BACKGROUND INFORMATION ON STATUS AND RESTORATION OPTIONS FOR SAND DAPHNE (*Pimelea villosa*) RELEVANT TO NORTHLAND

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Ocean Beach

Sand daphne (*Pimelea villosa*)

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REPORT INFORMATION SHEET

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EXECUTIVE SUMMARY

Sand daphne (*Pimelea villosa*) is a low growing shrub that inhabits the transition zone between spinifex-dominant foredunes and backdunes. The species is in national decline. In some Northland coastal sites high levels of mortality have been reported.

This report collates background information on the status and restoration options of sand daphne. This includes information gathered from the Northland region and nationwide particularly via the network of members of the Dune Restoration Trust of New Zealand. A literature search was also undertaken.

Decline of sand daphne is not confined to Northland. A number of other councils and Coast Care groups have been attempting to restore sand daphne to coastal dunes in several regions for some years - with mostly poor success. Anecdotal information on both the decline and restoration options for the species vary from lack of viable seed to a wide range of environmental factors related to human-induced modification of dunes. Published literature indicates that reproductive biology may not be the limiting factor.

This information will be useful to the Northland Regional Council and local Coast Care groups to develop and evaluate a range of practical management and restoration options for reversing the decline of sand daphne in the region. This may include a focus on reducing mortality of existing plant populations, encouraging natural regeneration, and the establishment of nursery-raised plants as part of restoration programmes.

Background information on status and restoration options for sand daphne (*Pimelea villosa*) relevant to Northland

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Introduction

As part of an Envirolink project (Regional Council Advice No. 1297-NLRC162), the Northland Regional Council (NRC) require background research information to be collated on the status and management of indigenous coastal sand dune plant sand daphne (*Pimelea villosa*, formerly know as *P. arenaria*). Sand daphne is a low growing shrub that inhabits the transition zone between spinifex (*Spinifex sericeus*)-dominant foredunes and backdunes in Northland and other regions of New Zealand. Merrett (2007) indicates sand daphne is one of a small suite of native species that occurs on unconsolidated sand dunes and in dune hollows of the North Island and Chatham Islands of New Zealand.

The species is listed as in 'gradual decline' (Forester and Townsend 2004; NZ Plant Conservation Network www.nzpcn.net.nz). This decline has been linked to a range of factors from issues with the reproductive biology of the species to various environmental and site factors caused by human-induced changes in the coastal zone.

Populations of sand daphne on some Northland coastal dune sites have such high levels of mortality that the species may continue to be lost from local sites. Developing a restoration plan for this species has become urgent for the NRC and Coast Care groups.

Methods

Information on the status, management and restoration initiatives of sand daphne in the Northland region was collated based on discussions with selected local contacts in the Northland Regional Council, the Department of Conservation, Queen Elizabeth II Trust and Coast Care groups. Three coastal dune sites in the Northland region where sand daphne are present were inspected with council, Department of Conservation and local community representatives.

Background information was also collated based on wide ranging discussions with members and trustees of the Dune Restoration Trust and with members of Coast Care groups in several regions regarding restoration initiatives for the species. A literature search was conducted on management and research that has been carried out on sand daphne with a focus on management and restoration of the species likely to be most relevant to the Northland region.

Sand daphne in Northland

The status of sand daphne (syn. *Pimelea arenaria*) in Northland has been identified by Forester and Townsend (2004) in a Department of Conservation guide to 50 highly threatened plants that occur in the region. They indicate in the guide that "these species are so threatened or in such serious decline in New Zealand that it is uncertain whether they will continue to persist in the wild".

Sand daphne is listed as in 'Serious Decline' within the Threat Category of 'Chronically Threatened' using the system of Molloy et al. (2002). Forester and Townsend (2004) mapped the distribution of the species in Northland with recent distribution and historical occurences indicated (Figure 1). Historical occurences are defined as where the species occured at a specific site but has not been seen for at least 10 years.

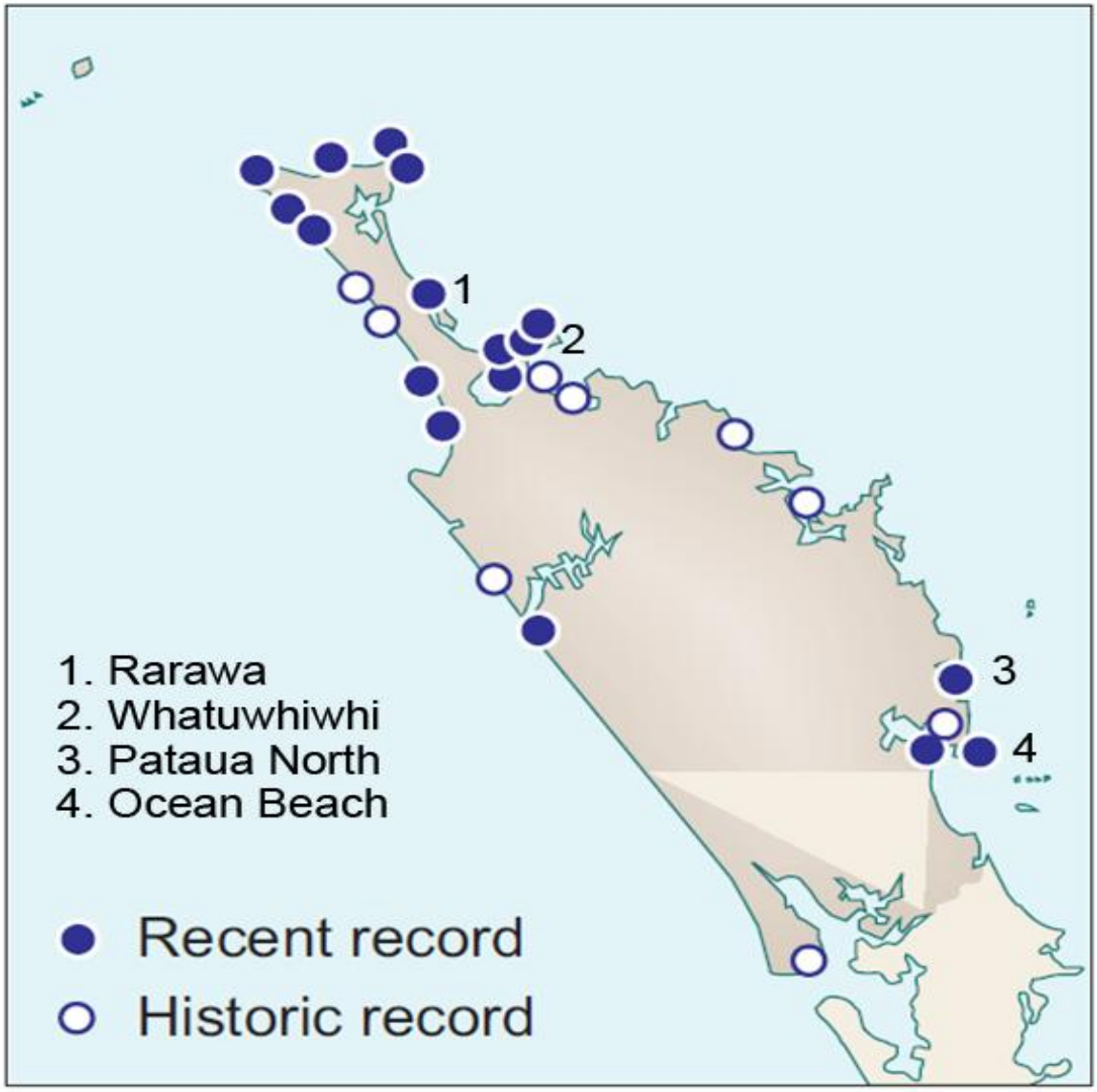

Figure 1: Recent and historic distributions (not seen for at least 10 years) of sand daphne in the Northland region (from Forester and Townsend 2004). The four sites visited have been added to the map.

Site visits

Four sites in Northland where sand daphne were inspected illustrate some of the site types, plant and population charateristics, and issues that occur with this species within the region.

Rarawa Beach

A substantantial population of sand daphne occurs at the southern end of Rarawa Beach (Figure 2). Healthy mature large plants of sand daphne, many 1-2 m wide, are found scattered within the semi-stable foredune within 10 m of the high water mark. Most plants occur within a shallow dune swale amongst light to medium cover of spinifex and scattered plants of sand coprosma (*Coprosma acerosa*), another threatened sand dune plant.

Figure 2: A population of healthy sand daphne occurs at the southern end of Rarawa Beach, east coast of the Far North (above). Plants occur within the spinifex zone immediately landward of the densely vegetated spinifex seaward facing slopes of the foredunes. Plants are healthy despite recent covering of wind blown sand (below).

Whatuwhiwhi

A small population of sand daphne occurs on densely vegetated backdunes at Whatuwhiwhi, Karikari Peninsula (Figure 3). In contrast to the Rarawa Beach plants, sand daphne on this site is growing within dense patches of the exotic ice plant (*Carpobrotus edulis*), buffalo grass (*Stenotaphrum secundatum*), kikuyu grass (*Pennisetum clandestinum*) and a range of exotic garden escapes. Most plants are within 10 m of the high water mark where the seaward dune comprises an eroding 1-2 m scarp dominated by exotic grasses.

Figure 3: Scattered plants of sand daphne growing amongst a dense cover or exotic grasses, ice plant and garden escapes, Whatuwhiwhi, Karikari Peninsula.

Ocean Beach

At Ocean Beach, Whangarei Heads, a few plants of sand daphne occur on the crests and upper slopes of steep foredune faces amongst spinifex and scattered within the transition zone between seaward foredunes and more densely vegetated cover on landward sites (Figure 4). Most vigorous plants tend to be amongst bare sand and are persisting within the vicinity of high use areas at this popular beach.

Figure 4: Plants of sand daphne on relatively exposed sites amongst spinifex on the crest of the foredune and on upper slopes, Ocean Beach, Whangarei Heads.

Pataua North

One of the largest northern populations of sand daphne is found within a 4.7ha QEII covenant at Pataua North, east of Whangarei. Plants are scattered throughout the covenanted area from the top of the foredune landwards to the covenant boundary fence. On the foredune, *Pimelea* is growing in association with spinifex, wiwi (*Ficinia nodosa*), exotic herbaceous weeds and sand wind grass (*Lachnogrostis billiarderei*). Further landward, spinifex and wiwi become less common, and buffalo grass becomes the most abundant species (Wildlands 2007). Site monitoring at Pataua North in 2007, 2010 and 2012 has indicated a substantial decline in the population.

The population has many dead or dying individuals but there are also some mature plants that appear healthy, both on relatively exposed open sites and within dense exotic vegetation further landward (Figure 5).

Figure 5: A healthy sand daphne plant on an exposed foredune crest within a light cover of buffalo grass (above) and a similarly healthy plant in the lee of a wilding pine within 30 cm high buffalo grass further landward (below).

Many individual plants of sand daphne at the Pataua North site have died back to leave dead crowns or scattered remnants of once larger plants. Most of the site where sand daphne occurs is dominated by a low cover of scattered buffalo grass and other exotic weed species (Figure 6).

Figure 6: Part of a sand daphne plant that was a remnant of a larger plant typical of the dieback occurring on the exposed dunes of Pataua North, east of Whangarei.

Collated information on sand daphne

Information was gathered from two major sources – through discussion with individuals in Northland and nationally, and a search of available literature. Only information considered to be most relevant to the NRC for current or future restoration or management plans aimed at reversing the decline of sand daphne in the Northland region is included. While some information from informal discussion could be regarded as anecdotal, the inclusion of the experience from several sources is considered to be valuable in the development of any proposed restoration and management plans in Northland.

The information is provided in brief note form with further information appended for selected sources. References are provided and sources of information are acknowledged.

Selected relevant literature

Dawson et al. (2005)

- In a study of the recruitment failure of sand daphne, the structure of four populations from the lower North Island, New Zealand, was examined for recruitment patterns, while one population was examined for flowering, pollination, and seed germination limits on regeneration.
- Line transects and searches found no seedlings, and measures of individual plant sizes (n = 331) showed bias towards medium, with some large, individuals, suggesting recruitment failure at all sites.
- Flowers are plentiful. The standing crop of nectar was c. 0.4–0.9 joules per hermaphrodite flower, with insects appearing to be the main pollen vectors.

- Pollination manipulations were carried out on both genders at one site, with fruit set measured from natural, hand out-crossed, and pollinator-exclusion treatments. Female flowers do not appear to be pollen limited as natural fruit set is only non-significantly lower than that in hand-outcrossed flowers. Only hermaphrodite plants selfed autonomously, with nearly 90% producing fruit.
- One quarter of the seed from both female and hermaphrodite flowers germinated.
- Results suggest that recruitment failure of sand daphne is not due to reproductive biology, pollen limitation, or poor seed germination. Therefore, recruitment failure probably occurs during the seedling establishment phases, due to environmental pressures and/or predation.

Merrett (2007)

- Eighteen populations of *P. arenaria* from throughout the North Island of New Zealand were investigated to determine sex ratios, fruit set and population size-class structures.
- Sex ratios were variable among the 18 study populations; the proportion of females was higher in populations in the northern half of the North Island (15.9-45.5%) than in populations from Kawhia southwards (0-12.7%).
- Females were absent from three south-western coastal populations.
- Although fruit set was relatively high, averaging 47% for female and 68% for hermaphroditic plants, recruitment failure was evident at most of the 18 sites surveyed.
- There was no evidence that sex ratios or fruit set were factors contributing to recruitment failure. Although most of the populations surveyed are not under immediate threat, lack of recruitment could affect population persistence in the long term.

Forester and Townsend (2004)

- Status of sand daphne in Northland is mapped as indicated above (Figure 1).
- Branches are often buried in sand so one plant often forms a mound and covers a large area.
- The major threats are habitat loss through development for housing and plantings to stabilise moving sand and disturbance from vehicles on beaches.

New Zealand Plant Conservation Network

- Habitat – grows on the landward side of foredunes, also found in back hollows and blowouts and, like sand coprosma, has the ability to trap sand but not as effectively as pingao (*Ficinia spiralis*) and spinifex.
- Confined to sand dunes and associated swales and flats - usually in free draining sites but sometimes bordering streams in places prone to sudden flooding.
- On Rekohu (Chatham Island) this species often extends outside these habitats onto the sandy peat soils that were once forest and are now mostly pasture, and in these places it sometimes extends into dune forest remnants. It can be very common in pasture there probaby because the soils are free draining and sandy and also because it is toxic and so cattle and sheep will not eat it. On the southern tablelands it is sometimes found within clears (on shallow peat soils) where it grows with other plants typical dune country such as Coprosma acerosa.
- Flowers September to March; fruits October to April.
- Easily grown from semi-hardwood cuttings. Can be grown from fresh seed, but may take several years to germinate.
- Threatened by competition from marram grass, browsing and trampling by cattle, sheep and horses; browsing of seedlings by possums; seed destruction by rodents; vehicle damage and fire.
- Source – www.nzpcn.org.nz

Wildlands (2007)

- A brief description of the sand daphne population at Pataua North. The population is in decline and Wildlands staff could not determine a singular cause.
- They suggest the decline as seen in 2007 could possibly be caused by a recent storm event blowing salt-laden water onto the plants.
- Stock are excluded from this population, the vegetation surrounding the plants is sparse, no vehicle tracks were seen in the vicinity of the plants, and rabbits are controlled and in very low numbers only.
- Both ripe fruit with developed seeds and seedlings were observed, suggesting that similar to the findings of Dawson *et al.* (2005) in southern North Island, decline is not due to reproductive biology, pollen limitation, or poor seed germination.

Related species

- New Zealand daphne (*Pimelea prostrata*, pinatoro) with status 'Non Threatened' established in planting trials on semi-stable backdune along Petone foreshore, Wellington harbour; 90% mortality within one year or planting (Bergin and Bergin 2012).
- Southern sand daphne (*Pimelea lyallii*) inhabits similar dune habitat to sand daphne but in far south with status 'Naturally uncommon'; on Codfish Island it remains relatively widespread though not particularly common in the more open sandy areas of the dune (except the exposed frontal fore dune); species has probably declined as the dune has stabilised and vegetation competition has increased (Wickes and Rance 2010).

Experience with restoration and management

A limited number of comments have been collated and mostly from individuals in the Dune Restoration Trust of New Zealand, particularly Robyn Smith for various sites in the greater Wellington region. Jim Dahm, Graeme LaCock, Mark Bellingham and several others have also provided information on Coromandel, Auckland, lower North Island and other sites. These notes are provided largely unedited in broad categories.

Seeding and propagation

- Pollination may be by small flying insects, possibly butterflies and moths, lizards. The flowers are highly scented.
- The plants around the Waitohu Beach and up to Waikawa Beach, Kapiti Coast, have good numbers of seed on sand daphne plants. Lizards like the fruit and probably distribute it or if not present, the seed falls off and rolls down dune slopes. Seed can be collected from beneath seeding plants on dunes by scooping up the duff with seed and then sowing it.
- Seed collected has a very high fertilisation rate, comes up very easily if sown very fresh and not cleaned – sown immediately in seed mix and only light cover of mix over seed. Slugs and snails need to be controlled.

Habitat preference and threats

- Most of the sand daphne in the wild is surrounded by either spinifex, sand coprosma, wiwi, or even lupin (*Lupinus arboreus*). It can occur with a light cover of other plants but appears to be intolerant of dense vegetation cover.
- Sand daphne planted on the lee of the incipient dune did not survive possibly because the plants were small; even though they naturally occur in that zone, getting plants to establish is difficult.
- Some form of protection for a year or so could help establishment of sand daphne on seaward sites, or plant seedlings behind another species in the lee of the incipient dune. This has yet to be tested.

- Sand daphne does not tolerate substantial sand movement; establishment is more likely to be successful on more stable flat dune areas where sand accumulation occurs at slow rates; these sites sometimes occur close to the front of the dune.
- Nursery-raised plants should be tested on a range of sites from foredune over the mid dune during any planned planting programme and monitored for performance on different sites.
- Best populations of sand daphne tend to be on mid-dunes immediately landward of the spinifex dominated foredunes and where there is open sand areas and minimal invasion of exotic grasses.
- Vigour of sand daphne plants in densely vegetation stable backdunes dominated by kikuyu and buffalo grass tend to be poor in most locations.

Planting – Wellington sites

- Experience with planting sand daphne with three different Coast Care groups and sites along the Kapiti Coast indicate that it does well. Preferred planting sites are on the lee side and backslopes of the frontal dune provided that there is also an incipient dune in front of that, i.e. establish on the lee of the second dune from the front.
- Backdune plantings at Riversdale Beach, Wairarapa – all planted sand daphne died during summer months possibly due to extended drought; planted on bare sand sites several hundred metres inland from coast on old erosion scarp.
- Plants are planted as soon as the sand is damp enough in autumn so they can get their roots down throughout the autumn and winter. In Northland, roots likely to continue growing for most of the year so earlier autumn planting may provide time for development of longer roots before dry summers.
- Rabbit and hare protection is recommended as sand daphne is highly palatable.
- Large nursery raised plants (e.g. PB3 planter bags) may be more successful when planted on dunes than smaller plants.

Planting – Coromandel sites

- Several hundred sand daphne planted as part of major restoration programmes on several east coast Coromandel beaches over many years have resulted in loss of most seedlings.
- Planted mostly in zone between spinifex dominated foredunes and mid dune zone where spinifex and open sand areas are increasingly becoming colonised by other coastal natives such as pohuehue and wiwi and exotic grasses and herbaceous species.
- Planted mostly as PB2 or PB3 stock with most plants having died within a year of planting; causes unknown.

Planting – west Auckland

- Group of 20 sand daphne planted adjacent to similar size planting of sand coprosma at TeHenga Beach, west Auckland last year.
- Only one plant surviving adjacent to a small tauhinu (*Ozothamnus leptophylla*) shrub.
- Planted in mid dune zone in open sand area with scattered spinifex and occasional small plants of regenerating tauhinu; higher survival of sand coprosma (50%?) planted in at same site; causes of mortality of sand daphne not known.

Options for future restoration plans

Based on this brief review of the literature, experience collated from selected practitioners and inspection of selected sites with sand daphne, restoration and management plans

could focus on investigating environmental and site factors aimed at reversing the decline of sand daphne. Despite concerns that various aspects of the reproductive biology of the species may be an issue (and on some sites and regions this still could be the case), the information collated suggested that the Northland Regional Council could work with local Coast Care groups to evaluate a range of site factors.

This can include a focus on reducing mortality of existing plant populations, encouraging natural regeneration, and the establishment of nursery-raised plants as part of restoration programmes. Options for future restoration plans could therefore include:

Existing plant populations – proposed treatments focussing on existing plants and sites:

- Exclusion of browsing animals such as rabbits, hedgehogs, etc.
- Testing effect of light applications of sand, fertiliser.
- Weed control – hand pulling vs chemical options.
- Evaluating proximity to other natives such as wiwi, sand coprosma, and spinifex .

Natural regeneration – treatments likely to be relevant to improving seed set, germination and early growth:

- Control of snails, rodents, rabbits, hedgehogs, etc…
- Comparison of microsites, e.g. moist depressions vs exposed sties.
- Enhancing regeneration of associated indigenous species.

Planting – a range of site and environmental factors that could be evaluated:

- Propagation options – seedlings/cuttings, container/plant size, direct seeding.
- Site preference - proximity to sea, sand movement, location on dune.
- Shelter/plant competition – exposed open site vs dense vegetation cover.
- Additives applied at planting – with and without slow release fertiliser.
- Browsing/predation – with and without exclosures, traps, poison.
- Planting a range of associated native species within habitat.

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