Composting of Invasive Plant Species

A Discussion of the Likelihood of the Survival of Propagules after a Complete Composting Process

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Introduction

In the Metro Vancouver region invasive plant species are removed from public lands by workers and volunteers. These invasive species are removed to ensure that the entire plant is taken so as not to leave any parts which could regenerate and spread. Disposal of the plant is then done under strict conditions in order to ensure that roots or seeds are not blown away to areas where they could germinate. Great care is taken to ensure that the work done by the workers and volunteers is not in vain and that the work does not contribute to the growth and spread of the invasive plant species being removed.

After harvesting the invasive species the plant material is taken to Fraser Richmond Soil and Fibre where it undergoes a composting process. This process is believed to include sufficient temperatures to kill the propagules of the invasive species harvested. However, there have been stories telling of occurrences where this composted soil has been seen to produce the invasive species supposedly killed during the process. This paper aims to discover if the soil from this composting facility has the potential to spread the invasive species being harvested from the Metro Vancouver region and to suggest possible ways in which this question can be scientifically answered.

Definitions

The term invasive plant has been defined as “any invasive alien plant species that has the potential to pose undesirable or detrimental impacts on humans, animals or ecosystems,” (Invasive Plant Council of BC, 2008). Other terms used in throughout this paper have been defined by the Merriam-Webster Dictionary in the following ways. Germination has been defined as “to cause to sprout or develop,” the term regenerate has been defined as “to be formed

or created again," a propagule is "a structure that propagates a plant" with propagate meaning "to cause to continue or increase by sexual or asexual reproduction", lastly the term composting refers to the action of "converting (as plant debris) to compost."

Methods

Information from scholarly sources was obtained by searching Google Scholar. Search terms included the scientific names of the specific invasive plant species with which the Metro Vancouver region is concerned. Searches also included terms such as: "composting" "composting of invasive species" and "temperature and the viable germination of seeds." By searching the Google web for the names of the communities close to the Metro Vancouver region, such as New Westminster, information was gathered about the ways in which other regions in the area are dealing with the concerns over the composting of the invasive plant species.

Anecdotal information about examples of invasive species growing in composted soils was gathered through comments made at regional and wider spread meetings. This information was gained through Metro Vancouver. For the scholarly information the quality of the sources was assessed by the Journal within which it was published as well as the author's credentials and expertise within the field in which the paper was published. Anecdotal information was included as hearsay and it was recognized that these comments were not made with scientific authority.

Results

Information was gathered concerning the phylogeny of the invasive plant species with which the Metro Vancouver region is most concerned. These invasive plant species include:

Lythrum salicaria, Daphne laureola, Heracleum mantegazzianum, Spartina anglica, Impatiens glandulifera, Hedera helix, Cytisus scoparius, Ilex aquifolium, Iris pseudacorus, Rubus discolour, Polygonum spp, Lamium galeobdolon, and *Vinca minor.*

Characteristics of these species studied for this project included methods of propagation, conditions for germination, dispersal distances, and mechanisms evolved for the purpose of protecting the propagule from external harms. A breakdown of the information gathered can be found in Table 1.

Table 1 reproductive phylogeny of Metro Vancouver's invasive plant species

Scientific Name	Common Name	Method of Propagation	Conditions for Germination	Dispersal Distance	Propagule Protection
Lythrum salicaria[1]	Purple Loosestrife	Seed dispersal	Pollination	-	-
Daphne laureola[2]	Daphne	Vegetative Spread	Cool temperatures	-	-
Heracleum mantegazzianum[15]	Giant Hogweed	Seed dispersal by wind or water	Strict conditions including a period of dormancy in cold temperatures.	Long distances	-
Spartina anglica[8]	Spartina	Seed dispersal	Germinates best when not exposed to high heats.	-	-
Impatiens glandulifera[16]	Policeman's Helmet	Seed dispersal	High heats can cause unsuccessful germination or non-viable adults.	-	-
Hedera helix[9]	English Ivy	Seed dispersal and root spread	Germinates best when not stored at high temperatures. Cleaned seeds have a high probability of germinating.	-	-
Cytisus scoparius[11]	Scotch Broom	Seed dispersal	Pollination by insects is vital to the germination of the seeds.	-	-
Ilex aquifolium[12]	English Holly	Seed dispersal and vegetative spread	Roots may penetrate the soil and start to grow even after being cut from the parent plant.	-	-
Iris pseudacorus[13]	Yellow Flag	Vegetative spread and seed dispersal	High heat is beneficial for germination.	-	Seeds can tolerate unfavourable conditions including high temperatures.
Rubus discolour[6]	Himalayan Blackberry	Vegetative cloning and seed dispersal	Pollination by bees.	-	-
Polygonum spp[3]	Japanese Knotweed	Seed dispersal	Competition depends on habitat and time of year.	-	-

Lamium galeobdolon[10]	False Lamium	Seed dispersal	Germinates best at low temperatures.	-	-
Vinca minor[5]	Periwinkle	Vegetative propagation (best)	Grows best when in contact with cold temperatures.	-	-

It was found that most of the invasive plant species reproduced by seed dispersal and many of the species were also able to reproduce by vegetative cloning. In most cases the vegetative cloning occurred only when the parent plant was in the soil however English Holly roots are able to become viable and spread even after they have been removed from the parent plant. Many of the species also required periods of cold temperatures for dormancy or cold temperatures during the germination time period. It was often found that high heats harmed the seeds ability to germinate or affected the plant once it was in the mature stage. Yellow Flag on the other hand was found to favour high temperatures for germination. Since composting involves high heats for extended periods of time it is possible that the temperature to germination relationships found in most of these species may correlate to the species' viability after the composting process.

The composting process involves temperature of at least 55°C for a minimum time period of 15 days[20]. The material to be composted is placed in large piles outside and the cooking process occurs through natural process due to moisture, heat and microorganisms within the large piles of material. During the 15 days of the composting process the composting material is mixed at least 5 times to ensure that all of the organic material is exposed to the same high temperatures. Aeration also occurs during this process to ensure proper oxygen and nitrogen levels for decomposition. In the composting process high temperatures and microorganisms work to break down the organic matter[7]. The conditions under which the organic material is composted at this site is sufficient to produce composted soil which meets the Organic Matter Recycling Regulations for class A compost which is the highest standard of compost available. The

decomposition and high temperatures are believed to be sufficient to kill the roots and seeds with which the species would conduct their reproduction.

In a study done on the composting of biological material containing the Sudden Oak Death pathogen[14] it was found that the high temperatures used in composting were sufficient to kill a large majority of the pathogens. Unfortunately, there have been no scientific studies conducted to observe the effects of composting on plant tissue and seeds from invasive plant seeds. It is possible that the wide spread distribution, competitive advantages, and survival rates seen in invasive species may come from adaptations which makes it possible for the propagules of these plants to survive harsh environments such as high temperatures. Given the high number of stories told about invasive species growing in composted material it is impossible to disregard the chance that some propagules may remain viable even after the process is complete.

Anecdotal information from members of the Metro Vancouver community have claimed to have witnessed occurrences where a number of the invasive species listed have grown in the composted soil bought from the Richmond Fraser Soil and Fibre centre where the composting had taken place. On October 21, 2010 the Greater Vancouver Invasive Plant Council held their fall forum which included participants from government, educational institutes, and the private sector along with volunteers, and students. Out of these participants fifty percent of all individuals claimed to have had experience with the invasive species growing in the composted soil. According to the comments made at the forum the species of concern included Japanese Knotweed, Giant Hogweed, English Ivy, Yellow Lamium, and Scotch Broom in descending order of concern[18].

Due to the high amounts of uncertainty regarding the composting of invasive plant species general consensus of the proper methods of invasive plant species disposal does not occur. Each community in the Lower Mainland region has decided on their own preferred

method of disposal of the invasive plant species collected from their communities. All of the communities have also decided to treat the invasive species collected from public lands by city workers differently from the invasive species collected by residents on their private lands. This may be due to the higher volumes of invasive plant material being collected on public lands versus those collected on private lands.

As examples of the ways in which the different communities are dealing with the issue of disposing of invasive plant materials four cities have been chosen for comparison. These cities include Coquitlam, Burnaby, North Vancouver, and the city of Vancouver and they were chosen due to their differences. Other municipalities in the region often had very similar scenarios to one of these cities and so it was felt it would be redundant to include this information in the paper.

In the city of Coquitlam all invasive plant species collected from public lands is sent to be incinerated as green waste. Incineration of green waste differs from composting in that the material is burned to ash and the resulting material is not used as soil. Invasive plant material collected from private lands is required to be placed into the yard waste and sent to Fraser Richmond Soil and Fibre for composting unless it is Giant Hogweed in which case it is sent to be incinerated. The city of Burnaby disposes of their invasive plant material collected from public lands in the same way as Coquitlam, by sending it for incineration. Residents however, are asked to dispose of any collected invasive plant material in their household garbage which is sent to the landfill. In contrast to Coquitlam, Giant Hogweed collected on private land is not sent to be incinerated instead it is asked that residents dry the material to remove the seeds then send the seeds to the landfill and the other material to be composted. The North Vancouver District takes a much harder stance on the disposal of invasive plant species requiring all material collected on public lands to be incinerated and all material collected on private lands to be sent to the landfill; composting of invasive plant material is strongly discouraged. The city of Vancouver on the

other hand composts almost all of the invasive plant material collected either on public or private lands. Material collected on public lands is composted at the Vancouver Landfill while all material collected on private lands is asked to be sent to the Fraser Richmond Soil and Fibre centre. However, Giant Hogweed collected from public lands is buried in the landfill rather than being composted[18].

Discussion

Vegetative cloning after the plant has been removed from the soil is very unlikely to occur in most species. For these species it is very unlikely that roots left in the composted material would be able to regenerate themselves and spread even if the composting process was insufficient to kill them. It is much more likely that seeds left in the soil survive the composting process and germinate after a period of time. However, even this seems unlikely for most species given that the high temperatures used in the composting process are likely sufficient to render most species unviable.

In saying that, taking into account only the ecology of each species, there may be a possibility that a very small fraction of seeds may survive the composting process. Seeds may become trapped in large clumps of other organic material and not reach as high of temperatures despite the attention to the turning of the material. However, while a few seeds may survive it is noted that many of these species' seeds require storage in a cool place before germination is possible. Since this is unlikely when the seeds are taken directly to the composting facility it is unlikely that seeds would germinate upon release from the composting process even if they are technically still alive. Furthermore, the small percentage of seeds that would be able to survive the composting process do to lucky placement within the organic material would likely be much

smaller than the large amount of anecdotal information telling of occurrences where germination occurred after composting.

Taking into account the fact that it has been shown that the composting process is sufficient to eliminate pathogens it is unlikely that even given the ecology of each species that they would be able to survive the composting process, especially the number of times as has been reported. Even though most composting facilities only test their compost for the survival of bacteria resulting from human waste and so on, if the bacteria is killed by the composting process it is likely that propagules will also be killed[17]. Bacteria, much like the propagules of the invasive plants are capable of protecting themselves from unfavourable conditions[14], thus if the conditions are such that the protective mechanisms employed by the bacteria are insufficient it is likely that any protective implements utilized by the propagules will also be ineffective. However, since tests are not done to ensure the death of the propagules it is not possible to say for certain that this is the case.

It seems much more likely that seeds from parent plants close to the site of the composted soil were blown into the composted soil by wind or transferred there by birds, squirrels, humans or other modes of transportation. In these cases the seeds would be placed in the soil after the composting process and so would not undergo the harsh environment. In many such cases the seeds would then germinate much the same as if they had fallen into a natural soil environment and these species may then begin to grow in the composted soil. It would appear as if the composted soil still contained viable propagules from the invasive species when in reality the seeds were placed there after the composting process had been complete.

At the Fraser Richmond Soil and Fibre centre the composting process occurs outside and the finished composted material remains outside until it is bought by the user. It may be possible that the propagules of invasive species are making their way into the composted soil at the

composting site prior to delivery but after the composting process has been complete. It may also be the case that the propagules are being placed in the composted soil after they have been bought and placed in outdoor gardens or lawns. In both cases the propagules may be being transferred by wind, water, birds, squirrels, clothing, and so on. The number of ways that propagules can transfer is so high that it is likely that cases would occur where the propagules would be placed in the soil after composting. This becomes more likely when there is a living source of the invasive plant species close by. However, for species such as Giant Hogweed, germination even after long distance travel is possible.

If propagules are being transferred into the composted soil after the composting process has been completed it may be beneficial to manufacture some type of covering with which to cover the composted soil being stored at the composting site. This would aid in the prevention of stray propagules finding their way into the soil after so much care has been taken to eliminate them from the soil. At the sites where the composted soil is used it may be more difficult and impractical to cover the soil.

To investigate whether propagule transfer into the composted soil is occurring after the soil reaches its intended site for use it may be beneficial to create a digital database using a method such as GIS to map the current locations of known live invasive species communities. This could then be used for reference when a user indicates that their composted soil has begun to grow an invasive species. The digital database could be used for quick reference to gain information on which invasive species are located near the site of the complaint and to determine if the invasive plant species growing in the composted soil could have been transferred there form a nearby source. Of course this method would not work for species with propagules which are capable of long distance travel before germination. However, knowing the distribution

patterns of the different species involved would allow a person to know whether it is likely that a certain invasive species would migrate to the area of complaint.

Given the fact that little information is known on the effects of composting on the viability of invasive species it is suggested that a scientific study be conducted on this topic to discover which, if any, propagules could indeed survive the composting process. In the mean time it may be best to implement covered storage sites and a digital database of known locations of the invasive species to discover if the propagules are being transferred into the soil after the composting process. A scientific study could also be done on the stored composted soil at varying lengths of time of storage to better understand how long it takes for propagules to become located in the stored soil and which species are most likely to be transferred into the soil at the composting site. For private users of the soil it may be best to provide education on the distribution methods of the invasive plant species in order to make them aware of the invasive plant species which may be located around their property and may lead to less public critique and fear of the composting process, especially if the scientific studies conclude that the propagules are unable to survive the composting process.

Given the fact that there is limited information concerning the composting of invasive species it is not surprising that different municipalities suggest different methods for disposal. However, a region wide plan for disposal may help to instil confidence in the plan chosen and to allow for less confusion about the proper methods of disposal. It is also interesting that the majority of the communities seemed most concerned with Giant Hogweed when this species was ranked as number two on the concerned list by the participants at the forum, with Japanese Knotweed beating it out for the number one spot. This confusion of the proper methods for disposal and the species of most concern only emphasize the need for a proper study to be

completed and a single method of disposal to be decided upon by the municipalities in the region.

[1]Ågren, J. 1996. *Population size, pollinator limitation, and seed set in the self-incompatible herb Lythrum salicaria.* Ecology 77:6, pg 1779-1790.

[2]Alonso, C. 2004.E*early blooming's challenges: extended flowering season, diverse pollinator assemblage and the reproductive success of Gynodioecious Daphne laureola.* Annals of Botany 93, pg 61-66.

[3]Carter, M.F., J.B. Grace. 1990. *Relationships between flooding tolerance, life history, and short-term competitive performance in three species of Polygonum.* American Journal of Botany 77:3, pg 381-387.

[4]Evergreen. *Invasive plant profile: dead nettle, yellow lamium.* www.evergreen.ca

[5]Huner, N.P.A., M. Krol, J.P. Williams, E. Maissan. 1988. *Overwintering periwinkle (Vinca minor L.) exhibits increased photosystem I activity*. Plant Physiology 87, pg 721-726.

[6]Lambrecht-McDowell, S.C., S.R. Radosevich. 2004. *Population demographics and trade-offs to reproduction of an invasive and noninvasive species of Rubus.* Biological Invasions 7, pg 281-295.

[7]MacGregor, S.T., F.C. Miller, K.M. Psarianos, M.S. Finstein. 1981. *Composting process control based on interaction between microbial heat output and temperature.* Applied and Environmental Microbiology 41:6, pg 1321-1330.

[8]Marks, T.C., A.J. Truscott. 1985. *Variation in seed production and germination of Spartina angelica within a zoned saltmarsh.* Journal of Ecology 73:2, pg 695-705.

[9]Metcalfe, D.J. 2005. *Hedera helix L.* Journal of Ecology 93:240, pg 632-648.

[10]Packham, J.R. 1983. *Lamiastrum galeobdolon L.* Journal of Ecology 71:155, pg 975-997.

[11]Parker, I.M. 1997. *Pollinator limitation of Cytisus scoparius (Scotch Broom), an invasive exotic shrub.* Ecology 78:5, pg 1457-1470.

[12]Peterken, G.F., P.S. Lloyd. 1967. *Ilex aquifolium L.* Journal of Ecology 55:3, pg 841-858.

[13]Sutherland, W.J. 1990. *Iris pseudacorus L.* Journal of Ecology 78:169, pg 833-848.

[14]Swain, S., T. Harnik, M. Mejia-Chang, K. Hayden, W. Bakx, J. Creque, M. Garbelotto. 2006. *Composting is an effective treatment option for sanitization of Phytophthora ramorum-infected plant material.* Journal of Applied Microbiology 101, pg 815-827.

[15]Tiley, G.E.D., F. Dodd, P.M. Wade. 1996. *Heracleum mantegazzianum Sommier and Levier.* Journal of Ecology 84:190, pg 297-319.

[16]Willis, S.G., P.E. Hulme. 2004. *Environmental severity and variation in the reproductive traits of Impatiens glandulifera* .Functional Ecology 18, pg 887-898.

[17]Allen Yee. Edmonton Waste Management Centre. (Allen.Yee@edmonton.ca)

[18]Greater Vancouver Invasive Plant Council. Oct 21, 2010. Fall Forum.

[19]Larry George. Edmonton Waste Management Centre. (lgeorge@shaw.ca)

[20]Fraser Richmond Soil and Fibre centre