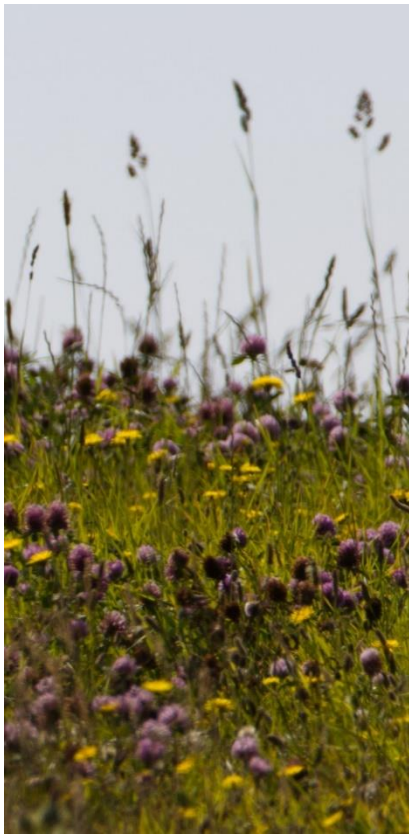


Environmental Enhancement at Tūmai Beach

A restoration plan prepared by the Tūmai
residents, 2021 – 2023



*Tūmai Beach Community
Report Number 2021/01*

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Executive Summary

The Tūmai Beach is situated alongside the Pleasant River Estuary (*Te Hakapupu*), 5Km north east of Waikouaiti and 45 km north of Dunedin. It comprises of 16 private house lots surrounded by communally owned pasture land and designated forest, tussock and estuary areas. The planting of forest areas in native species began in 2009. Thus far, at least 19,351 native plants have been established in communal areas. More than 2,500 additional native plants have been established within the private lots of the farm park subdivision. At least 52 species have been reinstated so far.

This plan sets out the goals and general strategy for environmental restoration at Tūmai Beach for the coming two decades, primarily to accelerate restoration of biodiversity and enhance the aesthetic values of the landscape and to facilitate walking access.

The overarching goal of the Tūmai Environmental Enhancement Plan is to *create a self-sustaining coastal subdivision and ecological landscape.*

This will be achieved by *integrating ecosystem restoration and sustainable pasture production, while providing opportunity for residents and their visitors to enjoy their natural environment and contribute to its protection and enhancement.*

Archaeological assessment of the planting areas will be completed first to ensure sites are not disturbed and have a plan in place in case a site is accidentally discovered during the planting process.

Stage #1 of work scheduled for the next two years (1 July 2021 to 30 June 2023) involves small scale experimental planting of at least 200 wire rush or in a restoring saltmarsh community in the soft sediments of South Arm estuary. We will also plant approximately 1100 plants of wet-tolerant species around a pond and two small seepage areas for Stage #2 of the restoration plan.

The remaining four stages of restoration require planting of a further 97,000 woody shrubs across 16 hectares in two main ecological zones: a 'Coastal Margin' strip averaging 25m wide around the edge of the Pleasant River estuary; and a 'Hillslope' zone on higher ground. The former restores representative estuarine margin shrubs and grasses, while the latter restores a native forest that will eventually grow to resemble that present at Tūmai before it was cleared for farming. Areas closest to the edge of the estuary are prioritised before areas further upslope. Together these plantings will reduce sediment and nutrient run-off into the estuary, restore native biodiversity (plants, birds, fish, lizards, invertebrates) and build ecological connectivity for "source to sea" ecosystem restoration.

Planting will prioritise consolidation of earlier, partially-successfully planted areas before adding plants to new areas within the existing pasture. Introduced mammalian predator control and provision of nest boxes and artificial refuges for invertebrates and lizards will follow once habitats are restored, and then enhancement of the remaining pasture areas for biodiversity will be prioritised.

Walking tracks will be formed to facilitate access to the planted areas and enjoyment of the Tūmai environment, its fauna and flora.

Tūmai Environmental Enhancement Plan

While planting continues, environmental gains will be protected by controlling woody and herbaceous weeds, exclusion of stock, preventing vehicles driving on the estuary's soft sediments, fire risk management, provision of irrigation water in times of drought, and following best practice guidelines for fertilisation of the remaining pasture areas at Tūmai Beach . Success of restoration will be monitored and reported, and this plan will be adjusted if needed every two years.

Guidance and collaboration with mana whenua, ecological restoration groups, farmers and the Department of Conservation are invited to integrate the environmental enhancement investments at Tūmai with similar efforts in the surrounding ecological landscape.

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Environmental enhancement at Tūmai Beach

Tūmai Beach Farm Park

The Tūmai Beach farm park is situated 47 km north of Dunedin and about 5 km north east of Waikouaiti (Fig. 1). “The land has outstanding rural and coastal views from a rolling hill landscape reaching 46m above the Pleasant River Estuary (*Te Hakapupu*) and river margin”¹. The eastern edge of the farm park is in a Coastal Landscape Preservation Area. Establishment of a Marine Reserve between the Pleasant River Mouth and Stony Creek is under consideration to protect the estuary flanking the Tūmai Beach farm park and inshore reefs along Tūmai Beach itself². Most of the building platforms and the mown pasture land are on “undulating terrace tops”³. The farm park model designates parcels of productive land in communal ownership for hay or baleage, and steeper areas for planting of native forest and silver tussock (*Poa cita*)⁴. There are 16 private lots (0.36 - 0.85 ha; average 0.5 ha) surrounded by a communal 35.6 ha. lot which is managed by a ‘Body Corporate’ legal structure called *Tūmai Beach Services Ltd.* and the *Tūmai Beach Restoration Trust*.

The aims of the Trust are to (a) facilitate, oversee and manage the restoration of the ecological systems and native flora and fauna within the Tūmai Beach Farm Park; (b) benefit the community by maintaining facilities and providing access to the Tūmai Beach Farm Park; (c) benefit the community by promoting and encouraging conservation programs and values with the Tūmai Beach Farm Park; (d) To promote pest management measures within the Tūmai Beach Farm Park; and (e) support and ensure the success of the Tūmai Beach Farm Park by assisting in the restoration of native flora and fauna in the surrounding areas (the halo) of the Tūmai Beach Farm Park.

Planting of native species to cover approximately half of the ground is a condition of the resource consent granted to develop the project in May 2008⁵ and was expected to deliver a “net environmental gain” from the Tūmai coastal subdivision. Restoration of coastal forest is a nationally important conservation priority. Most of the east coast of the South Island between the Catlins in the south and Kaikoura in the north are now farmland. Less than 10% of the original coastal zone vegetation of the Waikouaiti Ecological Area remains so it is classified as an acutely threatened land environment⁶. Warm and fertile coastal sites where biodiversity will naturally flourish⁷ are also important sites for recreation and environmental education. Reinsertion of woody vegetation in farming landscapes helps stabilise land, protect the coast from seawater incursions and climate change and reduces the amount of sedimentation and nutrient pollution of rivers, estuaries and near-shore ecosystems. Complementary goals are to enhance both biodiversity and aesthetic value of the landscape so that residents and the surrounding community can enjoy the area. Restored forest and shrubland will be retained in perpetuity and access to the areas by the public is legally guaranteed as part of the resource consent.

¹ Moller & Moller (2012).

² South-East Marine Protection Forum (2018).

³ Robins, M.J. (2007).

⁴ Moller & Moller, S. I. (2012).

⁵ More detail of the history of the development and consenting process is provided by Moller et al. (2013). The resource consent notice is available from the Dunedin City Council (2008).

⁶ Walker et al. (2007).

⁷ Moller et al. (2008).

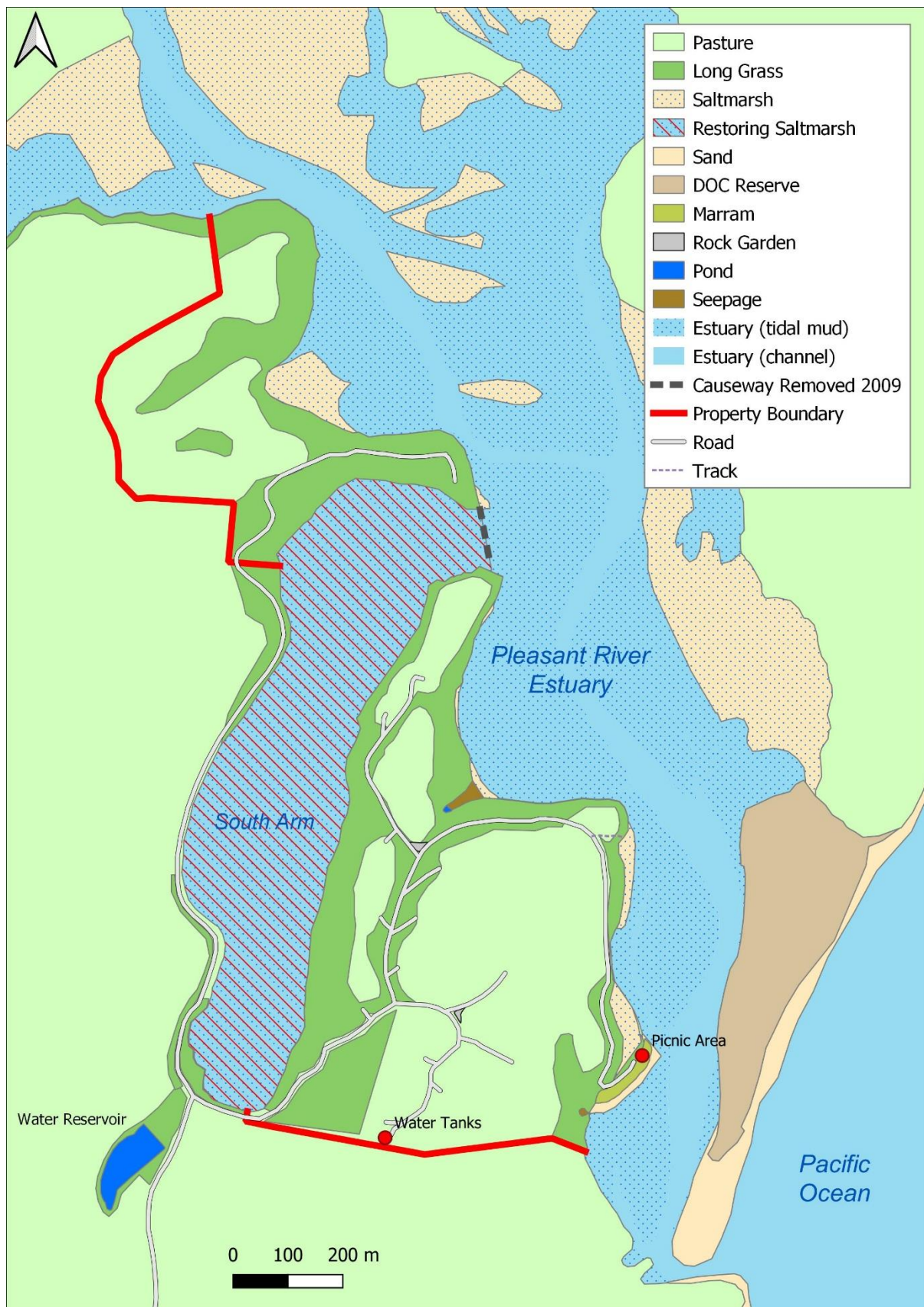


Figure 1: Overview of Tūmai Beach farm park at June 2021. Areas to the west of South Arm are no longer part of the Tūmai Beach farm park plans because Stage 3 of the original subdivision has been abandoned.

Enhancement achieved so far

Several plans were formulated to revegetate 29.24 ha (43% of the farm park's total 68.5 hectares) with native species⁸. Walton's Ltd., the developers of the farm park, planted 13,348 native forest shrubs in 2009. Inadequate follow-up care, frost, browsing by hares and rabbits, and unintended poisoning when grass was sprayed with glyphosate probably all contributed to low overall establishment rate (32%) and stunted growth⁹. Altogether 4,568 shrubs of 36 species survived across 15.19 hectares by 2012. Survival varied enormously between species and there is no prospect that the scattered surviving plants will achieve canopy closure. Canopy closure is the crucial pivot in the succession because it will eliminate the dense ground cover of grasses that currently blocks natural recruitment of native species and development of new microclimates and a forest litter layer¹⁰. The plants are scattered through about half of the area targeted for revegetation and many more are now required to establish a self-growing and ecological functioning forest in these partially restored areas¹¹.

Four substantive blocks ('M' and 'N' in Fig.1 and 2) totalling 1.31 hectare were planted on communal ground by the developers and residents between 2013 and 2015. Although enrichment planting and some releasing by the residents is ongoing at these sites, their restoration can be considered secure as the plants no longer need intensive care and a sufficient number have survived and are now growing to form a closed canopy that will exclude rank grass in the next 5-10 years. Natural regeneration of some species has begun and survival and growth of the planted specimens has been aided by ongoing control of hares and rabbits by the residents¹².

The resource consent conditions effectively expired in January 2021, so no further restoration work is legally mandated. However, the Tūmai residents are resolved to complete the intent of the original resource consent granted to the developers.

New owners of the lots at Tūmai have begun planting woody vegetation and silver tussocks, mostly in the vicinity of their houses and around their plot boundaries. As of July 2021, at least 2050 native shrubs, trees and grasses have been planted within six of the lots; and a further 2,752 in ribbons within nearby communal ground¹³. These private plantings add considerable species diversity and valuable habitat connectivity to the whole ecological landscape at Tūmai.

A small rock and tussock area is established at a road junction and another such area will be planted in the coming few months.

⁸ Wildland Consultants (2007b,c); Moore (2007a,b; 2010).

⁹ Moller et al. (2013).

¹⁰ Moller et al. (2013).

¹¹ This excludes planting of areas west of South Arm (Areas A-D and Toetoe in Fig. 2) because the farm park subdivision there has been abandoned. We hope that restoration work is continued there by the new owners to complement our efforts on the Tūmai Beach farm park.

¹² Approximately 200 shooting sessions have destroyed around 90 hares and 250 rabbits over the past four years.

¹³ Two house lots are not yet included in these two interim totals.



Figure 2: Areas already planted or now targeted for revegetation. Stage 3 of the Tūmai farm park development has been abandoned (the Resource Consent has lapsed) so Polygons A to D and the Toetoe patch to the west of south Arm are not considered further in this plan.

A significant part of the Tūmai environmental enhancement plan concerns restoration of South Arm of the Tūmai Estuary. A causeway blocking the arm was removed in 2009, leading to shallow tidal flows being reinstated over 26 ha of former estuary¹⁴. There has been obvious spread of glasswort (*Sarcocornia quinqueflora*) and gradual infilling of deep vehicle ruts formed when the arm was used as a cattle and sheep run-off and when the causeway blocking its entrance was removed.

No replanting of the estuary has occurred because it is expected that many of the species will naturally recolonise the area in time¹⁵.

In summary, with the exception of the natural restoration underway in the reflooded estuary, restoration progress to date has been steady but is far from complete:

- 1.31 ha. of native planting has been completed by establishing 16,610 plants.
- 6.83 ha. have been partially planted and now have 2044 plants established. Planting in these areas must be consolidated to achieve canopy closure, where upon natural regeneration can take over.
- 9.90 ha of the areas designated for native revegetation remain unplanted.
- established plants are dominated by a few species and are not representative of the target forest composition.
- 26 ha of estuarine habitat has been reflooded and is healing at a rapid rate.
- Walking tracks are mown through pasture areas and more are planned but not yet constructed to facilitate access to the ecologically restored areas.

Overall, this equates to having achieved about a tenth of the land-based revegetation and access provision work required.

Formulation of this plan marks a renewal of commitment to accelerate environmental enhancement of Tūmai Beach now that the developers have left without completing the conditions of their consent. The underlying approach of the earlier Wildland Consultants planning strategy has been retained, but details have been updated in the light of planting and vegetation surveys undertaken since then. This plan excludes planting of areas west of South Arm because the farm park subdivision there has been abandoned¹⁶. We hope that restoration work is continued there by the new owners to complement our efforts on the Tūmai Beach.

Enhancement goals

The overarching goal of the Tūmai Environmental Enhancement Plan is to ***create a self-sustaining coastal subdivision and ecological landscape.***

This will be achieved by ***integrating ecosystem restoration and sustainable pasture production, while providing opportunity for residents and their visitors to enjoy their natural environment and contribute to its protection and enhancement.***

¹⁴ Dunedin City Council (2008): p 20.

¹⁵ Morland (2001).

¹⁶ These are areas A-D and 'Toetoe' in Fig. 2.

Enhancement priorities

The first ecosystem restoration priority is to plant native species to create habitat for indigenous species and prevent seepage and sediment from reaching the estuary. Two main zones of equal importance are targeted – ‘Hillslopes’ for replanting forest and a ‘Coastal Margin’, a 25 m wide offset on the land side of the estuary’s soft sediment (Fig. 2)¹⁷. Hillslopes will be replanted with indigenous forest that is approximately representative of what stood there before clearing for farming. The Coastal Margin will be planted with salt and wind tolerant species, including low shrubs to mimic the natural species assemblage found there. Wildland Consultants identified restoration of this margin as being particularly important because the naturally occurring communities are severely degraded and threatened by weed incursions¹⁸. These margins are also important for minimising sediment and nutrient flows from land to sea.

Parts of this coastal margin are steep cliffs, in which places a ribbon of the estuarine margin species will be planted at the top of the cliff to encourage natural colonisation below. The width of the Coastal Margin zone was recommended to follow the 10 m land contour, which varies approximately between 20 and 30 m wide. Accordingly, this plan has calculated plant requirements for a Coastal Margin zone averaging 25 m wide. In practice, an ecological gradation from coastal to forest species is envisioned, rather than a hard or straight boundary between the two zones.

The relatively unmodified saltmarshes in the Otago Region have significant value in providing important habitat for indigenous invertebrates, fish, and birdlife¹⁹. Restoration of South Arm by reinstatement of tidal flows was considered an important step to recreate an ecologically important ecosystem, native fish spawning sites and insect habitat²⁰. Small trial plantings of wire rush (*Apodasmia similis*) in the restoring South Arm of the estuary, especially in the upper reaches which are most degraded, is proposed. A survey of the saltmarsh flora is then needed to decide whether further assistance is warranted to accelerate the natural process of estuary restoration currently underway²¹.

Once natural succession is underway to restore habitats, attention should shift to control of introduced predators (cats, stoats, rats) by trapping, poisoning or shooting. Encouragement of little penguins (*Eudyptula minor*) and yellow-eyed penguins (*Megadyptes antipodes*) by providing nest boxes and acoustic attraction will be attempted once resources allow and sufficient control of predators is proven. Rock refuges for lizards will also be considered. Once a leaf litter is forming, inoculations of forest duff from nearby forest remnants should be trialled to accelerate establishment of invertebrates to aid forest ecosystem cycling at Tūmai.

Immediate enhancement of the one small pond requires removal of the dense grass mat invading the open water and further planting of native species around the pond edges and wet-tolerant species in

¹⁷ Wildland Consultants (2007 a, b). The wildland Consultants team called this the ‘Estuarine strip’. We have renamed it “Coastal Margin” to distinguish it from planting in the estuaries soft sediments, which Wildland Consultants called “margin of the estuary arm”.

¹⁸ Wildland Consultants (2007b).

¹⁹ Otago Regional Council (1992, 2005).

²⁰ Pleasant River has records for upland bully (*Gobiomorphus breviceps*) and longfin eel (*Anguilla dieffenbachii*). Restoration is also likely to support Shortfin eel (*Anguilla australis*), giant bully (*Gobiomorphus gobioides*), common bully (*Gobiomorphus cortidianus*) and īnanga (*Gallaxius maculatus*) that have been recorded in nearby Watkins Creek. Species such as saltmarsh ribbonwood, glasswort, *Selliera radicans* and *Suaeda novae-zealandiae* are particularly important hosts for indigenous moths (Patrick 1995).

²¹ Five additional species are identified for potential planting in the soft sediments on the margin of the estuary arm if they are not found to be naturally restoring (Table 1).

the seepage area below it ('T' in Fig. 2). There is scope for creation of a second pond at a seepage area ('U' in Fig. 1) at the south eastern edge of the Tūmai, but this has low priority in the meantime.

Although restoration of our own land at Tūmai must take priority, collaboration with the neighbouring farm to seal off critical seepage areas (especially the water reservoir margins, and flat area adjacent to the road on the causeway flanking the southern margin of South Arm) should be the next priority. Complementary restoration efforts to consolidate the 2009 planting west of South Arm would be particularly welcome to extend ecological and landscape connectivity for restoration of the whole Pleasant River estuary.

Guidance by manawhenua from the Huirapa ki Puketeraki Rūnaka will be sought to maximise the cultural value of the Tūmai Beach restoration project. The area includes Waahi tapu (sacred sites), Waahi tāoka (reinforcing the relationship Kai Tahu have with Otago's water resources), mahika kai (food gathering places), kōhanga (nursery areas for Ngai Tahu's 'Taonga Species'²², including eels, whitebait, kanakana (lamprey), koukupu, waterfowl, watercress). Walking tracks and plants for weaving materials will also be established.

Collaboration with DoC to protect and enhance Tūmai Beach spit (a Ngai Tahu reserve administered by DoC)²³ has been sought. If the proposed Pleasant River to Sandy Beach Marine Reserve is established²⁴, restoration of the Tūmai Beach will be an important complement to complete 'sources to the sea' protection and enhancement strategy. Similarly, collaboration with the East Otago Catchment Group restoration efforts further up the Pleasant River catchment are the next priorities so that we contribute to a *Ki uta ki tai* ("Mountains to the sea") landscape restoration effort.

Plant species selections

All plants should be eco-sourced where practical so as to maximise chances of establishment and growth and build ecological integrity of the restoration programme.

Wildland Consultants identified 34 species suitable for planting at Tūmai and matched them to four habitat zones (Table 1)²⁵. They will form the bulk of our target species list, but we have augmented their list by applying the model created by Allen & Wilson (1991) to predict 54 species which were once present in the Tūmai forest before clearance for farming²⁶. Forty-one of these "missing" species were not included in the Wildland Consultants planting plan. Using a somewhat arbitrary target of ensuring that at least 100 specimens of these formerly present species should be planted to encourage their spread, we recommend accelerated planting of 8 relatively large and erect species that are conspicuously missing: kahikatea, houhere, miro, mapou, *Coprosma rotundifolia*, mahoe, putaputaweta and kotukutuku.

²² Their significance and the special role of Ngai Tahu in their care is legislated by the Ngai Tahu Settlement Act (1998).

²³ Johnson (1992) describes this as being in very poor condition with marram and lupin present.

²⁴ South-East Marine Protection Forum (2018).

²⁵ Their "Freshwater swamp" species will be chosen for the pond margin and seepage areas ('T' and 'U', Fig. 2); and Margin of Estuary species" for planting in the soft sediments of South Arm if necessary

²⁶ The method used species lists from 86 forest remnants in East Otago which were then clustered into six 'Forest types'. Selection of the appropriate forest type for a given site was identified from (i) distance from the sea, (ii) exposure to onshore wind, (iii) rainfall, and (iv) geology (measured on a coarse scale). When these predictors were applied for Tūmai, the model predicts that a 'Henley' coastal forest type stood at Tūmai and included 54 main species.

Table 1: Plant species selected as suitable for Tūmai farm park by the Wildland Consultants (2007b)

Table of Indigenous plant species suitable for establishment on the Waltons Ltd property						
Wildland Consultants						
<i>Ecological Assessment of the Waltons Ltd Property, Pleasant River Estuary, Otago . August 2007</i>						
Species	Common name	Plant type	Habitat			
			Freshwater swamp	Estuarine strip	Margin of estuary arm ¹	Hillslopes
Apodasmia similis	jointed wire rush, oi oi	rush			•	
Carex geminata		sedge	•			
Carex secta	pukio	sedge	•			
Carex virgata		sedge	•			
Coprosma crassifolia		shrub		•		•
Coprosma propinqua	mingimingi	shrub	•	•		•
Coprosma rubra		shrub		•		•
Cordyline australis	cabbage tree	tree		•		•
Cortaderia richardii	toetoe	grass	•			
Discaria toumatou	matagouri	shrub		•		
Elaeocarpus hookerianus	pokaka	tree				•
Ficinia nodosa	knobby clubrush, wiwi	sedge			•	
Griselinia littoralis	broadleaf	tree		•		•
Haloragis erecta		herb		•	•	
Helichrysum aggregatum		shrub		•		•
Hoheria angustifolia	narrow-leaved lacebark	tree		•		•
Isolepis cernua	slender clubrush	sedge			•	
Kunzea ericoides	kanuka	tree		•		•
Melicope simplex		shrub		•		•
Melicytus ramiflorus	mahoe	tree		•		•
Myoporum laetum	ngaio	tree		•		
Myrsine australis	mapou	tree		•		•
Olearia avicenniifolia		tree		•		•
Olearia fragrantissima		tree		•		•
Ozothamnus vauvilliersii	Cassinia leptophylla	shrub		•		
Phormium cookianum	mountain flax	herb		•		
Phormium tenax	flax	herb	•			
Pittosporum tenuifolium	kohuhu	tree		•		•
Plagianthus divaricata	saltmarsh ribbonwood	shrub			•	
Prumnopitys taxifolia	matai	tree		•		•
Podocarpus totara	Hall's totara	tree		•		•
Pseudopanax crassifolius	lancewood	tree		•		•
Schoenoplectus pungens	three-square	sedge			•	
Sophora microphylla	kowhai	tree		•		•

Surveys in 2012 and 2013 identified twelve species that either did particularly well from the 2009 planting at Tūmai and/or which are expected to be good for bird species and closing the canopy to eliminate grass cover: flax and mountain flax (Harakeke, wharariki), Ngaio, saltmarsh ribbonwood, *Hebe buxifolia* and *Hebe stricta*, kanuka, totara, *Pittosporum tenuifolium*, *Olearia traversii* (Chatham Island akeake), *Olearia lineata dertonii*, *Olearia avicenniifolia* and *Dodonaea viscosa* (akeake).

The target species lists are approximate and should be adjusted according to availability of plants and their prospects for survival and growth. Once canopy closure opens the ground to natural regeneration of woody species, we can expect a more representative community composition to emerge.

Staging of restoration effort

We can't do it all at once! Full enhancement will require persistence, patience and collaboration within the Tūmai community and with outside agencies. We will "learn-by-doing" and must remain agile to adjust when costs or practicalities intervene – the specific work programme will be revised at least every two years. The overall plan will be reassessed a decade from now when monitoring information can guide future prioritisation and speed of investment. We will prioritise two small restoration efforts (within the estuary soft sediments and in wet terrestrial areas) in stage #1 & #2; then areas closest to the estuary edge (especially where some initial planting allows consolidation) in Stages #3 & #4; then inland patches of forest on hillslopes where previous planting gives a start (Stage #5) before turning our attention to inland hillslopes with no planting so far (Stage #6). Prioritisation of areas is mapped in Fig. 3.

All the restoration work is important and will be completed eventually – the prioritisation suggested here is merely to deliver maximum environmental enhancement as quickly as possible. Prioritisation also reduces the risk of overload and the community not being able to adequately provide the after-planting care. Demonstrating some immediate success is also likely to encourage persistence until the whole farm park is enhanced.

Stage #1: South Arm estuary

Creating a series of small nursery areas of wire rush along the edge of the estuary (within the soft sediments) can quickly test their ability to establish and then spread naturally to colonise the whole margin of South Arm. *Sarcocornia* is already recolonising the disrupted soft substrate areas and is likely to cover most of the area in the next 10 years without our help. We therefore recommend an early trial planting of 10 patches, each with at least 20 plants, of wire rush spread along the sides of South Arm. Follow-up monitoring will determine whether such inoculations will greatly accelerate estuary restoration and recreate natural zonation at the estuary edge.

Stage #2: Freshwater seepage areas and pond

Areas of wet ground are small and ephemeral. So far there is only one freshwater pond within Tūmai Beach farm park itself. Freshwater swamp species (Table 1) will be planted in areas 'T' and 'U' (Fig. 2 & 3). Wet-tolerant species like flax (*Phormium tenax*), Kahikatea (*Dacrycarpus dacrydioides*) and tī (*Cordyline australis*) and tussocks *Carex secta* will be concentrated in these seepage areas. Immediate enhancement of the one small pond requires removal of the dense grass mat invading the open water.

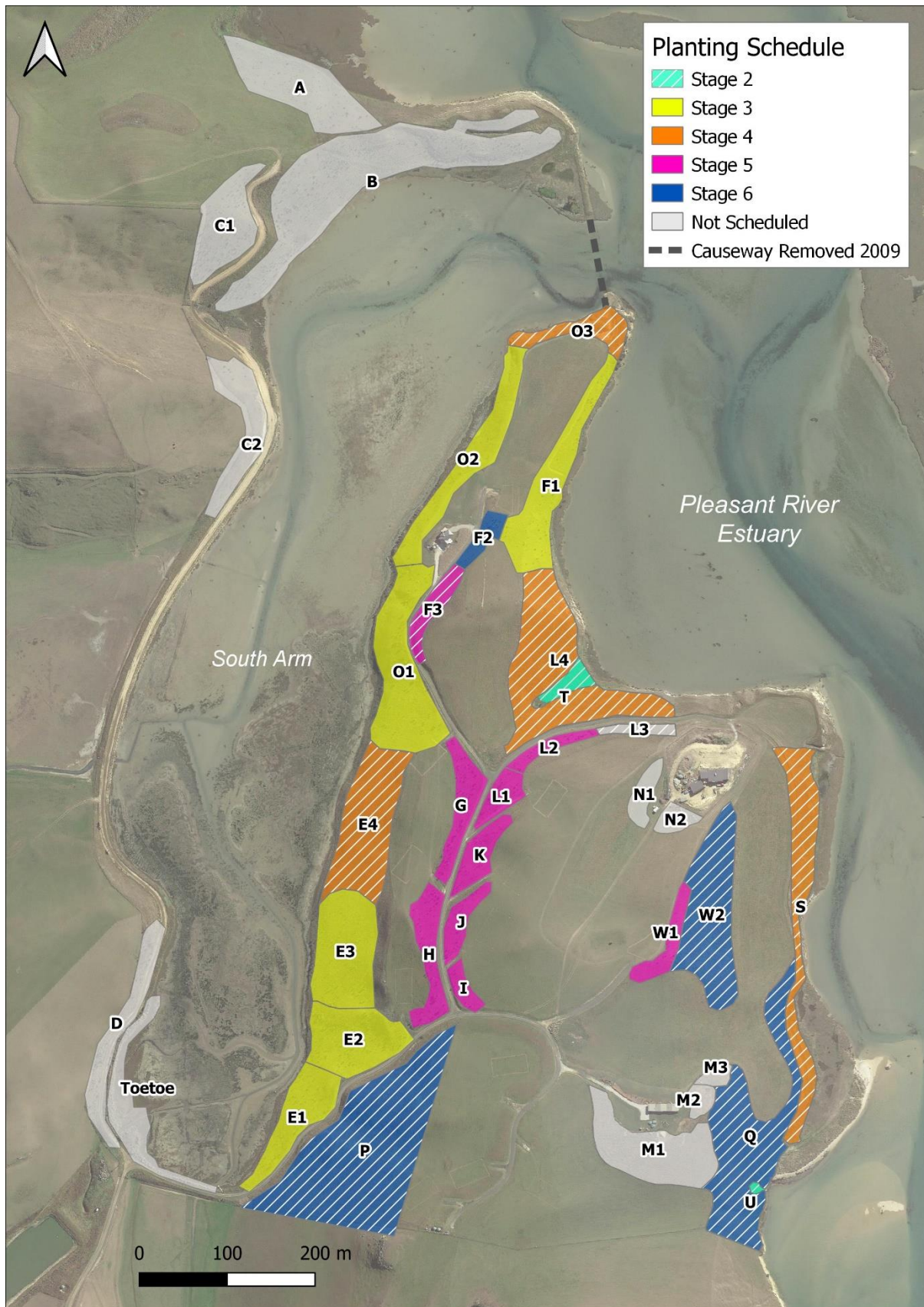


Figure 3. Staging of planting at Tūmai Beach farm park. Stage #1 is not marked because it involves planting small experimental areas concentrated mainly in the upper reaches of South Arm.

Stages #3: Consolidation planting along the estuary edge

The Coastal Margin and Hillslope areas are equally important and should be done together in each of the areas delineated in blue of Fig. 3. Planting alongside the estuary and consolidating planting alongside the existing partially successful restoration sites (deep green in Fig. 2) for fastest possible canopy closure are the next equal priorities. Consolidation was strongly recommended by Wildland Consultants²⁷ because (i) it is how plants naturally establish and spread, (ii) birds are attracted to groves and will nest in them and distribute seeds, and (iii) the crowns of the trees grow outwards, shading out competing grasses and allowing seedlings to establish on the edge of a grove, enlarging it. The polygons for top priority for enrichment planting are therefore E1, E2, E3, O1, O2, and F1 (Fig. 3). Propagation of Saltmarsh ribbonwood by inserting cuttings directly into the soft ground next to the estuary could also be tried.

Stage #4: New plantings along the estuary edge

A large new area of coastal hillslopes at L4, O3, and the coastal margin on the eastern flanks of the farm park ('S' in Fig. 3) and one gap (E4) on the edge of South Arm will be done next to complete the protection of the estuary edge.

Stage #5: Consolidation planting on inland hillslopes

Planting and enrichment of the existing planting on the higher ground around the main Tūmai roads is the next most important i.e. at F3, G, H, I, J, K and L1, L2 and W1.

Stage #6: New planting on inland hillslopes

New plantings on higher ground at F2, W2, Q and P are last priority. Blocks W2 and Q are particularly challenging because they face the prevailing North East wind and the slopes are relatively dry. Extra protection of the seedlings will be needed

Planting patterns within polygons

Planting in each polygon should take a clustered approach i.e. rather than simply mixing the target species in a random manor, some single species patches are recommended to encourage cross-pollination, especially in dioecious species (where there are separate male and female plants). Local tuning of some species assemblages is also advised i.e. some will be more successful than others in dry ridges and wetter southern faces that retain more moisture. It is also aesthetically more pleasing to have some patches of the same colour and texture rather than a uniform mix throughout the Tūmai landscape.

Care is needed to protect the views from the residents' houses on the margin of their lots. Selection of low species on the lip where the ground falls away westward will be needed, perhaps including a silver tussock 'viewing chute' as envisioned by the landscape architect who advised the Tūmai resource consent decision makers²⁸.

The total number of individual specimens of each species recorded as established in 2012 and 2013 for all areas and zones, is provided in Appendix 1 – where possible, complementary species should be added to those established for each zone in each area.

²⁷ Wildland Consultants (2007c).

²⁸ Moore (2007a,b; 2010).

Road margin plantings

While many residents are planting along the road margins that abut their property, the community planted a rock and tussock at the top junction of roads (Fig. 2). At least one other is envisioned at the road junction by 'L' and 'G' (Fig. 2). These add biodiversity and habitat connectivity, and enhance aesthetic appreciation of the landscape. While these road margin plantings are encouraged, they are not included in the formal plan so far and will likely occur in an *ad hoc* manner to suit the plot owner's needs to protect views and break wind.

Obstruction of vision on a few sharp corners should be avoided by keeping the plantings further back and choosing low plants at these junctions.

Eventual enrichment plantings

The first and urgent priority is to establish a close cover of woody vegetation and canopy closure to eliminate competition for space, moisture and nutrients by grass species. In the longer-term enrichment planting of established forest and communities will complete the ecological representativeness of the restoration efforts. Seven threatened plant species have been identified by Wildland Consultants²⁹ and several understory plants requiring established forest micro-climates are identified by predictive modelling of original forest composition³⁰.

Safeguarding archaeological sites

The Pleasant River estuary contains numerous sites of archaeological significance, including the Pleasant River Mouth Site Complex. Extensive excavations and survey of the area showed that there were multiples periods of Māori settlement for temporary campsites throughout the 14th-16th c. AD. An archaeological assessment (that included a summary of the previous excavations and finds around the estuary) was undertaken by consultant archaeologist Amanda Symon as part of the original resource consent application for the development of the Tūmai farm park subdivision.

This plan proposes large-scale planting of the subdivision in five stages that includes the experimental planting of jointed wire rush in South Arm estuary (Stage 1) and planting a further 97,000 woody shrubs in two main ecological zones - a ~25 m strip of 'Coastal Margin' around the Pleasant River estuary and a 'Hillslope' zone on the higher ground adjacent to the residential plots. The planting may damage, destroy or modify archaeological sites, especially in the 25m wide 'Coastal Margin' zone where other recorded sites have been found. Therefore, we need to undertake an archaeological assessment of the planting areas to ensure sites are not disturbed and have a plan in place in case a site is accidentally discovered during the planting process. The overall aim of the archaeological assessment is to recommend methods to avoid, minimize or mitigate adverse effects to archaeological sites.

There are four main objectives for the proposed archaeological assessment of planting areas at the Tūmai Beach farm park:

²⁹ Appendix 2 of Wildland Consultants (2007c).

³⁰ Appendix 3 of Moller et al. (2013).

1. Consultation with tangata whenua regarding the assessment of Māori values for the Archaeological Assessment.
2. Survey the planting area for any surface information that may indicate an archaeological site is present and locate the previously recorded archaeological sites in the area.
3. A targeted archaeological assessment of the planting sites written to the guidelines provided by Heritage New Zealand Pouhere Taonga (HNPT)³¹.
4. Potentially applying for an exploratory archaeological authority from HNPT to undertake strategic test-pits in the planting area.

Work on the archaeological assessment and discussions with mana whenua will be initiated as soon as possible³².

Number of plants required

The areas of each of the polygons designated for new or enrichment planting were calculated using a base GIS map by Chris Garden³³. The area calculations have assumed that the terrain is flat, so the actual surface area for planting is higher than our estimates in Table 2. In practice, this underestimation will be small because planting is precluded from very steep sections of the cliffs for safety reasons, yet we have assumed all of the coastal margin can be planted³⁴.

Plants required for each of targeted hillslope area were then calculated by multiplying their area by the plant spacings recommended from past experience. The Halo project (2020) recommends 2m spacing as a rule of thumb for tall woody species, but our experience in planting at Tūmai suggests that this is too sparse to ensure canopy closure in the dense smothering rank grass habitat at Tūmai. Accordingly, we use a one plant per 1.0 m for the coastal margin zone, but a 1.5 m spacing as recommended by Wildland Consultants (2007 b,c) for the forest species. The estimated number of plants will be much higher if extensive areas of silver tussock are included – our experience is that they need to be planted at around 9 tussocks per square m to exclude the rank grass that smothers the ground at Tūmai.

The total number of new plants required is estimated by subtracting the number of established plants in those areas from the 2009 plantings, as recorded in 2012 and 2013. Some of those plants may have died in the interim, so the calculations estimate the minimum number of new plants needed to achieve the core restoration goals.

The total number of plants required for each polygon in Fig.2 is presented in Table 2; and the total number of plants required at each stage is presented in Table 3.

So far planting of approximately 1.31 of a targeted 17.15 hectares has been completed i.e. just 8% of the targeted restoration area. Overall, around 97,000 more plants are required.

³¹ Heritage New Zealand (2019).

³² The archaeological assessment will be undertaken by Dr. Rebecca Kinaston in collaboration with Professor Richard Walter. Both researchers work at the University of Otago and Rebecca is the property owner (with Graham Johnson) of Lot 10 of the Tūmai Beach.

³³ Discrete polygons of planted areas were digitised in QGIS based on aerial (LINZ) and satellite (Google Earth) imagery, as well as GPS coordinates of established plants. Areas of these polygons were calculated in square metres using the New Zealand Transverse Mercator projection.

³⁴ A slope would have to be 48 degrees to require 50% more plants to cover the surface area at the same density. A 30-degree slope, which is still very steep and likely to exclude planting, results in requirement for only 15% more plants to cover the 'surface' area.

Table 3. The areas completed and targeted for restoration planting and the existing and required extra plants now required.

Stage	Area	Zone	Status	Area (m ²)	Established plants	Target	New plants required
Stage #1	South Arm	Estuary soft sediments	Proposed		0		200
Stage #2	U	Seepage	Proposed	157	0	157	157
Stage #3	E1	Coastal margin	Existing	3,952	132	3,952	3,820
Stage #3	E1	Hillslope	Existing	1,519	33	674	641
Stage #3	E2	Coastal margin	Existing	1,835	78	1,835	1,757
Stage #3	E2	Hillslope	Existing	5,352	257	2,376	2,119
Stage #3	E3	Coastal margin	Existing	3,176	85	3,176	3,091
Stage #3	E3	Hillslope	Existing	5,577	94	2,476	2,382
Stage #3	F1	Coastal margin	Existing	6,325	135	6,325	6,190
Stage #3	F1	Hillslope	Existing	1,781	27	791	764
Stage #3	O1	Coastal margin	Existing	5,415	83	5,415	5,332
Stage #3	O1	Hillslope	Existing	5,451	131	2,420	2,289
Stage #3	O2	Coastal margin	Existing	6,527	148	6,527	6,379
Stage #3	O2	Hillslope	Existing	498	4	221	217
Stage #4	E4	Coastal margin	Proposed	4,444	0	4,444	4,444
Stage #4	E4	Hillslope	Proposed	5,467	0	2,427	2,427
Stage #4	L4	Coastal margin	Proposed	5,594	0	5,594	5,594
Stage #4	L4	Hillslope	Proposed	8,757	0	3,888	3,888
Stage #4	O3	Coastal margin	Proposed	3,036	0	3,036	3,036
Stage #4	O3	Hillslope	Proposed	51	0	23	23
Stage #4	S	Coastal margin	Proposed	7,948	0	7,948	7,948
Stage #4	S	Hillslope	Proposed	921	0	409	409
Stage #5	F3	Hillslope	Proposed	2,280	0	1,012	1,012
Stage #5	G	Hillslope	Existing	3,756	116	1,668	1,552
Stage #5	H	Hillslope	Existing	3,983	110	1,768	1,658
Stage #5	I	Hillslope	Existing	1,219	30	541	511
Stage #5	J	Hillslope	Existing	2,037	100	904	804
Stage #5	K	Hillslope	Existing	2,638	126	1,171	1,045
Stage #5	L1	Hillslope	Existing	1,984	144	881	737
Stage #5	L2	Hillslope	Existing	1,480	69	657	588
Stage #5	W1	Hillslope	Existing	2,304	117	1,023	906
Stage #6	F2	Hillslope	Existing	1,488	25	660	635
Stage #6	L3	Hillslope	Proposed	1,012	0	449	449

Stage #6	P	Hillslope	Proposed	24,003	0	10,657	10,657
Stage #6	Q	Coastal margin	Proposed	4,781	0	4,781	4,781
Stage #6	Q	Hillslope	Proposed	9,642	0	4,281	4,281
Stage #6	W2	Hillslope	Proposed	10,590	0	4,702	4,702
Completed	M1	Hillslope	Completed	8,613	5,987	3,824	0
Completed	M2	Hillslope	Completed	1,011	10,000	9,097 [†]	0 [†]
Completed	M3	Hillslope	Completed	712	240	178 [‡]	0 [‡]
Completed	N1	Hillslope	Completed	1,605	294	401 [‡]	0 [‡]
Completed	N2	Hillslope	Completed	1,199	129	300 [‡]	0 [‡]
All	All	All	All	156,978	18,654[#]	113,073	97,229

[†] This is a pure silver tussock area. These must be planted close together (around 9 tussocks per m²) to prevent pasture grass incursions. No more tussocks are needed in this area.

[‡] Considerable numbers of large flax have been planted in these areas. The flaxes are large and sprawling, and are therefore effectively excluding the pasture grasses. Therefore, an overall target density of 1 plant per 2-m spacing (0.25 plants per m²) has been assumed, and no more plants are needed in these areas to ensure canopy closure.

[#] At least 2,752 additional native plants have been planted in communal ground in ribbons along the edges of the private lots, and more than 2050 within the lots themselves. These have not been included in this table or the plan as a whole.

Table 3. The areas completed and targeted for restoration planting and the existing and required extra plants now required.

Stage	Area (m ²)	Established plants	Target	Additional plants required
Completed areas	13,140	16,923	13,800 [†]	0 [†]
Stage #1		0	- [‡]	200
Stage #2	157	0	157	157
Stage #3	47,409	1,207	36,190	34,983
Stage #4	36,218	0	27,769	27,769
Stage #5	21,680	812	9,626	8,814
Stage #6	51,515	25	25,531	25,506
All	156,978	18,967[#]	99,273	97,229

[†] The target density (using the guideline spacings) has been exceeded in these areas, so no more plants are required.

[‡] No target is set for Stage #1 because the goal is to seed small areas to test for natural spread rather than to achieve blanket coverage.

[#] 2,752 additional native plants have been planted by the residents in communal ground in ribbons along the edges of the private lots, and more than 2050 within the private lots themselves. These have not been included in this table or the plan as a whole.

Woody weed control

Annual cutting (and poisoning of stumps) of Scotch broom (*Cytisus scoparius*) in zones O2, O3 and F1 has been undertaken by residents over the past 8 years because it threatens the remnants of indigenous scrub and silver tussock remaining there, and will hinder establishment of future forest species on the hill slopes. There is sign of reducing infestation, but it may take another decade or two to fully flush the seed bank built up over many years. Introduction of a broom biocontrol agent is one option, but regular community working bees have contained the threat so far. Occasional outliers (pioneering broom and gorse plants) are found well away from the main weed patches – it is imperative that these are killed immediately before they start a new seed bank in a new area on Tūmai. Outliers should be recorded and the area inspected for the next year to ensure that other plants are not established.

Single mature trees of African boxthorn (*Lycium ferocissimum*) and *Buddleja davidii* should be removed immediately to prevent the risk of their spread once ground cover of grasses is eliminated by canopy closure.

Ongoing gorse (*Ulex europaeus*), broom and wilding pine (*Pinus radiata*) control on the spit (Ngāi Tahu/DoC reserve) is undertaken sporadically by Tūmai residents already. Two main patches of gorse are gradually spreading and should be destroyed as soon as practical.

Fire risk management

Fire resistance is an additional consideration when considering what to plant. Prolonged dry weather can make the long grass areas at Tūmai extremely flammable, so at least until forest is fully grown, there is a need for extreme care to observe fire bans. The fire risk from the different forest species is reasonably well known and many of the species planted in 2009 have high flammability ratings³⁵. However, it is important to keep this risk in perspective: the expected fire risk in broad terms is by scale (highest fire risk first) as (1) rank introduced grasses; (2) some of the large native tussocks that build up considerable thatch; (3) native forest; (4) silver tussock (which is not expected to build up sufficient thatch to fuel a fire)³⁶.

The best overall strategy is to maintain a gap (“defensive zone”) between the forest and houses at Tūmai by maintaining broad mown perimeter. Fire risk will reduce as more rank pasture is replaced by forest. Vehicles must not be driven through rank grass in summer and the farmer cutting hay and baleage is contracted to mow the pasture areas just before the Christmas break when visitors and more of the owners are present. Use of chain saws and weed-eaters in long grass (for example to release plants) should be avoided in dry conditions.

All residents are required to hold 20,000 litres of water in reserve and have a fire engine connection available to assist the fire brigade control any outbreaks.

³⁵ Fogarty (2001).

³⁶ In litt, Dr William Lee. Landcare Research. However, we have noticed moderate build-up of a thatch under dense planting of silver tussock at Tūmai and recommend that such silver tussock beds are planted well back from buildings.

Stock exclusion

The permanent exclusion of grazing stock from the Tūmai block is crucial for the restoration effort. Occasional stock incursions occur through the aging fence along the southern boundary of the Tūmai Beach farm park. The Tūmai Beach Services Ltd. will establish a budget for eventual upgrading of this fence.

Pasture management

Baleage and hay is cut and carried off the farm park. Periodic fertilisation is required to maintain feed quality. Best practice is requested of the neighbouring farmer who is contracted to harvest the grass and manage the pasture i.e. minimum application rates, fertilising only when needed (as identified by prior soil testing), and precision application under calm wind conditions to avoid drift of fertiliser into the estuary.

Exclusion of stock is causing a gradual shift in composition of the pasture sward, including a rampant growth of red and white clover. Their nitrogen fixation builds hay and baleage quality, but may also increase nutrification of the estuary – hence the need for the concentration of planting around the estuary margin.

Occasional ragwort (*Jacobaea vulgaris*) plants are encountered and wrenched. Appearance of burdock (*Arctium lappa*) in the last three years is a concern because it is hard to kill, persists and spreads rapidly. It is a real nuisance for dogs in particular. Residents have gone to considerable effort to eradicate it by digging out their tap roots and spraying fresh leaves with glyphosate.

In the long-term there is considerable scope to create a diverse (multispecies) and colourful herbfield in the production spaces of Tūmai by over-sowing with herbs and different grasses. This in turn will attract and nurture insects. Introduction of native earthworms would be a New Zealand first – many species were driven extinct by intensive pasture farming. Such diverse ‘regenerative agriculture’ approaches to pasture management³⁷ are becoming more common and a part of a more integrated ‘multifunctional agriculture’ approach³⁸. In the meantime, the restoration will concentrate on the forest and estuary margin habitats, but pasture enhancement could be considered in the longer run.

Beekeeping

Introduced honeybees are kept by one of the residents at Tūmai. They provide crucial ecosystem services by pollinating pasture and forest species.

Walking tracks

Walking tracks will be established through all the planting areas where practical. These will facilitate the site preparation, planting, after-planting care, and monitoring of restoration success. Tracks will also allow the residents, visitors and general public to inspect the work and growth of the plants, watch birds, and enjoy the environment around the estuary. Public access is stipulated as a condition of the resource consent for the Tūmai subdivision³⁹.

³⁷ <https://regenerativeagriculturefoundation.org/regenerative-agriculture-alliance/>

³⁸ Renting, H., Rossing W.A.H., Groot J.C.J., Van der Ploeg J.D., Laurent C., Perraud D., Stobbelaar D.J., Van Ittersum M.K. (2009). Exploring multifunctional agriculture. A review of conceptual approaches and prospects for an integrative transitional framework. *Journal of Environmental Management*, 90 (Supplement 2), Pages S112-S123.

³⁹ The consent (Dunedin City Council, 2008) states: “The farm flats, shown as Lot 26, are to be vested with the Crown as coastal marine area, and therefore will become available for public use and enjoyment. On subdivision, a 20 m wide esplanade strip is to be created along the

Tracks will be marked out to avoid planting in the pathways from the outset and target archaeological risk assessment. Progress in forming permanent tracks and gravelling (and stepping them) will follow as fast as funds allow.

Protection of the estuary and salt marsh communities

The Tūmai residents have agreed not to drive on the soft sediments of the estuary unless required in an emergency or unless to launch a boat at a few launching spots. Boulders have been placed at spots where interlopers might gain access to the estuary. Past incursions by quad bikes, motorbikes and tractors have left ruts and mud patches, some of which last for years, and prevent re-establishment of saltmarsh species.

The salt marsh near the picnic area is degraded by introduced grass incursions and vehicles taking a short cut to reach the picnic area rather than traveling the full loop around to the road end. Residents and visitors will be discouraged from driving over the remaining *Sarcocornia* beds.

The salt marsh ecosystem is maintained by periodic flooding at high tides and pooled water. This natural flow and pooling should be uninterrupted if possible.

Spartina, an invasive estuarine weed, was detected in South Arm and sprayed with Gallant in May 2021 by Otago Regional Council. We will search for it in the planned survey of plant restoration of South Arm planned for the coming year.

Research, Monitoring and environmental education

Restoration work at Tūmai can offer important lessons to share with other community-led restoration projects. The immediate priority is to monitor plant survival and growth in the establishment phase.

Photo points will be established at fixed locations throughout all planted areas and images retaken every two years.

Later a stratified random selection of plants will be earmarked for re-measurement every 5 years. A minimum of 40 of each of the main species, and of some critical species for future ecological function of the ecosystem, should be monitored. Stratification of the sample for exposure to wind and distance from the sea would allow testing of hypotheses for determinants of growth and plant vigour.

Longitudinal measures of the strength of flowering and fruiting could be instigated to track the rate of reinstatement of forest ecosystem processes. Flowering and the arrival and abundance of pollinators are crucial next steps for natural plant propagation. We expect increases in the diversity and abundance of insects will be an early sign of restoration success and that this will trigger colonisation by insectivorous birds, especially early colonisers like fantails (*Rhipidura fuliginosa*). Arrival of frugivorous birds (especially silvereyes, bellbirds and tui) will herald accelerated natural seed dispersal and the beginnings of natural ecological selection of the most successful and suitable plants for Tūmai's forest. Deliberate planting of nectar plants will encourage the honeyeaters and provide the much-needed energy sources to secure a resident population of birds throughout the year.

estuary edge (including the new estuary edge defined by Lot 26), further providing for public access to and along the edge of the coastal marine area. The Committee considers this to be in accordance with the purpose of the Act, as it will meet section 6(d), 'the maintenance and enhancement of public access to and along the coastal marine area ...', a matter of national importance. The length of the esplanade strip created will be approximately 5km in length, a not insignificant amount. The new causeway will not have an esplanade strip but will have a right of way for public use, therefore also serving as public access along the estuary edge."

Periodic requests by researchers and bird watchers are received and always approved. Preliminary studies of the estuary ecology by the University of Otago have been hosted and are encouraged.

The Tūmai Beach enhancement site will be registered as a site in iNaturalist⁴⁰ for recording biodiversity sightings and locations by residents and visitors.

School visits and planting days, coupled with ecological lessons at school before and afterwards, are encouraged. At least three such visits are targeted in the period of this 2021-2023.

Next steps: the work plan for 2021 and 2022

The estimates of plant species numbers and staging priorities are only sensible first estimates. Supply of plants and funding constraints may prevent realisation of the detail in this plan. The most important need is to not plant inappropriate species that will become weeds, or to locate the estuarine margin plants higher up the slopes. Once canopy closure is achieved, later enrichment planting and natural succession will adjust the detailed representativeness of the eventual ecological communities present.

Each plant will cost around \$10 to establish⁴¹ – this includes the cost of propagation, site preparation, planting and follow-up care. Their low cost has been achieved in part because of the large scale of their restoration estimates and special supply agreements. We may not be able to keep costs for the Tūmai work as low as \$10 per plant. Our need for around 97,000 plants therefore requires an overall budget of at least one million dollars, much more than 16 families can muster on their own. Partnerships with external agencies and environmental restoration grants will be sought to help defray costs.

In view of the cost and uncertainties, we are reluctant to stipulate a time line for planting in the next two years. However, Stages #1 is small scale and we aim to complete it in 2021. We can realistically expect to make a start on stages #2, #3 and #4 in the next two years. We are resolved to go as fast as practical while being careful to not take on too much so that follow-up care of the plants is inadequate. In the interim and dry months we will concentrate our collective efforts in conducting the archaeological risk assessment and forming a network of walking tracks to facilitate access.

Acknowledgements

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Chris Garden prepared the maps in Figs 1 - 3, and calculated the areas of each polygon.

⁴⁰ <https://www.inaturalist.org/>

⁴¹ This estimate is provided by the Halo project.

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Appendix: Number of specimens of different species established in the partially planted polygons shown in Fig. 2.

Part 1

Species	A	B	C1	C2	D	E1- Marg in	E1- Hillslo pe	E2- Marg in	E2- Hillslo pe	E3- Marg in	E3- Hillslo pe	F1- Marg in	F1- Hillslo pe	F2
Cassinia leptophylla	55			5								1		
Coprosma parviflora/Coprosma propinqua	8	8	1	2								2		
Coprosma robusta	18	39	2	8	36	4	3		2			6	1	
Coprosma rugosa	12	31						1		1	1	9	1	
Cordyline australis		55	57					3	1	8	14	11	3	11
Corokia x virgata 'Bronze'	20	4		5	59	1	9		14					
Cortaderia richardii														
Dodonaea viscosa	8	1		8		1			2					
Dodonaea viscosa 'Purpurea'	7	6	7	2	7				3			3	1	1
Griselinia littoralis	24	118	42	9	30							18	2	2
Hebe buxifolia/Hebe elliptica					14	4	4		5		1			
Hebe parviflora	2	26	14	3		9	4		6			4		
Kunzea ericoides		128		6	24	5	1		1				2	1
Kunzea ericoides/ Leptospermum scoparium														
Leptospermum scoparium	42	8	53			9		3	11		3	5		
Metrosideros umbellata	1	19							2					
Myoporum laetum				1									1	
Nothofagus fusca		24	5		41	2		3	11					
Nothofagus solandri		6	1	1		1								
Olearia dartonii		14	24					5	1	19	25	2		2

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Olearia paniculata	25	68	19	2	63							10	2	2
Olearia traversii		44	3		53			1	1	2	7	7		1
Pittosporum eugenoides		30	13			1						3	5	2
Pittosporum ralphii		68	4									21	5	
Pittosporum tenuifolium/Pittosporum tenuifolium c*	30	246	41	8	78	60	7	39	133	12	12	9	2	1
Plagianthus divaricatus	58	2	5	2		20	2	8	22	10	2			
Plagianthus regius		44	13					7	10	30	25	12	2	
Podocarpus totara	44	156	17	14	29	7	3	2	21			8		2
Pseudopanax arboreus			2											
Pseudopanax crassifolius	7	3	1		11									
Pseudowintera colorata	1	7			31									
Sophora microphylla		48	18			4		4	6	3	1			
Sophora tetraptera		16	1			4		2	5		3	4		
Austroderia toetoe														
Total	362	1219	343	76	476	132	33	78	257	85	94	135	27	25

Part 2

Species	G	H	I	J	K	L1	L2	O1-Margin	O1-Hillslope	O2-Margin	O2-Hillslope	Toetoe	W1	TOTAL
Cassinia leptophylla														61
Coprosma parviflora/ Coprosma propinqua	1									1				23
Coprosma robusta			2		3									124
Coprosma rugosa	1				1					2				60
Cordyline australis	19	29	4	14	15	10	12	24	39	23		19		371
Corokia x virgata 'Bronze'			6	1	3									122
Cortaderia richardii												233		233
Dodonaea viscosa				6	1	9	2	2		1				41
Dodonaea viscosa 'Purpurea'				2	6	11	9	4	11	8				88
Griselinia littoralis		1	1	9	14	20	4	10	13	12			2	331
Hebe buxifolia/Hebe elliptica	7	1												36
Hebe parviflora														68
Kunzea ericoides	21	19		8				3	4					223
Kunzea ericoides/ Leptospermum scoparium			1											1
Leptospermum scoparium	1			1	15	17	6	4	1	3	1			183
Metrosideros umbellata					4	9				1				36
Myoporum laetum													89	91
Nothofagus fusca	3	2			2				1			1		95
Nothofagus solandri					2	5	2		1			1		20
Olearia dartonii	31	9		6	3	4	3	8	5	7	1			169
Olearia paniculata		6	1	5	3	4	2	4	4	11		2		233
Olearia traversii	1	5	3	10	7	4	4	8	4	3				168
Pittosporum eugenioides		3			9	3	5		5	6	1		2	88

Pittosporum ralphii			3	2	3								1	107
Pittosporum tenuifolium/Pittosporum tenuifolium c*	2	6	2	9	12	22	10		9	44	1	14	23	832
Plagianthus divaricatus	5	6		2	4	8	6	5	7	18				192
Plagianthus regius	21	12	1	2	1									180
Podocarpus totara		7		11	7	9	2	8	22	6				375
Pseudopanax arboreus						1								3
Pseudopanax crassifolius						1								23
Pseudowintera colorata		1		3	6	5								54
Sophora microphylla		3		3		1				1				92
Sophora tetraptera	3		6	6	5	1	2	3	5	1				67
Austroderia toetoe												265		265
Total	116	110	30	100	126	144	69	83	131	148	4	535	117	5055