The Report Committee for Robert Giacomo Yaquinto
Certifies that this is the approved version of the following report:

Landscape Preservation and Biodiversity Planning: The Kino Heritage Fruit Trees Project and Beyond

APPROVED BY
SUPERVISING COMMITTEE:

Supervisors:

Michael Holleran

Sarah Lopez

Landscape Preservation and Biodiversity Planning: The Kino Heritage Fruit Trees Project and Beyond

by

Robert Giacomo Yaquinto, BA, BFA

Report

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Community and Regional Planning

The University of Texas at Austin

May 2014

Abstract

Landscape Preservation and Biodiversity Planning: The Kino Heritage Fruit Trees Project and Beyond

Robert Giacomo Yaquinto, MSCRP

The University of Texas at Austin, 2014

Supervisor: Michael Holleran

This report argues that historic landscape preservation efforts need to embrace biodiversity planning. Historic landscape preservation sites need to develop biodiversity plans because they are uniquely qualified to provide the continuous monitoring that successful biodiversity planning requires. Not only will biodiversity monitoring at various historic landscape sites contribute to a nationwide collection of biodiversity planning data, but it will also provide a rich source of information that can be presented to draw a wider audience into the biodiversity discussion. After considering three precedents: Old Sturbridge Village, Old World Wisconsin, and Tucson Botanical Gardens, the report focuses on the Kino Heritage Fruit Trees Project and its real and potential impacts on biodiversity planning in southern Arizona and more broadly. Finally, the report considers how seed libraries and seed swaps might serve a similar purpose in other parts of the country.

Table of Contents

List of Figures……..vi
Introduction……1
Limitations……....2
Historic Landscape Preservation and Biodiversity Planning……5
Historic Landscape Preservation Briefly……..7
Historic Landscape Preservation in Practice……10
Biodiversity Planning…….....13
Defining Biodiversity……..14
What Biodiversity Planning Might Look Like, 1…….....17
Precedents……..20
Living History Museums……20
A Local Precedent……..22
The Kino Heritage Fruit Trees Project…….....29
Padre Kino, Very Briefly…….....30
Kino Heritage Fruit Trees Project Background…….....30
The Heritage Orchard…….....33
My Observations and Experience at the Heritage Orchard…….....36
What Biodiversity Planning Might Look Like, 2…….....38
Friends of Tucson's Birthplace's Mission Garden……..41
Mission Garden Project Background…….....41
Mission Garden…….....44
My Observations and Experience at the Mission Garden……46
What Biodiversity Planning Might Look Like, 3……47
Desert Survivors……49
Quantifying the Benefits……52
Beyond the Kino Heritage Fruit Trees Project…….....56
Seed Libraries…….....56
Seed Swaps……58
Is Saving Seeds Really Preservation too?.....59
Conclusion…….....61
Works Cited……..62

List of Figures

Figure 1 Native American Crops Garden……...24
Figure 2 Informational Signage in *Plants of the Tohono O'odham Path*…….....25
Figure 3 Informational Signage outlining the benefits of passive rainwater harvesting...26
Figure 4 Display garden promoting the efficiency of aquaponics…….....27
Figure 5 Informational signage explaining how to choose and grow cacti in Tucson.....28
Figure 6 Map of Project Sites Visited……...29
Figure 7 Entering the Heritage Orchard…….....33
Figure 8 Looking Northwest toward Downtown through the Kino Heritage Fruit Trees in the Mission Garden…….....41
Figure 9 Mission Garden Site Plan, showing both existing and future gardens……...47

INTRODUCTION

At first glance, historic cultural landscape preservation and biodiversity planning may seem to have little in common. However, over the course of this report, I will argue that not only are the two directly linked, but also that historic landscape preservationists have an obligation to both preserve the landscapes under their care and also engage the public directly to educate them about biodiversity's role in maintaining ecosystem. After a brief introduction, I will examine the history of landscape preservation in the United States and landscape preservation's ongoing and broadening role in light of global climate change. I will then execute an in-depth consideration of what exactly biodiversity means and how planners might approach it. Next I will consider two living history museum precedents, Old World Wisconsin and Old Sturbridge Village, and their efforts to engage the public and inform it about biodiversity's value. I will then carry out a thorough examination of three iterations Kino Heritage Fruit Trees project: the Tumacácori Heritage Orchard at Tumacácori National Historical Park, Friends of Tucson's Birthplace's Mission Garden, and Desert Survivors Nursery. In January 2014, I had the opportunity to visit all three, and during the course of my research, I have corresponded with or interviewed representatives from all three. As part of my examinations I will consider how the projects exist today, where they are headed, and what else they might consider doing as part of their efforts to provide the public with valuable information. Finally, I will consider how some of the Kino project's successes might be translated to different locations.

Limitations

In terms of historic landscape preservation, I have chosen my two main precedents based on their longstanding history of success. There are likely other, newer examples of living history museums that might have served as even better case studies. Ultimately, I chose Old World Wisconsin (opened 1976) and Old Sturbridge Village (opened 1946) because they have established themselves firmly in the biodiversity discussion, and chances are better that they will continue to expand their influence and outreach.

Next, when it comes to biodiversity planning and conservation biology, one report cannot possibly cover all of the different views, approaches, and theories. It is not within the scope of my expertise or this report to determine how to value biodiversity. Instead, I will proceed having accepted the following two axioms: (1) Biodiversity is important. (2) It is necessary to plan for biodiversity conservation as it exists in healthy ecosystems and to develop plans to restore biodiversity to heavily degraded ecosystems. As I argue for historic landscape preservationists' role in joining and broadening the biodiversity discussion, I will make my case by focusing solely on edible fruit and vegetable producing plants. I will consciously ignore microbes and animals. Narrow as my viewpoint is, I have two reasons for it.

First, according to Elmqvist et al., generally, more than 70% of the land in urban areas (specifically the U.K., U.S., Canada, Australia, New Zealand) is privately owned (125) and nearly a third (27%) of green space in cities is held privately in the form of residential gardens (136). Biodiversity planners need to recognize the implications of these statistics. By reaching out to home gardeners, they can begin affecting a significant

part of a city's green space. At the same time, these are private spaces, so there has to be flexibility. Exclusively promoting native species is not enough. Deriding non-native species is counterproductive. Biodiversity planners need to promote any cultivar that can be grown with minimal resource (water, fertilizer, pesticide) input and limited chances of negative impacts or becoming invasive.

Second, conservationists often use charismatic species, "species that serve as symbols and rallying points to stimulate conservation awareness and action to promote environmental concerns" (Ducarme et al. 1), to generate interest and funding. Edible fruit and vegetable producing plants are arguably the charismatic species of Kingdom Plantae. They are highly recognized, and people generally like them. By connecting people's interest in their local history to their excitement about and interest in fruit and vegetable producing plants, there is a genuine opportunity to draw people into the broader, more comprehensive and scientifically rigorous biodiversity planning discussion. (I acknowledge that there are disagreements among biodiversity planners and conservation biologists about the use of so-called charismatic species. If nothing else, they are still a good starting point. In their article "What are 'charismatic species' for conservation biologists?," Frédéric Ducarme, Gloria Luque and Frank Courchamp address both the benefits and harms of using charismatic species as both means of generating interest and also as measurements of biodiversity)

Both the Tumacácori Heritage Orchard and the Mission Garden are still in their early beginning stages. Before coming to graduate school, I spent three-and-a-half years selling wine. During that time I had the opportunity to meet many different winemakers,

to visit vineyards, and to generally learn about the grape growing process. One of the things I learned is that it takes roughly five years for vineyards (orchards too), to become productive when they have got virtually unlimited resources and funding. Even though the Tumacácori Heritage Orchard was planted in 2007, it has experienced all of the growing pains that any new undertaking might but without always having the resources to address them right away. The Mission Garden is still under construction. Its Kino Heritage Fruit Trees were only planted in March 2012. In short, my goal is to consider these projects not only in terms of what they have done but also in terms of what they plan to accomplish.

HISTORIC LANDSCAPE PRESERVATION AND BIODIVERSITY PLANNING

During our current period of environmental upheaval, historic landscape preservationists need to claim their place in the biodiversity planning conversation. No one is certain what climate change's full impact will be. In the meantime, preservationists need to work with biodiversity planners and conservation biologists to experiment with new plant cultivars to better understand what will and will not be viable as weather patterns shift and become less predictable. Major landscaping features like topography, trees, and in historically significant cases, the actual landscape design itself need to be preserved and maintained. After all, those are the features that define the aesthetic of the landscape. Beyond those features, however, preservationists should take a long-range view and embrace increasing experimentation. With obvious environmental changes ongoing, the alternative, maintaining the status quo, is quickly becoming unviable. That said, any experimentation or landscape modification should be done in the context of a well-informed and thoughtful consideration of the existing ecosystem's biodiversity and health. Of course, that begs the question, "what does biodiversity mean?"

As a concept, biodiversity and sustainability occupy a similarly nebulous realm. For some, it is an inventory of all species within a particular environment taken with the explicit goal of ensuring that a similar number of species is maintained over time. For others, biodiversity is a measure of the interactions between humans and the natural environment. According to the *Convention on Biological Diversity* it is: "the variability

among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Article 2). Lévêque and Mounolou address the next logical question, "If biodiversity has such a broad definition, why worry about losing a species here or there?" They write "biodiversity loss no longer means only the extinction of isolated species but rather the modification of entire ecosystems, with all their floristic and faunistic components" (9). In other words, each species is part of a system, and losing one here or there affects the system as a whole. Even though losing a single species may seem like a trivial modification, its loss could cause disruptions that lead to the loss of significantly more species. Biodiversity Planning has emerged as an attempt to influence and direct ecosystem modification. The overarching goal is conservation. However, generally speaking, biodiversity planning acknowledges and accommodates a sustainable harvest of natural resources.

Directing ecosystem modification is hard. It requires developing a plan of action, incredible amounts of research, and most importantly, funding. Often, projects lack one or all three of those components at the outset. The result is that many projects whose explicit goal is to positively impact biodiversity have to rely on anecdotal evidence instead of hard data. The Kino heritage fruit trees iterations that I plan to examine have not escaped this problem. Difficult as it may be, historic landscape preservationists, biodiversity planners, and conservation biologists have to make the effort to address biodiversity loss.

Historic Landscape Preservation Briefly

There are two basic types of landscape preservation. The more widely recognized and visible of the two is wilderness preservation. The less widely recognized and visible is manmade landscape preservation. Biodiversity preservation is an inherent aspect of wilderness preservation. Concern for biodiversity is less inherent in manmade landscape preservation. Manmade landscapes occupy a middle ground between wilderness and architecture. On the one hand, they are created and designed with specific plant palettes and landscape features, but on the other hand, they function as part of the local ecological system. Wilderness preservation efforts set the stage for manmade landscapes to be considered preservation-worthy. It's important to understand how wilderness preservation came about and how manmade landscape preservation developed into its own category.

In her essay "Landscape Architecture, Design, and Preservation," Nancy Volkman credits the painter George Catlin as the first American to recognize the need for wilderness preservation on a national scale. She writes, "George Catlin, surveying the drastic changes in the American West, especially the decimation of buffalo herds, made the farsighted proposal of establishing what he called a "nation's park" to preserve "Nature's works" (27-28).

However, it was not until after the Civil War that wilderness preservation began to gather momentum at a national scale. Frederick Law Olmsted Sr. led the movement. Interestingly, his argument for the creation of parks was based on his notion of a park's

ability to instill a sense of democracy. As Adam Wesley Dean writes in "Natural Glory in the Midst of War: The Establishment of Yosemite State Park," "Olmsted came to believe that America needed public parks. They provided an important "civilizing" influence on the frontier and demonstrated the power of republican government (392-93). It was under Olmsted's guidance that Yosemite was made into a California State Park in 1864.

Although Olmsted provided the most important professional viewpoint in the argument for landscape preservation, his was not the only voice calling for the protection of American wilderness. Through his explorations and writings, John Muir helped begin the conservation movement. Working together with the East Coast editor Robert Underwood Johnson, Muir helped convince President Benjamin Harrison to make Yosemite a national park. In 1892, John Muir helped to found the Sierra Club. Originally focused on preserving California wilderness, the club eventually broadened its preservation mission to a national scale (Volkman 31). Muir, perhaps more than anyone, helped bring the ideas of naturalism, conservation and wilderness preservation into the living rooms of ordinary Americans. In fact, Muir's campaign against the construction of Hetch Hetchy Dam was the first nationally organized wilderness conservation fight (Gillis 33).

With the formation of the National Park Service in 1916 (Mackintosh "Creating a Service to Manage the System"), the idea of a nationally directed wilderness conservation program became a reality. More importantly, it set the foundation for the preservation of manmade landscapes.

James Fitch outlines the development of manmade landscape preservation in *Historic Preservation: Curatorial Management of the Built World.* Manmade landscape preservation's greatest hindrance has been a lack of documentation. Fitch writes:

> The accurate reconstruction of a vanished garden requires the same mix of archival and archaeological documentation as would be needed in the restoration of historic buildings. Archival materials on old gardens and landscapes are, however, apt to be even more fragmentary and inconclusive than on old buildings. (272)

Other than major gardens, most landscapes weren't documented with any amount of significant detail. In some instances, Fitch notes that paintings have served as documentation, but those are few and far between. It's really only been since the invention of the camera that anyone can unequivocally claim to know a historic garden's layout and topography. According to Fitch one of the earliest successful uses of photography for landscape restoration was Professor Robert Harvey's work on Terrace Hill, the Iowa Governor's Mansion.

Unfortunately, with or without documentation, manmade landscapes aren't any easier to preserve than wilderness landscapes. Fitch points out that one of the greatest challenges facing would-be landscape preservationists is that many historic landscapes, gardens in particular, cannot be restored:

> "Where original plant material survives, restoration might dictate impossibly severe pruning. Moreover, if strict botanical accuracy were a criterion of the restoration, it would imply the replacement of modern plant types by antique varieties which might be difficult or impossible to locate today. (268)

He goes on to say:

> Landscape [preservationists] who are seriously interested in the management of historic landscapes will have to abandon these antitemporal and antienvironmental postures. They will have to face the fact that, unlike their

> architectural peers, they will be working with living tissue. This confronts them with change in their medium at two different time scales: changes in size, scale, and form of individual plants; and changes in the very species and varieties in use at any given historical period. This means that very few historic landscapes, at least in the Western world, have a physiognomy corresponding to the ambitions of the original designers. (268-69)

Although he does not address manmade landscape preservation as it relates to biodiversity planning, Fitch outlines an extensive history of manmade landscape preservation efforts including: Giverny, Jefferson's gardens at Monticello, the Lippitt Farmstead at the Cooperstown Farmers' Museum, Old Sturbridge Village's Heirloom Gardens, and Old World Wisconsin's Heirloom Gardens. Today, each represents different approaches to manmade landscape preservation. More relevantly, for nearly all of them, promoting biodiversity is a key component of their educational efforts. Some like Monticello and Old Sturbridge Village encourage their visitors to increase their own garden's biodiversity by providing them the opportunity (by selling plants and seeds) to plant the same plants at home. Others like Old World Wisconsin focus more on promoting historic gardening practices and the concept of biodiversity to their visitors by publishing gardening books.

Historic Landscape Preservation in Practice

The National Park Service's *Guidelines for the Treatment of Cultural Landscapes* specifies how historic landscape preservationists might approach their responsibility to both preserve the landscape. However, it fails to understand or provide guidance on landscape preservation's role in the local ecological system. The *Guidelines* states:

> Individual features in the landscape should never be viewed in isolation, but in relationship to the landscape as a whole. Each situation may vary, and some features may often be more important than others….
>
> Overall, it is the arrangement and the interrelationship of these character-defining features as they existed during the period of significance that is most critical to consider prior to treatment. As such, landscape features should always be assessed as they relate to the property as a whole.

The *Guidelines* goes on to define what should be considered character-defining features: topography, vegetation, circulation, water features, and structures, site finishings and objects must be taken into account when assessing the historical value of a landscape. Regarding vegetation, the *Guidelines* states:

> Vegetation may derive its significance from historical associations, horticultural or genetic value, or aesthetic or functional qualities. It is a primary dynamic component of the landscape's character; therefore, the treatment of cultural landscapes must recognize the continual process of germination, growth, seasonal change, aging, decay, and death of plants.

The National Park Service's understanding of vegetation is surprisingly aware of the lifecycle of plants, but is equally surprisingly unaware of the landscape's function in the surrounding ecosystem. The *Guidelines* consider the vegetation as though it is isolated from its surroundings. Because manmade landscapes are not wilderness, even more care should be taken to understand how preservation efforts will impact the surrounding area.

Robert Z. Melnick outlines a broader approach to historic landscape adaptation in his essay "Climate Change and Landscape Preservation: A Twenty-First Century Conundrum." He writes:

> Building on the recent work of ecologists and other natural-resource scientists, there are a number of important preliminary considerations and approaches to these problems…

> First, we must accept the premise of an uncertain but certainly variable future for these landscapes. We should directly embrace flexibility in our approaches, encourage frequent reassessment of conditions, and plan for the need to change course as conditions change…
>
> Second, when addressing these challenges to historic landscapes, we must adapt to change and ways to mitigate it. For starters, we can create resistance to change. This resistance can be in the form of a more flexible understanding of what we mean by character-defining features, for example, especially when it comes to historic plant materials and plant communities….
>
> Third, we should seek ways to promote resilience to change. This strategy may mean greater proactive intervention in certain highly valued landscapes, which, in turn, implies the setting of priorities….
>
> Fourth, we should be prepared to make difficult decisions about what to try to save, what is salvageable, and what is not…
>
> Fifth, we should learn from the Noah's Ark Project in Europe, which "aims to improve this situation through a deeper understanding of the behavior and response of immovable cultural heritage and historic materials to the [impacts of climate change]…
>
> And finally, we should recognize the "historical ranges of variation." Taking both the long and short views is vital in this preservation effort…(40-41)

More than the National Park Service, Melnick acknowledges that the reason for rethinking landscape preservation is climate change. Because he understands the potential ramifications of climate change, he is able to forcefully articulate the fact that landscape preservationists must begin making choices. Landscape Preservationists have to decide what is important and what is not, what can be replaced and what is irreplaceable, and at what point the amount of change to an historic landscape will render it no longer historically significant. More importantly, he recognizes that these landscapes exist within, impact, and are susceptible to much larger systems.

Biodiversity Planning

It is worth acknowledging right away that part of the issue with defining biodiversity stems from the fact that not all ecologists believe that biological diversity helps ecosystems function better:

> According to certain studies, ecosystem responses to such changes depend upon the specific composition of the community and its biological or morphological characteristics. In experiments carried out under controlled conditions, the presence or absence of species more able to use the resources than others (…) has emerged as one important explanatory factor. In reality, it is not so much species richness, as such, that is important, but rather the biological characteristics of the species and the diversity of functional types represented (….) Under these circumstances, it is not so easy to predict how a system will behave in the event of a gain or loss of species. (Lévêque and Mounolou 114)

However, among those who do believe that biological diversity improves ecosystem functioning, there are four basic steps in establishing a biodiversity plan. First, it is necessary for landscape preservationists, biodiversity planners, and conservation biologists to establish a general definition of biodiversity. Next, practitioners must determine the scale at which they are going to work. Then they must establish the temporal aspects of the ecosystem to be reviewed. Finally, practitioners must determine an approach to establish the existing biodiversity baseline and later to measure change in biodiversity as the plan of action is implemented. In reality, these four steps may not be enough. Margules and Sarkar outline a far more rigorous, exhaustive 11-step process. Their methods are more applicable at very large scales. However, their recommendations for establishing a baseline and measuring a plan's effects will be included below.

Defining Biodiversity

In *Planning for Biodiversity,* Sheila Peck offers a good, practical definition of Biodiversity:

> A biodiversity framework (…) consists of the components, patterns, and processes of ecosystems, each existing at multiple levels of organization and all varying over time (…) By incorporating all three ecosystem attributes (components, patterns, and processes), not only can specific variations in the biota be considered, but so can many other factors on which this diversity depends. (7)

For a more scientific definition, it is worth looking to the definition that conservation biologists Chris Margules and Sahotra Sarkar provide in *Systematic Conservation Planning*:

> Two hierarchical schemes are used for the classification of biological entities (Sarkar 1998). One is a spatial (or ecological) hierarchy starting with molecules and macromolecules, then cell organelles, cells, individuals, populations and metapopulations, communities, ecosystems and ultimately the biosphere. The second is a taxonomic hierarchy from alleles to loci, linkage groups, genotypes, subspecies, species, genera, families, orders, classes, phyla and kingdoms. Both hierarchies reflect evolutionary history and are constrained by evolutionary mechanisms. (6)

In both Peck's and Margules and Sarkar's definitions, scale is addressed. On the one hand, Peck refers to scale when she says "multiple levels." Margules and Sarkar are more specific. They start at the smallest end with molecules and gradually increase scale until they reach biosphere scale. Most biodiversity planning is focused on both the community level and what Peck refers to as the landscape level. For her, a biotic community is "any group of plants, animals, bacteria, and fungi that occurs together at a particular place and time"(9). The landscape level is a tier above communities and Peck argues that "Populations and communities are very useful scales, since they are basic biological units in parks and open spaces…landscapes are comprised of various communities and exhibit numerous patterns and processes essential to biodiversity" (Peck 12). She goes on to note that:

> At the landscape level, abiotic factors constrain where vegetation grows, land-use pressures affect the rate at which it is developed, large-scale disturbances influence species diversity, and vegetation patterns govern the movements of community animals (…) In general, diversity at any given level will be constrained by attributes associated with the level above and will exhibit properties that can be explained in part by the level below. (15)

Time is perhaps the least obvious component of biodiversity. However, it is arguably the most important one. It is impossible to begin to understand biodiversity without first establishing the timeframe in which the biotic features and processes to be measured exist. At smaller scales, the amount of time required to understand lifecycles and population variation over time, among other things, will be relatively short. In contrast, at the community and landscape level, the amount of time required to develop a sense of every biotic feature's lifecycle and variation over time could stretch into centuries. As Peck writes, "the amount of time [(required to) characterize the full range of biodiversity (19)] depends on the processes that influence this diversity" (19).

As Margules and Sarkar outline, it is necessary to collect, compile, and analyze existing data. They suggest "biological data in the form of records of the geographical locations of taxa may be available from previous collecting expeditions or surveys, or collected during new surveys" (77). They recommend extracting environmental data from "meteorological records and topographic maps, and from existing thematic maps of geology and soils" (77). In reality, any information available to help create a clear picture of an area's existing biodiversity at the scale and timeframe being considered should be included in the effort. Peck specifies the reasons for collecting existing information to create the baseline:

> The immediate need is to gain sufficient knowledge to make planning recommendations and decisions. A second reason is to test current ecological models and hypotheses…A third reason is to create baseline data for subsequent planning and monitoring…Lastly, the data will increase general understanding of area biodiversity. (115)

Additionally, as Ahren, Leduc and York discussed in *Biodiversity Planning and Design: Sustainable Practices*, one of the major challenges to measuring the actual impact of biodiversity planning is the lack of much methodical, detailed site analysis before project implementation. For example, not every project has funding to complete an existing biodiversity survey. Similarly, they go on to discuss the general lack of methodical, detailed impact analyses (monitoring, see below) after the plans have been implemented. Often, plan impacts are quantified with anecdotal evidence, but the lack of concrete measurements makes the information less reliable (4, 79).

Monitoring is the most challenging part of biodiversity planning. First, it is difficult to determine what to measure. According to Margules and Sarkar, total species diversity is the most commonly used surrogate. However, Elmqvist et al. suggest that measuring biodiversity alone will not produce the results that most biodiversity planners claim to be pursuing. In fact the research suggests that urbanization, for example, actually increases total biodiversity. Upon closer inspection, however, the reality is that the increasing biodiversity is not exclusively positive. Most often, the change is due to the introduction of non-native species. Non-native species are not necessarily harmful, but they are often not bioregionally adapted to the local climate. In other words, they require significantly more resources than native plants (128-33). The other challenge for ongoing monitoring is lack of funding and interest. Peck writes:

> Extended monitoring programs may also be less attractive to scientists…than short-term studies. The latter offer more rewards, for example, greater professional recognition, more possibilities for publication, and more access to available funding…Long-term or ongoing programs must maintain funding sources, consistency and quality in their data, and relevancy with the public. (148)

Unfortunately, the most critical aspect of biodiversity planning, with respect to providing a convincing argument for its importance and funding-worthiness, often gets left by the wayside. Even when it does not, picking a surrogate to measure an area's total biodiversity is not an easy task. It requires careful, precise monitoring. Rejoicing at an overall increase in total species may be the wrong response.

What Biodiversity Planning Might Look Like, 1

The plan will evolve in three parts. First as a regional plan, later as a site plan at the Heritage Orchard, and finally as a second site plan at the Mission Garden. Each plan will follow the four-step biodiversity planning process. For the all three plans, let's define biodiversity as agricultural biodiversity, specifically fruits and vegetables. For the regional plan, the scale will be southern Arizona, specifically the area added to the state by the Gadsden Purchase, because that's where the sites are. For all three temporal frameworks, let's go back to the Spanish arrival. Human beings have occupied southern Arizona for thousands of years, but using the Spanish arrival is a good point of departure because it marks a substantive change in agricultural practices and agricultural biodiversity in the region.

Between what archaeologists have uncovered and what the missionaries recorded, we know the types of plants and growing techniques employed by the local

Native Americans before the Spaniards showed up. Let's make the Native American crop selection our baseline. It is comprised of fruit and vegetable producing plants endemic to the region. To begin creating an image of how agricultural biodiversity has changed over the last 300 years we need to uncover as much historic information as is available: almanacs, correspondence and diaries, geologic surveys, newspapers, photographs, regional seed catalogs etc… We'll need to consult experts on the region, its climate, and its history. We need to know as much as possible about the different species that have been planted by the various groups that have occupied the region during the last three centuries because as tastes have changed, plants that might have done well previously may not currently be in favor. We also need to use the research to understand how the environment has changed during the last 300 years and how that has affected agricultural biodiversity. We need to know how the economy has changed too because it has also affected agricultural biodiversity. Once we have a sense of how things have changed in the region over the last 300 years, we'll need to establish some kind of goal. In order to do that, we need to find out what Arizona's climate is likely to be in the future. Perhaps we'll realize that the best option is not necessarily to increase the total number of different species being grown, but instead to shift agriculture toward species that are more suited to the local climate now and to what we think it might be in the future. Once our plan is adopted, the real work begins. Monitoring is going to require constant vigilance and a steady funding source. We'll have to track how our recommendations are being carried out and whether or not they're having the impacts we planned. Monitoring will help us make any changes, but more importantly, it

will establish a record that can be consulted, examined, shared, and after enough time, perhaps serve as a model for someplace else.

PRECEDENTS

Living History Museums

Living history museums have a core mission to provide the public with educational content. They fulfill their mission by actively attracting visitors.

Old Sturbridge Village, founded in 1946, has five different historical gardens, two of which are dedicated exclusively to displaying the agricultural biodiversity of early 19th-century New England. The gardens are designed to "exhibit plant types, gardening practices, and garden styles of the 1830s" (Heirloom Gardens). Their Bixby House kitchen garden "displays vegetable, herb, and small fruit varieties commonly cultivated in New England..." (Heirloom Gardens Old Sturbridge Village). Their herb garden includes over 400 individually labeled plants used during the 19th century for household, culinary, and medicinal uses. As part of their educational outreach, the museum is staffed with experts who care for the gardens, can answer visitor questions, and lead tours. Additionally, the museum sells its heirloom seeds in its gift shop, and it hosts an annual agricultural exhibition in September where visitors can show off the vegetables, flowers, and herbs they grew from the heirloom seeds (Heirloom Gardens Old Sturbridge Village).

Of course, it is difficult to measure the actual impact of the gardens at Old Sturbridge Village. However, anecdotal evidence, in particular the fact that the village has operated for nearly 70 years, suggests at least a certain level of success. Furthermore, the fact that the village creates the opportunity for continuous dialogue through its agricultural exhibition means that it can try to build awareness of agricultural

biodiversity's importance over time.

Unlike Old Sturbridge Village, the Heirloom Gardens at Old World Wisconsin are not designed to represent unique regional historical gardening. Instead, the gardens recreate the agricultural techniques and demonstrate plant varieties used by early migrants and immigrants to Wisconsin. In particular, Old World Wisconsin focuses on Danish, Finnish, German, Norwegian, and Polish settlers. Each group had specific gardening techniques and even specific preferred crops. Moreover, the gardens document how gardening practices changed as the different immigrant groups increased their wealth and became more assimilated.

Unfortunately, Old World Wisconsin does not package and sell seeds from the heirloom plant varieties it cultivates. Rather than encourage visitors to embrace regionally adapted plant varieties by giving them the opportunity to purchase and grow their own, Old World Wisconsin is a purely demonstrative endeavor. However, their historical gardener, Marcia C. Carmichael, published *Putting Down Roots: Gardening Insights from Wisconsin's Early Settlers*. Not only does the book provide in-depth detail about each garden at Old World Wisconsin, but it also provides information about the various, historical agricultural practices, techniques, and tools used onsite with the aim of providing environmentally friendly alternatives to contemporary gardeners. In this case, the shortcoming seems to be the assumption that visitors are already interested in regionally adapted heirloom plant varieties and that it is more important to pass on the historical agricultural techniques.

A Local Precedent

Although not initially under consideration, Tucson Botanical Gardens proved to be well worth the time I spent there. The Botanical Gardens are home to 17 specialty gardens designed to showcase various plant cultivars and design techniques. There are four historical gardens: the *Native American Crops Garden, Plants of the Tohono O'odham Path,* the *Prehistoric Garden*, and *Nuestro Jardín.* All four serve to educate Tucson residents and visitors about both the types of plants that have grown in the Sonoran climate for centuries and also how those plants have been and continue to be used by Tucson's various indigenous and ethnic groups. Furthermore, the Botanical Garden specifically works to educate local residents about the different plant cultivars appropriate for their Sonora Desert climate. There are gardens dedicated to teaching visitors about horticultural therapy, local wildflowers, and attracting birds, among others (*Tucson Botanical Gardens Visitor Guide and Map*). More than anything, Tucson Botanical Gardens is an educational intervention designed to promote biodiversity generally while focusing more specifically on appropriate, bioregionally adapted species. The quality of the gardens is not the Botanical Garden's only achievement. In addition to creating aesthetically pleasing gardens, the Botanical Garden provides clear and concise educational signage. The amount of information on any given sign is not overwhelming, but at the same time, there is enough information for someone to enter the Botanical Garden knowing absolutely nothing about the Sonora Desert climate and to leave with enough knowledge to start gardening in a responsible, biodiversity-promoting,

environmentally friendly way.

Figure 1 *Native American Crops Garden*

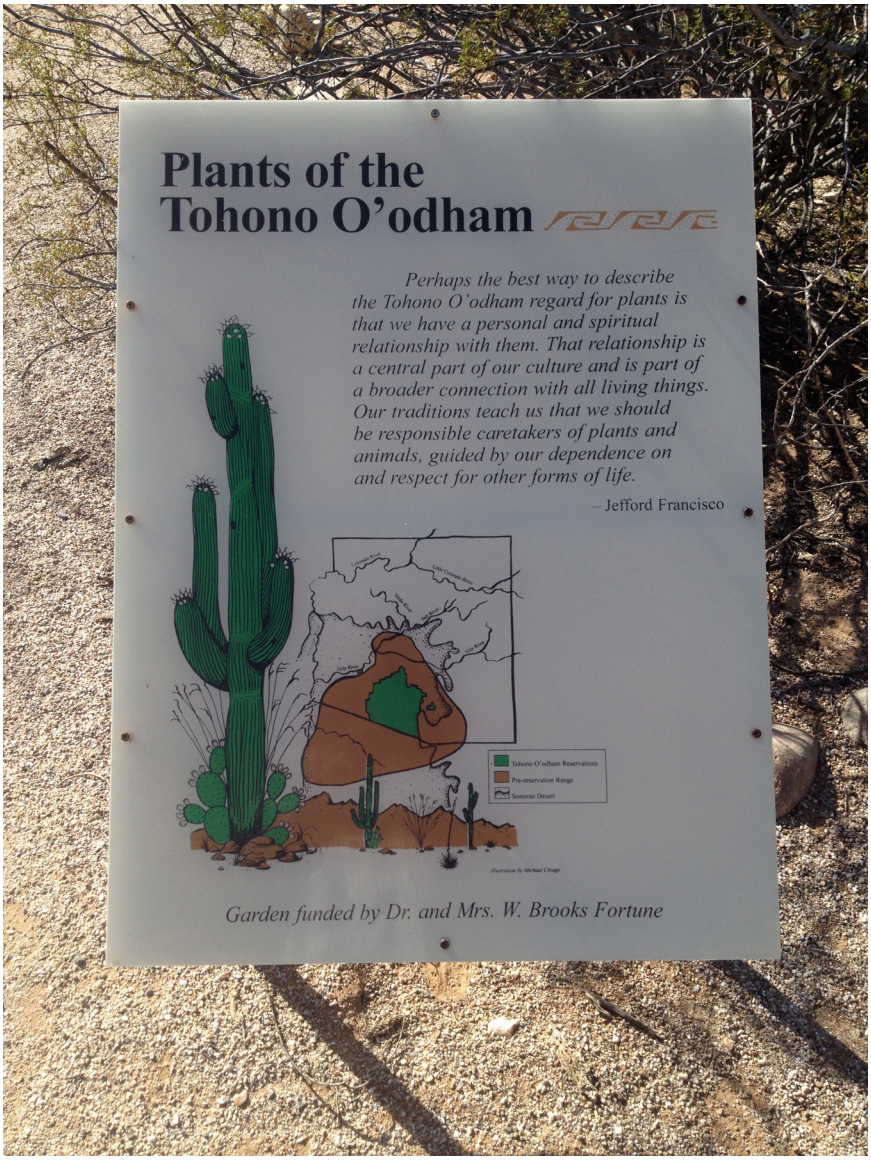

Figure 1 Informational Signage in *Plants of the Tohono O'odham Path*

Figure 2 Informational Signage outlining the benefits of passive rainwater harvesting.

Figure 3 Display garden promoting the efficiency of aquaponics.

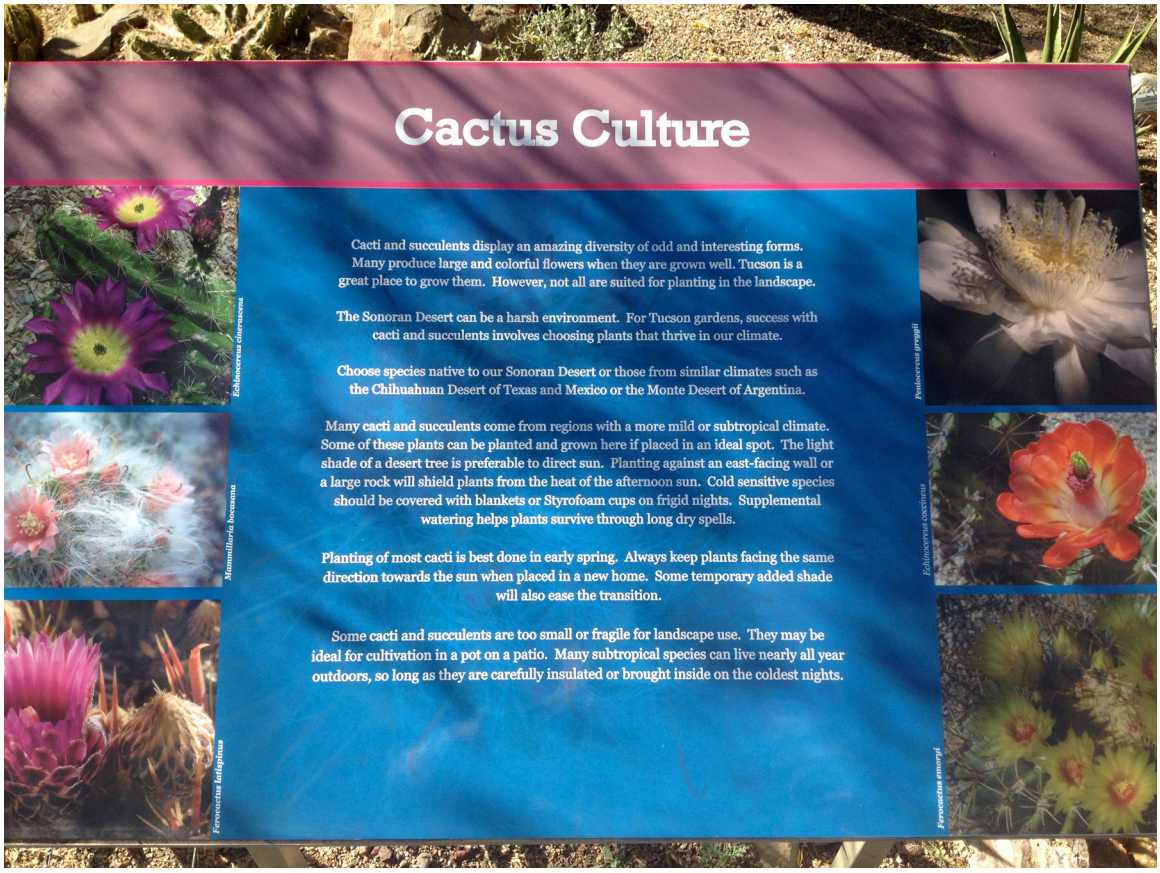

Figure 4 Informational signage explaining how to choose and grow cacti in Tucson. The sign specifically recommending species from the Sonoran Desert or similar climates like the Chihuahuan Desert.

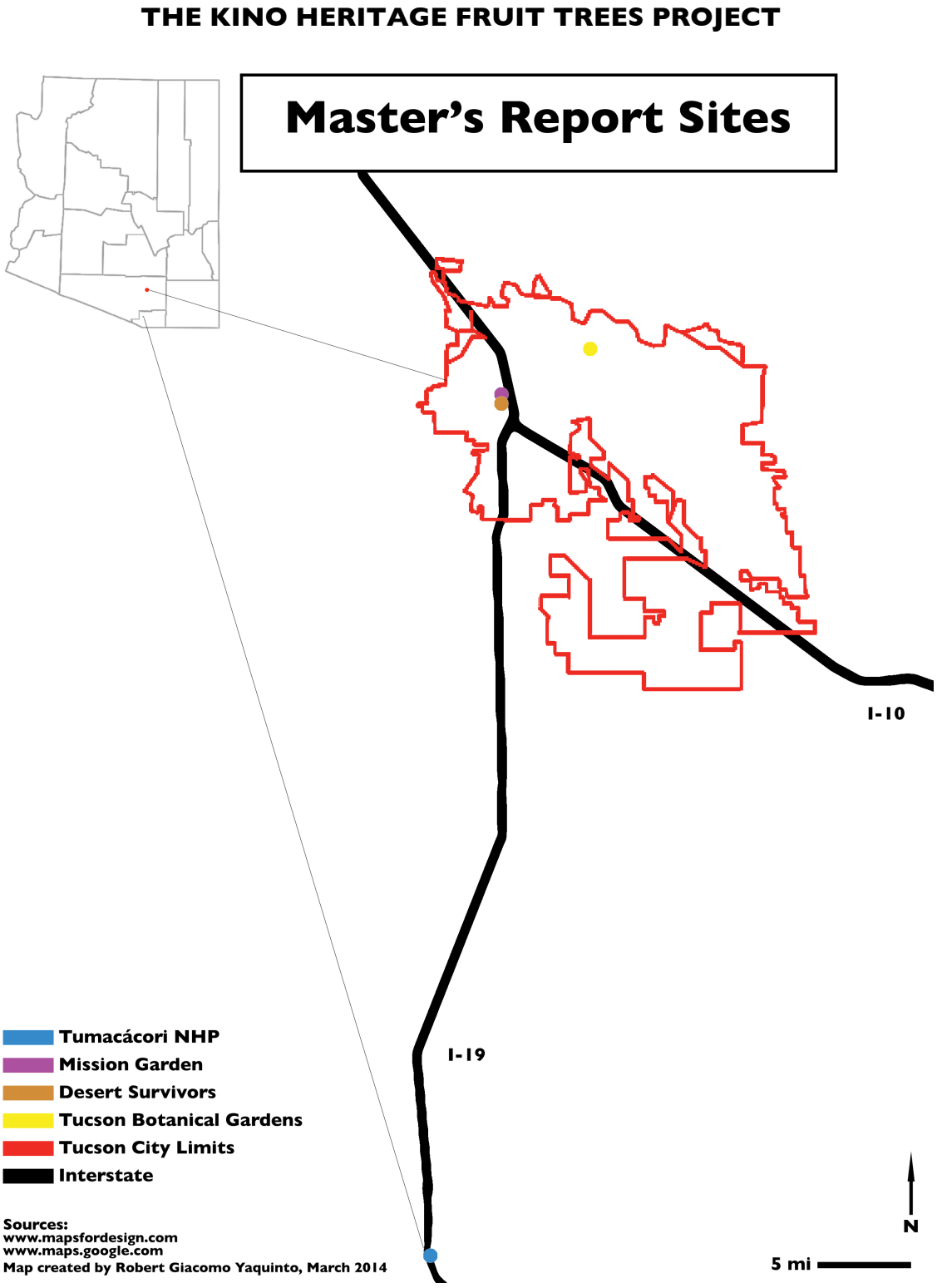

Figure 5 Map of Project Sites Visited

Padre Kino, Very Briefly

To begin with, it is worth knowing where the Kino project gets its name. Padre Eusebio Francisco Kino was born in the mid-seventeenth century in what is now northern Italy. He came to New Spain in 1681, and between 1687-1711, he established 24 missions and visitas between Baja California and the Pimería Alta, present-day northern Sonora, México and southern Arizona. Of particular relevance, he is often credited as the founder of modern agricultural and animal husbandry practices in the region ("Padre Eusebio Francisco Kino"). His legacy in the region extends into the present. Just south of Tucson, on the Tohono O'odham San Xavier Indian Reservation, a mission Kino established in 1692, Mission San Xavier del Bac, operated by the Franciscans since the mid-eighteenth century, continues to actively serve the indigenous community for whom it was built.

Kino Heritage Fruit Trees Project Backgrond

During the research process, I spoke with Jesús García, the Kino Project's driving force. García, an ecologist, works for the Arizona-Sonora Desert Museum, and I was curious about how he got involved with the project. The Arizona-Sonora Desert Museum is dedicated to protecting and promoting the Sonora Desert, so it seemed odd that they would also be working on non-native fruit trees. I was surprised to learn that it was mostly coincidental. One of Mr. García's friends, Robert Emanuel, a PhD student at the University of Arizona, was curious about the fate of the Jesuit missionaries' fruit trees. He applied for and received a grant from the National Park Service to find out. Another

of my questions was: Why Tumacácori? It turns out that re-establishing the mission orchard at Tumacácori NHP was part of the grant. The National Park Service awarded $10,000 to execute the investigation, and it was economically advantageous to funnel the grant through the Arizona-Sonora Desert Museum. Mr. García became involved when Mr. Emanuel was offered a job that did not allow him to continue overseeing the project. The Desert Museum administrators realized that Mr. García's background was perfect for the project. He grew up in an agricultural family in Sonora, México, and was intimately familiar with the region's traditional agricultural practices. While talking with Mr. García, he noted that Mr. Emanuel was not the first person to wonder about the Jesuit fruit trees. Initially unbeknownst to both Mr. Emanuel and Mr. García, someone at the Desert Museum had attempted to research the fate of the Jesuit fruit trees the late 1980s. They concluded that the trees were lost to history. Fruit trees have relatively short lives. Some live to be fairly old, about 100 years, but certainly not 300 years old. That being said, Mr. García knew an important detail that the researchers in the 1980s did not: the preferred method of propagation in the Sonora region is to use cuttings rather than grow new plants from seed. In other words, if someone wants a new tree, they grow a clone of the original. He specifically looked for 80-100-year-old specimens. Often, his searches took him into old ladies' backyards. As Michael Tortorello detailed:

> The tree would be a clone of the mother plant – or the grandmother. Now Mr. García could trace a tree's lineage back 100 to 150 years, to the days before Arizona's statehood. The missing link was the backyard gardeners who had watered the trees through the decades, passing a cutting to a child or neighbor. This would be someone like Adelina Áros, a 95-year-old woman who lived in (…) Menlo Park.
>
> Ms. Áros' backyard cuttings are now growing in the Mission Garden and at the nonprofit Desert Survivors nursery.

Mr. García looked for and researched plant cultivars between 2002-2007. He began propagating the plants, and in 2007, the Tumacácori Heritage Orchard was planted. Every cultivar is a heritage plant that was propagated from cuttings taken from ancient specimens Mr. García collected. So far, the Kino Heritage Fruit Trees project consists of the following species: Apple (Malus Sylvestris), Apricot (Prunus Armeniaca), Date (Phoenix Dactylifer A), Fig (Ficus Carica), Grape (Vitis Vinifera, V. Labrusca (A)), Olive (Olea Europaea), Peach (Prunus Persica), Pear (Pyrus Communis), Plum (Prunus Domestica, P. Sali Cina), Pomegranate (Punica Granatum), Quince (Cydonia Oblonga), Lime (Citrus Limettioides), and Orange (Citrus Sinensis). Some of the species collected have also been identified as cultivars, typically by the location in which they were found. For example, the Ruby Fig, the Ruby Pomegranate, the Garcia Camp Pomegranate, and the San Pedro Quince.

The Heritage Orchard

Figure 6 Entering the Heritage Orchard

Mr. García's direct involvement with the project at Tumacácori ended with the planting of the orchard. He was not involved in the site preparations, and he is not involved in the day-to-day maintenance of the orchard. To get a fuller picture, I interviewed Jason Wellborn, a former National Park Service employee who spent three years working in the Heritage Orchard. He is currently an Invasive Species Technician with the Nature Conservancy.

Mr. Wellborn did not start working at Tumacácori until 2010, which, according to Mr. García, is about the time that the orchard managers began to address some of

the orchard's challenges. Mr. Wellborn was able to give me additional background on the orchard site's modern history, preparation for planting, and insight into the orchard's management. The first issue I brought up was whether or not a biodiversity study had been conducted.

Like most projects, the funding was limited, so no biodiversity study was conducted before the orchard was planted. However, according to Mr. Wellborn, the orchard site has suffered from numerous disturbances over time, mostly from cattle. The site was most recently used to grow garlic and onions.

As part of the site preparation process, lots of new, clay-rich topsoil was brought in to amend the existing soil. Unfortunately, the clay's water retention properties have proved problematic. A soil scientist does not seem to have been consulted at the time the site was being prepared, so the orchard managers have been working since 2010 to amend the soil with volcanic rock.

The orchard has faced some additional challenges. Roughly every three years, the orchard becomes infested with grasshoppers. Mr. Wellborn helped implement an organic grasshopper control to combat the problem.

Both Mr. García and Mr. Wellborn noted that the altitude has been a challenge. Tumacácori is roughly 1000 feet higher than Tucson, so it is more susceptible to freezing temperatures. The originally planted Fig and Pomegranate varieties suffered because of the difference in climate. The orchard managers are currently working to replace them with more cold-hardy cultivars that Mr. García collected.

The orchard has also had to address irrigation issues. Initially, there were problems getting sufficient water to the trees farthest from the irrigation station. The first attempt to solve the problem was to increase the number of irrigation stations to three and increase water volume to the site. Today, a drip irrigation system has been installed to water each tree individually.

In terms of day-to-day maintenance, the orchard is cared for by the Tumacácori Committee, a group of 10-12 Master Gardeners. In addition to volunteering their time to maintain, prune, and fertilize the fruit trees, the Master Gardeners have also been involved in educating the public about the orchard.

Mr. Wellborn provided me with an interesting note about the site's appearance. I assumed the trees growing around the orchard made a rectangular shape because that is how the site was cleared. In fact, the orchard is planted in a section of the original orchard site. The reason the trees make a rectangle is because they are growing out of the old wall. Mr. Wellborn pointed out that the wall's footings retained moisture better than the surrounding soil, so they proved to be perfect for trees to establish themselves in the difficult growing climate.

Although there was not a baseline biodiversity study the park is interested in how biodiversity is being affected. In the recently planted herb garden (coincidentally called the Mission Garden, but unrelated the Mission Garden in Tucson) there has been a focus on planting historically appropriate herbs and flowers. Mr. Wellborn noted that flowers have been deliberately planted to attract pollinators, and even though they have

not begun scientifically measuring the impact, there is anecdotal evidence that the new plants are attracting more hummingbirds and butterflies.

My Observations and Experience at the Heritage Orchard

It would be easy to focus on the Heritage Orchard's missed opportunities. But that would be a rather shortsighted assessment. In talking with both Mr. García and Mr. Wellborn, the obvious issues are all related to funding, rather than lack of interest or effort. Every idea I suggested to improve visitor experience or provide visitors with richer information was either in the works or waiting for funding to be implemented. So with that in mind, the missed opportunities are minor, and they are all informational. For example, although there is a very nice informational sign at the orchard's entrance that very generally conveys how Mr. García brought the Kino project to fruition, there's no opportunity for anyone curious to find out more. The pamphlet the park provides for the self-guided tour does not add much additional information. During my visit, I noticed that none of the plants in the orchard are actually identified. For an informed visitor, it is easy to tell the difference between a fig and a pomegranate, but it is not as easy to know the actual cultivars. For a casual visitor, it may be impossible to distinguish one fruit tree from the next. It is clear that the orchard has an unusual planting scheme. As Mr. García explained to Michael Tortorello, "In a colonial orchard, there's no pattern." Rather than dividing the cultivars of fruit trees by row, they're mixed together. Unfortunately, there's nothing on-site to explain the logic behind the planting decisions. In his article, Mr. Tortorello goes on to point out that colonial planting schemes were

often designed to eventually create a continuous canopy that would provide shade for the missionaries. Finally, the information at the orchard and provided in the tour pamphlet does not make the connection that these cultivars are especially appropriate for local residents who wish to grow fruit trees. The orchard demonstrates a modern interpretation of an historical artifact, but it does not contextualize itself in the present day. It does not offer any information regarding how historic planting techniques might be applied in contemporary desert gardens. Similarly missing is an acknowledgement of the orchard's role in both expanding the local understanding of biodiversity and influencing Sonora Desert residents to choose bioregionally adapted plants over non-natives.

As an outsider and latecomer, of course, I have not had the opportunity to see how the project has developed over the last nearly seven years. And after talking with both Mr. García and Mr. Wellborn, I discovered that the preceding list of criticisms fails to acknowledge the significant progress that has been made. I noted earlier that it has only been recently that the orchard managers have been able to collect enough information to begin working through issues with climate, irrigation, and pest control. As Mr. García pointed out, sometimes the changes are slow, but they are always appreciable. It has only been recently that the informational signs at the orchard's entrance were installed. More significantly, the orchard is now wheelchair accessible. In fact, the whole park can be navigated by wheelchair. Although I have argued for more information to be on hand, making the park more accessible to more people is perhaps

more important. Lastly, providing more context is already in the works, and so is the plan to provide more programming. It is all a matter time.

What Biodiversity Planning Might Look Like, 2

Earlier, I offered an example of a provisional biodiversity plan for southern Arizona. The Heritage Orchard is a rich source of historical information within the region and a good site for especially in-depth and ongoing monitoring.

Padre Kino established the Tumacácori mission site at an existing Tohono O'odham site because of its proximity to the Santa Cruz River. The orchard site and surrounding area have been systematically farmed with varying intensity, for over 300 years. We generally know what's been grown on the site. The Tumacácori NHP's self-guided tour pamphlet notes that, "as recently as 1938, peach trees lined the mission acequia, stabilizing its banks and making use of moisture which seeped through its mud walls" (34). We also know that the area has been frequently disturbed by cattle and that it was previously planted to garlic and onions. Furthermore, we know the area has been susceptible to pest infestations fairly regularly in the recent past.

If we started digging and began to compile official records about weather patterns and pest infestations at the site, and looked for older, U.S. Geological Survey and other agencies' photographs to try and document changes in vegetation and the amount of development that took place near the site, we would begin to create the kind of objective accuracy that Fitch noted is an integral part of historic landscape

preservation. We could create a picture of how things have changed around Tumacácori over the last 150 years.

As it is, Google Earth has aerial maps going back to April 1992, and the U.S. Geological Survey's Earth Explorer has previews of aerial photographs of the orchard site's general vicinity going back to September 1951. Looking at these images the changes that have taken place are not obvious. Overall, the amount of vegetation seems fairly consistent between 1951 and the present. However, full-scale prints of the U.S. Geological Survey's images might reveal that even though the amount of vegetation stayed constant its component species changed significantly.

To travel back the remaining 150 years, we would need to consult official records, journals and ledgers kept by the missionaries and area farmers to find patterns and recurring ecological events. There is easily enough existing information to create the anecdotal biodiversity baseline I suggested earlier, in this case it would be site specific, and begin using the orchard's relationship to the surrounding region to begin outlining biodiversity goals for the future.

Even if the replanted orchard only benefits the surrounding ecosystem, the impact needs to be scientifically tracked over a sustained period of time. In terms of using the site to help build a regional picture, the site is important because it sits at a relatively high elevation. It faces different weather-related challenges than other growing areas in the region. Its elevation also means that the site might be able to support plants that cannot be easily grown in other parts of the region.

Regardless of what the orchard's impact is (good, bad, or neither), collecting the information gives biodiversity planners, proponents, and detractors an opportunity to discern whether or not their efforts are having the desired effects, what they might change to improve their efforts, or in a worst-case scenario, that their efforts have negatively impacted the site or failed to impact the site at all and they need to completely rethink their approach to the problem. Most importantly, after establishing an ecological, biodiversity history of the site and tracking the impacts of contemporary changes, the information can be shared with the public as part of the park's visitor interpretation and education program. Even if, from a biodiversity planning perspective, the effort fails, the information collected is no less valuable. By providing an interpretation of the observational information and project assessment to visitors, Tumacácori NHP has yet another level on which to engage visitors and the surrounding community and entice them to take an active role in the biodiversity conversation.

Friends of Tucson's Birthplace's Mission Garden

Figure 7 Looking Northwest toward Downtown through the Kino Heritage Fruit Trees in the Mission Garden.

Mission Garden Project Background

Unlike the Heritage Orchard at Tumacácori NHP, the Mission Garden is a privately funded endeavor. It was not supposed to be. During my research, I corresponded with William (Bill) O'Malley of the Friends of Tucson's Birthplace. Friends of Tucson's Birthplace was established in 2009, and it has an agreement with the City of Tucson and Pima County to operate and maintain the Mission Garden (*Mission Garden and the Friends of Tucson's Birthplace*). Mr. O'Malley explained that the Mission Garden was

originally part of a larger project, the Tucson Origins Heritage Park, and that both were part of a voter-approved project called Rio Nuevo. Unfortunately, all three ended up in the dustbin after the economy collapsed in 2008. According to Mr. O'Malley, the fact that the Rio Nuevo project, along with the smaller projects connected to it, had been scrapped caused frustration and outrage among Tucson residents. From their perspective, the "tax dollars [that] had already been spent on unseen projects (archaeology, landfill remediation, architectural plans…, interpretive research…)," could not just go to waste. Before it abandoned its plans for the garden, the City of Tucson built the site's adobe brick wall. Between the formalization of the site and the public's interest in making sure that something valuable came out of the work that had already been done, Mr. O'Malley believes that, "the public was therefore very well disposed to support the grassroots effort to bring at least the garden plans to fruition. This initial community support assured the Friends that the undertaking was worthwhile and it encouraged them to carry on." I was particularly interested in how the Friends of Tucson's Birthplace promoted the Mission Garden to donors and other supporters, preservationists particularly. Often justifiably so, living history museums do not have the best reputations with traditional, conservative preservationists. What is more, in the Mission Garden's case, the preservation that's happening is completely intangible. The garden is focused on plant varieties and growing techniques that have been used by Tucson's inhabitants over the course of 4000 years. Their mission statement reads, "Our mission is to preserve, honor, protect, restore and promote the cultural heritage of Tucson's Birthplace at the foot of Sentinel Peak ('A' Mountain)" (Friends of Tucson's

Birthplace). I assumed that ginning up broad support among Tucson's preservationists would have been laborious. To my surprise, Mr. O'Malley responded:

> Scholars and authorities interested in preservation support the project wholeheartedly, in part because it embodies the ideal venue for sharing and conveying the important archaeological findings on the site and in its vicinity that shed light on the local evolution of agriculture. Human culture has been an integral part of this landscape for more than 4,000 years. Although the colonial and post-colonial impacts on agriculture here are extremely significant and diverse, they are but the tip of the iceberg.

After perusing the Friends of Tucson's Birthplace's website, I wanted to know more about their perspective on community outreach. The website outlines partnerships with the University of Arizona, Native Seeds/SEARCH, and Manzo Elementary School among others. Mr. O'Malley responded:

> Helping people understand and appreciate their cultural and environmental heritage enables them to feel connected to the community in deep and meaningful ways. It makes them better prepared and more inclined to participate and contribute to reinforcing and building on these community ties.

Along similar lines, I was also interested in the specific types of outreach the Mission Garden plans to offer. Specifically I was curious whether or not the Mission Garden would work to promote historical cuisines and whether or not the garden eventually hoped to generate enough surplus produce to have its own farm stand or supply local restaurants. Mr. O'Malley told me, "Friends of Tucson's Birthplace has already begun to recover some nearly forgotten culinary traditions related to the celebrations of harvesting seasonal crops, and it aims to continue and increase these activities." Regarding surplus produce, Mr. O'Malley said that, "Much of the produce is used for educational purposes and on-site tastings [, but] some surplus produce is being sold at

the Community Food Bank Santa Cruz Farmers' Market at the nearby Mercado San Agustín."

Mission Garden

In 1701, Padre Kino established the visita that eventually became San Augustín. The Mission Garden is located on the exact spot of the San Augustín mission's garden. The garden covers four acres and is surrounded by reconstructed adobe walls. Like the Tumacácori Heritage Orchard, it is located near the Santa Cruz River bank. Unlike the Tumacácori Heritage Orchard, extensive archaeological excavations have found agricultural remains dating back to 2100 B.C.E. The site is believed to be the longest continuously inhabited location in the United States (*Mission Garden and the Friends of Tucson's Birthplace*).

According to additional information provided in *Mission Garden and the Friends of Tucson's Birthplace*, the plan is for the site to eventually have a series of timeline gardens representing the Early Agricultural and Archaic period farmers (2100 B.C.E – 50 C.E.), Hohokam farmers (500 – 1450 C.E.), and Tohono O'odham farmers (1450 – 1692 C.E.). As of my visit, Friends of Tucson's Birthplace had recently completed the initial season of both the Hohokam and Tohono O'odham gardens, but both are still being developed. The informational handout also details plans to establish gardens representative of Tucson's various immigrant groups: Spaniards, Mexicans, Yaquis, Chinese, African-Americans, and Anglo-Americans, but as of my visit, none had been planted yet. Lastly,

there are plans to build an interactive learning ramada to conduct hands on educational courses.

In March 2012, Friends of Tucson's Birthplace planted over 120 Kino Heritage Fruit Trees. Similar to the Tumacácori Heritage Orchard, the Mission Garden also began by planting a small selection of the Kino Heritage Fruit Trees. They are currently growing Apricots, Figs, Pomegranates, and Quinces. They have also planted an experimental vineyard, and they have plans to install an olive orchard. Unlike the Tumacácori Heritage Orchard, the Mission Garden's orchard is not planted on a grid, so it is easier to get a sense of the traditional missionary orchard management. Because of the way the plants are clustered, it is easier to imagine how the trees will eventually grow to provide a shade canopy. Additionally, learning from the challenges that the Tumacácori Heritage Orchard faced, the Mission Garden has been able to avoid irrigation issues by adopting drip irrigation right away. Also, because they are 1000 feet lower than Tumacácori, they have not had to deal with the challenges posed by more frequent freezing temperatures. Arguably, these advantages have made their fruit trees more productive sooner. During my visit it occurred to me that if I did not know beforehand, I might not have guessed that there was a five-year spread between the planting at Tumacácori Heritage Orchard and the Mission Garden's planting. Finally, perhaps because of the Mission Garden's intense focus on community outreach and education, each plant in the orchard (the entire garden actually) was identified. Anyone could visit the orchard and know definitively whether or not they were looking at a quince tree or an apricot tree.

My Observations and Experience at the Mission Garden

The friends of Tucson's Birthplace Mission Garden is an interesting embodiment of cultural landscape preservation practices. It is located beneath Sentinel Peak, also known as "A" Mountain, on the edge of the low-income Menlo Park neighborhood. Most of the four acres is waiting to be developed, so it takes a little imagination to really understand the Friends of Tucson's Birthplace's goal. That said, the Friends of Tucson's Birthplace appear to be laying the groundwork for what will eventually become a significant piece of historic cultural landscape preservation education. They are the only living history museum dedicated exclusively to Southwestern agricultural history. According to Mr. O'Malley, they are currently working to develop "signage, printed materials, and audio-guides for interpreting the cultural and environmental aspects of the garden site and surrounding region." They are already making major strides, but they have larger goals. According to their website, the group expects the Mission Garden to attract between 70,000-100,000 visitors annually, no small accomplishment considering that Tucson is home to both the Tucson Botanical Garden and the Arizona-Sonora Desert Museum.

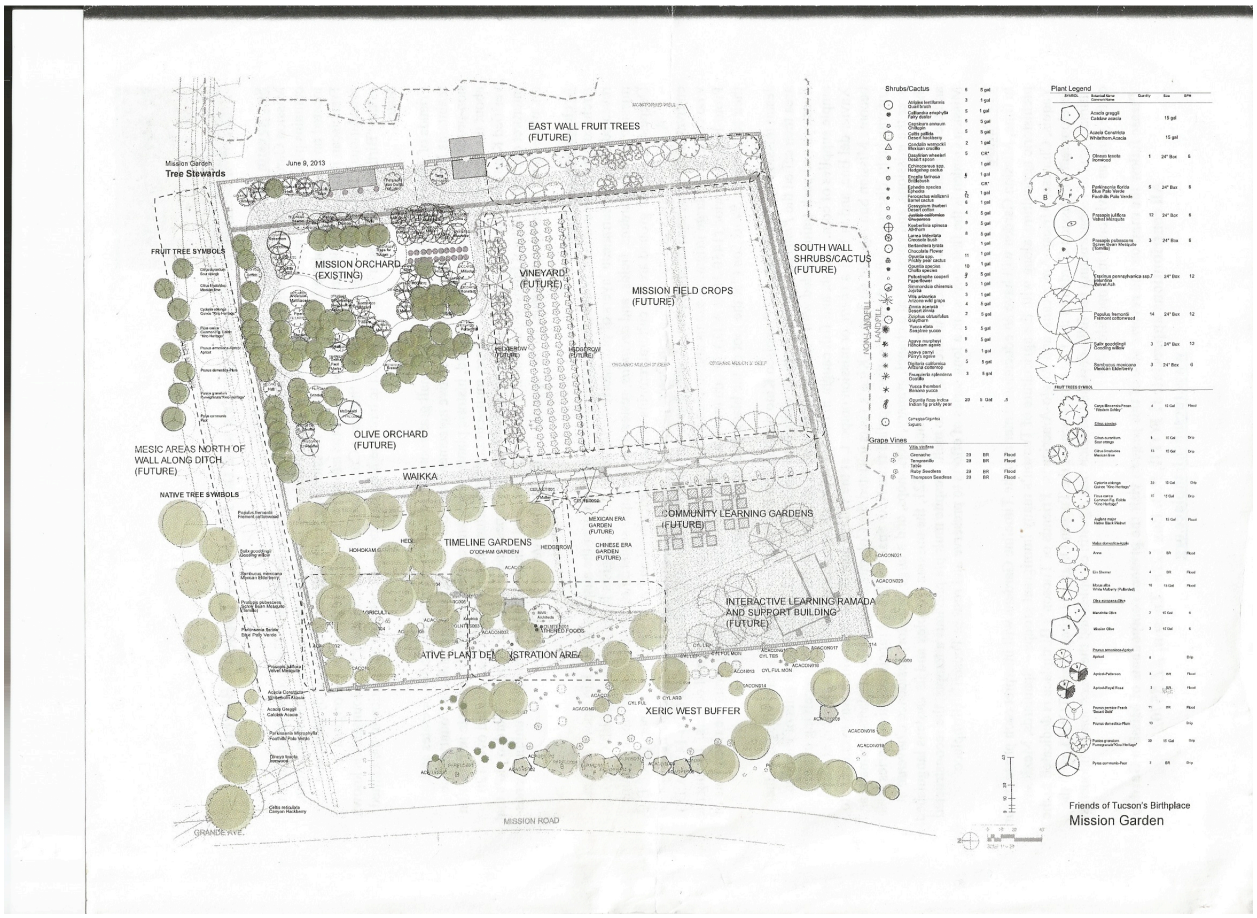

Figure 8 Mission Garden Site Plan, showing both existing and future gardens.

What Biodiversity Planning Might Look Like, 3

The Mission Garden, like the Heritage Orchard, represents another point of study within our biodiversity plan's defined region, southern Arizona. Unlike the Heritage Orchard, the Mission Garden plans to recreate Tucson's agricultural practices and agricultural biodiversity for the last 4000 years. Their experiment will provide an unparalleled look at southern Arizona's ability to support agricultural biodiversity.

There was not a formal biodiversity study conducted as part of the Mission Garden's site preparation. However, the extensive archaeological excavations

conducted are a rich source of information in terms of how agricultural biodiversity shifted over an extremely long timeframe. That information will help contextualize information about more recent weather patterns and pest infestations. Mr. O'Malley noted that the garden's site was vacant for most of the 20th century. With U.S. Geological Survey photographs, historic photographs, and aerial photographs we could document changes in vegetation and development near the site. We could begin to achieve Fitch's objective accuracy. It might be especially enlightening to seek out any correlations between shifting development patterns and the health of the Santa Cruz River. The picture could be further enhanced by any journals or ledgers kept by the missionaries at San Augustín and local farmers. However, unlike the Tumacácori Heritage Orchard, and even though we're only looking at the last 300 years, the 4,000 years of agricultural history on hand make reaching objective accuracy seems like less of a challenge.

In any case, if we simply use total biodiversity as our measure, the Mission Garden has succeeded in increasing it for the time being. However, immediate gains are not enough, and the Mission Garden has bigger goals. Successful biodiversity plans work to create some form of constancy. To that end, Mr. O'Malley pointed out that they "are currently in the process of documenting all the existing flora and fauna on the site." It will be interesting to see how they track biodiversity over time, what kinds of patterns they find and whether or not they discover any recurring events like the grasshopper infestation at Tumacácori Heritage Orchard. The Mission Garden is bound by the same reasons as the Heritage Orchard to track and report its findings about how the site

affects local biodiversity. However, it almost seems more important to track biodiversity at the Mission Garden because it is going to be planting so many more species, especially ones that have been cultivated in the past but are no longer being cultivated. Because the Mission Garden will be planting so many different fruits and vegetables, they will have a unique chance to influence local gardeners. The Mission Garden's location and history make it an excellent point of study as a complement to the regional plan. Its grassroots nature and emphasis on education will allow the Mission Garden to reach a wide audience and draw them into the biodiversity conversation. But ultimately their biggest impact will come from how well they track biodiversity moving forward and how they convey their findings.

Desert Survivors

Desert Survivors may seem like an odd inclusion. It is a nursery, not a living history museum. It's also where the loop closes. Visitors can learn about bioregionally adapted plants at the Heritage Orchard and the Mission Garden. They can go home and do their own research to draw their own conclusions. But when they're ready to make the transition from thinking to acting, Desert Survivors is where they will go.

Tucson psychologist Dr. Joseph Patterson founded desert Survivors in 1981. He saw it as an opportunity to fulfill his patients "need for meaningful activities and occupations to provide dignity and purpose in their lives" while also fulfilling growing local demand for native plants (*Desert Survivors*). Desert Survivors describes itself as "provid[ing] community-based work and developmental encouragement in homes and

group settings for people with a wide range of abilities, toward realizing the full potential for each individual" (*Desert Survivors*).

Since its founding, the nursery's focus has been exclusively native plant species. The nursery limited its focus because "Native plants give us a sense of place, and are important to supporting native pollinator populations and fauna" (*Desert Survivors*). According to Desert Survivors, Arizona is the third most biodiverse state in the country, and there are nearly 3000 native plant species within 50 miles of the nursery. With that in mind, it was surprising to learn that Desert Survivors plays an integral role in the Kino Heritage Fruit Trees project.

I corresponded with Jim Verrier, the nursery director, to find out why the nursery took on the Kino project. I was surprised to learn that the nursery is relatively small. I had thought it must be a largish commercial operation because it had taken on the role of main propagator (Native Seeds/SEARCH also helped propagate) for the Kino project. However, Mr. Verrier pointed out that, "We are a small four acre nursery with five horticulturists on our nursery staff."

I corresponded with Mr. Verrier before I visited Tucson, so I needed him to help me understand what the nursery was and what it did. What struck me about our correspondence was that I got the sense that Mr. Verrier does not see Desert Survivors as a landscape preservation operation. I asked whether or not the nursery was involved in any other preservation programs similar to the Kino project and he directed me toward Native Seeds/SEARCH. Native Seeds/SEARCH is more specifically focused on

heirloom crop seeds, specifically species native to the Southwest that are culturally significant to its indigenous populations. At the same time, Mr. Verrier wrote:

> Selling native plants gives people a sense of place, and supports pollinators and wildlife (to a more limited extent in cities). Tucson may be unusual in that there is a high demand for native plants, which I can only hope that we have helped to grow (…) Many of our customers show a strong interest in cultivating some of our rare or threatened (…) plants, sort of acting as a backyard repository.
>
> We want to offer a specialty niche of plants that are adapted to our area, and plants that serve an important role in our ecosystem (insects, birds, animals, etc). Our mission statement is best served by increasing our native diversity.

Mr. Verrier outlined a purpose and set of goals that would be perfectly at home describing the purpose and goals of any Melnick-inspired landscape preservation project. Maintaining a sense of place is only possible if there is an awareness of the place's history, in this case, its plant history. Moreover, focusing on plants that serve an important role in the local ecosystem requires an in-depth knowledge of the area's biodiversity and a sense, if not an explicit plan, about the effort necessary to keep everything fully functional. Additionally, Desert Survivors' community outreach is arguably another form of preservation. They work to maintain community integrity. Based on my understanding of the operation, I would argue that Desert Survivors is a vanguard embodiment of how preservation and biodiversity planning can come together to successfully impact the local community.

QUANTIFYING THE BENEFITS

Biodiversity planning is difficult, it is expensive, and it requires lots of time up front and a commitment to long term monitoring afterward. Right now, the lack of good, long-term data makes it hard to know whether or not biodiversity planning efforts are worth the expense. Lévêque and Mounolou provide two arguments in favor of continuing biodiversity planning efforts. The first is purely economical. They write:

> Since the 1980s, attention has turned to the economic value of biological diversity, both as a source of genetic resources for agriculture, and for its industrial uses…In this context, biological diversity is seen as a potential source of revenue, in particular for the developing countries, providing an *in fine* justification for interest in its conservation. If we fail to take the necessary measures, we shall lose the opportunity to derive profit from the potential benefits that biological diversity may bestow upon humanity. (227)

The second is more of a moral argument. Lévêque and Mounolou argue:

> It is now widely recognized that biological diversity plays a significant role in maintaining the major equilibriums of the biosphere. Biological diversity is involved in the water cycle and the major geochemical cycles, including the carbon and oxygen cycles. It contributes to the regulation of the physical/chemical composition of the atmosphere, influences the major climate equilibriums, and thus impacts the conditions of life on earth. All ecological functions are a product of the complex relationships among living species. (227)

For reasons beyond its control, border violence in particular, Tumacácori NHP has seen its annual visitation decline substantially since peaking around 80,000 annual visitors in the mid-1970s. The park's annual visitation has remained below 40,000 since 2010 and has not risen above 50,000 since 2003 (*Tumacácori NHP Annual Park Recreation Visitation Graph (1904-Last Calendar Year)*). However, even with fewer visitors, the park continues to have impressive economic impacts. According to the *Economic Benefits to Local Communities from National Park Visitation, 2011* Tumacácori NHP's 33,740 visitors in

2011 spent $1,250,000 that supported 16 jobs in communities within 60 miles of the park. The recently published *2012 National Park Visitor Spending Effects* report credits Tumacácori NHP's 35,158 visitors in 2012 with spending $1,891,900 that supported 26 jobs in communities within 60 miles of the park. 2011's visitor spending equates to roughly $37 per visitor coming into the local economy. 2012's visitor spending equates to roughly $54 per visitor coming into the local economy. Similar reports from 2007 and 2009 show that even though Tumacacori NHP has fewer visitors today, their visitors are spending more and having a generally larger impact on the local economy. In 2007 the park's 45,484 visitors spent $1,858,000 that supported 35 jobs in communities within 60 miles of the park (*Visitor Spending and Payroll Impacts, 2007*). Their spending equates to roughly $41 per visitor coming into the local economy. In 2009 the park's 40,637 visitors spent $1,369,000 that supported 18 jobs in communities within 60 miles of the park spent. Their spending equates to roughly $34 per visitor in the local economy (*Economic Benefits to Local Communities from National Park Visitation and Payroll, 2009*).

Projects like the Heritage Orchard should be seen as amenities that will increase a park's value by drawing more visitors. Based on the information provided to park visitors, Tumacácori NHP's visitors are interested in the site's history, its history within the context of Arizona's history, and the site's history within the context of American history. The Heritage Orchard makes Tumacácori NHP a richer experience. It shows visitors how the missionaries survived in a difficult environment, how Padre Kino

revolutionized agricultural practices in the region, and the impacts of Spanish heritage on American history.

Ongoing biodiversity monitoring should be seen as part of the enrichment the Heritage Orchard has to offer. More importantly, it should be a standard part of the Orchard's management. The Heritage Orchard's trees are already monitored for health, so adding basic biodiversity monitoring to the existing landscape management plan should not require much extra work. Any extra effort is justifiable because providing visitors with information about the Orchard's impacts gives them a better learning experience. It shows them why biodiversity is important, it gives them the information they need to consider how it may apply to their own gardening practices, and because they can purchase the Kino trees from Desert Survivors, the opportunity to participate by planting the same fruit trees at home.

The Friends of Tucson's Birthplace's Mission Garden is just getting off the ground, so there are not any numbers yet. However, the Friends of Tucson's Birthplace believe the Mission Garden will draw between 70,000 – 100,000 visitors annually ("Mission Garden Project"). Assuming they spend roughly the same amount as the visitors to Tumacácori NHP, that's potentially an additional $5.4 million coming into the local economy that might support an additional 73 jobs. More so than Tumacácori NHP, Mission Garden visitors will be coming specifically to learn about raising fruits and vegetables in the Sonora climate. They will want to know how different techniques benefit both crop production and the environment. They'll be especially interested in bioregionally adapted plants. In order to provide them with the best possible

information, ongoing biodiversity monitoring has to be part of the equation. The Mission Garden has already started the process, and since the gardeners will already be tracking crop successes and failures, adding biodiversity monitoring to the information gathering process should not require much additional work.

There are potential benefits beyond the local impacts. The Heritage Orchard is just one of many historic landscape preservation efforts run by the National Park Service. Biodiversity Planning's greatest challenge is generating enough information over a long enough period of time to determine whether or not it is having the desired effects on the environment. The National Park Service is uniquely situated to gather that information over a broad range of ecological systems. If the National Park Service made biodiversity monitoring a standard practice in all of its historic landscape preservation efforts, biodiversity planners could begin to really understand what, if any, impacts their efforts are having. With the potential to impact nearly 30% of the green space in cities, draw a broader audience into the biodiversity planning discussion, and potentially begin to really understand how biodiversity planning works, the effort seems minimal.

BEYOND THE KINO HERITAGE FRUIT TREES PROJECT

The Kino Heritage Fruit Trees project would not have come to fruition without backyard repositories. Jesús García took cuttings from plants in people's backyards because they were not available anywhere else. I have already mentioned Elmqvist et al.'s statistic suggesting that nearly 30 percent of green space in cities is held as private garden space. Of course, the Kino project is just one project, but its success in creating a living link to the Jesuit missionaries and their profound impact on agricultural practices in southern Arizona should be enough to push a genuine reconsideration of how biodiversity planners approach their difficult task. Most places will never have their own living history museum, and it is highly unlikely that anyone else will be able to execute a project quite like the Kino Heritage Fruit Trees project. The set of factors, local agricultural practices in particular, that came together to make the project possible will not be easily reproducible. That said, an avenue of access to local gardens that has been catching on recently is seed libraries and seed swaps. Seed libraries and seed swaps represent a slightly different approach to addressing biodiversity issues.

Seed Libraries

Seed libraries make their seeds available to anyone, generally, but not always, free of charge. In Berkeley and the surrounding area, residents can visit the Bay Area Seed Interchange Library (BASIL) to check out seeds for free. Like many seed libraries, at the end of the growing season, the seeds must be replaced with ones gathered from the new harvest. As Amanda Kimble–Evans writes in "Checking Out Seed Libraries," "Unlike

a seed bank, the libraries are living collections that change every time a gardener returns seeds. Because each grower saves seeds from the most productive, healthiest plants, the varieties become more adapted to the specific bioregion with each generation." Thus, not only do seed libraries help preserve biodiversity, but they also help create the very plants that are specifically adapted to the library's bioregion.

Seed libraries also serve in the preservation of historic cultural practices. In "Native Farmers Gather – Form Seed Library," Winona LaDuke writes about the seed sharing efforts being made by Native Americans in the Great Lakes region in both Canada and the United States. "For 14 years, Caroline Chartrand, a Métis woman who traveled from Winnipeg to the [annual Great Lakes Indigenous Farming Conference]…has been looking for heritage seeds of the Métis people of Canada. It is believed that in the 1800s the Métis grew some 120 distinct seed varieties in the Red River area. Of those, Caroline says, 'We ended up finding about 20 so far.'" Native American tribes are working with the White Earth Land Recovery project, Seed Savers Exchange, and other organizations to both preserve existing agricultural practices and reintroduce historic agricultural biodiversity to enrich themselves both nutritionally and culturally.

In New York, the Hudson Valley Seed Library is working to both maintain and expand the diversity of regionally adapted plants, specifically heirloom seeds with histories rooted in the Northeast (Williams 64). To promote their goal, the Hudson Valley Seed Library commissions artists to design unique packaging for the seeds they sell. According to Ken Greene, co-owner of the operation, the idea was "inspired, in

part, by the beautiful artwork in antique seed catalogs" (Williams 66) Greene goes on to say, "Seeds are living histories, and seed-saving gardeners play an essential role in keeping those histories alive" (Williams 69).

Seed Swaps

Seed swaps are typically informal gatherings of gardeners to exchange seeds they have grown. The emphasis is not necessarily on creating or promoting regionally adapted plant varieties as much as it is on creating the opportunity to grow new plants. However, as Mike Szuberla, coordinator of the Toledo Grows seed swap noted, "Seeds are, in a sense, suitcases in which people can transport their cultures with them." He goes on to say, "The word 'culture' is linked to the word cultivation, which means preparing the soil for planting" (Lane E1).

The Seed Ambassadors Project in Sweet Home, Oregon, occupies an interesting space between being a seed bank, a seed library and a cultural preservation organization. The people involved with the project travel the world looking for new plant varieties to bring back and adapt to the Oregon climate. At the same time, they offer classes on saving seeds and the importance of increasing agricultural biodiversity. Additionally, they conduct and promote seed swaps to increase access to a diverse range of bioregionally adapted plant species. Finally, they occasionally publish updated editions of *A Guide to Seed Saving, Seed Stewardship & Seed Sovereignty*, a free zine and "how to" guide about the importance of saving and distributing seeds. For them, not only preserving but also increasing agricultural biodiversity is as much an environmental issue as it is a cultural

one. They argue that plant and seed knowledge is equally important to biodiversity, and that it is impossible to have one without the other. To fund the Seed Ambassadors Project, the founders created Adaptive Seeds, a seed catalog dedicated to "steward[ing] & disseminat[ing] rare, diverse & resilient seed varieties for ecologically-minded farmers, gardeners & seed savers" (Still). In terms of vigorously working to increase bioregionally adapted plants by not only saving seeds but also ardently searching out new plant varieties from around the globe, the Seed Ambassadors Project and Adaptive Seeds represent an ideal, grassroots cultural and biodiversity preservation operation.

Is Saving Seeds Really Preservation too?

Saving seeds in the name of biodiversity is well and good, but is it really preservation? Historical and cultural landscape preservation are recognized and included within the accepted realm of traditional historical preservation efforts. Seed saving, on the other hand, occupies a more ambiguous area. Rather than preserving a specific landscape with cultural or historical significance, saving seeds asks preservationists to believe that the seeds themselves carry both cultural and historical value. For some groups like the Native Seeds/SEARCH, that is their core philosophy. Of course, like anything else up for preservation, the question becomes which seeds are valuable and which are not? Right now, most of the seed saving efforts are focused on open pollination, heirloom plant cultivars. The fact that the plant cultivars are considered to be heirloom seems to suggest either cultural or historical value, at least within a bioregional context, but what about hybridized plant seeds and genetically altered seeds? Arguably, those seeds

represent significant historic achievements. Even if everyone were to agree that the hybridized and modified plant varieties are too new today, should they eventually be considered worthy of preservation? Seed saving, at least when considering it as a form of landscape preservation, pushes traditional preservation into environmentalism. It is not uncharted territory for preservationists, but it is perhaps uncomfortable. Preservation, in any form, is environmentally beneficial, but it is often not carried out for specifically environmental reasons. Seed saving and the effort to increase and restore biodiversity, however, would require preservationists to make environmentalism a core component of their effort. At the same time, it would create an opportunity to bring environmentalists more fully into the realm of preservation, and that seems like something worth embracing. After all, organizations like Desert Survivors have already bridged that gap, even if they understand their efforts slightly differently.

CONCLUSION

It is worth repeating, biodiversity planning is hard. It takes an enormous amount of time, effort, and funding to do it well. Historic landscape preservation efforts, specifically living history museums like Old Sturbridge Village and Old World Wisconsin and the Tumacácori Heritage Orchard and the Mission Garden have played and will continue to play a strong role in promoting and educating the public about biodiversity. More importantly, they represent a novel solution to ongoing monitoring, the apparent killer of many biodiversity planning projects. Friends of Tucson's Birthplace's Mission Garden is already working to create a biodiversity inventory. If the Heritage Orchard, similar National Park Service operations, and living history museums around the country began a similar effort, they will eventually amass definitive evidence about the impact of biodiversity planning efforts. For the Tumacácori Heritage Orchard and the Mission Garden, things are just getting started, and both sites' plans for the future are encouraging. In the meantime, living history museums, seed libraries and seed swaps, and Desert Survivors should remain focused on promoting biodiversity and ecosystem health in the garden. In terms of preservation, these ongoing efforts will help preservationists to broaden their understanding of landscape preservation, and they will strengthen the growing ties between preservation and environmentalism. More importantly, they will bring a much wider audience to the biodiversity discussion.

Works Cited

Ahern, Jack, and Elizabeth Leduc & Mary Lee York. *Biodiversity Planning and Design: Sustainable Practices*. Washington: Island Press, 2006. Print.

Carmichael, Marcia C. *Putting Down Roots: Gardening Insights from Wisconsin's Early Settlers*. Madison, WI: Wisconsin Historical Society Press, 2011. Print.

Dean, Adam Wesley. "Natural Glory in the Midst of War: The Establishment of Yosemite State Park." *Civil War History* 56.4, 2010: 386-419. *Project MUSE*. Web. 26 Feb. 2014.

Desert Survivors. Desert Survivors Inc., n.d. Web. 5 Mar. 2014.

Ducarme, Frédéric and Gloria M. Luque and Frank Courchamp. "What are 'charismatic species' for conservation biologists?". *BioSciences Masters Reviews*, July 2013: 1-8. Ecole Normale Supérieure de Lyon: Département de Biologie. Web. 24 Feb. 2014.

Elmqvist, Thomas, et al. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities.* New York: Springer, 2013. Print

Fitch, James Marston. *Historic Preservation: Curatorial Management of the Built World.* Mc-Graw-Hill, Inc. 1982. Charlottesville, VA: The University Press of Virginia, 1990. 261-92. Print.

Friends of Tucson's Birthplace. Friends of Tucson's Birthplace, n.d. Web. 4 Mar. 2014.

García, Jesús. Personal interview. 28 Jan. 2014.

Gillis, Anna Maria. "Nature's Witness." *Humanities* 32.2 (2011): 28-33. Religion and Philosophy Collection. Web. 26 Feb. 2014.

"Heirloom Gardens." *Old Sturbridge Village*. Old Sturbridge Village, n.d. Web. 8 Dec. 2013.

"Heirloom Gardens." *Old World Wisconsin*. Wisconsin Historical Society, n.d. Web. 8 Dec. 2013.

Kimble-Evans, Amanda. "Checking Out Seed Libraries." *Organic Gardening* June 2011: 70. *ProQuest*. Web. 7 Dec. 2013.

LaDuke, Winona. "Native Farmers Gather - Form Seed Library." *News from Indian Country*: 7. 04 2011. *ProQuest.* Web. 7 Dec. 2013.

Lévêque, C., and Jean-Claude Mounolou. *Biodiversity*. Chichester: Wiley, 2003. eBook Collection (EBSCOhost), EBSCOhost. Web. 17 Nov. 2013.

Mackintosh, Barry. *Parks and People: Preserving our Past for the Future.* Ft. Washington, PA: Eastern National Park & Monument Association, 1990. National Park Service. Online EBook. 4 December 2012.

Margules, Chris and Sahotra Sarkar. *Systematic Conservation Planning*. New York: Cambridge University Press, 2007. Print.

Melnick, Robert Z. "Climate Change and Landscape Preservation: A Twenty-First-Century Conundrum." *APT Bulletin*, Vol. 40, No. 3/4 2009: 35-42. JSTOR. Web. 21 Nov. 2013.

Mission Garden and the Friends of Tucson's Birthplace. Tucson: Friends of Tucson's Birthplace, n.d. Print.

Native Seeds/SEARCH. Native Seeds/SEARCH, n.d. Web. 5 Mar. 2014.

O'Malley, William (Bill). "Re: Kino Heritage Fruit Trees Project." Message to the author. 27 Jan 2014. Email.

Peck, Sheila. *Planning for Biodiversity: Issues and Examples*. Washington: Island Press, 1998. Print

Still, Andrew. *The Seed Ambassador Project.* Adaptive Seeds, n.d. Web. 8 Dec. 2013.

Tharee, Lane. "GOOD TO GROW - Annual seed swap is a kind of cultural exchange program." *The Blade* [Toledo, OH] 24 Feb. 2006, City Final, Peach: E1. *NewsBank.* Web. 8 Dec. 2013.

Tortorello, Michael. "Seeds of an Era Long Gone." *New York Times*, 21 Nov. 2012. Web. 24 Feb. 2014.

Tucson Botanical Gardens Visitor Guide and Map. Tucson: Tucson Botanical Gardens, n.d. Print.

United Nations. United Nations Environment Programme. *Convention on Biological Diversity*. United Nations,1992. Web. 21 Nov. 2013.

United States. Department of the Interior. *2012 National Park Visitor Spending Effects*. National Park Service, Feb. 2014. Web. 8 Apr. 2014.

United States. Department of the Interior. "Earth Explorer." *U.S. Geological Survey*. U.S. Geological Survey, n.d. Web. 4 Mar. 2014.

United States. Department of the Interior. *Economic Benefits to Local Communities from National Park Visitation, 2011*. National Park Service, Feb. 2013. Web. 8 Apr. 2014.

United States. Department of the Interior. *Economic Benefits to Local Communities from National Park Visitation and Payroll, 2009*. National Park Service, Jan. 2011. Web. 8 Apr. 2014.

United States. Department of the Interior. *National Park Visitor Spending and Payroll Impacts, 2007*. National Park Service, Sep. 2008. Web. 8 Apr. 2014.

United States. Department of the Interior. *National Park Service Website*. National Park Service, 24 October 2012. Web. 26 Feb. 2014.

United States. Department of the Interior. "Padre Eusebio Francisco Kino." *Tumacácori National Historical Park*. National Park Service, n.d. Web. 3 Mar. 2014.

United States. Department of the Interior. *The Secretary of the Interior's Standards for the Treatment of Historic Properties + Guidelines for the Treatment of Cultural Landscapes*. National Park Service, n.d. Web. 21 Nov. 2013.

United States. Department of the Interior. *Tumacácori National Historical Park*. National Park Service, 2013. Print.

United States. Department of the Interior. *Tumacácori National Historical Park Annual Park Recreation Visitation Graph (1904-Last Calendar Year)*. National Park Service, n.d. Web. 8 Apr. 2014.

van Andel, Jelte, and James Aronson. *Restoration Ecology : The New Frontier*. Hoboken: Wiley, 2012. Ebook Library. Web. 21 Nov. 2013.

Verrier, Jim. "Re: Kino Heritage Fruit Trees Project." Message to the author. 20 Dec. 2013. Email.

Volkman, Nancy. "Landscape Architecture, Design, and Preservation." *Encyclopedia of*

Environmental Ethics and Philosophy. Ed. J. Baird Callicott and Robert Frodeman. Vol. 2. Detroit: Macmillan Reference USA, 2009. 26-33. *Gale Virtual Reference Library*. Web. 21 Nov. 2013.

Welborn, Jason. Personal interview. 7 Feb. 2014.