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Invasive species mapping, Howth, Co. Dublin



Howth Head Coastal Cliffs, Dublin (*Photograph* ©: Emer Ní Dhúill, 2018)

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1. INTRODUCTION

Fingal County Council invited tenders for mapping of invasive species at Howth, Co. Dublin. The objective of the mapping was to fulfil the objectives of Action 1A (1.5) of the Howth Special Amenity Area Order Operational Plan 2015-2020: *Control of invasive species with a particular focus on Rhododendron, Birch and garden plant escapes.*

The requirements of this project were two-fold. Firstly, Fingal County Council required that the coastal cliffs between Bellingham's Farm and the Baily Lighthouse be surveyed for invasive species as there has been a lot of dumping of garden waste in this location over the past few decades, which has led to several invasive and exotic species establishing themselves on the cliffs. The cliffs are fully within the Howth Head Special Area of Conservation (SAC) and the presence of invasive species is negatively affecting the native flora in this location. It was required that a site visit to the assigned location be carried out with Dr. Noeleen Smyth, National Botanic Gardens, in order to map and quantify (m²) the invasive and exotic species recorded. Dr. Emer Ní Dhúill carried out the desktop review of control measures of all invasive and exotic species encountered in order to determine the most appropriate methods of control.

The second part of the project was to produce a map of *Rhododendron ponticum* L. around the Summit of Howth. *R. ponticum* control has been carried out by the Council for the past ten years and they required mapping of the Summit of Howth in order to target new stands of *R. ponticum* along the edges of the heathland and any remaining individual shrubs. The area to be mapped included the large stand of *R. ponticum* west of the Rhododendron Gardens at the Deer Park Hotel, Howth.

The following report relates to the first part of the project which is the survey of the coastal cliffs between Bellingham's Farm and the Baily Lighthouse. The requirements of the second part of the project will be submitted separately as a map of *R. ponticum* on the Summit of Howth in PDF and GIS format.

2. SURVEY COASTAL CLIFFS BELLINGHAM'S FARM TO BAILY LIGHTHOUSE

A survey of the coastal cliff tracks and beaches between Bellingham's Farm and the Baily Lighthouse at Howth, Co. Dublin was carried out during October 2018 to record the locations of non-native invasive and exotic plant species. GPS points were recorded where non-native species were observed using a Garmin eTrex® GPS receiver and area of occupancy (m²) was recorded. Species locations were mapped using ArcView 10.6. Photographs were taken of the locations where non-native invasive species occurred. Appendix 1 gives the full list of every individual species, including area (m²) and location. Map 1 shows the location of all species recorded.

The invasive impact risk category of each species recorded was checked on the National Biodiversity Data Centre's list of high and medium impact species (NBDC, 2018) as well as referring to the reports on risk analysis and prioritisation for invasive and non-native species in Ireland and Northern Ireland (Kelly *et al.*, 2013) and the report on Ireland's invasive species (Stokes *et al.*, 2006).

Species listed nationally as invasive in Ireland come from the *Invasive Species in Ireland prioritization risk assessment* undertaken in 2013 (NBDC, 2018). The purpose of the prioritisation risk assessment was to understand the relative risk associated with an array of species (O’Kelly *et al.*, 2013). The nationally assessed species were scored and ranked into high; medium; and low impact categories (O’Kelly *et al.*, 2013). High risk invasive species were those assessed with an impact score of 18 +; medium risk invasive species scored 14-17; and low risk invasive species scored ≤ 13 . A more comprehensive detailed risk assessment than the *Prioritisation Risk Assessment* was undertaken in 2014 to gather information on particular species of national concern (NBDC, 2018). This detailed risk assessment is called the Non-native species APplication based Risk Analysis (NAPRA) and is a computer based tool for undertaking risk assessments of any non-native species of concern (<http://nonnativespecies.ie/risk-assessments/>).

A total of thirty-two species were recorded during the survey of the coastal cliffs of Howth, of which thirty-one were non-native and one was a vigorous native (*Carex pendula* Huds.) (see Map 1 in Appendix 2). Sixteen of these species were included in the national assessment under the *Prioritisation Risk Assessment* (O’Kelly *et al.*, 2013). Three of these species had been further assessed using the NAPRA detailed risk assessment tool (*Allium triquetrum* L., *Carpobrotus edulis* L. N.E. Br. and *Hippophae rhamnoides* L.). The sixteen remaining species recorded during the survey have not been assessed under either risk assessment. Of the non-native species recorded, three were categorised as ‘High Risk’; seven were ‘Medium Risk’ and six were ‘Low Risk’. Table 1 below lists the species recorded during the survey that have been assessed under the *Prioritisation Risk Assessment* and/or NAPRA and assigned an impact risk category.

Table 1. List of species recorded on the coastal cliffs of Howth that have been assessed under the *Prioritization Risk Assessment* and/or NAPRA, including number of individuals of each species recorded, impact risk category and impact score.

Species name	No. individuals/patches recorded	Area (m ²)	Invasive risk category	Impact score
<i>Allium triquetrum</i>	1	0.5	Medium	15
<i>Buddleja davidii</i>	6	701	Medium	15
<i>Carpobrotus edulis</i>	69	7,169	High	19
<i>Cotoneaster horizontalis</i>	3	950	Medium	14
<i>Crassula helmsii</i>	1	0.25	High	20
<i>Crocosmia x crocosmiiflora</i>	5	109	Low	10
<i>Fallopia baldschuanica</i>	1	400	Medium	14
<i>Fallopia japonica</i>	2	930	High	20
<i>Fuchsia magellanica</i>	5	335	Low	12
<i>Gaultheria shallon</i>	2	920	Low	10
<i>Hippophae rhamnoides</i>	2	26	Medium	14
<i>Leycesteria formosa</i>	1	1	Medium	14
<i>Libertia formosa</i>	2	201	Low	8
<i>Malva neglecta</i>	1	0.25	Low	7
<i>Phormium tenax</i>	4	37	Low	7
<i>Rosa rugosa</i>	1	1	Medium	14

One species of note that has not undergone a national assessment is *Veronica x franciscana* (Image 1). This species is considered established in natural and semi-natural habitats in Ireland and was considered during this survey to be invading the coastal cliffs of Howth. Twenty-four clumps of *V. x franciscana* were recorded with an overall area of 4,882 m² plus ten hedges (2,131m²) with combined area of 7,014m². This area is comparable to the area invaded by *Carpobrotus edulis* (Image 2), which is categorised as a 'High Risk' invasive species. The area reported for *V. x franciscana* excludes the occurrence of *V. x franciscana* in three mixed hedges.

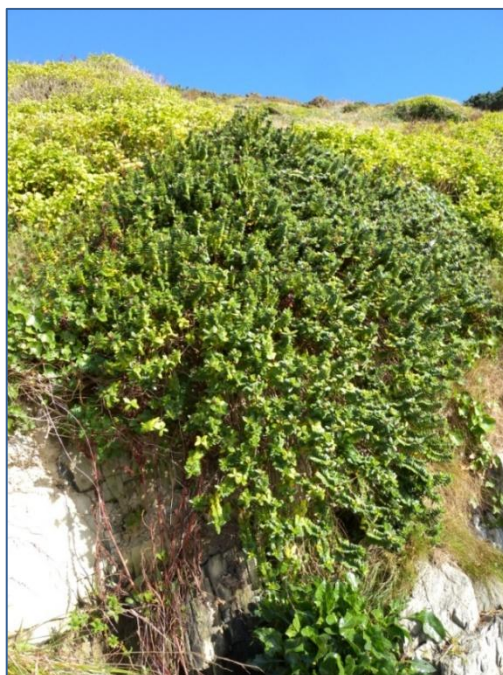


Image 1. Large *Veronica x franciscana* on cliffs at Nuns Beach, Howth (2018).



Image 2. *Carpobrotus edulis* on cliffs at Lions Head beach, Howth (2018).

Two large dense clumps of *Gaultheria shallon* occupying, an area of at least 920 m² were recorded during the survey (Image 3). These clumps were so dense, that little else was observed growing with them. This species is currently categorised as a low risk species in Ireland, however, in the location where it occurs in Howth, it is problematic and spreading.



Image 3. *Gaultheria shallon* on track of coastal cliffs, Howth (2018)

A large clump of a mix of *Crocsmia x crocosmiiflora* and *Libertia formosa* was recorded on the cliffs above Lions Head beach with a combined area of 900m². Both species were assessed as 'Low Risk' in Ireland, however, based on this survey they appear to be growing vigorously along the coastal cliffs of Howth.

The native species, *Carex pendula*, was included in the assessment due to its vigorous clump forming habit, and likelihood of spreading in the location surveyed in Howth. Table 3 gives details of the overall area occupied by non-native species (excluding non-native mature trees) along the coastal cliffs of Howth. This excludes species within mixed hedges.

Table 3. Areas (m² and hectares) of the different risk category species, non-assessed species, mixed hedges and mixed clumps on the coastal cliffs of Howth. Non-native mature trees have been excluded.

Details	Area (m ²)	Area (hectare)
Area occupied by non-native species (excluding mature trees and mixed hedges/clumps) broken down as follows:	20,581	2.05
Area occupied by High Risk non-native species	8,100	0.81
Area occupied by Medium Risk non-native species	2,080	0.21
Area occupied by Low Risk non-native species	1,602	0.16
Area occupied by Non-Assessed non-native species (including native <i>C. pendula</i>)	8,799	0.88
Area occupied by mixed clumps	900	0.09
Total area occupied by non-native species including mixed clumps (excluding mature trees and mixed hedges)	21,481	2.14

Mixed hedges and mature trees

A number of mixed hedges comprising non-native species occurred along the coastal cliffs track. Table 2 below details the mix of species recorded and the combined area (m²) of each mixed hedge and whether it was located on the land side or sea side of the track (Maps 2 and 3). Hedges on the land side of the track are likely to be on private land. Mature trees were excluded from the assessment (*Pinus* sp., *Abies* sp, *Salix babylonica*). These mature trees would not be subject to any control measure,

as removal would be extremely damaging to the habitat; and these species do not appear to be negatively impacting the habitat where they occur.

Table 2. List of mixed hedges recorded on the coastal cliffs of Howth including combined area (m²) of each hedge, and its location on the track (land side or sea side).

Mix of non-native species in hedges	Location of hedge	Area of hedge (m²)
<i>Hedge of Euonymus fortunei; Veronica x franciscana; Fuchsia magellanica; Berberis x stenophylla, Olearia macrodonta, and Griselinia littoralis.</i>	Land side	220
<i>Hedge of Olearia macrodonta and Buddleja davidii</i>	Land side	130
<i>Hedge of Hippophae rhamnoides and Libertia formosa</i>	Sea side	56
<i>Hedge of Veronica x franciscana, Berberis x stenophylla, Olearia spps.,</i>	Land side	284
<i>Hedge of Muehlenbeckia complexa and Ligustrum ovalifolium</i>	Land side	57
<i>Hedge of Olearia macrodonta, Salix species, Veronica x franciscana</i>	Sea side	42
Area occupied by mixed hedges		789

Management of hedges on private land is the responsibility of land owners. Hedges that contain non-native species have the potential to spread outside of private land. Management could be simply cutting the hedges after flowering and before seed set, in line with the legally allowable period for hedge cutting (from 1st March to 1st September hedge cutting is banned). This will help reduce fruit development and seed spread. Such management will help mitigate against any possible future impacts from these non-native species.

3. COMPLETE DETAILS OF NON-NATIVE SPECIES RECORDED INCLUDING CONTROL AND MANAGEMENT

Of the thirty-two species that were recorded sixteen were risk assessed for Ireland (Stokes *et al.*, 2006; O’Kelly *et al.*, 2013; O’Flynn *et al.*, 2014) (as outlined in Table 1). For the remaining sixteen not risk assessed, a desktop study was carried out to determine if these species were considered problematic or invasive in countries outside of Ireland. Set out below are details of the non-native species and single vigorous native species recorded during this survey. For species that have been previously assessed for invasiveness in Ireland, details of their risk category and impact score have been included. Details of species where invasive risk was not assessed are also outlined and included. The impact, if any found, of these species on the habitats they occupy has been outlined, along with information on management and control, if known, and recommendations for each species. The species are set out in order of risk of invasiveness from *High Risk* species to *Non-assessed* species.

1. *Carpobrotus edulis* (L.) N.E. Br.

English Name: Hottentot-fig
Family: Aizoaceae
Description: Robust procumbent succulent perennial with trailing stems to 3m, rooting at nodes and forming large, dense mats. Flowers from late spring to early autumn. Height 15cm, width indefinite (Brickell, 1996; O'Rourke & Lysaght, 2014; Webb *et al.*, 1996); GISD, 2018.



Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: South Africa

Introduced: Albania; Argentina; Australia; Bermuda; Chile; Croatia; France; French Polynesia; Germany; Gibraltar; Greece; Guernsey; Ireland; Italy; Malta; Mexico; New Zealand; Pitcairn; Portugal; Saint Helena; Spain; Tunisia; United Kingdom; United States

Climate where introduced: Temperate

Source: GISD (2018)

Invasive status:

Invasive category: Invasive. Considered established in natural and semi-natural habitats.

Risk Category: **High**

Impact score: 19

Source: O'Flynn *et al.*, 2014; O'Rourke & Lysaght (2014); Kelly *et al.* (2013); Stoke *et al.* (2006).

Additional information:

Sixty-nine individual clumps were observed on the cliffs from Bellingham's Farm to the Baily Lighthouse with a combined area of 7,169m² (see attached Maps 5 and 6).

Impact of invasive species:

C. edulis has a very dense fibrous root system concentrated in the upper 50cm of the soil, with new roots forming at each node as the plant spreads outward (O'Rourke & Lysaght, 2014; D'Antonio & Mahall, 1991).

Control and management:

A control program for *C. edulis* was implemented on the cliffs of Howth Head (Smyth *et al.*, 2013). This followed a successful pilot study on the control of this species in Ireland (Smyth & Jebb, 2011; Jebb *et al.*, 2009).

Physical control:

Weedy species can be removed by mechanical or manual control, by pulling weeds, grubbing with hand tools or, in more extreme cases, bulldozing and dragging (Smyth *et al.* 2013). DAISIE (2018) noted that manual eradication (hand-pulling and buried stem removal) appears to be the most

effective and cost-efficient method. Plant remains should be removed as they become an active part of regeneration (DAISIE, 2018). It was noted that manual control is only feasible when there is low cover of an invasive species (Smyth *et al.*, 2013). Prescribed burnings (> 100°C) is reported to reduce the seedbank (DAISIE, 2018), although such a method would not be suitable at Howth.

Chemical control:

Using the method devised by Smyth *et al.*, (2011; 2013), 3 g/l glyphosate and 0.3g/l diquat can be applied during early March and early September.

Biological control:

There is no approved biological control for this species in Ireland.

Recommendations:

It is recommended to implement a management program for *C. edulis* using chemical control methods devised by Smyth *et al.* 2013. Ongoing control would be required to eradicate this species from this location.

2. *Crassula helmsii* (Kirk) Cockayne

English Name: New Zealand Pigmyweed

Family: Crassulaceae

Description: A small succulent flowering perennial that grows rapidly to form an extensive lush-green "carpet" that floats on freshwater or may be submerged. Growth can extend from margins of sheltered waterbodies to completely cover the water surface with tangles of stems and shoots (DAISIE, 2018; Webb *et al.*, 1996)



Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: Australia, New Zealand

Introduced: Belgium; Denmark; France; Germany; Ireland; Italy; Netherlands; Portugal; Russian Federation; Spain; United Kingdom; United States

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/Invasive.

Risk Category: **High**

Impact score: 20

Source: O'Flynn *et al.*, 2014; Millane & Caffrey (2014); Kelly *et al.* 2013

Additional information:

One clump of *C. helmsii* was observed in a garden dump waste site. The species was not growing here, but was dumped with other garden waste (Map 7).

Impact of invasive species:

C. helmsii forms dense mats that smother other vegetation and may cause changes to the pelagic communities in lakes and it is extremely costly to control (Minchin, 2009; Stokes et al., 2006). Dense populations of *C. helmsii* can decrease biodiversity, displace native flora, increase oxygen levels, cause flooding, obstruct water flow, and reduce recreational value of lakes or ponds (GISD, 2018).

Control and management:

Due to the ability of *C. helmsii* to regenerate from vegetative fragments, complete eradication of large infestations is unlikely, but that control in the short-to-medium term can reduce the abundance of establishing populations (Millane & Caffrey, 2014). Control of low density infestations have been reported to be successful using double layers of light-excluding jute matting (Millane & Caffrey, 2014).

Recommendations

C. helmsii was recorded in a garden waste dump site, and was not recorded to be actually growing in this area. Control is outlined, however, it is recommended that complete removal of all plant waste in this dump site be carried out immediately to ensure that fragments of *C. helmsii* are not spread.

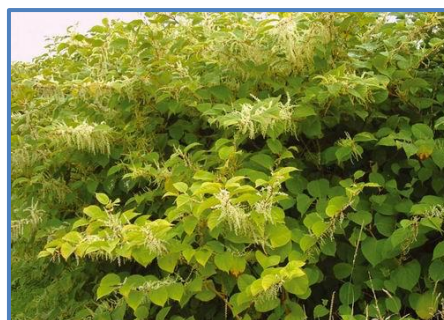
3. *Fallopia japonica* (Houtt.) Ronse Decraene

Irish Name: Glúineach bhiorach

English Name: Japanese Knotweed

Family: Polygonaceae

Description: Herbaceous perennials with robust erect stems up to 4 m tall and extensive system of rhizomes, 15-20 m long, penetrating 2-3 m deep in soil (NBG, 2017; DAISIE, 2018; Webb *et al.*, 1996).



Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: China, Korea and Japan

Introduced: Austria; Australia; Belgium; Bulgaria; Channel Islands; Croatia; Czech Republic; Denmark; Estonia; European ; Finlandpart of Russia; France; Germany; Great Britain; Greece; Hungary; Ireland; Italy; Latvia; Liechtenstein; Lithuania; Luxembourg; Netherlands; Northern Ireland; Norway; Poland; Portugal; Romania; Scotland; Slovenia; Spain; Sweden; Switzerland; Ukraine; WalesAustralia, United States

Climate where introduced: Temperate

Source: DAISIE (2018); Roskov *et al.* (2018)

Invasive status:

Invasive category: Invasive. Considered established in natural and semi-natural habitats

Risk Category: **High**

Impact score: 20

Source: O'Flynn *et al.*, 2014; Kelly *et al.* (2013); Stoke *et al.* (2006)

Additional information:

Two large clumps of *F. japonica* were recorded at Nuns beach, Howth during the survey, with a combined estimated area of 930m².(Map 8).

Impact of invasive species:

F. japonica lowers biodiversity by crowding out native plants (DAISIE, 2018). Riparian habitats invaded by knotweeds have lower invertebrate abundance, species richness and biomass, and lower plant species richness compared to uninvaded sites (Gerber et al., 2008)

Control and management:

Combined physical and chemical control is considered most effected for controlling *F. japonica*, although eradication is very difficult (NRA, 2010). Complete eradication can only be achieved through continued control and strategic management (NNSS, 2011). As rhizomes can remain dormant for at least twenty years, lack of visible regrowth is not evidence of eradication (NNSS, 2011)

Physical control:

Methods such as cutting, mowing and pulling can be effective over a long time period but this method needs to be repeated, and the disposal of material must be done with care (GISD, 2018). Physical control is effective for small, initial populations or environmentally sensitive areas where herbicides cannot be used (GISD, 2018). Two cuts, the first in May-June, the second in late summer and repeated annually until no new shoots appear is said to work eventually (GISD, 2018).

Chemical control:

Glyphosate-based herbicide or 2,4-D Amine herbicide can be applied in May and late September/early October; such control can take up to five years (NRA, 2010). Cut and inject technique can be applied in late October or November (NRA, 2010).

Biological control:

A leaf-feeding chrysomelid beetle, *Gallerucida nigromaculata*, regulates *F. japonica* in its native range of Japan and its use as a biological control agent in the United Kingdom and United States is being considered (DAISIE, 2018).

Recommendations:

It is recommended to begin a sustained control programme to eradicate the two large clumps of *F. japonica* employing chemical control measures as outlined above. It is essential to monitor any re-emergence of this species and to survey the surrounding area for any unrecorded plants.

4. *Allium triquetrum* L.

<i>Irish Name:</i>	Glaschreamh
<i>English Name:</i>	Three-cornered Garlic
<i>Family:</i>	Liliaceae
<u>Description:</u>	Spring-flowering bulb with bell-like white flowers on stems which are three-sided and to 45cm high. All parts smell of garlic (NBG, 2017; Webb et al., 1996; Stace, 1997).
<u>Status:</u>	Neophyte, alien introduced after 1500



Origin:

<i>Region of origin:</i>	Mediterranean Europe
<i>Regions where introduced:</i>	Azores, UK, Ireland, Northern Ireland, Portugal, Turkey
<i>Climate where introduced:</i>	Temperate
<i>Source:</i>	Preston <i>et al.</i> (2002)

Invasive status:

Invasive category: Considered established in natural and semi-natural habitats.

Risk Category: **Medium**

Impact score: 15

Source: O'Rourke & Flynn (2014); Stoke *et al.* (2006); NBDC (2018).

Additional information:

It is thought that *A. triquetrum* was introduced into Ireland three-hundred years ago and has since become naturalised in many counties (Devlin, 2014). This species has become best established in the mildest regions of Ireland, where the climate is comparable to its western and central Mediterranean origin (O'Rourke & O'Flynn, 2014) (Map 9).

Impact of invasive species:

Allium triquetrum is reported to spread by ant-dispersed seed and division of clumps; the former allows it to spread over longer distances and the latter over short distances (NNSS, 2018). No documented impacts have been reported to date, however; it was reported by Booy *et al.* (2015) that *A. triquetrum* can dominate waste ground due to its ability to colonise rapidly, thus outcompeting native vegetation.

A. triquetrum is established in the south and south east of Ireland, outside of which it has a scattered occurrence (O'Rourke & O'Flynn, 2014). As this species emerges in early spring, it may be competitively advantaged as it can dominate before other species emerge (Dowlin, 2011).

This species is reported to have become highly invasive in species-rich roadsides and grassland vegetation in some areas of Southwest England and the Channel Islands, where it is displacing native species that are regionally or nationally important (NNSS, 2018).

It is considered that there is great potential for this species to spread under the influence of a warming climate (Downen, 2011; O'Rourke & O'Flynn, 2014).

A. triquetrum was recorded in two locations during the survey in Howth occupying an area of 0.5m². The first location where it was recorded was at a garden waste dumping site. The presence of this species in this location is due to indiscriminate dumping of garden waste. The second record was further along the same track, and has most likely spread from the nearby dumping site. It is likely that there are more clumps of this bulbous perennial along the track that were hidden in vegetation, or were dying back at the time of surveying.

Control and management:

At present, there is no existing target management strategy to limit or prevent establishment of this species in Ireland (O'Rourke & O'Flynn, 2014). Combined physical and chemical control is considered most effective for *A. triquetrum* (NNSS, 2011; O'Rourke & O'Flynn, 2014).

Physical control:

For isolated occurrences of *A. triquetrum*, manual removal of bulbs is feasible. However, widespread eradication in well-established areas may not be economically viable and may also impact non-target species (O'Rourke & O'Flynn, 2014). Correct disposal of the species is imperative, to ensure it does not invade other locations. Burning of bulbs, bulblets and seed is recommended (HerbGuide, 2014). Cultivation in autumn and spring aids killing bulbs, but this method can take a number of years to see the effects of control (HerbGuide, 2014). Cultivation in summer also exposes bulbs, which allows for chemical control. Where a mowing regime can be implemented, mow as low as possible prior to flowering and repeating in a few weeks to tackle regrowth (HerbGuide, 2014). Mowing should not be carried out where the flowers have gone to seed (HerbGuide, 2014).

Chemical control:

For control of bulbs, cultivation in summer exposes them which allows for chemicals to be applied. Spraying annually in late winter to early spring before full flowering using 0.5g metsulfurone (600g/kg) plus 25mL Pulse® Penetrant wetting agent in 10L water is reported to give high levels of control, but will damage many broad-leaved species in the vicinity (HerbGuide, 2014). Application of 10mL glyphosate per litre of water at bulb exhaustion stage (i.e. early flowering) is reported to provide good control, but damages many companion plants (HerbGuide, 2014). It is recommended to carry out repeat sprays for 2-3 years and replant one year later if residual herbicides have been used (HerbGuide, 2014). The Risk Assessment for the UK by NNSS (2011), noted that Brush-Off (metsulfuron methyl) or Kamba 500 may be useful treatments, but likely only appropriate in a restricted number of semi-natural locations.

Recommendations:

Physical removal and correct disposal of *A. triquetrum* from the two locations where it was recorded and follow-on monitoring for any emerging plants is recommended.

5. *Buddleja davidii* Franchet

Irish Name: Tor an fhéileacáin

English Name: Butterfly-bush

Family: Buddlejaceae

Description: Perennial shrub with arching branches to 4m high. Flowers from summer to autumn (NBG. 2017; Webb *et al.* (1996); Online Atlas of British and Irish Flora (2018).

Status: Neophyte, alien introduced after 1500.

Origin

Region of origin::: China, Tibet

Introduced: Belgium, Bulgaria, Channel Is., Corse (Corsica), Croatia, Czech Republic, England, France, Germany, Great Britain, Hungary, Ireland, Italy, Liechtenstein, Netherlands, Northern Ireland, Poland, Portugal, Scotland, Spain, Switzerland, Wales.

Climate where introduced: Temperate

Source: DAISIE (2018)



Invasive status:

Invasive category: Alien/established. Considered established in natural and semi-natural habitats.

Risk Category: **Medium**

Impact score: 15

Source: O'Flynn *et al.*, 2014; Kelly *et al.* (2013); Stoke *et al.* (2006); DAISIE (2018).

Additional information:

NNSS (2018) noted that *B. davidii* forms dense monotypic thickets and outcompetes native species but that it is a valuable source of food for insects and provides cover for mammals.

B. davidii was recorded at seven locations along the track from Bellingham's Farm to the Baily Lighthouse during the survey. Four records relate to individual plants on the sea side of the track with a combined area of 100m². Two clumps related to individuals on the land side of the track, one clump covering an area of 600m² and the other small clump only 1m². *B. davidii* also occurred in a hedge mixed with *Olearia* sp. on the land side of the track.

Impact of invasive species:

No precise studies have been carried out on the level of impact of *B. davidii*, likely due to its long history of naturalisation (Tallent-Hassell & Watt, 2009). An economic impact assessment of invasive species found there were no negative effects known due *B. davidii* growth in Germany (Reinhardt *et al.*, 2003).

Control and management:

There is no control strategy implemented in Ireland at present. Tallent-Halsell & Watt (2009) reported that mechanical, physical, or combined mechanical and physical methods had mixed results in controlling *B. davidii*. Although small-scale eradication may be successful, the removal of this species may damage the habitat and it may become unsuitable for desired species, thus leaving it susceptible to reinvasion (Tallent-Halsell & Watt, 2009)

Physical control:

Dead-heading (removing seed capsules before they ripen) is recommended to reduce the spread of seeds (Tallent-Halsell & Watt, 2009; GISD, 2018). Physical removal on a small spatial scale may help in the early stages of invasion (seeds (Tallent-Halsell & Watt, 2009).

Young shrubs can be dug out, however this method was not recommended for mature plants in well established populations (Tallent-Halsell & Watt, 2009). After uprooting, it is recommended to plant alternative native species (GISD, 2018). It is necessary to remove and dispose of uprooted plants as they can grow as cuttings. *B. davidii* grows back vigorously when cut, therefore the use of a systemic weed killer on the stumps is essential (GISD, 2018).

Chemical control:

Mature plants can be cut and treated with glyphosate herbicide (Tallent-Halsell & Watt, 2009). Cutting must be carried out at the base of the seedling and be accompanied by an immediate white-washing of the stump with a systemic weed killer (GIDS, 2018).

Biological control:

Researchers in New Zealand are currently studying the possibility of biological control with *Cleopus japonicas* (GIDS, 2018).

Recommendations:

B. davidii is an important source of food for insects NNSS (2018). It is recommend to implement a management program to control this species in this location in Howth as outlined above. If possible, manual removal should be carried out and chemical control only employed where absolutely necessary. In the interim, it is recommended to dead-head flowers before they go to seed and to monitor the spread of this species in those locations. In locations where *B. davidii* is removed, replanting should be carried out with pollinator-friendly native species and continued monitoring for regrowth of *B. davidii* in those locations. Careful removal of *B. davidii* debris is essential as stem and root fragments can readily regenerate (Tallent-Halsell & Watt, 2009). The large clump of *B. davidii* (600m²), this is likely on private land.

6. *Cotoneaster horizontalis* Decne.

Irish Name: Cainchín balla

English Name: Wall Cotoneaster

Family: Rosaceae

Description: Undershrub with widely spreading deciduous branches forming a herring-bone pattern. Flowers in late spring. Height 1m width 1.5m (NBG, 2017; Brickell,1996; Webb *et al.*, 1996.

Status: Neophyte, alien introduced after 1500.



Origin:

Region of origin: China, Tiawan, Nepal

Introduced: Australia, Canada, Europe, Japan, United States.

Climate where introduced: Temperate

Source: CABI (2018)

Invasive status:

Invasive category: Considered established in natural and semi-natural habitats.

Risk Category: **Medium**

Impact score: 14

Source: NBDC (2018); O'Flynn *et al.*, 2014; Kelly *et al.* (2013); Stoke *et al.* (2006)

Additional information:

Three clumps of *C. horizontalis* were recorded in this survey with an estimated area of 950m² (Map 10)

Impact of invasive species:

When occurring on grassland habitats *C. horizontalis* is reported to decrease species richness and diversity, as well as affecting grassland specialist species (Piqueray, 2008). A risk assessment was carried out on *C. horizontalis* in the Netherlands and it was considered that the risk of establishment was high (Boer, 2014) . It was determined that if *C. horizontalis* was not managed, it could locally lead to permanent change in vegetation sturcture in coastal dune areas (Boer, 2014). Dispersal of the seed by birds may progressively accelerate the spread of the species (Boer, 2014).

Control and management:

Physical:

Young plants can be uprooted, ensuring both stump and shallow roots are removed, as both can re-sprout (Boer, 2014). Seedlings can be smothered by mulch or black plastic, hand-pulled or sprayed (Boer, 2014). Piqueray (2008) noted that cutting individuals would probably not eradicate *C. horizontalis*, but if repeated regularly (every 3 years), it would limit the development of fruiting individuals.

Chemical:

A combination cutting and chemical control can be applied to older plants. Such plants can be cut and painted with 100% glyphosate (Boer, 2014). Roundup Max in dilution of 1:32 can be applied to cut stumps, preferably in the month of September when the plant reallocates nutrients to the root system (Boer, 2014).

Recommendations:

It is recommended that a combined control program as outline above be implemented for the large clump of *C. horizontalis* (900m²). The remaining two smaller clumps can be manually removed. Ongoing management and control is essential as *C. horizontalis* can be difficult to eradicate due to its ability to sprout from remaining roots after uprooting and can produce fruit and seed when young plants (Boer, 2014).

7. *Fallopia baldschuanica* (Regel) Holub

<i>English Name:</i>	Russian-vine/Mile-a-minute
<i>Family:</i>	Polygonaceae
<u>Description:</u>	Summer flowering climbing plant which can reach 10 m (NBG, 2017; Devlin, 2018).
<u>Status:</u>	Neophyte, alien introduced after 1500
<u>Origin</u>	
<i>Region of origin:</i>	Central Asia
<i>Introduced:</i>	Austria; Belgium; Bulgaria; Croatia; Czech Republic; France; Germany; Great Britain; Greece; Hungary; Ireland; Italy; Liechtenstein; Madeira; Northern Ireland; Portugal; Romania; Sardinia; Sicilia; Slovenia; Spain; United States.



<i>Climate where introduced:</i>	Temperate
<i>Source:</i>	DAISIE (2018); Roskov <i>et al.</i> (2018)

Invasive status:

<i>Invasive category:</i>	Alien/established in Ireland
<i>Risk Category:</i>	Medium
<i>Impact score:</i>	14
<i>Source:</i>	O'Flynn <i>et al.</i> , 2014; Kelly <i>et al.</i> (2013); DAISIE (2018)

Additional information:

One large clump of *F.baldschuanica* was recorded during the survey, occupying an area of at least 400m² (Map 8).

Impact of invasive species:

F.baldschuanica can grow up to 10 m away from its rootstock and can climb rapidly over shrubs and trees, out-competing them for light and space (NNSS, 2018).

F.baldschuanica is regarded as invasive in parts of Europe (Germany, Spain, Italy and Slovenia) and many states in the United States (NNSS, 2010). There are no reported impacts from this species in Ireland.

Control and management:

No control method was found. Control of *F. baldschuanica* could be carried out following the methods used to control *F. japonica* (as per NRA, 2010; GISD, 2018).

Recommendations:

It is recommended to begin a sustained control programme to eradicate the large clump of *F. baldschuanica* using combined physical and chemical control measures as outlined for *F. japonica*. It is essential to monitor any re-emergence of this species and to survey the surrounding area for any unrecorded plants.

8. *Hippophae rhamnoides* L.

Irish Name: Draighean mara

English Name: Sea-buckthorn

Family: Elaeagnaceae

Description: Deciduous, dense bushy shrub up to 5m high, but can reach 10m high. Branches usually armed with stout spines. Flower in spring Webb *et al.* (1996); Devlin, (2014).



Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: Europe, Asia

Introduced: Czech Republic; Estonia; Ireland; Latvia; Lithuania

Climate where introduced: Temperate

Source: DAISIE (2018)

Additional information:

Two individual plants of *H. rhamnoides* with a combined area of 26m² were recorded during the survey of the cliffs of Howth. A mixed hedge of *H. rhamnoides* and *Libertia formosa* was also recorded but is not included in this figure.

Invasive status:

Invasive category: Invasive. Considered established in natural and semi-natural habitats.

Risk Category: **Medium**

Impact score: 14

Source: O'Flynn *et al.* (2014); O'Rourke & Lysaght (2014); Kelly *et al.* (2013); Stoke *et al.* (2006); DAISIE (2018)

Impact of invasive species:

H. rhamnoides spreads by suckering and forms dense thickets that can pose a threat to native vegetation of sand dunes and can shade out native plants (O'Rourke & Lysaght, 2014). The risk assessment of this species in Ireland stated that without an increase in the current management campaigns, *H. rhamnoides* will continue to impact upon conservation status of protected or important sites where it occurs (O'Rourke & Lysaght, 2014).

Control and management:

Dublin City Council are making continual efforts to control *H. rhamnoides* at North Bull Island, Dublin (O'Rourke & Lysaght, 2014; Rooney *et al.*, 2009).

Combined physical and control:

Physical removal, cutting, or digging up of well-established plants either by hand or mechanical is considered feasible followed by herbicide applied to the remaining stumps (O'Rourke & Lysaght, 2014).

Recommendations:

Combined control as outlined for *H. rhamnoides* above to remove the recorded individuals and mixed hedge, followed by replanting of native species is recommended.

9. *Leycesteria formosa* Wallich in Roxb.

Irish Name: Féithleann álainn

English Name: Himalayan Honeysuckle

Family: Caprifoliaceae

Description: Upright, thicket forming shrub, somewhat herbaceous with erect branches (bamboo-like blue-green first year shoots). Flowers summer to early autumn. Height and width 2m Brickell (1996).



Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: Himalayas, Indian sub-continent, W China

Introduced: Australia, Azores, Channel Islands; Great Britain; Ireland; Italy; New Zealand Northern Ireland; United States

Climate where introduced: Temperate

Source: DAISIE (2018); Roskov *et al.* (2018)

Invasive status:

Invasive category: Alien/established. Considered established in natural and semi-natural habitats

Risk Category: **Medium**

Impact score: 14

Source: O'Flynn *et al.* (2014); Kelly *et al.* (2013); Stoke *et al.* (2006); NBDC (2018); DAISIE (2018).

Additional information:

An individual plant of *L. formosa* was recorded during the survey with an area of 1m² (Map 11).

Impact of invasive species:

L. formosa is highly competitive and can colonise disturbed areas rapidly forming dense impenetrable thickets that exclude other plants (DPIPWE, 2018).

Control and management:

Control of this species along corridors, creation of buffers around affected areas and eradication of outliers is thought to be feasible although foliar application of herbicide carries risks of non-target damage due to the tall habit of the plant (DPIPWE, 2018).

Following a desktop study, no control method was found other than that described above.

Recommendations:

As only one plant of *L. formosa* was recorded, this individual should be manually removed with follow-up monitoring to determine if other plants are observed. As only one individual was recorded, the prospect of eradication of *L. formosa* from this location is good, however, it is essential to monitor the location for signs of regrowth, or recording of other individuals.

In the event of many individuals being observed, and where manual removal is not feasible, then a trial using combined control using the methods outlined for *Berberis x darwinii* using of 5% picloram potassium salt herbicide (Ward & Henzell, 2004); the methods outlined for *Gaultheria shallon* using glyphosate (Willoughby *et al.*, 2018) or the methods used for *Buddleja davidii* using glyphosate (Tallent-Halsell & Watt, 2009; GIDS, 2018).

10. *Rosa rugosa* Thunb. ex Murray

Irish Name: Rós rúscach

English Name: Japanese Rose

Family: Rosaceae

Description: Erect hairy shrub, 0.5-1.5m high. Stems stout with straight prickles of various sizes, not expanded at the base and underlying fine hairs. Forms dense thickets (NBG, 2017; Brickell, 1996).

Status: Neophyte, alien introduced after 1500

Origin:

Region of origin: Temperate Asia



Introduced: Austria; Belgium; Bulgaria; Channel Islands; Czech Republic; Denmark; Estonia; European part of Russia; Finland; France; Germany; Great Britain; Hungary; Ireland; Italy; Latvia; Lithuania; Netherlands; Northern Ireland; Norway; Poland; Sweden; Switzerland; Ukraine

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established.

Risk Category: **Medium**

Impact score: 14

Source: NBDC (2018); DAISIE (2018); Kelly *et al.* (2013)

Additional information:

One plant of *R. rugosa* was recorded during the survey with an estimated area of 1m² (Map 12).

Impact of invasive species:

Considered established in mainly artificial habitats (Stoke *et al.*, 2006). Dune plant communities are altered to monospecific stands once invaded by *R. rugosa*, resulting in greatly reduced light availability and decreased number of native species (DAISIE, 2018).

Control and management:

Physical control:

For small populations, manual removal by hand grubbing is considered effective, but roots and rhizomes must be removed as far as possible to prevent recolonization (DAISIE, 2018).

Chemical control:

Manual control can be combined with herbicide application (e.g. glyphosate). For small areas a paintbrush can be used, for large areas hand carried or tractor driven devices are needed (DAISIE, 2018).

Biological control:

No biological control methods have been described yet (DAISIE, 2018).

Recommendations:

The single plant recorded should be manually removed and the area monitored for other individuals of *R. rugosa*.

11. *Crocoshmia × crocosmiiflora* (Lemoine ex

Burb. & Dean) N.E. Br.

Irish Name: Feileastram dearg

English Name: Montbretia

Family: Iridaceae

Description: Robust, sometimes invasive, variable cormous perennial. Stems simple, up to 1 m in height. Flowers in summer. Hybrid origin (NBSG, 2017; Brickell, 1996; Webb *et al.*, 1996).

Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: Hybrid.

Introduced: Azores; Channel Islands; France; Great Britain; Ireland; Madeira; Northern Ireland; Portugal

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established.

Risk Category: **Low**

Impact score: 10

Source: Stoke *et al.* (2006); DAISIE (2018); NNSS (2018); ISI (2013)

Additional information:

C. x crocosmiiflora was on the Invasive Species Ireland Amber-recorded list, with an impact score of 10. This ISI assessment generated prioritised lists of established and potential invasive species in Ireland and Northern Ireland.

C. x crocosmiiflora is considered mildly invasive in west Britain and more widespread in Ireland and is considered an 'environmental weed' in New Zealand (NNSS, 2018).

Four small individual clumps of *C. x crocosmiiflora* were record (c. 1 – 2 m²) and one large clump (100m²) during this survey. An additional large patch was also recorded growing intermingled with *Libertia formosa* on the cliffs covering an estimated area of 900m² (Map 13).

Impact of invasive species:

This species is considered to have an adverse impact on landscape quality and native biodiversity (NRA, 2010).

Control and management:

Physical control:

Physical control of *C. x crocosmiiflora* is difficult as the corms can break easily from their chains and can result in re-infestation or further spread (NRA, 2010). For limited areas, the entire stand can be evacuated and buried at a depth of at least 2m, incinerated or disposed of at a licensed landfill (NRA, 2010). Composting is not recommended as the corms are very hardy (NRA, 2010). Evacuation can be



carried out any time of the year once the soil is suitable dry (NRA, 2010). Regular follow up is required over a two year period to control any regrowth or missed corms (NRA, 2010).

Chemical control:

Control can be achieved for *C. x crocosmiiflora* using glyphosate or metsulfuron, as used by the National Roads Authority in Ireland. Both chemicals can be applied during active growth in late spring or summer using foliar spray, wiper applicator or spot treatment (NRA, 2010).

Recommendations:

A combination of physical and chemical control is recommended for *C. x crocosmiiflora*. Careful removal of individuals will reduce the spread of this species, but would need to be regularly followed up to remove any re-growth. For the large patches where it occurs alone or mixed with *L. formosa*, chemical treatment may be most effective. The patch that is intermingled with *L. formosa* occurs on a cliff where evacuation would not be recommended. This is a difficult species to eradicate, but management of the species should deter its spread in this location.

12. *Fuchsia magellanica* Lam.

Synonym: *Fuchsia magellanica* var. *gracilis* (Lindl.) Bailey

Irish Name: Fiúise

English Name: Fuchsia

Family: Onagraceae

Description: Summer flowering bush shrub with yellowish bark. Height 3m, width 2 - 3m (NBG, 2017; Brickell, 1996; Webb *et al.*, 1996)

Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: Argentina, Chile

Introduced: Azores; Channel Islands; France; Great Britain; Ireland; Madeira; Northern Ireland; Portugal

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Considered established in natural and semi-natural habitats.

Risk Category: **Low**

Impact score: 12

Source: Kelly *et al.* 2013; Stoke *et al.* (2006)

Additional information:

During this survey, four individual plants of *F. magellanica* were recorded along with an additional two plants of light pink flowered *F. magellanica* var. *gracilis* (which is, in fact, synonymous with *F. magellanica*).



F. magellanica was also recorded in a mixed hedge, most likely on private land, occurring with *Veronica x franciscana*, *Euonymus fortunei*, *Berberis stenophylla*, *Olearia* sp and *Griselinia littoralis*; all alien species..

Impact of invasive species: Impacts are uncertain (Kelly *et al.*, 2013).

Control and management:

There is no management strategy for this species in Ireland. No control method was found during a desktop study. If the control or eradication of this species is required in the future, then combined physical and chemical control methods could be trialled following the methods used for *Berberis x darwinnii* using 5% picloram potassium salt herbicide (Ward & Henzell, 2004). Removal of flowers before fruit develop may reduce spread of this species

Recommendations:

As the impacts from *F. magellanica* are uncertain, it is recommended to leave this species *in situ*, but to monitor it for future invasiveness.

13. *Gaultheria shallon* Pursh

Irish Name: Caor na n-éan
English Name: Shallon
Family: Ericaceae

Description: Compact bushy shrub, spreading vigorously by suckers, with red shoots. Flowers late spring, early summer. Stems can grow upright and reach up to 2.5m in full sun, or have a creeping habit in lower light conditions. Plants can have multiple rhizomes and an extensive fine root system (NBG, 2017; Brickell. 1996; Willoughby *et al.*, 2018).



Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: North America
Introduced: Channel Islands, France, Great Britain. Ireland, Northern Ireland
Climate where introduced: Temperate
Source: NNSS (2018); DAISIE (2018)

Invasive status:

Invasive category: Alien/established in Ireland
Risk Category: **Low**
Impact score: 10
Source: NBDC (2018); DAISIE (2018)

Additional information:

Two large clumps of *G. shallon* were recorded during the survey at Howth with an estimated area of 920m² (Map 14).

Impact of invasive species:

G. shallon is spreading rapidly in the United Kingdom and can form impenetrable thickets that can outcompete native species and alter habitat dynamics (NNS, 2018). *G. shallon* can contribute to major habitat loss in a short period of time (NNS, 2018).

Control and management:

Non-chemical management is only considered to be practical on a small scale (Willoughby *et al.*, 2018).

Chemical control:

A recent study by Willoughby *et al.* (2018) on herbicide control of this species had positive results, however; the two herbicides that were most effective in that study have since been removed from the market.

Glyphosate treatment was effective with a kill rate of 85% in the Willoughby *et al.* (2018) study when used as follows: 3.6 kg a.i. ha⁻¹ glyphosate (as 10 l ha⁻¹ Roundup ProBio (360 g l⁻¹ glyphosate; Monsanto 2013) diluted in water plus Mixture B NF at 2% of final spray volume, applied initially when flower buds are swelling or flushed, but vegetative buds are largely dormant (late April in southern Britain), with a repeat application made 4–8 weeks later, followed by a repeat of this treatment the following year (i.e. four sprays in total), can give reasonably good control (85% kill).

Recommendations:

It is recommended to carry out control of *G. shallon* following the chemical methods outlined above.

14. *Libertia formosa* Graham

English Name: Chilean-iris

Family: Iridaceae

Description: Clump-forming, evergreen perennial rhizomatous plant which grows to about 60cm high and it blooms from late April to August. Height 90cm, width 60cm (NBG, 2017; Brickell, 1996; Devlin, 2014)

Status: Neophyte, alien introduced after 1500.

Origin

Region of origin: Chile

Introduced: Channel Islands; Great Britain; Ireland; Northern Ireland

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established. Low risk of impact. Considered established in natural and semi-natural habitats.

Risk Category: **Low**

Impact score: 8

Source: NBDC (2018); Stoke *et al.* 2006.



Additional information:

L. formosa was recorded growing mixed with *Crocoshmia x crocosmiiflora* with a combined area of 900m². Two additional clumps of *L. formosa* were observed; one clump with an area of 1m², the other covering an area of 200m² (Map 13).

Impact of invasive species:

L. formosa is considered an occasional species with a low risk of impact (NBDC, 2018). Impact from this species in Ireland is unknown.

Control and management:

No control method was found following a desktop study. Control using the methods employed by the National Roads Authority (2010) for *Crocoshmia x crocosmiiflora* using glyphosate or metsulfuron could be trialled on *L. formosa*.

Recommendations:

L. formosa is currently considered a species with low risk of impact in Ireland. This status should continue to be monitored in Howth. As *L. formosa* occurs intermingled with *C. x crocosmiiflora*, it will, by default, be included in the recommended control for *C. x crocosmiiflora*, i.e. using glyphosate or metsulfuron, as used by the National Roads Authority (2010).

It is further recommended that for the two clumps of *L. formosa* recorded, that they be monitored and that no control measures be implemented at present. If, in future, the species is considered to be spreading and impacting the habitat, then combined physical and chemical control can be implemented as above. The advantage of this, is that the efficacy of the glyphosate or metsulfuron control will be known based on the outcome of control of the mixed patch of *L. formosa* and *C. x crocosmiiflora*.

15. *Malva neglecta* Wallr.

Irish Name: Hocas francach

English Name: Dwarf Mallow

Family: Malvaceae

Description: Small herb, usually annual. Stems up to 50cm, more or less prostrate, downy. (NBG, 2017; Brickel, 1996; Webb *et al.*, 1996).

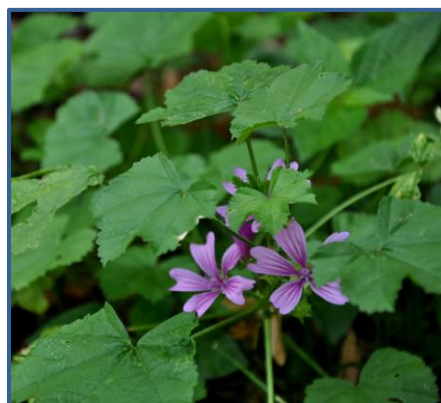
Status: Archaeophyte, alien introduced before 1500

Origin:

Region of origin: Europe, Asia temperate, North Africa

Introduced: Bulgaria; Channel Islands; Czech Republic; Denmark; Finland; Germany; Great Britain; Ireland; Liechtenstein; Northern Ireland; Norway; Sweden; Ukraine (DAISIE, 2018)

Climate where introduced: Temperate



Invasive status:

Invasive category: Alien/established. Unlikely to impact goals of legislation

Risk Category: **Low**

Impact score: 5

Source: Kelly *et al.* (2013); NBDC (2018); DAISIE (2018)

Additional information:

Only one individual was observed during the survey with an area of 0.25m².

Impact of invasive species:

Unlikely to impact goals of legislation in Ireland (NBDC, 2018).

Control and management:

No control required.

16. *Phormium tenax* J.R. & G. Forst.

English Name: New Zealand Flax

Family: Agavaceae

Description:

Habitat: Robust, shorty rhizomatous perennial (NBG. 2017; Webb *et al.*, 1996).

Status: Neophyte, alien introduced after 1500

Origin:

Region of origin: New Zealand

Regions where introduced: Azores; Canary Islands; Channel Islands; Great Britain; Ireland; Northern Ireland; Spain

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established in Ireland

Risk Category: **Low**

Impact score: 11

Source: NBDC (2018); DAISIE (2018).

Additional information:

Three mature *P. tenax* plants were recorded on the land side of the track with a combined area of 36m². A single seedling was recorded on the sea side of the track with an area of 1m².

Impact of invasive species:

P. tenax is considered to have a low risk of impact in Ireland (NBDC, 2018).



Control and management:

If *P. tenax* is considered to be spreading, manual removal could be carried out in conjunction with chemical control, where necessary. Tunison & Zimmer (1992) found 2% roundup on foliage and also on sprouts from roots of *P. tenax* resulted in eradication of this species from the Hawaii Volcanoes National Park. The localised alien plant eradication program was carried out to prevent the spread of potentially disruptive species while the populations were still manageable (Tunison & Zimmer, 1992).

Recommendations:

Although *P. tenax* is currently considered to have a low risk of impact in Ireland, it may be prudent to remove the seedling that occurs on the sea side of the track and to monitor the spread of the clumps on the land side of the path. *P. tenax* is frequently found on private property along the cliffs at Howth.

17. *Berberis darwinii* Hook.

English Name: Darwin's Barberry

Family: Berberidaceae

Description: Vigorous upright evergreen shrub. Flowers mid and late spring. Height and width 3m (NBG, 2017; Webb *et al.*, 1996).

Status: Neophyte, alien introduced after 1500.



Origin:

Region of origin: Chile, Argentina

Regions where introduced: Australia, Falkland Islands, Ireland, New Zealand, United States

Climate where introduced: Temperate

Source: GISD (2018)

Invasive status:

Invasive category: Alien/established.

Risk Category: **Not assessed**

Impact score: na

Source: DAISIE (2018); NBDC (2018).

Additional information:

One small individual plant was recorded on the track leading down to Doldrum Bay Sea, Howth during this survey. A risk assessment of *B. darwinii* was conducted on the Falkland Islands in 2008 that indicated this species was invasive in that location (GISD, 2018).

Impact of invasive species: Unknown

Control and management:

There is no control strategy implemented in Ireland at present. Several management techniques were trialled in New Zealand, which included a combination of physical and chemical methods (Ward & Henzell, 2004).

Physical control:

Removal of fruiting plants and seedling control is recommended (McAlpine & Jesson, 2008). As reported by Ward & Henzell (2004), a Cut-Stem treatment on saplings proved very effective. This involved cutting of all sapling stems coupled with an application of herbicide. That report noted that a Wedge-Method and a Trunk Injection method each proved very effective when used in combination with a herbicide. The Wedge-Method involves the cutting of wedges out of the trees at constant intervals and applying herbicide within each wedge; whilst the Trunk-Injection technique involves the drilling of holes into the main tree trunks and injecting herbicide within each hole (Ward & Henzell, 2004). The Cut-Stem and Wedge-Method resulted in a 100% kill rate, whereas the Trunk Injection had an 80-90% kill rate (Ward & Henzell, 2004). These trials were carried out in New Zealand.

Chemical control:

The trials carried out by Ward & Henzell (2004) found that a mixture of 5% picloram potassium salt herbicide (New Zealand brand name *Vigilant*) was most effective when combined with the physical control outlined above.

Recommendations:

Manual removal of the single individual *B. darwinii*, and continued monitoring of establishment of any new plants is recommended.

18. *Berberis × stenophylla* Lindl. (*Berberis darwinii* x *empetrifolia*)

English Name: Hedge Barberry

Family: Berberidaceae

Description: Vigorous evergreen shrub with long arching branches. Flowers in late spring. Height 3m, width 5m (NBG, 2017; Brickell, 1996; Webb *et al.*, 1996).

Status: Neophyte, alien introduced after 1500.



Origin:

Region of origin: Hybrid

Introduced: Ireland, United Kingdom

Climate where introduced: Temperate

Source: Roskov *et al.* (2018)

Invasive status:

Invasive category: Alien/established

Risk Category: **Not assessed**

Impact score: na

Source: DAISIE (2018)

Additional information:

Two separate hedges of *B. stenophylla* were recorded on the seas side of the track with a combined area of 90m². *B. x stenophylla* also forms part of two mixed hedges on the land side of the track, most likely on private land, which not included in this figure.

Impact of invasive species: Unknown

Control and management:

The combined physical and chemical control outlined for *Berberis darwinii* would be expected to be suitable for *B. x stenophylla*, as the trials carried out by Ward & Henzell (2004) using 5% picloram potassium salt herbicide were aimed at assessing the use of herbicide gels on woody vines and shrubs.

Removal of fruiting plants and seedling control was recommended for *B. darwinii* (McAlpine & Jesson, 2008). This management would apply to *B. x stenophylla* also.

Recommendations:

For hedges of *B. x stenophylla* that occur on the sea side of the track, a management program for removal of fruiting plants and replanting with pollinator-friendly native species is recommended. *B. x stenophylla* that was recorded within mixed hedges on the land side of the track on private land. Management of the hedges by land owners is recommended, i.e trimming before fruit develop.

19. *Carex pendula* Hudson

Irish Name: Cíb chrom
English Name: Pendulous Sedge
Family: Cyperaceae

Description: Tufted evergreen perennial forming dense clumps. Flowers late spring to early autumn. Height and width 1.5m (NBG, 2017; Brickell, 1996; Webb *et al.*, 1996)



Status: Native

Origin:

Region of origin: European south temperate element
Climate where introduced: Temperate
Source: Online Altas of British and Irish Flora (2018)

Invasive status:

Invasive category: Native vigorous
Risk Category: **Not assessed**
Impact score: NA

Additional information:

Six individual *C. pendula* plants were recorded during the survey, with a combined area of 10m².

In the United States, there is limited evidence of impacts caused by *C. pendula* (USDA, 2013). *C. pendula* is listed as a prohibited species in New Zealand as it can displace a wide range of native species (NPPA, 2012). *C. pendula* is also on the “watch list” for British Columbia (USDA, 2013).

Impact of invasive species:

C. pendula is a vigorous species native to Ireland.

Control and management:

Physical control:

On a small scale plants can be dug out by hand. In larger areas improving drainage by installing land drains will discourage the sedge, as will liming to reduce acidity (RHS, 2018). Plants should be cut regularly to prevent seeding (RHS, 2018).

Chemical control:

Carex sp. are resistant to selective lawn herbicide (RHS, 2018). Individual plants can be spot-treated with a ready-to-use spray. Glyphosate, which is a non-selective systemic weedkiller, can be applied to the foliage (RHS, 2018).

Recommendations:

Manual removal of the five individual *C. pendula* plants. Continued monitoring of reemergence of this species at these locations.

20. *Cordyline australis* (G. Forst.) Endl.

English Name: Cabbage-palm

Family: Agavaceae

Description: Erect palm-like tree, branching sparingly with age. Flowers borne in summer. Height 3-10m, width 1-4m (NBG, 2017; Brickell, 1996).

Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: New Zealand

Regions where introduced: Channel Islands, Croatia, Great Britain, France, Ireland

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established in Ireland

Risk Category: **Not assessed**

Impact score: NA

Source: DAISIE (2018)

Additional information:

Two *C. australis* plants were recorded during the survey.



Impact of invasive species: Unknown

Control and management:

Manual removal of *C. australis* can be carried out by cutting down or digging out the plants.

If however, this species is observed to be spreading, then combined control using 5% picloram potassium salt herbicide may be effective. This method has been trialled by Ward & Henzell (2004) to assess the use of herbicide gels on wood vines and shrubs.

Recommendations

As there were only two plants recorded, it would be recommended to either physically remove the plants, or if they are left *in situ*, it would be recommended that flower heads be removed before fruit develop.

21. *Echium pininana* Webb & Berthel.

English Name: Giant Viper's-bugloss

Family: Boraginaceae

Description: Rosette forming biennial flowering in mid to late summer. Height 4m, width 90cm (NBS, 2017; Brickell, 1996).

Status: Neophyte, alien introduced after 1500.

Origin:

Region of origin: Canary Islands

Introduced: Channel Islands, Great Britain, Ireland

Climate where introduced: Temperate

Source: DAISIE (2018)



Invasive status:

Invasive category: Alien/established in Ireland. Considered an occasional species in Ireland.

Risk Category: Not assessed

Impact score: NA

Source: DAISIE (2018); NBDC (2018)

Additional information:

Four individual *E. pininana* plants were recorded in the survey with an area of 1m² each. An additional large stand of *E. pininana* covering an area of c. 30m² was recorded at a garden waste dump site. Its presence in this location is considered to be due to indiscriminate dumping of garden waste.

This species is listed on the IUCN red list of threatened species due to its restricted distribution range; this species is endemic to the island La Palma in the Canary Islands (Santos & Reyes Betancort, 2013) (Map 15).

Impact of invasive species: - unknown

Control and management:

No control method was found. Chemical control using glyphosate or metsulfuron as outlined for *Crocsmia x crocosmiiflora* and *Allium triquetrum* may be effective on the foliage. The control for *Carpobrotus edulis* using 3 g/l glyphosate and 0.3g/l diquat could also be trialled on this species.

Recommendations:

Removal of flower heads before they go to seed is recommended to reduce the spread of seed. It is likely that many seedlings of this species will emerge in this location. Removal of the recorded plants and follow-up manual removal or chemical treatment of seedlings should help control the spread of this species. However, this will only be effective with continued management.

***22. Euphorbia characias subsp. wulfenii* (Hoppe ex W.D.J.Koch) Radcl.-Sm.**

Family: Euphorbiaceae

Description: Upright evergreen shrub with biennial shoots and clumps of erect woolly purple-tinged stems. Flowers early spring to early summer. Height and width 1 - 1.2m (The Plant List, 2013; Roskov *et al.*, 2018; Brickell, 1996).



Status: Alien

Origin:

Region of origin: SE Europe

Additional information:

One small clump of seedlings was observed on the land side of the track during the survey.

Invasive status:

Invasive category: **Not assessed**

Risk Category: **Not assessed**

Impact score: NA

Source: NA

Additional information:

A clump of seedlings observed at Howth in only one location.

Impact of invasive species: Unknown

Control and management:

No control method was found. Manual removal of this species would be effective in this location.

Recommendations:

As so few seedlings of *E. characias* subsp. *wulfenii* were observed, it is recommended to manually remove these seedlings and monitor any seedlings that may emerge.

23. *Veronica × franciscana* (Eastw.) J.T.Howell, P.H.Raven & P.Rubtzov

Synonym: *Hebe x franciscana* (Eastw.) Souster
Family: Scrophulariaceae
Description: Dense, rounded, evergreen shrub. Flowers summer to autumn. Height and width 60-120cm (however, plant were much larger on the cliffs at Howth, Co. Dublin (NBG, 2017; Brickell, 1996).



Status: Neophyte, alien introduced after 1500

Origin:

Region of origin: Hybrid
Introduced: Channel Islands, Great Britain, Ireland, Northern Ireland
Climate where introduced: Temperate
Source: DAISIE (2018)

Invasive status:

Invasive category: Considered established in natural and semi-natural habitats
Risk Category: **Not assessed**
Impact score: NA
Source: Stoke *et al.* (2006); DAISIE (2018)

Additional information:

Twenty-four individual clumps of *V. x franciscana* plus ten hedges were recorded during the survey of the cliffs of Howth with a combined area of 7,014m² (clumps may contain one to numerous plants) (see map 7). The individual clumps ranged in area from 1m² to 1,500m². In addition, *V. x franciscana* also occurred within a three different mixed hedges comprising numerous alien species (Map 16).

Impact of invasive species: Unknown

Control and management:

There is no management plan in place in Ireland for *V. x franciscana* and no information on control was found.

A combination of physical and chemical control could be employed to deal with this species in Howth. A trial could be carried out using the methods outlined for *Berberis x darwinii* using of 5% picloram potassium salt herbicide (Ward & Henzell, 2004); the methods outlined for *Gaultheria shallon* using glyphosate (Willoughby *et al.* ,2018) or the methods used for *Buddleja davidii* using glyphosate (Tallent-Halsell & Watt, 2009; GIDS, 2018).

Recommendations:

There are very large areas with *V. x franciscana* along the track and cliffs in the location surveyed (see Map 7). Two of the hedges where this species occurs with other alien species are most likely on private land. This species needs to be tackled immediately. It is recommended that a control program be implemented using combined physical and chemical control as outlined above. Effective treatment should result in control of this species in the locations recorded. Total eradication of *V. x franciscana* from this site is unlikely due to the amount of hedges with this species that occur on private land.

24. *Kniphofia uvaria* (L.) Oken

English Name: Red-hot-poker

Family: Liliaceae

Description:

Habitat: Evergreen perennial. Flowers in autumn. Height 1.2m, width, 60cm (NBG; 2017, Brickell, 1996).

Status: Alien

Origin:

Region of origin: Southern Africa

Introduced: Channel Islands; Great Britain; Ireland; Madeira; Turkey (in Europe)

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established in Ireland

Risk Category: **Not assessed**

Impact score: NA

Source: NBDC (2018); DAISIE (2018)

Additional information:

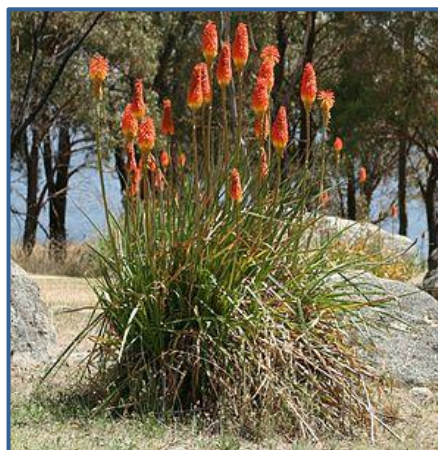
K. uvaria was recorded in two locations during the survey. One location had a 5m² clump. The other location had *K. uvaria* scattered through an area of 900m² (Map 17).

Impact of invasive species:

No impacts have been recorded to date in Ireland. In Australia, *K. uvaria* is considered an environmental weed and has spread into natural areas where it forms thick clumps of vegetation and threatens sensitive ecosystems (Cal-IPC, 2016).

Control and management:

No control method was found. Control using the methods employed by the National Roads Authority (2010) for *Crocsmia x crocmiiflora* using glyphosate or metsulfuron could be trialled on *K. uvaria*.



Recommendations:

It is recommended that combined physical and chemical control be carried out in line with those used by the NRA (2010) to control *Crocsmia x crocmiflora* using glyphosate or metsulfuron. As *K. uvaria* was only recorded in two locations, targeted management should control the spread of this species.

25. *Olearia macrodonta* Baker

English Name: New Zealand Holly

Family: Asteraceae

Source: NBG (2017)

Description: Vigorous upright shrub or small tree with hairy branches. Height 6m, width 5m (NBS, 2017; Brickell, 1996; Webb *et al*, 1996).

Status: Neophyte, alien introduced after 1500

Origin:

Region of origin: New Zealand

Introduced: Channel Islands, Great Britain, Ireland, Northern Ireland

Climate where introduced: Temperate

Source: DAISIE (2018)

Invasive status:

Invasive category: Alien/established in Ireland. Biodiveristy Ireland and DAISIE

Risk Category: **Not assessed**

Impact score: NA

Source: DAISIE (2018); NBDC (2018)

Additional information:

Three individual clumps of *O. macrodonta* were recorded during the survey with a combined area of 49m². This species was also recorded within a mixed hedge on the land side of the track with *Salix* sp. and *Veronica x franciscana*.

Impact of invasive species: Unknown

Control and management:

No control was found following a desktop study. Combined control measures could be trialled following Willoughby *et al.* (2018) as used for *Gaultheria shallon*; or Tallent-Halsell & Watt (2009) as used *Buddleja davidii*; or Ward & Henzell (2004) as used for *Berberis darwinii*.

Recommendations:

No control required at present. If, however, in the future, this species is considered to be spreading or impacting the habitat, then combined control measures could be trialled as outlined above.



26. *Olearia nummulariifolia* (Hook.f.) Hook.f.

Family: Asteraceae
Source: The Plant List (2013)
Description: Dense, rounded, slow-growing shrub with stout, upright shoots. Summer flowering. Height and width 2m (NBG, 2017; Brickell, 1996).

Status: Alien

Origin:

Region of origin: New Zealand
Introduced: Ireland
Climate where introduced: No information

Invasive status:

Invasive category: Alien
Risk Category: **Not assessed**
Impact score: NA
Source: NA

Additional information:

A single plant of *O. nummulariifolia* was recorded during this survey with an estimated area of 35m².

Impact of invasive species: Unknown

Control and management:

No control was found following a desktop study. If this species begins to spread or negatively impact the habitat, combined control measures could be trialled following Willoughby *et al.* (2018) as used for *Gaultheria shallon*; or Tallent-Halsell & Watt (2009) as used *Buddleja davidii*; or Ward & Henzell (2004) as used for *Berberis darwinii*.

Recommendations:

None required at present.



27. *Olearia paniculata* Druce

English Name: Akiraho
Family: Asteraceae
Description: Small tree with reddish twigs that are grooved on upper surface and angular in cross-section (The Plant List, 2013; New Zealand Plant Conservation Network (2018).

Status: Alien

Origin:

Region of origin: New Zealand



Introduced: Channel Islands, Great Britain; Ireland.

Climate where introduced: Temperate

Source: DAISIE (2018); NBDC (2018)

Additional information:

One large stand of *O. paniculata* was recorded during the survey with an area of 400m². An additional three individual plants were recorded with a combined area of 140m².

Invasive status:

Invasive category: Alien

Risk Category: **Not assessed**

Impact score: NA

Source: NBDC (2018)

Impact of invasive species: Unknown

Control and management:

No control was found following a desktop study. Combined control measures could be trialled following Willoughby *et al.* (2018) as used for *Gaultheria shallon*; or Tallent-Halsell & Watt (2009) as used *Buddleja davidii*; or Ward & Henzell (2004) as used for *Berberis darwinii*.

Recommendations:

None required at present.

28. *Olearia traversii* (F. Muell.) J.D. Hook.

English Name: Ake-ake

Family: Asteraceae

Description Dense upright shrub sometimes a small tree with stout angled shoots. Early summer flowering. Height 5-10m width 3-5m (NBG, 2017; Brickell, 1996).

Status: Neophyte, alien introduced after 1500

Origin:

Region of origin: New Zealand

Regions where introduced: Channel Islands, Great Britain, Ireland

Climate where introduced: Temperate

Source: DAISIE (2018)

Additional information:

A large clump of *O. traversii* was recorded on the land side of the track during the survey with an area of 90m².

Invasive status:

Invasive category: Alien/not established in Ireland (DAISIE, 2018).

Risk Category: **Not assessed**

Impact score: NA



Impact of invasive species: considered an occasional species in Ireland (NBDC, 2018)

Control and management:

No control was found following a desktop study. *O. traversii* is not considered established in Ireland. However, if this species becomes problematic in Howth, combined control measures could be trialled following Willoughby *et al.* (2018) as used for *Gaultheria shallon*; or Tallent-Halsell & Watt (2009) as used *Buddleja davidii*; or Ward & Henzell (2004) as used for *Berberis darwinii*.

Recommendations:

None required at present.

29. *Oxalis articulata* Savigny

Irish Name: Seamsóg ghlúineach

English Name: Pink-sorrel

Family: Oxalidaceae

Source: NBG (2017)

Description: Tufted, hairy perennial. More or less upright. Flowers from May to September (NBS, 2017; Webb *et al.*, 1996; Devlin, 2014)

Status: Neophyte, alien introduced after 1500



Origin:

Region of origin: Southern America

Regions where introduced: Azores; Balears; Channel Islands; Corsica; Croatia; France; Great Britain; Greece; Ireland; Italy; Northern Ireland; Portugal; Sardinia; Sicilia; Slovenia; Spain; Turkey (in Europe)

Climate where introduced: Temperate

Source: DAISIE (2108)

Additional information:

Two plants of *O. articulata* were recorded during the survey with a combined area of 2m².

Invasive status:

Invasive category: Alien/established in Ireland. Biodiversity Ireland and DAISIE

Risk Category: **Not assessed**

Impact score: NA

Source: NBDC (2018); DAISIE (2018)

Impact of invasive species:

There is no recorded impact from this species in Ireland. A paper on *Oxalis* species in the British Isles noted that *O. articulata* naturalised in waste ground, roadsides, and seashores, only becoming established near the coast and was rarely considered to become a weed (Young, 1958).

Control and management:

None required at present.

Control and management:

No control was found following a desktop study. If in the future, *O. articulata* is considered to be spreading, it could be controlled by manual excavation, or in line with controls outlined for *Allium triquetrum* (HerbGuide, 2014).

Recommendations:

None required at present.

OTHER:

The three species listed below were only recorded within dump sites. Their impact risk category is unknown. The immediate removal of all waste material in these dump sites will ensure that these species do not occur elsewhere along the cliffs of Howth

30. *Sedum spectabile* Boreau

English Name: Butterfly Stonecrop
Family: Crassulaceae
Status: Neophyte, alien introduced after 1500
Origin: China, Eastern Asia



31. *Dipsacus fullonum* L.

Irish Name: Leadán úcaire
English Name: Wild Teasel
Family: Dipsacaceae
Status: **Native or alien (native status doubtful)**



32. *Fascicularia bicolor* (Ruíz & Pav.) Mez

Synonym: *Fascicularia pitcarniifolia* (Verlot) Mez
English Name: Rhodostachys
Family: Bromeliaceae
Status: Neophyte, alien introduced after 1500.
Origin: Chile.



Invasive status: Unknown for all three non-native species (*S. spectabile*, *D. fullonum* and *F. bicolor*).

Control and management:

Removal of all material in garden waste dump sites is essential.

Recommendations:

S. spectabile, *D. fullonum* and *F. bicolor* were all recorded in garden waste dump sites. The presence of these species is due to indiscriminate dumping of garden waste. The immediate removal of all garden waste from these dump sites is essential along with follow-up monitoring to ensure that these species are eradicated.

4. CONTROL METHODS

As part of the desktop study, three types of control measure were considered: *physical*; *chemical*; *biological control*. Where possible, physical control, such as manual removal, should be the preferred method, with chemical control used only for large areas where physical control would not be feasible. In general, combined physical and chemical control is most effective for tackling invasive non-native species, with the aim of ultimately eradicating them over time.

Control methods were found for thirteen of the species recorded during the survey (Table 4). These control method will not necessarily be required for each of these species, as per the recommendations set out for each individual species.

The active ingredients in the chemical herbicides listed are approved by Department of Agriculture (2018).

Table 4. List of species recorded during the survey (2018) where control measures are known, including details of the active ingredient for chemical control and reference.

Species	Control method	Active ingredient for chemical control	Reference
<i>Carpobrotus edulis</i>	Chemical	Glyphosate and Diquat	Smyth <i>et al.</i> , 2013
<i>Crassula helmsii</i>	Physical	NA	Millane & Caffrey, 2014
<i>Fallopia japonica</i>	Chemical	Glyphosate or 2 4-D	NRA, 2010
<i>Allium triquetrum</i>	Combined	Glyphosate or Metsulfurone	HerbGuide, 2014
<i>Buddleja davidii</i>	Combined	Glyphosate	Tallent-Halsell & Watt, 2009
<i>Cotoneaster horizontalis</i>	Combined	Glyphosate	Boer, 2014
<i>Hippophae rhamnoides</i>	Combined	Glyphosate	Rooney <i>et al.</i> , 2009; O'Rourke & Lysaght, 2014
<i>Rosa rugosa</i>	Combined	Glyphosate	DAISIE, 2018
<i>Crocsmia x crocosmiiflora</i>	Combined	Glyphosate or Metsulfurone	NRA, 2010
<i>Gaultheria shallon</i>	Combined	Glyphosate	Willoughby <i>et al.</i> , 2018
<i>Phormium tenax</i>	Combined	Glyphosate	Tunison & Zimmer, 1992
<i>Berberis darwinii</i>	Combined	Picloram	Ward & Henzell, 2004
<i>Carex pendula</i>	Combined	Glyphosate	RHS, 2018

Set out in Table 5 is the list of species where no control was found. Included in this table are details of control measures to be taken. For species where combined control is required, details of the methods to be trialled are included. For species where no control is currently required, details of methods that

could be trialled, should the species become problematic in the future, are set out with the recommendations for each species.

Table 5. List of species recorded during the survey (2018) where control measures are unknown, including details of the active ingredient for chemical control and reference.

Species	Control required	Control to be trialled	Active ingredient	Reference
<i>Fallopia baldschuanica</i>	Yes	Combined	Glyphosate or 2 4-D	NRA, 2010
<i>Leycesteria formosa</i>	Yes	Physical	NA	NA
<i>Fuchsia magellanica</i>	No	NA	NA	NA
<i>Libertia formosa</i>	Yes	Combined	Glyphosate or Metsulfurone	NRA, 2010
<i>Malva neglecta</i>	No	NA	NA	NA
<i>Berberis x stenophylla</i>	Yes	Combined	Picloram	Ward & Henzell, 2004
<i>Cordyline australis</i>	Yes	Physical	NA	NA
<i>Echium pininana</i>	Yes	Combined	Glyphosate and Diquat; Metsulfurone	Smyth <i>et al.</i> , 2013; NRA, 2010; HerbGuide, 2014
<i>Euphorbia characias</i> subsp. <i>Wulfenii</i>	Yes	Physical	NA	NA
<i>Veronica x franciscana</i>	Yes	Combined	Glyphosate	Willoughby <i>et al.</i> , 2018; Tallent-Halsell & Watt, 2009
<i>Kniphofia uvaria</i>	Yes	Combined	Glyphosate or Metsulfurone	NRA, 2010
<i>Olearia macrodonta</i>	No	NA	NA	NA
<i>Olearia nummulariifolia</i>	No	NA	NA	NA
<i>Olearia paniculata</i>	No	NA	NA	NA
<i>Olearia traversii</i>	No	NA	NA	NA
<i>Oxalis articulata</i>	No	NA	NA	NA
<i>Sedum spectabile</i>	Yes	Physical	NA	NA
<i>Dipsacus fullonum</i>	Yes	Physical	NA	NA
<i>Fascicularia bicolor</i>	Yes	Physical	NA	NA

5. DUMPING OF GARDEN WASTE

The dumping of garden waste along the coastal cliffs of Howth over the past few decades has led to several invasive and exotic species establishing themselves in this location. The indiscriminate and careless dumping is a source of known invasive species and potentially problematic species escaping onto the coastal cliffs. Such dumping, although most likely done without knowledge or understanding of the potential threat to the surrounding environment, cannot continue.

Locations of recorded garden waste dump sites are shown in Image 4. Non-native garden escapes growing in these dump locations are shown in Image 5. With removal of all material from garden dump waste sites and cessation of dumping by landowners/landscapers, the introduction and spread of additional non-native invasive or potentially invasive species will be greatly reduced.

Garden waste dumping locations map



Image 4. Garden waste dump points on coastal cliffs of Howth (Map by Olivia Crowe)



Image 5. Garden waste dumping along coastal cliffs of Howth (Photographs © Emer Ní Dhúill)

6. RECOMMENDATIONS

It is clear from the proximity of garden waste dump sites to private properties that the main source of introduced alien species is from mismanagement of garden waste. It is imperative to get the message across to the landowners and landscapers that continued dumping of garden waste will not be tolerated. A lack of understanding as to the negative impacts on native species and ecosystems in this location is one of the main problems. A campaign, to explain the impacts of such dumping is of paramount importance. An awareness campaign, similar the *Be Plant Wise* (Biodiversity Ireland) can be tailored to deal with the issues specific to the coastal cliffs of Howth, i.e. dumping of garden waste. This would include explaining the potential negative impacts of such introductions and guidelines on

the correct disposal of garden waste material. A 'polluters pay' system is recommended for future dumping after clearance of the known dump sites has been carried out. This would most likely rely on landowners/landscapers reporting people seen dumping. The penalty for such actions would be determined by Fingal County Council and any legal issues associated with such penalties would need to be assessed by legal counsel. Unfortunately, change often only occurs where there is a monetary impact, therefore; the possibility of a penalty should act as a deterrent for future dumping.

A strategy of managing the invasive or potentially problematic species along the coastal cliffs of Howth is essential. By acting quickly to control and eradicate known invasive non-native species that are impacting the habitat; and potentially invasive species that are not yet impacting the habitat, will be both environmentally and economically beneficial. As stated by O'Flynn *et al.*, (2014) the prevention of invasive species establishment and spread is largely dependent on the promptness of response.

In many cases, combined control using physical and chemical methods should manage the spread of invasive non-native species on the cliffs of Howth, especially for the High and Medium risk species, and the large clumps of *Veronica x franciscana* and *Gaultheria shallon*.

Where possible, for species where only a few individuals were recorded, manual removal should be sufficient, with follow-up monitoring of re-emergence essential. For some species that are without a risk category, their removal is not as urgent, however, removal of flowers before fruiting and seed set would be beneficial to deterring further spread in the interim.

For the mixed hedges that occur on private land, management by the land owners is essential to ensure these species don't spread from their land. Management of any mixed hedges outside of private land would be carried out by Fingal County Council. For areas on public land where sections of hedges are to be removed, this process should be done in stages, with replanting of pollinator-friendly native species in place of the removed species. In the interim, removing of flowers before fruit and seed develop is important.

ACTIONS REQUIRED

- Commence an information campaign for landowners and landscapers on the impacts of mismanagement of garden waste.
- Encourage a collective community response to the issues relating to dumping of garden waste.
- Implement a management strategy to deal with the problematic non-native species while population sizes are still manageable.
- Prepare for urgent removal of the following species (Images 5-8 below) :
 - *Carpobrotus edulis*
 - *Crassula helmsii*
 - *Fallopia japonica*
 - *Gaultheria shallon*
 - *Veronica x franciscana*



Image 6. View of Lions Head beach, Howth with *Veronica x franciscana* and *Carpobortus edulis* on the cliffs (2018)



Image 7. *Crassula helmsii* in garden waste dump on track of coastal cliffs of Howth (2018).



Image 8. *Gaultheria shallon* on the coastal cliffs of Howth (2018)



Image 9. *Fallopia japonica* on Nuns Beach, Howth (2018)

For Howth, a localised non-native invasive species eradication program should prevent the spread of both invasive and potentially invasive species while the population sizes are still manageable. Any removal of non-native species along the cliffs, whether manually or chemically, must be carried out sensitively and with the stability of the cliffs in mind.

Continued management and follow-up monitoring for re-growth of the target species and investigation of emergence of native species is just as important as the initial control. There will be a seed bank, so re-emergence of the target non-native species is likely. Without continued management, control of the target species will be ineffective in the long-term.

It is considered that there is great potential for species to spread under the influence of a warming climate (O'Rourke & O'Flynn, 2014), therefore; tackling the issue of introductions of non-native species before it becomes problematic is of paramount importance.

If a management strategy is implemented and followed up by a long-term monitoring program of re-emergence of target species, then the control and possible eradication of the problematic non-native species is likely.

APPENDIX 1

List of species recorded during survey of coastal cliffs of Howth, including area of occupancy (m²) and number of individuals recorded.

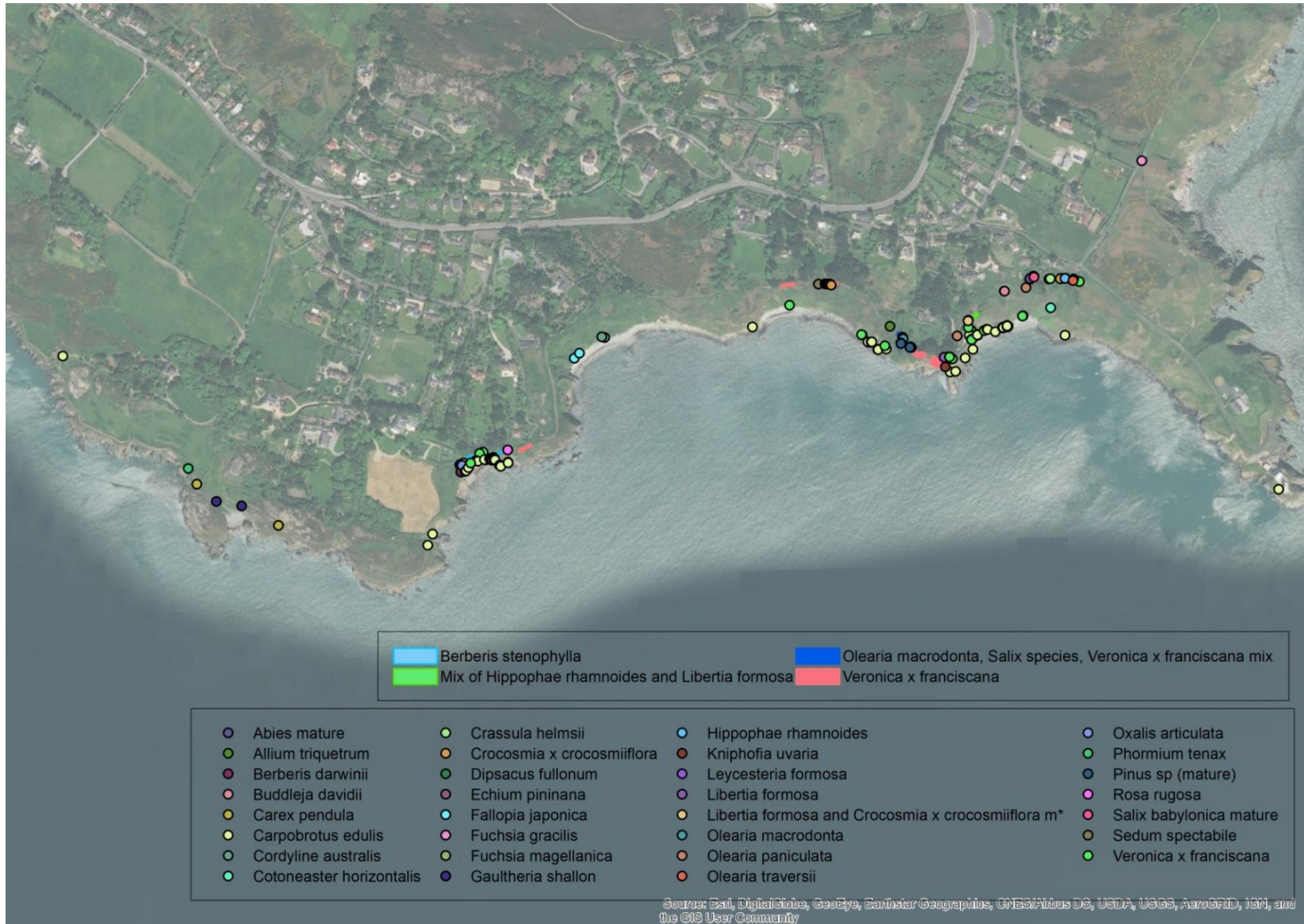
Species recorded	Area m ²	Number of individuals
<i>Allium triquetrum</i>	0.50	2
<i>Berberis darwinii</i>	1.00	1
<i>Berberis stenophylla</i>	89.62	4
<i>Buddleja davidii</i>	701.00	6
<i>Carex pendula</i>	10.00	6
<i>Carpobrotus edulis</i>	7169.25	69
<i>Cordyline australis</i>	18.00	2
<i>Cotoneaster horizontalis</i>	950.00	3
<i>Crassula helmsii</i>	0.25	1
<i>Crocsmia x crocosmiiflora</i>	109.00	5
<i>Dipsacus fullonum</i>	1.00	1
<i>Echium pininana</i>	34.00	5
<i>Euphorbia characias</i> subsp. <i>Wulfenii</i>	1.00	1
<i>Fallopia baldschuanica</i>	400.00	1
<i>Fallopia japonica</i>	930.00	2
<i>Fascicularia bicolor</i>	9.00	1
<i>Fuchsia magellanica</i>	335.00	5
<i>Gaultheria shallon</i>	920.00	2
<i>Hippophae rhamnoides</i>	26.00	2
<i>Kniphofia uvaria</i>	905.00	2
<i>Leycesteria formosa</i>	1.00	1
<i>Libertia formosa</i>	201.00	2
<i>Malva neglecta</i>	0.25	1
<i>Olearia macrodonta</i>	49.00	3
<i>Olearia nummulariifolia</i>	35.00	1
<i>Olearia paniculata</i>	540.00	4
<i>Olearia traversii</i>	90.00	1
<i>Oxalis articulata</i>	2.00	2
<i>Phormium tenax</i>	37.00	4
<i>Rosa rugosa</i>	1.00	1
<i>Sedum spectabile</i>	1.00	1
<i>Veronica x franciscana</i> (24 clumps plus 10 hedges)	7013.72	34
<i>Libertia formosa</i> and <i>Crocsmia x crocosmiiflora</i>	900.00	1
Mix of <i>Hippophae rhamnoides</i> and <i>Libertia formosa</i>	55.97	1
Hedge of <i>Euonymus fortunei</i> , <i>Veronica x franciscana</i> , <i>Fuchsia magellanica</i> , <i>Berberis stenophylla</i> , <i>Olearia</i> , <i>Griselinia littoralis</i>	220.18	1
Hedge of <i>Olearia</i> and <i>Buddleja davidii</i>	130.01	1
Mix <i>Veronica x franciscana</i> , <i>Berberis stenophylla</i> , <i>Olearia</i> , <i>Cytisus</i> , <i>Malva</i>	283.80	1
<i>Muehlenbeckia complexa</i> and <i>Ligustrum ovalifolium</i> mix	57.44	1
<i>Olearia macrodonta</i> , <i>Salix</i> species, <i>Veronica x franciscana</i> mix	42.02	1

APPDNEIX 2

- Map 1 Non-native species along the coastal cliffs of Howth
- Map 2 Non-native species and mixed hedges recorded on sea side of track
- Map 3 Non-native species and mixed hedges recorded on land side of track
- Map 4 Non-native species recorded along Lions Head beach, Howth.
- Map 5 *Carpobrotus edulis* recorded on the coastal cliffs of Howth
- Map 6 Close-up *Carpobrotus edulis* recorded on the coastal cliffs of Howth
- Map 7 *Crassula helmsii* recorded on the coastal cliffs of Howth
- Map 8 *Fallopia japonica* and *F. baldschuanica* recorded on the coastal cliffs of Howth
- Map 9 *Allium triquetrum* recorded on the coastal cliffs of Howth
- Map 10 *Cotoneaster horizontalis* recorded on the coastal cliffs of Howth
- Map 11 *Leycesteria formosa* recorded on the coastal cliffs of Howth
- Map 12 *Rosa rugosa* recorded on the coastal cliffs of Howth
- Map 13 *Crocsmia x crocosmiiflora* and *Libertia formosa* recorded on the coastal cliffs of Howth
- Map 14 *Gaultheria shallon* recorded on the coastal cliffs of Howth
- Map 15 *Echium pininana* recorded on the coastal cliffs of Howth
- Map 16 *Veronica x franciscana* recorded on the coastal cliffs of Howth
- Map 17 *Kniphofia uvaria* recorded on the coastal cliffs of Howth



Map 1. Non-native species recorded along the coastal cliffs of Howth, 2018 (Maps: O. Crowe).



Map 2. Non-native species and mixed hedges recorded on the sea side of the track along the coastal cliffs of Howth, 2018 (Maps: O. Crowe)



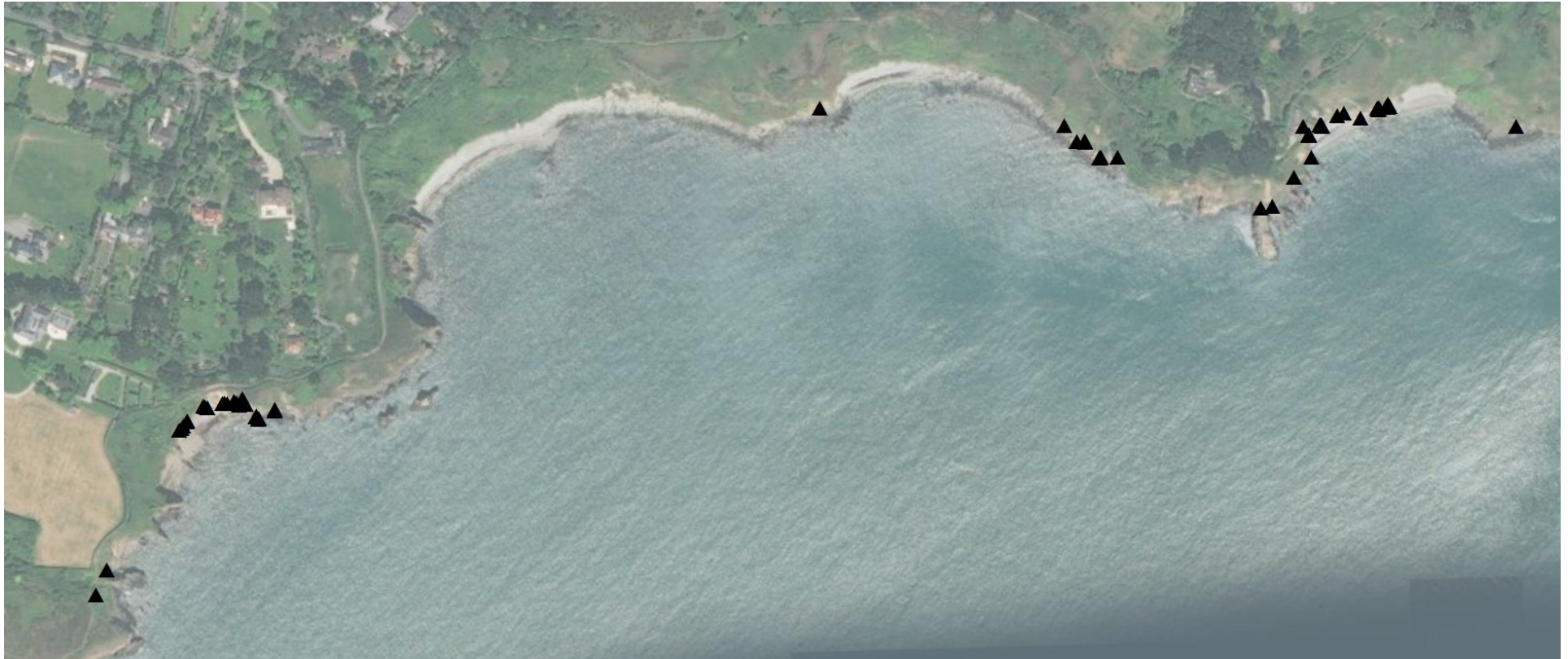
Map 3. Non-native species and mixed hedges recorded on the land side of the track along the coastal cliffs of Howth, 2018 (Maps: O. Crowe).



Map 4. Non-native species recorded along Lions Head beach, Howth, 2018 (Maps: O. Crowe).



Map 5 *Carpobrotus edulis* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 6. Close-up *Carpobrotus edulis* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 7. *Crassula helmsii* recorded in a garden waste dump location on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 8. *Fallopia japonica* and *F. baldschuanica* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map 9. *Allium triquetrum* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 10. *Cotoneaster horizontalis* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 11. *Leycesteria formosa* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 12. *Rosa rugosa* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 13. *Crocosmia x crocosmiiflora* and *Libertia formosa* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 14. *Galutheria shallon* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 15. *Echium pininana* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).



Map 16. *Veronica x franciscana* recorded on the coastal cliffs of Howth, 2018. Includes individuals and mixed hedges (orange = land side hedges; blue = sea side hedges (Maps: Olivia Crowe).



Map 17. *Kniphofia uvaria* recorded on the coastal cliffs of Howth, 2018 (Maps: Olivia Crowe).

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