Department of Defense

Legacy Resource Management Program

Project 09-461:

SUSTAINABLE LANDSCAPE DESIGNS UTILIZING NATIVE SPECIES TO INCREASE POLLINATOR HABITATS ON MILITARY LANDS

Mary Anderson

HQ AFSPC, Botanist

Pamela Bailey

US Army Research and Development Center

July 2010

Acknowledgements

I wish to acknowledge Dr. Mark Ford and Dr. Richard Lance, U.S. Army Engineer Research and Development Center, Lt. Col. Sames, Armed Forces Pest Management Board, and Mr. Jerry Thompson, JET Environmental for their time and efforts in reviewing and commenting on this document. JET Environmental also produced the final maps for this guidebook.

I also wish to thank the Office of Secretary of Defense, Legacy office for their funding support of this project and their time and efforts in reviewing and commenting on this guidebook to make it a useful tool for DoD land managers across CONUS.

Mary Anderson

Abstract

Pollination is an ecosystem service essential to reproduction of upwards of 80% of flowering plants, including many important food crops, as well as, endangered plants. Plant-pollinator relationships are one of the keystone indicators of healthy ecosystems and a sign of long-term plant health. With the loss of or damage to native habitats, there is growing concern that pollination relationships are imperiled with possible significant impacts to crop production and survival of endangered species, as highlighted in current literature. Due to the rapid decline in pollinators and loss of biodiversity, it is critical to provide islands and corridors of native species habitats, creating micro-niches to provide safe havens for these imperiled species. The Department of Defense (DoD) can be part of the solution by using native plant species in installation landscaping to provide our native pollinators with appropriate habitat.

This Department of Defense (DoD) Legacy Program (LEGACY) funded publication provides the DoD land managers with guidance on developing landscape plantings that provide food, water, and shelter to numerous pollinators and includes lists of suggested native plant for those plantings. It also provides introductory information on supporting pollinators through sustainable management techniques.

The main objective of this project is to serve as a guidebook of “Sustainable Landscape Designs Utilizing Native Species to Increase Pollinator Habitats on Military Lands.” The primary audience is the DoD land manager. These land managers can use it as a reference for recommending plant species for base landscaping and establishing planting areas as habitat for our native pollinator species, thereby promoting sustainable native landscapes. This initial effort selected ten of Bailey’s ecoregion Provinces (citation) that had the largest number of military installations. DoD installations across CONUS were overlaid on a GIS map of Bailey’s ecoregions and ten of 35 were selected. Landscape designs for each ecoregion were developed; these landscape designs are twofold – one is around a building, such as found in military family housing or small isolated facilities; the other was an “island” design that could be placed anywhere on a military installation, regardless of size. Additionally, native seed mixes were developed for each ecoregion. All the native plant recommendations were based on current information readily available from reliable sources (citations).

The second part of the guidebook includes information the land manager can implement to encourage pollinators by providing habitat recommendations for food, water, and shelter. Discussions about habitat modifications around an installation and small isolated landscape features, such as water sources, are made available.

Table of Contents

List of Tables

List of Figures

Introduction

This LEGACY funded guidebook provides the Department of Defense (DoD) installation land managers with guidance on developing native plantings that provide food sources via flowering native species and shelter, both naturally occurring and man-made, for a wide range of pollinators. Pollinators are not only bees but can be other insects, bats, birds, i.e. hummingbirds, and even lizards. But all of these species are showing a rapid decline in populations and distribution, and for many it is linked directly to the loss of biodiversity of native habitats. Therefore, it is critical for federal land managers to provide islands and vegetated corridors of native species. Military land managers can easily use native plants in the installation landscaping which can provide native pollinators with the necessary habitat. Other benefits for using native species to promote healthy populations of pollinators are for sustainable land use for military use, i.e. habitat restoration on training lands.

The main objective of this project is to provide military land managers with landscape designs they can implement on their installations. The landscape designs and seed mixes are adaptable for many of the DoD installations across CONUS. The designs provided herein are for plantings in the cantonment areas, around military housing and facilities and the seed mixes are suitable for seeding open spaces and for habitat restoration projects.

The first step was to determine which ten of the 35 ecoregion provinces, as described by Bailey's work for the United States Forest Service, had the highest number of military installations present in the ecoregion province. The process is described in the **Approach** section.

The LEGACY grant requires this guidebook, a fact sheet, a poster, and a PowerPoint presentation to be delivered. All these items will be available for download, at no cost, from the LEGACY website (www.dodlegacy.org) and the National Resources tab of the Defense Environmental, Safety, and Occupational Health Network and Information Exchange website (www.denix.osd.mil).

Approach

This guidebook is broken in two main sections: a) landscape designs and seed lists by the ten selected ecoregion provinces, and 2) other considerations for creating pollinator habitat, including background information on basic planting techniques and tips on how to implement habitat modifications to encourage pollinators. To begin, it was decided to focus on ten of 35 of the ecoregion provinces (Bailey, date) that had the highest number of military installations or sites per Province. Once those were selected, the landscape architect produced two designs and a seed mix for each Province. One of the designs was around a generic military housing footprint but could also be used around any isolated facility, and an island design. While these two areas were being developed, the second section on other considerations was being researched and written.

Selection of the Ecoregion Provinces

Bailey's ecoregions (Bailey and Cushwa, 1981) were developed by the United States Forest Service to be one of the most widely used systems to define, describe, and map the world's ecoregions. It is a hierarchical system with four levels: domains, divisions, provinces and sections. ***Domains*** are the largest geographic levels and are defined by climate, e.g., polar domain, dry domain, or humid tropical domain. Domains are split into smaller ***divisions*** that are defined according climate and vegetation, and the divisions are split into smaller ***provinces*** that are usually defined by their major plant formations. Some divisions also include varieties of "mountain provinces" that generally have a similar climatic regime to the neighboring lowlands but show some altitudinal zonation, and they are defined according to the types of zonation present. Provinces are divided into **sections**, which are defined by the landforms present. (*http://www.eoearth.org/article/Ecoregions_of_the_United* States*)*

These were created as a management tool system to predict responses to land management practices throughout biologically similar large regions of the country. Each ecoregion is determined by a combination of climatic and vegetation data which is also critical to pollinators. There are a total of 35 ecoregions in the United States, including Hawaii and Alaska; thirty of which occur in the continental United States (CONUS) and which were used as the base dataset for our initial analysis. The ecoregion datalayer was overlaid by a map of all the military installations in CONUS. Then each ecoregion was ranked by the number of military installations present, listed in Table 1. Ten ecoregion provinces were selected from this initial analysis and are ranked by highest number: A) Outer Coastal Plain Mixed Forest

Province; B) Eastern Broadleaf Forest (Oceanic) Province; C) Eastern Broadleaf Forest (Continental) Province; D) Southeastern Mixed Forest Province; E) California Coastal Chaparral Forest and Shrub Province; F) Southwest Plateau and Plains Dry Steppe and Shrub Province; G) American Semi-Desert and Desert Province; H) Pacific Lowland Mixed Forest Province; I) Laurentian Mixed Forest Province; and J) Great Plains – Palouse Dry Steppe Province (Figure 1).

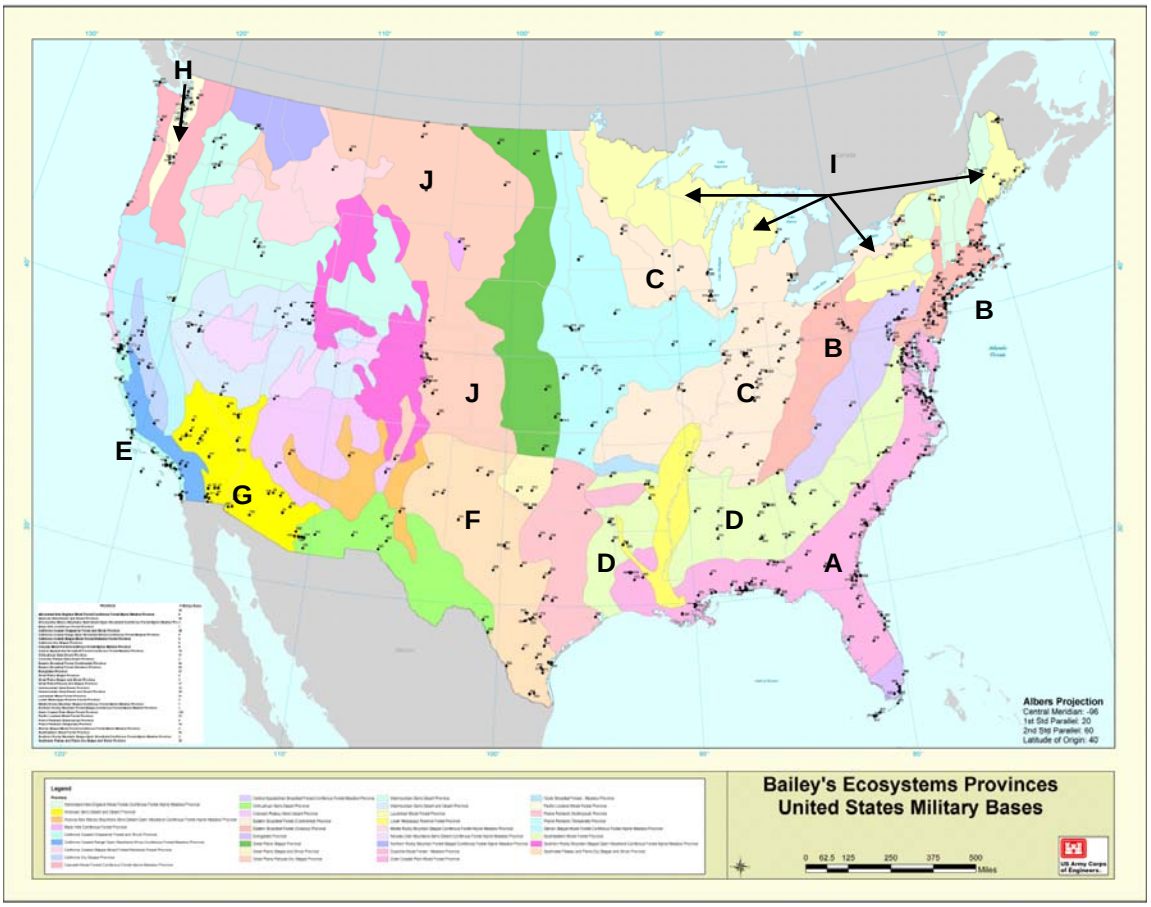


Figure 1 Map of the Ecoregion Provinces in the Continental U.S.

The initial list of military installations was reviewed and found to contain bases that had been closed, realigned, disposed, or combined (joint basing). Even after vetting the original list of military installations using various web-based resources (Military Bases in the Continental United States, www.globalsecurity.org; Military Installation Guide, benefits.military.com; and National Atlas, nationalatlas.gov), it was determined that the original top 10 provinces still had the highest numbers. There was one exception to this determination which was the Great Plains-Palouse Dry Steppe Province; it had one less installation than the Everglades Province. The Great Plains-Palouse Dry Steppe Province was selected because the southeast and

east coast regions were well represented with other provinces, whereas, the central part of CONUS was not. The military installation identifiers for this province are not of the same dataset as the other nine Provinces since the metadata for those maps were not available for this province.

Table 1. Number of Military Bases Per Province.

Province	# of Military Bases*	Map Reference
Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow	2	
American Semi-Desert and Desert	19	G
Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow	3	
Black Hills Coniferous Forest	1	
California Coastal Chaparral Forest and Shrub	**39**	E
California Coastal Range Open Woodland-Shrub-Coniferous Forest-Meadow	5	
California Coastal Steppe-Mixed Forest-Redwood Forest	1	
California Dry Steppe	7	
Cascade Mixed Forest-Coniferous Forest-Alpine Meadow	1	
Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow	13	
Chihuahua Semi-Desert	9	
Colorado Plateau Semi-Desert	2	
Eastern Broadleaf Forest (Continental)	24	C
Eastern Broadleaf Forest (Oceanic)	33	B
Everglades	16	
Great Plains Steppe	5	
Great Plains Steppe and Shrub	3	
Great Plains-Palouse Dry Steppe	9	J
Intermountain Semi-Desert	11	
Intermountain Semi-Desert and Desert	20	
Laurentian Mixed Forest	7	I
Lower Mississippi Riverine Forest	3	
Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow	1	
Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow	1	
Outer Coastal Plain Mixed Forest	61	A
Pacific Lowland Mixed Forest	15	H
Prairie Parkland (Subtropical)	8	
Prairie Parkland (Temperate)	14	
Sierra Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow	1	
Southeastern Mixed Forest	34	D
Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow	3	
Southwest Plateau and Plains Dry Steppe and Shrub	17	F

*The number of military installations for the ten Provinces selected has been adjusted to include only those installations that are currently active.

Selection of the Planting Palette and Development of the Landscape Designs

Once the provinces were selected, the landscape architect created two designs for each Province – a residential or facility and an island bed; each based on plant recommendations from existing publications found on the Pollinator Partnerships website (www.pollinator.org). Additional plant recommendations were obtained from the Lady Bird Johnson Wildflower Center website on Recommended Species (www.wildflower.org/collections). Each species list was vetted for potential invasive species or listed noxious weeds by state.

Because each ecoregion Province can span different states and United States Department of Agriculture (USDA) plant hardiness zones (Figure 2) (www.usna.usda.gov/Hardzone/ushzmap.html). The plants selected can span several hardiness zones and are suitable for planting within the chosen ecoregions. However, some varieties may be more adapted to the local area than others. It is always recommended to check with local nurseries that specialize in native species and the county cooperative extension service for plant recommendations in your area. To find suppliers, visit the Lady Bird Johnson Wildflower Center website - National Suppliers Directory (www.wildflower.org/suppliers/).

Figure 2. The 2003 U.S. National Arboretum "web version" of the USDA Plant Hardiness Zone Map.

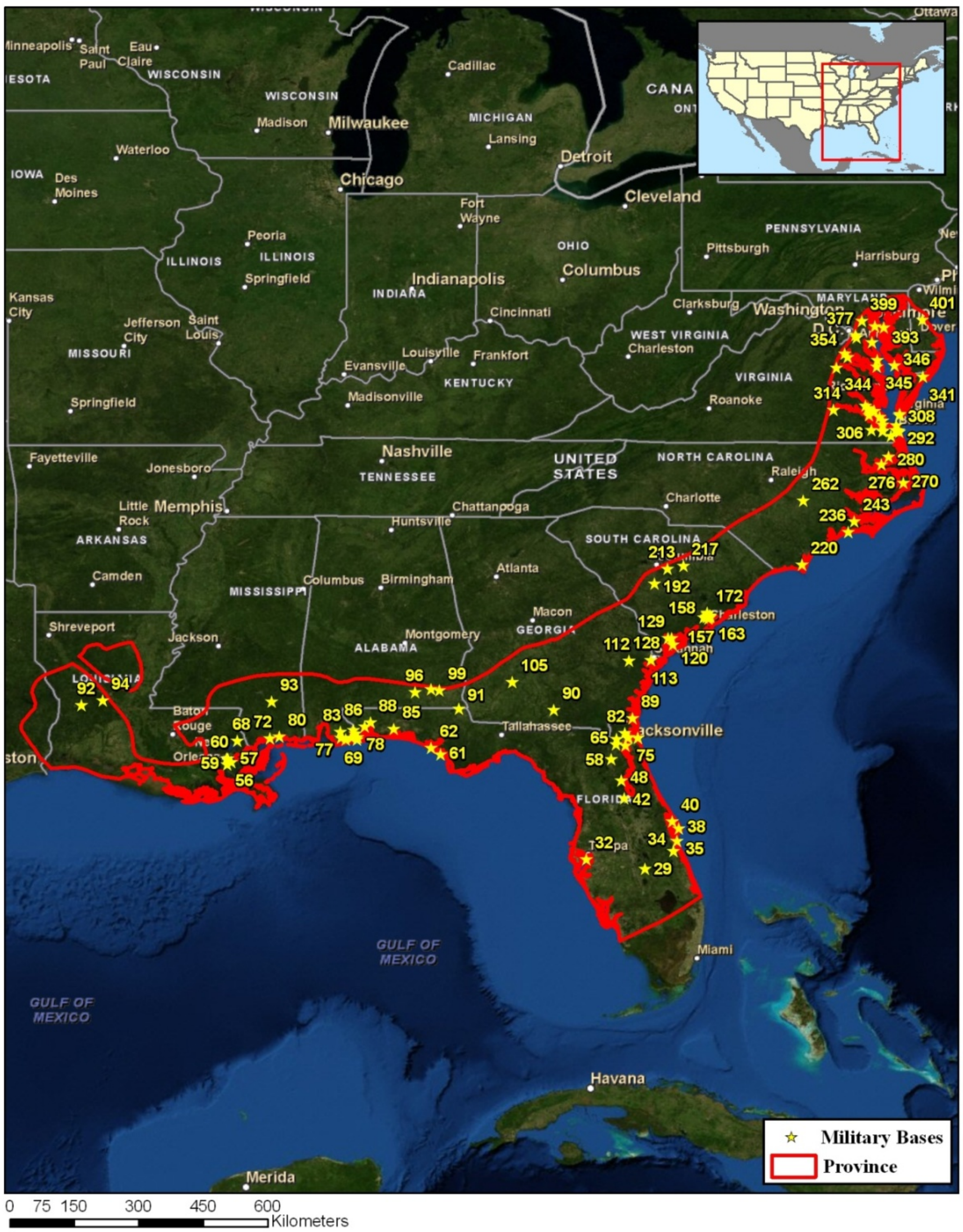
SECTION 1: ECOREGION PROVINCES AND LANDSCAPE DESIGNS

This section is broken into the ten provinces with a short description of environmental conditions of each province with a photograph of an example planting from that ecoregion, a map depicting the ecoregion overlaid with the military installations found in the ecoregion and a table listing the military installations, the landscape designs (residential and island, each with its own species list) and a recommended seed mix for habitat restoration or open areas in the cantonment.

A) Outer Coastal Plain Mixed Forest Province

In this province, the temperature and precipitation average ranges are small with barely ten degrees variance in temperature (60-70F) and 20 inches for precipitation (40-60 inches). These conditions support a temperate rainforest composed of evergreen oaks mixed with laurels and magnolias. The understory is well-developed with various tree ferns, small palms, shrubs and forbs. Vines and epiphytes (Spanish moss) are common and abundant. At higher elevations, the clouds and fog encourage moss growth on the trees. In different ecozones, the plant communities vary with some needle-like pines with understory of grasses and sedges to coastal marshes and interior swamps dominated by gum and cypress and minimal understory species. Soils vary from heavy clay to gravel with sands on the hilly and broad flats.

Outer Coastal Plain Mixed Forest Province

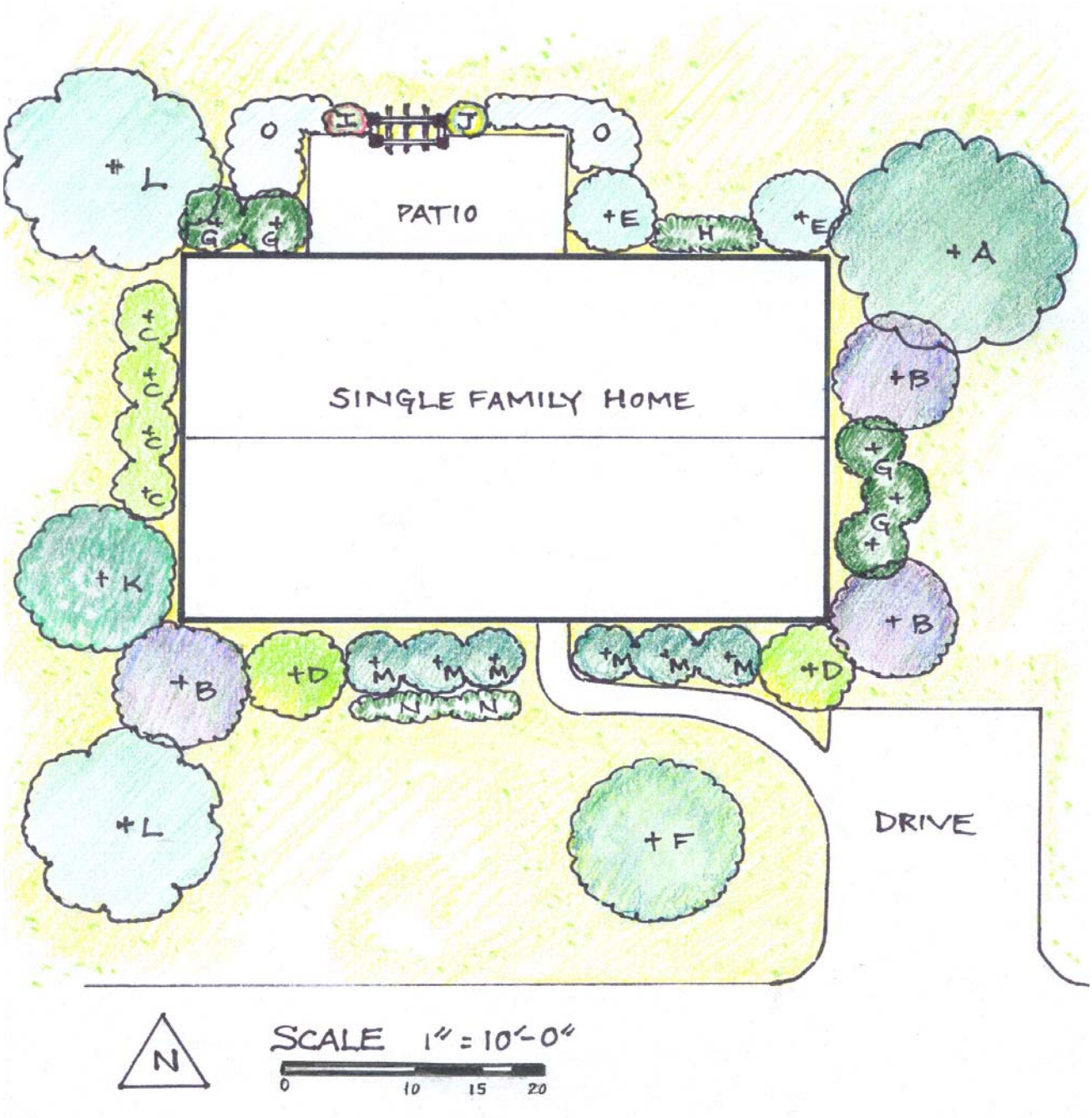


Military Installations in Outer Coastal Plain Mixed Forest Province

ID	Installation	ID	Installation
29	AVON PARK BOMBING RANGE	112	FORT STEWART MILITARY RESV
32	MACDILL AIR FORCE BASE	128	LAUREL BAY NAVAL AREA
34	US AIR FORCE MALABAR ANNEX	129	US NAVAL RES MARINE AIR STATION
35	PATRICK AIR FORCE BASE	157	US NAVAL RESERVATION
38	CAPE CANAVERAL AIR FORCE STATION	158	CHARLESTON AIR FORCE BASE
42	PINE CASTLE BOMBING RANGE	192	NORTH ARMY AIR BASE
56	ALVIN CALLENDER FIELD	213	MCENTIRE AIR NATIONAL GUARD STATION
58	CAMP BLANDING	217	SHAW AIR FORCE BASE
59	NAVAL SUPPORT ACTIVITY NEW ORLEANS	220	SUNNY POINT ARMY TERMINAL
60	JACKSON BARRACKS	262	SEYMOUR-JOHNSON AIR FORCE BASE
61	TYNDALL AFB	270	DARE COUNTY BOMBING RANGE
62	NAVAL COASTAL SYSTEMS CENTER	291	NAVAL AUX LANDING FIELD FENTRESS
63	JACKSONVILLE NAVAL AIR STATION	292	FLEET COMBAT TRAINING CTR ATLANTIC
68	CAMP VILLERE	293	ST JULIAN NAVAL DEPOT
70	PENSACOLA NAVAL AIR STATION	294	AMPHIBIOUS BASE USN
73	MAYPORT NAVAL STATION	295	CAMP PENDLETON SM RESERVATION
74	US NAVAL RESERVATION BRONSON FIELD	296	NORFOLK NAVAL SHIPYARD
80	KEESLER AIR FORCE BASE	297	OCEANA NAVAL AIR STATION
81	US NAVAL AIR BASE SAUFLEY FIELD	303	FORT MONROE
85	EGLIN AIR FORCE BASE	305	LANGLEY AIR FORCE BASE
88	WHITING FIELD US NAVAL AIR STATION	306	FORT EUSTIS
89	KINGS BAY NAVAL SUB SUPPORT BASE	313	YORKTOWN NAVAL WEAPONS STATION
92	FORT POLK MILITARY RESV	314	FORT LEE
93	CAMP SHELBY MILITARY RESV	315	US NAVAL SUPPLY CENTER CHEATHAM ANX
94	CLAIBORNE RANGE MILITARY RESV	318	CAMP PEARY NAVAL RESERVATION
99	HUNT ARMY AIRFIELD	344	FORT AP HILL MILITARY RESERVATION
101	FORT RUCKER		
105	MARINE CORPS LOGISTICS BASE-ALBANY		

Total Number of Installations: 61

Residential House Plan Outer Coastal Plain Mixed Forest Province



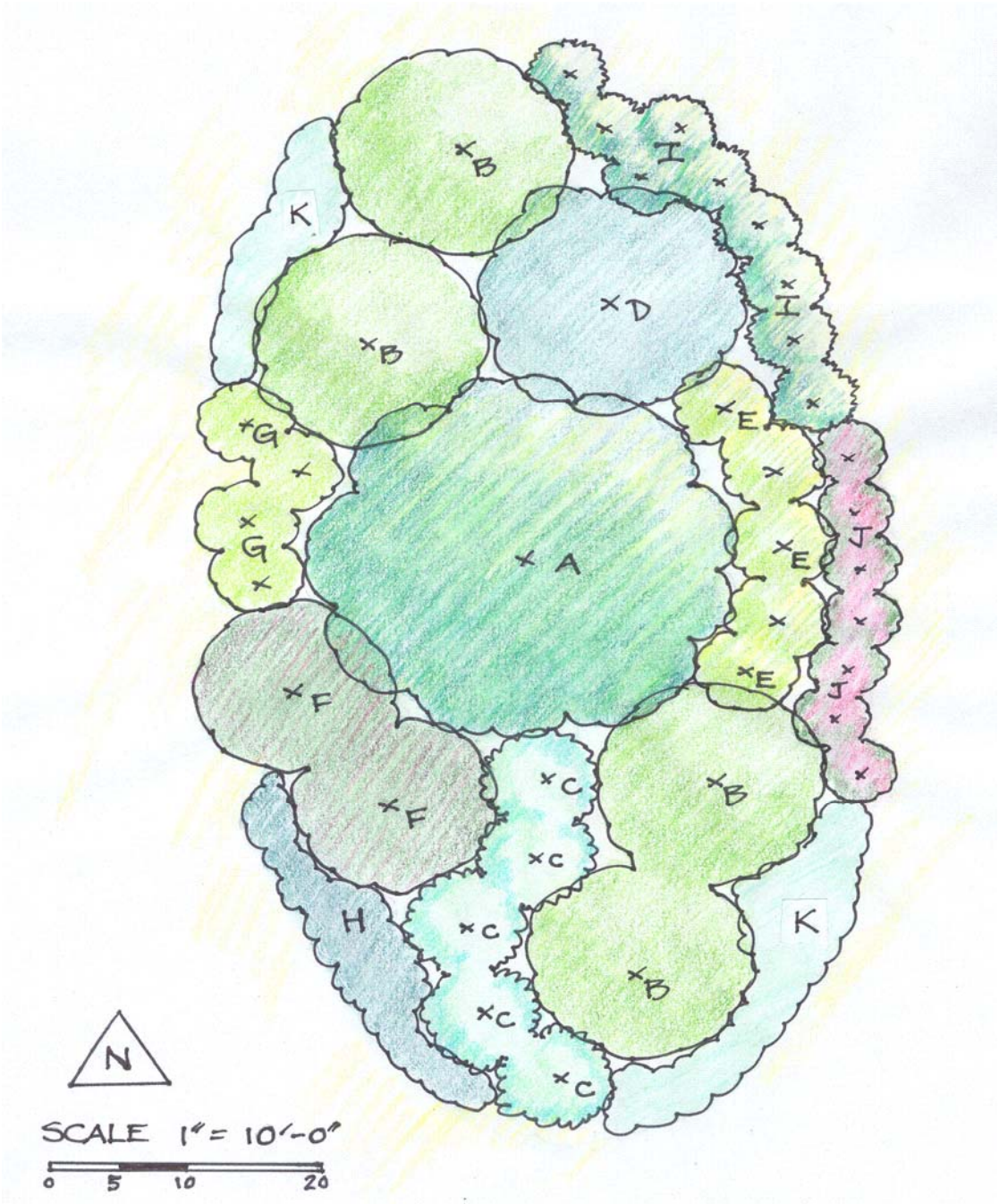
Residential Landscape Plan for Outer Coastal Plain Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Magnolia grandiflora*	Southern Magnolia	May, June
B. *Magnolia virginiana*	Sweetbay Magnolia	April, May
C. *Leucothoe axillaris*	Leucothoe	Feb - May
D. *Ilex cornuta "Burfordii*"	Burford's Holly	April, May
E. *Aesculus parviflora*	Bottlebrush Buckeye	July, Aug.
F. *Stewartia malcodendron*	Silky Camellia	May, June
G. *Rhododendron alabamense*	Alabama Azalea	March, April
H. *Sabal minor*	Dwarf Palmetto	June, July
I. *Bignonia capreolata*	Crossvine	April, May
J. *Gelsemium sempervirens*	Yellow Jessamine	March, April
K. *Morella cerifera*	Common Wax Myrtle	April
L. *Halesia dipt*era	Silverbells	April, May
M. *Ilex glabra*	Inkberry	May, June
N. *Crinum spp*.	Crinum Lilies	May - Sept.
O. Vegetable, Herb and Annual Flowers		May - Oct.

Notes: Yellow Jessamine and Crossvine are to be grown on the trellis on the patio in back of the house. The vegetable, herb and annual flowers extend the flowering season and attract later season pollinators.

Island Landscape Plan for Outer Coastal Plain Mixed Forest Province



Island Landscape Plan for Outer Coastal Plain Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Magnolia grandiflora*	Southern Magnolia	May, June
B. *Halesia dipt*era	Silverbells	April, May
C. *Ilex decidua*	Possum – Haw	March- May
D. *Magnolia virginiana*	Sweetbay Magnolia	April, May
E. *Aesculus parviflora*	Bottlebrush Buckeye	July, Aug.
F. *Morella cerifera*	Common Wax Myrtle	April
G. *Cyrilla racemiflora*	Leatherwood	May, June
H. *Sabal minor*	Dwarf Palmetto	June, July
I. *Fothergilla gardenia*	Fothergilla	March- May
J. *Ilex glabra*	Inkberry	May, June
K. Perennial Flowers:		May –Oct.

Crinum spp., Coreopsis spp., Helianthus spp., Iris spp., Liatris elegans, Lilium spp., Monarda spp.

Notes: Perennial flowers extend the flowering season and attract later season pollinators.

Seed Mix for Outer Coastal Plain Mixed Forest Province

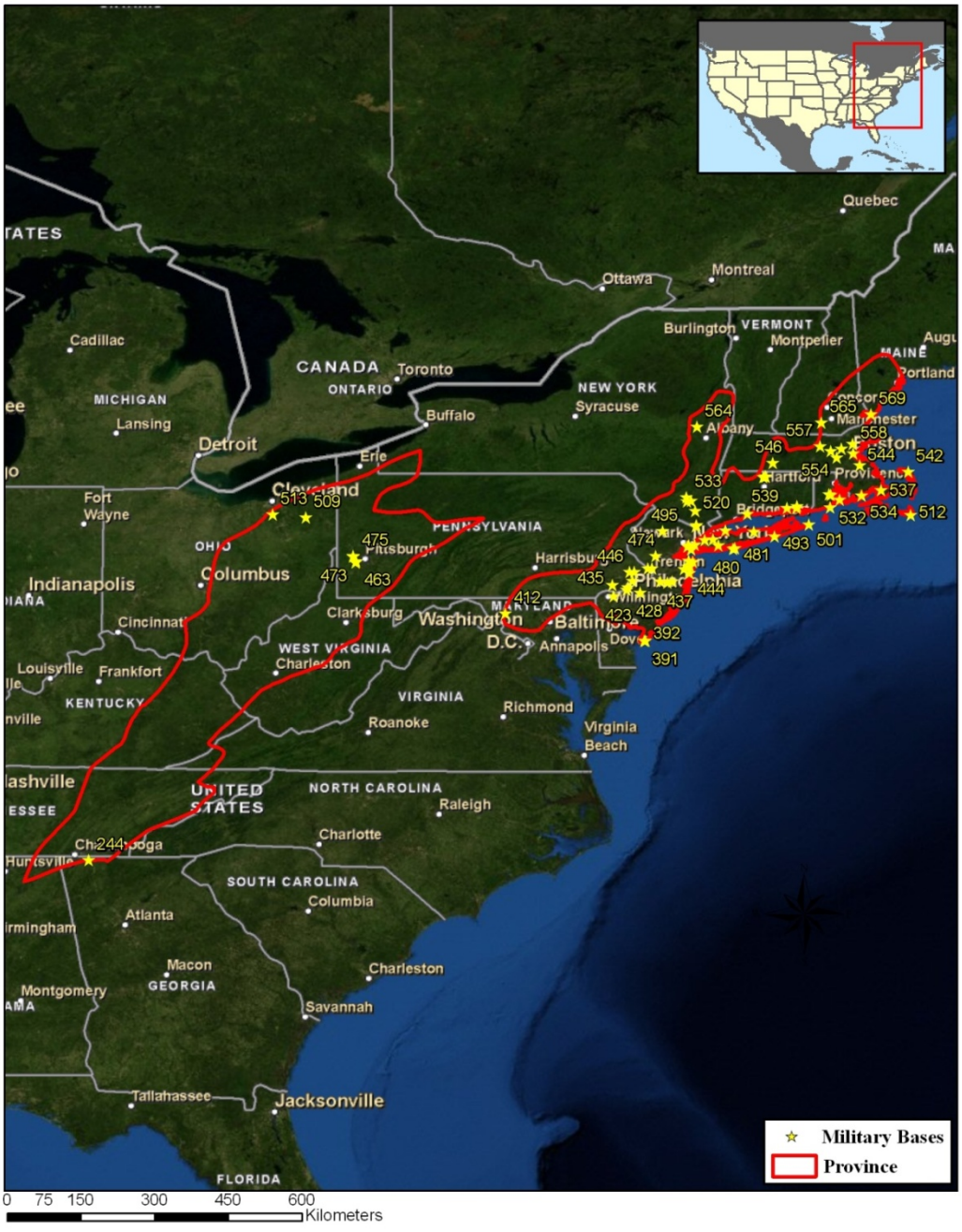
Latin Name	Common Name
Achillea millefolium	White Yarrow
Asclepias lanceolata	Red Milkweed
Boltonia caroliniana	Carolina Daisy
Coreopsis falcate	Pool Coreopsis,
Eupatorium fistulosum	Joe-Pye Weed
Eupatorium perfoliatum	Boneset
Helianthus angustifolius	Narrowleaf sunflower
Helianthus heterophyllus	Savanna Sunflower
Hibiscus grandiflorus	Swamp Rose Mallow
Lobelia elongate	Blue Lobelia
Monarda punctata	Spotted Beebalm
Oenothera biennis	Evening Primrose
Rhexia alifanus	Smooth Meadow Beauty
Rudbeckia hirta	Black Eyed Susan
Solidago sempivirens/ S. graminifolia	Seaside /Grass-leaved Goldenrod
Stokesia laevis	Stoke's Aster
Trifolium incarnatum	Crimson Clover

Amount by weight
1 oz. of each plant species

B) Eastern Broadleaf Forest (Oceanic) Province

This region is defined by the continental influence which ensures a strong annual temperature defined by cold winters and warm summers. There is year-round precipitation with more in the summer months. The dominate plant community is a temperate or winter deciduous forest dominated by tall broadleaf trees that provide a dense canopy in summer and open in the winter. Understory of small trees and shrubs develop weakly and are sparse, but have a thick ground cover of forbs in the spring. The soils are typically rich due to the leaf litter and abundant humus.

Eastern Broadleaf Forest (Oceanic) Province

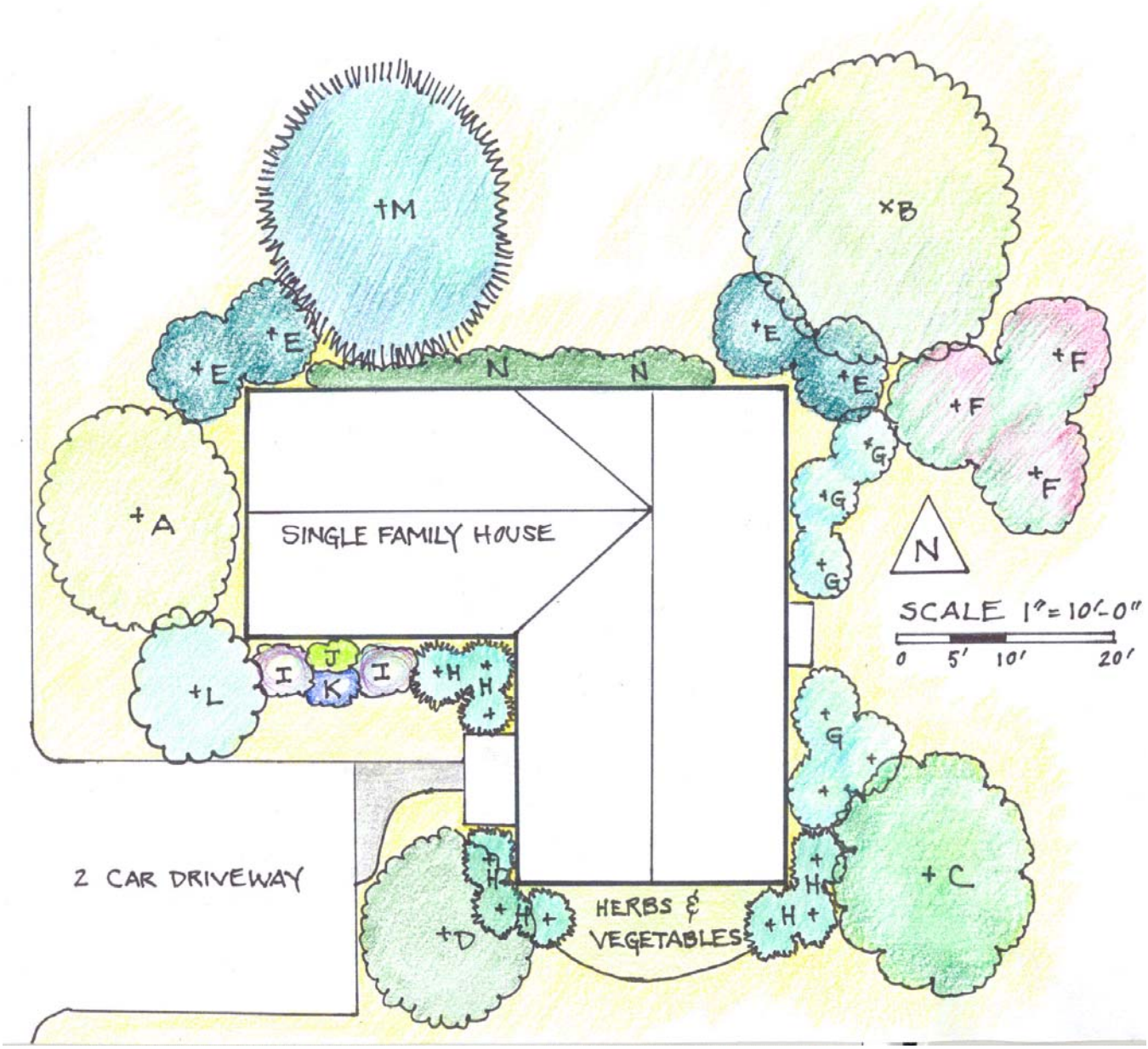


Military Installations in Eastern Broadleaf Forest (Oceanic) Province

ID	Installation
412	FORT DETRICK
434	QUARTER MASTER DEPOT US ARMY
439	JOINT BASE MCGUIRE – FT DIX - LAKEHURST
441	US NAVAL AVIATION DEPOT
453	NAVAL WEAPONS STATION EARLE
466	99TH REGIONAL SUPPORT COMMAND HQ
467	US NAVAL RESERVATION EARLE
473	PENNSYLVANIA AIR NATIONAL GUARD
474	BELLE MEAD GENERAL DEPOT
479	FORT HAMILTON
483	MILITARY OCEAN TERMINAL
492	ROSLYN AIR NATIONAL GUARD STATION
495	PICATINNY ARSENAL
509	RAVENNA ORDNANCE PLANT
520	NEW YORK STATE MILITARY RESERVATION
524	STONE RANCH MILITARY RESERVATION
526	FORT NATHANIEL GREENE
528	NEW LONDON NAVAL SUBMARINE BASE
530	US MILITARY ACADEMY STEWART SUBPOST
531	NEW YORK ARMY NATIONAL GUARD
536	ARMY NATIONAL GUARD
537	OTIS AIR FORCE BASE
539	CONN AIR GUARD
546	WESTOVER AIR RESERVE BASE
550	ARMY LABS FACILITY
555	HANSCOM AIR FORCE BASE
557	FORT DEVENS MILITARY RESERVATION
558	CAMP CURTIS GUILD NATL GUARD RES
564	STRATTON AIR NATIONAL GUARD BASE
565	NEW BOSTON AIR STATION
569	PORTSMOUTH NAVAL BASE

Total Number of Installations: 33

Residential Landscape of Eastern Broadleaf Forest (Oceanic) Province



Residential Landscape Plan for Eastern Broadleaf Forest (Oceanic) Province

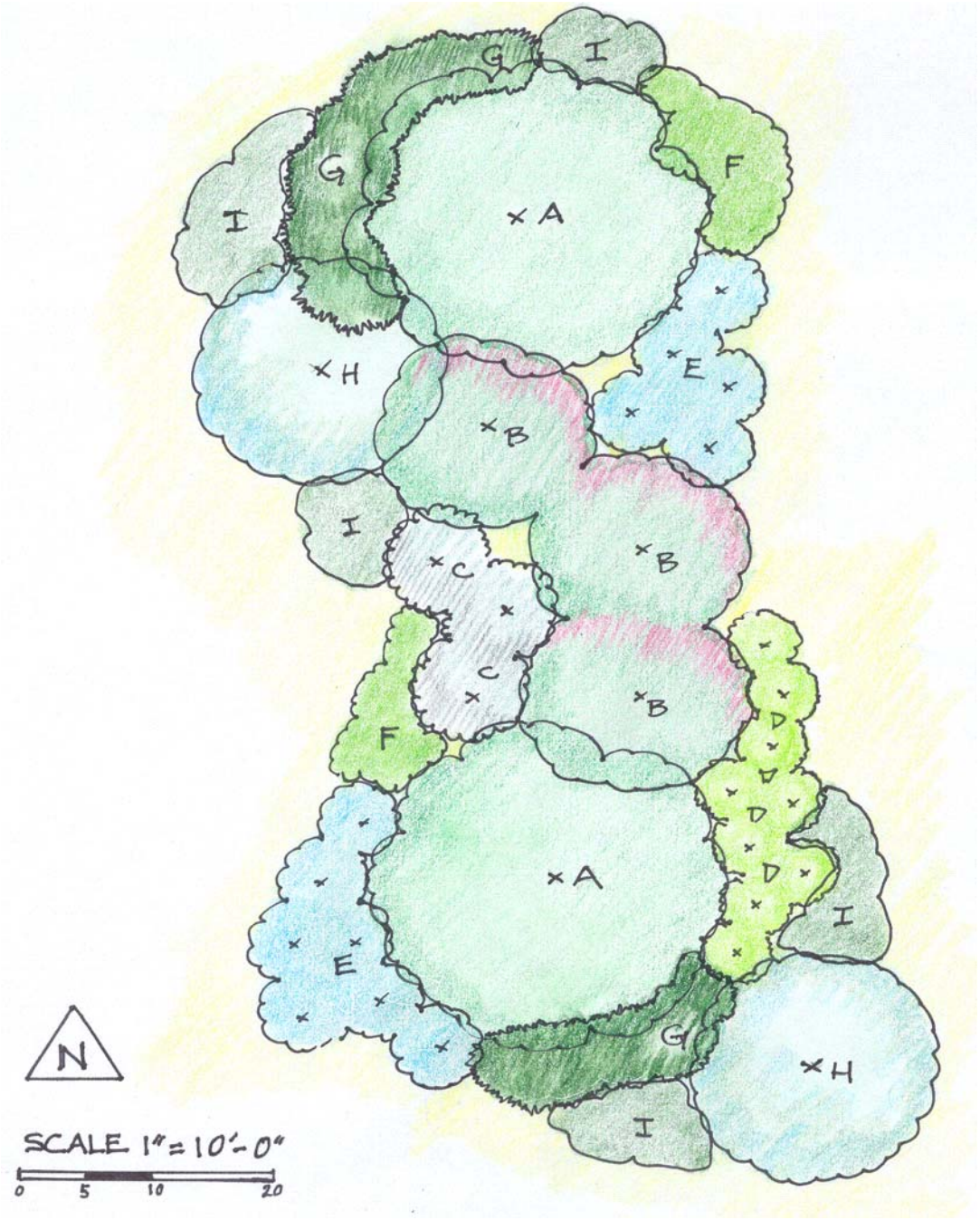
PLANT KEY

Latin Name	Common Name	Flowering Period
A. *Amelianchier arborea*	Downy Serviceberry	March, April
B. *Oxydendroum arboret*um	Sourwood	June, July
C. *Cladrastis lutea*	American Yellowwood	May, June
D. *Cercis canadensis*	Eastern Redbud	April, May
E. *Kalmia latifolia*	Mountain Laurel	May, June
F. *Sambucus canadensis*	Black Elderberry	June, July
G. *Rhododendron prinophyllum*	Roseshell Azalea	May
H. *Rosa Rogosa*	Rogosa Rose	July, Aug.
I. *Ceanothus americanus*	New Jersey Tea	May – Sept.
J. *Lilium spp.*	Native Lilies	June – Aug.
K. *Monarda spp.*	Beebalm	June - Sept.
L. *Cornus florid*a	Flowering Dogwood	April, May
M. *Juniperus virginiana*	Red Cedar	(see Notes)
N. Perennial Flower Border:		Apr-Aug

Lilium spp., Iris spp., Phlox spp., Rudbeckia spp., Monarda spp., and Salvia spp.

Notes: While the red cedar does not provide flowers and, therefore no nectar or pollen, it does provide protection from northern winds and habitat for pollinators. It will provide bare dirt under the dense canopy, also needed by pollinators. Many of the flowering plants also provide food and berries for birds and wildlife.

Island Landscape Plan for Eastern Broadleaf Forest (Oceanic) Province



Island Landscape Plan for Eastern Broadleaf Forest (Oceanic) Province

PLANT KEY

Latin Name	Common Name	Flowering Period
A. *Oxydendrum arboretum*	Sourwood	June, July
B. *Cercis canadensis*	Redbud	April, May
C. *Sambucus canade*nsis	Black Elderberry	June, July
D. *Rhus copallinum*	Dwarf Sumac	July – Sept.
E. *Rosa rog*osa	Rogosa Rose	June - Aug.
F. *Ceanothus americanus*	New Jersey Tea	May - Sept.
G. *Arctostaphylos uva-ursi*	Bearberry	April, May
H. *Cornus florida*	Flowering Dogwood	May
I. Perennial flowers: Iris spp., Lilium spp., Monarda spp., Phlox spp., and Rudbeckia spp.		May - Sept.

Notes: The perennial flowers can extend the flowering season and attract late season pollinators.

Seed Mix for Eastern Broadleaf Forest (Oceanic) Province

Latin Name	Common Name
Achillea millefolium	White Yarrow
Asclepias syriaca	Common Milkweed
A. tuberosa	Butterfly Weed
Aster novae-angliae	New England Aster
Coreopsis verticillata	Whorled Coreopsis
Eupatorium fistulosum	Joe-Pye Weed
E. perfoliatum	Boneset
Helianthus gracilentus	Slender Sunflower
Lobelia cardinalis	Cardinal Flower
Lupinus perennis	Lupine
Monarda didyma	Red Beebalm
M. fistulosa	Wild Bergamont
M. *punctata*	Spotted Beebalm
Oenothera biennis	Evening Primrose
Phlox bifida	Cleft Phlox
Rudbeckia lacinata	Cutleaf Coneflower
R. hirta	Black Eyed Susan

Amount by weight
1 oz. of each plant species

C) Eastern Broadleaf Forest (Continental) Province

These province climatic conditions are similar to those with the oceanic broadleaf forest to the east with decreased precipitation and hotter summers. Most of the precipitation occurs in the summer growing season making this area somewhat high in relative humidity. The plant community is very similar to that to the east but with the reduced precipitation favors a more drought-resistant oak-hickory association. The defining understory shrub of dogwood is complemented with sassafras and hornbeam. Many wildflowers species are present.

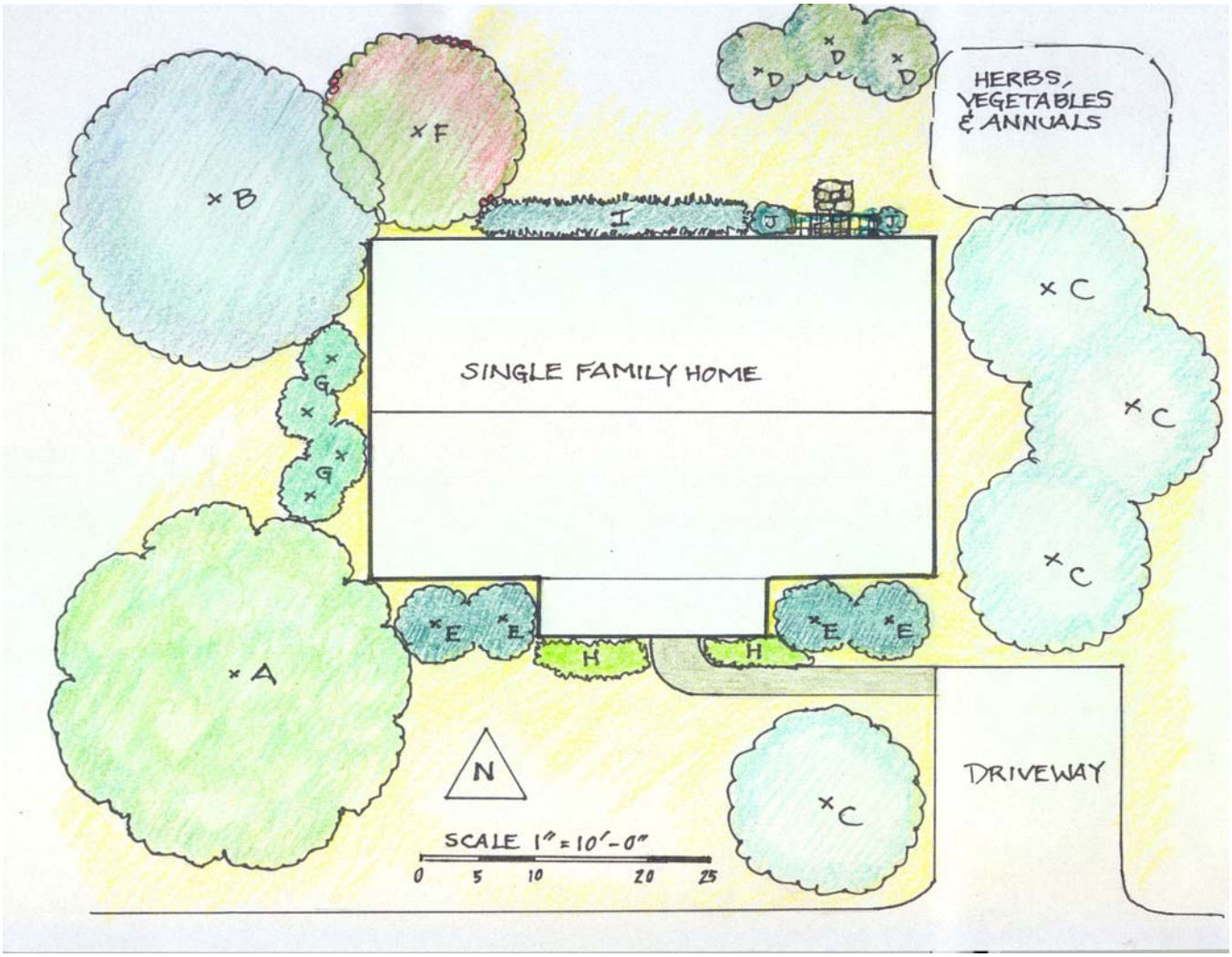
Eastern Broadleaf Forest (Continental) Province

Military Installations in Eastern Broadleaf Forest (Continental) Province

ID	Installation
231	REDSTONE ARSENAL
263	ARNOLD ENGR DVLPMT CNTR-USAF
273	MILAN ARSENAL
277	TENNESSEE NATIONAL GUARD
288	FORT CAMPBELL MILITARY RESERVATION
329	LEXINGTON-BLUE GRASS ARMY DEPOT
330	FORT LEONARD WOOD
339	FORT KNOX MILITARY RESERVATION
356	SCOTT AIR FORCE BASE
405	CAMP ATTERBURY MILITARY RESERVATION
420	STOUT FIELD
427	WRIGHT PATTERSON AIR FORCE BASE
482	GRISSOM AIR RESERVE BASE
497	INDIANA AIR NATIONAL GUARD
551	FORT CUSTER TRAINING CENTER
552	GREAT LAKES NAVAL TRAINING CENTER
556	DETROIT ARSENAL
559	SELFRIDGE AIR NATIONAL GUARD BASE
563	SENECA ARMY DEPOT
573	NIAGARA FALLS AIR RESERVE STATION
587	CAMP WILLIAMS MILITARY RESERVATION
589	FORT MCCOY MILITARY RESERVATION
591	FORT DRUM MILITARY RESERVATION
614	CAMP RIPLEY MILITARY RESERVATION

Total Number of Installations: 24

Residential Landscape Plan for Eastern Broadleaf Forest (Continental) Province



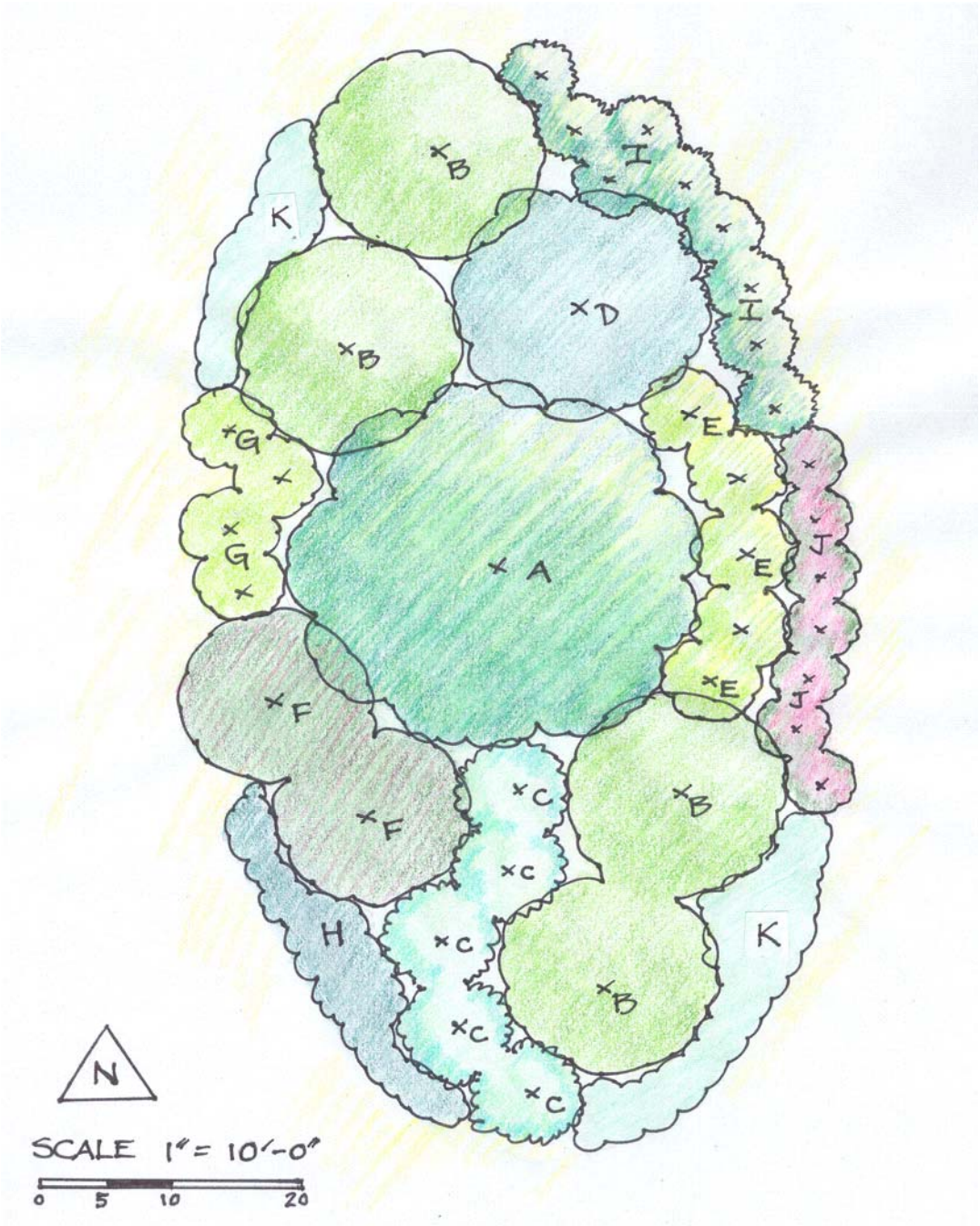
Residential Landscape for Eastern Broadleaf Forest (Continental) Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Tillia americana*	Basswood	April - June
B. *Sassafras albidu*m	Sassafras	May - June
C. *Cornus florida*	Flowering Dogwood	May
D. *Viburnum prunifolium*	Black Haw	April - June
E. *Leucothoe catesbaei*	Drooping Leucothoe	April, May
F. *Cercis canadensis*	Redbud	April, May
G. *Lindera benzoin*	Spicebush	March - May
H. *Iris spp. & Lilium spp*.	Iris and Lilies	May - Aug.
I. *Vaccinium vascillans*	Lowbush Blueberries	May, June
J. *Lonicera sempervirens*	Trumpet Honeysuckle	June - Aug.

Notes: Trumpet Honeysuckle will need to be planted on a trellis around the back entry of the house. Herbs, vegetables and annual flowers planted in a garden, will extend the flowering season and attract many pollinators.

Island Landscape Plan for Eastern Broadleaf Forest (Continental) Province



Island Landscape Plan for Eastern Broadleaf Forest (Continental) Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Tillia americana*	Basswood	April - June
B. *Cornus florida*	Flowering Dogwood	May
C. *Sambucus canadensis*	Black Elderberry	June, July
D. *Amelanchier arborea*	Downy Serviceberry	March, April
E. *Physocarpus opulifolius*	Eastern Ninebark	May - July
F. *Cercis canadens*is	Redbud	April, May
G. *Rhus aromatica*	Aromatic Sumac	April, May
H. *Vaccinium macrocarpon*	Cranberry	April, May
I. *Lindera benz*oin	Spicebush	March - May
J. *Comptonia peregrina*	Sweetfern	May
K. Perennial flowers:		May - Sept.

Erigeron spp., Iris spp., Lilium spp., Monarda spp., Phlox spp., and Tradescantia virginiana

Notes: The perennial flowers can extend the flowering season and attract late season pollinators.

Seed Mix for Eastern Broadleaf Forest (Continental) Province

Latin Name	**Common Name**
Achillea millefolium	White Yarrow
Asclepias syriaca	Common Milkweed
Asclepias tuberosa	Butterfly Weed
Aster novae-angliae	New England Aster
Coreopsis verticillata	Whorled Coreopsis
Eupatorium fistulosum	Joe-Pye Weed
Eupatorium perfoliatum	Boneset
Helianthus gracilentus	Slender Sunflower
Lobelia cardinalis	Cardinal Flower
Lupinus perennis	Lupine
Monarda didyma	Red Beebalm
Monarda, fistulosa	Wild Bergamont.
Or Monarda punctata	Spotted Beebalm
Phlox bifida	Cleft Phlox
Rudbeckia lacinata	Cutleaf Coneflower
Rudbeckia hirta	Black Eyed Susan
Oenothera biennis	Evening Primrose

Amount by weight

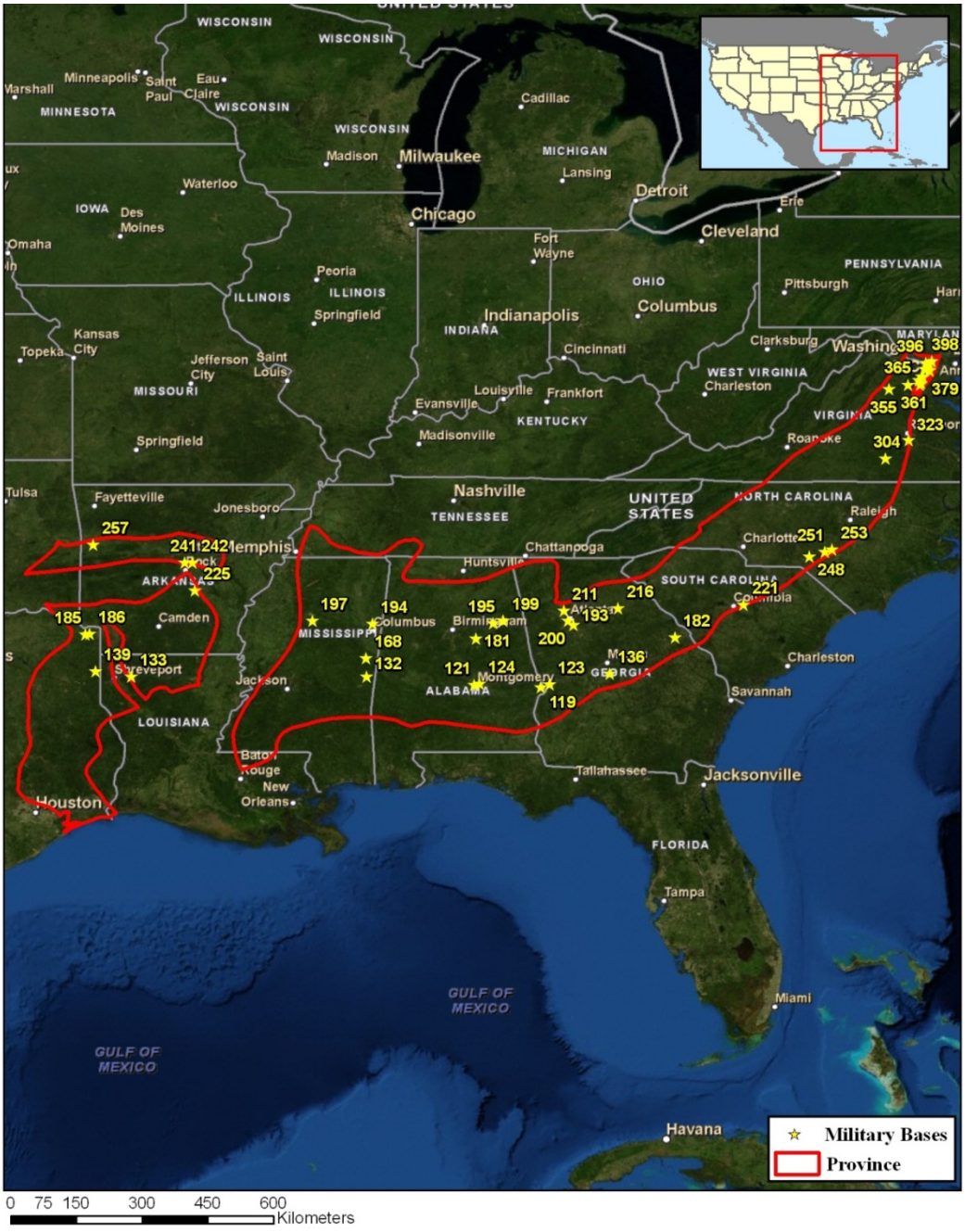
1 oz. of each plant species

2 1 oz. of each to produce 1 lb. seed mix

D) Southeastern Mixed Forest Province

The climate in this ecoregion is fairly uniform throughout with mild winters and hot, humid summers. The growing season is long with mild frosts in the winter and rarely snows; precipitation peaks in midsummer and early spring. Since precipitation exceeds evaporations, summers are humid. Climax plan communities are dominated by medium-tall to tall broadleaf deciduous forests, composed of oak, hickory, sweetgum, blackgum, red maple and winged elm, and evergreen trees (loblolly, shortleaf and southern yellow pines). Understory shrubs and vines are common, such as dogwood, viburnum, blueberry, American beautyberry, youpon and honeysuckles. Along the west Gulf coast shores, Spartina, a marsh grass, characterizes salt marshes.

Southern Mixed Forest Province

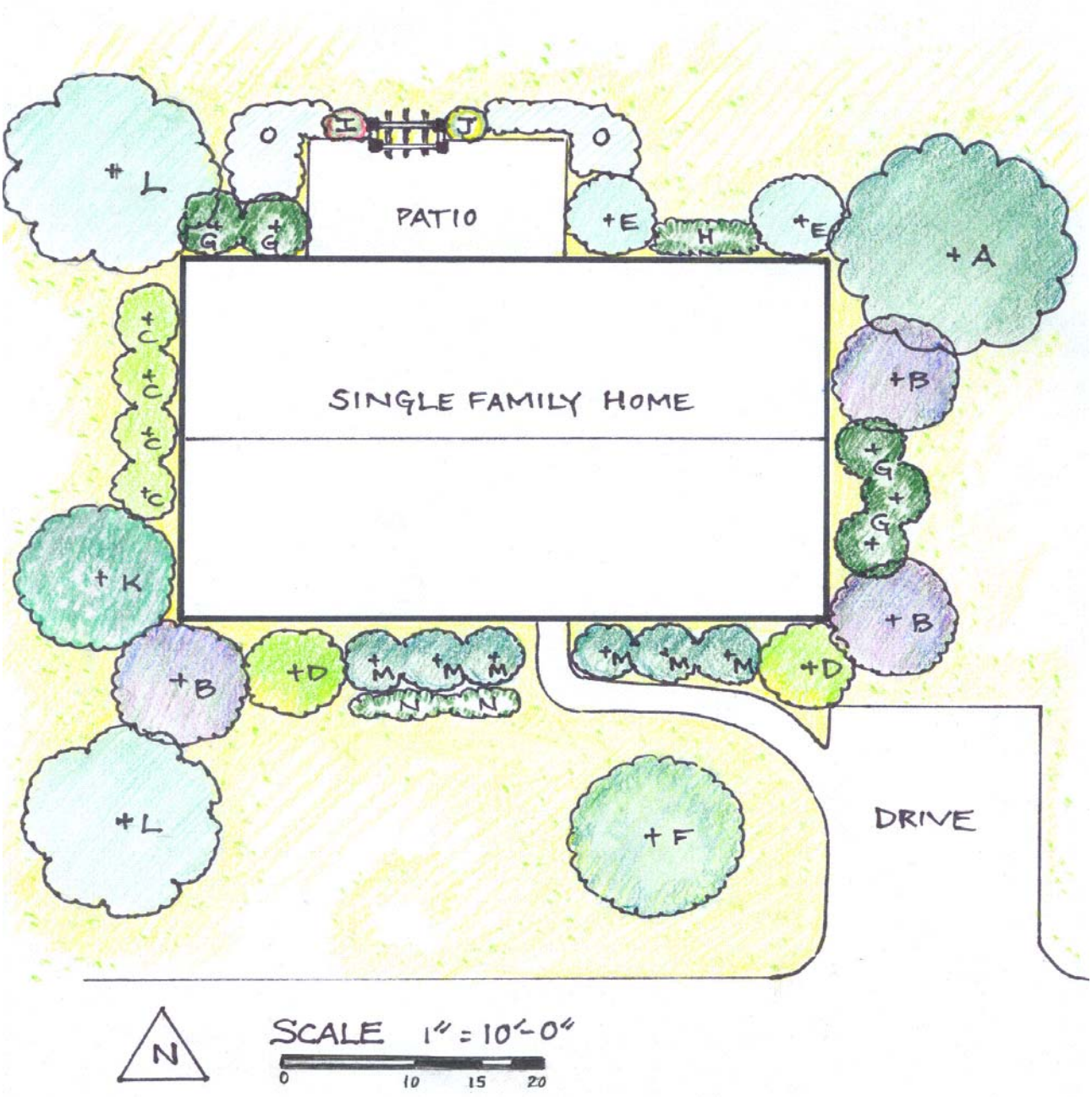


Military Installations in Southern Mixed Forest Province

ID	Installation
121	MAXWELL AIR FORCE BASE
123	FORT BENNING MILITARY RESERVATION
124	GUNTER AIR FORCE STATION
133	LOUSIANA ARMY AMMUNITION PLANT
136	ROBINS AFB
139	LONGHORN ARMY AMMUNITION PLANT
181	ALABAMA ARMY AMMUNITION PLANT
182	FORT GORDON MILITARY RESERVATION
185	RED RIVER ARMY DEPOT
186	LONE STAR ARMY AMMUNITION PLANT
193	FORT GILLEM
194	COLUMBUS AIR FORCE BASE
195	ANNISTON ARMY DEPOT
200	FORT MCPHERSON
211	DOBBINS AIR FORCE BASE
221	FORT JACKSON MILITARY RESERVATION
225	PINE BLUFF ARSENAL
241	CAMP JOSEPH T ROBINSON
242	LITTLE ROCK AIR FORCE BASE
248	CAMP MACKALL MILITARY RESERVATION
251	FORT BRAGG MILITARY RESERVATION
253	POPE AIR FORCE BASE
360	US NAVAL ORDINANCE STATION
361	QUANTICO MARINE CORPS BASE
363	NAVAL SURFACE WARFARE CENTER
370	FORT BELVOIR MILITARY RESERVATION
371	DAVISON AIRFIELD
379	BOLLING AIR FORCE BASE
381	ANACOSTIA NAVAL STATION
386	FORT MYER
394	WALTER REED ARMY MEDICAL CENTER
396	NATIONAL NAVAL MEDICAL CENTER
398	NAVAL SURFACE WEAPONS CENTER

Total Number of Installations: 34

Residential Landscape Plan for Southern Mixed Forest Province



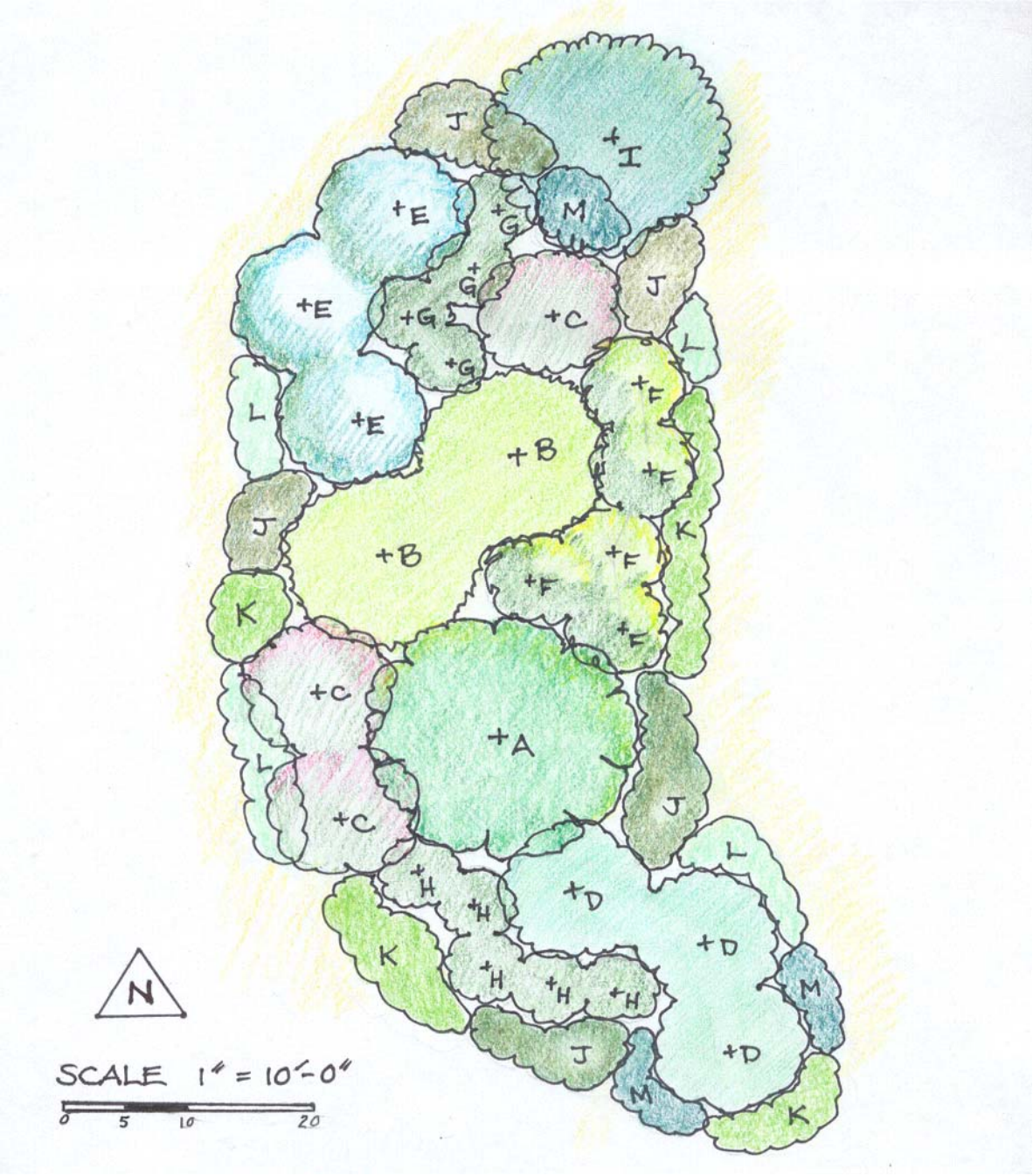
Residential Landscape Plan for Southeastern Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Magnolia grandiflora*	Southern Magnolia	May, June
B. *Rhododendron canescens*	Piedmont Azalea	June, July
C. *Ceanothus americanus*	New Jersey Tea	April, May
D. *Fothergilla major*	Witch Alder	April, May
E. *Philadelphus hirsutus*	Hairy Mock Orange	April, May
F. *Chionanthus virginicus*	Fringe Tree	April, May
G. *Rhododendron carolinianum*	Carolina Rhododendron	May
H. *Crinum americana*	Swamp lily	June - Aug.
I. *Lonicera sempervirens*	Coral Honeysuckle	April, July
J. *Gelsemium sempervirens*	Yellow Jessamine	March, April
K. *Magnolia virginiana*	Sweetbay Magnolia	April, May
L. *Cornus florida*	Flowering Dogwood	May
M. *Rosa virginiana*	Virginia Wild Rose	May - July
N. *Iris spp*.	Iris	May, June
O. Vegetables, Herbs, and Annual Flowers		Apr-Aug

Notes: Plant Coral Honeysuckle and Yellow Jessamine on a trellis as an entry to the patio. Plant vegetable, herbs, and annual flowers to attract pollinators throughout the summer and fall growing seasons.

Island Landscape Plan for Southeastern Mixed Forest Province



Island Landscape Plan for Southeastern Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Magnolia grandiflora*	Southern Magnolia	May, June
B. *Cornus florida*	Flowering Dogwood	May
C. *Cercis canadensis*	Redbud	March, April
D. *Ilex decidua*	Possum Haw	April
E. *Magnolia virginiana*	Sweetbay Magnolia	June
F. *Rhododendron* spp.	"Encore" Azalea	April &Sept.
G. *Rosa x hybida*	"Knock out" Roses	March - Dec.
H. *Rosa virgniana*	Virginia Wild Rose	May - July
I. *Ilex virginiana*	American Holly	April - June
J. *Crinum americana*	Swamp lily	June, Aug.
K. *Iris spp*.	Iris	May, June
L. *Coreopsis verticillata*	Threadleaf Coreopsis	May - July
M. *Phlox amoena*	Hairy Phlox	April - June

Notes: The dimension of this planting is approximately 100 feet by 40 feet; this could be suitably planted along a roadway, or as a planting adjacent to a building.

Seed Mix for Southeastern Mixed Forest Province

Latin Name	Common Name
Achillea millefolium	White Yarrow
Asclepias incarnata	Eastern Swamp Milkweed
Baptisia australis	Wild Blue Indigo
Clinopodium geogianum	Georgia Savory
Coreopsis auriculata	Lobed Coreopsis
Coreopsis verticillata	Threadleaf Coreopsis
Eupatorium hyssopifolium	Hyssop-leaf Eupatorium
Helianthus resinosus	Hairy Sunflower
Liatris pilosa	Shaggy Blazing Stars
Monarda punctata	Spotted Beebalm
Oenothera biennis	Evening Primrose
Phlox glaberrima	Smooth Aster
Rudbeckia hirta	Black Eyed Susan
Solidago odora	Sweet Goldenrod
OR *Solidago graminifolia*	Grass-leaved Goldenrod
Stokesia laevis	Stoke's Aster
Trifolium incarnatum	Crimson Clover

Amount by weight
1 oz. of each plant species

E) California Coastal Chaparral Forest Province

The climate in this province is characterized by hot, dry summers and rainy, mild winters; with an average precipitation of 10-50 inches and temperature averages between 50˚-65˚ F. Plant communities are dominated by endemic trees of the region – Monterey cypress, Torrey, Bishop, and Monterey pines. Coastal plains and larger valleys have sagebrush and grassland communities. On steep hills and mountain slopes too dry to support forest or woodland communities, most of the vegetation is scrub known as chaparral, which varies in composition with elevation and aspect. Along the coastline, the exposed areas support a more desert-like shrub community denoted as coastal shrub, dominated by coyote bush, California sagebrush, and bush lupine, as well as coastal buckwheat. Most of the soils in this region are quite fertile with adequate water.

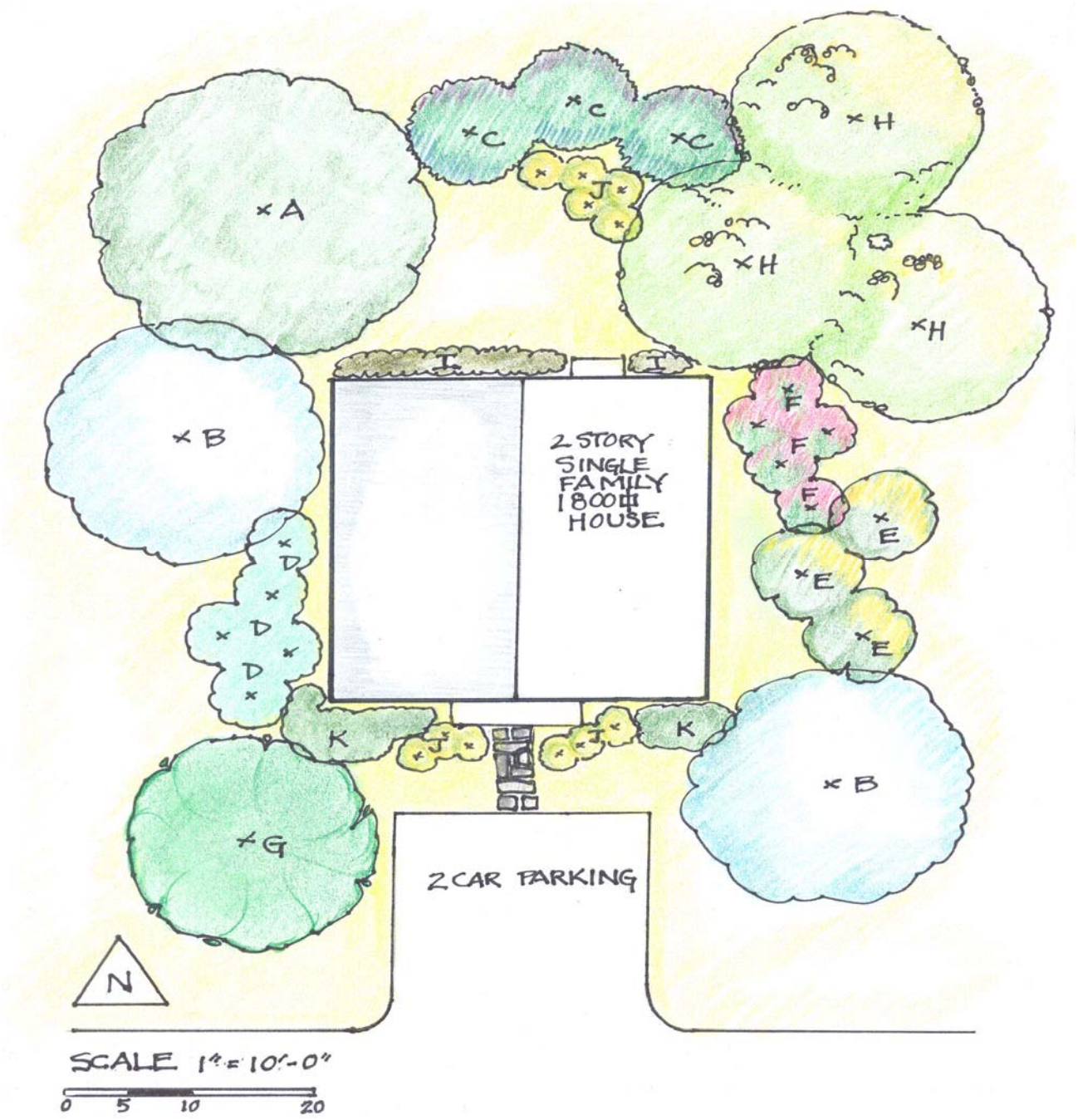
California Coastal Chaparral Forest and Shrub Province

Military Installations in California Coastal Chaparral Forest and Shrub Province

ID	Installation
134	IMPERIAL BEACH NAVAL AIR STATION
142	FORT ROSECRANS MILITARY RESERVATION
144	NORTH ISLAND NAVAL AIR STATION
156	MIRAMAR MARINE CORPS AIR STATION
159	US NAVY STATION SAN CLEMENTE
178	NAVY OUTLYING FIELD SAN NICOLAS IS
183	CAMP PENDLETON MARINE CORPS BASE
201	FORT MACARTHUR (MFH under LA AFB)
202	NAVAL WEAPONS STATION SEAL BEACH
210	LOS ANGELES AIR FORCE BASE
222	POINT MUGU NAWS
223	PORT HUENEME NAVAL CBC
237	VANDENBERG AIR FORCE BASE
260	CAMP SAN LUIS OBISPO
275	Ft. HUNTER LIGGETT MILITARY RESERVATION
321	MOFFETT FEDERAL AIR FIELD
331	CAMP PARKS MILITARY RESERVATION
332	HUNTERS POINT NAVAL SHIPYARD
335	OAKLAND NAVAL SUPPLY CENTER
337	OAKLAND ARMY BASE
340	RICHMOND RESERVE SHIPYARD

Total Number of Installations: 21

Residential Landscape Plan for California Coastal Chaparral Forest Province



Residential Landscape Plan for California Coastal Chaparral Forest Province

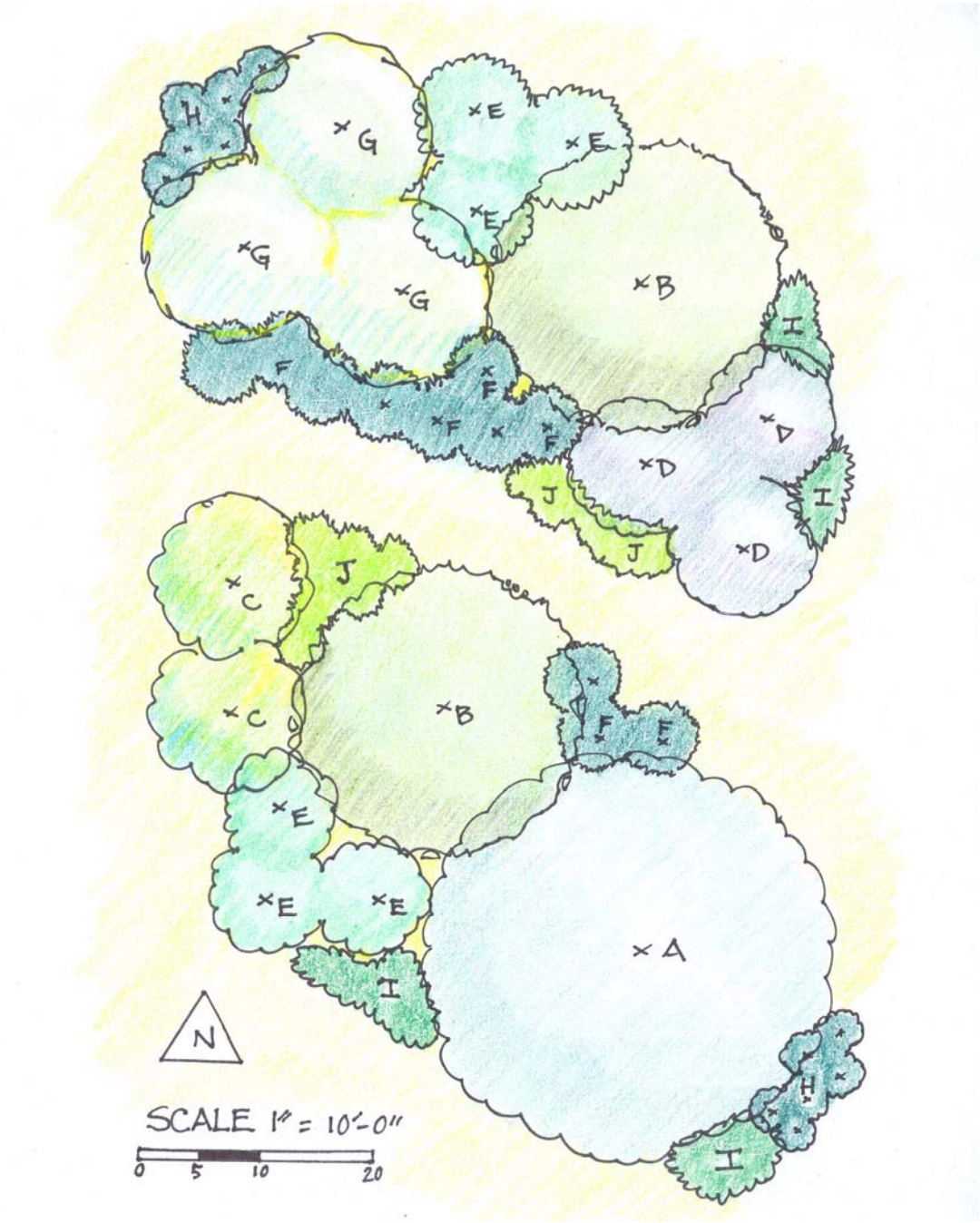
PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Acer macrophyllum*	Bigleaf Maple	March-June
B. *Prunus illicifolia*	Hollyleaf Cherry	March
C. *Malacothamnus fasicuculatus*	Mendocino Bushmallow	May - Aug.
D. *Salvia leucophylla*	San Luis Purple Sage	May - June
E. *Cornus glabrata*	Brown Dogwood	April, May
F. *Rhododendron occidentale*	Western Azalea	May
G. *Ceanothus thyrsifolius*	White Mountain Lilac	Feb. - June
H. *Aesculus californica*	California Buckeye	April, May
I. *Mahonia nervosa*	Cascade Barberry	April, May
J. *Salvia mellifera*	Black Sage	May, June
K. Perennial Flowers:		March - Aug.

Abonia umbellate (Pink Sand Verbena); Aquilegia formosa (Western Columbine); Dicentra formosa (Pacific Bleeding Heart); Lupinus spp.; Oenothera californica (California Evening Primrose); and Paeonia californica (California Peony).

Notes: Perennial flowers will extend the flowering season and attract many pollinators.

Island Landscape Plan for California Coastal Chaparral Forest Province



Island Landscape Plan for California Coastal Chaparral Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Acer macrophyllum*	Bigleaf Maple	March-June
B. *Prunus illicifolia*	Hollyleaf Cherry	March
C. *Ceanothus thyrsifolius*	White Mountain Lilac	Feb.- June
D. *Malacothamnus fasicuculatus*	Mendocino Bushmallow	May - Aug.
E. *Rhododendron occidentale*	Western Azalea	May
F. *Ribes menziesii*	Canyon Gooseberry	April, May
G. *Aesculus californica*	California Buckeye	April, May
H. *Arctostaphylos uva-ursi*	Kinnikinnick	March - June
I. *Eriogonium fasciculatum*	California Buckwheat	March - July
J. *Salvia leucophylla*	San Luis Purple Sage	May, June

Seed Mix for California Coastal Chaparral Forest Province

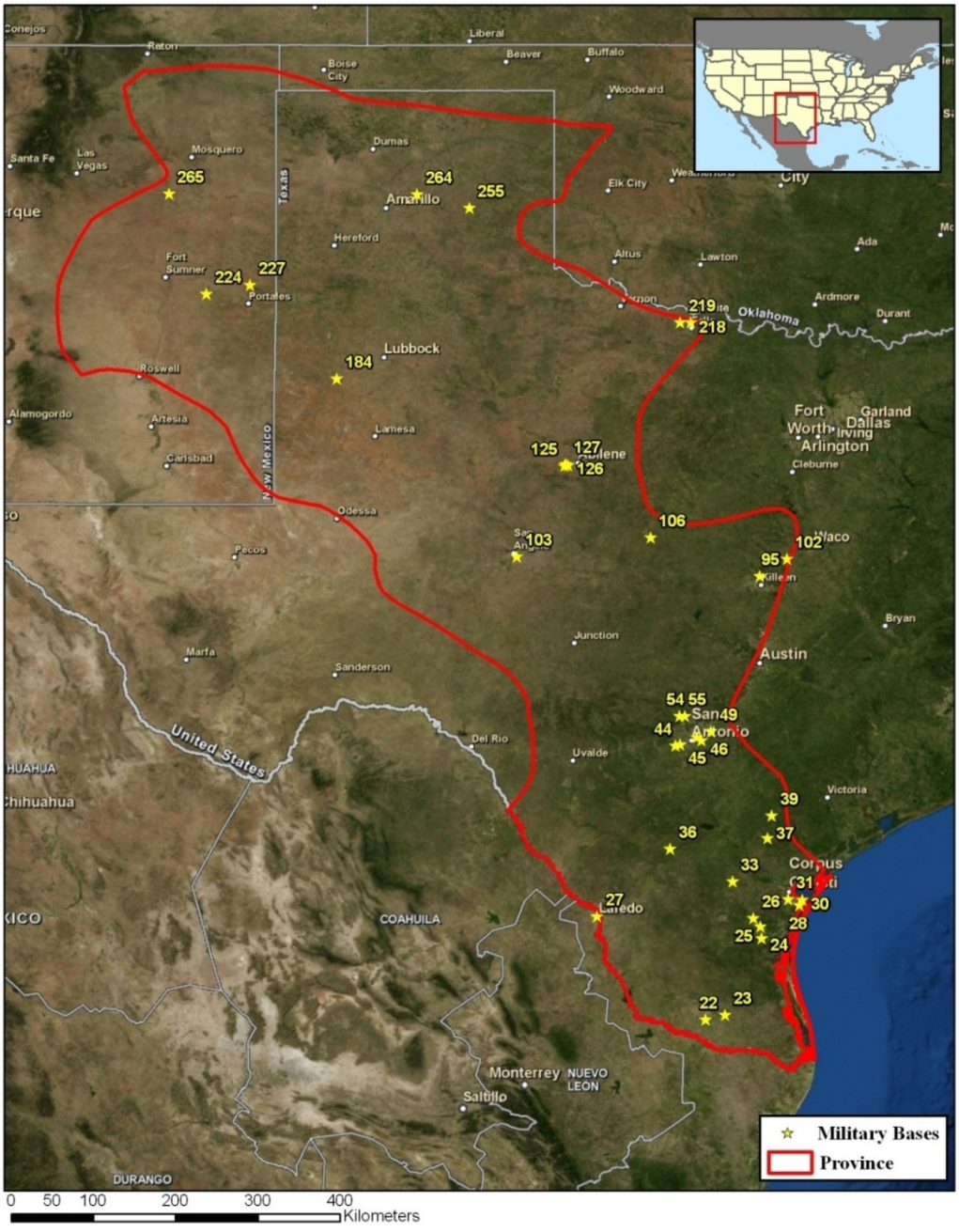
Latin Name	**Common Name**
Achillea millefolium	White Yarrow
Asclepias fasccularis	Narrowleaved Milkweed
Coreopsis tinctoria	Plains Coreopsis
Coreopsis lanceolata	Lance-Leaved Coreopsis
Delphinium nudicaule	Scarlet Delphinium
Eschscholzia californica	California Poppy
Helianthus gracilentus	Slender Sunflower
Linum perenne	Blue Flax
Lupinus albifrons	Silver Lupine
Monardella macrantha	Red Monardella
Oenothera californica	California Evening Primrose
Penstemon laetus	Mountain Blue Penstemon
Rudbeckia hirta	Black Eyed Susan
Silene lacinata	Cardinal Catchfly
Solidago californica	California Goldenrod

Amount by weight:
1 oz. of each plant species

F) Southwest Plateau and Plains Dry Steppe and Shrub Province

This region is semi-arid with long, hot summer (temperatures range from (70s to 90s) and short, mild winters (rarely getting below 32F); with frost-free days between 130 and commonly over 300. Precipitation is rarely as snow, predominately rainfall, from 30 inches in the eastern part to 10-15 inches in the western area. Most of the moisture is lost through evaporation and transpiration, producing very dry, with very low relative humidity. Vegetation is arid grasslands (needlegrass) with scattered shrubs (Ashe juniper and sabal palm) and low trees (i.e. mesquite, live oak, and acacia); very few forbes. Soils in this region are well correlated to the associated plant community.

Southwest Plateau and Plains Dry Steppe and Shrub Province

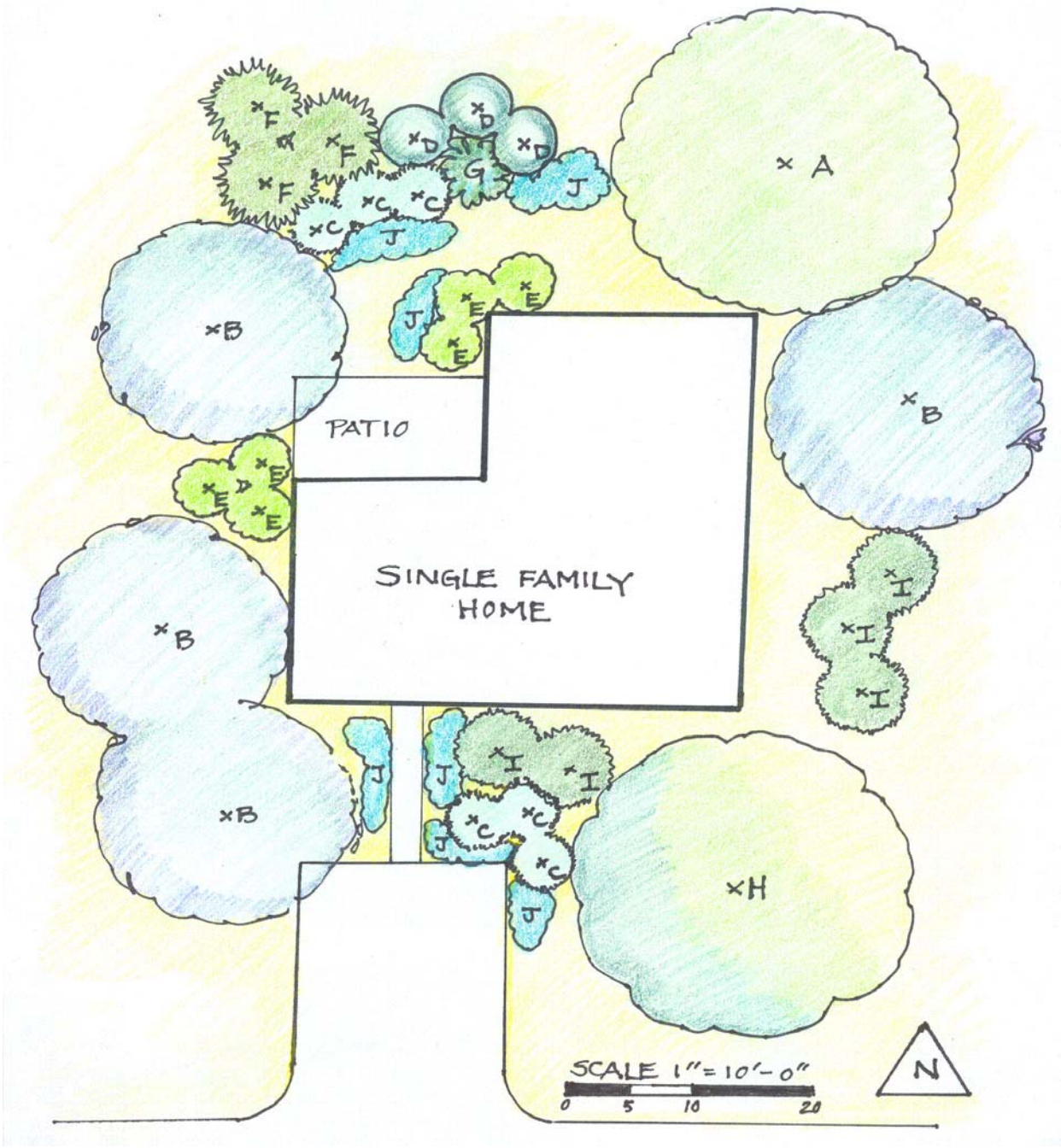


Military Installations in Southwest Plateau and Plains Dry Steppe and Shrub Province

ID	Installation
26	KINGSVILLE NAVAL AIR STATION
30	CORPUS CHRISTI NAVAL AIR STATION
33	ORANGE GROVE NAVAL AIR STATION
46	MARTINDALE ARMY AIR FIELD
47	JOINT BASE SAN ANTONIO
55	CAMP STANLEY MILITARY RESERVATION
95	FORT HOOD MILITARY RESERVATION
106	CAMP BOWIE MILITARY RESERVATION
126	DYESS AIR FORCE BASE
218	SHEPPARD AIR FORCE BASE
227	CANNON AIR FORCE BASE
255	PANHANDLE TRAINING AREA NATL GUARD

Total Number of Installations: 17

Residential Landscape Plan for Southwest Plateau and Plains Dry Steppe and Shrub Province



Residential Landscape Plan for Southwest Plateau and Plains Dry Steppe and Shrub Province

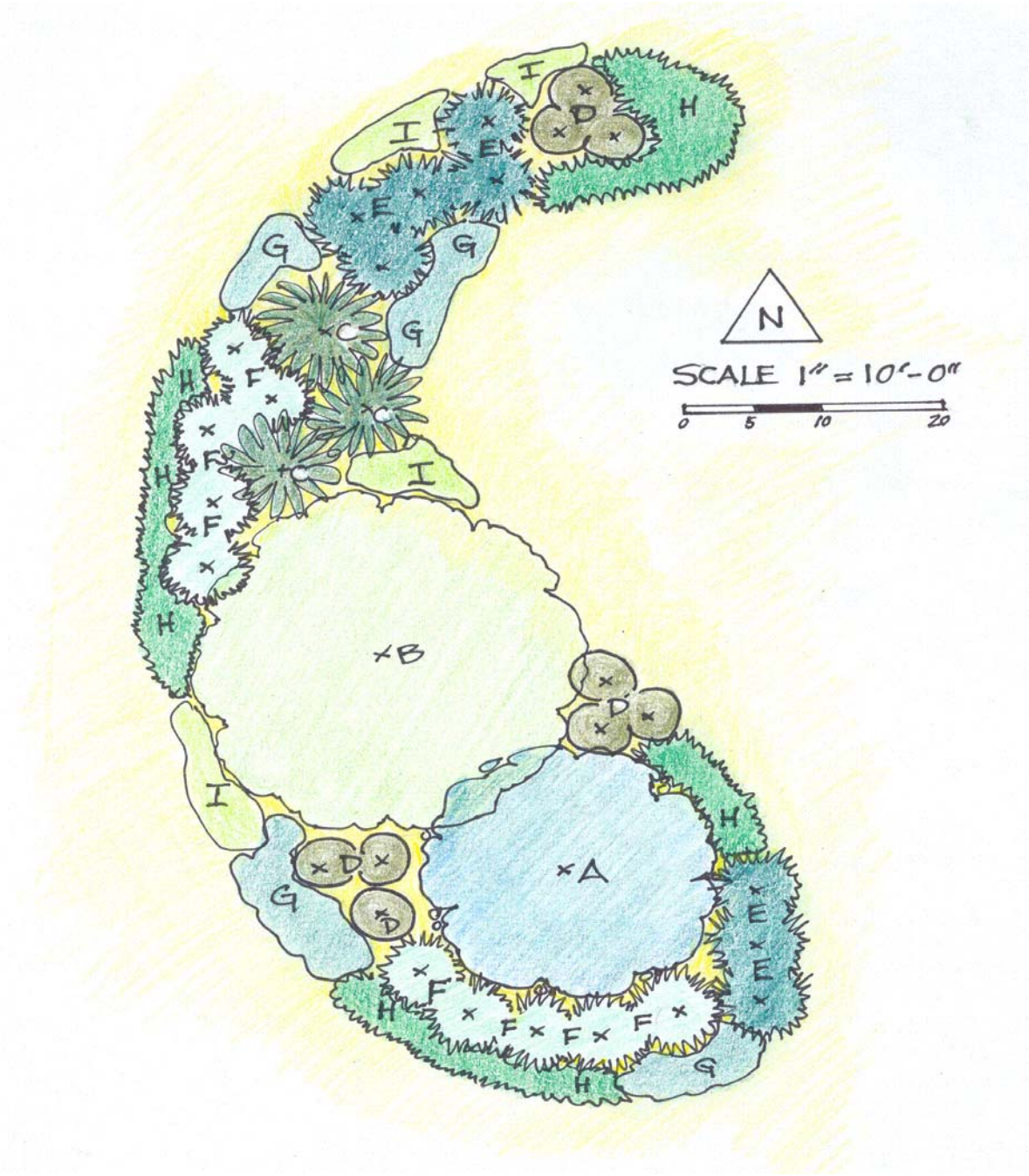
PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Prosopis velutina*	Velvet Mesquite	April - June
B. *Prunus angustifolia*	Chickasaw Plum	April, May
C. *Yucca el*ata	Soaptree Yucca	May, June
D. *Cylindropuntia imbricata*	Tree Cholla	June, July
E. *Chrysothamnus nauseosus*	Rabbitbush	July - Sept.
F. *Celtis pallida*	Desert Hackberry	April, May
G. *Opuntia engelmannii*	Englemann's Prickly Pear	May, June
H. *Acacia farnesiana*	Sweet Acacia	Feb. - April
I. *Garrya wrightii*	Wright's Silk Tassel	May - Aug
J. Perennial Flowers:		Apr - Aug

Asclepias spp.; *Baptisia australlis (*Wild Blue Indigo); *Liatris punctata* (Dotted Blazing Star); *Oenothera macrocarpa* (Bigfruit Evening Primrose); *Penstemon* spp.; and *Verbena* spp.

Notes: Perennial flowers will extend the flowering season and will attract pollinators from April to September.

Island Landscape Plan for Southwest Plateau and Plains Dry Steppe and Shrub Province



Island Landscape Plan for Southwest Plateau and Plains Dry Steppe and Shrub Province

PLANT KEY

Latin Name	Common Name	Flowering Period
A. *Prunus angustifolia*	Chickasaw Plum	April, May
B. *Prosopis velutina*	Velvet Mesquite	April - June
C. *Yucca elata*	Soaptree Yucca	May, June
D. *Cylindropuntia imbricata*	Tree Cholla	June, July
E. *Acacia greggii*	Gregg Acacia	June, July
F. *Cornus drummondii*	Rough-leaf Dogwood	April - June
G. *Amorpha canescens*	Leadplant	June, July
H. *Rubus bushii*	Bush's Blackberry	May, June
I. Perennial Flowers:		April - June

Asclepias spp.; *Baptisia australlis (*Wild Blue Indigo)*; Liatris punctata* (Dotted Blazing Star); *Oenothera macrocarpa* (Bigfruit Evening Primrose); and *Penstemon* spp.

Notes: The planting island is 95 feet long by 40 feet wide (in widest area). Perennial flowers will extend the flowering season and will attract pollinators from April to September.

Seed Mix for Southwest Plateau and Plains Dry Steppe and Shrub Province

Latin Name	**Common Name**
Achillea millefolium, var. occidentalis	Western Yarrow
Amorpha canescens	Leadplant
Asclepias asperula	Antelopehorns
Asclepias tuberosa	Butterfly Milkweed
Astragalus missouriensis	Missouri Milkvetch
Baptisia australis	Blue Wild Indigo
Callirhoe inclucrata	Purple Poppymallow
Delphinium carolinum	Carolina larkspur
Echinacea angustifolia	Echinacea
Gaillardia aristata	Common Gaillardia
Helianthus occidentalis	Western Sunflower
Liatris punctata	Dotted Blazing Star
Oenothera biennis	Evening Primrose
Oenothera macrocarpa	Bigfruit Evening Primrose
Penstemon cobaea	Beardtongue
Solidago missouriensis	Missouri Goldenrod
Vicia americana	American Vetch

Amount by weight:
1 oz. of each plant species

G) American Semi-Desert and Desert Province

The climate is hot and dry with long summers, frequently hitting the record highs for the US of over 100F. Winters while moderate do have occasional frosts. Precipitation falls as winter rains, widespread and gentle with strong summer thunderstorms. Some areas have no measurable rainfall. Vegetation is generally sparse with bare ground between individual plants but with mature biological crusts to keep the soil in place. Plant species are dominantly cacti and thorny shrubs with some forbes in the wetter areas. Paloverde, ocotillo and saguaro cover the rocky slopes, and along the northern edge of this province, the Joshua tree dominates the landscape with junipers and pinions scattered at the higher elevations. Soils in this region are gravel or bare rock covered with shallow loose soil.

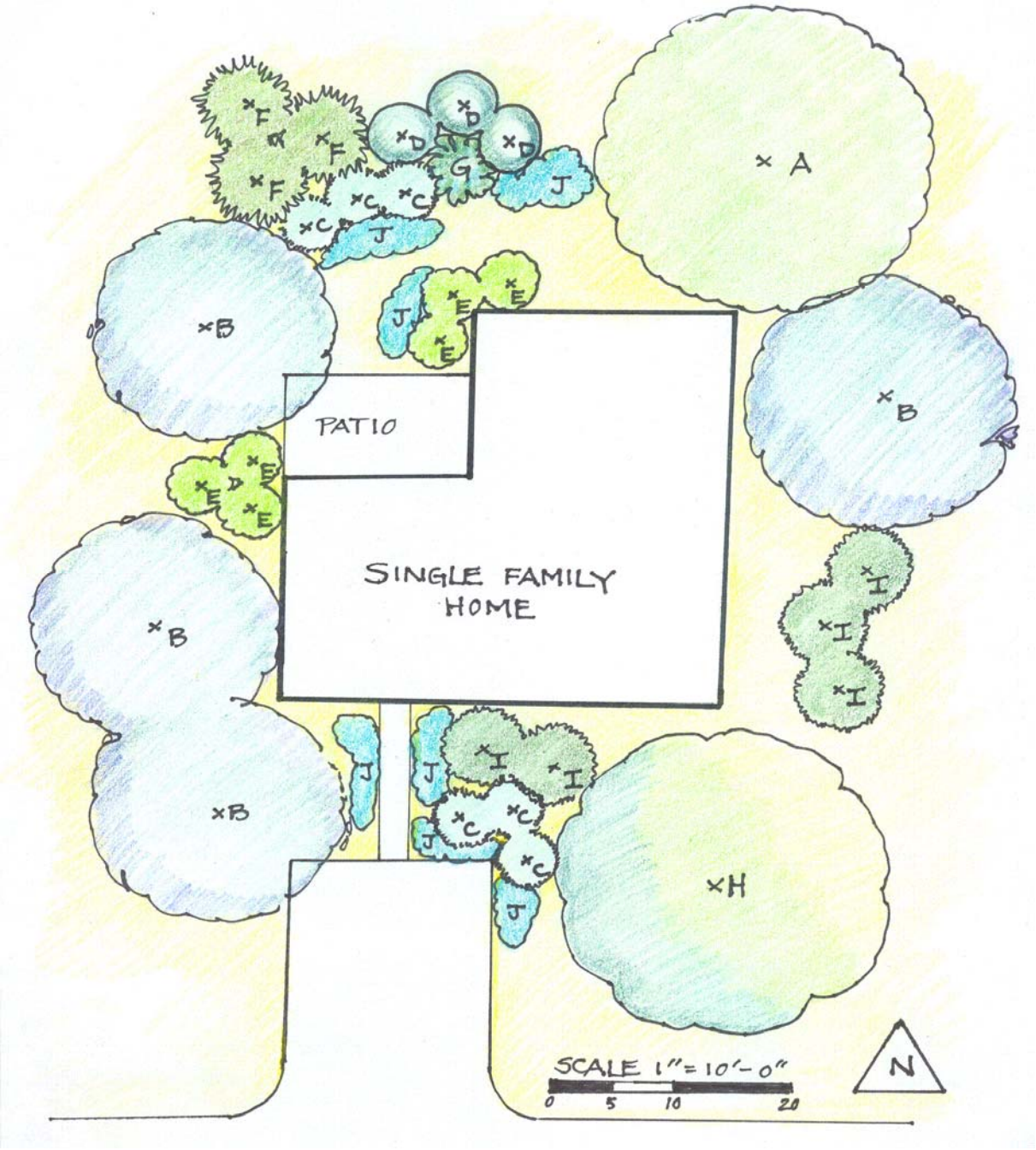
American Semi-Desert and Desert Province

Military Installations in American Semi-Desert and Desert Province

ID	Installation
115	DAVIS-MONTHAN AIR FORCE BASE
130	BARRY M GOLDWATER AIR FORCE RANGE
149	CASA GRANDE MILITARY RESERVATION
150	EL CENTRO NAVAL AIR FACILITY
171	US NAVAL RESERVATION
173	YUMA PROVING GROUND
175	FLORENCE MILITARY RESERVATION
180	CHOCOLATE MOUNTAIN NAVAL RES
187	BUCKEYE MILITARY RESERVATION
188	PHOENIX MILITARY RESERVATION
190	LUKE AIR FORCE BASE
229	TWENTYNINE PALMS MARINE CORPS BASE
240	EDWARDS AIR FORCE BASE
266	FORT IRWIN
272	CHINA LAKE NAVAL WEAPONS CENTER
279	NELLIS AIR FORCE BASE
282	NELLIS SMALL ARMS RANGE
287	CREECH AIR FORCE BASE

Total Number of Installations: 19

Residential Landscape Plan for American Semi-Desert and Desert Province



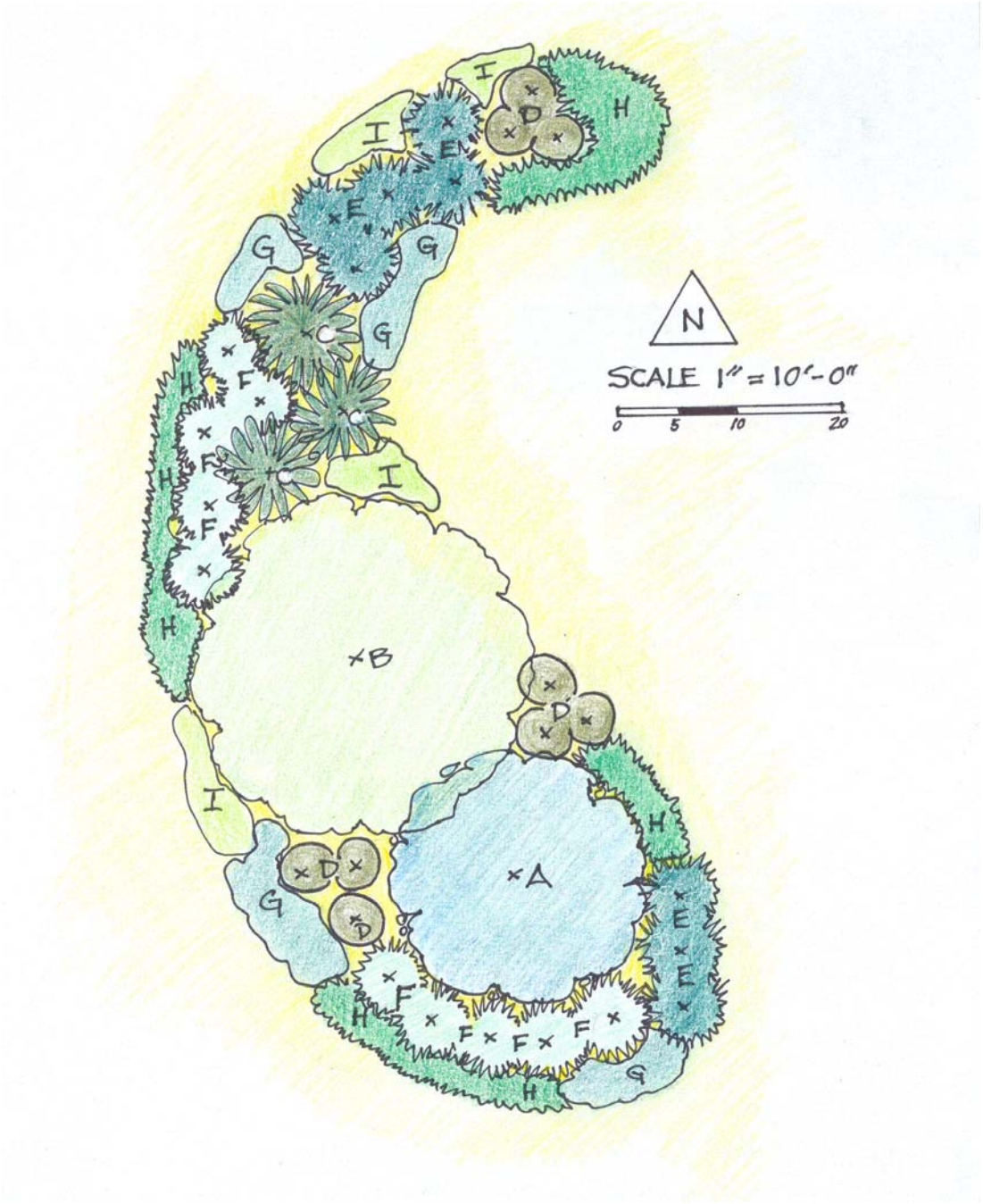
Residential Landscape Plan for American Semi-Desert and Desert Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Acacia farnesiana*	Sweet Acacia	Feb. - April
B. *Chilopsis linearis*	Desert Willow	April - Sept.
C. *Hesperaloe parviflora*	Red Yucca	July - Sept.
D. *Dasylirion wheeleri*	Desert Spoon	June, July
E. *Leucophyllum laevigatum*	Chihuahuan Sage	June - Aug.
F. *Fouquieria splendens*	Ocotillo	Feb., March
G. *Opuntia santa-rita*	Santa Rita Prickly Pear	June, July
H. *Parkinsonia microphylla*	Yellow Paloverde	April, May
I. *Senna wislizenii*	Shrubby Senna	June - Sept.
J. *Penstemon spp.*	Penstemon	June - Aug

Notes: There are many nice *Penstemon* species with showy flowers to attract pollinators through-out the flowing season, so it is recommended to plant as many as are available at local nurseries.

Island Landscape Plan for American Semi-Desert and Desert Province



Island Landscape Plan for American Semi-Desert and Desert Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Parkinsonia microphylla*	Yellow Paloverde	April, May
B. *Prosopis velutina*	Velvet Mesquite	April - June
C. *Agave palmeri*	Palmer's Agave	July, Aug.
D. *Ferocactus wislizeni*	Candy Barrel Cactus	July – Sept.
E. *Fouquieria splendens*	Ocotillo	Feb., March
F. *Yucca elata*	Soaptree Yucca	May, June
G. *Opuntia engelmannii*	Engelman's Prickly Pear	May, June
H. *Calliandra eriophylla*	Fairy Duster	Feb., March
I. *Opuntia spinosior*	Walking-stick Cholla	May, June

Notes: The planting island is 95 feet long by 40 feet wide (in widest area) and will attract pollinators from February to September.

Seed Mix for American Semi-Desert and Desert Province

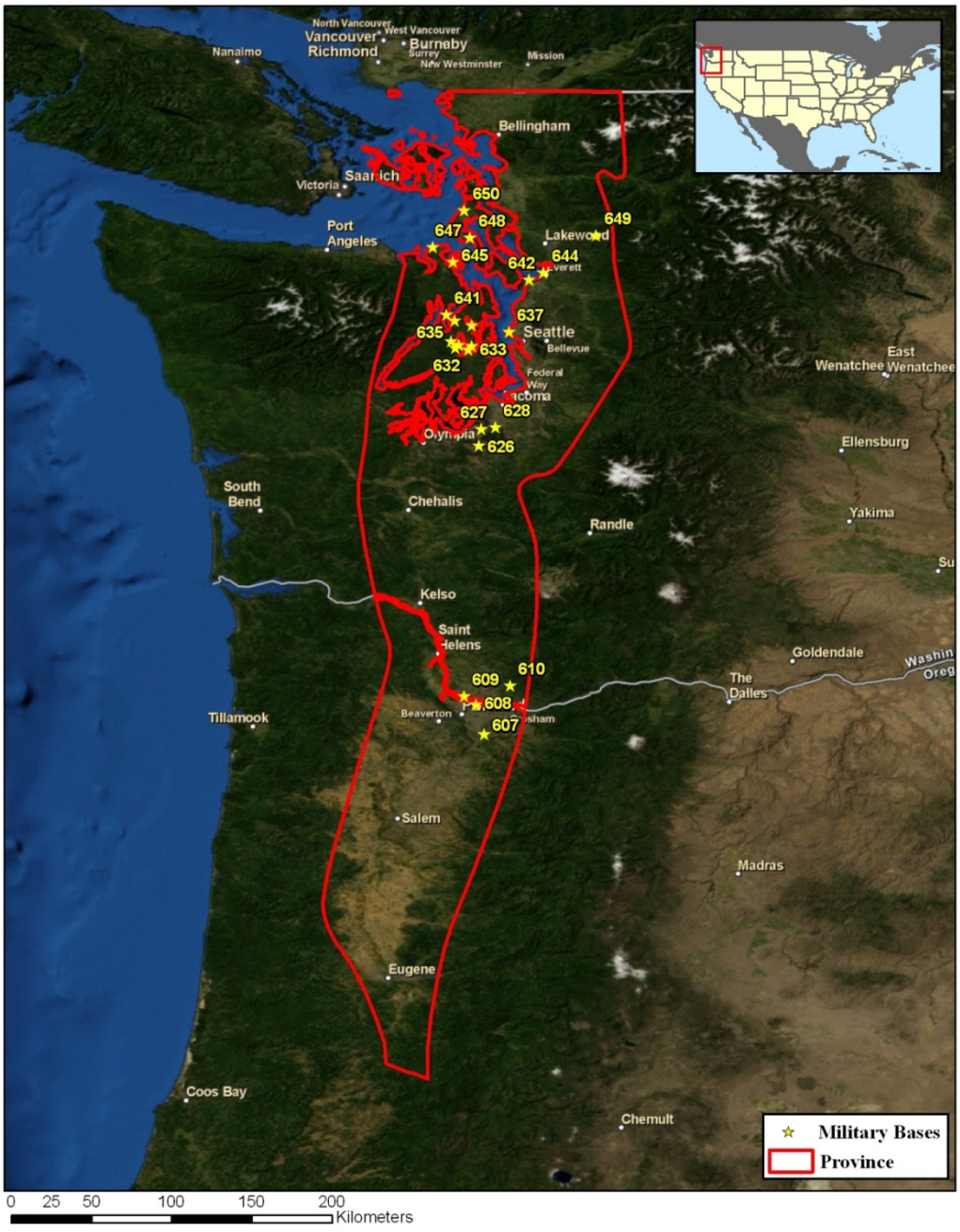
Latin Name	**Common Name**
Acacia greggi	Catclaw Acacia
Achillea millefolium	Yarrow
Argemone pleiacantha	Bluestem Pricklepoppy
Asclepias asperula	Antelopehorns
Asclepias tuberosa	Butterfly Milkweed
Astragalus praelongus	Astragalus
Bahia absinthifolia	Bahia
Coreopsis tinctoria	Calliopsis
Gaillardia aristata	Common Gaillardia
Helianthus occidentalis	Western Sunflower
Kallstroemia grandiflora	Arizona Poppy
Oenothera biennis	Evening Primrose
Lupinus arizonicus	Arizona Lupine
Penstemon parryi	Parry's, Beardtongue
Phacelia crenulata	Phacelia
Verbena ciliata	Mexican Vervain

Amount by weight:
1 oz. of each plant species

H) Pacific Lowland Mixed Forest Province

Due to this provinces' proximity to the Pacific Ocean, the climate is generally mild throughout the year with average temperatures of 48-55F and rainfall of 15-60 inches. The coastal mountain range is responsible for the reduced precipitation inland. Fog offsets the summer droughts. Historically, this region was covered with dense coniferous forests of western redcedar, western hemlock and Douglas fir, and along the coast, deciduous trees, i.e. big leaf maple, could be found. Poorly drained soils, remnants from glaciations, support biologically diverse swamp and bog communities.

Pacific Lowland Mixed Forest Province

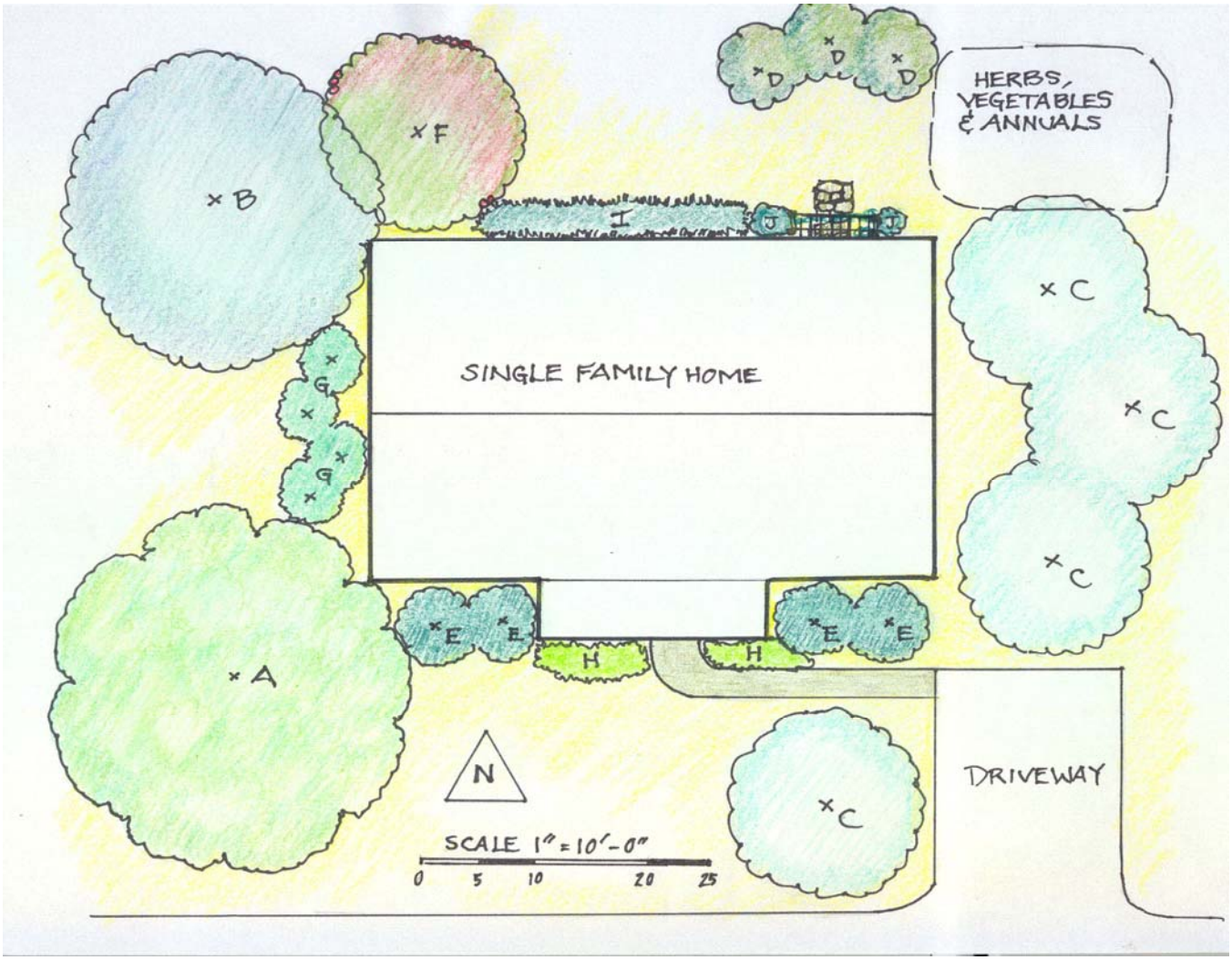


Military Installations in Pacific Lowland Mixed Forest Province

ID	Installation
607	CAMP WITHYCOMBE
608	PORTLAND AIR NATIONAL GUARD BASE
626	LEWIS-MCCHORD JOINT BASE
627	CAMP MURRAY NATIONAL GUARD
630	PUGET SOUND NAVAL SHIPYARD
632	CAMP MCKEAN NAVAL REC CAMP
634	JACKSON PARK NAVAL RESERVATION
635	CAMP WESLEY HARRIS NAVAL RES
637	FORT LAWTON
638	NAVAL UNDERSEA ENGINEERING STATION
639	BANGOR NAVAL RESERVATION
644	US NAVAL STATION EVERETT
649	NAVAL RADIO STATION JIM CREEK
650	WHIDBEY ISLAND NAVAL AIR STATION

Total Number of Installations: 14

Residential Landscape Plan for Pacific Lowland Mixed Forest Province



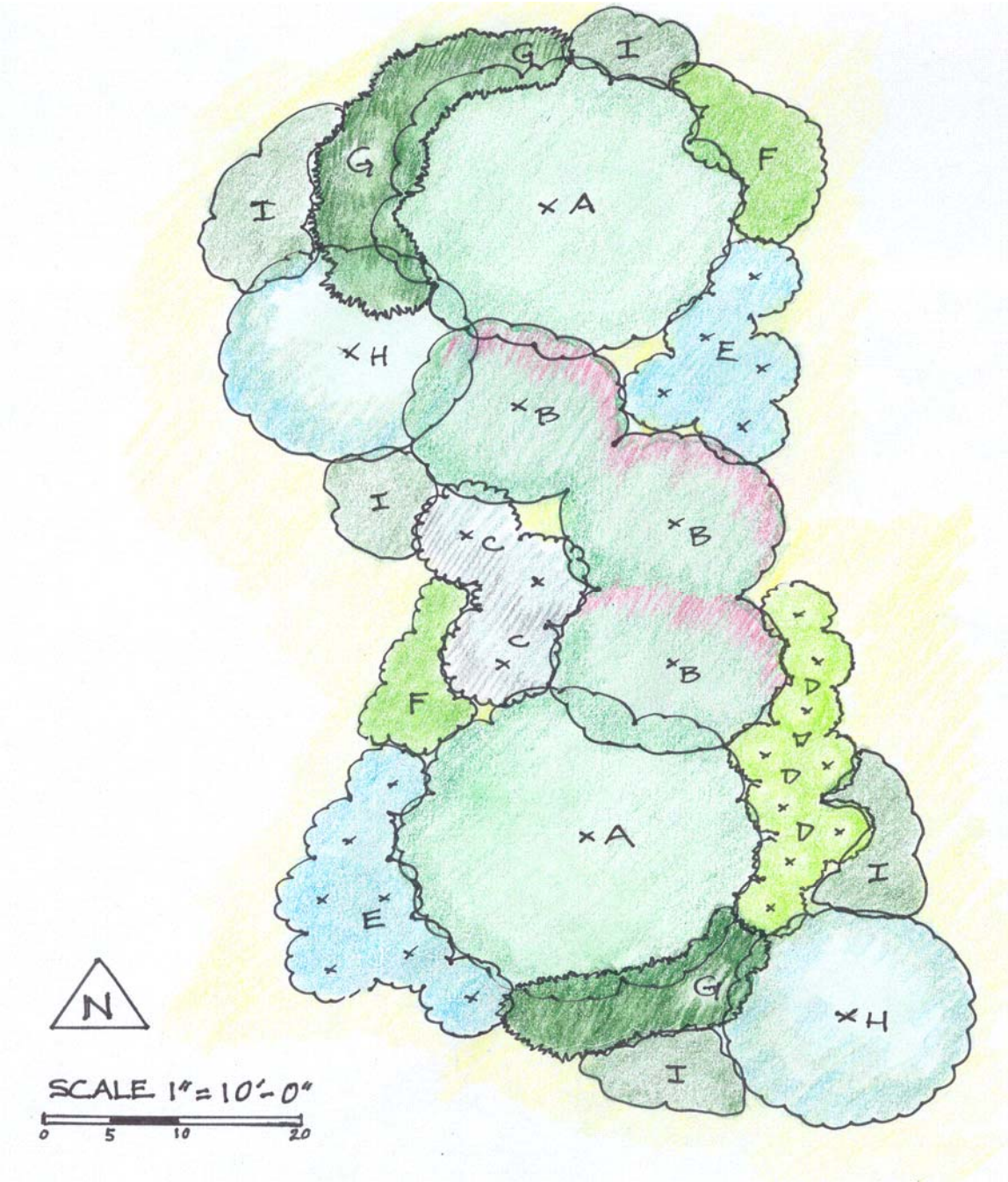
Residential Landscape Plan for Pacific Lowland Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Acer macrophyllum*	Bigleaf Maple	March - June
B. *Arbutus menziesii*	Madrone	April, May
C. *Philadelphus lewisii*	Mock Orange	May - July
D. *Ribes aure*um	Golden Current	March - June
E. *Mahonia aquifolium*	Tall Oregon Grape	March - May
F. *Cornus nuttallii*	Pacific Dogwood	April - June
G. *Rosa gymnocarpa*	Baldhip Rose	June, July
H. *Symporicarpos alba*	Snowberry	June, July
I. *Vaccinium parviflolium*	Red Huckleberry	April, June
J. *Lonicera hispidula*	Hairy Honeysuckle	June - Aug.

Notes: Hairy Honeysuckle will need to be planted on a trellis at the back entry of the house. Herbs, vegetables and annual flowers planted in a garden, will extend the flowering season and attract many pollinators.

Island Landscape Plan for Pacific Lowland Mixed Forest Province



Island Landscape Plan for Pacific Lowland Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Acer macrophyllum*	Bigleaf Maple	March - June
B. *Arbutus menz*iesii	Madrone	April, May
C. *Philadelphus l*ewisii	Mock Orange	May - July
D. *Rosa gymnocarpa*	Baldhip Rose	June, July
E. *Osmaronia cerasiformis*	Indian Plum	March, April
F. *Arctostaphylos uva-ursi*	Kinnikinnick	April, June
G. *Mahonia nervosa*	Creeping Oregon Grape	March - June
H. *Cornus nuttallii*	Pacific Dogwood	April - June
I. *Vaccinium parviflolium*	Red Huckleberry	April - Aug.

Notes: This Island planting is for an area 100 feet long by 45 feet wide.

Seed Mix for Pacific Lowland Mixed Forest Province

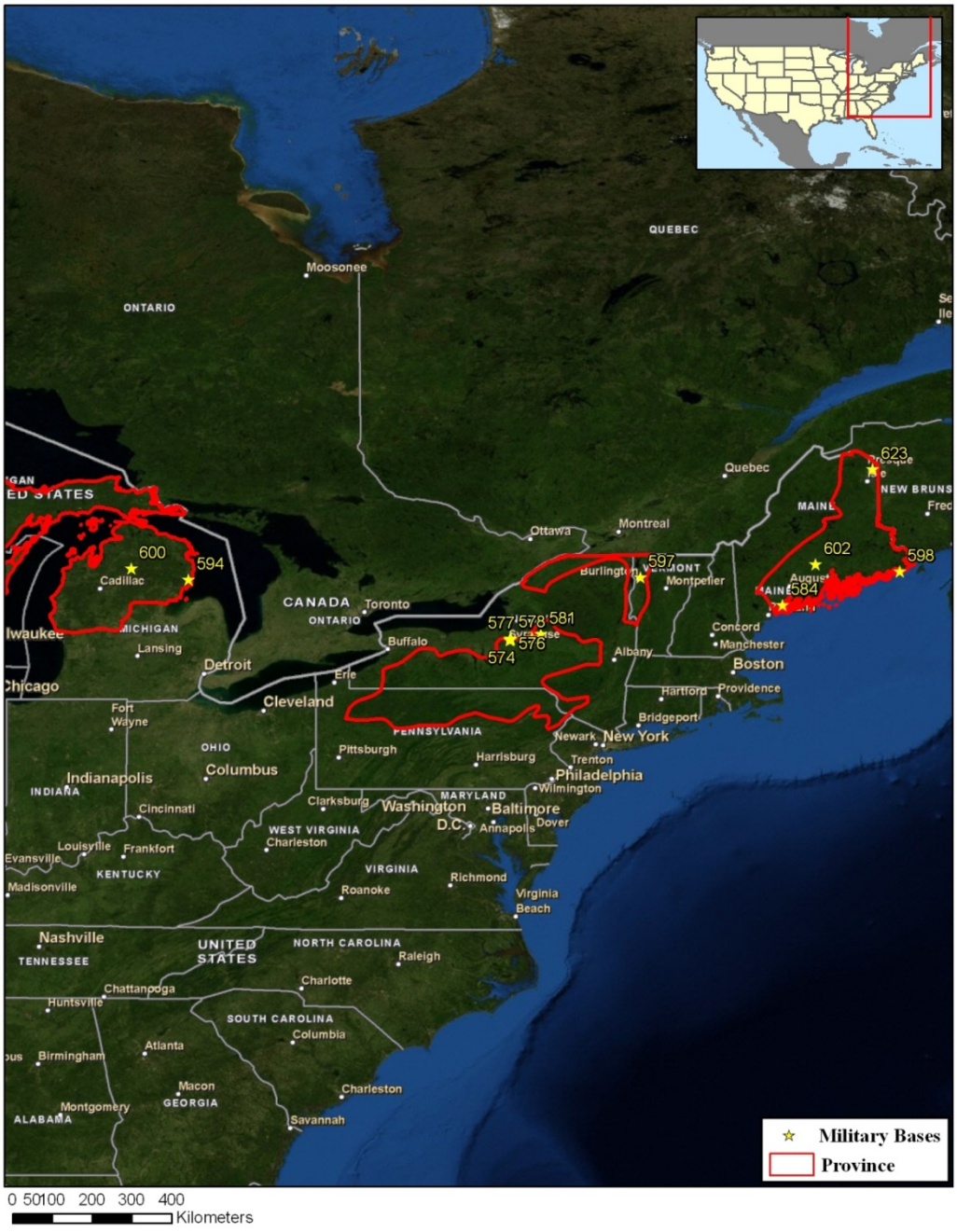
Latin Name	**Common Name**
Achillea millefolium	White Yarrow
Anemone deltoidea	Columbian Windflower
Balsamorhiza deltoidea	Deltoid Balsamroot
Brodiaea elegans	Brodiaea
Delphium nuttallianum	Common Delphinium
Helianthus occidentalis	Western Sunflower
Linum perenne	Blue Flax
Lupinus albifrons	Silver Lupine
Oenothera biennis	Evening Primrose
Penstemon serrulatus	Coast Penstamon
Polygonum bistortoides	American Bistort
Ranunculus occidentalis	Western Buttercup
Rudbeckia hirta	Black Eyed Susan
Silene lacinata	Cardinal Catchfly
Solidago occidentalis	Western Goldenrod
Trifolium macrocephalum	Giant-head Clover

Amount by weight
1oz. of each plant species:

I) Laurentian Mixed Forest Province

In this region, the winters are moderately long and somewhat sever with a frost-free season of only 100-140 days and with only 120 days with temperatures over 50F. Snow typically stays on the ground throughout the winter. These conditions delineate a short growing season but with maximum precipitation in the summer making the summer more humid. This region lies between the boreal forest and the broadleaf deciduous forest zones with a few mixed stands of conifers (mainly pine) in amongst the deciduous trees (yellow birch, sugar maple and American beech). The deciduous forests have dense understory of forbes and shrubs and the coniferous forest with its poorer soil and thus more open understory that is fire dependent. Lightening causing fires are common, especially in summer.

Laurentian Mixed Forest Province

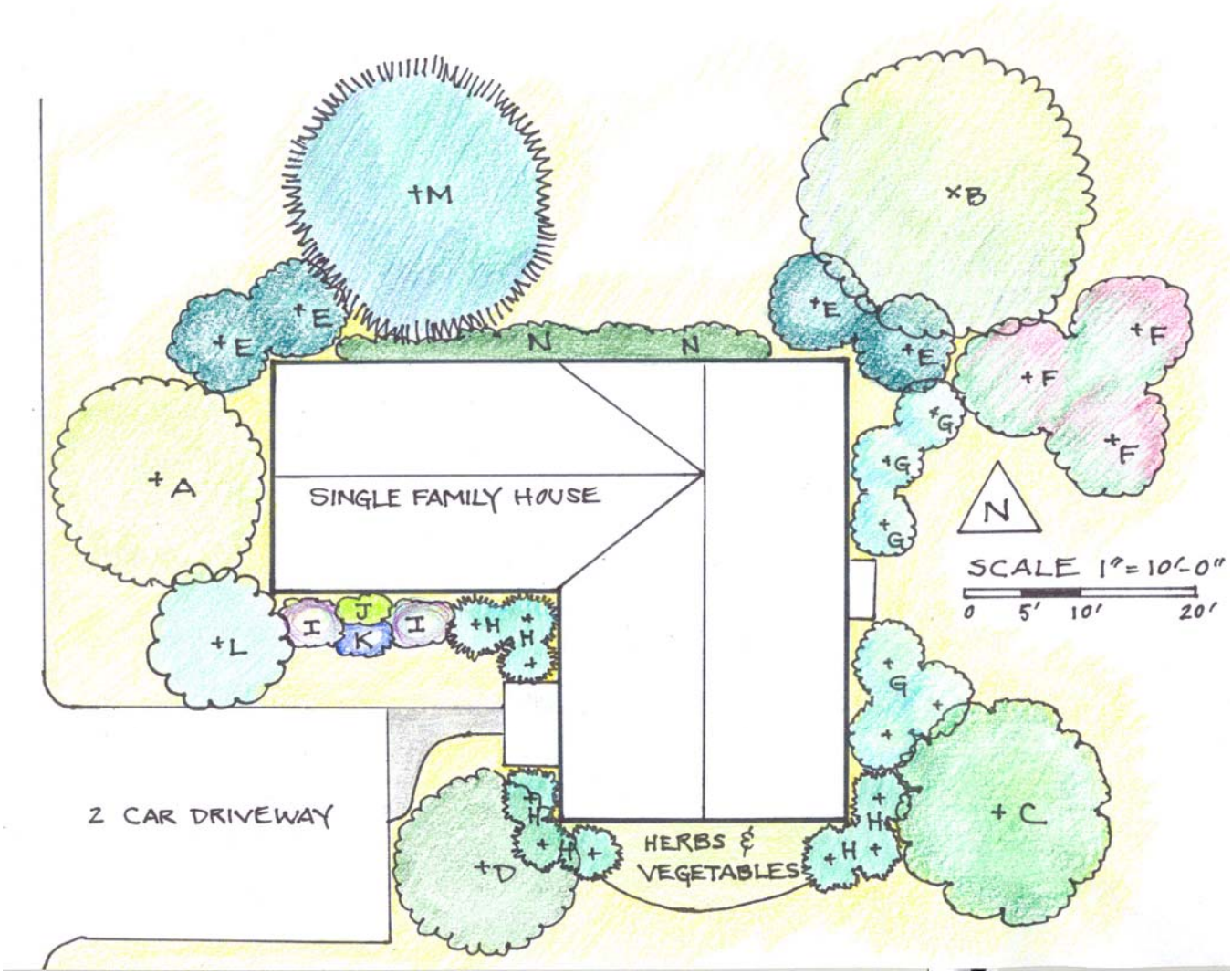


Military Installations in Laurentian Mixed Forest Province

ID	Installation
571	NEW YORK ARMY NATIONAL GUARD
574	HANCOCK FIELD USAF BASE
578	VERONA TEST SITE
584	BRUNSWICK NAVAL AIR STATION
598	US NAVAL RADIO STATION
600	CAMP GRAYLING MILITARY RESERVATION
602	PLYMOUTH NATL GUARD TRAINING AREA

Total Number of Installations: 7

Residential Landscape Plan for Laurentian Mixed Forest Province



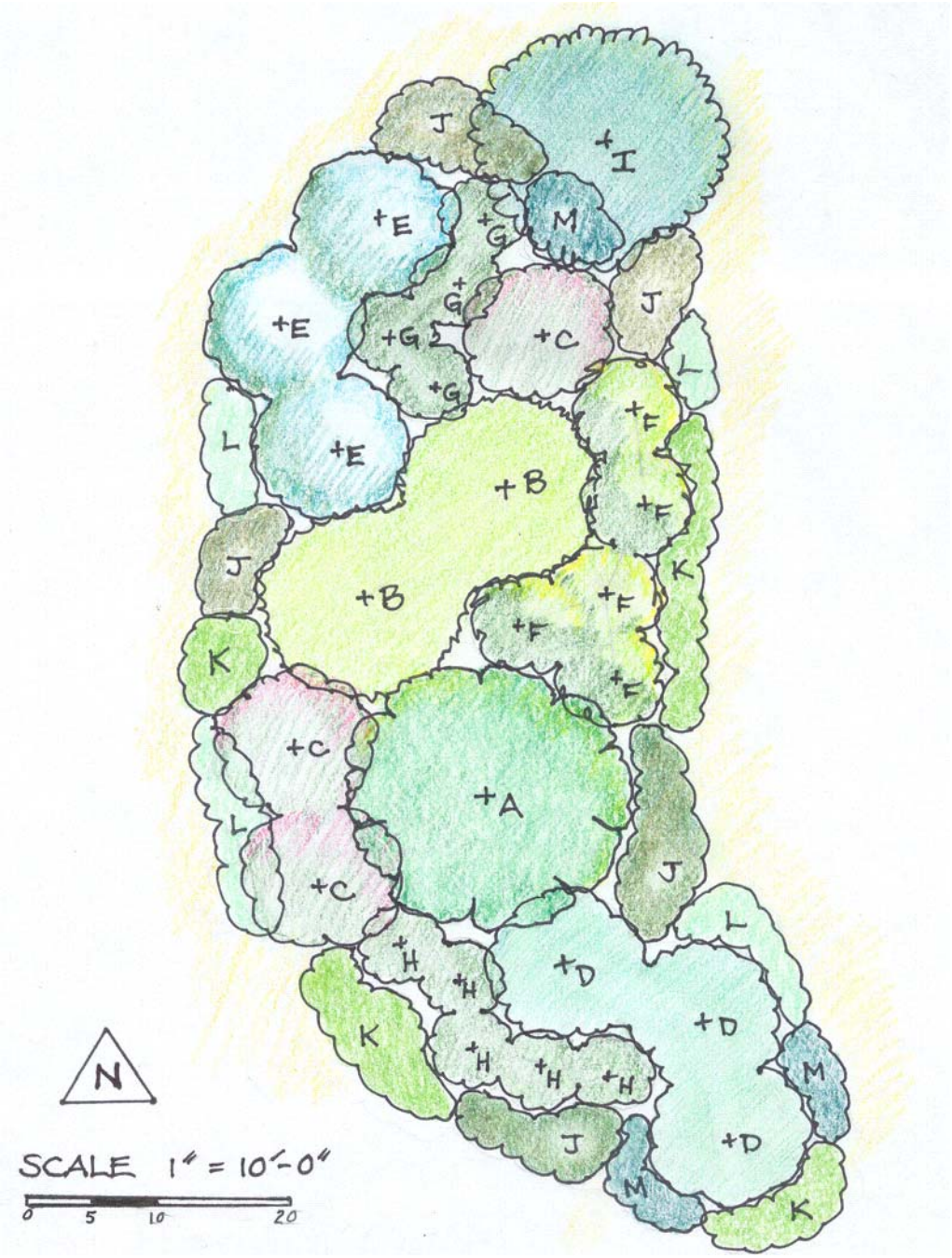
Residential Landscape Plan for Laurentian Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Sorbus americana*	American Mountain Ash	May, June
B. *Crataegus crus-galli*	Cockspur Hawthorn	May - Sept.
C. *Amelanchier arborea*	Downy Serviceberry	May, June
D. *Hamamellis virginiana*	American Witch Hazel	Oct. - Nov.
E. *Kalmia latifolia*	Mountain Laurel	May, June
F. *Sambucus canadensis*	Black Elderberry	June, July
G. *Viburnum acerifolium*	Maple-leaf Viburnum	May, June
H. *Dasiphora fruticosa*	Shrubby Cinquefoil	May - July
I. *Phlox maculata*	Wild Sweet William	April - June
J. *Monarda fistulosa*	Beebalm	June - Sept.
K. *Iris versicolor*	Blue Flag/ Wild Iris	May - July
L. *Cornus florida*	Flowering Dogwood	May
M. *Picea rubens*	Red Spruce	(see Notes)
N. *Gaultheria procumbens*	Wintergreen	July - Sept

Notes: While the red spruce does not provide flowers and therefore no nectar or pollen, it does provide protection from northern winds and habitat for pollinators. Under the dense canopy, it will provide bare dirt also needed by pollinators.

Island Landscape Plan for Laurentian Mixed Forest Province



Island Landscape Plan for Laurentian Mixed Forest Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Sorbus americana*	American Mountain Ash	May, June
B. *Amelanchier arborea*	Downy Serviceberry	May, June
C. *Kalmia latifoli*a	Mountain Laurel	May, June
D. *Sambucus canadensis*	Black Elderberry	June, July
E. *Hamamellis virgi*niana	American Witch Hazel	Oct. - Nov.
F. *Ilex verticillata*	Common Winterberry	May, June.
G. *Symphoricarpos albus*	Snowberry	May - Sept.
H. *Viburnum acerifolium*	Maple-leaf Viburnum	May, June
I. *Crataegus crus-galli*	Cockspur Hawthorn	May - Sept.
J. *Spiraea tomentosa*	Steeplebush	July - Sept.
K. *Vaccinium angustifolium*	Low Sweet Blueberry	May, June
L. *Iris versicolor*	Blue Flag/ Wild Iris	May - July
M. *Monarda fistulosa*	Beebalm	June - Sept.

Notes: The dimension of this planting is approximately 100 feet by 40 feet; this could be planted along a roadway, or as a planting adjacent to a building.

Seed Mix for Laurentian Mixed Forest Province

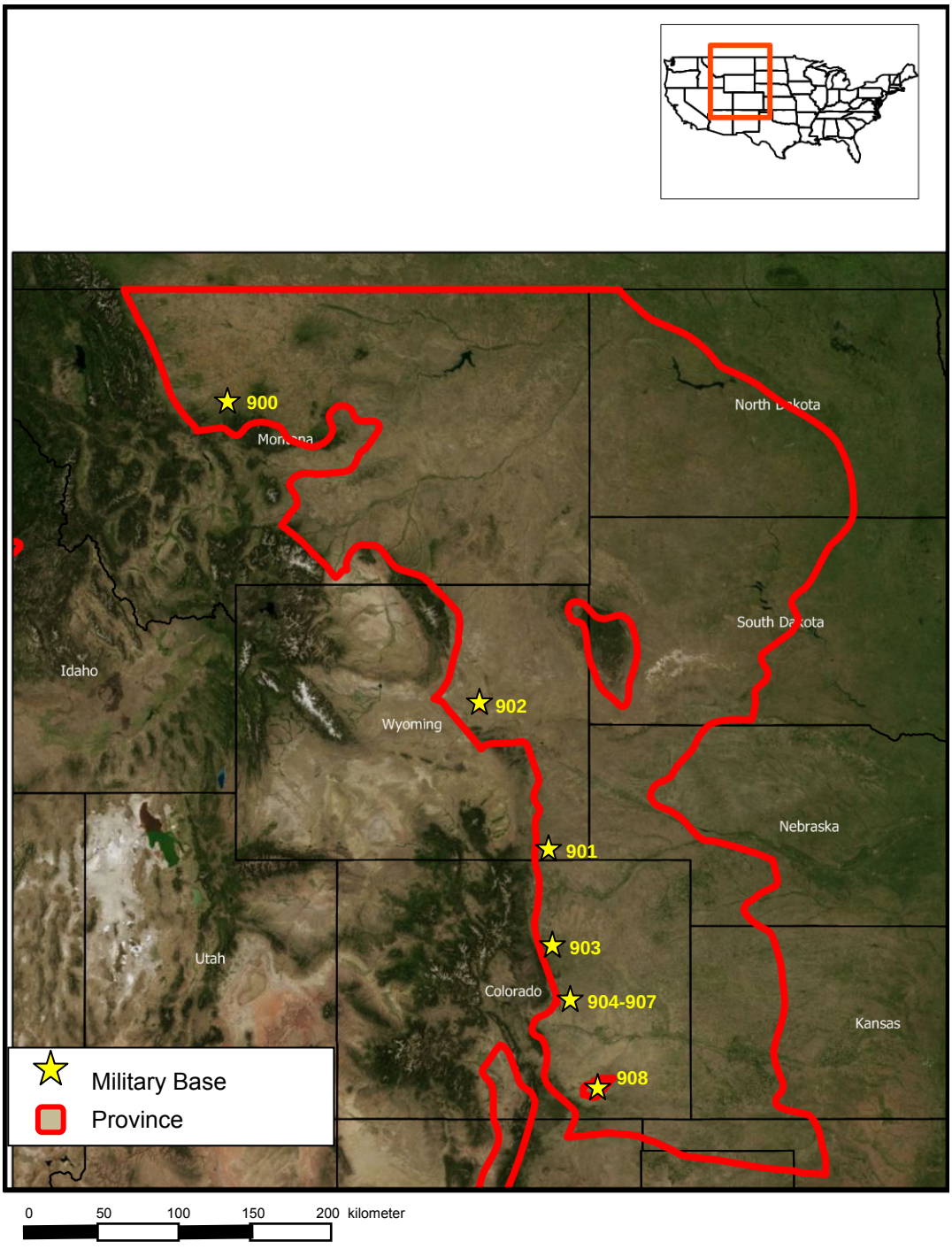
Latin Name	**Common Name**
Achillea millefolium	White Yarrow
Asclepias syriaca	Common Milkweed
Asclepias tuberosa	Butterfly Weed
Aquilegia canadensis	Red Columbine
Chelone glabra	White Turtlehead
Coreopsis verticillata	Whorled Coreopsis
Eupatorium maculatum	Whitetop Eupatorium
Helianthus gracilentus	Slender Sunflower
Lobelia cardinalis	Cardinal Flower
Monarda, fistulosa	Wild Bergamont.
Penstemon digitalis	Tall Beardstongue
Phlox maculata	Wild Sweet William
Physostegia virginiana	Obedient Plant
Rudbeckia hirta	Black Eyed Susan
Oenothera biennis	Evening Primrose
Viola canadensis	Canadian White Violet
Zizia aurea	Golden Zizia

Amount by weight
1 oz. of each plant species

J) Great Plains – Palouse Dry Steppe Province:

This region lies in the rain shadow of the Rocky Mountains, locally known as the Front Range; the climate of the Great Plains is semiarid continental. Average temperature 45F throughout most of the region and up to 60F in the southern edge. Lows into the single digits and summer highs in the 90's , occasionally hitting 100F. Precipitation ranges from 10 inches in the northern section to over 25 inches in the south; most of the precipitation is summer rainfall. Because evaporation exceeds rainfall, the region is arid with low relative humidity. The region does receive some snowfall but rarely and with strong winds, i.e. blizzards, or as hail with thunderstorms. Most of the vegetation is adapted to these climatic conditions and are known as shortgrass prairie, a formation of short grasses usually bunched and sparsely distributed, thereby leaving much of the soil exposed. The plant community consists mostly of grasses and forbes; many wildflowers bloom in spring and summer and the grasses, such as grama, needlegrass and buffalo grass, green and grow after plenty of rainfall. Most of the trees and shrubs in the area are pinyon pine or juniper and sagebrush and rabbitbrush.

Great Plains – Palouse Dry Steppe Province

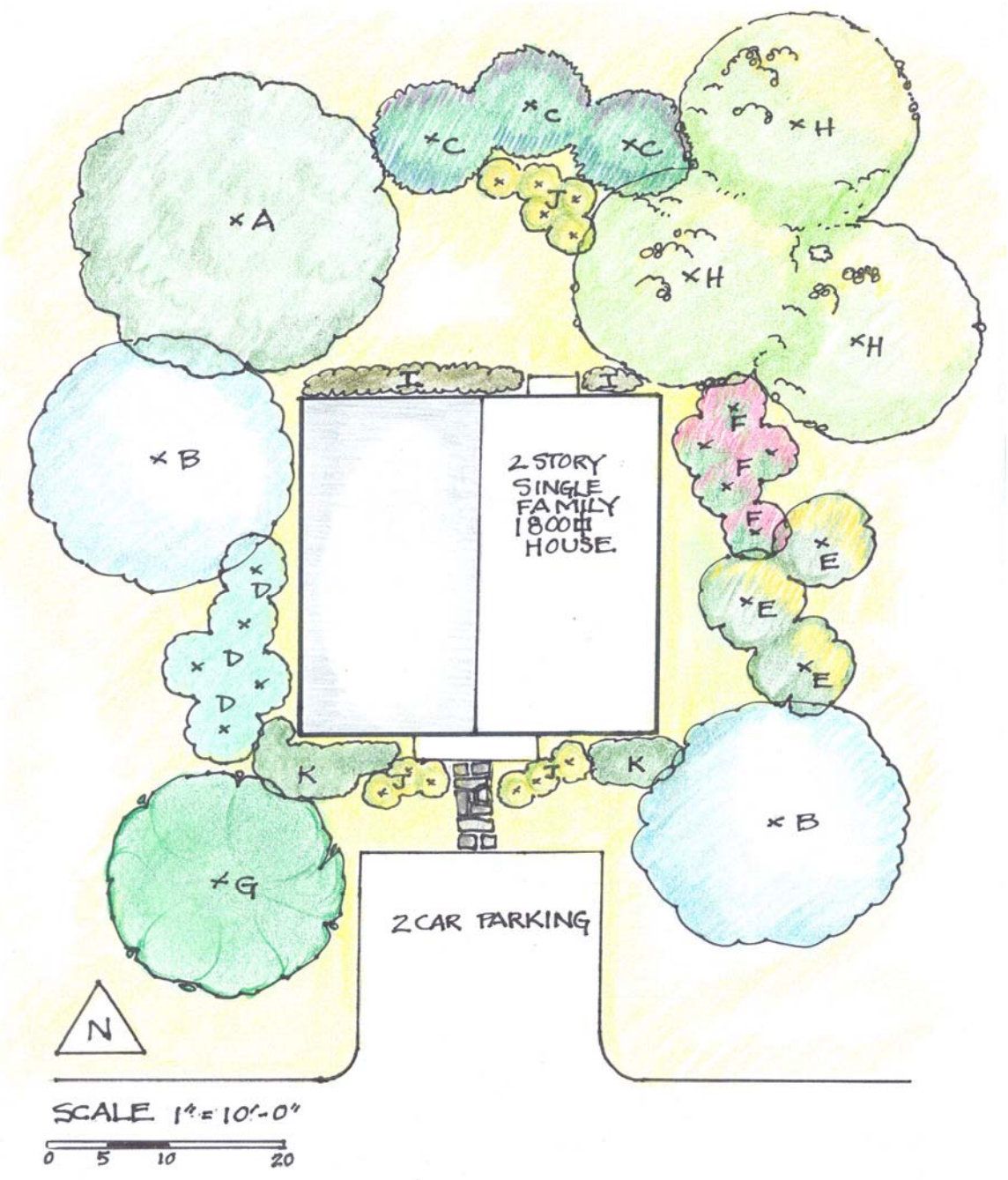


Military Installations in Great Plains – Palouse Dry Steppe Provence

ID	Installation
900	MALMSTROM AIR FORCE BASE
901	F. E. WARREN AIR FORCE BASE
902	CAMP GUERNSEY NATIONAL GUARD TRAINING AREA
903	BUCKLEY AIR FORCE BASE
904	AIR FORCE ACADEMY
905	PETERSON AIR FORCE BASE
906	FORT CARSON
907	SCHRIEVER AIR FORCE BASE
908	PINON CANYON MANEUVER SITE

Total Number of Installations: 9

Residential Landscape Plan for Great Plains – Palouse Dry Steppe Province



Residential Landscape Plan for Great Plains – Palouse Dry Steppe Province

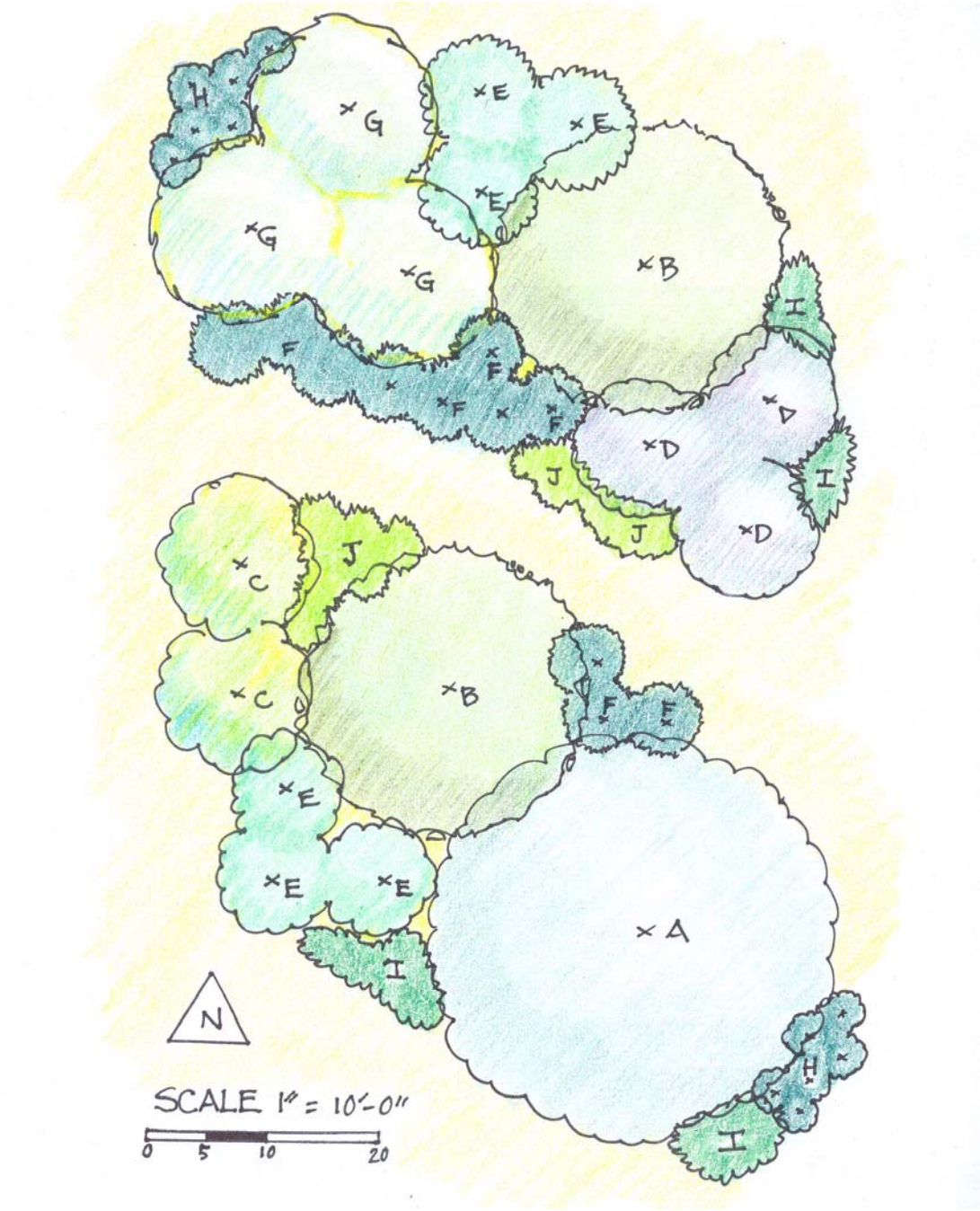
PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Celtis reticulata*	Netleaf Hackberry	June, July
B. *Alnus incana ssp. tenuifolia*	Thinleaf alder	Mar-Apr
C. *Sambucus racemosa*	Elderberry	June, July
D. *Physocarpus monogynus*	Mountain Ninebark	June
E. Shepherdia argentea	Buffaloberry	May, June
F. *Rosa woodsii*	Wood's Rose	July, Aug.
G. *Prunus americana*	American Plum	March, April
H. *Cornus sericea*	Red Osier Dogwood	Jun- Aug.
I. *Mahonia repens*	Creeping Barberry	April, May
J. *Ericameria parryi*	Parry's Rabbitbush	Aug., Sept.
K. Perennial Flowers:		May - Sept.

Aquilegia caerulea (Blue Columbine); Castilleja integra (Indian Paintbrush); Erigeron spp., Linum lewesii (Lewis' Flax); Monarda spp.; and Penstemon spp.

Notes: Perennial flowers will extend the flowering season and attract many pollinators.

Island Plan for Great Plains – Palouse Dry Steppe Province



Island Landscape Plan for Great Plains – Palouse Dry Steppe Province

PLANT KEY

Latin Name	**Common Name**	**Flowering Period**
A. *Celtis reticulata*	Netleaf Hackberry	June, July
B. *Cornus florida*	Flowering Dogwood	May
C. *Crataegus spathulata*	Littlehip Hawthorn	March, April
D. *Sambucus racemosa*	Elderberry	June, July
E. *Purshia tridentata*	Antelope Bittebrush	May, June
F. *Physocarpus monogynus*	Mountain Ninebark	June
G. *Prunus angustifolia*	Chickasaw Plum	March, April
H. *Arctostaphylos uva-ursi*	Kinnikinnick, bear-berry	May-June
I. *Mahonia repens*	Creeping Barberry	April, May
J. *Ericameria parryi*	Parry's Rabbitbush	Aug., Sept.

Notes: This planting plan is for an area 80 feet in length by 60 feet in width. These islands can be installed as shown or separately whatever best fits the area to be planted.

Seed Mix Great Plains – Palouse Dry Steppe Province

Latin Name	**Common Name**
Achillea millefolium var. occidentalis	Western Yarrow
Coreopsis tinctoria	Plains Coreopsis
Coreopsis lanceolata	Lance-Leaved Coreopsis
Dalea purpurea	Purple Prairie Clover
Echinacea pallida	Pale-purple Coneflower
Erigeron speciosus	Aspen Fleabane
Gaillardia aristata	Common Gaillardia
Helianthus occidentalis	Western Sunflower
Linum perenne	Blue Flax
Lupinus perennis	Lupine
Monarda pectinata	Pony Beebalm
Pedicularis procera	Giant Lousewort
Penstemon strictus	Rocky Mountain Penstemon
Phacelia sericea	Silky Phacelia
Rudbeckia hirta	Black Eyed Susan
Silene lacinata	Cardinal Catchfly
Vicia americana	American Vetch

Amount by weight
1 oz. of each plant species

SECTION 2: HABITAT ENHANCEMENTS

This section covers basic planning techniques, plant material and sources, and other considerations for habitat enhancements organized by food-water-shelter, the triad of environmental requirements.

Basic Planting Techniques

Site Selection

The location of your pollinator garden either as an island or a large meadow area requires planning and organization. Some questions that need to be answered are:

1. What is going to happen in this area in the future? Developed? Left as unimproved or conservation area? How many square feet or acres are you considering?
2. What water sources are available to this area? Will water need to be brought in or is water readily available?
3. What is the slope and aspect of the area?
4. What is your nursery source or seed source? Can you gather wildflower seed or plant material from adjacent lands?
5. Who is going to plant and maintain this area? How many man-hours is it going to take? At what cost? Volunteers? Grant funds available (such as National Public Lands Day)?
6. What is the current vegetation covers? Invasive species or noxious weeds or sod?
7. What time of year do you expect to plant?
8. What is the current soil and soil moisture regime?
9. What is your expected outcome?

This list of questions may seem daunting but good initial planning will ensure future success. It is recommended you build a project notebook with answers to these questions, reference material, and any communiqué (news releases, brochure, PowerPoint presentation) you may need to garner leadership support.

Site Preparation

Success of your pollinator garden depends on good site preparation; if you do not start with a clean (i.e. weed free), you will have problems later. So, first thing that needs to be done is to remove the existing vegetation. If it is sod, lay out the planting bed or stake out the area where the sod will need to be removed. Cut through the sod and peel it back; you can reuse the sod in other areas or compost it. If you are looking at a very large area, you may need motorized equipment – brush hog to mow the area, a tractor with a disc or harrow to break up the soil, and a seed drill for seeding the area. And because seed-to-soil contact is so important, a roller

would be very handy. If your site is heavily infested with weeds, you may need to begin with herbicide treatments to reduce the biomass and seedbank.

Soils and Amendments

Understanding the soil is another critical piece for successful planting or site rehabilitation. If you do not have a county(-ies) soil map for your installation, contact the county Natural Resources Conservation Service (NRCS) for a soil survey or check their Web Soil Survey site (websoilsurvey.nrcs.usda.gov). This site has DoD installation specific data, if it is available. The soil survey will provide you with the type of soil and vegetation information present in your project area. It is also recommended to get a soil test and you can work with your county cooperative extension service about the cost and directions for this test. If your project area is less than an acre, a soil test can be done with the kits available at local hardware stores or nurseries. As for any soil test, you are interested in level of nitrogen (N), potassium (P), phosphorus (K), and soil pH. The test results will indicate what, if any, soil elements (N-P-K) or amendments (adjust pH) will be necessary. The test from the county cooperative extension service will provide a very detailed analysis with soil improvement recommendations but there typically is a cost associated with those tests.

In improved or semi-improved areas, the soil has been amended previously for the landscaping and will likely not need anything more, whereas, unimproved or conservation areas may need minor adjustments. Sometimes, a single application of a balanced fertilizer will be sufficient.

If the soil is very sandy, it might need organic matter, such as straw or compost, incorporated into the soil to hold soil moisture, whereas, clay soils will definitely need organic matter tilled in to loosen up the soil matrix. Do not add sand to clay soil as that will make them even more hard-packed and impermeable.

Plant and Seed Selections

Diversity of plants is necessary to support a variety of pollinators and to provide food sources for both adults and larvae. So nectar and pollen plant sources are needed from early spring to autumn. Plants of varying heights, variety of flower color and bloom periods should be considered and planted. It doesn't hurt to use early blooming annuals in landscape, such as zinnias and cosmos, while they are not native species they do attract pollinators and provide food sources before many natives are able.

With a continuing demand for native plant stock and seeds, the nursery and catalog market is expanding to meet that demand. Remember the right plant in the right location is critical for success. This means, buy your plant stock as locally as possible to have plants that are adapted to those growing conditions – temperature range, precipitation, and available light.

Planting

Planting the desirable plants in your project area is the next task; actually selecting the plants (or seeds) is next but with the information this guidebook has provided that task has been done for you. So, in small areas, you might wish to use nursery stock for a more formal, instant success. When planting around buildings, it is best to begin with the larger material, such as trees and shrubs, followed by the forbs and grasses. For larger areas, seeding or grass plugs will be the way to go for labor and material costs.

If you are new to an area or to this concept, it is recommended you visit local nature trails or botanical gardens to get a “feel” for what plants do well in your region.

Interseeding: This method refers to planting seed directly into existing vegetation without tilling or applications of herbicides. If your project area already has a healthy stand of native species or grasses, you can use a seed drill or hand-toss the desirable seeds out into the area. While this method does take longer to establish, it is one of the easiest and less expensive methods to introducing more pollinator species into the landscape. For a child’s or Earth Day activity, you can make seedballs by mixing red clay with native seeds (3:1) get the mix moist, form ½ inch balls and let dry overnight. Toss out into the desired area and wait.

This method does take longer than seeding or using nursery stock because of the competition from the existing vegetation. The native seed bank may take four to five years to get established but this method is desirable because of the relative ease of adding pollinator plants to existing landscapes or restored areas, improvement in site quality, and the increased biodiversity of native species and pollinators.

Nursery Stock: This option is best for small project sites due to cost of the potted plants available from growers. There are a number of sources for nursery stock – local commercial nurseries, mail order catalogs, and the NRCS Plant Material Centers. However, not all native plants are available commercially, so you may need to substitute with other similar natives. Most non-native nursery stock doesn’t

have the pollen or nectar resources available and while they look pretty they are not suitable for pollinator gardens.

The first resource to access is the Lady Bird Johnson Wildflower Center (www.wildflower.org); they have gathered information on over seven thousand native species across the United States that are suitable for native gardens. The website provides species lists by state and/or common plant name; the search results include scientific and common names, duration (perennial or annual), habit (tree, shrub, vine, forb, or grass), sun and water requirements. Another link on this site provides both suppliers of plant material and contractors by state. It is always best to get the right plant for the right location – don't try and fit a plant with different growing requirements into the landscape. Work with the current environmental and climatic conditions; it's less expensive and has a higher chance of success than trying to change the local conditions to fit an artificial plant community.

Another excellent source of plant material, seeds and expert information is the NRCS Plant Material Centers (www.plant.materials.nrcs.usda.gov); there are 26 Plant Material Centers in CONUS, so the seed mixes and plant material are developed for your specific region. The biologists at these centers seek out plants that show promise for meeting specific identified conservation needs and test their performance. After the seed mixes and plants are certified, they are released for commercial production. Government and Tribal organizations can also contract to grow specific plants or seed mixes but do need sufficient time to develop and field test the materials. Unfortunately, this takes long term planning to utilize this service.

For the plant materials not available commercially, other means may be necessary to obtain native plants and seeds, and information. County Cooperative Extension Service offices will have information on plants suitable for your region; nearly all extension offices have a Master Gardener chapter of volunteers that may be helpful in locating sources of planting materials and even trained volunteers to help design and install the pollinator gardens. Another local resource would be the state Native Plant Society and local chapter. The members come from a broad background but are all interested in the conservation and appreciation of native plant and their habitats.

Plant salvaging is another means to gather native species from the wild in area that will be destroyed by development. If you can, collect whatever plants available on your base in areas that are projected for development and then use that material to replant after the construction is complete or in other areas on base. Avoid plant

salvaging from off-base unless it is with a reputable group, i.e. Master Gardeners or Native Plant Society, and you have an immediate need for the material.

A word of warning about some “native” plant nurseries, there are some who collect plants and seeds from public and private lands without permission and they may traffic in rare or endangered plants, even noxious weeds and invasive species. Be sure you are purchasing your plants from a reputable nursery. Ask them for certification of the nursery stock source.

Seeds: This is the best option for large project areas and areas without ready water sources, i.e. unimproved and habitat restoration/conservation areas of an installation. Much like nursery stock not all the desired species may be available commercially and the sources for plant material are often the same as for seed mixes. For some projects, it is not recommended to use commercial mixes but to create your own mix depending on your specific site conditions. Species selection for seed mixes can be more difficult than nursery stock because, unless you are familiar with the species in your region, you may purchase a seed mix with species that are not adapted to your region and, therefore, may not do well. It is strongly recommended that you seek out native areas and identify species present or to talk with local experts for recommendations. Customized seed mixes give you the opportunity to increase the diversity of both grasses and forbs in your project area. And a diversity in plant material leads to providing food and shelter sources for a variety of pollinators.

Seed mixes can be either purchased or hand-gathered from local sources to provide the local ecotypes that naturally evolved at or nearby the project site. These hand-gathered seeds can be added to a purchased seed mix.

The guidebook provides a recommended seed mix for each ecoregion province. These mixes are intended to be planting in open areas, along roadways, or in habitat restoration sites. Each mix has a minimum bloom period of three months with up to 6 months for some. Each mix consists of a minimum of 16 species with alternative species for some genera. In the ecoregions where applicable, clover is added for it growth habit as a ground cover and its nitrogen-fixing abilities to add to the soil fertility.

Each species in the mix are to be one ounce per pound of seed, with a seeding rate of:

- 1 ounce per 20 sq ft by: hand spreader
- 1 pound per 2,720 sq ft (100'x27' strip) by: hand spreader/ seed drill
- 14 pounds per43,560 sq ft (1 acre) by: seed drill

Using certified seed is recommended because the seed has known identity and meets certified quality standards for purity and germination (NRCS 2005). Certified seed has the best chance of success and least chance of introducing unwanted seed problems. Wildflower seed are sold on a pure live seed (PLS) basis and are recommended because they ensure that the desired product is what is being paid for, not dead seed or unwanted plant pieces. A pound of pure live seed contains 16 oz. of living seed of the desired species plus additional weight of the other material that has not been removed by the cleaning processes (NRCS 2005). Using the seed analysis tag, the PLS can be calculated to compare quality of "lots" of seed. For example, a seed lot with a tested germination of 80 percent and a purity of 90 percent also has a PLS percentage of 72 (0.80 × 0.90 = 0.72). In 1.0 PLS pound of this seed lot, the gross weight to buy and plant would be 1.39 lb (1.00 divided by 0.72) (NRCS 2005). For commercial seed mixes, which have been tested for germination and purity, the suggested rate generally varies from 10 to 15 lb/acre.

Depending on the species composition of the seed mix, it may take more than two to 3 seasons to become established and even then, the plant community will be constantly changing as climatic conditions change over time and competition from other species. In some sites, competition from noxious weeds or invasive species may be problematic, but not insurmountable. In some cases, a liquid application of a balance fertilizer in the early spring will encourage native species to outcompete the undesirable species or, as a last resort, spot treatment with herbicide may be required.

Establishment and Maintenance

To get best results and establishment of nursery stock or seeded areas, it is recommended to keep the soil moist and until plants are established and seed germination is confirmed. In habitat restoration sites with limited water resources, if you schedule seeding before the annual rainfall or late spring snowfall for seeding will give the seeds the best conditions for germination and establishment. For

smaller areas planted with nursery stock, periodic watering will be needed the first season or 2 and if the area is mulched, you can reduce your watering frequency.

Maintenance in the landscaped areas around buildings and island beds will follow typical maintenance schedules to keep the areas looking tidy. The seeded areas may look unkempt after the forbs have bloomed but resist mowing until all the plants have flowered and set seed, including the grass species. A fall mowing of the area to a height of 3-6 inches is all that will be needed for maintenance. It is important to build the seed bank of native species in these restoration areas and so getting the mature seed heads closer to the ground by mowing will add to the seed bank and provide overwintering habitat for beneficial insects and other pollinators. Reseeding or interseeding may be needed after the second season to augment the species composition of the area or fill-in bare, exposed soil.

Seed treatments

If the decision is to use customized seed mixes, be aware that some may require various seed treatments for proper germination. Treatments include sowing fresh seed, cold-moist stratification, warm moist stratification, cold dry stratification, inoculation, scarification, light treatment, and vegetative propagation. Treatment methods are briefly described below:

a. Sowing fresh seed works well for most spring flowering species. Seeds can be sown in flats to be set out when they have developed.

b. Cold moist stratification can be accomplished by mixing seed with damp sand or vermiculite. The mixture is placed in a plastic bag and put into a refrigerator where the temperature is 34-40◦F. Species differ on how much time they need to be stratified; some will require 10 days, while others will require 120 days, but for most species 60-90 days is typical (Guerrant et al 2004). Once the treatment is achieved, planting should take place in mid-spring when the outdoor temperature is warming up. Species that require stratification can also be sown directly outside in the fall.

c. Cold dry stratification requires that dry seed be placed in a plastic bag and put into cold storage for a period of time.

d. Warm moist stratification can be done by mixing seed with damp sand or vermiculite, then placing the seed in a plastic bag and warmed to 68-75◦F.

e. Scarification is the process of physically breaking down seed coats, so the plant embryo can take up water and begin to grow. Seeds can be scarified with a piece of sandpaper or by soaking in acid baths, which mimics the natural process of being eaten by an animal and broken down within the digestive system.

f. Inoculation of legumes with nitrogen-fixing bacteria enhances growth and is applied to wet seed just before it is planted (Steffen 1997). Full sunlight is needed for some seeds that require light to break dormancy and these species can be sown on the surface of a firm smooth seedbed. Some plant species have complex propagation requirements and require combining the above techniques in a particular pattern.

g. Vegetative reproduction is the process of dividing roots and planting pieces of the parent plant to create other individuals.

Other Considerations for Creating Pollinator Habitat

This section of the guidebook covers the three fundamental habitat requirements for sustainable pollinator populations and in this particular case, insect pollinators (Figure 3). Since the previous section provided landscape designs and plant lists by ecoregions, this section will continue along those lines with information about additional food sources or, rather, foraging habitat for insect pollinators.

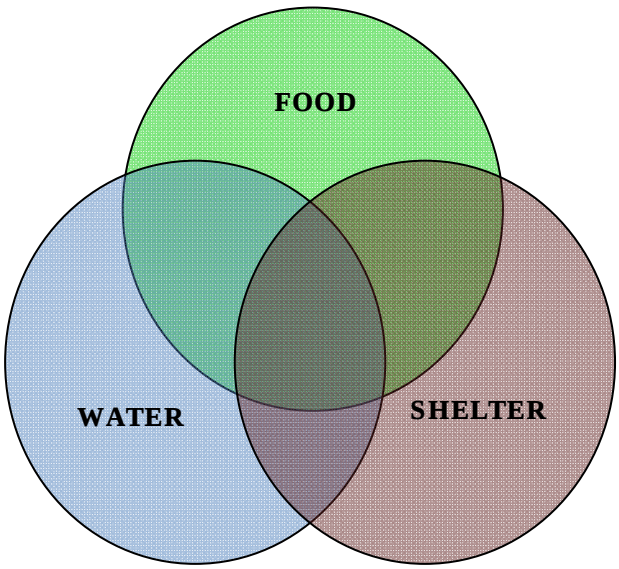


Figure 3. Animal species have three basic requirements for habitat: food, water, and shelter.

Sustainable landscapes provide mixtures of habitat in which all three basic necessities are available. Many species, including pollinators can move among different habitats on a landscape to obtain required resources.

Habitat Enhancement

Under optimal conditional, natural processes could be left to create habitat(s) that would meet all the needs of a diverse community of pollinators -- but such conditions are rarely encountered in developed areas of installations (and elsewhere). However, there are opportunities to manage landscapes in these areas to promote healthy pollinator populations and sustainable pollination services. Important components in such management approaches include planting seeds and growing plants that provide for basic pollinator necessities and that simulate some important ecological features found on natural landscapes.

For example, not many people realize that golf courses can provide stable, long-term habitat for many wildlife species, including pollinators, and can provide all three basic necessities (food, water, and shelter) for survival. Many golf course superintendents are actively seeking better ways to manage golf courses, including the use of fewer chemicals (pesticides and fertilizers). According to The Xerces Society (Making Room for Native Pollinators, Shepherd 2002) three simple things can be done at golf courses, and on any greenspace, to improve survival of native bees and other pollinators:

- Improve foraging habitat using a range of native plants that can be planned to provide nectar and pollen throughout the season of pollinator activity
- Provide suitable ground condition or wood structures for nesting sites, as well as appropriate nesting materials; and
- Minimize use of pesticides, particular insecticides and herbicides that kill non-target species (such as pollinators) and the plants that provide pollinators with nectar and pollen.

Plant selection is critical when designing and installing your landscape. First, selecting the right plant for the right location is paramount. When planning for creating foraging habitats consider (Shepherd, 2002):

- Using native plant species. Native plants are better adapted to local climates and can thrive with minimum maintenance. In contrast, many nonnative horticultural varieties and hybrids are not well-suited to local climate and,

while typically showy, lack sufficient nectar or pollen for sustaining native pollinators. Another consideration is considering is providing for larval stages of pollinators, i.e. caterpillars, which often feed on different plant species and plant parts than what the adults prefer.

- Selecting an assortment of plants with a diversity of flower and vegetative colors. This is not only pleasing to the human eye but bees, butterflies, and hummingbirds "see" flower colors differently and are attracted to differing color values. For example, hummingbirds are attracted to red colors and some bees need the ultraviolet (UV) markings on the flower petals to guide them to the nectar sources.

- Selecting an assortment of plants with a variety of flower shapes and sizes. Pollinators vary in size, and have different tongue lengths that can dictate the shapes of flowers from which they can extract nectar and pollen. For example, some bees have long tongues which can feed on the relatively deep, tubular flowers of lupines and penstemons, while other bees need more open flowers, like asters, in order to access nectar. Pollinators come in a variety of degrees of specialization for flower structure and plant species. Planting a high diversity of plants will enhance pollinator diversity and community stability.

- Providing a diversity of native plants that will flower throughout the growing season. Depending on your location or ecoregions, various resident pollinators may be active throughout the calendar year. Many social-living bees' species can be active and foraging all season, whereas, the activity of some solitary-nesting bees is synchronized with the flowering period of local foraging plant species.

- Opt for both annuals and perennials. Some native bee species are specialist, whereas, others are generalist. Some pollinators have a feeding preference for perennials over annual and vice versa. By providing both growth types in your landscape will increase the number of species you can attract and support.

- Right Plant- Right Location. What environmental conditions currently exist on the landscape? Wet/Dry/Moist? Sunny/Shady/Mixed? Is the soil clay, silt, or sand? All these factors will influence your plant selections and the success of your project.

- The Lady Bird Johnson Wildflower Center in Austin, TX, has gathered information on over seven thousand native species that can be used for

landscaping. This plant database can be searched by state or plant name, and the recommendations provide scientific names, common names, duration (perennial, annual), habit (tree, shrub, creeping, or grass), and sun and water requirements. This site also provides information, by state, about native plant suppliers and landscaping contractors that utilize native plants. Keep in mind that working with native plants that are adapted to contemporary, local environmental conditions increases the chance of successfully establishing a pleasing, more pollinator-friendly, relatively lower maintenance landscape compared to landscapes built around nonnative plants.

- Take a look at what is already growing in your project area. In some cases, you might already have a ready source of native species and only need to look to augmenting the plant community. Take a hint from other local wild areas for ideas.

- Avoid invasive species. Some plants, including native species, are known for being highly competitive, strong growing plants that invade disturbed areas quickly and out-compete desirable native plants. These invasive species will, over time, reduce the biodiversity and value of the habitat desired. When considering plant selection, check with the Base Environmental Office for assistance. Weed control in your landscape is important.

- Lastly, generally avoid rare plant species. Most are rare for a reason – stringent habitat or climatic requirements, lack of pollinators, or over-harvesting. In some cases, rare plants obtained from nurseries, could be used under selective conditions.

Food: Nectar Sources

Nectar is a concentrated sugary solution that plants naturally produce to attract pollinators. Pollinators, with their often energetically demanding lifestyles (e.g. flight, heater bees in honey bee colonies, larval development) require this high-energy resource for survival. Some plants use extra floral nectaries to attract mutualistic species, like ants, that protect the plant from herbivores. When selecting landscape plants, it is important to understand that *some* commercial varieties have been selectively bred for showy flowers, but sometimes at the expense of nectar and pollen production. Such plants may be very resource poor, and, while they may attract pollinators to their large and/or bright inflorescences, they provide little or no reward for the pollinators' time and efforts to reach and explore the flower. A landscape with many such plants could be detrimental to local pollinator populations.

All pollinators are attracted to blooms either for the color of the flowers or the scent of the nectar. Plant selection is therefore critical, and the first part of this handbook provides many options. There are numerous sources for purchasing or otherwise obtaining native plants, most of which are excellent resources for pollinators.

There are also many options for providing supplemental food resources for pollinators. Nectar feeders can be purchased or constructed, and are generally to maintain. Nectar feeders can be deployed as part of landscape design around buildings, in parks, etc. or can be part of many different kinds of installation community activities, such as Earth Day events, school projects, Master Gardener projects, etc. Something as simple as a saucer placed in a sunny area, out of the wind, can hold fermented fruits and sugar solutions that provide food for adult pollinators. In this case, as long as the fruit stays moist it is safe to leave out; but if it becomes moldy or slimy (sign of a bacterial contamination), it should be removed and the saucer thoroughly washed before re-using.

Another simple feeder option is to make a simple sweet syrup (1:4 sugar: water) and place it in a small glass canning jar with a small hole in the lid (poked out with an awl or nail) stuffed with an absorbent material (e.g. sponge, cotton or candle-wicking). The jar can then be hung upside-down in a sunny outside location. Ideally, the absorbent material will become saturated for easy feeding of butterflies, but not so wet that it drips and attracts non-target insects like ants.

Food: Pollen Sources

Pollen, in its dry form, provides an important food resource for some pollinators (especially bees) and typically contains 16-30% protein, <10% fat, <7% starch, and trace amounts of minerals. Pollen is a particularly important resource for provision stashes (e.g. pollen balls) used by solitary bee larvae after hatching. Pollen sources are most easily provided by flowering plants, both perennials and annuals.

Native bees, most of which are solitary or live in small groups, will collect pollen from many floral sources, including trees, shrubs, and forbs, while domesticated honey-bee colonies will primarily forage on a single source of pollen when trees or crops are in bloom (which is why they are used primarily for pollination of cultivars like apples, almonds, blueberries, etc).

Pollen is the male gamete found on the flower stamen. Most flowering plants need to have pollen moved from one flower to another in order to accomplish fertilization. Therefore, not only do some pollinators require pollen resource, most plants require

pollinators for transporting pollen within and between flowers of individual plants. Monoecious plants are plants that have female and male individuals and require pollen be moved from male plant to a female plant. Dioecious plants have both male and female anatomy within the same individual plant. Some dioecious plants require pollinators to move the pollen from the male stamen consisting of the filaments and anthers, onto the female pistil consisting of the stigma, style and ovary, in order to produce seed. Other plants have flowers that can "in-cross" (self-fertilize), but tend to have more robust seed and propagation yields when "out-crossed." Luckily for bees, plants do not require all the pollen collected from one flower to be deposited on another flower. One way to look at it, then, is that the bee gets "paid" in pollen for its pollination labors.

Other pollinators typically obtain pollen unintentionally as they search flowers for nectar and then transfer pollen to other flowers as they forage. Flower structure is often adapted to transfer pollen to these unsuspecting pollinators. Some pollinators, such as ants and beetles, may also, like bees, forage on pollen.

The first part of this guidebook provides lists of plants that can be used to promote healthy pollinator populations, and there is a surplus of information on the World Wide Web that is easily accessible and applicable to nearly any ecological region. A good example is a fact sheet provided by the Ohio State University Extension Service, "Some Ohio Nectar and Pollen Producing Plants, both Major and Minor Sources" by Dr. James E. Tew, that lists plants, natives and cultivars, grown in Ohio. The fact sheet provides a table listing plants that are good nectar and pollen resources, as well as the plants' bloom dates.

Leafy or green vegetation is another important food resource for pollinators, particularly some larval stages (i.e. caterpillars). In addition to food, such vegetation also provides shelter from predators and weather. More details are provided below in the SHELTER section of this guidebook.

Water

Water can be provided in our man-made environments. Naturally occurring open water, such as ponds, lakes, seeps, or wetlands is the best, but on many of our military lands we have to rely on alternative sources such as installed ponds, watering troughs, rain gardens and birdbaths.

Puddlings or mud puddlings are moist depressions in the ground (i.e. mud) or shallow buried containers filled with moist sand and minerals and/or sea salt. Male

butterflies, perhaps seeking minerals that may enhance reproductive competitiveness, in particular, seek out these resources. It is very easy to create such artificial puddling areas using a clean, shallow plastic or clay saucer that is at least 16 inches in diameter and two inches deep. The saucer is filled with a mixture of coarse sand and mushroom compost and should be kept soggy though out the season. Pollinator resting areas can also be combined with puddling sites by, for example, placing flat rocks along the edges of puddles. Such puddling sites should be placed in full sun but out of wind. Windbreaks can be constructed if sites are not readily available. Both the University of Kentucky and University of Texas recommend baiting puddles with stale beer or fermenting fruits, and suggest using sea salts high in minerals.

Stock tanks or troughs can be a ready source of fresh water in isolated open range areas or unimproved habitat areas on military bases, but they also come with risks for bats, birds, small amphibians and reptiles. Water for Wildlife (Taylor and Tuttle, 2007) provides clear instructions on how to build escape structures into both round and rectangular stock tanks and troughs (Figure 4). If man-made ponds mimic natural ponds and lakes, there should be no problem with pollinators and other animals getting trapped and drowning. The bottoms and edges should be either vegetated or rocky with gently sloping edges (< 45 degrees). There are a number of references and websites that provide many helpful options for providing water in an urban setting.

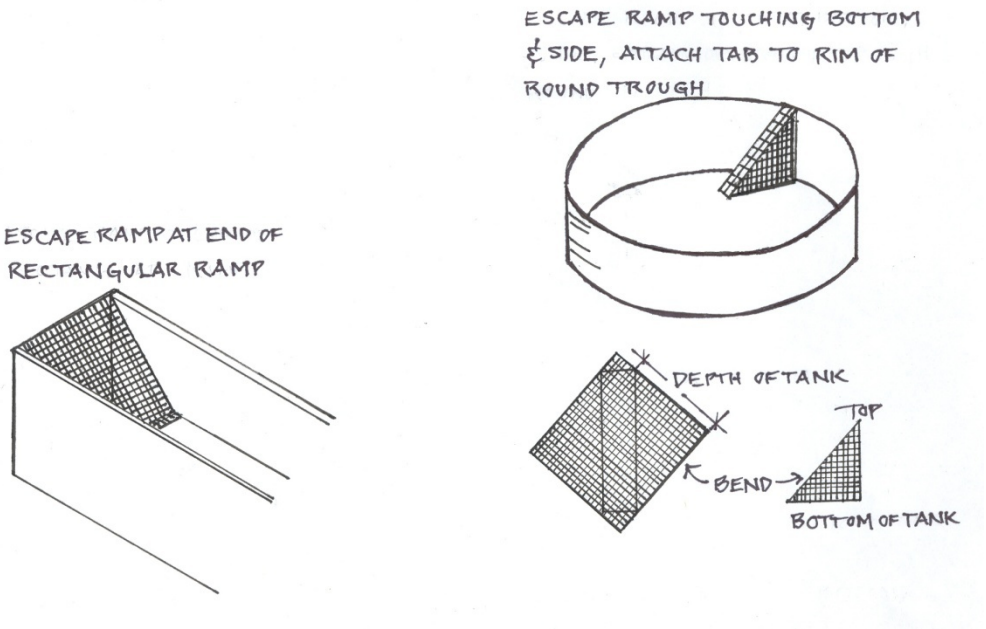


Figure 4. Escape structures for rectangular and round water trough.

Shelter

Shelter can come in many forms, as pollinators may utilize bare ground (e.g. ground-nesting bees), including banks and cliff faces, and various vegetative structures, including undersides of leaves, rotting wood, stem pith, etc., for shelter. Diversity in vegetation (trees, shrubs, grasses, and forbs) creates a “layering” effect (Figure 5) that provides many sheltered niches for pollinators to utilize as both nesting and loafing sites.

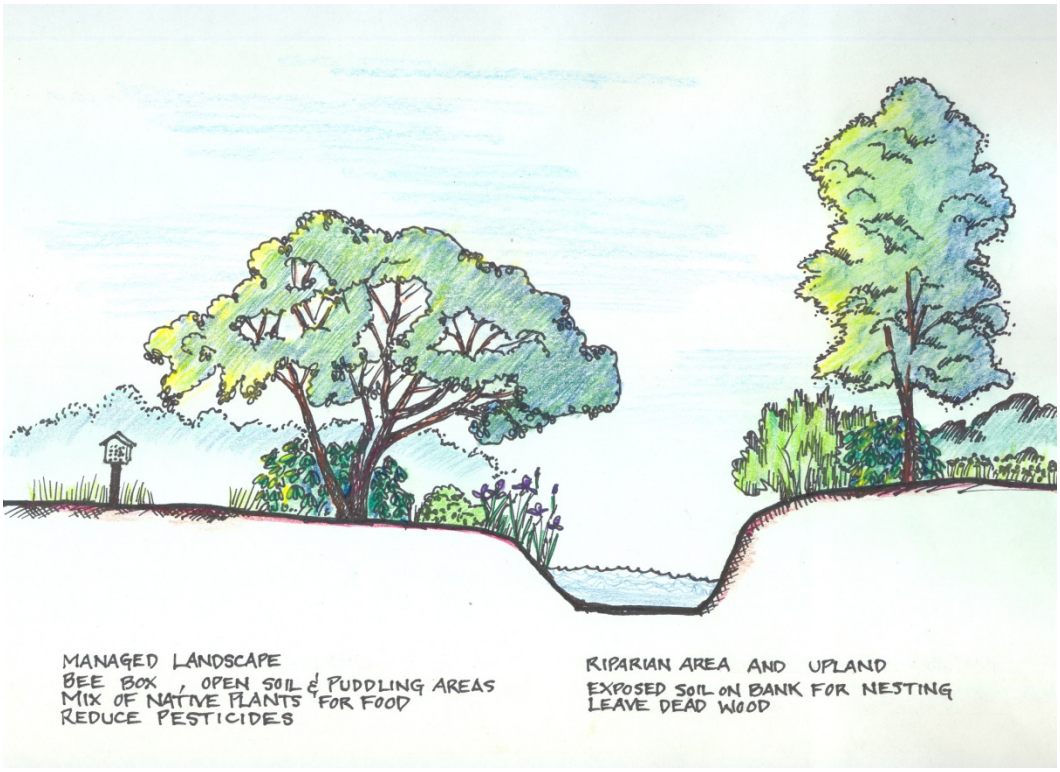


Figure 5. Section view of pollinator habitat features.

Additionally, there are several options for supplementing available natural shelter with man-made shelters. For example, according to Making Room for Native Pollinators (Shepherd, 2002), there are several simple ways to provide nesting sites for both ground-burrowing and wood-nesting bee species. One of the most important factors is mimicking naturally occurring features of nesting sites, especially location (. . . location, location!). Knowing your local pollinators is critical to providing them with appropriate nesting habitats. For example, because ground-nesting bees will avoid wet, muddy soils, select well-drained ground, with a south to southeast aspect for a sand pit would be ideal. Man-made nests for wood-dwelling bees can be made from scrap wood, but it is important to never use pressure-treated wood for this purpose because of the chemical preservatives (Figure 6). In this case, openings to nest sites should be on an aspect protected from direct winds.

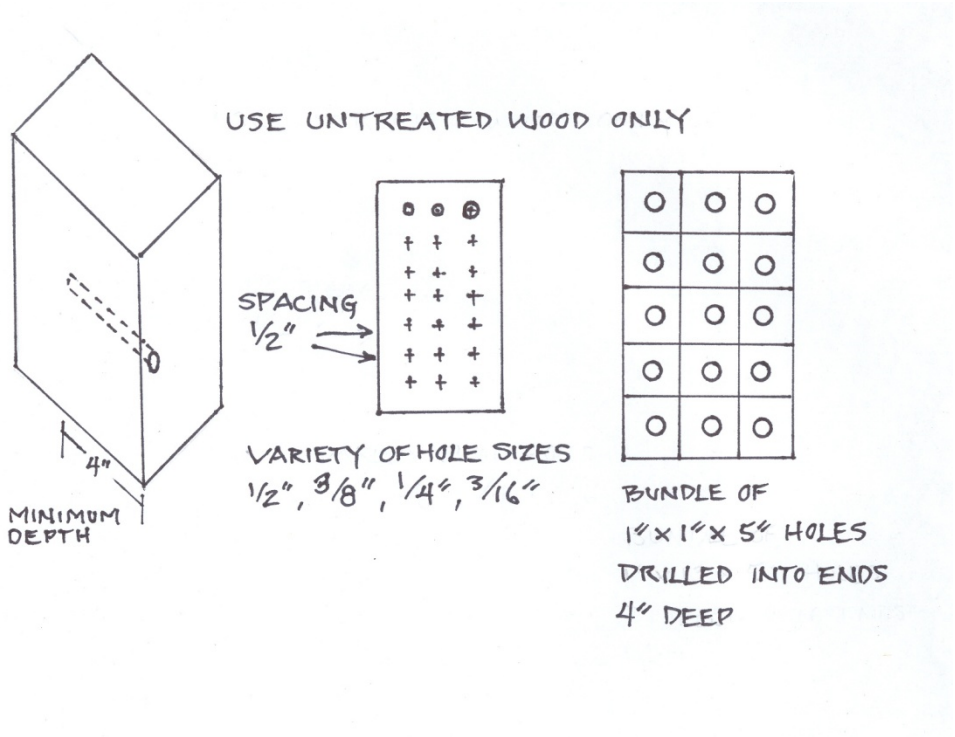


Figure 6. Nest box for wood nesting pollinators.

Butterflies can also benefit from man-made houses. In the REFERENCES section, websites are provided for purchasing butterfly houses as are plans for making a simple butterfly house made from one cedar fencing slat. Like bluebird boxes or other bird houses, building butterfly houses or other pollinator nest structures can be a fun do-it-yourself, family, or other community activity.

In addition to nest sites, sunning, “loafing,” or resting sites, such as mentioned previously in connection with puddlings, can also be incorporated into landscape design. The key for sunning or loafing sites is they have to be out of direct wind. If there is a lack of naturally occurring sites that are protected from the wind, it is very easy to construct one that will not be out of place in the landscape. Such sites are particularly important for butterflies, and even more particularly for newly emerged butterflies. Sunning sites allow them to spread their wings so they can dry out and allows the young butterflies a place for getting acclimated to their new environment. The wings dry out in a few minutes, but those minutes are critical to the butterfly’s survival.

Figure 7 depicts various nest sites used by native bees that are solitary and colonial, and that utilize ground, wood, or stem pith nests. Some of these are easily reproduced on the landscape. There are a number of commercial sites that sell bee nests or nesting tubes. See REFERENCES for those producers.

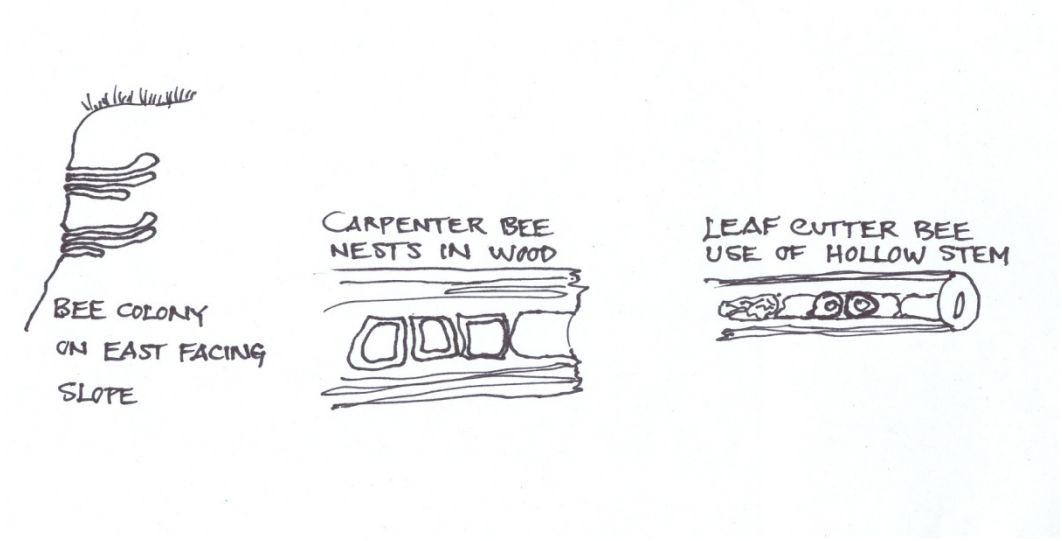


Figure 7. Various Bee nesting sites (adapted from Brusca).

Additionally, vines, grasses, leaves, and seed fluff all provide valuable natural materials that some pollinators will use when building nests. Cotton batting and string and natural fiber yarns, dryer lint, and shredded paper are also very good sources of nesting materials that are easy to provide in man-made holders.

Bats are critical pollinators of the agave plants in the southwest but they face problems with lack of shelters in those areas. Bat Conservation International and a number of websites provide plans for bat houses. Some of these houses are small and can house <100 bats whereas others are large “condos” on stilts, and can house over >1000 bats. See the REFERENCES section for plans and sources.

Literature Cited

Alaux C., F. Ducloz, D. Crauser and Y. Conte. 2010. Diet effects on honeybee immunocompetence. Biology Letters. Published online. Doi:10.1098/rsbl. 2009.0986.

Bailey, R. G.; Cushwa, C T. 1981. Ecoregions of North America (map). (FWS/OBS-81/29.) Washington, D.C.: U.S. Fish and Wildlife Service. 1:12,000,000.

Bailey, R. G. 1983. Delineation of ecosystem regions. Environmental Management 7: 365-373.

Bailey, P. and C.O. Martin. 2007. Overview of prairie planting techniques and maintenance requirements. EMRRP Technical Notes collection (ERDC TN-EMRRP-ER-05). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Brusca Richard C. no date. “About bees, habitat, and coevolution”. resonatingbodies.wordpress.com (last visited 20 Feb 2010)

Guerrant E.O., K. Havens, and M. Maunder. 2004. Ex Situ Plant Conservation. Island Press, Washington D.C.

Kurz, C. 2001. A practical guide to prairie reconstruction. University of Iowa Press. Iowa.

Manske, L. 2006. http://wwwGrazingHandbook.com (last visited 15 Feb 2010)

Natural Resource Conservation Service. 2006. Native grass seed available purchasing strategies and handling guidelines. Plant Materials Technical Note, Plant Material Program, USDA.

Pollinator Partnership. 2009. Selecting plants for pollinators (10 ecoregions). www.pollinator.org. (last visited 20 Jan 2010)

Shepherd, Matthew. 2002. Making Room for Native Pollinators: how to create habitat for pollinator insects on golf courses. The Xerces Society and the United States Golf Association. www.pollinator.org/pds/Making_Room_for_Native_Pollnators_pdf.pdf (last visited 15 Jan 2010)

Shepherd, M., S. L. Buchmann, M. Vaughan, and S. H. Black. 1996. Pollinator Conservation Handbook. The Xerces Society. Portland, OR.

Steffen, J. F. 1997. Seed treatment and propagation methods. The Tallgrass Restoration Handbook for Prairies, Suvannas, and Woodlands. Island Press, Washington D.C.

Taylor, Daniel A. R. and M. D. Tuttle. 2007. Water for Wildlife: A Handbook for Ranchers and Range Managers. Bat Conservation International. www.batcon.org (last visited 20 Feb 2010)

Tew, James E. no date. “Some Ohio Nectar and Pollen Producing Plants—Both Major and Minor Sources”. Ohio State University Extension Fact Sheet HYG-2168-98. OARDC/Entomology, Honey Bee Lab, 1680 Madison Ave., Wooster, OH 44691-4096. Ohioline.osu.edu/hg-fact/2000/2168.html (last visited 15 Jan 2010)

USDA Forest Service http://www.fs.fed.us/land/ecosysmgmt/ecoreg1home.html. (last visited 18 Feb 2010)

U.S. National Arboretum. 2003. Web version of the USDA Plant Hardiness Zone Map http://www.usna.usda.gov/hardzone/ushmap.html (last visited 20 Jul 2010)

Wilson, E. O. 1992. The diversity of life. Belknap Press of Harvard University Press, Cambridge, MA.

Resources

Pollinators:

Bumblebee Boxes: http://www.bumblebeeconservation.org.uk/downloads.html

Bumblebee Boxes: http://www.wildforms.co.uk/html/bumblebee_homes_boxes_for_bumb.html

Bumblebee Boxes: http://www.kendall-bioresearch.co.uk/bnestbox.htm

Natural Resource, Agriculture and Engineering Service. 2010. Managing Alternatives Pollinators A Handbook for Beekeepers, Growers, and Conservationists. NY.

National Research Council. 2007. Status of pollinators in North America. The National Academies Press, Washington D.C.

Waser, N. M. and J. Ollerton. 2006 *Plant-pollinator interactions*. The University of Chicago Press, Chicago.

Native Plants:

Lady Bird Johnson Wildflower Center (www.wildfower.org)

Natural Resources Conservation Service (www.nrcs.usda.gov) Plants Database

Non-Profit Organizations:

Bat Conservation International (www.batcon.org)

NAPPC (North American Pollinator Protection Campaign (www.nappc.org)

Pollinator Partnership (www.pollinator.org)

Resonating Bodies (resonatingbodies.wordpress.com)

The Xerces Society: Pollinator Conservation (www.xerces.org/pollinator-conservation/)

Wildlife Water Development:

Arizona Game and Fish Department. 2005. Wildlife Water Development Standards. AZ Game and Fish Dept. Phoenix AZ.

Krausman, Paul, R. Rosenstock, S. Steven, and S. W. Cain III. 2006. Developed Waters for Wildlife: Science, Perception, Values, and Controversy. Water and Wildlife Special Section, The Wildlife Society Bulletin, Vol. 34(3).

Schemnitz, S. D. 1980. Wildlife Management Techniques Manual. The Wildlife Society, Washington D. C. pp. 366-382.

Contact Information

Lead Author:
Ms. Mary Anderson, Botanist and Program Manager
HQ AFSPC/A7AI
150 Vandenberg St., Ste 1105, Peterson AFB, CO 80917
Mary.Anderson@Peterson.AF.mil
719-554-5034

Contributors:
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road, Vicksburg, MS
Ms. Pamela Bailey, Research Botanist and Landscape Architect
pamela.bailey@usace.army.mil
601-634-2380
Mr. Scott Bourne, Research Physical Scientist
scott.bourne@usace.army.mil
601-634-3980
Ms. Jennifer Emerson, Technical Formatter
jennifer.c.emerson@usace.army.mil
601-634-2238