Plant and Pollinator Relationships: Creating Food in a Changing World

"FARMING WITH POLLINATORS" ACTIVITY

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Overview

Many of our favorite crops require assistance from pollinators for fertilization, which allows plants to form fruits and seed pods. The formation of fruits and seed pods allows plants to continue their life cycle. Some of the foods we eat contain seeds that we directly consume, such as strawberries and citrus. However, we consume the stalk of some plants, such as broccoli, but broccoli still needs pollinators to continue its life cycle and grow, so even though we don't eat the seed pods that form from pollination of the blooms on broccoli, we wouldn't have broccoli without pollinators!

We can't just plant crops everywhere even though our pollinators readily consume the nectar and pollen from many of our favorite fruits and vegetables. We need biodiversity. If our ecosystems are diverse, then they are able to withstand changes, such as extreme weather patterns, climate change, and invasive species. Additionally, many of our pollinator species need different plant species for different parts of their life cycle. For example, tiger swallowtails need trees for food sources during their larval stage, but they depend on nectar from wildflowers and flowering shrubs as adults. If we ensure that we have a variety of trees, shrubs, and wildflowers alongside our crops, our pollinators will have the food sources they need at different stages of their life cycle.

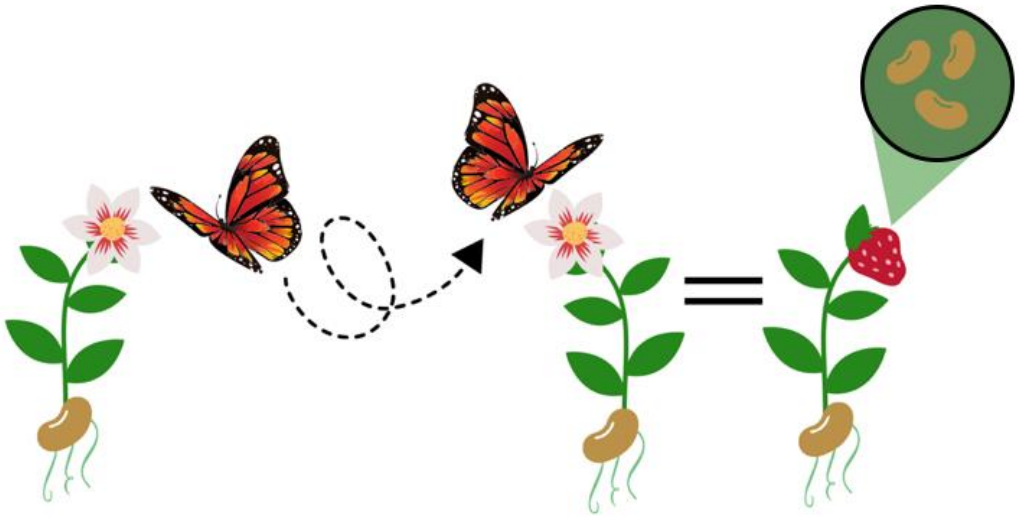
With increases in human population, we need more spaces to grow the food we all need. Agriculture requires large amounts of land, and we must ensure that we are caring for the land that we depend on to grow the food we eat. Increasing plant diversity on a farm can prevent erosion, increase crop yields, and provide forage for livestock. In this lesson, we will learn how farmers and other landowners can improve plant biodiversity on their farm, which will improve the livelihoods of our pollinator species that we need for survival.

What is pollination?

Pollination is the process of moving pollen from one bloom to another bloom, encouraging the creation of fruits and seed pods! Pollination can be assisted by pollinators, or it can happen by wind travel from plant to plant.

What is a pollinator?

A **pollinator** assists plants in pollination by moving a powdery substance called pollen from plant to plant. Pollinators aid this process in different ways! Some are trying to eat **nectar**, which is the sweet liquid produced by plant structures called **nectaries**. Nectaries can be found in different places on the plant, but they are often found at the base of the bloom where it meets the sepal. Plants produce nectar to encourage visitation from pollinators, and when the pollinators come to eat nectar, they get pollen on their bodies. The pollen-covered pollinators then take the pollen to their next food source. Some pollinators eat pollen directly and get it on their bodies in the process. Sometimes predatory insects and vertebrates accidentally assist with pollination just by crawling around the plant hunting for other insects. For example, if a predatory insect is hunting other insects on plants and moves the blooms around, pollen can get into the air and travel to other plants. Pollinators can be bees, butterflies, wasps, moths, beetles, flies, birds, and others!

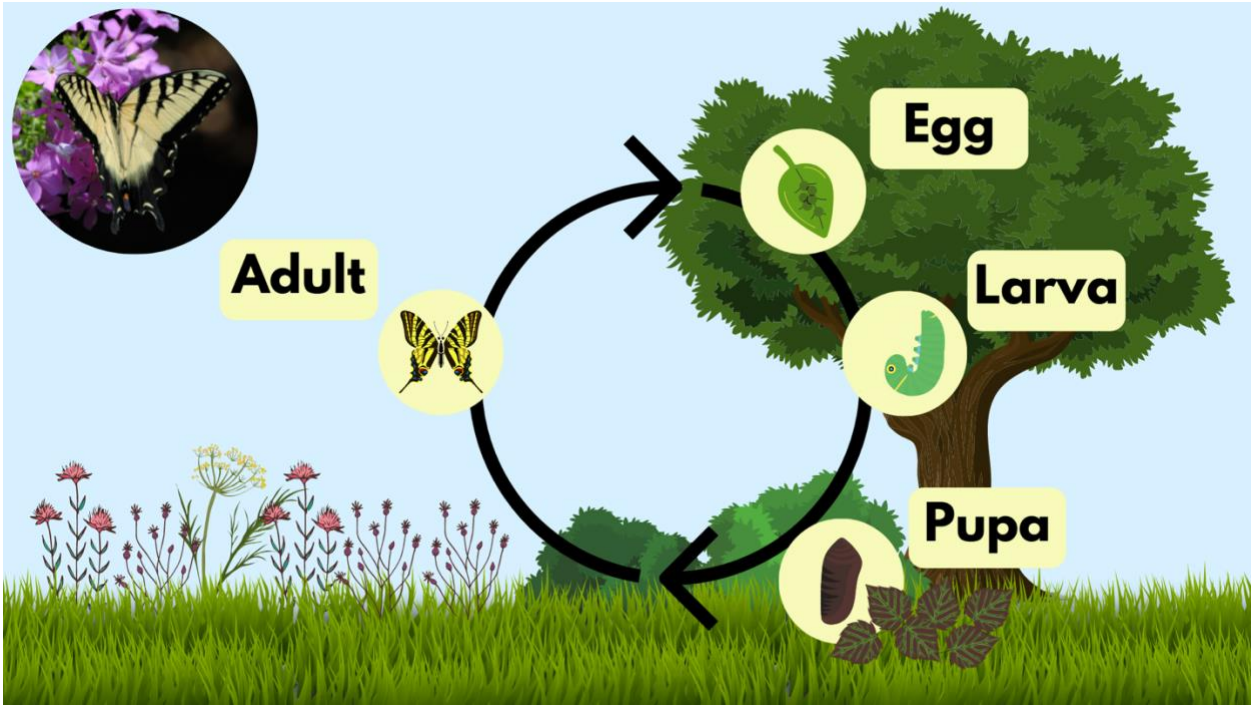


What does a pollinator need to survive?

A pollinator needs habitat! **Habitat** is the space where an organism lives and the space where their needs are met. Pollinators need food, water, and shelter-just like we do. Just like humans, at different life stages, pollinators depend on different food and shelter sources. Let's consider the tiger swallowtail butterfly, which is a butterfly commonly seen in Georgia. The tiger swallowtail caterpillar eats the leaves

of trees such as cherry and birch and will hide amongst the leaves during this stage in their **life cycle**. When the **larva** (the caterpillars) **pupate**, which means they form their **chrysalides**, they hide in fallen leaves on the ground to blend in. Once they emerge as adults, they travel to various blooms on wildflower and flowering shrubs seeking nectar. As larva and adults, grasses year-round, especially dried, dead grasses in the winter, serve as great places for pollinators to hide from pesticides, harsh winds, rain storms, cold weather, and predators. Some pollinators, including many of our moth species, pupate underground, which helps them stay warm and dry during the winter months before emerging in the spring!

Not only do pollinators need different food at different parts of their life cycle, but some pollinators are extremely picky in general! In **food webs**, which is the interactions of food consumption between organisms, there are generalists and specialists. **Generalists** eat a wide variety of food sources; **specialists** are more specific. For example, monarchs are generalists as adults but as caterpillars they are specialists. Monarch butterflies will consume nectar from a variety of flower sources, but monarch caterpillars will only eat the leaves of milkweed plants. Many of our plants and pollinators have relationships such as these where their life cycles are inherently linked. Monarchs assist with milkweed pollination, which helps milkweed plants continue their life cycle. Both the leaves for the monarch caterpillars and the nectar for the monarch butterflies allow the monarch to survive and continue its life cycle as well.

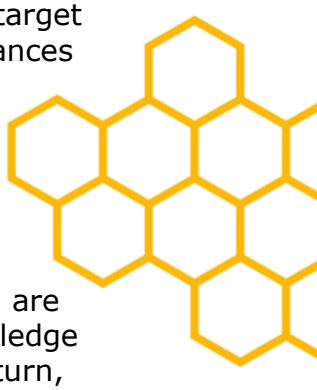


This figure demonstrates the life cycle of a tiger swallowtail, which is a butterfly commonly found in Georgia.

How do humans impact pollinators?

The Bad

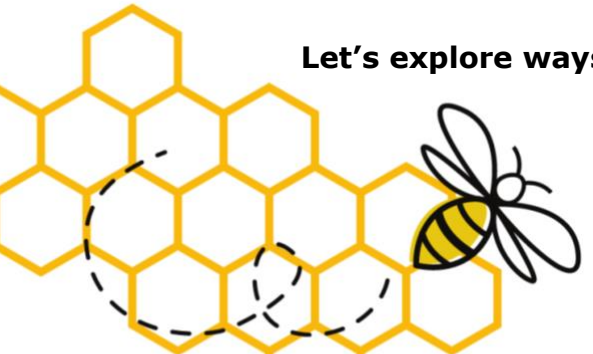
Human populations are increasing, which means humans need more space and more food to survive. Additionally, humans don't always nurture the spaces they have, even if their needs are met. Creating more roadways and buildings takes away from the habitat pollinators need to survive and prevents pollinators from traveling safely to food sources via **habitat fragmentation**. **Pollution** has a similar effect on pollinators. Pollutants, particularly chemicals, can inhibit the growth of plant communities, which are required for pollinator survival. The misuse of chemicals in agriculture is of great concern. **Herbicides** (chemicals that target plants) and **pesticides** (chemicals that target insects) can travel great distances via water and air. It is important that the labels are read before using these chemicals, and if there is ever any question regarding appropriate use, a professional can be contacted.



The Good

More and more people are learning about pollinators and their needs. If you are reading this, you are learning about pollinators, and you can take this knowledge and share it with others! There are solutions to help our pollinators, and in turn, help us get the food we need to survive. We can't just plant crops everywhere even though our pollinators readily consume the nectar and pollen from many of our favorite fruits and vegetables. We need **biodiversity**. If our ecosystems are diverse, then they are able to withstand changes, such as extreme weather patterns, climate change, and invasive species. Additionally, many of our pollinator species need different plant species for different parts of their life cycle.

In agriculture settings, it is possible to turn productive land into a safe space for pollinators. Areas that aren't being used for crops, such as around fences or near field corners and edges, are great places to plant wildflowers for pollinators. Between crop rows are great places for pollinator plants as well. Rotating crops in the landscape is important to ensure that nutrients aren't depleted and using cover crops between plantings is a great way to put nutrients back in the soil, which will help with the next crop cycle! Cover crops aren't consumed; they are planted solely to put nutrients back into the soil, and legumes, which are plants in the bean family, are great options. Legumes can provide food and shelter for pollinators, while simultaneously improving soil quality. Cover crop and wildflowers in other areas of ag land, can increase soil nutrients and prevent erosion. Cattle fields experience an abundance of hoof traffic, and planting clover (a legume), is great forage for cattle to eat, a nutrient source for the soil, and a food source for pollinators!



Let's explore ways to improve pollinator spaces in agriculture!

Farming with Pollinators

What you will need:

- "Pollinator Management Plan" worksheet
- Crop description sheet
- Georgia ecoregions map
- Georgia growing zones map
- Farm location map
- "Pollinator Syndromes" chart
- "Guide to Propagation and Characteristics of Favorite Georgia Natives: Part I—Thirty Perennials for Pollinators" by Heather Alley with UGA
- Farming with Pollinators PowerPoint
- Folder for materials (optional)
- Pencil
- Ruler (optional)

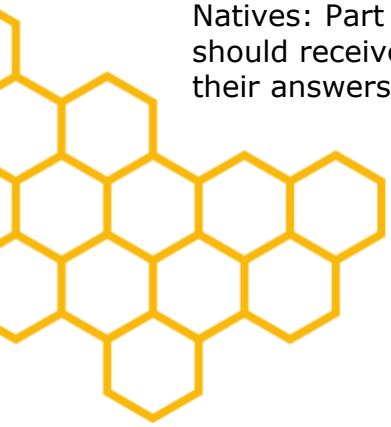
Divide students into groups. There are **six** different farms provided, but you can have multiple groups have the same farm to keep the groups smaller if preferred. Students will work together to create a pollinator management plan for their particular farm. They will fill out the provided "Pollinator Management Plan" chart. A **management plan** is used to help landowners and conservationists assess methods for improving the health of productive and natural lands. Students will use provided materials to assess the current soil conditions and potential climate patterns on their farm. Students will also assess the possible pollinators they currently have on their farm based on the provided information on their crop (i.e. bloom time, bloom color).

After assessing current farm conditions, students will then select up to 10 pollinator plants they can add to their farm. Students will use the "Guide to Propagation and Characteristics of Favorite Georgia Natives: Part I—Thirty Perennials for Pollinators" by Heather Alley with UGA to select their plants. Students will go through the guide and select plants that grow well in their farm's soil and climate conditions. However, students must think critically because in order to create a successful management plan, students need to create food for pollinators during their active seasons. Students will need to select **three plants that bloom in spring, three that bloom in summer, and three that bloom in fall**, while simultaneously ensuring these plants can grow in their farm's soil and climate.

The provided plant guide may list pollinators that the students can include on their chart when tasked with describing potential pollinators for their new plants, but if the plant they select does not, then they may refer to the "Pollinator Syndromes" sheet and select generic pollinator groups based on the flower preferences of that group (i.e. if a student selects a purple flower to add to their farm, then they would

select whichever pollinators like purple flowers: butterflies, flies, and moths (bats do not pollinate in Georgia)).
This is a rather large activity and can take quite a bit of time. Teachers can select to have all students work with the same crop as a class to make the beginning stages easier and more efficient. All of the materials needed for this activity, including a PowerPoint presentation can be found at www.gacd.us/pollinators. The materials can be shared with students for access on school laptops or tablets, or hard copies can be printed out.

We advise printing out a class set (six folders that contain the necessary materials). Each folder should contain a crop description sheet, a Georgia ecoregions map, a Georgia growing zones map, a farm location map, the "Pollinator Syndromes" chart, and a copy of a "Guide to Propagation and Characteristics of Favorite Georgia Natives: Part I—Thirty Perennials for Pollinators" by Heather Alley. All students should receive a copy of the "Pollinator Management Plan" worksheet to record their answers.



Follow-Up Questions and Discussion

Have students discuss pollinator habitat. What are the components of pollinator habitat? How are humans changing pollinator habitat?

What is the role of pollinators in agriculture?

Describe at least two ways to improve pollinator habitat on a farm.

Why does the type of a soil on a farm matter when considering pollinators?

Why do our farms need flowers that bloom in spring, summer, and fall?

Pollinator Management Plan

In Georgia, we have a wide variety of pollinators! We have a variety of moths, butterflies, beetles, flies, bees, and wasps, all of which assist in pollination! The beautiful wildflowers we see on roadsides or the flowers in our neighbors' gardens aren't the only plants that need pollinators for pollination. Many of our crops in Georgia depend on pollinators.

We all know bees are excellent pollinators. In our state, we have bumblebees, honeybees, ground-nesting bees, leaf cutter bees, and mason bees. The honeybees we see are not native to Georgia, but our smaller bees like our ground-nesting bees and mason bees, are native species. Many of our beloved crops depend on our small, native bees, such as "apples, cherries, squash, watermelon, blueberries…and tomatoes" (Mader et al. 2011). It is important that we create spaces for pollinators on our agricultural landscapes, not just for the pollinators themselves but for us as well!

Farm Assessment	
Farm Ecoregion:	
Farm Growing/Hardiness Zone:	
Soil Composition:	
Average Farm pH:	
Highly Eroded Soils:	Yes No
Size of Eroded Space (acres):	
Flooded Soils:	Yes No
Size of Flooded Space (acres):	

Use Farm Locations Map, Georgia Ecoregions Map, Georgia Growing Zones Maps, Soil Map, and Soil Health (pH) Map to fill in this information about your farm. Information regarding your farms ecoregion and growing zone will help you understand the climate in your farm's area. Understanding the climate, combined with information on soil health, will help you understand which plants will grow well on your farm.

Primary Crop:	
Crop Bloom Color:	
Crop Bloom Time:	
Potential Pollinators for Crop:	1.
	2.
	3.

Use your crop sheet to assess which pollinators might already be coming to your farm based on the crop that you grow. It is important to provide plants that grow well in your farm's conditions AND that provide food for pre-existing pollinators.

Pollinator Management Plan

Please refer to the "Guide to Propagation and Characteristics of Favorite Georgia Natives: Part I-Thirty Perennials for Pollinators" by Heather Alley and the University of Georgia (UGA). Pick **up to 10 pollinator plants** that can be integrated on your farm to increase pollinator spaces. You will need at least **three spring bloomers, three summer bloomers, and three fall bloomers**. The guide will not have all of this information for every plant, so please fill out the chart to the best of your ability with the information provided within the guide.

	Plant Common Name	Plant Scientific Name	Growing Zone/ Ecoregion	Soil Preference (sandy, loamy, clay)	Soil moisture preference	Soil pH Preference	Bloom Time	Bloom Color	Potential Pollinators
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Pollinator Syndromes

"Pollinator Syndromes" describe flower characteristics, or traits, that may appeal to a particular type of pollinator. Such characteristics can be used to predict the type of pollinator that will aid the flower in successful reproduction. A combination of color, odor, quantity of nectar, location and type of pollen, and flower structure can each affect a potential pollinator's ability to locate a flower and its food resources.

	Type of Pollinator							
Trait	**Bat**	**Bee**	**Beetle**	**Bird**	**Butterfly**	**Fly**	**Moth**	***Wind***
Color	White, green or purple	Bright white, yellow, blue, or UV	White or green	Scarlet, orange, red or white	Bright red and purple	Pale,or dark brown, purple	Pale red, purple, pink or white	Pale green, brown, or colorless
Nectar guides	None	Present	None	None	Present	None	None	None
Odor	Strong and musty; emitted at night	Fresh, mild, pleasant	None to strongly fruity or foul	None	Faint but fresh	Putrid	Strong sweet; emitted at night	None
Nectar	Abundant; somewhat hidden	Usually present	Sometimes present	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden	None
Pollen	Ample	Limited; often sticky, scented	Ample	Limited	Limited	Limited	Limited	Abundant; small, smooth
Flower Shape	Bowl shaped; closed during day	Shallow; with landing platform; tubular	Large and bowl-shaped	Large, funnel -like; strong perch support	Narrow tube with spur; wide landing pad	Shallow; funnel-like or complex with trap	Regular; tubular without a lip	Regular and small
								

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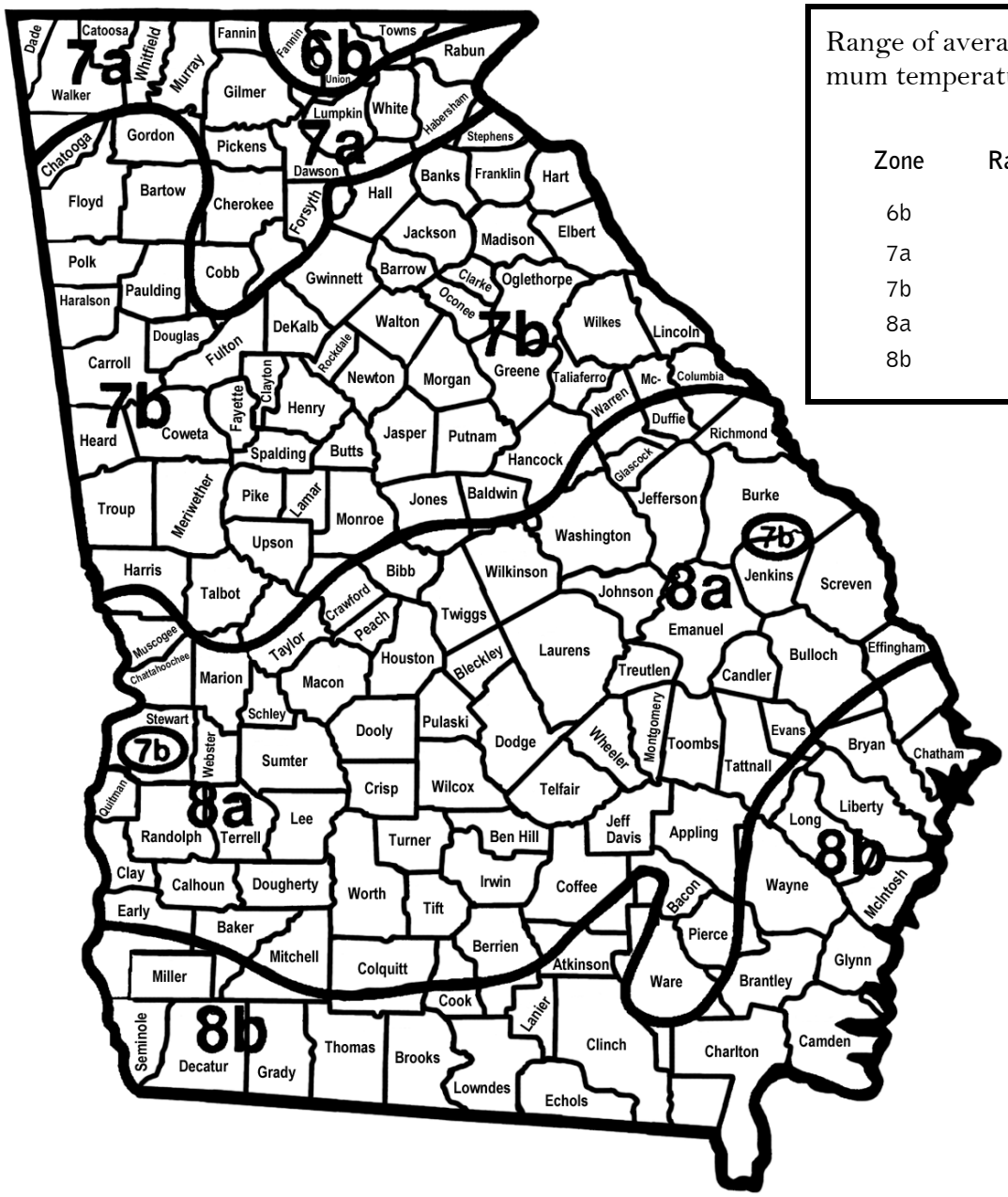
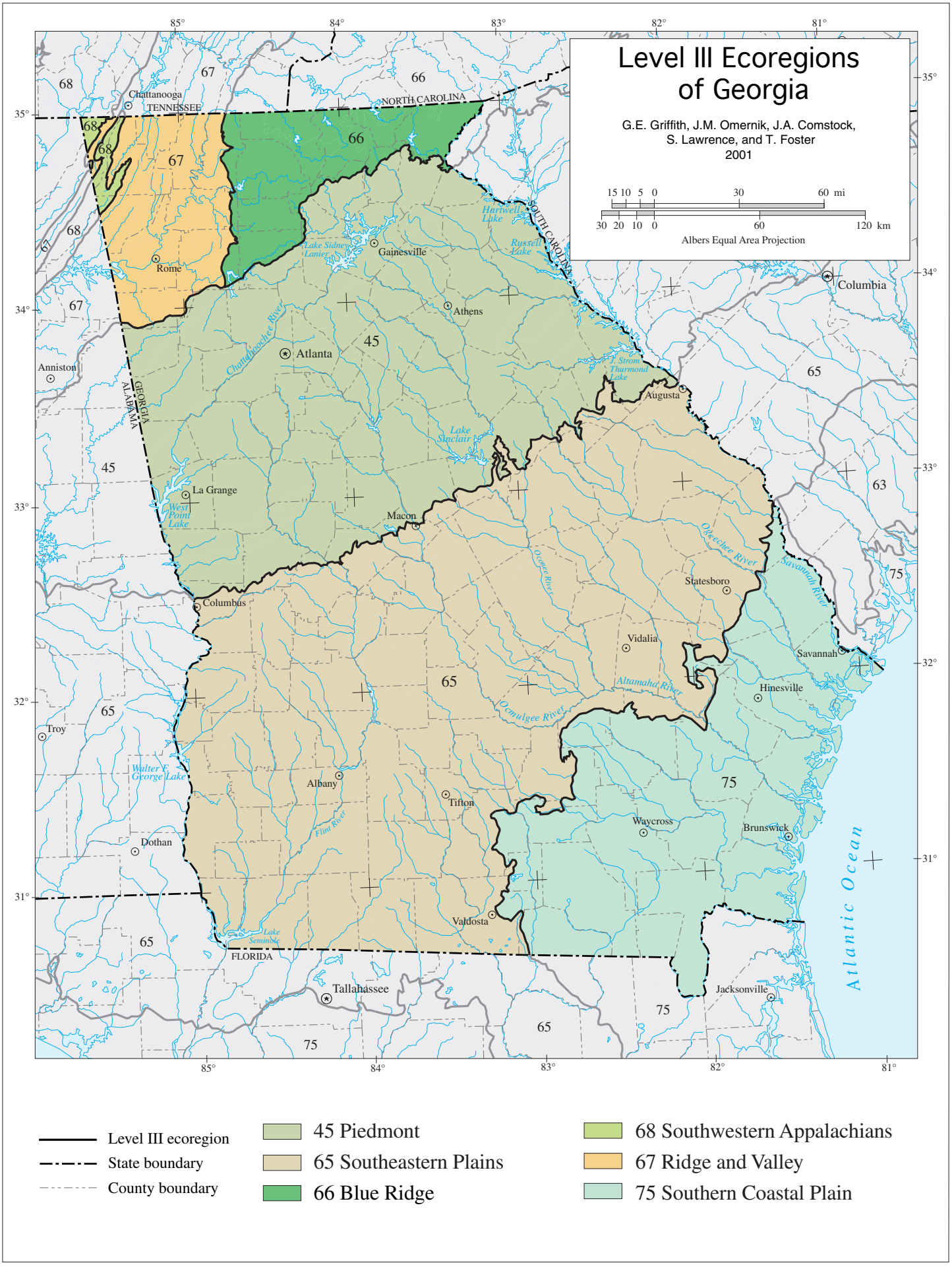
WWW.POLLINATOR.ORG

Georgia Plant Hardiness Zones



Range of average annual minimum temperatures for each zone

Zone	Range in degrees F
6b	-5 to 0
7a	0 to 5
7b	5 to 10
8a	10 to 15
8b	15 to 20


Level III Ecoregions of Georgia
G.E. Griffith, J.M. Omernik, J.A. Comstock, S. Lawrence, and T. Foster
2001
15 10 5 0 30 60 mi
30 20 10 0 60 120 km
Albers Equal Area Projection
Chattanooga
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
Rome
Gainesville
Athens
Atlanta
Columbia
Augusta
Anniston
GEORGIA
ALABAMA
La Grange
Macon
Columbus
Statesboro
Vidalia
Savannah
Hinesville
Troy
Albany
Tifton
Waycross
Brunswick
Dothan
Valdosta
FLORIDA
Tallahassee
Jacksonville
Atlantic Ocean
Hartwell Lake
Russell Lake
Lake Sidney Lanier
Chattahoochee River
Strom Thurmond Lake
Lake Sinclair
West Point Lake
Ocmulgee River
Ocmulgee River
Oconee River
Altamaha River
Savannah River
Walter F. George Lake
Flint River
Lake Seminole
85°
84°
83°
82°
81°
35°
34°
33°
32°
31°
Level III ecoregion
State boundary
County boundary
45 Piedmont
65 Southeastern Plains
66 Blue Ridge
68 Southwestern Appalachians
67 Ridge and Valley
75 Southern Coastal Plain