how to restore habitat & native pollinators

A Demonstration Project
Dyess Airforce Base

native seed
Native Seed Trade Association

Legacy
Resource Management
Program

contents

A Demonstration Project
Dyess Airforce Base

native seed
Native Seed Trade Association

This project was funded by
the Department of Defense
Legacy Resource Management Program

Introduction

"How to Restore Habitat and Native Pollinators" is the result of a three-year project at Dyess Air Force [DAFB] in Abilene, Texas. The goal of this project was not only to reconstruct the native prairie ecosystem, but also to restore the mutualistic relationships in ecosystem functions—specifically between the native plants and their native pollinators. It is the interaction between native pollinators and their native plant hosts that sustain and regenerate native plant communities. Any attempt at restoring an ecosystem that fails to address the health of the pollinator complex cannot succeed. Long-term persistence of species is more likely to be obtained when restored or reconstructed areas are managed for the needs of both plants and pollinators. This workbook attempts to provide resource managers with the tools they need to accomplish this.

The decline of native pollinator populations is linked to fragmentation of native plant communities and competition with alien invasive species [e.g. European honeybee and Africanized honeybee]. The optimal venue for addressing declines in native pollinator populations is through efforts to restore and conserve native plant communities and through the removal and management of invasive species. Invasive plant species have become an integral

part of many ecosystems and are especially symptomatic of degraded lands. Research has demonstrated that the presence of invasive plant species changes the ecosystem in many ways, one of which is by creating a less diverse environment.

The purpose of this workbook is to demonstrate how marginal and degraded Department of Defense [DoD] landscapes can be put to constructive use for conservation while continuing to meet the needs of military readiness. Resource managers can learn how to better manage marginal lands and how to restore ecosystem health and their subsequent critical processes. The effort to promote biodiversity and restore degraded lands is an important responsibility of the DoD. Increasing biodiversity through the removal of invasive species AND through the re-establishment of native plant and pollinator communities will support the mission by providing realistic, more stable, and more easily maintained training situations.

October 1999

Restoration Chronology Sequence

To highlight the restoration process undertaken at Dyess Air Force Base, we have included images in a chronological sequence in the upper right hand corner of each page. In this way, we hope to illustrate how an area will change during the restoration process.

getting started

Box 1. **Dyess Air Force Base [DAFB] is located in Abilene, Texas. This is the geographic location of the area, but it tells us nothing about the local habitat. To find out what ecoregion DAFB is situated in, we refer to an ecoregion map [see resources below] and determine that this region historically was composed of Tall Grass Prairie.**

Ecoregions of North America
by Robert G. Bailey (USDA–Forest Service)

Where Are You?

The first step in building viable **pollinator habitat** is to determine what **ecoregion** your installation resides in.

Ecoregion is just a fancy word for a wide area with a distinguishing set of similar ecological features [see Box 1].

One important thing to remember is that the ecoregion description for your current location might not match the habitat that is there now. In our demonstration project at Dyess Air Force Base, we determined that it is situated in the Tall Grass Prairie ecoregion. However, anyone living and working in Abilene knows that there has not been a Tall Grass Prairie in that location for more than 100 years. So one might ask why this information is important.

To restore **native** insect pollinator populations, you must restore their habitat. Unless you know what the habitat was when the pollinator populations were healthy, how could you expect to help restore their populations? Knowing their historical ecoregion is the first step in understanding what they will need to survive.

DAFB October 1999

The Ecological Components

We now know our ecoregion, but how do we find out what its **ecological components** are? Most ecoregions have a descriptive name associated with them. In our example, Tall Grass Prairie, we see the word "grass" so we can be sure that certain grass **species** will predominate this system. But what kind of grasses?

This is when we need to delve deeper into the text that describes the terrestrial components of a particular ecoregion. Most of these descriptions will be broad outlines of the main or predominant species that characterize that region. [In our example, Big Bluestem and Switchgrass are the two species of grasses that are mentioned in the broad description]. To get a more comprehensive idea of all the important species of a particular ecoregion it is often helpful to find publications

Box 2. **Plant species for my ecoregion**

tree species

1

2

3

4

5

6

grass species

1

2

3

4

5

6

flower species

1

2

3

4

5

6

on the **flora** of a region. Your local library or the library at your local university is a good place to begin the search for the published flora for your region. Not only will you get a very comprehensive species list for the ecoregion but you will also find interesting historical information that will come in handy later.

The success of your pollinator habitat will fully depend on how accurate and comprehensive the species list is for your ecoregion.

DAFB October 2000

A Species List

Historical Plant List

Once you have identified your ecoregion, you can begin to develop the associated list of plant species that form the backbone of that biological system [see Box 2]. Your next task is to find a published book or paper on the flora of your ecoregion. Often, books or papers like "The Flora of Taylor County" were published years ago—but that's okay. Your main objective is to find a comprehensive list of all the plant species that occurred in your particular ecoregion.

Once you have identified your ecoregion and compiled a list of plant species, you will then need to add some ecological information about those species. The most important piece of information you will need concerns the time of flowering. Since pollinators rely on plants for nectar and pollen as their food source, you want to make sure to identify when each species will bloom. We will talk about the importance of this later in the workbook, but for right now make sure to get this information when you are compiling the list of species for your project.

A few *Bombus* pollinator species from private collection

Box 3. **Historical Pollinators Species**

family	genus	species
1		
2		
3		
4		
5		
6		
7		
8		

Historical Pollinator List

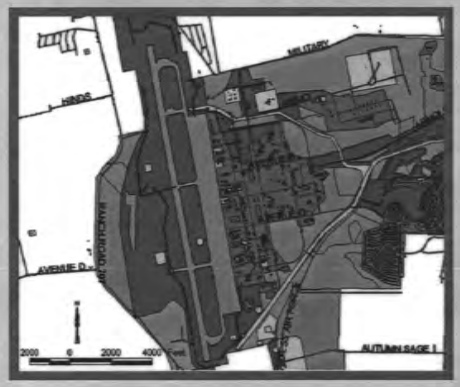
The best way to get information about insect pollinator communities is to study entomological collections at major museums. It is best to start locally with either a university or local natural history museum. You want to find locality records for species in your region. It is best to start by limiting your search to the insect order Hymenoptera. This is the order in which native bees will occur. Your main task is to determine what species have been collected in your region and then find the date when that individual was collected. Obviously, the older the collection date the better the information is for your research. Remember, you are playing the detective role and your mission is to create a list of native insect species that occurred in your region 80 or more years ago. The older the collection record the better the information is because the more likely it is that insect occurred when the ecoregion of the area was more in tact.

Unfortunately, this task could prove daunting. You could spend years in different entomological collections and only come up with a few species names, and they may not even be for your county but for a county nearby. If this happens, the alternative is to search the literature and see if anyone did insect surveys in the area of interest a very long time ago. If this also leads you nowhere then the only way to begin to piece together a skeletal list of potential insect pollinators for your site is to find an adequate **control site.** You will need to locate a site that is much less degraded than the one you want to restore and it should contain at least 75% of the native plant species you want to re-establish on your site. Your next step is to begin sampling the control site and prepare a list to determine what species occur there that do not occur on your site [see Box 3].

DAFB October 2000

DAFB Base housing
October 1999

DAFB Picnic Area
June 2001



GIS map of DAFB habitat areas

What Do You Have?

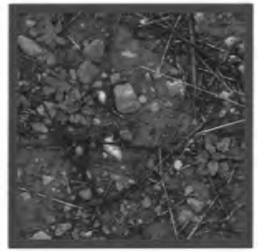
Now that you know which ecoregion your site occupies, what the main ecological components are, and which species historically occurred in your region, you are ready to begin the next phase.

Site Selection

Site selection is an important consideration for your pollinator habitat **restoration** project. We suggest choosing a marginal piece of land no less than 1.5 acres in size and not more than 10 acres. One essential ingredient will be public access. As with any conservation project, the more opportunity the public has to observe and participate in the process the higher the chance for project success. If the local community perceives a sense of ownership, they will become **stewards** of the area, protecting and enhancing it for the enjoyment of future generations. Along with this comes the opportunity to educate the public about the decline of native insect pollinators.

Okay, now that you have chosen your site, what is the current species assemblage of this site? Who lives there now and in what numbers?

The best way to get a handle on the ecological components of your chosen site is to **inventory** the plants and insects on the site, and in the surrounding areas.



DAFB February 2001

When selecting a site, keep in mind that it should be:

- **no smaller than 1.5 acres**
- **no larger than 10 acres**
- **accessible to the public**

Box 4. **Place the vegetation grid on the ground and identify how many different plants are within the grid. Take one plant of each different species and place in the plant press. Record the number of individuals of each species in the grid and the number of individual plants taken. Repeat this process for all 10 samples in each acre that you plan to create pollinator habitat.**

Vegetation grid, plant press, insect collecting bowls

Plant Inventory

The undertaking of a plant inventory can be a time consuming task. A thorough inventory of your site requires sampling throughout the year, with at least one sample taken during each distinct season. The soil should also be tested for dormant seed that is viable but not germinating due to adverse conditions. The more the plot is surveyed the better the ecological information.

The number of samples depends on the size of the site; a practical number is 10 samples per acre. Your main goal is to make sure you have a representative plant sample from every plant species that you see on your plot. A simple way to approach the inventory is to build a vegetation square/grid 2' X 2' out of PVC. Set the square out on your plot in 10 different places and take a sample of every different plant species in the square [see box 4 for detail].

Each plant that is sampled will need to be placed in a plant press with an identifying label—Plot 1, Sample 1, latitude and longitude, time, date, plus any other important information (e.g., in flower).Once the plants have been in the press for about two weeks they are ready to be taken out, identified and processed. All of these data should be kept in a database or on a spreadsheet for easy access.

DAFB February 2001

Opaque yellow bowl for sampling insect pollinators

Box 5. **A "kill jar" is made by taking a mason jar, and filling the bottom quarter with plaster-of-paris. Once the plaster of paris has set, ethyl acetate is poured onto the plaster-of-paris until it is soaked. Close the lid. What you are making is a miniature gas chamber. Keep the lid tightly closed and when putting the insects in, try to be quick so as not to let the "gas" escape.**

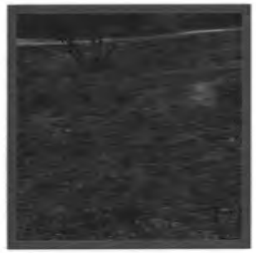
Pollinator Inventory

There are several ways to sample for insect pollinators. We will discuss the two easiest methods: yellow pan trapping, and sweep netting. We recommend doing the pollinator inventory at the same time as the plant inventory—mostly for convenience.

Yellow pan trapping: this method requires 10 opaque yellow bowls for each acre of habitat. The bowls should be randomly set out on your site a half hour before sunrise and left for a period of 24 hours. Each bowl should be filled with about 1/2 gallon of water and one or two drops of dishwashing fluid [which breaks the surface tension of the water, allowing the insects to sink and drown].

Sweep netting: this method requires a standard size insect net and a "kill jar" [see box 5]. This should be done on a sunny day in the late morning. It is best to walk in a straight line [think transects] across your plot sweeping the vegetation. The contents of the net are emptied quickly into the kill jar.

Repeat this process 5 times on each acre.



DAFB February 2001

Mesquite thicket adjacent to plot at DAFB.

Surrounding Landscape

In addition to inventorying your site, it is important to understand what the surrounding area will contribute in terms of plant seeds and spore as well as how it will contribute to the insect flow in and out of your site. For example, at DAFB most of our sites were next to mesquite thickets. Since our restoration was to be a prairie it was important to understand that eventually the mesquite, cactus and yucca would all tend to move into the prairie site. The only way to handle this was to understand from the beginning the factors associated with the site and how they would act to undermine the restoration efforts.

You can either inventory the area completely surrounding your site or be ignorant of what that area will contribute to your restoration. It is better to know those contributions in advance so that, when you construct your management plan, you can take them into consideration. I would recommend that you inventory for plants and insects on the adjacent 3 acres on each side of your site. This inventory could provide you with invaluable information and will be the overriding factor in your long-term management plan.

The management plan for the long term care of your restored site will be discussed in detail later in the workbook [see "Management Plan" section starting on page 24].

DAFB February 2001

Historical vs. Current Information

DAFB February 2001

Now that you have collected current plant and insect data from your site you need to compare that with the historical information you gathered at the beginning of this process.

What you will likely see is a very different species composition of plants in your current habitat. The critical step here is to identify how many and which species you have currently that did occur historically. These will be the species that you rely on to form the backbone of your habitat restoration. The next step is to make a list of species that need to be re-introduced to your site. The best way to construct this list is to use your historical research to guide you about which species occurred in that ecoregion who are not there now. It would also be helpful at this point to determine what percentage of the population each species filled. For example, in a prairie system, the number of grass species occupied about 70% of the system whereas the number of forbs (flowering plants) occupied only 30% of that system. You might not be able to figure out exactly what percentage each species represents but you should be able to get a general percentage for grass versus flowers versus woody vegetation.

The more difficult aspect of this comparison is getting a handle on the historical pollinator community. If you were not able to determine what the species assemblage was of the insect pollinator community do not worry. There are two ways to recreate this type of information. The best way would be to find a control site within a 50-mile radius of your project site. You are looking for a control site that represents the historical ecosystem which you are trying to restore. Even if the control site is not a perfect representation it might still be suitable. You will have to do a plant inventory and an insect inventory to determine how many native plant species are there compared to your site. If you are lucky enough to find a control site that is only slightly degraded, say it has at least 75% of the native plant species that you know occurred on your site historically then you can probably use that site. If you cannot find a suitable control site, the next step is to look very carefully at the species assemblage of the pollinators that occur on your site currently. You will be

Lessons Learned

At DAFB, our demonstration site, we started the project in the middle of a four-year drought that was one of the severest droughts in 100 years. We did not take soil samples and in the final year of our project, the drought conditions ended and we were faced with a number of invasive plant species that we did not know were going to occur on our site. This did not cause a problem initially because our seeds were able to establish themselves and build up enough biomass to protect them from competition. However, this did change the nature of the long-term management plan and required us to implement removal and control methods for species we hadn't earlier considered. We also decided to re-seed the plot with more of the native species we wanted to establish. This re-seeding was a precaution. Our measure of biological success was to ensure that we had a viable population of plant species that would be regenerative.

looking to see how many of the species are generalists and how many are specialists. You will need to have a good understanding of the ecology of each species. The plant species list you created above will need to be studied with an eye towards pollinators. Grass species are wind pollinated so they will not play a critical factor in the creation of pollinator habitat. The important species will be those that flower, and this is where you might be able to find out which species are known to pollinate the flower species you plan to re-introduce. If you do not have any of these pollinator species on your site now, there are ways to re-introduce pollinators but only if they can be found locally.

DAFB April 2001

At the end of this section, you should have a list of plant species you plan to re-introduce to recreate the historical ecosystem and a list of insect pollinator species that will represent a healthy community.

Invasive Species

Invasive plant species are plants that are often not native to the local ecosystem and that have a tendency to take over. Some of the most famous invasive species are Kudzu on the east coast of the United States, and Leafy Spurge in the northern U.S. These plant species not only take over, but also reduce the species diversity of an area rapidly, creating a disturbed and unbalanced system.

During the plant inventory process, you will undoubtedly come across several invasive species [IS] and you will need to pay special attention to these or they will undermine the habitat restoration process. Complete removal of these species is the optimal situation, however, the pollinator community you have on your site might rely on these species as their primary food source. The complete removal of IS will cause your insect pollinator community to crash very suddenly if there is not an alternative food source available in the same abundance.

We strongly recommend that you take soil samples of your site several times a year and have those samples placed in a greenhouse where they get lots of sun and water. IS seed can lie in the soil dormant for up to 20 years and if conditions are not right you might not know they are on your site [see sidebar].

Before You Go On...

Once you have finished the above section, you should have completed the following:

1. Identified your ecoregion
2. Prepared an historical plant species list
3. Prepared an historical pollinator species list
4. Selected a site for restoration
5. Completed a plant species inventory for site
6. Completed a pollinator species inventory for site
7. Identified a control site
8. Completed a plant species inventory for control site
9. Completed a pollinator species inventory for control site
10. Developed a plant palette: list of plant species for re-introduction
11. Developed a pollinator palette: list of pollinator species for re-introduction

These items must be complete before you can go further in the workbook.

Personnel & Time

One full time employee will be needed to complete the initial assessment—identification of ecoregion, determination of historical ecological components, on-base restoration sites and potential control site. This process should take about 1 year or 2100 employee hours depending on how easy it is to access the specific types of information needed. In addition, this same employee will be needed to synthesize the current and historical information and to develop the native plant and native pollinator species re-introduction list.

The inventory for pollinators and plants (both native and invasive) for the base site and surrounding area, and for the control sites will require two full time employees or 4500 employee hours. This process will take one year to carry out, as sampling will be needed monthly or bimonthly plus the time needed to process the specimens obtained during the inventory. These employees can also be responsible for taking soil samples at the site during the inventory process.

Equipment

Soil sampling equipment or a kit

One vegetation grid

10 opaque yellow bowls

One insect sweep net

1000 2 dram vials with stoppers to curate insect specimens

1 gallon 70% ethyl alcohol

100 each insect pins in sizes 000, 00, 0, 1, 2

Insect collection box where pinned specimens can be placed

Insect labels

One plant press with lots of newspaper and cardboard

Botanical paper and glue for curating plant specimens

Labels for botanical specimens

Hand-held GPS unit

Resources

Ecoregion information:

Some good websites to help you generally identify your ecoregion:

www.worldwildlife.org/ecoregions/ecoregions_map.htm

www.fs.fed.us/land/pubs/ecoregions

www.fs.fed.us/institute/ecolink.html

Historical information about native plants and native pollinators:

Local university—check the biology department and talk to anyone who can help you find out who has done work locally in botany or entomology. They should be able to give you names or lead you to publications.

Local arboretum—should have information about the floral history of the region.

Local natural history museum—should have an entomology collection or should be able to help you locate one.

restoration plan

Clearing the site of all standing vegetation

Habitat Creation

The foundation of your restoration plan lies in the two species lists you created earlier. You should have a plant species list and a pollinator species list. These are the two components critical to the long-term biological success of your overall restoration effort.

This restoration program should not be undertaken if the area to be restored is less than 10 acres. If the surrounding landscape is completely degraded and there is no functional ecosystem present, a small-scale effort will not be able to **regenerate** itself over the long term. The goal is to restore ecosystem processes that can eventually lead to both a sustainable and regenerative condition. Small-scale prairie restoration efforts are often thwarted because the woody vegetation from the surrounding area will encroach and overtake the system. Even with continual management strategies, small-scale restoration efforts are often unsuccessful.

The first step in your restoration plan is to prepare your site for the re-introduction of native plant species that are indicative of the **ecosystem** of your installation. The initial step in preparing your site is identifying the **invasive** plant species that either are/or potentially could be on your site. Then you need a strategy for removal and control of these invasive species [IS].

Removing Invasive Species

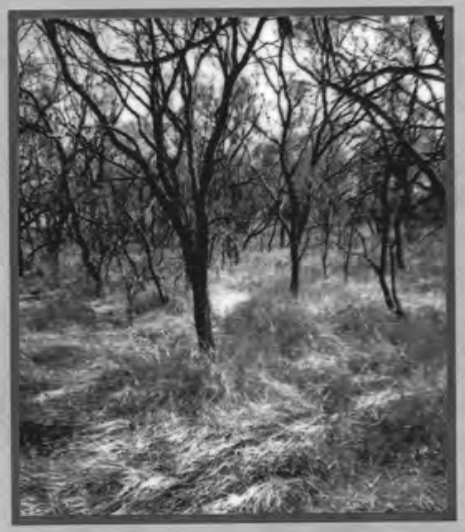
The three most common methods used to remove and control IS are: burning, mowing, and chemical treatment. Since our goal is to restore the insect pollinator population, we would rather not use chemicals to remove or control IS, as this could be toxic to the entire insect community. Of the two methods left, the choice of which to use will depend entirely on the species composition of your invasive plant community.

Many situations benefit from a pre-restoration **prescribed burn.** At many installations, a prescribed burn could help the mission by enabling the natural resource

DAFB April 2001

The three most common methods used to remove and control invasive species are:

1. **burning**
2. **mowing**
3. **chemical treatment**



Mesquite, a woody invasive that takes over prairie systems

manager to work with the fire team on this project. We would recommend a fall burn followed by a deep disking of the soil. The disking would expose any seed or root material to the winter cold and is one additional step in killing IS. This will not completely remove all the IS on your site but will be a good start at reducing the population and removing at least a few of them. Eradication and control of invasive species will be an ongoing effort that can only be won through persistence.

Invasive species affect native pollinators ecologically because their bloom cycle is out of synchrony with that of the native plant community. Most IS bloom earlier than the native plants, which impacts the life cycle and ecology of native bees that have often moved out of an area when the IS bloom wave is finished. This leaves no pollinators by the time the native plants come into their bloom cycle.

In addition to invasive plant species, there are also some invasive insect pollinators that will impact your restoration plan. European honeybees [and Africanized honeybees] forage in large numbers—unlike native bees, which are solitary pollinators—and can decrease the forage success of native pollinators by out-competing them for food and nesting resources. European honeybees are inefficient pollinators. Because they have not co-evolved with the native plants, they often cannot get to the nectar easily so they steal it. The presence of European honeybees disrupts the natural composition of the native bee community and has a detrimental effect on the reproduction of native flowering plants. If you have a feral colony of European honeybees on your site or close to your site, you will want to have it removed. Otherwise, your native pollinator restoration effort will be completely undermined and your native plants will not be able to **sustain** a viable population.

Once you have prepared your site by removing the invasive plant and insect species you will be ready for the next step: planting native species.

DAFB May 2001

Native seed being used for restoration

Re-Introducing Native Plants

The first step is to create what is referred to as your **plant palette**. The palette will include every species that occurred in the ecoregion. However, you will begin the habitat restoration process by selecting the species that will mimic the early **successional** processes of the specific ecosystem you are trying to recreate. The significance of this step is that it will help in restoring the ecosystem *processes* not just the *components*. By focusing on the early successional species, you will be re-introducing plants that are fast growing, more hardy, and serve the purpose of being nurse plants to the ones you will re-introduce next. Also, you want to establish a prolonged bloom wave, so when you plan the initial planting palette you want to make sure that you choose early successional species that will provide you with flowers throughout the growing season. This will help the pollinator community that is already established on your site change from using invasive plant species as a food source to using the newly re-introduced natives.

Native seeds that are specific for an ecoregion can be difficult to purchase. The importance of using native species cannot be stressed enough. Finding a supplier of native species on your list might seem difficult at first, but it will be well worth the effort. If you cannot find a supplier of seed that is specific for your ecoregion, you might be able to find cultivated species that will work just as well. Often you can contract a seed producer to collect seed from your region and they will grow out the seed to help increase the amount available for your project. Again, this should be done well in advance of planting time so that you know what you are getting and how much you will have to use. [Refer to: "How to Buy Native Seed" on page 20]

Once you have obtained the seed—and again, large areas respond better to seeding than planting with plugs- you will need to prepare the ground for planting. Often you will have to clear the plot with a bush-hog or a tractor with a front loader bucket. The key is to prepare the ground so that it is ready to receive the seed. The critical task when seeding is to get the seed to have good soil contact. When seeding with natives, we recommend using a no-till seeding drill. This helps calculate the seeding

DAFB May 2001

Equipment you will need:

1. **bush-hog**
2. **tractor with front loader bucket**
3. **no-till seeding drill**

Calibration of no-till drill for native seeding

rate of the drill and ensures that a thorough job is accomplished. Hand-seeding large tracts of land can be a time consuming task and the seed contact with the soil will have to be made using a cultipacker or something that will roll the seed that has been spread by hand, into the soil. A no-till drill accomplishes this all at once.

In our demonstration project we combined the initial fall seeding of the plots with **National Public Lands Day** so that we could use this activity as an educational and outreach opportunity. This also helped us get the Boy Scouts and the local native plant society involved while we were all out there, and it gave everyone an opportunity to see what we were doing and to hear why we were doing it. Creating these outreach opportunities can help with the long-term success of the project, since it instills a sense of **stewardship** in those who have been involved in each stage of the project.

After the initial planting of the early successional species, each subsequent fall a different plant palette will need to be seeded to help stimulate the ecosystem process to begin and sustain itself. We planted our early successional species in the first fall planting, and the next fall we planted the mid and late successional species once we were sure that our initial seeding was successful. It is difficult to say how many seedings you will end up doing, but it will be on the order of three to four times depending on how competitive your invasive plant community is, how well your seeds took to the site, and how the overall establishment of your re-introduced community goes. You might find that certain species just did not take in your area, and you might need to find suitable replacements for those species and seed for those. Again, this will take careful attention and will need to be fine-tuned for your particular site.

Pollinator Restoration

The inventory of your pollinator community should have yielded a list of species, most of which will probably be **generalists**. If you were lucky enough to find historical information about which pollinators occurred in your particular ecoregion before disturbance, then you should have an idea about what species need to be re-introduced onto your site. If you were not able to generate a list of pollinators that were present historically then the job becomes more difficult. This is where the ecological information about the plants you are re-introducing comes in. There should be pollinator association records for the flowering plants you are re-introducing to your site.

DAFB June 2001

Limestone trails are good for public and for pollinators

Signs help explain why woodpiles are left on the site

Nesting augmentation for pollinating insects—a bee condominium

A mobile pollination unit (MPU) on the site

That is one way to generate a list of pollinators to compare with your current community. Again, if this is not possible then the only way to aid in pollinator restoration is to make sure you have both an overabundance of food and nesting resources. Another way to aid your pollinator restoration effort is if you found a control site that contains at least 75% of the original ecosystem in tact. If you found a control site, then you can use the pollinator inventory from your control site to see who is NOT currently on your site.

Most native insect pollinators—mainly bees—nest in the ground or in wood. While your habitat restoration is slowly coming along, you can augment nesting habitat in several different ways. Nesting sites can be augmented both naturally and artificially. Simple steps such as clearing ground and creating limestone trails are ways to enhance the site while creating potential nesting sites. For native bees that nest in wood, leaving woodpiles or putting in wood trap-nesting boxes are two sure ways to increase nesting habitat.

Insect pollinators can be re-introduced to a site if there is a local control site that contains the species of bees that you want to re-introduce into your newly restored habitat. The trap nesting boxes mentioned above can be set out in the control areas and female bees will lay their eggs in them. These traps can then be moved onto the restored site and once the eggs hatch (and there is a food resource they can use) you will have re-introduced particular bee species back into your system. You must take care when undertaking this process. The most important thing to consider is what species of bee you are bringing onto your site. Is the species one that could occur in the type of ecosystem you are restoring? Will you have the type of food resource that species relies on to survive? Finally, will there be the proper kind of nesting area available for that particular species? You do not want to find yourself bringing a particular species onto your site if it does not belong there in the first place. You also do not want to bring a species onto your site that cannot sustain itself because of a lack of food or shortage of nesting space.

DAFB June 2001

Before trying to re-introduce a species to you site, ask yourself:

1. Is the species one that can occur in the type of ecoregion being restored?

2. Will you have the food resource that the species relies on to survive?

3. Will there be the proper kind of nesting area available for this particular species?

Trap-nesting bees from an offsite location can pose one other important consideration. You should not take all the eggs from the site, as this will deplete the following year's bee population on that site, it is essential that you take 25% only of the eggs that are laid in your trap nest. You will also have to be very aware of the timing of when you set the trap out and when you remove the trap. The best way to determine this is to know the ecology of the species you plan to trap and pay attention to their behavior on the site.

Another consideration when thinking about the pollinator component of your habitat restoration is the diversity of food resources. Insect pollinators will not only need a prolonged bloom wave, they will also require a diversity of food resources. You will find when you generate your plant species list that there will be a lot of different species of flowering plants. The important thing to notice is the floral **morphology** of these plants. Some flowers will be flat, others will be tubular, and others will consist of little florets. This diversity in floral morphology will help increase the diversity of bee species that your site will be able to support. For example, bumblebees are "buzz" pollinators. What that means is that they can only pollinate a certain type of flower that will open with the buzz from the bumblebees' wings. Otherwise, the flower looks like it is closed, or at least other bees cannot get inside to get the pollen or nectar—only bumblebees are able to. Floral diversity is another very important consideration if you hope to re-establish a healthy and diverse insect pollinator population.

Box 6. **A diverse floral morphology will provide a variety of nectar and pollinator resources for many different kinds of native pollinating bees.**

01 ray or composite
02 umbel-like in structure
03 ray or composite with disk flowers
04 spike
05 tubular


01


02


03


04


05

Before You Purchase

You must have a species list before you can begin the process of purchasing seed. In addition to having a species list, you will need to determine if you want these species combined in a mix or if you want to seed them separately. You will need to establish what type of seed you are interested in buying.

Ecotype vs.Cultivar Seed

There are two main types of seed widely available: **ecotype**, and **cultivars**. Ecotype seed usually comes with a source identified tag so that you know where the species originated. It will provide you with information about whether or not that particular seed type will grow in your region. Cultivar seed is also region specific, but it has been cultivated for the highest seed vigor and can be used in many of the same applications as ecotype seed. It all depends on what your long term goals are for the site that is being seeded as to which type of seed to choose. Either type will work in most situations.

Quantity & Cost

Determining how much seed to buy will depend on what kind of species you will be purchasing. Each species has a different seeding rate and the amount of seed needed will depend on the area you will be seeding and on which species you will be using. This is also why it is difficult to estimate the cost of seed because each species of seed has a different price associated with it.

Bulk vs. Pure Live Seed

Native seed can be purchased in two different ways, either in bulk or by the Pure Live Seed (PLS) pound.

Bulk If you buy using bulk, then you order however many pounds of each species you want. Bulk purchasing of seed is easy, but does not really provide you with enough information about the seed you are purchasing.

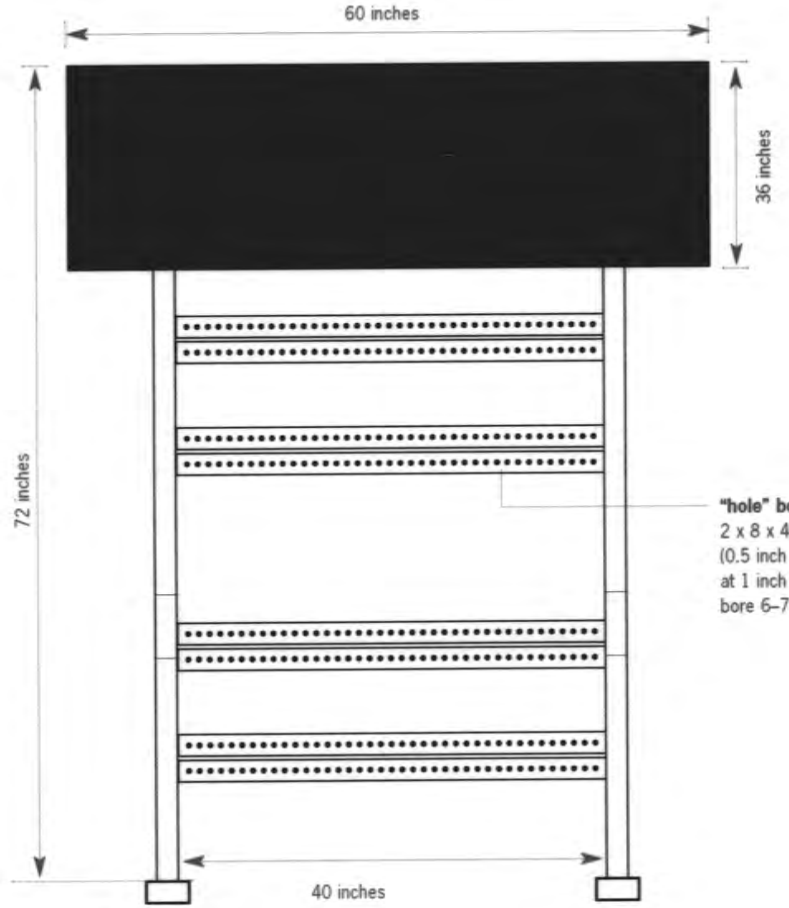
Pure Live Seed PLS is a percentage that gives you information about purity and germination. For example, if you specify that you want purity to be 90% then you should expect that by weight 9 out of 10 are native seed. You will also want some information about the percentage of seed that are expected to grow or germinate. Again, if you specify a germination rate of 90% then you expect 9 out of every 10 seeds will germinate. PLS is a formula that multiplies the percentage (%) of purity by the percentage (%) of germination divided by 100 to give you the percentage (%) of Pure Live Seed (PLS). So, if you specify that you want 75% PLS, then 75% of the seed in a 1 pound bag will be Pure Live Seed. If you compare prices of seed and you are using PLS as your basis for comparison then you will have a real good idea of what you will be getting for your money, and it will make shopping for seed a lot easier.

One thing to remember is that some species are available in very small amounts and to test that seed could make the cost prohibitively expensive. Seed of these species are often purchased in small quantities as bulk seed rather than on a PLS basis.

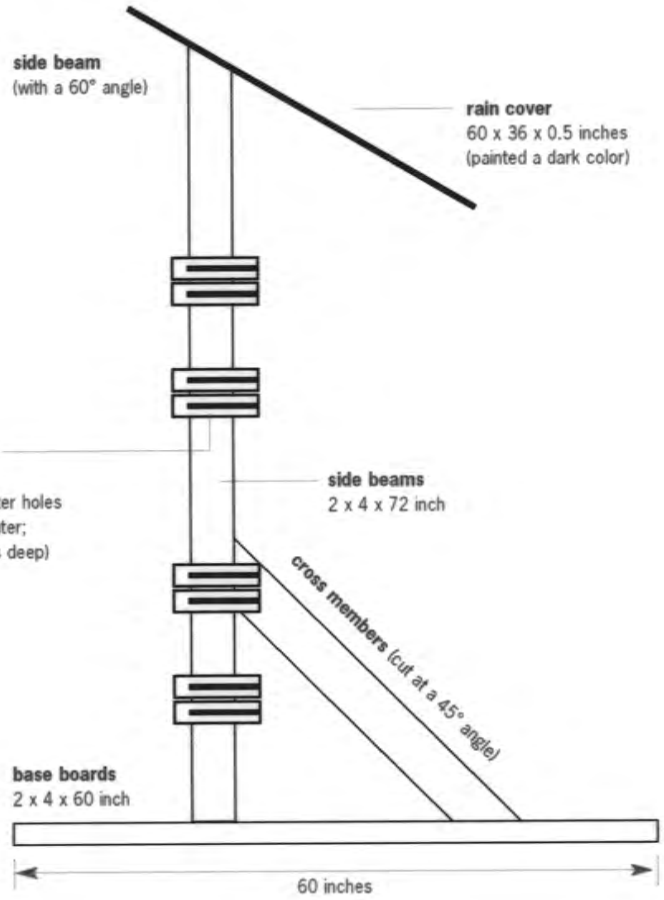
Resources

To find a list of native seed suppliers you can either contact the Native Seed Trade Association or the Lady Bird Johnson Wildflower Center in Texas.

PLEASE NOTE: DO NOT USE PRESSURE-TREATED WOOD



elevation



section

Personnel & Time

This section will take three years and requires the efforts of two full time employees or 12,500 employee hours. Two people will be required to prepare the site, seed the site and incorporate the outreach program into the seeding and trail building process. One person will be required to remove honeybee colonies, to take the plant palette and identify the source for native seed and a supplier of the seed. The pollinator reintroduction effort will only require the skills of a single person, as that is not as labor intensive. Again, the time for this part of the process is three years.

Equipment

A heavy duty mower that has adjustable mow heights [e.g. DR Field & Brush Mower]

A Truax [or similar brand] no-till grass seeding drill

Native seed in large quantities [quantities and price will depend on species used and the seeding rate]

A burn crew if a prescribed burn will be used to manage the site

management plan

Habitat Survey & Monitoring

The final and most important step of your restoration is monitoring. Constant attention to the site is important to notice changes and to observe processes. It will be very important to continue inventorying plant and pollinator community assemblages on your restoration site. You want to make sure that your habitat assemblage of species is > 90 % native. Again, this could take time as you continue to remove and control invasive species and as you continue to reseed. The overall goal of the habitat restoration is to restore or reconstruct the ecosystem that was once on that site. The habitat restoration must not only consist of the correct species but these species need to be able to sustain and regenerate themselves so that the only management needed is invasive species control.

DAFB October 2001

Pollinator populations will also need to be inventoried and monitored. The critical issue with pollinators is to maintain species diversity by having a wide range of food sources available throughout the year. In addition, nesting sites can also be a limiting factor in restoring a healthy and viable native pollinator community. Sampling three times a year should provide you with enough information about the health of your pollinator community. You can use this information to determine if you need more nesting sites or more diversity in your forb habitat.

Observation is critical to the overall success of your restoration. When you walk the site, you should be able to identify most if not all of the plants. This will help you identify problem areas and areas where an invasive plant might have moved in. By spending time on the site you will also be able to observe pollinator activity—such as flower visitation and/or nesting areas. Observation is just as important as actual inventorying and can provide you with more of the ecological information you need to determine if your restoration is actually sustainable.

The no-till drill we used had three different bins separating seed by size.

Seeding & Species Diversity

For the first few years after the initial restoration you may need to re-seed each fall to ensure that native species become established. This will depend on the level of degradation at your site, and there is no rule as to how many times one needs to seed. The goal is to have a functional ecosystem that consists of most if not all of the species that historically occurred on the site. Often, weather patterns or soil changes are so dramatic that the new microclimate might not support the same species assemblage that historically occurred there. If this is the case, you might find that you need to tweak the system and add species that are more drought tolerant, or that are adapted to cooler climates or a different soil composition. Again, the goal is to have a habitat that can sustain and regenerate itself. You will always need to manage for invasive species, but if the core components of your restoration can withstand competition and maintain a native framework, then you will not need to reseed every year.

Species diversity in both plants and insect pollinators is one way to insure the success of your restoration. In our prairie restoration, we knew that we needed over 100 different species of plants to recreate the Tall Grass prairie system that occurred on our site historically. Not all 100 species could be introduced in the initial seeding so we tried to introduce them in stages, seeding for the early successional species first, followed by seeding of mid and late successional species. This provided certain species with the opportunity to establish themselves before other species were introduced. Again, this process depends on the system you are restoring and the condition of your site.

Burning & Mowing

The restored site will require management especially during the early establishment of newly re-introduced species. This management can be in the form of mowing and/or burning depending on the system you are working with. Not only are these strategies necessary to keep invasive species under control and off the site, but some of the native species require certain "pressure" to produce seed or to flower.

DAFB May 2002

Many native species evolved with fire and grazing and are therefore accustomed to these types of pressures in order to survive. Prescribed burns can mimic fires caused by lightening and will often help some grass species set more seed. The same holds true with mowing. Mowing provides a similar pressure as grazing and therefore is very effective in helping to manage your newly restored site.

When to mow or burn is site dependent. You will need to understand the historical ecology of your site to know when these pressures need to be applied. Certainly fall and spring burns are commonplace, and that is usually the time of year when this management tactic is carried out. Mowing is different. If you are mowing to control an invasive plant then that plant's ecology will dictate the time of year to mow. If you are mowing to simulate grazing pressure for your native species, the historical ecology is where you will find the information you need.

At some point in the restoration process, burning and/or mowing will be the only management protocol necessary to keep your site functional. When to carry out these types of management practices will be site and ecosystem dependent. Just remember, the long-term success of your restoration effort will depend on your management plan.

DAFB May 2002


stewardship

Methods to Instill Stewardship

The biological success of your restoration project will depend not only on the long-term management plan of your site, but also on the amount of buy-in you have from the local community. From the beginning of the restoration project, try to be mindful of every opportunity you have to instill stewardship in your local community.

DAFB May 2002

Easy steps include:

- Install trails and interpretive signage on your restoration site.
- Make seed packets and bee boxes available in the base self-help store.
- Write newspaper articles about the program and why it is important.
- Create a display of native pollinators and native plants for the recreation center.
- Involve the golf course superintendent and demonstrate how to make the out-of-play areas more natural.
- Spread the word about your project!

Personnel & Time

For the management and stewardship, aspects of this process only a single full time employee will be needed to carry out the tasks involved in these sections. The individual will need to continue the inventorying of plants and pollinators on the site, will be responsible for invasive species removal and control, will need to be on site making general ecological observations with some frequency and will need to insure that a stewardship program is designed and implemented. The restored system will always require some form of management because of invasive species, however, as the system matures and becomes regenerative the amount of management will decrease over time.

glossary

control site a place that serves as a reference condition and is apart from the area you are studying.

ecological components all the living organisms of a system.

ecoregion a region with similar ecological features.

ecosystem a community of organisms that function as a system or complex.

flora a treatise or monograph on the plants of a particular region.

generalists organisms that utilize a wide variety of ecological resources.

habitat the environment an organism occupies.

invasive a species that is often non-native to the ecosystem, and whose introduction causes or is likely to cause economic or environmental harm.

inventory a process to catalogue all the organisms in a particular region or environment.

morphology the shape or structure of an organism.

native a species that occurs in a particular region, ecosystem and habitat without direct or indirect human actions.

plant palette a list of plant species with details of their flowering time, color, height and ecological requirements.

pollination the transfer of pollen grains from a plant's anther to its stigma.

pollinator an organism that transfers pollen.

pollinator palette a list of pollinator species with details of their food and nesting requirements.

prescribed burn a managed plan to use fire in a particular area.

regenerate the ability of an organism to maintain and reproduce itself through time.

restoration to reconstruct or recreate an ecological condition that once occurred on a site but has become degraded.

species groups of actually or potentially interbreeding populations, which are reproductively isolated from other such groups.

steward someone who takes an interest in or manages a particular area or environment.

stewardship fostering a connection with the land or environment so as to care for it over time.

successional change in species community composition over time.

sustain the ability of an organism to maintain itself over time.

index

Native Seed Trade Association 2212 F Street NW Washington DC 20037 *p: 202.833.1150 f: 202.833.3189 e: dsouthard@nativeseed.org*