

MEASURING TIDAL CURRENTS NEAR COOK STRAIT, NZ

ADCP Flow Surveys

Narrow tidal channels often provide challenges to shipping. Reliable charting of tidal-stream flow is important for safety. Acoustic Doppler current-profiler (ADCP) survey is now a commonplace method of charting tidal streams. This article describes surveys carried out in Tory Channel and Te Aumiti (French Pass), two contrasting narrow channels adjacent to Cook Strait.

Tidal-stream data are vital for small and medium-sized shipping to provide safety and transit-time information. The data typically provide a guide as to normal times for changing tidal-stream direction and hydrographic features like back eddies. Two high-profile tidal streams at the northern tip of the New Zealand's South Island were surveyed in early 2006 using vessel-based ADCP. The work was commissioned by Land Information New Zealand to assist in their compilation of tidal products. ADCP data were augmented by moorings and, in one case, by drifter and radar data. This article describes the two channels, techniques used and general results.

The Channels

Te Aumiti (French Pass) and Tory Channel Entrance are two tidal streams in the Marlborough Sounds which are formed by a sequence of drowned river valleys. The area is of significant tourist value, with the main ferry link across Cook Strait passing down Queen Charlotte Sound. Both this Sound and neighbouring Pelorus Sound support substantial aquaculture activity, the latter being the home of green-shell mussel production in New Zealand. The western extremity of Marlborough Sounds is closed off by D'Urville Island, the gap between this and the mainland being Te Aumiti (French Pass). Tory Channel supports significant traffic, including passenger ferries, whilst Te Aumiti (French Pass) sustains less traffic.

Tides

The tides in the region are complicated as they have very different properties on the west and east coasts, with the M2 tide being close to 180 degrees out of phase. At Te Aumiti (French Pass) the tidal range is around 4m, and there are time differences in high tide either side of the Pass of around 25 minutes. Tory Channel, some 50km to the south-west, has a tidal range of only 1.25m, both sites exhibit a substantial S2 tidal component, as well as M2. Tidal elevation records were updated; new tidal-elevation records being determined through survey of a group of temporary pressure gauges. These were contemporaneous with the ADCP survey work and provided a context for understanding of tidal-stream flow phasing.

Equipment

The majority of the work was conducted from the 9m, aluminium vessel *Cappy*, skippered by Barry Bird out of Nelson. The ADCP was mounted halfway along the starboard side on a retractable frame. The hull and mount configuration generated little in the way of bubbles that influenced the ADCP, so high-quality results were obtained up to 8 knots, although the majority of the work was conducted at 6 knots. The ADCP was a 300-kHz RDI workhorse combined with Fugro OmniSTAR DGPS. This frequency enabled bottom tracking, but due to the blanking distance did not sample the very near-surface flow. Survey distances were of the order of 10km in a cycle, and were repeated over a period of thirteen-plus hours. Surveys were conducted on both spring and neap cycles. A single current meter was moored at each location. As one of the goals of the work was to identify tidal-stream timing it was felt that the mooring would significantly help increase the temporal resolution as the ADCP transects were around an hour apart.

Tory Channel

Tory Channel is about 500m wide at its narrowest and exits directly into Cook Strait. A number of passenger-ferries pass through the Channel daily, along with many recreational vessels. The current meter was moored in 50m of water, near the centre of the study region. The flows at the peak of the tide pushed the mooring over at a substantial angle but the data were sufficient to show the change of the tide. Tory Channel sustains strong, regular flows. Maximum current speeds reached over 3m s⁻¹ (5.8 knots) during the Spring tide and were significant throughout the entire survey region. The work was conducted throughout a period of relatively neutral weather. There is significant interest in the influence on Tory Channel flow of weather systems and flow variation in Cook Strait. The flow was very well behaved, essentially appearing as a plug flow with weak gyres in adjacent embayments. There is strong interaction between Cook Strait flow, which is not purely tidal, and the clearly tidal Channel flow. This suggests it is susceptible to interactions with weather systems and ocean circulation that might generate anomalous flows. We managed to capture one such event that manifested itself strongly in the tidal height measurements. This gives an insight into the natural and expected, but non-systematic, variation in such flows. In the channel itself the flow was very well ordered. While there was evidence of some small-scale variability, regular tidal flow appears dominant.

Te Aumiti (French Pass)

Te Aumiti (French Pass) contracts down to a navigable channel only 100m wide at one point, and was famously crossed by Dumont D'Urville in the *Astrolabe* in 1827.. Despite significant flows in the throat, actual means flows in the wider area are much reduced. Maximum current speeds reached over 4m s⁻¹ (~8 knots) during Spring tide. However, speeds were particularly large only right in the narrows itself. There was some concern that bubbles might reduce the quality of data from Te Aumiti (French Pass), so GPS-tracking drifters were repeatedly deployed upstream and this gave a Lagrangian (one that follows the flow) perspective. The drifters showed that

sometimes not all the upstream flow was entrained into the pass itself, and it very clearly showed the quasi-stationary eddies that form. While a number of drifters were trapped in these eddies they are not truly representative of flow, as drifters are surface following whereas the water can move vertically. Following on from this point, the ADCP data clearly showed strong vertical flows in the 90m-deep hole to the north-east of the pass, the scene of multiple dive fatalities.

The raw ADCP data were inter-polated onto a regular grid, as specified by the national charting agency LINZ. Some scales of variability were smaller than the normal grid spacing used, so care was taken when reporting extremes. The interpolated results have been incorporated into the New Zealand Nautical Almanac (1). They also enable reliable calibration of coastal flow and tide models, as these channels control key fluxes.

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<https://www.hydro-international.com/content/article/adcp-flow-surveys>
