

Viewpoint

Applying United Nations Sustainable Development Goals, Mt. Cuba Center Gardens with Native Plants and Grows Conservators

Élan R. Alford *, Sam Hoadley, Caroline R. Fazzini, Laura K. Reilly, Amy Highland, Ellen C. Lake and Jeffrey A. Downing

Mt. Cuba Center, 3120 Barley Mill Road, Hockessin, DE 19707, USA; shoadley@mtcubacenter.org (S.H.); cfazzini@mtcubacenter.org (C.R.F.); lreilly@mtcubacenter.org (L.K.R.); ahighland@mtcubacenter.org (A.H.); elake@mtcubacenter.org (E.C.L.); jdowning@mtcubacenter.org (J.A.D.)

* Correspondence: ealford@mtcubacenter.org

Abstract: Mt. Cuba Center is a botanical garden created with a conservation purpose: to work with native plants and inspire people to become conservators of native habitats. Adherence to this founding mission aligns Mt. Cuba's activities with 4 of the 17 United Nations Sustainable Development Goals. This article shares aspects of the center's founding, interpretative plan and content, horticultural research, and conservation programs. We hope that it will inspire the development and implementation of more botanical garden conservation programs that catalyze members, guests, and community partners to participate in and amplify conservation efforts through collective actions. By highlighting the region and its beautiful native flora, Mt. Cuba teaches conservation of native habitats and how to incorporate native plants into home gardens. The garden's conservation messages are brought to life through interpretive plans, horticultural research, and public engagement. The garden itself acts as a tool to promote conservation by influencing guest attitudes and experiences. The renewal of Mt. Cuba from a fallow cornfield to a thriving ecosystem illustrates that individuals can make a difference. By telling its story and demonstrating accessible conservation actions through its work with native plants, Mt. Cuba aims to transform garden guests into conservators.

Keywords: botanical garden; native plants; UN Sustainable Development Goals; interpretation; horticultural research; community science; Trial Garden



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Citation: Alford, É.R.; Hoadley, S.; Fazzini, C.R.; Reilly, L.K.; Highland, A.; Lake, E.C.; Downing, J.A. Applying United Nations Sustainable Development Goals, Mt. Cuba Center Gardens with Native Plants and Grows Conservators. *Sustainability* **2022**, *14*, 6074. <https://doi.org/10.3390/su14106074>

Academic Editors: Paul Smith and Helen Miller

Received: 1 April 2022

Accepted: 13 May 2022

Published: 17 May 2022

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1. Introduction

Setting the Stage, the Importance of Place and Conservation Vision

Serving as scientific and cultural attractions, botanical gardens have a role in educating the public about plant conservation [1], global change, and the United Nations' (UN) 2030 Sustainable Development Goals (SDGs) to sustain global biodiversity and empower their visitors to live healthier and more sustainable lives [2]. When a botanical garden inspires individuals, there is an opportunity to change attitudes and motivate action, amplifying conservation efforts. Heywood [3] writes that botanical gardens "need to . . . intensify their attempts to put across the conservation and sustainability messages to the public through their displays, collections, electronic media, and so on". Engaging with the SDGs, Mt. Cuba Center inspires conservation action and a passion for the natural world through its natural beauty, interpretive programs for the public, outreach with local communities, continuing education classes, and research.

Mt. Cuba Center's garden and mission have been shaped by two factors: place and people. In 1935, Lamot du Pont Copeland, a scion of the du Pont family renowned for both their entrepreneurialism and botanical fascination, and Pamela Cunningham Copeland built their family home near the village of Mount Cuba, in northern Delaware, USA. Mrs. Copeland wanted a home with hills and forests to remind her of her childhood

home in Connecticut, and Mr. Copeland needed to be close to his family and business life in Wilmington, Delaware. They bought farmland in the Delaware Piedmont and thereby fulfilled each one's geographic criteria (Figure 1). During the early years on the property, the Copelands developed their landscape and gardens with the help of renowned designers including Marian Coffin and Thomas Sears. Initially, formal gardens surrounding the house were created. The Copelands later purchased an adjoining piece of property that became the site of their naturalistic gardens, which were designed and maintained to mimic natural landscapes. Over time, the Copelands reimagined the landscape and its role in the broader ecosystem, paving the way for regional conservation efforts and Mt. Cuba's present-day mission: to inspire an appreciation for the beauty and value of native plants, and a commitment to protect the habitats that sustain them.

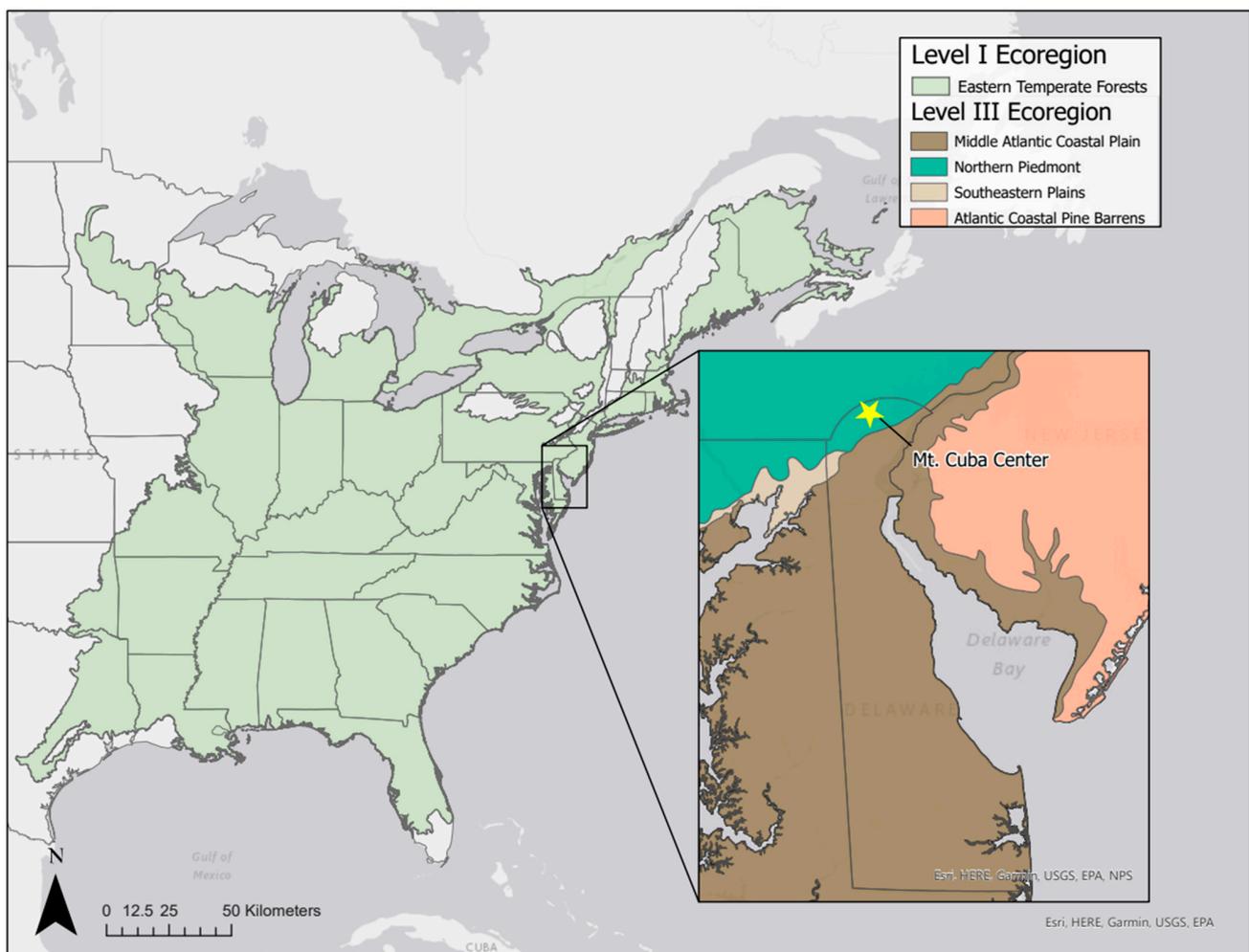


Figure 1. Mt. Cuba Center is located in the Eastern Temperate Forest ecoregion (shown in light green) in northern Delaware, USA. The inset shows the botanical garden (star) occurs near the southern edge of the Northern Piedmont region (shown in dark green). Ecoregions are from <https://www.epa.gov/eco-research/ecoregions-north-america> (accessed on 20 September 2021).

During the decades when the Copelands' house served as their home, the garden consisted of a broader array of ornamental, non-native species than it holds today. Through the years, as the Copelands' personal understanding of native plants and ecology evolved, so did their vision for the gardens. In 1965, Mr. Copeland wrote a letter to Seth Kelsey, the landscape architect who designed the naturalistic garden, suggesting that the estate could be opened as a privately endowed public botanical park [4]. It took several more decades to fully form and implement this vision and open to the public.

Between the 1950s and 1980s, conservation science became an emerging concept in botanical gardens [5], developing meaning beyond a prevailing view by the public that gardens are simply botanical theme parks [6]. Mt. Cuba Center incorporated as a foundation in 1989 and, at the founding, embraced a conceptual focus on conservation. This specialization arose from conversations between the Copelands and renowned American plantsman Dr. Richard Lighty. He asked the Copelands what they loved about their garden. Their response, the wildflowers, determined that native plants would be the focus. The private estate's eventual shift to a public garden emphasized what the Copelands loved about the area: the Piedmont, rolling hills, wildflowers, and native plants. Stated in her own words, Pamela Copeland wanted Mt. Cuba "to be a place where people will learn to appreciate our native plants and to see how these plants can enrich their lives so that they, in turn, will become conservators of our natural habitats" [7].

The siting of this home and the Copelands' visionary planning set the course for what Mt. Cuba has become today. The heart of Mt. Cuba's identity is formed by creating a sense of place embracing the rich flora of the Eastern Temperate Forest ecological region [8] and its communities. More than just a pretty garden, Mt. Cuba's displays featuring native plants in formal and naturalistic settings are designed to inspire future generations to take conservation action. Solidifying this focus, Mrs. Copeland outlined an accessions policy for Mt. Cuba in 1984, focused on native plants and emphasizing that collections be consistent with education and research in conservation, botany, and ecology [9]. The intentional choice to embrace wildflowers [10] and other native species filled a unique niche in the du Pont family's rich tradition of furthering horticultural endeavors in the local region of southeastern Pennsylvania and Delaware. There are five du Pont legacy botanical gardens in the area: Mt. Cuba, the E. I. du Pont Garden at the Hagley Museum, Longwood Gardens, the gardens at Nemours Estate, and Winterthur Museum, Garden, and Library. Mrs. Copeland stated ongoing development and habitat destruction were part of the reason she wanted to create an ecological learning center with the intention of inspiring people to become conservators. To instill this sentiment in others, the Copelands bought and conserved lands near their home in collaboration with their cousin and neighbor, Henry B. du Pont III, and held lands encompassing the nearby Red Clay Reservation in a non-profit trust. Red Clay Reservation has long been a protector of the environment through its own preservation and restoration projects as well as a programming partnership with the Delaware Nature Society. In 2018, the Red Clay Reservation lands were merged and became a part of Mt. Cuba, which now totals 438 hectares (ha) (1083 acres). Portions of the former Red Clay Reservation are now accessible to guests as the Trails throughout Mt. Cuba's natural lands.

In line with the mission and founding intention, Mt. Cuba's community practices horticulture, research, conservation, and education with respect to three overarching goals that form a conservation continuum (Figure 2). These goals aim to inspire an appreciation for the beauty and value of native plants, motivate conservation action, and measurably improve the health of habitats and ecosystems. As a result of Mt. Cuba's early commitment to focus on native plants, guests now have a unique opportunity to experience mature ecological communities in gardens that have been nurtured by our horticulturalists for more than half a century. Additionally, very few botanic gardens have associated natural lands. Mt. Cuba Center offers guests the option to explore these areas and to view conservation and research in action. We strive to conduct research that is approachable, understandable, applicable, and usable to our guests and the conservation community.

Botanical gardens can ensure that their conservation credentials are translated to guests [1]. Mt. Cuba engages the public and demonstrates conservation principles and the value of native plants to sustaining ecological communities on multiple scales in the gardens and natural lands. Although most research on rare, threatened, and endangered plants is conducted by the staff and research partners, the results are shared with the conservation community and the public. Additional research on the horticultural and ecological value of native plants and their cultivars, and land management and restoration experiments are

accessible to guests. Signage, guided tours, and education programs simultaneously help the public to interpret the landscapes that surround them and suggest actions individuals can take to contribute to conservation efforts. By demonstrating the beauty and ecological value of adding native plants to the home landscape, i.e., conservation by addition, Mt. Cuba makes conservation action easily accessible and nurtures a conservation-minded community.



Figure 2. Three goals form a conservation continuum that guide Mt. Cuba Center’s horticulture, research, conservation, and education efforts. These goals aim to inspire an appreciation for the beauty and value of native plants, motivate conservation action, and measurably improve the health of habitats and ecosystems.

2. Four Significant Sustainable Development Goals at Mt. Cuba Center

Botanical gardens can contribute to all 17 of the SDGs [11], although 5 SDGs (2, 4, 11, 13, and 15) have been identified as highly relevant [2]. However, across the globe, botanical gardens differ in their practices and foci; thus, the emerging connections of the SDGs at botanical gardens differ—with individual gardens identifying unique SDG profiles. Examples of these unique profiles were featured in a 2018 theme edition of the *BGJournal* highlighting SDGs 1, 2, 4, 6, 11, 12, 13, and 15 [12–19] at different gardens. Royal Botanic Gardens, Kew described alignment with nine goals (1, 2, 3, 4, 5, 9, 13, 15, and 17) [20]. At Mt. Cuba Center, we highlight four SDGs (4, 8, 11, and 15) from our work. In all, the differences in SDG profiles across the literature show that there are multiple avenues for botanical gardens to engage with the SDGs. Some SDGs have unique alignment with specific programs, and others, such as SDG 15, are universally relevant across institutions.

As a garden built on visionary principles to inspire and transform guests into conservators, Mt. Cuba reaches audiences in specialized ways that reflect the founders’ vision. Several of the SDGs are incorporated into practice at Mt. Cuba Center. Table 1 summarizes 4 of the 17 SDGs that are significant parts of Mt. Cuba’s work, tying them to the founding intention and articulating the organizational program areas where the goals are addressed.

Applying these four SDGs is integral at Mt. Cuba in pursuit of the founding vision, but also to address pressing local needs. Mt. Cuba sits in a region that has experienced high levels of habitat disturbance and conversion, commensurate with agriculture and human settlements over a gradient from rural to urban settings. Although only 4 percent of the USA land area is developed as urban landscape, the Eastern Temperate Forest accounts for approximately 78 percent of this development type [21]. Within the Eastern Temperate Forest, the Northern Piedmont, where Mt. Cuba is located, is one of the most highly developed ecoregions. The surrounding ecoregions: the Atlantic Coastal Pine Barrens, the Northeastern Coastal Zone, and the Southern Coastal Plains, are also in the same category and have greater than 20 percent of their land area developed. In these places, engaging in conservation work requires connecting with people who experience nature in fragments and working amongst a patchwork of landcover types to improve the habitat quality. Despite these challenges, there are benefits to working in highly developed areas, such as increased opportunities for innovation and reaching vast urban and suburban audiences.

Below are highlights describing how Mt. Cuba leverages interpretation and research findings in alignment with four SDGs. SDGs 4, 8, and 11 are discussed, as the garden showcases native plants and promotes their use, communicating information and messages meant to effect change in public behaviors. The interpretative master plan, in line with SDG 4, is designed so that guests who visit the garden encounter messages that express how consequential native plants are and how their own actions influence change. The

messages and accomplishments at the Trial Garden, aligned with SDG 8, explain native plant use and impact on markets. SDG 11 relates native plant horticultural research to making developed, human-inhabited areas more resilient and sustainable. Mt. Cuba Center embodies SDG 15 by managing 417 ha (1030 acres) of natural lands, providing trails and educational opportunities for guests throughout these areas, conducting conservation research, monitoring biodiversity, and providing financial assistance for regional land conservation efforts.

Table 1. The relationship between the Sustainable Development Goals, Mt. Cuba Center’s foundational concepts, and current garden activities.

Sustainable Development Goal	Mt. Cuba Center Foundational Concepts	Mt. Cuba Center Garden Divisions and Activities
SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	<ul style="list-style-type: none"> Share knowledge Be a learning center to encourage and promote the awareness of the need to preserve native flora and fauna 	Education and Guest Experience <ul style="list-style-type: none"> Provide accessible general admission options for financially disadvantaged groups Offer classes on native plants, ecology, ecological horticulture, etc. Conservation and Research <ul style="list-style-type: none"> Provide community science components in research programs
SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	<ul style="list-style-type: none"> Provide instruction on propagation, transplanting, and care of native plants and wildflowers 	Horticulture; Conservation and Research <ul style="list-style-type: none"> Select native plants suitable for the marketplace Promote professional horticulturists and the nursery industry Offer classes on native plants, ecology, ecological horticulture, etc. Provide internships and fellowship programs
SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable	<ul style="list-style-type: none"> Teach the interdependence of human life, plant life, and insects and animals Teach that everyone can contribute and become a conservator, and that conservation efforts are not limited to specialists or to special locations 	Education and Guest Experience; Horticulture; Conservation and Research <ul style="list-style-type: none"> Conserve urban biodiversity by promoting native plants in individual and commercial landscape design Survey the local wholesale nursery to understand native plant offerings and opportunities Education and outreach to neighboring land owners Trial Garden research and horticultural suggestions for native plants
SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	<ul style="list-style-type: none"> Preserve open land and existing wood lots Use property as a conservation area Promote interest in insects as these are becoming scarce from habitat reduction and herbicide/pesticide use 	Horticulture; Conservation and Research <ul style="list-style-type: none"> Conservation horticulture Ex situ conservation collections from the Eastern Temperate Forest Biodiversity surveys Education and Guest Experience; Horticulture; Conservation and Research <ul style="list-style-type: none"> Promote the use of native plant species in gardening and landscaping Raise awareness of conservation needs Demonstrate best management practices in natural lands to promote biodiversity Conservation land purchases

2.1. SDG 4, Ensure Inclusive and Equitable Quality Education and Promote Lifelong Learning Opportunities for All

2.1.1. Interpretive Plan

Mt. Cuba's founding director, Dr. Richard Lighty, wrote about the educational mission of the organization: "(t)he goal of interpretation should be to bring visitors to a greater appreciation of the beauty and fragility of our environment so that they will work to protect it" [22]. One way that Mt. Cuba works to ensure inclusive and equitable education and promote lifelong learning opportunities for all is by providing a coherent and comprehensive interpretive program that shares the garden's story and conservation message. This program is broad and designed to resonate with guests with varying plant knowledge and gardening sophistication. Recently, Mt. Cuba developed and executed a comprehensive interpretive plan. This multi-phase process involved the articulation of three core messages meant to inform all interpretive content (Table 2). The core messages represent a continuum of understanding. The first message describes the experiential aspects of engaging with nature, while the second outlines scientific concepts that contextualize the ecological importance of native plants. The final message is a call to action, encouraging guests to consider their personal role and opportunities to contribute to a healthier ecosystem. The stepwise message structure circumvents plant blindness, a lack of awareness about plants, in the public and instead provides a clear link between native plants and sustainable choices [23].

Table 2. Core messages, subthemes, and objectives of the interpretive program at Mt. Cuba Center.

Core Messages	Subthemes	Objectives
Immersion in nature can evoke an inspirational experience	<ul style="list-style-type: none"> - Our connection to nature deepens when our senses are awakened - Plants are beautiful and interesting - The gardens at Mt. Cuba Center are dynamic works of art - Landscapes tell the story of human and natural influences that have shaped them 	<ul style="list-style-type: none"> - Encourage guests to slow down and provide tools for deeper engagement with the garden
Nature is a complex living system	<ul style="list-style-type: none"> - We are all part of a connected ecosystem - Native plants form the base of the food web and have co-evolved with wildlife over millennia - Ecological gardening and land management support living systems and the broader environment 	<ul style="list-style-type: none"> - Provide the content that supports a deeper understanding of nature and the importance of native plants
We can steward our earth through the choices we make at home and in our communities	<ul style="list-style-type: none"> - The evolution of Mr. and Mrs. Copeland's garden is an example of the steps that a home gardener can take to support the conservation of natural habitats - Mt. Cuba Center staff are stewards of Copeland's legacy, the garden, and the mission of conservation - Our shared commitment to research and education contributes to the conservation of natural habitats - Our choices are significant and can effect positive change 	<ul style="list-style-type: none"> - Provide actionable items to take home that maximize the likelihood of behavior change

The goal of the interpretive materials is to effectively convey the core messages by providing various entry points to engage with Mt. Cuba's mission. The interpretive team develops content and designs and then initiates pilot testing and evaluation to produce onsite interpretive signage (Figure 3), interactive activities, and tour updates. Ultimately, no matter where someone falls on the continuum of understanding nature, ecological systems, and personal opportunities, there are moments to spark inspiration.

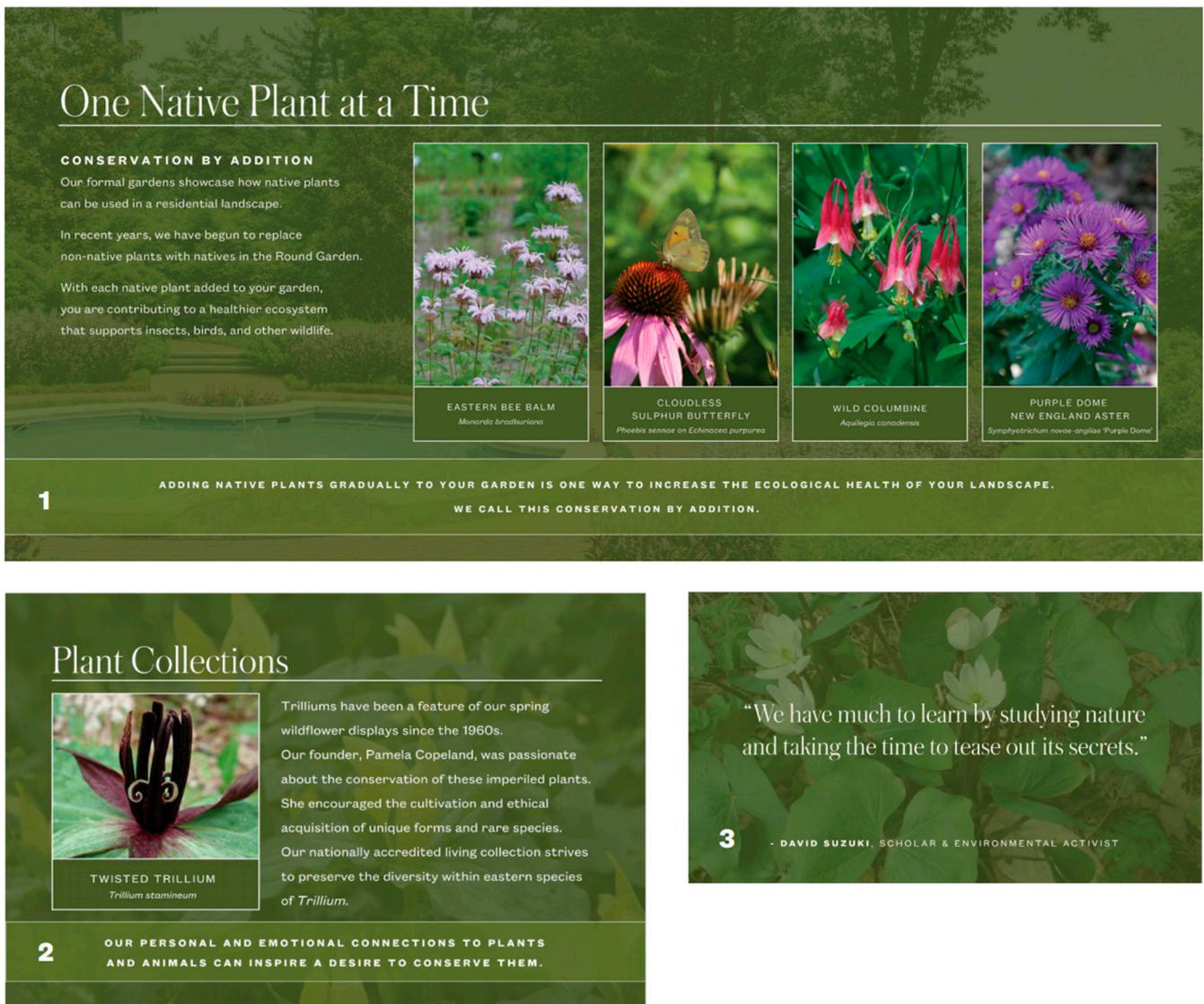


Figure 3. Three examples of the different sized signs used for interpretative content: (1) large, 0.91 m × 0.41 m; (2) medium, 0.39 m × 0.25 m; and (3) small, 0.25 m × 0.14 m. The large content signs delve into broader, overarching thematic concepts and address each of the three core messages. The medium size signs provide information about specific topics in ways that incorporate the three core messages. The small signs feature quotes that aim to provoke reflection among guests and encourage deeper engagement with the garden.

Mt. Cuba uses evaluations to measure the extent to which new signs and activities promote audience inspiration, understanding, and conservation-minded behavior. Feedback leads to adjustments to the final version of interpretive materials. Overall, the results gauge how the interpretive plan is achieving Mt. Cuba's founding intention, inspiring guests to become conservators of our natural habitats. The results show introspective impacts for guests. For example, at least three quarters of respondents strongly agree that the signage inspired new ideas about their home garden or landscape and that the signs helped them look at their surroundings in a new way (unpublished data).

2.1.2. Facilitating Inclusivity and Access

Access for underserved audiences is encouraged and supported by several programs that make classes and garden admission affordable for special groups and under-resourced guests. There is a free admission day for current or former service members on Veterans Day,

and Mt. Cuba participates in Blue Star Museums programs for active military personnel. Mt. Cuba also offers free or discounted adult admissions with the Museums for All program (food assistance card-based), and for Delaware residents with Delaware electronic benefit transfer cards or Delaware Art-Reach ACCESS cards. Children ages 6 to 17 receive discounted admission, and admission is free for children 5 and under. Once a week, a Story Time Sprouts program is presented, where a nature-themed book is read in the garden. The event is included with admission and intended for those five and under. Additionally, local regional public libraries have a Library Membership program where their patrons can check out a membership to Mt. Cuba and gain free general admission.

Adult education programs offer online and in-person lifelong learning opportunities. Learning topics include native plants and ecology, ecological gardening, conservation, wellness, and nature art. Students may work toward an Ecological Gardening Certificate, which consists of a series of courses covering sustainable landscape techniques, plant identification, invasive plants, integrated pest management, botany for gardeners, and more. Volunteers are engaged in community science opportunities including studying pollinator attractiveness of various native plants and monitoring sensitive ecological indicator species such as native orchids or rare species.

2.2. SDG 8: Promote Sustained, Inclusive and Sustainable Economic Growth, Full and Productive Employment and Decent Work for All

Native plant horticulture conveys economic benefits. Surveys show that a moderate to significant percentage of nursery and garden center revenue comes from native plant sales and services, with moderate percentages at large wholesale nurseries and significant percentages at small wholesale or retail nurseries [24]. In addition, landscape architects and designers derive moderate to substantial revenue from native plant sales and services. However, they depend on long-term results to help them select reliable plants and want evidence showing long-term success, valuing data analyzed across varying environmental gradients [24]. Native plant use may continue to grow as more products become available and economic benefits are realized.

Mt. Cuba generates and disseminates valuable information and influences demand in the horticulture industry. The Trial Garden at Mt. Cuba Center enriches the community and contributes to SDG 8 by promoting native plants for garden use through research and engagement. Investigatory projects are conducted by Mt. Cuba personnel and volunteers, and in collaboration with scientific professionals. Mt. Cuba contributes to the horticulture economy by evaluating native plants and promoting top performers to regional nursery growers and consumers. Published trial reports help popularize top performers with garden supply centers and the public. Mt. Cuba's trial results are often featured in major media in the USA, including The New York Times, The Washington Post, Fine Gardening magazine, and many other publications and news outlets. The results are also presented through talks to local and regional groups ranging from garden clubs to horticultural industry conferences. Overall, Mt. Cuba's research trials provide a scientific basis for native plant purchase recommendations. This contributes to the garden's social relevance [25] by enhancing value to the community and providing a local socio-economic impact through fostering horticultural demand and supporting those commercial enterprises that promote the use of native plants. Additionally, Mt. Cuba's website (mtcubacenter.org) provides information about nurseries that offer native plants for sale in Delaware, Maryland, New Jersey, and Pennsylvania, thereby connecting the public to the native plant marketplace.

Native Plant Trial Garden: A Site for Research and Outreach

Originally the site of the Copelands' cut flower garden, the Trial Garden at Mt. Cuba Center was established in 2002. It identifies and evaluates the best native plants for gardens of the mid-Atlantic region. In 2011, the Trial Garden was expanded, adding a shade structure, and allowing for a greater diversity of trials with flexibility to conduct comparative studies in the sun and shade. The Trial Garden is a public-facing and fundamental resource

to display native plant research. It sits prominently between the formal and naturalistic gardens, inviting guests to walk among the trials, notice differences among different selections, and vote for audience favorites.

At Mt. Cuba, horticultural trials are designed to study a particular taxonomic group and assess garden performance over a period of three to five years, depending on the genus. Trial plants are obtained from commercial sources and are often supplemented with wild collections. Multiple trials are conducted concurrently on a staggered schedule so that, in most cases, one trial concludes in each calendar year. Horticultural researchers tend the Trial Garden and collect data on a weekly basis during the growing season, typically May through September. Data collection includes plant ratings and qualitative observations, measurements, and serial photography.

Recent trials have also assessed the ecological value of native plants. This work was initiated through a collaboration with researchers and graduate students at the University of Delaware to compare pollinators in annual and perennial selections of *Coreopsis* [26] and herbivore use of cultivars versus wild types of several native woody plants [27]. This research has continued with the assistance of a cadre of community scientists known as the Pollinator Watch Team. These community scientists follow a strict protocol to collect data on pollinator visitation to various plants in bloom. Plants most frequented by pollinators are awarded bonus points in the overall rating. Thus, the final plant rating reflects both horticultural merit and pollinator interest. Figure 4 summarizes the horticultural scores and pollinator data for the *Echinacea* trials published in 2021.

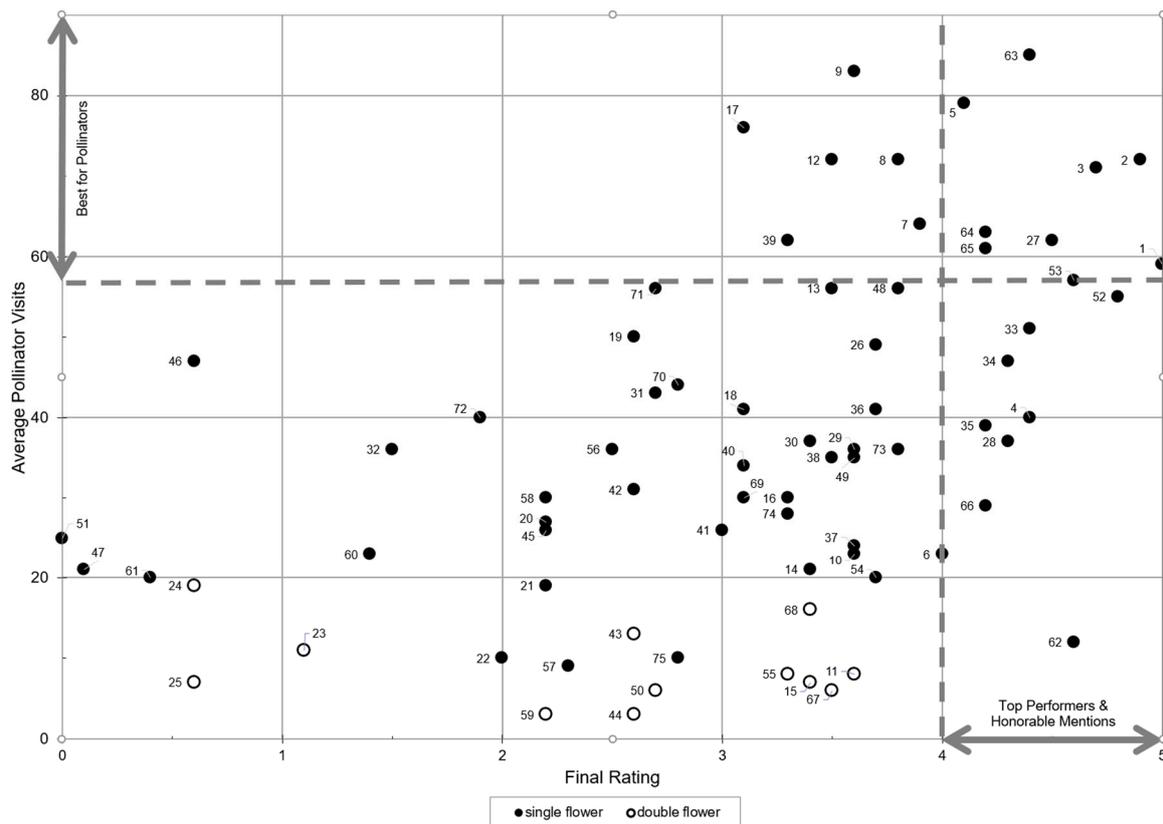


Figure 4. *Echinacea* performance data from the Trial Garden showing the final rating (0 to 5) on the *x*-axis and the average pollinator visits on the *y*-axis. Single flower types are filled circles and double flower types are open circles. Top-performing *Echinacea* and honorable mentions, those with an average final rating of 4 or more, occur to the right of the dashed vertical line; names are in bold text below. The 15 best *Echinacea* for pollinators, based on average visits from bees, wasps, and butterflies, occur at and above the dashed horizontal line, with plants averaging 57 visits or more. These names are asterisked below. Plants that are both top-performing and best for pollinators occur in the upper

right quadrant beyond the intersecting dashed lines. The seventy-five trialed taxa are numbered according to flower color. Grouped by flower color, the taxa are then listed in descending final rating score with pink flowers (1–25); pale pink flowers (26); coral and orange/pink flowers (27–32); orange flowers (33–47); red flowers (48–51); red/pink and orange/red flowers (52–53); yellow flowers (54–61); white flowers (62–72); mixed flowers (73); and green-pink or green flowers (74–75). The pink-flowered taxa are (1) *E. purpurea* ‘Pica Bella’*; (2) *E. ‘Sensation Pink’**; (3) *E. ‘TNECHKR’ (KISMET® Raspberry)**; (4) *E. ‘Purple Emperor’*; (5) *E. purpurea ‘Ruby Star’**; (6) *E. purpurea ‘Vintage Wine’*; (7) *E. purpurea ‘Magnus’**; (8) *E. ‘Balsombabur’ (SOMBRERO® Baja Burgundy)**; (9) *E. purpurea**; (10) *E. pallida*; (11) *E. ‘Balsclblum’ (DOUBLE SCOOP™ Bubblegum)*; (12) *E. purpurea ‘Baby Swan Pink’**; (13) *E. tennesseensis*; (14) *E. purpurea ‘Fatal Attraction’*; (15) *E. ‘Balscanery’ (DOUBLE SCOOP™ Cranberry)*; (16) *E. tennesseensis ‘Rocky Top’*; (17) *E. ‘Amazing Dream’**; (18) *E. purpurea ‘PAS702917’ (PowWow® Wild Berry)*; (19) *E. purpurea ‘Magnus Superior’*; (20) *E. purpurea ‘Kim’s Knee High’*; (21) *E. ‘Dixie Belle’*; (22) *E. angustifolia*; (23) *E. purpurea ‘Southern Belle’*; (24) *E. purpurea ‘Butterfly Kisses’*; and (25) *E. ‘Elegance’*. The pale-pink-flowered taxon is (26) *E. pallida ‘Hula Dancer’*. The coral- and orange/pink-flowered taxa are (27) *E. ‘Glowing Dream’**; (28) *E. ‘Balsomcor’ (SOMBRERO® Hot Coral)*; (29) *E. purpurea ‘Playful Meadow Mama’*; (30) *E. ‘Rainb299’ (Rainbow Marcella)*; (31) *E. ‘Fiery Meadow Mama’*; and (32) *E. ‘Peacock’*. The orange-flowered taxa (33–47) include (33) *E. ‘TNECHKIO’ (KISMET® Intense Orange)*; (34) *E. ‘Julia’*; (35) *E. ‘Balsomenco’ (SOMBRERO® Flamenco Orange)*; (36) *E. ‘Aloha’*; (37) *E. ‘Tiki Torch’*; (38) *E. ‘Eglow’ (Evening Glow)*; (39) *E. ‘Balsomador’ (SOMBRERO® Adobe Orange)**; (40) *E. ‘Leilani’*; (41) *E. ‘Dixie Blaze’*; (42) *E. ‘Firebird’*; (43) *E. ‘Marmalade’*; (44) *E. ‘Cantaloupe’*; (45) *E. ‘Echgol243’ (Golden Skipper)*; (46) *E. ‘Echor273’ (Orange Skipper)*; and (47) *E. ‘Dixie Sun’*. The red-flowered taxa include (48) *E. ‘Balsomsed’ (SOMBRERO® Salsa Red)*; (49) *E. ‘Dixie Scarlet’*; (50) *E. ‘Hot Papaya’*; and (51) *E. ‘Solar Flare’*. The red/pink-flowered taxon is (52) *E. ‘Santa Fe’*. The orange/red-flowered taxon is (53) *E. ‘POST301’ (Postman)**. The yellow-flowered taxa are (54) *E. paradoxa* var. *paradoxa*; (55) *E. ‘Meteor Yellow’*; (56) *E. ‘Cleopatra’*; (57) *E. ‘Sunrise’*; (58) *E. ‘Chiquita’*; (59) *E. ‘Balsclenc’ (DOUBLE SCOOP™ Lemon Cream)*; (60) *E. ‘Balsomemy’ (SOMBRERO® Lemon Yellow)*; and (61) *E. ‘Balsomselo’ (SOMBRERO® Sandy Yellow)*. The white-flowered taxa are (62) *E. ‘Snowcone’*; (63) *E. purpurea ‘Fragrant Angel’**; (64) *E. ‘Balsomblanc’ (SOMBRERO® Blanco)**; (65) *E. purpurea ‘PAS702918’ (PowWow® White)**; (66) *E. purpurea ‘Baby Swan White’*; (67) *E. ‘TNECHPV’ (PUFF® Vanilla)*; (68) *E. purpurea ‘Milkshake’*; (69) *E. purpurea ‘Virgin’*; (70) *E. purpurea ‘Happy Star’*; (71) *E. purpurea ‘White Swan’*; and (72) *E. purpurea ‘Whites331’ (Innocent Meadow Mama™)*. One taxon has mixed flowers, (73) *E. ‘Cheyenne Spirit’*. One taxon has green-pink flowers, (74) *E. purpurea ‘Green Twister’*. One taxon has green flowers, (75) *E. purpurea ‘Green Jewel’*.

Engaging in plant-based solutions to combat biodiversity loss [1], Mt. Cuba provides advice on which native species selections to plant in the mid-Atlantic. At the conclusion of each trial, a report is published, highlighting the top-performing plants from horticultural and ecological perspectives, and providing maintenance recommendations, as well as disease and pest information. Cultural and ecological data from the reports can help support marketing information for native plants, directly addressing an area where nursery and gardens centers have reported gaps [24]. The Trial Garden reports are created for gardeners, the nursery industry, and the professional landscape industry. The goal is to share information to consider when selecting a plant, such as which plants successfully establish, are beautiful, and best provide valuable ecological functions. Trial recommendations can consequently encourage interest and use, increasing native plant demand.

Reports are available at Mt. Cuba or electronically on the website. Salient findings reach the wider public via press features, interviews, and lectures. The Manager of Horticultural Research presents findings to garden groups and professional audiences. Mt. Cuba engages with the nursery industry to promote top performers from the evaluations and works to ensure that adequate supply is available in the retail market. Mt. Cuba hosts Trial Garden events for guests from the local nursery trade, the media, and nearby gardens. These events showcase current trials and keep nursery professionals apprised of results, which helps them anticipate future public demand.

Trial gardens are an important tool botanical gardens can use to aid in native plant selections and designs, by testing and then promoting reliable, tested taxa. While trial gardens can be a point of pride and knowledge for an organization, they are also labor-intensive endeavors that require planning to work toward specific objectives, so they avoid being viewed as resource sinks [28]. As at Mt. Cuba, Trial Garden methodologies can record pollinators and ecological function to assess and highlight wildlife supporting horticulture, providing valuable data to consumers [29]. These data have multiple benefits for the nursery industry, the customer, and the environment. They create economic impact because plants with pollinator-friendly signage are more likely to be purchased by customers [30], providing information on wildlife resources, and ultimately enhancing habitat embedded in urban/suburban development. The data must be shared to have these effects. Purchasers need information on unfamiliar plants [31] because home gardeners are more likely to plant native species that are attractive to pollinators only if they are aware about the relationships of native plants and native insects. With planning and strategy, botanical gardens can use a trial garden to highlight ecological information and bolster marketplace value.

The Trial Garden program has been designed to support Mt. Cuba's mission. It focuses on inspirational beauty through horticultural evaluation, ecological value through pollinator data, and motivating conservation among the public by promoting native plants for use in home landscapes. Trial gardens present enormous opportunities for botanical gardens to connect with regional constituencies because of the direct applicability of their results for broad audiences, including home gardeners.

2.3. SDG 11: Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable

Botanical gardens can contribute to improving environmental quality in urbanized areas, through greening projects [32] or popularizing new plants [33]. In fact, researchers studying the mid-Atlantic region show that the use of native plants in landscaping supports larger and more diverse animal communities [34]. Mt. Cuba Center promotes these benefits to support the region in becoming more ecologically resilient and sustainable. The garden assesses the horticultural and ecological value of native plants and cultivars and has had an active role in popularizing new plants for decades, focusing on garden-worthy native species.

Horticultural Research

Native plant gardening is a high-interest area [35,36] around the nation. In the northeastern USA, ornamental horticulture is an important segment of the agricultural sector, with environmental horticulture showing particularly strong growth in areas including floriculture, nursery crops, and horticultural retail/services [37]. In the southeastern USA, increased clientele demand for native plants drives their use and promotion by nursery associations and non-profit plant conservation organizations [38]. For example, customer interest in native plants has led to landscape architects using native plants almost exclusively in more than 30 percent of their projects [39]. As native plant demand has grown in the marketplace, Mt. Cuba has conducted research and used its results to stimulate consumer demand and inform the nursery industry about trends and opportunities.

Mt. Cuba studies local market forces to identify meaningful approaches to increase native plant production and consumer use. In 2017, Mt. Cuba conducted a survey of the USA mid-Atlantic region's wholesale nursery market to evaluate the proportion of native and invasive plants available to retail sellers. The study determined that approximately one third of the 1368 species and one quarter of the 6885 taxa (including hybrids and cultivars) available regionally in the wholesale market were native to the Eastern Temperate Forest [40]. Evaluating the wholesale market provides information on what is available to consumers through their local retailer, who gets their supply from the regional wholesale market. Using findings of what plants are available, Mt. Cuba conducts outreach to neighboring residential communities. In these local groups, Mt. Cuba works to guide and inspire neighbors to increase the native biodiversity in neighborhood plantings based on

what is available. Beyond the garden's immediate area, the information from this study can be used by horticultural professionals across the region, who make design decisions and suggestions for landscape architecture and landscape design, which in turn affect the broader community.

Limitations in the supply of native plants must be addressed to increase their use. For example, landscape architects report that the top two reasons for why they do not use more native plants are a lack of sources and sufficient quantities [39]. Lack of supply has also been reported by the ecological restoration sector [41]. These data and Mt. Cuba's survey [37] demonstrate the potential to increase market share to meet native plant demand. Mt. Cuba is exploring opportunities to grow the native plant market through partnerships and collaborations, to promote the use of more native species and increase regional availability.

Mt. Cuba also helps to increase the availability of native species in the marketplace by identifying and introducing notable selections. Mt. Cuba's gardens serve as a living laboratory to study native species and identify plants with exceptional horticultural performance. Since 1988, the Plant Introduction Program has brought many high-performing native plant selections to the nursery trade. These plants are selected for their strong ornamental appeal, broad regional adaptability, and wildlife value. Some Mt. Cuba introductions are among the most popular selections available. A few introductions are branded under the registered trademark "Mt. Cuba Collection", and analysis is underway to determine the impact of the Mt. Cuba brand on consumer choices. To date, Mt. Cuba has made 19 introductions of garden-worthy selections of native species (Figure 5). The process continues to this day, with several bright prospects in development.

2.4. SDG 15: Protect, Restore and Promote Sustainable Use of Terrestrial Ecosystems, Sustainably Manage Forests, Combat Desertification, and Halt and Reverse Land Degradation and Halt Biodiversity Loss

Mt. Cuba Center conducts research and practices and promotes conservation through work in its greenhouses, gardens, and natural lands. This work is accomplished by Mt. Cuba's staff and through extensive collaborations with local and regional researchers and conservation partners. The results are shared with guests via signage and programs; the public through social media, news coverage, public lectures, and research reports; and academic and conservation professionals through conference presentations and publication of results in peer-reviewed journals.

Plant propagation and production teams at Mt. Cuba Center support conservation horticulture and protect biodiversity through work with rare native taxa, often in collaboration with partner institutions. Mt. Cuba actively conserves certain species in the garden and greenhouse via ex situ conservation. These conservation efforts often require research to determine how to propagate, establish, and maintain plants. Research results are shared to improve regional conservation efforts. For example, propagation methods are often posted on the Native Plant Network website <https://npn.rngr.net/aboutNPN> (accessed on 31 August 2021). Successful propagation efforts sometimes lead to sustained projects where Mt. Cuba supports conservation partners as a rare plant propagator. The plant material that is produced is sown and transplanted into regional sites to increase the size and number of field populations.

Mt. Cuba Center conducts additional conservation and research projects through management of a "living laboratory" of approximately 417 ha (1030 acres) of preserved natural lands. The area consists of a variety of habitat types that are managed for ecological function including forests, meadows, and streams. In 2021, a trail system was opened to allow guests to access a portion of the natural lands, including grasslands and woodlands. Across the property, the natural lands team conducts active management programs to remove invasive species and control deer populations, and to promote grassland plant and bird diversity, and sustainable and diverse forest habitats. The team conducts research on flora composition and distribution, novel reforestation strategies, and wildlife diversity and monitors rare plants and other species of concern.

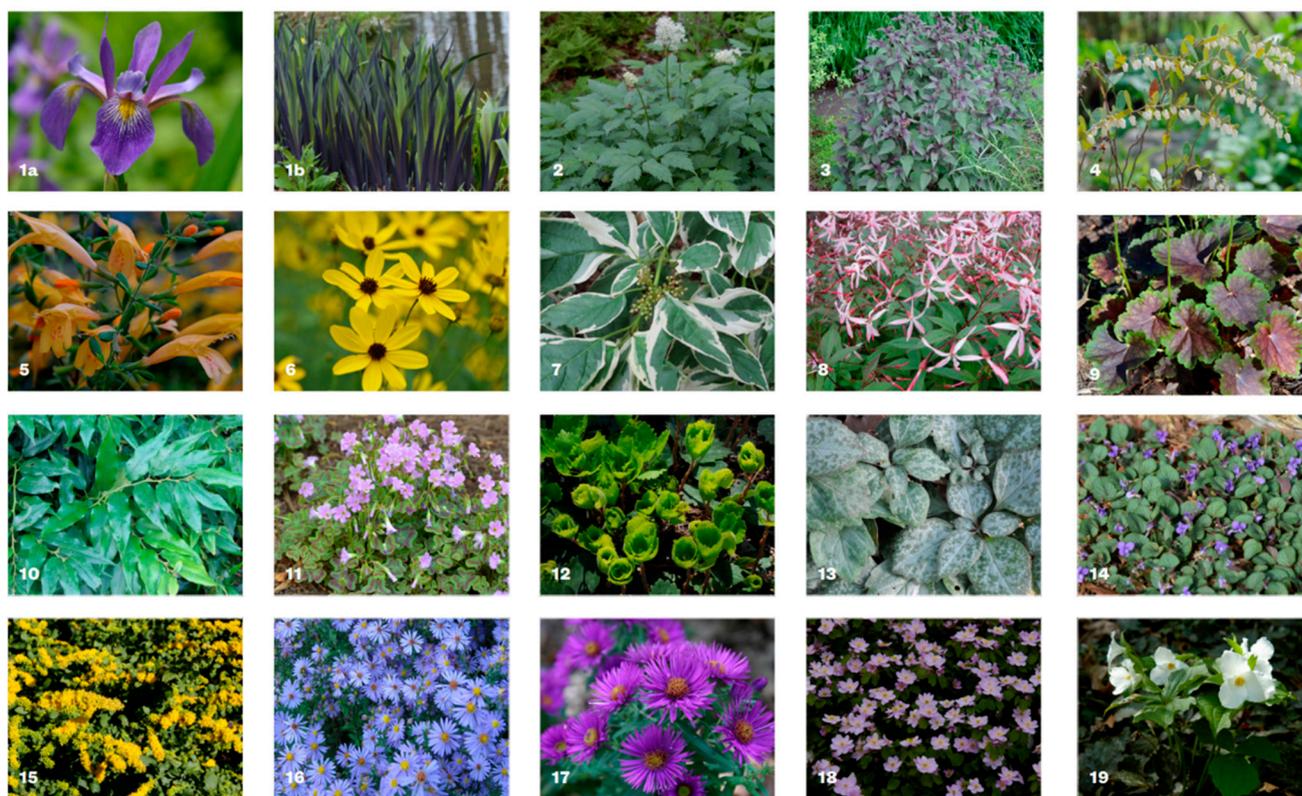


Figure 5. The nineteen Mt. Cuba Center plant introductions with year introduced, including (1a) Purple Flame blue flag (*Iris versicolor* ‘Purple Flame’) showing the flower and (1b) foliage, 2020; (2) Misty Blue white baneberry (*Actaea pachypoda* ‘Misty Blue’), 2009; (3) Chocolate white snakeroot (*Ageratina altissima* ‘Chocolate’), 1994; (4) Verdant leatherleaf (*Chamaedaphne calyculata* ‘Verdant’), 1996; (5) Amber Blush upright scarlet calamint (*Clinopodium coccineum* ‘Amber Blush’), 2011; (6) Gold Standard tall tickseed (*Coreopsis tripteris* ‘Gold Standard’), 2016; (7) Silver and Gold red osier dogwood (*Swida sericea* ‘Silver and Gold’), 1988; (8) Pink Profusion Bowman’s root (*Gillenia trifoliata* ‘Pink Profusion’), 1997; (9) Garnet American alumroot (*Heuchera americana* ‘Garnet’), 1989; (10) Greensprite drooping leucothoe (*Leucothoe fontanesiana* ‘Greensprite’), 1991; (11) Love in Vein violet wood-sorrel (*Oxalis violacea* ‘Love in Vein’), 2017; (12) Forest Green Allegheny pachysandra (*Pachysandra procumbens* ‘Forest Green’), 1992; (13) Silver Streak Allegheny pachysandra (*Pachysandra procumbens* ‘Silver Streak’), 2009; (14) Silver Gem prostrate blue violet (*Viola walteri* ‘Silver Gem’), 2010; (15) Golden Fleece autumn goldenrod (*Solidago sphacelata* ‘Golden Fleece’), 1989; (16) Bluebird smooth aster (*Symphiotrichum laeve* var. *laeve* ‘Bluebird’), 1994; (17) Purple Dome New England aster (*Symphiotrichum novae-angliae* ‘Purple Dome’), 1989; (18) Pink Pearl rue-anemone (*Thalictrum thalictroides* ‘Pink Pearl’), 2007; and (19) Quicksilver large-flowered trillium (*Trillium grandiflorum* ‘Quicksilver’), 1992.

Mt. Cuba establishes a diverse array of research collaborations, including partnerships with professional scientists in the public and private sectors, and educational institutions. In recent years, Mt. Cuba has funded surveys conducted on its property in the gardens and natural lands to document habitat conditions, and the diversity of plants [42] and bees [43]. Experimental garden plots have been established to study plant traits and insect preferences [27]. Fellowship programs have diversified the research scope. The Environmental Psychology Fellow investigated native plant use in homeowners’ gardens and found that emphasizing the esthetic and ecological value of native plants increases adoption [44]. Their work elucidated that Mt. Cuba’s influence on residential neighbors is based on trust, expertise, availability, and benevolence. Other fellowship projects have focused on plant conservation, with research fellows conducting community science projects with volunteers. Recently, an Orchid Fellow updated the entirety of the state records of orchids occurring in

Delaware. The current Conservation Fellow has started monitoring pollination and fruit set in showy orchis (*Galearis spectabilis*) and initiated a rare plant monitoring program.

Since Mt. Cuba's founding, the Copelands' conservation vision has flourished and now extends beyond the gardens to include collaborative research and conservation efforts in the natural lands and broader region. Echoing the founders' practice of acquiring land for preservation, Mt. Cuba Center provides financial assistance for land conservation. This program preserves open space in the region, contributing funds toward conservation land purchases. Over the past 16 years, Mt. Cuba has contributed more than 100 million USD to protect 5600 ha (13,838 acres) of undeveloped habitat. In 2012, Mt. Cuba provided 20 million USD to secure 445 ha (1100 acres) that became Delaware's First State National Historical Park. Mt. Cuba does not keep these lands; ownership is maintained by conservancies and other conservation partners.

3. Conclusions

This article highlighted how interpretive and research programs at Mt. Cuba Center address several SDGs and inspire a community of conservation. Interpretive content is designed to layer core messages and educate the public along a continuum of understanding about native plants and ecological horticulture. The Trial Garden and natural lands are living laboratories shared with the public. The horticultural research findings provide native plant recommendations to homeowners and the nursery industry and help supplement the economy by guiding plant demands and trends. Other botanical gardens may adapt these programs and create mission-based interpretive content or conduct evaluations to recommend native plants to the public and trade.

Mt. Cuba's approaches to the SDGs represent work that has evolved over the years through experience. Expert staff share these efforts with the broader community by communicating research discoveries in relatable terms to our guests and students, and through engaging media stories for the public at large. In all, the alignment of Mt. Cuba's mission with the SDGs has been a fortuitous dovetail of the organization's founding intention and the work conducted by many hands to conceptualize and deliver impactful programs that inspire and motivate communities of conservation.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su14106074/s1>, Table S1: Interpretive evaluation guest response data.

Author Contributions: Conceptualization, É.R.A., A.H. and J.A.D.; methodology, S.H., C.R.F. and L.K.R.; formal analysis, S.H., C.R.F. and L.K.R.; investigation, S.H., C.R.F. and L.K.R.; resources, Mt. Cuba Center, S.H., C.R.F. and L.K.R.; data curation, S.H., L.K.R. and C.R.F.; writing—original draft preparation, É.R.A., S.H., L.K.R. and C.R.F.; writing—review and editing, É.R.A., S.H., L.K.R., C.R.F., A.H., E.C.L. and J.A.D.; visualization, É.R.A., S.H., C.R.F. and E.C.L.; supervision, J.A.D.; project administration, S.H., L.K.R. and C.R.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded, in part, by the Institute of Museum and Library Services (IMLS), grant number MA-10-19-0717-19. The APC was funded by the authors' institution.

Institutional Review Board Statement: Exempt for completely anonymous survey procedures.

Informed Consent Statement: Not applicable for voluntary, completely anonymous surveys.

Data Availability Statement: The unpublished interpretive evaluation data are provided in the Supplementary Materials. *Echinacea* data from Figure 4 for final rating, average pollinator visits, flower color, and flower type are electronically archived here, https://issuu.com/mtcuba/docs/2003-3-echinacea_report-interactive/22 (accessed on 20 January 2022) on pages 18–19 and 22–23. *Echinacea* plants were used for the Trial Garden study. Plants were obtained from suppliers located in the USA. Bluebird Nursery (Clarkson, Nebraska) provided *E. pallida*. Bluestone Perennials, Inc. (Madison, Ohio) provided *E. 'Balsblum'* (DOUBLE SCOOP™ Bubblegum); *E. 'Balsombabur'* (SOMBRERO® Baja Burgundy); *E. 'Balsomsed'* (SOMBRERO® Salsa Red); *E. 'Cheyenne Spirit'*; *E. 'Cleopatra'*; *E. 'Echor273'* (Orange Skipper); *E. 'Eglow'* (Evening Glow); *E. 'Hot Papaya'*; *E. 'Julia'*; *E. 'Meteor*

Yellow'; *E. purpurea*; *E. purpurea* 'Green Jewel'; *E. purpurea* 'PAS702917' (PowWow® Wild Berry); and *E. 'Rainb299'* (Rainbow Marcella). C. Raker and Sons, Inc. (Litchfield, Michigan) provided *E. 'Balscanery'* (DOUBLE SCOOP™ Cranberry); *E. 'Balsclum'* (DOUBLE SCOOP™ Bubblegum); *E. 'Balsclcmc'* (DOUBLE SCOOP™ Lemon Cream); *E. 'Balsomador'* (SOMBRERO® Adobe Orange); *E. 'Balsombabur'* (SOMBRERO® Baja Burgundy); *E. 'Balsomcor'* (SOMBRERO® Hot Coral); *E. 'Balsomemy'* (SOMBRERO® Lemon Yellow); *E. 'Balsomenco'* (SOMBRERO® Flamenco Orange); *E. 'Balsomsed'* (SOMBRERO® Salsa Red); and *E. 'Balsomselo'* (SOMBRERO® Sandy Yellow). Creek Hill Nursery (Leola, Pennsylvania) provided *E. 'Eglow'* (Evening Glow); *E. purpurea* 'Kim's Knee High'; *E. purpurea* 'PAS702917' (PowWow® Wild Berry); *E. purpurea* 'Pica Bella'; *E. 'Solar Flare'*; and *E. 'Sunrise'*. Emerald Coast Growers (Lancaster, Pennsylvania) provided *E. 'Dixie Scarlet'*; *E. 'Echgol243'* (Golden Skipper); *E. 'Fiery Meadow Mama'*; *E. 'Hot Papaya'*; *E. 'Marmalade'*; *E. 'Peacock'*; and *E. purpurea* 'Green Jewel'. ForestFarm (Williams, Oregon) provided *E. 'Dixie Belle'*; *E. 'Dixie Scarlet'*; and *E. purpurea* 'Baby Swan White'. Garden Crossings, LLC (Zeeland, Michigan) provided *E. 'Balsclcmc'* (DOUBLE SCOOP™ Lemon Cream); *E. 'Balsomador'* (SOMBRERO® Adobe Orange); and *E. 'Balsomemy'* (SOMBRERO® Lemon Yellow). Green Leaf Plants, a division of Aris Horticulture, Inc. (Lancaster, Pennsylvania), provided *E. 'Balsomblanc'* (SOMBRERO® Blanco). High Country Gardens (Clinton, UT) provided *E. tennesseensis* 'Rocky Top'. Intrinsic Perennial Gardens (Hebron, Illinois) provided *E. 'Snowcone'*. Jelitto Perennial Seeds (Louisville, Kentucky) provided *E. angustifolia*; *E. pallida* 'Hula Dancer'; *E. purpurea* 'Baby Swan Pink'; *E. purpurea* 'Green Twister'; *E. purpurea* 'Happy Star'; and *E. purpurea* 'Magnus Superior'. Lazy S's Farm & Nursery (Barboursville, VA) provided *E. paradoxa* var. *paradoxa*; *E. tennesseensis*; and *E. tennesseensis* 'Rocky Top'. North Creek Nurseries, Inc. (Landenberg, Pennsylvania) provided *E. 'Cheyenne Spirit'*; *E. 'Cleopatra'*; *E. 'Julia'*; *E. 'Purple Emperor'*; *E. purpurea*; *E. purpurea* 'Butterfly Kisses'; *E. purpurea* 'Magnus'; *E. purpurea* 'PAS702918' (PowWow® White); *E. purpurea* 'Playful Meadow Mama'; *E. purpurea* 'Ruby Star'; *E. purpurea* 'Whites331' (Innocent Meadow Mama™); *E. purpurea* 'White Swan'; and *E. 'Rainb299'* (Rainbow Marcella). Plants Nouveau (Mobile, Alabama) provided *E. 'Echor273'* (Orange Skipper). Roots & Rhizomes (Randolph, Wisconsin) provided *E. purpurea* 'Fatal Attraction'; *E. purpurea* 'Southern Belle'; and *E. purpurea* 'Vintage Wine'. Sooner Plant Farm (Park Hill, Oklahoma) provided *E. purpurea* 'Milkshake'; *E. purpurea* 'Kim's Knee High'; and *E. 'TNECHKIO'* (KISMET® Intense Orange). Terra Nova Nurseries, Inc. (Canby, Oregon) provided *E. 'Aloha'*; *E. 'Amazing Dream'*; *E. 'Cantaloupe'*; *E. 'Chiquita'*; *E. 'Dixie Belle'*; *E. 'Dixie Blaze'*; *E. 'Dixie Sun'*; *E. 'Elegance'*; *E. 'Firebird'*; *E. 'Glowing Dream'*; *E. 'Leilani'*; *E. 'Meteor Yellow'*; *E. purpurea* 'Fragrant Angel'; *E. 'Tiki Torch'*; *E. 'TNECHKR'* (KISMET® Raspberry); and *E. 'TNECHPV'* (PUFF® Vanilla). Terrain (Glen Mills, Pennsylvania) provided *E. purpurea* 'Milkshake'. Walter's Gardens, Inc. (Zeeland, Michigan) provided *E. purpurea* 'Virgin'; *E. 'Santa Fe'*; and *E. 'Sensation Pink'*. White Flower Farm (Litchfield, Connecticut) provided *E. 'Cantaloupe'*; *E. 'POST301'* (Postman); and *E. purpurea* 'White Swan'.

Acknowledgments: The authors thank Julie Rotramel for Figure 1 production and editing assistance; Joe Johnson for comments on the draft; Martha Boyd for reference assistance; and Caroline Ralston for improving the flow and edits to make the document more approachable. The authors are indebted to George Coombs for his work establishing the Trial Garden's *Echinacea* plantings. We also thank the anonymous reviewers for improving the final version.

Conflicts of Interest: The authors declare no conflict of interest.

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