COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION of FISHERIES and OCEANOGRAPHY

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By F. Boland, G. R. Cresswell, and J. Wood

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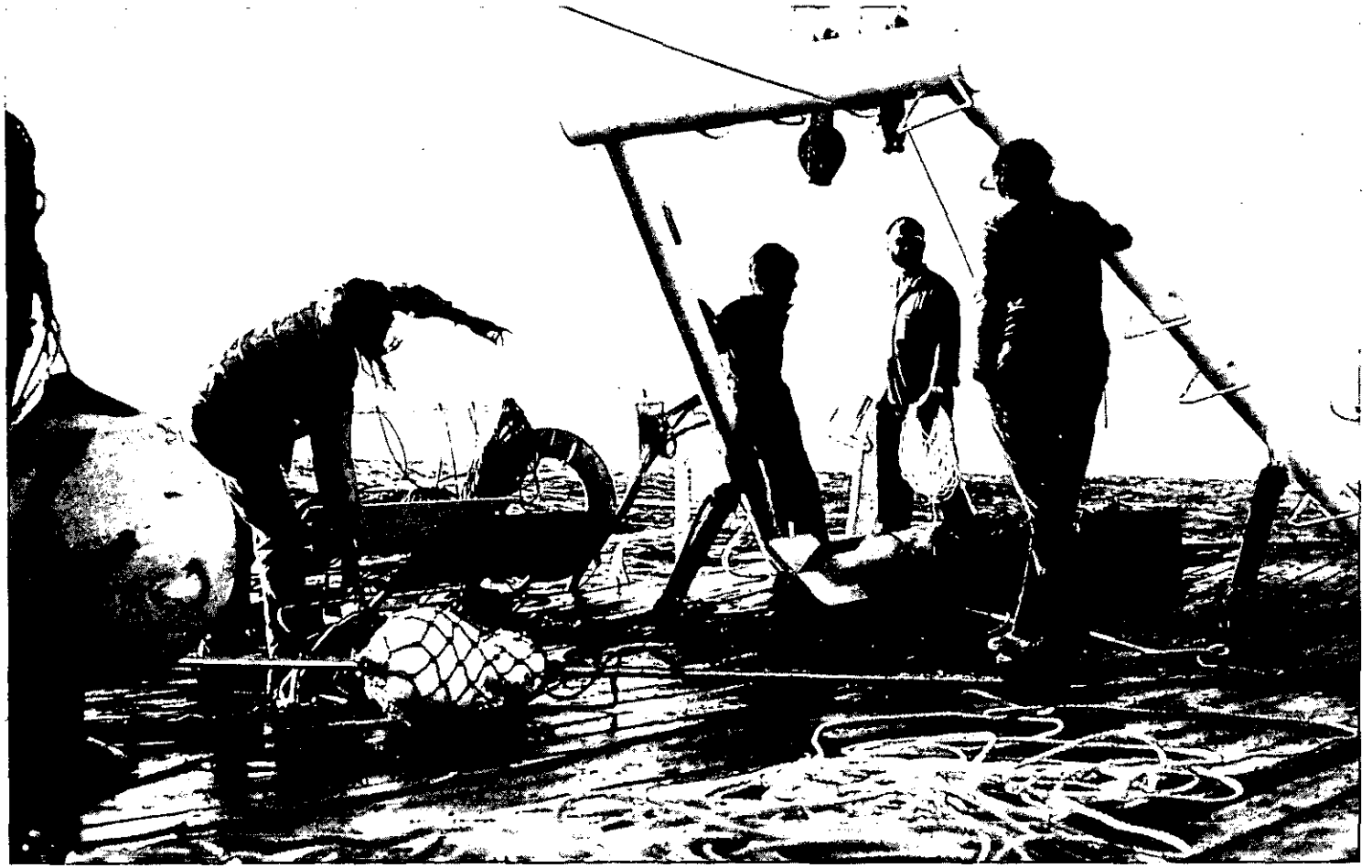

Plate 1. Deploying the last mooring of the day -
R.V. *Sprightly* quarter-deck, December 1974.

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I. INTRODUCTION

Over the past four years we have been using and modifying a 2-anchor continental shelf mooring system for current meters. Because we have operated in many areas around Australia (N.S.W. coast, Moreton Bay, Great Barrier Reef, Gulf of Carpentaria, W.A. coast) in a variety of vessels (prawn trawlers, fishing boats, tug, boom defence vessel and frigate), and because in many cases the mooring operation has been carried out by sometimes only one of us and available crew, we have tended towards light-weight gear which can, for instance, be loaded into a small truck by one person at some remote airport (e.g., Weipa in the Gulf of Carpentaria). With the exception of the concrete anchors, which we arrange to have cast at the port of operation, all the gear can be moved around by one man — a boom and block and tackle are needed for the anchors.

The aim of this report is to describe the mooring and to give details of our experience and of the cost and source of supply of the components — questions which we are most often asked — so that interested parties in Australia can, if they wish, duplicate the mooring, or at least use it as a starting point to develop their own moorings.

II. THE MOORING

The mooring, as is presently being used on the relatively shallow (50-60 m) continental shelf of Western Australia between 29° and 32°S, is shown in Figure 1.

The individual components of the mooring are listed in Table 1. These are mainly standard items available from the sources shown with the major exception of the sub-surface float. In its original form this float was a hollow steel ball 600 mm in diameter with a weight of 63 kg and a lift of 54 kg. These were found too awkward to handle because of their weight and to have a poor lift to drag ratio because of the spherical shape.

The replacement floats consist of a foam-filled PVC cylinder fibre-glass bound with stabilising fins on one end. Their dimensions are 1.3 m long, 0.2 m diam. They weigh 20 kg and have a net lift of 30 kg. Their lift to drag ratio at one knot is ~ 12 : 1. They have been pressure tested to a depth of 100 m.

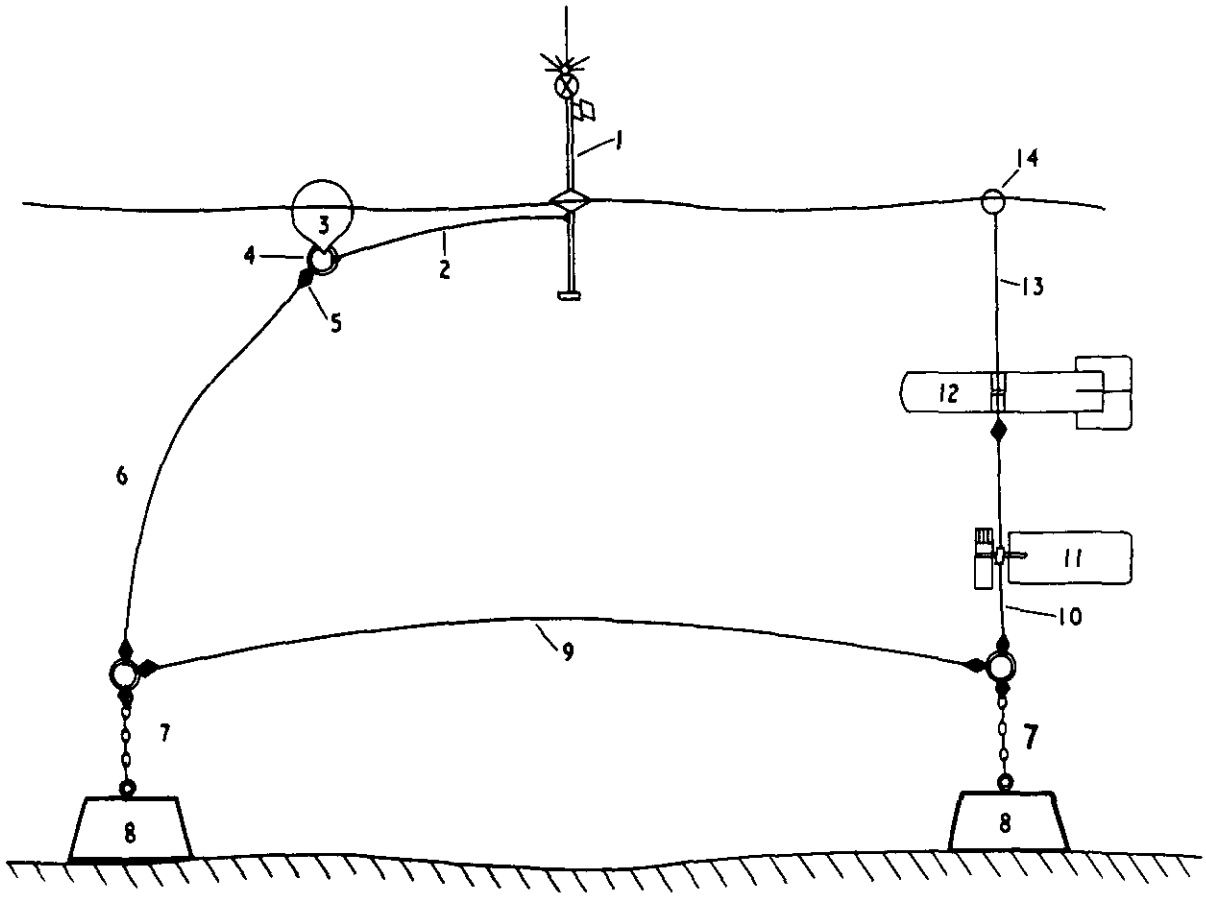

Figure 1. The mooring.

TABLE 1

	Item	Where Available	No. Req.	Approx. Cost
				$
1	Bamboo, aluminium or fibre-glass "Marker"buoy		1	40.00 - 300.00
2	12 mm diam. polyethelene mono rope, 10 m length	Miller Ropes Twines & Textiles, 49 Robey St., Mascot, N.S.W.	1	2.06
3	Inflatable float, "Polyform","75",70 kg buoyancy.	Marine Accessories, 16 Darghan St., Glebe, N.S.W.	1	13.50
4	Stainless steel rings, 12 mm diam. section x 150 mm diam.		3	16.05
5	*Swivels, stainless steel, ball bearing "Sapphire" S.N. 65	Hunt's Marine Centre Pty Ltd, 629 Princes Highway, Blakehurst, N.S.W.	8	65.95
6	12 mm diam. polyethelene mono rope, 100 m, 1550 kg breaking strain, "Marker" line	Miller Ropes Twines & Textiles, 49 Robey St., Mascot, N.S.W.	1	20.68
7	12 mm gal., short link chain x 1 m	W. Kopsen & Co. Pty Ltd, 189 Sussex St., Sydney, N.S.W.	2	6.00
8	Concrete blocks, 600 mm diam., 220 kg, cast with 12 mm ring bolt.		2	20.00
9	12 mm diam. polyethelene mono rope, 200 m, 1550 kg breaking strain, "Ground" line	Miller Ropes Twines & Textiles, 49 Robey St., Mascot, N.S.W.	1	39.06
10	4 mm stainless steel wire, 7 x 19 const. x 10 m, "Instrument" line	Bullivants Australian Co. P/L, 62 O'Riordan St., Alexandria, N.S.W.	1	3.36
11	Instrument			
12	Sub-surface torpedo float, fibreglass 30 kg buoyancy (CSIRO design)	Instalrite Plastics Pty Ltd, 16 Woodfield Boulevarde, Caringbah, N.S.W.	1	93.75
13	6 mm diam. polyethelene mono rope or polyethelene staple rope, 40 m, 380 kg breaking strain	Miller Ropes Twines & Textiles, 49 Robey St., Mascot, N.S.W.	1	3.09
14	Trawl float, "Nokolon"	Marine Accessories, 16 Darghan St., Glebe, N.S.W.	1	4.30
Miscellaneous Items				
	Nylon rope thimbles ½" galvanised shackles 5/16" stainless steel shackles Monel metal mousing wire			

*12.12.74. We are at present phasing out the "Sapphire" swivels because of continuing problems with corrosion. The replacements are "Ronstan" R.F.75.

In addition to the double anchor instrument mooring, one or two redundant marker moorings are put down in the vicinity in case the main marker breaks free or is run down by a ship. Ranges and bearings of the various surface markers to each other are recorded. All surface markers carry identifying numbers.

With a few exceptions the mooring components can be bought at a local ships chandlers. Table 1 lists the components and, where relevant, their breaking strains as well as their suppliers and costs as at late 1973. It should be pointed out that these costs are Australian Government prices and that we have seen many price increases particularly for plastic items, since the list was prepared.

III. DEPLOYMENT AND RECOVERY

In Western Australia we have been using the Research Vessel *Sprightly* for our mooring work. It has an "A" frame at the stern and a winch above the forward end of the quarter deck.

The mooring is deployed with the ship moving slowly ahead at about 1-2 knots. The trawl float (14) enters the water first, followed by the sub-surface float (12) and instrument (11). When all the instrument line (10) is in the water, and away from the ship due to the ship's motion, the instrument anchor (8) is lowered by the ground line (9) which has been previously flaked out and is fed onto the winch warping drum. The swivel (5) at the top of the chain (7) on the instrument anchor prevents any rotation of the descending anchor tending to wind the ground line around the instrument line and ring (4).

Since the ground line is roughly 4 times the depth, when the instrument anchor reaches the bottom there is a large amount of ground line left. This can be paid out by hand under tension as the ship moves away. Also the excess allows time for the marker anchor to be readied. The marker line is put around a warping drum and the ground line becomes quite taut due to the ship's motion as the marker anchor enters the water. After this anchor has been lowered to the bottom, the inflatable float and then the Dan marker are put in the water — almost pulled into the water, really, due to the ship's motion. Recently on *Sprightly* we have frequently been free dropping the marker anchor, having carefully flaked the line onto the deck.

The recovery is in the reverse order. The swivel above the ring of the marker anchor is to allow twists to spin out of the marker line as the length of it in the water decreases. Similarly the swivel at the end of the ground line onto the ring allows twists in the ground line to spin out. As the ropes are brought aboard they are coiled on deck ready for redeployment with a new instrument.

In the event that the Dan marker and inflatable float are missing then the redundant markers serve to locate the mooring area, with the trawl float exactly locating the instrument line. A grapnel can then be used to snag the ground line. If this fails because the ground line has parted, then the instrument line can be snagged by tightly circling around the trawl float vicinity with the grapnel line.

If the trawl float, as well, has gone it is possible to do what fishermen refer to as "shooting a line": a length of several hundred metres of a negatively buoyant line (e.g., nylon) supported at both ends by floats is allowed to float down with the current onto the instrument line. Once it strikes this line the floats move together. One is picked up and the ship steams around to close the loop on the instrument line. It can then be brought on board. We must hasten to add that the recovery attempts for a lost mooring are, more often than not, time consuming and soul destroying and that the extra time and little extra cost for one or two redundant markers are well warranted.

A variation of this method is to use positively buoyant rope which is weighted every fifty metres or so with lines of measured length rising from the weights up to floats at the surface. In this way there is little likelihood of the line tangling on rocks and protuberances on the bottom. Also we have recently tried steaming to close a circle around the suspected instrument location with several hundred metres of 9 mm wire being attached to the line. This has been quite successful.

To minimise the time to recover lost moorings we are currently testing weak links and pingers, but mainly we are looking forward to the time when we will use acoustic command releases in our moorings.

IV. EXPERIENCE IN WESTERN AUSTRALIA

In Western Australia the interest in ocean circulation is in its influence on the life cycle of the western rock lobster. The circulation study is a full-time operation rather than the "one-off" experiments that we have conducted previously and for this reason we will centre our discussion of mooring experiences around it.

From November 1973 to August 1974, 33 mooring operations were carried out. Table 2 summarises the recovery operations. It can be seen that 24, or more than 70% of recoveries were trouble free. Of the 9 recovery attempts in which trouble was encountered, 3 resulted in lost current meters.

An annoying problem initially was caused by the "Sapphire" swivels failing; they contained load carrying pins which were held in with a type of key ring. These rings were definitely seen to cause failures in 10% of the operations – and because of the numerous extra markers which were lost, the actual failure rate of the swivels was much higher. This problem was subsequently solved by welding the load carrying pins into the swivel body.

V. ACKNOWLEDGEMENTS

We wish to thank the many captains and crews of the ships on which we have operated for their suggestions on how to improve our moorings.

TABLE 2

RECOVERY DATA

Site	Start and Finish Dates	Trouble Free Recovery	Comments on Surface Markers	Comments on Mooring Components - Failure Wear etc.	Recovery Technique	Meter Lost
A	17.11.73 - 16.12.73	Yes	Only inflatable float from main mooring remaining			
A	16.12.73 - 15. 3.74	No	Trawl float only - sighted after acoustic location of meter	Failure of swivel above marker anchor ring	Grapnel	
A	29. 3.74 - 19. 4.74	Yes				
A	19. 4.74 - 18. 5.74	Yes				
A	18. 5.74 - 13. 6.74	No	Trawl float only		Grapnel	
A	13. 6.74 - 10. 7.74	Yes	Trawl float missing			
A	10. 7.74 - 18. 8.74	Yes				
B	18.11.73 - 16.12.73	Yes	Both Dan buoys missing			
B	16.12.73 - 11. 1.74	Yes		Marker anchor missing - failure of swivel below ring		
B	11. 1.74 - 29. 3.74	No	None remaining	Failure of swivel above marker anchor ring	Shot line	
B	29. 3.74 - 19. 4.74	Yes				
B	19. 4.74 - 18. 5.74	Yes				
B	18. 5.74 - 12. 6.74	Yes	Extra marker missing			
B	12. 6.74 -	No	None remaining	*Chance recovery by fisherman one month later*		
D	16.12.73 - 11. 1.74	Yes	Trawl float missing			
D	11. 1.74 - 23. 2.74	No		Line caught under ship and parted - also sub-surface float was missing (line somehow cut)	Grapnel	
D	25. 2.74 - 15. 3.74	Yes		Swivel near to failure		
D	15. 3.74 - 8. 4.74	Yes				
D	8. 4.74 - 1. 5.74	Yes				
D	1. 5.74 - 11. 6.74	Yes				
D	11. 6.74 - 9. 7.74	Yes	Trawl float missing			
D	9. 7.74 -	No	Trawl float missing	Grapnel successful but line inadvertently cut		Lost
E	11. 1.74 - 25. 2.74	No	Trawl float intact	Ground line chafed through near marker anchor	Grapnel	
E	25. 2.74 - 16. 3.74	Yes				
E	16. 3.74 - 8. 4.74	Yes	Extra marker missing	*Some chafing of ground* line at marker anchor		
E	8. 4.74 - 2. 5.74	Yes				
E	8. 4.74 - 20. 4.74	Yes				
E	8. 4.74 - 2. 5.74	Yes		Marker anchor had separated from mooring probably due to swivel		
E	2. 5.74 - 11. 6.74	Yes				
E	2. 5.74 - 11. 6.74	No		Strap holding meter had corroded		Lost
E	11. 6.74 - 9. 7.74	Yes				
E	9. 7.74 - 14. 8.74	Yes		Both lines to marker anchor badly chafed		
G	9. 4.74 -	No	Trawl float missing	Line caught on rudder and mooring dragged by current for several miles - line parted - numerous recovery attempts failed		Lost