# A Re-Design of The Native Orchid House at The Belize Botanic Gardens

# A RE-DESIGN OF THE NATIVE ORCHID HOUSE

# AT THE BELIZE BOTANIC GARDENS

**Master's Project Proposal**
**Jill A Weissman**

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## Introduction

***Project focus/question:***

This project focuses on the re-design of The Native Orchid House (NOH) at The Belize Botanic Gardens (San Ignacio, Cayo District, Belize, Central America). The project question is: *what is the research/design process associated with creating a collection display at a public [botanical] garden?* More specifically, *how can this process be applied to re-design the Native Orchid House at The Belize Botanic Gardens?*

***Research Hypotheses/Contributions to Current Research***

This project is primarily product oriented (see 'Project deliverables', below), and is about developing a site-specific, executable design. In addition, the project may also contribute to current landscape architecture theory. The 'project question' (above) and The Belize Botanic Gardens' Master Plan (Houston, 2008) inspired several hypotheses:

*(1) the design aesthetic chosen for the Native Orchid House is not dependent on the biological conservation value of the collection.*

*(2) a 'naturalistic' aesthetic is not the only way to present natural systems or the message of conservation to the public, but such a style is gaining in [design] popularity and may have inherent horticultural and socio-psychological merits*

*(3) the form of a well designed collection-- one that works for plants and people-- is* ***not*** *based on institution type or garden type. It takes its cues from the horticultural requirements of the collection, site conditions, the institution's mission statement, the goal of the display garden, and last but not least, the artistic vision of the designer*

These hypotheses (and concomitant research) may serve as part of a *specific* "public gardens design" methodology. Though the prior art itself is not groundbreaking, and the hypotheses may be already assumed, the particular combination and application of such study may be original. At the very least, the relevance and import of auxiliary research (in the form of a literature review) was guided by these hypotheses.

***Project deliverables***

The project deliverables include (1) a written report that reviews applicable literature; outlines extant site conditions; and proposes a design that is substantiated, in form and function, by information gathered from the literature review; and (2) conceptual drawings of the proposed design that give a clear sense of scale and character. (See also Section 7: "Design goals")

***Project procedure:***

A site visit took place in late January 2009. The site was documented through photographs, measurements, narrative, sketches, and informal discussions with Gardens managers (Heather duPlooy and Brett Adams) and staff. Programming/design goals were clarified through this visit.

Several preliminary designs were produced after the site visit. A final design concept was selected, and detailed drawings rendered. These were presented to The Department of Landscape Architecture and Regional Planning (University of Massachusetts, Amherst) and the client (The Belize Botanic Gardens) received copies of all project deliverables. The final project is visually diverse, including photos, sketches, and hand and computer -renderings. All written and visual documentation were delivered to the client.

***Organization of the report:***
The report is comprised of a literature review (Sections 1-5), site history and description (Section 6), and site analysis and recommendations (Section 7).

The project site (The Native Orchid House) is introduced by way of "zooming in" from coarse (macro) to fine (micro) scales. ***Section 1*** is a geophysiographical introduction to the site at a 'coarse scale'. The country of Belize is introduced, then The Cayo District and Mountain Pine Ridge Forest Reserve (located in The Cayo).

***Sections 2, 3, and 4*** introduce the author's hypotheses about the design of public collection gardens and literature associated with these. Sections 2 and 3 explore the [biological] conservation value of such collections and the value of 'naturalistic style' garden design.

Section 4 is a review of correspondence with landscape architects, collection curators, and botanical garden managers. A brief survey of native plant gardens at other botanical gardens serves as "case studies" (Request-for-Information letter sent by the author is in Appendix A. Transcripts of correspondence and case studies are presented in Appendix B).

***Section 5*** is an introduction to orchids, their native habitats and cultivation requirements. This information was collected from literature and discussions with an orchid curator.

In ***Section 6***, the author returns to the project site at a fine scale. The institution of the Belize Botanic Gardens is introduced. The managers' goals and suggestions for The NOH, as well as the physical site conditions, are described. Information was primarily culled from a site visit and in-person discussions with the Gardens' managers. The Gardens' website and Master Plan (Houston, 2008) were also consulted.

***Section 7*** presents information collected during the site visit. Numerous photos accompany the site description and analysis. A site analysis and [proposed] sitemap from the 2008 Master Plan, existing and proposed planar and sectional views of The Native Orchid House are included. Proposed changes to the 2008 Master Plan are highlighted on the [Plan's] site map. All of the author's design recommendations are presented in the report in "bullet point" format.

## 1. Climates, Topography, and Vegetation Belize, Central America:

**Key Terms**
*Subtropical:* climate zone found between the Tropics of Cancer and Capricorn (23.5 degrees N and S of the Equator); it features a greater degree of seasonality than the equatorial tropics
*Rain forest:* "A very wet, essentially non seasonal [sub/tropical] forest" (Kricher, 1997)

Belize is a country located in Central America, approximately 8866 sq miles (about the size of New Hampshire), bounded to the north by Mexico, to the west and south by Guatemala, and to the east by the Caribbean Sea (Beletsky, 1999) ( Fig 1-1). The beautiful coastline features many cayes and islands, and is highlighted by the largest coral reef in the western hemisphere.


*Figure 1-1*: Belize, Central America

It is considered *subtropical*, lying above the equator at 15-19 degrees North (Lyon, 1999); unlike equatorial tropical climates, there are seasonal variations in temperature and rainfall (though there are still ~ 12 hrs of daylight throughout the year). The country lies within the New World (American) tropical rainforest zone, and 79% of forest in Belize is considered rainforest (McLeish, 1995). Belize's climatic designation as 'subtropical' may label these rainforests as such, but in general, *subtropical rainforest* is a nominal designation only and can be considered localized portions of tropical rainforest (Ayensu, 1980).

Rainfall amounts vary depending on latitude, higher rainfall occurring in the South. In general, the rainy season is June through November, the dry season December through May. Rainfall amounts, elevation, and soil type strongly influence vegetation type. In general, November through January includes the coolest months, with temperatures averaging 75 degrees F. May through September include the warmest, with average temperatures of 81 degrees F. (http://www.myproworld.org/locations/Belize.htm; 11/09).

Though it is one of the smaller countries in Central America (and one of the least populated), it has a rich diversity of flora: "the estimated 400 species of native flowering plants… [includes] 317 species of bromeliads/orchids" (Jacobs and Castaneda, 1998). About 70% of Belize is still forested, and most water resources (as well as the coastline) remain in "relatively pristine conditions" (Ibid). About one third of Belize's natural environment is protected by the government and other public/private agencies, though limited funding hinders regulations enforcement and effective management (Beletsky, 1999).

In the North and coastal areas, large areas of low tableland (rising to about 300') are found, including savannahs, swamps, lagoons, marshes, and inland, some areas of broadleaf rainforest (Lyon,1999). Most forests in Belize are *secondary forests*, the land previously disturbed by the Mayans and Europeans (McLeish, 1995).

The more mountainous regions are found in the west and interior parts of the country. It is here that The Maya Mountains are found, rising up to 3770' (Doyle's Delight). In the Northwestern area of the Mayas is the distinctive *Mountain Pine Ridge* habitat (see 'Mountain Pine Ridge Forest Reserve', below).

**Cayo District (Belize):**
Belize is made up of (6) districts ("states") (Figure 1-2); The Cayo District is the largest and encompasses the country's largest area of protected land, including the Maya Mountains and Mountain Pine Ridge Reserve (Eltringham, 2001). The Cayo is in the interior-western part of the country, bordering Guatemala. The largest town, San Ignacio (population was 16,400 in 2000 [http://on.wikipedia.org/wiki/San_Ignacio; 11/09]), is on the Macal River, only 9 miles east of Guatemala (see Fig 1-2).


*Figure 1-2*: The Cayo District (Belize

Cayo is known for its incredible scenic beauty, diverse topography and vegetation, and cultural attractions. Its waterfalls, canyons, rivers, caves, mountains, and Mayan temples make it a desirable destination ecotourists from all over the world. Indeed, ecotourism is the District's largest revenue base (Beletsky, 1999).

Two primary habitats are found in Cayo: Pine Ridge/ Savanna (in The Mountain Pine Ridge Forest Reserve); and broadleaf (rain) forest. Vegetation cover varies depending on elevation and rainfall.

Average temperatures in Cayo are lower than those of coastal areas. During the coolest months (November –January) nighttime temperatures can drop into the 40s (F) (http://www.myproworld.org/locations/Belize.htm; 11/09).

**Mountain Pine Ridge Forest Reserve (Southern Cayo): Key Terms**

*Holridge Life Zone:* The Holdridge life zones system is a global bioclimatic scheme for the classification of land areas (http://en.wikipedia.org/wiki/Holdridge_life_zones; 8/09)

*Lower Montane Forest:* Broadleaf forest formation found in lower elevations of mountainous regions

*Savanna:* in the context of this project, 'savanna' is a tropical grassland that occupies a transitional zone between marsh/ pineland and intermediate rainforest; it features an unclosed canopy (though there may be trees found singly or in sporadic groupings) and a forbs-dominated ground cover (http://en.wikipedia.org/wiki/Savannah; 8/09)

*Ecosystem:* An ecosystem is a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the physical (abiotic) factors of the environment (http://en.wikipedia.org/wiki/Ecosystem*;* 8/09)

*Ecotone:* Transition area between two adjacent but different plant communities, such as forest and grassland (http://en.wikipedia.org/wiki/Ecotone; 8/09)

One of the most scenic and ecologically unique areas of Belize, The Mountain Pine Ridge Forest Reserve (MPR) (See Figure 1-3) is rich in orchid species, and features a diversity of plants not seen elsewhere in Central America (McLeish, 1995; Jacobs and Castaneda, 1988). *(Note: "Ridge" is a term descriptive of forest type, and is not indicative of topography.)* The MPR is an area of approximately 126,825 acres in the northern foothills of the Maya Mountains (Zisman, 1996). It is managed and protected as a "forest reserve" by The Ministry of Forestry (since 1944), and is classified as a timber "production forest" (since 1952); 54,508 acres are dedicated to silviculture (Ibid). The Reserve is now loosely managed as a conservation area for wildlife, vegetation, watershed protection, and ecotourism.

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The protected areas in interior Belize are dominated by the massive Maya Mountain and Mountain Pine Ridge "bloc", made up of 16 "statutory reserves" managed under various public/private agencies (Jacobs and Castaneda, 1998). These protected area form, in essence, a country-wide green 'corridor', stretching from the Guatemalan border to the coast (Ibid). These protected areas, managed by various entities (to varying degrees of success) are envisioned as eventually being incorporated into the single largest land area [in Belize and Northern Central America] dedicated to "the protection and wise use of biodiversity, scenic values, renewable natural resources and cultural heritage" (Ibid).


*Figure 1-3*: Detail of The Cayo District (Belize)

Though The Mountain Pine Reserve is officially under environmental protection, there is an ongoing issue with agriculture encroaching along the northern boundary (Zisman, 1996). Indeed, land clearing and agriculture are reported as the primary threats to Belize's biodiversity (Jacobs, Castaneda, 1998). The illegal collection of orchids in the Reserve has also been reported (Zisman, 1996).

The Reserve sits atop a granite massif, with areas of limestone in the west (Zisman, 1996). It boasts a stunning karstic topography—the bordering limestone hills feature an abundance of caves (Ibid). Clear streams, creeks, and waterfalls-- fed by underground aquifers-- crisscross the landscape. Most streams flow into The Macal River (running south to north), which forms the western and southern boundary of The MPR.

The MPR is classified by the *Holdridge Life Zone* as "Subtropical Lower Montane Wet to the west and south, and Subtropical Lower Montane Moist in the north and east" (Zisman, 1996). Rainfall ranges seasonally from 60-80" throughout the year, September through October receiving the highest average rainfall. January is the coolest month (mean minimum temps are between 88 and 90 degrees F), with temperatures steadily rising in the dry season (February through May). By May, temperatures can reach over 100 degrees F, and relative humidity can drop to 70% (mean maximum temps are between 102 and 104 degrees F). Prevailing winds are easterly.

The primary tree cultivated for timber production is Pinus caribaea. Over 50% of the trees in The MPR are pine species (P. caribaea and P. patula). ~36% is broadleaf forest, grassland (savanna) makes up 3.4%, and wetland, 0.6% (Zisman, 1996). A diversity of vegetation—from dry forests and grassy banks, to denser, streamside vegetation, can be found. Furthermore, there is a "relatively high proportion of endemics in pine ridge" (Jacobs, Castaneda, eds., 1998), making it of particular botanical and conservation interest.

The Reserve is dominated by the pine-oak savannah community. The open pineland (or pine savanna) is a biologically unique and important habitat (Laughlin, 2002; Jacobs and Castaneda, 1998). It consists mostly of forbs (grasses), with clusters of trees and shrubs found where soil fertility and moisture is greater. The savanna's boundaries are rather fluid; it is an ecotone of the rockier, open shrublands as well as broadleaf forests (Laughlin, 2002; McLeish, 1995). "The diversity of habitat structure, soil variation, and ecosystem processes in the savanna support a rich flora" (Laughlin, 2002), including many terrestrial orchids. Lithophytic ("rock-loving") orchids are found perched in the rocky outcrops that surround the open pineland. Numerous species of this type inspired one researcher to dub an outcrop "Orchid Cascade" (Kumble, 2006).

Epiphytic (tree dwelling) orchid species are found in the tree canopies that border the richer, wetter soils of river and creek banks. Oaks in particular, found in clusters in the savanna or in ravines along streams, support a "rich and varied [epiphytic] orchid population" (McLeish, 1995).

Littoral (streamside) vegetation is much more diverse than that of the rockier, drier upland, and offers "the richest variety of Belizean epiphytic orchids" (Ibid). Areas of rainforest grow in the richest soils along the larger streams of The Reserve.

The limestone hills bordering The MPR feature yet another habitat, that of dry deciduous forest, similar in composition to that of the Northern Yucatan Peninsula (McLeish, 1995). The Maya Mountains proper boast intermediate (on the higher slopes) and advanced (on the lower slopes) rainforest.

**2. The Conservation Value of a Display Collection at a Botanical Garden**

*Hypothesis: the design aesthetic chosen for The Native Orchid House is not dependent on the biological conservation value of the collection.*

**Key Terms:**

*In-situ:* in the context of this project, refers to plants originating and existing in their native habitat

*Ex-situ:* in the context of this project, refers to plants removed from their native habitat and existing in cultivation (e.g., in a display collection)

*Conservation garden:* a type of botanical garden, [most often] developed in response to local needs for plant conservation; some of these gardens contain, or have associated areas of, natural vegetation in addition to their cultivated collections. Included in this category are native plant gardens, which only cultivate plants from their surrounding region or national flora. Most conservation gardens play a role in public education (Wyse-Jackson, 2000).

**Key Organizations:**

**BGCI** (Botanic Gardens Conservation International): "an international organisation that exists to ensure the world-wide conservation of threatened plants, the continued existence of which are intrinsically linked to global issues including poverty, human well-being and climate change" (http://www.bgci.org/).

**NBC** (National Biodiversity Committee): Belizean government and non-government group [established 1996] that provides guidance for developing national policies regarding the conservation of biological resources.

**CBD** (The Convention on Biological Diversity): The Convention is an international treaty (effective 29 December 1993); "It has 3 main objectives: (1) To conserve biological diversity; 2) [To] use biological diversity in a sustainable fashion; (3) To share the benefits of biological diversity fairly and equitably" (http://www.cbd.int/)

**CPC** (Center for Plant Conservation): "The mission of the Center for Plant Conservation is to conserve and restore the rare native plants of the United States." (http://www.centerforplantconservation.org/)

**CITES*** (Convention on International Trade on Endangered Species of Wild Fauna and Flora): "is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival" (http://www.cites.org/). *See The New York Botanical Garden Case Study in Appendix B

Informal discussions with ecologists (including Dr. Charles Canham of the Cary Institute of Ecosystem Studies, Millbrook NY; 9/13/09) led to the hypothesis that the landscape within The Native Orchid House does not have a significant ecological impact on the macro-scale (surrounding) landscape. That is, the design of such a small-scaled, insular landscape is not considered to contribute to the conservation of an ecosystem or of a species. Its design does not affect the Belize Botanic Gardens site as a whole, or even any aspect of the

landscape outside of the House walls. The design, therefore, does not require a region or site-wide site analysis. *Its ecological affect on the site, and the surrounding site's impact on it, are considered nil.* The design of The Native Orchid House is one inspired by philosophies of science education (i.e., exhibit curation more so than landscape ecology). *Its prime purpose is seen as one of public education, and conservation by way of education.* (See also Section 7: 'What this design is not'.)

Research was conducted to verify if such a display possesses any de facto conservation value. If such research verified the above hypothesis, the design form could be open to a variety of aesthetic interpretations, rather than bound to one by way of ecological necessity.

As repositories of plant collections, botanical gardens are "part of a nation's scientific capital" (Maunder et al, 2001). The form and function of this capital has certainly changed over the centuries (Kumble and Houston, 2008), and modern botanical gardens are often multi-faceted, multi-disciplinary institutions that are increasingly serving as vanguards, in part or parcel, in the race to protect out planet's vanishing biodiversity (Marinelli, 2007). "Conservation is already, and very appropriately, recognized as being a major activity for botanical gardens in both their research and educational programs." (Ashton, 1986) There is a growing awareness—reaching beyond the scientific community-- that many plant (and animal) species and habitats are severely threatened or have already been permanently lost to development. There is also growing understanding of the urgent need to integrate conservation and sustainable practices with development on a global scale (Wyse-Jackson, 2000). Such urgency calls for botanic gardens to get creative in the ways they draw people in, for people bring two resources necessary for long term conservation: the potential for mass education and money. To attract people, botanical gardens need a "compelling message", or narrative, and they need to advertise (or market) this message, perhaps using lessons from the rather aggressive marketing community (Marinelli, 2007). Botanic gardens must start to sell the lifestyle associated with sustainability and conservation, "creating spectacular landscapes and structures that advance the knowledge and practice of sustainability and make a bold innovation statement" (Ibid). *A display garden, however small, can contribute to such a narrative*, even if only by way of encouraging people to repeat visit because of its beautiful design. Further, a *small-scale display gardens may especially facilitate peoples' understanding of complex, large-scale ecological systems*.

The Convention of Biological Diversity (CBD) emphasizes the conservation of threatened species in their country-of-origin in support of their recovery, rehabilitation, and reintroduction to natural habitats. The long-term goal of conservation is the eventual recovery/conservation of in-situ populations. Don Falk, executive director of The Center for Plant Conservation, puts it bluntly: "The real end goal of conservation has to be to put itself out of business… I would always want to describe the end process as moving plants back out into nature" (Glowka et al, as quoted in Mlot, 1989).

An important aspect of effective, long-term conservation is the development and monitoring of national and international (global) conservation programs and guidelines; Botanic Gardens Conservation International (BGCI) and CBD strive for this. Botanical gardens cannot contribute to long-term

conservation as isolated entities, but must act as part of a collective whole—an international botanical community. Botanical gardens must critically review and standardize their conservation activities, and work on bridging the gap between the public and scientific communities, the disciplines of horticulture and botany (Maunder, 1993). Ultimately, "[i]f botanical gardens are to be taken seriously by the governments of developing nations they will have to play a part in the development process" (Ibid). In part, this means that the garden will work with the surrounding community to conserve endemic plants of particular cultural and/or economic value. Botanical gardens need to balance their display and repository roles with their scientific research, practicing these at multiple scales, local, regional, and global.

Ex-situ conservation is a viable option in which botanical gardens can partake. There are various methods of such conservation, including the cultivation and display of the whole plant, or the collection of seeds/tissue/ other genetic material. Current technology, space, and labor limitations makes seed banks the conservation method of choice (Ashton, 1986), though this Master's project explores the method of conserving an entire organism via a living display. Ex situ conservation has scientific limitations, though. That is, the "wild" environment—notably its selection pressures (including gene dispersal) --cannot be replicated ex-situ. Ex situ collections, especially of smaller size, may yield unexpected hybridizations and resultant domestication (Ashton 1986, Mlot, 1989). Extant habitats remain the source of great genetic diversity and provide the stimuli of natural selection, dynamics that cannot, at present, be replicated in ex-situ populations (Ashton, 1986 ; Maunder et al, 2001; Mlot, 1989). The *dynamics* of the natural landscape—from the landscape architectural in nature (the interrelationships of wind and light, ground and sky), to the more scientific (mychorrizal associations and pollen [gene] dispersal), are extraordinarily challenging to simulate, especially if the site is of very limited size. In general, habitat requirements can be met in ex-situ displays (Ashton, 1986). But what should a dynamic, genetically diverse, community-based display look like? "Do we expend large efforts on maintaining increasingly artificial fragments of a historical community…[an] anachronistic biological community… or will we accept new assemblages possibly dominated by exotic species and perhaps even accept that exotic species may play a valuable ecological role in the new 'greenhouse' ecology" (Maunder, 1993)?

Seeds/plants collected in-situ and grown ex-situ in these same 'source' countries presents a plant collection with greater genetic diversity and [therefore] long-term conservation potential. Studies of botanic garden palm collections by Maunder et al (2001) lead to the conclusion that "effective ex situ conservation of threatened plants will only be feasible in the source countries where genetically diverse ex situ populations can be managed in tandem with wild populations."

As mentioned, genetic variation [of a species] may not –and IS often not —reflected in a botanic garden collection (Maunder et al, 2000; Ashton, 1986). Plant species, especially in the tropics, may exist in very small, isolated populations, each showing different adaptive [genetic] variations. There is a growing argument that a botanic garden should seek to conserve the rarer alleles (genetic traits) of a species population (Mlot, 1989). A display garden's aesthetic appeal is not necessarily affected by its inherent lack of genetic diversity, but this does affect broader, long term conservation goals that

may be thought derivative of such collections—that is, the reintroduction of cultivated plants to the wild. 'Inbreeding depression' and a resultant decrease in plant fitness are observed in long-term cultivated collections (Maunder et al, 2000; Mlot, 1989). For these reasons, it is especially important that the "managers of ex-situ population define, as carefully as information allows, the characteristics they are intending to conserve: all alleles in the subsample or only some, and, if some, then which?" (Ashton,1986). In determining this, the role of the botanic garden in conservation management is defined by clearly qualifying the potential research value of its plant collection. This collection can thence serve as an invaluable "gene library" (Ibid) with the potential to contribute to long-term conservation goals.

The display of plants in a public garden—however 'ecologically' appropriate looking this display is-- does not address a long term conservation goals. This is not to diminish the important role a well-maintained, aesthetically pleasing ex-situ collection serves the visitor. Certainly, a well designed display can present a memorable, multi-sensory educational experience for the visitor. The indirect impact of this experience on conservation—in terms of inspiring awareness, interest, and financial contributions-- cannot be underestimated. In terms of scientific, long-term conservation value, a paucity of genetic diversity and reproductive capability of a display collection (especially outside of the country-of-origin) render it limited (Ashton, 1986 ; Maunder et al, 2001; Mlot, 1989). Such a collection can serve as a *living laboratory* in which scientists can refine and practice their knowledge. It can afford an opportunity to discover genotypes belying naturally occurring phenotypes (Ashton, 1986). It can also serve as a *refuge* for endangered plants. (Kuroiwa, 2002) *The end goal, though, of any research that ex-situ populations afford is the conservation of in-situ ecological communities.* In-situ conservation is key to insuring species diversity and survival. "…[T]he effective conservation of threatened …[species]…. will be dependent upon extensive and secure habitat areas" (Maunder et al, 2001). Maunder (1993), again: "Currently single species are not the highest priority for species rich tropical areas…" In-situ habitat management (complemented by ex situ conservation) is necessary.

The Botanic Gardens Conservation Strategy (1989) recognizes that there are a "great diversity" of botanical gardens worldwide (Wyse-Jackson, 2000), and that the potential for such institutions to aid in conservation efforts is valuable insofar as they are united and standardized in goal and action. To this end, the BGCI issued an "International Agenda" (2000) to botanical gardens worldwide. This Agenda is a standardized framework that serves to guide an institution's conservation programs and policies. The Agenda emphasizes that though there may be various types of botanic gardens (including one explicitly dubbed "conservation garden"), all gardens can --and should--engage in conservation efforts, and these efforts can be expressed through various activities on and off site. Most importantly as far as this project is concerned, is the discussion of ex-situ conservation (as well as the display of living collections, seed banks, and germplasm collections). *The Agenda does not specify a particular 'aesthetic' for living displays*, and only emphasizes their [public] educational role and limited conservation value. The Agenda, as with all other literature reviewed, stresses that ex-situ conservation is subsidiary to in-situ efforts. The botanic garden must prioritize their ex situ collections, focusing on species that are "in immediate danger of extinction"; "of local economic

importance"; are "required for specific reintroduction or habitat restoration"; are "local 'flagship' species or subspecies that will stimulate conservation awareness"; are "species or taxa that are of special scientific interest" (Wyse-Jackson, 2000). Further, the collection must be assessed and documented according to "stricter scientific and horticultural standards to maximize their value for conservation purposes" (Ibid).

The Belize National Biodiversity Committee's (NBC) National Strategy (1998) is cognizant of the value and limitations of ex-situ conservation measures and the key role of the botanical garden in supporting such measures. As such, the NBC supports The Agenda, recommending the following:

- "Ecosystems management must be promoted as a measure to conserve not only species, but critical habitats and their inter-and intra-specific relationships"

- "Promote ex-situ conservation of Belize's biological resources as a complement to in-situ conservation."

- "Ex-situ conservation of plant species will be achieved through Botanic Gardens, Public Parks, School Gardens, a National Herbarium…"

**Conclusions about collection displays at botanical gardens:**
It is clear that the modern botanic garden serves as a 'showcase' of plants—local and exotic—and that there are various ways these collections are presented. The literature review has shown that science (in particular, botanical conservation science) does not prescribe a definitive aesthetic for such collections; it is feasible that this decision falls under the jurisdiction of the landscape architect.

Plant collections can and should be grown for display *and* research, though they may not contribute to long term conservation goals in terms of reintroduction of species into the wild. They do contribute to long term goals in terms of educating the public and generating interest and revenue.

As a future leader in conservation of species endemic to Belize and greater Central America, The Belize Botanic Gardens should make it a priority to engage in the protection/management of threatened in-situ populations—by direct or indirect means. Harrison Flint (1989) expresses the heart of what scientific intellect has corroborated: "It seems ethically essential that we give our first attention to nature itself, by conserving natural ecosystems, before turning to our constructed gardens and landscape."

**3. Naturalistic Garden Design: Habitat Creation/ Restoration**

*Hypothesis: a 'naturalistic' aesthetic is not the only way to present natural systems or the message of conservation to the public, but such a style is gaining in [design] popularity and may have inherent horticultural and socio-psychological merits.*

(Note: The terms *naturalistic design* and *habitat design* are used interchangeably in this discussion.)
From a purely horticultural point of view, the primary focus of the project at The Belize Botanical Gardens' Native Orchid House is to provide optimal growing conditions for species of *orchids*. In broader terms, the focus is about creating a *native plant garden* and considering the ecological and aesthetic elements that inform the design as such.

A literature review readily provides insight into the appropriate cultural conditions for orchid displays. Literature has not provided a consensus specific to the design of 'orchid displays at subtropical botanical gardens'. Because of this, a wider net has been cast in terms of defining what kind of space is being designed. Fortunately, prior art has much to say about the form and function of native plant gardens.

One may incorporate native plants into any style of garden design. It can be formal, informal, small in scale or large. There is a style though, dubbed *naturalistic design* (Lovejoy, 1998), that examples the use of native plants in their most complex expression. The author has decided to explore this native plant design style for The Native Orchid House because of its horticultural seriousness and diverse and holistic educational/narrative potential.

Naturalistic design is the reconstruction, in small or large part, of an entire plant community, "intended to echo the physical partnerships and social structures … that we see repeated over and over in an enormous variety of natural settings and habitats" (Lovejoy, 1998). This is *habitat recreation* rather than a superficial design 'style' that incorporates token native plants. This is a holistic site planning *methodology* that understands ecological function as inspiring [highly organic] forms. This combination of form and function can lead to highly dynamic designs that can be appreciated at the intimate individual (human) and larger (ecosystem) scales. The maxim associated with a naturalistic garden may be "the right plant in the right place": such design pays close attention to the horticultural needs of the plants and sites them appropriately. This makes for a healthier and less maintenance intensive display in the long run. Such maintenance benefits are likely *not* conferred to the project site, though, as the display is an insular, highly artificial one that is not going to become 'naturalized'. (Also see Section 5: "Orchids in cultivation")

Ecosystems are a highly complex network of ecological relationships (*processes*) that exist from coarse to fine scales (Leopold, 2005). They may present many microclimates and other limiting site factors (soil type), and these may create a broad through extremely site-specific palette of plant diversity. Full restoration or re-creation of an ecosystem is usually impossible for this reason. (Marinelli,1994) At the very least, the macroscopic levels of the native plant community (trees, shrubs) can be established through the efforts of the landscape architect and others (Flint, 1989). Many landscape architects over the last century have designed-by-imitation the natural landscape (O.C. Simonds, Jens Jensen, James Van Sweden, Michael Van Valkenburgh) and have been influential proponents of the use of native plants. As mentioned, habitat re-creation and restoration goes beyond artful imitation. Such landscapes —especially of sufficient scale and complexity— contribute to the preservation of a species for they imitate not just forms but ecological functions. *In the preservation of an entire eco-community and its processes lies the preservation of the individual species*.

Ecologically speaking, and perhaps most apropos regarding The Native Orchid House, is the idea that naturalistic/ecological gardening is about gardening in layers— not only in terms of size and texture, but in ecological relationships akin to those found in native plant communities. "Ecological processes are strongly affected by the structure of a community" (Leopold, 2005). In any forest habitat, from

temperate woodland to tropical rainforest, a layered community and concomitant aesthetic exist.

For the visitor, naturalistic (habitat) design, rich in sensory cues, can confer an immediate sense of "regional uniqueness". It can emphasize a sense of "integrity", "compatibility", and "wholeness", though its multi-scalar (micro to macro) functionality and form, its seasonal dynamism. These elements can work together to create a strong sense of self-awareness and orientation. Immersion in habitats also encourages continual observation and interaction from the visitor. Simply put, "[o]ur psychic roots draw us to nature, even when we resist" (Flint, 1989).

Nassauer (1995) comments that "[n]ature is a cultural concept that is frequently mistaken as an indication of ecological quality. It has no specific appearance in form and may be as readily applied to a canopied urban plaza…or cultivated field… as to a wilderness." This statement was made to emphasize that the way a place looks is not necessarily indicative of its level of ecological quality, and that a degree of design and management—human 'interference'— "is necessary to represent and maintain ecological function" (Ibid). Though 'nature' and 'ecological quality' may be polymorphous in form, *naturalistic design* presents the vernacular of 'natural', and readily fulfils ecological functions. What, then, should this vernacular look like?

"In design terms, naturalistic gardens are simple and uncluttered, their lines based on gentle curves and sweeps rather than straight lines and geometrical axes... The concept of planting within beds and borders is retained… but within them, the shape, size, texture, and mass of each plant is at least as important to the overall composition as the colors involved" (Lovejoy, 1998). Plants of various sizes, textures, and colors are woven together to form an informal, patterned tapestry that emphasizes areas of negative space as well as positive. Layered massing encourages sweeping vertical and horizontal movements of the eye, the keen balance of texture, light, and form creating a comfortable visual experience. A great sense of dynamism (flow) is encouraged by such design, both aesthetically and by way of the natural processes that occur over time.

Naturalistic gardens can attract wildlife, mitigate storm-water runoff, and showcase indigenous plants and materials. In their fullest expression, they replicate existing ecological patterns and processes. It is clear that people can find such landscapes highly attractive: they seem to innately offer the qualities in which humans are 'programmed' to feel comfortable. Over the last few decades, people have become more and more intellectually aware of the ecological benefits of such design (Lovejoy,1998). More recently, and perhaps importantly, people have become comfortable with the 'wild' aesthetic of these gardens *outside* of the context of 'wilderness' (i.e., the national park), and have accepted them as a narrative of the residence, the city park, and the botanical garden. This is especially true if the wildness is not perceived as *too* 'chaotic' or 'messy' (Nassauer, 1995). This is achieved through design that incorporates accepted ('vernacular') forms and "cues for care" (Ibid).

**Potential Narratives of Naturalistic Design:**
As said, *naturalistic/habitat design* implies a focus on plant communities rather than individual native species (Blumer, 1994). It can tell a non-anthropocentric story about the relationship between humans and the larger world. They may present great diversity (though Leopold [2005] notes that "natural communities are not necessarily diverse") and dynamism; they are indigenous and therefore work hand in hand with concepts of sustainability; they can be multi-sensory, multi-scalar, and interactive (heuristic) experiences for human visitors and encourage an ongoing dialogue between people and the rest of the natural world.

The presentation of the passage of time (seasonal change; succession) is often an important element of such design. (Leopold, 2005) Short term changes (a plant's lifecycle) and long-term ecological change evolving beyond a human lifespan, can be emphasized in naturalistically designed gardens. The landscape architect who designed the [eco-zone based] Master Plan for The Makino Botanical Garden (Singapore) expresses this concept: "When planning a garden I have always sought to forge a plan of four dimensions, one of which would be the time axis along which the garden would change according to both its flora's growth and shifting social needs" (Inada, 2002).

It is essential to understand that the eco-homo narrative that habitat design *can* tell is *not* the narrative that everyone reads when they enter such a designed space. This is expressed most recently in a BGCI article "Ecological integrity or landscape aesthetics?" (Villagra-Islas, 2009). Though a review of the literature professes the potential for such an aesthetic to engage the visitor in a specific narrative, there is a dearth of studies that reveals if people perceive and value the ecological processes that underlie naturalistic landscapes (Ibid). There is also a lack of research regarding how people's socio-cultural backgrounds affect their perceptions of such landscapes and their 'sustainable management' (e.g. prescribed burns; allowing plants to change/senesce according to season/life cycle without human interference).

There have been many books and articles written about people's landscape preferences (Bell's Pattern, Perception and Process, 1999; Kaplan and Kaplan's* The Experience of Nature: A Psychological Perspective, 1989). These studies reveal that there seem to be universal landscape preferences—elements of place that people agree are 'beautiful' or 'comfortable', 'unattractive' or 'uncomfortable', regardless of culture, gender, or socio-economic status. Indeed, landscape preference may very well be "a remnant of the adaptive behavior that helped establish [our] species" (Lewis, 1996). Regardless, the design elements that this research has revealed as being universally attractive should be incorporated into a design. (*Kaplan and Kaplan identify four elements that aid people in reading a landscape; the degree to which these elements harmoniously exist is often directly proportional to people's preference for such a landscape. Elements include "coherence", how well a landscape is organized; "legibility, how well can one orient themselves in the landscape; "complexity", how diverse the landscape is; and "mystery", how exciting the landscape is, i.e., if it offers the prospect of the 'unknown').

The average person perceives their attraction to a place as based on aesthetics alone, (Villagra-Islas, 2009) an important fact remember when designing habitat displays. The ecologist

may have an ecosystem-wide understanding of such a landscape, perceiving it as attractive because it is ecologically 'healthy'. The layperson may not [intuitively] grasp this broader ecological story/message and perceive elements only in the context of looks rather than underlying processes. For example: one study surveyed laypersons and experts' perceptions of a landscape that was subjected to a prescribed burn (to increase biodiversity and remove potential fuel). "[w]hile experts associated more open scenes [created by the fires] with healthier landscapes, lay people liked them because of the accessibility and depth of view these landscapes provide" (Villagra-Islas, 2009).

Further studies are in order to ascertain visitors' perceptions of the ecological story behind a naturalistic display-- and really, if such displays innately aid in inspiring such perception. Though the visitor may not understand a habitat display like an ecologist (without explicit signage), incorporating design elements that are known to create positive experiences will inspire return visits. *The narratives of 'conservation' and 'adaptation' may not be told so much through the design aesthetic as through corresponding signage.*

**Where to begin...**

The landscape architect who attempts creation of such a garden does best to closely observe the functions and forms of nature, for it is the distillation of nature's lessons that is sought. It is important to note that *plant communities/associations* may be determined by the existence of key species (usually of trees) or dominant physiography (floodplain; prairie). Though a plant community is not often a well defined spatial entity, it provides a framework within which the designer can begin to recognize functional and formal patterns.

The key to designing successful naturalistic gardens is keen observation and understanding of nature. "Studies of relatively undisturbed natural landscapes provide one of the best ways to learn the principles of design that can be incorporated into the gardens" (Morrison, 1994). The designer may do well to begin their observations by thinking about s*pecies composition and distribution* (Morrison, 1994): What are the dominant species in an ecosystem? At what zone (layer) do they exist? Do they exist in masses? Singularly? Some may only exist in limited microclimates, while others may be abundant throughout. Still others may be visually dominant in a particular season (Ibid).
In addition to the above, the designer of an orchid collection can think about the ratio of epiphytic to terrestrial species (personal communication with Francisca Planchard-Coelho; 8/13/09), and how best to display each type.

The methods in which *variety* (diversity) and *unity* are created in nature-- the repetition of *spaces and edges*-- creates a visual order. It is incumbent upon the designer to observe how these qualities and patterns are created. Visual diversity in nature may be very complex (perhaps especially for a rainforest ecosystem), but the visual essence of this can be captured.

*(From Morrison, 1989)* Initial investigation of a site involves, first and foremost, a *[Physical] Site Analysis*. This is a survey of existing vegetation; light, temperature, humidity conditions, and other site factors. Secondly, the designer develops a *Proposed Mass/ Space Plan*. This may be generated by first thinking about circulation in the proposed garden, as a pathway is the key space around which all other masses can be developed. Next, *plant selection and arrangement* is researched. Data from the site analysis leads to selecting the

"right plant for the right place". Exotic (non-native) species may be combined with natives if desired, as long as the exotics are not invasive and end up overpowering indigenous selections. In nature plant density is often high—much higher than in the garden. This is especially true in the tropical rainforest. Though density may not be replicated, spatial arrangement can be mimicked. Plant placement may occur in horizontal and vertical (ground level to canopy) masses, arranged with attention to spatial form and microclimate. These arrangement of negative and positive space within these "vegetation zones" (Morrison, 1989) is equally important, masses and spaces flowing into each other. Edges (where plantings meet pathway) are often not sharp and have an irregular, informal ('organic') shape.

## 4. Correspondence and Associated Case Studies

*Hypothesis: the form of a well designed collection-- one that works for plants and people-- is* ***not*** *based on institution type or garden type. It takes its cues from the horticultural requirements of the collection, site conditions, the institution's mission statement, the goal of the display garden, and last but not least, the artistic vision of the designer.*

The author decided that one of the best and most practical approaches for gathering background information about the design of botanical garden collections was to contact landscape architects and directors whom have had first-hand experience with such gardens.

*It is hypothesized that many design styles can serve as vehicles for the same message.* This may be especially true for non-restorative projects (e.g., an extant habitat is not being restored) that are of a small scale in an enclosed space, as was the nature of this project.

Correspondence was solicited to gather a consensus about the design process of a display collection at a public garden and discover if there is a [popularly accepted] design type that works best for displaying native plants with a conservation message in mind. This consensus was then compared with the hypotheses.

A list of various botanical gardens, arboreta, and landscape architects was compiled, sourced through a long familiarity with the horticultural and design fields. A "request for information" letter (Appendix A) was sent to these sources requesting suggestions and advice for this project. These experts were chosen because of their experience designing, curating, and/or managing display collections at [United States] public gardens known for their dedication to plant conservation. This dedication was often stated explicitly in their mission statement, and reflected in at least one of their display collections (if not site-wide) and auxiliary activities (i.e.: research, education; financial benefactions). In general, the information requested concerned the design of collection gardens at botanical gardens/arboreta. Namely: Does the design of a collection reflect that of the larger garden? From where is the inspiration for this aesthetic derived? Is there a particular aesthetic associated with native plant and/or conservation gardens?

Of those queried, a handful responded via email or telephone, and this provided the framework for a 'tried and true' design methodology. Also, the author visited several notable [public] native gardens; these are included as brief "case studies". For

each study, the institution's mission statement is presented, followed by a brief description of the display. In this way, an attempt is made to see if and how a display's aesthetic reflects the institution's conservation message. Full transcriptions of correspondence, as well as case studies, are included in *Appendix B.*

Summary of Correspondence:

(1) All correspondents confirmed the hypothesis that *the design of specialty collections within a larger botanical garden should reflect the horticultural needs, design aesthetic, mission statement, and goals of the garden*.

(2) *The overarching goal of all displays is to attract and educate the visitor*. Of course, the design must be functional—meeting horticultural, maintenance, and accessibility requirements. In order to achieve the goal, this functionality should be presented in a beautiful, exciting way; this is where the creativity of the landscape architect comes in.

(3) The design of botanic garden displays follows a methodology common to all site planning and the greater process of site design.

(4) A botanic garden display design is often a process that requires input from multiple disciplines, including horticulture, botany, and landscape architecture.

(5) There is no set standard – popularly accepted or scientifically supported--when it comes to choosing a design form for native plant gardens/ conservation gardens. As long as the garden form meets the first two criteria (above), it serves its purpose. This is stated by correspondents and exampled in case studies.

(6) Explicit signage is necessary to deliver the "take home message"/narrative of a collection

These six touchstones are helpful in guiding the design of any public display garden.

## 5. An Introduction to the Orchid Family

**Key Words:**
*Epiphyte:* growing in the tree canopy
*Terrestrial*: growing on the ground

**The Rainforest Community:**
It is essential for the landscape architect to know a thing or two about the vast Orchid Family (Orchidaceae) before embarking on the design of an orchid collection. A thorough knowledge of the collection's horticulture is sine qua non for a successful design concept. A detailed planting plan most obviously showcases the designer's intimate knowledge of his/her subject; the depth and clarity of this knowledge reflected in the flourishing of the collection.

Before discussing the Orchidaceae, a brief introduction to elements of a *rainforest* are considered, for epiphytic orchids

are significant part and parcels of the rainforest habitat. Areas of rainforest are found streamside in the MPR and in the higher elevations and slopes of The Maya Mountains (McLeish, 1995), and it is this habitat which will be, in small part, created in the recommended design. The aesthetic of the rainforest – masses of luxuriant green in dazzling arrays of textures and forms-- evolves from a synthesis of multiple ecological communities--habitats of the forest canopy, the forest understorey, and the forest floor. Understanding this *layered ecology* is essential to creating an authentic (layered) habitat display. In the rainforest—and perhaps most dramatically seen in the Orchid Family-- *form follows function* from the macroscopic to the microscopic.

Tropical rainforests are found in a 'belt' around the equator, where high temperatures and humidity inspire such luxuriant, dense growth. These forests only cover approximately 7% of the Earth's surface (Newman, 1990), but are unrivalled in plant and animal diversity. Indeed, 82% of the world's biodiversity exists in the rainforest (http://en.wikipedia.org/wiki/Rainforest; 9/09*)* and a few acres of rainforest may be home to hundreds of plant species. "In species richness [tropical rain forests] are only rivaled by coral reefs" (Whitmore, 1990).

There are many different kinds of tropical rainforest, varying in structure and species (Kricher, 1997). In the wetter mountainous, rainforest types may be defined according to elevation as "Upper Montane " (highest elevations, may also be "cloud forests"), "Lower Montane" (mid level elevations) or Lowland (lowest elevations). A lower montane moist forest is found in areas of the MPR and presented in this project.

The rainforest is an exemplary study in "layered" ecology. These layers—sometimes discrete and sometimes no-- include the highest "emergent layer", where the highest trees soar above the rest; the main "canopy", where flatter topped trees form a unique 'bird's eye view' habitat for animals and plants, and the 'lower tree layer' comprising the upper reaches of the understorey (Kricher, 1997). "[T]he layered structure [of the rainforest] is the key to its fantastic richness, because the layers provide innumerable tiny and discrete habitats" (Ayensu, 1980).

The distinct habitats of each layer are borne of associated microclimates. The climate of the emergent and canopy layers one of low humidity and high wind flow, rainfall, sunlight, and temperature variation. These aspects gradually tip in the other direction as one descends to forest floor, where the humidity is highest, and the wind flow, rainfall, sunlight, and temperature variations are lowest. (Consider the fact that only around 2% of the sunlight that hits the upper canopy ever reaches the forest floor) (Ayensu, 1980).

The Orchid Family is the second largest with over 30,000 naturally occurring species throughout the world (NYBG Watson Building Display, 2009). In the American ["New World"] tropics, they are primarily *epiphytes*, or "air plants". They have adapted to life in the canopy, using trees as their perches. Their roots divorced from the soil and exposed to the air, they survive on nutrients collected from rainwater and fallen debris. The number and diversity of epiphytes-- including members of the bromeliads, cacti, moss and fern families-- is greatest in the rain forest, where it can "seem as though every bit of plant surface is a substrate for other plants" (*Forsyth and Miyata, 1984*; Fitch, 1981). Organic matter

(composed of living and dead elements) in the canopy represents a community distinct from that of the forest floor (Nadkarni, 2001). In fact, in one tropical rain forest, [dead; i.e. root/humus mat] organic matter was found to be in significantly greater concentrations in the canopy than underfoot – and with different chemical compositions (Ibid). The unique ecology of the forest canopy lends it an important role in the nutrient cycling of the forest ecosystem as a whole (Ibid). *The Native Orchid House may best introduce the epiphytic community through a layered 'vertical' display—featuring species at canopy, upper, mid, and lower trunk levels.*

Temperate forests share epiphytic denizens as well, though in the comparatively diminutive forms of algae, lichens, fungi and mosses.

With this in mind, we may ask why certain plants take to life in the trees. If so many rain forest species adopt this lifestyle, there must be some biological advantage in doing so. And indeed there is. The greatest advantage is perhaps one of increased sunlight: the rain forest floor is rather dark, as large-leafed, skyscraper trees prevent most light from reaching the ground (Whitmore, 1990). Perching in the canopy therefore confers a great solar advantage to non-tree plants. There are other advantages as well: seed dispersal via wind is a greater possibility in the canopy (though this is not the primary vector of pollen), as well as access to pollination by birds and bats (Ibid). Epiphytic life has its disadvantages, too. Such a life harbors various environmental stresses, primarily, a lack of water. "Treetop habitats in the tropical rain forest are really not too different from many arid habitats in terms of availability of water: the humidity is relatively low, the temperatures are relatively high, and breezes add further to evaporative water loss" (*Forsyth and Miyata, 1984;* Benzing, 1990). Epiphytes also exhibit a high rate of photosynthetic metabolism (due to their prime solar real-estate); this leads to a much greater evaporative water loss which cannot be as easily replenished as plants whose roots are anchored in solid ground. Once a plant's roots lose contact with soil, water availability is greatly diminished (Dressler, 1981).

For epiphytes, the advantages of increased sunlight outweigh the disadvantages of decreased water (Fitch, 1981). Therefore, they have developed ingenious ways of dealing with water loss and desiccation, in some ways similar to members of the cacti family. Some orchids develop bulbous stems for storing water. Some develop thickened, waxy leaves; their exposed roots are surrounded by a protective coating and expand and contract depending on water availability. Epiphytic orchids often exhibit *Crassulacean acid metabolism*, where their stomata open at night (instead of during the day, to reduce water loss) to absorb carbon dioxide. This carbon dioxide is stored as malic acid and used the next day in photosynthesis (Arditti, 1992; Benzing, 1990; Forsyth and Miyata, 1984). Some Bromeliads have developed a "funnel form", their leaves converging to a center that that can hold water like a storage tank (Forsyth and Miyata, 1984).

Nutrient availability is limited for epiphytes (Whitmore, 1990). Rain contains small quantities of nutrients (including nitrogen), but canopy-dwellers must collect more in the form of leaf litter or other organic debris. In order to do so, many epiphytes have evolved bowl or "basket-like" shapes and grow in the crotches of trees, where collection can occur (Forsyth and Miyata, 1984). Some epiphytic orchids and bromeliads have a symbiotic relationship with ants: they offer the ants a site for

nesting, and the water-soluble excreta of their inhabitants provide valuable nutrients. Epiphytes may also benefit from the waste of visiting birds and bats (Kricher, 1997).

Most epiphytes are not parasitic on their hosts. They use them primarily as platforms (which in itself can put great physical strain on the tree). Some orchids do have mycorrhizal associations with root fungi, and these roots may invade the host, digesting cellulose and lignin essential to structural support (Forsyth and Miyata, 1984; Batty et al, 2002).

There are tens of thousands of orchid hybrids (NYBG Watson Building Display, 2009). Orchid flowers have mesmerized people throughout the ages, from the shaman to the botanist, the lay-person to the elite connoisseur. Zealous hybridization has produced a stunning confection of preternatural colors and fragrances, but diversity occurs naturally within this family. The morphology of the orchid flower is a magnum opus of the botanical arts. The diversity of this family is perhaps most obviously exampled in a dazzling array of flower forms—all with one function in mind: pollination. As the staff of The Belize Botanic Gardens is keen on educating visitors about the *diversity* of the Orchid Family, perhaps the great diversity of flower form is most apt to immediately capture attention.

In Darwinistic terms, pollination is the most important event in a flower's life (as reproduction is in an animal's). (Kricher, 1997) So the 'story of pollination' is very relevant to any public botanical display, and this narrative converges nicely with that of 'species diversity'—as in, the two stories can be presented in parallel. There is also the story of interdependency within an ecosystem—a "web of life", holistic way of looking at any species that examples evolved interactions between species and other members of the ecosystem. Diversity, pollination, and inter-species relationships (co adaptation) can be presented as iterative stories that are part and parcel of an entire ecosystem.

Though canopy-living provides orchid pollen with access to wind, "tropical plants avoid wind pollination because this scattershot method of gene dispersal is effective only if there are lots of targets nearby" (Forsyth and Miyata, 1984). Ironically, rain forests present incredible plant diversity, but there are often only a handful of like-species in isolated locations (as opposed to like-species spread evenly throughout). The rain forest represents a "rarefied plant community"(Ibid) rather unlike that of temperate habitats. Animals—especially birds and bats—are the most common pollinators in the tropics, and they can spread a plant's genes over the greatest distance. And it's up to the plant to attract these visitors with a diverse palette of visual and olfactory enticements. Not only must a plant attract pollinators, it must somehow ensure that these pollinators deliver their genes to the appropriate plant. Thus, a plant "fine-tune[s] its morphology and ecology to match those of its pollinator. This process results in flowers evolving suites of characteristics that make the nectar available only to specific types of animals" (*Forsyth and Miyata, 1984*; Kricher, 1997). Rain forest pollinators are often highly specialized, as are their pollen sources.

Some orchid flowers attract pollinators by mimicking—in shape and color—nectar or pollen bearing organs. This deception alone serves its purpose, without any 'real' reward (i.e., nectar) being offered in return for the pollinator's services. Some orchids lure pollinators (such as the tachinid fly) by mimicking females; when the male attempts to copulate

with this female form, he is being tricked into pollinating the flower (Forsyth and Miyata, 1984). Yet others employ tantalizing movement to get the job done; male *Centris* bees perceive the movement of certain Orchid flowers as a "territorial challenge" (Ibid). Their 'acceptance' of this challenge results in pollination.

Most pollinators are rewarded for their efforts—usually with a tasty meal; sometimes, with an increased sex appeal garnered from collecting an orchid's fragrance (Forsyth and Miyata, 1984).

**Flowering Patterns:**
It is interesting to note that rainforests usually aren't saturated in blooms during any one time of year, as mass-blooming is a product of the distinct seasons of temperate climates (Kricher, 1997). Seasonal changes and 'broadcast' methods of seed dispersal create, synchronous flowering in temperate zones. In the rainforest, plants are dispersed much more sparsely, and there aren't as many seasonal cues to inspire a blooming frenzy. In the rainforest, changes in rainfall patterns may cue certain plants to flower rather than changes in daylight or temperature (Arditti, 1992). In general, flowering can occur year at any time in a tropical climate, but in order to not expend an exorbitant amount of energy year-round, plants produce flowers in limited quantities. Furthermore, masses of flowers can often be seen in the canopy, not from the floor. This may be especially true for native orchids, which enjoy life far above the ground. "The beauty of the flowers of tropical rainforests is portioned out, both spatially and seasonally" (Forsyth and Miyata, 1984). Because of sparser, limited flowering, rainforest pollinators are usually highly specialized (rather than the generalized pollinators of temperate areas). These pollinators *remember* a plant's location, and engage in repeat visits to its flowers throughout the bloom period. This ensures that its pollen is dispersed far and wide (Forsyth and Miyata, 1984).

**Orchids in cultivation (ex-situ displays):**
Ann Lovejoy (1990) remarks that *"… gardening is not natural. Indeed… gardening is by definition is interference with nature."* Almost all botanical collections can be considered 'gardens' as such, where plants have been removed from their native habitat and thereafter remain in cultivation. As such, plants in any botanical garden collection, even if the design mimics a native habitat, is going to need supplemental care (watering, feeding, repotting, etc) from their human caretakers. Most plants grown in public gardens, especially if they are not indigenous to the site, are not a dominant species, and are not woody, are "captive" plants that would not ordinarily thrive without support from their captors. Perhaps this is because in-situ conditions can not be perfectly replicated ex-situ… in particular the complex ecological relationships that exist between a plant and its native community (as with many orchids), and especially if the display is within a very small, enclosed area (as in The Native Orchid House).

Subtropical plants featured in display collections at subtropically-located botanical gardens have climate on their side and are apt to perform better with less care for this reason. "Climate is the most important factor that determines if a species can grow, mature, and reproduce on a site, once it has successfully reached that location" (Leopold, 2005). This being the case, the native orchids grown at Belize Botanic have ambient humidity, temperature, and light levels on their side; caretakers do not have to ameliorate these conditions as much

as those grown in temperate hothouses. Contrary to popular opinion, orchids are relatively easy to grow and have adapted to a variety of harsh conditions in their native environments. Often in the garden, "many kill their orchids due to over attention and kindness rather than neglect" (Teo, 1979). The best advice for growing orchids successfully is constant experimentation with adjusting growing conditions, as no two gardens, regardless of similarity, will yield the same results.

A discussion with David Horak (3/09), curator of the Orchid Collection at The Brooklyn Botanic Garden Robert W. Wilson Aquatic House (Steinhardt Conservatory), explored the care of orchids in cultivation:

In general, orchids like 40-50% sunlight—bright, dappled shade. They need constant air movement/circulation around their leaves and roots (being used to canopy conditions). Orchids appreciate high humidity – many prefer constant foggy conditions (The BBG has a "fogging system" providing water of much smaller particle size than mist; orchids do not necessarily like larger water droplets on their foliage). Mist systems are easier to install than fog ones, as they can run on standard water-line pressure.

There are a plethora of orchid species, and each species and genus may require slightly (or greatly) different growing conditions. Some require more light, some less; some require cool montane conditions, some are adapted to lowland tropical temperatures. Some have a dormant period and require dry conditions during this time; some are used to being enveloped in constant fog. Depending on the kinds of species and genuses for display, many growing conditions—in effect, microclimates-- may have to be provided. Indeed, Belize is home to over 300 species of bromeliads and orchids (Jacobs and Castaneda, 1998) and a similarly diverse range of distinctive landscapes to match.

Common potting media for greenhouse orchids include fir bark (chips/ small nuggets); charcoal; sphagnum moss—even, in part, styrofoam peanuts. Mr. Horak reports that he has seen rice hulls as potting material, as well. In general, orchids like neutral to slightly acidic growing conditions [i.e. rainwater], and one must be careful that the decomposition of said potting media does not alter the pH (for example, sphagnum moss is slightly acidic to begin with, and over time, becomes greatly acidic—in the 3-4 range).

Clay and plastic pots that allow ample aeration can be used, as well as bored out Tree Fern trunks so long as these are supplied from a farm, and not harvested in the wild), wire baskets, wooden, slatted baskets (cheap and renewable), and sometimes, no pot at all. Certain orchids, such as Vanda hybrids, flourish on just a wire hangar, their extensive roots dangling mid air. Of course, removed from any growing medium, one must be diligent about supplying adequate moisture.

Mr. Horak reminds that there are two primary ways of growing and displaying orchids: (1) In pots, and (2) on "mounts", pieces of wood that orchids are tied to that serve as support-and-medium in one (*see Figure 5-1*). Each method of display has its benefits and disadvantages:

Pots require potting media (which can be expensive and hard to come by in Belize), and plants in pots require transplantation [into larger pots] every one to three years, which can be time-consuming and expensive.

*Figure 5-1*: *(Clockwise; Top Left to Bottom Left)* Clay orchid pots (with holes for aeration); Sphagnum moss potting medium; Wooden baskets hanging on overhead rack; Orchids on hangars (no potting media necessary); Fishing wire used to secure orchids to mount; Cork bark mount; Root mass of a well established orchid completely engulfs its mount; Tree fern [trunk] mount

This is not only because orchids like to be potted 'tightly', in a space only allowing for approximately 2 years' growth, but also, it takes this amount of time for most organic media to break down and be rendered inhospitable for growth.

The benefits of growing orchids in pots include the fact that they are extremely convenient in terms of plant transport and display. They also retain water, obviating the need to water every day. Each time a potted plant is divided, the resulting plants are mature enough to create a bloom. Pots may also be easier to display on accessible tables or benches.

Orchids can also be grown on "mounts", chunks of wood used as a growing perch/substrate. The orchid is usually attached to a suitable piece with fine fishing wire ("bell wire"). At The BBG, cork oak (Quercus suber), grape vine (*Vitis sp*.), and Tree Fern (*Dicksonia sp.)* trunks were among the wood substrates observed.
The orchids roots fairly rapidly growing around and into the wood, and this wood piece can be hung by wire or perched in an appropriate location. It is important to note that in order to establish orchids in this manner, one must fasten them onto the substrate *when their roots are actively growing*, usually in spring- early summer, or sometimes again in fall. It is also important to use *the appropriate wood substrate*, one that does not rot too quickly, that is not *allelopathic* (toxic such that it represses growth) in any way to the orchid, that has enough texture so as to provide good root footholds… In general, a suitable wood would most likely be one that hosts epiphytes in the wild. *Close observation of where orchids grow in the field is essential to trying to recreate appropriate conditions in a mounted display.*

Mounted plants can last for many years without having to be re-mounted; roots can completely envelop the mount and the plant can reach a large size. However, mounted plants must be hung from wall or ceiling mounted rack or pipe. They must also be watered every day, perhaps more than once depending on temperature/humidity.

Rock is not often used as a free-standing substrate because of its weight. When asked about securing orchids directly onto limestone, which is prominent in The MPR and Maya Mountains, Mr. Horak warned that limestone is probably too basic for orchid growth, and may not provide nearly enough porosity. (The recorded existence of orchid growth on such substrates--as per MacLeish, 1995, and Kumble, 2006--challenges this assertion.) Lava rock (pumice) is lightweight and porous, and Mr. Horak has seen this used as a substrate. This type of rock is not indigenous—or perhaps readily available—in Belize.

Of first and foremost importance in successful orchid culture at The Belize Botanic Gardens may be the modification of the Orchid House structure. The managers at The Belize Botanic Gardens (personal communication with Brett Adams; 1/09) mentioned that there is inadequate light in The House; it is realized that the thickness and spacing of the side slats plays a big part in this. The big problem is these slats are non adjustable. The bigger problem is that the slats are arranged incorrectly! They circumscribe The House horizontally, running east to west around the structure. This means that there are areas of The House that remain in shadow for the entire day, as the sun's path follows the direction of the slats. *The slats should be arranged North to South, so that shadows are dispersed evenly throughout the day* (Teo, 1979).

Mr. Horak suggested removing more slats—perhaps even eliminating all of the side ones (leaving only those on the roof). If some lateral enclosure is needed (perhaps to prevent animals from entering, etc), perhaps wire can be used. Perhaps "saran" (a kind of "blanket mesh" material), or a comparable shade cloth can be used instead wooden slats—a cloth which can be pulled up or down like a roman shade. Perhaps the slats are made adjustable, so that they can function as louvered blinds, or maybe there is a dual-slat system, where there are adjustable --or removable-- horizontal and vertical pieces overlapping, affording an even greater range of light and shade. *Determining which sort of system would work best requires a thorough solar aspect study, revealing the varied light conditions each option affords. As well, a detailed investigation into the light requirements and tolerances of display plants is necessary*.

It is important to realize that there is the task of getting orchids to survive in cultivation. Then there is the task of getting them to flower in cultivation, and this may be more of a challenge. Oftentimes, an orchid may produce healthy foliage growth but never flower because appropriate conditions (usually associated with light) are not provided. Orchids provided with too much shade may exhibit this and has been observed at The Belize Botanic Gardens.

With this in mind, a first step is to *know the natural growing conditions (and their periodicity) of the orchid species*: Are the plants used to a dry period when they are exposed to a lot of sunlight? (Deciduous trees lose their leaves during dry periods and orchids growing in their canopy are then exposed.)

K.H. Teo, in Orchids For Tropical Gardens (1979), provides additional points for successful tropical orchid cultivation:

- Tropical orchids in the rainforest canopy often grow all year round as there are no marked seasonal changes. Some orchids exhibit *cyclic growth*, as they are from habitats that do have seasonal changes (orchids of higher elevations of the Maya Mountains and MPR fall into this category). These orchids have *active* periods of flowering, followed by *rest* periods where growth is slow to nil. Thereafter, vegetative growth resumes and the active cycle begins again. The cultural requirements (especially concerning water and temperature) of these species differ according to what phase of the growth cycle they are in. *Knowing the periodicity of an orchid's growth cycle and the concomitant cultural requirements is essential to induce flowering.*

- Light, Temperature: Not all orchids need full sun to flower. In fact, one problem with growing orchids in the [sub]tropics may be that temperatures are too high and sunlight too intense. These conditions may inhibit flowering.

- Water: Caretakers usually error on the side of overwatering their orchids. *It is always better to underwater*. Watering frequency is dependent on potting media, growth period of the plant (is it in an active or rest period?), and time of day (it is best to water in morning so that leaves can fully dry before cooler evening temperatures. It is recommended to *never* water midday, as the sun's intensity is at its

greatest and water droplets on the leaves focus this intensity even more, resulting in foliar 'sunburn'). *It is best to completely soak the potting media and make sure it thoroughly drains and dries between waterings.*

- *Careful attention to the pH of the water is necessary*, as this affects nutrient solubility and availability. Most orchids need a slightly basic pH, between 5.5 – 7.5. Rainwater is usually ideal.

- For planting terrestrial orchids, *prepared soil should reach a depth of 1 – 2'*. The soil can include garden compost (leaf litter) or humus, and *the planting hole itself should be filled in with big stones, pieces of brick*, etc, to provide sufficient aeration and drainage.

- For mounting epiphytes, a non-rotting or rusting wire must be used (plastic is often chosen). *Roots may have to be tied to a mount that offers additional water absorption* (coconut husks, tree fern roots). For establishing lithophytes, perhaps pockets in the rock are filled with such material, and orchids are mounted to this, rather than directly to the rock. *Keep in mind the direction of growth for each species*, as some grow upwards and some send out growth from the bottom.

## 6. The Belize Botanic Gardens: History; Mission Statement; Visitorship; Master Plan (2008); NOH Site Description; Goals for NOH Design

**History:**
The Belize Botanic Gardens (www.belizebotanic.org) is located in the northwestern Cayo District, nestled in the northern foothills of the Maya Mountains approximately 10 miles from San Ignacio (see Figure 6-1). The Macal River runs along the northern boundary of the site, and the Gardens sit atop the limestone bluffs flanking the River.

The land comprising The Belize Botanic Gardens was pastureland purchased by Ken duPlooy in 1989 and 1994. The Gardens unofficially began as Ken planted various trees and shrubs on the rather "blank slate" property. Ken's interest quickly blossomed into that of a passionate lay-botanist, and 45 acres was eventually registered as the non-profit Belize Botanic Gardens in 1997. The development of this property as a botanical garden was and continues to be an intense labor of love, and The Gardens remain privately owned by the duPlooy Family. Heather duPlooy and Brett Adams serve as Gardens managers and collection curators. Brett is also site foreman, information manager, and in charge of orchid propagation.

There are, at most, eight fulltime employees who help maintain and support The Gardens through a variety of tasks, from taking down large trees and installing new beds, to daily watering and leading tour groups.

Because the property was used for many years as a cow pasture, the soils are very compacted. Prior compaction is exacerbated by the fact that soils are composed of a large percentage of clay. Consequently, during the rainy season, there are often sheet flows over various areas of the property, water gouging slopes and pooling in low areas with very slow infiltration. The most immediate remedy has been to dig trenches throughout the landscape in an attempt to direct the water into appropriate areas.



*Figure 6-1*: Satellite view of San Ignacio and The Belize Botanic Gardens (*left*); 'Zoom-in' showing The Gardens' property line (*right*)

*Although the nature of the surrounding soils will not affect the landscape inside The Native Orchid House, a more in-depth water-flow/soil study should be made concerning a design of the land surrounding The House. The author was not present during the rainy season, but the hill on the southern side of The House (estimated to have a 15-20% slope), as well as the slope to the north of the house (experienced during the entry approach) will affect design recommendations made regarding building entry/egress, surrounding plantings, landform (i.e., berms, terraces), and structural recommendations (i.e. walls, stairs).

**Belize Botanic Gardens' Mission Statement**

The Gardens' mission statement is: "To protect the floral diversity of Belize by existing as the information resource for the community, government, industry and science and be a place of beauty for all visitors to enjoy." *(from website)*

The goals and work of the Gardens supports this mission: *(from website) "…we offer you beautiful plants in a beautiful place, but we're oh! so much more. Our main work is encouraging sustainable agriculture, maintaining conservation collections and engaging in conservation education. We aim to inspire our community and visitors (this could be you!) to protect our leafy friends and their habitats by learning more about the wonderful world of plants.*

**Visitor Demographic**

(information gathered from personal communication with Heather duPlooy, 8/09) The Gardens' clientele is primarily middle class visitors from the United States. The second highest demographic is Belizean school children from all over the country. Most of these visitors have come explicitly to see The Gardens in part or parcel, though some learn of The Gardens by way of being guests at the adjacent duPlooy's Jungle Lodge Hotel. The exact number/ratio of visitors was not given/known, though large school groups are reported at being divided into smaller groups of 15 – 20 students to facilitate guided tours.

**Belize Botanic Gardens' [Extant] Plant Collections/ Design of these in Master Plan (2008)**

*(from website) Our collections are all the plants you come to see and that we work with. We focus primarily on the flora of Belize but also display exotic plants from around the world's tropics. We target threatened Belizean plants as well as economically, botanically or horticulturally important species such as orchids, palms, cycads, bromeliads, passion flowers and hardwoods.*

The Gardens' aim is reported as creating "a first-class biological educational and study resource for Belizean and overseas researchers, and to conserve many of Belize's native plant species in small areas representative of their natural habitats" (Eltringham, 2001). The design component of this aim is expressed in the espousal of 'representative natural areas' to display the collections and educate the visitor.

Currently, The Gardens features several 'garden areas' of various sizes, scattered throughout the property (*see Figure 6-2*). Some are intended as Belizean habitat displays ('Rainforest'; 'Riverine Forest'), some feature specific families/genera ('Palms of Belize'; 'Heliconia Lane'), and some organize plants according to their similar uses or attributes ('Plants of the Maya'; 'Butterfly Garden') (Houston, 2008).

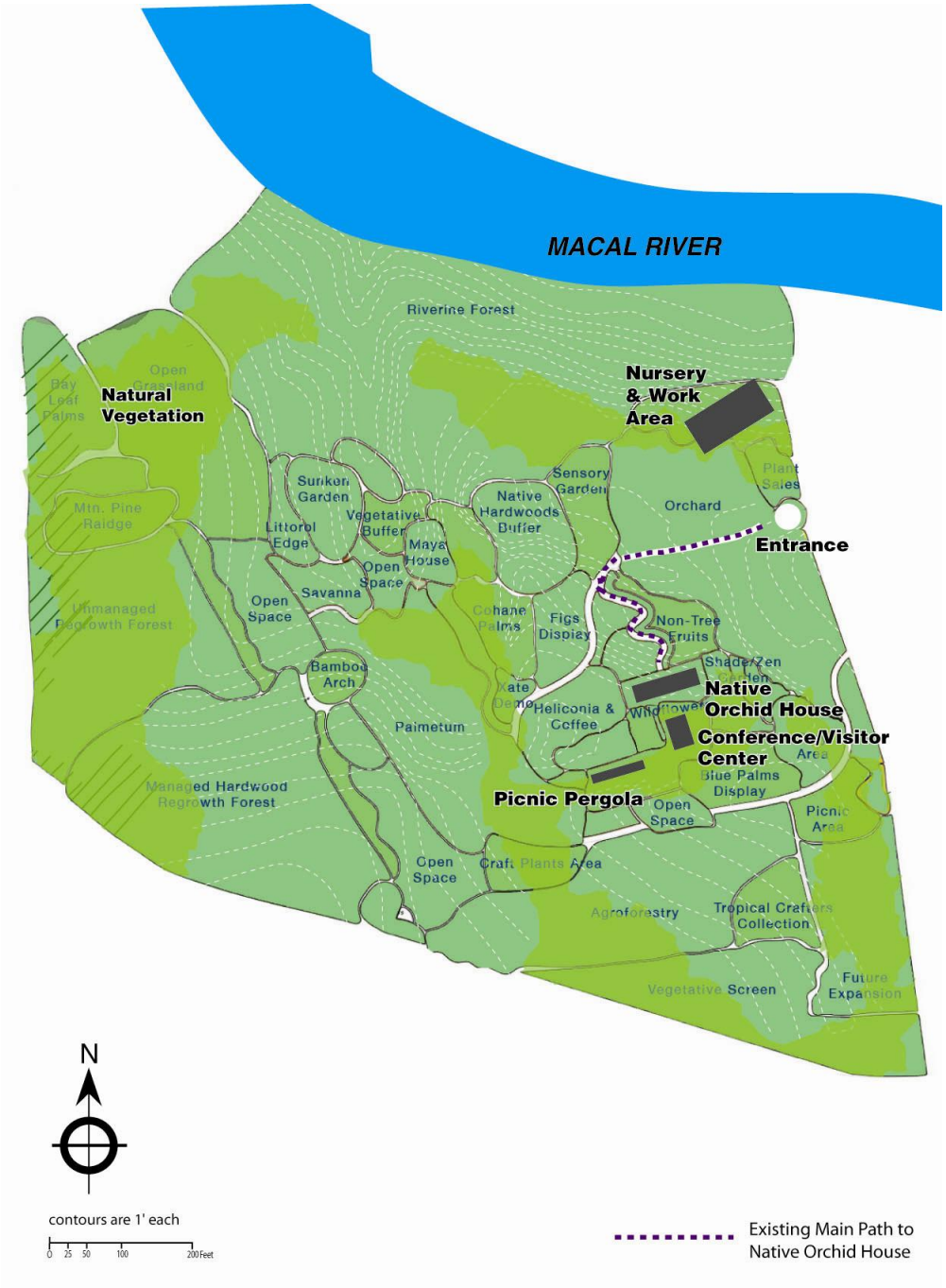


*Figure 6-2*: Map of The Belize Botanic Gardens (with proposed and existing garden areas)

# Area of Focus

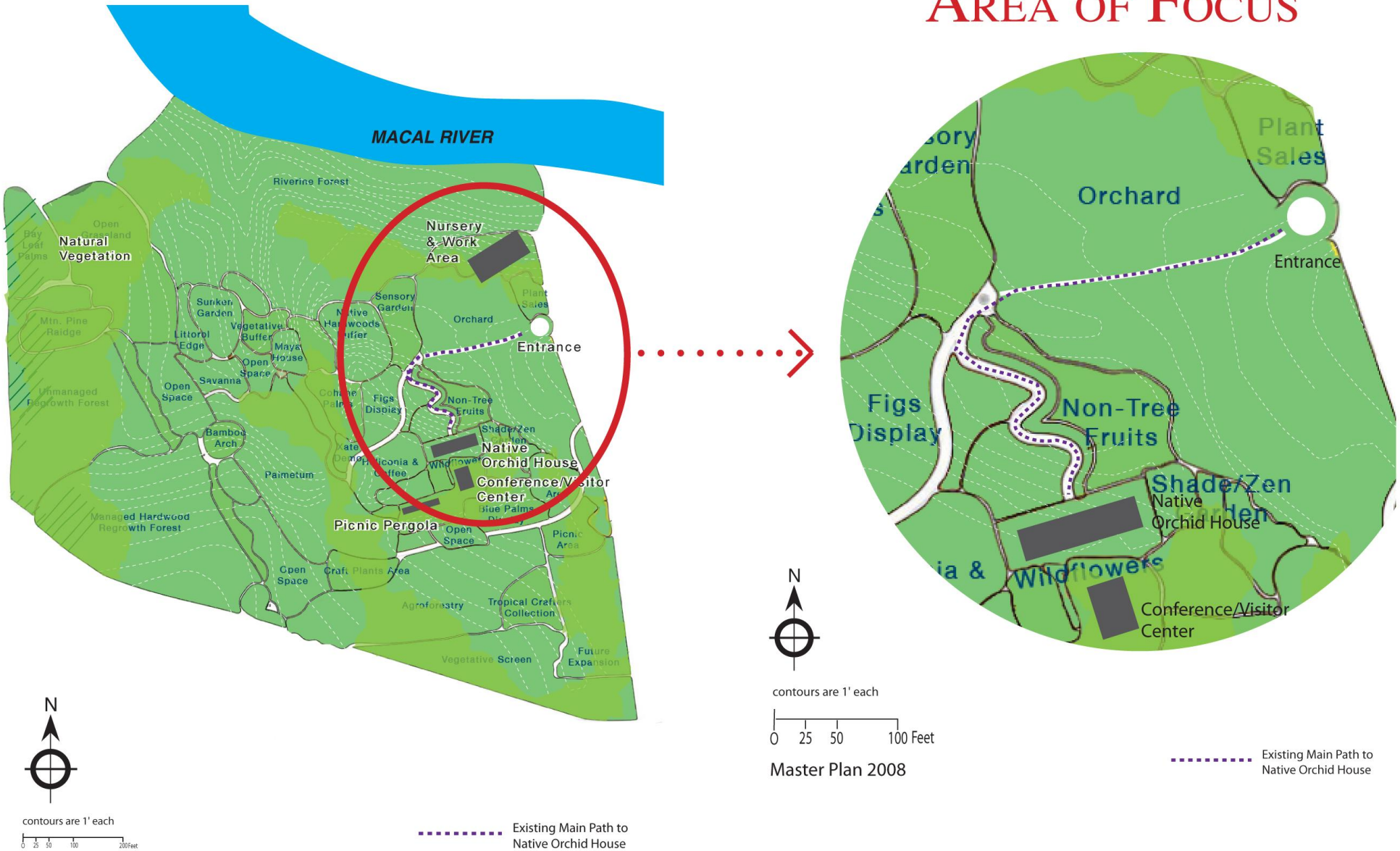


*Figure 6-3*: Project focus area (Native Orchid House location in context of entire property)

In general, habitat displays are sited in physiogeographically appropriate areas of The Gardens (i.e., the 'Mountain Pine Ridge' exhibit is located at the highest elevation of the property; the 'Riverine Forest' is located along the Macal River).

The representative habitats of The Gardens become part of an overarching narrative expressed in the Master Plan. The visitor can take a journey through the habitats of Belize -- from the 'sea' (the proposed 'Sunken Garden') to the extant 'Mountain Pine Ridge'-- experiencing the ecotones that exist between these two (Houston, 2008) (See Figure 6-2).

The Plan cites the Gardens as comprised of an "inner garden" and "outer garden". "The inner garden is focused more on showy plants and is the intended location of most of the designed displays. The outer garden is more naturalistic and contains most of the habitat displays" (Houston, 2008). The Plan proposes more garden 'areas' (habitat and other displays), each of which is assigned a 'use' insofar as it "attempts to meet BBG's [Belize Botanic Gardens'] goals and foster an ecological-conservation ethic among The Gardens' different audiences" (Houston, 2008).

The Native Orchid House (see Figures 6-3; 6-4) is mentioned in the Plan as "a beautiful showcase for BBG's [Belize Botanic Gardens'] native orchid collection, one of its most popular and important collections" (Houston, 2008). The Plan proposes a 'Shade/Zen Garden' outside the eastern end of The Native Orchid House; a 'Succulent Terrace and 'Wildflower and Scrub' area to the north; and a "Non-Tree Fruits and Shrubbery" planting to the south (in addition to the existing 'Butterfly Garden').

**Orchids at Belize Botanic Gardens and The Native Orchid House (NOH):**
*(from website) Currently our most important collection is our orchid collection. Since 1997 we have been working with Brendan Sayers of the National Botanic Gardens, Glasnevin, Ireland to collect, grow and study the orchids of Belize. So far, this collaboration has resulted in 20 orchids species added to the known orchid flora of Belize, including 1 newly described species to science.*

The extensive orchid collection is the pride and joy of The Belize Botanic Gardens. Nearly 120 orchids are grown on-site; most remain in pots in a 'hoop house' (a temporary greenhouse-- closed to public access) near The Gardens' main entrance. Belize Botanic Gardens' managers wish to share as much information about their collection as possible, and an orchid list with selected photos, soon to be accompanied by taxonomic descriptions, is on The Gardens' website.

*Figure 6-4*: The Native Orchid House; northern face (*left*) and western face (*right*)

The Native Orchid House (NOH) has sentimental value to the Gardens' managers, as it was built by Ken duPlooy (1999), its founder, who passed in 2001. Mr. duPlooy took a great personal interest in native orchids, and the eponymous *Pleurothalis duplooyi*, discovered on a joint Belize Botanic Gardens-National Botanic Gardens [Glasnevin] expedition, was named in his honor (personal communication with Heather duPlooy; 11/09).

The House is also significant as the largest structure on the property and the only one [thus far] built for housing collections. It is reported that many people visit The Belize Botanic Gardens specifically to see the orchid collection (personal communication with Brett Adams; 1/09).

**Goals of The NOH Design:** ***What is the garden's message?***
The managers of The Belize Botanic Gardens have a general idea of the narrative they wish The NOH to tell. The collection should express the idea of the *diversity of plant adaptations*: "We want our guests to leave with a sense of the vast forms and functions of plants. From there we hope they appreciate the necessity and diversity which hopefully leads to their acting to protect it" (personal communication with Heather duPlooy, 8/1/08). In particular, orchids are understood as "the queens of adaptation" (Ibid), and as such, offer a unique opportunity to engage in such a narrative.

It is reasoned that a beautiful display with an explicit message will capture the audience's attention long after their visit.

**7. Project Overview**
*"A survey was taken at Kew [Gardens] some years ago… only 16% of the people who visited were there to see the plants… They came for the garden"* (Alexander, 2009).

A display garden's value as an experiential teaching tool is invaluable. It is this primary role about which the designer should think.

To this end, a display must capture the visitors' attention. This is done by combining horticultural knowledge with artful design. The average person visits—and re-visits-- a display because it is beautiful. They enjoy the pretty flowers, the excitement of changing exhibits, a sense of something new to see or learn each visit. The average visitor does not intuitively understand or even appreciate the science behind the display or the broader ecological import of a habitat recreation. As expressed in the quote above (Alexander, 2009), people come to a botanical garden for the *experience* rather than for unalloyed 'nature' or botanical science. This experience is all about intentional, artistic design-- orderly, explicit presentation. It is about a presentation that is simpatico, in part or whole, with a culturally accepted aesthetic.
*This aesthetic is not derivative of garden type (i.e. 'conservation garden'), nor should it be.*

If a "naturalistic" ecosystem based form is chosen (as was done for a section of The NOH), *it is chosen as a creative response to the mission statement, extant site aesthetic, and project goals—not as a conditional response to an institution labeled a "conservation garden".* Such an aesthetic is not the only way to teach the lesson of conservation, nor may it be appropriate for The NOH or inner garden collections. The Belize Botanic

Gardens is in such a location that if a visitor goes almost *anywhere* within The Cayo District, they can see this naturalistic aesthetic and learn such conservation lessons. That is, the aesthetic of The Belize Botanic Gardens is not unique, and looks basically like every other landscape seen anywhere in the interior of the country—with the exception of some explanatory signage. Importantly, too, is the fact that visitors to the Gardens are often middle-upper class tourist from the United States or Europe, and that if these tourists have made it all the way to The Gardens—they are seeking exploration through travel, are highly mobile, financially able, and are likely visiting many of the surrounding natural sites. How does the Gardens' naturalistic aesthetic distinguish it from the plethora of surrounding conservation sites/forests/parks? By offering a *garden* experience ("garden" implying a *planned, cultivated* space).

The Belize Botanic Gardens has many aesthetic options with which to promote their mission and offer this experience. The design for The NOH is one option and does not purport that it *should be* the face of conservation.

The Master Plan (Houston, 2008) prescribes a naturalistic aesthetic, claiming that conservation gardens *should* support such a design type by organizing collections on an ecosystem level, preserving as much "natural" vegetation as possible and creating naturalistic vegetation 'linkages', or 'corridors' where they are absent. This is not specific to "conservation botanic gardens', but, as Mr. Houston mentions, is one aesthetic that may "enhance the conservation efforts of botanic gardens." Perhaps the aesthetic of native plant displays is more formal and traditional, showcasing how they "can be used in commercial, residential, and public landscapes to replace more traditional exotics" (Kumble and Houston, 2008). Such an aesthetic may be especially apropos for displays in the 'core'/'inner' area of a garden (this is usually found adjacent to extant buildings) (Houston, 2008). Indeed, a recent study in the *BG Journal* emphasizes that it is important to "[complement] more naturalistic landscape exhibits with innovative plant displays and interpretation techniques to enhance the experience of the general public" (Villagra-Islas, 2009).

More specifically, the small scale and insular nature of The NOH, its unique quality of being the only structure housing plant collections as well as the largest enclosed structure on the Belize Botanic Gardens property, and its singular role as showcase of The Gardens' orchid collection, encourages the designer to 'do something different' inside this space, distinguishing it from other naturalistic settings at The Gardens.

The author agrees that the naturalistic aesthetic espoused by the Master Plan is concomitant with broader, 'green infrastructure' planning and may serve as a conservation teaching tool. But the author disagrees with Mr. Houston's claim that this design form *should* follow from the label 'conservation' or 'native plant' garden. This is supported by academic research and personal experience.

Most importantly, the design goal of the project is to create a satisfying—and better yet—enchanting—visitor experience, where one can learn about orchids, experience their dazzling diversity up close (as is not often possible in the wild), understand the importance of orchid conservation, and the Belize Botanic Gardens' role in this effort.

*What this design is **not**:*

- This design is *not* a comprehensive investigation into broader [regional] ecological or socio-cultural factors of the site**.**

  The Master Plan (Houston, 2008) adopts the language of McHarg's Design With Nature and Forman's Landscape Ecology. Its parlance is that of the green infrastructure movement – a proactive, multi-faceted, multi-disciplined, holistic approach to land planning inspired by the seminal studies and passions of McHarg, Forman, [Aldo] Leopold, [Rachel] Carson, and many others. The importance of these is appreciated and supported by the author, and de facto, by the very existence of The Belize Botanic Gardens. Forman rightly suggests that "the ecosystem concept…may be applied at any level of spatial scale, from the size of a rabbit dropping, say, to the planet" (Forman, 1986). In all practicality, though, the scale and purpose of this design obviates a landscape-ecological planning approach. The project presents a human-controlled, insular microcosm. The fine scale ecological processes that may occur (such as cross fertilization between species) are a far secondary consideration to its value as a beautiful, educational display.

- This project is *not* an investigation into the significant financial or labor challenges that the location and administration of The Gardens present. The author realizes that these challenges greatly contribute to the extant site conditions and affect implementation of the proposed design.

**Project Description**

As stated earlier, this project focuses on the re-design of the Native Orchid House at The Belize Botanical Gardens. Native orchid propagation and research are very important to this institution. Its mission statement, goals, and the personal passions of the managers, support the development of an exceptionally thoughtful and horticulturally appropriate orchid collection design. *This design is, in essence, a detailed concept plan for The Native Orchid House.*

First and foremost, this design addresses the horticultural requirements of the orchid collection. Secondly, the design creates an aesthetically and functionally appropriate sense of place. It achieves this through a thoughtful response to the Gardens' mission statement, goals, Master Plan (2008), visitor demographic, and site conditions. Further, the design is concerned with the individual *human* scale, and the presentation of a habitat at this scale. It is about the *creation*, in small part, of the dominant visual elements of a habitat.

Multi-faceted site planning and "place making" techniques detailed in Lynch and Hack's touchstone Site Planning, and re-iterated by many others, were reviewed to assist with this work. Positive spatial-psychic elements illuminated by research (in particular, of Kaplan and Kaplan) were explored, as they are found—at least in part—in all 'successful' places.

**Design Goals:**

- To provide refuge for many members of The Belize Botanic Gardens' orchid collection and native plants
- To provide recommendations, and where appropriate, solutions, to the physical and structural shortcomings of the existing NOH structure
- To create a landscape 'experience' that is beautiful, dynamic, and educational, engaging the visitor in a story of "adaptation" and "diversity"
- Such an experience will encourage the exchange of information, further research, or financial contributions. In these ways, The NOH will support the mission of the Belize Botanic Gardens and contribute to long term conservation goals.

➢ Though the design does not explicitly focus on sustainable practices and the use of local materials, it is flexible enough to incorporate and showcase such a message in part or whole. The key idea is that the message of 'sustainability' can be delivered in various ways-- at the very least, through eye-catching signage. Local materials and simple, inexpensive conservation practices, some already in use at the Gardens or suggested in the Master Plan, are part and parcel of all following design recommendations.

➢ It should be mentioned that extant technology, from solar panels to cutting edge irrigation/misting systems, can confer a great measure of sustainability. A detailed cost analysis and survey of extant technology is in order, but not within the scope of this project.

<u>Broader Issues: Why is a re-design necessary?</u>
A re-design is necessary because, first and foremost, the space does not provide optimal growing conditions for the orchid collection. It is too shady inside the House for many of the orchids (personal communication with Brett Adams; 1/09), and there is not enough humidity. This is not only, perhaps, due to the structure itself, but also to the interior layout. A ~10' high lime/river stone wall partitions the space and creates afternoon shade in the eastern portion of the House.

The structure itself is superficially problematic by way of the numerous 3" pine slats that circumscribe the building. These slats are completely stationary and cannot be adjusted in varying degrees (they can only be left as is or removed completely). They also run in an east – west direction (as mentioned in *Section 5*), creating areas of constant shadow within The House. Re-aligning these slats, removing portions of them, or making them adjustable, is a necessary—and feasible-- task.

A complete re-design or re-siting of the building to address these problems will not be considered, as funding is limited (and major structural changes are assumed to be especially costly); materials, skilled labor, and the ability to incorporate the latest technology are limited (i.e., thoughts about mechanical lateral slats/roof that open and close automatically depending on incident light; use of steel/ plastics in new construction); and the author's knowledge of architectural construction—especially in a tropical climate—is limited.

Attempts to modify the light conditions have involved (1) permanently removing some of the stationary wooden slats on the side of the building, thereby letting in more light and (2)

cutting back/removing all trees over 5-6' in height within the building, as these trees have shaded out other species. As well, several mid-sized trees outside of the House (especially on the eastern side) have contributed to shady conditions and should be removed.

Secondly, a re-design is necessary because the space does not aesthetically reflect the seriousness and dedication (infused in the mission statement and goals) with which the institution seeks to study and display native plants—especially native orchids. The excitement and dedication with which The Gardens' NOH and orchid collection is presented on their website belied the disappointing in-person experience. As well, discussions with the managers proved their goals for the space unrealized. They envision The NOH as the aesthetic centerpiece of The Gardens—the visual symbol that visitors associate with their Gardens experience.

In addition, the uniqueness of The NOH and its location warrant an especially high priority and thoughtful re-design. The House stands apart from the rest of the Garden by its very nature of being a structure--the only structure used for indoor display as well as the one with the largest footprint. It is visually prominent as *the* key feature of the "inner" (core) garden area.

As it stands now, its potential as a cynosure is severely restricted by fundamental problems with the structure itself, a poorly orchestrated [entrance] approach, non-descript, poorly delineated spaces inside the building, and little to no directional and informational signage (see below).

**Details: Site visit**
**Constraints and Opportunities**

A week-long site visit was made in January 2009. The purpose of the visit was to meet the managers and get a sense of the 'spirit of the place'. The site was documented through measurements, sketches, written notes and photos.

The Gardens offers the designer many challenges: most notably, those of remote location, limited funding, and limited labor (especially skilled labor). These constraints are not addressed in this project.

They also offer many opportunities: The climate offers a year round growing season, and species grow with a bounty and speed unknown in temperate climates, attaining mature heights in a matter of years. Such growth means constant plant maintenance, but it also affords great opportunities, especially for 'instantly gratifying' living displays. The diversity of species in such a climate is tremendous—a gardener and botanist's dream. Though a number of indigenous species are threatened, the Gardens' location in close proximity these species' provenances instills it with great potential for effective ex-situ and in-situ conservation projects that have local and global impacts.

The Gardens' impressive extant orchid collection and collection/propagation programs provide a strong core for this project. As well, the advantages that the passion and dedication of managers and staff confer cannot be underestimated.

Site conditions and specific constraints and opportunities are detailed below.

<u>The Arrival Experience:</u>

*The NOH is a key feature of the "inner garden", and sits on a plateau created in a hillside. The land slopes towards The House on its south side, and away from The House on its east, west, and north sides.*

*(All letters in bold refer to Figure 7-1)* The visitor enters The Gardens proper through a small 'arbor-like' structure, arriving at the Main Entrance [Circle] **(1).** The visitor proceeds west along the main pathway (6+ feet wide), a compacted dirt road [created by the 4-wheel maintenance vehicles] **(2).** This pathway soon encounters two secondary pathways: one leads to the Pond Area; the other, to the Butterfly Garden and The Native Orchid House **(3).** There is a small sign post at the juncture of the main path and that leading to The NOH, signaling the direction of The NOH with a Mayan glyph. There were no other signs observed at any point along the path.

The path to The NOH is a diminutive (~4.0' wide) mulched path that is flanked by the newly installed "Butterfly Garden" **(4).** This garden includes herbaceous plants, native and non-native, that are known to attract such pollinators. This path is highly reticulated, winding its way up a gentle slope with scattered trees. These turns somewhat mitigate the slope, but do not seem to have any other intent. Most striking is the sudden, *looming* presence of The NOH, which appears unexpectedly--in full view—from the pathway **(5)**. Its 2+ storey height and block form reads heavier and severe. This is emphasized through circumscription by innumerable wooden slats and latticework.

Also, the visitor approaches this massive rectangle from down-slope and square in the middle of its long (85') side. Because of its scale and uniformly closely spaced slats, the structure almost reads as solid mass, rather than a light and airy lath structure. These aspects make for an abrupt and intimidating approach experience, akin to an apparition materializing in an unexpected clearing-in-the-woods.

In addition to the above, one soon observes the greatest issue with the approach path: it does not actually lead to The NOH entrance. Nor does it connect with the exit. The path abruptly ends about 16' from the building, depositing the visitor in a lawn area that flanks the building's north side **(5)**. The visitor is now almost up against the long, tall, structure. There is a small sign post against the building verifying that this is, in fact, The NOH. Being so close to such a mass with no entry in sight is uncomfortable, though a bench placed against the building offers a pleasant view of adjacent hills (to the west) back towards the approach path (north) (See Figure 7-2). In order to reach the entry on the western side of the building, the visitor is forced to sidle along its north side and round a corner, then turn 90 degrees again to finally enter **(6)**.

The seemingly random grouping of small trees, spaced far enough apart to yield an 'open', scattered feeling rather than a 'hide-and-reveal' experience, followed abruptly by a very foreshortened grassed foreground, does not 'prepare' the visitor for the sudden appearance of the building.

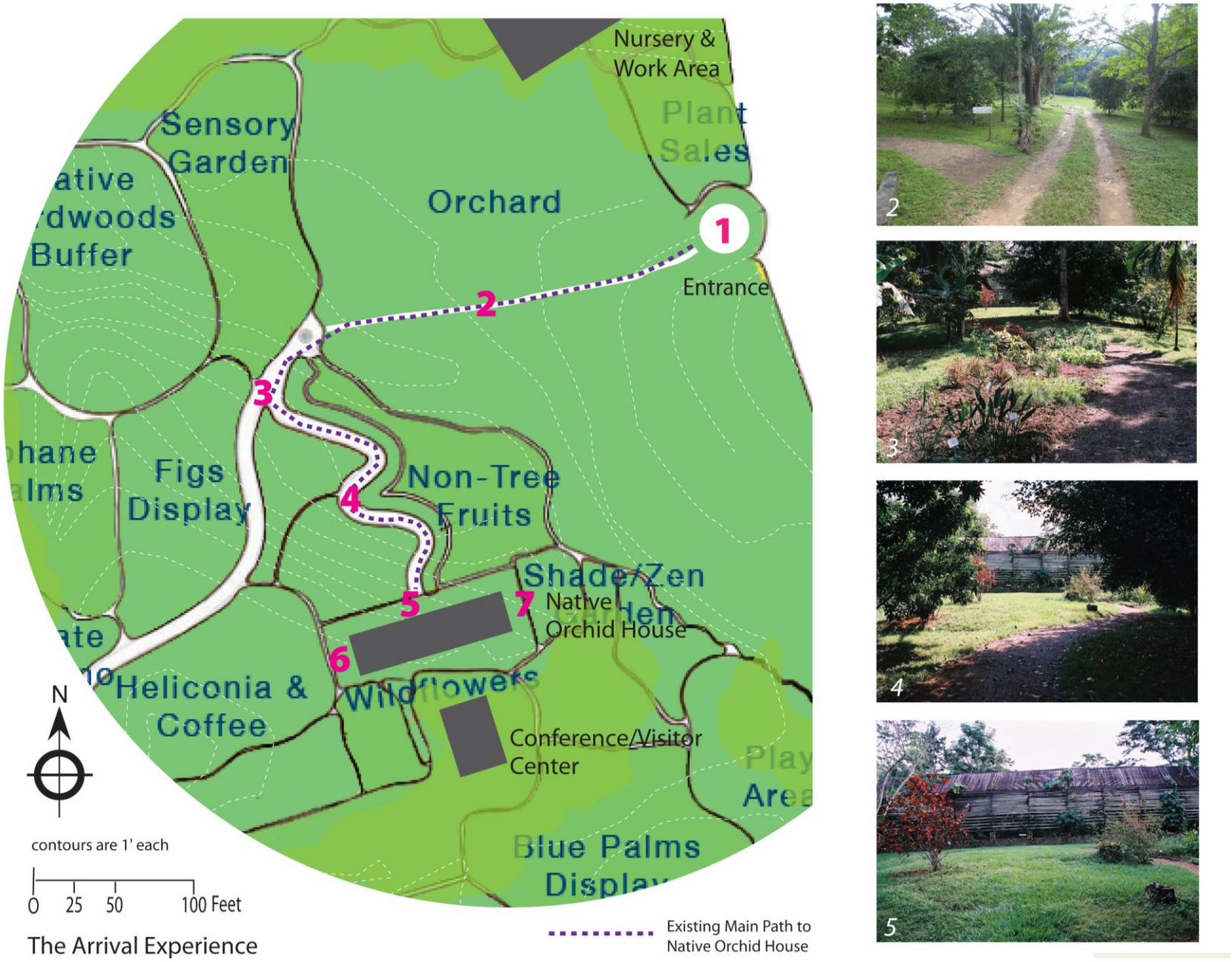


*Figure 7-1*: The "arrival experience" (approach to The Native Orchid House)

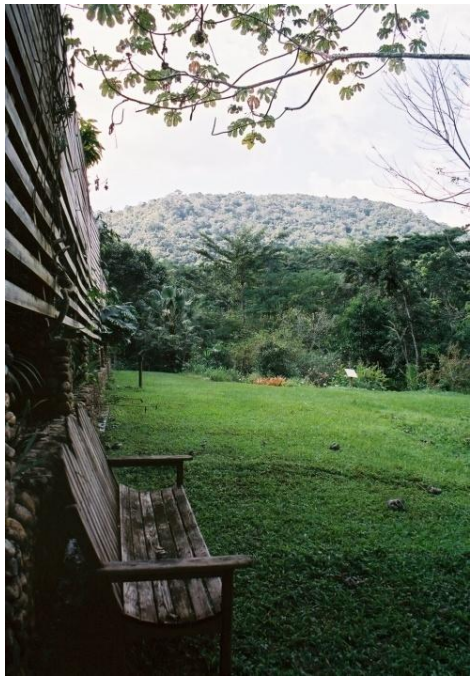

*Figure 7-2*: Views from the north face of The House; looking west (*left*) and north (*right*)

*Figure 7-3*: Steep slope on south side (Conference/Visitor Center on right)

*Figure 7-4*: Detail of structure (north face)

The awkwardness of the approach is exacerbated by the proportions and style of the building, which in this context can read as massive and overwhelming rather than blending-with-the-landscape and inviting. Once The NOH entrance is finally located, one may notice a small sign above the doorway labeled "Native Orchid House". Even still, there is no sense of arrival via signage or design (e.g., a 'gateway').

On the south side of the Native Orchid House, there is a grassy slope, estimated to be 15-20% (See Figure 7-3). Despite the steepness, erosion problems were not observed.

Existing Building:

The current structure is basically a lath house built of pressure treated pine that measures ~ 25' wide by 85' long by 22' tall. A ~2.5' high x 1.5' wide riverstone wall bounds the building on all sides (See Figures 6-4; 7-4). The wooden framework connects to this wall; ~3" wide stationary pine slats running east to west circumscribe the framework. In addition, wood lattice covers portions of the shorter ends. Slats running north to south cover the mansard roof, which rises to ~22'. There are some solar panels installed atop the roof; these provided electricity for the pump associated with the water feature.

There is no concrete floor under the planting beds. The only exterior element that has a below-grade component is the riverstone wall.

*Opportunities*

- The structure provides an "orderly frame" for any display
- It provides a degree of protection from the elements
- Physical elements (wooden slats) can be modified without any damage to the structure

The "Exterior Site Analysis" on the following page (Figure 7-5) is a visual summary of these existing conditions.

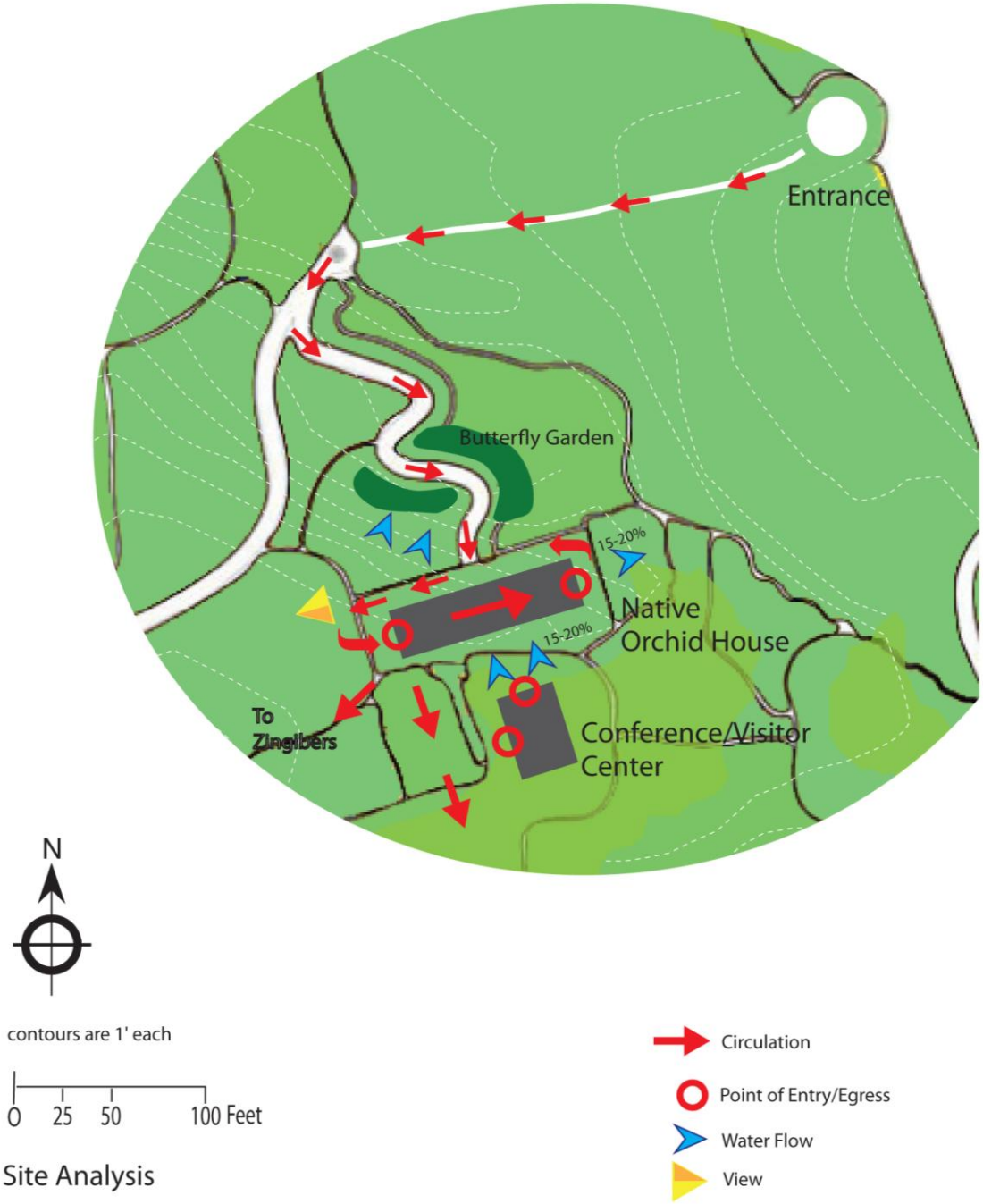


*Figure 7-5*: Exterior site analysis

Inside The NOH: Circulation and Existing Grades
*(Letters in bold refer to Section A in Figure 7-6)*

As a foundation of spatial delineation, the circulation pattern represents a key element of any design. A discussion of the current circulation and the issues it presents is therefore in order.

*The pathway is linear, running through the center of The NOH from entrance to exit…*
The visitor enters The House through a doorway on the western face. There is no 'foyer' or sense of arrival at the entry point; instead, the visitor immediately proceeds on a somewhat "S-shaped" gravel pathway (~5' wide) that proves fairly noisy (**A**). Small logs border it on both sides. The pathway soon leads to 2 informal steps, created by angular river rocks placed upright (**B**). These steps have a 4" rise and lead to a Japanese-styled arch bridge (+4"). The bridge arches over a water feature (**C**); at the peak of the arch the visitor is raised another 4".
After walking the bridge, there is a 4" drop onto a [cemented] river-cobble step **(D**), and one comes face to face with the interior wall. After another 4" drop, the visitor proceeds through an archway cut into in the wall (~6.5-7' tall) onto a landing directly under the archway (this landing has a small floor drain) (**E**). There follows a step (4" rise) (**F**), then onto a cemented-cobble walkway (4" rise) (**G**) that runs the length of the shorter (eastern) end of The House. The walkway is punctuated by a small central tree pit.

*All said and done, there is a 12" elevation change over 21' within The House*. Right before exiting, one descends another 2 steps (12") **(H**), bringing the change in elevation from entrance to exit to zero. The reasons for this (9 changes in level-- including 6 steps, a landing, and an arched bridge), are not clear at all, from a functional or formal point of view. Not long before my visit, there was a raised (~1.5') wooden boardwalk running the length of the House from the entry to the wall. (The boardwalk was removed to bring the visitor "closer to the orchids" (personal communication with email Heather duPlooy; 10/22/09.) This raised pathway explains some of the incongruities in [level of] the current ground plane. The existing bridge was level with the end of the boardwalk, so this, at least, explains the need to install 2 approach-steps after its removal.

The apparent reasons for the steps hardly warrant their existence, namely: the placement of the bridge, and an archway that is not tall enough to serve its task without the visitor being forced to descend several inches. The interruptions they demand of the observer's stroll makes one consider their swift removal.

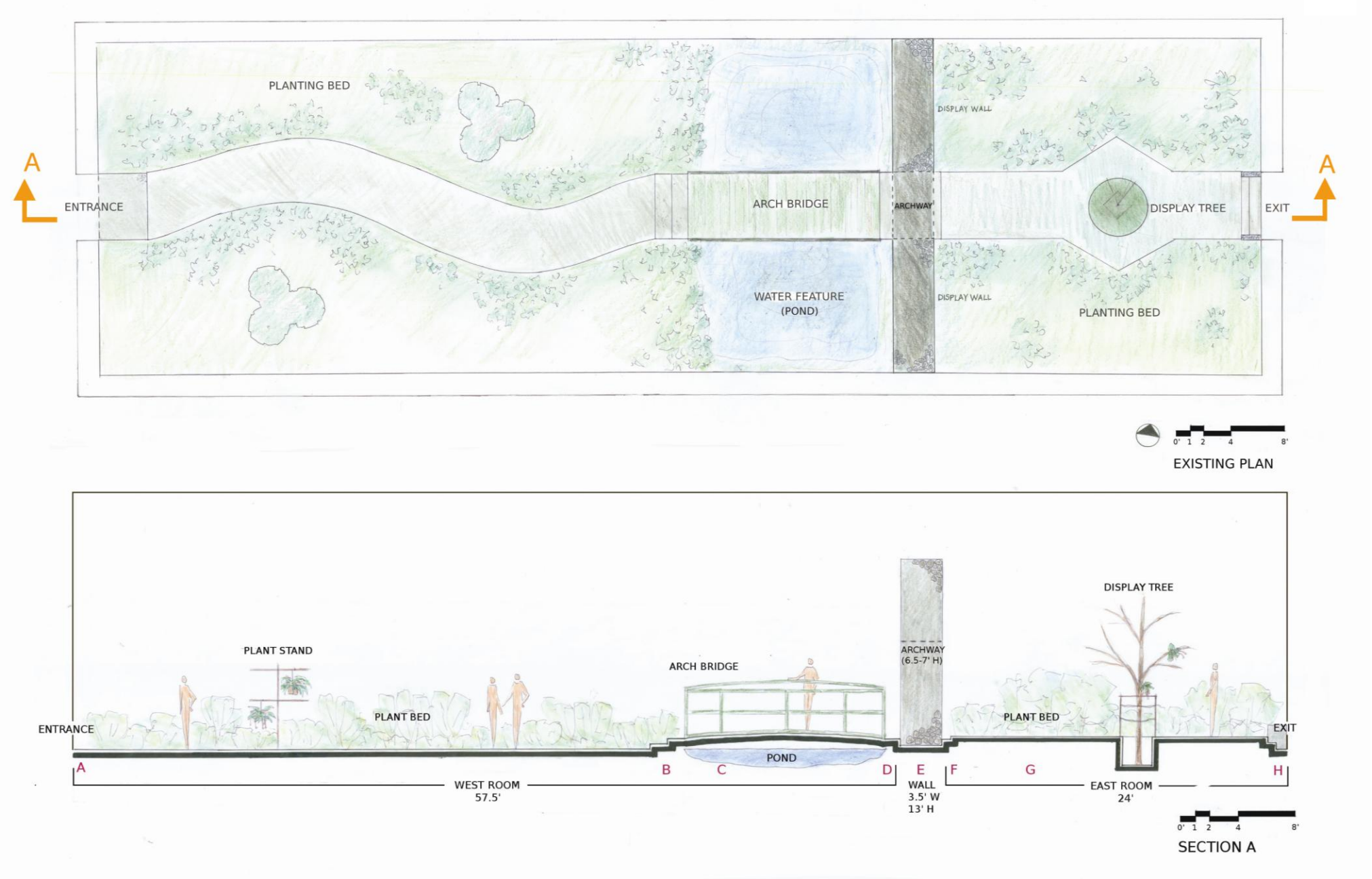


*Figure 7-6:* Plan and Section (A) of existing NOH interior

Rooms of The NOH

A ~13' tall x 3.5' wide high interior wall partitions the space into two rooms, one larger [west side] and one smaller [east side] (See Figures 7-7 and 7-8). The West Room is approximately twice the size of the East. There is little differentiation between the two rooms in terms of design, save for size and pathway media. The planting palette seems the same throughout. The rooms offer different light conditions, as there are outside trees shading the eastern room. This room also experiences the afternoon shadow of the interior wall. The extent and duration of the wall's shadow was not studied in detail, nor was its role in creating potential microclimates [associated with differences in temperature/ humidity related to levels of incident light]. It was inferred from on-site observations that the east and west rooms present the same general climactic conditions.

Exiting The House

After exiting, the visitor finds themselves on a narrow (~8') strip of grass **(7)** (See Figure 7-1), and must turn the corner to view the approach path. The visitor must return to the approach path or double back through The House to continue their journey, for there are no connecting pathways at the exit point.

The water feature (interior wall)

The large water feature in the House—a 13'tall x 25' long x 3.5' wide cemented river-limestone wall (perforated with a small archway, 5' wide x 6.5-7' high) to allow visitors pass-through) flanked by a 13'wide x 25'long pond (cemented bottom with recirculation pump) – is not in service. The intention was for water from the pond to be carried by black, plastic tubing to the top of the wall, where it would cascade from perforations [in the pipe] over the wall, quenching plants rooted in its crevices. It is reported that most of the water ends up in the pond and is then pumped back up the wall again. At its best, it is a closed-circuit watering system that creates a lush "living wall". As of January 2009, several cracks and holes in the southern half of the wall prevent the cascade effect, causing most of the water to be absorbed by the wall itself. The northern side of the wall was fixed for the very same problems some time ago, and though successful, the job was labor and time consuming.

Because the water feature is non-operational, the pond remains stagnant. Algae growth was observed on the surface.

*Constraints*

- Because of the above, the wall remains a gray, static, looming, feature that appears a design afterthought, commanding a superficial though discomfited contemplation (or, if inclined to romantic affectation, a grotto-esque melancholic brooding) without defining any sense of space.
- The archway height does not feel comfortable (too low at 6.5-7' high)

*Opportunities:*

- The wall partitions the space into two distinct rooms; the east room is of a small, intimate scale
- The archway offers a sense of mystery and formality
- The wall can serve as an impressive vertical display (if repairs are made and plants are provided consistent water)

*Figure 7-7:* WEST ROOM; *(left)* Bird's eye view looking west [entrance doorway, gravel pathway, arch bridge, and pond are visible]; (*right*) Eye-level view looking east [informal steps, arch bridge, and wall are visible)

*Figure 7-8:* EAST ROOM; *(left)* Bird's eye view looking east [cemented cobble walkway; central tree pit, and exit doorway are visible]; *(right)* Eye-level view looking west [exit steps; tree pit, and wall are visible]

Water access

Water for The House is pumped up from the Macal River and collected in an adjacent well. This water is unfiltered and not treated with any chemicals (personal communication with Heather duPlooy; 10/4/09).

The plants in The House are usually hand-watered from hoses (Ibid). The eastern side of The House has four waist high plastic pipes (~2" D) fastened to the structure's wood beams. On top of these are sprinkler heads; their dispersal range covers the entire section.

There are 'misters' (black pipes with misting heads) attached to the ceiling, but these are no longer used as they become clogged from calcium [and other deposits] that the water collects from the well (Ibid).

There is a raised spigot near the entryway at the western end of the house, a couple more positioned in the planting beds, and at least one outside of the house. It is reported that the number of extant spigots provides enough water access, though as said, these only work for the hand-held garden hose watering method.

Soil Conditions

The soil inside the house is too dense (as well as being nutrient poor) for growing orchids. Brett Adams reports it is too "clayey", and it is the resulting density, perhaps more so than the lack of nutrients, that prohibits their flourishing. 4" of a lighter, soil mix has been spread over the extant soil in the eastern end of The House. This mix was made on site. Because it is costly to buy growing media from outside sources, it is helpful if material added to replace or amend the existing can be made on site from readily available sources.

Plant Display

The House presents only a handful of the 120 native species grown at the Garden (personal communication with Brett Adams; 1/09), though this was hard to verify as the author often could not tell which plants were orchids and which were not. Only one plant was verified as being an orchid, as it was the sole bloom seen during the site visit. There were no informational signs, though the one orchid had a pink plastic ID/accession tag. ID tags were not observed on any other plants.

Most of the plants were planted directly into the beds. In the western room, there was one plant stand (similar in appearance to a coat stand) on which potted orchids were displayed. In the eastern room, a potted orchid hung from the branch of a small tree in the walkway tree-pit.

The overriding impression was that *there was no sense of order—formal or functional—underlying the display*. Plants were not arranged according to flowering period, economic/cultural value, provenance, etc. *The lack of a narrative (take-home message)-- at any scale—was a key contributor to the space's effeteness* .

**Summary of existing conditions to be addressed in re-design:**

- Steep slope (15-20%) to Conference/Visitor Center
- Slope on eastern side of house
- Lack of destination, visual cues, wayfinding / informational signage outside and inside the House ("why would I want to go there?"/ "What is that plant?")

- House dominates the landscape during the approach because there is not enough enough "foreground"
- House does not let in enough light; light levels are not adjustable
- Mineral-laden water clogs sprinkler heads
- Singular method of watering-- by hand (garden hose)—is labor intensive and time consuming for staff
- Pathway to The House does not clearly lead to entrance (west end); no sense of arrival once building is reached
- Not enough space to comfortably walk around house from extant approach path to entrance
- Exit from The House (east end) does not connect to existing circulation system
- Steep, bare slope on north side: access up hill is poor; erosion is potential concern
- Interior display has no narrative/ message
- Display plants are not labeled
- Interior water feature is dysfunctional
- Archway of interior wall is too low
- Interior spatial delineation (including circulation pattern) needs to be more effective
- Display methods/materials are not appropriate for or effective in delivering the intended 'take home' message

**Client's suggestions:**
The framework of any design at a public institution is, in part, embedded in the institution's Master Plan, mission statement, and goals. It is assumed that the managers at such an institution bring an expertise and intimate knowledge of the site, and that their ideas support those expressed in the mission and goals. Therefore, as manager and NOH curator, Brett Adams' suggestions for the site (personal communication; 1/19/09) were considered with much seriousness. These include:

- Remove all vegetation within the House over 5-6' to allow more light in
- Orchids can be displayed in pots on tables or benches. Orchids in pots are easily rotated into the House (for display) from the propagation area.
- Common species can be grown directly in the House; less common can be grown in the propagation area and rotated into display as appropriate
- Some terrestrial orchids can be grown directly in beds
- The two rooms of The House can represent two distinct climates (with associated orchid species)
- Beds can be given elevation through mounding or raised structures; Pots/platforms/stands of different heights can be grouped to create repetitive variations in height
- Foliage planting should be sparse[r] so as not to detract from orchid display

**Detailed Design Recommendations:**
*The design recommendations that follow attempt to address the design goals and meliorate problematic existing conditions (delineated above). These recommendations can be implemented in phases, in part or parcel, as time, labor availability, funding, and professional discretion allows.*

NOH Approach/ Entry (western end of House)
(See Figure 7-9)

- A wider, more "formal" entry from the northwest (as delineated after walking the property) is introduced as main entry to NOH. Current path is retained as a 'secondary trail'.
- Wayfinding signage is installed
- Existing "Butterfly Garden" is relocated on hillside between The NOH and Conference/Visitor Center
- Front of NOH is planted, in an informal "organic" manner (like rest of property), as a broadleaf ecotone—transitional from the extant Pond Area to the Savanna (adjacent to Conference Center). This area is introduced as an "Intermediate Rainforest" and corresponding signage is installed. The forest planting counteracts the "looming" presence of the NOH, and serves as an appropriate part of the ecological narrative the Master Plan proposes.
- The above allows The NOH to read as more part of the surrounding landscape—a 'natural' clearing-in-the-woods—rather than an abrupt and overwhelming manmade presence.
- The lawn area adjacent to the northern face of the building is a "sitting area"

NOH Exit (eastern end of House)
(See Figure 7-9)

- Trees are cleared outside the eastern end to allow more light into House and into [exterior] proposed garden space
- Ground level outside eastern end is contoured to match finished grade of [interior] exit pathway, eliminating extant steps.
- The exit connects The House with proposed garden space (the "Terraced Garden") and the Conference/Visitor Center.

C) Hillside between NOH and Conference/Visitor Center
(See Figure 7-9)

- More formal pathway is introduced leading to The Conference/Visitors' Center. An artful sign or sculpture is placed at the peak of the hill. This serves as a wayfinding 'gateway' that can be seen from The NOH entrance.
- The "Butterfly/Birds/Bees" Garden flanks the path and defines the main entrance to The Center
- A stone wall (~3 – 4' in height; made of local material) is introduced between the Center and the NOH, mitigating the steep slope and providing space for a pathway between the Center and the Terraced Garden. The area between the wall and the NOH may be planted with a suitable groundcover.

Top of Hill, South of Conference/Visitor Center
(See Figure 7-9)

- Savanna exhibit is introduced adjacent to The Conference/Visitor Center; this area is suitable, horticulturally and thematically, to such a display


*Figure 7-9*: Exterior design recommendations

NOH Building

- A thatched 'pergola' is introduced to define the entrance, creating a distinct arrival experience; the thatched roof is also used to display plants (See Figure 7-12)
- Building sides are perforated with larger windows (below roofline) to allow more light in, offer views from inside, and alleviate its massive-seeming proportions
- Side slats are arranged in a *north-south* direction; in addition, slats may be removed or added to create varied light conditions
- Additional ceiling trusses/ wood members may have to be installed to accommodate the shade/misters recommended below.
- An interior adjustable (motorized) shade is installed along ceiling trusses
- A misting system, including lines (perforated ½" PVC piping), nozzles, and filters is installed on ceiling trusses. Free-standing misters as well as misting fans may also be used
- Ceiling and wall-mounted circulation [and/or misting] fans are installed
- An auxiliary filtration system and/or a new well may have to be installed depending on the amount of mineral deposits in the well water.

West Room: Habitat Display (See Figures 7-10; 7-12 through 7-16)

*A habitat display—in small part -- is presented in the west room. Some of the salient physical features") found in the Mountain Pine Ridge and surrounding Maya Mountains are interpreted (notably a "Rock Outcrop" and "Epiphyte Display Tree). Vegetation is primarily herbaceous material under 5-6' in height. Species presented may be endemic to the multiple ecotones of The Reserve, Maya Mountains, or other suitable habitats.*

*This display concept is flexible in form and meant to serve as a starting point for organization and interpretation of The Gardens' orchid collection.*

A habitat display is chosen because:

- It is compatible with the extant and recommended (Master Plan) aesthetic at The Belize Botanic Gardens.
- Habitat display can impart lessons of 'form follows function', or "diversity and adaptation" in a holistic manner
- Habitat display is sensually immersive, and can therefore inspire an intimate, heuristic experience

*The Mountain Pine Ridge (and Maya Mountain) habitat is emphasized. This is because:*

- The MPR is rich in orchid and [other] endemic plant species; it is a unique habitat in the country and Central America; it is of national conservation concern. *These aspects render the plants of The MPR a priority for ex situ conservation (BGCI Agenda, 2000 )*
- The MPR is a popular destination of eco-tourists, and may therefore capture the interest of a large portion of visitors
- The MRP features multiple ecotones and therefore allows for a broad plant palette
- The recommended display is flexible enough in aesthetic to not only present orchids of The MRP, but those of other habitats

- *The display will feature exciting, multi-sensory elements, including:*
- A vertical element (layering) is introduced with large display tree and a raised walkway, offering PROSPECT ["walkways have been built in several jungle areas and give completely new insight into a world previously viewed only from below…" (Ayensu, 1980)]. In re-creating the layers of orchid habitats of a singular subtropical tree, the canopy and understorey (mid-trunk, lower trunk, and ground level) can be considered in terms of the interrelationships of ecology and aesthetic.
- A naturalistic water feature
- Exciting signage that introduces the themes of diversity, adaptation, and conservation (this is key to successful interpretation).

*The design creates a beautiful experience that is also highly functional by introducing:*

- A more formal (distinct) entry and primary 'node' echoes the Gardens' Main Entrance [Circle]; it complements the naturalistic form of the display, and creates a distinctive 'foyer'. Both areas are large enough for visitors to pause and look around (without interrupting the flow of traffic) before proceeding.
- No vegetation (with the exception of the artificial "Epiphyte Display Tree") is more than 5-6' tall
- Pathway is essentially level (<2% slope) for entire length, and no longer bi-sects the room. This creates a larger area for the display and an uninterrupted viewshed. The path is wide enough (up to 7') to allow groups to gather and read signs without interrupting the flow of traffic. The organic form of the path is part and parcel of the larger design, and creates a sense of mystery (as the end point of the journey cannot be observed from earlier points).
- Path material is stone dust or *Stabilizer*® (offered by Stabilizer Solutions Inc).
- A bench can be placed along the south wall, creating a sitting-viewing area

<u>Interior wall</u>

- Left intact and repaired as necessary; incorporated into larger design as 'substrate' for foliage plants and orchids-of-note
- Used to define functions of spaces (strolling vs. sitting areas) more so than climates (because of difficulty in creating significant climatic distinctions without introducing expensive technology or significantly altering the building structure)
- The archway is heightened to 7.5 - 8'
- Floor grates are installed by wall base for water collection (to capture water run-off from wall). Water collected in these grates can be re-circulated into water feature.
- Orchids (in-bloom) are displayed around the archway; pots are fastened onto wall with brackets or 'chicken wire' is fastened onto wall and mounted orchids are hung from this. The visitor will have the space to pause and observe this display before proceeding.

East Room: The "Garden" (See Figures 7-11; 7-12 through 7-16)

*A more 'formal' garden is presented in the smaller-scaled east room. The scale of this room lends itself to read as an intimate [residential] garden space, an area of refuge. The display may be of a more 'formal' style here—a sort of 'courtyard' or patio aesthetic. The theme of the entire space, or a portion of the space, may be changed every few months to create visitor appeal.*

*The sitting areas may serve as display space as well. The section drawings associated with this recommendation (Figures ) illustrate a temporary potted-plant display. When the display is rotated out, the area accommodates seating once again.*

The Garden features:

- Sitting-viewing area(s)
- Small-scaled plant display can be changed/ rotated
- Beds are raised 4-6" to define space and prevent plant damage
- Pathway material and paving pattern may be more 'formal' (tile; brick; stone)
- Area can be used as turnaround, or visitor can proceed through eastern exit
- A 'bamboo arbor' is introduced to provide a 'terminus' and echo stone arch of interior wall

*Figure 7-10*: Elements of recommended design for West Room, including (*top row*) [artificial] tree for epiphyte display; stairs to raised walkway; muti-level [layered] plantings; (*bottom row*) [artificial] rock arranged to display plants and water features

*Figure 7-11*: Elements of recommended design for East Room, including (*top row*) intimate seating area; bamboo arbor; bamboo edging for raised plant beds; (*bottom row*) more formal pathway material and [changing] displays

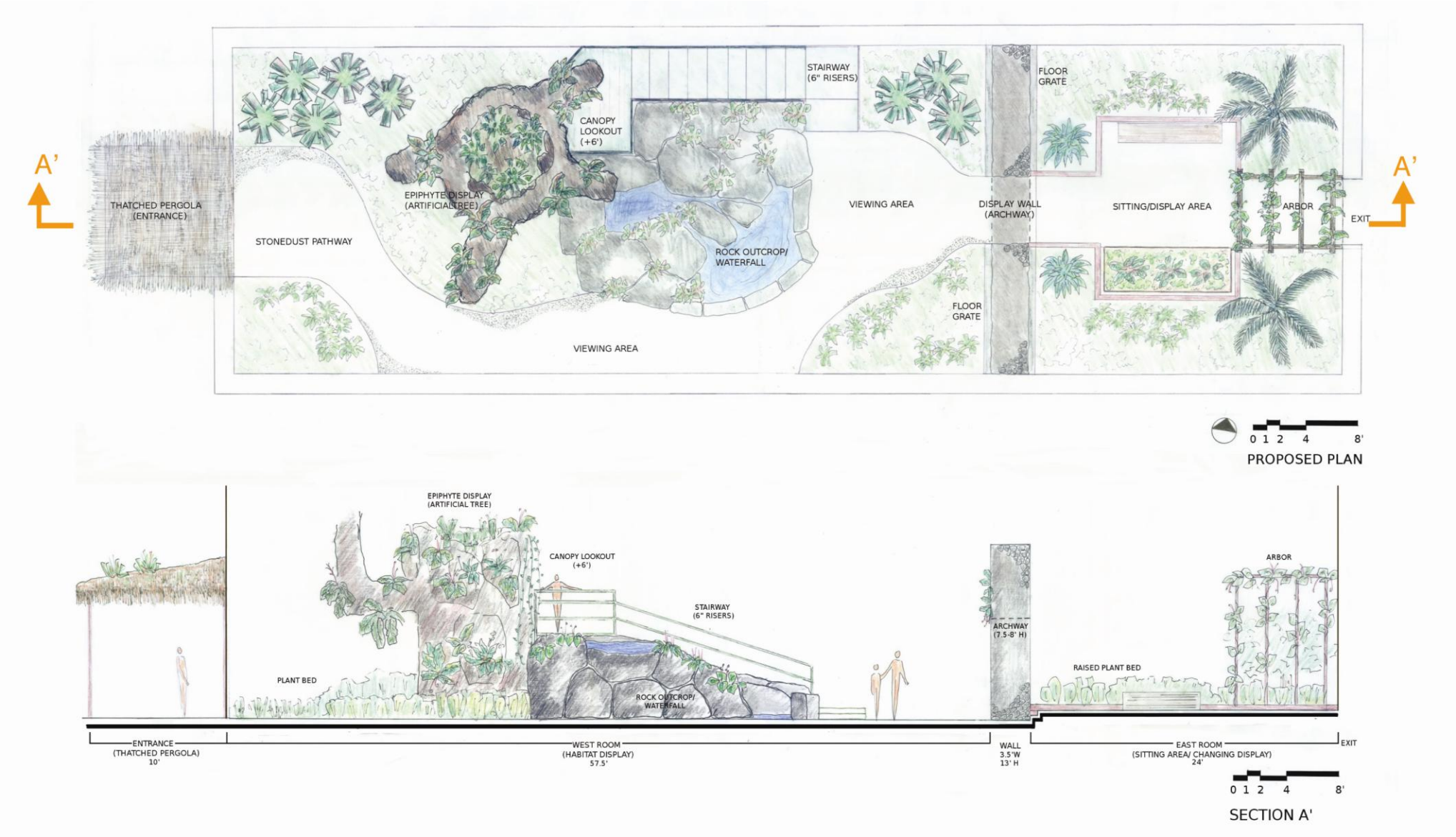


*Figure 7-12:* Plan and Section (A') of proposed NOH interior

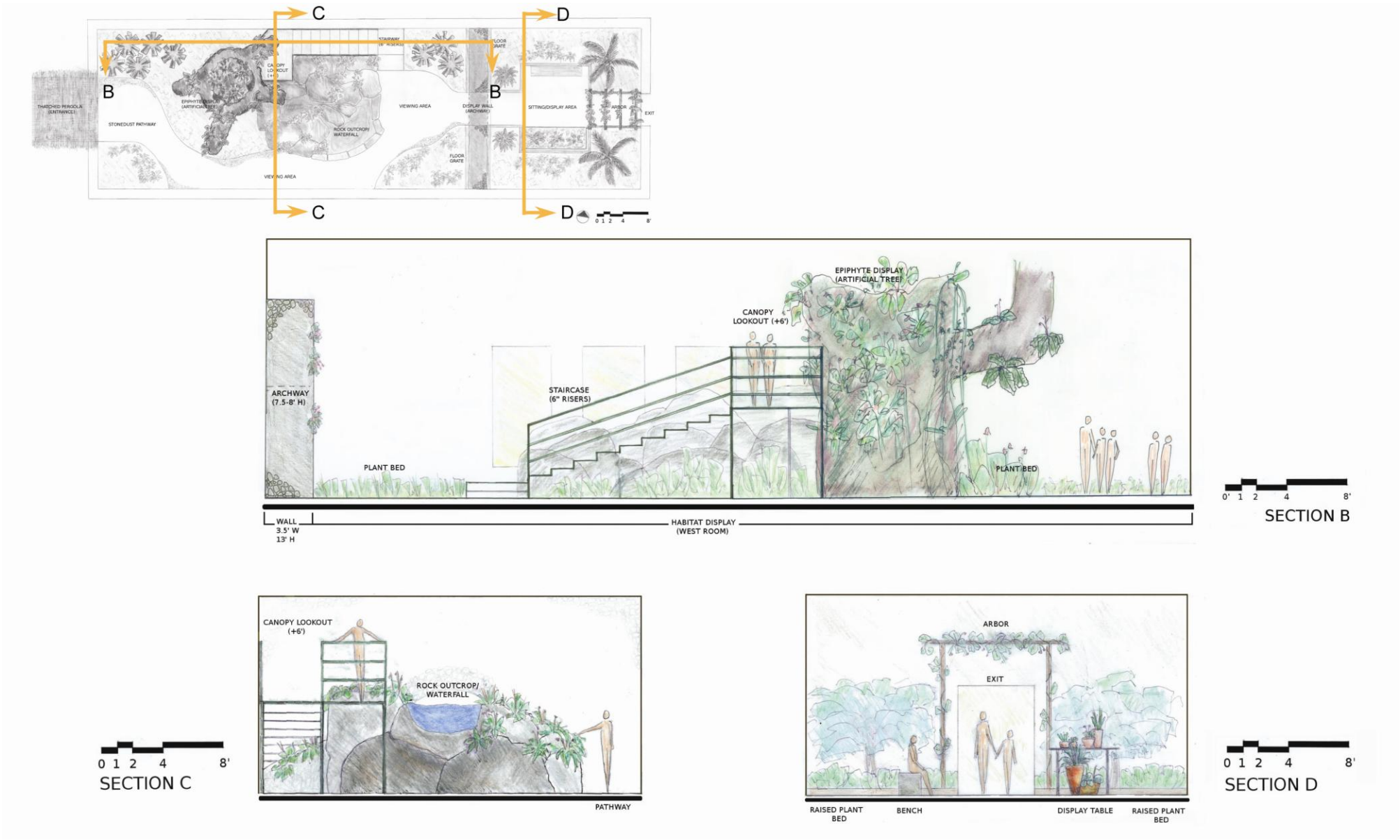


*Figure 7-13*: Sections (B, C, D) of proposed NOH interior

*Figure 7-14*: ‘Bird’s eye view’ of proposed NOH interior

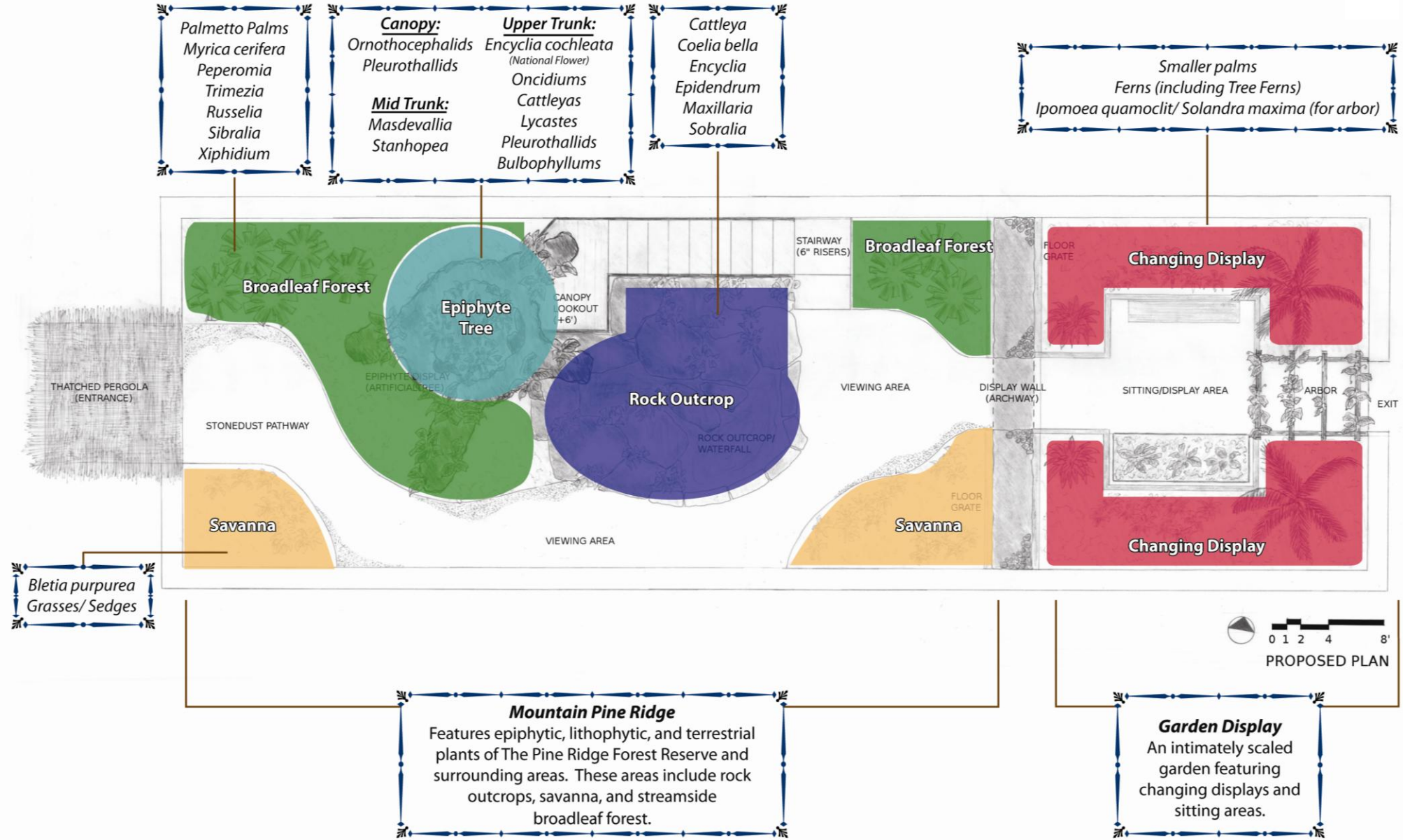


*Figure 7-15:* Conceptual planting plan

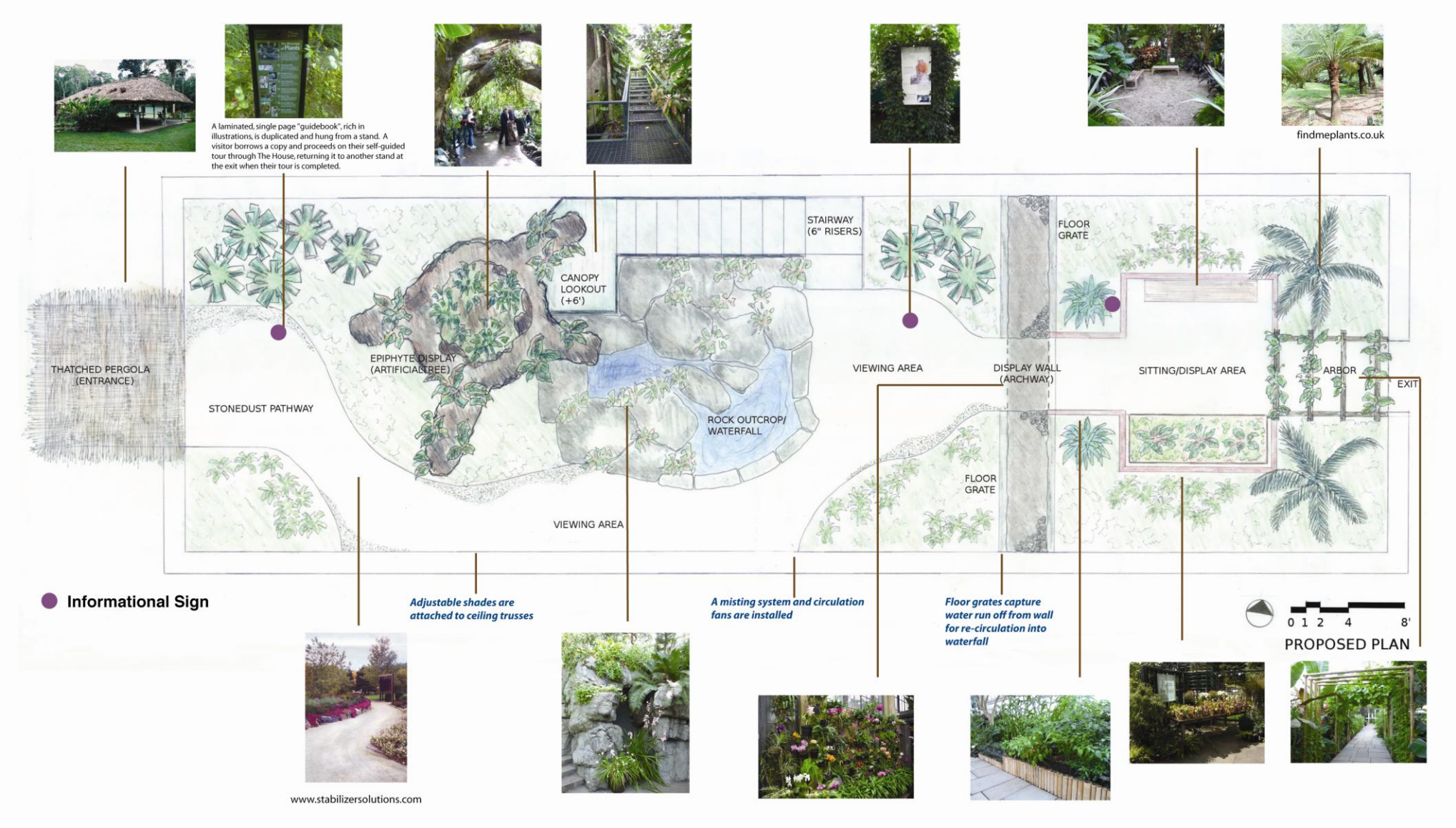


*Figure 7-16:* Photo annotated plan

**Conclusion**

The recommendations for The Native Orchid House are numerous. As mentioned, they are meant as broad guidelines which may be realized in part or parcel. At this stage, a general (conceptual) phasing plan is necessary to help to prioritize recommendations and facilitate project management and implementation.

The recommendations address several areas of the project site: The NOH approach; exit; building [the actual structure]; and display [inside the building]. Details about the Belize Botanic Gardens' work force and financial capabilities were not researched by the author. The production of construction details, as well as labor and financial estimates, were not within the scope of this project. These are essential pieces of information, though, for developing a comprehensive phasing plan.

In lieu of this information, the *location* (of a design recommendation within the project site) and *scale* (its degree of design detail), will be the parameters used to guide phasing at this time. It is suggested that completion of tasks be approached "*from the outside [of The NOH] in, and the inside, out*", and "*from coarse to fine scale*". Coarse details outside of the NOH are completed, followed by coarse details inside; then fine details in The NOH are completed, followed by fine details outside. Following this, we have:

(*See preceding 'Detailed Design Recommendations', Section 7)*

**Phase 1:**

- All grading, drainage, and base layers for pathways and proposed gardens are completed around the outside of The NOH. These areas include: the main path to The NOH; The NOH exit path, the path leading to The Conference/Visitor Center; and the Savanna Exhibit adjacent to The Center.
- As recommended, a new well may have to be installed to address excess mineral deposits in irrigation water. It has not been determined whether this problem can be addressed through less invasive/expensive means, such as auxiliary filters.

**Phase 2:**

- The NOH structure is remediated as recommended . Additional ceiling trusses may have to be built for installation of a misting/fan/adjustable shade system.
- Extant slats circumscribing the building are removed. Some of these slats may be re-installed in the correct alignment (north-south).
- Additional 'windows' (perforations) in the building and the installation of adjustable shade will eliminate many slats.

**Phase 3:**

- All grading, drainage, and base layers for pathways and proposed garden features are completed inside The NOH.
- The archway of the 'Interior Wall" is heightened to 7.5 - 8'. The extant wall is repaired as necessary to allow for display and maintenance of foliage plants and orchids.
- Floor grates by the wall base (for capture of water run-off) are installed

**Phase 4:**

- Main features of the "Habitat Display" are installed (including the 'rock outcrop', 'epiphyte display tree', and 'raised walkway').

**Phase 5:**

- Misting system, air circulation system, and adjustable shade system are installed.
- Any other necessary irrigation/filtration systems are installed.

**Phase 6:**

- Top layers of pathways are completed, signs are installed, other fine scale design details are completed inside The House

**Phase 7:**

- All plants are installed inside The House

**Phase 8:**

- Top layers of pathways are completed, signs are installed, other fine scale design details are completed outside The House.

**Phase 9:**

- All proposed garden areas outside of The House are planted.

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To Whom It May Concern,

I am a Master's student studying Landscape Architecture at The University of Massachusetts, Amherst. I am gathering research for a Master's project and would appreciate your help in this endeavor. This project involves the re-design of the interior of the "Native Orchid House" at the Belize Botanic Garden (www.belizebotanic.org). Their prized orchid collection is especially important because it features native orchids—many endangered or rare—and they are one of the few (if not only) institutions that educates the local public about such species and garners support for their conservation.

I have always had a strong interest in horticulture. As a landscape architect, I would like to pursue this interest through the design of institutions of public horticulture, primarily botanical gardens and arboreta. Thus far, my public horticulture design experience includes designing a small outdoor "demonstration garden" at The Los Angeles Botanical Garden and Arboretum. I have not yet designed a family/genus -specific plant collection, (i.e. orchids), nor have I designed for an indoor plant collection (orchids at the Belize Botanic Garden are arranged in an enclosed orchid house). I would like any information that may facilitate the design and curation of such collections.

I understand that such a design must first and foremost take into account the horticultural requirements of the collection. Assuming that these requirements are provided, can you shed any light on the design aesthetic that may be chosen for displaying a specific plant collection? That is, what are some of the guidelines your institution has chosen to guide the [design] aesthetic of plant collections? Has the design aesthetic been governed by site limitations? By the particular mission/ master plan of the institution? By the need to make the site comply with ADA regulations?

In your experience, does the design aesthetic of [smaller] collections in botanical gardens/arboreta usually reference an overall [site-wide] design aesthetic? If so, is this reference visible in the design details (signage, paving material) or larger, overarching organizational schemata?

In short, what I'm looking for is any information/experiences you may have that sheds light on the design process of specific collections/exhibits within an institution's entire collection. I would also like to determine if these factors are specific to the site, the particular institution, or signify a design methodology shared by institutions of public horticulture.

I appreciate any help you can offer, including suggestions of pertinent reading material or other people I may contact.

**(1)**
**Michael Hamm, President and CEO of The Portico Group**
(Seattle, WA; *www.porticogroup.com*)

The Portico Group is "committed to preserving and showcasing our native heritage" and has taken the helm in some of the most innovative and site-immersive public garden projects, including: The San Francisco Botanical Garden (CA), The Buffalo and Erie Botanical Garden (NY), The Holden Arboretum (OH), Washington Park Arboretum (WA), and The Beltline Arboretum (GA).

Mr. Hamm clarified what the designer should focus on when working at a botanical garden. They should keep in mind the mission (goals, objectives, vision) of the institution, the site, and the particular story wishing to be told to the visitor. That is, what kind of experience does the institution wish the visitor to take home? Is it an "eco-story" (lessons about ecology), is it one of research and conservation? One of culture?
And how is this story to be told? Through experiential (hands-on) learning? Is it multi-sensory (audio, visual and tactile)? Perhaps the story is told through "zones of engagement", where "[v]isitors will be more than passive views of plant displays… [they] will collaborate with scientists, horticulturalists, artists, and educators in the search for new ideas and new technologies" (Marinelli, 2007).

The author asked Mr. Hamm what the 'sphere of influence' is for designing collections; where does the new design begin spatially, experientially? At the entrance to the Native Orchid House? At the entrance to the larger Gardens? What is the 'sphere of influence' of the collection design?

He mentioned the mnemonic **ADROIT** (coined by The Portico Group) to help clarify some of these questions:

**A** – Arrival
**D**- Decompression
**R**- Reception
**O**- Orientation
**I**- Interpretation
**T**- Transformation

ADROIT is a summation of the stages of transition people experience—consciously or subconsciously—as they make their way from one space to another. In particular, it is the process a visitor to a public place engages in as they make their way from arrival to exit. These transitions are intricately orchestrated in public places such as botanical gardens, where almost every aspect of the visitor experience is preconceived and designed for accordingly. Understanding the stages of this 'transition process' [below] can be quite helpful in designing appropriate and effective spaces.

In brief:
A visitor's *arrival* is their transition from one landscape (such as, the outside world of the city or suburbs) to another (say that of the botanical garden). The "point of entry needs to be visible and welcoming. The way to enter and the routes of travel must be easily and intuitively understood" (APLIC-Tok Interpretive Concept Workshop led by The Portico Group; 9/5/2003). Amenities such as restrooms and picnic areas may be positioned near an arrival point. A welcoming gateway announcing the entrance, as well as signs immediately orienting the visitor, are recommended.

*Decompression* is a period de-stressing for the visitor, when feelings from the previous landscape are shed to make way for the new experience. Visitors must feel safe and secure after arriving, and know that "their needs will be attended to." (Ibid)

*Reception* involves a visitor's warm reception by staff; this may also apply to a 'sense of reception' or welcoming via properly placed and designed amenities and spaces.

*Orientation* is about "wayfinding and spatial understanding"—critical components in visitors' decision making. Appropriate spatial organization (circulation, signage, repetition of forms) is necessary in order that visitors do not become disoriented when presented with new information.

*Interpretation* occurs when the visitor is comfortable and oriented in a space, and they are ready to "learn and see things in new ways as they explore". New information and ideas (various educational displays) can be presented when the visitor has been prepared for such reception.

*Transformation* is the final step in this experiential journey, signifying that one has not only absorbed and interpreted information, but that this has inspired a sort of 'feedback loop', where the experience itself may affect how one absorbs and interprets other experiences. A positive transformation is one where the visitor leaves with good feelings, and perhaps even wants to take something (i.e., a souvenir, guidebook, map, brochure, etc) with them to remind them of the experience.

**(2)**
**Edward L. Blake Jr., Principal of The Landscape Studio** (Hattiesburg, MS; *http://www.thelandscapestudio.com/*), Mr. Blake Jr. designed the Master Plan for the renowned Crosby Arboretum. Touchstones that informed the design of The Crosby Arboretum can be applied to any design project: The experience of place is envisioned holistically; it is a dynamic community of plants, animals, and people. With this in mind, the smaller displays are reflective of the larger ones ("[e]ach is to each as all is to all"). The interpretive experience is about revealing indigenous forms and processes, those perhaps unique to the region. This is supported by man-made structures that are inspired by natural forms, made from indigenous materials.

***Case Study: The Crosby Arboretum*** *(Picayune, MS; http://www.crosbyarboretum.msstate.edu/)*

The Crosby is an exceptional showcase of the various ecotones (transitional ecosystems) of the Southern Gulf region of Mississippi (specifically, the Pearl River Drainage Basin). "The Crosby is rare in that its whole purpose is to conserve and display the plants indigenous to the watershed in which it is located. The whole collection is a collection of species structured in communities indigenous to Mississippi's Gulf coastal plain" (Personal correspondence with Mr. Blake Jr., 1/09). The native landscape itself *is* the exhibit/narrative-- a revelation of ecological processes and how man has affected and continues to affect these. The visitor can learn about the "aesthetic, agricultural, scientific and industrial contributions of plants and ecosystems" (Wells, 1989) through immersion in the 104 acre Pinecote interpretive area. Pinecote is a created (ex situ) display that features an extensive and varied path system through savanna, woodland, and aquatic ecotones.

The Arboretum also manages over 1000 acres of natural areas (in situ) representing seven habitats.

**(3)**
**Mr. Herbert Schaal**, **Principal of EDAW (**Ft Collins, CO; *http://www.edaw.com/*)

The global EDAW firm, with 34 offices worldwide, is engaged in various projects at multiple scales. This firm emphasizes a collaborative design process—engaging landscape architects, architects, planners, and ecologists in their projects. "The fusion of design, environment, economics, and planning helps EDAW to balance aesthetic, environmental, and social goals."

Mr. Schaal led the team that developed the master plan of Coastal Maine Botanical Gardens (*http://www.mainegardens.org/* ). His design expertise involves designing interpretive ("narrative") landscapes, especially children's and botanic gardens. (Sorvig, 2005) The Gardens, a relatively young institution (first opened to the public in 2007), was founded by a grassroots organization dedicated to conserving and showcasing the picturesque coastal Maine landscape. As such, it features many native plant collections rich in extant and site-inspired forms and materials.

Mr. Schaal points out that regardless of project location or design genre, "the process of design is always the same" (Personal communication; 12/1/08). A 'universal' design methodology may be summarized as follows:

(1) Define the purpose of the place to be designed (enlisting the help of the client); for public displays, this may involve understanding the institution's mission statement and goals, as well as the purpose/program of the collection.

(2) The program of the place is fulfilled through a series of key decisions about: circulation (points of egress, access); site boundaries (determining where they are physically and psychically); types and quantity of gathering spaces; grading and drainage; etc.

(3) Study the site to determine what kind of "landscape elements" fit with it programmatically, ecologically, aesthetically... Elements may include savannah, cliffs, jungle, allee, desert, woodland, etc. Study the ecology associated with these elements.

(4) Survey ideas that synthesize to create a site's *genius loci*—the sense of place. These include cultural, historical, and spatial aspects; landform and structure, natural and manmade patterns; "elements to affect every sense and intelligence". These ideas are "artfully combine[d]" in the iterative design process, a process that continues until "the purpose, requirements and program, site, [and] landscape type… evolve seamlessly into a beautiful, purposeful place."

**(4)**
**Todd Forrest, Vice President for Horticulture and Living Collections at The New York Botanical Garden (NYBG)**
(Bronx, NY; *http://www.nybg.org/* )

The author's queries (in italics), followed by Mr. Forrest's responses, follow:
*(1) Is the planned Native Plant Garden (and other areas that display native plants) designed to display plants in both*

*"formal" ("architectural") and "informal" ("naturalistic") ways?*

The new Native Plant Garden will include both formal plantings (a traditional mixed border using native plants, single species plantings within bioswales, geometric groves of trees, etc.) and informal plantings (wet and dry meadows, aquatic plantings, woodland plantings, etc.). The paths, buildings, and water features will have a distinctly contemporary feel—not at all naturalistic.

(2) *The trend in modern botanical gardens seems to be to display native plants in replications of their native habitats (i.e. an ecosystem-by-ecosystem presentation). Do you strive to do this at The NYBG? What is the advantage of presenting native/endangered plants in this way (as opposed to a more 'ornamental' layout)?* We do not. Our current native plant garden used this model and we found that it failed aesthetically and horticulturally. Instead, we will allow the planting conditions across the site determine the plant palette used and design for impact throughout the year.

(3) *Do you think that there is a particular aesthetic that best suits the display native plants? Do the concepts of "sustainability" and "conservation" lend themselves to one particular aesthetic (specifically, for small display collections, as I am working on)?* We have found that the general public responds to excellent design and is not interested in gardens that are indistinguishable from "nature." Beautifully designed and well maintained gardens inspire. Haphazardly designed and poorly maintained gardens reflect a lack of passion, horticultural knowledge, and skill. As long as the plant material is well grown, well labeled, and clearly displayed, it can serve to inspire interest in conservation. As for sustainability, we follow the right plant, right place model. If you give a plant the growing conditions and care it requires, it will thrive in the long run.

The more difficult the space, the more the final design reflects the creativity of the designer. A small lathe house could be planted to echo the natural habitats of the orchids, or it could follow a more Victorian approach. Either way, if the plants are well chosen, well grown, and well displayed, the garden will inspire greater interest in the plants it includes.

**(5)**
**Francisca Coelho, Associate Vice President for Glass Houses and Exhibitions at The New York Botanical Garden**

Ms. Coelho has designed and/or helped design the annual Orchid Show, as well all other seasonal displays. She is intimately familiar with the horticulture and design of display collections, in particular, the Conservatory 'rainforest' displays. When asked why The NYBG rainforest displays are presented with a 'naturalistic' form, Ms. Coehlo responded that the displays are intended to give the message of diversity and adaptation. As rainforests are naturally diverse (hundreds of species may be present in a single acre), such an aesthetic was selected.

Her advice on display design proved invaluable:

- Think about the climates of Belize and the range of temperatures in which orchids grow… Where is it hottest? Coolest? Most humid?

- How can the NOH be divided to create various microclimates? The interior wall may aptly serve this purpose.
- The slats on the building can be rearranged to create several different variations in light levels.
- The display must not be static: a visitor will return if the display offers something new each time. *Give the visitor a reason to return!*
- When deciding how to organize a collection, think about the message that the display is intended to convey.
- Plants can be organized by biome; by flowering time; by genus/species… Many orchid flowers are diminutive, or they flower for short periods. Because of this, plants may have to be massed together or rotated in and out of the House during their flowering period. *A display should make a strong visual impact!*
- Orchids can be mounted in chicken wire baskets, secured with fishing twine.
- Raising beds brings orchids closer to the visitor and prevents trampling.

**(6)**
***Case Study: NYBG Upland and Lowland Rainforest Conservatory Exhibits; Future Native Plant Garden***

The New York Botanical Garden is a world renowned public garden with a mission to be an "advocate for the plant kingdom." It pursues this mission not only through the exceptional display of living collections —250 verdant acres immersed in the New York metropolis—but through contributions to botanical science (international research, exploration, and education) and plant conservation.
NYBG is a worldwide leader in orchid conservation, and since 1990, has served as a refuge for confiscated or ailing plants (implementing CITES guidelines). (Watson Building Display, 2009). Since then, hundreds of orchids have been brought to the Garden for "rehabilitation". The NYBG also hosts an annual, internationally acclaimed Orchid Show in the Enid A Haupt Conservatory (the historic Haupt Conservatory comprises ~1 acre under glass, representing 8 biomes). Several rooms of the Conservatory are of comparable size with The NOH (the longer rooms are ~25' W X 80' L), including those of the Upland and Lowland rainforests. A "canopy walk" in the lowland rainforest raises the visitor over 10' feet into an artificial tree (fiberglass-resin composite), heavily planted with epiphytes and vines. This 'heightened' experience proves especially popular with visitors. The rainforest rooms also feature plentiful rocks (artificial and lava) of all sizes that serve as naturalistic edging and planters. Other rooms of the house (including those of the aquatic special collections, and seasonal exhibits) are presented in a much more formal manner.

The NYBG displays a rich palette of native and ornamental plants in formal beds adjacent to the Conservatory. Native plants are showcased in naturalistic form in the Native Rock Garden and Everett Children's Adventure Garden (where the landscape itself, with and abundance of kid-friendly signage, becomes a hands-on teaching tool). A new 3.5 acre Native Plant Garden (with an Olin Partnership-designed master plan) will be opening in 2012.
The goals of the Native Plant Garden design are mentioned below *(*New York Botanical Garden Press Release, 2008*)* as they are very similar to those of The NOH:

- "It will serve as a center for the study and display of plants [native to the northeastern United States]… a place containing documented, arranged collections of living plants for the purposes of scientific research, conservation, education, display, and enjoyment…"
- "[it] will display a variety of native plants combined beautifully in an integrated and holistic design."
- "It will accommodate groups of visitors while preserving a sense of intimacy for individuals. It will provide new opportunities for education through interpretive signage and teaching areas."

**(7)**
**Kris Jarantoski, Executive Vice President and Director of The Chicago Botanic Garden** (Glencoe, IL; *http://www.chicago-botanic.org/*)

"Behind every design at The Chicago Botanic Garden is our mission: 'To promote the enjoyment, understanding and conservation of plants and the natural world."

"Before we employ a landscape architect to design a new garden, we create a program for the garden with staff. The program talks about the purpose, content, aesthetics, educational uses, and functionality of the garden. Once an LA is chosen, the program is given to them. Of course, the program has to fit in with the surrounding landscape or be separated with walls or hedges. We have a certain vocabulary of material throughout the Botanic Garden (types of gravel surface, types of boulders from Wisconsin, type of brick) and designers are expected to respect that… We have a certain style throughout."

**(8)**
**Ben Chu, Horticulture Supervisor at the Missouri Botanical Garden** (St Louis, MO; *http://www.mobot.org/*)

"The [Missouri Botanical] Garden maintains many collections and through our collections we hope to present an aesthetically pleasing display that will serve concurrently as a teaching tool for garden enthusiasts and researchers alike and just a beautiful place to visit. Our Iris collection is displayed in a fashion to illustrate the progression of specie Iris to its eventual crosses, hybrids and cultivars. Similarly our Hemerocallis collection attempts to show the differences between the many crosses, but, is achieved through careful arrangements of the color palette. Other collections are arranged with more an eye to the Landscape aesthetics. Hamamellis, Lagerstromea, Hostas may be arranged in the Garden with other woodies or perennials, but, the particular species of note will predominate the arrangement. Certainly, all collections are subject to site limitations-soils, shade, water drainage patterns, existing plant material. The mission of the Garden-*to discover and share knowledge about plants and their environment in order to preserve and enrich lives*-influences the diversity of our collections. It mandates that we try to push the hardiness envelope, to present new and unusual plant introductions, and to demonstrate various garden styles-Japanese, Chinese, Woodland, Parterre, Victorian-style, Aquatics, etc."

"The goal of the Garden's design is to present the collection and garden styles in its own unique way, but, to do so with seamless transition and an overall cohesiveness throughout the 79 acres. Signage in wayfinding, plant labeling, cautionary all conform to a Garden standard."

**(9)**
**Kamaui Aiona, Director of Kahanu Garden at The National Tropical Botanical Garden** (Hana, Hawaii; *http://www.ntbg.org/*)

"We do assemble collections at our garden, and we landscape with them according to our goals and mission of education and conservation. We also do have a master plan that helps us remember these goals and mission."

**(10)**
**Uli Lorimer, Curator of The Native Flora Garden, The Brooklyn Botanic Garden (BBG)** (Brooklyn, NY; *http://www.bbg.org/*)

*[Re: Garden aesthetic/ interpretation at The Brooklyn Botanic's Native Flora Garden]*
"As per your questions about native plant driven designs I hope I can add to your understanding by telling you about my own observations here at BBG. The first and in my mind most important thing about native plant designs and how they teach the public about concepts like adaptation and conservation is interpretation. If you get this aspect right, then you don't necessarily need a particular aesthetic for the garden. This is one thing I might add that we here at BBG do VERY poorly. The current signage in the native flora garden dates to the 80's! That being said, I think that my garden displays plants both architecturally and naturalistically. The garden is sufficiently large enough to display the different layers of the forest (i.e. canopy, small tree, shrub, herbaceous layers) and in that there is a certain architecture to the way it is put together. This wasn't always the case. When the garden was first laid out, nearly 100 years ago, all of the trees were mere saplings and it was very wide open and sunny. Unfortunately, not many images remain from that time to serve as a contrast to what is has become today. (Again, with proper interpretation we could be telling the story of plant succession and climax forests!!) The plants, for the most part are left to mingle and move around as they would do in nature, so this lends itself to a naturalistic feel. We leave dead trees standing (as long as they aren't a safety hazard) as habitat for other creatures and to add to the naturalistic look and feel of the garden. I also leave the leaves and twigs were they fall in order to simulate natural soil formation. I do place a lot of emphasis on clean walkable paths. It creates a good juxtaposition between man made and controlled and the chaos of the planting beds. I also figured that if you can stroll comfortably without tripping or having to constantly look down, then you can focus on the plants and trees instead."

"We do strive to display plants that would naturally grow together and that are representative of larger ecosystems. The advantage of doing this is that it retains a little bit of the aura, feeling, and character of these habitats. There also may be relationships between the different members of an ecosystem that are not immediately apparent. Natural root grafts and parasitism are two things that come to mind. I successfully cultivate plant parasites as well as mycoparasites (Indian pipes {Monotropa uniflora} parasitizes the mycorhizzae which infect the nearby Beech trees) in the garden because they are planted with the species with which they evolved. In a way you are also trying to create an authentic experience by designing with an ecosystem approach. Not that anyone could possible reproduce nature, but we can try!!)."

*[Re: 'Sustainability'; Maintenance of The Native Flora Garden]*
"We always seem to emphasize sustainability when using native plants and almost create a myth that these plants require no maintenance at all! I am frequently asked what exactly I do at the garden and doesn't all of this just come up anyway? Despite outward appearance, the native flora garden is quite highly managed. Understanding how plants interact with each other (i.e. which ones will move aggressively, which ones will increase slowly over time) helps me to manage the overall look and feel of the garden. I also make it a point to be as minimally invasive as possible when I work in the garden. I want it to look like I was never in the beds weeding, planting, etc… Overall I do feel that natives will require less water, fertilizer, resources than other ornamentals."

*[Re: Formal Display of Natives]*
"I have seen in a few other botanic gardens, natives used in containers. I thought this was a clever way to display these plants because it lets people know that they can be used in a formal setting as well as in "naturalistic" settings. Rancho Santa Ana Botanic Garden in Claremont, CA has a wonderful display of container natives as does Longwood Gardens in Kennett Square, PA."

*[Re: Suggestions for The Belize Botanic Gardens' Native Orchid House]*
"Since your space is small, I think focusing on how the plants are interpreted will allow you to paint a larger picture of conservation and sustainability. I assume some of the orchids you are working with are epiphytes, so perhaps choosing an ornamental tree or tree fern to which they could be attached could let people know how and where these species grow. I have always been a big fan of plants growing on plants because that is how it is in nature. I grow a number of vines on other shrubs that serve not only as physical support but also make for attractive ornamental combinations as well."

**(11)**
***Case Study: BBG Steinhardt Conservatory Aquatic House/ Orchid Collection; Native Flora Garden***

The mission statement (adopted Oct 1994) of The Brooklyn Botanic Garden is, in part, conservation-focused: *The Garden is dedicated to] Seeking actively to arouse public awareness of the fragility of our natural environment, both local and global, and providing information about ways to conserve and protect it* (from website).

The aesthetics of the display collections at The Brooklyn Botanic, much like at The New York Botanical Garden, vary, ranging from formal and highly architectonic designs, to naturalistic presentations like those of the Native Flora Garden and sections of the Steinhardt Conservatory. The Orchid Collection is displayed in the Steindhardt's Conservatory's Aquatic House. This House (or room) reflects a rather formal aesthetic, with two sunken rectangles displaying aquatic habitats. Orchids are mounted to rocks or trees in the aquatic displays, or are displayed in the ceiling plane, hanging from metal racks. Walking under this 'canopy' of epiphytes is quite pleasing though the display does not attempt to mimic a true canopy at all.

The Conservatory Entrance room features an impressive rock-water feature display that soars up to about 10'. Most of the

rock is artificial, and crevices were created to serve as planting pockets.

The Native Flora Garden features plants within a 50 mile radius of New York City. Its 'naturalistic' form, with a minimal design elements introduced to guide the visitor and facilitate interpretation, is in stark contrast with the rest of the Garden. (The Native Garden is completely fenced off from the larger Garden in recognition of this distinct aesthetic.)

Native plants are combined with ornamentals in highly textural, 'free form' plantings alongside the administration buildings, but these are more formal in style, distinctly framed with brick walkways.

**(12)**
**Mr. Joachim Gratzfeld, Botanic Gardens Conservation International (BGCI) Director of Regional Programmes**
(Kew Gardens, UK)

"I do not think that there is one single-recipe approach to displaying species for awareness raising. Whatever the display is going to look like at the end of the day, I believe it is a type of artwork, but one that is the result of a discourse between the scientists at the gardens and designers, and it should try to blend the various ideas and issues both 'parties' come up with."

"The ultimate intention is to deliver a conservation message, how you do that is eventually your choice, and you may have to convince the botanists at the respective gardens that for a display that is limited in space you may need to employ techniques that derive more from the world of design than from natural science."

**(13)**
**Mr. Thomas Hecker, President of EcoBotanic Designs**
*(http://www.ecobotanicdesigns.com)***,** a horticultural/design firm specializing in botanic garden and conservatory design and sub/tropical flora, Mr. Hecker has designed exhibits for public gardens all over the world. He has worked as a tropical horticulturalist at the Climatron Conservatory at the Missouri Botanical Garden, and as director of Magic Wings Butterfly House (NC) and Naples Botanical Garden (FL).
(Mr. Hecker has actually visited The Belize Botanic Gardens and has walked through The Native Orchid House. The author asked for his response to the visit but did not receive a reply.)

"I like both ways [naturalistic and formal] to display native plants, first to show how they might be found in nature, with the correct tree host in your case. But at the same time it is a Botanical Garden, which means… most visitors think it is [a] place with pretty plants, more than a museum that is keeping plants for scientific research. So if I were to house the native orchids, I would go over the top with many more species than might exist in the wild on one tree and mass plantings for optimal show. Additionally, I would display native plants in a formal way, to engage and excite the visitor to be inspired to want that wild plant in their garden, instead of an exotic plant."

"…the bottom line is the bottom line, so the more visitors that come to the Garden and get motivated to respect native plants, money will follow to conserve native habitats."

**(14)**
**Ms. Janet Marinelli,** author of several books about native gardening and botanical gardens; former director of publications at The Brooklyn Botanic Garden, **President and founder of Blue Crocus Consulting** (*http://www.janetmarinelli.com/blue-crocus-consulting/*), a firm that devises programs and artistic and sustainable concepts for public gardens [for implementation by designers].

"…learn all you can about not only the conservation status of Belize's native orchids but also their ethnobotanical, cultural, and economic value, so that your design accommodates and encourages the local communities to become involved in the Garden's orchid work. For example, how can members of the community become involved as 'citizen scientists' or 'community ambassadors' to help save threatened species? Can the propagation and sale of native orchids become both a strategy for conserving threatened wild populations and a way to encourage local sustainable development? How can your design for the orchid house serve as a model for sustainable building?"

**(15)**
***Case Study: The North Carolina Arboretum (***Asheville, NC; *http://www.ncarboretum.org/ )*

The Arboretum was chosen as a case study because it features exceptional and diverse examples of native plant gardens. Like the Belize Botanic Gardens, the Arboretum is a relatively young institution (established 1990), and is immersed in the context of a greater rural/conservation landscape (Southern Appalachian Mountains/National Forest), one with a strong cultural history rich in people-plant connections.

The Arboretum mission is concerned with plant and people relationships in multiple facets: " [to cultivate] connections between people and plants through creative expressions of landscape stewardship, including Conservation, Education, Garden Demonstration, Research, [and] Economic Development." The Arboretum accomplishes this mission at the local, regional, and global scales, not only as founder of the Bent Creek Institute (BCI), which supports growth of the region's natural product and integrative medicine industries, but as host of The Center for Plant Conservation meetings and propagator of rare and endangered plants.

The *values* of the Arboretum may also inform any endeavor undertaken by The Belize Botanic Gardens. The Arboretum engages in each project with *insight* ("We are knowledgeable about plants and work to teach others about their importance."); *authenticity* ("We plan and work thoughtfully and carefully with respect to our regional landscape and culture."); and *responsibility* ("We develop, communicate, interpret and support the importance of plants to our world.").

The Arboretum features three notable [native plant] gardens in its core area. These displays are more formal in nature, featuring a diverse abundance of local materials (stone, wood) in their pathways and structures. Sustainable practices (rainwater collection, recycled materials) are displayed with great intention and creativity (there is eye-catching and easy-to-understand signage throughout each garden) and the stunning work of local artists—from sculptures to gateways—are featured the gardens. The narrative of each garden is always about plant-people relationships, either how people have used or use plants in crafts/medicine, or how people can

establish sustainable practices and native plant gardens in their own backyard.

Display gardens include:

- *Stream Garden*: "a streamside plant community reflects the region's natural heritage in a formal setting… The Stream Garden demonstrates how such plants, both indigenous and non-native, can be used in landscape design" (from website).

- *Heritage Garden*: "a living museum garden devoted to the Southern Appalachian culture, horticulture and craft" (from website). (Features a "teaching shed" and "reconstructed stone chimney" for hands-on and distance learning.)

- *Plants of Promise Garden*: "Award-winning landscape plants, new introductions and superior plants derived from the region's native flora… are not only displayed on a residential scale but they are also evaluated for use in the Southern Appalachian region" (from website). This garden, in addition to having multi-season visual appeal, is of special interest to the homeowner who wants to test displayed cultivars in their own garden.