Distribution of *Prunus laurocerasus* at Dunsany, Co.Meath

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Declaration

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Abstract

In Ireland the invasion of non-native species has been a focal point of many discussions surrounding biodiversity conservation, with vast differences in opinions surrounding implications of invasive species and the costs of removal. However scientific evidence states that when non-native species become invasive, they then hold the capability of transforming ecosystems and threaten native and endangered species, it is these factors that confirm that non-native species are the main cause of biodiversity loss worldwide.

Dunsany estate in County Meath was chosen as an appropriate site to perform this study. *P. laurocerasus* was planted as a winter cover for Game birds over the last hundred years , with Dunsany Estate currently implemented rewilding measures and the landowner, Randal Plunkett opening his estate for research, this provided an excellent opportunity in assessing invasive species. This study focused on the distribution of *P. laurocerasus,* herbivory , associated tree species and succession rates across the nine woodlands identified where *P. laurocerasus* occurs. The distribution of *P. laurocerasus* was preformed using Q field software, allowing for the area of each stand of *P. laurocerasus* to be documented. The degree of herbivory was assessed using 90 herbivory markers which were strategically placed across the estate's woodlands. Associated trees surrounding stands of *P. laurocerasus* were also collated to determine if there was any correlation between *P. laurocerasus* and a certain tree species. The density of *P. laurocerasus's* canopy was categorised to document its growth and other changes over time.

The findings of this study can inspire many future research questions on the distribution of *P. laurocerasus* across Dunsany Estate, impacts of herbivory , succession rates, associated tree species and other factors surrounding invasive species in Irish woodlands.

Keywords

Rewilding, *P. laurocerasus* , herbivory, regeneration, Succession, Invasive species.

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Introduction

1.1 Rewilding

Rewilding can be defined as the management of ecological succession with the goal of restoring natural ecosystem processes and reducing human control of landscapes (Gillson *et al.,* 2011). Agricultural and silvicultural land abandonment represents a significant challenge for the future sustainability of our rural areas (Lennon, 2019). It is difficult to define whether an ecosystem can benefit from land abandonment, as it is subjective to the individual ecosystem. Some species associated with agricultural landscapes decline, while some successional plant species may rapidly increase (Queiroz *et al.,* 2014).

There are many forms of rewilding practices, a common method used in many cases is passive rewilding. The passive form of rewilding includes the concentration of successional vegetation to reach the overall goal of restoring natural ecosystems processes by greatly reducing humans' control of landscapes (Navarro & Pereira, 2015; Conti & Fagarazzi, 2005). On the other hand, animal led landscape rewilding tends to lead to more human disturbances such as hunting/poaching and game viewing. It is therefore expressed by Hall (2014) that rewilding can follow two paths, one seeking to extract culture from nature, with the other path most commonly practiced across Europe tends to inject nature into culture. It has been suggested that passive rewilding can increase the occurrences of unwanted ecological conditions such as rapid invasive species dispersal, zoonotic diseases and wildfires while also leading to increases in animal populations which were once controlled by habitat carrying capacities (Goulding & Roper, 2002).

Another form of rewilding is the use of large herbivores to manage and adapt habitats. The concept is based on what European landscapes looked like during the middle Holocene where there was a gradual shift from open canopy mixed grasslands and woodland ecosystems. It was managed by herbivores such as cattle, horse , bison and wild boar and this landscape created a unique, species rich, landscape which was maintained across Europe (Van Wieren, 1995 ; Lorimer *et al.,* 2015).

1.2 Current Rewilding campaigns across Ireland.

1.2.1 Wild Nephin

Ballycroy National Park is one of Ireland's newest national parks , it consists of 11000 ha of Atlantic blanket bog and upland mountainous terrain. Most of it's land area is designated under the Natura 2000 network with special areas of conservation and special protection areas (Filgueiras, 2018) . In 2013 Coillte and NPWS formed a coalition to create a wild area of the Ballycroy national park and Coillte's adjacent commercial forestry lands. The proposal of a 15-year plan to convert the existing Coillte lands into Ireland's first wilderness area was developed (Fisher, 2013). The concept of rewilding these lands in a remote region of Ireland offers an opportunity to limit the financial loss of commercial forestry while also greatly increasing the public value of the woodlands. Rewilding initiatives creates the correct conditions for increases in biodiversity, improves climate change mitigation such as improving carbon sequestering ability of peatlands and provides a recreational area for ecotourism, benefiting the local community with increased footfall resulting in economic growth across the local area (Navarro & Pereira, 2015; Brown *et al.,* 2018).

Interestingly Wild Nephin chose to centre their rewilding theme on landscape scale vegetation rather than animal-led rewilding, possible reasons for this include the possibility of local farmer's livestock and crops suffering from animal introductions as well as the associated disturbances of large herbivores and subsequent management requirements (Lennon, 2019) .

The management required for vegetation scale rewilding in Wild Nephin is an important element regarding rewilding in Ireland as there is a lack of official national or European environmental legislation or guidance (Lennon, 2019). Furthermore, there are gaps in knowledge surrounding the rewilding of heavily modified landscapes such as commercial forests (Carver, 2016). Recommendations from environmental schemes as part of the Natura 2000 network, such as the management of invasive species has led to invasive species control across the reserve (Corlett, 2016) . Invasive species such as Rhododendron (*Rhododendron ponticum*) and (*Prunus laurocerasus*) both present in Wild Nephin tend to greatly reduce light reaching ground flora and therefore need to be reduced for rewilding to be considered

successful. The removal of such species requires long term investment and is a current dilemma considering the large stands of *Rhododendron ponticum*, *P. laurocerasus* , giant hogweed(*Heracleum mantegazzianum*), Japanese knotweed (*Reynoutria japonica*)that inhibit woodlands across the island of Ireland (Stokes *et al.,* 2004).

1.3 Dunsany Estate, its farmland and change over time

Dunsany Castle Estate, owned and run by Randall Plunket is a relatively large estate in South Co. Meath. This holding consists of 650 hectares and its farmland is of good quality favouring livestock and arable practices (Rewilding Europe, 2020). In 2014 Randall's vision of returning some of his estate into a wild, natural state to combat climate change and habitat degradation led to the removal of livestock from his farm (Gabardi, 2019). Then the 300 acres of pasture became part of his rewilding initiative (Walsh, 2020).

The estate also consists of 220 hectares of forestry which would have been an important part of the estate lending itself to hunting and timber production. The woodlands consist of a mix of native and non-native species , with patches of deciduous and coniferous woodland species with various introductions of plants for winter cover . A characteristic of large estates is the occurrences of cultivars and alien species as well as decorative, unnatural adaptations such as straight rows of trees and pathways which has led to the dispersal of alien species such as *P. laurocerasus* which has subsequently spread across the estate (Wagner *et al.,* 2017,2021). The remaining farmland is intensively farmed for cereal production with its profit's contributing to the upkeep and daily running of the estate (Donohoe, 2019).

1.4 Invasive species management methods

Regarding *P. laurocerasus* there are no legal provisions surrounding the management of this species. There are however various methods of controlling invasive species such as *Rhododendron ponticum* and *P. laurocerasus.* A study by O'Halloran, (2015), highlighted the various methods of management processes such as applying Glyphosate directly to the plants leaves. Other methods include the physical removal of the complete plant, this interrupts the

nearby soil structure and surrounding native plants. Stump treatment has been suggested as the most appropriate management method of invasive species removal across woodland settings, here plants are cut close to the ground and exposed stems are treated with a herbicide. Finally stem injecting includes the injection of herbicides directly into the plants stem, this method is used with Japanese Knotweed (*Reynoutria japonica*) across Ireland, and this method reduces the amount of herbicide used and lessons its effect on surrounding plants (Higgins, 2008).

1.5 *P. laurocerasus* in general its range and distribution.

Cherry laurel (*Prunus laurocerasus*) is an evergreen shrub of the Rosaceae family and is native to the Black Sea coast and South-west Asia where it grows on moist soils in forest understoreys or as a subdominant tree (Kolayli *et al.,* 2003). It flowers from March to the first half of April and bears small cherry fruits which ripens from July to September. *P. laurocerasus* was introduced to Europe about 400 years ago (Hättenschwiler and Körner 2003). In Ireland *P. laurocerasus* is used for hedging and is cultivated in plantations for evergreen foliage (Whelton, 2013). *P. laurocerasus* evergreen oval coriaceous leaves cause a dense shade, while is strong arching stems tend to form dense canopies greatly reducing light reaching the surrounding understory plant species.

There are both positive and negative aspects of *P. laurocerasus* presence on local wildlife. *P. laurocerasus*'s dense cover is an important nesting facility for birds and provides abundant nectar for many insects. Its rapid growth and dense cover ,shades out plants of the woodland understory, and generally out–competes less vigorous shrubs and young native trees. Like *Rhododendron ponticumn*, if unmanaged, *P. laurocerasus* will form an almost impenetrable shrub layer or understory in a woodland and effectively out compete all other vegetation for light except for the mature trees. The success of *P. laurocerasus* distribution across Ireland's woodlands is fed by illegal dumping of garden waste that may contain the alien species seed like *P. laurocerasus & Rhododendron ponticum*. In estates like Dunsany *P. laurocerasus* was planted as winter cover for gamebirds which led to its succession. Another factor of *P. laurocerasus* success is a consequence of the mutualistic relationship with its seed dispersal and native animals with songbirds like Thrushes feeding on berries in the autumn , which leads to alien species spread and establishment (Parsons, 1976; Richardson *et al.,* 2000; Sulusoglu *et al.,* 2015). Alien, invasive species greatly effect ecosystems through altering

species diversity, community structure and interactions with other plant or animal species, this can result in the local extinction of native species (Gerber *et al.,* 2008,Pyšek *et al.,* 2012). A study focusing on the effect of *P. laurocerasus* in suburban deciduous forests of Switzerland noted how native plant species richness in both ground vegetation and shrub layer reduced in areas colonized by *P. laurocerasus,* additionally the presence of *P. laurocerasus* reduced soil moisture and after ten years of invasion, greatly reduced the soils productivity and structure of its microbial community (Rusterholz *et al.,* 2018). This study also noted how soil moisture retention reduced by 10 % where *P. laurocerasus* was present, which was considerably lower than other invasive plants with soil moisture reductions of up to 40% recorded (Martin *et al.,* 2009).

1.6 Herbivory of *P. laurocerasus*

Deer tend to nibble a little bit of anything green, nibbling and moving on (Oliver, 2013). They can tolerate plants that humans and other herbivores cannot (Gebert & Verheyden-Tixier, 2001). Lesser celandine (*Ficaria verna*) contains protoanemonin and ranunculin but is actively grazed by deer, similarly lords and ladies (*Arum maculatum*) consists of a cocktail of eight or more toxins, including various alkaloids, aroine, nicotine, saponins, cyanogenic glycosides, acrid substances and oxalates but is also grazed by deer. *P. laurocerasus* is rich in cyanogenic glycosides, though deer browse on the leaves of young *P. laurocerasus* , highlighting the wide palate of deer (Oliver, 2013; Lucia, 2021) .

A study performed by the University of Georgia observed ornamental plants considered toxic such as *P. laurocerasus* to be rarely eaten by Deer. Furthermore, The Faculty of Veterinary Medicine in Milan recorded a case of a red deer intoxicated with *P. laurocerasus* (Guitart et al., 2010). Studies on mountain laurel (*Kalmia latifolia*) and rhododendron (*Rhododendron maximum*), invasive species which play a similar role to *P. laurocerasus* , contain toxic compounds but are still browsed by deer and both are actively browsed in times of food shortages (Forbes & Bechdel, 1931). When young deer were restricted to *Kalmia latifolia* and *Rhododendron maximum* alone, they did not browse enough of either plant to maintain their live weight. Again, when restricted to *Kalmia latifolia* or *Rhododendron maximum* and supplemented with grain for 49 days the deer maintained a healthy body weight, however when grain was removed the deer became thin and week with some exhibiting signs of rickets , greatly effecting the deer's immune system with individuals dying of pneumonia. Finally, the

force-feeding of *Kalmia latifolia* caused the toxic compound of the laurel to prove fatal when fed in large quantities, suggesting that while deer are not immune to laurel's toxicity, they do have some tolerance of its toxins (Freeland & Janzen, 1974).

1.7 Aims and Research Questions

P. laurocerasus distribution and its role in woodland habitats haven't been studied at Dunsany Estate, furthermore there is little relevant literature documenting *Prunus laurocerasus* distribution across Ireland which is interesting considering the vast stands of this plant across most woodlands. This study investigates an appropriate mapping method of determining the distribution of this species across the woodlands of Dunsany estate. Other features such as the role of herbivory , rewilding, and the management of invasive species also play an important part in understanding the ecology and likely uses of P*. laurocerasus* in rewilding campaigns across Ireland.

1) What is the *P. laurocerasus* distribution across Dunsany, measured through ArcGIS and other mapping methods?

2) What is the extent of *Prunus laurocerasus* recruitment?

3) What is the extent of deer herbivory on *P. laurocerasus ?*

4) Is there any sign of deer trampling effects on *P. laurocerasus?*

5) If deer utilise *P. laurocerasus*, do they select particular parts of the plant or growth stages?

Materials and Methods

Dunsany Estate, County Meath 53.54 N, 6.62 W is an area of 1700 acres with up to 700 acres undergoing rewilding measures (figure 2.1).

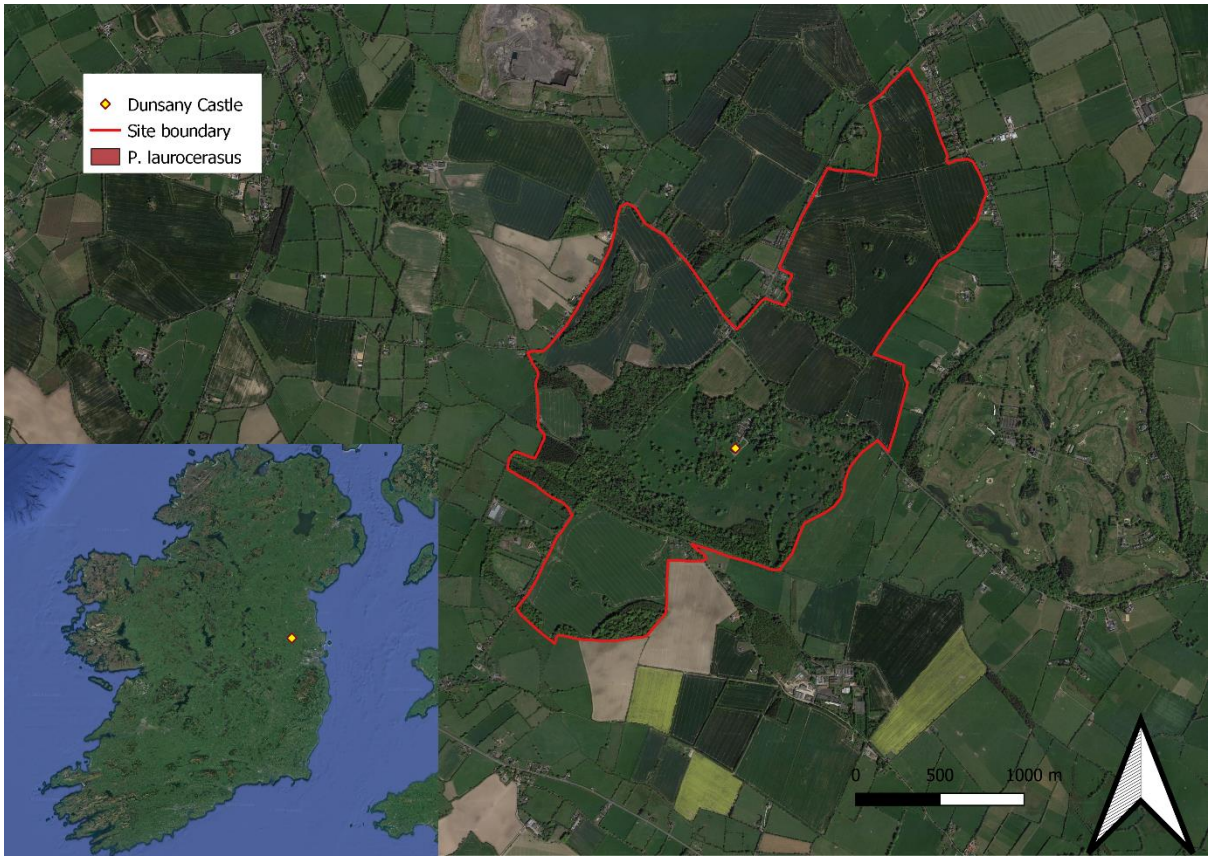

Figure 2.1. Map of Dunsany estate Co. Meath Ireland

The practical part of this project was conducted between June and August 2022. Woodland sites potentially containing P. *laurocerasus* were identified using Google maps of the estate. Subsequent winter imagery of the estate on Google earth allowed for *P. laurocerasus's* evergreen leaves to stand out amongst the mainly deciduous woodlands, followed by recommendations from the estate's owner Randal Plunkett. The locations of *P. laurocerasus* and other points of interest across the estate was achieved using ArcGis Qfield in the field which was supplemented using Arcmap 10.7.1 software through ArcGis.

2.1 Field survey and Survey points

It was established that each woodland needed to be analysed and for an appropriate surveying methodology to be created. Firstly the 8 semi natural woodlands and one recent plantation were isolated, and the appropriate names given for ease of identification (figure 2.2). *P. laurocerasus* was planted across the semi natural woodlands over the last two hundred years most likely as a winter game cover. Some of these semi-natural woodlands may have been remnants of ancient woodlands, however the recent introduction of non-native species by Randal's ancestors has greatly influenced the plant composition of these woodlands.

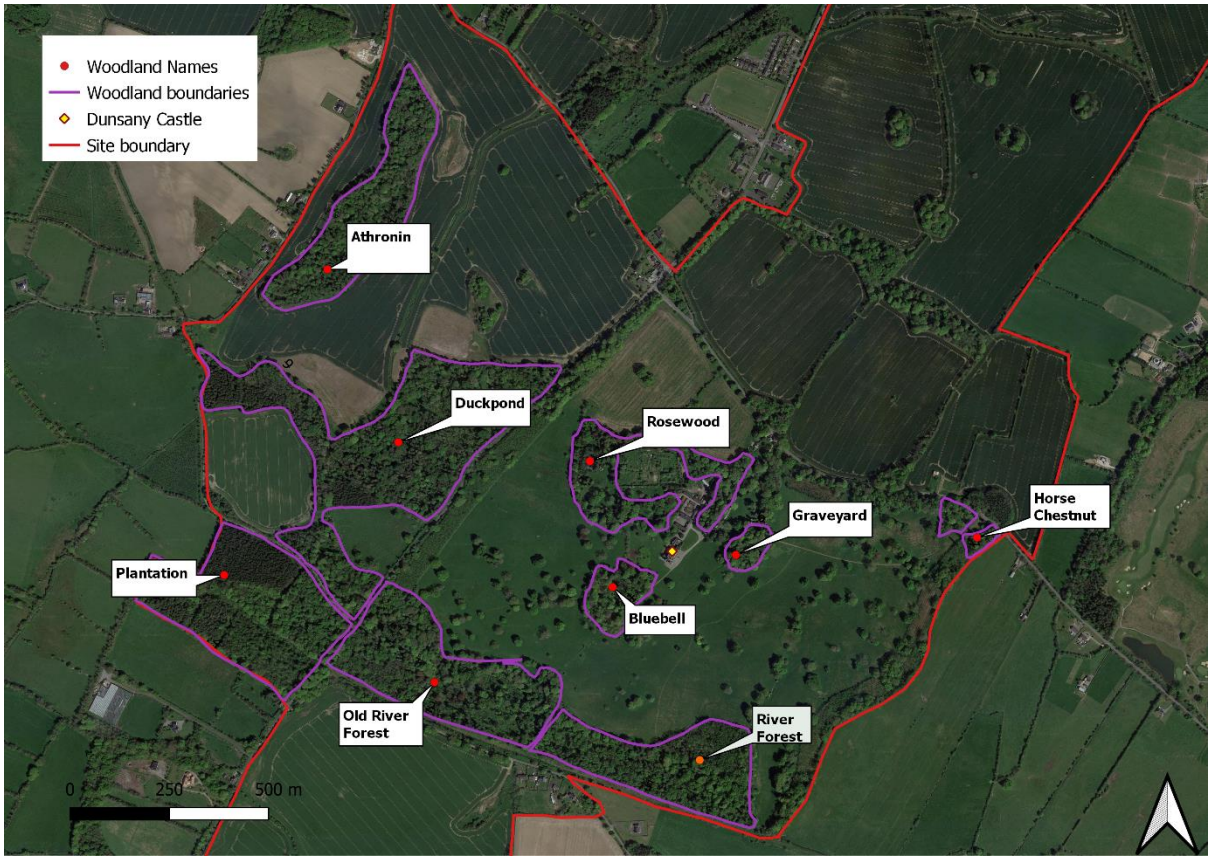

Figure 2.1 Map of Dunsany including woodland names

2.2 Prunus Mapping and Stand characteristics

2.2.1 Mapping

The research methodology described in this section has been adapted from the 'best practice guidance for habitat survey and mapping' (Smith *et al.,* 2011). This guidance portrays the correct ways of developing habitat mapping. It is crucial that standardised methods of habitat mapping are used to develop an accurate ,legible overview of *P. laurocerasus* across Dunsany estate. The mapping of *P. laurocerasus* across Dunsany was achieved using the Samsung tab A7 with 32GB of data storage. The application QField 2.2.1 Coordinated Capybara was also installed onto this tablet. This software required access to GPS and an internet connection in the form of mobile data while in the field. Due to the size of each woodland, transect lines were set out to ensure accurate mapping of the *P. laurocerasus's* distribution (figure 2.2). The use of transect lines when analysing plant distribution reduces the chances of areas within the survey area being unaccounted for. This was achieved through determining the degree of visibility in the woodland e.g. a mature woodland with sparse ground flora transect lines could be placed up to 20 meters apart, whereas for mixed woodlands such as Athronin transect lines needed to be closer at 10 meters apart.

Transect lines were established through a raster layer in ArcGis pro, this was then imported into Q field. The tablet's GPS and Q field software allowed for the transect line's coordinates to be found and followed in the field, enabling accurate mapping of the *P. laurocerasus* present. Once the transect lines were confirmed individual or stands of *P. laurocerasus* were mapped using Q field, this entailed walking around the perimeter of the *P. laurocerasus* canopy and dotting the points on Q field, this was repeated for every stand and individual *P. laurocerasus* that occurred.

This software also allowed for the surface area of each polygon to be measured providing data that can be used in finding total *P. laurocerasus* area, which can then determine factors such as which woodland has the highest surface area of *P. laurocerasus.* Documenting each

polygon and its size allows for the increase or decrease in total surface area to be documented over time as well as fragmentation occurrences.

2.2.2 Stand Characteristics.

Obtaining further information surrounding the growing characterises of *P. laurocerasus* was a vital element of understanding its success and likely future distribution across the estate. Firstly, the canopy cover was measured through standing under a canopy and determining the extent of the canopy, by measuring the stand and leaf cover. this was assessed in 25 percentiles

- 0-25%
- 25-50%
- 50-75%
- 75-100%

Another component of the stand characteristic was to note the tree species within each individual stand of *P. laurocerasus.* In areas of dense *P. laurocerasus* cover indications such as leaf foliage or dead wood species can give an indication of pre-existing tree species. This information can provide information regarding relationships between individual tree species and *P. laurocerasus.*

2.2.3 Recruitment

Recruitment rates were established by collating individual occurrences of *P. laurocerasus* seedlings. When walking around the perimeter of each stand of *P. laurocerasus* attention was paid to signs of seedlings. Another characteristic of *P. laurocerasus* includes underground shoots that send out foliage that appeared to represent a seedling, however cases of under ground shoots from the main plant can occur and are therefore deem as not a new seedling.

2.3 Herbivory interactions

2.3.1 Herbivory markers

A vital component of the field work was to assess the extent of herbivory on *P. laurocerasus*. This was achieved by selecting ten undamaged stems in each of the nine woodlands and placing a white string on each stem in order for each stem to be revisited and analysed after a period of time. Each marked leaf's location was recorded in Qfield in order for each to be easily revisited. After an appropriate period of time of up to three weeks , visual examination of each herbivory marker , allows for herbivory interactions to be identified and collated. Figure 2.3 below illustrates the positioning of each herbivory markers across the nine woodlands.

2.3.2 Camera traps

Some areas with obvious signs of herbivory were monitored using camera traps. The camera trap's locations were placed in strategic locations as illustrated in Figure 2.3 . The camera traps used were Bushnell 14 MP Aggressor camera, its storge consisted of a Sandisk 8 Mbyte SD cards. Imagery of herbivory occurrence with *P. laurocerasus* allowed for the behaviour of the herbivore to be assessed post browsing and to which plant species they progressed to. This was achieved by going through each camera shot analysing the presence and determining the behaviour of herbivores within each image, noting interactions such as direct herbivory, bark stripping e.t.c around stands of *P. laurocerasus .*

Figure 2.2 Map of Dunsany with position of Camera traps and Herbivory markers

Table 2.1: Survey areas and number of herbivory markers set per woodland.

Survey Sites	**Number of Herbivory Markers**
Athronin	10
River Forest	10
River Forest 2	10
Duckpond	10
Rosewood	10
Spruce	10
Horse Chestnut Woodland (right side)	10
Graveyard	10
The Plantation	10

2.4 Data analysis

Each of the 9 woodlands sites were visited after 3 weeks and each 10 survey markers were analysed and noted in a field book, photo evidence also verified each interaction. Data was collated into an excel file where statistical analysis such median and mean value was calculated for each woodland site giving an overall herbivory percentage for the three survey weeks.

Microsoft excel also provided the software for analysing the degree of *P. laurocerasus* canopy cover across the 120 stands. Again, statistical analysis can be implemented to assess any correlations with *P. laurocerasus* and other parameters.

Results

3.1 Mapping the Distribution of *P. laurocerasus* across Dunsany Estate

Figure 3.1 P. laurocerasus Distribution across Dunsany Estate

120 individual polygons illustrate the distribution of *P. laurocerasus* across Dunsany estate (figure 3.1). Some polygons consisted of individual *P. laurocerasus* while larger stands of multiple *P. laurocerasus* were included in a large polygon as seen in Athronin and Rosewood especially around the castle's outbuildings. *P. laurocerasus* was mainly found in woodlands and hedgerows and therefore the grassland areas of the estate were not part of this study. *P. laurocerasus* distribution across the estate is broad with high occurrences throughout most of the woodlands. One characteristic of *P. laurocerasus* growing habit is that once it reaches a certain maturity its branches begin to weaken and eventually reach the ground , this characteristic amongst others greatly increases it canopy cover and also greatly reduces the succession of ground flora and other tree species which is apparent across the estate. The higest percentage of *P. laurocerasus* was found in Rosewood, while the largest area of *P.*

laurocerasus was found in Duckpond. The Plantation featured the second lowest percentage of *P. laurocerasus* , with Bluebell absent of any occurrences of *P. laurocerasus.*

3.1.1 Area of *P. laurocerasus*

Total area of woodland survey sites = 69.03 ha

Total area of *P. laurocerasus* = 11.96 ha

Table 3.1 Illustration of the areas of *P. laurocerasus* and the woodlands they were found in.

Survey Sites	**Survey Sites total Area (ha)**	***P. laurocerasus area (ha)***	***P. laurocerasus %***
Athronin	8.71	0.78	8%
River Forest	7.73	2.18	28%
Old River Forest	11.80	2.34	19%
Duckpond	20.00	3.32	16%
Rosewood	5.56	1.66	29%
Bluebell	2.04	0	0%
Horse Chestnut Woodland (R)	0.38	0.09	23%
Graveyard	0.98	0.23	23%
The Plantation	11.83	1.36	11%

3.2 *P. laurocerasus* recruitment

Overall, there was very sparse signs of *P. laurocerasus* recruitment, on some occasions there tended to be rare occurrences of individual saplings in dense stands of *P. laurocerasus.*

Figure 3.2. A P. laurocerasus seedling found in Duckpond

Figure 3.3 A young *P. laurocerasus* seedling found in Athronin

3.3 Types of Herbivory

It is evident that there are many signs of herbivory across the stands of *P. laurocerasus* . Over the three weeks of herbivory surveying using herbivory markers, a staggering 17% of samples were found to experience some form of disturbance from herbivory. Figure 3.4, 3.5, 3.6 portray herbivory markers that were interacted with showing visible signs of herbivory. Another form of herbivory that *P. laurocerasus* experienced across Dunsany is bark stripping. This activity is practiced throughout the stands of *P. laurocerasus* with some recent occurrences as seen in figures 3.7 & 3.8. The scars of previous bark stripping are apparent, and it was hard to find a single *P. laurocerasus* plant that avoided this form of herbivory interaction. From walking around the Estate's woodlands there is a widespread, obvious browsing line of *P. laurocerasus* and is continued deep into stands of *P. laurocerasus* and near road margins. Figures 3.9 & 3.10 illustrate the degree of herbivory and the distinct browse line of *P. laurocerasus.*

Figure 3.4. Signs of Herbivory on P. laurocerasus leaf

Figure 3.5 Signs of herbivory to P. laurocerasus shoot

Figure 3.6 Damage to P. laurocerasus leaf, possible due to herbivory

Figure 3.7 Bark stripping to a P. laurocerasus stem

Figure 3.8 Extent of bark stripping of P. laurocerasus

Figure 3.9 Extent of browse line across the estate

Figure 3.10 Browsing line of P. laurocerasus

3.4 Herbivory Markers

Overall, across the nine woodlands, 20% of all herbivory markers experienced some damage from herbivory. Woodlands such as Athronin and Old River forest experienced the highest rates of damage from herbivory while Horse chestnut and the Graveyard's herbivory markers experienced no physical interactions from herbivores. (table 3.2)

Table 3.2 Herbivory rates across the survey markers.

Survey Sites	Number of Herbivory Markers	Herbivory Markers interacted with	Damaged stem Percentage
Athronin	10	4	40%
River Forest	10	2	20%
Old River Forest	10	4	40%
Duckpond	10	2	20%
Rosewood	10	2	20%
Spruce	10	1	10%
Horse Chestnut Woodland (right side)	10	0	0%
Graveyard	10	0	0%
The Plantation	10	3	3%

3.5 Camera Traps

In total 642 images were recorded between the three camera traps. Of the 642, 387 of these images captured deer passing through or interacting with *P. laurocerasus* . Other animals captured on the camera traps were foxes, pine martin and badgers. Activity tended to peak at early morning from 4:30 to 7:00, reducing during the day with a subsequent increase in activity at dusk between 21:30 and 23:00. There are however occurrences of interaction throughout the day, especially in Athronin and River Forest.

Figure 3.11 shows a deer possibly browsing on *P. laurocerasus* , this image is taken very close to an herbivory marker and subsequently the herbivory marker in front of the deer's nose was affected by herbivory but unfortunately no camera footage illustrates this happening.

Figure 3.11 Deer interacting with P. laurocerasus

Figure 3.12 Deer standing near P. laurocerasus

Figure 3.13. Deer interacting with P. laurocerasus branches

Figure 3.14 Deer interacting with P. laurocerasus most likely scratching itself.

Figure 3.15 Deer Stag appearing to interact with P. laurocerasus.

3.5 *P. laurocerasus* Canopy Cover

Table 3.3. P. laurocerasus Canopy cover

Degree *of P. laurocerasus* Canopy Cover				
Polygon ID	0-25%	25-50%	50-75%	75-100%
1-120	7	17	51	45

A characteristic of *P. laurocerasus* is its thick waxy leaves which tend to form a dense canopy, this is evident with the *P. laurocerasus* present in the survey site. Most well-established plants hold a dense canopy with small amounts of light reaching the woodland floor. Both the 50-75% and 75-100% percentiles have the highest polygon counts with 80% of all polygons falling into these categories(table 3.3).

3.6 Associated species

Table 3.4. Frequency of major tree species associated with *P. laurocerasus* stands at Dunsany

	Tree Species					
	Oak	Ash	Beech	Sycamore	Conifer	Other
1-120	48	76	56	52	34	33

Ash, Beech and Sycamore tended to be found in close proximity to *P. laurocerasus.* Other once off ornamental tree species such as Redwood , possible planted by Randal's ancestors also were found with *P. laurocerasus* growing in close proximity (table 3.4)

Discussion

This vegetation survey was first of its kind conducted in Dunsany Estate in Co. Meath and will provide a baseline for future research and analysis. Subsequently there is little evidence of scientific reporting mapping *P. laurocerasus* across semi natural woodlands in the Republic of Ireland. In total 11.96 ha of *P. laurocerasus* was mapped across the 9 woodlands. Herbivory , canopy cover, seedling regeneration and associated tree species were all recorded in this study.

4.1 Mapping of *P. laurocerasus*

Accurately mapping the frequent occurrences of *P. laurocerasus* was a challenging exercise requiring long hours and depending on GPS to determine the exact location and direction to take. This thankfully was an enjoyable task with Q field software. The tablet's network and GPS proved vital amongst dense stands of *P. laurocerasus.* Landmarks such as clearings in the woodland canopies , roadways, and remnants of farming activities such as stone walls and gates all helped oneself manoeuvre and familiarise with each woodland.

In total 11.96 ha of *P. laurocerasus* was mapped across the nine woodlands of Dunsany estate. This amounted to 120 individual polygons, some containing a singular *P. laurocerasus* plant with other polygons containing hundreds of individual *P. laurocerasus* plants. Duckpond possessed the largest amount of *P. laurocerasus* while Rosewood contained the highest percentage surface area of *P. laurocerasus* with 29% of the woodland consisting of *P. laurocerasus* . Duckpond contained large, impenetrable stands of *P. laurocerasus* while on the other hand Rosewood, the nearest woodland to the Castle consisted of a narrow band of *P. laurocerasus* running around the farmyard and each side of the avenue. This stand was previously restricted by the adjoining farmland, however since the implementation of rewilding practices next to these areas, this stands area may increase in future years with appropriate growing conditions and open area available for this plant to increase its area.

This study highlighted the importance of monitoring the distribution of a specific invasive species which in turn can inform management techniques and provide a baseline for measuring the growth or decline of an invasive (Stokes *et al.,* 2006). This can be implemented for the *P. laurocerasus's* area and distribution across the woodlands of Dunsany estate to inform Randal on potential future problems that may arise from an increase in *P. laurocerasus* such as a reduction in native tree regeneration, and a reduction in the density and distribution of woodland ground flora (Hawthorne *et al.,* 2015).

The practice of analysing other forms of imagery of the survey site can help understand the characteristics such as gaps in woodland canopies, specific species present e.t.c. One example when assessing the species composition of a woodland is the use of winter imagery and/or satellite imagery from google maps. When trying to isolate and identify stands of *P. laurocerasus* across Dunsany estate, winter imagery proved not to provide enough detail when distinguish between *P. laurocerasus* and other tree species. The only place where winter imagery proved effective was using google earth street view along the main roadways that possessed google earth street view information. This proved unaffected as from driving around the roadways the *P. laurocerasus* on woodland boundaries were visible during the surveying dates an also provided little information regarding its possible growth rates. Therefore, from completing this survey winter and satellite imagery proved ineffective for this species, however, may prove useful for other species. Imagery from varied time periods also provided little insight to *P. laurocerasus's* change in distribution and range as the image's detail was not intricate enough to isolate *P. laurocerasus* . Other possible surveying techniques could include the use of a flying drone that may provide an insight into the *P. laurocerasus* from directly overhead. This concept has hidden costs as well as familiarising oneself with successfully operating this machine to provide helpful imagery (Kedia *et al.,* 2021).

4.2 Herbivory

A vital part of this study was isolating an analysing indicators of herbivory to gain an insight into the degree of herbivory of *P. laurocerasus* across Dunsany estate. It is evident that herbivory can have a direct and significant impact on the structure and overall ecological functioning of a woodland community as well as having an impact on the physical structure of the woodland and other associated plant and animal species that may be influenced by the occurrence of herbivory. This is true of Dunsany with *P. laurocerasus* showing clear signs of herbivory across the nine woodland types (figure 3.2). Herbivory on the other hand can create conditions needed for regeneration of a woodland habitat and herbivores can play an ecosystem engineer's role in shaping the diversity of species present within a specific habitat (Sulusoglu *et al.,* 2015). The dense shade emitted from *P. laurocerasus* canopy tends to greatly reduce ground flora beneath stands of this plant. However, herbivory interactions such as bark stripping may slightly reduce the overall canopy allowing for small pockets of light to reach the forest floor allowing ground flora to germinate (Pyšek *et al.,* 2012).

In order to assess the extent of herbivory 90 herbivory markers were placed on individual, healthy *P. laurocerasus* leaves over a three week period. This proved difficult as untouched leaves within herbivores browsing range were hard to find, most had already experienced some signs of herbivory. White butchers string was used as the herbivory marker as this material would eventually rot if some markers could not be retrieved. The white colour also stood out amidst the green leaves and brown *P. laurocerasus* stems(figure 3.5). Of the 90 herbivory markers 18 experienced some interaction from herbivory. In most cases the herbivory interaction consisted of a leaf tear or complete removal as seen in Figure 3.5 & 3.6. The high level of 20% of all markers experiencing herbivory interactions was unexpected as from scientific literature (Guitart *et al.,* 2010) herbivores such as deer were only found to browse on *P. laurocerasus* during periods of food shortages such as in winter months. With the wide expanse of grassland, abundant ash, sycamore and oak seedlings as well as arable crops such as winter barley (*Hordeum vulgare)* and triticale (*×Triticosecale)* it is surprising the extent of herbivory to *P. laurocerasus.* The sampling period of three weeks could be

considered a short surveying period, however during this there was sufficient time to portray the extent of herbivory. Possible increasing the surveying duration as well as carrying out herbivory sampling throughout the year would give an interesting insight into the degree of Herbivory with a likelihood of an increase during the winter months due to *P. laurocerasus* evergreen leaves and absence of cereal and reduction in grassland foliage availability.

Dunsany is home to many native red deer. The deer roam between Trim and Dunsany estates. Many occurrences of deer were spotted while walking around Dusany's woodlands and they were also spotted in trail camera footage (figure 3.12 & 3.13). Herbivory markers interactions were highest in Athronin, River Forest and Old River Forest, these mature woodlands with adjoining cereal crops provide the favourable conditions for deer as well as reduced human interactions, away from the castle and residential areas. The distinct browse line that is apparent across the *P. laurocerasus* stands of Dunsany have been caused by deer browsing, with evidence of deer interacting with *P. laurocerasus* caught on trial cameras (figure 3.14).

4.2.1 Controlling Herbivory

Herbivory in Dunsany was generally low in the plantation while the mature woodlands experienced higher levels ,this is mainly due to the reduced species composition of the plantation and its location away from grassland and cereal production. When isolating the potential of removing or lessoning the effect of herbivory there are many factors at play and each need to be considered carefully as there is no one size fits all approach. It is difficult to determine whether the removal of deer from an individual woodland in Dunsany would allow for native woodland species to flourish aiding to natural succession. The removal of this herbivore will cause *P. laurocerasus* to increase its foliage across its lower canopy, which will increase its distribution over time (Guitart et al., 2010). Therefore, the presence of Red Deer across Dunsany could be considered instrumental in reducing *P. laurocerasus* distribution and in turn opening spaces for native species to germinate and eventually compete with *P. laurocerasus.* However , some studies have proven that the exclusion of deer from a specific area until native tree saplings exceeded the maximum browse height of deer allows for forest regeneration to occur, however with the large stands of *P. laurocerasus* in

Dunsany the removal of deer would most probably cause many saplings and ground flora to be placed under *P. laurocerasus* dense canopy cover (Mitchel & Kirby.,1990). Therefore, if herbivory levels were to become a problem, *P. laurocerasus's* distribution growth would quickly outpace the negative impacts on local flora that excessive herbivory would have.

4.3 Ecosystem Value of Native woodland in Ireland.

Dunsany Estate consists of many small pockets of native woodland, with large mature oak trees remaining as a remnant of what Ireland's woodlands would have looked like hundreds of years ago. This is interesting as the Republic of Ireland is one of the least forested countries in Europe with only 697,600 hectares ,10.5% of Ireland land area occupied for forestry (Wagner *et al.,* 2017,2021). Unfortunately, 68% of this figure consists of conifer plantations of non-natives such as Sitka spruce (Forest Service 2012). This means that there is only 100,000 hectares of native woodland in Ireland and 20% of this can be said to be dated prior to the 1600s deeming it as ancient woodland. Dunsany estate existed back as far as the 1600s and many parts of the woodlands have since been untouched.

Species rich habitats benefit local plant and animal species as well as the landowner and residents. Threats such as invasive species as well as agricultural expansion can greatly affect the health of habitats however , in Dunsany the implementation of plantations linking each mature woodland together lessons the effects of fragmentation while also creating a buffer zone around the estate's boundary. There was no occurrences of *P. laurocerasus* in the recent woodlands planted by Randal , and the uniform dense planting technique may reduce the chances of this invasive from establishing as each plantation is well established with uniform tree species all at a similar growth stage.

4.4 Invasive species

Invasive foreign species can cause a serious threat to native ecosystems especially Woodland (Kedia *et al.,* 2021). The most common invasive species found across Ireland's woodlands are *Rhododendron ponticum*, *P. laurocerasus* and Himalayan balsam (*Impatiens glandulifera)* all of which were present across the woodlands of Dunsany. The National Survey of Native Woodlands found that 25% of all sites consisted of *Rhododendron ponticum*. Both *Rhododendron ponticum* and *P. laurocerasus* greatly reduces ground flora and natural regeneration due to their rapid growth rate , which greatly reduces the degree of light reaching the woodland floor. While *Rhododendron ponticum* flowers provide a source of pollen and *P. laurocerasus* produces a flower and fruit , they both inhibit toxins that reduces its attraction to native insects and mammals (Hättenschwiler & Körner 2003). The removal of invasive species requires painstaking methods, and the removal of *Rhododendron ponticum* and *P. laurocerasus* can amount to €2,500-€3,500 per hectare (Higgins, 2008).

4.5 *P. laurocerasus* succession

Overall signs of *P. laurocerasus* succession were very scarce. The high level of herbivory and dense shade emitted by *P. laurocerasus* aswell as other woodland species reduces the degree of light reaching the woodland floor. There was no signs of independent *P. laurocerasus* seedlings in any woodland except Duckpond and Athronin. These seedlings occurred in small openings amongst dense stands of *P. laurocerasus* which were not accessible to deer and therefore avoided herbivory (figure 3.2&3.3). Across Dunsany the increase in *P. laurocerasus's* range is predominately caused by mature *P. laurocerasus* trees breaking down and reaching the ground, once there the branches begin to root, tillering and continuing to increase the plants canopy cover.

4.6 Rewilding

The future of the semi-natural woodlands across Dunsany could take several directions. Currently, Randal's passive rewilding theme of leaving his lands completely alone makes future projections hard to anticipate. Currently there is little signs of scrub forming around the woodland edges and few individual saplings germinating in the grassland areas. This passive method is truly the cheapest and easiest method of rewilding however after fifteen years of rewilding more signs of woodland formation would be preferred (Gillson *et al.,* 2011). If Randall took on a more hands on approach implementing management techniques with the overall aim of increasing biodiversity and expanding the conservation value of his rewilded woodlands. Other measures currently avoided by Randal is the introduction of ecological desirable native plant and animal species that have the capacity to improve woodland structure and may advance Randal's wish of rewilded woodlands similar to Ireland's ancient past (Pywell et al. 2002a). As this study has highlighted dominant invasive species such as *P. laurocerasus* and *Rhododendron ponticum* tend to outcompete more fragile species for nutrients and light (Bullock 2000, Bullock 1996). The management of both species is therefore required to lessen the effects on native species, the propagation of disease towards *P. laurocerasus* such as shot hole disease may slightly reduce the plants leaf diameter therefore increasing stress to the plant which may reduce its canopy cover (Smith *et al.,* 2020). More invasive measures however such as ring barking and application of selective herbicides may provide a more effective reduction in *P. laurocerasus's* distribution, allowing for native woodland species to increase in diversity and densities.

4.7 Associated tree species

Dunsany is home to species rich semi natural woodlands with a vast array of native and non-native tree species. Randal's ancestors also introduced once off ornamental trees across the woodlands of the estate such as Redwoods . When assessing the tree species surrounding occurrences of *P. laurocerasus* proved that generally, ash beech and sycamore were found most commonly in proximity to stands of *P. laurocerasus* (table 3.4). It is difficult to determine whether there are any correlations between *P. laurocerasus* and a particular tree species. More often than not *P. laurocerasus* tended to occur beneath opening in the woodland canopy where a once mature tree once stood. Many observations of decaying mature trees were found amongst stands of *P. laurocerasus* and therefore the associated trees near *P. laurocerasus* tended to be of the same species as what lay vertical as deadwood.

4.8 Project limitations and changes for the future

Future or subsequent research on this topic would allow for a comparison to be made on the change in the range and distribution of *P. laurocerasus* across Dunsany estate.

Isolating the herbivory on *P. laurocerasus* as there seems to be gap in knowledge surround herbivory on *P. laurocerasus .* There is no doubt that *P. laurocerasus* is browsed on across Dunsany estate. Deer being the only large herbivore , further analysis such as capturing deer and closely monitor their diet when enclosed within a stand of *P. laurocerasus*

Other measures of assessing herbivory could be done through analysing deer dung to see if there is any sign of toxins associated with *P. laurocerasus*. This could then be compared to deer dung in the Phoenix Park or elsewhere where *P. laurocerasus* is not present or occurs in sparse densities.

Overall, a major limitation of this study would have been the short sampling period, Herbivory markers were placed following the completion of mapping *P. laurocerasus* . If this study was to be repeated, the application of herbivory markers during mapping may be influential, however this would result in a variation in time between habitat markers being set.

The assistance of drone footage would aid the mapping of stands of *P. laurocerasus* , providing indications such as the area and shape of a larger stand which would increase the efficiency of mapping.

Conclusion

Mapping the distribution of *P. laurocerasus* across the woodlands of Dunsany Estate Co. Meath provides a baseline for future analysis regarding this plant's distribution over time. A subsequent study can provide Randal with an insight into where his passive rewilding campaign is heading. Dunsany, the first Irish rewilding project to become part of the European rewilding network can prove a catalyst for future rewilding incentives across the island of Ireland.

Up to date software proved effective in accurately mapping *P. laurocerasus* as the extent of this non-native plant was underestimated during the planning of this project. The total area of *P. laurocerasus ,* 11.96 ha was surprising and unforeseen and highlights invasives species potential in covering large expanses of land. Analysing herbivory was another factor of this study and the relationship between herbivory and *P. laurocerasus* was substantial, distinct browse lines and bark stripping were a common factor across the Estate's woodland with each experiencing at least one herbivory characteristic. Red deer occurred often during this study with frequent observations across the six camera traps which were strategically placed amongst stands of *P. laurocerasus* in each woodland, confirming that deer were the main cause of disturbance to *P. laurocerasus.* Other elements of the study such as associated tree species and degree of *P. laurocerasus's* canopy cover was also analysed, however the findings

of both parameters give a good foundation for isolating the degree of native plant species succession beneath *P. laurocerasus's* dense canopy layer, which is a cause for concern, however native tree species tend to occur in heathy numbers around the reserve. Further and more extensive work including a future survey of the distribution of *P. laurocerasus* across the woodlands of Dunsany Estate in the next five years, or a similar study isolating the Diet of Red deer across Dunsany will be needed to support these results .

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