Kingston University London

Biodiversity Management Plan: Invasive Flora August 2023

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The updated Biodiversity Management Plan: Invasive Flora August 2023 was sent to the Kingston University Estates Committee for notification of the document update in October 2023.

Contents

1. Introduction

1.1 What is an invasive non-native species?

Thousands of non-native invasive species are introduced into the UK every year, mainly through the horticultural industry, but also by hitchhiking on migratory species or coming in accidently with imports.

Of these, over a course of years, a few species are found to be extremely invasive and detrimental to our native flora and fauna through a combination of ideal habitat conditions combined with a lack of predators and/or plant competition, which would be present in their native ranges. Once such species are identified, they may be added to lists of plants and animals which are legally classed as Invasive Non-Native Species (INNS) due to their detrimental effect on biodiversity.

Due to the slow process of legal adoption, there are many non-native species which are invasive in nature, have a detrimental impact on local biodiversity, but which:

- haven't been adopted by all devolved governments as being INNS for their countries.
- are only present on registers for different local areas, as species of concern in the local biodiversity context – for example the London Invasive Species Initiative (LISI).
- have been highlighted as being of concern by ecologists but have no current legal control systems, so they continue to be added to our habitats.

Nearly all Kingston University sites contain one or more INNS – either flora or fauna (see Table 1); as well as one or more species which are invasive and/or listed as species of concern. For the floral plants on our sites in these categories, many were planted deliberately as part of planned landscaping schemes.

INNS cause a loss of biodiversity for a number of reasons:

- Because they are non-native, they have no associated biodiversity control mechanisms in this country with no natural enemies or disease to suppress their growth.
- No species have evolved to co-exist with them, and therefore they support a far more limited range of insects, fungi, birds etc. than native plants.
- In the case of plant species, they operate several methods to outcompete other vegetation for resources such as light, water and nutrients. Their strong competition lowers the diversity of vegetation in an area because:
    - Of rapid growth – growing faster than native species and shading them out.
    - Of dense growth – either with many individuals tightly packed together (as with Himalayan Balsam), or by forming a dense shrub (as with Rhododendron) - outcompeting most other vegetation in an area.

1.2 Legislation

Because INNS can be so damaging to the natural environment, legislation exists to help prevent the further spread of certain species. The key legislation instruments for invasive species are as follows:

- Wildlife and Countryside Act 1981 as amended, Section 14 of Schedule 9.
- Environmental Protection Act 1990, Section 2a.
- Anti-social Behaviour, Crime and Policing Act 2014, Part 4.
- Infrastructure Act 2015, Part 4.

- Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 – still applies to the UK under domestic legislation through the European Union (Withdrawal) Act 2018.
- Invasive Alien Species (Enforcement and Permitting) Order SI 2019/527.

It should be noted that Regulators do not have a duty to undertake control of invasive species, and this often falls to the landowner or other stakeholders. While landowners are not obliged to control invasive species on their land, legal action can be taken against them if a species is allowed to spread to adjacent land or into the wild.

1.2.1 Wildlife and Countryside Act 1981, Schedule 9

Under this law, it is an offence to plant or 'otherwise cause' to grow in the wild any species of non-native flora listed on Schedule 9. For England and Wales, this includes the following species. Please note that this is not the complete list of Schedule 9 species but contains those likely or known to be found on Kingston University campuses:

- Cotoneasters (including Cotoneaster, Entire-Leaved, Himalayan, Hollyberry, Small-leaved)
- Floating Pennywort
- Himalayan Balsam
- Invasive Garlics: Three-cornered Garlic and Few-Flowered Leak (aka Few-Flowered Garlic)
- Japanese Knotweed
- Japanese Rose
- Montbretia
- Rhododendron - Common (or Pontic) x Great (or American) Rhododendron hybrid
- New Zealand Pigmyweed (aka Stonecrop, Australian Stonecrop)
- Virginia Creeper and False Virginia Creeper
- Variegated Yellow Archangel

1.3 Scope

This document contains sections on the different invasive flora on site and the management strategies (if applicable) for each undertaken at Kingston University (KU). The invasive invertebrate Oak Processionary Moth is managed under KU Biodiversity Action Plan under Appendix 3 Oak Processionary Moth Management Plan.

In addition to species listed in Schedule 9; species on our sites which are also in the London Invasive Species Initiative as being of particular concern (London Biodiversity Partnership, 2014), or have been identified in the Botanical sector has having negative impacts on native habitats, are also dealt with, in particular where the species are causing problems within habitats such as the Kingston Hill Woodland.

Table 1 contains a list of the INNS which have been recorded at KU sites (correct as of August 2023). Please note, lack of records does not account for evidence of absence, some species colonise sites over short timeframes, or are only easily identifiable at certain times of the year. If evidence is to be provided of species not being on site, full systematic surveys must be conducted within an acceptable timeframe to be considered ecologically valid.

Table 1: INNS which have been recorded on KU sites (correct as of August 2023). Y = Recorded on site, L = Highly probably due to local records.

Site / Species (Flora and Fauna)	Cotoneaster sp inc. Entire-leaved, Himalayan, Hollyberry and Small-leaved *(Cotoneaster horizontalis, Cotoneaster integrifolius, Cotoneaster simonsii, Cotoneaster bullatus and Cotoneaster microphyllus)*	Floating Pennywort *(Hydrocotyle ranunculoides)*	Himalayan Balsam *(Impatiens glandulifera)*	Invasive Garlics: Few Flowered Garlic AKA Few Flowered Leek *(Allium paradoxum)*	Invasive Garlics: Three-cornered Garlic (Allium triquetrum)	Japanese Knotweed *(Fallopia japonica)*	Japanese Rose *(Rosa rugose)*	Montbretia (*Crocosmia x crocosmiiflora*)	New Zealand Pigmyweed *(Crassula helmsii)*	Rhododendron *(Rhododendron ponticum* and *Rhododendron ponticum x Rhododendron maximum)*	Yellow Azalea *(Rhododendron luteum)*	Variegated Yellow Archangel *(Lamiastrum galeobdolonsubsp. Argentatum)*	Virginia Creeper *(Parthenocissus quinquefolia)*	Bamboo – all species. Site specific issue for Kingston Hill.	Cherry Laurel (*Prunus laurocerasus*). Site specific issue for	False Acacia *(Robinia pseudoacacia)*. Site specific issue for	Snowberry *(Symphoricarpos albus)*	Deep rooting stipas and other non – native grasses	Non-Native Lady' s Mantle species inc. *Alchemilla mollis*	*Oak Processionary Moth (OPM) *(Thaumetopoea processionea)*	Chinese Mitten Crab *(Eriocheir sinensis)*	Signal Crayfish (Pacifastacus leniusculus)	American Mink *(Neovison vison)*	Ring-necked Parakeet AKA Rose-ringed Parakeet (*Psittacula krameria*)	Grey Squirrel (*Sciurus carolinensis*)
Kingston Hill (KH)	Y			Y	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y					Y	Y
Knights Park (KP)	L		Y		L	Y														Y	L	L	Y	Y	Y
Middle Mill (MM)	Y		Y		Y	Y	Y												Y		Y	L	L	Y	Y
Penrhyn Road (PR)	Y	Y					Y	Y	Y				Y						Y	Y				Y	Y
Seething Wells (SW)	L																			Y				Y	Y
Clay Hill (CH)	L																							Y	Y
Roehampton Vale (RV)	L					Y														Y				Y	Y
Dorich House (DH)																				Y				Y	Y
Tolworth Court (TC)			Y																	Y		L		Y	Y

*Falls under "The Plant Health (Forestry) Order 2005" as amended in 2018".

2. Species management index

2.1 Cotoneasters (all species) (KH, MM, PR (other sites TBC))

Cotoneasters were introduced to the UK from Eastern Asia in the 19th century as a garden plant and used throughout roadside planting schemes by municipal organisations. Since this time, it has been shown that many species in this family have spread into valuable native habitats resulting in the smothering of habitats including limestone grasslands and outcompeted many native species. Cotoneaster berries are easily dispersed by birds contributing to its widespread distribution. There are several species of Cotoneaster which are classed as INNS in legislation. With all of the issues from cotoneasters including dispersal by bird species to the wider environment, KU aims to eradicate established cotoneaster species from our sites and landscaping and not plant any cotoneaster species (invasive or cultivated) as part of new landscaping schemes.

2.1.1 Objective timescale

- Short term (1-10 years) – Map locations of Cotoneaster species on our sites. Where they are found in the non-landscaping habitats, remove all species and dig out roots. Ensure that cotoneasters are not part of any new landscaping schemes at any of our sites.
- Long term (10 years onwards) – Where cotoneasters have been used as part of formal landscaping schemes, plan alternative planting schemes for all areas. Establish funding streams/projects under which the removal and replacement of this plant will take place. Replace this plant with native or ornamental shrubs which provide berries for birds but are not classed as (or known to be) invasive in the UK.

2.1.2 Method

- Manual removal – Reduce the plant until you can see where the stems enter the ground. If plants are not growing in very sensitive locations around other vulnerable plants, manually dig out all of the root ball. Remove all arisings and bag up for removal to a contaminated landfill location. Mark up the location where the plant has been dug up and monitor for at least 4 years to check for regrowth. Dig out any regrowth, and monitor – repeat as needed until we have 4 years free of any regrowth.
- Herbicide treatment - For large shrubs over badger setts/in dangerous locations. Reduce the spread as much as possible (hand tools only around badger setts) without exposing the badger sett. Then treat the remaining plant with specific herbicides using the scraped stems treatment method as outlined in Plantlife, 2023; but only with an agreed non-glyphosate herbicide, to weaken and potentially kill the plant. Continue to manage the regrowth in this manner until the plant is dead and no regrowth is found. The dead plant will become brittle over time, but still provide a cover for setts, so can be left in-situ and planted around with appropriate native species.

2.2 Floating Pennywort (*Hydrocotyle ranunculoides*) (PR)

Floating Pennywort is an invasive aquatic plant originating from Central and South America which arrived in the UK in the 1980s as an ornamental oxygenating plant in the aquatic trade. Floating pennywort can grow up to 20cm per day and can regenerate from tiny fragments. It quickly escaped into the wild both through people dumping the plants in waterbodies, and also via animals visiting infected water bodies. This species readily outcompetes native species, forming dense mats on the water. It impacts native habitats and the variety of species which rely on these habitats including fish and insect communities.

With restrictions on chemical use near water, management tends to largely rely on sustained and labour intensive mechanical and manual clearance, which is often ineffective and only acts as a stop gap.

2.2.1 Objective timescale

- Short term – Control the growth in the existing location at the Penrhyn Road forensic garden pond.
- Long term (3-5 years) – Replace the pond in this garden completely, remove all infected soil and sediment, compost these in the onsite invasive compost heap in the garden.

2.2.2 Method

- Manual management of existing locations – Continue to thin out this plant each autumn with the help of volunteers. Compost onsite to avoid off site movements.
- Long term – Completely replace the existing infected pond. Ideally this would be a concurrent process by creating a new pond on site at PR. Once the new pond is established, then remove (and replace if possible) the existing pond from the site. However, locations for a new pond are limited and all have some drawbacks. An alternative is for the existing pond to be drained, any species found (which would be retained) would have to be kept in a temporary holding tank for one whole season, to ensure that no infected plant material has been added to the holding tank. Then the old pond could be dug out completely, re-lined and then allowed to fill with rainwater. Invertebrate species which have been retained would be added back to the re-lined pond. Because of the location in the walled garden, addition of native pond plants to the new pond are recommended, but only after they have been kept in the holding tank for a season to ensure that they are not infected with invasive plant species – as this is a known vector of invasive plant colonisation into ponds.

2.3 Himalayan Balsam (*Impatiens glandulifera*) (KP, MM and TC)

Himalayan Balsam grows in dense clumps in damp habitats, slowly shading out native vegetation. Its flowers almost continually from June to October, outcompeting native species for pollinators. Studies have shown that this plant can reduce the pollination of surrounding plants, reducing the above ground plant species richness and the below ground seed stock by 25% and 30% over long time periods and impacting the symbiotic relationships between ectomycorrhizal fungi and saplings (Rusterholz *et al.*, 2017; Ruckli *et al.*, 2016). The seed pods of the Himalayan Balsam are explosive; each pod can scatter seeds up to 7 metres away, with each plant producing up to 800 seeds. Where established, Himalayan Balsam can cause erosion on riverbanks, where the plant dies back each winter, it leaves soil exposed to erosion during river flow events. This is a particular problem as the species thrives in damp conditions. Despite the many disadvantages, it should be noted that the long flowering period of Himalayan Balsam is of benefit to invertebrates that otherwise may lack forage in degraded habitats.

Groups linked to the Hogsmill River Catchment Partnership are investigating the use of a rust fungus (*Puccina sp*.) which completes its entire life cycle on a single plant species (autoecious) and infects the stems and leaves of Himalayan Balsam through the growing season (CABI, 2023). The aim of this work is to weaken the plants in the local population to aid the longer term aims for eradication.

2.3.1 Objective timescale

- Short and long term – To continue to undertake balsam bashes on all KU sites, remove plants before they can produce seed to help reduce additional seeds entering the system and adding to the local seed bank in the catchment – on going in the short to long run while the rust fungus starts to establish from its dispersal points.
- Short and long term – To undertake balsam bashes on upstream sites to reduce the number of seeds entering the river and flowing down stream to our sites.
- Long term (15+ years) – To support the introduction of the rust fungus on all sites if the opportunity arises, and then manage the sites in accordance with the best methodology to increase the rust fungus prevalence and spread, through the catchment. Monitor any plant locations with rust infections on KU landholdings and report all progress yearly.

2.3.2 Method

- Balsam bashes are an easy and non-disruptive way to reduce the density of Himalayan Balsam by pulling it out of the ground with volunteers under ecological supervision. Bashes require labour and a commitment to yearly interventions to be effective. Plants which are pulled can be safely left to wither in sunlight (above the water line) to reduce their viability, but the root sections must be broken off and the main stems crushed to stop pulled plants converting flowers to seed heads using the residual energy in the pulled plant. This method removes the need to rake the pulled plants to contaminated landfill locations. Bashes need to be conducted throughout the growing period to affect the waves of new plants coming up. But they must be carried out in a way that is sensitive to protected species such as nesting birds or water voles (under the supervision of an ecologically competent person).

2.4 Invasive Garlics: Few Flowered Garlic AKA Few Flowered Leek (*Allium paradoxum*) (KH) Three-cornered Garlic (*Allium triquetrum*) (KH, MM and likely KP due to its position on the Hogsmill)

Few Flowered Garlic is native to the Caucasus and Iran. Introduced into cultivation in the UK in 1823 and first recorded in the wild in 1849. Introduced as a horticultural plant and spreading due to its ability to produce large quantities of vegetatively produced bulbil, which are spread by water along rivers, by vehicle tyres along roads and tracks, by animals and as dumped garden waste (NNSS, 2011). This plant is found in Kingston Hill at the memorial garden. There is a risk of it spreading into the woodland Site of Interest for Nature Conservation (SINC) which surrounds our campus from this location.

The seeds of Three-cornered Garlic are spread naturally by ants. It was established initially in Guernsey in 1849 and is now naturalised and increasingly abundant and widespread in milder areas of the UK, especially in the south and west where it is found in damp and shaded habitats, woods, scrub, stream banks and hedgerows. Three-cornered Garlic can be a threat to native flora as it forms monocultures that smother other plants. It is listed under Schedule 9 to the Wildlife and Countryside Act 1981 with respect to England, Wales and Scotland (Naturespot, 2023). This species entered our site via the Hogsmill River and is found on the riverbank in one location at Middle Mill, it also seems to have been planted in the community garden at Kingston Hill between 2021-2022.

2.4.1 Objective timescale

- Short term (1 year) – Add these locations to the invasive species mapping at Kingston University.
- Medium term (1+ years) – Continue to weed these plants out of the areas where they have colonised our sites. Eradication at Kingston Hill may be impossible because of the bulbils which get moved around by leaf blowing of materials off footpaths by different contractors, so control and reduction where possible, are the main focuses at Kingston Hill. At Middle Mill, as the colonisation via the river is a relatively recent event – work to continue to pull out the plant from the riverbank when seen, to minimise the spread and hopefully work to eradicate it in the one location before it spreads. Because of the issue of sewage contamination in the river water, signposting the Three-cornered Garlic for culinary foraging on our sites is not recommended.

2.4.2 Method

- Few Flowered Garlic – Manual removal and isolating all arisings from compostable materials at Kingston Hill. Hold the contaminated vegetation in large tonne bags in the middle invasive species bay in the composting area at Kingston Hill. Treat the arisings with non-glyphosate herbicides to reduce the viability.
- Three-cornered Garlic – Manual removal of the plant and bulbs – crush the bulbs at the river side and leave to dry out under bank side vegetation to avoid moving it from our site.

2.5 Japanese Knotweed (*Fallopia japonica*) (RV, KH, KP and MM)

Japanese Knotweed is a known invasive plant. In some circumstances in healthy habitats with little disturbance single plants may be constrained by surrounding vegetation and not show signs of expanding. However, in areas with ground disturbance which can impact the roots (such as riverbanks with natural impacts from winter rains) the plant can spread easily and rapidly to dominate the ecosystem. During the autumn and winter, Japanese Knotweed completely dies back, exposing bare soil, a problem in areas of slopes or riverbanks where erosion can readily occur.

Japanese Knotweed is also well known for causing problems in urban areas where it can emerge through concrete and tarmac floors, because of this and its well-publicised impacts on house prices, developments and insurance issues, it is one of the few invasive plants familiar to the general public by name. All parts of the plant and the soil where it grows (potentially up to 7 metres (radius) from any stem and up to 2-3 metres in depth) is classed as contaminated waste. The plants' rhizomes can stay dormant in the soil for years, as such, areas which are managed have to be monitored for regrowth, especially in areas where ground disturbance can occur, and reactivate the plant. Activities such as animals burrowing can be one example of how this can happen.

2.5.1 Objective timescale

- Short term (as soon as a plant is recorded) – Treat all plants with herbicide – either root injection for larger stems or by weed wiping the leaves of smaller plants.
- Long term (1 year onwards) – Monitor and re-treat all new growth. Ensure monitoring happens yearly at all locations where treatment occurs to ensure that long dormancy periods do not allow the contaminated location to become forgotten and not be monitored.
- Ensure that all major developments on sites with contaminated soils and this plant have an approved method for dealing with this plant and the associated contaminated soil as part of their risk register, site work methods, project soil management plan, landscaping contract work and project outcomes.

2.5.2 Method

- (For normal grounds management) – Herbicide treatment using approved herbicides.
- Monitoring – Yearly monitoring – aim to incorporate these checks into the ground's maintenance inspections in the Grounds Maintenance Specification, in the same way as OPM is monitored and recorded.

2.6 Japanese Rose (*Rosa rugosa*) (MM and PR)

Rosa rugosa is a plant species which is native to coastal habitats in Eastern Asia. First introduced into the UK as an ornamental species, as a rootstock for other roses and as a hybrid. This species can alter soil nutrition, by increasing potassium, manganese and nitrogen. This alters the species abundance and plant numbers surrounding it to minimal native species. It can form thick monocultures, which can cause problems for landowners and the public as they are difficult to control, especially as they can coppice if cut. If growing in coastal environments, it can impact dune habitats. Its rhizomes can break off and can spread by water to new areas. The hips from this species have been known to float for up to 42 weeks (both fresh and seawater) and still be viable. Once established, growth is fast, leading to its rapid expansion over large areas of dune habitats, smothering native plant growth. It significantly reduces biodiversity by creating dense thickets that shade out open dune habitats.

2.6.1 Objective timescale

- Short term (1-5 years) – Map locations of known Japanese Rose on our sites.
- Once locations are mapped, plan new planting for the sites.
- Long term (5 years onwards) – Systematically replace this plant across our sites. Ensure continued mapping and checks to make sure that the plant has not colonised other areas of our sites via birds spreading seeds.

2.6.2 Method

- Avoidance – Monitor all landscaping contracts. Make sure that all landscaping designers and architects know that this plant is a banned plant on our sites, and that they will have to provide landscaping schemes with both the common and Latin plant names on all submissions. This helps ensure where dog roses etc. are being added as apart of naturalist planting schemes, that this species is banned for inclusion and cannot be substituted in by nurseries. If they are substituted in, contractors will be required to remove and replace with an agreed alternative at their cost.
- Manual management of existing locations – The two known locations are part of formal managed landscaping. All cuttings from the species must be treated as contaminated waste and not added to our green composting. For the location at MM, which is by the Hogsmill river, control is especially important to avoid rose hips and cuttings entering the water.
- Manual removal – Phase out this plant from our sites – dig out all plants and monitor areas for root regrowth. Plant replacement roses which do not use Rosa rugosa as any part of the plant including root stock, as well as target new floral shrub species for landscaping schemes.

2.7 Montbretia (*Crocosmia x crocosmiiflora*) (PR)

When in flower Crocosmia species are easily recognised by the distinct shape and colour of their flower heads. All are non-native in the UK. The hybrid Montbretia with relatively short stems and orange flowers, is the main species to have escaped into the wild. When not in flower, Crocosmia species are more difficult to identify. Look for rusty brown dead leaves and remains of previous years flowering heads. Montbretia was originally created in France from parent plants of South African origin. Introduced into the UK in 1880 as a garden plant. It had escaped by 1911 both naturally and through the disposal of garden waste and spread rapidly across the UK in the latter part of the 20th century. It can completely dominate habitat where it grows, sometimes excluding native plant species. Spreads mainly by rhizomes, rarely by seed. Montbretia is listed under Schedule 9 to the Wildlife and Countryside Act 1981 (NNSS, 2011).

Found to date in a few of the landscaping beds in Penrhyn Road.

2.7.1 Objective timescale

- Short term (1-2 years) – Check all sites for this plant and record and map all locations.
- Medium term – With little possibility of escaping to the wild from Penrhyn Road, look to control the growth and spread of this plant at PR. All weeding of the plant should be treated as controlled waste and disposed of accordingly.
- Long term – Ensure that this plant is not part of any proposed planting scheme at KU sites. Replace existing plants at known locations in the long term to remove this plant from our landscaping.

2.7.2 Method

- Manual removal by digging up the full plant from any beds – ensure that the corm (bulb like root structure) is also dug up when removing this plant. As rooting by the leaves are unlikely, these can be collected and mulched with the normal garden waste when surface level cutbacks are undertaken. Any seed heads on plant stems need to be treated as contaminated waste and added to the contaminated waste holding areas.

2.8 New Zealand Pigmyweed (*Crassula helmsii*) (PR)

New Zealand Pigmyweed is native to coastal regions of southern Australia, Tasmania and New Zealand, it was brought to UK in 1911 for sale as an "oxygenating plant" for ponds. The first dispersal into the wild was probably either by natural vectors from garden ponds or when the contents of aquaria or ponds were emptied out. It first recorded in the wild in UK at Greensted Pond in Essex in 1956 (NNSS 1999). It has been found in the pond in the forensic garden at Penrhyn Road, but in recent years, appears to have been outcompeted by Floating Pennywort (see Section 2.2). This pond should still be classified as being contaminated by this plant, until the pond is removed/replaced in the future.

New Zealand Pigmyweed may cover small ponds to a depth of 0.5m or cover the margins and bed of larger deeper waterbodies. It grows in ponds, lakes, reservoirs, canals and ditches as well as on damp mud on the margins of ponds and reservoirs impacting the ecology of ponds by causing extensive decline in native plants. Dispersal in UK is almost certainly entirely by vegetative fragments, of which even a single node on 10mm of stem can root to form a new plant. It flowers abundantly and produces seed but attempts to germinate these have failed and they may not be viable. In addition, turions; short shoots with very short internodes, which break off easily, are produced in the autumn and as these float, they are an effective means of colonisation within wetland systems. It is likely that dispersal to new areas is mainly anthropogenic, by movement of vegetative fragments on boats, machinery used to manage water bodies, clothing and possibly on the legs of animals such as wildfowl (NNSS 1999). With restrictions on chemical use near water, management tends to largely rely on sustained and labour intensive mechanical and manual clearance.

2.8.1 Objective timescale

- Short term – Control the growth in existing locations in the Penrhyn Road forensic garden pond.
- Long term (3-5 years) – Replace the pond in this garden completely remove all infected soil and sediment, compost these in the onsite invasive compost heap in the garden.

2.8.2 Method

- Manual management of existing locations – Continue to thin out this plant each autumn with the help of volunteers. Compost on site to remove the risk of offsite transport.
- Long term – See Section 2.2.2 for full details.

2.9 Rhododendron (All species on site at Kingston Hill)

Rhododendron dominates the areas in which it grows, spreading tall and wide to the detriment of the surrounding environment. The shading effect of its canopy and speed of growth, combined with its non-native nature, means that very little lives on, in or beneath it, producing a dark and sterile under-canopy. Pre 2012 Rhododendron was not systemically controlled at Kingston Hill, resulting in a woodland with large swaths with no successional woodland growth and no natural tree colonisations.

The most effective method of sustained clearance on our sites, has been from a combined method of cutting, levering and chipping. This has been far more effective than cutting combined with herbicide treatment (details for the separate methods are outlined in Parrott and MacKenzie, 2013), with either combination, regrowth does occur. However, the herbicide method produced large areas of regrowth over large established and spreading root plates which could not be cleared easily. With the combined method, regrowth can happen from smaller fragments of roots in the ground, which are easier to pull out, leading to smaller and weaker plants.

Full eradication will be a long term rather than short term goal and will only be achieved if there are no breaks in management practices. Replanting of cleared areas (outside of natural colonisation) can only happen after approximately 3 years of the area being kept Rhododendron free, to minimise regrowth around establishing trees, which will compromise the new planting, and be far harder and more time-consuming to remove.

2.9.1 Objective timescale

- Short term (1-15 years) – Continue to reduce the Rhododendron growth and vigour over the next 10 years across the university grounds.
- Long term (15 years onwards) – Work to eradicate the Rhododendron in areas where it cannot be removed quickly (over badger setts) after succession planting has taken hold. As areas around setts cannot be dug, plants in these areas will have to be treated with herbicides.

2.9.2 Method

- Manual removal – Cutting down stands of Rhododendron to a height of approx. 1.5-2m, then using the remaining tall stump as a fulcrum to lever out the roots from the ground. Pull out all new regrowth from root fragments while also using these to dig out the remaining viable roots.
- Herbicide treatment – For large shrubs over badger setts/in dangerous locations. Cut down/reduce the canopy spread as much as possible (hand tools only around badger setts). Then treat the remaining plant with specific herbicides to weaken and potentially kill the plant. Continue to manage the regrowth from this area to stop the plants increasing in volume.
- Chip all clean arisings which are small enough to chip – This will remove the viability of these sections re-rooting. All items too large to chip must be stacked off the ground to minimise re-rooting, and then the root materials which are too contaminated with soil to chip are stacked on top. These piles can be utilised by wildlife as habitats, but they must be monitored to ensure that Rhododendron sections do not re-root before they dry.

2.10 Variegated Yellow Archangel (*Lamiastrum galeobdolon subsp. Argentatum*) (KH)

Variegated Yellow Archangel is an invasive plant species that is native to Europe and Asia. It was first recorded in the wild in Oxfordshire in 1974. It has become a significant problem in the UK due to its ability to spread quickly, forming dense mats that outcompete native plant species. While its ability to naturally colonise more ancient woodland is not well documented in Europe, once it enters a woodland through both fly-tipping of garden waste as well as deliberate introductions to "beautify" the countryside, it can spread, impacting ground flora communities. Evidence from North America provides cases of invasion of natural woodlands (NNSS, 2019). It can also cause problems in woodlands by preventing the growth of young trees and reducing biodiversity. Each plant also produces hundreds of seeds (TCV 2023).

This plant has been introduced to the woodland at Kingston Hill via extensive garden vegetation fly-tipping which occurs on the public footpath, as well as into the woodland over the boundary fence, to the north of our site.

2.10.1 Objective timescale

- Short term (1-3 years) – Map the locations of this plant and try to establish how far its spread from the original infection point.
- Short-long term (2 to 3 years onwards) – Work with contractors to manually remove this plant once a year to help reduce the plant in the woodland and if future capacity allows, to use volunteer sessions to remove this plant from our woodland.

2.10.2 Method

- Manual management of existing locations – Digging up the plant and removing it from the site is an effective method of control, taking care to remove all the roots as well as the stems and leaves. As with Japanese Knotweed, this plant is classed as controlled waste and needs to be disposed of properly.
- If vegetation is being stored on site, it needs to be isolated from the composting streams at Kingston University and treated with an appropriate non-glyphosate based herbicide to kill the plant.

2.11 Virginia Creeper (*Parthenocissus quinquefolia*) (PR,KH)

Virginia Creeper is an invasive species that is native to North America, it is grown as an ornamental plant in the UK primarily for its vibrant autumnal foliage. However, its aggressive growth habit means it climbs over other plants, smothering them and reducing biodiversity. It can also damage buildings by growing into cracks and causing structural damage. It was added to the legislation as an invasive species in 2010. We have two instances of Virginia Creeper on university campuses; we have the species at Kingston Hill where it was planted as part of formal landscaping schemes, and we have it on the periphery of Penrhyn Road where it has come into our site from a neighbour's garden. The False Virginia Creeper (*Parthenocissus inserta)* is also on the invasive species list.

2.11.1 Objective timescale

- Short term (1-2 years) – Map locations of known Virginia Creeper and any instances of False Virginia Creeper on our sites.
- Control the growth in existing locations.
- Medium term (2-3/5 years) – Decide which locations the plant can be replaced with alternative climbing plants and plan for long term eradication.
- Long term (3/5 years onwards) – Eradicate this plant and replace with other climbing species.

2.11.2 Method

- Avoidance – Monitor all landscaping contracts. Make sure that all landscaping designers and architects know that this plant and the related False Virginia Creeper is a banned plant on our sites.
- Short term – Manual management at existing locations – control the plant to our borders where it is coming in from neighbouring properties. Limit the growth of the plant on our site to the current locations and reduce the spread of the plant outside of these.
    - Where long term climbers are desired as part of landscaping: find alternative climbing plants to replace the invasive plant.
    - Stem inject the plants to kill the main sections (with a non-glyphosate product).
    - Retain the dead structural woody growth on the walls to act as a climbing lattice with wiring reinforcement.
    - Then cut off the rooting areas and dig up all roots.
    - Monitor to ensure that there is no regrowth for at least 3 years.
- Long term (3 years post treatment (or 2 if the treatment appears to have worked very well)) – Plant new climbers in the locations, trail them through the remaining woody lattice of the dead Virginia Creeper and allow new plants to establish.
    - Continue to monitor all historic locations which contained Virginia Creeper every 2 years to ensure that there is no new growth from new site invasions or missed root stock remnants.

2.12 Bamboo – all species (site specific for KH, but to adopt throughout other campuses where possible).

Bamboos are a diverse group of mostly evergreen perennial flowering plants from the grass family Poaceae. Studies have shown that regardless of bamboo being native or exotic in a region, it can become invasive in some ecosystems, even when a bamboo species is not listed as having spreading characteristics. (Tanganeli Buziquia *et al.*, 2019).

Areas of the Kingston Hill Woodland have an abundance of bamboo, some of which has escaped into the woodland margins from older landscaping schemes at the university and others having colonised the woodland from adjacent gardens where they have been cultivated as visual screening. Where the bamboo is well established, it has caused the complete loss of an understory ecosystem in parts of the woodland. Some varieties of bamboo are notoriously difficult to eradicate because of their deep and far-reaching root systems. Digging up of the root system is key to reducing bamboo where we have been successful in thinning out the bamboo coverage. Stem injection has been very hit and miss for effective removal.

2.12.1 Objective timescale

- Short term – Map the locations of new bamboo colonisation in the woodland and mark up areas where control with the help of volunteers may be tricky due to terrain. Try to establish how far it has spread from the original infection point.
- Short-medium term (1-10 years) – Aim to continue to remove bamboo with the help of volunteers and contractors, with an aim to eradicate all bamboo from Kingston Hill campus in the next 10 years.
- Long term (10+ years) – Continue to monitor the woodland every two years for bamboo to find new locations of colonisation or areas where regrowth from root fragments have occurred.

2.12.2 Method

- Continue to manually dig up the roots of all bamboo stands. Treat the roots and cuttings as controlled waste and remove rather than attempt to compost.
- Cut stems can be reused (once dry) in local insect hotels where they are created on our campus or given to local groups to create insect hotels with the warning about not allowing the plant to root from cuttings.
- Where possible work with volunteers to dig out the roots, but in difficult terrain such as sloped areas, contractors will have to be used to allow for safe effective working using an established harness system.

2.13 Cherry Laurel (*Prunus laurocerasus*) (site specific for KH)

Native to the Balkan region of southeast Europe and western Asia. Planted in UK by the early 17th century, recorded in the wild by 1886. Spreads by layering from where is has been planted, to form dense stands. Also produces abundant fruit. Still available as a hedging plant with various cultivars sold as garden ornamentals. The fruits are eaten by birds and the seeds dispersed in their droppings. The leaves are toxic and avoided by herbivores. It can be invasive in the shrub layer of woodlands, it is shade tolerant, but itself casts a dense shade that excludes other species from both the shrub and field layers, and ultimately prevents the regeneration of canopy trees (NNSS, 2019).

While not on the main invasive species legislation, Cherry Laurel is classed as a Category 3 on the LISI list. Which defines it as a species of high impact or concern which is widespread in London and require concerted, coordinated and extensive action to control/eradicate. However, this species is one which is readily used by nesting birds at our Kingston Hill woodland and local bird surveyors have found it particularly useful for blackbird and song thrush (A.Fure, 2023). Cherry Laurel acts in a similar way to Rhododendron in our woodlands. However, until all listed invasive species are removed from the woodland, targeting Cherry Laurel will be of low priority. Long term there will be a need to find a management balance accounting for the positive impacts for birds with the negative impacts on the woodland flora on our sites.

2.13.1 Objective timescale

- Short term (1-5 years) – Continue to monitor the occurrence and extent of the species in our woodland and other sites and map all locations.
- Short term (1-5 years) – Remove all young saplings and areas where the plant is spreading readily from established trees in the woodland.
- Medium term (5-15/20 years) – Retain scattered specimen trees in the woodland, monitor their extent and periodically control the extent of growth in spots. Leave all cut arisings in the woodland and use for dead hedging in areas to create more cover for birds.
- Medium term (5-15/20 years) – Plant other native or non-invasive species which offer the same benefits to target bird species.
- Long term – Once we achieve aims to eradicate Rhododendron from our woodlands, we can reassess the status and benefits of the Cherry Laurel on our sites and look to eradicate this species from Kingston Hill if it is appropriate.

2.13.2 Method

- Removal using arboricultural contractors (with appropriate Tree Protection Order licences as applicable), retaining deadwood on site and tall monoliths where possible. Dead hedge the cut material to create more structure within the northern woodland at Kingston Hill.

2.14 False Acacia aka Robinia (*Robinia pseudoacacia*) (KH)

Introduced into UK in the 1630s, this plant was found in the wild by 1888. Planted as an ornamental tree in parks and streets, also in land reclamation schemes on brownfield sites. Widely naturalised and invasive in mainland Europe, especially towards the south, locally persistent by suckering, but also sometimes self-seeding, especially in southern and eastern counties of England. Environmental impacts are reported in central and southern Europe, where it invades semi-natural habitats (NNSS 2019). The presence of nitrogen-fixing root nodules leads to eutrophication of invaded sites. This species is listed under Category 4 of the LISI list where it is classed as a species which is widespread for which eradication is not feasible but where avoiding spread to other sites may be required (London Biodiversity Partnership, 2014). The species can live for 60-100 years typically, but there are records from Europe of trees which are 300 years old. While it is reported that the threat in Britain is less serious as it colonises mainly urban and brownfield sites. This species is a threat at Kingston Hill as it is spreading throughout the northern section of the woodland at Kingston Hill, the source of the spread being mature trees which would have been planted at least 60 years ago.

2.14.1 Objective timescale

- Medium term (5-10 years) – Where capacity allows, continue to dig up all saplings from the woodland around mature trees on our site with the help of volunteers and work with contractors to annually clear the saplings where funding permits.
- Long term (10+ years) – Work to secure funding to remove all of the saplings from our sites and look to remove – where appropriate the mature trees from our woodland site, replacing them with large standards of a native species appropriate to that area of the woodland as part of the works to regenerate the health of the woodland from the impacts of non-native species and thus retain the Grade 1 Borough listing of the SINC.

2.14.2 Method

- Manual removal by digging up all saplings and removing their roots.
- Cutting down the mature trees on a slow cycle and replacing with heavy standards of native trees. Where possible (so long as they are not viable and are safe to retain (not on steep slopes)) retain the dead trunks as standing deadwood monoliths for invertebrates or create large log piles. Short stumps (of a height that is shorter than the widest diameter or of the above ground trunk) can be retained on steep slopes, as the risk of falling over into other areas is removed. Retain some of the freshly cut limbs at the time of felling (where appropriate) for immediate donation to the Kingston School of Art for use by students on courses such as product design. If there is no immediate use, the material will be used in habitat piles. Once they are used for any habitat piles, there will be no future dismantling for courses etc.
- Chip all shrubby growth into mulch on the woodland floor away from tree stumps.

2.15 Snowberry (*Symphoricarpos albus*) (site specific for KH)

The Snowberry shrub was introduced into Europe in the early 19th century from North America, a deciduous shrub that produces pink flowers in the summer, and white berries in the autumn and winter, it has been planted often for ornamental visual interest in landscaping schemes. As with the other non-natives, Snowberry can grow prolifically, forming a dense thicket which suppress the growth of other species. It is listed under Category 2 in LISI, which categorises it under "species of high impact or concern, present at specific sites that require attention (control, management, eradication etc)". The Woodland Trust also notes that non-native species such as Snowberry, Himalayan Balsam and Rhododendron are encroaching into our woodlands and competing with our native plants (Ebsford Environmental, 2021).

2.15.1 Objective timescale

- Short term (1-2 years) – Map all known locations of Snowberry on KU sites.
- Long term – Eradicate this species from our sites and ensure that it is not part of any proposed or accepted landscaping schemes on KU properties.

2.15.2 Method

- Manual management of existing locations – Cut back to the rooting points each winter outside of the bird nesting season and then dig out. If there is no capacity with volunteers to do this in the next 5 years while Rhododendron is being prioritised, see if funding can be obtained to undertake manual removal with contractors. As with Japanese Knotweed, this plant is classed as controlled waste and needs to be disposed of properly.
- Mulch this species down for composting if the plants have no berries on them, otherwise treat as contaminated waste and remove from site.

2.16 Deep rooting invasive non-native grasses e.g. Stipas (e.g. New Zealand Stipa *Anemanthele lessoniana*) and other non-native grasses (all sites)

Non-native grass species are often used in formal landscaping schemes to provide easy-care, visual and sensory interest in landscaping schemes, with examples of Stipas and other non-native grasses easily found across KU sites as well as neighbouring public realm locations. However, many are able to easily self-seed and spread into the wider environment. This is an issue with established native grassland habitats. While species in the Stipa family are currently only deemed as invasive in the USA and UK, horticultural organisations suggest that the ability to self-seed is less of an issue in UK gardens (Gardeners World Magazine, 2021); however local evidence has shown that Stipas have escaped into species rich grasslands which are part of existing green spaces (Pers Comms A.Fure 2023), as well as having been found colonising landscaping features such as brown roofs in the case of the Town House Building where it was never added. This shows that this is an issue that has yet to be considered properly in the UK.

2.16.1 Objective timescale

- Short term (1-3 years) – Map locations of the non-native grasses found in our formal landscaping areas as well as areas where they have colonised.
- Control the growth in existing locations where the species is known to be an issue – such as the brown roofs on the Town House Building.
- Long term (3-5 years+) – Periodically check the status of the species planted against invasive species studies and look to replace all non-native species which have been evidenced to be a problem in natural habitats with alternative native grass/sedge or reed species. Where possible, these should have similar visual/sensory properties to the grasses they are replacing.
- Remove any non-native grass species from planting schemes at KH, RV, DH and TC, where the species have a higher probability of colonising significant native grassland habitats on or immediately adjacent to our site such as Richmond Park.

2.16.2 Method

- Avoidance – Monitor all landscaping contracts from 2023. Make sure that all landscaping designers and architects know that this plant and the other non-native grasses are not acceptable at the following campuses: RV, DH, KH, and TC; and discouraged in all others.
- Manual management of existing locations – Control the plant to our borders where it has been planted in the PR, KP, MM and KH landscaping locations. Treat the plant as invasive and treat all roots and cutbacks of this plant as invasive – remove from our sites and do not compost.
- Manually pull out of all brown roofs where the grass has colonised.

2.17 Non-Native Lady's Mantles: Garden Lady's Mantle (Alchemilla mollis Syn. Alchemilla acutiloba, Alchemilla acutiloba mollis, Alchemilla acutiloba var. mollis) (PR and KH). Silver Lady's Mantle (Alchemilla conjuncta Syn. Alchemilla argentea) and Crimean Lady's Mantle (Alchemilla tytthantha Syn. Alchemilla multiflora)

A recent addition to the UK Non-Native Species Secretariat portal pages. The main information covers *A.mollis*, native in the Carpathian Mountain region of southeast Europe (Bulgaria, Romania, Greece) and southwest Asia (Northern Anotalia, Caucasus, Northern Iran) (Vitkova *et al.*, 2011). Cultivated in Britain since 1874, it was first recorded in the wild in 1948, at Box Hill, Surrey (VC17). *A.mollis* has been widely grown as an ornamental plant in British gardens for over a century (NNSS, 2021). It spreads vigorously by seed and vegetative growth, so escapes are likely to have originated directly from gardens or as a result of the dumping of garden waste.

Recent reviews by botanists have highlighted the negative impact of this species on specialist grasslands where their spread and domination are at the detriment to specialist native species, including rare native Lady's Mantle. This has led to an increase in costs for some conservation organisations in controlling this species on nature reserves. As such non-native Alchemilla's as listed above should be avoided in all sites which either contain grasslands (KH and TC) or are situated near grasslands or nature reserves (MM/RV/DH). Vegetation and roots from gardening of existing species need to be treated as invasive species and not added to the composting piles at Kingston Hill to avoid accidently spreading this species throughout our sites. Native alternatives to the non-native species should be used if desired in planting schemes by landscape architects- https://www.ukwildflowers.com/Web_pages_intros_indexes/english_index.htm#L has a list of the native species and their current distribution.

2.17.1 Objective timescale

- Short term (1-3 years) – Map locations of known Non-Native Lady's Mantles on our sites and control the growth in existing locations.
- Long term (3/5 year+) – Remove this plant from Kingston Hill and replace with more appropriate species.

2.17.2 Method

- Avoidance – Monitor all landscaping contracts from 2023. Make sure that all landscaping designers and architects know that this plant and the other non-native Lady's Mantles are not acceptable at the following sites: RV, DH, KH, MM, and TC.
- Manual management of existing locations – Control the plant to our borders where it has been planted in the PR landscaping project and at Kingston Hill in the landscaping project in the centre of the site. Treat the plant as invasive and treat all roots and cutbacks of this plant as invasive – remove from our sites and do not compost.
- Long term (3 years onwards) – Replace this plant with another species which is not a risk to grasslands as outlined above. This might be a native Lady's Mantle species or an alternative native or ornamental species which has no known invasive tendencies at the time of selection.

3. Management, finance and behaviour changes

3.1 Management and finance

There will be costs associated with the removal of invasive flora on Kingston University campuses across all sites. Some of the costs are being met through volunteer work days managed by the Biodiversity and Landscape Manager at the lower end of the cost scale, however there is a time limitation in the number of days that can be run in this manner under the required ecological supervision.

Other invasive species such as Japanese Knotweed is being treated with the costs met as additional costs in the Grounds Maintenance contract. But this work has limitations based on the licenced methods that can be used by the team near waterways, where the majority of our Japanese Knotweed is located.

To achieve effective long-term removal of invasive plants, without further negative impacts on the environment through chemical additions to the system; extensive manual removal is needed. This has been demonstrated to have a significant impact in the areas where volunteers have worked on Rhododendron and Bamboo. However, there are higher financial costs associated with this route when skilled waged personnel are being used – as would be necessary for eradication.

Long term, implications around habitat management for Biodiversity Net Gain as a requirement for planning, may require the allocation of appropriate funds for this work via contractors.

3.2 Behaviour change

Until that time, one key change that must be achieved at Kingston University to help tackle the issue, is a behaviour based one. Which imposes changes to the design ethos of formal landscaping schemes; both to exclude all invasive species as well as species which are deemed to be invasive in natural environments but are not yet listed under primary legislation.

It should be noted that within horticultural fields, many invasive plants are still sold for landscaping projects. This demonstrates these changes must be a client lead behaviour change from expectations of senior leaders at KU to ensure that those ideals are being carried forward through influence in the design of landscaping in major developments. It cannot be something that as clients we can rely on landscape designers or architects to lead on, as current evidence across the sector and the schemes installed, all evidence:

1. the lack of ecological awareness of the impacts of proposed schemes on native species on our site,
2. the lack of consideration of how planned landscaping relates to the wider, local environment outside of site boundaries.

If this client based behavioural step change is not achieved, the university will continue to create problems with resulting financial costs, to resolve at a later date.

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