justified.

While proceeding towards the anchorage off the beach, the engineers and the Chief Officer were able to identify the points of ingress of water and to reduce the flow. Once the ship was anchored the situation was stabilised and eventually the level of water lowered.

Under the Marpol Convention, ships' masters are required to report oil spills "without delay". The Master advised MRCC Canberra of the incident and the pumping overboard of the oil at 0600. Between the time of the incident and the time of reporting, the Master was fully engaged in renegotiating the Pasco Passage, reaching a safe anchorage and ensuring the safety of his ship. Pumping overboard of diesel oil began at 0307 and was completed at about 0600, with a break from 0440 to 0520, although the bilge pumps continued to pump water overboard until the ship arrived back at Beauty Point. It was later estimated that about 10 tonnes of diesel oil was pumped overboard.

The delay of three hours in reporting the discharge of oil is considered reasonable and in accordance with Marpol Convention requirements. However, earlier advice to MRCC regarding the striking of the submerged obstruction and the ingress of water into the engineroom would have been prudent, in case the Wyuna had foundered.

Having made a full appraisal and having discussed the situation with all on board, the Master's decision to weigh anchor and proceed back to Beauty Point is considered to be reasonable, particularly as the anchorage was not protected from the predominant westerly winds.

After the incident, the Master and Second Mate undertook an exploratory survey of the Pasco Passage by air, which confirmed the presence of uncharted rocks in the passage. They also engaged the services of a fisherman from Flinders Island and a diver to assist in a closer examination of the rocks (see Appendix). The position of one of these rocks was on, or very close to, the Wyuna's track line and showed evidence of having been struck recently, bearing traces of red pigment paint.

CONCLUSIONS

It is considered that:

1 The Wyuna struck an uncharted underwater obstruction, later confirmed to be an uncharted rock.

2 Neither the Master nor the Second Officer realised that the soundings in the areas through which they were proceeding were in "hairline", or appreciated the full significance of that fact.

3 The Master's concerns for the safety of the ship, both from the foundering and explosion/fire points of view, were justified.

4 The Master's orders to pump overboard the diesel oil accumulating in the engineroom bilge was justified.

5 The Master's conclusion that the radar information was wrong and that the Wyuna had grounded on the northern shore of Mid Pasco Island was erroneous.

6 The Master's decision to make for the closest sandy beach was appropriate.

7 In taking the Wyuna back through the Pasco Passage the Master risked the ship striking the underwater obstruction a second time.

8 The reporting of the oil discharge at 0600 was in accordance with the requirements of the Marpol Convention.

9 Earlier advice to MRCC Canberra of the striking of the submerged obstruction and the ingress of water would have been prudent.

10 The Master's decision, after having made a full appraisal of the situation, to weigh anchor and return to Beauty Point, was reasonable.

APPENDIX

INVESTIGATION OF PASCO PASSAGE

After the Wyuna had returned to Beauty Beach, one of the students contacted Mr Wheatley, of Killiecrankie Enterprise, Flinders Island, seeking information of any underwater obstructions known to the local fishermen. Mr Wheatley responded that a number of rocks were known to exist in the passage and that the fishermen kept close inshore to North Pasco Island when making the passage.

On 10 and 11 December 1992, the Master and Second Officer of Wyuna undertook an investigation of the Pasco Channel, first in a light aircraft and then in a fishing vessel. These investigations confirmed the presence of an uncharted rock, mid-way between North and Mid Pasco Islands, and two other uncharted rocks, lying north-east and north-west of the first rock. The top of the rock lying in the middle of the passage was found to have been scraped clean of weed and bore pieces of red pigment paint, indicating that it was the obstruction struck by the Wyuna.

In reporting the findings of their investigation, the Master and Second Officer made the recommendation that Wyuna be fitted with a scanning sonar system. Such equipment, had it been fitted, should have provided warning of the existence of the rocks in the Pasco Passage.

APPROACHES TO
PRIME SEAL I. ANCHORAGE
and
FRANKLIN SOUND

Surveyed by Commr. D. A. T. Gale, D.S.C., R.A.N.,
H.M.A.S. Warrego, 1953

Soundings in hairline are from earlier and imperfect surveys

NATURAL SCALE 1 : 80,000

Projection—Gnomonic

Historic Wreck
The site of an historic wreck is protected from unauthorised interference. For details see Annual Australian Notice to Mariners No 21.

Tidal Information and Chart Datum

Place	Height above datum of soundings						Datum to which soundings are reduced and Remarks
	Average Heights				Height at Springs near the Solstices		
	High Water		Low Water		High Water	Low Water	
	Mean Higher	Mean Lower	Mean Lower	Mean Higher	Mean Higher	Mean Lower	
Eddystone Pt.	*5.0 feet*	*4.2 feet*	*1.7 feet*	*2.3 feet*	*5.6 feet*	*1.2 feet*	
	Mean Sp.	Mean Neaps	Mean Sp.	Mean Neaps			
Waterhouse I.	*8.0 feet*	*7.0 feet*	*1.0 feet*	*2.0 feet*			
Roydon I.	*8.5* "	*7.5* "	*1.5* "	*2.5* "			
Goose I.	*8.5* "	*7.5* "	*1.5* "	*2.5* "			
Big River Cove	*8.4* "	*7.9* "	*1.8* "	*2.3* "			*11.6 ft. below B.M. ⊼ inscribed, H.M.A.S. Warrego 1953, on flat top rock on eastern end of Big River Cove beach.*
Lady Barron Hr.	*5.4* "	*5.0* "	*1.8* "	*2.2* "			*16.7 ft. below B.M. ⊼ cut on face of cattle ramp situated 305 . 147 ft. from northern side of the jetty root*

BRITISH UNITS — METRES

Feet	6	12	18	24	30	36	42	48	54	60
Fathoms	1	2	3	4	5	6	7	8	9	10
Feet	1.8	3.6	5.5	7.3	9.1	10.9	12.8	14.6	16.4	18.3
1	0.3	2.1	3.9	5.8	7.6	9.4	11.3	13.1	14.9	16.7	18.6
2	0.6	2.4	4.2	6.1	7.9	9.7	11.6	13.4	15.2	17.0	18.9
3	0.9	2.7	4.5	6.4	8.2	10.0	11.9	13.7	15.5	17.3	19.2
4	1.2	3.0	4.9	6.7	8.5	10.3	12.2	14.0	15.8	17.7	19.5
5	1.5	3.3	5.2	7.0	8.8	10.6	12.5	14.3	16.1	18.0	19.8

SATELLITE DERIVED POSITIONS
Positions obtained from satellite navigation systems are referred to World Geodetic System 1972 Datum (WGS 72); they should be moved 0.11 minutes SOUTHWARD and 0.03 minutes EASTWARD to agree with this chart.

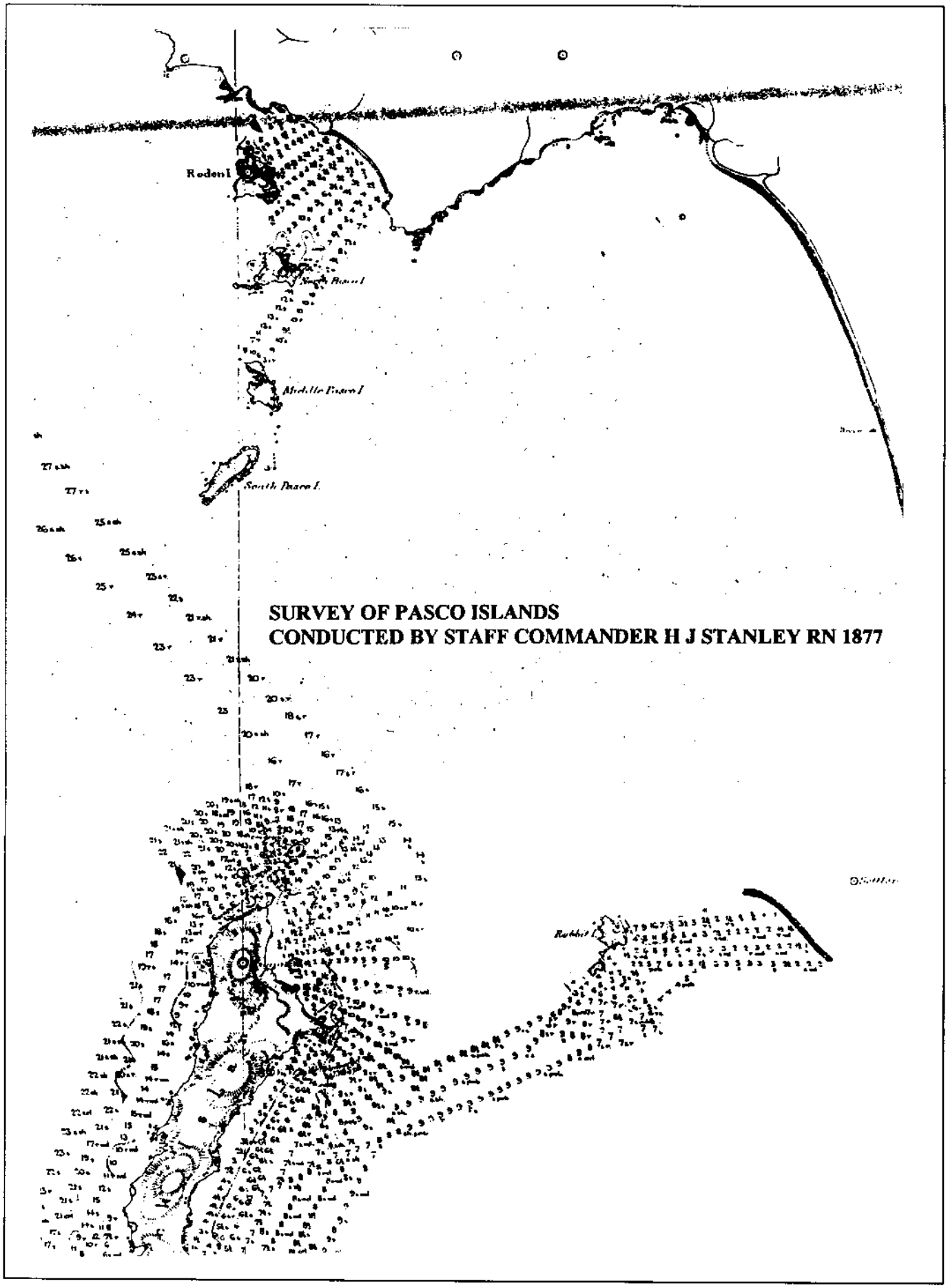
45

50

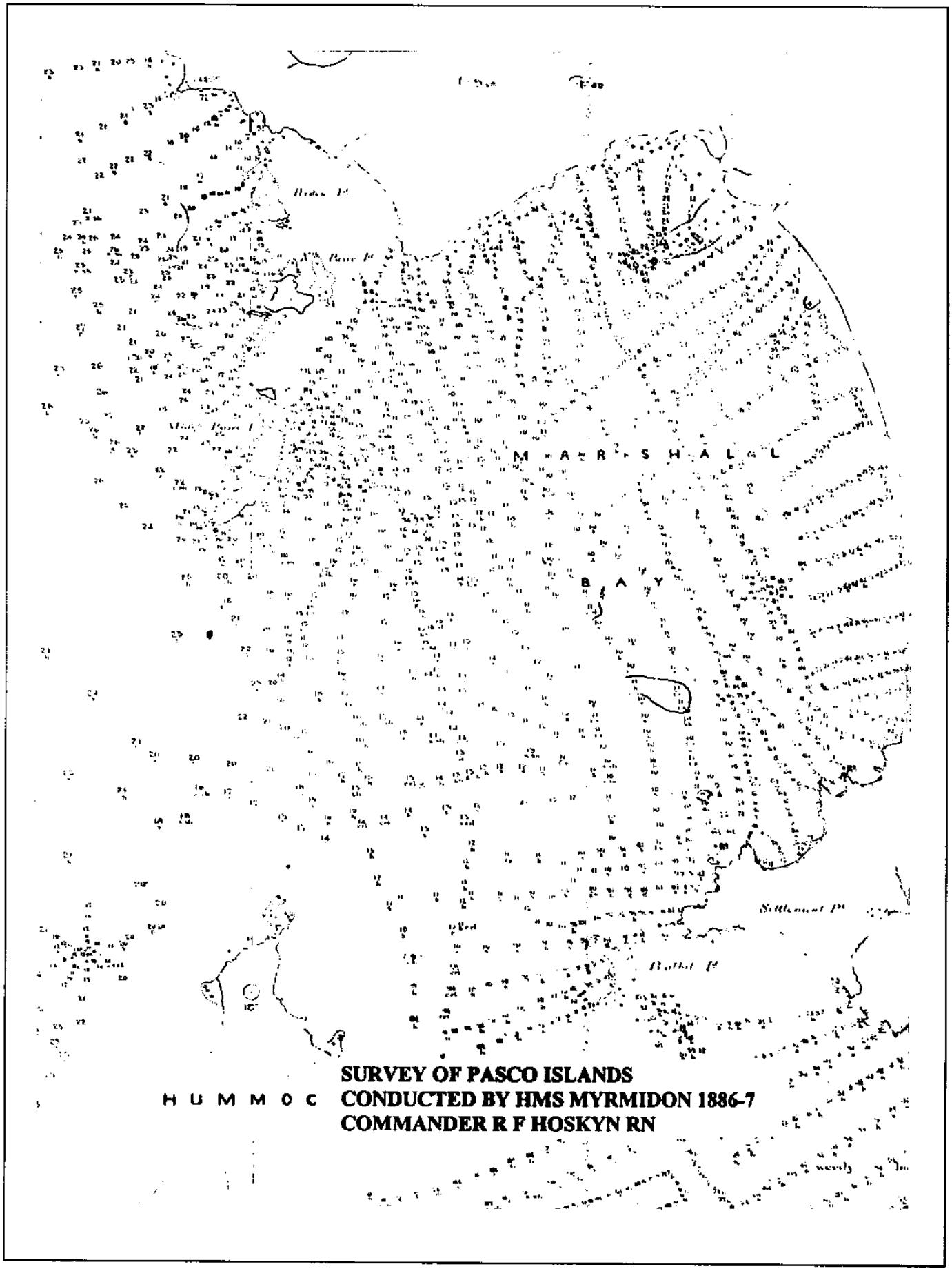
Chart AUS 179 - Plan Title Block

Plane of Reference for Depths →IH			Plane of Reference for Heights →IH	Soundings and Drying Heights
10	12	9_2 * 9.7	Sounding in true position	403.1 410.412 412.1 Q10a
11	+12? *	3349	Sounding out of position	412 412.1 412.2 Q3
12		(147)	Least depth in narrow channel	412 412.1 412.2 Q4
13		330	No bottom found at depth shown	412.3 Q2
14		12 9_1	Soundings taken from old or smaller-scale sources shown in upright, hairline figures	412.4 412.3 Q10 Q12
15	4_9 4 2 0	9_9 3_4 2_2	Drying heights and contours above chart datum	413 413.1 413.2 Q9
b			Half tide channel (in intertidal area)	2_3 1_3 Q_4 1_1 Q_2

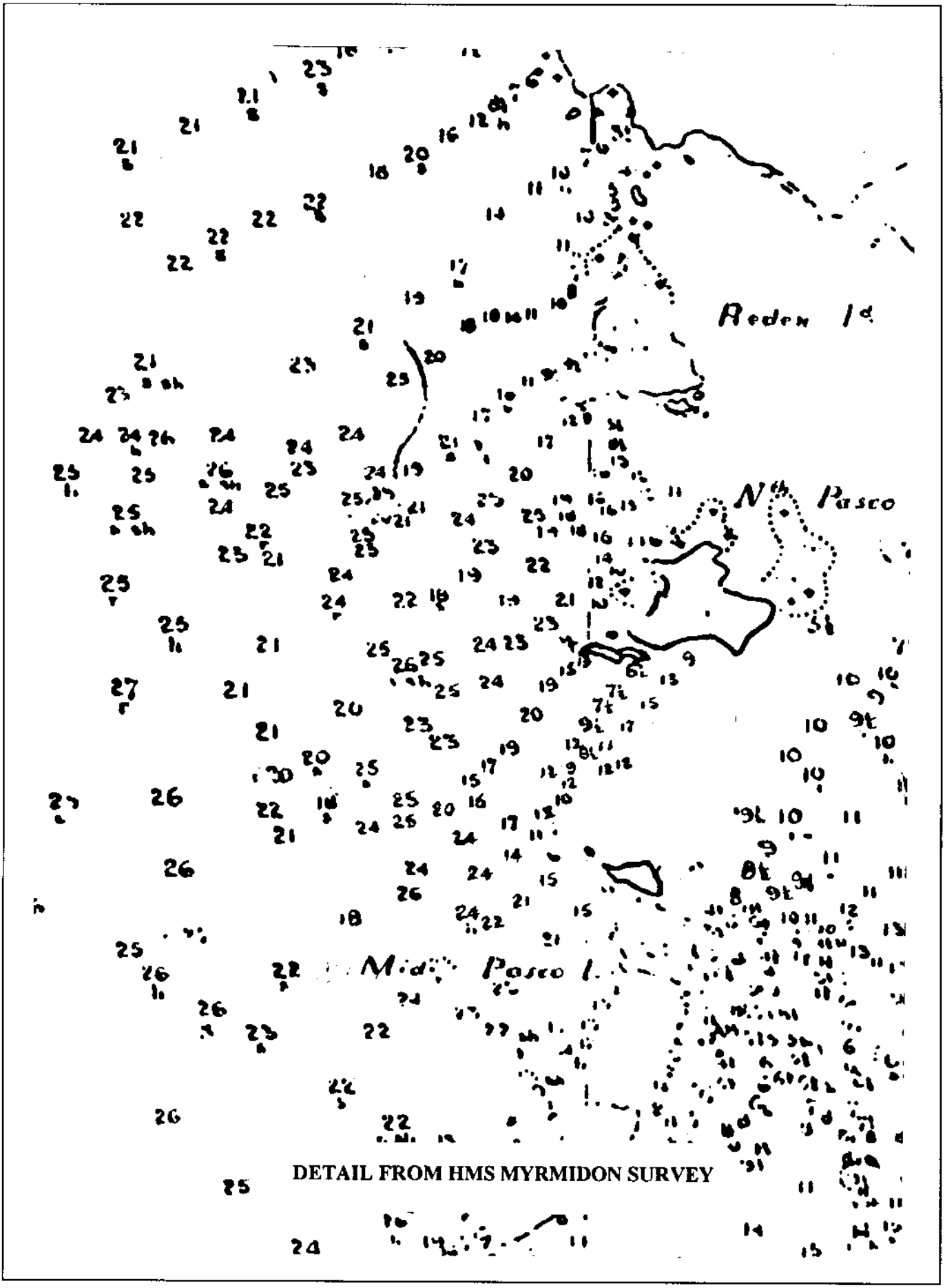
Extract from Chart 5011 - Symbols and Abbreviations
Description of Soundings



Survey of Pasco Islands conducted by Staff Commander H J Stanley RN 1877



Survey of Pasco Islands conducted by HMS Myrmidon 1886–7
Commander R F Hoskyn RN



Detail from Myrmidon Survey