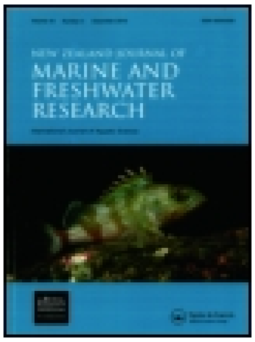

New Zealand Journal of Marine and Freshwater Research

ISSN: 0028-8330 (Print) 1175-8805 (Online) Journal homepage: http://www.tandfonline.com/loi/tnzm20

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N.Z. Journal of Marine and Freshwater Research 10 (4): 641–50. Dec. 1976

MORPHOLOGICAL STABILITY OF PAUATAHANUI INLET, PORIRUA HARBOUR

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ABSTRACT

Vertical aerial photographs made over a 31-y period (1942–73) show only a few small changes in channel and bank morphology of the inlet; the changes apparently occur more slowly than in the Avon-Heathcote Estuary.

INTRODUCTION

Pauatahanui Inlet (41° 06′ S, 174° 54′ E), situated on the west coast of the North Island 20 km north of Wellington City, is a tidal estuary of 4.5 km^2 with a tidal mud-flat area of 1.1 km^2. The inlet is approximately 3.5 km long by 2 km wide and lies in an east–west direction. This inlet and the Porirua Inlet, which is of elongate form, 4 km long and 1.3 km wide lying in a south-west–north-east direction, constitute the Porirua Harbour. The catchment area of Porirua Harbour is 600 km^2 (Heath, in press). Both inlets have common access to the sea via a narrow, 0.1-km-wide entrance opening to the north (Fig. 1).

The harbour was formed by the postglacial drowning of the seaward end of the west flowing rivers about 10 000–14 000 y ago. The 1855 earthquake raised Porirua Harbour about 1 m (3.3 ft), slightly less in the Porirua Inlet, but slightly more in the Pauatahanui Inlet (Stevens 1974).

Surface sediments (McDougall, in press) in the main outlet channel around Golden Gate Peninsula are very coarse gravel and shell. Banks to the north and east of the peninsula are predominantly sand with small areas of approximately 100% shell on their highest points. Areas around the sand banks at the west end of the inlet and the mud flats at the east end of the inlet (east of a line drawn north-south between the outlets of Kahao and Horokiwi Streams) are sandy silt or silty sand. The deep area in the centre of the inlet which leads south to Browns Bay, south of the peninsula, has surface sediments that are predominantly silt. The shoreline is rock, gravel, and sand flat (McDougall, in press).

To monitor any future changes caused by development of the land around Pauatahanui Inlet, the present state of the inlet and how fast it has been changing recently should be known. Charts made in 1850, 1950, and 1967 generally show insufficient detail for these purposes, but aerial

Received 30 October 1975; revision received 29 July 1976.

TABLE 1—Runs of vertical aerial photographs examined in study of changes in channels and banks, Pauatahanui Inlet, Porirua Harbour (* = illustrated in Figs 2–5)

Date	Time of Run	Predicted H.W. at Plimmerton	Predicted L.W. at Plimmerton	Time of Photography (h min) Relative to H.W. or L.W.
*17-3-42	1012	1537	0715	2 57 after L.W.
*13-11-47	0818	1005	1619	1 47 before H.W.
29-11-56	1116	0645	1244	1 28 before L.W.
19-9-58	1257	1325	0731	0 28 before H.W.
1-11-66	1418	1049	1659	2 41 before L.W.
17-1-67	1005	1328	0731	2 34 after L.W.
19-11-68	0907	0807	1413	1 00 after H.W.
*20-11-68	1550	0852	1459	0 51 after L.W.
28-9-69	1218	1042	1651	2 36 after H.W.
29-10-73	1504	1055	1710	2 06 before L.W.

photographs taken from 1942 to 1973 clearly show at least changes in shape and position of banks and channels. A new bathymetric survey (Irwin in press) based on soundings made in 1974 fixes the present configuration of the inlet and should allow future changes to be quantified. However, this paper deals only with the qualitative changes visible on aerial photographs.

AERIAL PHOTOGRAPHY

Ten runs of vertical aerial photographs are available for the 31-y period from 1942 to 1973 (Table 1). These were flown from various heights and at various times and height of tide. The photographs were brought to a common scale of 1 : 4000 and studied for changes in channels and banks. Because such features show most clearly at low water, photographs specially taken at low water in 1968 are used to illustrate features discussed; more recent photographs do not show the details so well.

TABLE 2—Freshwater inflow data for Porirua Harbour, derived by correlation techniques from 6 years continuous records from a tributary of Makara Stream (Wellington Peninsula), and from flow records on the Porirua Stream.

Inlet	Stream	INFLOW ($m^3.s^{-1}$) Low Flow	Mean Flow	Ann. Flood	Max. Flood
Porirua					
	Porirua	0.12	0.68	28.0	140.0
	Kenepuru	0.04	0.10	7.1	40.0
Pauatahanui					
	Kahao	0.018	0.18	3.5	30.0
	Horokiwi	0.080	0.45	18.0	110.0
	Pauatahanui	0.090	0.50	17.0	95.0
	Duck	0.020	0.09	4.2	35.0

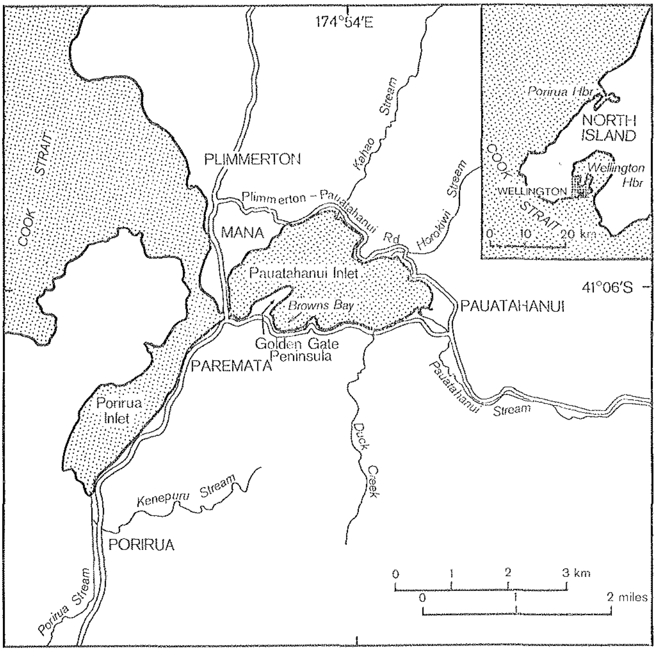

FIG. 1—*Porirua Harbour, showing Pauatahanui and Porirua Inlets, and position of harbour (inset).*

FRESHWATER INFLOW AND TIDAL FLOW

Freshwater inflow, apart from the direct land run-off, is contributed by six streams into the harbour. Two streams, the Porirua and Kenepuru, flow into the south end of Porirua Inlet and are noted because of their possible influence on the Pauatahanui Inlet: the Porirua Inlet outflow passes close to the Pauatahanui Inlet entrance. The four streams entering the Pauatahanui Inlet do so at the eastern end; Duck Creek on the south side, Pauatahanui Stream at the east end, and the Horokiwi and Kahao Streams on the north side.

Inflow records supplied by the Ministry of Works and Development are derived from correlation techniques; no continuous flow records exist except for the Porirua Stream (Table 2). The combined mean freshwater inflow from the four main streams entering the inlet is $1.22\ m^3 \cdot s^{-1}$.

The inflow is small compared with the tidal prism, which is $22 \times 10^6\ m^3$, $17 \times 10^6\ m^3$ on spring and neap tides respectively, giving a mean flow rate of $760\ m^3 \cdot s^{-1}$ on an incoming neap tide (Heath 1976).

CHANGES IN CHANNEL MORPHOLOGY

At the west end of the inlet, the main channel from the bridge closely follows the Golden Gate Peninsula along the north side and down the south-west side and appears unchanged in position or width over the period 1942–73.

North of the Golden Gate Peninsula the shallow bank area is divided by three northward trending channels A, B, C (Fig. 2); these appear unchanged in position and width over the 31 y 1942–73. A developing channel (Fig. 2, *lower*) appears east of bank D.

Flowing into the south side of the inlet, Duck Creek has a short indistinct channel over a narrow mud flat, the water being comparatively deep close inshore in this area. No variation is apparent over the period.

KAHAO STREAM

This stream enters the north-east corner of the inlet. South of the Plimmerton–Pauatahanui Road, the stream passes through a stable scrub-covered area. The channel over the mud flats south of this point tended to curve towards the south-west, then south, in 1942. Subsequent photography shows the channel to trend in a south-west direction over the mud flats only.

A very small-scale bird-foot effect developed at the end of the channel after 1958, when the channel divided at the end into two branches. By 1966 a third branch had formed, and in 1968 four branches, two with divided ends, are visible (Fig. 3). The total length of the channel over the mud flat area is approximately 130 m, of which the outer 70 m shows the bird-foot effect.

HOROKIWI STREAM

The stream enters the northern shore of the inlet and passes for about 220 m in a south-west direction through a stable scrub-covered area south of the Plimmerton-Pauatahanui Road. Over the mud flat the channel extends a further 200 m and shows slight variations in the direction of its end over the period.

A very small-scale bird-foot end to the channel over the whole mud flat area is very prominent in 1947 and remains till 1958 (Fig. 4). From 1958 onwards a near parallel adjacent channel formed to the north-west of the main channel.

PAUATAHANUI STREAM

This stream enters at the eastern end of the inlet. In 1942 the main channel flowed for approximately 160 m northward on to the mud flat area thence nearly due west for 280 m. Over the 31-y period this stream channel shows little change in width or direction except for the development of a west-flowing branch where it enters the mud flat area. Figure 5 shows this channel is absent in 1942, but has joined the main channel by 1956, and appears the most prominent by 1968.

FIG. 2—West end of Pauatahanui Inlet, showing channels A, B, C and bank D: (*upper*) 17 March 1942; (*lower*) 20 November 1968.

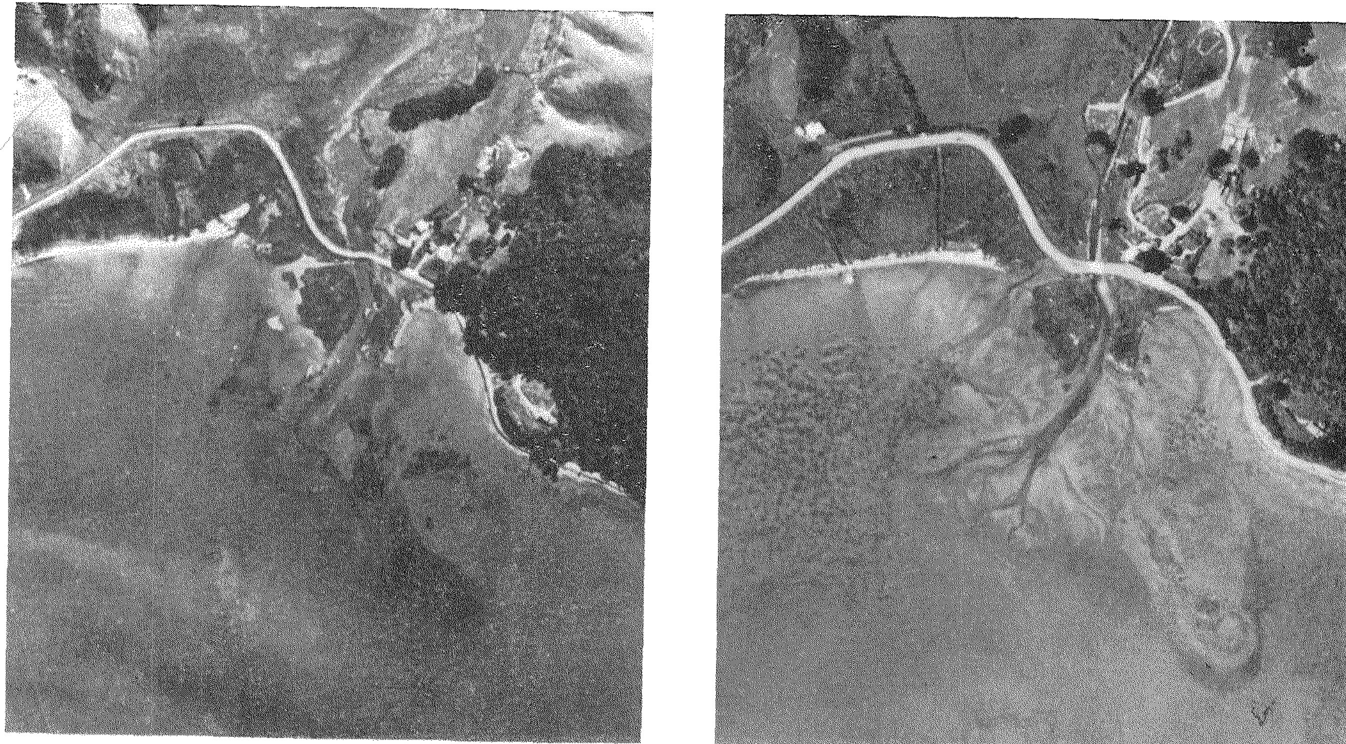

FIG. 3—Mouth of Kahao Stream, Pauatahanui Inlet, showing (*left*) south-west and south trending channel over tidal area, 17 March 1942, and (*right*) south-west trending channel with bird-foot effect over tidal area, 20 November 1968.

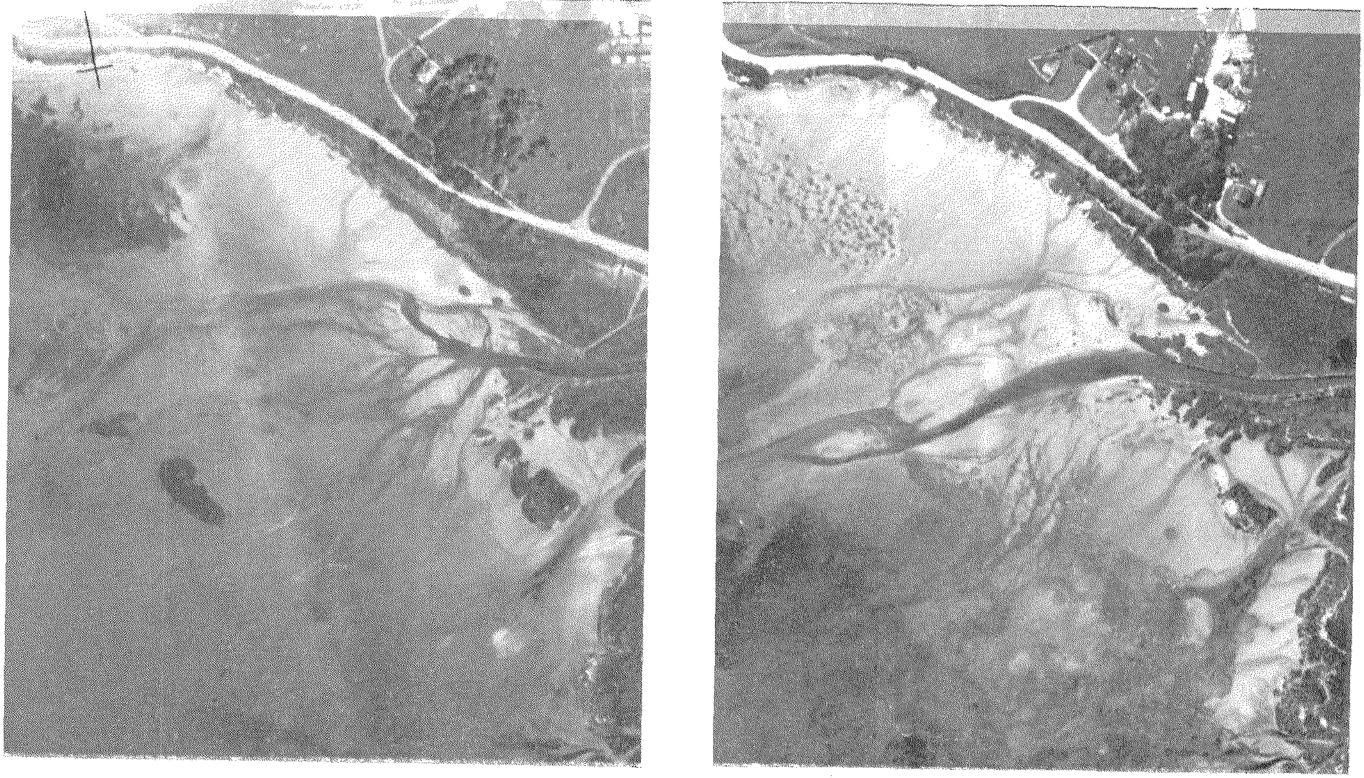

FIG. 4—Mouth of Horokiwi Stream, Pauatahanui Inlet, showing (*left*) channel with bird-foot effect over tidal area, 13 November 1947, and (*right*) one main channel over tidal area, 20 November 1968.

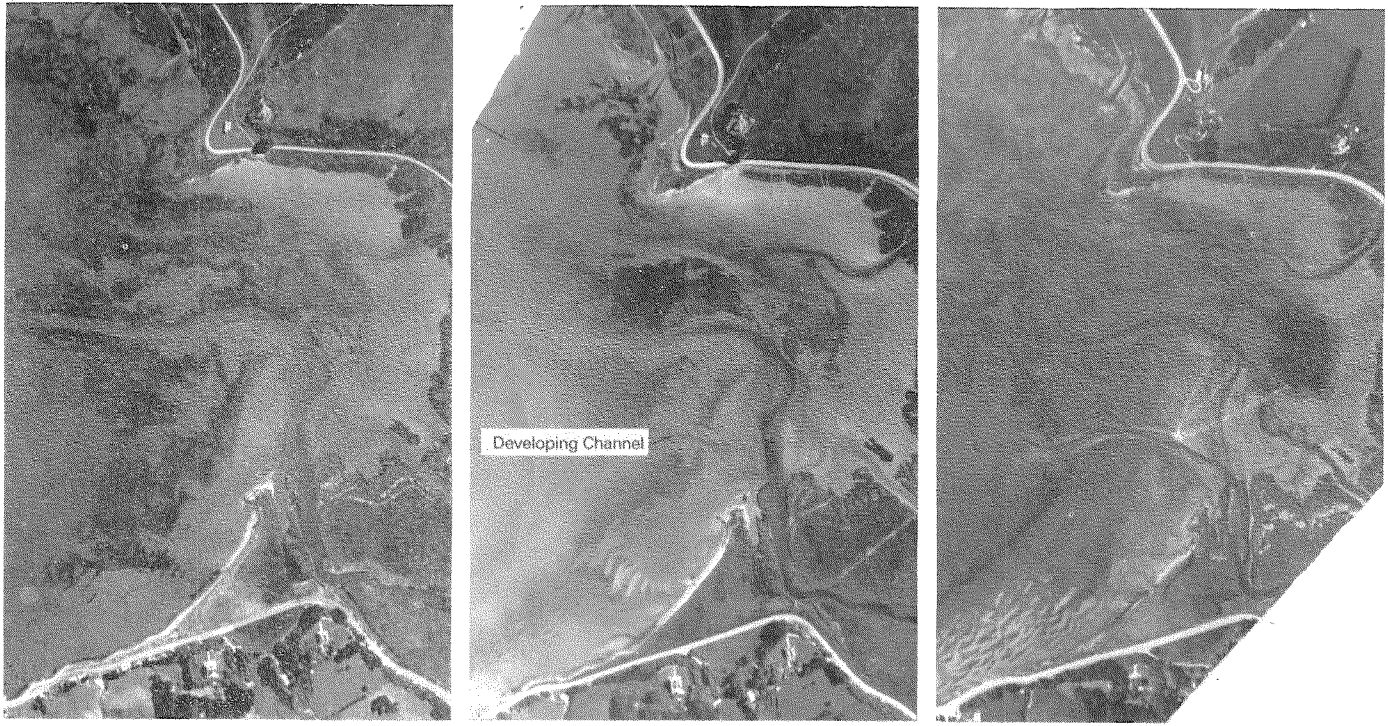

FIG. 5—Mouth of Pauatahanui Stream, at east end of Pauatahanui Inlet, showing (*left*) single channel over tidal area, 17 March 1942, (*middle*) single channel over tidal area but indications of west-flowing branch developing near mouth, 13 November 1947, and (*right*) second, west-flowing channel developed near mouth, 20 November 1968.

CHANGES IN BANK MORPHOLOGY

Most banks are at the western end of the inlet, and they lie to the north of the main channel.

Over the period 1942–73 the position and shape of the banks have remained very stable, with one notable exception. A prominent bank (D, Fig. 2) was in 1942 oval in shape; by 1956 the eastern end of the bank had narrowed, a trend that continued in 1958, and by 1966 it had become a narrow tail. The east end of this tail appears to be now being broached by a channel (Fig. 2, *lower*).

DISCUSSION

The most notable result of comparisons of aerial photographs over the 31-y period is the stability of the main channel and banks. The change of channel form at the east end of the inlet is comparatively small, but the new channel developed over the mud flats at the outlet of the Pauatahanui Stream is a larger change. Changes in bank form are slight, the bank at the east end of the inlet (Fig. 2) being the exception in that the shape, but not the position has changed.

Studies of the Avon-Heathcote Estuary (43° 33′ S, 172° 44′ E) show that long-term changes have taken place in the position of the outlet channel and position and shape of the spit (Knox *et al.* unpublished 1973). Within the estuary there has been a changing pattern of low tide channels. These changes in both the Heathcote and Avon River channels were marked between 1920 and 1962, but there has been little change since. In general, the low water channels of both inflow rivers have widened and straightened. The authors suggest that channel form is an adjustment to higher flood flows and lower dry weather flows or to a reduction of grade by infilling.

The period of observation of channels in Pauatahanui Inlet (31 y) is less than the 42 y considered for the Avon-Heathcote Estuary, but considerably more change is apparent in the Avon-Heathcote Estuary. No firm comparisons can be made between the two estuaries because of the absence of data on sediment load and rate of runoff.

Cyclic morphological changes, if they occur, are likely to be of longer period than the time interval considered (31 y) or shorter than 2.5 months, which was the shortest interval between photography. The continuity of trend of the small changes at the observed intervals suggests slow secular change. Compared with the Avon-Heathcote Estuary, changes appear to be small.

ACKNOWLEDGMENTS

Thanks are expressed to Mr M. J. Lankow, Science Information Division, DSIR, for photographic reproduction, to Dr L. Carter, NZOI, for helpful comments, and to Miss P. Lawrence, NZOI, for drawing the figure.

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