

Plants and vegetation in proposed wind-farm area, Waipipi, Waverley (April 2012)

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Botanical surveys of an area proposed for a wind-farm at Waipipi, Waverley were made on 27-28 February and 7 March 2007, and 9-12 April 2012. This resulted in descriptions of vegetation types, a vegetation map, a list of the indigenous and exotic flora and descriptions of some features of the area's botanical importance. The 2007 survey and report for the earlier wind-farm proposal were of two blocks of land, called East and West blocks (Harper, Somers & Sullivan 2007). These two blocks are submersed in the larger area of land covered by the present proposal. The 2012 survey re-visited all the places found to have important natural values in 2007. A 'Central' block was defined as that land between the 2007 East and West blocks, and a 'North-west' block was created for land between the 2007 West block and the Whenuakura River.

Aerial photographs (2009) were used to detect different vegetation types and these were located and examined on the ground from a vehicle and on foot. Vegetation units were drawn on aerial photographs in the field and compiled as a vegetation map using Google Earth. Some mosaics of different vegetation types were mapped as single units, as described later. A plant list was made for the entire survey area (Appendix 4). Columns within this list show the plants (a) in each of the East, Central, West and North-west blocks of Waipipi and (b) in parts of the proposed wind-farm that are important for indigenous plant conservation.

Vegetation types have been named following Atkinson (1981).

Landforms

Much of the land on which it is proposed to build a wind-farm is on a series of flat terraces parallel to the coast, the result of sand mining between 1971 and 1987, followed by re-shaping of the land surface. Surface drains were dug across and along the previously mined surfaces in a grid pattern and these eventually fed into the natural drainage systems through the coastal dunes that were not sand mined. Some streams reached the sea, either over coastal cliffs or they flow through dune hollows to the beach. Only the largest stream of the wind farm proposal still follows its natural course across the land that was sand mined.

A line has been drawn on the vegetation map to separate the previously mined dunes from 'un-mined' dunes, i.e. those that have natural dune landforms.

Natural dune terrain extends inland from the coast to the seaward edge of past sand mining. Unmined dunes also occur inland from the main east-west farm track (in front of the main pine plantations).

Some sand is mobile under the effects of wind, exacerbated by the removal or disturbance of plant cover by factors such as grazing animals, off-road vehicles, fire and, perhaps, rabbits. Marram grass builds tall dunes that eventually become unstable and result in sand blow-outs. Some sand blow-outs are also on previously mined land.

Dunes begin on the shore in places, but in other places the shore of the study area is defined by mudstone sea cliffs, with the dunes starting on top at up to 10 m above sea level. The mudstone occurs in approximately horizontal layers and, in places, fresh water seeps out continually onto the cliff face from the top of impervious layers. The main aspect of the sea cliffs is south-west which means the sheer faces of the cliffs can be shaded much of the time.

The Whenuakura River borders the wind farm proposal in the north-west. In 2012 there was only a narrow tidal fringe on the true left (i.e., the Waipipi) side of the river, but this probably changes over time. About 200 m up from the river mouth is a flat river terrace with intact natural swamp vegetation. From almost sea level, it slopes gently upwards away from the river where it meets pasture on uneven mudstone slopes.

Vegetation

1. Sand-mined surfaces

After sand mining, the reinstated surfaces were converted to pasture. The pasture varies considerably in composition from place to place in relation to water table and, possibly, an uneven redistribution of sand and peat at the conclusion of sand mining. In the attached photo-file are pictures of a range of pasture types, ranging from very dry to boggy (extended captions for these photos comprise Appendix 2). Wet pasture is associated typically with drains and the terrace edges. A narrow strip of boggy pasture occurs on the rim of some terraces (photo **E12**) and, more commonly and extensively, at the base of the terrace risers (photos **W17, 18**).

Apart from two mapped areas (**WV2** and **NWV2**), pasture on previously mined surfaces has limited intrinsic botanical significance for conservation and it has been mapped as one vegetation unit. Few indigenous plants were found in dry pastures on previously mined surfaces. Wetter areas tended to have some indigenous rushes and sedges and, especially along drains, patches of raupo (*Typha orientalis*) (photo **W12**). At times, such areas are heavily used by stock, resulting in pugged ground and browsed plants.

Cutty-grass is often conspicuous in wet areas on the previously mined surfaces. One of the largest areas, **EV3**, is immediately upslope from the swamp described below as **EV1** and shown in photos **E23-25**. A random transect through this area gave a cover of 48% cutty-grass and 48% exotic species. There were only three other indigenous species in this wet pasture, all quite uncommon - a small patch of raupo (visible in photo **E25**) and a few reeds (*Juncus edgariae*, *Eleocharis acuta*). This is an example of a previously mined area with extrinsic conservation importance. Its native species are not, in themselves, that significant, but the vegetation has valuable down-stream roles. Fencing of the water course would

improve water quality for the important wetlands (**EV1**) downstream. Some details follow for the two wet areas which have regenerated with a locally high proportion of native vegetation on previously mined land.

WV2 Swamp and bog was identified as a significant site in Harper et al. (2007), where it was the sole area delineated as having conservation importance on previously mined land, an area of swamp and bog just below the western wind monitoring tower. A separate column in the plant list (Appendix 4) listed all the species found in **WV2**. Most unusually, this area had regenerated naturally with predominantly indigenous species after sand mining. In 2007, a rusting iron pipe ran down the terrace riser and carried water from a drain across the terrace beside the wind monitoring tower into the back part of the terrace below. The strip of raupo swamp still grows here (photo **W11**), and contains some exotic herbs, including lotus, an American willow-herb (*Epilobium parviflorum*) and, in 2012, hemp agrimony. In 2007, this swamp was stated to be a filter for nutrients in the water because on the seaward side of the raupo was an area of bog, i.e., a low-fertility plant community. The bog was characterised by a dense sward of plants that are mostly shorter than 20 cm, on wet soil high in organic matter (early-stage peat). Such vegetation is referred to here (and later for other sites) as turf (photos **W12, 13**). It was dominated by a rhizomatous dwarf sedge, *Schoenus nitens*, which usually occurs elsewhere in the region's dune country in natural dune slacks. Growing with the *Schoenus* were other typical species of sand country dune slacks, including sand gunnera (*Gunnera arenaria*), slender spike sedge (*Eleocharis gracilis*), a small leafy rush (*Juncus caespiticius*), native lobelia (*Lobelia anceps*) and, very rarely, native dune willow-herb (*Epilobium billardioreanum*). Sand gunnera is a creeping herb that has a national conservation status of 'At Risk – Declining' (de Lange et al. 2009).

In 2007 it was stated (Harper et al. 2007) that 'protection of the raupo strip on the landward side of the bog is critical for protection of the bog itself.' It was noted that where the raupo strip was narrow or absent in 2007, immediately east and west of the area marked **WV2**, the bog was dominated by exotic plants that are characteristic of higher fertility sites. At the eastern edge of the area marked as **WV2**, where the raupo filter effect is less, there were scattered, indigenous, taller reeds (photo **W14**), including sea rush (*Juncus kraussii*), kapungawha (*Schoenoplectus tabernaemontani*) and mariscus (*Cyperus ustulatus*), with a sward of cutty-grass (*Carex lessoniana*) and some rank pasture grasses. Grazing animals seemed not to be affecting the natural values of this bog.

During the 2012 survey, it found that the iron pipe had been dragged out of the swamp since 2007 and a ditch had been dug along the inland side of the raupo area discussed above. Ditches had been cleared to carry water from the drain that discharged water off the terrace above. Some adjoining rough pasture had been mown. As a result, the naturalness of the area was diminished by 2012 and is likely to continue to do so unless the earlier water regime can be restored. The area defined in Harper (2007) as being important indigenous vegetation, has been reduced in this 2012 report.

NWV2 Swamp. Swamp vegetation with some native plants occurs in numerous places at the foot of terraces within the sand mined area, mostly adjoining streams and drainage ditches. As one of the best examples, **NWV2** has been delineated because it is relatively large and has a high proportion of indigenous plants. It is the result of one of the larger straightened streams across the mined surface flowing off the terrace above. It is joined by ditches along the foot of the terrace which have partly in-filled and become swampy. Patches of raupo, cutty grass and looping sedge are each locally dominant. There are scattered tussocks of mariscus and several of purei (*Carex secta*), the latter being rare at Waipipi except for the Whenuakura River edge swamp. The main stream broadens over wet redeposited sand with three-square. This is also one of the few places at Waipipi with a more robust cutty grass, an unnamed form of *Carex geminata*. Exotic plants are common in some places, especially congested sedge, glaucous sweetgrass and Mercer grass.

2. Pasture/scrub mosaic on natural dune surfaces

Mapped as ‘**pasture/scrub mosaic**’ are areas of natural dune terrain, i.e. dunes that had not been mined for iron sand but which are grazed by cattle. Within these extensive dunes, some of the smaller mapped areas are discrete vegetation types while larger areas are generally mosaics of several to many vegetation types. Areas mapped as **EV1** and **CV2** (the latter being a re-mapping of RAP #43 in Ravine 1992) are examples of vegetation mosaics where it was not feasible to map each vegetation type.

‘Natural’ dunes have many of the plants found in pasture on mined land, although marram grass (*Ammophila arenaria*) is often the predominant exotic grass on dry dunes (seen in the background e.g. of photos **C4a**; **W16, 20**; **E5, 21**; **NW21**) and it can remain as a minor component of dry pasture (photo **C4b**). Scattered shrubs of boxthorn (*Lycium ferocissimum*), blackberry (*Rubus fruticosus*) and lupin (*Lupinus arboreus*) are typical, although lupins occur also in some pasture on previously mined land (photo **E11**).

Compared with the grid drainage patterns of previously mined dunes, in unmined dunes there is a dendritic pattern of water courses. In both mined and unmined dunes, the waterways are generally narrow, heavily trampled and grazed by stock. Where indigenous vegetation occurs around water courses it most commonly consists of cutty-grass with scattered patches of raupo and kapungawha (the most intact example is that shown in photos **W1a, W1b, W1c**, those photos being from the riparian zone of the largest stream of proposed wind-farm, an area mapped as **WV1**; around smaller streams, examples include photos **NW19, NW29**).

3. Ponds on sand-mined surfaces. Several artificial ponds were examined briefly during the survey of surrounding land. Most are used for stock water and several for waterfowl hunting. Part of the largest, known locally as Standalone Pond, is shown in Photo **C5a** and its exit stream in **C5b**. Some unexpected finds were made of indigenous aquatic plants in the ponds, including fennel-leaved pondweed which is listed as nationally ‘At Risk’ (Table 1; Appendix 3). Over the past two or three decades, fennel-leaved pondweed and several other indigenous water plants

seem to have disappeared from many of the natural dune lakes of the region, as exotic waterweeds have spread and increased. With one exception, the worst invasive waterweeds of the region were not found in Waipipi, probably because boats that often carry waterweeds are not brought here from beyond Waipipi itself. Because of their decline elsewhere, the indigenous aquatic plants, blunt pondweed and horse's mane weed are listed among the 'regionally threatened and uncommon' plants in Appendix 3.

The only really invasive waterweed found in Waipipi is curled pondweed (Table 1). In 'Frog Pond', curled pondweed grew with the indigenous blunt pondweed and at Standalone Pond it was found only in the exit stream rather than the main pond itself. Of interest, three floating duckweed species were found growing together in the most eastern pond (Table 1, Photos **E6a, b**). They all probably occur elsewhere at Waipipi as they are dispersed by waterfowl, but the sheltered waters among raupo at East Pond provided good habitat. There is no concern about the conservation of the two indigenous duckweeds, *Lemna* and *Wolffia*, and purple-backed duckweed is exotic.

	Standalone Pond	Frog Pond	East pond
Grid ref.	WP 051	WP 025	WP
Plants			
Kapungawha (<i>Schoenoplectus tabernaemontani</i>)	√		
Horse's mane weed (<i>Ruppia polycarpa</i>)	√		
Fennel-leaved pondweed (<i>Stuckenia pectinata</i>)	√		
*Curled pondweed (<i>Potamogeton crispus</i>)	√ ¹	√	
Blunt pondweed (<i>Potamogeton ochreatus</i>)		√	
*Water buttercup (<i>Ranunculus trichophyllus</i>)	√		
Water milfoil (<i>Myriophyllum propinquum</i>)	√		√
Sharp spike sedge (<i>Eleocharis acuta</i>)	√		√
Raupo (<i>Typha orientalis</i>)			√
Duckweed (<i>Lemna disperma</i>)	√		√
*Purple-backed duckweed (<i>Landoltia punctata</i>)			√
Watermeal (<i>Wolffia australiana</i>)			√
Azolla (<i>Azolla filiculoides</i>)	√		√

¹ In outlet drain, not seen in main pond

Table 1: Submerged and emergent aquatic plants of 3 larger artificial ponds in Waipipi. Plants of wet fringing pasture are not included. * denotes exotic species.

4. Important indigenous vegetation on natural dune surfaces

Within the natural dune terrain, a number of areas are identified on the vegetation map as having considerable natural value because they have predominantly indigenous vegetation, and usually contain species that are now uncommon in South Taranaki-Wanganui sand country. Some of these are rated as nationally threatened or uncommon species (Appendix 3).

In the largest area of mobile sand in the Western Block (**V6i**), some evidence was found in 2007 of charred rhizomes of club sedge (*Ficinia nodosa*) and the sand mobility may be at least partly the result of fire, perhaps early in the 2000s. The 15 largest areas of eroding sand are mapped collectively as ‘Sand’ although they all contain some vegetation, native and exotic.

EV1: The most extensive wetland within the wind-farm proposal is on dissected terrain of small dunes down a slope near the eastern boundary of the Eastern Block. This has all been mapped as EV1, but in three blocks separated by dry narrow sand ridges. It is a mosaic of different kinds of swamp and bog communities with inter-fingered low dunes. Different parts of the wetland occur at different levels, the lowest being perhaps 10-15 m below the most elevated parts. Dry dunes within EV1 have little intrinsic importance for indigenous plants but stock that graze the dune pasture also trample in the wetland, at least during dry seasons (photo E2), and browse the wetland plants, including harakeke or flax (photo E1).

Much of **EV1** is dominated by cutty-grass (most easily seen *in situ* in photo **E5**, but also – just outside the wetland **EV1** – in photos **E23-25**). Other locally common or sometimes dominant indigenous species are raupo, harakeke (flax) and a shrub daisy, *Olearia solandri*. Although the entire wetland has been mapped as **EV1**, there are two especially important parts of it. One is the shrub daisy shrubland **EV1b**, towards the western edge of the wetland (photos **E5**, **E6**, **E8**). This shrub daisy is scattered in the North Island and northern South Island, mostly near the coast. More or less intact wetlands with seemingly old stands like this one at Waipipi are rare, especially in places other than the margins of estuaries or dune lakes. Only a few young plants of the shrub daisy were seen during the survey, and they may not establish freely under the present grazing regime. Weeds may also be a limiting factor here, especially the locally abundant hemp agrimony (*Eupatorium cannabinum*) (photo **E7**); this weed has probably not been present for more than 15 years and is known in New Zealand as a weed only from near Hawera to Wanganui.

The most important part of **EV1** vegetation is the eastern-most swamp (**EV1a**). Comprising heavily grazed raupo and cutty-grass on the fringes, the core has the greatest range of indigenous wetland species in the entire survey area. Most notable and very rare in the region is swamp buttercup, a species that has a national conservation status of ‘Data Deficient’ (Appendix 3). It grows in water 100-200 mm deep, over an area of a few square metres. Growing with it are others which were not found elsewhere

during the survey: swamp pennywort (*Hydrocotyle pterocarpa*) and jointed twig-rush (actually not a rush but a robust sedge, *Machaerina [=Baumea] articulata*); or only rarely elsewhere: swamp willow-weed (*Persicaria decipiens*) and a fine cutty-grass (*Carex virgata*).

The wetland's integrity has already been compromised by drains right through it and by grazing; the area of intact indigenous vegetation is much less than in 2007. The swamp's natural values might be restored and ensured by infilling of the drains and fencing. Also important to the swamp's future is the quality and quantity of the water flowing in from the previously mined terrace inland and immediately adjoining it. This was mentioned above in relation to an area of cutty-grass, **EV3**, covered by photos **E23-25**.

CV2 (RAP #43, in part [Ravine 1992]) : On an area of natural dune terrain along a coastal and semi-coastal strip of the proposed wind-farm, is an area that was defined by Ravine (1992) as a Recommended Area for Protection (RAP) in the Protected Natural Areas Programme (PNAP) survey of the Foxton Ecological District (FED). A small part of this area was called EV2 in Harper (2007). **CV2** has several indigenous plant communities that are very important for plant conservation, some being types not found elsewhere in the surveyed area.

By definition, FED comprises all the sand country between Paekakariki (north of Wellington) and Hawera. The 46 'Priority 1' RAPs identified by Ravine (1992) were each the best remaining examples, not already in formal reserves, of their particular types of indigenous vegetation and terrain (e.g. various types of dune wetlands, including lakes, swamps, bogs and periodically wet slacks, plus sand plains, dry dunes and estuaries). 'Waipipi Dunes RAP #43' was one of these. Although the eastern end of **CV2** is used currently by off-road vehicles for beach access, the impacts are quite localised (photo **E14**). The vehicle track follows a narrow dune slack (moist inter-dune hollow) that is dominated by indigenous plants. The most-used part of the track retains the rhizomatous sand sedge (*Carex pumila*). Moist sand in the slack with less vehicle and foot traffic contains some of the species which make the larger dune reserves at Waitotara and Whangaehu (Whitiau Scientific Reserve) so important. These include dune half-star (*Selliera rotundifolia*), sand milfoil (*Myriophyllum votschii*) and sand gunnera (photos **E16-18**), each having a national threatened plant status (Appendix 3). Other indigenous species include tape-measure plant (*Lilaeopsis* sp.), a dwarf sedge (*Isolepis cernua*), sand buttercup (*Ranunculus acaulis*), native lobelia (*Lobelia anceps*), a small leafy rush (*Juncus caespiticius*) and the small sedge *Schoenus nitens* that is characteristic of peaty sand elsewhere in the survey area. Surrounding the slacks are stands of taller reeds, especially club sedge and oioi.

On dunes towards the beach (i.e., beyond the quad bike in photo **E14**) is golden sand sedge or pingao (*Ficinia spiralis*), which is rated 'At Risk' nationally (Appendix 3), and silvery sand grass, spinifex (*Spinifex sericeus*). Areas of bare sand occur between pingao and spinifex patches. Semi-fixed dunes adjoining the slack have areas dominated by the indigenous, rhizomatous, and a tufted grass, sand bent (*Lachnagrostis billardiarei*) with tauhinu shrubs (*Ozothamnus leptophyllus*). This small area is one the best mixed communities of indigenous vegetation on dry dunes in the proposed wind-farm, though further west there are quite extensive areas of spinifex and pingao lacking in exotic marram grass. There

are also small colonies of sand coprosma (*Coprosma acerosa*), another nationally 'At Risk' species. In the North-west Block is an area of unmined dunes with small patches of sand coprosma shrubs. Photo **NW30a** shows the densest patch found in Waipipi, where about 12 shrubs occur in an area seemingly sprayed for blackberry – dead blackberry stems are visible in the lower left quarter of the photo. In the same location is the single shrub of sand coprosma in Photo **NW30b** and shows live blackberry all around it.

Inland from the taller reeds are large beds of club sedge and oioi (photo **E20**) and, locally, the densest patches of three-square sedge seen in the survey area (photo **E21**).

Extensive dry dunes that have not been sand-mined are excluded from **CV2** when they are dominated by marram and pasture grasses (photo **E13**), with scattered or locally common boxthorn and blackberry. In these areas, native club sedge is sometimes common, especially in and around dune hollows. These dunes are on the landward side of **CV2** and also extend east and west of **CV2**.

NWV3: cabbage tree treeland. A small area of unmined dunes contains the only stand of cabbage trees within the proposed wind farm, and is mapped as 'NWV3 treeland' and shown in Photos **NW5-10**. It is fenced and, in April 2012, appeared to have been ungrazed for some months. The stand comprises a number of old cabbage trees, some of which have rings of young cabbage tree trunks around them, evidence of some earlier time without stock grazing, when new shoots were able to grow from the trunks of old trees. In 2012, very young shoots were sprouting from some of the trunks, again through lack of recent grazing. Throughout New Zealand, cabbage trees in farmland are mostly doomed to die out through lack of regeneration, which makes the recovering Waipipi grove of at least local importance. All the species found in and close to the cabbage tree grove are listed in a separate column in Appendix 2. Uncontrolled boxthorn is a threat, long-term, to the site. One exotic plant species of interest here is a species of veld grass, *Ehrharta calycina*. It was planted in dunes with pine plantations, including Santoft and Waitarere forests, by the NZ Forest Service before the mid-1980s and generally has not spread far beyond. Waipipi is remote from any other known site.

WV1: The area mapped as **WV1** is a mosaic of vegetation types comprising the riparian zones of the largest stream of the wind-farm proposal. The stream was clear and with a steady flow during the survey. It has a sandy bed with patches of (mostly exotic) water plants in and bordering it (photo **W1a**), of which glaucous sweetgrass (*Glyceria declinata*) is the most abundant in many parts. The stream is incised with generally steep banks rising to 10 m or more. These banks have a few specimens each of plants rarely seen in the survey area, namely cabbage tree (*Cordyline australis*), mamaku tree fern (*Cyathea medullaris*), wheki tree fern (*Dicksonia squarrosa*) and cliff kiokio fern (*Blechnum triangularifolium*). More common are toetoe (*Austroderia toetoe*), mariscus (photo **W1d**), flax or harakeke and cutty grass (*Carex lessoniana*), with exotic grasses and shrubs such as boxthorn and blackberry. The native vines, pohuehue (*Muehlenbeckia complexa*)² and NZ spinach (*Tetragonia*

² Pohuehue is a major food plant for larvae of the indigenous copper butterfly

implexicoma) were common, often climbing through boxthorn where they are protected from grazing animals. Joining the main stream, steep swampy channels through the dunes had tall reeds including raupo, kapungawha and sharp spike sedge (*Eleocharis acuta*) (photos W1b, W1c). These are less stock-damaged than similar channels elsewhere in the pasture of the survey area. For their intrinsic natural features and to retain water quality of the main stream these channels have been mapped as part of the riparian zone **WV1**.

Straddling the border of an area excluded from the proposed wind farm, on the lower true right bank of the stream, is an area of peaty turf vegetation, similar to that in **WV2** and some very small areas in **CV2**. *Schoenus nitens* is generally dominant, with other native herbs including slender spike sedge, the small rush (*Juncus caespiticius*) and native lobelia. Clumps of the taller rush, oioi, are scattered through and around this turf vegetation.

WV3: Adjoining the eroding dune area **V6i** is the most extensive natural area of oioi or jointed wire-rush (a restiad rush, *Apodasmia similis*) bog (Area WV3; photos **E15, 20, 21**). These parts are similar to oioi rushland further east (**V4**). To the west of the oioi rushland, down a very gentle slope, oioi gives way to a turf dominated by *Schoenus nitens*. This is rather similar in composition to that on the mined surface below the western monitoring tower (WV2), including the presence of sand gunnera. It has several indigenous species not or rarely seen elsewhere in the proposed wind-farm, including sea primrose (*Samolus repens*) and sand willow-herb (*Epilobium billardioreanum*). At its lowest end, the bog has two seemingly natural dune ponds, the larger about 20 m diameter (just visible in photo W20). The pond contains native pondweed (*Potamogeton cheesemanii*) and a charad alga (probably *Chara globularis*, the charad found in Standalone Pond). This wet area is also the only place where an exotic grass, floating sweetgrass (*Glyceria fluitans*)³, was found on the survey. The margins of the pond were heavily stock-trampled although the rushland and turf vegetation were not. A list of plants in Area WV3 appears as a separate column of Appendix 2.

5. Vegetation on sites that are not on dunes

NWV1: Whenuakura River terrace swamp.

One of the most important areas of indigenous vegetation within and bordering the proposed Waipipi wind farm is a swamp adjoining the Whenuakura River. It lies perhaps 200 m up-river from the sea and extends from the tidal edge of the river and across a terrace that slopes gently upwards towards the low steep hills to the east. A list of plants recorded is in Appendix 4. The vegetation is dominated by raupo but this is sparse in some parts allowing a range of other indigenous swamp species. The sparse raupo suggests that the swamp has relatively low fertility. In other words, livestock and farm fertiliser are not having great effects on the swamp. Purei (*Carex secta*), swamp toetoe, kapungawha (*Schoenoplectus tabernaemontani*) and harakeke (flax) are conspicuous, with localised patches of an indigenous wetland

³ Although once included in *Glyceria fluitans*, glaucous sweetgrass (*G. declinata*) is a distinct species and, in New Zealand, is a far more common grass. Glaucous sweetgrass occurs widely in drains of Waipipi.

grass, swamp millet (*Isachne globosa*), large cutty grass and a summer-green sedge, kukuraho (*Bolboschoenus fluviatilis*). Woody plants include scattered karamu (*Coprosma robusta*) and pohuehue (*Muehlenbeckia complexa*) with a few shrub daisies (*Olearia solandri*). Smaller plants include looping sedge, sharp spike sedge and the fern, swamp kiokio (*Blechnum minus*). Along the river edge of the swamp are plants of saline areas, including arrow-grass, half-star, sea celery and sea primrose. Exotic plants were common on the wet pasture edges, especially jointed-leaved rush and Mercer grass. Several willows, probably grey willow (*Salix cinerea*) were seen from a distance. The area is very intact, probably has a larger native flora than was found in April 2012 and warrants further survey for both flora and fauna. Run-off of silt and fertiliser from adjoining land would change the nature of the swamp.

NWV3: North-western sea cliffs. In general, the sea cliff vegetation is dominated by indigenous plants, several of which are nationally threatened or uncommon (Appendix 3). All sea cliff species found in NWV3 appear in a separate column in Appendix 4. Because the proposed wind farm is not anticipated to result in disturbance of the sea cliffs, only some parts were surveyed in some detail and these are mapped. A detailed survey of all the sea cliffs would probably show that all the cliffs are important for indigenous plants and more species may occur there than were recognised in the April 2012 survey. On wet mudstone just east of the mouth of Whenuakura River (**NWV3a**) are some of the largest intact patches known in New Zealand of a mat-forming button daisy, *Leptinella dispersa* subsp. *rupestris*, and also rosettes of the native puwha (*Sonchus kirkii*). Both species have a national conservation status of 'At Risk'.

EV4: Eastern sea cliffs. Where the stream from the dune swamps EV1 drops over a mudstone cliff on to the beach there is a narrow incised 'gorge' which has not been grazed intensively. It also is a channel for salt-laden winds from the sea. The 'gorge' has a number of coastal plants that are rare or absent from the whole proposed wind farm, including a button daisy (*Leptinella squalida*), *Colobanthus muelleri* and coastal blechnum fern (*Blechnum blechnoides*). As stated for the sea cliffs NWV3, because the proposed wind farm is not anticipated to result in disturbance of the sea cliffs, only one part of EV4 was surveyed in some detail and it is mapped. Species found in EV4 are not listed separately, but all appear in the combined plant list of the Eastern Block in Appendix 4.

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Appendix 1: List of mapped vegetation types

A semi-quantitative method is used to denote plant cover for some vegetation types (after Atkinson 1981) of the survey area. Plant cover, as a percentage, was estimated or measured for each prominent species in each mapping unit and indicated in one of four percentage classes, as follows:

<u>boxthorn</u>	≥ 50% cover
boxthorn	20-49% cover
(boxthorn)	10-19% cover
[boxthorn]	<10% cover

Different strata are separated by a forward slash (/), the shorter plants being to the right of the (/). Species in the same strata are separated by dashes (-).

Hypothetical example: [boxthorn] / marram – club sedge / (hawkbit)

This describes a community with very sparse boxthorn in a marram-dominated grassland, with some (20-49% cover) of club sedge of about the same height, with a scattered ground cover of hawkbit. Where relevant, bare ground is shown as part of the cover, e.g.

(Tauhinu) / spinifex – [marram] / sand

This describes an area where bare sand covers > 50% of the area, with the remaining area having sparse tauhinu shrubs over grassland of spinifex with a small amount of marram.

In practice, some of the plant communities were of too small an extent to show on the vegetation map and they are mapped as part of larger mosaics. At the opposite end of the size scale, the most extensive vegetation of the area covered by the wind-farm proposal is pasture. As discussed in the text, there are many different combinations of pasture plants and weeds in the area's pasture and it was not possible or meaningful in terms of identifying places of conservation importance to identify all of these or to map them separately. Some examples of typical plant associations in pasture are given below.

EV1: Mosaic of wetland vegetation with interspersed dry dunes

- a) Cutty-grass – jointed-leaved rush: sedgeland in swamp
- b) Raupo: reedland in swamp
- c) Raupo / sharp spike sedge – swamp willow weed – (swamp buttercup) – [jointed leaved rush] / duckweed: reed - sedgeland in swamp
- d) Harakeke: tussockland in swamp
+ vegetation with various mixtures of a, b, & c
- e) (*Olearia solandri*) / cutty-grass - tall fescue – hemp agrimony: shrub - sedgeland in bog
- f) Marram – Yorkshire fog: grassland on dry dunes

[EV2 of Harper (2007) has been renumbered as CV1]

EV3: Cutty-grass sedgeland in pasture on previously mined dune surface (but similar sedgeland (not mapped separately) occurs on unmined surfaces, in moist hollows. Two areas adjoining the important wetlands of EV1. They are identified mainly as filters of water entering EV1.

EV4: coastal cliffs and adjoining narrow incised stream course

WV1: Riparian zone of the major incised stream

- a) glaucous sweetgrass – (Mercer grass) – (jointed-leaved rush) – [creeping buttercup]: grassland, rooted in stream and on stream margin
 - b) [tall fescue] – [soft rush]/ glaucous sweetgrass – looping sedge – [perennial ryegrass] – [water pepper] – [white clover]: grassland on low terraces adjoining stream
 - c) raupo – (kapungawha) – (harakeke) / cutty-grass – [sharp spike sedge]: sedge – reedland in swampy small gullies
 - d) boxthorn – [pohuehue] – [mamaku] - [cabbage tree] / (toetoe) - (harakeke) / tall fescue - Yorkshire fog - [mariscus]: shrub-grassland on dry and moist valley sides
 - e) (oioi) / Schoenus nitens – *Juncus articulatus* – [slender spike sedge]: rush-sedgeland turf vegetation on peaty dune slack
- + *vegetation with various mixtures of a-e where zones adjoin (i.e. along ecotones)*

WV2: turf vegetation and reedland on flat wet surface of previously sand-mined dunes

- a) raupo / (lotus) – [American willow-herb]: reedland in swamp
- b) [oioi] / Schoenus nitens – jointed-leaved rush - [sand gunnera] – [slender spike sedge] – [native lobelia]: rush sedgeland, short turf on wet peaty sand
- c) [kapungawha] – [oioi] – [mariscus] – [sea rush] / cutty grass – (congested sedge) - (lotus) – (Yorkshire fog) / jointed-leaved rush: sedge-rushland on wet peaty sand

(b) and (c) tend to be a mosaic, with (b) on the less fertile soils, i.e. immediately on the seaward side of the widest areas of raupo swamp

WV3a: Dune slack with rushes, bog and pond

- a) oioi: rushland on gentle sloping dune valley floor
- b) [oioi] / Schoenus nitens – (jointed-leaved rush) - [sand gunnera] – [slender spike sedge] – [native lobelia] – [sand willow-herb]: rush-sedgeland, short turf on wet peaty sand in broad floor of dune
- c) water buttercup – [pondweed]: floating herbfield in pond

(a) and (b) are interspersed in patches along the zone where they meet (i.e. along ecotones)

CV1: Recommended Area for Protection (RAP) #43 (Ravine 1992)

A mosaic of dune slacks, seepages and dry dunes (the area mapped as 'RAP' contains some of the best representative areas of types (a) to (j) in Waipipi. Examples:

- a) (tauhinu) / spinifex – marram - (pingao) / sand convolvulus: grassland on dry dunes
- b) marram – club sedge: sedge grassland on dry dunes
- c) (marram) – [pingao] / sand: foredune with sparse vegetation
- d) sand carex) / dune half-star – sand gunnera – [tape measure plant] – [Isolepis cernua] / sand: herbfield on damp dune slack
- e) oioi - club sedge – [three-square]: sedge rushland on damp dune slack
- f) [mariscus] – [club sedge] / three-square: sedgeland on damp dune sides and bottoms
+ *vegetation with various mixtures of b-e where zones adjoin (i.e. along ecotones)*
- g) club sedge {to 1.5 m tall} (oioi) / jointed leaved rush – red clover – creeping buttercup – (Mercer grass): reedland in moist broad dune hollow
- h) club sedge {to 0.5 m tall} / hare's tail – Yorkshire fog / (sand carex) - [Schoenus nitens] / sand gunnera – sand half-star / sand: sedge-grassland in damp dune hollow
- i) Schoenus nitens – (red clover) – [white clover] – [sand gunnera] – [slender spike sedge]: sedgeland in wet dune hollow (growing under electric fence-line)
- j) (sand carex) / sand milfoil – halfstar – [sea primrose]: herbfield in 5-7 m diameter dune hollow

NWV1: coastal swamp beside Whenuakura River.

- (a) raupo / purei – [kukuraho] reedland
- (b) [shrub daisy] / raupo – purei – [swamp millet] reedland

NWV2:

NWV3: cabbage tree treeland

(cabbage tree) / Mercer grass – tall fescue – cutty grass: tree – grassland

NWV4: coastal cliffs (note also small area of sea cliffs mapped in East block as EV4)

- (a) sparse herbs on wet, very steep to vertical mudstone
- (b) turf mats on mudstone ledges

V4: Oioi rushland on dune slopes and tops of sea cliffs

V6: wind-eroding dune sand, mostly with marram grass grassland

V7: *Pinus radiata* plantation

V8: Pasture and pasture/scrub mosaic. Extensive on previously mined surfaces and on natural dune terrain. Occurs in a wide range of different species combinations, mostly exotic species and resulting from e.g. of differing soil types, soil wetness, mowing and grazing and the history of cultivation and re-sowing. It includes some small areas of native rushes and sedges in dune hollows. Because natural dune topography often has exotic shrubs (e.g. boxthorn, lupin, blackberry) it has been mapped as ‘**pasture/scrub mosaic**’ where it was not feasible to map individual patches of shrubs. Areas of marram grass are mapped in this vegetation type. On previously mined dunes, shrubs are quite uncommon and marram is localised and these areas are included in land mapped as ‘**pasture**’.

1. Pasture/scrub mosaic on natural dune topography

- a) [boxthorn] - marram – Yorkshire fog – cocksfoot / browntop / (hawkbit) – [plantains]: on dry natural dune terrain (the relative proportions of marram to other grasses and ‘weeds’ varies greatly from site to site)
- b) [boxthorn] / (club sedge) – (sand coprosma) / cocksfoot - Yorkshire fog – [pohuehue]: pasture on natural tall hind-dune terrain [beside old trig]
- c) (blackberry) / cocksfoot – browntop – tall fescue: pasture on moist natural dune terrain (the relative proportions of blackberry and grasses varies greatly with site)
- d) [oioi] – mariscus / jointed leaved rush – creeping buttercup: rushland in dune hollow
- e) boxthorn – [taupata] / blackberry – pohuehue – [climbing dock] / marram – (mariscus) – club sedge / cocksfoot: vine – grassland on rolling dunes
- f) spinifex → marram – [pingao] / sand: grassland on foredune

2. Pasture on previously mined dunes

- g) (Yorkshire fog) – [three square] / red clover – creeping bent / (hawkbit) – (jointed-leaved rush) - [narrow-leaved plantain]: wet pasture on mined surface
- h) Tall fescue – (ratstail) – (bristle grass) / hare’s-foot trefoil – (fathen) – (Mercer grass): pasture on dry (re-sown?) mined surface
- i) (lupin) / Yorkshire fog – cocksfoot – (Yorkshire fog) – paspalum / (catsear): pasture on moderately-dry mined surface
- j) Tall fescue – congested sedge – Yorkshire fog / red clover – (lotus) / hawkbit - (white clover): pasture on moist mined surface
- k) Jointed-leaved rush – Yorkshire fog – (red clover) - (creeping bent) – [congested sedge] / (hawkbit) – (creeping buttercup): pasture on boggy mined surface

- l) marram → sand carex - (marram) / sand; 'pasture' on inland sand blow-out (from sand ridge to dune hollow); with sparse lupins & sand convolvulus
- m) [mariscus] – [club sedge] / jointed leaved rush – creeping bent – (Yorkshire fog) – (red clover) – (white clover) – [lotus major]: pasture on broad dune flat, previously mined; with sparse congested sedge and patches of cutty grass
- n) Mercer grass – 3 square – (mariscus) – (large cutty grass): wet 'pasture' beside overflowing stream

Appendix 2: List of photographs

The plant list (Appendix 2) is divided into **E, C, W** and **NW** to denote the discrete, eastern, central, north-western and western and blocks of Waipipi, and the photograph numbering follows this lettering; the text below is in alphabetical (C,E,NW,W) then numeric order. Some vegetation names are included in the descriptions.

Central Block

C1 – C3 = RAP: mapped as **CV1**, most of this area was proposed for protection in the Protected Natural Areas survey report (Ravine 1992) and it still has very high conservation importance. A very small portion of the eastern end of the RAP lay in the Eastern block of the 2007 wind-farm proposal and was shown in Harper et al. (2007) in photos **E14 – E18, E20** (now re-numbered as **C2a-C2g**, see below).

C1: foredunes and 2nd-3rd dunes behind. In places, the fore dunes are accumulating sand with vigorous growth of native sand-binding grass, spinifex (Photo **C1c, C1e**). Pingao (or golden sand sedge) is also on some fore dunes but it maintains its sand-binding role for longer than spinifex, being found widely in the next 2 or 3 rows of dunes behind the fore dunes (**C1a, b, c**). Both spinifex and pingao form lower profile dunes than the exotic grass, marram (**C1a, b,c**). Marram can lead to long-term dune instability and blow-outs. Photo **C1d (was E19)** is at the eastern end of the RAP and shows spinifex with unstable marram dunes above it, and with the only shrubs found in the survey area of a native daisy, tauhinu.

C2: dune hollows (= dune slacks). Hollows between dunes that have not been sand mined vary greatly in wetness, depending upon factors like seasonal water table, natural drainage, and the inflow and outflow of water overground or by seepage underground. The substrate is usually sand which may be compact or loose, and some have accumulated organic material from dead plants. The resulting vegetation is a mosaic of different communities, some dominated by native species, others by exotic plants (usually species of wet pasture).

C2a-e (2007 photos), C2f (2012). Dune hollow near the sea.

Compacted damp sand (partly by occasional vehicle use) with creeping turf plants, at the eastern end of the RAP. This is the best representation of this plant community in the wind-farm proposal and it appears to have changed very little between 2007 and 2012. It contains listed three nationally threatened species, sand gunnera and sand halfstar (both rated as ‘At Risk - Declining’) and sand milfoil (‘At Risk - Naturally Uncommon’), the first two being seen in closer views **C2c-e**, the milfoil in **C2f**. Photo **C2e** also shows tape-measure plant (*Lilaeopsis* sp.). On dunes behind the quad bike in **C2a** is the golden sand sedge, pingao, also a species rated nationally as ‘At Risk’. The track follows a narrow dune slack (moist inter-dune hollow) that is dominated by indigenous plants. The most used part of the track in **C2a** retains the rhizomatous sand sedge (*Carex pumila*), which is also seen as wispy leaves across view

C2c, C2d. Taller reeds in **C2b** are club sedge, with the exotic grass, marram, on dry mobile dunes. This small area is of particularly high conservation importance.

C3. Dune hollows away from sea.

C3a, b (2007) show hollows dominated by the native restiad rush, oioi. The abundance of oioi decreases with distance from the sea, often being replaced by native sedges, three-square, club sedge and mariscus. **C3a** (2007) has a young pampas grass in left foreground. **C3b** (2012) shows 2 colour forms of oioi, presumably genetic differences. **C3c** has a foreground of exotic jointed-leaved rush mixed with indigenous sand sedge (*Carex pumila*) and, just behind, Mercer grass with 3 large clumps of oioi (left, centre and right) and club sedge beyond, with marram on the distant dunes.

C3d (2007). A variation on the hollows dominated by oioi, this hollow has a dense cover of the sedge ‘three-square’ with large tussocks of mariscus sedge with black seed heads) in foreground. Three-square is rhizomatous and occurs quite widely in the study area’s dune slacks, usually as a minor cover component; it sometimes grows in wet, modified pasture on previously mined surfaces.

C3e (2007). Same site as **C3d**. Three-square sedge - close view of stems bearing flower heads near their tips.

C3f (2012). Near the inland margin of the RAP is an electric fence. Right under the fence in numerous places, the dense sward of exotic jointed-leaved rush, on left, gives way to a native ‘turf’ where a sward of a suckering native sedge, *Schoenus nitens* also contains scattered patches of other native plants, including sand gunnera, slender spike sedge (*Eleocharis gracilis*), arrowgrass, tufted rush (*Juncus caespiticius*) and sea primrose. Oioi is in top right of the picture.

Photos of pasture/scrub mosaic on natural dune terrain, outside CV1 –CV3.

C4a (2007): View across natural dune terrain on eastern side of main stream. Mostly exotic plants in lightly grazed pasture: Yorkshire fog, cocksfoot, sparse marram, with scattered bushes of boxthorn, blackberry, and locally common inkweed in foreground. This area of dunes was cut by narrow channels (**W1b, W1c**) that run into the main stream.

C4b(2007): Natural dune terrain with marram grass pasture, scattered boxthorn and a pine plantation beyond.

C4c (2012) Cattle in unmined dunes, with blackberry and rough pasture, east of main stream.

C4d (2012) Rough pasture on unmined dunes east of main stream

C5. Standalone Pond. An artificial pond (perhaps created from a wetland here in the past) used for stock water and waterbird hunting. **C5a** shows part of the shore which is grazed in the foreground with Mercer grass and jointed-leaved rush at the water’s edge. In the middle distance is one of two fenced areas of a tall sedge kapungawha (*Schoenoplectus tabernaemontani*) at this pond. Its shorter relative,

three-square (*S. pungens*) occurs several places on the grazed margins. **C5b** is the exit stream of the pond that is just visible in the distance. Circular hay bales have been put in it at intervals and the stream has the invasive, submerged, exotic curled pondweed (see main text).

Eastern Block

E1. 2007 view of “East Swamp – EV1a” – wetland complex near eastern edge of proposed wind-farm. Swamp edge with cattle-chewed flax (harakeke); also raupo and, at foot of picture, the grass-like, sward-forming sedge, cutty-grass (*Carex lessoniana*) which was the dominant plant through much of the wetland.

E1a - E1h. 2012 “East Swamp – EV1a” There was less evidence of stock grazing impact in 2012 than in 2007. General views show:

E1a: *Machaerina articulata* swamp with cutty grass understorey – patch less than 10 m diameter and the only place in Waipipi where this species occurs.

E1b: main cover of cutty grass with tussocks of mariscus; flax in distance.

E1c: core area of the swamp with the rare swamp buttercup (*Ranunculus macropus*) which is visible in lower half of photo as bright green leaves each with 3 leaflets (see close views in E1f and E1g). The main cover is sharp spike sedge (*Eleocharis acuta*) with sparse, taller raupo and flax in background.

E1d, E1e: ditches dug through East Swamp. The key areas **E1a-E1c** lie on the north side of these ditches but that area is now very small and the ditches compromise the future of these key areas.

E1f: sharp spike sedge with leaves of swamp buttercup; native swamp willow-weed in lower left (shown also in **E1h**).

E1g: leaves of swamp buttercup among jointed-leaved rush.

E2. (2007). About 200 m west of **E1**. Part of the inter-fingered wetland and low dune complex, trampled heavily by cattle around the wetter core of raupo. Toetoe and flax in background.

E3. (2007). About 150 m west of **E2** – flax swamp with a weedy daisy, hemp agrimony in gaps.

E4. (2007). One of several sluggish stream courses through the eastern wetland/dune complex. Scattered toetoe, flax and cutty-grass with tall fescue and other rank pasture grasses; stream with occasional raupo and exotic jointed-leaved rush, congested sedge, glaucous sweet-grass.

E5 photos. Vegetation mapped as EV1b - south-west corner of ‘East Swamp’: this is the only area of native shrubland in the entire proposed wind-farm area. Shrub daisies, *Olearia solandri* (10-40% cover) with cutty-grass understorey and patches of rank pasture grasses (tall fescue, cocksfoot, Yorkshire fog) and pink-flowered hemp agrimony; clumps of flax and toetoe. Dunes with marram towards the sea. Several of the shrub daisies occur in ‘Whenuakura swamp’, but too few to be classed as ‘shrubland’.

E5a-E5f: (2012); **E5g-E5j:** (2007)

E5a (2012) is a general view, similar to **E5i** (2007). Large clumps of toetoe, flax and club rush with pasture grasses between them. The shrub daisy is hard to see here, but is in photo **E5b** as small-leaved green shrubs in front of the flax and also a young one in left foreground. Grey-fawn seed-heads of hemp agrimony, a perennial swamp weed, is in front of flax on right (it is flowering in February 2007 photos **E5g, E5h**).

E5c, E5d (2012): the shrub daisies are grey sticks, mostly dying or dead. In **E5e** the tall shrub daisy appears healthy and in **E5f** there is foliage of a young shrub at right, with the trunk of an old shrub at left.

E5g (2007). Closer view of the shrub daisy shrubland shown in E5, more dense shrubs in background; flax, toetoe, cutty-grass – the only exotic plant visible is hemp agrimony.

E5h (2007). About 50 m west of the shrubland in **E5 and E6**, the western edge of **EV1b** is dominated by raupo (and not shown here, flax and cutty-grass) with hemp agrimony locally common.

E5i (2007). View south-east from western edge of **EV1b** – flax clumps and swards of cutty-grass in foreground, with dense raupo beyond, then daisy shrubland; marram on coastal dunes in distance.

E5j (2007). . Shrub daisies left and right behind flax, in swamp shrubland, with cutty grass and sparse kapungawha; marram on coastal dunes in distance.

E10-13 (2007). Pasture on previously mined surfaces.

E9 (2007). Dry pasture on the highest mined terrace of eastern wind-farm block (eastern wind monitoring tower in centre distance). The area appears to have been re-sown recently (2007 photo) and the pasture plants have bare ground between them. The most common grass is tall fescue, with ratstail and herbs that include fathen, haresfoot trefoil (the grey heads visible in this photo and in **E10**) and fleabane. The common presence of the weedy wetland grass, Mercer grass, indicated that this terrace must often be wetter than the dry conditions during 2007 survey. The second pasture terrace is in middle distance (see **E11**).

E10 (2007). Closer view of same pasture as **E9**. The grey haresfoot trefoil and dry fescue grass dominate; the foreground tussock is bristle grass (*Setaria gracilis*) a common weed of dry pastures and lawns.

E11 (2007). Pasture on 2nd mined terrace (that seen in middle distance of **W9**). Scattered lupin bushes, with pasture dominated by Yorkshire fog and cocksfoot. Eastern wind monitoring tower at left in distance.

E12 (2007). Pasture on moist front rim of 2nd terrace. Pasture of tall fescue, Yorkshire fog, congested sedge, red clover, jointed-leaved rush, lotus major.

E13 (2007). Unmined dunes with marram on dry areas and the common large tussock is club sedge. Red clover is common in moist pasture in foreground.

E14 (2012). The exit stream from swamp **EV1** drops over the mudstone sea cliff. The gully and narrow 'gorge' mapped as **EV4** have mats of native turf plants (not easily seen in the photo), mostly with succulent leaves to store water. Flax is visible at left and wind-swept oioi at right. The mat plants include sand gunnera (*Gunnera arenaria*), nationally rated as 'At Risk - Declining'. Plants seen only here in the proposed wind-farm area are a button daisy (*Leptinella squalida*), a willowherb (*Epilobium komarovianum*), coastal fern (*Blechnum blechnoides*) and *Colobanthus muelleri*. Others present include sea primrose, common half-star, sand buttercup, NZ ice plant, native lobelia.

Pasture on previously mined surfaces (more pasture on mined surfaces is depicted in photos W12, 14, 17-19; NW29).

E23 a-c (2007) Areas of cutty grass (*Carex lessoniana*) sedgeland mapped as **EV3**. In **E23a** the view is westward across the shallow drainage ditch whose water flows through heavily stock-pugged pasture dominated by cutty-grass. Water runs from right to left through the middle of the tallest cutty-grass in the picture. Apart from some small areas of raupo, several indigenous rushes (*Juncus edgariae*) and sparse sharp spike sedge, no other indigenous species were found before the fence. Photo shows one small, cattle-trampled patch of raupo among the cutty grass and a view of the eastern wind monitoring tower. **E23b** is a view down the drainage ditch to the fence-line that separates **EV3** from the important wetlands mapped as **EV1**. The ditch may carry the stream that is flowing in **E4**. In drier ground in the foreground the cutty-grass becomes sparse and gives way to dry pasture of Yorkshire fog, cocksfoot, browntop and clovers.

E23c is a closer view of cutty-grass to show the intermixed pasture grasses, creeping bent, Yorkshire fog and tall fescue plus exotic rushes (*Juncus articulatus*, *J. bufonius*), clovers, plantains and other flat weeds.

North-west Block

NW1 & NW2 (2012). Whenuakura River & swamp by estuary, mapped as **NWV1**.

NW3 and NW4 (2012). Whenuakura River edge swamp with swamp toetoe in flower mapped as **NWV1**.

NW5 (2012). Cabbage tree grove from pasture edge (vegetation **NWV3**)

NW6-9 (2012). Cabbage trees treeland mapped as **NWV3**, in various stages of regeneration. **NW6-8** show old trunks surrounded by slim younger trunks, the result of new sprouts off the old trunk some

years ago. **NW9a** shows a very young (few months' old) shoot off an old cabbage tree. In grazed land, such shoots usually get browsed off.

NW9b shows a seedling cabbage tree that germinated without being browsed by cattle, in the protection of boxthorn. **NW9c** - Chance events allow other native shrubs to germinate and survive, such as these two *Coprosma* shrubs on a steep bank above a small incised stream (karamu, *C. robusta* at left: taupata, *C. repens* at right).

NW10-13 (2012). Sea cliffs close to mouth of Whenuakura River. The vegetation is mapped as **NWV4a**.

NW10: view westwards; cliff face wet with freshwater seepages. The small sand accumulation at cliff base, just above high tide, has e.g., sand buttercup and button daisy.

NW11: view eastwards, taken from close to same point as **NW10**. Cliffs vegetated in places, with some slumped on to beach (marram is obvious).

NW12: plants in a sand pocket on sea cliff just E of Whenuakura R mouth; native puwha (*Sonchus kirkii*) and sea celery

NW14-17 (2012). Sea cliff with ledges, east of Whenuakura River mouth. Vegetation is mapped as **NWV4b**.

Dunes on unmined surfaces - pasture/scrub mosaics, some boggy

NW18, 19 (2012). Stream from a pond on a mined terrace, which has flowed into an unmined dune hollow; two views from same spot, **NW18** being landward to dunes, with sparse raupo in foreground; **NW19** is seaward, with more raupo, plus bright green looping sedge on water's edge.

NW20a (2012). Yellow stems of looping sedge (*Isolepis prolifera*) and taller seasonally dying raupo.

NW20b (2012). purei (*Carex secta*) tussock beside stream in NW18,19; rare in Waipipi except for the Whenuakura River swamp (NW1, 2).

NW21 (2012). Natural dune terrain with marram grass cover and solitary taupata (*Coprosma repens*) shrub and climbing dock.

NW22a (2012). General view inland of natural dune terrain; damp dune hollow in foreground with tussocks of the indigenous mariscus sedge and ground cover of jointed-leaved rush; dry dunes in distance with marram and boxthorn shrubs.

NW22b (2012). Similar area to NW22a, but closer to Whenuakura River. Swamp dune hollow with mariscus, oioi and jointed-leaved rush.

NW23 (2012). Damp dune hollow with sward of rhizomatous sand sedge (*Carex pumila*); dry dunes with marram.

NW24 (2012). Damp dune hollow dominated by jointed-leaved rush and scattered tussocks of mariscus; dry dunes beyond, with marram and boxthorn.

NW25 (2012). Damp dune hollow near **N24**, with electric fence. Trampled area on left with jointed-leaved rush; untrampled area on right with sand sedge (*Carex pumila*), *Schoenus nitens*, and a few tussocks of mariscus; dry dunes in top right with marram.

NW26 (2012). Crest of dry dune near an old trig point, with low shrubs of sand coprosma (*C. acerosa*) extending from lower left to mid-picture; top left is erect club sedge, top right is boxthorn.

NW27, 28 (2012). A small stream that soaks into the beach before reaching the sea west of the main stream. It flows in a straightened course across previously mined terraces and into a dam before a short winding course through unmined dunes, but has insufficient flow to enter the sea (at least during the survey in April 2012). It might be compared with the mouth of the main stream in photos.

NW30a (2012). The densest patch of sand coprosma found in Waipipi; about 12 shrubs in this view, in an area seemingly sprayed for blackberry – dead blackberry stems are visible in the lower left quarter of the photo.

NW30b (2012) Same location as NW30a; a single shrub of sand coprosma with live blackberry all around it.

‘Pasture’ on previously mined surfaces

NW29 (2012). Straightened stream across previously mined land, view inland from edge of natural dunes (on left). Tussocks of mariscus in stream course; lupins in ‘pasture’ on flat terrace surfaces.

Western Block

Note on WV1. Main stream of the proposed wind-farm. The coastal end of this stream was described and mapped in the 2007 survey report, when it lay in the Western block of 2007 wind-farm proposal. In 2012, the stream was surveyed for its full length to the inland limit of the land lying within the 2012 proposed wind-farm. Although the stream actually flows through the Central Block in its upper reaches, for easier reference the new data and photographs from 2012 are all regarded here as part of WV1. Photos of pasture and pasture/scrub mosaics both east and west of the main stream are labelled as ‘C’ (Central Block).

W1 (2012) view up main stream showing grassed stream terraces and steep banks. Boxthorn in foreground, toetoe on bank at right.

W1a (W5 in 2007). View upstream in main stream of west block. Stream with floating beds of glaucous sweetgrass, edges with raupo, cutty-grass and tussocks of mariscus and swamp toetoe. Banks are dominated by exotic pasture grasses (cocksfoot, Yorkshire fog and tall fescue, with blackberry and boxthorn) and, in this view, is a shrub of mahoe (*Melicytus ramiflorus*) and clumps of the robust fern, cliff kiokio (*Blechnum triangularifolium*). The area of dunes beyond the stream is shown also in **W10**.

W1b (W2 in 2007). Narrow swampy channel through dunes into main stream (**W1a**). Raupo (*Typha orientalis*) with occasional tall rush (*Juncus pallidus* – indigenous). Foreground and background as in **W1** (+ blackberry in right foreground).

W1c (W3 in 2007). Same channel as **W1b**, about 50 m toward main stream. Tall clumps of raupo (at right) with sward of cutty-grass (*Carex lessoniana*) around it, kapungawha beyond; a bed of sharp spike-sedge in mid-left.

W1d (2007) (W6 in 2007). Mariscus and toetoe on bank about 5 m above main stream.

W1e (2012). On low damp terrace of main stream; cutty grass partly protected from cattle-browsing among blackberry with more blackberry and boxthorn beyond.

W1f (2012). Indigenous taupata shrub (*Coprosma repens*) on foot of bank above swampy terrace of main stream, severely cattle-browsed; ground cattle pugged.

W1g (2012). Main stream terraces with stock crossing, downstream from main east-west farm road – stream bank degradation.

W2a (2012). Main stream upstream from main east-west farm road. Possibly following its natural course across previously mined terraces. Foreground dark seed heads of exotic congested sedge (*Cyperus congestus*); across stream the water's edge has glaucous sweetgrass at left and brighter green, indigenous looping sedge at right.

W2b (2012) mouth of the main stream, from beach looking inland. This stream which enters the sea from the dunelands, should be compared with that in photos NW27, NW28, a smaller stream that soaks into the beach before reaching the sea west of the main stream.

W7 and W8. Near downstream limit of the west block and on the true right bank is a dune slack (flat hollow) with peaty sand and a turf of mostly short-stature native sedges and rushes. This view is a small part of that turf with a tall clump of the restiad rush, oioi and, in foreground, the dwarf native sedges *Schoenus nitens* and slender spike sedge (*Eleocharis gracilis*). Exotic species in this view include red clover, lotus major and jointed-leaved rush. This vegetation is very similar to the more extensive turfs in photos **W12, W13**.

W9. Close-up of part of turf in **W7, W8**, showing the native looping sedge (*Isolepis prolifera*) and exotic jointed-leaved rush; *Schoenus nitens* visible in background.

Photos of WV2, W11-W16

W11 (2007). On previously-mined terrace, just towards the sea from the western 60 m wind monitoring tower – rusting iron pipe from field drains on the ‘tower terrace’, feeding into a raupo swamp. Grazed wet pasture in foreground with Yorkshire fog, red clover, lotus and the native rhizomatous sedge, three-square.

W12 (2007). Peaty turf on seaward side of the raupo in **W11** – western wind monitoring tower in distance. Turf similar to that in **W7**, **W8**, but more extensive and some parts with few exotic species. Dominated by *Schoenus nitens* with locally common slender spike sedge, scattered clumps of oioi and some of the creeping, exotic jointed-leaved rush, red clover and hawkbit (the yellow flowers in the photo).

W13 (2007). Close-up of part of **W12**, to show the nationally ‘At Risk’ herb, *Gunnera arenaria*, with *Schoenus nitens* and slender spike sedge and also young plants of hawkbit, narrow-leaved plantain and white clover.

W14 (2007). About 150 m east of **W13**, a view similar to **W12** but raupo only in left of picture. This raupo appears to be a filter for farm nutrients, so that the area in this photo is more fertile than in **W11**, **W12**, and **W13**. The large clumps of reeds are mariscus (with black seed heads), sea rush (*Juncus kraussii* var. *australiensis*) and kapungawha, in a sward of cutty-grass. Wind monitoring tower in background.

W15 (2012). Hemp agrimony and raupo on edge of swamp **WV2**

W16 (2012). pipe from photo **W11** (2007), dragged out.

Pasture on mined surfaces not mapped in areas covered by Photos W1-16

W17 (2007). Swampy pasture on mined surface. Jointed-leaved rush dominant, with Yorkshire fog, creeping bent, congested sedge (*Cyperus congestus*), red clover, tarweed and a few clumps of oioi. Hawkbit (*Leontodon saxatilis*) and plantains among taller plants. Western wind monitoring mast in background.

W18 (2007). Close view of a portion of the pasture in **W17**.

W19 (2007). A shallow drain across the mined terrace some 150 m west of the western wind monitoring tower. Drain dominated by jointed-leaved rush and Yorkshire fog; a patch of raupo at far end; tussocks of club sedge (*Ficinia nodosa*) on rim of drain and dry pasture of browntop, sweet vernal (*Anthoxanthum odoratum*) and red clover either side, with scattered bushes of lupin (*Lupinus arboreus*) and blackberry.

Vegetation mapped as WV3. Photos W20-23. Swamp in unmined dune hollows.

W20 (2007). Oioi beds – water drains into a small (20 m diameter) pond at the base of semi-mobile dunes. The margins of the pond were heavily stock-trampled but the oioi beds had little sign of cattle. The main vegetation of the foreground gap in the oioi is a turf of the small native sedge *Schoenus*

nitens (see also in **W12, W13**). This turf contains some *Gunnera arenaria* and is the only place in the wind farm proposal with sea primrose (*Samolus repens*). Here, too, was the largest amount of a native dune willow-herb (*Epilobium billardioreanum*) found during the survey.

W21 (2007). View inland from the same site as **W20**, towards recently mobilised dunes with scattered marram. The sand in this area is much more extensive than in aerial photographs of about 5 years ago, though is moving away from the wetland in the foreground. The wetland has tall clumps of oioi with red clover among short rushes.

W22 (2007) (W15 in 2007). View to the sea across ‘natural’ dune terrain near western block’s lower eastern boundary – dense swards of the restiad rush, oioi, in damp peaty dune slacks with scattered toetoe. Marram on partly mobile dunes nearer the sea. Foreground of rough pasture with Yorkshire fog, tall fescue, red clover and clumps of the tall native sedge, club-sedge (*Ficinia nodosa*). This is continuous with area 150 m to west, shown in **W20, W21**.

W23 (2007) (W16 in 2007). View inland from the same point as **W22**, and a similar but broader view than W21. Dense stands of oioi in peaty dune slack; partly mobile dunes further inland with marram (and cattle). (Western wind monitoring mast in distance).

Waipipi plant 1 & 2

Gunnera arenaria fruits and foliage. At Waipipi, a few patches in short turf vegetation on terrace below the western wind monitoring tower (vegetation type WV2) and in dune slacks in WV3 and EV2. Conservation status nationally is **At Risk – Declining**. (Photos by CCO at Waitotara River mouth, between Wanganui and Waverley.)

Waipipi plant 3

Ranunculus macropus leaf, flower and fruit. Conservation status nationally is **Data Deficient**. At Waipipi, common in a few square metres of ‘East Swamp’ in Waipipi East Block. (Photo by CCO at Plimmerton near Wellington)

Waipipi plant 4

Schoenus nitens flower/fruitleading head; plants usually 5 - 10 cm tall, but to 150 cm among tall reeds. At Waipipi, the species is locally dominant in short turf vegetation on peaty, low fertility wetland, especially in vegetation mapped as WV2, WV3, EV2, including the *Gunnera* sites. (Photo by CCO at Whangaehu River mouth, Wanganui)

Waipipi plant 5

Sand coprosma (*Coprosma acerosa*) in fruit. Conservation status nationally is **At Risk – Declining**. Photo by CCO on dunes in NW part of Waipipi, April 2012. Has gone from much of NZ’s dune country and is not common at Waipipi, but scattered, mostly in dunes towards the Whenuakura River.

Waipipi plant 6

Swamp millet (*Isachne globosa*), an example of a regionally uncommon plant, and found at Waipipi only in the Whenuakura River swamp. Photo CCO at L Humuhumu in Northland.

Appendix 3: Threatened and uncommon indigenous plants at Waipipi

1. Nationally threatened and uncommon plants

(following de Lange et al. 2009)

Nationally Critical

Sebaea ovata – an annual herb

At Risk – Declining

Coprosma acerosa – sand coprosma

Gunnera arenaria – sand gunnera

Leptinella dispersa ssp. *rupestris* – a button daisy

Selliera rotundifolia – sand half-star

At Risk – Relict

Ficinia (Desmoschoenus) spiralis – pingao

Sonchus kirkii – coastal puwaha

At Risk - Naturally Uncommon

Myriophyllum votschii – sand milfoil

Stuckenia pectinata – fennel-leaved pondweed

Data Deficient

Ranunculus macropus – swamp buttercup

2. Regionally threatened and uncommon plants

These plants are listed on the basis of the author's knowledge of their distributions and abundances in South Taranaki and Wanganui districts.

Blechnum blechnoides – coastal blechnum

Bolboschoenus fluviatilis – kukuraho

Epilobium billardioreanum – a willow-herb

Hydrocotyle pterocarpa – swamp pennywort

Isachne globosa – swamp millet

Lachnagrostis billardierei – sand bent

Lachnagrostis striata – a wetland grass

Machaerina (Baumea) articulata – jointed twig rush

Olearia solandri – a shrub daisy

Oxalis rubens – wiry oxalis

Potamogeton cheesemaniae – red pondweed, manihi

Potamogeton ochreatus – blunt pondweed

Ruppia polycarpa – horse's mane weed

Schoenus maschalinus – dwarf bog-rush