

# Drift along Australia's Southern Coasts

A. M. EBLEN

Assistant, Horace Lamb Institute, Adelaide

and

R. RADOK

Director, Horace Lamb Institute, Adelaide

**SUMMARY** Out of a total of 20,000 drift cards released from 28 locations along Australia's coast and across the Southern Ocean in the Australian and African Sectors, 2,561 were recovered along Australia's coast and 116 at other locations of the Southern hemisphere. This paper deals with some of the conclusions which may be drawn from the Australian recoveries.

## 1 INTRODUCTION

Twenty-eight batches with a total of 20,000 extruded slightly buoyant plastic cards have been released at 28 locations along Australia's coast and across the Southern Ocean in the Australian and African sectors. These releases occurred from oil drilling ships and operating platforms, launches and American and Japanese oceanographical expedition ships between December, 1969 and May, 1972. The last cards found and referred to in this paper were reported in May, 1977. No reference will here be made to cards found along the coasts of New Zealand, Africa and South America and the islands of the Pacific Ocean beyond the statement of fact that 67 turned up in New Zealand, 39 at Macquarie Island, 3 in Chile, 5 in South Africa and 2 on other islands.

Drift cards permit only qualitative evaluation of surface drift, local pollution potential and popularity of beaches. While cards, mostly single cards have continued to be reported over a number of years, it is not sensible to muse about their histories between release and recovery without being prepared to enter into the realm of science fiction, although, as a matter of fact, this has been attempted (Bye, 1976). There are huge stretches of Australian coast which are visited rarely or not at all, as, for example, hundreds of miles of cliff-lined sections of the coast of the Great Australian Bight, where it is very likely that cards are lying undetected in large numbers. At other places, sea weed came ashore with the cards and covered them up before sand was deposited on top. Beaches are more popular in Summer, a time of sand accretion, and sand-covered cards are likely to reappear during Winter. In other words, the fact that cards are reported years later does not imply that the cards have been all that time at sea.

What is the sense in undertaking drift card studies and what conclusions can be drawn from such studies? Atlases give maps of ocean currents which at one time were conceived as being as persistent and invariable as working day peak hour traffic along a city's main arteries. This myth is destroyed by drift experiments when cards are released far enough offshore.

Cards released relatively close inshore can give insight into local conditions, including effects of land and sea breezes, ocean and continent winds, etc. If the aim of a study is an investigation of short term vulnerability of beaches to pollution, for example, from oil escaped from drilling rigs or during ship collisions, systematic patrolling of beaches

for a period after the release of the cards is vital. On the other hand, if there is a pollution time level set within which the released material becomes relatively harmless, for example, as a result of oxidation or evaporation of more volatile components, a mere knowledge of the time of recovery of first cards may be sufficient for an assessment of the conditions at any one time. Repetition of experiments under different seasonal and weather conditions can eventually yield a sound assessment. The results below display the variability of coastal drift and the need for repeated releases.

These were some of the considerations which led to the releases discussed below. They were conducted by the Horace Lamb Institute on behalf of various organisations as well as on its own initiative. Preliminary results of some of the releases were reported in a Research Paper of the Institute (Marshall & Radok, 1972). After a general discussion of the mechanisms causing coastal drift along Australia's South coast, the following sections discuss the various card releases grouped geographically according to release points.

## 2 SURFACE DRIFT MECHANISMS

Flow conditions along Australia's coast are quite likely more complex than those along other coasts of the oceans for reasons which are only now being appreciated. The South coast faces the Southern Ocean, the only body of water which runs right around the rotating earth so that winds acting on it have infinite fetch. These weather systems move in high pressure and low pressure belts, displaced latitudinally with the seasons, and are largely responsible for one of the major ocean currents: *The Antarctic Circumpolar Current*. Variations in the current, i.e. changes in speed or direction or both, induce major changes in sea level along Australia's Southern coast which have recently been described (Provis & Radok, 1977). Associated with these sea level changes, water masses move North and South into the Indian and Pacific Oceans, and, of course, also in Easterly and Westerly directions along Australia's South coast. This is the first main mechanism which is responsible for the apparently erratic behaviour of the cards.

Since the cards float on top of the ocean, they move with the surface water which is driven by the wind. Overall, weather systems are accompanied by winds with rotating directions which, on the average, cause cards to move in more or less closed curves which gradually change location until suitable wind conditions dump the cards on a beach.



Apart from the gradient winds just discussed, the presence of a large continental mass surrounded by ocean creates conditions under which temperature differentials between land and sea induce air flows with different time scales. Firstly, one has the well-known land and sea breezes which act at right angle to a coast and bear a strong diurnal character. They are stronger in Summer than during Winter, and do not extend far inland.

Less well-known are the seasonal ocean and continent winds, a new terminology recently introduced (Radok & Tetzlaff, 1977). These air movements extend far into the continent and depend on the sizes of the mass of land and ocean involved. In Summer, when air

risers over the centre of Australia, air moves in at ground level radially from the ocean, with some deflection by Coriolis forces inland; a return flow occurs at some height, as has been demonstrated by recent balloon flights. In Winter, a similar, weaker and reverse circulation occurs. Depending on the season in which cards approach a coast, the ocean or continent wind will act steadily on the cards and beach them or send them offshore.

Finally, one has eddies which are attached to such geographical features as the Great Australian Bight. Very little is known about these circulations in Australian waters, but they have been studied diligently in other parts of the world.

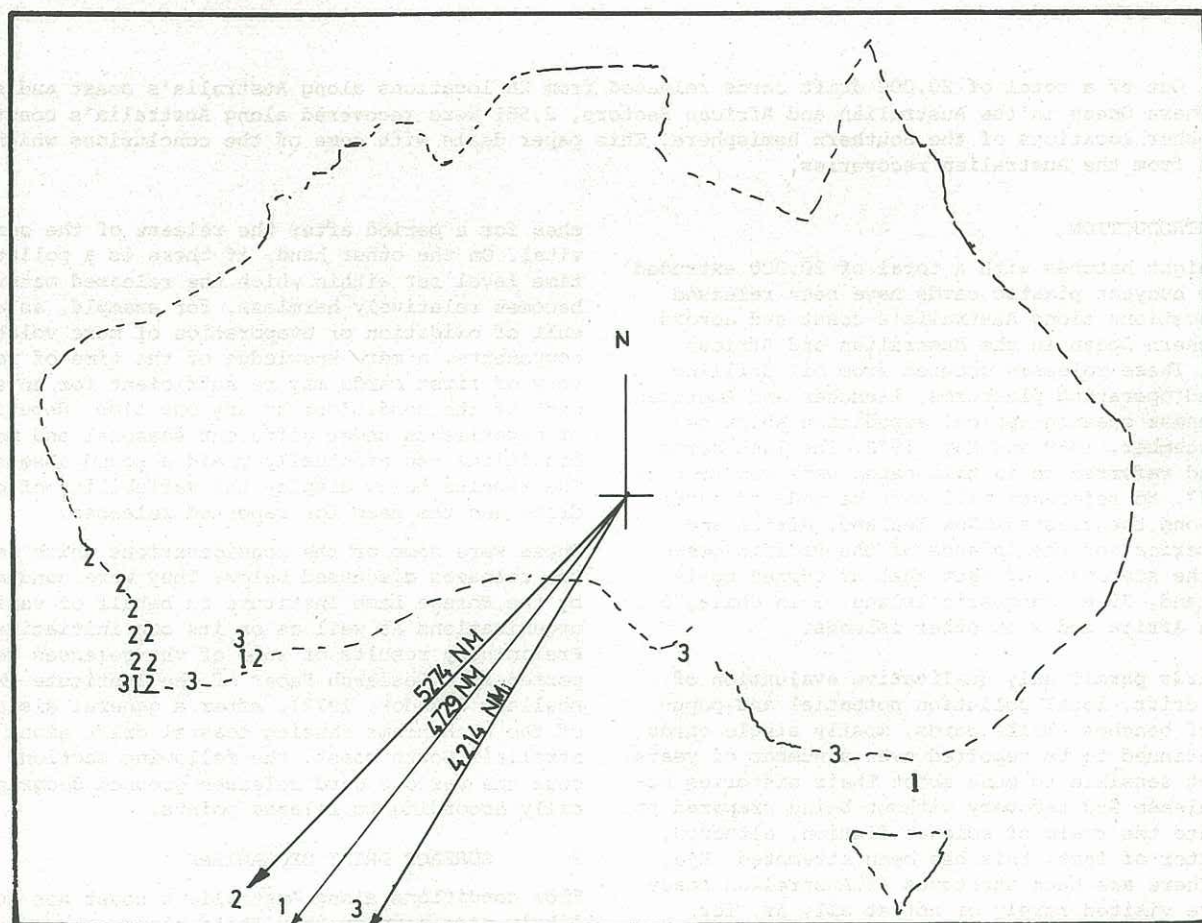


Figure 1 South African releases

GROUP	RELEASE	DATES			RELEASE	LOCATIONS			NUMBERS	
		FIRST	LAST			FIRST	LAST		RELEASED	FOUND
1	25. 3.70	1. 9.71	1. 1.72		50°00'S 25°31'E	33°57'S 115°04'E	34°10'S 119°33'E		1000	3
2	27. 3.70	28. 8.71	6. 2.72		39°34'S 20°10'E	30°50'S 115°20'E	34°21'S 119°20'E		1000	14
3	22. 3.70	22. 3.76	9.10.76		60°01'S 33°04'E	34°49'S 117°15'E	34°54'S 137°01'E		1000	5

### 3 SOUTH AFRICAN RELEASES

Opportunities for oceanographical work away from the immediate neighbourhood of Australia are rare and only arise by courtesy of other nations, since Australia does not yet possess oceanographical vessels. Up to date, no attempt has been made to release cards from commercial vessels, because of the logistics involved. Thus, when the Japanese research vessel Fuji was visiting Perth on its way to Capetown via Antarctica late in 1969, the opportunity was used to release cards South of Australia's West coast (cf. Section 4) and South of Capetown. Figure 1 shows the recovery points of the 22 cards recovered out of a to-

### 4 WEST AND CENTRAL AUSTRALIAN DEEP SEA RELEASES

Figure 2 summarizes the locations of recovered cards for 7 releases of 4500 cards, mainly between the Head of the Bight and Antarctica from the National

tal of 3000 (actually 2000 more cards were released without single recoveries). It is seen that most of the recovered cards were found around the South-West corner of Australia. Cards from the two Northern release points arrived within days of each other about 18 months later, while 5 cards from the Southern release point took 6 years. Did the latter cards reside on the beaches for an extended period? Or did they travel once or several times around the Antarctic, gradually spiralling their way North? We will never know unless such releases are repeated systematically many times.

Science Foundation research vessel ELTANIN late in 1969 and early 1970 and from the Japanese vessel Fuji in 1969 South of Perth. All 5 cards of only



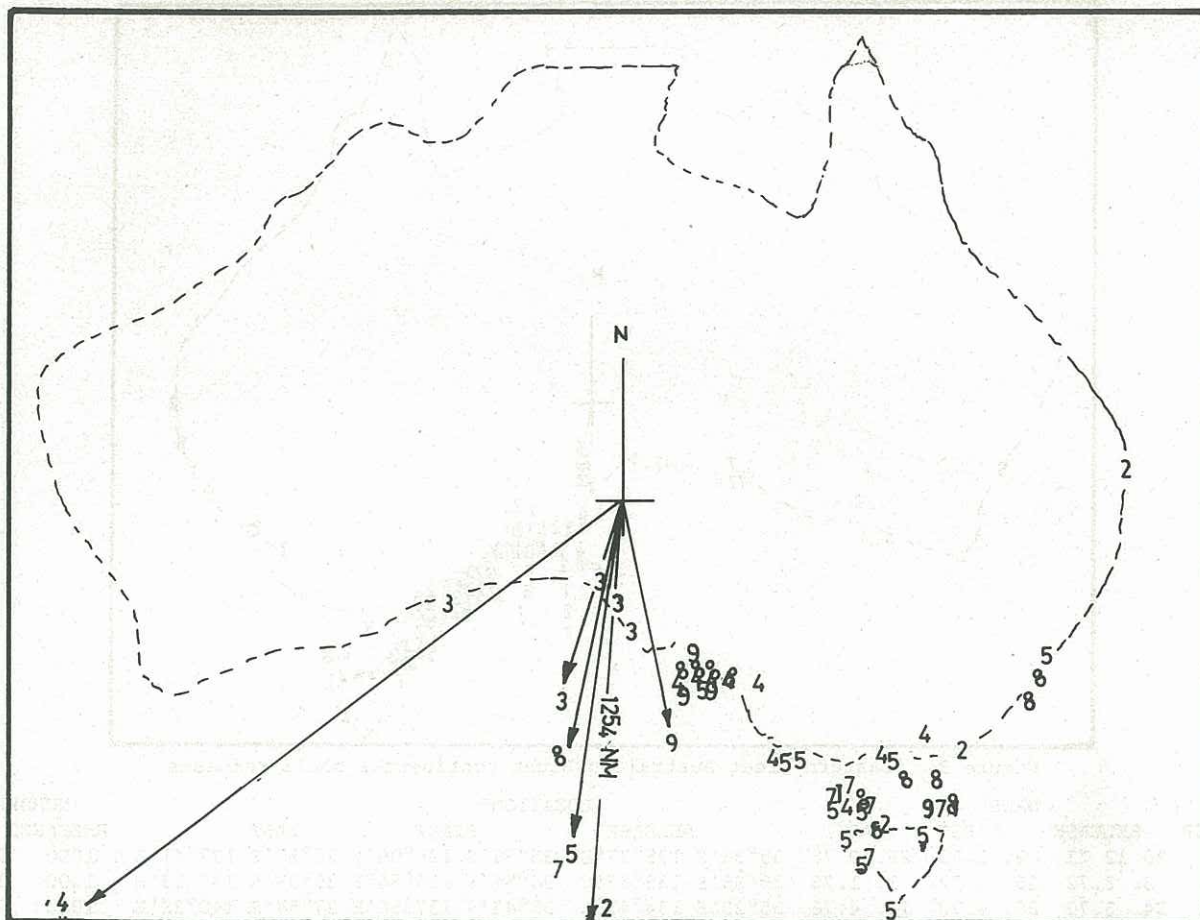


Figure 2 West and central Australian deep sea releases

GROUP	DATES			LOCATIONS						NUMBERS	
	RELEASE	FIRST	LAST	RELEASE	FIRST	LAST	RELEASED	FOUND			
2	11. 1.70	29. 3.71	19. 5.77	63°56'S 132°02'E	37°47'S 148°30'E	26°38'S 152°58'E	500	3			
3	23.12.69	18. 4.71	27.11.71	35°00'S 132°00'E	32°06'S 127°56'E	33°37'S 134°54'E	1000	5			
4	18.12.69	6. 2.71	1. 8.76	40°00'S 111°32'E	35°36'S 138°35'E	35°59'S 137°13'E	1000	12			
5	27.12.69	1.5.70	26.12.76	40°03'S 132°07'E	35°36'S 137°27'E	38°18'S 146°07'E	500	26			
7	22. 1.70	4.12.70	16. 1.77	41°00'S 132°00'E	38°03'S 149°56'E	42°12'S 145°10'E	500	18			
8	24. 1.70	24. 5.70	20. 2.77	37°00'S 132°00'E	36°03'S 136°51'E	38°55'S 145°56'E	500	19			
9	26. 1.70	28. 6.70	24. 1.77	36°17'S 135°55'E	35°56'S 137°40'E	43°20'S 137°29'E	500	5			

one of the releases (Batch 3) moved Westwards, while all others, depending on their release distance from the Australian shore, spread over the South Australian beaches including those of Kangaroo Island and the South-East. First reports occurred after 4 - 5 months for closer to shore batches (5, 7 - 9), and after 14 - 16 months for the others, where it must be noted that the closest in Batch 3 led to the longest elapse of time. Did these cards move in an eddy attached to the Great Australian Bight and come ashore under favourable wind conditions? Are there still many out there awaiting their chance?

#### 5 EASTERN GREAT AUSTRALIAN BIGHT CONTINENTAL SHELF RELEASES

OCEAN DIGGER under charter to the Shell Development Company of Australia led to commissioned releases of 6000 drift cards at two locations on the continental shelf South of Port Lincoln. A striking feature of these releases was Batch 7 only 10 cards of which were found, most of them West of their release point, as far West as Eucla. All other releases beached their cards in large numbers on the shores of the South-East, with single cards moving North along the East coast. Between 18 % and 27 % of these cards were recovered. Where are the cards of Batch 7? On the rocks at the bottom of the cliffs of the Great Australian Bight or floating around in the eddy of the Bight? There have not been any recent reports of cards of this batch!

#### 6 BASS STRAIT RELEASES

The North-West Acid Company commissioned drift card releases in Bass Strait along the Northern shore of Tasmania as part of a development study. FIG. 4 summarizes the recoveries of these cards 3000 of which were released in batches of 500. In certain cases more than half of the cards released were recovered; the last release led to a single report, a fact which might have been due to the distance from which these releases were organised without presence of a member of the Institute. Most likely more cards were found, but not sent in. It is remarkable how these cards stayed in Bass Strait and continued to be reported even five years later from closeby locations.

#### 7 OPERATING PLATFORMS OF BASS STRAIT

Altogether 2500 cards were released in four batches on the same day on behalf of the Esso-Hematite Co. from four operating platforms. 137 of the first batch were recovered, while the other batches largely disappeared. Single cards from these other batches were found as far North as Cairns; cards of Batches 0 and 4 stayed in Bass Strait.

#### 8 CONCLUSIONS

The results of these 28 drift card releases under quite varying conditions do not yield a simple picture of the drift around Australia's coast. They show on the one hand that substances released in the



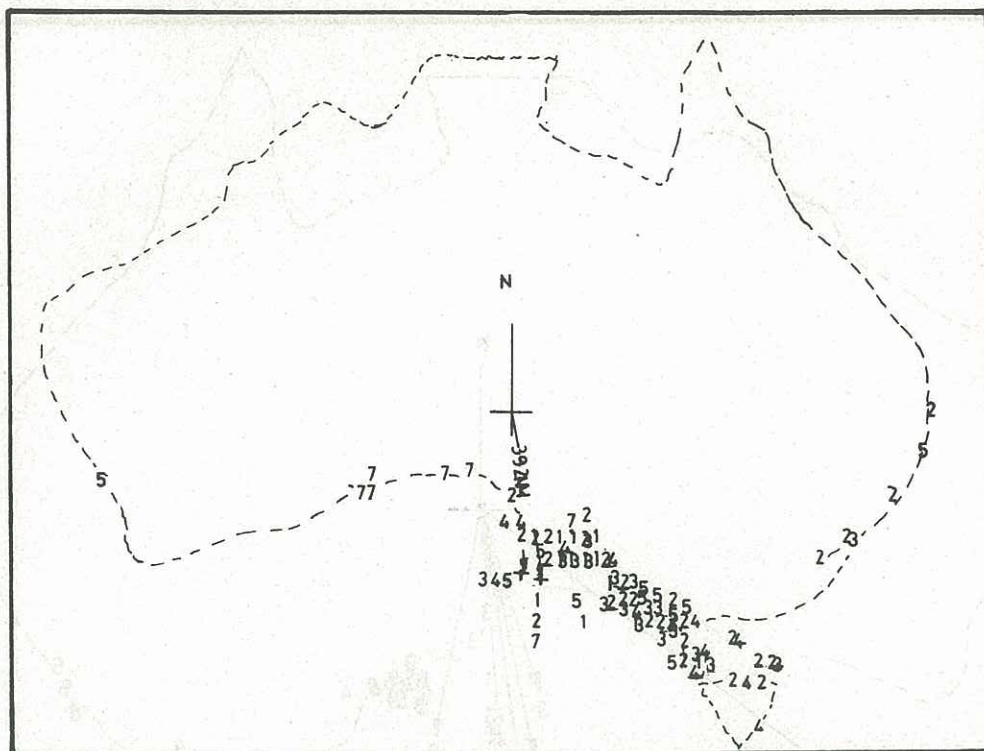


Figure 3 Eastern Great Australian Bight continental shelf releases

GROUP	RELEASE	DATES		LOCATIONS				NUMBERS	
		FIRST	LAST	RELEASE	FIRST	LAST		RELEASED	FOUND
1	20.12.71	2. 1.72	26.10.75	35°36'S 135°37'E	35°36'S 138°06'E	35°10'S 137°41'E		1000	193
2	3. 3.72	25. 4.72	1. 1.76	35°36'S 135°37'E	34°54'S 135°54'E	35°39'S 137°13'E		1000	180
3	24. 3.72	26. 4.72	13. 4.76	35°23'S 134°47'E	35°43'S 137°56'E	37°54'S 140°22'E		1000	273
4	2. 5.72	28. 5.72	21.12.75	35°23'S 134°47'E	36°02'S 136°51'E	38°13'S 141°14'E		1000	178
5	15. 4.72	19. 5.72	26. 1.76	35°23'S 134°47'E	37°54'S 137°56'E	38°13'S 141°14'E		1000	209
7	2. 2.72	23. 7.72	15. 4.74	35°36'S 135°37'E	32°48'S 134°13'E	31°51'S 127°51'E		1000	10

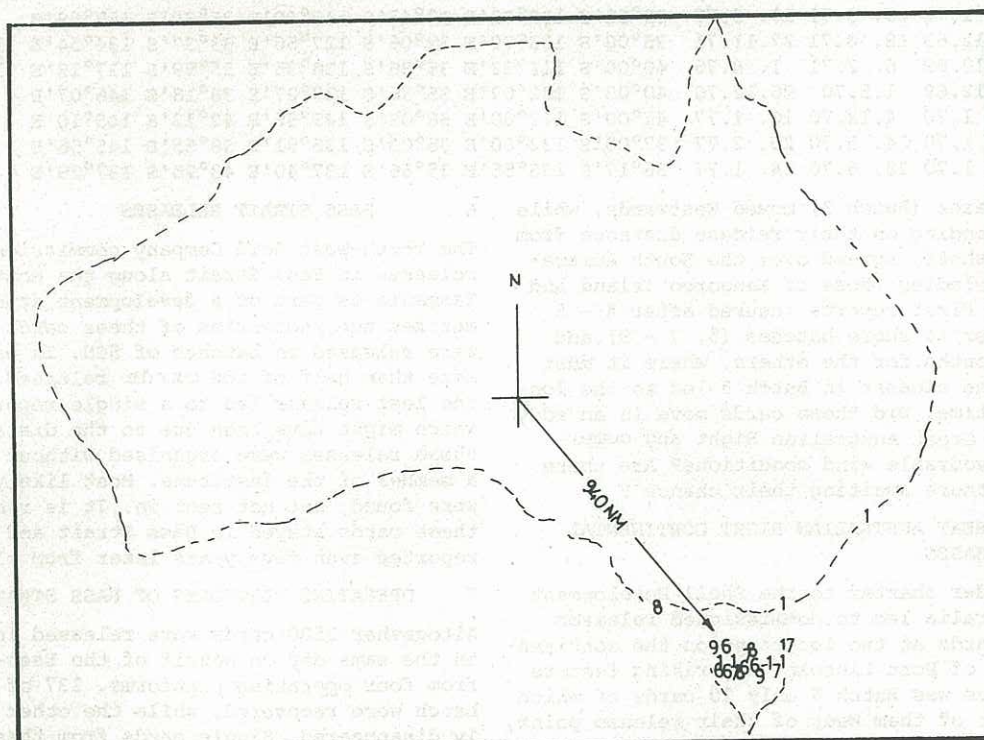


Figure 4 Bass Strait releases

GROUP	RELEASE	DATES		LOCATIONS				NUMBERS	
		FIRST	LAST	RELEASE	FIRST	LAST		RELEASED	FOUND
1	18. 8.70	23. 8.70	12.12.75	40 58'S°146°00'E	40°51'S 145°30'E	39°55'S 148°17'E		500	117
6	3. 2.70	3. 2.70	17. 6.76	40 59'S°146°01'E	40°51'S 145°30'E	40°46'S 145°17'E		500	250
7	23. 3.70	23. 2.70	15.11.71	40 58'S°146°50'E	41°03'S 145°50'E	41°03'S 145°50'E		500	261
8	19. 5.70	27. 5.70	1. 7.74	41 08'S°146°27'E	41°08'S 146°26'E	38°03'S 141°11'E		500	200
9	26. 5.70	12. 6.70	3. 4.76	41 08'S°146°27'E	40°46'S 145°18'E	40°56'S 145°17'E		500	



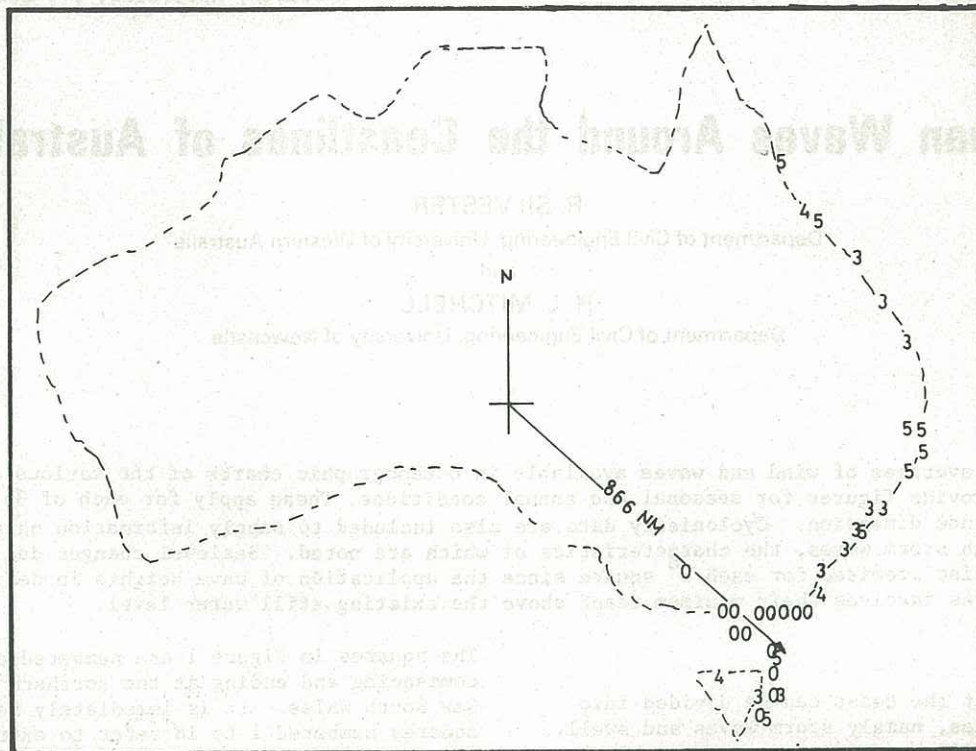


Figure 5 OPERATING PLATFORMS OF BASS STRAIT

GROUP	RELEASE	DATES		RELEASE	LOCATIONS		LAST	NUMBERS	
		FIRST	LAST		FIRST	LAST		RELEASE	FOUND
0	19.12.69	3. 1.70	10. 4.77	38 18'S°147°40'E	38°40'S 145°41'E	37°48'S 149°17'E		500	137
3	19.12.69	10. 3.70	1. 2.72	38 36'S°148°09'E	34°28'S 150°54'E	35°36'S 150°06'E		1000	22
4	19.12.69	27. 6.70	2. 1.72	38 25'S°148°19'E	41°03'S 145°50'E	36°44'S 149°59'E		500	5
5	19.12.69	3. 9.70	17.10.71	38 14'S°148°13'E	33°29'S 151°22'E	16°05'S 145°49'E		500	12

ocean will find their way to shores, given sufficient time. If the release points are sufficiently close to a shore, large proportions can, but need not beach in the neighbourhood. The question of the distance beyond which the probability of large scale recoveries of drift cards is reduced cannot be discussed on the basis of the available data. Also, none of the releases discussed here are sufficient to resolve questions relating to seasonal differences in drift conditions.

#### 9 ACKNOWLEDGEMENTS

The authors wish to express their thanks to the various organisations which contributed to this study

financially and by making facilities available. Apart from those mentioned in the text, the contribution of the Australian Research Grants Commission must be mentioned.

#### 10 REFERENCES

- J.A.T.Bye, 1976. Personal communication.
- P.G.Marshall & R.Radok; Drift Cards in the Southern and adjacent Oceans. Horace Lamb Centre Research Paper, No. 52, 1972.
- D.G. Provis & R.Radok, Variations in Australian Mean Sea Levels (in preparation) 1977.