A guide to propagating Norfolk Island's native plants and seeds

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With cultural and scientific contributions from Naomi E. Christian and expert review from Dr Kevin Mills, specialists in the flora of Norfolk Island

Dedication

This book is dedicated to Duncan Sanderson, who loved the plants of Norfolk Island. He restored a large area of native forest, and is particularly celebrated for propagating hundreds of *Wikstroemia australis* (Kurrajong/Kurryjunk). Duncan generously shared his knowledge and enthusiasm for Norfolk Island's plants with others. We hope the knowledge collated in this first edition will honour his legacy and continue his work.

Hibiscus insularis flower (Image: Mark Scott)

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Cover image *Myoporum obscurum* flower and fruit (Image: Mark Scott)

Foreword

The Norfolk Island language was originally an oral language. Approximately 35 years ago, the process of developing a way to write the Norfolk language down commenced, and today there is an officially accepted spelling of Norfolk (Norf'k). The language is classified by UNESCO as Endangered[1].

Naomi E. Christian is a botanist and Norfolk Islander who learned to speak Norfolk while growing up on Norfolk Island. This was before the language became a written language. Therefore, Naomi made a recording of herself as she delivered the spoken foreword on 31 October 2021.

Lilli-unna King is a Norfolk Islander (Norf'k Islander) who learned to speak and write Norf'k while growing up on Norfolk Island. Lilli-unna transcribed the spoken foreword into Norf'k.

Naomi E. Christian then translated the Oral Foreword into English. To preserve the actual message in the Oral Forward, Naomi used a 'free translation' method as opposed to a 'literal method.'

1 https://thenorfolknavigator.com/language accessed 2 November 2021

English transcription by Naomi E. Christian

I commend this book to anyone with an interest in the plants of Norfolk Island. As a botanist I understand the value of the research herein. As a Norfolk Islander, I am so pleased that a book has been written on how to propagate and grow some of Norfolk's native plants.

I was talking with one of the authors when she said: "*When I was on Norfolk, I noticed that people were interested in, and knew how to grow native plants*." Her insight didn't surprise me: this kind of knowledge is part of our story as Norfolk Islanders.

History books have made the mutiny on the Bounty famous. Prior to the mutiny, the crew of the Bounty had spent quite some time in Tahiti. Some of the Tahitian women and Bounty men began to fall in love during this time. They probably didn't realise that this love would form a lasting bond between two cultures. That bond was the first seed of the Norfolk Island family tree.

In 1791, the men and women of the Bounty climbed ashore on Pitcairn Island. It wasn't long before babies conceived of both Tahitian and English blood were born. Our family tree had sprouted and began to grow.

There is little doubt that this was a hard time for the people of Pitcairn. It would have been difficult enough to find food, let alone clothing. But they had knowledge: not just from the English seafarers, but from the Tahitian people. They knew that coconut palms were more than a food source. For example, they would strip the midveins from the fronds to make brooms, known as a 'niau' brooms [2]. There were also breadfruit trees on Pitcairn[3]: another plant that didn't just provide food; but one which could be used to make tapa cloth for clothing[4]. With this innate knowledge, the family tree flourished. Soon, the population had grown too large for Pitcairn.

2 Meralda Warren, pers. comm 28 October 2021
3 Meralda Warren, message to Naomi E. Christian, Facebook Messenger, 30 October 2021
4 Pauline Reynolds, message to Naomi E. Christian, Facebook Messenger, 28 October 2021

In 1856, the family tree set seed; when the people of Pitcairn set sail on board the Morayshire. It took a few weeks to reach Norfolk, where they came ashore on Bounty Day (8 June). As a botanist, I wish I had been there with them, to see what they saw: endemic trees like the Bastard Oak (*Ungeria floribunda*), Melicytus (*Melicytus latifolius*) and Kurranjong/Kurryjunk[5] (*Wikstroemia australis*) before they became the rare wonders they are today.

Those early Norfolk Islanders adapted their plant knowledge to their new home. Where once they had made 'niau' brooms from the midveins of coconut palms, they learned to use the midvein of what we now call a 'Niau Palm' (*Rhopalostylis baueri*). On Pitcairn, they had used the flowers of Mu'uu to make pot scrubbers[6]. They found the leaves of Norfolk Mu'uu (*Cyperus lucidus*) made durable hats and could be woven into baskets and other useful items[7].

This book might not have propagation methods for all of Norfolk's native plants, but the authors want the book itself to grow. They would like to include more species, research, and local knowledge. If you have knowledge that is not captured in this book, please share it with the authors, or pass it on to someone else. When you pass away, don't take the knowledge you have with you; it is a gift you can pass on to our next generation right now.

5 Mervyn Buffett, pers. comm. as recorded by Naomi E. Christian, 31 October 2021
6 Meralda Warren, pers. comm 28 October 2021
7 Joy Cochrane, pers. comm 29 October 2021

Norf'k transcription by Lilli-unna King[8]

'Ai komend dieh buk gen eniibohdi huu laik' Norf'k plaant. Aa bohtanist iin mii el andastaan aa waelyuu o d riiserch iinsaid, en aa Norf'k Ailender iin mii daa glehd f sii sambohdi se rait daun watawieh f groe sam o dem Norf'k plaant.

Wan'dem ortha laana mii "When I was on Norfolk, I noticed that people were interested in, and knew how to grow, native plants". Letl wanda dem sii daa, es paat o awas storii!

Iin 1789, wen em Tahitian wahine en em Baunti salan fas stig'tiith f wan'netha, yu fain dem naewa noe dem se biikam de siid o d Norf'k Ailen faemli trii. Dem histrii buk yuus' larna ewribohdi baut aa myuutinii en hau aa fas siid o aklan wohsh ap orn Pitkern iin 1790.

Naewa tek lorng f dem Tahitian en English salan f habuu wan'netha. Dem tek aa faemlii trii siid en plant et. Wen aa fas biebii se born, aa siid staat' groe. Yu fain bin es haadan baek den, f fain' wetls, klorth en' thing. Bat dem haed' nohlij, nort jes fram em English siimien, bat fram em Tahitian salan. Dem noe koknat el duu f iit. Nort uni daa, dem bin yuusa tek aa niau fram em koknat paam f miek' niau bruum[9]. Haed' bredfruut[10] orn Pitkern, en daas netha thing el duu, nort jes f wetls, bat f miek' taapa kloth soe dem gat' klorth[11]. Lorngf' dem kaina nohlij, aa faemlii trii groe guud orn Pitkern. Kaina tuu guud, en suun, se groe tuu big!

Iin 1856, aa faemlii trii set siid, wen dem Pitkern salan set siel f Norf'k orn aa Morayshire. Tek dem wiiks f get ya en dem kam ashor orn Baunti Dieh. Hepi ai wish ai bin deya lorngf' dem! Daa bohtanist iinsaid mii wud bii se tin'ai orn dem Bastard Oak (*Ungeria floribunda*), Melicytus (*Melicytus*) en em Kurryjunk[12] (*Wikstroemia australis*) orl abaut baek den.

Dem haet' lern plenti nyuu thing f yuus em Norf'k plaant. Said dem bin strip aut' koknat niau, dem lern f yuus wan Norf'k paam iinsted f miek' niau bruum. Daas awas Niau Paam. Orn Pitkern dem bin yuus' yuus dem M'uu f miek' poht scraba[13], f wohsh ap, bat dem tin'ai orn awas M'uu f miek' haet en' baasket en dem[14].

8 Scientific amendments and references inserted Naomi E. Christian, 2 November 2021
9 Meralda Warren, pers. comm 28 October 2021
10 Meralda Warren, message to Naomi E. Christian, Facebook Messenger, 30 October 2021
11 Pauline Reynolds, message to Naomi E. Christian, Facebook Messenger, 28 October 2021
12 Mervyn Buffett, pers. comm. as recorded by Naomi E. Christian, 31 October 2021
13 Meralda Warren, pers. comm 28 October 2021
14 Joy Cochrane, pers. comm 29 October 2021

Uni gat sam o awas loekal plaant iin di eh buk, bat aa ortha hoepen iiwen dieh buk el groe! Dem want' iinkluud mor Norf'k spiishiis, mor riiserch en plenti mor loekal nohlij.

Soe, ai aasen' orl yorlyi, ef yuu noe wan netha wieh f groe samthing iin dieh buk, laana daa ortha. En laana dem ef yuu noe watawieh f groe samthing defrent. Ef yuu kaa laana dem, ala yuu nor gat taim, dumain. Paas et orn gen yus letl salan, nau. Noe yuus teken wathing yuu noe baut awas trii en watawieh f groe et lorng' yuu wen yus taim kam f rest piisful en kwaiet daun'taun.'

Acknowledgements

This research received support from the Australian Government's National Environmental Science Program (NESP) through the Threatened Species Recovery (TSR) Hub. Development of this book was also supported by the Norfolk Island National Park and Botanic Garden, the Australian National Botanic Gardens, Friends of the Australian National Botanic Gardens, and the University of Queensland.

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The authors, along with Kevin Mills and Naomi E. Christian, would like to thank the Norfolk and Pitcairn Island communities for sharing their local and cultural knowledge, and a special thanks to those who speak Norfolk-Pitcairn (both dialects) who assisted with recorded oral history for cultural information including traditional plant names.

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Summary

Norfolk Island is a remote subtropical island in the South Pacific. It currently has 46 plant species listed under the Environment Protection and Biodiversity Conservation Act (EPBC Act 1999), the majority of which are endemic species. Deforestation and biological invasions have resulted in the decline of native plant populations. Restoration of native vegetation, particularly endangered species, is an important step in reducing an extinction debt in existing native flora and has already been effective in preventing the extinction of some of Norfolk Island's critically endangered plant species. This seed handbook details seed collection and propagation techniques for many of the woody native plant species found on Norfolk Island, particularly threatened or endemic species. It is a resource for those who are interested in planting Norfolk Island's native trees and shrubs to help optimise germination success, improve seedling establishment, and expand seed-based restoration efforts.

Norfolk Island vegetation (Image Leah Dann).

Using this handbook

The handbook covers an important selection of native species found on Norfolk Island. Most of the species selected are endemic and EPBC listed, as these species are unique to the island and are in the most need of propagation to increase populations. There are also some native species included because they are popular for gardens, good for revegetating property, and/or easy to grow. A number of the species in this book have cultural significance on Norfolk Island, particularly *Wikstroemia australis* (Kurryjunk), *Hibiscus insularis* (Philip Island Hibiscus), and *Rhopalostylis baueri* (Niau palm).

This handbook contains an introductory section (Section 1) with general information about Norfolk Island and plant propagation history. General information on seed collection, processing, and plant propagation are covered in Section 2. This includes summary tables of horticultural notes and the fruiting times across all the species studied. Section 3 of the handbook includes individual pages for each of the selected species. Section 4 provides some closing notes about this handbook and suggestions for future directions.

Terminology: there are various types of fruits, but for simplicity we are using descriptive terms rather than botanical definitions. When discussing "seeds" we are generally referring to the dispersal unit which may refer to both seeds and fruit or other dispersal structures unless specified. Conservation status of species is listed according to the categories under the EPBC Act 1999. The species names and families used are those recognised by the Australian Plant Census (APC). Local Norfolk Island common names for plant species are used where available.

Section 1

The Norfolk Island Group

Location and geomorphology

The Norfolk Island Group (which includes Norfolk Island, Phillip Island, and Nepean Island, as well as numerous surrounding rocky islets) is an isolated volcanic island group in the South Pacific Ocean. The Group is located between New Zealand to the south and New Caledonia to the north, approximately 1,500 km east of Brisbane, Australia (see locator map in Figure 1). Its subtropical climate, numerous endemic species, and remote location make the Norfolk Island Group unique and of conservation importance to the South Pacific and globally (see Figure 2 for mean monthly precipitation and temperature data).

Norfolk Island formed into an emergent volcanic island about 2–3 million years ago. The highest points on the island are Mount Bates (318 m) and Mount Pitt (316 m). The southern plateau contains steep valleys carved out by streams. Alluvial and acid swamp soils typically occur in the base of the valleys, deep soils occur on the more level land, while thinner soils are found on the coast. The topsoils throughout the high elevation forest areas, found mostly in the National Park on the northern part of the island, are predominantly fertile krasnozems derived from basalt or tuff. The soil is porous and friable, and therefore does not hold water well. It is, however, nutrient rich and supports a variety of native plant communities. Phillip Island is also volcanic, whereas Nepean Island is limestone (Director of National Parks, 2010; Hutton & Stephens, 1956; Mills, 2010a).

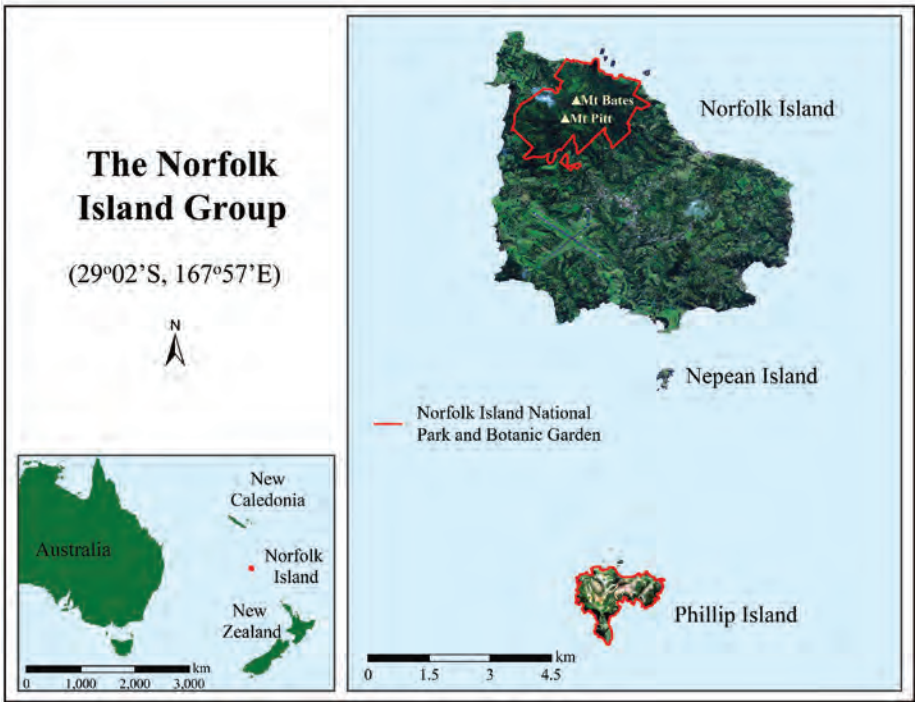


Figure 1. Map of the Norfolk Island Group, located approximately 1,500 km east of Brisbane, Australia. The Norfolk Island Group is divided into three main islands: Norfolk Island (the northernmost and largest of the three islands), Nepean Island, and Phillip Island (the southernmost island).

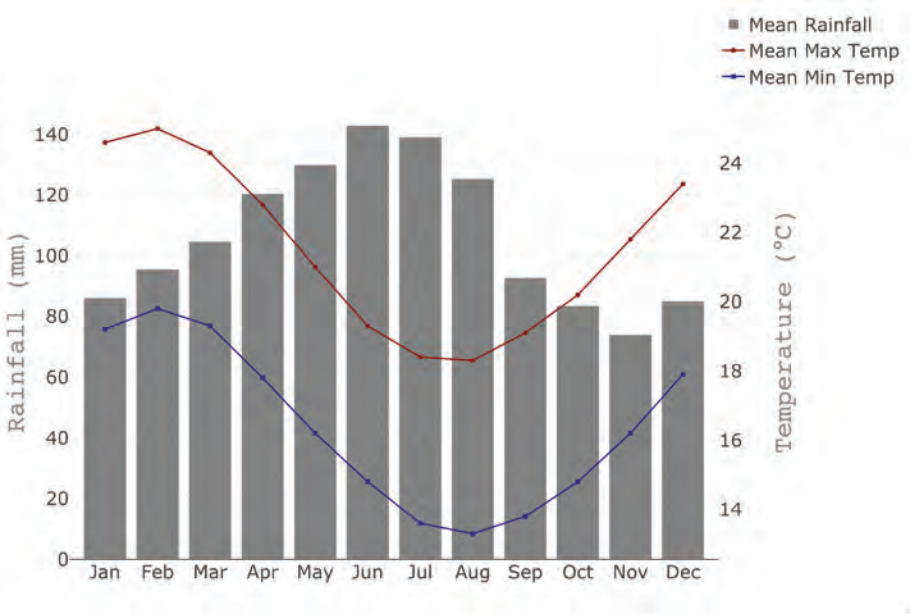


Figure 2. Long-term climate data (1939-2021) for the Norfolk Island Group. Data represent mean monthly rainfall and mean monthly minimum and maximum air temperatures. Peak rainfall tends to coincide with the cooler winter months whereas the summer months tend to be drier (Data collected from the Australian Government Bureau of Meteorology, accessed August 2021).

History

Prior to English settlement in 1788, Norfolk Island was covered by dense rainforest with abundant Norfolk Island pines (*Araucaria heterophylla*) emerging from the canopy, particularly in the high elevation regions. The forest was extensively cleared and grazed during two early British convict settlements, and large changes to native forest have occurred throughout the subsequent free settlement period to the extent that only a small proportion of the island still supports vegetation that resembles the original state (Benson, 1980; Director of National Parks, 2010; Gibbs et al., 2017). Native forest is currently at risk from numerous alien invasive plant and animal species, such as red guava or porpieh (*Psidium cattleyanum* var. *cattleyanum*), which was introduced in 1788 for its fruit (Christian, 1999), the African olive (*Olea europaea* subsp. *cuspidata*), and the black rat (*Rattus rattus*), which was unintentionally introduced during World War II construction efforts. In order to preserve the remaining unique native ecosystems, the Norfolk Island National Park and Botanic Garden was established in January 1986 under the National Parks and Wildlife Conservation Act (NPWC Act). In July 2000, this act was replaced by the EPBC Act (Benson, 1980; Director of National Parks, 2010; Gibbs et al., 2017). Norfolk also has numerous public reserves, many of which are in coastal areas. These are very important refuges for coastal species such as *Euphorbia norfolkiana*, *Abutilon julianae* and *Coprosma baueri* (Naomi E. Christian pers. comm., October 2021).

Vegetation

Norfolk Island consists primarily of subtropical species and is currently thought to have 181 native vascular plant species, 24% of which are considered endemic taxa, and a further 378 introduced (non-native) species (Director of National Parks, 2010; EPBC Act, 1999). Approximately one-quarter of Norfolk's native plant species are considered threatened (Mills, 2010a; EPBC Act, 1999). The native vegetation supports many endemic and native bird and invertebrate species. Norfolk Island's native flora and fauna face threats common to insular species such as small populations, limited geographic range, low genetic diversity, and predation and competition from introduced species (Caujapé-Castells *et al.*, 2010; Director of National Parks, 2010). The majority of threatened plant species on Norfolk Island can be found within the Norfolk Island National Park, which covers 650 hectares. Considerable work is being conducted to preserve the remaining forested areas and control invasive species within the National Park and council reserves, as well as on private land (Director of National Parks, 2010; EPBC Act, 1999; Mills, 2008).

Plant propagation for conservation

Native plant propagation has numerous conservation benefits including increasing plant population size and providing native fauna with habitat, shelter, and food. Some of Norfolk Island's most endemic and endangered plant species have been rescued from extinction by actively propagating and re-planting species across the island. This includes, for example:

Broad-leafed Meryta (*Meryta latifolia*) – Before and during early European settlement, *Meryta latifolia* was common in certain native plant communities across the island. Its numbers steadily decreased due to deforestation and grazing to the extent that a 1988 survey conducted by Sykes and Atkinson (1988) found just 33 individual plants on the island. Propagation efforts were initiated by a small number of private landholders in the mid-1980s. They worked together to monitor male and female trees that were too isolated for effective natural pollination. When the inflorescences of both male female flowers emerged, the local landholders manually pollinated the female flowers. This resulted in fertile seed, and sparked interest in the species and more widespread propagation and replanting (Naomi E. Christian pers. comm., October 2021). In 2003 there were 149 individuals found across the island, although only 20 were mature females capable of reproduction (Coyne, 2011). Since then, *Meryta latifolia* numbers have increased in the National Park, public reserves, and on private land. They now regenerate naturally in several locations on the island and have much more stable populations (Naomi E. Christian pers. comm., October 2021).

Norfolk Island Abutilon (*Abutilon julianae*) – In 2003, less than 50 individuals of this species were found across the Norfolk Island group. *Abutilon julianae* could not be found at all on Phillip Island after pigs, goats, and rabbits were introduced in the late 1700s to early 1800s. On Norfolk Island, the plant was grazed by cattle and by 1904 was seen only in two places. Shortly after, it completely disappeared from Norfolk Island and was presumed extinct. However, following feral mammal eradication on Phillip Island, *Abutilon julianae* began to once again emerge. By 1987, three major populations were established on Phillip Island. *Abutilon julianae* was then successfully propagated on Norfolk Island from the Phillip Island populations (Coyne, 2011). Abutilon plants have become more abundant in recent years, largely because of revegetation efforts by public and private landholders.

The success of diverse restoration efforts has led to increased plant propagation programs and a greater diversity of native species being used in restoration, amenity plantings, and private gardens across Norfolk Island and beyond.

The aim of this handbook is to further the conservation of Norfolk Island's threatened plants by providing a consolidated resource that captures some local knowledge and summarises propagation insights developed by practitioners, researchers, and gardeners over the years.

Norfolk Island vegetation (Image Leah Dann).

Section 2

Propagating Norfolk Island's native and threatened plant species

Seeds act as the primary regeneration strategy of many trees and shrubs and are an effective method of propagating many of Norfolk Island's native woody plant species. Cuttings appear less successful for many woody species but tend to mature much more quickly than plants grown from seed.

Please note that permission must be obtained in advance from landholders and park or reserve managers in order to legally collect seeds and cuttings. Seeds should be collected in a sustainable manner so as not to harm the natural processes in the ecosystem. It is strongly recommended not to collect more than 20% of available seeds from any individual plant. Cuttings should also be taken sustainably in order to avoid hindering growth or development of the plant, and with good hygiene, sterilising tools between sampling each plant.

Seed collection

Collection times and methods vary depending on the particular plant species and the precipitation and temperature during the year. If seeds are collected too early, they may not be mature and will be less likely to germinate. Collecting seeds too late increases the risk of them being eaten, diseased or otherwise deteriorated. Seeds should be collected when mature, which is typically when the fruit has ripened or when seeds or fruit are naturally dispersing from the plant. Fruiting times for Norfolk Island plants have been summarised in Table 1. Some species drop fruit after they mature, and others may have fruit, pods, or capsules that stay on the tree but open up to shed seeds. Seeds from many plant species are consumed by animals, such as rats and birds. Seeds that are rapidly shed from capsules can be bagged before ripening to discourage predation and to catch seeds before they fall to the ground. It is usually best to collect seed directly from the tree or shrub, as seeds on the ground are prone to rotting, infection or depredation by insects. Fruit pickers, pole pruners, secateurs, and a tarpaulin laid out under the tree are good tools for seed collection. Seeds used for storage or planting should be mature, viable, and pathogen-free. Seeds that have been predated upon by insects will often have tiny holes that can be detected by careful examination. Seeds that have holes or are soft and rotten should be

excluded from the collection. Not all seeds will be viable. A subset of seeds from the collection can be cut open to estimate the viability of the whole collection. When cut in half, viable seeds are typically white or greenish on the inside and plump; they should not be empty, dried out, rotten, or dark in colour. Collecting seeds from several individual plants and locations can maximise the chance of obtaining viable seeds and representing the genetic diversity of the plant population. Collect seeds into breathable mesh, paper, or calico bags so they do not rot (Bonner & Karrfalt, 2008; Yeson *et al*, 2021).

There are a variety of seed collection methods and tools. Seeds should be collected in a breathable bag (Image: Leah Dann).

Table 1. Fruiting information including species names, fruit or capsule colour when ripe, and typical fruiting months of the plant species profiled in this handbook.

Scientific name	Common name	Fruit or capsule colour when ripe
Abutilon julianae	Abutilon	Dark brown
Araucaria heterophylla	Norfolk Island Pine	Brown
Baloghia inophylla	Bloodwood	Dark brown
Boehmeria australis subsp. *australis*	Nettle Tree	Brown, green, or cream filaments
Celtis paniculata	Whitewood	Blueish-black
Coprosma baueri	Coastal Coprosma	Orange
Coprosma pilosa	Mountain Coprosma	Purple
Cordyline obtecta	Rauti, Ti	White or blueish-purple
Elaeodendron curtipendulum	Maple	Blueish-black to dark green
Euphorbia norfolkiana	Norfolk Island Euphorbia	Brown
Hibiscus insularis	Phillip Island Hibiscus	Brown
Meryta angustifolia	Narrow-leaved Meryta	Dark greenish-purple
Meryta latifolia	Broad-leaved Meryta	Purple
Myoporum obscurum	Popwood	Pinkish-purple
Nestegis apetala	Ironwood	Yellow, pink, red, or purple
Pittosporum bracteolatum	Native Oleander	Yellow to brown
Rhopalostylis baueri	Niau Palm	Red
Ungeria floribunda	Bastard Oak	Brownish-yellow
Wikstroemia australis	Kurrajong, Kurryjunk	Brick red

Table 1 cont. *Fruiting months indicate months that fruit has been bagged or collected from plants on Norfolk or Phillip Island. Most species should be collected ripe. For species that are heavily predated upon, bagging before the ripening period is advisable.*

Scientific name	Typical fruiting months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Abutilon julianae				■	■	■	■	■	■	■	■	■
Araucaria heterophylla					■	■	■					
Baloghia inophylla	■	■					■	■	■	■	■	■
Boehmeria australis	■	■	■	■	■	■	■	■	■	■	■	■
Celtis paniculata				■	■	■	■					
Coprosma baueri	■	■	■	■								■
Coprosma pilosa	■	■										
Cordyline obtecta			■	■	■	■	■					
Elaeodendron curtipendulum	■	■	■	■	■	■	■	■	■	■	■	■
Euphorbia norfolkiana					■	■	■					
Hibiscus insularis			■	■	■	■	■	■	■	■	■	
Meryta angustifolia				■	■	■	■					
Meryta latifolia				■	■	■	■					
Myoporum obscurum	■	■	■							■	■	■
Nestegis apetala						■	■	■	■	■		
Pittosporum bracteolatum	■	■	■	■	■	■	■	■	■	■	■	■
Rhopalostylis baueri	■	■	■	■							■	■
Ungeria floribunda	■	■	■							■	■	■
Wikstroemia australis	■				■	■	■	■	■	■	■	■

Seed storage and dormancy

Seeds of many plant species can be planted immediately after collection. Others benefit from being stored in a cool, dry environment for a period of time before planting. If seeds are collected and will not be sown within six months, it is often advisable to remove the fruit from the seeds before storage. Seeds can be cleaned by removing fruit or capsules by hand or by rubbing on a sieve and using water to either float pulp or wash debris away from the seeds (Bonner & Karrfalt, 2008; Dunphy *et al.*, 2020). If seeds are to be stored, then drying the seeds will help maintain viability during storage. Many seeds can be dried to low water content and stored in a refrigerator or a freezer for long-term storage (termed orthodox seeds). Some species, particularly tropical plants, produce seeds that cannot be dried or frozen and stored or that quickly lose viability in storage (termed recalcitrant or intermediate seeds) (Dunphy *et al*., 2020; Sommerville *et al.,* 2021; Walters, 2015; Wyse & Dickie, 2017).

If not planting immediately, orthodox seeds should be stored with low moisture contents in moisture-proof sealed containers, as this will extend their longevity (Bonner & Karrfalt, 2008; Dunphy *et al*., 2020). Orthodox seeds in this handbook can typically be air dried and stored in a refrigerator or dried to moisture content in equilibrium with 15 % relative humidity and frozen at -20 °C without significant loss of viability (Royal Botanic Gardens Kew Seed Information Database, 2021). Recalcitrant and intermediate seeds should be air dried and stored above freezing in containers that prevent moisture loss but still allow for gas exchange (for example in polyethylene bags) (Bonner & Karrfalt, 2008). Proper storage can increase longevity of seeds, which is important for reducing seed waste when handling seeds of endemic or endangered species. See Table 2 for general storage recommendations and Table 4 for species-specific storage behaviour.

Recalcitrant seeds tend to germinate more quickly than do orthodox seeds and are best sown immediately for propagation purposes. Orthodox seeds tend to have higher longevity compared to recalcitrant seeds, but often have dormancy periods that delay germination. There are a variety of dormancy types – the species in this handbook primarily exhibit physiological dormancy, physical dormancy, morphological dormancy, morphophysiological dormancy, or no dormancy. Physiological dormancy is caused by factors within a seed's embryo that supress germination until environmental cues (such as temperature or moisture levels) cause chemical changes within the seed that allow for germination. Some seeds have conditional physiological dormancy, meaning they have a widening range of environmental conditions in which they can germinate

without treatment, but under specific conditions may require treatment. Physical dormancy is caused by an impermeable layer in the fruit or seed coat that must be damaged or removed to allow for germination. Morphological dormancy arises from a seed embryo being underdeveloped when seeds are shed, requiring an after-ripening period (often at a particular temperature) for the embryo to fully mature. Morphophysiological dormancy results from both an underdeveloped embryo and physiological dormancy. Warm and cold stratification cycles are often used to break morphophysiological dormancy. Not all seeds have dormancy, and dormancy types and treatments vary depending on the species (Baskin & Baskin, 2014a; Bonner & Karrfalt, 2008; Tiwari *et al*., 2016). Dormancy is commonly alleviated by pre-treatments that will improve germination and emergence success during propagation. Treatments can include scarifying seedcoats, soaking seeds in water, drying seeds, hot and/or cold temperature treatments, chemical treatments, or a combination of treatments (Baskin & Baskin, 2014a; Bonner & Karrfalt, 2008; Tiwari *et al.,* 2016). Scarification, or the cutting/scraping of the outside of the seed or dispersal unit, can be done with sandpaper, scalpels, knives, or gently in a blender with water. Some seeds require the removal of fruit, and some seed capsules need to dry out before they can be opened to extract seeds. The dormancy levels of seeds can change during storage and can affect propagation results. See Table 3 for general dormancy alleviation recommendations and Table 4 for species-specific dormancy classes. Refer to the individual species profiles for further details and handling recommendations for each plant species.

Table 2. *Seed storage recommendations that generally apply to orthodox, intermediate, and recalcitrant seeds. Species-specific storage behaviour can be found in Section 3: Species Profiles.*

Seed storage behaviour	Orthodox	Intermediate	Recalcitrant
Advice for the collector/ propagator	Remove any pulp if present, dry and store in cool conditions for medium to long-term.	Remove any pulp if present, store in cool conditions for short to medium term.	Remove pulp but do not dry seeds. Do not store seeds, sow immediately. If short-term storage is required then store in cool and moist conditions.

Table 3. Seed dormancy information and general advice for alleviating dormancy. The dormancy class of individual species and the specific treatment(s) suggested for each can be found in the species profiles in Section 3.

Dormancy class	Non-dormant	Physical dormancy	Physiological dormancy	Morpho-logical dormancy	Morpho-physiological dormancy
Advice for the collector/ propagator	No treatment needed	Scarification or heat treatment needed just before sowing.	Expect delayed germination. Various treatments applied before sowing may assist with germination.	Expect delayed germination, as seeds require time for embryo development.	Expect delayed germination, various treatments such as warm and cold stratification cycles may be required.

Seeds can be sowed into trays until seedlings emerge. Seedlings can later be pricked out into bags or pots as they grow larger to prevent them from competing for space or becoming root-bound. (Image: Leah Dann).

Seed propagation

Germination, or the development of the plant embryo that results in seedling emergence and plant growth, is influenced by environmental conditions including moisture, temperature, soil pH, light, and aeration. Environmental conditions and the timing of planting to maximise germination success is species-specific. While soil can be used as a growing medium, it is typically better to use a seed raising mix that includes fertiliser and various sized particles and to sow seeds in a tray or container that allows free draining (such as seed trays or seed bags). If soil from the environment is used instead of a seed raising or potting mix, it is good to heat sterilise the soil in an oven to destroy any pathogens and weeds that may be present in the soil. Ensure that the soil or mix does not hold so much moisture that the seeds rot but does not drain so quickly that the seeds or seedlings dry out and wither. Mulch tends to hold water while pumice or coarse sand helps with drainage. Fertiliser will provide seeds and seedlings with nutrients. Moisture, light, and temperature requirements vary depending on the species, but as a general rule most seeds should be sown in a fairly warm environment (but not so hot that they grow fungus and rot) with plenty of light (but not direct sun) and should be watered frequently. Keeping the trays/bags/pots in which seeds are planted off the ground can help prevent insect and vertebrate predation. Seeds should typically be sown close to the surface, so they receive enough light and oxygen, and just barely covered by the seed raising mix so they don't dry out. Seedlings can be thinned out if necessary as they emerge. When seedlings are large enough, they should be pricked out of the trays and transplanted to root trainers, larger containers, or planter bags filled with potting mix or soil, so they have enough resources and do not become root bound. When seedlings are large enough to survive outside, they can be planted directly into the ground. However, it is best not to plant seedlings outside just before the hottest and driest months (see Figure 2 for mean monthly temperatures and precipitation on Norfolk Island). Mulch may be used for plants that prefer a damper environment, and fertilizer is beneficial in nutrient-poor soils (Dunphy *et al*., 2020; Yeson *et al*., 2021).

Table 4. Species summary for each plant species profiled in Section 3 of this handbook. Table includes the name, family, status, growth form, storage behaviour, dormancy class, time to seed emergence, time to plant maturity, habitat, and light and moisture requirements for plant growth of each species.

Scientific name	Common name(s)	Family	Status	Growth form	Seed storage behaviour
Abutilon julianae	Abutilon	Malvaceae	Critically endangered*	Sprawling shrub	Orthodox[i]
Araucaria heterophylla	Norfolk Island Pine	Araucaria-ceae	Unlisted*	Tree	Intermediate
Baloghia inophylla	Bloodwood	Euphorbia-ceae	Unlisted	Tree	Intermediate
Boehmeria australis subsp. *australis*	Nettle Tree	Urticaceae	Critically endangered*	Sprawling shrub to small tree	Orthodox[i]
Celtis paniculata	Whitewood	Ulmaceae	Unlisted	Large tree	Orthodox[i]
Coprosma baueri	Coastal Coprosma	Rubiaceae	Endangered*	Shrub	Uncertain
Coprosma pilosa	Mountain Coprosma	Rubiaceae	Endangered*	Shrub to small tree	Uncertain
Cordyline obtecta	Rauti, Ti	Asparaga-ceae	Vulnerable	Tree	Orthodox[i]
Elaeodendron curtipendulum	Maple	Celastraceae	Unlisted	Tree	Orthodox[i]
Euphorbia norfolkiana	Norfolk Island Euphorbia	Euphorbia-ceae	Critically endangered*	Shrub	Orthodox[i]
Hibiscus insularis	Phillip Island Hibiscus	Malvaceae	Critically endangered*	Large shrub	Orthodox[i]

* = endemic to the Norfolk Island Group
[i] = inferred from related species
ND = no dormancy
PY = physical dormancy
PD = physiological dormancy
cPD = conditional physiological dormancy
MPD = morpho-physiological dormancy
MD = morphological dormancy

Seed dormancy class	Approximate time to emergence	Approx time to maturity	Habitat	Light (for plant growth)	Moisture (for plant growth)
PY+PD[i]	20–30 days	2 years	Open sites (such as rocky cliffs and grassy areas)	Sunny to partly shaded.	Adaptable
Uncertain	10–15 days	20+ years	Widespread (shady forest, sunny areas, harsh coastal environments, cliff edges, sand, etc.)	Can grow in most light levels. Is shade tolerant but grows faster in light.	Adaptable, hardy
PD[i]	20–36 days	5+ years	Widespread (often found in moist palm forest and hardwood forest)	Adaptable, grows best in some shade.	Adaptable, prefers moisture
cPD[i]	28–30 days	3 years	Variety of habitats, colonises open areas	Adaptable	Adaptable
PD[i]	19–30 days	15–20 years	Widespread (often found at lower elevations)	Adaptable, hardy	Adaptable
cPD[i]	95–105 days	3 years	Primarily a coastal plant, but adaptable to different environments	Adaptable, can grow in full sun.	Adaptable
cPD[i]	175 days	10+ years	This species is more common in higher elevation areas	Shade	Damp
cPD[i]	30 days if cleaned, 70 if not	5+ years	Widespread	Grows in most conditions including sunny, but prefers slight shade.	Adaptable
PD[i]	40–50 days if treated, 70–100 days if not	10+ years	Widespread (forest, coast, disturbed areas)	Adaptable	Adaptable
PD[i]	13–20 days	1 year	Coastal	Prefers slight shade but can grow in full sun.	Adaptable
PY+PD[i]	23–40 days	7–18 years	Found on Phillip Island (Norfolk Island group). Found in open areas. Grows well in gardens.	Adaptable	Hardy, drought tolerant, will also grow in moist areas.

Table 4 cont. *Species summary for each plant species profiled in Section 3 of this handbook.*

Scientific name	Common name(s)	Family	Status	Growth form	Seed storage behaviour
Meryta angustifolia	Narrow-leaved Meryta	Araliaceae	Vulnerable*	Tree	Orthodox[i]
Meryta latifolia	Broad-leaved Meryta	Araliaceae	Critically endangered*	Tree	Orthodox[i]
Myoporum obscurum	Popwood	Scrophulariaceae	Critically endangered*	Shrub to small bushy tree	Uncertain
Nestegis apetala	Ironwood	Oleaceae	Unlisted	Tree	Orthodox[i]
Pittosporum bracteolatum	Oleander	Pittosporaceae	Vulnerable*	Tree	Uncertain
Rhopalostylis baueri	Niau Palm	Arecaceae	Unlisted	Palm	Orthodox[i]
Ungeria floribunda	Bastard Oak	Malvaceae	Vulnerable*	Tree	Orthodox[i]
Wikstroemia australis	Kurrajong, Kurryjunk	Thymelaeaceae	Critically endangered*	Small tree	Orthodox[i]

* = endemic to the Norfolk Island Group
[i] = inferred from related species
ND = no dormancy
PY = physical dormancy
PD = physiological dormancy
cPD = conditional physiological dormancy
MPD = morpho-physiological dormancy
MD = morphological dormancy

Seed dormancy class	Approximate time to emergence	Approx time to maturity	Habitat	Light (for plant growth)	Moisture (for plant growth)
Likely dormant, class uncertain	45–70 days (cleaned)	5+ years	Widespread	Adaptable, grow well with some shade	Adaptable, prefer some moisture
Likely dormant, class uncertain	45–70 days (cleaned)	5+ years	Widespread	Adaptable, grow well with some shade	Adaptable, prefer some moisture
PD[i]	50–200 days	2-3 years	Along forest margins and in cleared/open spaces	Can tolerate full sun, fairly shade intolerant	Adaptable (mulch for low moisture areas)
Likely dormant, class uncertain, possibly PD	Variable – about 150–300 days. It can often take a long time (~300 days) if the seeds are planted immediately after ripening. However, if the seeds are cleaned and stored in the fridge until April, they will emerge faster (~150 days)	10+ years	Widespread	Adaptable	Adaptable
PD[i]	80–180 days	5+ years	Widespread (common in forested areas)	Adaptable	Adaptable
likely MD[i] or MPD[i]	90 days	10+ years	Most common in gullies and lower valley sides, but also found on ridges in shady areas	Shady areas	Damp environment
Likely dormant, class uncertain, suspect PD	160–285+ days	Unknown	Forested areas under a canopy	Shady areas	Damp environment
ND[i]	25–55 days	1 year	Adaptable and hardy. Found in drier areas of the rainforest, open areas, slopes, and dry ridges. Tends to grow well in disturbed areas	Moderate to high light levels	Adaptable

Norfolk Island vegetation (Image Leah Dann).

Section 3

Species profiles

This section of the handbook provides general information and propagation suggestions for selected Norfolk Island plant species. Habitat, light, moisture, seed collection, seed propagation, time to emergence and time to maturity are based on information gathered in the field, from nursery experiments, and from local and practitioner knowledge unless otherwise cited. Seed dormancy and storage information are based on literature and database searches. If data were not available for the selected species, we reviewed the knowledge for closely related species (often from the same genus, sometimes from the same family if variation was low) and used this to infer the likely dormancy and seed storage characteristics of the species. Light and moisture categories are based on the environmental conditions in which the plants are found naturally. Time to emergence is based on growth experiments conducted in a nursery on Norfolk Island under shade cloth with regular watering. Table 1 and Table 4 summarise the information found in these profiles.

Abutilon julianae

Common Name: Abutilon.

Family: Malvaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Sprawling shrub.

Plant Description: This shrub can grow to about one metre tall or more. Young stems and the underside of leaves are hairy, and the top side of the leaves are smooth. Leaves are heart-shaped with serrate (saw-toothed) margins, and are 3–9 cm long and 2.5–7 cm wide. Flowers have a staminal column (looks like a stalk) that protrudes past the petals. The petals are yellow, but shorter than the green calyx (which encloses the petals at the base, making them difficult to see) (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: Hairy, lantern-shaped fruits with accordion-like folds that house dark brown seeds.

Habitat: Often found in open areas such as rocky cliffs and grassy areas.

Light (for plant growth): Sunny to partly shaded.

Moisture: Adaptable.

Seed Collection: Seeds found primarily April–December. Collect capsules when brown.

Seed Storage: Likely orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021; Sommerville *et al.,* 2021).

Seed Dormancy: Physical and/or physiological dormancy are present in related species (Cardina & Sparrow, 1997; Erickson *et al*., 2016a; Leon *et al.*, 2004). For this species, nursery experiments show successful germination of untreated seeds when removed from capsule. Experiments on other species in this genus indicate that heat treatment or nicking may increase or quicken germination (Erickson *et al.,* 2016a) but have not yet been trialled for this species.

Seed Propagation: Pop seeds out of the capsule's accordion folds when the capsule is almost black in colour. Sow seeds on seed raising mix and lightly cover with a few millimetres of seed raising mix.

Time to Emergence: Approximately 20–30 days when removed from capsule and otherwise untreated.

Time to Maturity: Approximately two years.

Other Information: This plant species is great for erosion control and as an understorey plant. This species all but disappeared from Phillip Island, only recovering when the pigs, goats, and rabbits were eradicated. It was successfully re-propagated on Norfolk Island with the exclusion of cattle from the National Park and other areas around the island (Coyne, 2011; Flora of Australia vol. 49, 1994). This is a reasonably popular plant in local gardens, which has made it much more abundant in recent years (Naomi E. Christian pers. comm., October 2021).

A. julianae *seed capsule*

A. julianae *seedling*

A. julianae *flower (Images: Mark Scott)*

A. julianae *mature plant*

Araucaria heterophylla

Common Name: Norfolk Island Pine.

Family: Araucariaceae.

Status: Unlisted.

Range: Endemic to the Norfolk Island Group. Although this species is endemic to Norfolk Island, it has been widely planted around the world.

Growth Form: Tree.

Plant Description: This tree can grow up to 70 m tall, its trunk up to two metres in diameter. The branches tend to be horizontal. When this species is young the branches are noticeably symmetrical, but the symmetry is not always as apparent when they age. The bark is flaky and easy to peel. The leaves are scale-like and overlapping, and they are arranged spirally around small stems with multiple stems per branch (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The seeds of this species are contained within the scales of a cone. The male cones are ovoid, 4–5 cm long, 1–1.3 cm wide. Female cones are shaped like a globe but are not perfectly spherical. Female cones are about 7.5–10 cm long, 8–10 cm wide, and are made up of upturned, overlapping triangular scales that are winged at the top (Flora of Australia v49, 1994). Seeds, excluding the scales, are about 2.5–3 cm long and 1.3–1.5 cm wide (Flora of Australia vol. 49, 1994; Ntima 1968) and tend to remain attached to the scale. Cones are typically greenish when they fall from the tree, but scales will dry to brown and become easier to separate from the cone when ripe.

Habitat: Widespread. Can grow in shady forest, sunny areas, harsh coastal environments, cliff edges, sand, etc.

Light (for plant growth): Able to grow in most light levels. Although this species is shade tolerant, it grows faster in light (Ntima 1968).

Moisture: Adaptable to most moisture conditions, hardy (Zimmer *et al*., 2015).

Seed Collection: Variable, often May–July. This species often has mast years every three to five years in which many cones are produced. Fewer cones tend to be produced between the mast years. Try to collect whole cones rather than individual scales, and allow cones to dry out to more easily separate the scales.

Seed Storage: Intermediate (Ntima, 1968; Royal Botanic Gardens Kew Seed Information Database, 2021; Tompsett, 1994). It is recommended to sow seeds within a month of collection rather than storing them (Ntima, 1968). Seeds can be air dried and stored in a fridge or freezer, but this will likely reduce viability. Seeds can tolerate desiccation down to 12% moisture content but with reduced viability, and they do not tolerate freezing well (Royal Botanic Gardens Kew Seed Information Database, 2021; Tompsett, 1994).

Seed Dormancy: Uncertain for this species (Itititaty *et al.*, 2020; Bonner & Karrfalt, 2008). Seeds of this species do not seem to require pre-germination treatments within the range of temperatures typically experienced on Norfolk Island. However, other species in the genus show delayed germination in cooler temperatures (Bonner & Karrfalt, 2008; Ntima, 1968).

Seed Propagation: Collect cones just as they fall off the tree, allow them to dry so that the scales separate, and sow scales shallowly in seed raising mix.

Time to Emergence: 10–15 days.

Time to Maturity: 20+ years.

Other Information: This tree is an iconic symbol of Norfolk Island and has great cultural and ecological importance. It is often planted as an ornamental tree and is a common nesting tree for seabirds. The vast majority of timber processed by the local sawmill is Norfolk Pine. The timber is used for construction and joinery (Naomi E. Christian, pers. comm., October 2021).

A. heterophylla *seedling*

A. heterophylla *mature plant*
(Images: Dianne Deans)

Baloghia inophylla

Common Name: Bloodwood.

Family: Euphorbiaceae.

Status: Unlisted.

Range: Native to the Norfolk Island Group. Also native to New Caledonia, Lord Howe Island, Queensland and New South Wales.

Growth Form: Tree.

Plant Description: This tree grows to about seven metres tall, sometimes taller. It has smooth, opposite leaves that are oval or primarily oval with the broader end at the tip of the leaf and the narrower end at the base. Leaves have a fine point at the tip and smooth leaf margins. The leaves are about 5–11 cm long and 3.5–6 cm wide. The flowers are white and about 7 mm long. When cut, the tree readily releases a distinctive red sap (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit is initially green to yellow-green in colour and then turns dark brown to black when ripe. Seeds are brown in colour, oval to egg shaped, and up to 1 cm long.

Habitat: Widespread. Often found in moist palm forests and hardwood forests.

Light (for plant growth): Adaptable, but grows best in some shade.

Moisture: Adaptable, but prefers moisture.

Seed Collection: Mature seeds can be found year round, but are most prevalent during the spring and summer. Often found July-February. Pick seeds when the fruit/capsules are almost black in colour.

Seed Storage: This species has intermediate storage characteristics (Sommerville *et al.,* 2021).

Seed Dormancy: Physiological dormancy is present in related species (Baskin & Baskin, 2014a; Ititiaty *et al.*, 2020). This particular species appears to have a low depth of dormancy as no treatment (other than removal of seeds from capsules) is required for germination.

Seed Propagation: Dry capsules in a paper bag until they split open, or open them by hand or with a light tap from a hammer. Separate capsules and seeds. Sow seeds at medium density on top of seed raising mix and sprinkle with seed raising mix until they are lightly covered.

Time to Emergence: 20–36 days if seeds are removed from capsules prior to planting.

Time to Maturity: 5+ years.

Other Information: The red sap of this tree was probably once used as a stain, ink, or dye. The timber was used for fence stakes. The fruit attracts the endangered Norfolk Island green parrot.

B. inophylla *seed capsules; seeds are ready to extract when the capsules are brown (Image: Mark Scott)*

A cracked open ***B. inophylla*** *seed capsule with seeds inside (Image: Mark Scott)*

B. inophylla *seedling (Image: Leah Dann)*

B. inophylla *mature plant with flowers (Image: Mark Scott)*

Boehmeria australis subsp. *australis*

Common Name: Nettle Tree.

Family: Urticaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Sprawling shrub to small tree.

Plant Description: Spreading shrub to small tree, up to five metres tall with hairy, serrated (toothed) leaves that are approximately 8–12 cm long and 4.5–7 cm wide. The leaves are broader and rounded at the base, narrowing to a point at the tip. There are often little round bumps on the leaf surface. Flowers are very small, cream coloured, tubular, and located on the stems of the plant, often clustering at the leaf base (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The seeds are tiny (usually 1 mm diameter or less) and attached to brown or green filaments on the stem at the base of the leaves.

Habitat: This plant can grow in a variety of habitats, but often colonises open areas.

Light (for plant growth): Will grow in most conditions.

Moisture: Adaptable to both dry and moist conditions.

Seed Collection: Seeds can be found year-round. Collect when filaments are brown and green by rubbing seeds off the stem into a bag. Seeds are on the ends of the filaments.

Seed Storage: Likely orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021; Sommerville *et al*., 2021).

Seed Dormancy: Conditional physiological dormancy is present in related species (Baskin *et al*., 2020). *Boehmeria australis* subsp. *australis* appears to have a low depth of dormancy as it does not need pre-treatment.

Seed Propagation: Sprinkle seeds onto seed raising mix, add a very thin layer of mix on top to hold them in place. Try to somewhat separate out the filaments, but it is okay if they are a bit clumped together. If seedlings are clustered when they emerge, it may be good to thin them out.

Time to Emergence: 28–30 days.

Time to Maturity: Approximately three years.

Other Information: This plant will often attract birds to an area. Note: this plant is not a stinging nettle.

B. australis *seeds are located on the ends of the brown and cream strands (Images: Mark Scott)*

B. australis *seedling*

B. australis *mature plant*

Celtis paniculata

Common Name: Whitewood.

Family: Cannabaceae.

Status: Unlisted.

Range: Native to the Norfolk Island Group. Also native to Australia (QLD and NSW) and New Caledonia. Other Pacific islands have records of plants under this scientific name, but studies indicate that these are a different species/subspecies (Flora of Australia vol. 49, 1994).

Growth Form: Large tree.

Plant Description: Large tree up to 20 m tall with large buttresses in the base of mature trees. The leaves are papery, narrow, pointed at both ends, 7–10 cm long, 3–4.5 cm wide, with entire (smooth, non-toothed) margins. The flowers are green (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of this tree is fleshy, 8–10 mm long, ellipsoid in shape, and blueish-black in colour. The seeds are hard, spherical to slightly ovoid, and up to approximately 5 mm diameter.

Habitat: Usually found in lower elevations, but is fairly widespread.

Light (for plant growth): Adaptable, hardy.

Moisture: Adaptable.

Seed Collection: Can be found year round, but is most prevalent April–July. Collect when the fruit is soft and almost black in colour.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Physiological dormancy is present in related species (Bonner & Karrfalt, 2008; Sánchez *et al*., 2019) This species appears to have a low depth of dormancy as seeds germinate quickly if fruit is removed from seed. Scarification may increase or further speed up germination as it does for related species (Bonner & Karrfalt, 2008; Sánchez *et al*., 2019), but this has not yet been trialled for this species. However, scarification is not necessary for this species to germinate.

Seed Propagation: Remove fruit from seeds by hand. Seeds and pulp may be separated using water. Sow at medium density with a light layer of seed raising mix covering the seeds.

Time to Emergence: 19–30 days after planting if fruit has been removed from seed.

Time to Maturity: 15–20 years.

C. paniculata *seedling (Images: Mark Scott)*

C. paniculata *fruit, which are ready to pick when blackish in colour*

Coprosma baueri

Common Name: Coastal Coprosma.

Family: Rubiaceae.

Status: Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Shrub.

Plant Description: This shrub has smooth, shiny, opposite leaves which are egg shaped with the narrower end at the base of the leaf. Leaf margins are entire but slightly recurved under. There are small pits on the underside of leaves. Flowers are light green and tend to be clumped together. Male flowers tend to be in larger clusters than the female flowers (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of this species is bright orange when ripe, ovoid (6–7 mm long) and typically contains two tan seeds of approximately 4 mm diameter.

Habitat: Primarily found coastally, including on cliff edges, but adaptable to different environments.

Light (for plant growth): Adaptable, but can grow in full sun.

Moisture: Adaptable. This species can grow on drier cliffs edges but can also grow in moister forested areas.

Seed Collection: Seeds can usually be found December–April. Collect seeds when the fruit is orange in colour.

Seed Storage: Uncertain. Some species from this genus are orthodox, others are recalcitrant (Royal Botanic Gardens Kew Seed Information Database, 2021). A New Zealand species *(Coprosma robusta)* does not show recalcitrant seed storage behaviour but also does not store well when dried (Mackay *et al*., 2002; Mackay *et al*., 2004). Air dried storage and refrigeration (at 2–4 °C) are recommended for *C. robusta* (Mackay *et al*., 2002; Mackay *et al*., 2004) and could be applied to *C. baueri* in the absence of species-specific information.

Seed Dormancy: Conditional physiological dormancy is present in related species (Baskin *et al*., 2020; Rowarth *et al*., 2007). *Coprosma* seeds typically require light to germinate. Seeds will germinate much more quickly if cleaned (fruit removed). Low temperature stratification may alleviate dormancy and therefore lessen germination time but has not yet been trialled for this species.

Seed Propagation: Remove fruit from the seeds by hand. Sow at medium density and cover with a very thin layer of seed raising mix.

Time to Emergence: 95–105 days for cleaned seeds.

Time to Maturity: Approximately three years.

Other Information: This hardy, low growing shrub has glossy leaves that make it an attractive native alternative to the introduced *Coprosma repens* (Mirror Plant).

C. baueri seedling (Images: Mark Scott)

C. baueri fruit

C. baueri mature plant

Coprosma pilosa

Common Name: Mountain Coprosma.

Family: Rubiaceae.

Status: Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Shrub to small tree.

Plant Description: This species grows up to about 6 meters tall. Distinct features include soft, hairy leaves with domatia (small pits) in the axils of the primary veins. The leaves are arranged opposite to each other and are oval in shape with a small point at the tip (approximately 2–6 cm long). The flowers are small and a pale green colour (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit is dark purple in colour, 4–6 mm long, with the base of the fruit slightly wider than the top and small seeds.

Habitat: This species is largely restricted to higher elevation habitats, particularly in sheltered areas and palm forests.

Light (for plant growth): Prefers shady areas.

Moisture: Prefers damp conditions.

Seed Collection: January–February.

Seed Storage: Uncertain. Some species from this genus are orthodox, others are recalcitrant (Royal Botanic Gardens Kew Seed Information Database, 2021). A New Zealand species *(Coprosma robusta)* does not show recalcitrant seed storage behaviour but also does not store well when dried (Mackay *et al.*, 2002; Mackay *et al.*, 2004). Air dried storage and refrigeration (at 2–4 °C) are recommended for *C. robusta* (Mackay *et al.*, 2002; Mackay *et al.*, 2004) and could be applied to *C. baueri* in the absence of species-specific information.

Seed Dormancy: Conditional physiological dormancy is present in related species (Baskin *et al.*, 2020; Rowarth *et al.*, 2007). *Coprosma* seeds typically require light to germinate. Seeds will germinate much more quickly if cleaned (fruit removed). Low temperature stratification may alleviate dormancy and therefore lessen germination time but has not yet been trialled for this species.

Seed Propagation: Can sow directly into a tray or container when fruits are dark purple. However, seeds may germinate faster if pulp is removed. Cover with a light layer of seed raising mix.

Time to Emergence: 175 days if untreated.

Time to Maturity: 10+ years.

C. pilosa seedling (Images: Mark Scott)

C. pilosa female flowers

C. pilosa male flowers

C. pilosa fruit, which are ripe when blackish purple in colour

C. pilosa mature plant

Cordyline obtecta

Common Name: Rauti, Ti.

Family: Asparagaceae.

Status: Vulnerable.

Range: Native to Norfolk Island and New Zealand (Armitage & Clarkson, 2008; de Lange *et al.*, 2005; Flora of Australia vol. 49, 1994). This species was originally thought to be endemic to the Norfolk Island Group, but is now considered the same species as the New Zealand *Cordyline kaspar*. Both have now been grouped under *Cordyline obtecta* (Armitage & Clarkson, 2008; de Lange *et al.*, 2005; Flora of Australia vol. 49, 1994).

Growth Form: Tree.

Plant Description: This tree grows 10–20 m tall, with a relatively thin trunk (20–30 cm in diameter) and greyish bark that flakes as it ages. Mature plants typically exhibit a branched or multi-stemmed form but can be single stemmed. The leaves are long and narrow (35–100 cm long, 2.7–7 cm wide) and pointed at the tip. They are directly attached to the top of the trunk with no stalk. Leaves are bright green and tough. Flowers are small and white (5–6 mm diameter) and grow in a branched, broadly pyramidal inflorescence (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of this species has a sphere-like shape, is 4–5 mm in diameter, green when unripe, and will ripen to a white or blueish-purple colour. There are multiple small, shiny, black seeds per fruit. Seeds tend to be curved.

Habitat: Widespread throughout various habitats and elevations, both in open spaces and forest understorey. Rapidly regenerates following removal of woody weeds.

Light (for plant growth): Will grow in most conditions including full sun, but prefers slight shade.

Moisture: Adaptable.

Seed Collection: Seeds can typically be found from March–July. Collect when the fruit turns white or blueish-purple.

Seed Storage: Orthodox (Broadhurst *et al.*, 2016; Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Related species have conditional physiological dormancy (Fountain & Outred, 1991). Cleaning seeds and cold stratification may increase or speed up germination (Fountain & Outred, 1991), but is not necessary for this species.

Seed Propagation: Fruits can be directly sown into a pot or tray with a thin layer of seed raising mix on top but will emerge much faster if fruit is removed and only the seeds are sown.

Time to Emergence: 30 days if cleaned, 70 if not.

Time to Maturity: 5+ years.

Other Information: This plant has an attractive form with lush rosettes of strappy leaves. It is a low growing, hardy plant which makes it a great alternative to introduced Cordylines in home gardens. It also attracts native bees.

C. obtecta seedlings (Image: Leah Dann)

C. obtecta unripe fruit; seeds are ready for planting when fruit is blueish-purple or white in colour (Image: Mark Scott)

C. obtecta mature plant (Image: Leah Dann)

Elaeodendron curtipendulum

Common Name: Maple.

Family: Celastraceae.

Status: Unlisted.

Range: Native to the Norfolk Island Group. Also native on Lord Howe Island and New Caledonia.

Growth Form: Tree.

Plant Description: This tree grows to about 13 metres tall and has opposite, broadly elliptical leaves that are toothed around the margins. The flowers are clustered and have small green petals about 2–3 mm long (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The thin flesh of this fruit is greenish to blueish black and very dark in colour. Below the flesh there is a woody endocarp with approximately three small seeds per fruit (although the exact number will vary).

Habitat: Widespread across Norfolk Island. Often found both in the forests and coastally, as well as in disturbed areas.

Light (for plant growth): Adaptable.

Moisture: Adaptable.

Seed Collection: Year round. Collect when fruit is almost black in colour.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021; Sommerville *et al*., 2021).

Seed Dormancy: Physiological dormancy is present in related species (Ititiaty *et al.,* 2020). For this species, seedlings emerge faster if the fruit/endocarp is scarified and/or crushed, although this is not necessary.

Seed Propagation: Seeds can be planted without treatment but will emerge faster if the fruit/endocarp is scarified or crushed. Scarify fruit with a file or blade or crush the woody endocarp with a clamp (this may damage or destroy seeds if not done carefully). Alternatively, sow the fruit directly into seed raising mix without treatment.

Time to Emergence: 70–100 days if untreated, 40–50 days if woody endocarp is heavily scarified.

Time to Maturity: 10+ years.

E. curtipendulum *seedling*

E. curtipendulum *fruit and leaves*

E. curtipendulum *fruit cut open to reveal multiple small seeds inside (Images: Leah Dann)*

Euphorbia norfolkiana

Common Name: Norfolk Island Euphorbia.

Family: Euphorbiaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Shrub.

Plant Description: This shrub can grow about 1–3 meters tall. It has smooth, narrow leaves (6-10 cm long, 1–1.3 cm wide) that are narrowly oval (with the more pointed end of the leaf at the base) with entire margins. The leaves are in a whorled arrangement (arranged in concentric circles). Flowers are yellow to greenish yellow (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The seed capsules of this species are approximately 1 cm in diameter and spherical to ovoid shaped with 3 lobes. Seeds within the capsule are ovoid to cylindrical, 3–4 mm long, and smooth.

Habitat: Prefers sheltered coastal environments below pines that are not too dense, but appears adaptable to a wide range of habitats.

Light (for plant growth): Prefers slight shade but can grow in full sun.

Moisture: Adaptable.

Seed Collection: Seeds can be found sporadically year round, but are more likely to be found May through July. Collect capsules when they become dry and brown but before they split.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Physiological dormancy is present in related species (Cristaudo *et al.*, 2019). Seeds of this species may have a low depth of dormancy as no treatment is needed.

Seed Propagation: Remove the seeds from the capsules before planting. It is difficult to open the capsules without damaging the seeds, so it is best to simply keep the dry capsules in a container or paper bag until they pop open and release the seeds. Sow seeds onto seed raising mix and cover with a thin layer of seed raising mix.

Time to Emergence: 13–20 days.

Time to Maturity: Approximately one year.

E. norfolkiana *seed capsule; collect capsules when they are brown but before they split open (Image: Mark Scott)*

E. norfolkiana *seedlings (Image: Mark Scott)*

E. norfolkiana *mature plant (Image: Leah Dann)*

Hibiscus insularis

Common Name: Phillip Island Hibiscus.

Family: Malvaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Large shrub.

Plant Description: This shrub tends to layer as it grows. It tends to be shorter and sprawling (up to 2.5 m tall) in harsh environments, but can grow taller and bushier when cultivated. The leaves are oval to egg shaped (2–5 cm long, 2–4 cm wide) with scalloped margins. The leaves and young stems are hairy. The flower is a typical hibiscus-type flower shape and has yellow to greenish-yellow petals with a purple base when young. Flowers turn to a pinkish-purple as they age (Flora of Australia vol. 49, 1994). Juvenile foliage is distinctly different to mature foliage. This means that plants grown from seed appear different to those grown from cuttings (Naomi E. Christian pers. comm., October 2021).

Fruit/Seed Description: The seed capsule is found within the base of the flower. It is ovoid to almost spherical in shape, sectioned, and green to brown in colour depending on the age. The seeds within the capsules are furry.

Habitat: Typically grows in open areas on Phillip Island (Norfolk Island Group).

Light (for plant growth): Adaptable.

Moisture: Hardy and drought tolerant, but does best with plenty of water.

Seed Collection: The flowers can stay on this shrub year round, but the highest number of capsules can be collected from March to November. It is best to collect capsules when they are dry and brown.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Physical and/or physiological dormancy is present in related species (Erickson *et al.*, 2016a; Erickson *et al.*, 2016b). Heat treatment or nicking may increase or quicken germination but have not yet been trialled for this species, as it does not appear to require any pre-treatments and generally germinates well if seeds are removed from the capsule.

Seed Propagation: Place capsules in a paper bag in a dry location if capsules have not already dried out. Remove seeds from dry capsules by hand or using a sieve, sow in seed raising mix, and cover lightly with mix.

Cuttings: Take woody cuttings – approximately 6 mm thick – dipped in rooting hormone and placed in potting mix. May take several months to form roots. Plants tend to mature more quickly when grown from cuttings compared to seed.

Time to Emergence: Approximately 23–40 days.

Time to Maturity: Can be up to 7–18 years before flowering when grown from seed, sooner if propagated from cuttings.

Other Information: This hibiscus is currently found on Norfolk Island and Phillip Island (Norfolk Island Group). It was previously described as only found naturally on Phillip Island before being propagated on Norfolk Island. It is unknown if it evolved only on Phillip Island or if it was also present on Norfolk Island before the introduction of Polynesian rats (Coyne, 2011). This is an attractive flowering plant in the home garden and does best when it is well watered (Christian, 2017).

H. insularis *seed capsule (Images: Mark Scott)*

H. insularis *seedling*

H. insularis flower

H. insularis mature plant

Meryta angustifolia

Common Name: Narrow-leaved Meryta.

Family: Araliaceae.

Status: Vulnerable.

Range: Endemic to the Norfolk Island Group.

Growth Form: Tree.

Plant Description: This species grows to about six metres tall and can have either a single trunk or a trunk that has a few branches towards the top. The leaves have a narrow oval shape, with a narrow, pointier end at the leaf base and a broader, more rounded end at the leaf tip. *M. angustifolia* tends to have smaller, narrower leaves (20–25 cm long, 6–7 cm wide) compared to *M. latifolia*. The leaves are thick and green, with a very prominent lighter green midrib. Flowers are clustered and a pale green colour (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of the *Meryta* trees are a very dark greenish-purple colour and a lumpy or ribbed spherical shape, approximately 5–8 mm diameter. They can be found at the centre of the leaf whorl in branching clusters.

Habitat: Widespread in various habitats and elevations within the Norfolk Island National Park.

Light (for plant growth): Adaptable, grows well with some shade.

Moisture: Adaptable, but prefers some moisture.

Seed Collection: Year round, but most prevalent April–July. Collect when fruits are dark in colour.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Likely dormant, class uncertain.

Seed Propagation: Clean fruit from seeds before planting. The easiest way to do this is by soaking the fruits in water, rubbing the fruit either by hand or on a sieve, and then pouring off the water to leave only the remaining seeds.

Time to Emergence: 45–70 days (with fruit removed).

Time to Maturity: 5+ years.

M. angustifolia *inflorescence (Images: Mark Scott)*

M. angustifolia *mature plant and green fruit; fruit is ripe when purple in colour*

Meryta latifolia

Common Name: Broad-leaved Meryta.

Family: Araliaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Tree.

Plant Description: This species grows to about six metres tall and can have either a single trunk or a trunk that has a few branches toward the top. The leaves have a broad oval shape, a the narrow, pointier end at the leaf base and a broader, more rounded end at the leaf tip. *M. latifolia* has longer, broader leaves (50–75 cm long, 25–30 cm wide) than *M. angustifolia*. The leaves are thick and green, with a very prominent lighter green midrib. Flowers are clustered and a pale green colour (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of the *Meryta* are a very dark greenish-purple colour and a lumpy or ribbed spherical shape, approximately 5–8 mm diameter. They can be found at the centre of the leaf whorl in dense clusters.

Habitat: Widespread in various habitats and elevations.

Light (for plant growth): Adaptable, grow well with some shade.

Moisture: Adaptable, but prefer some moisture.

Seed Collection: Year round, but most prevalent April–July. Collect when fruits are dark in colour.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Likely dormant, class uncertain.

Seed Propagation: Clean fruit from seeds before planting. The easiest way to do this is by soaking the fruits in water, rubbing the fruits either by hand or on a sieve, and then pouring off the water to leave only the remaining seeds.

Time to Emergence: 45–70 days (if cleaned).

Time to Maturity: 5+ years.

Other Information: The large leaves of *M. latifolia* can be used as a wrap for baking. During convict times, the leaves were used by prisoners to wrap their bread before baking in the fire (Coyne, 2011).

M. latifolia *ripe fruit (Image: Mark Scott)*

M. latifolia *mature plant (Image: Leah Dann)*

Myoporum obscurum

Common Name: Popwood.

Family: Scrophulariaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Shrub to small tree.

Plant Description: Bushy shrub to small spreading tree. Can grow up to 7 m tall. The leaves are approximately 8–14 cm long, narrow and tapered at each end with a smooth leaf surface and pointed tips. Leaf margins are entire (smooth) to dentate (toothed). The flowers are small and white with pinkish-purple spots (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of this species is spherical (5-6 mm in diameter) and turns from green to white and then to pinkish-purple when ripe. Below the external fleshy layer, is a woody layer that contains multiple small seeds.

Habitat: Found primarily inland, particularly in cleared/open areas, canopy gaps, and along the forest margins.

Light (for plant growth): Can tolerate full sun, fairly shade intolerant (Broadhurst *et al.*, 2016).

Moisture: Adaptable, but prefers some moisture. It is best to use mulch if planting in low moisture environments or in full sun.

Seed Collection: Ripe fruit can typically be found October–March. Collect when fruit is purplish-pink in colour.

Seed Storage: Uncertain. Some species from this genus exhibit orthodox storage characteristics, others exhibit recalcitrant storage behaviour (Duncan *et al.*, 2019; Royal Botanic Gardens Kew Seed Information Database, 2021). Until information is available for this species, we suggest avoiding storage or only allowing minimal (air) drying and cool (fridge storage) for less than one year.

Seed Dormancy: Physiological dormancy is present in related species (Baskin *et al.,* 2020).

Seed Propagation: Can be planted directly but will germinate better if the fleshy fruit layer is removed. Seeds from related species germinate faster if the woody endocarp is also scarified before sowing, but this has not been trialled for this particular species. Sow on seed raising mix and cover lightly.

Time to Emergence: Approximately 50–200 days. On the shorter side if fruit is removed and longer if not.

Time to Maturity: Approximately 2–3 years.

Other Information: Popwood is a low growing shrub with attractive flowers and fruit. When planted close together and trimmed regularly, Popwood is a great hedging plant. If planted on Norfolk Island, it needs protection from grazing animals. (Naomi E. Christian pers. comm., October 2021).

M. obscurum *seedling (Images: Mark Scott)*

M. obscurum *fruit is magenta when ripe and green when unripe; flowers are white with magenta spots*

M. obscurum *mature plant*

Nestegis apetala

Common Name: Ironwood.

Family: Oleaceae.

Status: Unlisted.

Range: Native to the Norfolk Island Group. Also native to New Zealand (found on some islands off the North Island) (Flora of Australia vol. 49, 1994).

Growth Form: Tree.

Plant Description: This tree can grow over six metres tall. It has smooth, narrowly elliptic leaves approximately 5–11 cm long and 1.5–4 cm wide with a very distinctive yellow midrib. The flowers are small and clumped, typically about 3 mm long, and green to yellow in colour (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit of this tree is ovoid and approximately 1–1.5 cm long. The fruit is green when unripe, but yellow, pinkish, red, or purple when ripe.

Habitat: Widespread in various habitats and elevations.

Light (for plant growth): Adaptable.

Moisture: Adaptable.

Seed Collection: Primarily June–October. Do not collect when green, best to pick fruits when they gain colour and become soft.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Likely dormant, class uncertain. Suspect physiological dormancy.

Seed Propagation: Clean seeds before planting. Seedlings will emerge much faster if the seeds are planted in early winter.

Time to Emergence: Variable – about 150–300 days. It can often take a long time (~300 days) if the seeds are planted immediately after ripening, particularly if they are sowed during the summer months. However, if the seeds are cleaned and stored in a refrigerator until the weather cools down (around April), they will emerge much faster (~150 days).

Time to Maturity: 10+ years.

Other Information: The timber from this tree is very hard and was used for making fence posts, cabinets, and wheel axles (Coyne, 2011). The mulch is currently used in nest boxes around the Norfolk Island National Park because it has antifungal properties.

N. apetala fruit is firm and green when unripe. The fruit softens when ripe and ready to pick. Ripe fruit can be a variety of colours including yellow, pink, red, or purple (Images: Mark Scott)

Pittosporum bracteolatum

Common Name: Native Oleander.

Family: Pittosporaceae.

Status: Vulnerable.

Range: Endemic to the Norfolk Island Group.

Growth Form: Tree.

Plant Description: This is a tree that can grow up to seven metres tall. The leaves are long and thin with the narrower end at the base of the leaf, approximately 7–9 cm long and 1.7–3 cm wide, smooth, and pseudo-whorled (arranged in an almost spiral pattern). The flowers are a cream colour with 12–15 mm long petals. The bark of the mature tree is dark brown with lighter horizontal marks (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: Seeds are contained in a stalked, egg-shaped to spherical-shaped capsule (~5 cm) that is closed when immature (green in colour) and flares open into 3 segments when mature (yellow to brown in colour) to expose many shiny, spherical black seeds (about 4 mm diameter) that are covered in a very sticky substance.

Habitat: Widespread in various habitats and elevations. Common throughout forested areas.

Light (for plant growth): Adaptable.

Moisture: Adaptable.

Seed Collection: Seeds can be found year-round, collect seeds when capsules have fully opened (when capsules are yellow or brown).

Seed Storage: Uncertain. Some species from this genus exhibit orthodox storage characteristics, others exhibit intermediate or recalcitrant (Royal Botanic Gardens Kew Seed Information Database, 2021; Sommerville *et al.*, 2021).

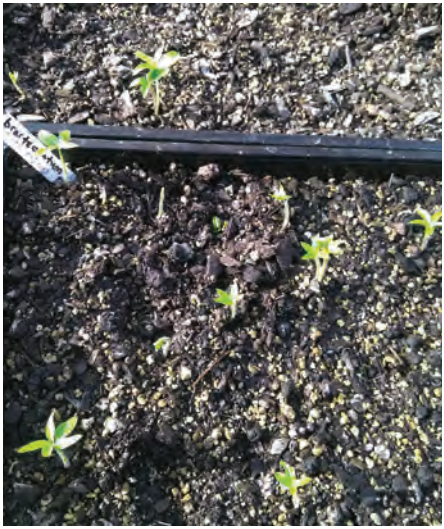
Seed Dormancy: Physiological dormancy is present in related species (Baskin *et al.*, 2020; Rowarth *et al.*, 2007). No treatment is needed prior to sowing seeds of this species. However, low temperature stratification may decrease time to germination (Moore *et al.*, 1994), but has not yet been trialled for this species.

Seed Propagation: Remove seeds from capsules. For easier handling, rub the seeds in soil or talcum powder to make them less sticky and easier to spread out. If possible, spread on seed raising mix in a single layer at medium density, although seedlings will still emerge if seeds are clumped together when planted. Cover lightly with seed raising mix. If seedlings show clustering, it is advisable to thin them out or transplant them.

Time to Emergence: Approximately 80–180 days.

Time to Maturity: 5+ years.

P. bracteolatum *seed capsule and seeds (removed from capsule) (Images: Leah Dann)*



P. bracteolatum *seedlings*

P. bracteolatum *young plant*

Rhopalostylis baueri

Common Name: Niau Palm.

Family: Arecaceae.

Status: Unlisted.

Range: Native to the Norfolk Island Group. Also native to the Kermadec Islands. This variety was originally thought to be endemic to the Norfolk Island Group, but is now considered synonymous to what was previously *R. baueri* subsp. *cheesmanii* in the Kermadec Islands Group (New Zealand) (Coyne, 2011; de Lange *et al*., 2005; Flora of Australia vol. 49, 1994).

Growth Form: Palm.

Plant Description: This palm can grow beyond 10 m tall with a trunk diameter of 60 cm. It has a distinct crown-shaft (50–60 cm long) with 3-4 m long pinnate leaves (leaves have leaflets on both sides of the stem arranged opposite to each other). The flower inflorescence is 30–50 cm long with many thick branches (often up to 60 cm). Inflorescence branches are a pale creamy colour with pale mauve male flowers or cream-coloured female flowers. The inflorescence branches turn from cream to green when fruit forms (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit is 12–15 mm long, spherical to slightly ovoid, and bright red when ripe.

Habitat: This species is very common in gullies and the lower sides of valleys, but can also be found on ridges in shady areas, albeit less frequently. It prefers a cool, damp environment.

Light (for plant growth): Shady areas.

Moisture: Damp environment.

Seed Collection: Variable, typically November–April. Collect fruits when bright red in colour.

Seed Storage: Likely orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Likely has morphophysiological or morphological dormancy (Baskin & Baskin, 2014b).

Seed Propagation: Can directly sow to a tray or pot of seed raising mix when fruits are red in colour. Immediate use is recommended as storage requires removal of the red fleshy fruit layer to avoid pathogens.

Time to Emergence: Approximately 90 days.

Time to Maturity: 10+ years.

Other Information: *Rhopalostylis baueri* seeds are popular food for the endemic green parrots as well as to invasive red parrots and rats. They were also a popular food for the now extinct wood pigeon *Hemiphaga novaseelandiae* subsp. *spadicea*. (Coyne, 2011). The name niau palm stems from the use of the midveins of the palm fronds to make a niau broom. These brooms are still made today, and can be seen in many Norfolk Island homes. Pitcairn Island people continue to make niau brooms today using the midveins of the coconut palm. (Meralda Warren pers. comm., 2021).

R. baueri *seeds (ripe when bright red) (Image: Mark Scott)*

R. baueri *seedling (Image: Leah Dann)*

R. baueri *inflorescence (Image: Mark Scott)*

R. baueri *young plant (Image: Leah Dann)*

A traditional Norfolk Island niau broom, made from the midveins of the niau palm (Rhopalostylis baueri), held by Fay Bataille (Image provided by Jodie Williams from the Fay Bataille Photographic Collection, Norfolk Island, photographed circa 1928).

Ungeria floribunda

Common Name: Bastard Oak.

Family: Malvaceae.

Status: Vulnerable.

Range: Endemic to the Norfolk Island Group.

Growth Form: Tree.

Plant Description: This tree grows up to 15 metres tall. It has broadly oval to egg-shaped leaves which vary widely in both size and length to width ratio (but are approximately 6–12 cm long and 4–8 cm wide). Leaves are fuzzy with raised veins underneath. The inflorescence is 3–7 cm long with many pink flowers (typically 5 petals per flower) (Flora of Australia vol. 49, 1994).

Fruit/Seed Description: The fruit is velvety, brownish-yellow, with five accordion-fold lobes (so that if you take a cross section of the fruit it creates a star-like shape). The fruit is approximately 3–4 cm long and 2–2.5 cm wide with multiple brown, oval, fuzzy seeds inside.

Habitat: Typically found in forested areas. Grows well under a dense canopy.

Light (for plant growth): Shady areas.

Moisture: Damp.

Seed Collection: Primarily available October–March, but can be found periodically throughout the year.

Seed Storage: Orthodox (inferred from related species) (Royal Botanic Gardens Kew Seed Information Database, 2021).

Seed Dormancy: Likely dormant, class uncertain though physiological dormancy is common in the family (Cardina & Sparrow, 1997; Erickson *et al.*, 2016a; Leon *et al.*, 2004).

Seed Propagation: Remove seeds from capsules when they are brownish-yellow and sow, covering lightly with seed raising mix. Do not over water as seeds are prone to rotting. Seedlings may take months to emerge. They may emerge more quickly if the soil is disturbed after several months.

Time to Emergence: 160–285+ days.

Other Information: The seeds of this plant are often consumed by rats. If predation becomes a problem, wire caging around immature fruit may protect seeds from predation while they ripen.

U. floribunda *seed capsule (Image: Mark Scott)*

U. floribunda *seed removed from capsule (Image: Mark Scott)*

U. floribunda *seedling (Image: Mark Scott)*

U. floribunda *flowers, leaves, and capsules (Image: Naomi E. Christian)*

Wikstroemia australis

Common Name: Kurryjunk, Kurrajong.

Family: Thymelaeaceae.

Status: Critically Endangered.

Range: Endemic to the Norfolk Island Group.

Growth Form: Small tree.

Plant Description: This small, fast-growing tree can grow up to eight metres tall but is typically shorter. The leaves are smooth, opposite, with entire margins, and are elliptical to a narrow oval shape that tapers at each end (approximately 3–7 cm long, 2-3 cm wide). The tree will often have both yellow and green leaves. It is semi-deciduous, and at times will drop all of its leaves before replacing them, possibly associated with dry conditions. The flowers are longer than they are wide (~4 mm in length), thin and a yellowish-green colour (Flora of Australia vol. 49, 1994; Mills, 2010b).

Fruit/Seed Description: The fruit is ovoid to egg shaped, about 4mm long, and turns dark red when ripe.

Habitat: Adaptable and hardy. Found in drier areas of the rainforest, open areas, slopes, and dry ridges. Tends to grow well in disturbed areas.

Light (for plant growth): Moderate to high light levels. Prefers a light gap rather than complete shade.

Moisture: Tolerant of both dry and moist environments.

Seed Collection: Bag fruits before they ripen due to rat and insect predation. Collect when fruit is red. Collection times vary, but typically ripe seeds can be found anywhere from winter to summer (often found May–November, January).

Seed Storage: Orthodox (inferred from related species) (Ititiaty *et al.,* 2020; Royal Botanic Gardens Kew Seed Information Database, 2021; Sommerville *et al*., 2021).

Seed Dormancy: Likely not dormant based on related species (Ititiaty *et al*., 2020)

Seed Propagation: Remove seeds from the fruit before planting. Sow at medium density and cover with a few millimetres of seed raising mix.

Time to Emergence: Approximately 25–55 days.

Time to Maturity: Approximately one year.

Other Information: Norfolk Islanders historically utilised the yellow inner bark of the Kurryjunk as the raw material for rope that could be used to tie up barbed wire. The same yellow inner bark was also used to make stock whips (Mervyn Buffet, pers. comm. October 2021).

W. australis *seedling*

W. australis *ripe fruit (Images: Mark Scott)*

W. australis *flower*

W. australis *mature plant*

Section 4

Conclusions and future directions

This is the first edition of the handbook "A Guide to Propagating Norfolk Island's Native Plants and Seeds," and as such has plenty of room to grow and improve. We hope this handbook can be expanded in the future to include additional species and information, and we invite people to share new information to the email norfolkseedhandbook@gmail.com.

This handbook aimed to provide a timely contribution towards threatened plant propagation and conservation on the Norfolk Island Group. We discussed 19 plant species in detail, most of which are threatened and/or endemic to the island group. There are additional threatened and endemic species that were not covered here, and it should be an important priority to collect information for them.

Some additional critically endangered endemic trees and shrubs that were not detailed in this book include *Melicytus latifolius, Achyranthes arborescens,* and *Achyranthes margaretarum.* Other EPBC-listed endemic woody species include *Melicope littoralis, Melicytus ramiflorus* subsp. *oblongifolius, Myrsine ralstoniae,* and *Pennantia endlicheri.* There are also several endangered and critically endangered endemic herbaceous plants, orchids, vines, and ferns which were not covered in this book, including but not limited to *Clematis dubia, Elatostema montanum, Plexaure limenophylax, Lastreopsis calantha, Pteris kingiana, Pteris zahlbruckneriana, Senecio evansianus,* and *Dendrobium brachypus* (also known as *Thelychiton brachypus).* Many other native and endemic species that are not listed in this handbook are valuable to restoration work and are in need of conservation and further study. There are also many native species that can be planted in gardens in place of introduced species, which we did not cover in this handbook. For example, the native plant species *Plumbago zeylanica* (plumbago) and *Hibiscus tileaceus* (Pulau) are attractive flowering plants that make excellent alternatives to introduced ornamental plants.

In this handbook, we used information currently available from a wide range of experts and from our own work on the island, but there are still important gaps in knowledge that need to be studied. Plant recruitment, germination, and continued survival depends on complex biotic and abiotic interactions. An increased understanding of the interactions between Norfolk Island's plants and animals such as pollinators, seed dispersers, and seed predators would be valuable to

optimise conservation strategies and better understand the biology and ecology of Norfolk Island's native plants.

It is also important to further study interactions between environmental factors and seed germination/plant persistence. While it is critical to understand germination for practical applications such as propagation and ex situ conservation, it will also be important to understand germination thresholds and the capacity of seeds to tolerate or avoid stress in the context of future climate change. Norfolk Island recently experienced some of the driest years on record, highlighting the need to understand the germination niche, particularly temperature and moisture, and how this may affect potential persistence or adaptation of native plants in the future.

We hope this handbook is helpful to those who wish to propagate plant species of Norfolk Island. We are grateful to those who have contributed in the past and who are currently contributing to the conservation of Norfolk Island's native plant species, and hope more people are inspired to grow and conserve these important plants.

Norfolk Island vegetation (Image: Leah Dann).

Literature cited

Armitage, J. D., & Clarkson, J. J. (2008). A morphological and molecular investigation of *Cordyline* hybrids and cultivars. *Acta Horticulturae*, 799, 89–95. https://doi.org/10.17660/ActaHortic.2008.799.10

Australian Government Department of the Environment and Energy. (1999). *Environment Protection and Biodiversity Conservation Act 1999*: EPBC Act Threatened Flora in Norfolk Island. http://www.environment.gov.au/cgi-bin/sprat/public/publicreports.pl (accessed 7 May 2018.)

Baskin, C. C., & Baskin, J. M. (2014a). Types of seeds and kinds of seed dormancy. In *Seeds* (pp. 37–77). Elsevier. https://doi.org/10.1016/B978-0-12-416677-6.00003-2

Baskin, C. C., Baskin, J. M., Yoshinaga, A., & Wolkis, D. (2020). Physiological dormancy in seeds of tropical montane woody species in Hawai`i. *Plant Species Biology*, 36(1), 60–71. https://doi.org/10.1111/1442-1984.12295

Baskin, J. M., & Baskin, C. C. (2014b). What kind of seed dormancy might palms have? *Seed Science Research*, 24(1), 17–22. https://doi.org/10.1017/S0960258513000342

Benson, M. L. (1980). Dieback of Norfolk Island pine in its natural environment. *Australian Forestry*, 43(4), 245–252. https://doi.org/10.1080/00049158.1980.10674278

Bonner, F. T., & Karrfalt, R.P. (2008). *The woody plant seed manual.* Agricultural Handbook 727. United States Department of Agriculture, Forest Service.

Broadhurst, L., Clarke, B., & Pleines, T. (2016). *Constraints to Threatened Plant Recovery in Commonwealth National Parks*. CSIRO, Australia

Cardina, J., & Sparrow, D. H. (1997). Temporal changes in velvetleaf (*Abutilon theophrasti*) seed dormancy. *Weed Science*, 45(1), 61–66. https://doi.org/10.1017/S0043174500092481

Caujapé-Castells, J., Tye, A., Crawford, D. J., Santos-Guerra, A., Sakai, A., Beaver, K., Lobin, W., Vincent Florens, F. B., Moura, M., & Jardim, R. (2010). Conservation of oceanic island floras: Present and future global challenges. *Perspectives in Plant Ecology, Evolution and Systematics*, 12(2), 107–129. https://doi.org/10.1016/j.ppees.2009.10.001

Christian, N.E. (1999). A study of the determinants of invasive success and management options for the weed species *Psidium cattleianum* Sabine var. *cattleianum* (Strawberry guava) in Norfolk Island. Honours Thesis, Southern Cross University.

Christian, N.E. (2017). Back from the Brink – Norfolk Island Rare Plant Propagation Trials. Unpublished Report.

Coyne, P. (2011). *Norfolk Island's fascinating flora*. Petaurus Press, ACT.

Cristaudo, A., Catara, S., Mingo, A., Restuccia, A., & Onofri, A. (2019). Temperature and storage time strongly affect the germination success of perennial *Euphorbia* species in Mediterranean regions. *Ecology and Evolution*, 9(19), 10984–10999. https://doi.org/10.1002/ece3.5535

de Lange, P. J., Gardner, R. O., Sykes, W. R., Crowcroft, G. M., Cameron, E. K., Stalker, F., Christian, M. L., & Braggins, J. E. (2005). Vascular flora of Norfolk Island: Some additions and taxonomic notes. *New Zealand Journal of Botany*, 43(2), 563–596. https://doi.org/10.1080/0028825X.2005.9512975

Director of National Parks. (2010). *Norfolk Island Region Threatened Species Recovery Plan.* Department of the Environment, Water, Heritage and the Arts, Canberra.

Duncan, C., Schultz, N., Lewandrowski, W., Good, M. K., & Cook, S. (2019). Lower dormancy with rapid germination is an important strategy for seeds in an arid zone with unpredictable rainfall. *PLOS ONE,* 14(9), e0218421. https://doi.org/10.1371/journal.pone.0218421

Dunphy, M., McAlpin, S., Nelson, P., Chapman, M., & Nicholson, H. (2020). *Australian Rainforest Seeds: A Guide to Collecting, Processing and Propagation*. CSIRO Publishing. https://doi.org/10.1071/9781486311514

Erickson, T., Barrett, R., Merritt, D., & Dixon, K. (Eds.). (2016a). *Pilbara seed atlas and field guide: plant restoration in Australia's arid northwest*. CSIRO Publishing, Victoria

Erickson, T. E., Merritt, D. J., & Turner, S. R. (2016b). Overcoming physical seed dormancy in priority native species for use in arid-zone restoration programs. *Australian Journal of Botany*, 64(5), 401. https://doi.org/10.1071/BT16059

Flora of Australia (1994). Volume 49, Oceanic Islands 1. Australian Government Publishing Service, Canberra

Fountain, D. W., & Outred, H. A. (1991). Germination requirements of New Zealand native plants: A review. *New Zealand Journal of Botany*, 29(3), 311–316. https://doi.org/10.1080/0028825X.1991.10416609

Gibbs, M., Duncan, B., & Varman, R. (2017). The free and unfree settlements of Norfolk Island: An overview of archaeological research. *Australian Archaeology*, 83(3), 82–99. https://doi.org/10.1080/03122417.2017.1404732

Hutton, J. T., & Stephens, C. G. (1956). The paleopedology of Norfolk Island. *Journal of Soil Science*, 7(2), 255–267. https://doi.org/10.1111/j.1365-2389.1956.tb00883.x

Ititiaty, Y., Brescia, F., Bordez, L., Gensous, S., McCoy, S., & Fogliani, B. (2020). Implications of seed traits for restoration of ultramafic plant taxa from the Goro plateau in the subtropical hotspot of New Caledonia. *Restoration Ecology*, 28(6), 1505–1516. https://doi.org/10.1111/rec.13248

Leon, R. G., Knapp, A. D., & Owen, M. D. K. (2004). Effect of temperature on the germination of common waterhemp (*Amaranthus tuberculatus*), giant foxtail (*Setaria faberi*), and velvetleaf (*Abutilon theophrasti*). *Weed Science*, 52(1), 67–73. https://doi.org/10.1614/P2002-172

Mackay, A. (2004). Seed dormancy and germination of a panel of New Zealand plant species: *Carex trifida, Corposma robusta, Cyperus ustulatus, Hebe stricta, Muehlenbeckia australis, Myrsine australis, Phormium tenax and Sophora prostrata.* Dissertation, Massey University.

Mackay, A. C., Mcgill, C. R., Fountain, D. W., & Southward, R. C. (2002). Seed dormancy and germination of a panel of New Zealand plants suitable for re-vegetation. *New Zealand Journal of Botany*, 40(3), 373–382. https://doi.org/10.1080/0028825X.2002.9512798

Mills, K. (2008). Plant conservation on a remote oceanic island: the case of Norfolk Island. *Australasian Plant Conversation, 17*(3), 3

Mills, K. (2010a). Defining indigenous plants: Some problematic species from Norfolk Island. *Cunninghamia,* 11(4), 407–412

Mills, K. (2010b). The flora of Norfolk Island 11: field survey and assessment of the critically endangered endemic plant *Wikstroemia australis* (Kurrajong). The Author, New South Wales

Moore, S., Bannister, P., & Jameson, P. E. (1994). The effects of low temperatures on seed germination of some New Zealand species of *Pittosporum*. *New Zealand Journal of Botany*, 32(4), 483–485. https://doi.org/10.1080/0028825X.1994.10412934

Ntima, O. (1968). *Fast Growing Timber Trees of the Lowland Tropics No. 3: The Araucarias.* Commonwealth Forestry Institute, Department of Forestry, University of Oxford.

Rowarth, J. S., Hampton, J. G., & Hill, M. J. (2007). New Zealand native seed germination requirements: A review. *New Zealand Journal of Botany*, 45(3), 485–501. https://doi.org/10.1080/00288250709509732

Royal Botanic Gardens Kew. (2021) Seed Information Database (SID). Version 7.1. Available from: http://data.kew.org/sid/ (September 2021)

Sánchez, J. A., Pernús, M., Torres-Arias, Y., & Barrios, D. (2019). *Dormancia y germinación en semillas de árboles y arbustos de Cuba: Implicaciones para la restauración ecológica*. *218*(2), 32.

Sommerville, K. D., Errington, G., Newby, Z.-J., Liyanage, G. S., & Offord, C. A. (2021). Assessing the storage potential of Australian rainforest seeds: A decision-making key to aid rapid conservation. *Biodiversity and Conservation*, 30(11), 3185–3218. https://doi.org/10.1007/s10531-021-02244-1

Sykes, W.R. & Atkinson, I. A. E. (1988). *Rare and Endangered Plants of Norfolk Island*. Botany Division, DSIR, Christchurch, New Zealand.

Tiwari, A. K., Tiwari, T. N., & Prasad, S. R. (2016). Seed dormancy in ornamental plants: A review. *Indian Journal of Agricultural Sciences*, 86(5), 580–92.

Tompsett, P. (1994). Capture of genetic resources by collection and storage of seed: A physiological approach. In *Tropical trees: the potential for domestication and the rebuilding of forest resources* (pp. 61-71). Natural Environment Research Council, UK.

Walters, C. (2015). Orthodoxy, recalcitrance and in-between: Describing variation in seed storage characteristics using threshold responses to water loss. *Planta*, 242(2), 397–406. https://doi.org/10.1007/s00425-015-2312-6

Wyse, S. V., & Dickie, J. B. (2017). Predicting the global incidence of seed desiccation sensitivity. *Journal of Ecology*, 105(4), 1082–1093. https://doi.org/10.1111/1365-2745.12725

Yenson A.J.M., Offord C.A., Meagher P.F., Auld T., Bush D., Coates D.J., Commander L.E., Guja L.K., Norton S.L., Makinson R.O., Stanley R., Walsh N., Wrigley D., Broadhurst L. (2021) Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collections. Third edition. Australian Network for Plant Conservation, Canberra.

Zimmer, H. C., Brodribb, T. J., Delzon, S., & Baker, P. J. (2015). Drought avoidance and vulnerability in the Australian Araucariaceae. *Tree Physiology*, tpv111. https://doi.org/10.1093/treephys/tpv111

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