# Environmental implications of a proposed channel excavation for boat access near the Rangitikei Rivermouth

Report prepared for Mr John Grice, Tangimoana Boating Club

By Dr Roger Shand

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**Client Report 06/03**

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## 1.0 Background

On 4 November, 2005, an application for a resource consent to excavate the bed of the Rangitikei River was made to Horizons Regional Council by Mr John Grice on behalf of the Tangimoana Boating Club. The excavation was to cut a new boat access channel between the existing boat ramp and the main channel (see Figs 1 and 2). The proposed cut would be approximately 270 m long by 12 m wide by 4 m deep, with (side) batters at ~20 degrees. Details of the excavation, as sketched in the resource consent application, are shown in Fig 3.

The proposed channel is to facilitate quick and safe access to the lower river and sea for recreational boats and emergency rescue craft during all but the most extreme tide/river conditions. Such a proposal was seen by the club as the best way to remedy deteriorating channel depths which had been occurring since the major flood event of the 14th to 17th February, 2004. This was an extreme event with a rainfall return period of 150 years.

Prior to making the application, Mr Grice had consulted with the the Manawatu District Council, Fish and Game NZ, Te Runanga o Papawhenua. and the Department of Conservation (DOC). With the exception of DOC, all partiers supported the application to cut a new channel. As managers of this crown land, DOC were concerned about potential ecological impacts. They required a favourable report regarding environmental effects before making any decision.

In February 2006, Mr Grice commissioned Coastal Systems (NZ) Ltd to prepare a report that would focus on the following departmental concerns as described by Biodiversity Manager (Palmerston North) Ms Vivienne McGlynn:

*Activities in the coastal marine area are guided by the NZ Coastal Policy Statement and administered by Horizons Regional Council on behalf of the Minister of Conservation. The Rangitikei River is also classed as a Protection Area in the Regional Coastal Plan with an area of saltmarsh recognize as a Recommended Area for Protection (under the Protected Natural Area Programme run by Department of Conservation). Restrictions are placed on those activities that have adverse effects on this environment. Any development in this environment then comes under scrutiny and requires an assessment of the effects that the development is likely to have. Resource consent applications require an Assessment of Environmental Effects and this application did not have one. In this case the Department is interested in knowing the effects of the proposed cut in the mudbank on the estuarine processes e.g. hydrological effects, sedimentation, effects on bird feeding habitat.*

While the following assessment of environmental effects focuses on natural physical processes and ecology, some consideration is also given to other uses and values.

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1. 1962 (vertical), 1967 (vertical), 1970 (vertical), 1971 (vertical), 1980 (vertical), 1983 (vertical), 1990 (vertical), 1995 (vertical), 2000 (vertical), 2002 (vertical), 2003 (vertical), 2004 (oblique).

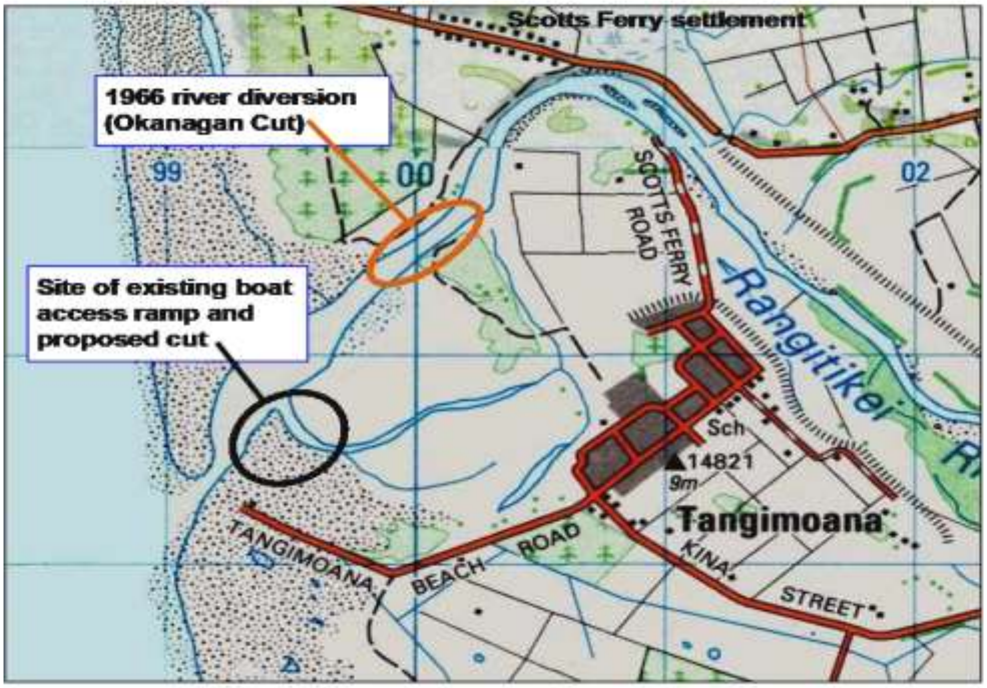


Figure 1 Topographic map of the Rangitikei Rivermouth area showing the site of the proposed cut and location of the 1966 river diversion.


Figure 2 Natural features, boating utilities and location of the proposed cut near the mouth of Rangitikei Rivermouth.

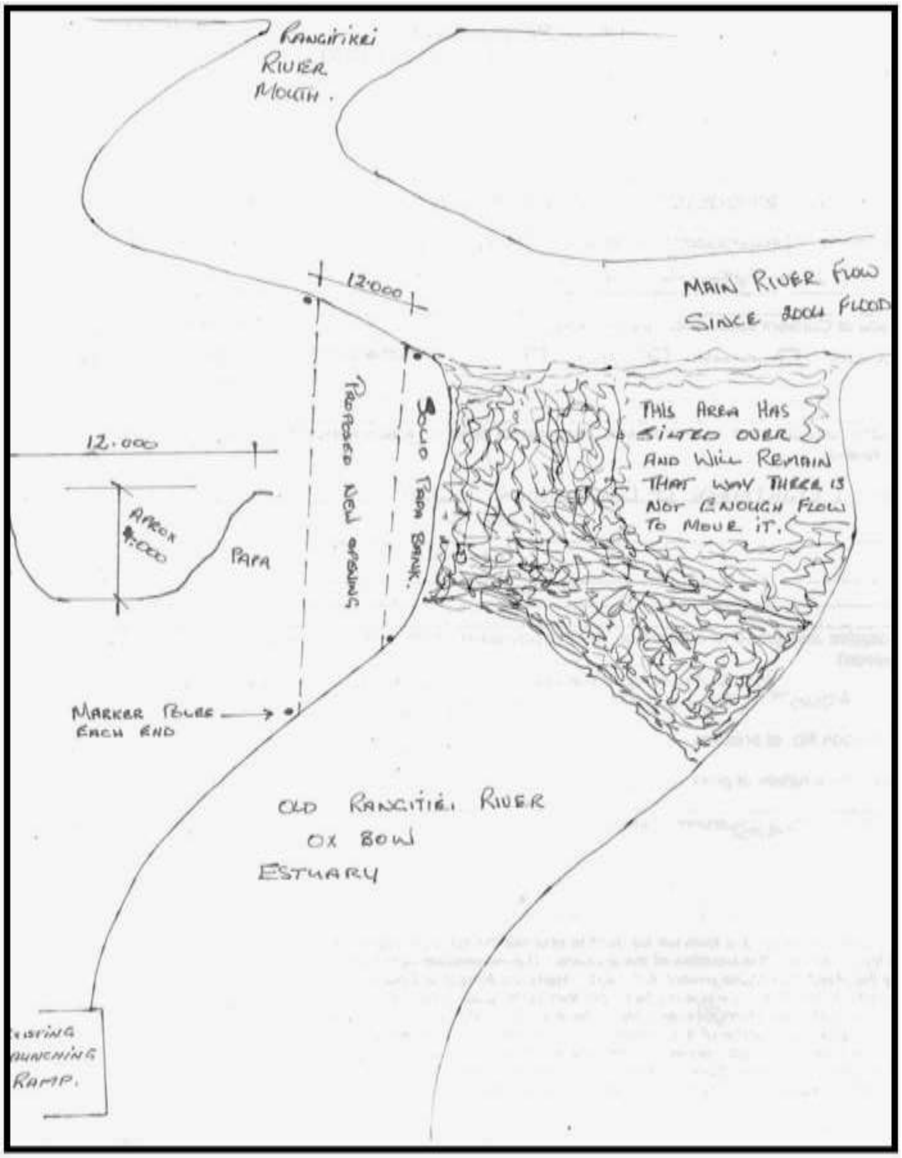


**Figure 3 Sketch of the proposed cut as attached to the Tangimoana Boating Club's resource consent application.**

The investigation consisted of familiarization of relevant literature, acquisition of historical aerial photographs[1], a fly-over on 27th April, 2006 when oblique photographs were taken (e.g. see Fig 2), abstracting data from photographs using standard photogrammetric techniques and using time-based analysis procedures to determine the nature and extent of channel changes. In addition, a site visit was made on the 25th May, 2005 by Dr Roger Shand (coastal process scientist), Mr Colin Ogle (ecologist) and Mr John Grice of the Tangimoana Boating Club.

## 2. Physical characteristics and dynamics

The Rangitikei River is 241 km long, making it the 3rd longest in the North Island, and has a natural annual mean flow of 88 $m^3/s$ which is the 6th largest in the North Island. The natural annual low flow is 14.7 $m^3/s$, and natural annual flood flow is 830 $m^3/s$. The coastal region is characterized by a wide sandy beach with predominant north to south littoral drift, sand dunes, estuary and broad flood plain. This grades into river terraces, then hill country which provides much of the river's finer sediments, and finally to the Ruahine Ranges and Kaimanawa Mountain headwaters which provide the river's substantial (gravel) bed-load.

In recent times the flow and sediment regimes have undergone several anthropogenic changes. In the late 1970s, part of the Rangitikei headwaters were diverted into Lake Taupo as part of the Tongariro Power Development (TPD) Eastern Diversion. In the lower river flood flows have decreased by 0.4%, the mean flow by 11% and the low flow by 16%. Water allocation has reduced flows by a further 2.6 $m^3/s$. The Rangitkei River provides most of the metal for the Rangitikei and Wanganui regions with 210 000 $m^3$ being extracted in 2003.

While these regime-shifts may have modified sediment transport processes to the extent that navigability in the lower reaches is affected, the most notable changes were associated with the 1966 river diversion known as the Okanagan Cut which cut out the loop that passed Tangimoana (see Fig 1). While this work carried out as part of the Lower Rangitikei Flood Control Scheme, it also relieved bank erosion at Tangimoana. Fig 4 shows both the natural channels and the Okanagan Cut operating in 1971.

The old river bed has slowly infilled and the seaward channel remnants are locally referred to as the 'Estuary' and the 'Basin' (see Fig 2). The Basin has undergone greater infill due to its closer proximity to the coastal sand supply which blew directly into the Basin and was also transported upstream under the action of waves and flood currents to reach the Basin. In addition, sand was/is then blown further up the Basin where sediments of fluvial origin (silts) are also deposited during higher tides or during floods. By contrast the Estuary remains a tidal channel.

It is noted that while the old river courses are known locally as the Estuary and the Basin, estuarine processes actually affect much of the area below the Okanagan Cut. Nonetheless, to avoid confusion, the local meanings will be used in this report, and the entire area seaward of the Okanagan Cut will simply be referred to as the 'lower river'.

The most significant morphological change resulting from the Okanagan Cut, as evident in the sample of aerial photographs available to the author, has been the systematic migration of the main channel from a northern entrance (and south spit) to a southern entrance (and north spit). This process is illustrated in Fig 5 which depicts the behaviour of the true left bank.

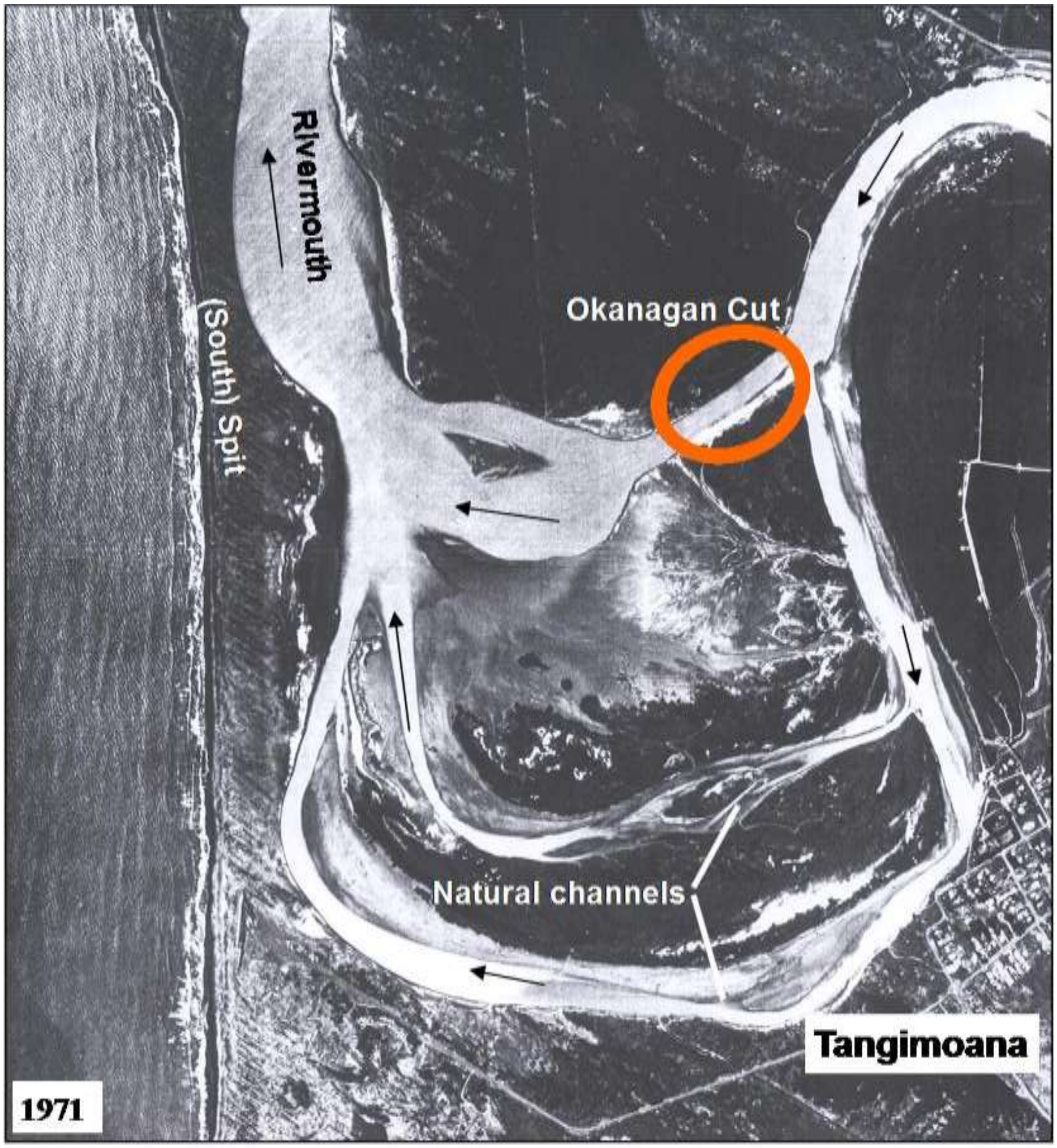


**Figure 4** Lower river simultaneously flowing through the original (natural) channels at bottom of this 1971 photo, and through the Okanagan Cut made in 1966. For several years both the natural and diversion channels operated.

While the direction of net longshore drift can, in general, skew outlet orientation and spit development, the river geometry immediately upstream of an entrance can override this control, especially for larger rivers. For example, the Whanganui River flows to the north behind the South Spit after changing to this direction at Landguard Bluff. With the

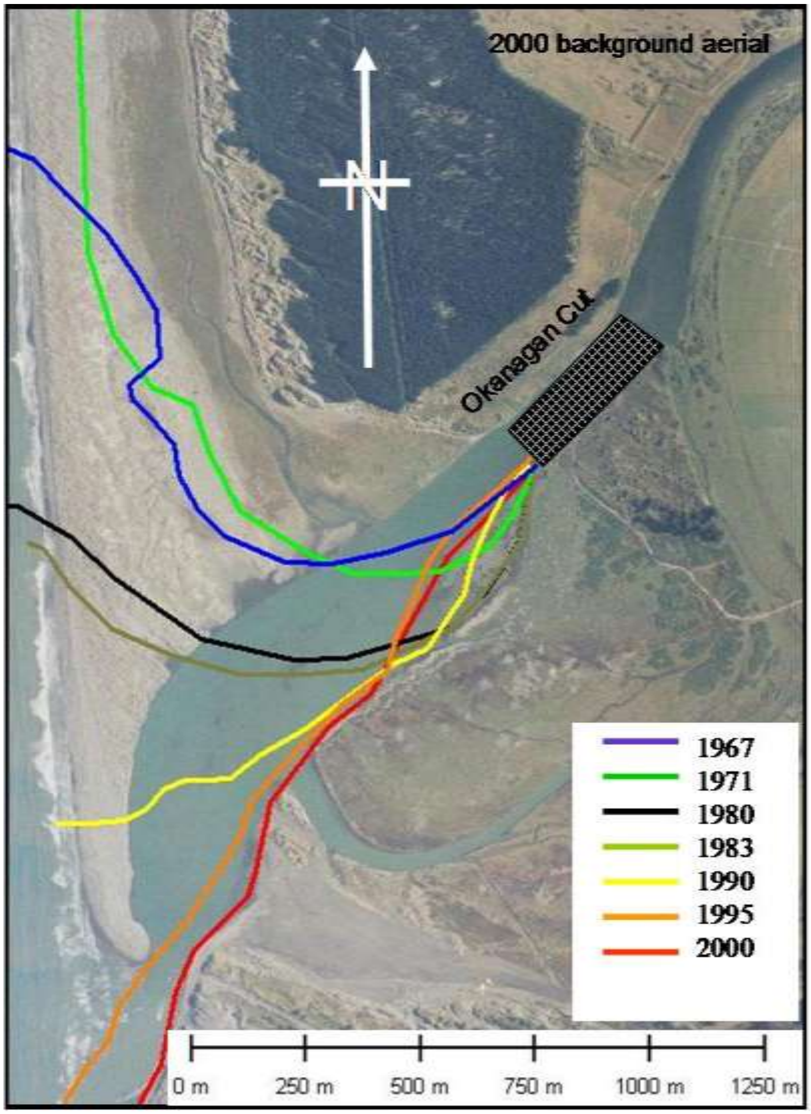


Figure 5 Systematic southward migration of the left bank of the main river channel since opening of the Okanagan Cut in 1966.

Rangitikei River, the Okanagan Cut has a southerly offset and this allowed the entranc to migrate toward the south and the spit to change from a southern attachment to a northern attachment.

A further morphological change has been the ongoing development of a shoal downstream of the Okanagan Cut (Fig 6). Shoals often occur downstream of a flow constriction as deposition accompanies the drop in velocity. The flow can then bifurcate, i.e. fork with channels running along each bank. Over time, one channel tends to predominate and the other may infill. Such a process is indicated in Fig 6. While different water levels at the time photographs were taken mean that these data only

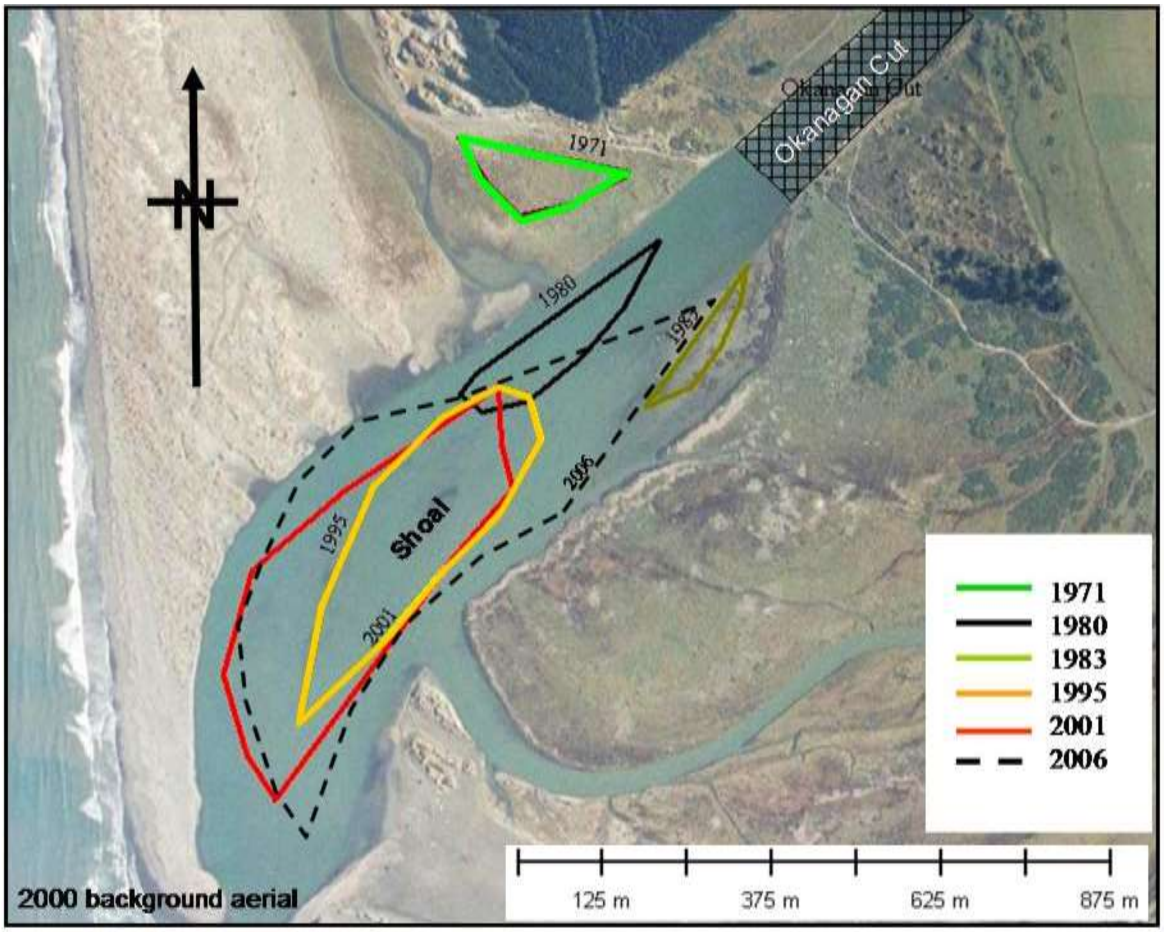


**Figure 6 Development of the shoal below the Okangan Cut based on aerial photographs. Location of the shoal margins are influenced by tide and river levels at time of photography. Note the 2006 outline is approximated from the 2006 oblique aerial.**

provide an indication of shoal dimensions, the spatial extent does appear to be increasing. While there were no post-flood vertical aerials available to the author at the time of writing this report, the 2006 oblique aerial (see Fig 7) indicates that the shoal is extending toward the north and that the right bank is eroding.

Further significant morphological change was associated with the February 2004 flood which breached the spit. Since that time the entrance has migrated back toward the south. These more recent changes can be appreciated by studying oblique aerial photos taken on 1 August, 2004, some 6 months after the flood (e.g. see Fig 8), and the oblique photos taken in April of this year (e.g. see Fig 2). In particular:

- The section of the (north) spit detached by the breach subsequently migrated onshore under wave action and merged to the southern beach (Fig 8), which consequently underwent a dramatic increase in width (Fig 2). It is noted that breaching of rivermouth spits during a flood, and the subsequent merging of the tip with the adjacent beach, is a well recognized mechanism by which littoral sediment bypasses an entrance. Furthermore, the dramatic input of sediment onto the south coast is now available to be blown inland and this will cause dune instability if the growth of dune grasses is unable to keep pace with the rate of sand deposition.

- At the mouth of the Rangitikei River, some of the old north spit sediment also merged directly to the mouth of the Basin (Fig 8). This sediment input has blocked drainage from the Basin and this has been has been redirected toward the Estuary as depicted in Fig 2.

- It is also very likely that the present infill at the mouth of the Estuary, the cause of the present boat access problem, is sourced from the north spit sand which is being moved upstream by waves and currents during flood tides.

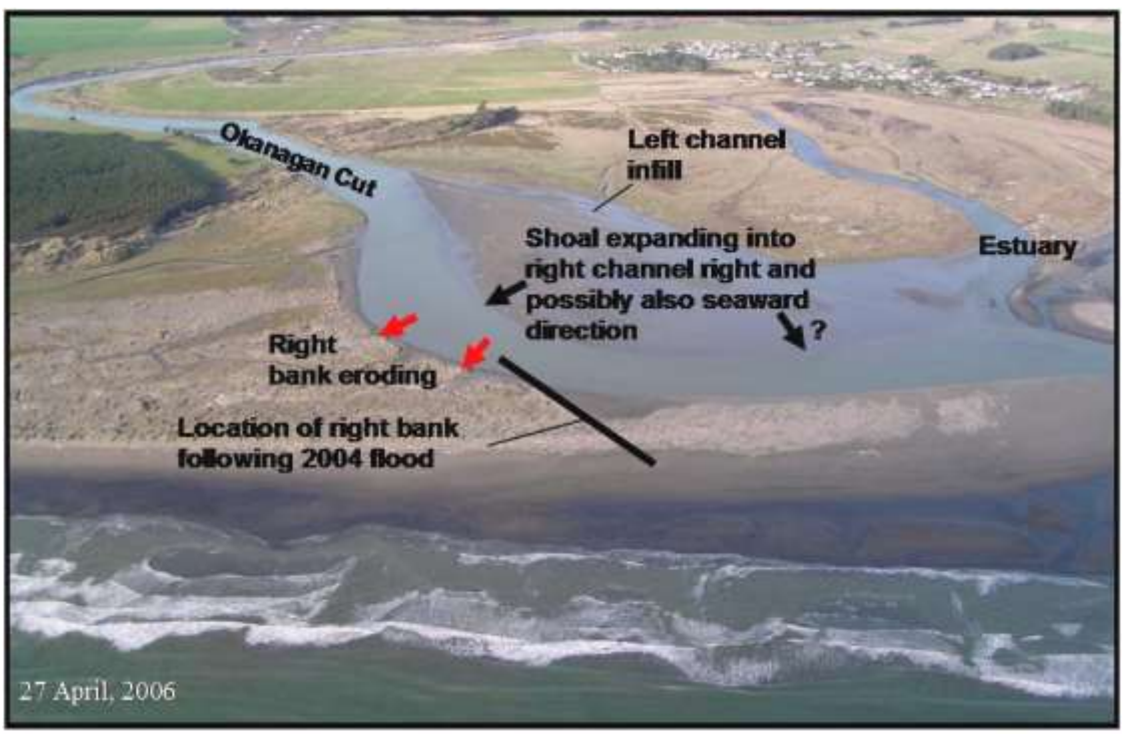


**Figure 7 Channel processes occurring at the present time between the Okanagan Cut and the Estuary.**


Figure 8 Existing utilities, and morphological processes 6 months after the extreme flood event in February 2004.

The 2006 oblique air photo (Fig 2) indicates that the seaward end of the shoal may be extending toward the mouth of the Estuary, although vertical aerial photos are needed for confirmation. However, if this is indeed the case, then such a process may also contribute, either now or in the future, toward infill of the Estuary mouth.

It might be expected that natural channel meander processes will result in the alignment of the main channel eventually returning towards the left bank – and eventually opening the Estuary entrance. However, the present tendency for the main channel to erode the northern riverbank, the increasing size of the shoal, the infill of the channel along the southern side of the shoal and the volume of north spit sediment which has come across to the southern coast and river bank, will greatly hinder such a return process. Predicting the future behaviour of the main channel with any certainty would require a study well beyond the scope the present investigation

## 3.0 Boat Access

Several different boat access locations have been used on the eastern side of the river since the 1966 diversion. Prior to the cut, and for some time thereafter, boat access was from the slipway at Tangimoana. Reduced depths subsequently resulted in a slipway being made about 1 km upstream of the diversion. However, localized shoaling also occurred in this area and boat owners began to launch from the mouth of the Basin. This approach required driving down the entire length of the Basin and at times this was hindered by tides, flood levels and soft sediments.

In 2002-03 access switched to the Estuary with a slipway being constructed, along with a metalled accessway and car park (see Fig 8). River/sea access via the Estuary worked well until the 2004 flood after which the entrance to the Estuary has been infilling. In February of this year, a small cut was excavated within the Estuary mouth (see Fig 2) to allow boat access for the club's annual fishing contest. This channel was expected to provide a 'temporary solution'. The present proposal to bypass the Estuary mouth is the latest move to ensure boat access.

## 4.0 The effect of physical processes upon the proposed cut

The natural processes described in section 2 whereby sediment enters the Basin and Estuary, will also affect the proposed cut. As such sedimentation processes are likely to continue into the future, ongoing maintenance will be required to keep the proposed cut navigable.

The cut will cross the present drainage outlet from the Basin as marked in Fig 2. The Basin's drainage has been deflected toward the Estuary following the recent sediment accumulation associated with merging of the north spit. Having the basin drainage join the new channel may compromise the hydraulic efficiency of the cut and hasten its infill.

Alternatively, a separate Basin drainage channel could be made which joins the main river channel further downstream. However, this would also require ongoing maintenance.

The cut requires excavation of a substantial volume (~12 000 $m^3$) of soft muddy sediment and this material is to be spread in situ. Excavation could present logistical difficulties for the operator given the unstable footing and it will also cause widespread surface disruption. Care will also be required in placing the spoil to ensure that this material does not slump or wash back into the channel.

Uncertainty in the future behaviour/alignment of the main channel (section 2) adds further concern to the longer-term viability of the proposed cut as this area could become isolated from the sea.

## 5.0 Effects of the proposed cut on the physical environment

Given the extent of the natural change evident within the lower river/entrance area over the last 40 years, the proposed cut will have minimal affect upon the hydraulic and sedimentation processes within the lower river system. Even at a very local scale, the effects of natural change will dominate, especially with infill presently occurring at the mouths of both the Basin and the Estuary. However, as noted above, the excavation and spoil could impact on the current drainage outlet for the Basin and also on the ecology which is considered in the following section (6).

After a settling period, the new cut will take on the appearance of, and blend in with, other water courses within this expansive lower river/estuary system. Foot and vehicle access to other locations will not be compromised, and, based on historical evolution and spatial scale, it is difficult to see how there could be any adverse effects on historical values, cultural values, spiritual values or any other special values as specified in the Resource Management Act (1991).

## 6.0 Effects of the proposed cut on local ecology

The tidal areas in the vicinity of the proposed cut consist of soft fine silts with firmer silt and sand occurring in more elevated areas.

Flora in the area of interest consists of several different communities of saltmarsh vegetation which are described in Appendix A. Of particular relevance to the proposed cut is a thriving community of the native sedge *Carex litorosa* which has a national conservation status of ‘Chronically threatened – serious decline’. While the proposed cut would eliminate a large number of the observed *Carex litorosa*, further surveys covering the lower river system would be required to assess the significance of the observed community.

It is also noted that stems of a tall bamboo-like grass called *Phragmites* is being used to mark the present boat access channel between the slipway and the main river channel. *Phragmites* has been labeled one of the world's worst weeds because of its ability to spread and block waterways. Further description and discussion on this plant pest is provided in Appendix A. Alternative means of marking navigable channels should be used in the future.

Appendix A also details the types and numbers of birds observed during the field trip. A greater variety were evident compared with the Whanganui Estuary and in some cases greater numbers. Many crab holes were evident on the mudflats and plenty of footprints of wading birds indicated the area was a significant feeding habitat. If the spoil from the cut excavation is to avoid the *Carex litorosa* community, then it will have to be spread out on the mud flats near the mouth of the Estuary, and hence impact on this food source for wading birds. Further information would be needed to assess the significance of the loss of feeding habitat in terms of the total available within the lower river system.

When assessing the effect of the proposed cut on the plant and bird habitat, the impacts of flood events and larger scale morphological change also needs to be taken into account. In particular, the system appears to have the capacity to recover from silt deposition as evident from the response to river floods, so the effect of spoil on the mudflats should only be temporary. In addition, natural estuaries are highly dynamic environments where the spatial pattern and species composition of both flora and fauna continually adjust in response to changing channels and landforms. The dramatic morphological evolution of the lower river system during the past 40 years has resulted in continually changing environments in the vicinity of the proposed cut. This situation is likely to continue given both the changes that have followed the 2004 flood, and the future changes indicated in the preceding description of physical processes.

## 7.0 Alternative boat access

Given the range of physical and ecological issues associated with the proposal to excavate a new channel, alternatives for boat access were considered.

The temporary channel (Fig 2) excavated through infill at the mouth of the estuary last February is still functional through the mid to upper part of the tidal cycle. This channel is ~100 m long. Increasing the depth by say 1 m and the width by say 5 m would allow boat access throughout the tidal cycle. This deepening of the existing channel amounts to a partial 'reinstatement' of the pre-flood channel at the mouth of the Estuary. While this alternative will still be subject to the same sedimentation problems as the proposed cut, there are several advantages with this smaller-scale option.

Excavation will occur within the recent infill at the mouth of the Estuary rather than through undisturbed mud flats. The reduced volume of material to be excavated (~90%) makes the operation more straightforward, cheaper and less environmentally disruptive.

Spoil can be spread within the relatively wide Estuary entrance which has been subject to significant recent change, rather than over previously undisturbed mud flats.

While the excavation can be carried out using a land-based long-reach digger, the viability of mounting the excavator on a pontoon should be investigated.

The relatively small channel cross-section and length will minimize future maintenance volume. However, should the rate of infill increase to an extent that makes maintenance excavation impractical, then this same situation, albeit to a greater degree, would affect the proposed cut.

The channel deepening option avoids the area of *Carex litorosa.* There will also be minimal impact on the bird feeding habitat as most dumping should occur about the Estuary mouth which, as noted above, has recently undergone significant natural disruption anyway.

As indicated in the description of physical process (Section 2), boat access via the Estuary-Basin area may become increasingly difficulty because of future changes in the main channel. If this were to occur, safe and more reliable access may be possible below the Okanagan Cut where the river width increases and flow decreases. Estuarine processes are also less pronounced than further downstream. However, vehicle access would cross private property so this would need to be negotiated. In addition, significant upgrade of the vehicle accessway would be required. Nonetheless, the club should consider such alternatives in its longer-term planning.

A further aid to such planning would be ongoing monitoring using vertical aerial photography. Mr Lawrie Cairns of *Lawrie Cairns and Associates – Survey Services and Aerial Photography*, based in Palmerston North, has indicated the cost of an annual survey would be less than $500. Sequential photography, as demonstrated in the present study, enables geomorphological change to be identified and even predicted.

## 8.0 Recommendations

1. That the proposed cut between the estuary and the main river channel be abandoned;
2. That the ‘temporary’ channel excavated in February 2006 within recent infill at the mouth of the Estuary be deepened to allow boat access throughout the tidal cycle;
3. That care be taken during this excavation to minimize disruption of the tidal mud flats in general and to the *Carex litorosa* plant community in particular;
4. That spoil from the excavation be placed only in the vicinity of the Estuary mouth;
5. That maintenance excavation be carried out as required;
6. That the club work toward establishing viable alternatives as part of its longer-term planning;
7. That monitoring using vertical aerial photography be undertaken at about yearly intervals to assist future planning.

## Acknowledgements

Mr Colin Ogle is thanked for his invaluable observations (compiled as Appendix A) of the ecology in the vicinity of the boat launching area. Dr Mike Shepherd is thanked for reviewing the manuscript. Mr Harold Barnett and Mrs Noelene Wevell of Horizons Regional Council are thanked for providing information. Mr John Grice is thanked for a most interesting field excursion and refreshments at the Boating Club, and Mr Craig Mitchell-Anyon is thanked for flying us over the rivermouth – while managing to avoid training planes from the Ohakea Airforce Base.

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# Appendix A

## Comments on the ecology of the Tangimoana Estuary in the vicinity of a proposed new channel for the Tangimoana Boating Club

By Colin C. Ogle[1]

In the course of a familiarisation tour of the estuary with Dr Roger Shand and Mr John Grice on 25 May, 2006, I noted several matters of ecological relevance regarding future management. I also took a number of photographs, several of which are attached. Whilst not being particularly familiar with the estuary before this visit, I am familiar with the nearby Tawhirihoe Scientific Reserve which I have been visiting since the early 1990s. I also note that I was the scientific field investigator (with Don Ravine) and advisor that resulted in 50 ha of the Rangitikei River estuary becoming a Recommended Area for Protection (RAP) with the Protected Natural Areas Programme survey of the Foxton Ecological District (Ravine 1992).

The place names referred to below are as depicted in Figs 2 and 8 in Dr Shand's report

1. **Flora in the vicinity of the proposed boat access**

   In the general area under consideration, I noted a number of different plant communities that could all be called collectively 'saltmarsh vegetation'. On soft fine silts in the Basin between the carpark causeway and the access road to the beach is sparse vegetation composed almost solely of a small tufted sedge, *Isolepis cernua* and sea primrose (*Samolus repens*). Slightly more elevated areas with sand and firmer silt contained a larger variety of taller plants. A creeping sand sedge (*Carex pumila*) occupied the most sandy areas, but it also grew among taller vegetation comprising sea rush (*Juncus kraussii*) and three-square (*Schoenoplectus pungens*) with scattered plants of oioi or jointed rush (*Apodasmia similis*).

   Immediately seaward of the carpark/boat launch ramp, I found numerous plants of a native sedge, *Carex litorosa*, which has a national conservation status of 'Chronically threatened – serious decline'. Nationally, its habitat is exclusively saltmarshes where it forms tussocks to about 30 cm tall. It has a history of local extinctions e.g. the Hutt River estuary in 1950s or 1960s, the Waikanae estuary since about 1975,

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Whitiau Scientific Reserve at the Whangaehu River mouth in about 1990. I know of a small number of plants at the Manawatu Estuary, but north from there I know it only at Tangimoana, Waitara River and then the King Country.

At Tangimoana, my guesstimate is that at least 200 plants of C. litorosa exist between the carpark and the main river channel. This area includes the proposed cut. Immediately upriver (east) from the carpark I found dozens more *C. litorosa*, this time among dense sea rush and shorter stature succulent plants such as a native saltmarsh celery (*Apium 'filiforme'*), and a button daisy (*Leptinella dioica* ssp. *dioica*). It is almost certain that the construction of the carpark will have eliminated many plants of *C. litorosa* and other saltmarsh plants. Although a reasonable estimate of the loss could be made from calculating the densities of *C. litorosa* immediately up and down stream from the carpark then measuring the area of the carpark and boat-ramp, this is probably not useful after the event. The main issue is to protect the remaining population which seems particularly suited to this environment.

The proposed cut for boat access would eliminate a large number of *C. litorosa*, but whether this is the largest area of the tussock in the whole estuary is unknown. If the existing channel, referred to as the temporary channel in Fig 2 of Dr Shand's report, is simply deepened and excavated silt is not dumped on vegetated areas, i.e. not deposited on the left hand side of the existing channel, then *C. litorosa* should not be affected.

In mentioning above the button daisy, *Leptinella dioica* ssp. *dioica*, it should be noted that this is a regionally very sparse plant, with small amounts in the Manawatu and Whanganui estuaries, and several others south to Makara west of Wellington. The more southern forms have been described as a separate subspecies (ssp. *monoica*, listed as nationally 'taxonomically indeterminate – gradual decline'), but between the Rangitikei River and Makara the forms intergrade and there is doubt about the validity of maintaining two subspecies. Further genetic work could be instructive, and it is important to keep existing populations of this variable plant for future research.

### 2. *Plant pest - Phragmites australis* ('common reed')

*Phragmites* is a tall grass of waterways with a known capacity to colonise large areas. It is indigenous to 'almost every part of the world from the tropics to the cold-temperate zones, except New Zealand' (Burrows 1998). The only records in 'Flora of New Zealand Vol. 5: Grasses' (Connor and Edgar 2000) are 'several locations near Napier …… once in Westland'. Therefore, it came as a considerable surprise when I identified the several patches of the bamboo-like grass immediately in front of the Tangimoana boating club as *Phragmites australis*. It is rhizomatous, meaning that one young plant can become an extensive patch in suitable habitat. In New Zealand seeds are rarely found (Connor & Edgar 2000). The weed potential of *Phragmites* is well-known and documented, according to Burrows (1998). He goes on to report that it grows in freshwater and slightly brackish water and coastal lagoons where its vigorous rhizome and shoot systems, and the height and density of the plant give it competitive advantage over other species in the same habitats. Most other species are excluded. This is enhanced by winter die-down of foliage. Burrows (1998) cites Holm et al. (1977): 'Phragmites is one of the world's worst weeds, capable of blocking up waterways and drainage canals'. Seed is rarely set in New Zealand and its spread is either by chance dispersal of fragments, e.g., during flood events or use of machinery, or by deliberate planting. At Tangimoana, the cutting of stems of this grass to mark the tidal channel for boat users, might start new colonies unless the sticks are dried first.

I have contacted Hilary Webb, a pest plants officer with Horizons Regional Council (HRC), about *Phragmites*, and she states that she knows that it is at Tangimoana and it has been there at least 8-9 years. This knowledge had obviously not reached Manaaki Whenua - Landcare Research by 2000 (loc. cit.). HRC stated they will have the funding and ability to deal with *Phragmites* (H Webb, pers.comm. May 2006).

## 3. The Rangitikei River estuary as bird habitat

Gathering data on birds from a single visit to any site is insufficient to form a sound opinion as to that site's significance for birds. However, I was impressed by both the numbers and variety of waders and other wetland birds I saw in the estuary on our visit. They included 10 banded dotterel, 1 variable oystercatcher, 3 royal spoonbills, > 20 pied stilts, 1 white-faced heron, 4 eastern bar-tailed godwits, > 500 black-backed gulls, several unidentified shags, a kingfisher (on the mud flat), black swans and mallards. This is a greater variety and, for some, with greater numbers, than I would expect to see at the Whanganui Estuary at the same time of year. In some of the mudflats we crossed there were many crab holes and plenty of footprints of wading birds (probably banded dotterels**).**

If excavated material from the proposed cut is to be dumped away from the threatened C. litorosa, then it will have to go on to the mud flats in the vicinity of the Estuary mouth (Figs 2 and 8 in Dr Shand's report) which is an area used for bird feeding. More extensive surveys of the birds and their favoured feeding habitats would be needed to determine whether the dumped silt could impact significantly on birds in the estuary. In addition, more information is needed about the area of tidal flats that would be affected by the spreading of dumped material. If both these factors were found to be significant, then complete removal of excavated material from the estuary might need to be considered. Nonetheless, it should be borne in mind that after large flood events fresh silt is spread over the mudflats anyway and the system seems to have the capacity to recover. However, simply deepening the existing ('temporary') channel, rather than cutting a new channel, will greatly reduce the volume of material to be dumped and minimal effect on feeding habitat is expected.

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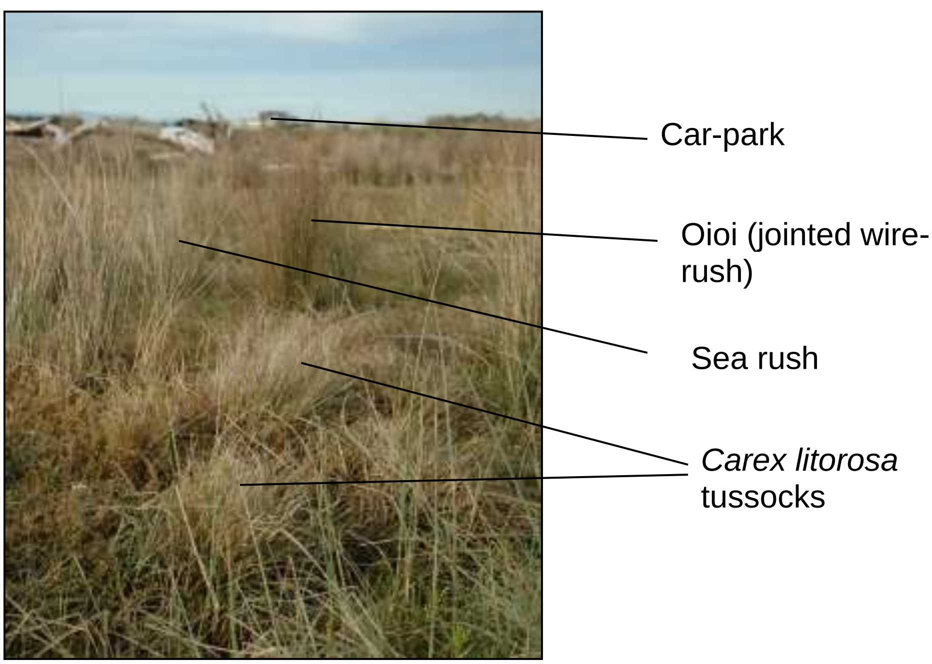
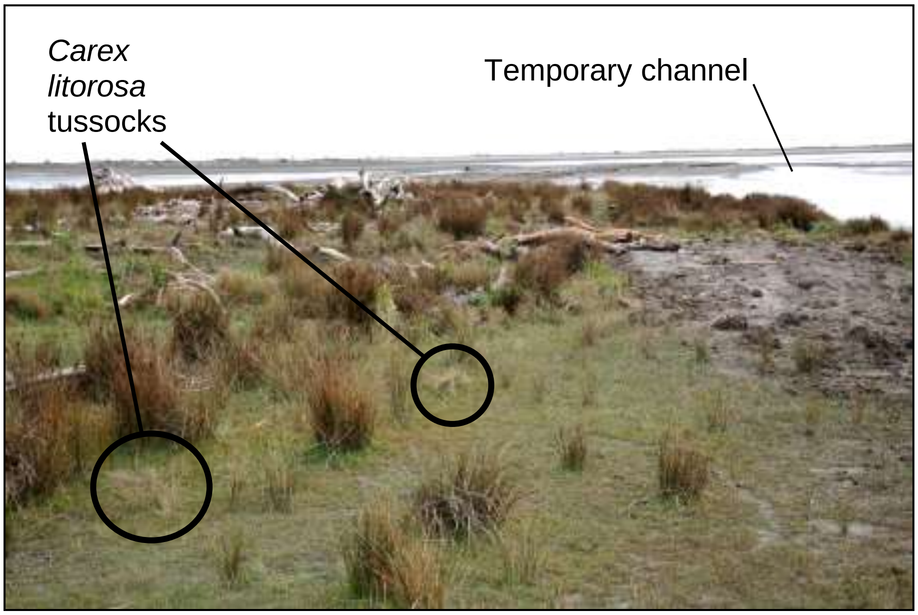
## Figures

Salt marsh vegetation containing *Carex litorosa*, about 20 m from car-park for Tangimoana boat-ramp



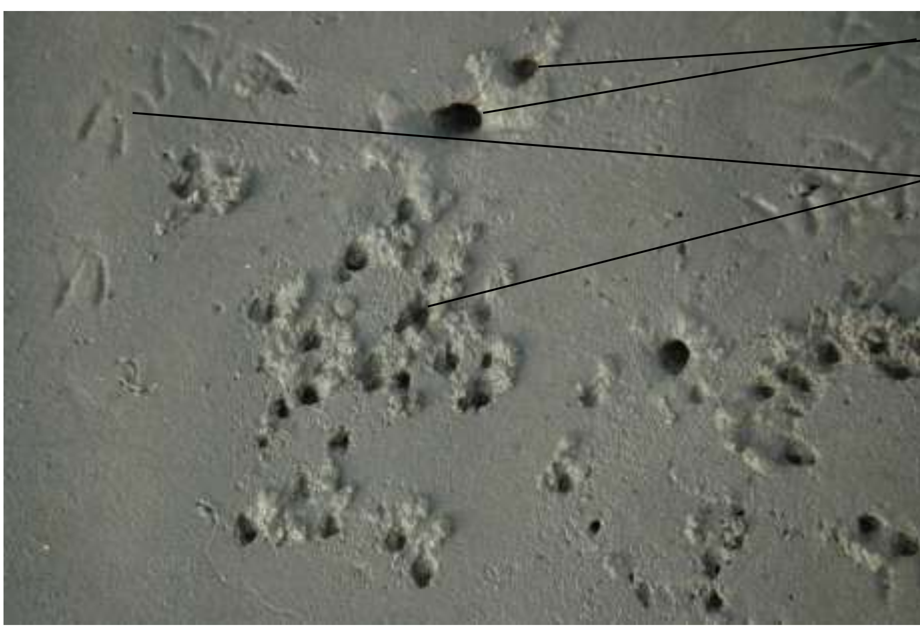
View towards coast from boat-ramp car-park,
in vicinity of proposed new channel




*Carex litorosa* at Tangimoana 20 m from boat-ramp car-park.
The curled leaf tips are a feature of this sedge

*Carex litorosa* seed head and curled leaf tips
Whangaehu River saltmarsh, 1995

Holes of mud crab and probably banded dotterel probings, Tangimoana estuary – unvegetated mudflats on route of proposed new channel



Saltmarsh on soft silt, 'The Basin', Tangimoana, Rangitikei River estuary