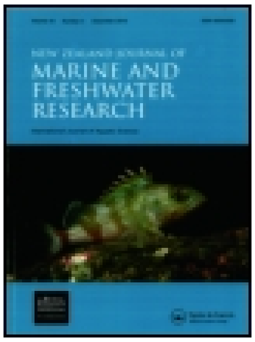

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DRIFT CARD OBSERVATIONS OF CURRENTS IN THE CENTRAL NEW ZEALAND REGION

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SUMMARY

The paths of drift cards released in the Cook Strait region are examined. Further evidence of the D'Urville and Canterbury Currents is presented.

INTRODUCTION

Several methods have been used in the New Zealand region to measure currents, and the most valuable results have been derived from drift cards and the customary technique using the geostrophic approximation. As the latter method requires the assumption of a surface of no motion, and the continuity equation (which the geostrophic currents satisfy) requires that no isolines of dynamic height anomalies exist perpendicular to any coast close inshore, it becomes invalid on the coastal shelf. Consequently most of the information about New Zealand coastal currents has been derived from drift cards.

A general account of the surface currents in New Zealand coastal waters has been presented by Brodie (1960) and a more specific region, Hawke Bay, has been examined by Ridgway (1960). From the release of drift cards in the Cook Strait region it has been possible to examine in more detail the surface flow in this area.

DATA

In 1953–54 a total of 3,500 drift cards were released at 5 to 10 mile intervals along shipping routes in the area extending from latitude 39° 30′ S to 42° 30′ S and longitude 171° E to 176° 30′ E. Although insufficient cards were dropped in some specific places (off the Marlborough Sounds and in Tasman Bay) to permit a true statistical approach, the percentage recovery rates for all regions have been calculated and percentage recovery isolines drawn (Fig. 1).

The drift card track records are presented in two separate charts (*see* Fig. 3 which shows cards dispatched from November to April, and Fig. 4 which shows those dispatched from May to October). The division enabled variability between these periods to be examined.

DISCUSSION

Many of the coastal areas in the Cook Strait region are seldom visited and the likelihood of cards once ashore being destroyed or covered over is high in areas such as the sandy expanse of Farewell Spit, the rocky coastline of the Marlborough Sounds, and the relatively isolated south-east coast of the North Island.

It is clear that the surface currents are strongly dependent on the wind system existing in the region as well as being frictionally coupled to the circulation which exists below the Ekman Layer.

Cook Strait, which lies between the main islands of New Zealand, is oriented almost due north and south, bounded in the south by the Cook Strait Canyon, an extension of the Hikurangi Trench, and in the north by a large area of coastal shelf extending from Cape Egmont to Farewell Spit. There is a concentration of air movement through Cook Strait so that the area experiences an abnormally large number of gales. Moreover, a south-west wind along the west South Island coast, for example, may curve through Cook Strait as a north-west wind and then appear as a north-easterly on the coast of Marlborough as far south as Kaikoura (Garnier 1958, p. 47). The general wind conditions in this area as given by Garnier are shown in Fig. 2.

Cook Strait is a region of highly variable tides and strong tidal streams with surface velocities up to 7 knots produced by the water level differences resulting from the time delay between high tide on one side of the Strait and on the other. High water on the western side

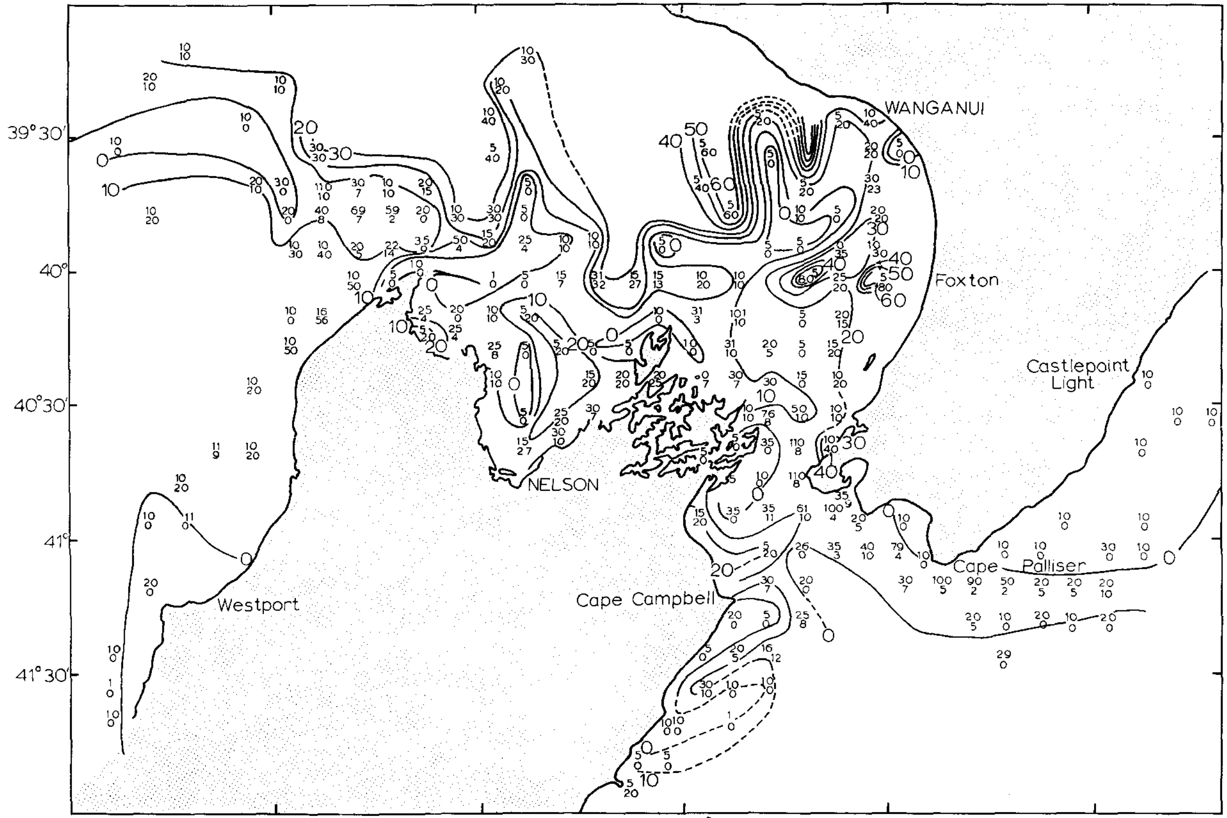

FIG. 1—Percentage recovery isolines. Large numbers give the value of the isoline; upper small numbers the number of cards released; lower small numbers the percentage recovery from that dispatch station.

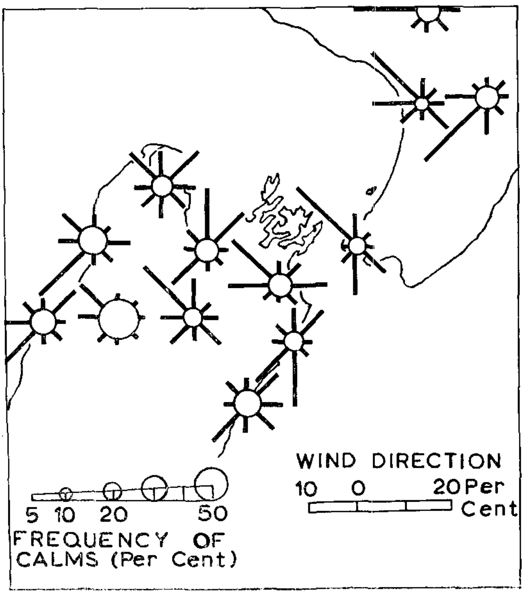

FIG. 2—Mean annual percentage frequency of wind direction in the Cook Strait region.

of Cook Strait occurs about 5 hours later than on the eastern side (Hydrographic Dept. 1958). These tidal streams will have a strong influence on cards which are in the immediate vicinity of Cook Strait. Gilmour (1960) has described the flow in Cook Strait as essentially turbulent with rapid fluctuations in both speed and direction and has found that subsurface tidal flow velocities are roughly of the same magnitude as the surface velocities.

Two methods were used to analyse the drift card observations. The first (Figs 3, 4) used a statistical technique where no tracks were drawn through zero or low percentage recovery areas as given in Fig. 1. The second method used was to plot the shortest path from the dispatch to the recovery points and from this plot to draw current rose patterns (Fig. 5). One rose was plotted to each rectangle of 20′ longitude and 15′ latitude. Each unit segment of these roses represents the passage of a card through that particular rectangle and the resultant rose gives some indication of the variability of currents in that rectangle.

The recoveries show that there is a strong influx of surface water from the west coast of the South Island into the northern end of Cook Strait (Figs 3, 4) though the high recovery rate from the south-west North Island coast is possibly aided by the circumstance that this area is well populated and has popular beach resorts. This current is

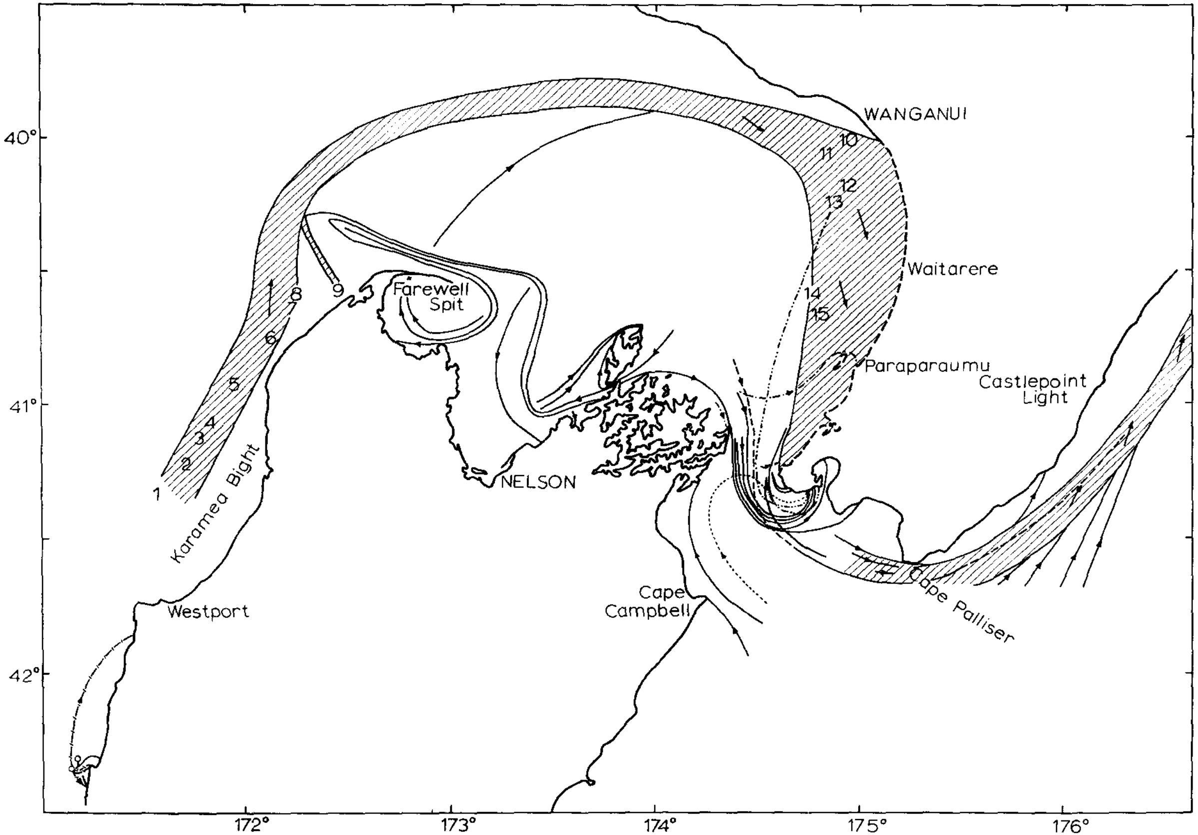

FIG. 3—Paths of drift cards released from November to April. Areas where the recovery rates were high are hatched; the region where a large number of recoveries were made is dashed.

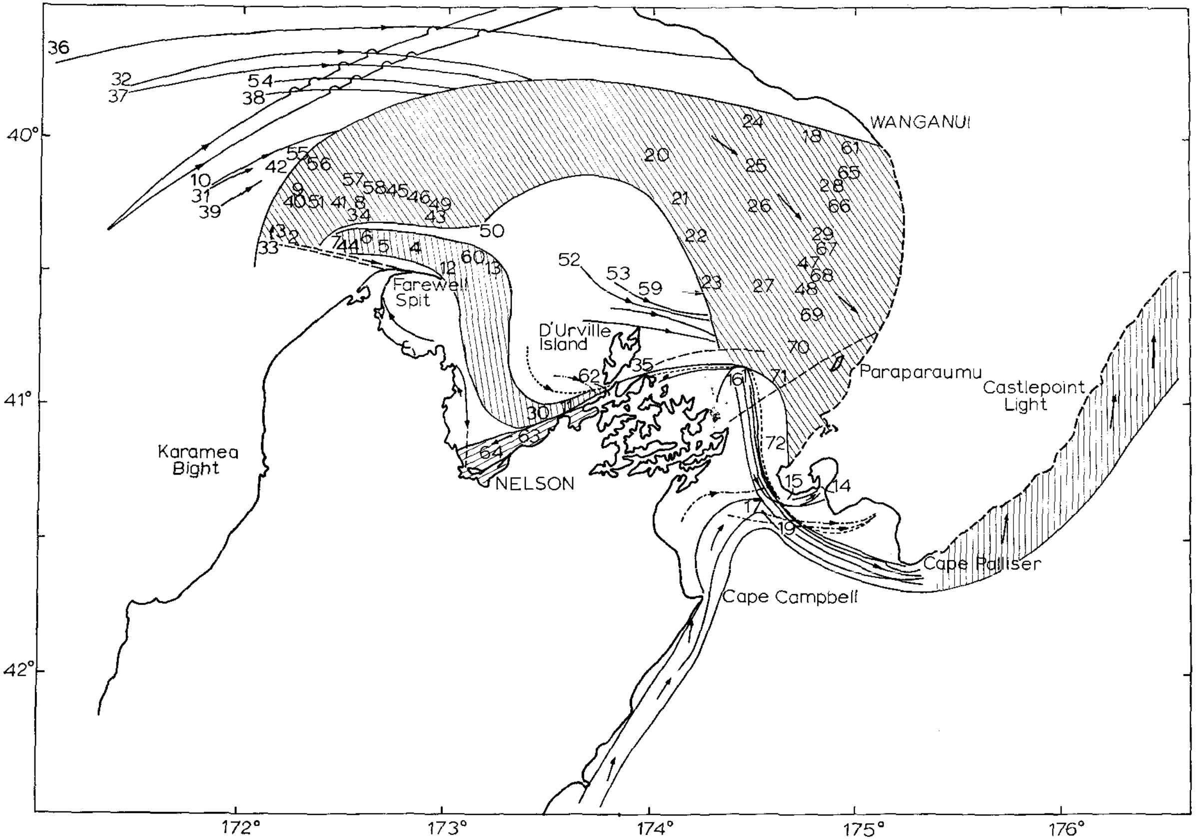

FIG. 4—Paths of drift cards released from May to October. Areas where the recovery rates were high are hatched; the regions where a large number of recoveries were made are dashed.

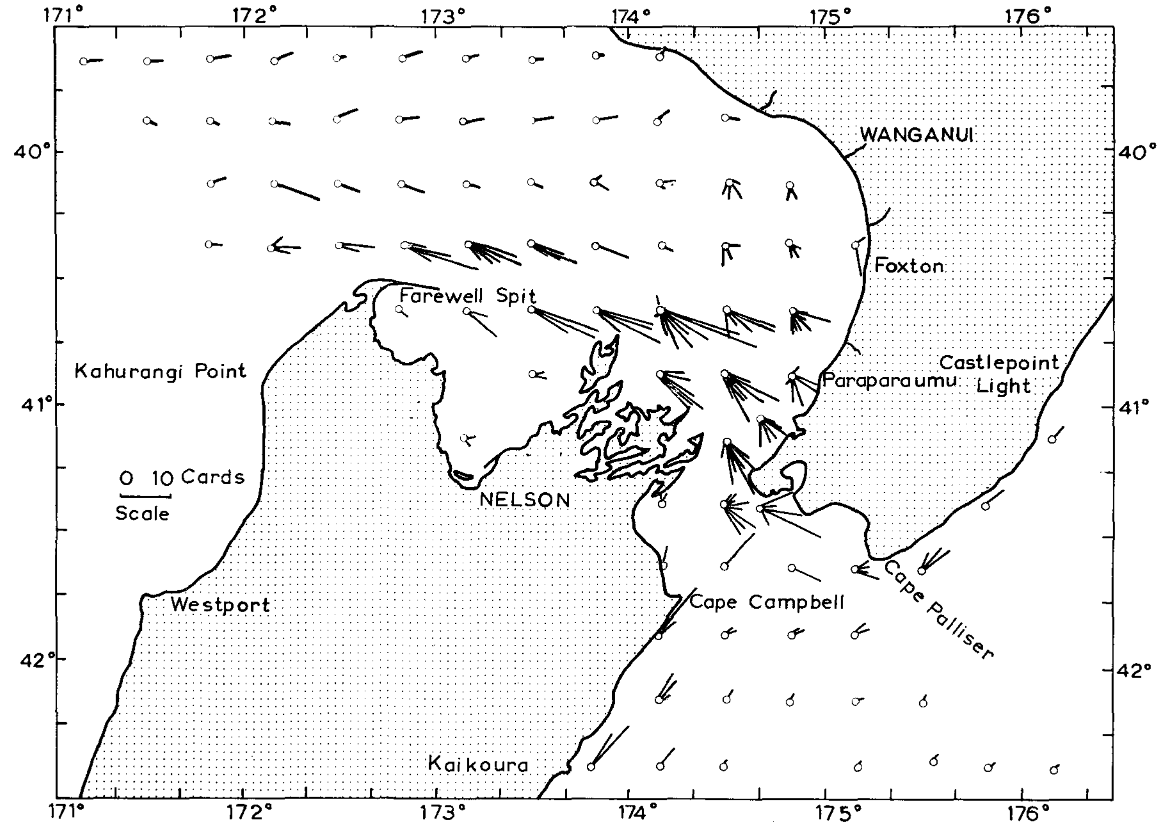

FIG. 5—Plot of the number of cards passing through each rectangle of 20′ longitude and 15′ latitude centred on the rose.

the D'Urville Current (Brodie 1960) and is represented by the upper hatched area of Figs 3, 4. Specific dispatch stations in these hatched areas from which recoveries were made are numbered and the rates of recovery from these stations are given in Tables 1 and 2. The regions of high recovery are shown by a dashed coastline.

The surface current entering Tasman Bay branches off Separation Point, one branch flowing west into Golden Bay and the other sweeping south-east towards Nelson before proceeding north. Close inshore in eastern Tasman Bay there exists a south-flowing current. The circulation in this region therefore consists of a clockwise gyre in Golden Bay and a counter-clockwise flow in southern Tasman Bay opposed by a south-flowing current close inshore on the eastern shore of Tasman Bay.

Both the D'Urville Current and the surface current entering Tasman Bay are derived from the north-flowing surface current off the west coast of the South Island. This latter current appears to divide into the two components north-west of Farewell Spit.

A well defined surface current which has previously been named the Canterbury Current extends from Kaikoura up the east coast of the North Island close inshore. It appears to sweep in a wide arc through the southern end of Cook Strait south of the narrows.

Calculated travel times in the D'Urville Current reveal a maximum speed of about $\frac{3}{4}$ knot if the path as given in Fig. 4 (upper hatched region) is correct. Travel times in the other currents are possibly too long owing to the slight chance of cards being picked up immediately on stranding.

No indication of the variability of the current speeds can be obtained from drift cards as a card may be stranded a long time before it is recovered. The currents generally have only slight variations in direction

TABLE 1—Dispatch and recovery of drift cards from stations shown in Fig. 3

Label	Number dispatched	Number recovered
1	10	2
2	10	1
3	1	1
4	10	2
5	10	2
6	10	6
7	5	1
8	10	8
9	10	5
10	5	2
11	5	2
12	5	3
13	5	1
14	5	1
15	5	2

TABLE 2—Dispatch and recovery of drift cards from stations shown in Fig. 4

Label	Number dispatched	Number recovered	Label	Number dispatched	Number recovered
1	5	1	37	10	1
2	10	2	38	10	1
3	10	2	39	10	1
4	10	1	40	10	1
5	10	3	41	10	1
6	10	1	42	10	7
7	10	1	43	10	5
8	10	1	44	10	3
9	10	1	45	10	3
10	10	1	46	5	1
11	5	1	47	5	1
12	5	1	48	10	2
13	5	1	49	10	2
14	5	1	50	10	3
15	5	4	51	10	1
16	5	1	52	10	1
17	5	3	53	10	2
18	5	1	54	10	1
19	10	1	55	10	2
20	5	3	56	10	1
21	5	2	57	10	2
22	5	4	58	10	1
23	5	1	59	10	2
24	5	2	60	10	1
25	5	4	61	5	3
26	5	1	62	5	2
27	5	4	63	5	3
28	5	3	64	5	4
29	5	3	65	5	2
30	5	1	66	5	1
31	10	1	67	5	3
32	10	1	68	5	4
33	10	3	69	5	1
34	10	2	70	5	2
35	5	2	71	5	2
36	10	1	72	5	2

(Fig. 5) and the few exceptions which do occur are probably due to the effect of chance long-term winds in the opposite direction to the general flow.

No interpretation can be given of subsurface currents by drift card measurements alone. However, from sediment analysis in the region of Farewell Spit, van der Linden (in press) has derived a bottom current system in this region of much the same pattern as the surface currents deduced here from drift card records with the northerly tending current off the west coast of the South Island branching into two components north-west of Whanganui Inlet. The direction of long-shore bottom currents can also be derived from the mode of formation of bay bars, spits, and beaches. The western end of Tahunanui beach has migrated laterally westwards 4,000 ft in the period between 1850 and 1954 and in recent years a spit has been building up seawards where this beach meets the Waimea River (Bruce 1962). These formations signify the presence of a westerly longshore current. The formation of spits at Sandy Bay and off Motueka is in both cases due to south-easterly longshore currents. A south-westerly longshore current on the eastern side of Tasman Bay has built up a sand spit at Delaware Bay. Although the formation of these structures may be primarily the effect of local longshore currents derived from the direction of the waves, the waves in these areas are mainly produced by local winds. Tasman Bay is relatively sheltered from oceanic swell and, consequently, the surface currents can be expected to be in the same direction as the bottom currents.

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REFERENCES

BRODIE, J. W. 1960: Coastal currents around New Zealand. *N.Z. Jl Geol. Geophys. 3 (2):* 235–52.

BRUCE, J. G. 1962: The geology of the Nelson City area. *Trans. R. Soc. N.Z. Geol. 1 (11):* 157–81, 4 Pls.

GARNER, D. M. 1961: Hydrology of New Zealand coastal waters, 1955. *Bull. N.Z. Dep. scient. ind. Res. 138,* 85 pp.

GARNIER, B. J. 1958: "The Climate of New Zealand. A Geographic Survey." Edward Arnold, London. 191 pp.

GILMOUR, A. E. 1960: Currents in Cook Strait. *N.Z. Jl Geol. Geophys. 3 (3):* 410–31.

HYDROGRAPHIC DEPARTMENT 1958: "The New Zealand Pilot". 12th ed., London. 500 pp.

RIDGWAY, N. M. 1962: Nearshore surface currents in southern Hawke Bay, New Zealand. *N.Z. Jl Geol. Geophys. 5 (4):* 545–66.

VAN DER LINDEN, W. J. M. (in press): Sediments of north-west Nelson, South Island, New Zealand. *N.Z. Jl Geol. Geophys. 12 (1).*