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Ecological restoration through removal Of invasive alien species: a case study of Junglescapes' efforts in karnataka

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Ecological restoration through removal of Invasive alien species: a case study of Junglescapes' efforts in karnataka

ABSTRACT
This is a case study on the efforts and outcomes of Bengaluru-based NGO 'Junglescapes' to ecologically restore the forests of Karnataka through the removal of invasive alien plant species Lantana Camara.

_VO**IS Planet** portal primarily focuses on environmental sustainability covering various aspects: **Low carbon, Renewable energy usage** and **E-waste management.**

It is aimed at aggregating and helping co-create knowledge and information on environmentally responsive behaviours and concurrently pursuing result-oriented social media campaigns to encourage people and specifically the youth, to take proactive actions in promoting sustainable lifestyle and creating a positive impact on the environmental ecosystem in their surroundings

By: _VO**IS Planet**

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1. BACKGROUND OF THE CASE STUDY

1.1 ECOLOGICAL DEGRADATION: A GRAVE BUT IGNORED CONCERN

Ecological Degradation: A spot at Wallaroo Mines, South Australia where most of the vegetation has been lost due to mining.

Photo credit: creativecommons.org

Over the past thirty years, ecological degradation has become a major global environmental concern. This refers to the decline or destruction of the natural environment and the depletion of its resources, such as soil, water, and biodiversity, largely as a result of human activities such as pollution, sand mining, and timber logging. When the rate of degradation surpasses the rate at which the ecosystem can naturally regenerate, it results in a net loss of the natural environment. This is when ecological restoration is necessary.

Most ecosystems, whether on land or in water, have been degraded to some extent due to various factors such as developmental pressures, population growth, and over-exploitation, as well as stressors like invasive species and climate change.

The Bonn Challenge and the United Nations' declaration of the 2021-30 decade as the "Decade of Ecosystem Restoration" have brought ecological restoration to the forefront of the global biodiversity and climate change agendas.

In addition, the degradation of buffer areas due to human activities like livestock grazing and fuelwood collection has also been increasing, leading to the severe denudation of forested areas. It is estimated that around 40% of forests may need to be restored.

One of the major dire consequences of ecological degradation has been the loss of biodiversity. This is dangerous also because there is a dialectical relationship between biodiversity and climate change in that they both influence and are influenced by each other. Biodiversity is affected by climate change, as rising temperatures and changing weather patterns can alter the distribution and abundance of species. For example, a study published in the journal Nature found that climate change is causing many species to shift their ranges poleward or to higher elevations, leading to changes in the distribution and abundance of species in different regions (Parmesan and Yohe 2003).

At the same time, biodiversity can also influence the impacts of climate change. For instance, diverse ecosystems are more resilient to the impacts of climate change, as the presence of multiple species can help to buffer against the negative effects of extreme weather events and other perturbations (Briske et al. 2008). In addition, the protection of biodiversity can help to mitigate climate change by maintaining the functioning of ecosystems that provide important ecosystem services, such as carbon sequestration and the regulation of water cycles (de Groot et al. 2010). In addition, the temperature in a regular non-degraded forest will be lower by several degrees. A restored forest is therefore the prescription to fight against **global warming**.

Another significant consequence of forest degradation is the increase in conflicts between humans and wildlife. When forests are overrun by invasive species like Lantana Camara and Senna Spectabilis, it can reduce the availability of edible vegetation, leading animals to seek food in human settlements.

Many ecosystems are now damaged to the point where they cannot recover on their own and require intervention. For example, mangroves along coastlines are often severely impaired and need assistance. Additionally, protected areas like national parks may be ecologically vulnerable due to the presence of invasive species such as Lantana Camara.

The impact of ecological degradation on biodiversity is widely recognized, but its effect on ecosystem services is often underestimated.

In the Western Ghats, the degradation of natural ecosystems poses a direct threat to water security and the livelihoods of millions of people in the region. This degradation has serious consequences for human well-being and economic sustainability. (Venkataraman, R., 2020, July 30)

1.2 ECOLOGICAL DEGRADATION: A GRAVE BUT IGNORED CONCERN

The desert locust, an invasive species recently attacked India and Pakistan causing huge damage to flora.

Photo credit: Bhagirath/BCCL Jaipur

Invasive alien species are species that are non-native to an ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive alien species can be plants, animals, fungi, or microorganisms, and they can be introduced to a new environment through a variety of means, including intentional or accidental introduction by humans, natural dispersal, or through the movement of goods and materials.

Once established in a new environment, invasive alien species can outcompete native species for resources, alter ecosystem function, and affect the health and well-being of both human and animal populations. invasive alien species can also contribute to biodiversity loss and the decline of threatened or endangered species.

There are many examples of invasive alien species around the world, including plants such as kudzu in the south-eastern United States and water hyacinth in Africa and South America, animals such as the European rabbit in Australia and the Burmese python in the Florida Everglades, and microorganisms such as the zebra mussel in North American waterways.

The impact of invasive alien species can be significant, and efforts to prevent their introduction and to control or eradicate established populations are often necessary. These efforts can involve a range of measures, including legislation, quarantine and inspection programs, public education and outreach, and management and control strategies.

There is a complex relationship between invasive alien species and climate change. Climate change can create conditions that favour the establishment and spread of invasive alien species in new areas, as rising temperatures and altered precipitation patterns can alter the environmental conditions that species are adapted to and create new opportunities for colonization. For example, a warmer climate may allow invasive alien species that are adapted to warmer temperatures to expand their range into areas that were previously too cold for them to survive. In addition, climate change can also alter the distribution and abundance of native species, creating openings in the ecosystem that invasive alien species can exploit.

On the other hand, invasive alien species can also contribute to climate change by altering the functioning of ecosystems. For example, certain invasive alien species can alter the carbon sequestration capacity of forests or disrupt the nutrient cycling processes of an ecosystem, leading to changes in the amount of carbon dioxide and other greenhouse gases in the atmosphere.

Overall, the relationship between invasive alien species and climate change is complex and multifaceted, and understanding this relationship is important for predicting and managing the impacts of invasive alien species on ecosystems and for mitigating the negative impacts of climate change.

Invasive species is a major issue in many wildlife sanctuaries in India. Some of the most prevalent invasive species in dry deciduous forests are Lantana Camara, Chromolaena odorata, Senna (earlier classified under Cassia) Spectabilis and Parthenium hysterophorus.

2. THE PROBLEM

2.1 LANTANA CAMARA: ONE OF THE WORLD'S WORST INVASIVE ALIEN SPECIES

Left Image: Flower of a West Indian Lantana Camara
Photo credit: creativecommons.org

Right Image: Flowers of Lantana Camara in West Bengal, India.
Photo credit: creativecommons.org

Lantana Camara, also known as red sage or wild sage, is a species of flowering plant native to the tropical regions of the Americas. However, it has been introduced to many other parts of the world as an ornamental plant and has become an invasive alien species in many of these areas. This plant has caused significant negative impacts on native ecosystems and has been listed as one of the world's worst invasive species by the International Union for Conservation of Nature (IUCN).

L. Camara is a perennial shrub that grows to a height of 1-3 meters and has clusters of small, brightly coloured flowers that bloom throughout the year. It is highly adaptable to a wide range of climates and soil types and is able to tolerate drought and salt spray, making it well-suited to colonize a variety of habitats. The plant reproduces both sexually, through the production of seeds, and vegetatively, through the growth of new shoots from the roots. It is also able to regenerate from cuttings, making it difficult to completely eliminate once it becomes established in an area.

L. Camara was introduced to many parts of the world as an ornamental plant, and it was widely planted in gardens and public spaces for its attractive flowers and ability to tolerate a range of conditions. However, it has escaped cultivation and has spread rapidly in many areas, becoming naturalized and invasive. It is able to outcompete native plants for resources such as light,water, and nutrients, and can alter the structure and composition of native plant communities. L. Camara has also been shown to have negative impacts on animal species, such as reducing the abundance of nectar-feeding insects and reducing the use of areas by birds and other animals (Lowe, Browne, Boudjelas, & De Poorter, 2000).

L. Camara has become an invasive species in many parts of the world, including Africa, Asia, Australia, Europe, and the Pacific Islands (Lowe et al., 2000). It is listed as a noxious weed in many countries and is subject to control measures such as manual removal, herbicide application, and the use of biological control agents. One example of a biological control agent that has been used against L. Camara is the Lantana Camara leaf-feeding moth (Hypolimnas bolina), which feeds on the leaves of the plant and reduces its growth and reproduction (Caldwell & Albrect, 1983). Other biological control agents that have been used against L. Camara include a leaf-mining fly (Liriomyza camarae) and a stem-boring weevil (Listronotus setosipennis) (Cuda, Denton, Hight, & Frank, 2002).

Lantana plants produce thousands of seeds each year, which are dispersed by various means such as air, water, birds, insects, cattle, and humans. These seeds can remain dormant in the soil for over 10 years, and their dormancy is often broken by soil disturbance or forest fires. The seeds are colourful and attract attention, which can contribute to their spread.

In conclusion, Lantana Camara is an invasive alien species that has caused significant negative impacts on native ecosystems around the world. It is highly adaptable and able to reproduce both sexually and vegetatively, making it difficult to control once it becomes established. Control measures such as manual removal, herbicide application, and the use of biological control agents have been used to try to reduce the spread of L. Camara, but it remains a significant threat to native plant communities in many parts of the world.

2.2 IMPACT OF INFILTRATION OF LANTANA CAMARA IN INDIA

Lantana camara grows in between trees at Bandipur National Park, Karnataka
Photo credit: The Hindu

Lantana Camara was brought to India by the British around 1805 from South America as an ornamental plant and has since then spread across the country.

In India, L. Camara has become an invasive species, causing significant negative impacts on both natural ecosystems and agriculture (Khan & Khan, 2013). Despite efforts to control its spread, it has continued to spread rapidly, causing concern among forest officials in various parts of the country. These efforts to contain the invasive plant have largely been unsuccessful.

One of the main impacts of L. Camara in India is on native plant species. L. Camara is a fast-growing plant that can quickly outcompete native plants for resources, leading to a decrease in biodiversity (Sharma & Singh, 2016). It is particularly problematic in grasslands and forests, where it can form dense thickets that block the growth of other plants (Khan & Khan, 2013). This can lead to the displacement of native plant species and a reduction in the overall health of the ecosystem (Sharma & Singh, 2016).

In addition to affecting native plants, L. Camara can also have negative impacts on wildlife (Khan & Khan, 2013). The plant produces toxins that can be harmful to animals that consume it, and its dense growth can make it difficult for animals to move through affected areas (Sharma & Singh, 2016). This can reduce the overall population of certain species and disrupt the balance of the ecosystem (Khan & Khan, 2013).

L. Camara can also have significant impacts on agriculture in India (Sharma & Singh, 2016). The plant is known to be allelopathic, meaning that it produces chemicals that can inhibit the growth of other plants (Adhikari & Shrestha, 2017). This can make it difficult for farmers to grow crops in areas infested with L. Camara (Khan & Khan, 2013). The plant's thick growth can also make it difficult for farmers to access and manage their fields, leading to reduced crop yields and financial losses (Sharma & Singh, 2016).

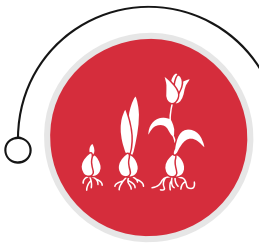
There are various efforts underway in India to control and manage the spread of L. Camara (Khan & Khan, 2013). These include the use of herbicides, manual removal, and the introduction of biological control agents such as insects that feed on the plant (Sharma & Singh, 2016). However, these efforts can be costly and may not always be effective in completely eliminating the plant (Khan & Khan, 2013).

In the Nilgiris Biosphere, invasive species have invaded 40-60% of many forest areas, including protected areas and tiger reserves, leading to the loss of native vegetation in areas such as Wayanad and Coorg. These invasive weeds displace native species of vegetation and prevent the growth of native vegetation. For example, the domination of Lantana in most parts of Bandipur has reduced the reappearance of bamboo, which is a key food source for elephants that depend on a diverse diet. In the Shola grasslands of the Western Ghats, invasive species like Wattle are degrading these ecosystems, which provide the important ecosystem service of rainwater harvesting. These grasslands act as sponges, capturing and retaining rainwater and releasing it into rivers throughout the year, making them vital for water security. As a result, the invasion of invasive species is now one of the main threats to ecosystems in large parts of the Western Ghats. (Venkataraman, R., 2020, August 18)

In conclusion, Lantana Camara has had significant negative impacts on India, including on native plant species, wildlife, and agriculture (Sharma & Singh, 2016). Efforts to control and manage the spread of the plant are ongoing, but more research is needed to find effective and sustainable solutions to this invasive species problem (Khan & Khan, 2013).

2.3 LANTANA CAMARA: NOTORIOUSLY HARD TO GET RID OF

Lantana Camara is notoriously hard to get rid of. There are several reasons why it is difficult to get rid of Lantana Camara:

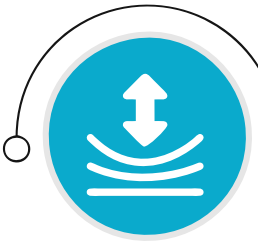


High reproductive rate

It has a high reproductive rate, producing large amounts of seeds that can be dispersed by wind, water, and animals allowing it to easily spread.

Tolerance to adverse conditions

It can tolerate severe environmental conditions, including drought, salt, and poor soil quality making it difficult to control using traditional methods such as herbicides.



Resilience to control measures

Lantana Camara can regrow from its roots even if the above-ground portion of the plant is removed making it difficult to completely eradicate the plant using methods such as cutting or mowing.

Lack of effective control measures

There are currently no reliable, long-term control measures for the plant. Herbicides and biological control methods such as the introduction of insects that feed on it have had limited success

Overall, Lantana Camara is a difficult plant to control due to its high reproductive rate, tolerance to adverse conditions, resilience to control measures, and lack of effective control methods.

3. JUNGLESCAPES

Junglescapes team with community members
Photo credit: Junglescapes

Junglescapes is a grassroots wildlife conservation NGO that has been dedicated to the ecological restoration of degraded forest habitats in the Western Ghats of South India, particularly in and around the Bandipur tiger reserve in Karnataka, since 2008.

In 2017, it became the first Asian organization to win the prestigious Society for Ecological Restoration (SER) Full Circle Award at the Global Restoration conference in Brazil, which recognizes efforts that involve indigenous communities and their knowledge in restoration projects.

The NGO focuses on three main areas: ecological restoration, environmental stewardship, and eco-based livelihoods.

It follows a community-participative model in which local, predominantly indigenous village communities are active partners in the projects and works closely with the Forest Department to address degradation and manage human-animal conflicts.

Junglescapes adopts a bottom-up approach, focusing on improving the abiotic health of the forest through soil and hydrology restoration and removing and restoring areas impacted by Lantana Camara.

3.1 JUNGLESCAPES' GOAL: ECOLOGICAL RESTORATION

Junglescapes team with community members
Photo credit: Junglescapes

Ecological restoration involves helping damaged or destroyed ecosystems recover to their previous state or as close to it as possible.

Junglescapes uses scientific methods and reference models from native ecosystems to guide the restoration process and ensure that the restored ecosystem is similar to the original.

Ecosystem integrity, including both living and non-living elements, is crucial for successful restoration. This approach considers all aspects of an ecosystem, including soil, hydrology, flora and fauna, to increase the resilience and regenerative capacity of the ecosystem.

Restoration efforts may focus on a variety of plant and animal species, including insects and larger mammals, and may take place over a long period of time. It is estimated that at least 20% of forest ecosystems in India may need restoration, and considering other types of ecosystems as well, the restoration economy in the country could potentially be worth nearly a trillion rupees in the next 20 years.

Traditional conservation methods, which aim to protect natural spaces, have become increasingly difficult due to the increasing impact of human activities. Therefore, conservation alone is no longer sufficient to address the issue of ecosystem degradation.

4. JUNGLESCAPES' APPROACH TO ECOLOGICAL RESTORATION

4.1 COMMUNITY-PARTICIPATIVE MODEL & RESTORATION-BASED LIVELIHOOD

Forest dwelling community members working with Junglescapes
Photo credit: Junglescapes

Junglescapes involves local communities in the restoration of forests, providing them with economic opportunities and the chance to take on a responsible role in caring for the forests.

This short-term benefit also has long-term effects as the communities start to demonstrate stewardship towards the forests, helping to prevent further degradation and ensuring their protection.

One of the key advantages of involving communities in the process is that they bring their traditional ecological knowledge, gained from living in the forest for many years, to the project. This traditional knowledge, combined with scientific knowledge, has proven to be a successful approach in the organization's restoration efforts, as the scientific knowledge has helped with the management of invasive species, planning and monitoring of restoration projects, and seed processing and storage, among other things. (Venkataraman, R., 2015).

Most of the villagers living near the forest are members of indigenous communities who were relocated from within the forest when the national park was established about 50 years ago. These communities, such as the Jenu Kurubas and Soligas, have a history of being nomadic and do not have a strong connection to agriculture. As a result, much of the land given to them at the time of relocation has remained unused.

In the past, efforts to rehabilitate indigenous people have focused on providing them with vocational training in non-forestry skills, but these efforts have had limited success due to challenges in integrating into mainstream society.

Many members of these communities end up working in unskilled jobs in villages and small towns, and their disconnection from the forests also leads to the loss of traditional ecological knowledge.

4.2 THE CUT-ROOTSTOCK METHOD

Junglescapes volunteers uprooting lantana using the cut-rootstock method
Photo credit: Junglescapes

Junglescapes employs a method called the cut-rootstock method to restore areas invaded by Lantana, a weed that can disrupt natural ecosystems. This method was developed by the Centre for Environmental Monitoring of Degraded Ecosystems in Delhi, which is a Centre of Excellence of the Ministry of Environment and Forests in India.

The cut-rootstock method has been successful in the Corbett Tiger Reserve and involves manually cutting the rootstock of the Lantana 2-3 inches below the soil to prevent it from regenerating. This method is preferred to others, such as grubbing with heavy machinery or burning, as these methods can disturb dormant Lantana seeds under the soil and cause them to germinate, leading to the more rapid growth of the weed.

It is important to restore the plots after removing the Lantana to prevent the invasion of secondary weeds. The use of scientifically validated protocols for managing invasive weeds like the Lantana is crucial in ensuring the success of restoration efforts.

The following are the key differences between the CRS method and other traditional methods of removal:

- **Avoidance of grubbing or slashing**

  The CRS method does not involve pulling the bushes out of the ground or cutting the stems or branches. This helps avoid soil disturbance and the re-emergence of Lantana from cut branches or twigs that are left on the soil.

- **Avoidance of soil disturbance**

  The CRS method causes minimal disturbance to the soil, which helps prevent dormant Lantana seeds in the soil from being exposed to sunlight and germinating. This is important in reducing the likelihood of Lantana regrowing from the local seed bank. The CRS method leaves a scar on the ground approximately 6 inches by 6 inches in size per plant, as shown in the images below.

- **·Protection of pre-existing native saplings and vegetation**

  The CRS method minimizes disturbance to native vegetation, including saplings and grassy patches, that may be present under or in between Lantana plants. The removal process does not harm native saplings that may have been bent due to suppression by Lantana but are otherwise unaffected by the removal process.

- **Preservation of grassy patches**

  Preserving grassy patches that exist between Lantana bushes is a key aspect of the CRS method, especially in dry deciduous forests. These patches are important for quickly restoring the pilot plot to a healthy habitat and preventing the re-appearance of Lantana. In contrast, traditional methods like using heavy machinery to pull out the bushes (grubbing) destroy all vegetation, including grass cover, making the restoration process more difficult. (Venkataraman, R., 2015)

5. PLANT REMOVAL AND RESTORATION EFFORTS

Ecological restoration by Junglescapes has helped reconnect two parts of Bandipur Tiger Reserve
Photo credit: Junglescapes

Since 2008, Junglescapes has been partnering with the forest department on efforts to restore and revitalize the degraded forests in the Bandipur Tiger Reserve region.

To support the regrowth of the underbrush and forest, Junglescapes has enlisted the help of local villagers to plant native species of grass and construct trenches and small water storage structures. (TWC India Edit Team., 2021, June 5).

Additionally, the organization has established community eco-development groups made up of around 50 villagers living on the outskirts of the Bandipur Tiger Reserve. These groups receive training and support from Junglescapes.

6. OUTCOMES

6.1 ECOLOGICAL RESTORATION

Before and after pictures of a restoration project by Junglescapes.

Photo credit: Junglescapes

As it can be noticed, the lantana bushes in the photo have been eradicated as a result of the restoration work. In their place, new diverse types of plants and grass have come up.

Since 2007, Junglescapes and participating communities have successfully restored over 1,500 hectares of degraded forests in the region, leading to the recovery of native flora and fauna. (Venkataraman, R., n.d.).

A 2015 study found that the CRS method used by Junglescapes has had almost 98% success in eradicating Lantana Camara in moderate-density areas and 80% success in high-density areas. The restoration efforts have been most successful in moderate and low-density areas, with moderate success in high-density areas. The restored areas show promising potential for becoming biodiverse

K.N. Mahesha, a volunteer ornithologist from Kunagahalli village, reports that the return of native trees has reduced the incidence of elephants coming to the village in search of food.

When Junglescapes began their work, the area had low plant diversity, which led to erosion and degradation during heavy rainfall. However, thanks to their efforts, the increased moisture and improved soil health have led to the return of natural vegetation and the associated animal and bird species.

6.2 COMMUNITY LIVELIHOOD

The community members perceive this as a valuable alternate livelihood
Photo credit: Junglescapes

Prior to their involvement in the restoration project, the community members primarily engaged in seasonal farm labour, which averaged 10 days of work per month. However, the restoration effort is a year-round undertaking and has allowed these community members to generate three times their previous income. This has led to a marked improvement in the quality of life for their families.

In addition, the community members have experienced intangible benefits in terms of increased self-confidence and social status.

Furthermore, Junglescapes has trained villagers living near the forests in the creation of craft items made from Lantana. The Lantana that is sustainably harvested is transported to a craft centre, where it is sold and generates income for the villagers.

7. ANALYSIS

Junglescapes' community-based restoration efforts have had significant positive impacts on the environment and the participating communities in Karnataka. The organization has successfully eradicated Lantana Camara in moderate and low-density areas and has contributed to the recovery of native flora and fauna in the region. The restoration efforts have also had tangible economic benefits for the participating communities, providing livelihood opportunities and increasing their income threefold. In addition, the restoration of degraded forests has the potential to generate numerous ecosystem services, increasing the overall value of the restoration project.

The involvement of local communities in the restoration process has been integral to the success of the project and has had positive impacts on their quality of life, including increased self-confidence and social status. The widespread occurrence of Lantana Camara in the region suggests that such restoration efforts could be sustained over an extended period of time as a means of creating sustainable alternative livelihoods for marginalized individuals.

8. CONCLUSION

The efforts of Junglescapes to restore the forests of Karnataka through the removal of invasive alien plant species, particularly Lantana Camara, have had significant positive impacts on the environment and the participating communities. The organization has been successful in eradicating Lantana Camara in moderate and low-density areas, leading to the recovery of native flora and fauna in the region. The restored areas show promising potential for becoming biodiverse habitats in the future, and the increase in grass cover is expected to support more ungulates. The return of native trees has also reduced the incidence of elephants coming to the village in search of food.

In addition to the environmental benefits, the restoration efforts have had tangible economic benefits for the participating communities.

The year-round nature of the restoration project has allowed community members to generate three times their previous income from seasonal farm labour. The involvement of local communities in the restoration process has also had intangible benefits, such as increased self-confidence and social status. Junglescapes has also trained villagers in the creation of craft items made from sustainably harvested Lantana, providing a source of income for these villagers.

The widespread occurrence of Lantana Camara in the region suggests that such restoration efforts could be sustained over an extended period of time as a means of creating sustainable alternative livelihoods for marginalized individuals. The restoration of degraded forests also has the potential to generate numerous ecosystem services, increasing the overall value of the restoration project. By restoring key ecosystem components such as ponds, lakes, grazing lands, wetlands, rivers, and forests, these efforts not only improve the livelihoods of participating communities but also contribute to the preservation of biodiversity and the maintenance of native knowledge.

Overall, the case study demonstrates the feasibility of implementing restoration efforts as a means of creating sustainable alternative livelihoods for local communities while also contributing to the conservation of natural habitats and the preservation of biodiversity.

REFERENCES

1. Briske, D. D., et al. (2008). "Grassland responses to global environmental changes." Environmental Research Letters, 3(1), 014009.

2. Caldwell, D. K., & Albrect, E. (1983). The introduced flora of Australia and its weed status. Australian Journal of Ecology, 8(1), 11-19.

3. Cuda, J. P., Denton, S., Hight, S. D., & Frank, J. H. (2002). Biological control of Melaleuca quinquenervia in Florida: From classical to augmentative approaches. In J. T. Cuda, S. D. Hight, & J. H. Frank (Eds.), Melaleuca quinquenervia: A literature review (pp. 189-198). Gainesville, FL: University of Florida, Institute of Food and Agricultural Sciences.

4. de Groot, R. S., et al. (2010). "Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making." Ecological Complexity, 7(3), 260-272.

5. Invasive Alien Species. (n.d.). Retrieved from https://www.cbd.int/invasive/

6. Invasive Alien Species. (n.d.). Retrieved from https://www.iucn.org/resources/issues-briefs/invasive-alien-species

7. Invasive Species. (n.d.). Retrieved from https://www.epa.gov/invasivespecies

8. Invasive Species. (n.d.). Retrieved from https://www.nationalgeographic.com/environment/habitats/invasive-species/

9. Khan, M. A., & Khan, M. A. (2013). Impact of Lantana Camara on biodiversity and agriculture in India. Journal of Environmental Biology, 34(6), 1247-1253.

10. Lowe, S., Browne, M., Boudjelas, S., & De Poorter, M. (2000). 100 of the world's worst invasive alien species. Auckland, New Zealand: IUCN/SSC Invasive Species Specialist Group.

11. Parmesan, C., & Yohe, G. (2003). "A globally coherent fingerprint of climate change impacts across natural systems." Nature, 421(6918), 37-42.

12. Sharma, R., & Singh, H. (2016). Invasive alien species: A threat to biodiversity and agriculture. Journal of Animal Research, 6(3), 563-566.

13. TWC India Edit Team. (2021, June 5). Ecoguardians: Here's how Junglescapes is restoring ecosystems and protecting forests from invasive species. The Weather Channel. Retrieved December 20, 2022, from https://weather.com/en-IN/india/environment/news/2021-05-22-how-junglescapes-is-working-towards-ecosystem-restoration

14. "Lantana camara." Encyclopedia of Life, eol.org/pages/553786.

15. "Lantana Camara." Invasive Species Compendium. CAB International, www.cabi.org/isc/datasheet/110792.

16. "Lantana Camara." Plants of the World Online, plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:528938-1.

17. Vilà, M., Richardson, D. M., Py ek, P., & Carlton, J. T. (2010). Ecological impacts

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