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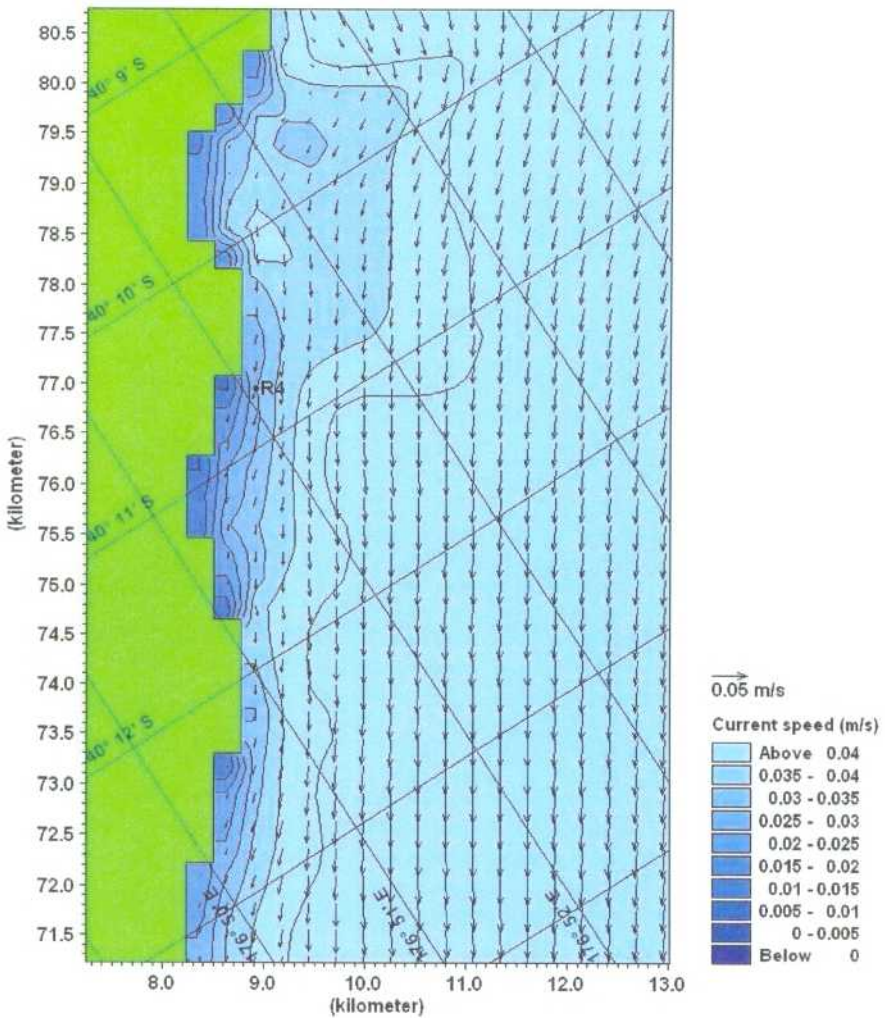


Figure 15a: Predicted residual tidal currents in the vicinity of Te Angiangi Marine Reserve.

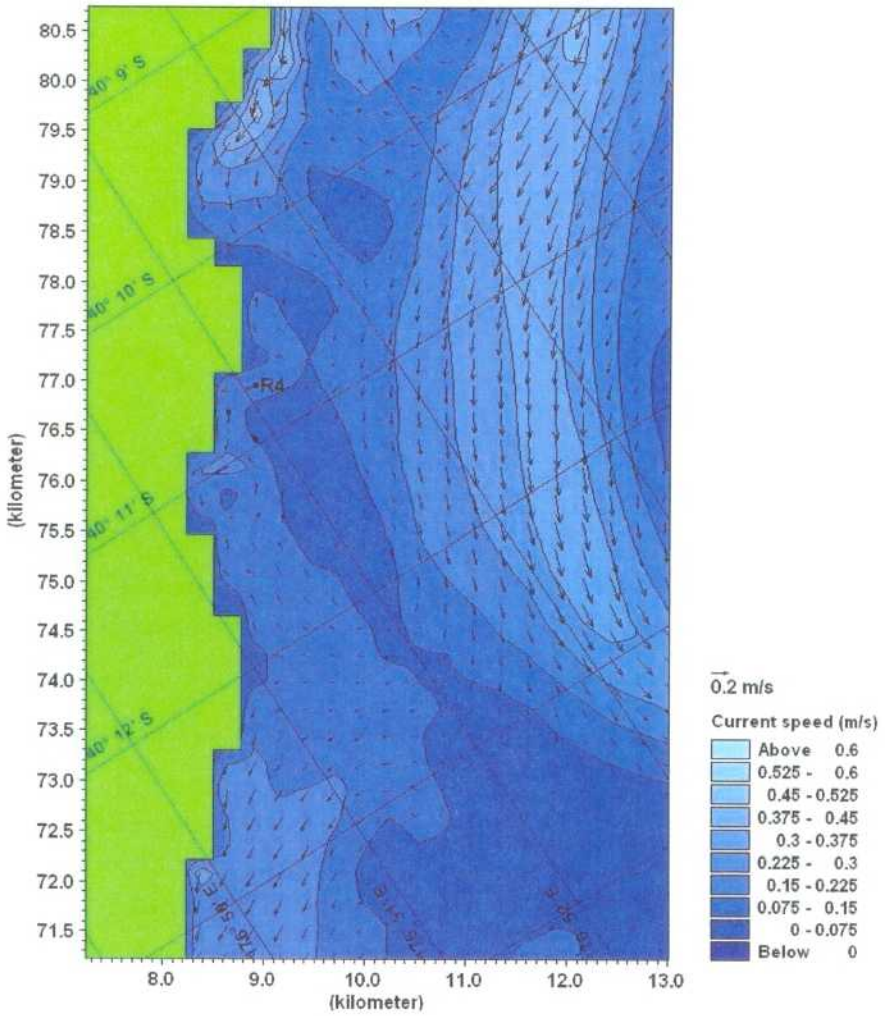


Figure 15b: Predicted residual currents in the vicinity of Te Angiangi Marine Reserve under conditions of a weak Wairarapa Coastal Current, easterly storm wave conditions and tides.

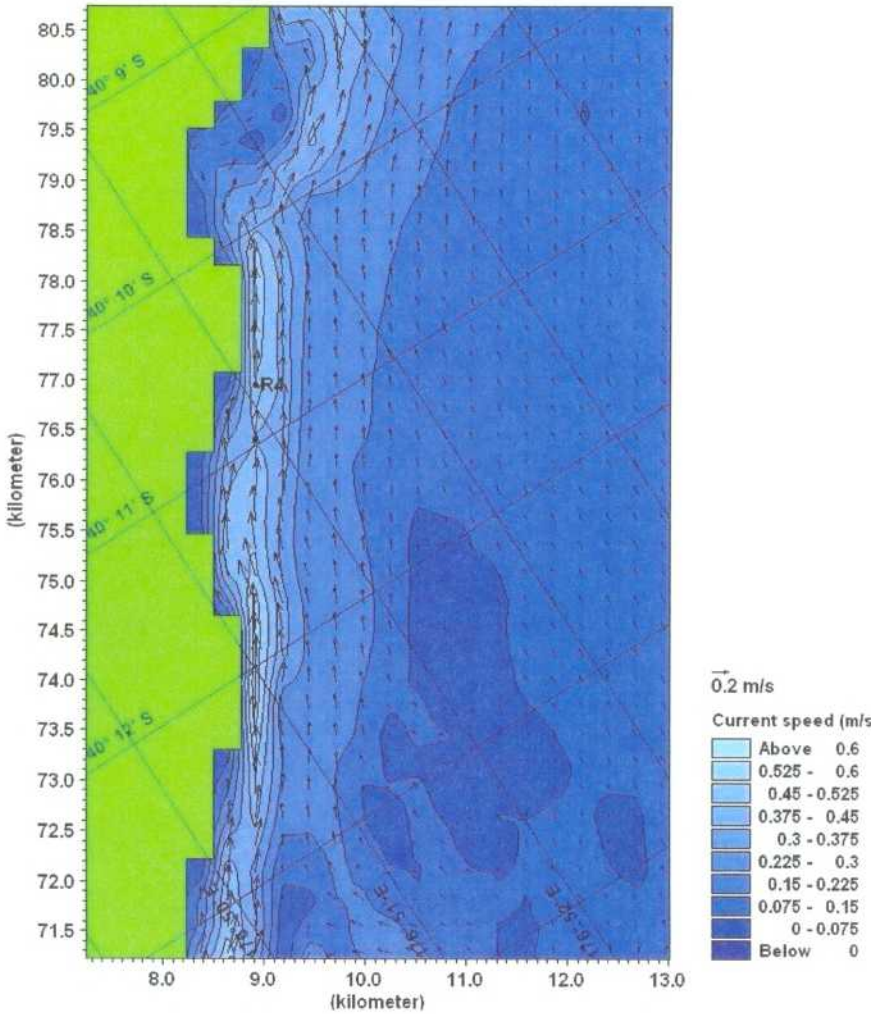


Figure 15c: Predicted residual currents in the vicinity of Te Angiangi Marine Reserve under conditions of an average Wairarapa Coastal Current, average wave conditions and tides.

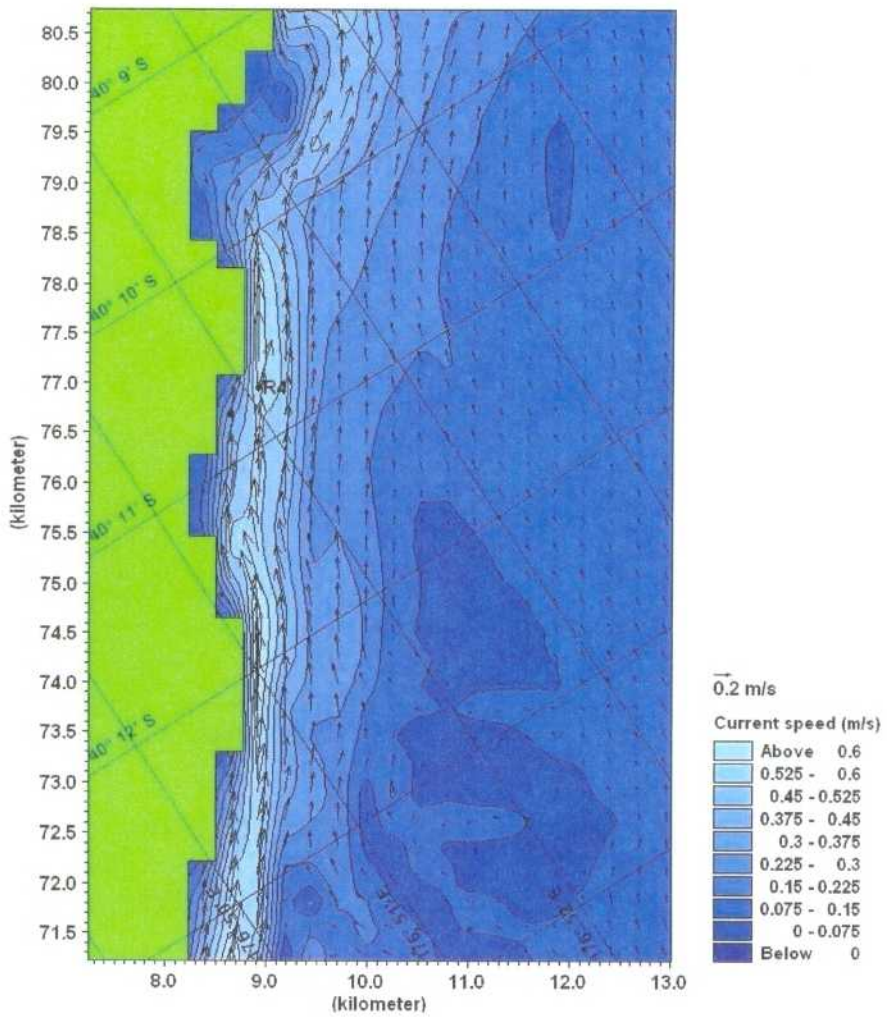


Figure 15d: Predicted residual currents in the vicinity of Te Angiangi Marine Reserve under conditions of a strong Wairarapa Coastal Current, southerly storm wave conditions and tides.

**0.5 day simulation for kelp species**

Under tidal forcing (Figure A4.la) very little transport of kelp occurs within 0.5 days. A relatively weak uniform residual current transports larvae south of the Marine Reserve (1890 m down coast) with very little transport offshore (540 m).

Under the influence of weak WCC and easterly storm wave conditions (Figure A4. lb) a weak onshore residual restricts larvae to the inshore zone resulting in very limited settling away from the Marine Reserve.

Under the influence of average WCC and wave conditions (Figure A4.1 c) the residual northward current results in settling to the north of the Marine Reserve (7020 m) but limited offshore transport and settling. A similar pattern of dispersal and settling is observed for the strong WCC and southerly storm wave conditions (Figure A4.1 d). Due to the predicted residual current being stronger more settling occurs away from the Marine Reserve (8910 m up coast) with a small offshore residual resulting in greater offshore settling (1620 m).

**4-day and 10-day simulations for bubu, limpet, and paua species**

Under tidal forcing (Figure A4.2a) larvae are transported away from the Marine reserve due to the net residual to the south and settle between the Marine Reserve and Blackhead Point (up to 8370 m down coast). Under the influence of a weak WCC and easterly storm wave conditions (Figure A4.2b) the onshore net current results in settling mostly at the release site with limited offshore settling (1350 m). Under the influence of average WCC and wave conditions (Figure A4.2c) dispersal occurs up coast (14040 m) with relatively high numbers in the near shore zone. Under the influence of a strong WCC and southerly storm wave conditions (Figure A4.2d) larvae the pattern observed under average WCC and wave conditions is repeated but with greater dispersion and settling further from the Marine Reserve (27270 m up coast and 10260 m down coast). Settling offshore is limited to less than 1620 m.

For tides alone (Figure A4.3a) slightly more larvae settle towards Blackhead Point. For weak WCC and easterly storm wave conditions (Figure A4.3b) slightly more larvae settle offshore. Under the influence of average WCC and wave conditions (Figure A4.3c) and strong WCC and southerly storm wave conditions (Figure A4.3d) there is very little difference in the predicted settling patterns between the 4 and 10-day simulations.

**20 and 30-day simulations for kina**

Under tidal forcing (Figure A4.4a) very kina settle up to 11340 m down coast. The net residual current to the south at the Marine Reserve transport larvae away from the Marine Reserve resulting in a large proportion of the settled larvae between the Marine Reserve and Blackhead. Further the residual current is small so that only a very small number of larvae settle south of Blackhead Point.

Under the influence of a weak WCC and easterly storm wave conditions (Figure A4.4b) the onshore net current results in settling mostly at the release site with limited offshore settling (1890 m). Under the influence of average WCC and wave

conditions (Figure A4.4c) dispersal occurs up coast (14040 m) with relatively high numbers in the near shore zone. Under the influence of a strong WCC and southerly storm wave conditions (Figure A4.4d) larvae the pattern observed under average WCC and wave conditions is repeated but with greater dispersion and settling further from the Marine Reserve (27270 m up coast). Settling offshore is limited to less than 1620 m. These patterns of dispersal and settling are very similar to those observed for the 30-day simulations (Figures A4.5a-d).

## 3. Conclusions

This study has combined the effects of tides, waves and ocean forcing on the dispersal of larvae along the Central Hawke's Bay coastline. Model predictions show that under tides alone there are small residual currents along the length of coast between Cape Turnagain and Te Angiangi Marine Reserve. With the influence of the Wairarapa Coastal Current and waves there are much stronger residuals and the predicted complex pattern of residual flows is strongly influenced by the combination of waves and relative strength of the WCC.

- At the Marine Reserve residual flows are to the north for average to strong WCC conditions.
- For weak WCC conditions residual currents at the Marine Reserve are very weak.
- Residual currents flow to the north and south at Cape Turnagain.
- Residual currents flow to the north and south at Blackhead Point under average and strong WCC conditions.
- For weak WCC and average wave conditions it is predicted that residual currents at Blackhead Point are to the south.
- Within the Porangahau River embayment residual flows are generally very weak and are directed onshore under weak WCC conditions and to the north under average and strong WCC conditions.

Because of their short larval duration there is little opportunity for bull kelp to be dispersed but under increasing forcing there is transport of bull kelp south of Cape Turnagain, north of the Porangahau river, either side of Blackhead Point and north of the Marine Reserve.

For bubu, limpet and paua the potential for transport is greater compared to bull kelp because of their increased larval duration. Transport of these species is predominantly to the south of Cape Turnagain but with dispersal occurring to both the north and south under strong WCC conditions. Under strong WCC conditions there is transport north of the Porangahau river and to either side of Blackhead Point. At the Marine Reserve transport is to the south under tides alone but under average and strong WCC conditions dispersal occurs to the north of the Reserve.

The observed pattern of dispersal for kina is very similar to that observed for bubu, limpet and paua and this indicate that an equilibrium pattern of transport and dispersion is developed after 10-20 days of forcing conditions.

Based on the predicted patterns of residual currents and the resultant dispersal patterns for bull kelp, bubu, limpet, paua and kina the following broad conclusions can be made with respect to the different release locations along the stretch of coast between Cape Turnagain and Te Angiangi Marine Reserve.

**Cape Turnagain**

The area to the south of Cape Turnagain consists of a long sandy beach (c. 12 km) with no intertidal rocky reef and few subtidal reefs. The nearest substantial area of intertidal reef is at Akitio (c. 20 km south of the Cape). The modelling suggests that populations of kaimoana along the coast from Cape Turnagain to Porangahau Beach are largely dependent upon self-recruitment. It is only under persistent strong Wairarapa Coastal Current and wave conditions that limited recruitment may occur between Blackhead Point and Porangahau Beach.

**Porangahau Bay**

Porangahau Bay contains a 14 km sandy beach (c. 6 km north of the river mouth, and 8 km south of the river mouth). The only intertidal reef along this stretch of coast is located off Porangahau River mouth (Taikora Rock). The modelling implies that populations of intertidal and estuarine shell fish in the bay are likely to self-recruiting. Populations on Taikora Rock will receive limited larvae from Blackhead Point and the potential for recruitment from the reefs south of Porangahau Beach is very limited.

**Blackhead Point**

Intertidal and shallow subtidal invertebrate populations just south of Blackhead Point appear to be relatively isolated, receiving little larval input from the north or the south under most weather conditions. Only under prolonged calm conditions will there limited connectivity with reefs to the north (including Te Angiangi Marine Reserve).

**Te Angiangi Marine Reserve**

Populations in Te Angiangi Marine Reserve are self-recruiting and receive most external larval inputs from the reefs immediately to the south of Blackhead Beach. Any potential benefits the Te Angiangi Marine Reserve are likely to be greatest on the

reefs north of it, and numbers of larvae potentially settling on these reefs from the marine reserve are likely to quite large.

Because of the limited larval duration populations of bull kelp along the Central Hawke's Bay coast may be reproductively isolated from each other and may require careful management to ensure adequate recruitment

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## 5. Appendix 1: Larval dispersal plots: Released from Cape Turnagain

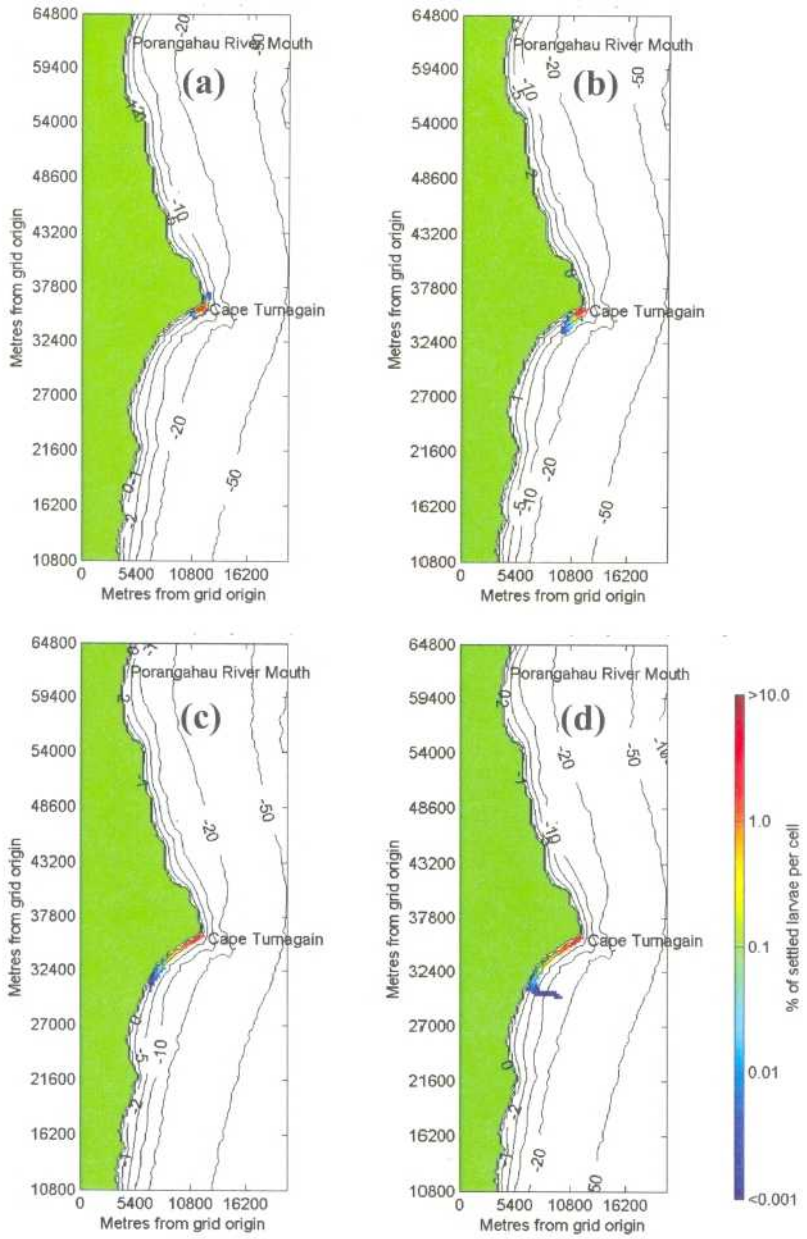


**Figure A1.l:** **Release Point Rl: Cape Turnagain. Larvae type: Bull Kelp. Simulation time: 0.5 days.** Predicted settled larvae per cell (as a percentage of the total settled) for (a) tides alone, (b) tides plus weak WCC conditions plus easterly storm waves, (c) tides plus average WCC and waves and (d) tides plus strong WCC conditions plus southerly storm waves.



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