Forest Defenders

A virtual reality experience exploring invasive species extermination methods

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Forest Defenders is a virtual reality experience developed in Unity that educates users about invasive plants, shrubs, and trees in Illinois, along with the methods used to control them. About one-third of the state's plant species are invasive [5], often going unnoticed. Set in an imaginary Illinois forest, participants can use manual and chemical control methods to remove invasive species and help restore the environment. The project aims to raise public awareness and promote wider adoption of these methods. Forest Defenders was exhibited at CAVE2 in the University of Illinois Chicago's Electronic Visualization Laboratory.

CCS CONCEPTS • Arts and humanities • Human-centered computing • Human computer interaction (HCI) • Interaction paradigms • Mixed / augmented reality • Virtual Reality

Additional Keywords and Phrases: CAVE2, Design, Creative Coding, Theater, Life on Land, Invasive Species, Typography

1 INTRODUCTION

In 2015, the United Nations created the Sustainable Development Goals, a blueprint for achieving a sustainable global future by 2030. Goal 15, Life on Land, includes protecting, restoring, and promoting the sustainable use of terrestrial ecosystems. Target 15.8 specifically focuses on invasive species, aiming to introduce measures to reduce their impact on land ecosystems by 2020. While nearly all UN members adopted legislation to further prevent invasion, already introduced invasive species continue to threaten various land environments today. [4]

Invasive, or alien species, are non-native organisms that cause significant damage to their introduced ecosystem [7]. Their negative impact makes them a subset of non-native species (species that have been introduced to a region [5]).

2 PROBLEM

Invasive species outcompete natives due to genetic and environmental advantages. Some can thrive in harsher conditions or change the soil chemistry, making it harder for native plants to survive. They often grow quickly, taking over available space. In many cases, invasives lack local predators, allowing them to spread even faster without natural control [7]. They

pose a significant threat across North America, including Illinois, which ranks fifth nationally in invasive presence. Many of the state's ecosystems are at risk, with forests covering approximately 14% of the land, but only 1.5–2% falling under formal protection. Without proper action, the resulting loss in biodiversity may lead to long-term, irreversible damage [5].

Despite the looming threat, awareness of invasive species and appropriate management strategies remains limited. Although many techniques used to control invasive species are not suitable for implementation by the public, increasing their knowledge is critical. By fostering collaboration between community members, policymakers, and environmental professionals, these strategies can over time become more accessible and powerful.

3 VR PROJECT DEVELOPMENT

3.1 Concept & Revision

After creating a base concept, mechanics, and storyboard based on the cross-disciplinary "Design+Theater+Coding methodology [3], more research was done to create gameplay accurate to real life control methods. During an improv-acted presentation of the concept, feedback was gathered from the audience, with suggestions to educate the user more about the invasive and native plants within the environment. To implement this change, signage was added near the compost machine, displaying informational text and images when plants were composted or planted.

Testing in CAVE2 revealed inefficient mechanics and unclear visuals. Dragging tools like the axe or spray across the forest was slow, and dull colors made objects hard to distinguish. The compost machine clashed with the natural setting. These issues were resolved iteratively, ending with an inventory system for tool switching, adjusted colors and brightness for clarity, and a redesigned compost station to better match the environment.

3.2 Environment & Interactions

Forest Defenders is set in a fictional Illinois forest, infested with invasive plants and trees, and very few native species. When the game begins, the forest is dark and foggy, and cricket chirping can be heard, creating an unsettling ambience. As the player interacts and eliminates invasives, the sky gets brighter, and the fog clears out, illustrating the forest's healing.

The game features three core interactions, each corresponding to a method of invasive species control. Signage in the forest guides the player with step-by-step instructions and shows which invasive objects each method can eliminate.

3.2.1 *Composting & Replanting*

Various plants are scattered throughout the environment. Invasive ones can be grabbed by the player and brought over to the forest's compost station. When the plant is placed into the compost machine, facts about the plant are displayed on a nearby signboard. A native species plant is dispensed from the machine, which the player can take over to the garden section of the station. Similarly, when the plant is placed into the garden, its information is displayed on a signboard.

Figure 2: Participants utilizing the compost station, comprised of the bin, garden, and signage.

Composting, while fundamentally straightforward, requires increased precision when applied to invasive species management. It must consist solely of organic matter and be maintained at a sufficiently high temperature to effectively neutralize any viable plant material from invasives. Despite these specific requirements, composting remains a low-cost and chemical-free strategy, making it one of the most accessible control methods. Additionally, it enriches soil quality, facilitating the reestablishment of native plant communities. Though the composting stations represented in the project are conceptual, their real-world application could lead to advancement in sustainable invasive species management. [6]

3.2.2 *Cut Stump Method (CSM)*

Invasive trees are also present. Because of their size and weight, their method of control involves cutting. Cuttable trees emit red typography particles from their base. When the user collides with the tree holding the axe, it will get cut, leaving the stump and particles. The user must spray the tree stump to fully exterminate the invasive tree, causing it to disappear.
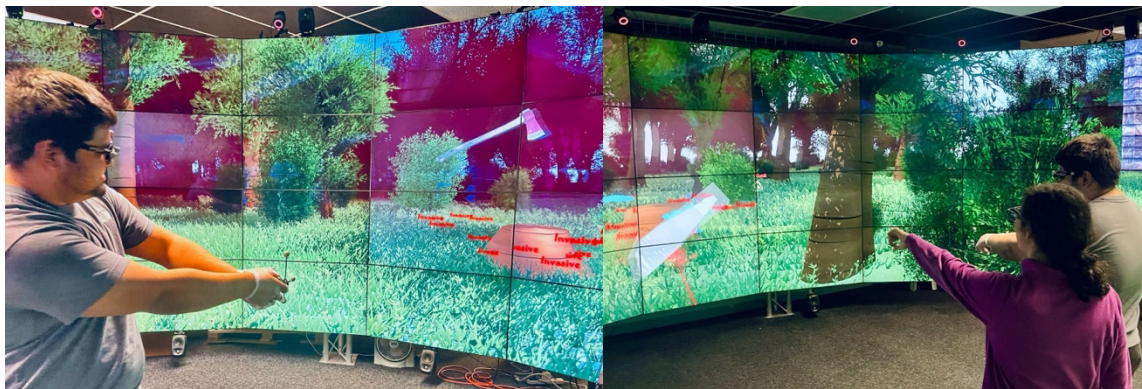

Figure 3: Participants cutting down a tree and spraying a stump with chemical spray.

The combination of axe and spray is based on the Cut Stump removal method. Spraying the stump is required to fully kill off the tree, otherwise it could continue to spread fatal chemicals to the forest soil through its roots. Various herbicides can be combined to make sprays, including Triclopyr, which causes certain plants to grow abnormally, killing them. [2]

3.2.3 *Basal Bark Treatment (BBT)*

Some trees are surrounded by typographic rings. They can be treated by another control method, Basal Bark Treatment. When the player sprays these trees, the rings disappear, but the tree remains. Unlike CSM, BBT kills the tree slowly over time, instead of immediately. However, it requires less resources, only needing sprays (versus the power and time required to cut down trees). Although the player can spray anywhere on the tree in the game, in real life, BBT should be applied near the tree's base. Like CSM, herbicides are used in the spray, but the amount and type vary based on the plant. [2]

4   TYPOGRAPHY

For typographic elements, distinct font and color choices were made to help players easily recognize interactive elements. Invasive plants use the "Rockwell Extra Bold" for its heavy, blocky, appearance, symbolizing the domination of invasive species. Plant names are labeled to support player recognition, aiding in real-world identification. Invasive trees use two different typefaces based on their control methods. "Jokerman Bold" (CSM) and "BeoSansHard R23" (BBT) feature wild, unfamiliar designs that emphasize a disruptive nature. All invasive elements are colored bright red, making them stand out and symbolize their unnatural presence in the ecosystem. By contrast, native plants use the "Baskerville Light" typeface. Its clean, delicate serif conveys calmness and harmony, reflecting the role of native plants in a balanced environment. These elements are colored soft green to represent their belonging in the landscape. Like invasive species, native plants are labeled with their names to aid in real-world identification.

5   CONCLUSION

The project was exhibited at CAVE2 at UIC's Electronic Visualization Laboratory on April 9th, 2025. CAVE2 is a Virtual Reality Environment approximately 24 feet in diameter and 8 feet tall. It consists of 88 near-seamless passive stereo off-axis-optimized 3D LCD panels, a 20-speaker surround audio system, and a 14-camera optical tracking system, all powered by a high-performance computer cluster [1]. Team members navigated and narrated the experience to approximately 50 viewers, successfully showcasing the completed environment and all core interactions.

Forest Defenders highlights the potential of virtual reality to educate the public about invasive species. Through an immersive, responsive, environment, and interactive mechanics, players learn about specific invasive plants, and real-world control methods that promote environmental restoration. As public awareness of these control methods grows, more local, state, and national governments are likely to adopt and implement them, advancing the objectives of SDG 15.

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