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Hayley H. Kopelson
The Impacts of Invasive Plant Species on Human Health
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Kudzu, an invasive plant species, overwhelming an abandoned building.

Introduction

Invasive plant species clearly have profound impacts on ecological health and well being, but the impacts of invasive plant species on the health of human communities is a topic that hasn't received much attention. Before I discuss this issue further, defining what makes a species invasive is critical to my argument. An invasive species is a species that is not native to the environment/ecosystem it inhabits, and has negative impacts on ecosystem health, human health, and/or economics (Yukon Invasive Species Council, 2014). Several factors have led to the increased spread of invasive species, which include but are not limited to: habitat fragmentation (Lee, *et al.*, 2007), habitat patch isolation (Lee, *et al.*, 2007), land use development, homogenization of species diversity (Lee, *et al.*, 2007), transportation of invasive species via waterways, transportation through other organisms (Vidra and Shear, 2008), etc. While there are many ways for invasive species to become the dominant species within an ecosystem, there are only a few ways to control them, which tend to be expensive, destructive, time consuming, and long term in nature.

While human health is a concern according to the definition of what makes an invasive species invasive, the issue is not frequently discussed. Based upon my understanding of human health in the environment, there are several ways that invasive plant species may in fact be harmful to human health (physical, mental, and psychological).

One of the ways that invasive species may be detrimental to human health can be linked to the theory, Attention Restoration Theory (ART), initially proposed and researched by the Kaplans. ART provides an analysis of the kinds of environments that lead to improvements in directed-attention abilities (Berman, *et al.*, 2008). Directed attention plays an important role in successful cognitive and emotional functioning in day-to-day life, and requires its own form of replenishment in the form of “soft fascination” (Kaplan, 2005). Soft fascination is the combination of moderate fascination and aesthetic pleasure that best characterize environments that humans find restorative (Kaplan, 2005). In order to understand soft fascination and ART, a preference matrix characterizing two, 2-dimensional and two, 3-dimensional restorative aspects of the environment is a useful tool (Kaplan, 2005):

Two-Dimensional	Three-Dimensional
Coherence	Legibility
Complexity	Mystery

Coherence can be thought as whether or not a person can make sense of a place based upon a quick glance. For instance, one quick look at a lecture hall or classroom, and you’re very aware of what that area is designed to be. Complexity is the opposite of coherence. In an environment, complexity requires some thought and deciphering before an area can be understood. An area can be visually complex, or complex simply because it’s new for someone. Legibility can be understood as whether or not a person can find their way into and out of an area easily. Typically,

the use of landmarks increases an areas' legibility and allows for easier way finding. The final aspect of the preference matrix is mystery. In order for a site to be mysterious, that area must have extent, and should urge a person to continue exploring to see what else may be in that landscape. Each of these concepts, or preferences, is related to the other preferences within the matrix, and each has their own role in restoring directed attention.

Another theory connected to ART and directed attention is the concept proposed by E.O. Wilson, called biophilia. Biophilia is the theory that there is a strong affiliation with nature, considered to be of evolutionary origin, which manifests itself in a human being's innate preferences for natural settings containing cues for water, food, and shelter (Wilson, 1984). Since the theory was proposed in 1984, there has been evidence showing that exposure to natural places can lead to positive mental health outcomes, whether that exposure comes in the form of a view of nature from a window, being within a natural setting, or exercising within a natural environment (Barton and Pretty, 2009). The latter has proven to be extremely beneficial to human health; "green exercise" leads to positive health outcomes, fosters social bonds, increases environmental knowledge and can influence behavioral patterns (Barton and Pretty, 2009).

While green space clearly has positive impacts on human health, 'bad' green space may prove to be detrimental to human health. Considering the theories above, a bad green space may not be legible, may offer no mystery or extent, could be too complex to understand, or too coherent to be interesting. For example, a poorly

maintained green space could be overrun with invasive plant species, such as European Buckthorn and wild grape, and may not even be navigable because it's so overgrown. While this patch of land may be considered green space, it would not be considered restorative.

Green space may also not be restorative if the area is perceived as being unsafe. Perceived or actual safety tie into the concept of restorative spaces and ART; if a space feels dangerous, you are relying heavily on directed attention so that you can be fully aware of your surroundings. Research has shown that nature settings are more conducive to recovery when there are no obvious signs of danger (Herzog and Rector, 2008). In the psycho-evolutionary theory, the body's physiological defenses are weakened by stressful settings, which lead to mental and physical fatigue (Ulrich, 1983). Restorative environments must provide a pleasant and calming setting in order to restore directed attention; the feeling of danger disrupts this restorative benefit and is not healthy for humans (Kaplan and Kaplan, 1989; S. Kaplan, 1995, 2001). However, bad green spaces can easily be perceived as dangerous, especially if overrun with invasive plant species, even if the area is in fact a safe one. Invasive plant species are typically fast growing and prolific; these species are hard to manage and keep maintained due to their life cycle, hardiness, and quick rates of reproduction. If plant species overrun a particular area, it may be too costly to take care of the problem, especially if the plant species is resilient and continues to come back even after treatment. Even though identifying management strategies for invasive plant species that minimize negative environmental impacts, but support human benefits, is crucial for sustainable outcomes in land use

development (Marshall, *et al.*, 2011), these plans are often not feasible with budgetary constraints, especially within shrinking cities. Depending on the type of invasive plant species, and its ability to outcompete native plants/ruin human efforts of maintenance, natural areas can quickly become walled in by non-native shrubs and vines, creating a thick barrier that reduces visibility. The observable lack of setting care (or lack of “cues to care”) only exacerbates the feeling of perceived or actual danger (Herzog and Chernick, 2000).

As you can see, Attention Restoration Theory, Biophilia, Psycho-evolutionary Theory, and safety can all be linked to the poor maintenance and the continued spread of invasive plant species. Based upon several studies, a combination of refuge, nature, rich in species (biodiversity), and a low or no presence of social threats can be interpreted as the most restorative environment for those suffering from stress (Grahn and Stigsdotter, 2010). Invasive species can potentially derail each of those restorative qualities and contribute to poor human health. Therefore, I hypothesize that excessive invasive plant species proliferation will impact human health in negative ways. In order to learn more about the effects of invasive plant species on human health, I will do a literature review of relevant research in green psychology, urban land planning, and invasive species/biodiversity, which will hopefully shed light on whether or not invasive plant species are generally detrimental to human health.

Methods

I will review all relevant data, especially in connection with the theories above, and link those to invasive plant species. Data that contributes to my paper will be coded into one or more of the following categories: ART, Psycho-evolutionary Theory, and other relevant green psychology, Safety/Danger (perceived and actual), land use planning in regards to green space, biodiversity, invasive species, and economics (gains and losses in connection to invasive species). At the end of the literature review, I plan on discussing: how biodiversity is beneficial for human health and how invasive species are detrimental to human health, how invasive species can be beneficial to human health, whether or socioeconomic factors play a role in determining the effects of invasive plant species on humans, and make suggestions for further research.

Results and Discussion

While several of the articles I read concluded that increased plant biodiversity has a positive impact on human health, and invasive species negatively impacts plant biodiversity (Fuller, *et al.*, 2007), I also found evidence suggesting that invasive species can not only be beneficial for human health, but also can benefit economics and socioeconomic factors.

Biodiversity as a positive factor in human health

According to Fuller, the psychological benefits gained by green space users increases with the level of biodiversity, and visitors to urban green spaces can even detect differences in species richness. Urban green spaces offer critical harbors for remnant biodiversity, and these green spaces can provide a potential solution to the issues caused by intensified land use and fragmentation (Kong, *et al.*, 2010). In connection to that idea, distribution of invasive, exotic species is also correlated with high levels of land development and homogenization (Vidra and Shear, 2008). The larger a green space is, the more restorative it can be for human health. As the size of the green space, or patch, increases, the invasibility of that area decreases, since there are lower edge-to-area ratios (Vidra and Shear, 2008). In order to promote habitat connectivity and facilitate species movement, the space between patches should be small (Lee, *et al.*, 2008). Therefore, in order to plan urban green spaces that promote high levels of biodiversity, which in turn positively impacts human health, several things should be considered: 1) The areas surrounding patches of green space shouldn't be homogenous in terms of land use, 2) patch size should be large enough to allow for successful ecosystem functioning and for psychological benefits to humans, and 3) the areas between green spaces should allow for species movement and repopulation.

Invasive species as a negative factor in human health

Biodiversity clearly has positive impacts on human health since humans react positively to higher levels of species richness. Invasive species, especially cosmopolitan invasive species (Bardsley and Edward-Jones, 2007) limit or completely derail the restorative effects of plant biodiversity (Vidra and Shear, 2008). As the botanical composition of a region loses its individual characteristics, and becomes more homogenized by cosmopolitan species, then social identity/sense of place also change (Bardsley and Edward-Jones, 2007).

Invasive plant species are not only harmful due to loss of biodiversity; they are also directly harmful to human health and economics. Take for example, *Ailanthus*, commonly known as the tree of heaven. The roots on this tree are incredibly powerful and can damage walls, roads, and other structures. *Ailanthus* also produces powerful allelochemicals, which prevent other native species from establishing themselves and even cause allergic reactions within humans (Bardsley and Edward-Jones, 2007). According to an agronomist in Sardinia, “*Ailanthus* is a very great problem, people are allergic to the pollen... too little is done [to manage *Ailanthus*] at the moment, it is very expensive...” (Bardsley and Edward-Jones, 2007). Another invasive species that poses serious threat to human health is *Heracleum mantegazzianum*, otherwise known as giant hogweed. Giant hogweed is a Federally listed noxious weed that causes severe eye and skin reactions on contact, and can lead to scarring and even permanent blindness (DEC, 2014).

Invasive species as a positive factor in human health

While there are multiple negative impacts of invasive plant species on the health of humans, there are also several benefits that the literature pointed out. In particular, the paper by Marshall, *et al.*, “Considering the social dimension of invasive species: the case of buffel grass” analyzed how the invasive plant species, buffel grass, was an economic and social benefit to the pastoralists living in Australia. After the pastoralists weighed the costs and benefits of their resource dependency, the pastoralists decided that buffel grass was a greater benefit than drawback for their intents and purposes. These social and economic components of resource dependency were significantly correlated with the capacity to cope with, and adapt to, the change in attitude towards buffel grass in regards to managing the grass on grazing and public lands of high environmental value (Marshall, *et al.*, 2011). If buffel grass did not provide economic and social benefits, then the pastoralists may not have given the buffel grass such high value.

Another argument in favor of invasive species as a benefit to humans and ecosystems is that we, as a culture, define a species as invasive or non-invasive. By implying or giving a certain set of underlying values to plants based upon their native habitat, we dismiss their benefits or drawbacks from an ecological and/or social standpoint just on the fact that the plant may not ‘belong’ there, or did not originate in this ecosystem (Schuttler, *et al.*, 2011). These values change based on stakeholder input, profession choice or affiliation, socioeconomic status, education level on the matter at hand, etc. and to some extent, impact whether or not we choose to embrace invasive species, depending on the usefulness or harm the plant

species may cause. For example, Shackleton, *et al.* (2007) found that rural communities in southern Africa would prefer *higher* densities of an invasive cactus because the cacti grow an edible fruit that these communities have grown dependent on. Invasive plant species do not necessarily have to be considered a detriment, as this case shows; invasive plant species can clearly have utilitarian and economic/social benefits.

Since invasive plant species are so prolific, it may also be best to utilize their fecundity and hardiness for environmental, economic, and social purposes. Perhaps these species can be used in different contexts and provide benefits to both humans and ecosystems, if a different value is given to it (Bardsley and Edward-Jones, 2007). As historic ecosystems degrade and our efforts to restore them falter or fail, novel ecosystems thrive and come to be. Novel ecosystems may be perceived as having limited value in regards to the traditional practice of ecological restoration, but there is potential for these novel ecosystems to be valued if the goals under urban restoration are broadened to include the social benefits (discussed earlier). If we expand our value system, then we can value non-native, invasive plant species that may be beneficial to social and environmental causes (Standish, *et al.*, 2011).

Conclusion

While invasive plant species pose a clear threat to human health and well-being, these nonnative species may also provide humans with benefits. Many variables affect our ability to deem an invasive plant species useful or detrimental, such as: the ecosystem in question, land use policy (farming vs urban vs rural land

use), and what socioeconomic situation or status a person maintains. Invasive species can be harmful to an ecosystem if humans place high value on the restorative features of nature, such as well-maintained green space and biodiversity, but a person may place more value on an invasive plant if it can put food on the table during times of need. Many different factors must be considered before deeming an invasive plant species to be a nuisance, and multiple stakeholder viewpoints must be included in the distinction; a naturalists' word is not the end all on the topic. While my hypothesis was somewhat supported by the research, I was not able to definitively state whether or not invasive species, as a general rule, are detrimental to human health.

Further research into how humans cope with and utilize invasive species can and should be done. Most of the studies I read were short-term, and therefore, long-term studies and analyses should be conducted to fill that gap (Barton and Pretty, 2010). The demographics targeted (college students) for research in some of these studies are also a limiting factor; multiple demographics should be considered in further studies to account for different value systems. Small sample sizes were also used frequently in each of these studies; perhaps a larger sample size could lead to more accurate statistics and shed light on other viewpoints that may have been neglected.

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