Opportunities and Threats at the Fullerton Arboretum

Summary of Activity: Investigate different implementations of key plant features in plants from different climate settings. Assess plant features in terms of rewarding services; to enhance exploitation of opportunities or reduce the exposure to threats. Properly apply the terms, "climate" and "evolutionary adaptation." Develop general theoretical understandings about plant features in different environmental settings.

Skills to be Developed

1. Knowledgebase. Develop and enhance student understandings of the concepts of climate and evolutionary adaptation.
2. Empirical science. Students observe and accurately sketch different implementations of selected plant features.
3. Situational awareness. Students consider plant features in the context of ongoing plant operations and prevailing environmental conditions.
4. Synthesis. Students are challenged to apply inductive logic to predict the utility of unfamiliar implementations of plant features in different climate settings.

What Students will Turn In for Credit: 1) This packet with sketches and accompanying explanations; and 2) Quiz.

Opportunity: A favorable or advantageous circumstance or combination of circumstances.

Threat: An indication of imminent harm, danger, or pain

Individual living things maintain the living state by:

1.   Exploiting opportunities in their surrounding environment, thereby receiving rewards.

2.   Avoiding threats in their surrounding environment, thereby reducing stress.

For example, when you get hungry (stress), you may seek opportunities in your surrounding environment to relieve that stress – and avoid the threat of diminished performance. If the sandwich shop is across a busy street, you must cross the street in order to exploit sandwiches there and receive a rewarding result. But passing cars pose a threat to you. If you get hit by a car while crossing the street, the resulting stress could overwhelm your body's ability to maintain the living state. Opportunities often come with a price. Success happens when opportunities can be exploited while minimizing exposure to or impact from surrounding threats.

Plants and, generally, all living things are able to maintain the living state in their particular environments because they are able to exploit opportunities and avoid / reduce threats in their surroundings. Living things achieve this by bringing their inherited traits to bear on their surroundings.

But as there are many different kinds of natural environments, each with its own mix of opportunities and threats, there is no single mix of traits that is optimal in all environments. As a result, we see specialized features that seem to be consistent with their surroundings. For example, light colored leaves in hot arid climates help reduce heat uptake, reducing water loss. Large surface roots in the tropical rain forest quickly gather nutrients yielded by decomposing leaves. Biologists have noticed these specializations and have a word for them – "adaptations."

Adaptations

An adaptation is a trait that meets the two following conditions: 1) it maintains or increases the fitness of an individual (to live long enough to achieve sexual maturity, and then to successfully contribute toward reproduction); and 2) it is the result of many generations of evolution by natural selection. The second condition often is assumed by naturalists in their haste explain everything. Establishing the actual evolutionary history of a given trait CAN be done, but it is a laborious, difficult and time-consuming process. Nonetheless, as is the tradition in field biology, "rewarding features" that we can observe in the

field today often are referred to as "adaptations." We carry on that tradition, but with the understanding that we use the expression, "adaptation" in a casual sense.

An adaptation is label that we apply to a feature ALWAYS in the context of its surrounding environment. In this exercise, we will characterize the surrounding environment in terms of climate.

Climate
A description of the weather patterns for a region throughout the year – often expressed in terms of temperature, rainfall and day length.
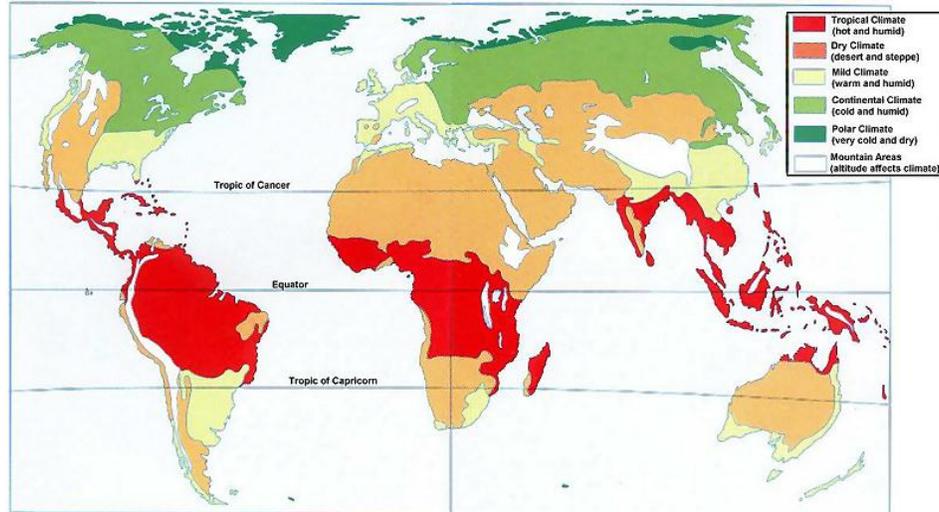
World Climate Zones

	Climate of the **Chaparral** Ecosystem	Climate of the **Desert** Ecosystem	Climate of the **Tropical Rain Forest** Ecosystem	Climate of the **Coast Redwoods** Ecosystem
Seasons	WSSF	WSSF	Rainy / Not-so-rainy	WSSF
Seasonal Temperature Pattern	Cool winter. Warm spring and fall. Hot summer.	Cool to cold winter. Warm spring and fall. Very hot summer.	Hot all year long	Cool to cold winter. Chilly spring and fall. Cool summer.
Seasonal Sunlight Pattern	Long day length in summer. Short day length in winter.	Long day length in summer. Short day length in winter.	Bright and sunny all year long.	Long day length in summer. Short day length in winter.
Annual Rainfall	14 inches	7 inches	Over 100 inches	40 inches to 100 inches
Seasonal Rainfall Pattern	Rain mostly between October to April. Drought the remainder of the year.	Rain mostly between October to April. Drought the remainder of the year.	All year. Some months more than others.	Rain mostly between October to April. Low rainfall in other months.
Most Stressful Circumstances	End of summer – drying out. Fire.	End of summer – drying out.	Shortage of soil nutrients. Shortage of growing space due to crowding. Shortage of solar access.	Low rain during summer. Drying, high elevation atmosphere. Fire.
Special Opportunities	Real estate made available because of reduced competition from less hardy trees.	Real estate made available because of reduced competition from less hardy trees.	Warm, rainy, sunny weather all year round.	Mild temperatures and abundant seasonal rain.

Climate of Chaparral Ecosystem – Cool mild winters with about 14 inches of rain, followed by hot summers and long periods of drought. Cool moist in winter, hot and dry in summer.
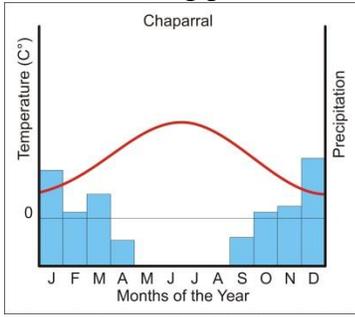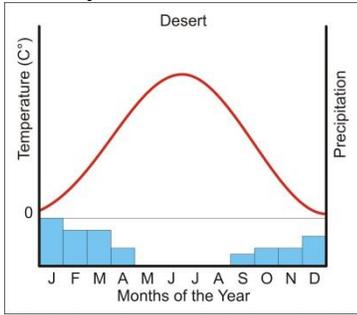

Source: Tom Morris

Source: Wikimedia Commons

Source: Wikimedia Commons

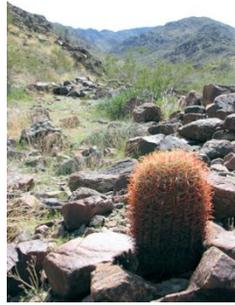|	Rewarding Plant Features	Why are they rewarding? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to threats?
Chaparral	Low, ground covering growth pattern.	
	Small leaves	
	Vertically oriented leaves	
	Light colored leaves	
	Spine-tipped leaves	

Sketches of Rewarding Plant Features (pick two examples of the above features and sketch them)

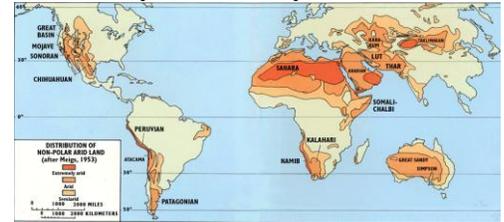| Chaparral Feature	Chaparral Feature
How it works	How it works

Climate of Desert Ecosystem – Cool, sometimes cold winters with about 7 inches of rain, followed by extremely hot summers and long periods of drought. Cool moist in winter, very hot and dry in summer.
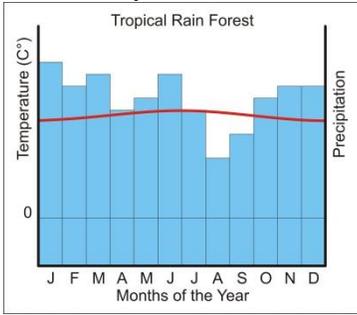

Source: Tom Morris

Source: Tom Morris

Source: USGS.

	Rewarding Plant Features	Why are they rewarding? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to threats?
Desert	Tall, vertical growth pattern	
	Photosynthesis in stems	
	No leaves	
	Water storage in modified stems	
	Clusters of dangerous spines on stems	

Sketches of Rewarding Plant Features (pick two examples of the above features and sketch them)

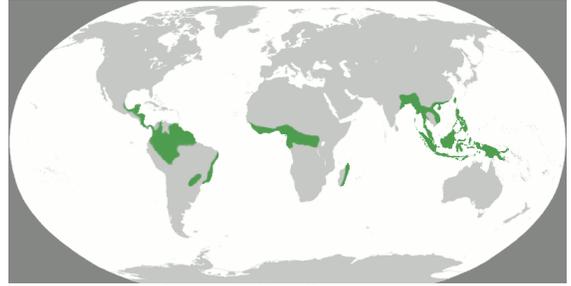| Desert Feature	Desert Feature
How it works	How it works

Climate of Tropical Rain Forest Ecosystem – Hot and rainy throughout the year. Rain every month of the year, up to 100 inches per year. Summer-like conditions all year long. No winter-spring-summer-fall seasonal cycle.

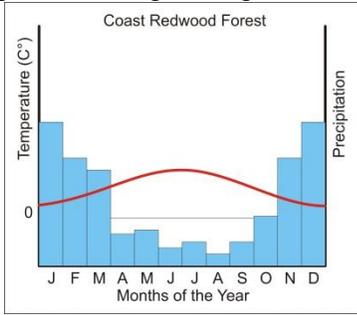Source: Tom Morris

Source: Microsoft clipart

Source: Wikimedia commons

	Rewarding Plant Features	**Why are they rewarding? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to threats?**
Tropical Rain Forest	Large, shallow roots	
	Large leaves	
	Tall, and very large growth	
	Umbrella-like canopy top	
	Epiphytic lifestyle	

Sketches of Rewarding Plant Features (pick two examples of the above features and sketch them)

Tropical Rain Forest Feature	Tropical Rain Forest Feature
How it works	How it works

Coast Redwood Forest Climate – Cool to cold winters, cool to warm summers. Rains mostly between October and April; little rain in summer months. At least 40 inches of precipitation per year. Frequent exposure to fog throughout the year.

Source: Tom Morris

Source: Wikimedia Commons

Source: USGS

	Rewarding Plant Features	Why are they rewarding? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to threats?
Coast Redwood Forest	Tall – up to 100 feet tall.	
	Conical hair brush growth pattern	
	Abundant needle-shaped "leaves"	
	Thick, spongy bark	

Sketches of Rewarding Plant Features (pick two examples of the above features and sketch them)

Coast Redwood Forest Feature	Coast Redwood Forest Feature
How it works	How it works