WOODY INVASIVES OF THE GREAT LAKES COLLABORATIVE

www.woodyinvasives.org

Guide to Prioritizing Removal & Replacement of Invasive Woody Plants Used in Landscaping

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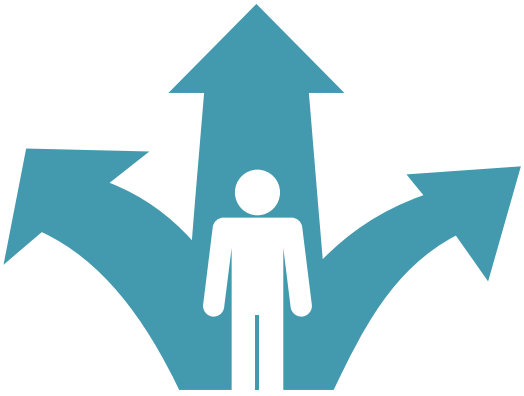

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Table of Contents

Table of Contents (cont.)

Introduction

The decision trees that form the appendices of this report (also integrated into the species profile pages on woodyinvasives.org) are intended to help users of the website, who are perhaps newly discovering that plants in their home landscaping are invasive, prioritize which species should be removed first based on risk to the surrounding environment, economy, and occasionally, to human health. In a perfect world, everybody would remove all invasive plants from their landscaping right away, but in reality, removing mature woody plants can involve a hefty investment of time and/or money. These decision trees can help citizens prioritize so that their investment in woody species removal/replacement provides the greatest environmental benefit/risk reduction.

These decision trees were developed with the residential or commercial property in mind, where the number of plants being considered for removal is relatively small. While some of the decision-making factors used here can also be applied to woodlands, conservation lands, or other larger properties, there are other important factors for managing those land-use types that have not been integrated into these decision trees.

The decision-making factors integrated into the decision trees are primarily related to a plant's ability to cause problems off site, either by starting or contributing to an invasive population or by hosting insect or disease pests. While the decision trees do not explicitly include factors related to problems a plant may cause on-site, we appreciate that these factors will likely influence property owners' thinking and that unwanted occurrences such as weediness, messy fruit or other plant parts, aggressive vegetative spread, and severe storm or cold damage may increase a property owner's desire to remove the offending plant. However, decision tree users should avoid extending this line of thinking in the other direction; a plant with known invasive potential might be well-behaved and attractive in a highly maintained landscape but can still spread and cause problems in natural areas, especially in cases where the speicies decision tree indicates a high priority for removal.

Finally, the decision trees assume that the plants being considered are not sterile cultivars. There are species, namely Japanese barberry and Callery pear, for which new sterile cultivars have been developed by university researchers and brought to market in recent years (2018-present). However, these cultivars make up a relatively small part of the market for these species. A property owner who buys a property with one of these species planted or who planted the species themselves should assume the plants are not sterile unless they specifically purchased a sterile cultivar.

Decision-Making Factors

The remainder of this guide will introduce and explain the factors used in the decision trees, how quantitative thresholds were selected and will provide guidance on how to answer the decision tree questions and where to find quality supplemental information.

Factor 1: Regulation

It is the responsibility of every citizen to know, understand and abide by the laws and regulations of the location where they live. For the most part, decisions about whether or not to remove woody invasive plants from private property are not prescribed by regulation. However, there are a few cases where jurisdictions do (or at least can) require management of certain species on private land. In these cases, the WIGL Collaborative decision trees always indicate a high priority result.

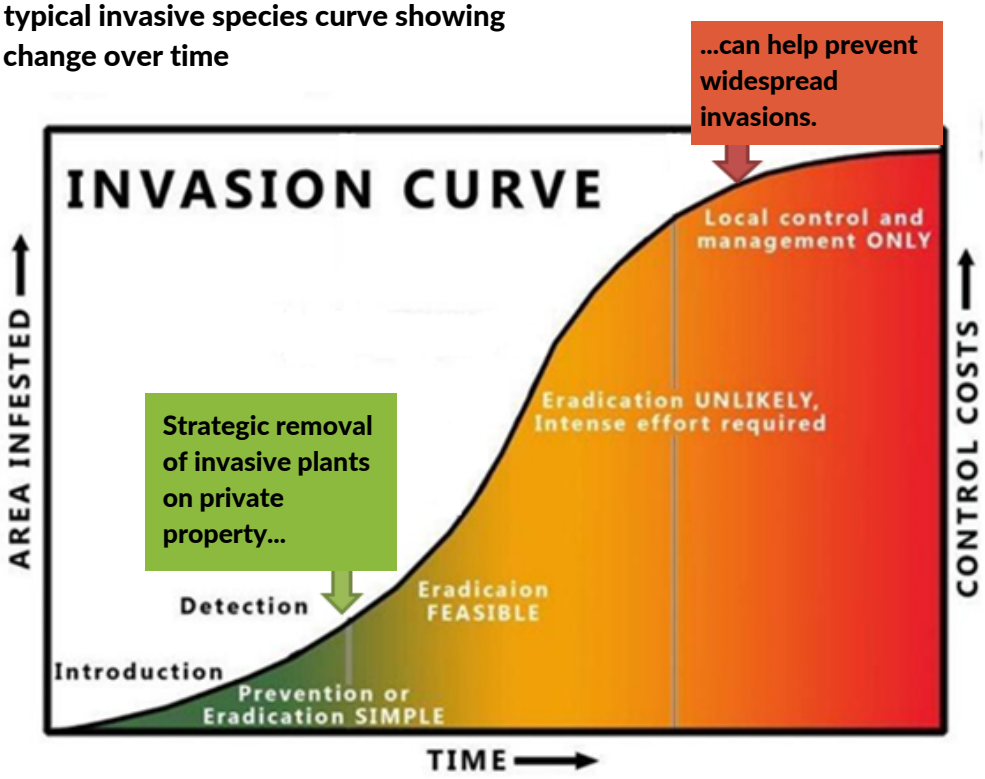
Example Factor 1 decision tree question: "Is the plant or population to be managed located in [jurisdiction name]?"

For more information: the WIGL Collaborative developed a full overview of how the Great Lakes jurisdictions regulate woody invasive plants. Find it at the project website here: https://woodyinvasives.org/regulatory-information/

Factor 2: Current local distribution

The WIGL Collaborative supports an early detection and rapid response (EDRR) model as the most efficient strategy for managing invasive plants (see Figure 1). Applied to prioritizing invasive species removal, an EDRR strategy says it is more important to remove individuals of species that either have not yet formed an invasive population locally or only have small, isolated populations outside of cultivation, assuming suitable habitat is available (see Factor 6). A private property owner can certainly can become "part of the solution" by removing a plant belonging to a ubiquitous invasive species, the potential environmental benefits of doing so are generally not as significant. The only exception to this is when considering a plant that only produces male flowers (see also Factor 3). A male plant in cultivation is actually less likely to contribute its genetics to an invasive population if there are few or no wild plants in the area.

Figure 1: A typical invasive species curve showing population change over time



Example Factor 2 decision tree question: "What is the known distribution of the species outside of cultivation in your area?"

For more information: All WIGL Collaborative invasive plant profiles include a county-level distribution map (U.S. only) from the Early Detection and Distribution Mapping System (EDDMapS). The records submitted to EDDMapS are verified for correct species identification by experts. However, EDDMapS is only useful to the extent that users have submitted reports for the location of interest. In areas where use of EDDMapS is low, invasive plants - even very common ones - are likely to be under-reported and under-represented on the maps. It may be beneficial in such cases for decision tree users to contact a local naturalist at a park district, forest preserve district, or nature center to ask about the status of the species in question in their location. Decision tree users with interest in invasive plants can help improve our collective knowledge of invasive species distributions by learning how to identify invasive plants of concern, establishing a free EDDMapS profile, and submitting reports to EDDMapS (or any similarly verified database of invasive species distributions).

Factor 3: Current or potential fruit production

Generally speaking, plants have a few more strategies for reproducing than animals do. Some plants have perfect flowers (flowers with both male and female plants) and others have male and female flowers on separate flowering structures but on the same individual plant. In either of these cases, the plant is capable of self-pollination to form fruit. However, some plant species bear male and female flowers on different individual plants. Pollen must travel from a male plant to a female plant to result in fruit production. Among invasive species, this last reproductive strategy relates to the risk of spread. A male individual of a potentially invasive species growing in a garden cannot establish or contribute to the invasive population if there are not females of the same species nearby. Among invasive species with separate male and female plants, removal of male/seedless plants is generally of lower priority than removal of female/fruit-bearing plants. Decision tree users should keep in mind that all plants are fruitless before they reach maturity and that woody plants can take several years to reach maturity. Any immature plants of unknown sex should either be assumed female or monitored carefully for fruit production as they mature.

Example Factor 3 decision tree question: “Does the plant on your property produce any fruit?”

Factor 4: Seed dispersal mechanisms and distances

Invasive woody plants growing in gardens and other maintained landscapes only pose risk to vulnerable habitats when their seeds can readily reach those habitats. Seed dispersal mechanisms among the woody plant species considered by the WIGL Collaborative are (in order from highest to lowest potential spread distance): surface water, birds and wildlife, gravity assisted by wind, and simple scatter. Table 1 on the following two pages lists the distribution mechanisms exhibited by the woody species covered by the WIGL Collaborative.

<u>Seed dispersal by surface water</u>

Species whose seeds spread by movement in water are usually adapted to grow in near-shore (riparian) areas, or are habitat generalists that can at least tolerate riparian conditions. Fruits often fall from the plants directly into the nearby water body or are carried there by wind. Once in water, fruits are carried by currents for a time before eventually being deposited elsewhere. (Continues on page 7)

Table 1: Woody invasive species and their known means of seed dispersal

Species	Surface water	Animal - birds	Animal - deer	Animal - other	Wind	Simple scatter	References
Amur cork tree *Phellodendron amurense*		✔				✔	Wisconsin DNR 2017
Amur honeysuckle *Lonicera maackii*	✔	✔	✔			✔	Bartuszevige & Gorchov 2006, Guiden et al. 2015, McNeish & McEwan 2016
Amur maple *Acer ginnala*	✔				✔	✔	Minnesota Dept. of Ag. 2021
Asian bittersweet *Celastrus orbiculatus*		✔				✔	Fryer 2011
Autumn olive *Elaeagnus umbellata*		✔	✔			✔	Munger 2003 (a), Williams et al. 2008
Black alder *Alnus glutinosa*	✔					✔	McVean 1955
Black locust *Robinia pseudoacacia*	✔					✔	Stone 2009 (a), Säumel & Kowerik 2013
Border privet *Ligustrum obtusifolium*		✔				✔	Munger 2003 (b)
Bush honeysuckles *Lonicera spp.*		✔	✔			✔	Munger 2005
Callery pear *Pyrus calleryana*		✔				✔	Culley 2019
Common barberry *Berberis vulgaris*	✔	✔				✔	Gucker 2009
Common buckthorn *Rhamnus cathartica*		✔				✔	Minnesota Dept. of Ag. 2021
Glossy buckthorn *Frangula alnus*	✔	✔				✔	Gucker 2008, Hampe 2004

(Table 1, continued)

Species	Surface water	Animal - birds	Animal - deer	Animal - other	Wind	Simple scatter	References
Japanese barberry *Berberis thunbergii*		✔				✔	Zouhar 2008
Japanese honeysuckle *Lonicera japonica*		✔	✔			✔	Munger 2002 (a), Williams et al. 2008
Multiflora rose *Rosa multiflora*		✔	✔		✔	✔	Munger 2002 (b)
Norway maple *Acer platanoides*	✔				✔	✔	Säumel & Kowerik 2013
Porcelain berry *Ampelopsis brevipedunculata*	✔	✔	✔			✔	Waggy 2009
Russian olive *Elaeagnus angustifolia*	✔	✔	✔			✔	Zouhar 2005
Siberian elm *Ulmus pumila*					✔	✔	Extension Foundation 2019
Tree-of-heaven *Ailanthus altissima*	✔				✔	✔	Landenberger et al. 2007, Säumel & Kowerik 2013
White mulberry *Morus alba*		✔	✔	✔		✔	Stone 2009 (b)
White poplar *Populus alba*					✔	✔	Gucker 2010
Wineberry *Rubus phoenicolasius*		✔	✔	✔		✔	Innes 2009, Williams et al. 2008
Winged burning bush *Euonymus alatus*		✔				✔	Fryer 2009
Wintercreeper *Euonymus fortunei*		✔				✔	Zouhar 2009

(Continued from page 4)

In a developed setting, movement by water can also occur when plants adapted to riparian situations are planted near stormwater drainages, ditches or catch basins, which convey fruits or seeds to waterways. The distance water-borne seeds travel varies by species and local conditions and is not well studied. However, the potential for long-distance spread on the scale of miles is generally high, particularly when the seed is adapted for this type of transport (Säumel and Kowarik 2010). WIGL Collaborative decision trees indicate high priority removal for water-dispersed species growing in a situation where their seeds are likely to be conveyed to surface waters.

Example Factor 4, water-dispersed species, decision tree question: "Is the plant growing immediately adjacent to a body of water, wetland, stormwater ditch or catch basin?"

Seed dispersal by birds, deer and other animals

Invasive woody species whose seeds are spread by birds and wildlife often produce fleshy fruit that attract these animals. The fruit are either eaten directly from the plants or fall via gravity and are eaten off the ground. The animals then move around and deposit the seeds elsewhere. The pattern of dispersal of these seeds, called a seed shadow, is determined by many factors including but not limited to the size and characteristics of the fruit, fruit-eaters' food preferences, the gut biology and foraging behavior of the fruit-eating species, and characteristics of the landscape. However, most seed dispersed by fruit-eating animals is shed relatively close to its point of origin. For example, there seems to be rough consensus in literature that fruit-eating birds deposit most seeds within 100 m/328 ft of the parent plant (Wotton and McAlpine 2015). That said, studies indicate that some small percentage of seed is carried farther, and in some cases much farther. Seed shadows of wildlife-dispersed species typically follow a long-tailed distribution pattern, sometimes also called an exponential decay curve (see Figure 2).

To fully understand how invasive plants in cultivation can contribute seeds and start invasive populations off-site, we need to be able to estimate the seed-travel distances close to the end of the long tail of the seed shadow curve. Studies on fruiting species with similar seed characteristics to most of the fleshy-fruited species covered by the WIGL Collaborative have found maximum bird-dispersal distances of 500 m/0.31 mi (Kohri et al. 2011), 1025 m/0.64 mi (Jordano 2007), and 1200 m/0.75 mi (Setter et al. 2002). The WIGL Collaborative decision trees use the most conservative number of

of 0.75 miles to represent maximum anticipated radius of the seed shadow generated by fruit-eating birds. Seed shadows associated with deer browse likely have longer tails. Deer take longer than birds or smaller mammals to digest food and deposit seeds, allowing more opportunity for long-distance movement. In a study looking at deer movement and distribution of plant seeds, Williams et al. (2008) found that deer moved up to 2000 m/1.24 mi on 96% of days during the study period. The same study estimated a digestion time of 23 hours among deer for non-fibrous foods based on literature values and thus concluded that almost all seed consumed by deer was deposited within 1.24 miles of its origin. The WIGL Collaborative decision trees use this distance (rounded to 1.25 miles) to represent the seed shadow radius of species reported in literature to be browsed by deer during fruiting.

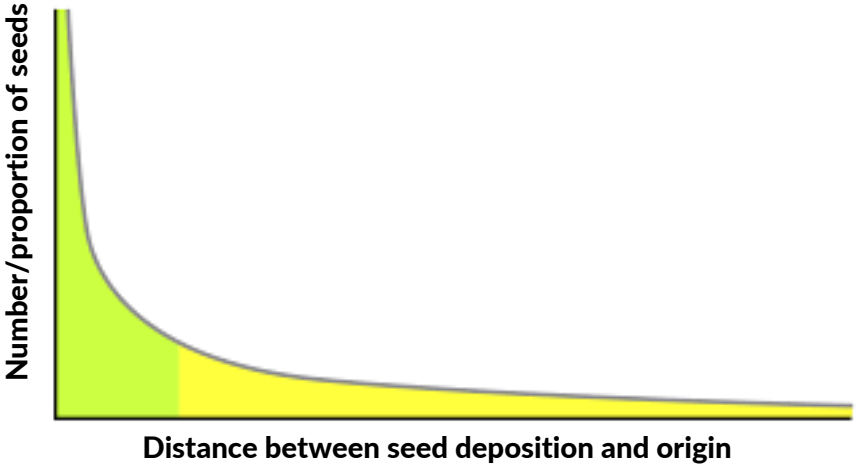


Figure 2: A representative seed shadow distribution pattern. The portion of the distribution in green is sometimes called the pillar, while the yellow portion is the long tail.

A final note on seed distribution by wildlife is that we were not able to quantify anticipated long-distance dispersal associated with predators. It has been demonstrated that predators such as foxes, coyotes, owls and raptors can contribute to long-distance invasive plant dispersal by either by consuming fruit directly or by preying upon birds and small mammals with undigested seeds in their guts. The predators then play a secondary role in dispersing the seeds, and typically travel much further than herbivores. Research has shown that this type of seed dispersal does occur, likely does contribute to long-distance dispersal of invasive plant seeds, and in may even increase seed germination rates compared to seeds that are dispersed only by the primary consumer (Hämäläinen et al. 2015). However, the extent and distances associated with this phenomenon have not been reliably quantified. Similarly, we are not able to quantify human spread of invasive plant seed, though again, it is known that people can and do

unintentionally spread invasive plant seed. For example, if a person has an invasive fruiting tree on their property, it is entirely feasible that they could do yard work under the tree, get seed stuck in the tread of their shoes, and go for a hike miles away wearing the same shoes and spread the seeds, assuming the shoes are not cleaned between activities. A property owner who wants to be completely certain that their landscape plants are not contributing to invasions should either place high priority on removing all plants bearing fleshy fruits or be very careful about cleaning all apparel and equipment that comes into contact with fruit or seeds.

Example Factor 4, animal-dispersed species, decision tree question: "Is the plant growing within [vector-specific distribution distance, e.g. 0.75 miles for birds, 1.25 miles for deer] of suitable habitat for the species?"

Seed dispersal by wind

Wind dispersal of plant seeds also follows the long-tailed distribution pattern displayed in Figure 2 (previous page). For example, a study found that while most tree-of-heaven (*Ailanthus altissima*) seeds are deposited within 50 m/164 ft of the parent tree, a small proportion of seed was consistently found 100 m/328 ft from the nearest seed-bearing tree, which was the boundary of the study area (Landenberger et al. 2007). Tree-of-heaven has relatively light seeds compared to Norway maple (*Acer platanoides*), which in known to have a lower mean dispersal distance than tree-of-heaven (Martin and Canham 2010). Minnesota uses a distance of 300 ft in its noxious weed law as the maximum expected seed travel distance for both Norway and Amur maple (*Acer ginnala*). The WIGL Collaborative decision trees also use a threshold of 300 ft for these species, and for Siberian elm (*Ulmus pumila*), for which seed dispersal data could not be found in literature. A threshold of 400 ft is used for tree-of-heaven, due to its observed ability to spread seed at least 100 m.

Example Factor 4, wind-dispersed species, decision tree question: "Is the plant growing within 300 ft of suitable habitat for the species?"

Seed dispersal by simple scatter

The seed shadows for species with heavy seeds that are dispersed primarily by gravity are thought to be fairly small in the absence of surface water or animal assistance. The seed shadow radius in these situations is likely only slightly larger than the crown width of the parent plant.

Example Factor 4, scatter-dispersed species, decision tree question: “Is the plant growing immediately adjacent to suitable habitat for the species?”

Decision Tree Factor 5: Vegetative reproduction

Vegetative reproduction in woody plants occurs when plants spread either by sending up clonal shoots from the roots or rhizomes or by growing new roots from branch tips or from above-ground creeping stems. In the absence of seed production, vegetative growth from cultivated plants is only a problem off-site when the plants are grown immediately adjacent to a suitable habitat along the property line. Vegetative growth can certainly cause additional problems onsite.

Example Factor 5 decision tree question: “Is the plant growing immediately adjacent to suitable habitat for the species?”

Decision Tree Factor 6: Proximity to suitable habitat

Seed from a plant used in landscaping must arrive in suitable habitat for seed germination and plant survival in order to either start or contribute to an invasive species population.

Example Factor 6 decision tree question: “Is the plant growing within [expected distribution distance] of suitable habitat for the species?”

For more information: The first element to consider is cold hardiness, which can be found in the “distribution” section of each WIGL Collaboriate species profile. If the species in question is not reliably cold hardy in the location being considered, it will generally not find suitable habitat. That said, species that were previously not seed-hardy in northern locations may eventually become hardy due to the effects of climate change. The second thing to consider is general habitat type. Each WIGL Collaborative species profile contains a list of frequently invaded habitats in the “habitats invaded” section. From there, we recommend using an online map tool with an aerial photo layer (or WIGL's interactive decision support tool) to determine whether the listed habitat types occur within the specified distance from the cultivated plant.

An additional note on Factor 6 is that many invasive species are particularly adept at growing in very disturbed conditions that people don't typically think of as habitats or natural areas worthy of protection. A person may not particularly care if the railroad right-of-way, old field, or abandoned commercial lot a quarter mile from their property becomes invaded. However, these disturbed, low quality habitats can easily become stepping stones from which seed spreads further and further over generations, eventually reaching parks, forest preserves, and other natural areas.

Decision Tree Factor 7: Hybridization with high-value native species

In some cases, invasive species are known to hybridize with high-value or relatively rare native species, impacting the native species' ability to successfully reproduce. This is usually of greatest concern when pollen-bearing invasive plants can readily contribute pollen to receptive plants of the native species. Like seed distribution, pollen movement follows a long-tailed distribution pattern (see Figure 2). For Siberian elm (*Ulmus pumila*), a species known to hybridize with a native relative, a study found a maximum pollen dispersal distance of 8 km/5 mi (Bertolasi et al. 2015). We were unable to find a pollen distribution distance for white mulberry (*Morus alba*), which similarly hybridizes with a native tree, but as it is a wind dispersed pollen-bearing tree of similar size to Siberian elm, the decision tree applies the 5 mile distance to this species as well.

Asian bittersweet, an insect-pollinated plant, is capable of cross-pollinating a native relative at distances of 100 m/328 ft, though the maximum potential cross-pollination distance could be much higher and is unknown (Zaya et al. 2021). For this species decision tree, we used 500 ft as a conservative value for potential cross-pollination.

Example Factor 7 decision tree question: "Is the plant growing within [expected pollen distribution distance] of habitat where [native species relative] is likely to occur?"

For more information: The Biota of North America Program (BoNAP)'s online plant atlas shows native plant distribution at the county level. Decision tree users may also wish to contact a local naturalist at a nearby park district, forest preserve district, or nature center to ask about the local distribution of the native species in question.

Decision Tree Factor 8: Relationship with a crop pest

Some invasive plant species act as primary or secondary hosts to known crop

pests. An invasive plant's ability to damage crops by hosting pests generally depends on its proximity to the crop in question. In the case of soybean aphid and common buckthorn (*Rhamnus cathartica*), this distance can be quantified. While soybean aphids can travel great distances on atmospheric currants and have been known to infest soybean crops in areas with little or no known buckthorn, the risk of early-season crop damage and greatest economic impact is highest when soybean occurs within 4 km/2.5 mi of buckthorn hedgerows (Bahlai et al. 2010). In cases where a precise relationship between proximity to alternate hosts and risk to crops has not been established, the decision trees indicate a higher removal priority in communities where at-risk crops are frequently grown.

Example Factor 8 decision tree question: “Is the plant near an agricultural area known for [crop type] production?”

Decision Tree Factor 9: Relationship with a human disease vector

A few invasive woody species are associated with tick species which can transmit diseases to humans. In these situations, a higher priority is suggested for removing the plant species in locations where either the disease or the carrier tick species is common.

Example Factor 9 decision tree question: “What is the incidence of [disease or vector type] in your area?”

References

Bahlai, C. A., Sikkema, S., Hallett, R. H., Newman, J., & Schaafsma, A. W. (2010). Modeling distribution and abundance of soybean aphid in soybean fields using measurements from the surrounding landscape. *Environmental Entomology*, 39(1), 50–56. https://doi.org/10.1603/EN09127

Bartuszevige, A., & Gorchov, D. (2006). Avian seed dispersal of an invasive shrub. *Biological Invasions*, 8, 1013–1022. https://doi.org/10.1007/s10530-005-3634-2

Bertolasi, B., Leonarduzzi, C., Piotti, A., Leonardi, S., Zago, L., Gui, L., Gorian, F., Vanetti, I., & Binelli, G. (2015). A last stand in the Po valley: Genetic structure and gene flow patterns in *Ulmus minor* and *U. pumila*. *Annals of Botany*, 115(4), 683–692. https://doi.org/10.1093/aob/mcu256

Culley, T. M. (2019). Protecting the future of our forests: limiting the impact of the introduced ornamental Callery pear tree. *Proceedings of the 60th Annual Meeting of the Society for Economic Botany*. Cincinnati, OH. http://econbot.org/file.php?file=sitefiles/Meetings/Conference_Program_5-30-19.pdf (accessed 12/13/21).

Extension Foundation. (2019). Invasive species: Siberian elm. https://invasivespecies.extension.org/ulmus-pumila-siberian-elm/ (accessed 12/13/21).

Fryer, J. L. (2011). *Celastrus orbiculatus*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/vine/celorb/all.html (accessed 12/13/21).

Fryer, J. L. (2009). *Euonymus alatus*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/euoala/all.html (accessed 12/13/2021).

Gucker, C. L. (2010). *Populus alba*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/popspp/all.html (accessed 12/13/21).

Gucker, C. L. (2009). *Berberis vulgaris*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/bervul/all.html (accessed 12/13/21).

Gucker, C. L. (2008). Frangula alnus. In: Fire Effects Information System (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/fraaln/all.html (accessed 12/13/21).

Guiden, P., Gorchov, D. L., Nielsen, C., & Schauber, E. (2015). Seed dispersal of an invasive shrub, Amur honeysuckle (*Lonicera maackii*), by white-tailed deer in fragmented agricultural-forest matrix. *Plant Ecology*, 216(7), 939–950. https://doi.org/10.1007/s11258-015-0480-x

Hämäläinen, A., Broadley, K., Droghini, A., Haines, J. A., Lamb, C. T., Boutin, S., & Gilbert, S. (2017). The ecological significance of secondary seed dispersal by carnivores. *Ecosphere*, 8(2), e01685. https://doi.org/10.1002/ecs2.1685

Hampe, A. (2004). Extensive hydrochory uncouples spatiotemporal patterns of seedfall and seedling recruitment in a 'bird-dispersed' riparian tree. *Journal of Ecology*, 92(5), 797–807. https://doi.org/10.1111/j.0022-0477.2004.00918.x

Innes, R. J. (2009). *Rubus phoenicolasius* . In: Fire Effects Information System (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/rubpho/all.html (accessed 12/13/2021).

Kohri, M., Kamada, M., & Nakagoshi, N. (2011). Spatial–temporal distribution of ornithochorous seeds from an *Elaeagnus umbellata* community dominating a riparian habitat. *Plant Species Biology*, 26(2), 174–185. https://doi.org/10.1111/j.1442 1984.2011.00313.x

Jordano, P. (2007). Frugivores, seeds and genes: analyzing the key elements of seed shadows. In Dennis, A. J., Schupp, E. W., Green, R. J., & Westcott, D. A. (Eds.). *Seed Dispersal: Theory and its Application in a Changing World.* (229-251). Centre for Agriculture and Bioscience International (CABI). http://dx.doi.org/10.1079/9781845931650.0000

Landenberger, R. E., Kota, N. L., & McGraw, J. B. (2007). Seed dispersal of the non-native invasive tree *Ailanthus altissima* into contrasting environments. *Plant Ecology*, 192(1), 55–70. https://doi.org/10.1007/s11258-006-9226-0

Martin, P. H., & Canham, C. D. (2010). Dispersal and recruitment limitation in native versus exotic tree species: Life-history strategies and Janzen-Connell effects. *Oikos*, 119(5), 807–824. https://doi.org/10.1111/j.1600-0706.2009.17941.x

McNeish, R. E., & McEwan, R. W. (2016). A review on the invasion ecology of Amur honeysuckle (*Lonicera maackii*, Caprifoliaceae) a case study of ecological impacts at multiple scales. The Journal of the Torrey Botanical Society, 143(4), 367–385. https://doi.org/10.3159/TORREY-D-15-00049.1

McVean, D. N. (1955). Ecology of *Alnus glutinosa* (L.): seed distribution and germination. *Journal of Ecology*, 43(1), 61–71. https://doi.org/10.2307/2257119

Minnesota Department of Agriculture. (2021). Specially regulated plants: Amur maple. https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/amurmaple (accessed 12/14/21).

Minnesota Department of Agriculture. (2021). Restricted plants: common buckthorn. https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/commonbuckthorn (accessed 12/14/21).

Munger, G. T. (2005). *Lonicera* spp. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/lonspp/all.html (accessed 12/13/21).

Munger, G. T. (2003 a). *Elaeagnus umbellata*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/elaumb/all.html (accessed 12/13/21).

Munger, G. T. (2003 b). *Ligustrum* spp. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/ligspp/all.html (accessed 12/13/21).

Munger, G. T. (2002 a). *Lonicera japonica*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/vine/lonjap/all.html (accessed 12/13/21).

Munger, G. T. (2002 b). *Rosa multiflora*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/rosmul/all.html (accessed 12/13/21).

Säumel, I., & Kowarik, I. (2010). Urban rivers as dispersal corridors for primarily wind dispersed invasive tree species. *Landscape and Urban Planning*, 94(3), 244–249. https://doi.org/10.1016/j.landurbplan.2009.10.009

Setter, M., Bradford, M., Dorney, W., Lynes, B., Mitchell, J., Setter, S., & Wescott, D. (2002). Pond apple - are the endangered cassowary and feral pig helping this weed to invade Queensland's wet tropics? In Jacob, H. S., Dodd, J., & Moore, J. H. (Eds.) *13th Australian Weeds Conference: Papers & Proceedings*. (173-176). Perth: R.G. and F.J. Richardson.

Stone, K. R. (2009 a). *Robinia pseudoacacia*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/robpse/all.html (accessed 12/13/21).

Stone, K. R. (2009 b). *Morus alba*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/moralb/all.html (accessed 12/13/21).

Waggy, M. A. 2009. *Ampelopsis brevipedunculata*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/vine/ampbre/all.html (accessed 12/13/21).

Williams, S. C., Ward, J. S., & Ramakrishnan, U. (2008). Endozoochory by white-tailed deer (*Odocoileus virginianus*) across a suburban/woodland interface. *Forest Ecology and Management*, 255(3), 940–947. https://doi.org/10.1016/j.foreco.2007.10.003

Wisconsin Department of Natural Resources. (2019). Amur cork tree is an emerging threat to Wisconsin forests. *DNR Forestry News*, April 25, 2019. https://forestrynews.blogs.govdelivery.com/2017/04/25/amur-cork-tree-is-an emerging-threat-to-wisconsin-forests/ (accessed 12/14/21).

Wotton, D., & McAlpine, K. (2015). Seed dispersal of fleshy-fruited environmental weeds in New Zealand. *New Zealand Journal of Ecology*, 39.

Zaya, D. N., Leicht-Young, S. A., Pavlovic, N. B., & Ashley, M. V. (2021). Heterospecific pollination by an invasive congener threatens the native American bittersweet, *Celastrus scandens*. PLOS ONE, 16(3), e0248635. https://doi.org/10.1371/journal.pone.0248635

Zouhar, K. (2009). *Euonymus fortunei*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/vine/euofor/all.html (accessed 12/13/21).

Zouhar, K. (2008). *Berberis thunbergii*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/shrub/berthu/all.html (accessed 12/13/21).

Zouhar, K. (2005). *Elaeagnus angustifolia*. In: *Fire Effects Information System* (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/elaang/all.html (accessed 12/13/21).

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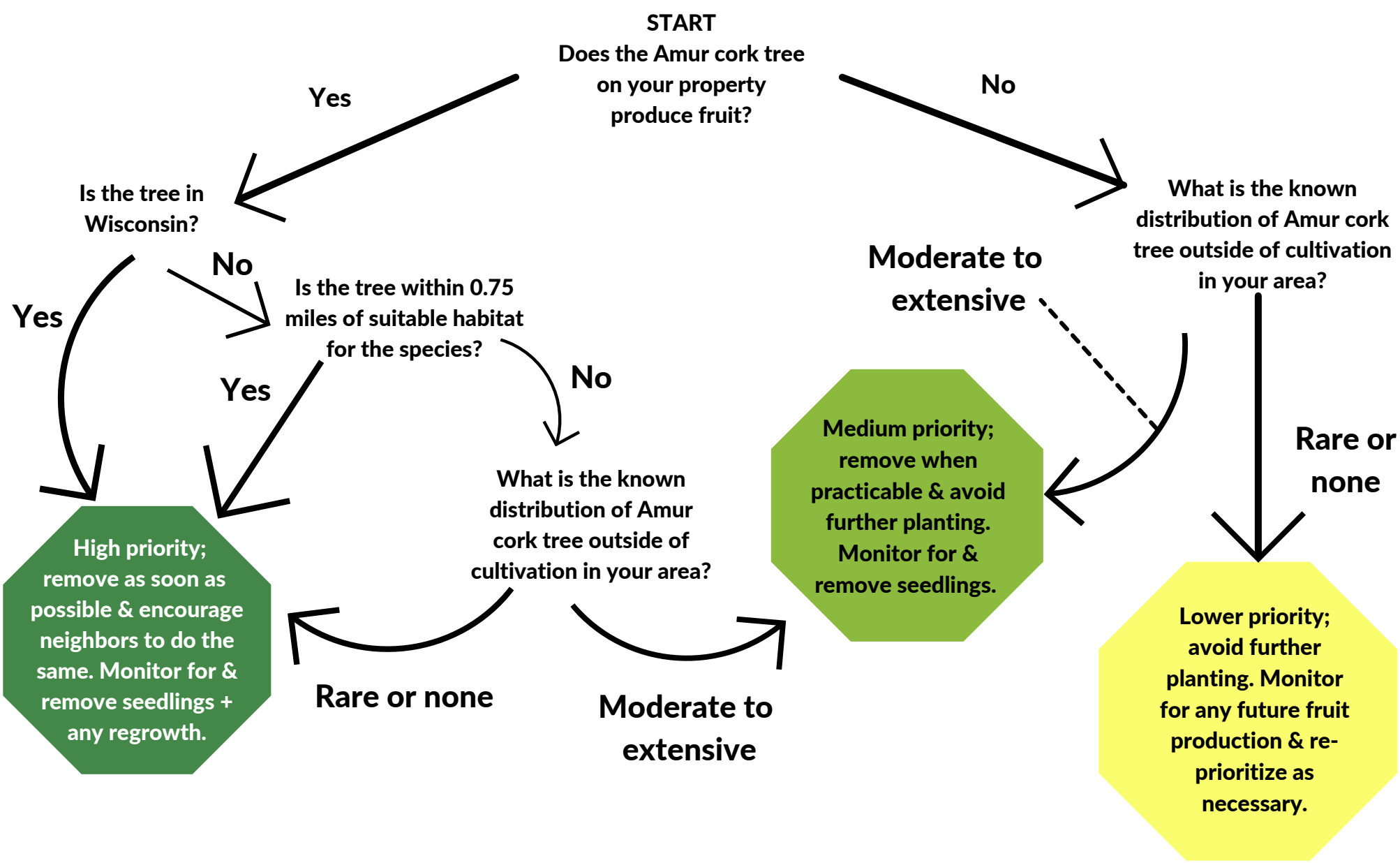

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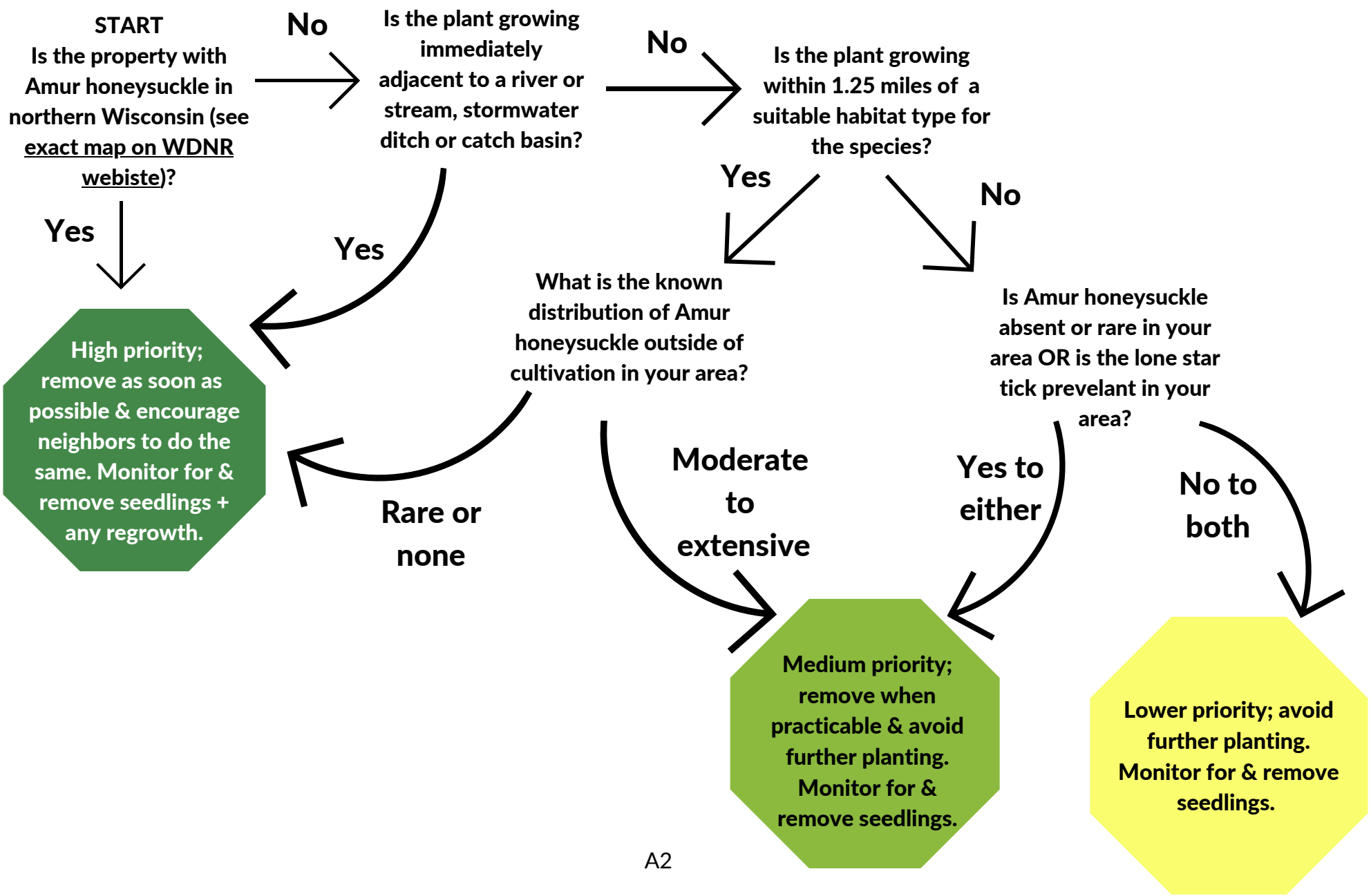

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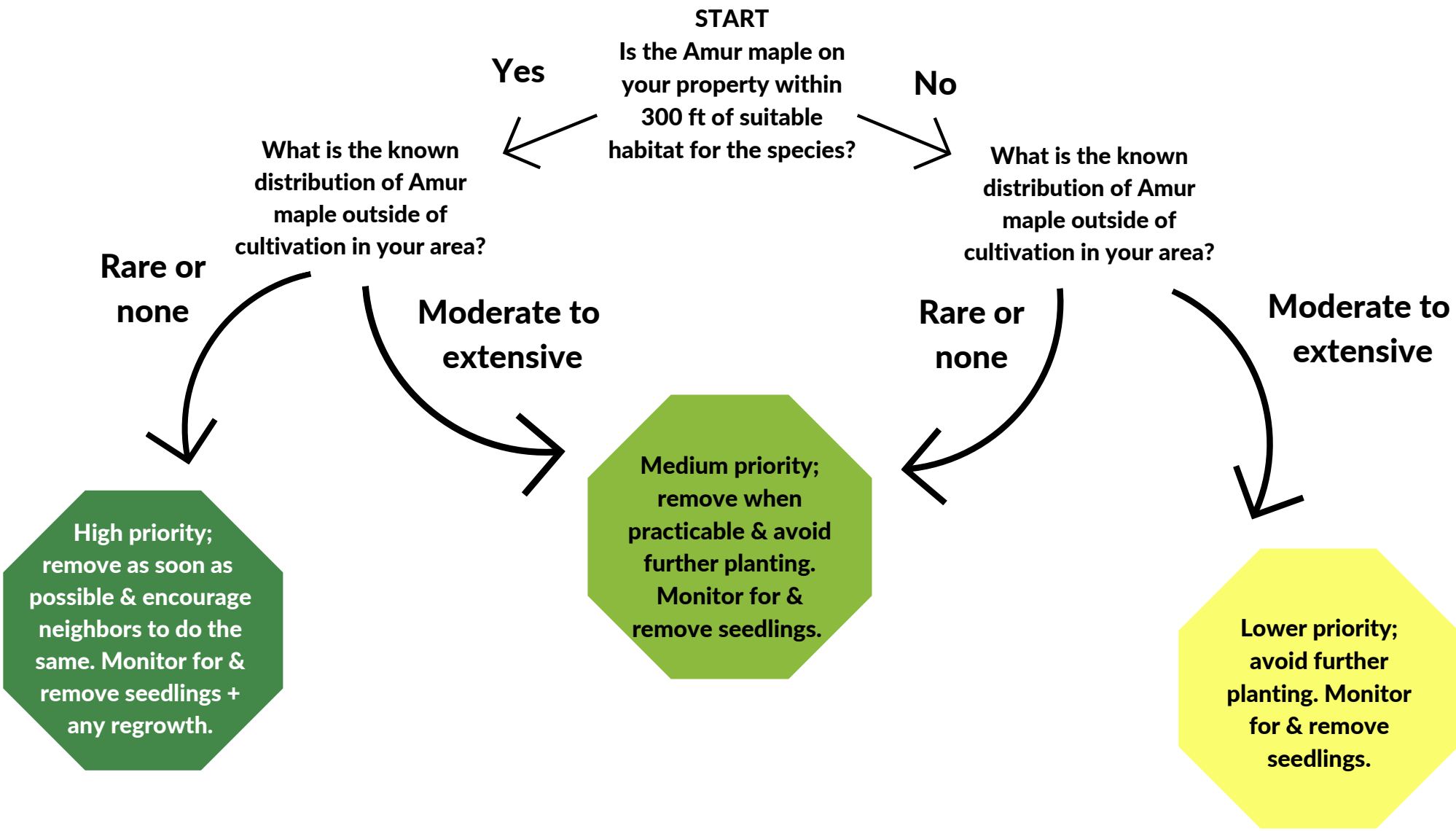

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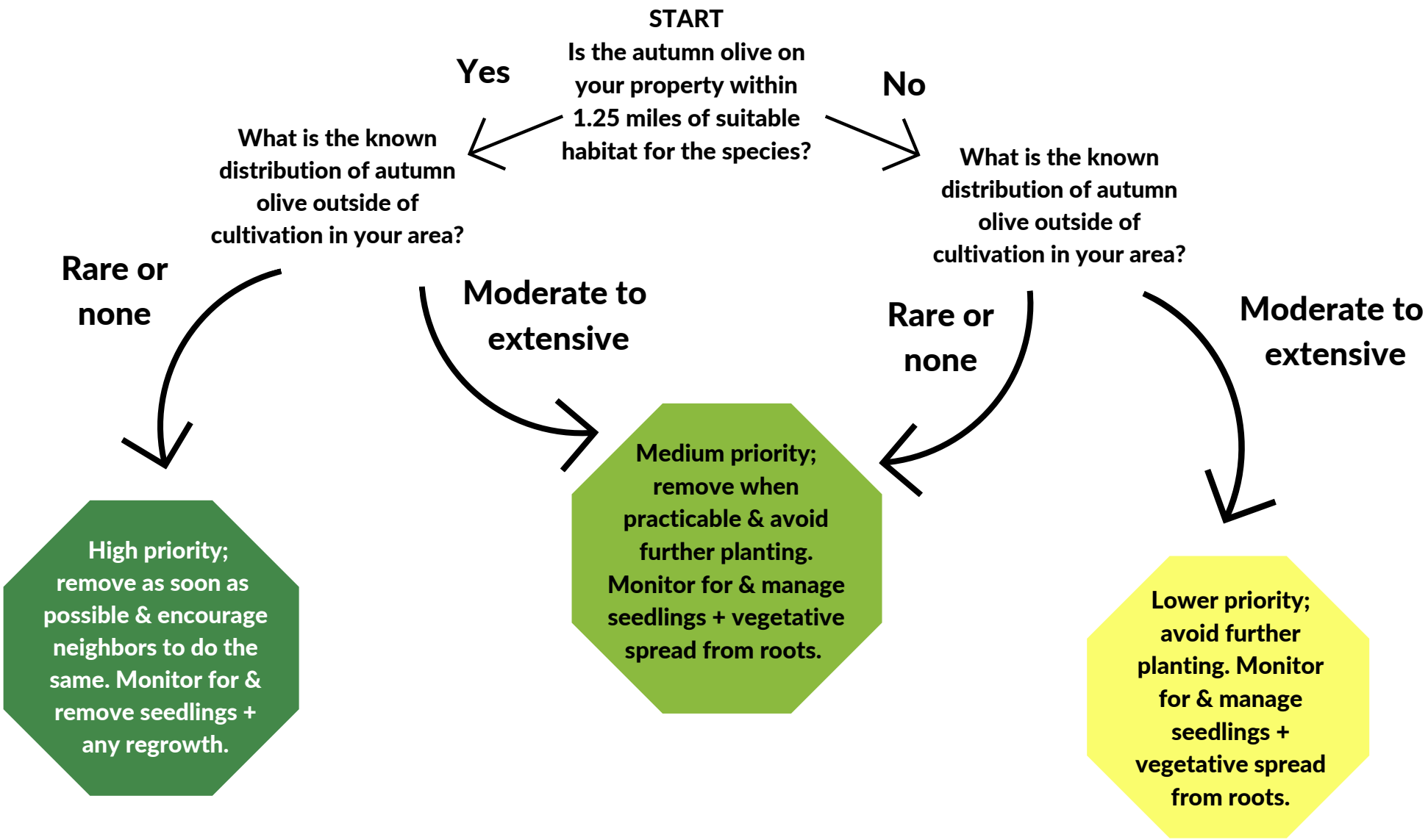

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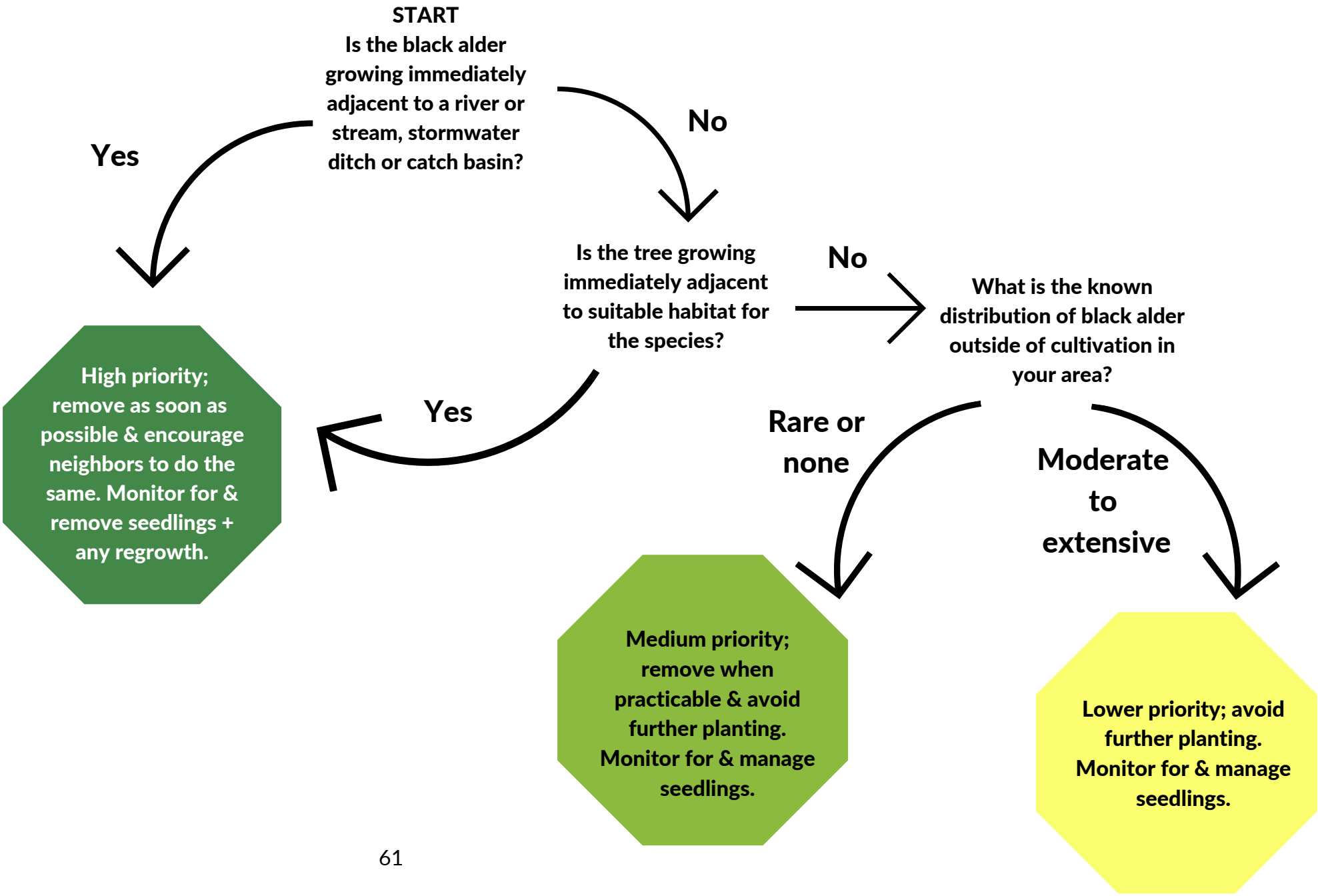

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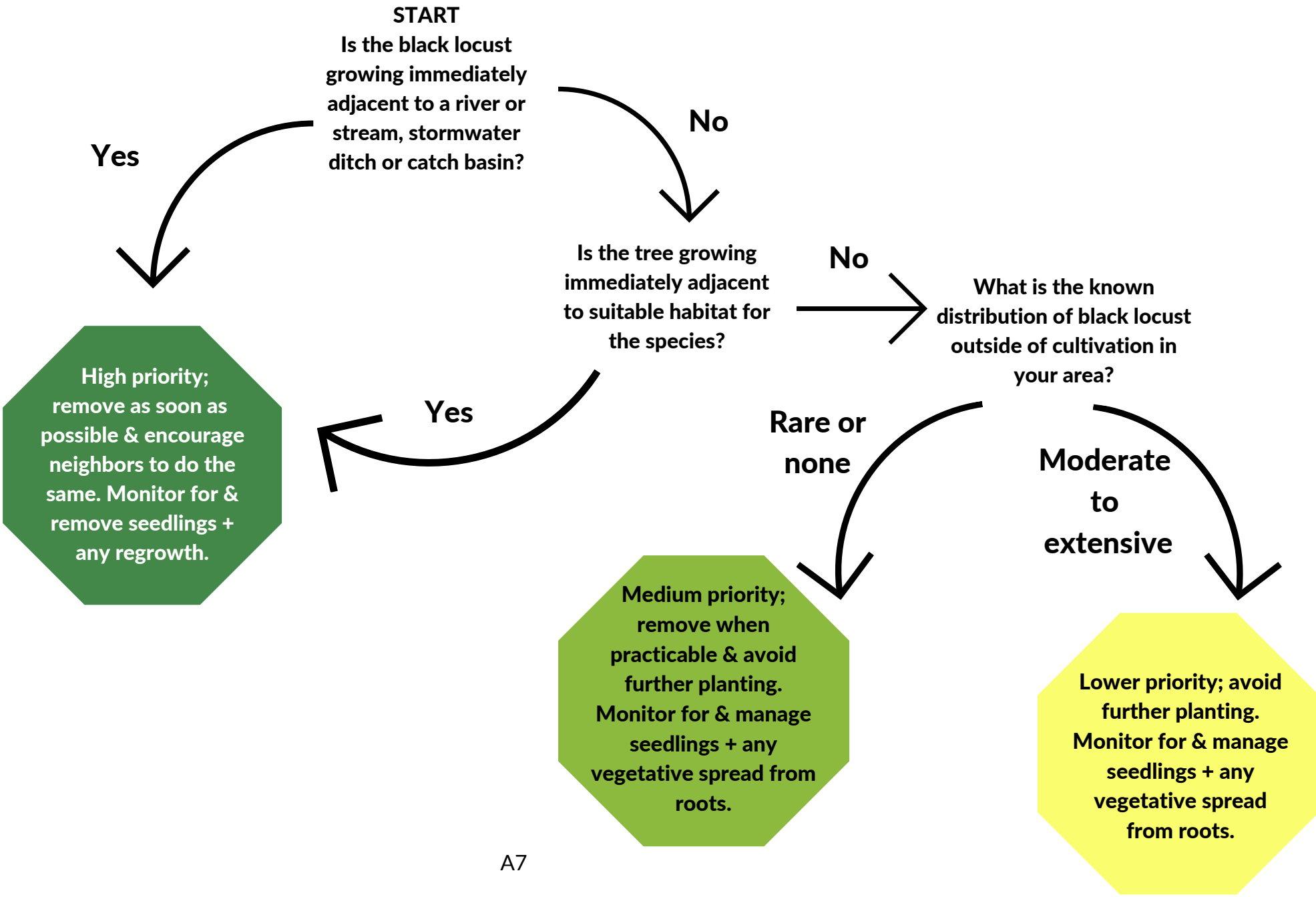

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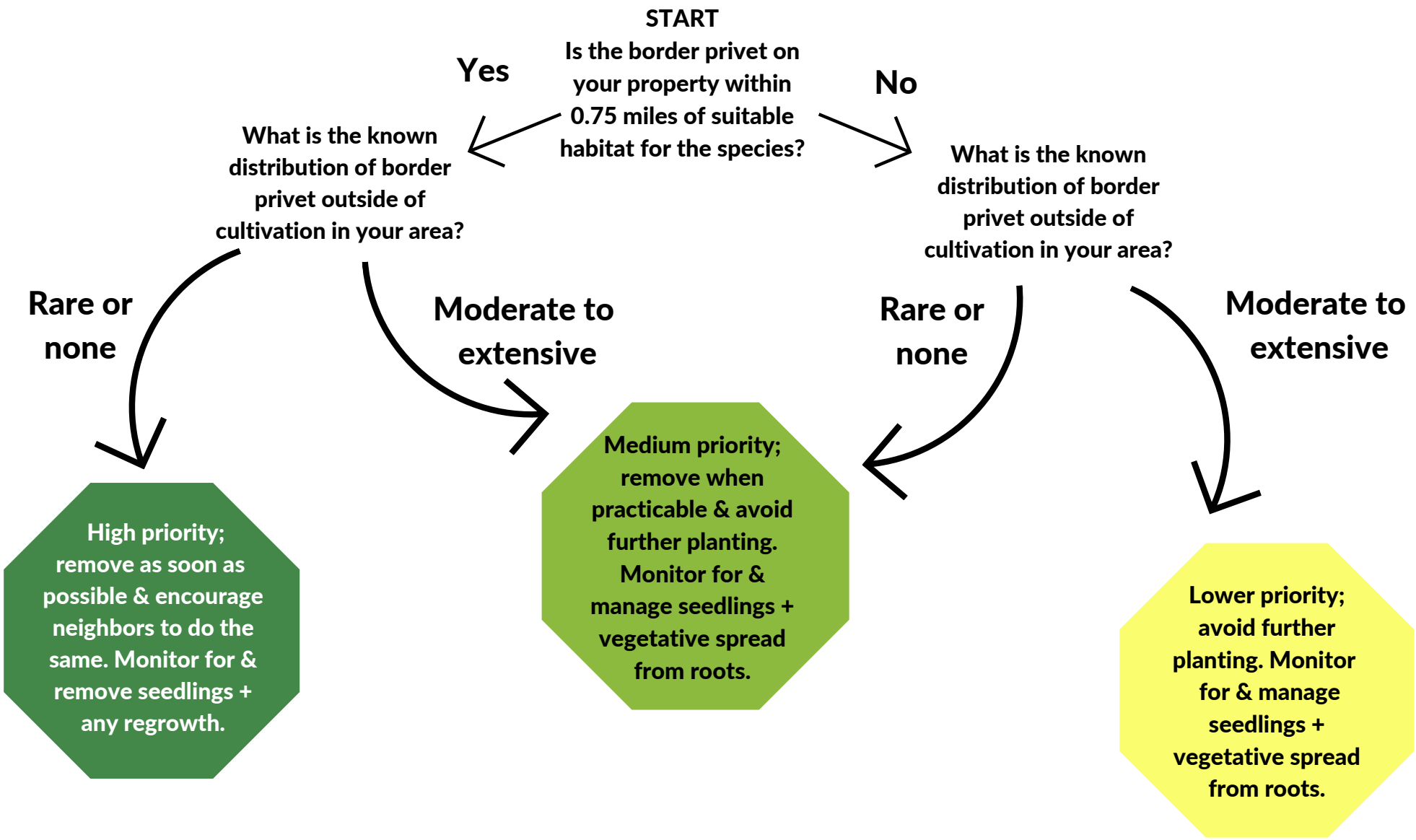

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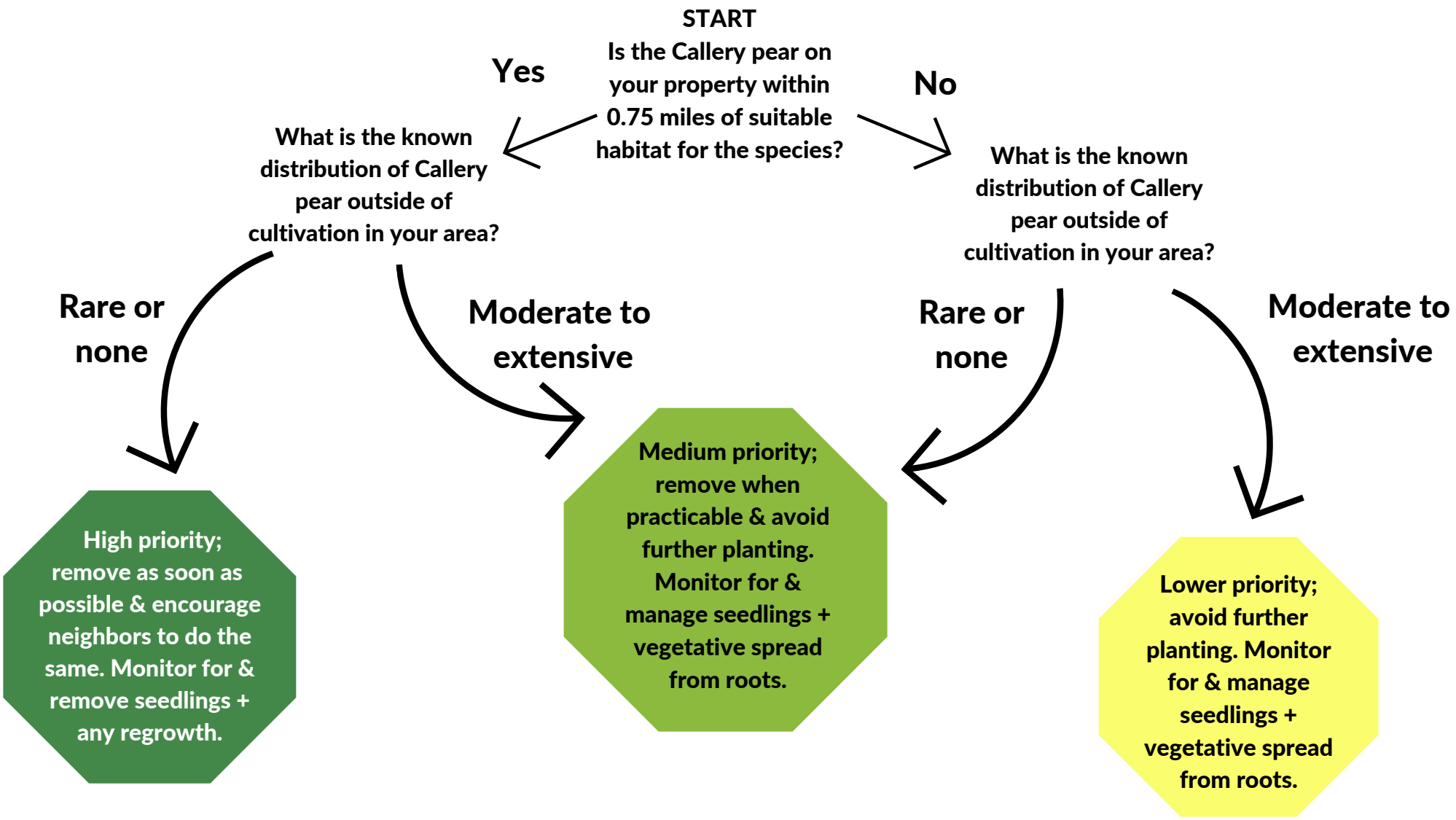

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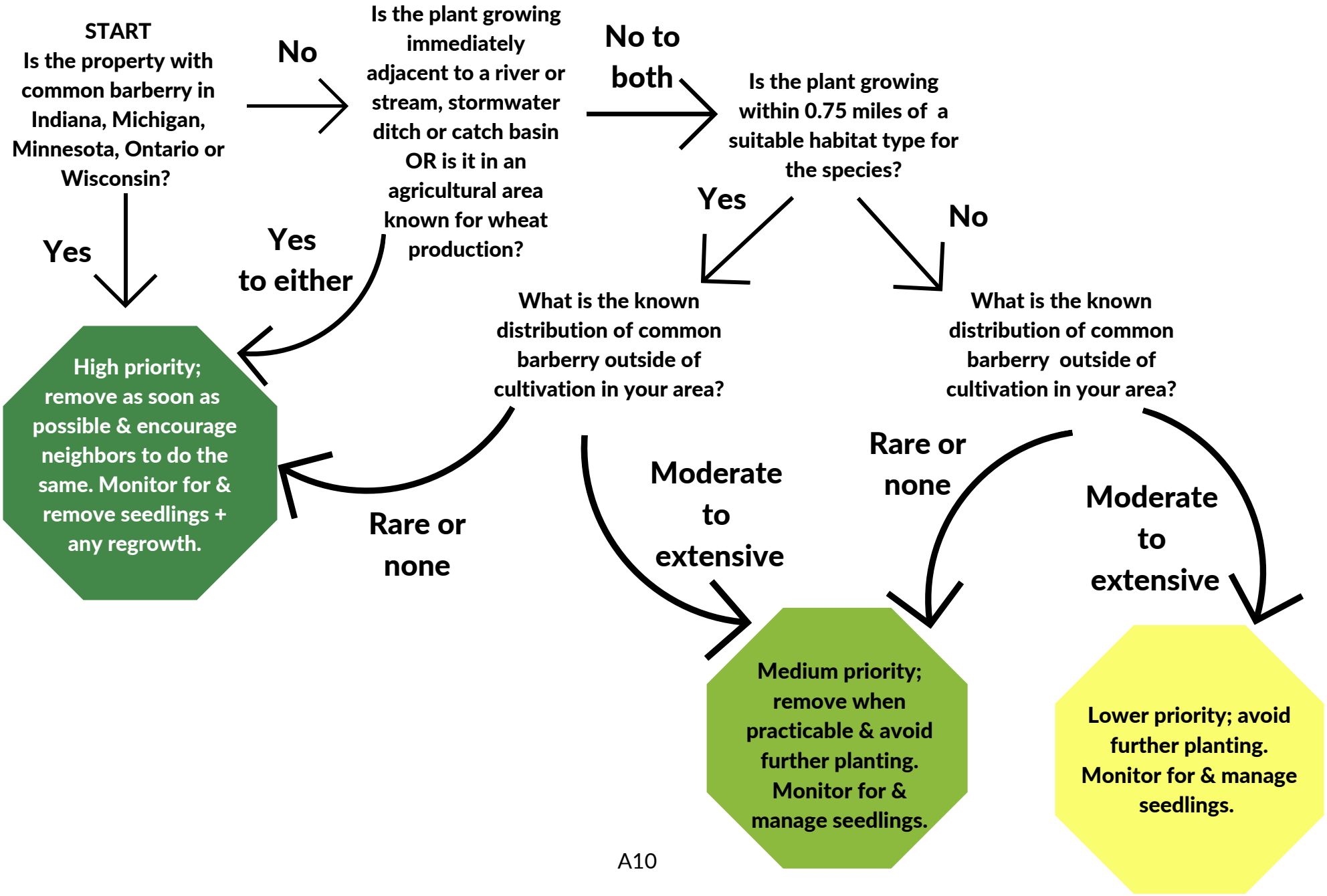

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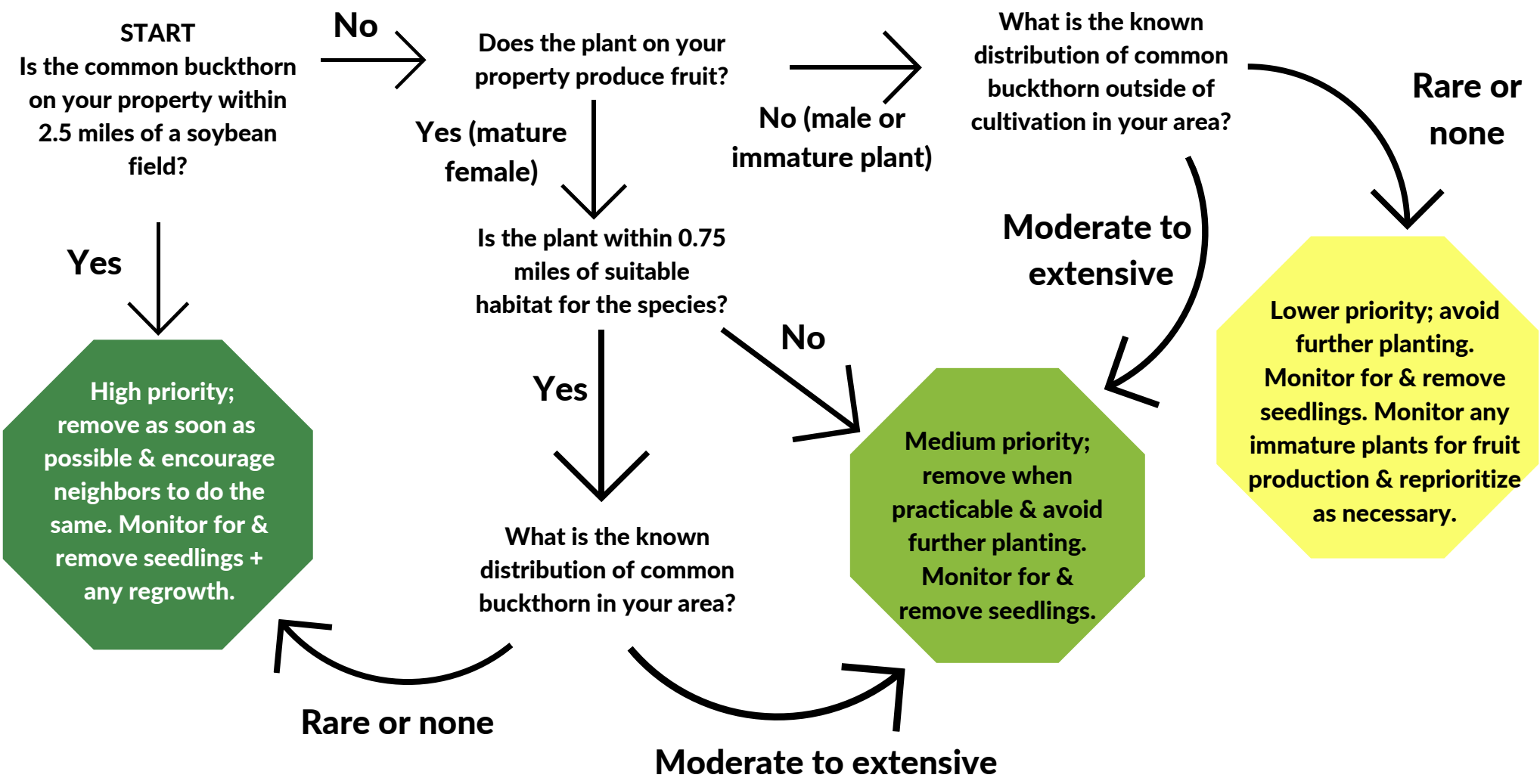

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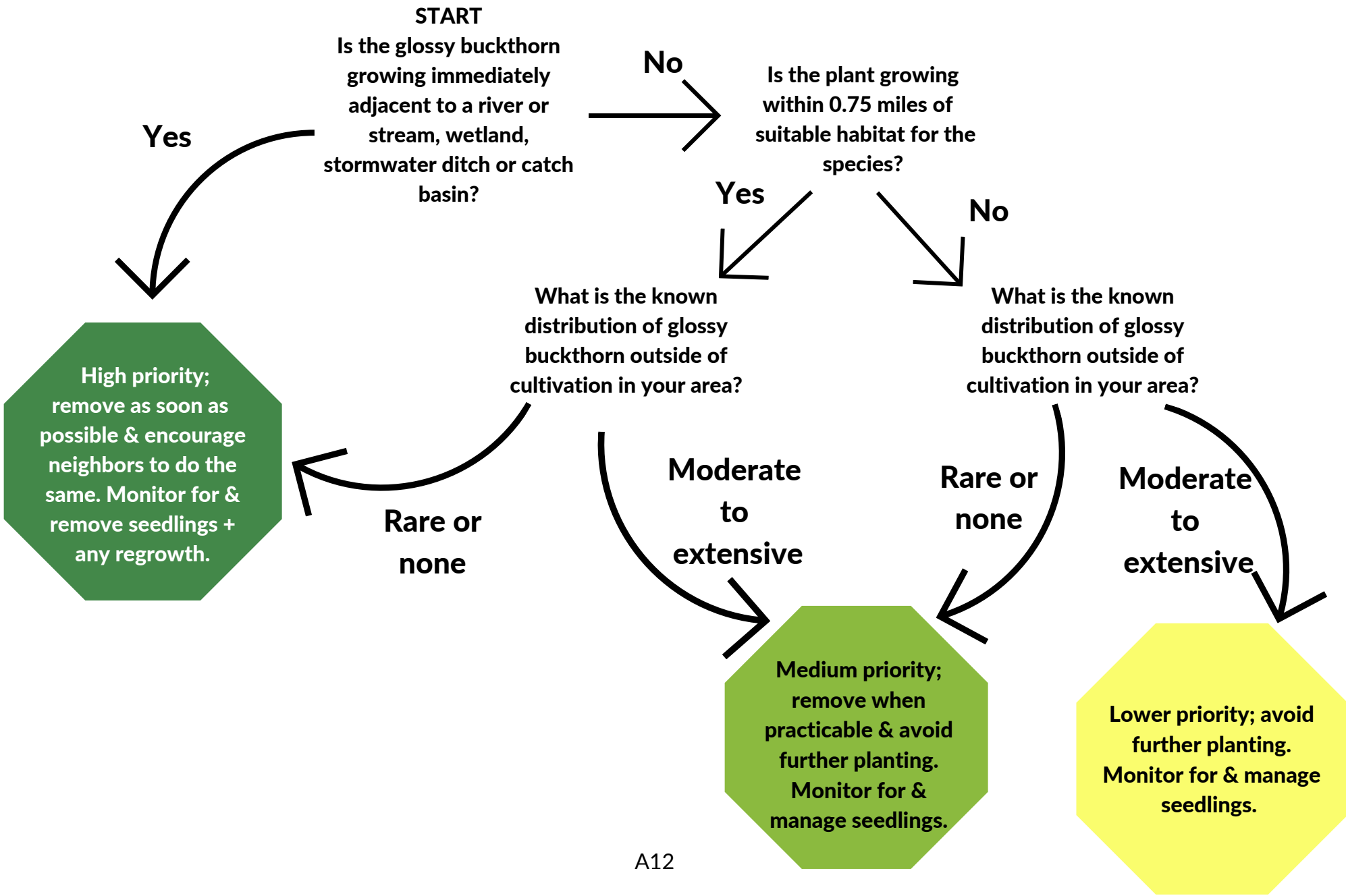

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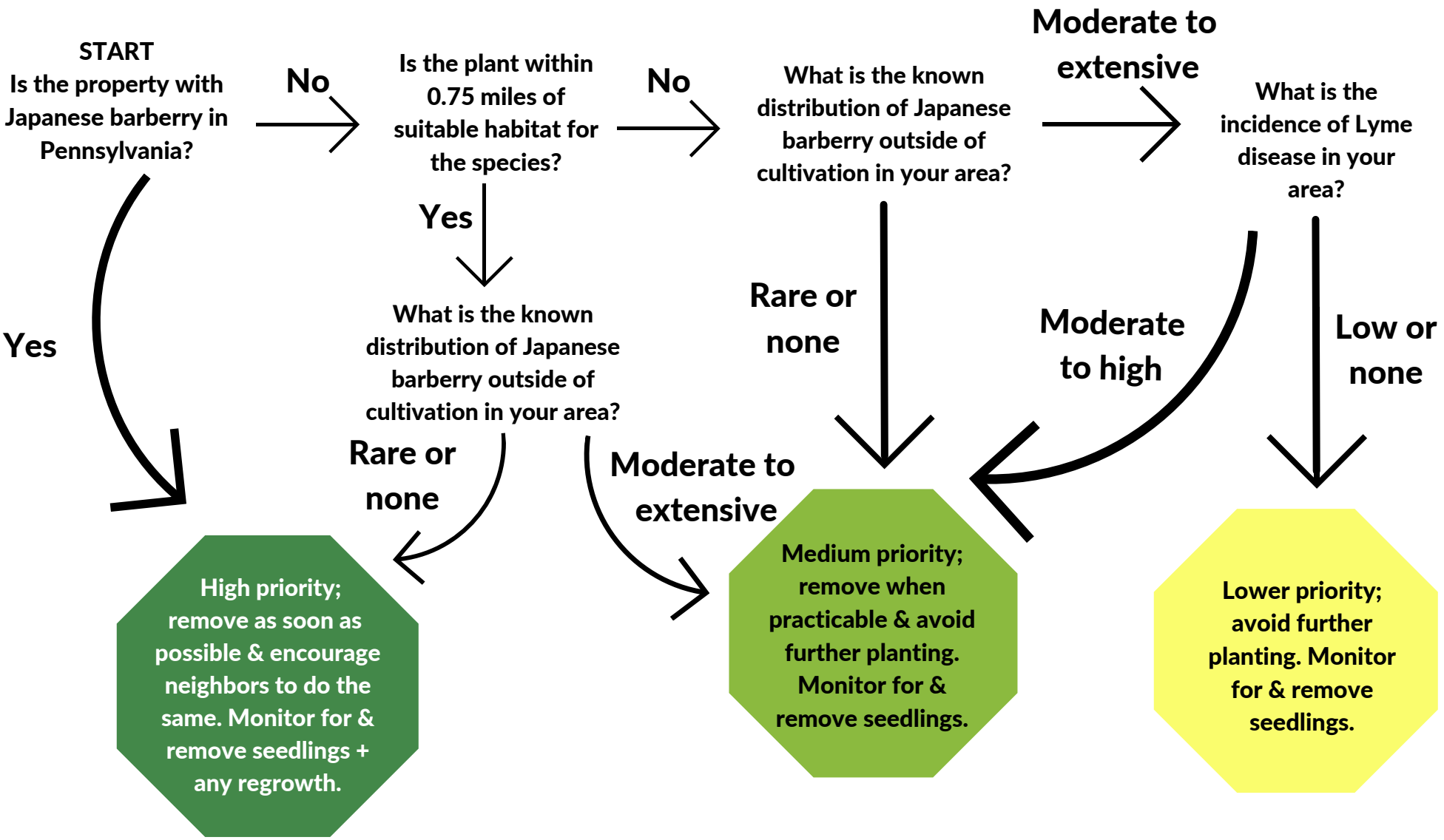

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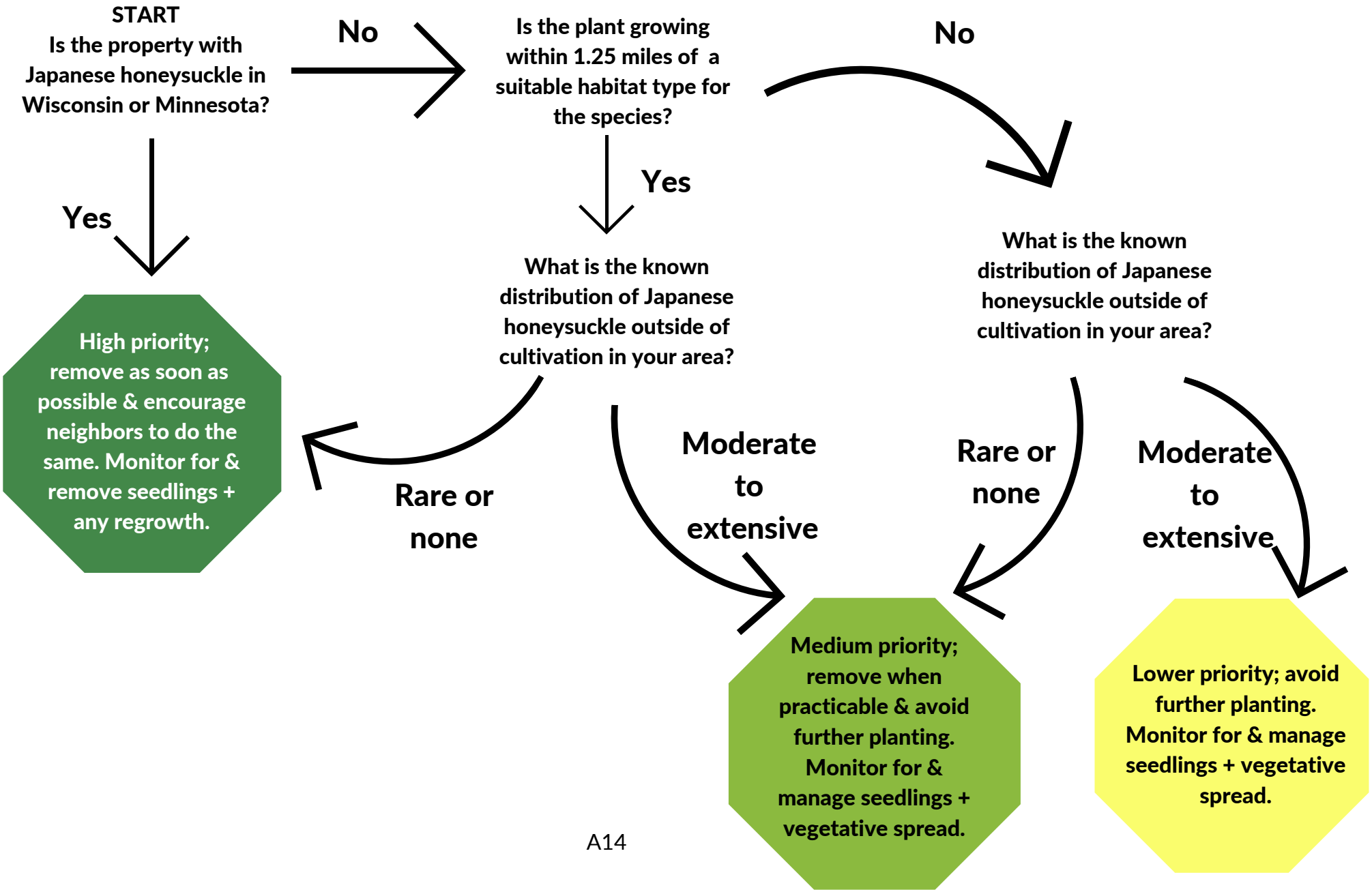

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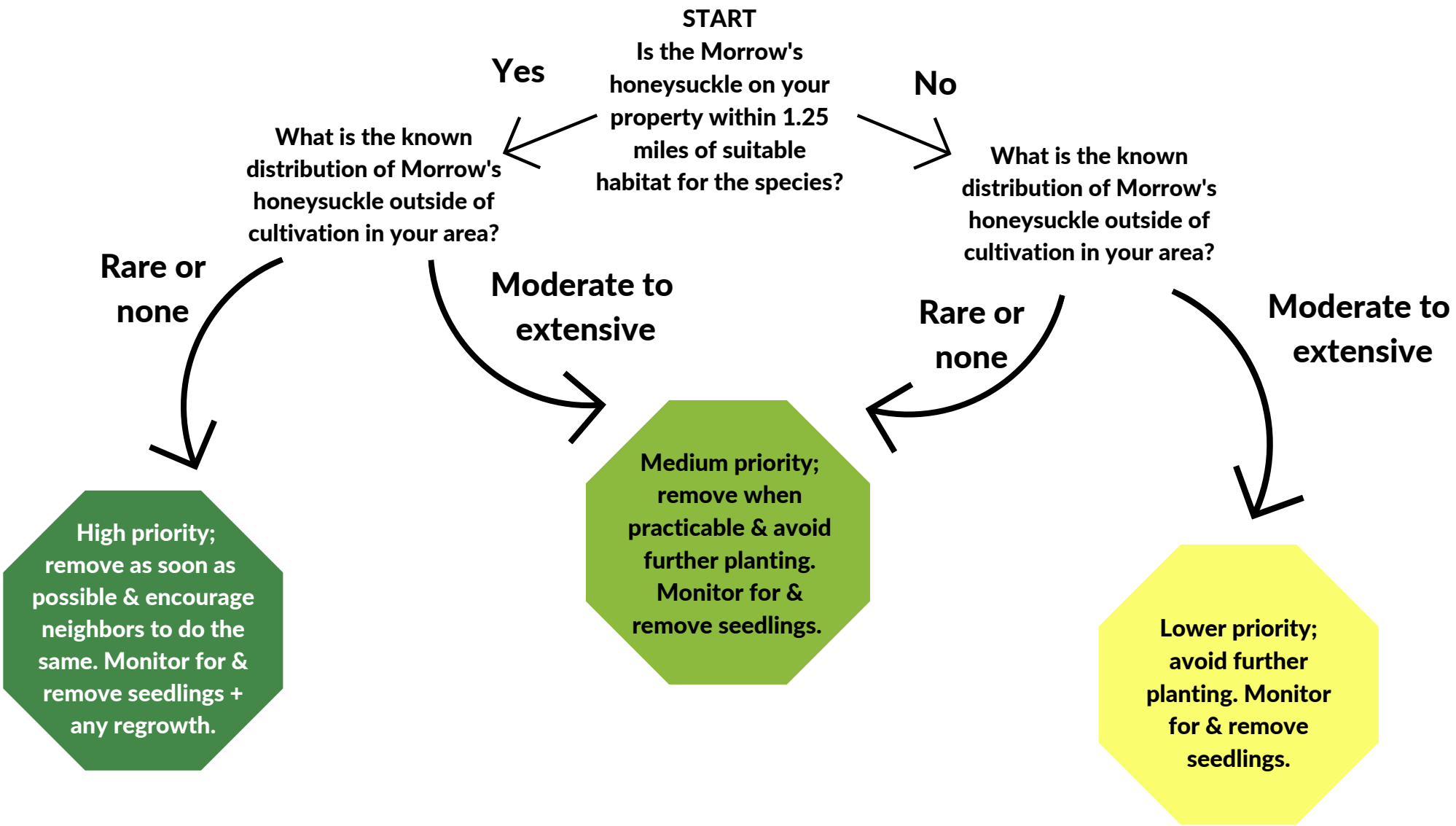

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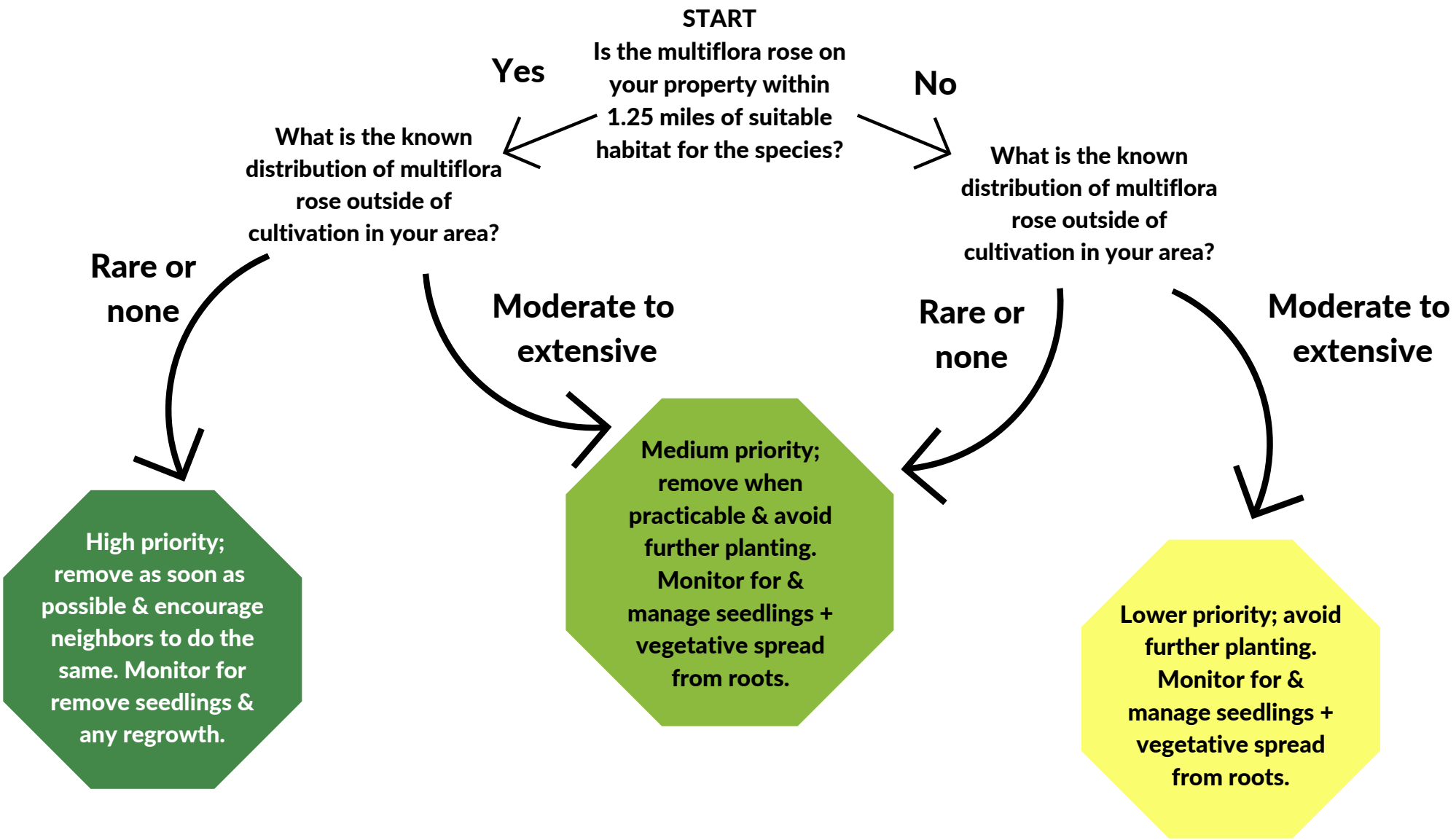

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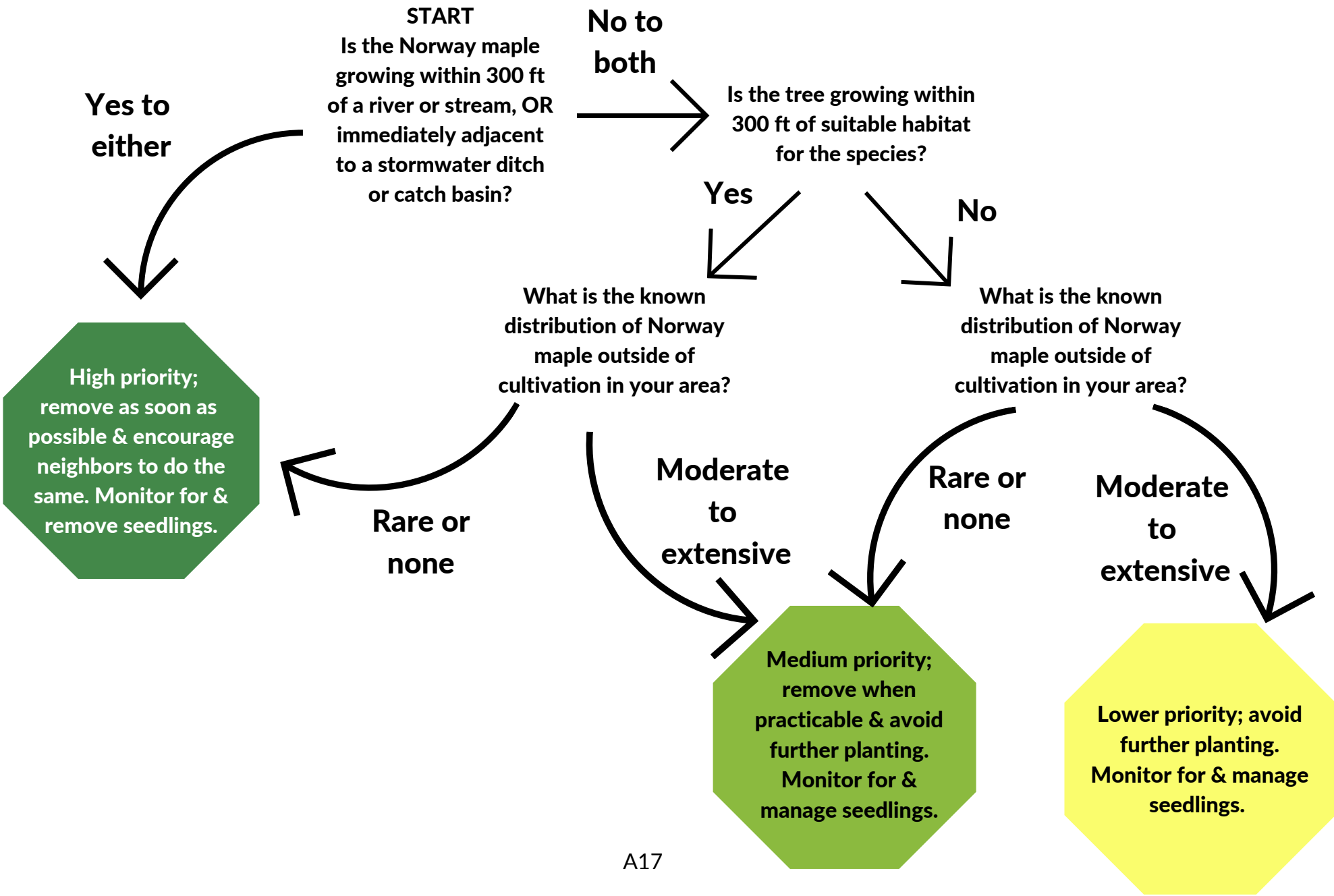

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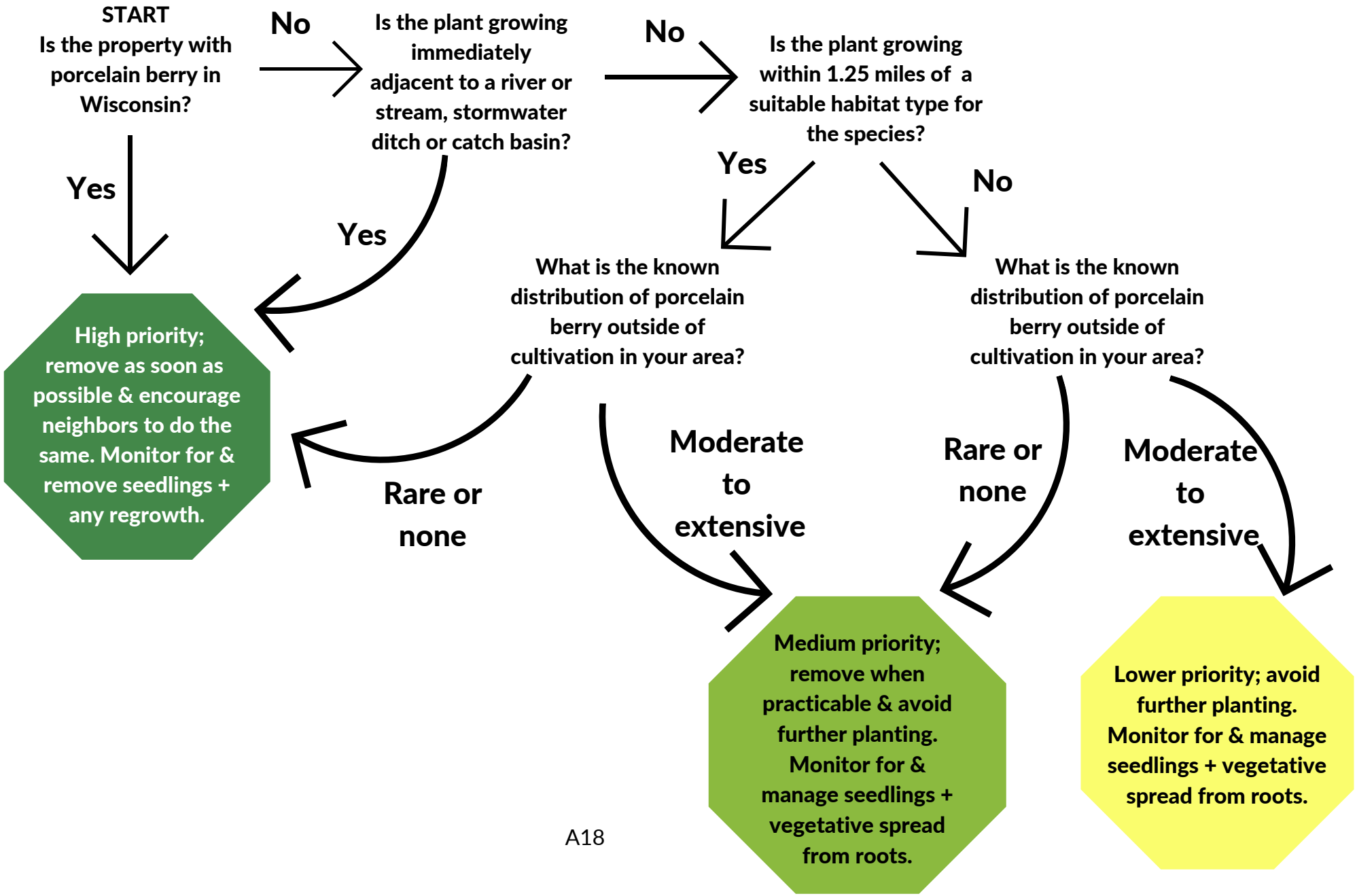

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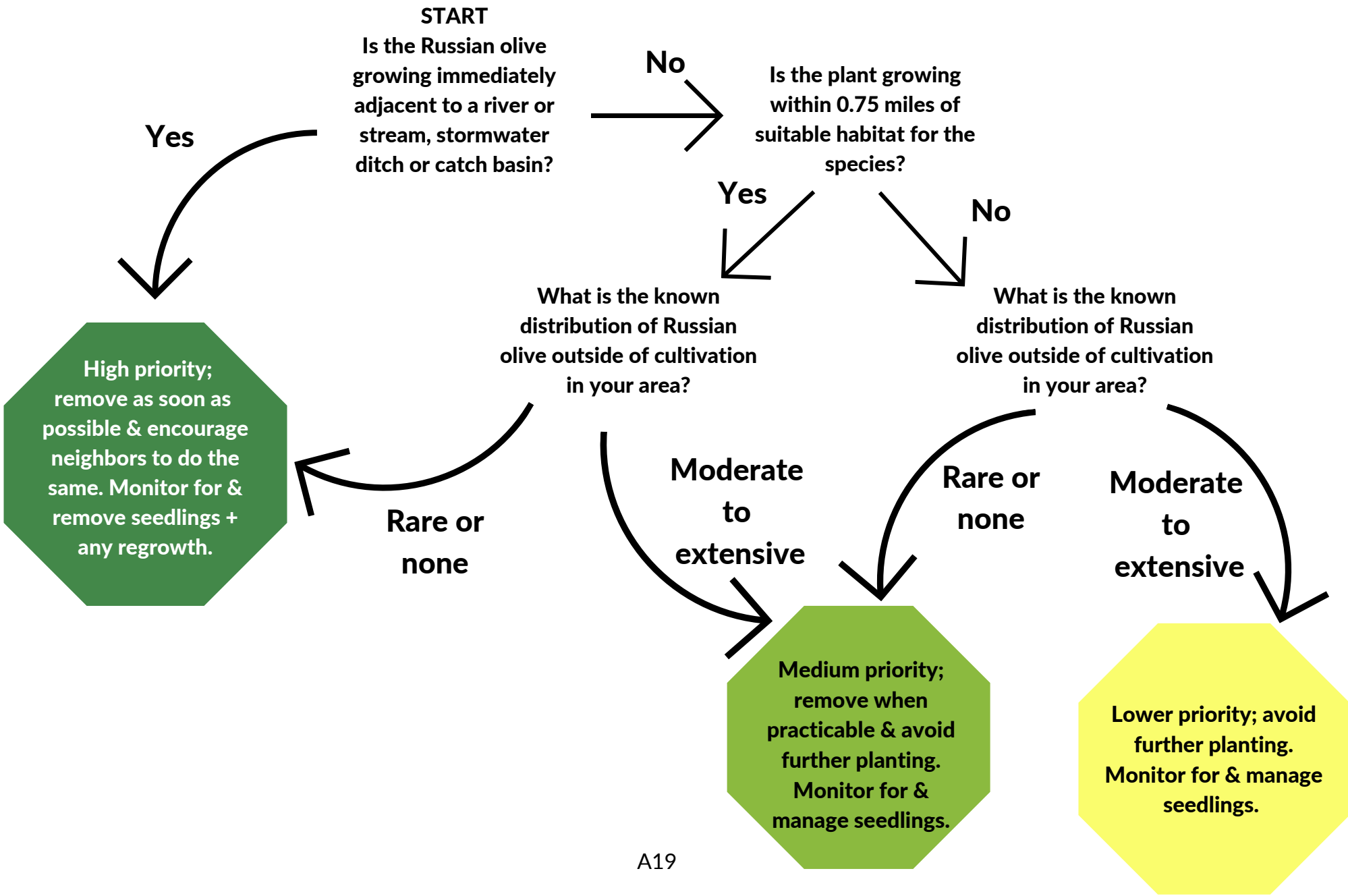

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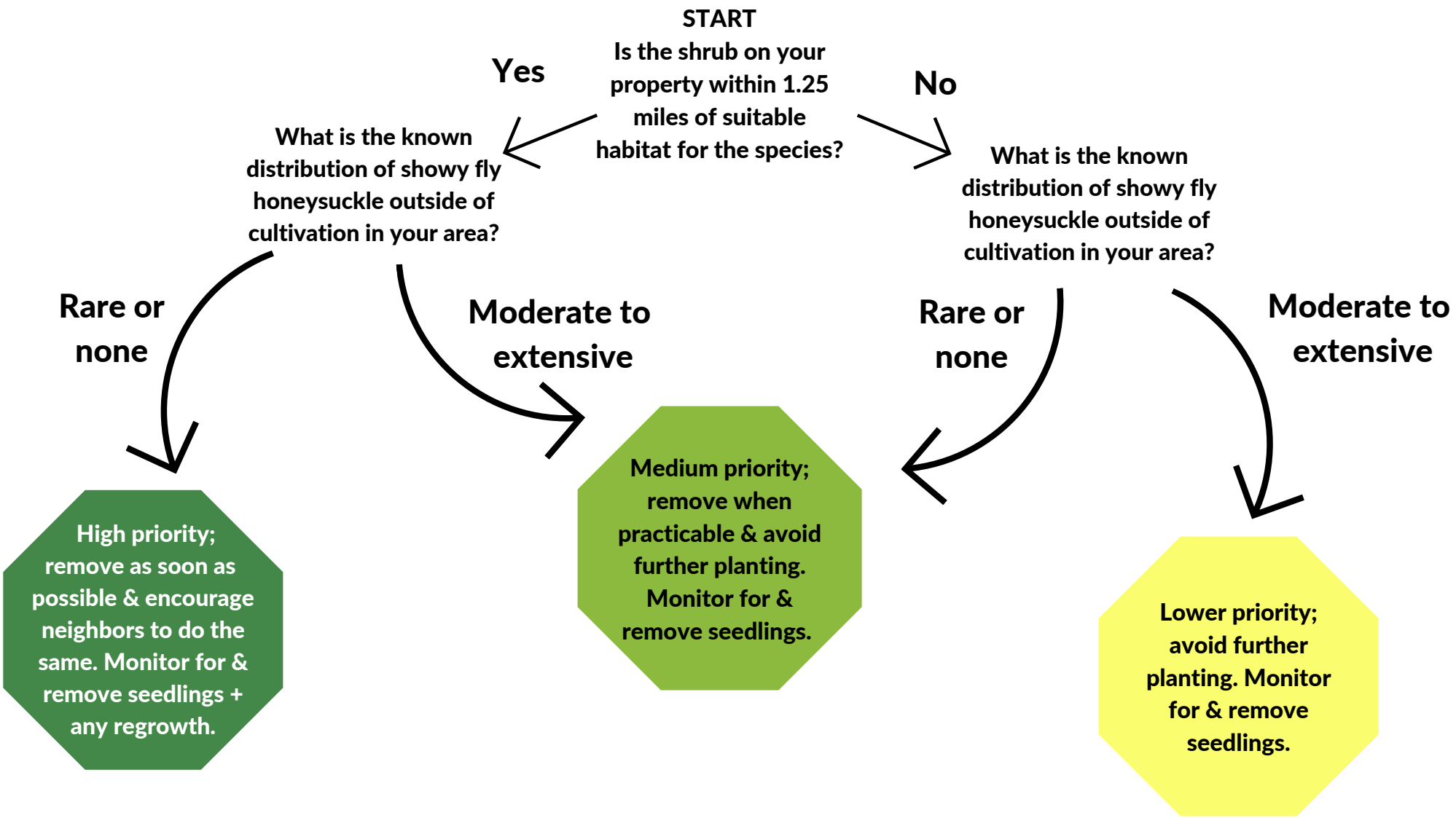

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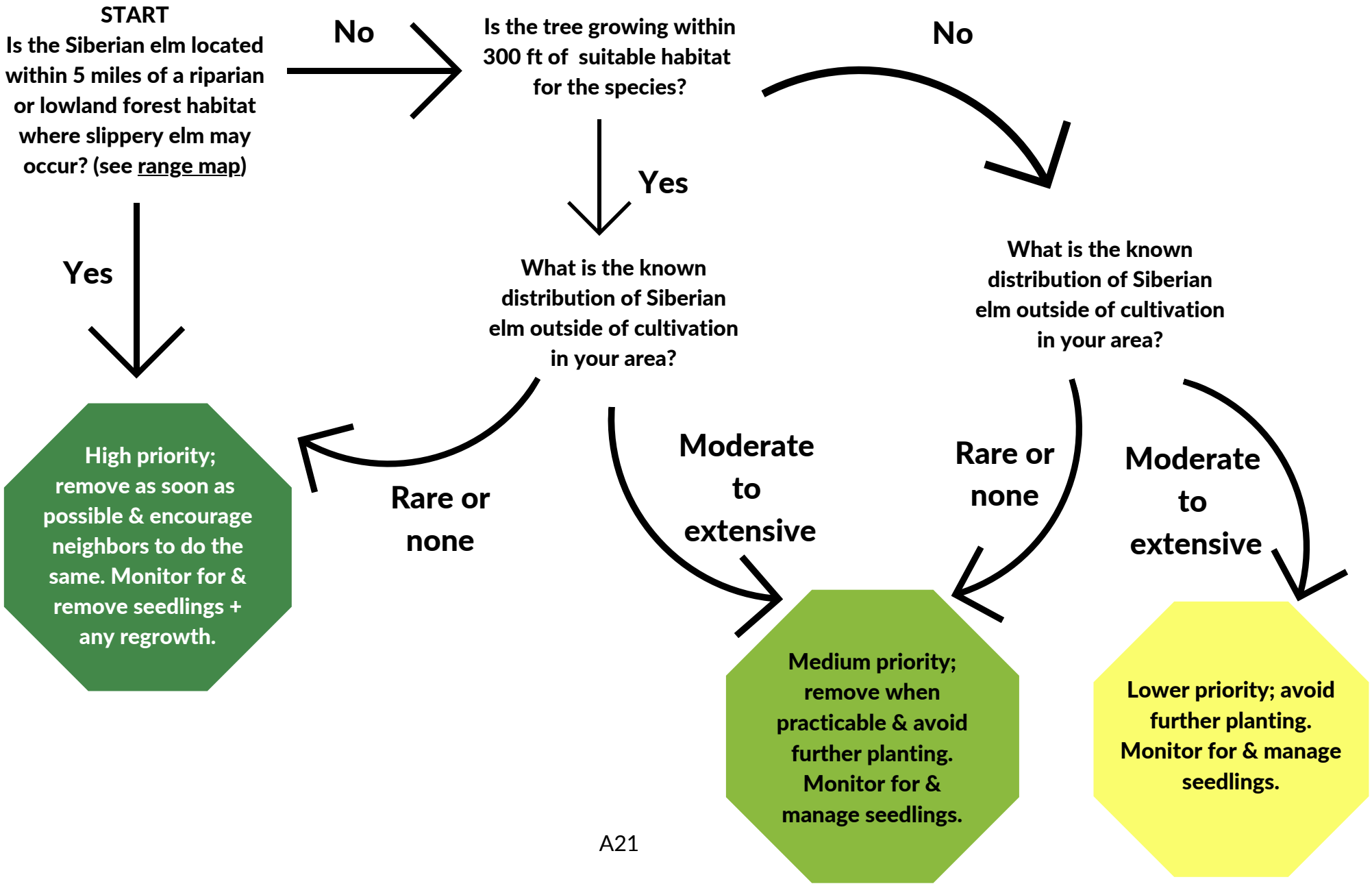

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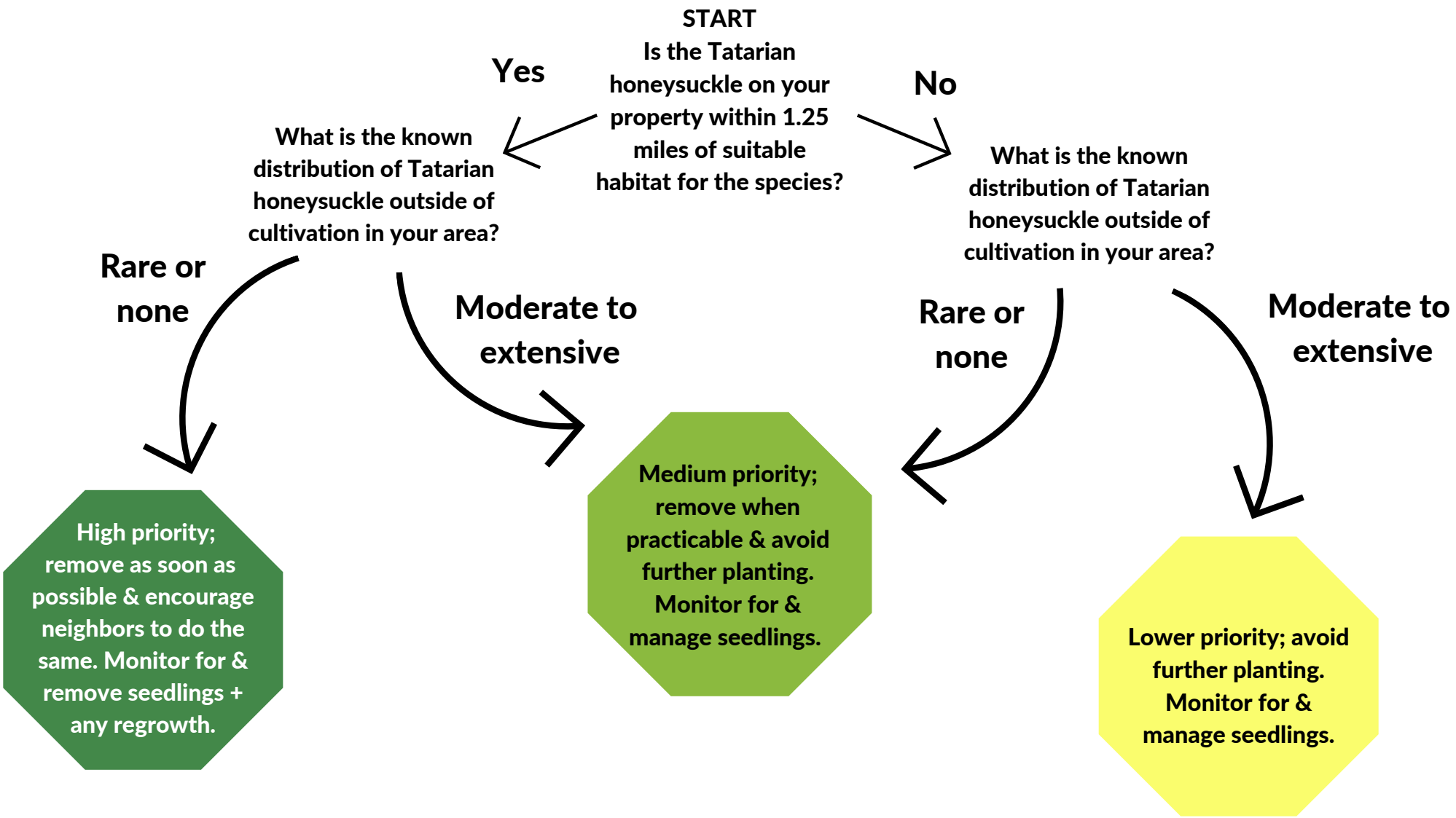

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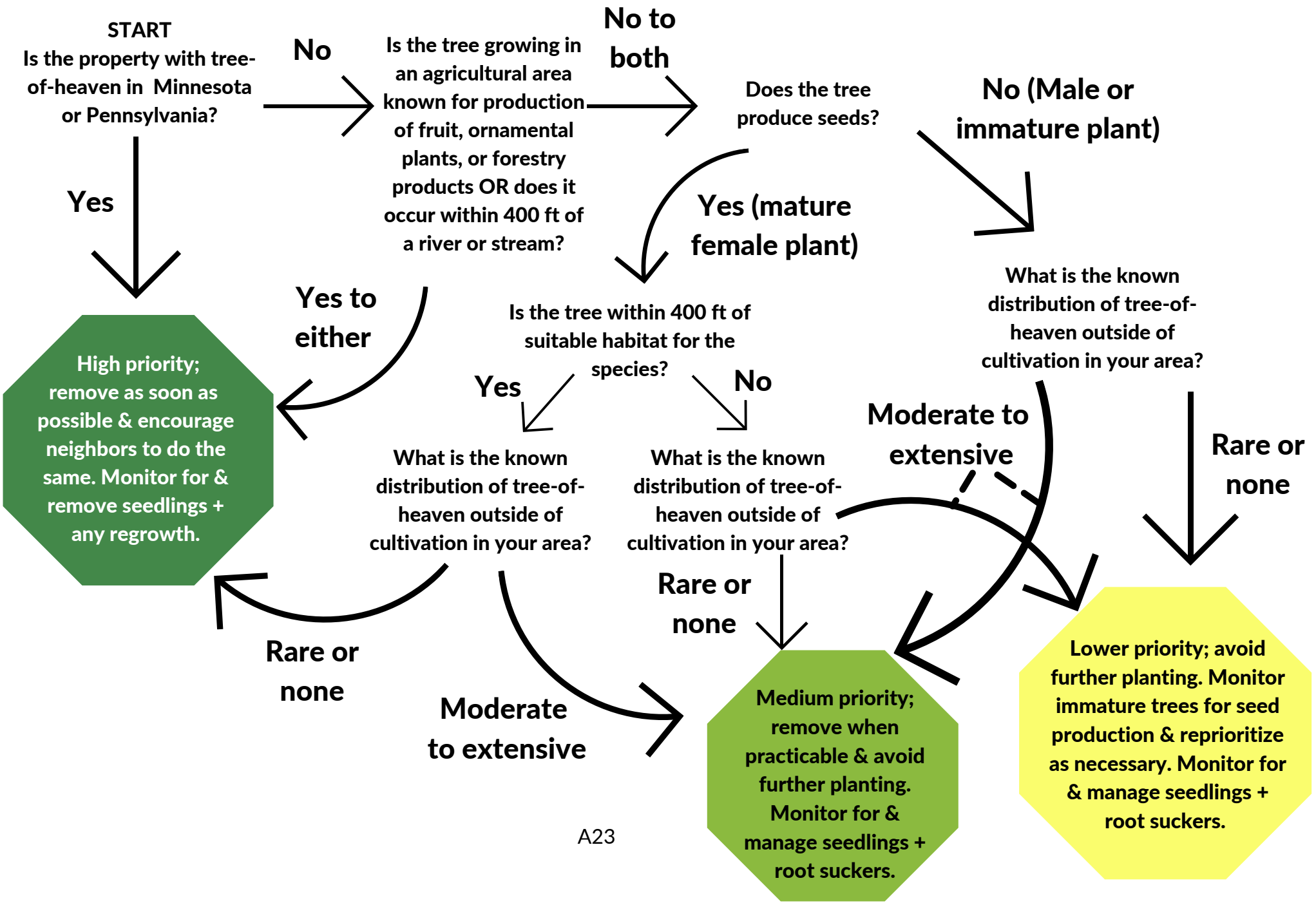

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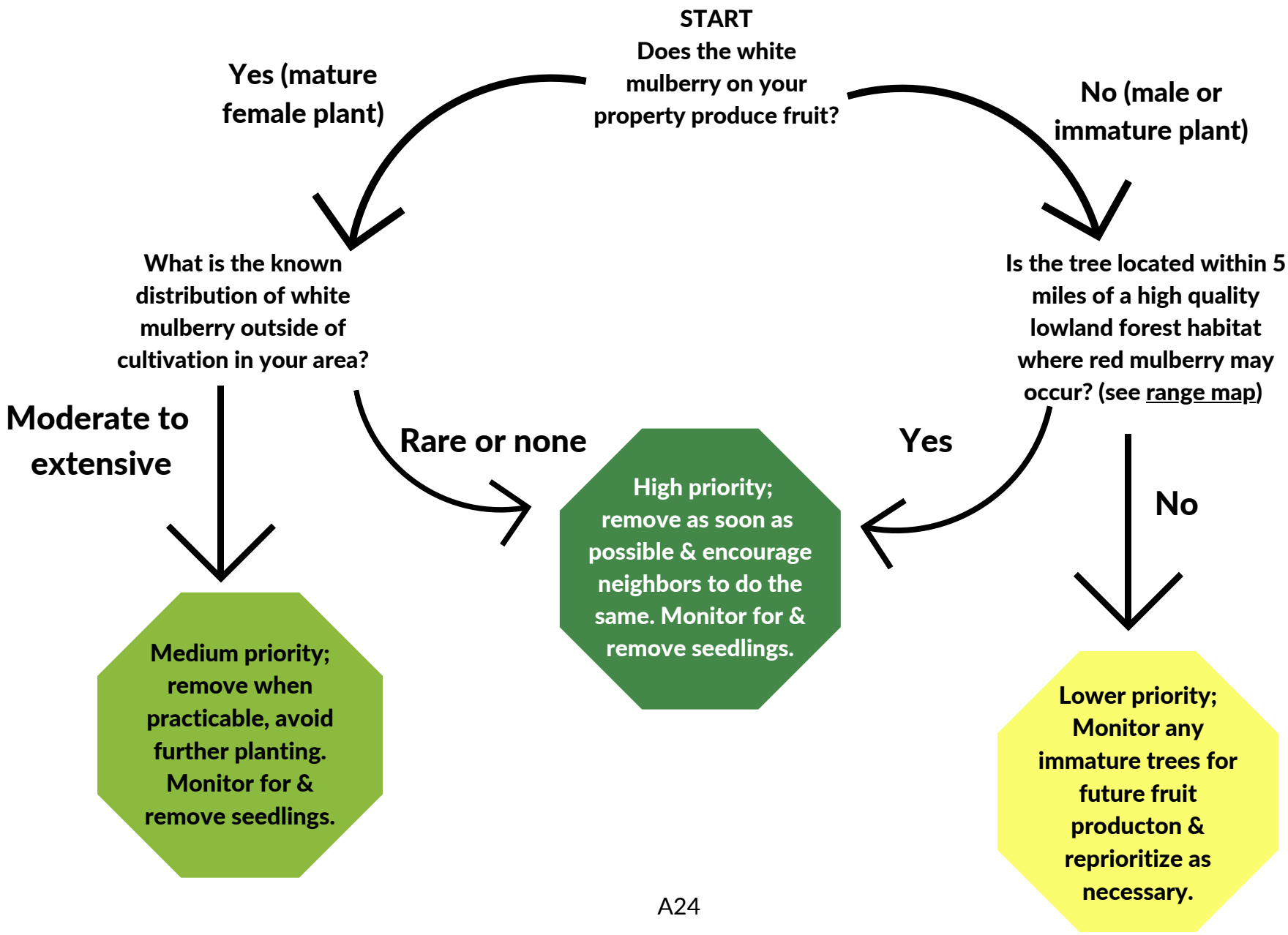

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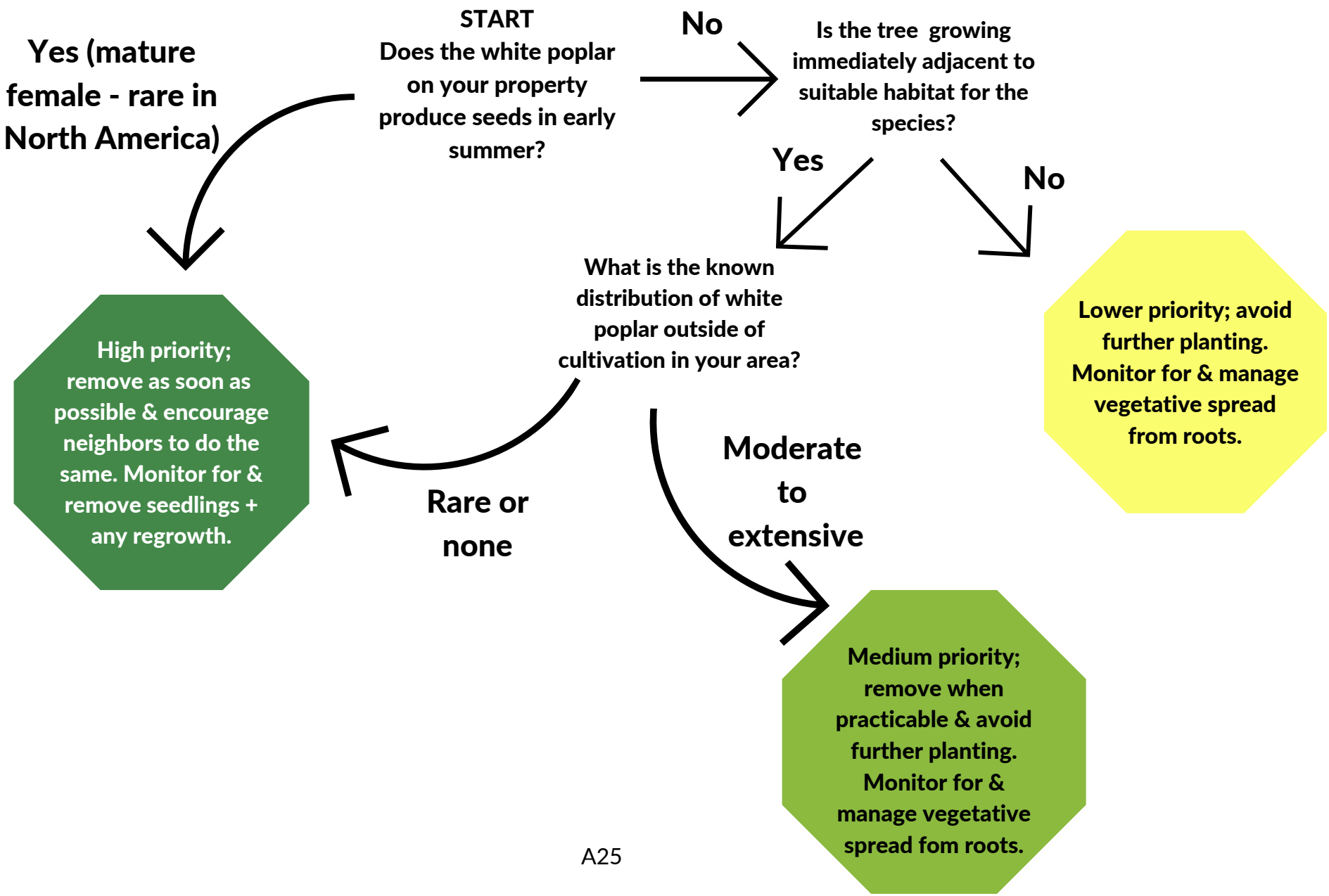

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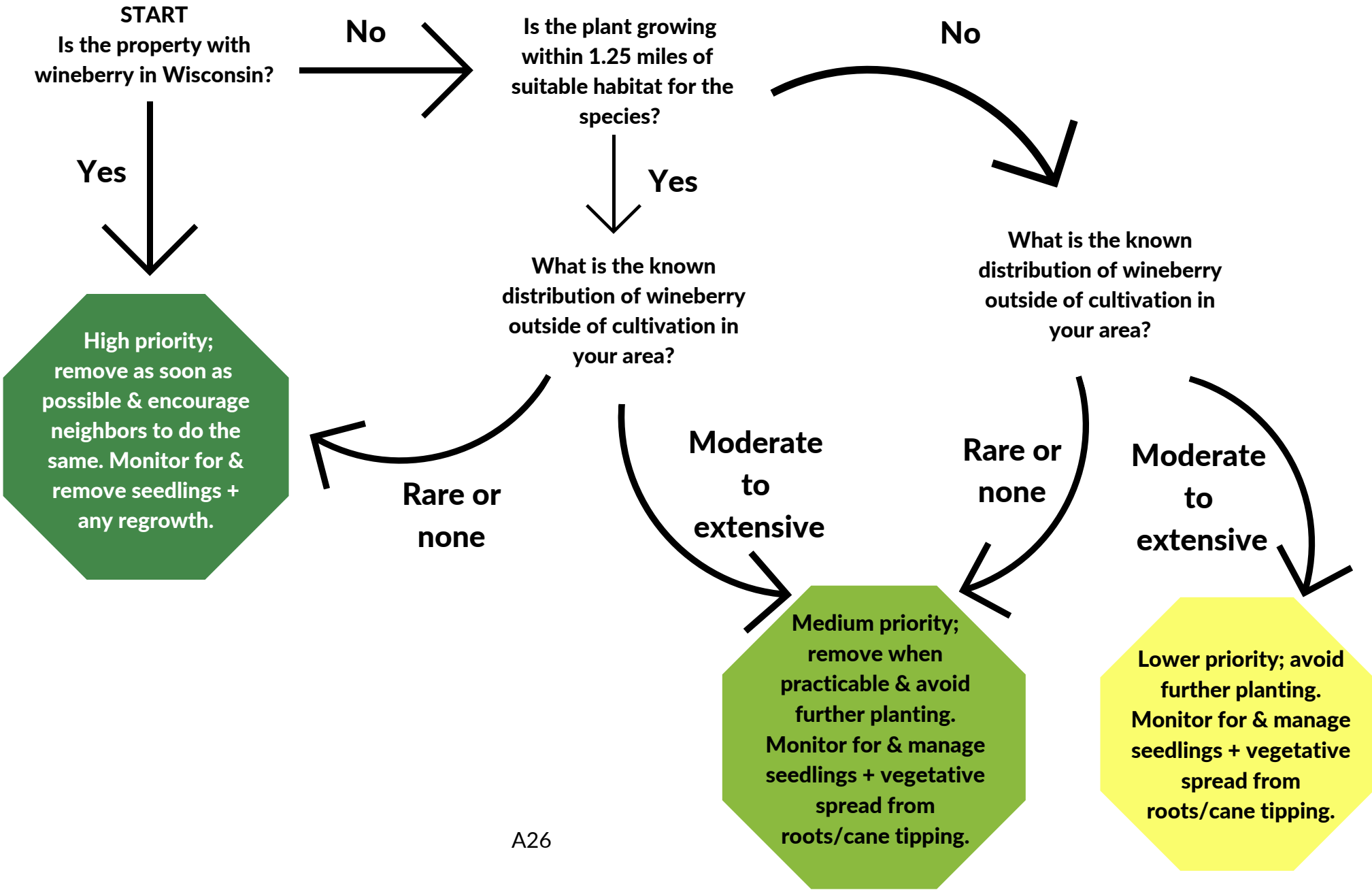

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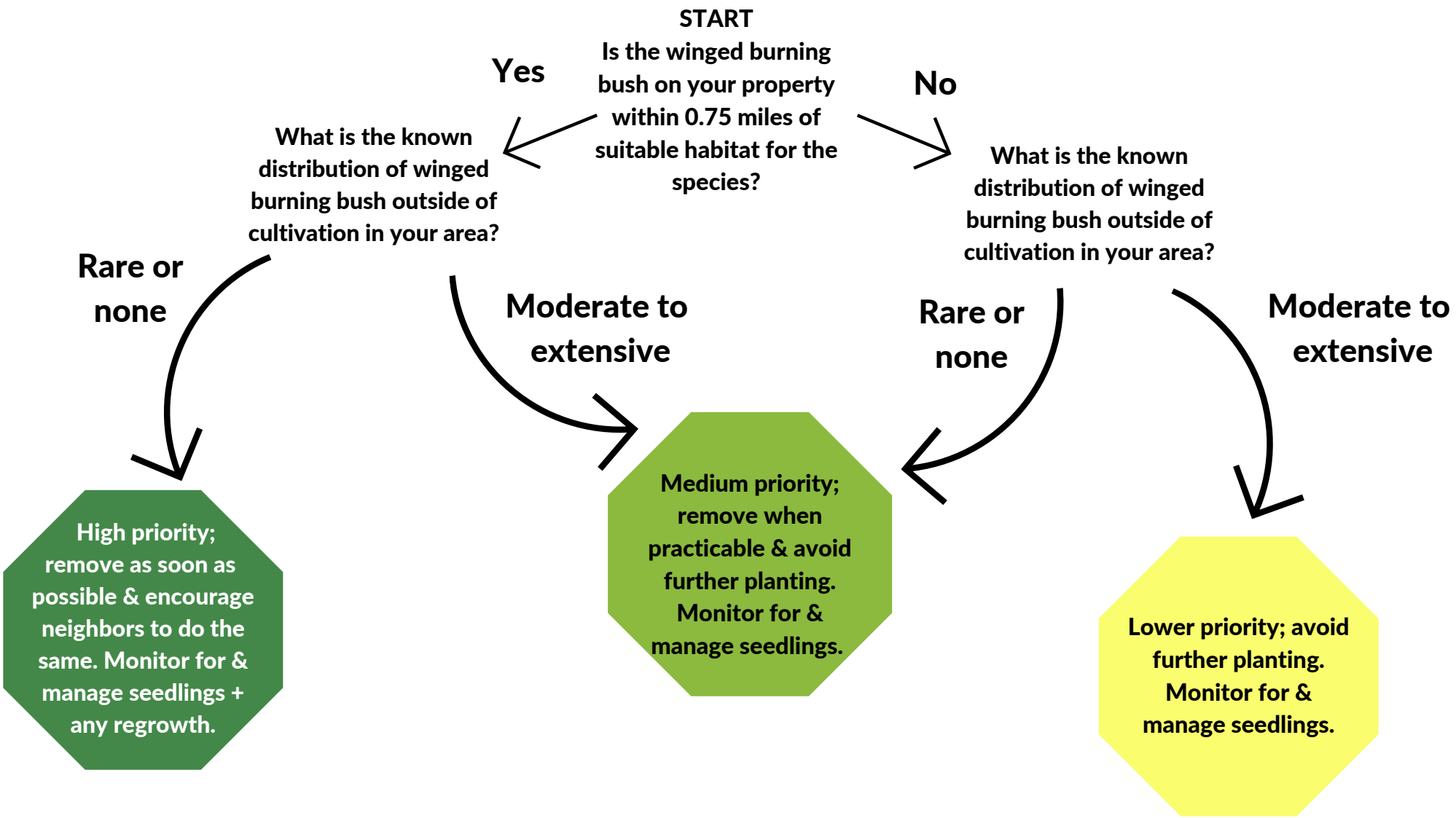

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