CAMPUS AS A LIVING LAB LEARNING MODULE

MODULE TITLE: “Water-wise” Adaptations of California Chaparral Plants
(prepared by Lisa Schultheis)

CAMPUS: Foothill, Native Hill Garden

MODULE BACKGROUND

The Campus as a Living Lab Project

San Jose State University, Foothill College and De Anza College have collaborated on a project to infuse sustainability throughout the curriculum at our institutions. This project, called the Campus as a Living Lab, is funded by the California State University Chancellor's Office. The Campus as a Living Lab program is focused on using physical sustainability features on our campuses to promote sustainability through hands-on learning activities. For our collaboration, each campus developed a series of one-session teaching modules (approximately 1-3 hours each) that faculty members can use to incorporate sustainability into their courses. Each module focuses on a physical feature at SJSU, De Anza or Foothill. All modules are designed to address specific GE area student learning objectives and provide students with an active learning experience.

General sustainability definition and principles.

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." (Bruntland 1987)

By definition, this requires citizens who wish to act sustainably to engage in actions that are ecologically sound, economically feasible, and socially responsible.

Specific sustainability principles that apply to this feature.

The Native Hill at Foothill College is an example of the interaction and perseverance of natural species within a man-made environment. The garden is planted as an example of how the landscape would have looked before changes introduced by humans. That garden can be used to demonstrate the impacts of humans on flora, fauna and natural systems.
Discussion of how this feature helps promote a sustainable society.

Using the Native Garden at Foothill College for observation, research and study, students can obtain a better understanding of how local plant and animal life evolved to survive the climatic conditions of the bay area. Armed with a better understanding of the characteristics of flora and fauna with limited influence of humans, students can observe changes in the natural systems that occur due to large scale environmental influences such as climate change, pollution and urbanization. This understanding will also help students better appreciate the conditions (such as diversity, water consumption, natural succession) that are required to maintain ecosystem health.

Key Concepts presented in this module.

An important component of sustainability is an understanding and appreciation of the environment and the natural resources it provides, which includes an understanding of local biodiversity found in natural communities. Students are introduced to common chaparral plants present in the Foothill College Native Plant Garden. Through a combination of lecture, direct observations, small group and class discussions, students learn about features characterizing chaparral communities and adaptations typical of chaparral plants, particularly adaptations associated with water conservation. The activity focuses on evolutionary processes and biodiversity as a component of sustainability, and considers the merits of using native species in sustainable landscaping with an emphasis on water-wise plantings.

- Discuss the concept of sustainability (social equity, economic vitality, environmental integrity)
- Define biodiversity.
- Explain how the evolutionary process of natural selection generates biodiversity.
- Recognize and identify the chaparral community and representative plants.
- Discuss the potential merits of landscaping with native plants
- Contrast regions of campus with native, water-wise plantings to those with water-intensive lawn plantings

Description of activities used in this module.

Students will receive instruction in the concept of natural selection and the relationship with the environment. Species will be observed and monitored to analyze that interaction.

Activities will include:

- reviewing the concepts of sustainability, biodiversity, and natural selection/plant evolution
- discussing the Mediterranean climate and plant adaptions
- observing characteristics of flora in a garden with plants adapted to this climate
- sharing observations and discussing applications of findings to existing landscapes that are not adapted to this climate without significant input of resources
Connecting the feature’s elements to GE course principles.

This component would relate, but not specifically connect to, GE course principles of the following Natural Science area criteria:

Foothill College Area III Natural Sciences
   N5. The practice of thinking critically, including evaluating ideas and contrasting opinions
   N6. The ability to evaluate, use and communicate scientific data
   N12. An understanding of the interdependence of humans and their environment
   N13. A recognition of how human behavior has altered the environment.
   NL15. Observation and collection of data through direct interaction with the material world

Student Learning Outcomes for this module.
This module relates to the following Student Learning Outcome associated with Biology 1C at Foothill College (“Evolution, Systematics and Ecology”):

“Students will explain natural selection of populations under different selective pressures.”

MODULE GENERAL INFORMATION

Materials required to complete the activities.
   • Access to the California Native Plant Garden (Foothill College)
   • Access to lawn areas on campus (optional)
   • Student worksheet
   • Sample pictures of focal plants (presented as a powerpoint in advance, or in a handout that you can print from the powerpoint)
   • Garden map

Applicable disciplines.
This module would be appropriate in current form for Biology, Environmental Science, Horticulture and Life Science disciplines.

Time required for delivery: Approximately 2 hours.

Recommended student load: 25 to 30 students

Delivery location.
This module can be delivered completely within the Native Garden, or can be completed using a Foothill classroom for lecture components and the Native Garden for field activities. Native Hill is located on
the west side of the Foothill Campus within the loop road. Parking would be by permit ($3/day for visitors) in lot 5. The facility is open during daylight hours and early evening hours every day.

Campus contacts for module.

Access to the Native Garden is free and does not need to be scheduled. Access to a Foothill classroom would need to be arranged at least 1 week in advance by contacting:

-Lisa Schultheis, instructor, schltheislisa@fhda.edu  650-949-7780

Instructor preparation for module.

To prepare for delivering this module, it is recommended that the instructor consider the following activities:

- tour the Native Garden at Foothill to familiarize yourself with the layout of the garden and the location of plant species to be studied in the module.
- examine photos of the various plants at CalPhotos, maintained by the Regents of the University of California, Berkeley. This collection of photos is searchable by plant genus or species name. It is available online at http://calphotos.berkeley.edu/.

If desired, any questions can be answered by Lisa Schultheis (650-949-7780).

Educational resources and textbooks.

http://www.cnps.org/cnps/grownative/benefits.php

Water-wise plants:
http://www.mastergardeners.org/plant-dictionary
http://www.valleywater.org/Programs/Water-WisePlants.aspx
http://www.sanjose.watersavingplants.com/
MODULE LECTURE NOTES AND CLASS LESSON PLAN

Definitions.
The following definitions are provided to help clarify material in the module. The definitions are from Reece et al. (2010) and Reece et al. (2015), two commonly used biology textbooks, and are similar to definitions you would find in other textbooks:

biodiversity = the variety of living things; includes genetic diversity, species diversity, and ecosystem diversity

biome = any of the world’s major ecosystem types, often classified according to the predominant vegetation for terrestrial biomes and the physical environment for aquatic biomes and characterized by adaptation of organisms to that particular environment.

taxon (plural, taxa) = a named taxonomic unit at any given level of classification

taxonomy = a scientific discipline concerned with naming and classifying the diverse forms of life.

homologous structures = structures in different species that are similar because of common ancestry.

analogous structures = having structures that are similar because of convergent evolution, not homology

Lesson:
This lesson involves in-the-field interactions with living plant material and collection of qualitative data based on in-the-field observations. Either during lab or in preceding lectures, students should have exposure to the following concepts through lecture or other type of presentation:

Sustainability
Suggestion: ask what students think this term means and write their ideas on a display (in class or on a portable white board); if not captured in their responses, explain that sustainability includes social equity, economic vitality, environmental integrity and their intersections.

Biodiversity
Suggestion: ask what students think this term means and write responses on a display (in class or on a portable white board); ensure they understand it includes several levels of biology (genetic, species, and landscape diversity)

Natural selection as a primary mechanism of evolutionary change.
The extent of coverage depends on the specific class. At a minimum, students should understand that evolution acts on existing variation in a population, and that adaptations are features that increase fitness (chances of surviving and reproducing) in a given set of environmental conditions.

Characteristics of a Mediterranean climate.
Ask students to contrast summer and winter in our region; ensure students know that a Mediterranean climate is characterized by mild, wet winters and warm, dry summers (also found in the Mediterranean, central Chile, southern Africa and western Australia)
Selective pressures associated with a Mediterranean climate that impact plant species. The primary factors to emphasize for this exercise are the warm, dry summer periods. Features of the chaparral biome (alternatively, you can cover this after students have gathered their own observations from the garden) characterized by dense growth of shrubby plants with adaptations to withstand hot, dry summers. Chaparral plants also typically have adaptations allowing recovery from fire.

While in the garden, students work in small groups (of 3-4) to find and identify selected species. Students should record observations of above-ground morphological features that the representative specimens share (see MODULE LAB ACTIVITIES and MODULE LAB WORKSHEET below), and hypothesize how these features are adaptations to Mediterranean climate conditions. The following chaparral taxa are present in the garden: Arctostaphylos, Ceanothus, Cercocarpus, Heteromeles, Rhamnus, Rhus, Salvia mellifera. In addition the garden contains Artemisia and Baccharis which are more characteristic of coastal scrub but are frequently found in chaparral. Each group of students can be assigned a different subset of plants to examine.

Depending on the class and the extent to which evolution has been covered, students can compare multiple species within one genus (e.g. Arctostaphylos) and use specific examples from the garden to illustrate homologous versus analogous features.

After finding their assigned plants and gathering observations, students are expected to report back to the class with a brief oral description of their findings.

Students will then participate in a brainstorming session on benefits of landscaping with native plants and how this contributes to sustainability. This can occur following an optional excursion to central areas of campus that are planted with water-intensive lawns.

MODULE LAB ACTIVITIES

Recommendations for garden logistics

Students groups should be spread throughout the garden to minimize crowding. I recommend the following locations for groups to work, with reference to the garden map provided with this module. Each location could reasonably accommodate two groups with 3-4 students per group. I provided a list of accessible plants with each location, from which you could assign each group 3-4 plant taxa. Please emphasize with students that they should not remove material from the plants or damage the plants.

Area “1”, along the pedestrian sidewalk.
   Arctostaphylos
   Artemisia
   Baccharis
   Ceanothus


Heteromeles
Salvia mellifera
Area “2”, path within garden.
Arctostaphylos
Baccharis
Cercocarpus
Heteromeles
Rhus

Area “3”, within garden
Artemisia
Arctostaphylos
Baccharis
Ceanothus
Cercocarpus
Heteromeles

Area “4”, including plants along the edge of the parking lot.
Arctostaphylos
Baccharis
Ceanothus
Rhamnus

On the MODULE LAB WORKSHEET, students should record observations of above-ground morphological features that the representative specimens share, and hypothesize how these features are adaptations to Mediterranean climate conditions. The following chaparral taxa are present in the garden: Arctostaphylos, Ceanothus, Cercocarpus, Heteromeles, Rhamnus, Rhus, Salvia mellifera. In addition the garden contains Artemisia and Baccharis which are more characteristic of coastal scrub but are frequently found in chaparral. Each group of students can be assigned a different subset of plants to examine.
MODULE EVALUATION AND SUPPORT

Methods of evaluation.

1. Completion of a worksheet which includes sketches of representative leaves, written descriptions of the plant’s features, how they propose selected features are adaptive, and other general observations of the garden.

2. Brief oral presentation to the class (while in the garden)

3. Final reflection on potential benefits of native water-wise plants in landscaping, and how this relates to sustainability.

Suggested answers to worksheet questions.

Students should have observed and described:
- Plants are shrubby
- Thick waxy cuticle (cuticle refers to the waxy coating on leaves)
- Leaves often hard (sclerophyllous)
- Relatively small leaves
- Vertical orientation of leaves

Features associated with specific plants. I can provide a powerpoint containing images of plants with notes on relevant features upon request.

Potential benefits of gardening with natives include providing habitat and resources for wildlife, less water use if choosing water-wise natives, potentially less maintenance, and less use of fertilizers and pesticides. In our garden we have numerous bees, butterflies, birds (including quail), squirrels, rabbits, and lizards that students might observe while visiting.

ALTERNATIVE APPLICATION OF THIS MODULE

Because this activity focuses on making close observations of the natural world, it might also be attractive to visual arts classes (drawing, photography) by providing a theme (water conserving adaptations of native plants) around which a portfolio could be developed.
MODULE LAB WORKSHEET

NAMES: _________________________________   _________________________________

You will be assigned four species to find within the garden. For each species, record your observations and descriptions below. In approximately 40 minutes the class will reconvene. Be prepared to show and/or describe your assigned species to the class, and to describe how the features you observed might be adaptive for the hot, dry summers characteristic of our region. Each person in your group must present one plant to the rest of the class.

On the attached sheet there are four boxes, one per plant. In each box, sketch a representative leaf, to scale. Describe the features of the plant. Include growth form (e.g. herbaceous, woody groundcover, shrub, tree), features of the leaves (size, shape, texture, orientation) and other features you observe.

Please answer the following questions in the spaces provided.

1. What features did the four plants have in common?

2. Pick at least two features and describe how each feature might be an adaptation that helps the plant survive our hot, dry summers.
3. Record other observations of the garden. For example, do you see any evidence of animal life? If so, describe what you observed. Do you see any evidence of human impacts (besides the fact the garden is planted)? If yes, describe your observations.

4. In terms of sustainability, what benefits might there be to gardening with native plants?

5. Consider the large lawn areas in the central campus. Offer ideas (be creative!) for designing a more sustainable landscaped area that is aesthetically pleasing yet accommodates foot traffic, seating, and other needs of the campus community.
<table>
<thead>
<tr>
<th>Plant 1: ______________________________</th>
<th>Plant 2: ______________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant 3: ______________________________</td>
<td>Plant 4: ______________________________</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Foothill College California Native Plant Garden.