



The National Park Service wishes to thank Toyota USA Foundation for donating one million dollars to make National Park Labs possible at Golden Gate National Recreation Area and four other parks across the country.

We also wish to acknowledge the important role played by the National Park Foundation in working with Toyota USA Foundation to establish and guide this generous grant.

National Park Labs is a program of the National Park Service, National Park Foundation, and Toyota USA Foundation. This multi-year program is the first of its kind to provide high school students with experiences that will enhance the quality of science and mathematics and foster stewardship of national park resources. Five national park sites were competitively selected to participate in this exciting endeavor. The other NPL sites are Carlsbad Caverns National Park (NM) and Guadalupe Mountains National Park (TX), Lowell National Historical Park (MA), National Capital Region Parks (DC), and Santa Monica Mountains National Recreation Area (CA).



Overview

National Park Labs at Milagra Ridge (NPL) is a hands-on education program that engages high school students in a project-based science curriculum. This Educator's Handbook has been prepared for the classroom teachers and the Site Stewardship Program (Golden Gate National Parks Association-GGNPA) and National Park Service (NPS) staff who together make up the National Park Labs education team. It contains the background information, lesson plans, and handouts for the modules that comprise the program.

National Park Labs is linked to the Environmental Studies Course and Science I Core Course at Oceana High School, as well as science courses at other Jefferson Union School District high schools. The program includes a classroom-based introductory module, five field-based modules, and a culminating activity. The five field-based modules are scheduled to coincide with the seasonal work of the park's restoration team.

Perspectives provides the students with an opportunity to get acquainted with the National Park Labs web site, the restoration cycle, and the process of formulating study questions. A word puzzle helps students become familiar with vocabulary that will be used throughout the program. A classroom lesson facilitated by NPS staff gives students a brief history of Milagra Ridge, engages them in a discussion about the mission of the National Park Service, and creates a context for learning about Environmental Justice. After the Park Service visit, students create a list of Top Ten Environmental Rights and share a vision of what is and what should be in a national park.

Plant Propagation revolves around genetic diversity and plant reproduction. After playing a board game that introduces the concept of genetic diversity, students visit one of the park's native plant nurseries to help with propagation and other nursery functions. In a classroom experiment, students sprout seeds, introduce variable soil conditions, and then monitor the effects of these conditions on the seedlings. Students review the concepts with *The Private Life of Plants*, a video illustrating the complex interactions between plants, animals and the abiotic elements of the environment.

Invasive Plant Removal focuses on interdependence in nature. This module begins with several National Park Labs web site-based lessons that feature Web Quest, an interactive investigation of the Endangered Species Act. Students again access the web site to practice using a dichotomous key. During a field visit to the park, students remove invasive plants from a restoration site. The module concludes with a lesson in Environmental Justice and community planning.

Planting begins with a lesson that helps students understand plant structure and adaptation. During the Planting field visit, students study structure and function as they transplant indigenous plants into a restoration site. The field lesson concludes with a look at the importance of volunteers in achieving restoration goals. Back in the classroom, students research international restoration projects to understand the global nature of ecological restoration. They then use the National Park Labs on-line Plant Guide and other resources to create a multicultural quilt of plant uses.

Land Values introduces students to different perspectives on land use. A classroom lesson has students consider the history of and formulate questions about the Marin Headlands and Milagra Ridge Nike Missile Sites (Cold War Era). The field session takes students to the Marin Headlands to tour the Nike Missile Site and evaluate changes in the landscape. In a follow-up classroom lesson, they assess the differing values held by the military, National Park Service, and nearby communities.

Monitoring reemphasizes interdependence in nature. In preparation for the field session, students learn how to use a compass, digital camera, and record data. During the field visit, they perform quantitative and qualitative monitoring studies of Milagra Ridge. Students compare their qualitative monitoring to work done by previous classes. The module concludes with students drafting a proposal to the National Park Service with recommendations for applying monitoring to endangered species management.

A **Culminating Project** is chosen by the teacher and students to fit the needs of the class and allow students to apply what they learned during the program. Classes may choose to create exhibits describing some aspect of their restoration work and present these exhibits at a local restoration fair, or perform a restoration project in a local city park. Students may choose to research local issues, propose solutions, and take actions.

CURRICULUM ORGANIZATION

The modules in this curriculum are divided into pre-visit, on-site, and post-visit lessons. The first page of each module provides an overview of these lessons and summarizes the activities. The next pages contain background information on topics covered in the module. The lesson plans that follow include a summary, expected duration, materials list, facilitation procedures, and handouts when applicable.

Icon Key: Icons used in the lesson plans and summaries designate where the lessons take place and whether the teacher or NPS staff facilitate the lessons.

Location Icons:



Classroom



Park



Web-based

Facilitator Icons:



Teacher



NPS Staff

Glossary: At the end of the handbook we have included a Glossary of terms for all words that may be new to students or teachers.

AUTHENTIC ASSESSMENT

Students will keep a journal documenting their thoughts and questions during the program. These journals can be used to assess the students' understanding of important concepts and the evolution of their knowledge and attitudes. Each module includes integrated assessment activities. We encourage teachers to create a rubric based on these activities.

EDUCATIONAL STANDARDS

The National Park Labs curriculum focuses on science principles learned through authentic restoration activities in a national park. Students also practice applied math skills and examine issues in Environmental Justice that relate to the restoration work. The program is an excellent vehicle for helping students obtain important life skills necessary to find and keep employment, and effectively contribute to society.

The following sources were used to compile the educational standards for the program:

- ▶ **Science:** The science standards correlate directly to Jefferson Union School District's (JUSD) life science standards for grades 9 through 12. Specifically, the program teaches Science 1.3.4 – Analyze and explain examples of the interdependence of organisms in ecosystems, biochemical processes, the role of genetic inheritance, and the patterns and processes through which organisms and ecosystems change over time. The program also supports five other elements of the 1.3 science standards.
- ▶ **Math:** The math contained in the program supports JUHSD's Mathematics 1.2.1 and 1.2.2 – standards related to Algebra. Students all gain from using the applied math within the context of science.
- ▶ **Social Studies:** This program supports JUHSD's World History, Cultures and Geography and the United States History course studies of the Cold War Era. Students utilize historic landmarks within the GGNRA to analyze the local and national politics of the Cold War.
- ▶ **Environmental Justice:** The Environmental Justice aspects of the program meet national behavioral studies standards for grades 9 through 12. These standards are based on information from *Content Knowledge, A Compendium of Standards and Benchmarks for K-12 Education*. The Environmental Justice components are partially derived from *Principles of Environmental Justice* issued by the First National People of Color Environmental Leadership Summit, October 1991, Washington, D. C.
- ▶ **Life Skills:** The program incorporates standards for grades 9 through 12 from the National Life Skills section of *Content Knowledge, A Compendium of Standards and Benchmarks for K-12 Education*.

PROGRAM LOGISTICS

So that all students may participate in and enjoy their program days at Milagra Ridge, please take careful note of the following:

- ▶ **We must have one completed “Agreement for Sponsored Voluntary Services” form for each class** that participates in the program. We must also have a signed **“Parental Approval” form for each student**. We have provided master copies of these forms on the following pages of this handbook. Please note that park policy requires each individual/group in the program to complete these forms. **Those who do not complete the required forms will not be allowed to participate.** Groups complete and return these forms at the beginning of the school year, or before the first field session in which they will participate.
- ▶ Clothing appropriate to the nature of the activities and weather conditions at the Milagra Ridge is required. The following is a list of program-day considerations that need to be relayed to students so they are prepared and can have a positive learning experience.

Dress in layers to accommodate the variable temperatures characteristic of Milagra Ridge (clothing and footwear may get dirty).

On sunny days, a cap and sunscreen are needed.

If there is a chance of rain, bring personal rain gear if possible.

- ▶ Arrangements can be made to accommodate most students with special needs. Please call the NPS staff to discuss any specific circumstances.

Form No. 10-86
Rev. (9/99)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
VOLUNTEERS-IN-PARKS PROGRAM

Golden Gate National Recreation Area

Agreement for Sponsored Voluntary Services

NAME OF SPONSOR, ORGANIZATION, OR EVENT

ADDRESS (Street, city, state, zip code)

CONTACT PERSON (Liaison for day-to-day operations)

WORK TELEPHONE (Including area code)

HOME TELEPHONE (Including area code)

Brief description of work to be performed, including minimum time commitment required.

Do work to support native habitat restoration in outdoor restoration areas and the native plant nursery, including (but not limited to) transplanting seedlings, removing invasive species, sowing seeds, collecting seeds, filling flats and pots with soil, disposing of plant material and soil, cleaning up at the nursery and work sites, and moving plants, pots, flats, equipment and tables. Use tools including (but not limited to) picks, shovels, trowels, and shears.

We agree to obtain parental or guardian consent for each individual under 18 years of age and to comply with applicable child labor laws. We understand that the individuals volunteering under this agreement will not receive any compensation for the above work and that they will NOT be considered to be Federal employees for any purpose other than tort claims and injury compensation, and we understand that volunteer service is not creditable for leave accrual or any other employee benefits. We also understand that either the National Park Service, or we, may cancel this agreement at any time by notifying the other party. We agree to provide the National Park Service with a listing of active participants, and the number of hours each contributed, when and as requested.

Signature

Date

The National Park Service agrees, while this arrangement is in effect, to provide such materials, equipment and facilities that are available and needed to perform the work described above, and to consider you as a Federal employee only for the purpose of tort claims and compensation for work related injuries.

Signature of Park VIP Coordinator

Date

TERMINATION OF AGREEMENT

Agreement Terminated on

Month, Day, Year

Signature of Park VIP Coordinator

Form No. 10-89
(1/83)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
VOLUNTEERS-IN-PARKS PROGRAM

Golden Gate National Recreation Area

Parent Approval Form

NAME OF VOLUNTEER

PARENT OR GAURDIAN'S NAME

ADDRESS

PHONE: (Residence)

(Business)

I affirm that I am the parent/guardian of the above named volunteer. I understand that the National Park Service's Volunteers-In-Parks program does not provide compensation, except as otherwise provided by law, and that the service will not confer on the volunteer the status of a Federal employee. I have read the attached description of the work that the volunteer will perform.

I give my permission for _____ to participate in this program

sponsored by _____

(Name of sponsoring organization, if applicable)

at _____ from _____ to _____

(Name of park or office)

(Date)

(Date)

(Signature)

(Date)

Perspectives

SUMMARY OF INSTRUCTIONAL ACTIVITIES



📍 **Restoring Milagra Ridge & Question Formulation** - page 4

- 🕒 ▶ Students review Restoring Milagra Ridge on the National Park Labs web site: www.nps.gov/goga/parklabs
- ▶ Students work together to formulate questions about Milagra Ridge, Endangered Species Act, Golden Gate National Recreation Area, or other elements of the program.
- ▶ Students use a word puzzle and the National Park Labs web site Glossary to study vocabulary.

📍 **Perspectives** - page 11

- 🕒 ▶ Students are introduced to the restoration cycle.
- ▶ Students learn about concepts such as biological diversity, endangered species and land use.
- ▶ Students consider the role of the National Park Service by studying its mission statement.
- ▶ Students examine their pre-conceived ideas about environmentalists and what it means to be an environmentalist.

📍 **Top Ten Environmental Rights** - page 14

- 🕒 ▶ Students create their list of Top Ten Environmental Rights.
- ▶ Students compare their ideas about environmental rights with the ideas of others and with the National Park Service mission.
- ▶ Students think about what they might find in a national park that shows how the National Park Service fulfills its mission and supports Environmental Justice.

The Restoration Cycle

Restoring native plant habitats takes place on a yearly cycle. Timing is determined by factors such as weather, when plants bloom, and when they go to seed.

Plan

Planning plays a significant role throughout the habitat restoration cycle. Many factors must be considered before a plan can be developed and implemented.

Planners must address issues such as environmental impact, cultural and historical significance, recreational uses, long-term management costs, and volunteer and educational opportunities. Once a long-term plan has been drawn up, restorationists create short-term plans addressing the nuts and bolts of growing, caring for, and planting indigenous plants into a restoration site.

Remove

Before a restoration site can receive indigenous plants, invasive exotic plant species must be removed. Exotic plants are those occurring as a result of deliberate or accidental actions by humans. These plants can originate from many different countries; those from Mediterranean climates are particularly successful at establishing themselves in San Francisco.

Exotic plants were brought to the Bay Area for agriculture, livestock grazing, forestry, ornamental landscaping, and soil stabilization. Many exotic plants out-compete indigenous plants. This can result in a dramatic reduction of bio-diversity.

When and how exotic plants are removed varies depending on the characteristics and life cycle of each species. Some plants, such as mustard, are annuals and grow only during a brief period. It is important to remove mustard before it can go to seed. Perennial plants, such as ice plant, can be removed all year.

Plants are safely removed by using the best tool for the job. A weed wrench can leverage some pulling power to remove the deeply rooted scotch broom. A small hand pick helps to dig up pampas grass seedlings. But a polaski is used to remove the larger bushes. Sometimes the best tool for the job is a pair of strong hands. The relatively shallow roots of the iceplant allow it to easily separate from the soil.

Propagate

Plants indigenous to Golden Gate National Recreation Area (GGNRA) are not sold in local nurseries or seed catalogs. Therefore, the park staff propagate the plants needed for habitat restoration projects in the park's own native plant nurseries. These plants are used to revegetate a variety of plant communities within the park including sand dunes, riparian, coastal scrub, and many more.

Plant propagation is the multiplication of plants by either sexual or asexual methods. Sexual multiplication is carried out using seeds, while asexual multiplication is done with cutting, layering, division, or grafting. Propagules (seeds and cuttings) for revegetation are collected from the restoration site itself or from the surrounding areas, the closer to the site the better. It has been discovered that the genotype (genetic makeup) of plants can change within very short distances.

The time of year when seeds and cuttings are collected depends on the life cycle of each plant species. Generally, collection takes place between spring and fall. No more than 10 percent of the native seed base is collected. This allows the habitat to continue to build its own seed base.

Getting seeds to germinate in a nursery can sometimes be challenging. For example, in nature, small rodents eat lupine seeds. When the seed passes through the rodent's digestive system, the outer seed coat is scarified and redeposited on the ground with the animal's feces. This acts as a natural fertilizer. Natural processes such as this need to be mimicked in the nursery. To do so, nursery staff put seeds in a contraption that uses sandpaper to scarify the seed and then the seeds are planted in compost.

Plant

Revegetation means to provide an area with new plant cover. Once invasive exotic plants have been removed, appropriate indigenous species are planted to help the habitat recover.

Revegetating a vulnerable site both helps prevent a reinvasion of exotic species and rebuilds the native seed bank. Thus, the plant community reaches a state of resiliency more quickly and is able to provide habitat for other members of its ecosystem. Outplanting and direct seeding are the two methods of revegetation that are used at GGNRA.

Outplanting is the process of taking plants that have been raised in the nursery (which sometimes includes immature specimens) and planting them in the landscape. Direct seeding is the process of sowing seeds in the restoration site and letting

them germinate and develop naturally. Once in their natural habitats, native plants are essentially on their own. A strong root system, which allows a plant to access water and nutrients, is key to the plant's survival.

Revegetation takes place during the rainy season. Working in wet and/or muddy conditions may not be comfortable, but it significantly reduces the mortality rate of the seedlings and makes all the hard work in the nursery worthwhile.

Monitor

Monitoring is the collection and analysis of data at regular intervals over time. It is used to predict or detect natural and human-induced changes and to provide the basis for the appropriate management response.

The collection of baseline data on natural resources and the initiation of long-term monitoring programs are essential parts of the natural resource program. The GGNRA monitors approximately 2 percent of a restoration site. This low percentage is due to constraints in time and the number of people available to do the work. Monitoring methods are employed to generate qualitative and quantitative data. Qualitative data is gathered using photomonitoring, and quantitative data is gathered by conducting vegetative transects. Monitoring data is used to revise both long-term and short-term plans, completing the restoration cycle.

Restoring Milagra Ridge & Question Formulation

SUMMARY

Students read Restoring Milagra Ridge using the National Park Labs web site and answer journal questions. Students become acquainted with vocabulary as they use the web site (or the Glossary from this handbook) to complete a word puzzle. Students formulate questions that will help motivate their learning for the remainder of the program.

TIME

100 minutes

MATERIALS

- ▶ Computers with Internet access or copies of Restoring Milagra and copies of the Glossary (in the last section of this handbook)
- ▶ Vocabulary Word Puzzle
- ▶ Perspectives Worksheet #1

Lesson

Teacher explains to the class that the restoration project they will perform at Golden Gate National Recreation Area is a hands-on science project. Students need to know the human and natural history of Milagra Ridge, as well as the vocabulary of habitat restoration so that they can fully understand the issues involved in the project.

Teacher distributes Perspectives Worksheet #1. Students access the web site (or Milagra Ridge handout) and complete the worksheet.

Teacher distributes the Vocabulary Word Puzzle. Definitions to the hidden words are provided on the handout. To solve the word puzzle, students must access the National Park Labs web site, go to the Glossary, and look for the words that match the definitions. Students complete the word puzzle. The class discusses and clarifies any definitions that were difficult to understand.

Students brainstorm questions they have about the National Park Labs program, the National Park Service, the history of Milagra Ridge, the students' role in the program, etc.

Students enter these questions in Perspectives Worksheet #1. This is the first step in a questioning process that will continue throughout the program. The purpose of the questioning is not necessarily to find answers but rather to allow the questioning to evolve with deeper sophistication and understanding of the issues.

Restoring Milagra Ridge

Milagra Ridge, a 240-acre parcel of land that overlooks the town of Pacifica, California, is essentially an island ecosystem surrounded on all sides by development and unconnected with any other parcel of open space. Invasive plants, soil erosion, and soil compaction due to off-trail traffic challenge this delicate ecosystem in its efforts to sustain biological and genetic diversity. Once a part of the United States Army's coastal fortification system, Milagra Ridge was added to Golden Gate National Recreation Area (GGNRA) in 1987. Noting the rare and endangered species -including the Mission blue butterfly (*Icaricia OR Plebejus icarioides missionensis*) -found there, the National Park Service dedicated its efforts to the ridge's ecological restoration.

Milagra Ridge comprises the relatively flat ridge top; two hills on the southeast and northwest sides of the ridge with peak elevations of 710 and 672 feet, respectively; and steep slopes draining into Milagra Creek on the northeast. In the eastern portion of the ridge, there is also a settling pond that was created by the military for sewage treatment. The settling pond has since developed into an important wetland habitat for a number of animals, including the red legged frog (*Rana aurora draytonii*), a species that is threatened in California.

Coastal scrub and coastal prairie are the major plant communities found on the windy, often-foggy, exposed slopes of Milagra Ridge. Coastal scrub dominates the slopes, and assemblages of mixed scrub and prairie (grassland) species occupy the ridge top. Silver leaf lupine (*Lupinus albifrons*), a small and uncommon native plant, supports a population of the federally listed endangered Mission blue butterfly on Milagra Ridge. Stonecrop (*Sedum spathulifolium*), a succulent plant found in rocky outcroppings on the ridge, supports the federally listed endangered San Bruno elfin butterfly (*Callophrys mossii bayensis*). Native animals found on Milagra Ridge include gray fox, bobcat, skunk, raccoon, gopher, mice and voles, black tailed deer, coyote,

garter snakes, gopher snakes, western fence lizards, American kestrels, red-tailed hawks, scrub jays, hummingbirds, ravens, and many others.

Students from local high schools help restore indigenous plant habitat on Milagra Ridge, which in turn assists in the protection of the ridge's endangered species. Throughout the year, they participate in every phase of the restoration cycle, from collecting seed to growing native plants in the school's nursery, and finally, to outplanting the young plants in the landscape.

The Site Stewardship Program (SSP) of the Golden Gate National Parks Association, the nonprofit partner of the GGNRA, manages the restoration and monitoring of Milagra Ridge. Site Stewardship staff and volunteers work together to restore the ecological integrity of GGNRA lands and to protect rare and endangered species.

Perspectives Worksheet #1



Directions: Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs. Find Restoring Milagra Ridge. Answer the questions below.

PART 1

1. Why did Milagra Ridge become a national park?

2. How was Milagra Ridge used before it became a national park?

3. Why is it considered an island ecosystem?

4. What are the endangered species that live at Milagra Ridge?

5. How does your community help protect endangered species?

PART 2

Write at least 3 questions that you have about the National Park Labs program, the National Park Service, your role in the program, etc.

1.

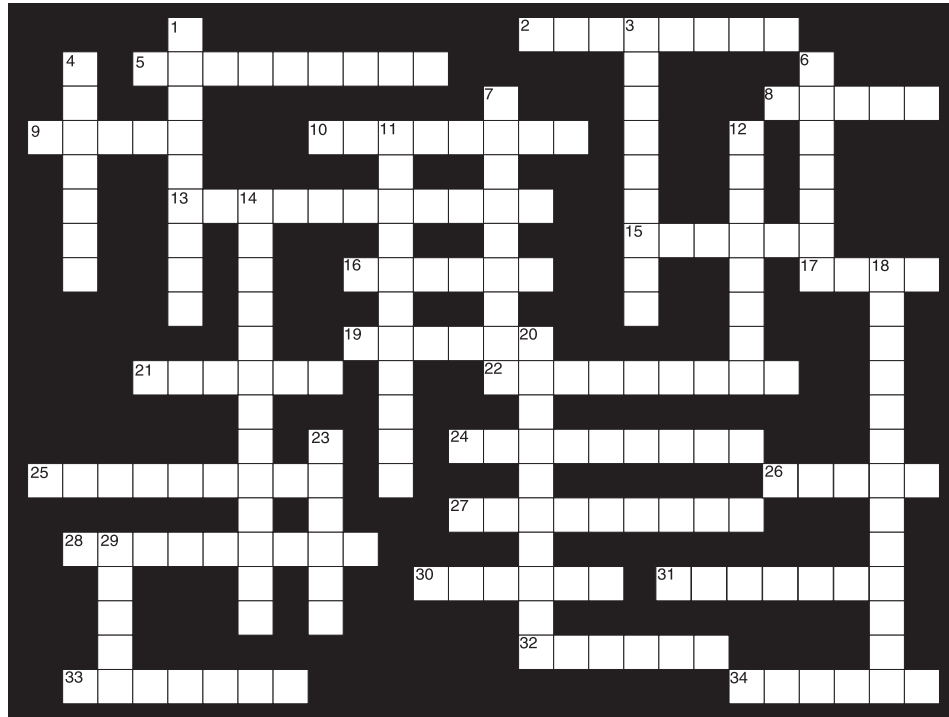
2.

3.

Vocabulary Word Puzzle



Directions: Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs/. Find the Glossary. Find the words that match the definitions.



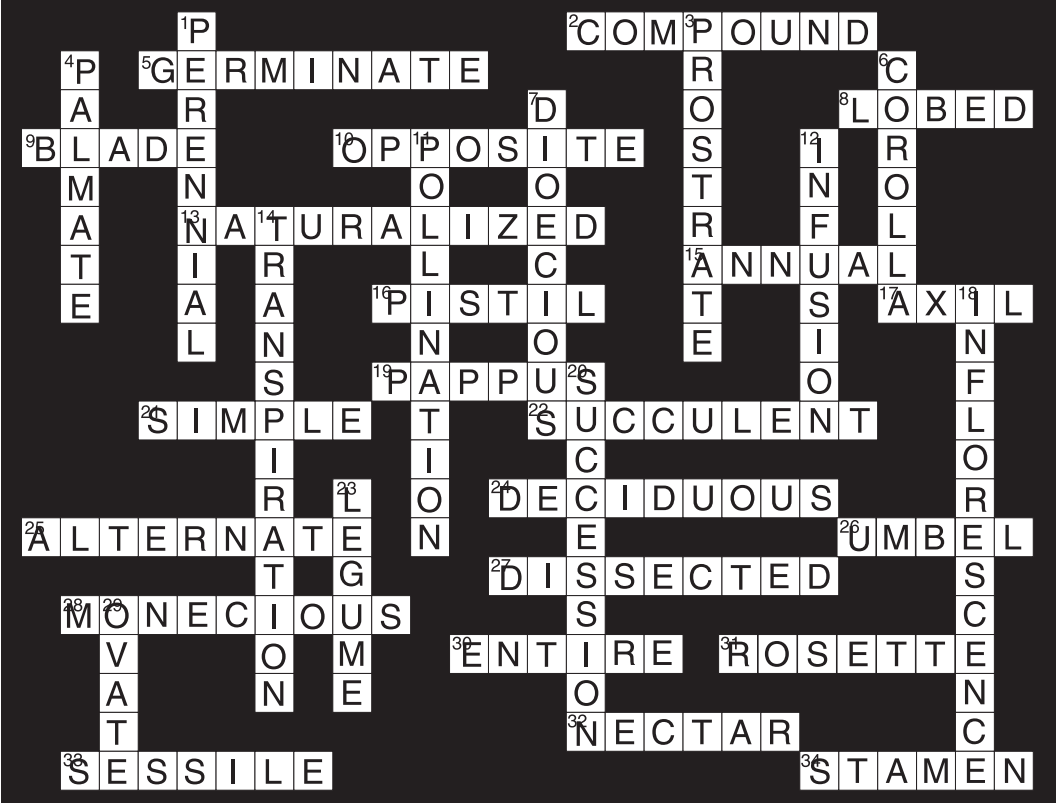
ACROSS

- | | |
|---|---|
| 2 One leaf contains several leaves | 21 A leaf with only one segment |
| 5 To sprout | 22 A plant with thick, fleshy leaves |
| 8 Leaves with round or wavy edges | 24 Plants that lose leaves when it gets cold |
| 9 The leaf itself | 25 Leaves not directly across from each other |
| 10 Leaves directly across from one another | 26 A convex-shaped inflorescence |
| 13 Taking over natural range of native plants | 27 Leaves that look feathery |
| 15 Plants that die after 1 year | 28 Male and female flowers on one plant |
| 16 Female part of a flower | 30 Leaves with straight, smooth edges |
| 17 Where the leaf attaches to the stem | 31 Circular cluster of leaves at plant base |
| 19 A tuft of hair | 32 Sweetish liquid in flowers |
| | 33 Having no stalk |
| | 34 Male part of a flower |

DOWN

- | | |
|--|--|
| 1 Plants that resprout without being replanted | 12 Liquid extract |
| 3 Lying flat or trailing along the ground | 14 Loss of water from plants |
| 4 Leaves shaped like a hand | 18 The flowering part of a plant |
| 6 Petals of a flower | 20 Progressive changes in nature |
| 7 Species with male and female plants | 23 A plant with nitrogen-fixing bacteria |
| 11 Leads to fertilization and seed production | 29 Leaves that are egg-shaped |

Vocabulary Word Puzzle (Key)



Perspectives

SUMMARY

Students meet members of the park education staff and learn about the National Park Service mission, park resources specific to Milagra Ridge, and concepts such as biological diversity, endangered species, and land use. They create their own version of the restoration cycle, and begin to develop their own sense of stewardship.

TIME

100 minutes

MATERIALS

- ▶ National Park Service mission puzzles
- ▶ Restoration Cycle cards
- ▶ Copies of poem
- ▶ Perspectives Worksheet #2

Lesson

Park staff introduce themselves. They explain park staff role in the National Park Labs program. The class discusses the questions students formulated in the lesson on Restoring Milagra Ridge and Question Formulation.

Students work together in groups to assemble puzzles. The activity introduces students to the National Park Service mission, park resources specific to Milagra Ridge and related concepts.

Students continue in small groups to learn the restoration cycle. They use cards with descriptive words or illustrations to place in order by season. Each group posts their restoration cycle on the wall. Students conduct a gallery walk while answering questions in Perspectives Worksheet #2. Everyone then discusses the role students will have in returning open space to its indigenous plant ecosystem.

Students listen to a poem about one meaning of stewardship. They write their interpretation in Perspectives Worksheet #2.

Perspectives Worksheet #2



Directions:

Answer the following questions during your gallery walk.

1. In what ways are the restoration cycle presentations alike?

2. In what ways are the presentations different?

3. What are the main steps in the restoration cycle?

4. What are conditions that could cause the restoration cycle to change?

5. What is your role in the restoration cycle at Milagra Ridge?

QUOTE:

You must teach your children that the ground beneath their feet is the ashes of our grandfathers. So that they will respect the land, tell your children that the earth is rich with lives of our kin. Teach your children what we have taught our children - that the earth is our mother. Whatever befalls the earth befalls the sons of the earth. If men spit upon the ground, they spit upon themselves. This we know. The earth does not belong to man; man belongs to the earth. This we know. All things are connected like the blood which unites one family. All things are connected. Whatever befalls the earth befalls the sons of the earth. Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself....

Chief Seattle

6. What is your understanding of this quote?

Top Ten Environmental Rights

SUMMARY

As an introduction to Environmental Justice, students identify and question stereotypes they may have about environmentalists. Students create a list of Top Ten Environmental Rights. They compare their ideas about fundamental environmental rights with the National Park Service mission and the *Principles of Environmental Justice*, created at the First National People of Color Environmental Leadership Summit. Students think about what they might see in a national park that would indicate that the National Park Service fulfills its mission and supports Environmental Justice.

TIME

Part 1: 30 minutes

Part 2: 40 minutes

MATERIALS

- ▶ National Park Service mission
- ▶ *Principles of Environmental Justice*
- ▶ Perspectives Worksheets #3, #4, #5 and #6

Lesson

Part I

Students receive Perspectives Worksheet #3. Students envision an environmentalist and then draw this person. Students share and describe their drawings. As they present their work, teacher asks questions about their pictures to help clarify their perspectives and identify any subconscious assumptions or stereotypes:

- ▶ What type of environmental issue is your environmentalist supporting?
- ▶ How much money does your environmentalist make a year?
- ▶ What is the education level of your environmentalist?
- ▶ What is your environmentalist wearing?
- ▶ What is the race and gender of your environmentalist?
- ▶ Where does your environmentalist live?

Teacher gives each student Perspectives Worksheet #4 and facilitates a discussion about the drawing exercise:

- ▶ How are these examples of environmentalists similar?
- ▶ How are these examples different?
- ▶ Are there types of people (race and gender) who are not represented in these drawings?
- ▶ What environmental issues concern the people in the drawings?
- ▶ What is the definition of an environmentalist?

Students write a paragraph answering the following question:

- ▶ Are you an environmentalist? Why or why not?

Part 2

Teacher divides the class into small groups and gives each student Perspectives Worksheet #5. Groups brainstorm at least three environmental rights everyone deserves.

Class creates their list of Top Ten Environmental Rights by combining their lists.

Students receive Perspectives Worksheet #6, the *Principles of Environmental Justice* and the National Park Service mission. They identify the similarities and differences between their Top Ten Environmental Rights, the *Principles of Environmental Justice*, and the National Park Service mission.

Students discuss what physical evidence they might see at a national park that would indicate that the National Park Service fulfills its mission and supports Environmental Justice. Teacher prompts the students to think about the diversity of people (different languages, disabilities, children, elderly, etc.) they might find in a national park and the things that make national parks accessible to specific groups (multilingual signs, curb cuts, children's activities, wheelchair-accessible trails).

Students add to or revise the questions they have in their Perspective worksheets based on this lesson before they visit the park.

Principles of Environmental Justice



PREAMBLE

We, the People of Color, gathered together at this multi-national People of Color Environmental Leadership Summit, to begin to build a national and international movement of all peoples of color to fight the destruction and taking of our lands and communities, do hereby re-establish our spiritual interdependence to the sacredness of our Mother Earth; to respect and celebrate each of our cultures, languages and beliefs about the natural world and our roles in healing ourselves; to insure Environmental Justice; to promote economic alternatives which would contribute to the development of environmentally safe livelihoods; and to secure our political, economic and cultural liberation that has been denied for over 500 years of colonization and oppression, resulting in the poisoning of our communities and land and the genocide of our peoples, do affirm and adopt these Principles of Environmental Justice:

1. Environmental Justice affirms the sacredness of Mother Earth, ecological unity and the interdependence of all species, and the right to be free from ecological destruction.
2. Environmental Justice demands that public policy be based on mutual respect and justice for all peoples, free from any form of discrimination or bias.
3. Environmental Justice mandates the right to ethical, balanced and responsible uses of land and renewable resources in the interest of a sustainable planet for humans and other living things.
4. Environmental Justice calls for universal protection from nuclear testing, extraction, production and disposal of toxic/hazardous wastes and poisons and nuclear testing that threaten the fundamental right to clean air, land, water and food.

5. Environmental Justice affirms the fundamental right to political, economic, cultural and environmental self-determination of all peoples.
6. Environmental Justice demands the cessation of production of all toxins, hazardous wastes, and radioactive materials, and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production.
7. Environmental Justice demands the right to participate as equal partners at every level of decision-making including needs assessment, planning, implementation, enforcement and evaluation.
8. Environmental Justice affirms the right of all workers to a safe and healthy work environment, without being forced to choose between an unsafe livelihood and unemployment. It also affirms the right of those who work at home to be free from environmental hazards.
9. Environmental Justice protects the right of victims of environmental injustice to receive full compensation and reparations for damages as well as quality health care.
10. Environmental Justice considers governmental acts of environmental injustice a violation of international law, the Universal Declaration On Human Rights, and the UN Convention on Genocide.
11. Environmental Justice must recognize a special legal and natural relationship of Native Peoples to the U.S. government through treaties, agreements, compacts, and covenants affirming sovereignty and self-determination.
12. Environmental Justice affirms the need for urban and rural ecological policies to clean up and rebuild our cities and rural areas in balance with nature, honoring the cultural integrity of all our communities, and providing fair access for all to the full range of resources.

13. Environmental Justice calls for the strict enforcement of principles of informed consent, and a halt to the testing of experimental reproductive and medical procedures and vaccinations on people of color.

14. Environmental Justice opposes the destructive operations of multi-national corporations.

15. Environmental Justice opposes military occupation, repression and exploitation of lands, peoples and cultures, and other life forms.

16. Environmental Justice calls for the education of present and future generations which emphasizes social and environmental issues, based on our experience and an appreciation of our diverse cultural perspectives.

17. Environmental Justice requires that we, as individuals, make personal and consumer choices to consume as little of Mother Earth's resources and produce as little waste as possible; and make the conscious decision to challenge and reprioritize our lifestyles to insure the health of the natural world for present and future generations.

Adopted, Washington, D. C., October 1991
First National People of Color Environmental Leadership Summit

National Park Service Mission



To conserve the scenery and the natural and historic objects and wildlife therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Perspectives Worksheet #3



Directions: Draw a picture of an environmentalist.
Label the parts of your drawing that identifies your image as an environmentalist.

A large, empty rectangular box with a thin black border, intended for the student to draw a picture of an environmentalist.

Perspectives Worksheet #4



Directions: Answer the questions below.

1. What is the definition of an environmentalist?

2. What are common concerns of people who care about their environment?

3. Are you an environmentalist? Write a paragraph that explains why or why not.

4. What concerns do you have about your environment?

Perspectives Worksheet #5



Directions: Brainstorm at least three environmental rights with others in your group. Create a list of Top Ten Environmental Rights with the all members of your class.

1. What are the environmental rights that every person deserves?

2. What are the Top Ten Environmental Rights as determined by the members of your class?

Plant Propagation

SUMMARY OF INSTRUCTIONAL ACTIVITIES



📍 **Return of the Wild!** - page 4

- 🕒 ▶ Students play Return of the Wild! board game and learn about the benefits of biodiversity.
- ▶ Students create a two-dimensional collage that represents biological diversity in nature.

📍 **Plant Propagation** - page 9

- 🕒 ▶ Students participate in a variety of nursery operations which may include:
 - ▶ propagating plants sexually and/or asexually
 - ▶ transplanting seedlings ▶ maintaining pots and leach tubes
 - ▶ cleaning seeds ▶ pruning plants
 - ▶ planting or weeding in the demonstration garden
- ▶ Students learn about plants and nursery operations:
 - ▶ use microscopes to identify and study plant pathogens
 - ▶ calculate the number of plants to put in a restoration area
 - ▶ calculate the number of plants that nursery staff must propagate
 - ▶ gain an understanding of how nursery work fits into the restoration cycle

📍 **The Private Life of Plants** - page 17

- 🕒 ▶ Students watch the video *The Private Life of Plants*
 - ▶ Students complete a worksheet about the video.
 - ▶ Students work in groups to illustrate how seeds are dispersed.

📍 **Seed Experiments** - page 20

- 🕒 ▶ Students will:
 - ▶ germinate seeds under varying conditions
 - ▶ compare plant growth and health
 - ▶ introduce further variations on plant treatment, including changing soil quality
 - ▶ test soil pH, nitrogen, phosphorous, and potassium levels
 - ▶ analyze data gathered, create lists of most favorable and least favorable conditions for plant viability, and graph some aspect of their experiment results

Plant Propagation

GOLDEN GATE NATIONAL RECREATION AREA NATIVE PLANT NURSERIES

Golden Gate National Recreation Area (GGNRA) has six nurseries specializing in the propagation of plants indigenous to the San Francisco Bay Area. Plants raised in the nurseries generally replace invasive, exotic species removed from habitat restoration sites throughout the park. NPS staff propagate approximately 150 different plant species—from grasses to trees—in these nurseries. This large number reflects the wide diversity of the park's ecosystems, ranging from sand dunes to coastal chaparral to redwood forests.

The Presidio Native Plant Nursery is the largest of the six nurseries. Its structures and facilities are typical of those found in many commercial plant nurseries. The three greenhouses are equipped with automatic irrigation systems and motorized fans to control humidity and temperature. Several shade houses protect the young, delicate seedlings from the harsh rays of the sun while they are hardening off. These structures and their fittings control the principal environmental conditions that influence plant growth: light, water, temperature, carbon dioxide, and oxygen. This optimizes seed germination and helps ensure high survival rates in the nursery. It allows nursery staff to remove less seed from the wild than they would need to without these structures.

GENETIC DIVERSITY

A high level of genetic diversity allows some plants to survive after being planted into the restoration site even if it is a dry year or a wet season, or if animals nibble on the seedlings in April. Genetic diversity in GGNRA is maintained by collecting seeds at different times, by transplanting seedlings that have sprouted both early and late, and by planting both small and robust plants. Native plants are propagated carefully because once they are planted out in their native environment, they are left to nature's whim, with no human intervention.

What is Plant Propagation?

Plant propagation is the multiplication of plants by either sexual or asexual methods. Sexual propagation involves seeds, while asexual propagation is done using cuttings, layering, division, or grafting. At the Native Plant Nursery, staff prefer to propagate plants sexually, using seeds collected in the park. This results in genetically diverse plants, which are more likely to succeed in the face of disease or variations

in environmental conditions. Asexual propagation is used when there is not enough seed available for collection or when propagating plants that reproduce asexually in the wild. The drawback to asexual propagation is that all the new plants are clones of the mother plant, and therefore have no genetic diversity.

Asexual Propagation: Vegetative Methods

Using runners, stem cuttings, and crown divisions are common methods of vegetative propagation in nurseries and at home. All vegetative propagation methods produce plants with genotypes that are identical to the mother plant and, therefore, limit genetic diversity. However, such methods have the advantage of producing a large plant in a short period of time.

Runners

A runner is a specialized stem that develops from the axil of a leaf at the crown of a plant. It grows horizontally along the ground and forms a new plant at one of the nodes. Two plants in the park that produce runners are the beach strawberry (*Fragaria chiloensis*) and yerba buena (*Satureja douglasii*).

Vegetative propagation by runners involves removing a runner from the mother plant, dividing it into sections, and planting these sections in potting soil. Within two or three weeks, adventitious roots develop at intervals (every other node in the case of the beach strawberry) along the runner to produce "daughter" plants, which can then be transplanted into pots.

Sexual Propagation:

Seeds are the main method by which plants reproduce themselves in nature. Because seeds from different species of plants vary greatly in size, shape, and structure, plants can often be identified by looking at the seeds they produce. Regardless of their size, shape, or structure, all seeds have three basic parts -- the embryo, food storage tissues, and seed covering.

Embryo

The embryo is a new plant formed from the union between a male and female gamete during fertilization. It consists of an embryo axis that has a growing point at both ends—one develops into the shoot and one develops into the root—and one or more seed leaves (cotyledons) attached to the embryo axis. Plants can be classified according to the number of cotyledons they have. For example, monocotyledonous plants (grasses, corn, and bulbous plants) have one cotyledon while dicotyledons, or dicots, (all broadleaf plants, lupines and most of the herbaceous and woody shrubs in the Presidio) have two cotyledons. Dicots and monocots are both examples of angiosperms (plants whose seeds are borne within a mature ovary, or fruit). Gymnosperms, such as conifers, are plants whose seeds are not enclosed in an ovary.

Food storage tissues

The successful germination of a seed and the emergence above ground of the resulting seedling depend on energy produced from complex storage products (carbohydrates, fats, oils, and proteins) laid down in the seed by the mother plant.

Seed covering

Nearly all seeds are surrounded by one or two seed coats (testa) which help to protect the embryo from damage. The outer seed coat is usually dry and hard.

Seed Transport

Because plants are unable to move from one place to another, they depend on wind, water, and animals to distribute their seeds. Plants have adapted special characteristics to help their seeds disperse. For example, wind-dispersed seeds tend to be very small and light and have physical features that enable them to be carried by air currents; coyote bush (*Baccharis pilularis*) and mock heather (*Ericameria ericoides*) have feathery "parachutes" (the botanical name for this parachute is pappus). Some seeds have small claw-like protrusions on their seed coat that enable them to stick to the hide of an animal such as a raccoon or deer. Other seeds are borne in fruits or berries that are eaten by birds or other animals. The seeds inside these berries usually have tough coats that cannot be completely digested by the animal. Consequently, the whole seed passes through the animal and is dispersed wherever the animal relieves itself.

Return of the Wild!

SUMMARY

Return of the Wild! introduces students to the importance of maintaining biological diversity when propagating plants for habitat restoration projects. While playing Return of the Wild! students will discover that they score highest by collecting early-season, mid-season, and late-season germinators of a species. A post-game discussion helps students understand why this variation is essential. Return of the Wild! also familiarizes students with some of the more prominent species that grow in Golden Gate National Recreation Area. It presents some of the challenges that the NPS staff encounter in plant propagation, as well as some of the techniques they use to keep propagation success rates high. The game illustrates that it is impossible for people to entirely control the propagation process. Some cards in the compost pile describe things that can be controlled (how much water plants get, for example) but some describe things that cannot be controlled (a fox carcass rots and fertilizes a native plant community or a big storm wipes out the plants). Students find that the scores in Return of the Wild! fluctuate as these scenarios are encountered. Students then create a two-dimensional collage that represents biological diversity in nature.

TIME

100 minutes

MATERIALS

- ▶ Return of the Wild! board games (provided by NPS)
- ▶ Score Sheet
- ▶ Plant Propagation Worksheet #1
- ▶ Nature pattern images
- ▶ Construction paper and glue

Lesson

Part I

Teacher divides the class into small groups and passes out the game boards and pieces. Teacher explains that the students are to begin playing the game as soon as they receive a board and pieces. Students start by drawing ten cards each, moving

along the board, and following the instructions on the cards they pick up along the way. If they begin with BONUS cards, they can draw extra cards immediately.

Students play as much of the game as possible in fifteen minutes.

Teacher stops the games, passes out the score sheets, and walks the students through the scoring procedure.

Once scores are tallied, teacher distributes Plant Propagation Worksheet #1 and facilitates a group discussion: Based on the scoring procedure, what is valued most in this game? Diversity. What types of diversity are valued? Diversity of species and genetic diversity within a species represented by early-season, mid-season, and late-season germinators. Why is it important to have early-season, mid-season, and late-season germinators within a species? So the species can better survive environmental disturbances. For example, early spring germinators may not survive an early spring frost but mid-spring and late-spring germinators probably will. If students were to focus this game on the ecosystem instead of the nursery, how might the scoring change?

The key concept in successful ecological restoration with native plants is natural selection, not cultural selection. All aspects of the native plant nursery cycle emphasize the maintenance of genetic diversity; seeds are collected from many different plants, and both small (late-season germinators) and robust (early-season germinators) are transplanted.

Part 2

Biological Diversity Collage

Teacher distributes images of nature patterns (i.e. light and dark tones, shadows, contour edges of shape, negative and positive space, and color variations).

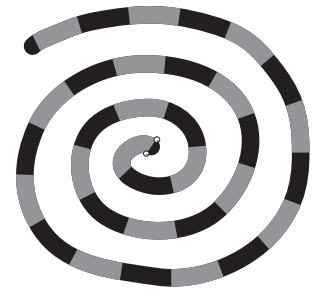
Students look closely at the differences among color, texture, light, and shapes within their images. Students tear shapes out of construction paper. Students then experiment with the arrangement of torn paper shapes to represent the differences in the images. The direction and placement of the torn paper in the composition should symbolize the color, texture, light, and shapes within their images. Students glue their pieces after experimenting with composition.

Students then create a second collage from the same image. Only one color can be used in this image.

Teacher explains that the single-colored collage represents monoculture and the multicolored collage represents biological diversity. Teacher facilitates a discussion that helps students compare their images. Include the following questions: What is monoculture? An area covered exclusively by one species. What is biological diversity? The variety of life in a given ecosystem. What might be the effect of a monoculture on the biological diversity of a region? What impact might a monoculture have on the heterogeneity or homogeneity of the environment?

Plant Propagation Worksheet #1

Return of the Wild!



1. Describe three actions or events that increased your final number of native plants and three actions or events that decreased your final number of native plants.

2. What is valued most in this game based on the scoring procedure?

3. Why are these values considered important?

4. How might you change the scoring if this game focused on the ecosystem instead of the nursery?

Return of the Wild! Score Sheet

INSTRUCTIONS:

- Check the boxes and circle the germination times that correspond to the plant cards in your hand. Give yourself one point for each plant you have checked.
- If you have all the plants in a community, check the community box. Give yourself one point for each community you have checked.
- If you have all three germination times for any plant, give yourself an additional 10 points for that plant. Total your points at bottom.

FOREDUNE COMMUNITY

- | | | | |
|--|-------|-----|------|
| <input type="checkbox"/> Morning Glory | early | mid | late |
| <input type="checkbox"/> Yellow Sand Verbena | early | mid | late |



RIPARIAN COMMUNITY

- | | | | |
|----------------------------------|-------|-----|------|
| <input type="checkbox"/> Bulrush | early | mid | late |
|----------------------------------|-------|-----|------|

DUNE SCRUB COMMUNITY

- | | | | |
|---|-------|-----|------|
| <input type="checkbox"/> Pearly Everlasting | early | mid | late |
| <input type="checkbox"/> Coyote Brush | early | mid | late |
| <input type="checkbox"/> Mock Heather | early | mid | late |
| <input type="checkbox"/> Sticky Monkey Flower | early | mid | late |

SERPENTINE BLUFF COMMUNITY

- | | | | |
|---|-------|-----|------|
| <input type="checkbox"/> San Francisco Wallflower | early | mid | late |
| <input type="checkbox"/> Coast Buckwheat | early | mid | late |
| <input type="checkbox"/> Yarrow | early | mid | late |

SERPENTINE GRASSLAND COMMUNITY

- | | | | |
|---|-------|-----|------|
| <input type="checkbox"/> California Poppy | early | mid | late |
| <input type="checkbox"/> Soap Plant | early | mid | late |

number of different plants _____
 number of communities _____
 number of diversity points _____
 TOTAL POINTS _____

○ Plant Propagation

SUMMARY

Students work with nursery staff on plant propagation and other nursery operations. They gain an understanding of how nursery work fits into the restoration cycle. Students learn that a primary goal of the native plant nurseries is to increase genetic and species diversity of plants growing within Golden Gate National Recreation Area. Students who visit the nursery gain an appreciation for the vegetation that once thrived in the greater San Francisco Bay Area and understand how our local ecosystem benefits from diversity. The class also knows that their work is crucial to park restoration, and that they are welcome to return to the nursery as a volunteer.

TIME

85 minutes minimum

MATERIALS

- ▶ Pots
- ▶ Propagation tags
- ▶ Plant information cards
- ▶ Demonstration plants
- ▶ Colored pencils
- ▶ Paper
- ▶ Calculators
- ▶ Plant Propagation Worksheet #2
- ▶ Whiteboards or flip charts (2)
- ▶ Markers
- ▶ Scrub brushes
- ▶ Microscopes
- ▶ Specimen dishes
- ▶ Specimens for microscope station
- ▶ Clipboards

○ Program

Welcome

Park staff welcome the students and explain the nursery guidelines. Students divide into groups.

Stations

Students rotate through stations. They write a journal question at the end of each station. Students record the total amount of work performed at their final station. Park staff and students clean up the stations.

Conclusion

Park staff and students form a circle after students have rotated through all the stations. Students share a question from their journals, ask a new question, or tell something they learned during the day.

Park staff lead a discussion. Include the following questions: What was the total amount of work performed at each station? How does the nursery fit into the restoration cycle? How does biological diversity and genetic diversity benefit animal populations?

Park staff thank the students for their work.

Station Guidelines

STATION 1 - TRANSPLANTING

Procedures:

- ▶ Park staff use a plant card to introduce the species the students will be transplanting.
- ▶ Park staff place the rack of seedlings in the center of the table and ask the students which plants seem best fit for transplanting; it is likely that students will choose the largest plants as the most vital.
- ▶ Park staff ask students to think back to the Return of the Wild! board game they played in the pre-visit lesson. Why would they want to transplant seedlings of various sizes? Park staff help the students understand that to promote genetic diversity they should transplant seedlings of various sizes, because the size of a seedling is an indicator of when its seed germinated, not its health. (Propagating a set of plants with a variety of germination rates will allow the species to cope with a larger range of climatic conditions. For instance, if Pacifica or other areas of San Mateo County were to experience an especially cold winter month, the plants that germinate during that month are likely to freeze to death. However, if the plant community in the area includes early-season, mid-season and late-season germinators, the species is likely to survive the atypical weather conditions.)

- ▶ Park staff give a careful transplanting demonstration, followed by a demonstration by one of the students. Without a patient introduction to the process, the students may focus on finishing as many transplants as they can and disregard the quality of the work. During the transplanting, students tag the finished transplants, and get soil.
- ▶ During transplanting students and staff may discuss previous experiences they have had working with plants, other volunteer work they have done, or what plans they have for the future. Staff can also use the time to help students imagine the GGNRA landscape that they are helping to create—one that is richer each year with indigenous plant growth.
- ▶ Students then complete the section on transplanting in Plant Propagation Worksheet #2.

STATION 2 - DEMONSTRATION GARDEN

Procedures:

- ▶ The demonstration garden is a simulation of the plant communities that historically covered a part of Milagra Ridge.
- ▶ Park staff take a few minutes to introduce the station. They point out the diversity of species in the demonstration garden and the lack of invasive behavior among native plants. Students look at a small section of the demonstration garden. Park staff lead a discussion. Include the following questions: Is there more or less plant diversity in the small section as in other areas around the nursery? Why don't the native plants overrun each other? How would the garden be different if it were a monoculture? If you depended on the land for food and medicine, which type of ecosystem would you rather live near? How does the biological diversity of plants benefit animal populations? Are all of the plants in bloom? Are some of the plants in seed? How is it beneficial to insects and other animals to have a variety of plants blooming at different times of the year? Students discuss plant adaptation.

Group Math Problem: Park staff pose a math problem and ask students what information they need to find the answer. As they call out the information they need (percentage of seeds that germinate and survive), a volunteer writes the information on the whiteboard. If necessary, the group can draw a diagram. Students create an equation to calculate the answer (the equation should come from the students, NOT from the park staff).

Question: Of the 1,000 plants needed for a restoration site, 200 are Coast buckwheat. If the survival rate for Coast buckwheat is 80 percent, how many seeds need to be propagated at the nursery to meet the goal for this species? Note: The survival rate is the percent of propagated plants that survive to be transplanted into the field. This percentage varies for each plant species and is determined by a germination test in which 100 seeds are sown and the sprouts that survive are counted. The average survival rate for plants grown in the park's native plant nurseries is about 60 percent.

Sample Problem-solving Method: (Students may reach the answer in a variety of ways; park staff will let them follow their instincts.)

1. Let n = number of plants to propagate, r = survival rate, and z = number of plants needed for restoration site.
2. The number of plants propagated times the survival rate for the species equals the number of plants required for the restoration site ($n \times r = z$).
3. $n \times 80\%$ (value of r) = 200 (value of z)
4. $n = 200$ (value of z) / 80% (value of r)
5. $n = 250$ (value of n)

You need to propagate 250 seeds in order to have 200 of them sprout and survive for planting into the restoration site.

- ▶ Students then complete the section on the demonstration garden on Plant Propagation Worksheet #2.

STATION 3 - SEED CLEANING

Procedures:

- ▶ Park staff demonstrate the appropriate seed cleaning technique.
- ▶ During seed cleaning students and staff may discuss seed-related questions:

What are some of the different ways that seeds travel? (airborne, in feces, floating in water, stuck to animals' fur) How do you think the seeds we are working with

today travel when they are in nature? Are you removing a dried fruit exterior, a flying mechanism, or a sharp shell? Does this seed remind you of any others you have seen?

- ▶ Park staff explain to the students that in the park no more than 5 percent of any plant's seeds are collected, and seeds are collected from at least 10 individual plants per species.
- ▶ Students consider how the seed collection protocol supports genetic diversity. By propagating seeds collected from a variety of plants within a species, genetic diversity is maintained within GGNRA. High genetic diversity helps ensure that the species will thrive when faced with a variety of environmental pressures, such as climate shifts, diseases, predators, etc.
- ▶ Each group totals their number of seeds cleaned. Students then complete the section on seed cleaning on Plant Propagation Worksheet #2.

STATION 4 - POT WASHING/MICROSCOPES

Procedures:

- ▶ Park staff explain to the students that they will clean and sterilize nursery containers, and use microscopes to study the pathogens that make this cleaning and sterilizing a vital step in successful nursery operations. They discuss the importance of using bleach when cleaning pots. Students start thinking about the relationship of pot washing and disease and the relationship of disease and genetic diversity.
- ▶ Students spend the first portion of the station at the microscope stations. Students should be careful of insects with stingers and of the hot light bulbs on the microscopes (the top light bulbs are the hottest). Students use the microscopes to examine the different diseases and insects, and to compare specimens of diseased or bug-infested plants with healthy plants.
- ▶ Students then move to the pot-washing sinks. Park staff assign each student a task: disassembling pots and racks, washing, rinsing, sterilizing, inspecting, and storing clean pots. After several minutes, students switch tasks.
- ▶ Students discuss the relationship of genetic diversity to a species' ability to survive disease. (Some individuals in a species are more resistant to disease than oth-

ers, so a diverse population has a better chance of surviving any given pathogen.)

- ▶ Each group determines their total number of clean containers.
- ▶ Students then complete the section on pot washing on Plant Propagation Worksheet #2.

STATION 4 - PRUNING STATION

Procedures:

- ▶ Park staff briefly explain the purpose of the shade house.
- ▶ Park staff demonstrate how to prune plants. If plants have nodes, students should prune down to the third node.
- ▶ Park staff facilitate a discussion during pruning. Include the following questions: What is the function of leaves and roots? What is the root-to-shoot ratio? Show students a healthy root base. Why do park staff prune plants at the nursery? What would happen if plants from the shade house were planted in the ground? Why are plants started in the nursery instead of planting directly from seed to ground? What is a good way to prevent fungus from thriving at this stage of the plant's growth?
- ▶ Park staff ask students to consolidate the plants, compost the clippings and return plants to their original position in the shade house.
- ▶ Students determine the total number of plants pruned.
- ▶ Students then complete the section on pruning on Plant Propagation Worksheet #2.

Plant Propagation Worksheet #2



Directions: Complete the section for each station at the Native Plant Nursery. Formulate at least one question at the end of each station.

DEMONSTRATION GARDEN STATION

1. What is the common name of the plant? _____

2. What is the total number of plants needed for the site? _____

3. What is the survival rate of the plant species?

4. Write the equation and use it to solve the problem.

5. What is the total number of seeds that need to be propagated for the restoration project?

6. Write at least one question about the Demonstration Garden Station.

TRANSPLANTING STATION

1. How many plants did your group transplant? _____

2. Write at least one question about the Transplanting Station.

POT WASHING STATION

1. How many containers did your group wash? _____

2. Write at least one question about the Pot Washing Station.

SEED CLEANING STATION

1. How many seeds did your group clean? _____

2. Write at least one question about the Seed Cleaning Station.

PRUNING STATION

1. How many plants did your group prune? _____

2. Write at least one question about the Transplanting Station.

🕒 The Private Life of Plants

SUMMARY

Students watch the video, *The Private Life of Plants*, and answer and create questions. The video explains how certain plants disperse their seeds with the assistance of biotic and abiotic components of the environment. By completing the worksheet, students begin to understand that plants have many ways of dispersing seed, utilizing wind, water, and animals. Students illustrate how seeds are dispersed.

TIME

75 minutes

MATERIALS

- ▶ Plant Propagation Worksheet #3
- ▶ *Private Life of Plants* video (provided by NPS)
- ▶ Objects that represent a type of seed (button, seed, etc.)

🕒 Lesson

Students read Plant Propagation Worksheet #3. Before starting the video, teacher asks the students to pay particular attention to issues of interdependence depicted in the video. Students watch the video.

Students divide into four groups. Each group receives an object that represents a type of seed.

Students discuss and answer the questions in Plant Propagation Worksheet #3. Each group presents their version of seed dispersal to the class.

Plant Propagation Worksheet #3



Directions: Discuss and answer the following questions.

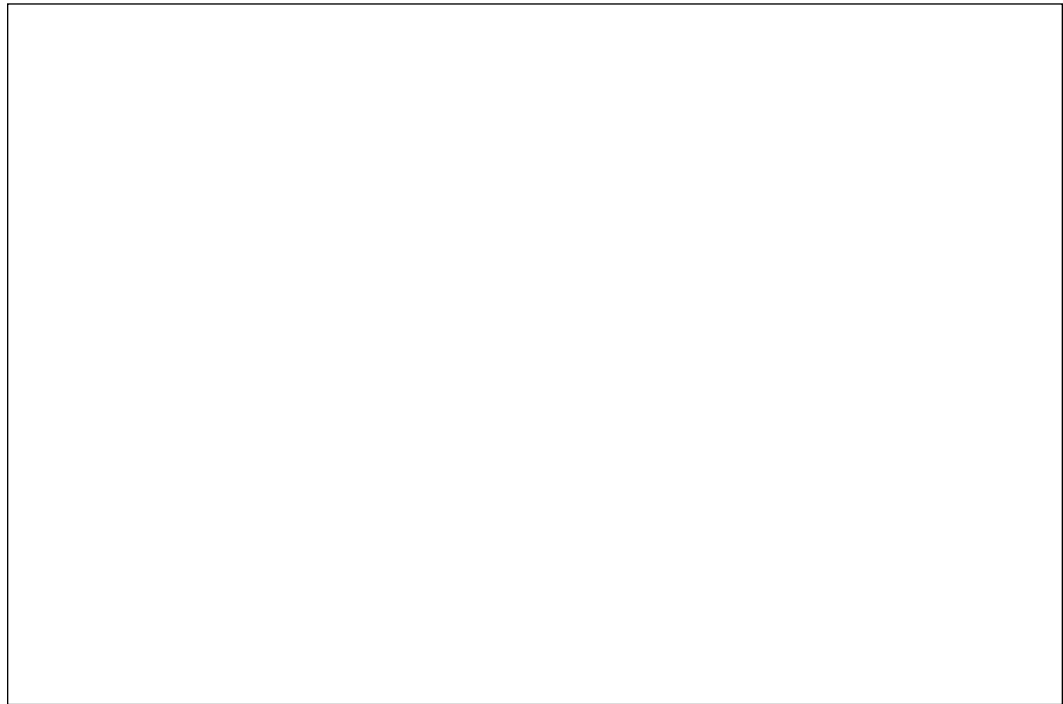
1. What are four different ways plants disperse their seeds?

- a. _____
- b. _____
- c. _____
- d. _____

2. Draw the host plant of your "seed."

3. Usually, we think of animals as dependent on plants. The video shows plants that depend on specific animals for the survival of the species. How does your host plant depend on animals?

4. Illustrate or describe how your "seed" is dispersed.



5. What are some abiotic and biotic factors in your host plant's environment?

ABIOTIC	BIOTIC

6. The video shows many complex interactions between abiotic and biotic components of the environment. What conditions would severely affect the interactions in the ecosystem of your host plant?

Seed Experiments

SUMMARY

Students germinate seeds, compare plant growth and health, introduce variations on soil pH, test soil, and gather and analyze data on prime conditions for plant growth.

TIME

three 50-minute class periods
5 minutes each day for observing/recording for the 2 weeks following the class periods

MATERIALS

- ▶ Seeds
- ▶ Paper towels
- ▶ Pots
- ▶ Substances to change soil conditions, such as baking soda, vinegar, fertilizer, sand, clay, silt, etc.
- ▶ Plant Propagation Worksheets #4, #5, #6 and #7
- ▶ Petri dish or plastic bag
- ▶ Soil
- ▶ Soil test kits (provided by NPS)

Program

Part I

Teacher gives each student paper towels, petri dish or plastic bag, and two seeds. Yarrow, poppy and other California native plant seeds are available at local nurseries. Lima beans can also be used.

Teacher distributes Plant Propagation Worksheet #4 and asks students to make observations about their seeds' appearance.

Students put their seeds between the paper towels, insert them into the petri dish or bag, and water them (a clean spray bottle works well). Towels should be moist, not wet; standing water encourages fungi. Students record their names on their petri dishes or bags.

Students water seeds for one week (or longer if necessary) until most of the seeds germinate. During this time, students make daily observations and record important information on Plant Propagation Worksheet #4.

Part 2

At the end of the week (or when most of the seeds have germinated), the students compile their information on germination rates and complete the first part of Plant Propagation Worksheet #5.

In groups of two or three, students choose the types of variations they will introduce into their seedlings' soil medium. Possibilities include changing pH (by adding acidic or basic substances such as vinegar and baking soda), altering soil composition (sand/clay/silt ratio), using various fertilizers, and using store bought soil mix versus dirt from the yard. Altering soil conditions demonstrates the importance of soil composition and the effects of contaminants in soils. Students leave the soil of one or more seedlings unaltered to serve as the control group for their experiment.

Students transplant seedlings into the altered soil.

Using soil testing kits, students test soil pH, nitrogen, phosphorous and potassium levels. Students then begin Plant Propagation Worksheet #6.

Part 3

Students monitor plant growth and health for one week and record their observations on Plant Propagation Worksheet #6.

At the end of the week, students compile their data and complete Plant Propagation Worksheet #7.

Plant Propagation Worksheet #4

(Answer before sowing seeds)



1. What is the common name of your seed species?

2. Describe the condition of your seeds. What do the seed coats look like? Is there any visible damage? Are the seeds robust or withered? etc.

3. Predict the number of days it will take for your seeds to germinate.

4. Monitor daily changes below. Note the day of seed germination.

	Date	Time	Observation
Seed A			
Seed B			

Plant Propagation Worksheet #5

(Complete one week after sowing seeds)



1. How long did it take for your seeds to germinate?

Seed A: _____ days Seed B: _____ days

2. Did your seed take a longer or shorter time to germinate compared to other seeds in your classroom?

(circle one) Longer Shorter

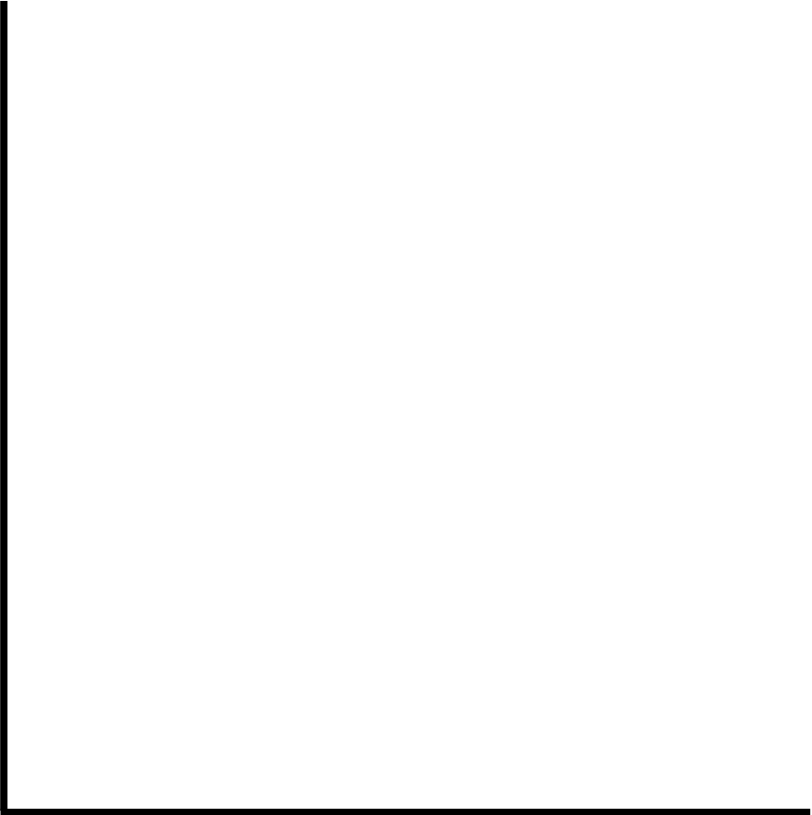
3. What is the average time that it took for all the seeds in your classroom to germinate?

Sum of germination days \div Number of seeds =
Average days of germination

4. What was the germination rate (percentage of seeds sown that germinated) in your classroom?

Number of germinated seeds \div Total number of seeds \times 100 =
% germination rate

5. Graph the time it took for all the seeds to germinate.
Label both axes.



6. What are some of the reasons why the seeds germinated on different days?

Plant Propagation Worksheet #6

(Complete immediately after treating soil)



1. How was your soil treated?

Seedling A	Seedling B

2. Measure the pH, nitrogen, phosphorous, and potassium levels of the soil and record below:

Seedling A: pH _____ nitrogen _____
phosphorous _____ potassium _____

Seedling B: pH _____ nitrogen _____
phosphorous _____ potassium _____

3. Predict the growth of the plant in altered soil (experimental plant) compared to the control plants.

4. Monitor daily changes below:

	Date	Time	Observation
Seed A			
Seed B			

Plant Propagation Worksheet #7

(Complete one week after treating soil)



1. How has your experimental plant grown in comparison with your control plant?

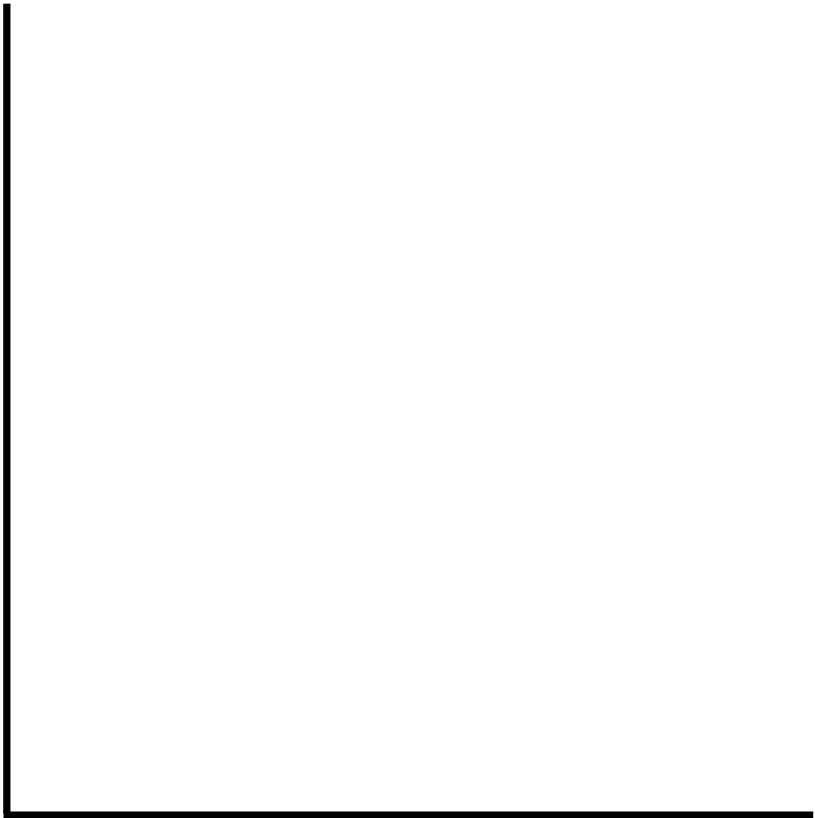
2. How has your plant grown in comparison with other plants in your classroom?

3. How does your actual plant growth compare to your prediction from Worksheet #6?

4. What are the most favorable conditions for plant growth?

5. What are the least favorable conditions for plant growth?

6. Create a graph that compares plant growth under varying conditions. Include all details that you feel are important. Label both axes.



7. How do contaminants in soil affect genetic diversity?

Invasive Plant Removal

SUMMARY OF INSTRUCTIONAL ACTIVITIES



🕒 Endangered Species Act - page 3

- 🕒 ▶ Students learn about the Endangered Species Act through an interactive project on the National Park Labs web site.
- ▶ Students work in groups to complete a 1200-1500 word essay about endangered species.

🕒 Plants and Culture - page 4

- 🕒 ▶ Students learn about the concept of exotic and indigenous plant species.
- ▶ Students compare the ecological role of indigenous and exotic plant species in an ecosystem, and assess the impact of removing invasive plants based on interdependencies within the system.

🕒 Milagra Ridge Introduction - page 7

- 🕒 ▶ Students visit Milagra Ridge for an introduction to the history, strategies for invasive plant removal, and techniques for seed collection.
- ▶ Students formulate questions about their experience.

🕒 Milagra Ridge Historic Timeline - page 9

- 🕒 ▶ Students work in groups to create a Milagra Ridge timeline using historic photographs.
- ▶ Students identify the factors that have contributed to the decline of endangered species at Milagra Ridge. They examine inherent values in each land use.

🕒 Mystery Plants - page 11

- 🕒 ▶ Students are introduced to the use of a dichotomous key by identifying the Mystery Plants on the National Park Labs web site.

🕒 Invasive Plant Removal - page 13

- 🕒 ▶ Students identify and remove invasive plants from a restoration site.
- ▶ Students calculate the rate of weeding for their group and use that calculation to estimate how many people-hours it will take to weed all the restoration sites in the park.
- ▶ Students discuss the contributions of volunteers in national parks.

❶ **Community Forum Role-Play:**

The Case of the Pampas Grass - page 17

- ❷ ▶ Students play the roles of community members during a planning process to decide whether or not to use herbicides on Milagra Ridge.
- ▶ Students reflect on the Environmental Justice issues addressed in the planning process and write journal entries about the role-play activity.

Exotic Plants

WHAT ARE EXOTIC PLANTS?

The National Park Service defines exotic or "non-native" species as those occurring in a given place as a result of deliberate or accidental actions by humans. Exotic plants have been introduced to North America for a variety of reasons, including livestock grazing, agriculture, forestry, ornamental landscaping, and soil stabilization.

The exchange of food plants around the world has immeasurably enriched human cultures. Potatoes, peppers, chocolate, and tomatoes, once found only in Central and South America, now thrive in gardens around the world. These species evolved on continents where their populations were kept in check by various environmental factors such as climate, disease, and herbivores. However, when they arrive in a new environment free of such ecological constraints, many become weeds along roadsides and in other disturbed areas. Some spread into natural areas, and a number of these can be classified as invasive. Exotic invasive plants dramatically reduce biodiversity by covering extensive areas so completely that other species cannot co-exist.

The spread of invasive species is one of the worst threats to biological diversity in National Parks. For example, more than 1,000 acres in Everglades National Park are lost every year to the Brazilian pepper tree and other invasive species that spread rapidly through the wildlands. Iceplant, a threat to the natural areas of California, forms thick mats in California's coastal sand dunes. Very few indigenous plants can co-exist in this iceplant monoculture. Iceplant was brought to California from South Africa more than a hundred years ago to stabilize soil and prevent sand movement across roads. Researchers have since learned its faults as a soil stabilizer and invasive weed, but too late to prevent its spread throughout coastal California.

The park targets iceplant for removal, not just because of its status as an exotic species, but because it is invasive. It is not naturally a "bad" plant. Iceplant became problematic in California due to lack of predators. Natural resource managers, needing to control the worst invasive species, remove iceplant from areas where it directly threatens endangered species habitat. Other exotic species that successfully co-exist with natives are left in place, and have become a permanent element of the California flora.

Many invasive species share biological characteristics that enable them to spread rapidly. Among these are:

- ▶ Exceptional reproductive abilities including vegetative reproduction (from stems, roots, or both), massive seed production, and extremely effective seed dispersal methods.
- ▶ Adaptation to frequent disturbance.
- ▶ Ability to survive in highly compacted or low-nutrient soils.
- ▶ Ability to produce chemicals that inhibit growth of nearby vegetation.

Endangered Species Act

SUMMARY

Students are introduced to the Endangered Species Act through an interactive project on the National Park Labs web site. They work in groups of four to complete a 1200-1500 word paper about endangered species.

TIME

6 class periods

MATERIALS

- ▶ Computers with Internet access

Lesson

Students form small groups. They access the National Park Labs web site, and go to Endangered Species Web Quest. Each of the 10 butterflies at the top is one part of the project. Several tasks are to be completed within each part.

Day One

- ▶ Students complete Part 1 and Part 2.
- ▶ Students summarize Part 3; complete Tasks 1, 2 and 3.
- ▶ Students turn in summaries and a copy of Task 2.

Day Two

- ▶ Students complete Part 3, Task 4.

Day Three

- ▶ Students complete Part 4, Tasks 1, 2, 3, and 4.

Day Four

- ▶ Students complete Part 5, Tasks 1, 2, 3, and 4.
- ▶ Students complete Part 6, Tasks 1, 2, 3, 4, and 5.

Day Five

- ▶ Students complete Part 7, Tasks 1, 2, 3, 4, and 5.
- ▶ Students complete Part 8.
- ▶ Students complete Part 9.

Day Six

- ▶ Students complete Part 10.

Plants and Culture

SUMMARY

Students learn about the concept of exotic and indigenous species. They compare the ecological roles of indigenous and exotic plant species in an ecosystem, and assess the impact of removing invasive plants based on interdependencies within the system.

TIME SCHEDULE

100 minutes

MATERIALS

- ▶ Ecosystem cards
- ▶ Plant species cards
- ▶ Invasive Plant Removal Worksheet #1

Lesson

Part 1

This activity demonstrates the concept of interdependence. Teacher assigns ecosystem "roles" to the students by handing out ecosystem cards: bumblebee, yarrow, sand, carbon, rain, wind, gopher, poppy, sun, etc. Students announce their role and whether they are a biotic (living) or abiotic (non-living) part of the ecosystem. Teacher asks every other student in the circle to turn and face the outside. Students then become a yurt (a round, self-supporting structure) by holding hands or linking at the elbows, leaning back with their arms in front of them, and finding balance. The yurt illustrates the delicate balance in any ecosystem.

Teacher takes the role of an invasive species, attempting to break the balance of the ecosystem by pulling the students' hands apart. Some sections stick together and others split apart, but the overall balance of the structure is broken. Students discuss the interdependence of the biotic and abiotic elements of an ecosystem, and how invasive plants affect the interdependencies. Can a yurt support itself in two or more separate pieces? How was the yurt affected when the interdependencies were broken? How is this a model of nature? How do invasive plants affect an ecosystem?

Part 2

Teacher divides the students into six groups. Each group receives a plant species card and a world map. Each group studies its card and determines if its plant should be removed from the restoration area. The group creates an argument for or against

the plant species being removed. Groups present their arguments to the class. During the presentations students show where their plant is from using the world map and dry-erase markers. Teacher notes (if students have not) that many invasive plants come from places with climates similar to California's, such as Western Australia, South Africa, western coast of Chile, and the Mediterranean.

The class discusses the following questions: How did invasive plants get to California? Is it possible for California indigenous plants to grow invasively? Under what circumstances? What do park rangers and other land managers need to know in order to make good decisions about plant removal?

Students complete Invasive Plant Removal Worksheet #1.

Invasive Plant Removal Worksheet #1



Directions: Complete the following after the Plant Species presentations.

1. What are the arguments that support the removal of plants?

2. Most exotic plants are from which countries?

3. What is the role of exotic plants in their native habitat?

4. How did invasive plants get to California?

5. Under what conditions can California native plants grow invasively?

6. What do park managers need to consider in order to make informed decisions about plant removal?

○ Milagra Ridge Introduction

SUMMARY

Students spend four hours on Milagra Ridge. Activities include an orientation, introduction to invasive plant removal and seed collection. The activities are structured so students can form their own opinions about values and priorities with different land uses.

TIME

4 hours

MATERIALS

- ▶ Picks
- ▶ Gloves
- ▶ Invasive Plant Removal Worksheet #2

○ Program

Welcome

Park staff welcome the students and facilitate a warm-up activity. A few students share questions from their journals. These questions can be used as discussion topics during the station rotations.

Stations

Students cycle through three stations with NPS staff:

- ▶ Station 1 - Orientation to Milagra Ridge and history, including biological diversity vs. monoculture.
- ▶ Station 2 - Introduction to invasive plant removal (tools and safety).
- ▶ Station 3 - Seed collection.

Students complete Invasive Plant Removal Worksheet #2 at each station.

Park staff and students clean up the stations.

Conclusion

Students gather in a large group. Students write questions in their journal. Each student shares one question with the group. Staff thank students for their work and explain the importance of volunteers working on restoration projects in Golden Gate National Recreation Area.

Invasive Plant Removal Worksheet #2



Directions: Complete the section for each station at the field session at Milagra Ridge. Formulate at least one question at the end of each station.

MILAGRA RIDGE ORIENTATION

1. How do native plant areas look different from areas where exotic plants are growing?

2. Write at least one question about the history of Milagra Ridge.

TOOLS AND SAFETY

1. What tools were used to remove plants? _____

2. Which plant species were removed? _____

3. Write at least one question about removal.

SEED COLLECTION

1. Which seed species were collected? _____

2. Write at least one question about seed collection.

🕒 Historic Timeline

SUMMARY

Students work in groups to create a Milagra Ridge timeline with historic photographs. They identify the factors that have contributed to the decline of endangered species at Milagra Ridge. They determine values of each land use.

TIME SCHEDULE

100 minutes

MATERIALS

- ▶ Historic photographs for each land use (provided by NPS)
- ▶ Invasive Plant Removal Worksheet #3
- ▶ Poster paper
- ▶ Markers

🕒 Lesson

Students divide into five groups. Each group receives two photographs and the worksheet. Students study the photographs and complete the Invasive Plant Removal Worksheet #3. They identify factors that impact endangered species and determine the values that the specific land use represents.

Each group creates a poster that illustrates the value placed on the land, and the impact on the landscape as a result of the value system.

The class then discusses the common and opposing values among the posters, as well as the common and opposing impacts to the land.

Invasive Plant Removal Worksheet #3



Directions: Answer the questions below while examining the historic photographs.

1. Is there evidence of physical changes to the landscape?

YES?

NO?

Identify the evidence that indicates the physical changes to the landscape.

Identify the evidence that indicates the landscape has not changed.

How might these changes have impacted the endangered species?

What are examples in nature that can impact endangered species?

4. What are possible changes in the future that might impact endangered species?

5. What are the common values placed on the land in your photographs?

🕒 Mystery Plants

SUMMARY

Students are introduced to the process of using a dichotomous key by investigating the Mystery Plant section of the National Park Labs web site.

TIME

50 minutes

MATERIALS

- ▶ Computers with Internet access
- ▶ Invasive Plant Removal Worksheet #4

🕒 Lesson

Teacher explains to the students that a dichotomous key is an important tool used by biologists to identify plants. The user of a dichotomous key must answer a series of questions about the plant he/she is trying to identify. Some of the questions are easy to answer but some take knowledge of plant biology or special vocabulary. Identifying the Mystery Plants on the National Park Labs web site will help students understand how to use a dichotomous key and learn some of the terms necessary to identify plants.

Teacher distributes Invasive Plant Removal Worksheet #4. Students access the National Park Labs web site. Students complete the worksheet as they identify the Mystery Plants.

The class discusses the process of identifying plants. Include the following questions: What kinds of things need to be observed in order to identify a plant? What new terms did students learn? Students will use their observation skills and their new vocabulary when they identify which plants to remove during their next visit to Golden Gate National Recreation Area.

Invasive Plant Removal Worksheet #4



• Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs.

• Locate the section titled Can YOU Use a Dichotomous Plant Key?

At each step in a dichotomous key you are asked to choose between _____ for the plant you're trying to identify.



MYSTERY PLANT #1

What is a simple leaf?

What is the common name for this plant?



MYSTERY PLANT #2

What is an inflorescence?

What is the Latin name for this plant?



MYSTERY PLANT #3

What are rhizomes?

Draw a picture of this plant on the back of this page.



MYSTERY PLANT #4

What are dissected leaves?

This plant is a member of what family?



MYSTERY PLANT #5

What are pedicels? _____

In what part of the world does this plant originate?

○ Invasive Plant Removal

SUMMARY

Students learn to compare the ecological roles of indigenous and exotic plant species in an ecosystem, and to assess the impact of removing invasive plants based on interdependencies within the system. They use math and estimation skills to complete GGNRA Work Performed Data Sheets and to estimate the total people-hours it will take to weed an area of the park.

TIME

4 hours

MATERIALS

- ▶ Gloves ▶ Picks
- ▶ Small whiteboard & dry-erase markers
- ▶ Invasive Plant Removal Worksheet #5
- ▶ GGNRA Work Performed Data Sheet

○ Program

Welcome

Park staff welcome students back to the park. A few students share questions from their journals. (These questions are used as discussion topics during the station rotations.) The class discusses key concepts of invasive plants. Students offer their ideas of what these concepts mean. Park staff use the restoration cycle visual aid to illustrate how today's projects relate to other work the students will do in the park.

Stations

Students cycle through three stations. Park staff facilitates discussion about the species' native habitat, its introduction to North America, and how it threatens indigenous California ecosystems as students perform work. Students complete GGNRA Work Data Sheet, and as well as appropriate sections of Invasive Plant Removal Worksheet #5 at each station.

Conclusion

Students gather in a large group. Park staff thank the class for their hard work and explain the importance of volunteers working on restoration projects in GGNRA. Students are a part of a community of people from around the world who have contributed to habitat restoration in the park.

INVASIVE PLANT REMOVAL (THREE STATIONS)

Procedures:

- ▶ Park staff show students the boundaries of the weeding area, and an example of the invasive species to be removed. They point out any indigenous plants in the area that are endangered or especially delicate; removal of invasive species in the field is important but students must still remember to preserve the indigenous plants in the area. Students will be more likely to move carefully through plant habitat and remove invasive plants conscientiously if they have some understanding of the importance and fragility of the indigenous plants in the area.
- ▶ Before weeding, park staff give a careful safety demonstration with any tools that the group will use. Tools will be collected from any student who is using them in a way that endangers her/himself, other students, or staff. Students who are not using picks or weed wrenches safely can help weed by hand or take responsibility for bagging weeds and consolidating piles.
- ▶ During the stations, park staff facilitate a discussion. Include the following questions: What do you predict will happen in this ecosystem now that the invasive plants are removed? Can you describe the interactions between the indigenous plants and the invasive plants? (The invasive plants crowd the native plants, limit their growth and sometimes kill them.) Is it better to remove the roots of one plant or pull the top off of ten plants? (Remove the roots.) Has this species gone to seed? (If so, ensure that the seeds are being piled up with the weeds, not spread around the site.) Have you seen any of these plants before? Is this plant exotic or indigenous? What benefits does this plant have in its native habitat? Is this plant invasive? Is this plant annual or perennial?
- ▶ When weeding is complete, students discuss the importance of keeping accurate records of work that was accomplished. Students should complete the GGNRA Work Performed Data Sheet. During the last ten minutes of one of the stations, students work together on the math problem described below.

Group Math Problem: Park staff pose the following question and ask students what information they need to find the answer. As they call out the information they need (size of area weeded today, number of students weeding, etc.), a volunteer writes the information on the whiteboard. If necessary, the group can draw a diagram. Students create an equation to calculate the answer (the equation should come from the students, NOT from the park staff).

Question: You are the natural resources manager for a large park. You and your team have determined that invasive plants are severely disrupting the ecosystem of a 25-acre area of the park. You need to recruit volunteers and plan workdays to accomplish the enormous task of removing the invasive plants. Based on your experience today, how many people-hours (1 person doing 1 hour of work) do you estimate will be required to accomplish the weeding?

Sample Problem-solving Method: (Students may reach the answer in a variety of ways; park staff will let them follow their instincts.)

1. Determine the area of the site the group weeded today by multiplying the length times the width. (The students should measure the length and width with the meter wheel.) For example, if width is 40 meters and length is 30 meters, area equals 40 meters x 30 meters = 1,200 square meters.

2. Convert the area of the site from square meters into acres (4,047 square meters = 1 acre). For example, let Y equal the area of the site in acres:

$$4047 \text{ sq. meters} / 1200 \text{ sq. meters} = 1 \text{ acre} / Y \text{ acres}$$

$$4047 \times Y = 1 \times 1200$$

$$Y = 1200/4047$$

$$Y = .3 \text{ acre}$$

3. Calculate the number of people hours it took to weed the site today. For example, 12 students x .3 hours (20 minutes) = 4 people-hours

4. Calculate the number of people hours for the 25-acre site. It took 4 people-hours to weed .3 acres; how many people hours will it take to weed 25-acres. Let Z equal the number of people hours required to weed all 25 acres.

$$Z \text{ people-hours} / 4 \text{ people-hours} = 25 \text{ acres} / .3 \text{ acres}$$

$$Z/4 = 83.33$$

$$Z = 83.33 \times 4$$

$$Z = 333.2 \text{ people hours}$$

Solution: 333.2 people-hours will be required to get all the weeding done. (33 volunteers who each work a little over 10 hours.)

Invasive Plant Removal Worksheet #5



Directions: Complete the section for each station at the field session at Milagra Ridge. Formulate at least one question at the end of each station.

STATION 1

1. Which plant species was the target species? _____

2. What is the total number of individual plants removed by your group? _____

3. Write at least one question about invasive plant species.

STATION 2

1. Which plant species was the target species? _____

2. What is the total number of individual plants removed by your group? _____

3. Write at least one question about plant removal techniques.

STATION 3

1. Record the length and width of the removal site. _____

2. Complete the work performed data sheet at your final station.

3. Write at least one question about the future of this site.

Community Forum Role-Play: The Case of the Pampas Grass

SUMMARY

Students participate in a debate to determine if National Park Service managers should use herbicides to eradicate invasive pampas grass on Milagra Ridge. They come to understand many different players and views, and the Environmental Justice issues that need to be resolved for successful planning. Through role-play, students work as a team to design a plan that meets the needs of a diverse community.

TIME

50 minutes

MATERIALS

- ▶ The Case of the Pampas Grass
- ▶ Invasive Plant Removal Worksheet #6
- ▶ Role cards

Lesson

Teacher reminds the students that they have been studying environmental issues in Golden Gate National Recreation Area, a national park. These environmental issues are of critical importance to nearby residents whose communities border the park. Today's activity will help them understand the complexity of open-space planning in a city environment.

A student reads aloud *The Case of the Pampas Grass* that describes a fictional but realistic scenario set at Milagra Ridge. The scenario involves a Town Meeting at which the participants must try to influence an important decision about the environment.

Teacher explains that the students will be asked to role-play particular members of the community with very different perspectives and needs. The class divides into small groups. Each group receives role cards representing stakeholders in the pampas grass removal project. The role cards should be distributed carefully so that each group contains students representing a variety of roles.

Students read their role card aloud to the rest of their group. Each group formulates a plan for the pampas grass removal that is acceptable to all the stakeholders in their group. If the groups have trouble moving the discussion forward, the teacher can assign any of the following responsibilities to group members: Leader, Scribe, Vote Manager, Plan Designer, and Presenter.

Student groups describe which stakeholders were represented in their groups and present their final project plan to the rest of the class. Students vote for or against the use of herbicide on Milagra Ridge.

The class discusses the following two principles of Environmental Justice and how those principles relate to urban planning:

Environmental Justice calls for universal protection from nuclear testing, and extraction, production and disposal of toxic/hazardous wastes and poisons that threaten the fundamental right to clean air, land, water, and food.

Points for discussion: Quick-fix urban ecological practices must be weighed against the possible danger of lasting toxic affects; how do we clean up and rebuild our urban parks in balance with nature?

Environmental Justice demands the right to participate as equal partners at every level of decision making, including needs assessment, planning, implementation, enforcement, and evaluation.

Points for discussion: Do all stakeholders have their voices heard? What causes some voices to be heard over others? What can be done to create more equity in the urban planning process?

Recall the Top Ten Environmental Rights lesson: How do the students' plans for Milagra Ridge support their list of Top Ten Environmental Rights?

Students complete Invasive Plant Removal Worksheet #6.

The Case of the Pampas Grass

Background Information

SCENARIO:

Pampas Grass is an invasive exotic plant species that was introduced to the United States from Western South America for horticultural purposes. It has huge grass-like seed heads. The seeds are easily dispersed through wind. Several seeds have landed at Milagra Ridge, producing strands of pampas grass. Pampas grass is a high priority invasive plant to control because its population can grow to immense proportions if uncontrolled. Pampas grass can grow as tall as 20 feet and can spread to form vast fields in which none of the indigenous Milagra Ridge plants could get enough light, water and soil to survive.

The park staff must decide how to control the pampas grass before it spreads out of control. The staff faces three options: apply herbicide, remove each plant physically, or do nothing to contain the pampas grass and use the park's limited resources for other purposes. The use of herbicide will make the removal of pampas grass much swifter. The National Park Service has called for a Town Meeting so that the public can offer opinions on the management of Milagra Ridge and whether or not to use herbicides.

The Case of the Pampas Grass

Stakeholder Role Cards

THE PLAYERS:

The Environmental Action Team

You are the Director of a small non-profit agency located in Pacifica. Although you have only four staff people and fifty members, you are well respected by the community. You oppose the herbicide solution because you feel that the city already has far too many challenges keeping the water supply clean. A contract with a local company may contribute to the economy but you feel residents should not have to sacrifice the community's health for jobs.

The Mayor's Office

You are the Representative of the Mayor's Office. From your viewpoint, the local company most likely to get the herbicide contract needs the business. You support any plan to bring jobs to the community. You also feel any environmental damage to wildlife will be minimal.

Dog Owner

You walk your dog every day in the park. There are very few parks where dogs are permitted. Dog walking provides exercise for you and your dog. You would like the park's resources used for a comfort station, benches, and trail improvements instead of for the removal of pampas grass.

Landscape Historian

You believe that the Spanish brought pampas grass here from South America. You feel that pampas grass should be left alone as a tribute to a neglected part of local history. You also would like to see some archeological work done at the site, with hopes of finding some artifacts and remnants from the Spanish period of exploration. You feel that exotic plant communities could be used as teaching tools to help people understand more about the cultures that brought the plants to the area.

UC Berkeley Ecologist

You support the park's effort to restore indigenous plant habitat. You bring your classes to Milagra Ridge because it is an important educational tool to help the public understand the significance of genetic and plant diversity and the delicate balance of nature that must be restored for the health of all living things.

The Eco Club President

You are the President of a nationwide environmental organization. You have over 150,000 members across the country and an operating budget of \$75 million. Your headquarters is in San Francisco but you live in Pacifica. You recognize the lasting dangers of using herbicides. You also want a ban on the use of pampas grass as ornamental garden plants. All Pacific residents would have to remove any pampas grass from their home landscaping. This will prevent the spread of pampas grass.

Hiker

You are the parent of three young children. Your family visits Milagra Ridge often. You enjoy the views and identifying plants along the trails. You are concerned that invasive plants are overrunning the indigenous plants.

Hiker

You love to come to Milagra Ridge for bird watching. You are aware of the affect of herbicides on birds and other wildlife.

Volunteer

You have volunteered for the National Park Service for over ten years ever since you were studying Environmental Science at San Mateo College.

Health Care Professional

As a cancer specialist, you are fiercely opposed to herbicides in any capacity. Every day at the local clinic, you see people from your community being treated for emphysema and asthma that could be avoided if they were not exposed to toxins.

Scientist with herbicide company

You work for the company that produces herbicide. From your viewpoint, the dangers of using herbicide are minimal. You believe the herbicides will wipe out the pampas grass and leave the area safe for the indigenous species.

Artist

You are an artist and teach art classes. You have been bringing students to Milagra Ridge for over fifteen years. Your favorite time of year is when the pampas grass is in bloom. The plant makes for a perfect subject for beginning artists.

Local High School Student

You are a local high school student. You came to the meeting today because you are interested in the future of your national park. You are willing to listen to all the alternatives with an open mind and then give your opinion about the use of herbicides on Milagra Ridge.

Invasive Plant Removal Worksheet #6

The Case of the Pampas Grass



1. Explain your personal point of view on The Case of the Pampas Grass.

2. How does your personal view address principles of Environmental Justice?

3. What question do you have about national park or city planning in regards to habitat restoration projects?

Planting

SUMMARY OF INSTRUCTIONAL ACTIVITIES



🖱️ **Plant Structure & Function** - page 2

- 🕒 ▶ Students locate and study a flowering plant on their school grounds.
- ▶ Students describe the plant and label the parts of the plant.
- ▶ Students discuss pollination and plant adaptation.
- ▶ Students use the Plant Guide on the National Park Labs web site to categorize plants by adaptation or structures.

🕒 **Planting** - page 6

- 🖱️ ▶ Students examine and describe for other students the adaptations of various indigenous plants.
- ▶ Students participate in the restoration of an area by planting native plants.

🖱️ **Habitat Restoration Around the World** - page 9

- 🕒 ▶ Students read articles about habitat restoration projects in other parts of the world.
- ▶ Students discuss articles and complete worksheets.

🕒 **Planting** - page 11

- 🖱️ ▶ Students examine and describe for other students the adaptations of various indigenous plants.
- ▶ Students learn more about the cultural uses of plants.
- ▶ Students participate in the restoration of an area by planting native plants.

🖱️ **Plant Quilt** - page 13

- 🕒 ▶ Students use the Plant Guide on the National Park Labs web site and additional resources to create a multicultural depiction of plants and plant uses.

Revegetation

To revegetate means to provide an area with new plant cover. In the Golden Gate National Recreation Area, revegetation usually refers to placing indigenous plants in areas from which park staff and volunteers have removed invasive, exotic plant species.

Why is it necessary for park staff to revegetate restoration sites? Why not just remove invasive plants and then let natural ecological processes revegetate the area gradually over time? Although this is the preferred option, it takes many years for an area to revegetate naturally. The site must be visited repeatedly to prevent the establishment of exotic, invasive species that may out-compete native seedlings. Additionally, many disturbed areas no longer have a native seedbank remaining in the soil. Growing plants in the nursery and introducing them into an area when they are relatively mature, or sowing seeds directly on-site, helps resource managers speed up the natural process. The indigenous plant community will reach a state of resiliency more quickly, and provide habitat for other members of the ecosystem. For example, by introducing mature silver lupine (*Lupinus albifrons*) to a site such as Milagra Ridge, park staff are able to provide much-needed habitat for the endangered Mission Blue butterfly.

REVEGETATION METHODS

Planting and direct seeding are the two methods used in the park to revegetate restoration areas. Planting involves transplanting seedlings that have been raised in the nursery and are already relatively mature. Direct seeding entails sowing seeds on-site and letting them germinate and develop naturally.

Propagules (seeds and cuttings) for propagating plants at the nursery or for direct seeding are gathered from the restoration site or from the immediate area. It is preferable to collect propagules as close to the site as possible because the genotype (genetic makeup) of plants can change within a very short distance. Sometimes seeds or cuttings of the required species are not available in the immediate area and must be gathered from farther away. As a general rule, however, it is best to gather the propagules within the boundaries of the watershed in which the restoration site is located.

🕒 Plant Structure & Function

SUMMARY

Students draw and label the parts of a flowering plant. They use the Plant Guide on the National Park Labs web page to compare and group plants according to the plants' adaptations.

TIME

100 minutes

MATERIALS

- ▶ Computers with Internet access
- ▶ Planting Worksheet #1

🕒 Lesson

Day 1

Students locate flowering plants on or near their school grounds.

Students examine the plant and describe the texture and color of the leaves, stem, and petals.

Students draw the parts of the flowering plant, including each of the following structures:

- Roots
- Stem
- Sepals
- Petals
- Pistil (stigma, style and ovaries)
- Stamen (filament and anther)

Students complete the Planting Worksheet #1 by labeling the parts of the flowering plant, matching the parts with their functions, and describing the process of pollination.

Teacher leads a discussion about flowering plants:

- ▶ What role do insects play in the process of pollination?
- ▶ What type of insects might visit your plant for food? Why?
- ▶ How do leaves help you determine which plants use a lot of water?
- ▶ How have flowering plants adapted to survive?

Students access the National Park Labs web site (www.nps.gov/goga/parklabs) and find the Plant Guide.

Students create a chart that categorizes and sorts the plants in the Plant Guide.

Students create their own categories and organization for the chart, using at least five different categories.

Planting Worksheet #1



Directions:

1. Locate a flowering plant near your school. Examine the textures and colors of the leaves, stem and petals of the plant. Complete the following.

- Draw and label the plant in the box below.
- Match the part with its function on the left.

_____ where photosynthesis occurs

_____ develops into a fruit

_____ absorb nutrients

_____ receives pollen

_____ supports the flowers and leaves

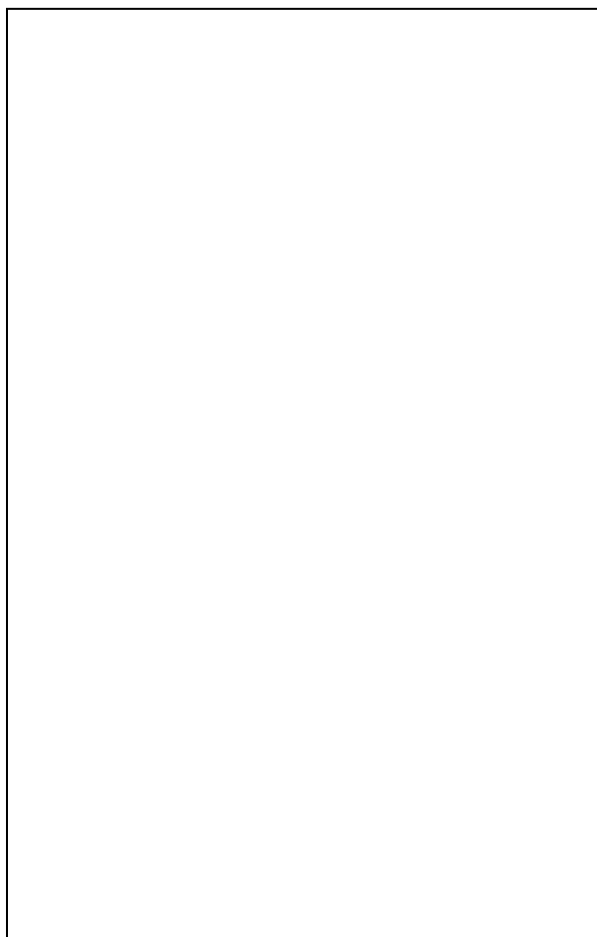
_____ protects flower buds

_____ supports the anther

_____ attract insects with color

_____ connects the stigma and ovary

_____ releases the pollen



2. Describe the process of pollination in detail.

Planting Worksheet #2



Directions: Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs. Locate the section titled Plant Guide and complete the following:

1. Create a chart below that categorizes and sorts the plants in the Plant Guide. Use at least 5 categories.
2. Explain how and why you chose the categories.

2. Write two questions about plant adaptation.

○ Planting

SUMMARY

Students study adaptations of plants and compare and contrast the essential functions that these adaptations serve. Students plant a restoration site.

TIME

4 hours

MATERIALS

- ▶ Picks ▶ Gloves
- ▶ Restoration Cycle (visual aid)
- ▶ Planting Worksheet #3
- ▶ GGNRA Work Performed Data Sheet

🔄 Program

Welcome

Park staff welcome students to the park. Using the Restoration Cycle visual aid, park staff ask the students to point out what step in the restoration cycle they think they will perform today. Park staff explain the planting project. They ask the students why revegetation is important. (The hope is that after establishing an indigenous plant community, various native animals will return, including many birds, insects, frogs and butterflies.)

Spread Plants

Students are introduced to the species that their group will be planting. Park staff explain the basics of plant spacing and ask the students to work in pairs to properly space the plants throughout the planting area.

Planting

Park staff give a planting demonstration and explain pick safety rules. Plants can survive rough handling but will always respond better if handled with care. Transplanting can disturb root systems; roots are the principal pathways by which plants take up water and nutrients, and any damage to the fragile root hairs will reduce the plant's ability to feed itself. Once planted in its natural habitat, the plant will not be watered or given fertilizer. Therefore, the bigger and healthier the root system, the better the plant will be able to remove water and nutrients available in the soil. One moment of rough or poor handling can ruin months of careful preparatory work in the nursery!

Students and staff plant. Staff facilitates a discussion. Include the following questions: Which step in the water cycle does fog represent? Condensation. How do plants fit into the water cycle? Transpiration through stomata. How does the weather and climate affect plants? How can a plant protect itself from wind? How can a plant protect itself during drought periods? How have plant roots adapted to the local climate? Why are we planting at this time of year? Once planted in its natural habitat, the plant will not be watered or given fertilizer. The rainy season provides the plants with needed moisture.

GGNRA Work Performed Data Sheet

Each group completes the GGNRA Work Performed Data Sheet. Students complete sections of Planting Worksheet #3 at each station.

Conclusion

Staff and students form a circle.

Staff review adaptations and functions with the class, emphasizing that different adaptations serve the same function for different plants. All plants have some method to regulate water loss, protect themselves from weather and insects, and disperse their seeds.

Park staff thank the class for their hard work during the planting.

Planting Worksheet #3



Directions: Complete the section for each station at the field session at Milagra Ridge. Formulate at least one question at the end of each station.

STATION 1

4. What is the total number of individual plants planted by your group? _____

5. Write at least one question about plant adaptations.

STATION 2

4. What is the total number of individual plants planted by your group? _____

5. Write at least one question about plant revegetation methods.

STATION 3

4. Record the length and width of the planting site. _____

5. Complete the work performed data sheet at your final station.

6. Write at least one question about the future of this site.

🌍 Habitat Restoration Around the World

SUMMARY

Students are introduced to habitat restoration projects around the world. They compare these projects with each other, and with the restoration projects in Golden Gate National Recreation Area. They address the relationship of the Endangered Species Act to each project. They design a set of questions and recommendations for a restoration project manager to consider.

TIME

100 minutes

MATERIALS

- ▶ Four articles on restoration projects (These can be found using a simple Internet search.)
- ▶ Planting Worksheet #4

🌍 Lesson

Teacher explains to the class that the park restoration project they have been working on fits into a much larger picture of restoration projects worldwide. Today students will learn about some other restoration projects and have a chance to compare Golden Gate National Recreation Area's restoration project to the others. Each student is given one of the four articles on restoration projects.

Students read their articles. After reading the articles, students divide into groups by article. In their groups, students discuss their article and answer questions 1 to 8.

Students "jigsaw": Form new groups of four in which one representative from each of the original groups is present in the new group. In the new groups, students present the restoration project they read about. Students answer questions 9 to 11.

The class comes together. They discuss the purpose of restoration. In Golden Gate National Recreation Area, the goal of restoration is to increase plant and animal diversity, and protect Endangered species. Is this a valid goal? How does it compare to the goals of the other restoration projects? Considering other environmental challenges, how important is restoration? Who benefits from restoration of natural areas?

Planting Worksheet #4

Restoration Around the World



TO BE DISCUSSED IN FIRST GROUP:

1. What is the goal of this restoration project?
2. Who or what will benefit from this project, if successful?
3. Does this project benefit people of all economic classes? Why or why not?
4. Who is sponsoring or funding this restoration work?
5. Does this project show collaboration between interest groups or is it a one-sided effort?
6. Who might be against this project? Who or what does it affect negatively?
7. How does this project approach endangered species and their protection?
8. What is your opinion of this project?

TO BE DISCUSSED IN SECOND GROUP:

8. Do you think one of these projects is more important or valuable than another?
9. If you had to choose only two of the four projects, which two would you choose? Why?
10. Compare these projects to the restoration project you have been working on in the Golden Gate National Recreation Area. Which is more valuable? Why?

Planting

SUMMARY

Students study adaptations of plants and compare and contrast the essential functions that these adaptations serve. Students plant a restoration site.

Program

Students cycle through three stations. Students engage in similar planting activities as in earlier visit to Milagra Ridge. They discuss cultural uses of plants. They complete Planting Worksheet #5 at each station.

Planting Worksheet #5



Directions: Complete the section for each station at the field session at Milagra Ridge. Formulate at least one question at the end of each station.

STATION 1

1. What is the total number of individual plants planted by your group? _____

2. Write at least one question about cultural views.

STATION 2

1. What is the total number of individual plants planted by your group? _____

2. Write at least one question about cultural uses of plants.

STATION 3

1. Record the length and width of the planting site. _____

2. Complete the work performed data sheet at your final station.

3. Write at least one question about this restoration project.

🕒 Plant Quilt

SUMMARY

Using the Plant Guide on the National Park Labs web site and additional research, students create a “quilt” depicting different ways cultures view and use plants.

TIME

50 minutes on Day 1

35 minutes on Day 2

MATERIALS

- ▶ Old magazines
- ▶ Glue
- ▶ Scissors
- ▶ Tape
- ▶ 12" x 12" squares of white paper
- ▶ 14" x 14" squares of construction paper (various colors)
- ▶ Computers with internet access
- ▶ Additional research material on cultural uses of plants

🕒 Program

Day 1

Students brainstorm about how different cultures view and use plants. (For some cultures, certain plants are food or medicine while for others they are not. Some cultures use plants ornamentally; some use them for religious ceremonies. Plants that are considered weeds for some people are desirable for others.) Teacher prompts the students to think about plants from various viewpoints.

Students divide into small groups. Each group receives a piece of the white paper. Using images and ideas from the National Park Labs web site, the resource material, and the magazines, they begin creating a quilt square depicting what they understand as one culture’s view of a particular plant.

Students clean up; teacher tells them that they must be ready with their quilt square by the beginning of the next class session.

Day 2

Each group glues its completed quilt square onto a piece of the construction paper.

The entire class places the squares together in the shape of a quilt. Once the class agrees on the arrangement of the squares, the class tapes the squares together.

The class hangs the quilt on the classroom wall. Each group describes its square to the other students.

Land Values

SUMMARY OF INSTRUCTIONAL ACTIVITIES



📍 **Nuclear Reactions** - page 1

- 🕒 ▶ Students consider and express personal opinions about military land values.
- ▶ Students formulate questions about the history of the Nike Missile Site in the Marin Headlands (similar to one once installed at Milagra Ridge).

📍 **Cold War Landscape** - page 6

- 🕒 ▶ Students visit the Nike Missile Site in the Marin Headlands
- ▶ Students formulate questions about their visit.

📍 **Land Values** - page 8

- 🕒 ▶ Students identify the values and priorities of the United States Army and the National Park Service.
- ▶ Students compare these values and priorities to their Top Ten List of Environmental Rights.
- ▶ Students formulate questions.

● Nuclear Reactions

SUMMARY

Students consider and express personal opinions about military land values. They generate questions after reading fact sheet.

TIME

Part 1: 30 minutes

Part 2: 30 minutes

MATERIALS

- ▶ Land Use Statements
- ▶ Nike Missile Site Fact Sheet
- ▶ Land Values Worksheet #1

○ Lesson

Part 1

Teacher designates one side of the classroom as AGREE and the opposite side as DISAGREE. Students will need to choose whether they agree or disagree with a statement that is read aloud. The teacher emphasizes that there are no right or wrong answers, just a matter of personal belief.

Students stand in the center of the classroom. Students read statements aloud. They decide their choice by moving to the respective sides of the room. Teacher facilitates discussion after each statement. Teacher asks at least one student on each side to explain her/his decision.

The following are suggested questions:

- ▶ Why do you agree/disagree?
- ▶ What thoughts helped you come to your decision?
- ▶ What are the pros and cons of your decision?
- ▶ What might make you change your decision?

Part 2

Students receive and read the Nike Missile Site Fact Sheet. They generate at least one question about military land use, and share their questions with the class.

Students then discuss how their questions might relate to other types of land uses (agriculture, urban growth, open space, recreation opportunities, wildlife habitat, transportation needs, etc.).

Students answer first question in Land Values Worksheet #1.

Land Use Statements



Directions: Read each of the following statements.
Decide if you agree or disagree.

- The presence of nuclear warheads makes me feel safe.
- The United States has no enemies.
- The United States should continue to develop nuclear warheads for defense.
- The United States should work towards abolishment of all nuclear weapons.
- The United States should continue to test nuclear warheads in the future.
- Using land for universities is more productive than military purposes.
- We should continue to invest money in military technology.
- Military installations should be located away from cities.
- A strong national defense is more important than the protection of endangered species.
- I think resolution can be achieved without military intervention.
- The military conducts useful research for civil purposes.

Nike Missile Site Fact Sheet



What are the Nike Missile Sites?

- High security nuclear missile storage and launching facilities
- Designed to protect urban areas from potential enemy attack
- Each Missile Site holds from 12-24 surface-to-air guided missiles Hercules Missiles.

When were these sites active?

- Constructed during the beginning of the Cold War
- Activated between 1959 and 1965
- Deactivated in 1974 when the SALT I treaty deactivated all Nike Missile Sites except for two for historic preservation, one in the United States and one in the former Soviet Union.

Where were they located?

- 300 Nike Missile Sites built throughout the country, 12 Nike Missile Sites served the Bay Area

Who operated these systems?

- Nike soldiers were selected through extensive tests.
- Every soldier was specialized in training so that no one person could singularly know how to launch the missile.
- Every soldier was expected to do 24 to 72 hour shifts in practice for the challenges of being at war.
- The soldiers had to remain secretive about their job so that the outside population did not know about the operations.

How do the Hercules Missiles work?

- High explosive or nuclear warhead which explodes upon impact
- Through radar detection, the warhead intercepts and destroys enemy targets
- Can target anything within a 100 mile radius
- If dropped on land, a Hercules Missile has 2 1/2 times the nuclear power of the bomb dropped on Hiroshima.

How did the United States government explain building Nike Missile Sites?

- Defense against a perceived threat from Soviet attack
- A part of the necessary preparation within the nuclear arms race
- "Our business at the time was to be ready and we were ready."
-Ron Parshall, U.S. Army veteran.

○ Cold War Landscape

SUMMARY

Students visit the Nike Missile Site in the Marin Headlands. They formulate questions about their visit.

TIME

2 hours

MATERIALS

- ▶ Land Values Worksheet #1

🏠 Program

Students divide into three groups. Each group begins at a specific station. Students rotate through the stations:

- ▶ Conflict and Technology
- ▶ Cold War Landscape
- ▶ Crucial Minutes

The groups reconvene to share their experiences and reactions from each station. Students complete Land Values Worksheet #1: Students write about what it might have been like to serve as a soldier at the Nike Missile Site, and formulate questions.

Land Values

SUMMARY

Students identify the values and priorities of the United States Army and the National Park Service. Students compare to their Top Ten List of Environmental Rights. Students formulate questions.

TIME

Part 1: 30 minutes

Part 2: 20 minutes

MATERIALS

- ▶ Land Use Statements
- ▶ Top Ten List of Environmental Rights
- ▶ National Park Service mission
- ▶ Land Values Worksheet #2

Lesson

Part 1

Students review the Land Use Statements. They work in groups to list the statements that support the values and priorities of the United States Army.

Students review the National Park Service mission and list the Land Use Statements that support the values and priorities of the National Park Service.

Students then generate at least two more statements about land use that support the values of the United States Army and two more statements for the National Park Service. They add their statements to their lists.

Students compare both lists. They determine the similarities and differences between the values of the United States Army and the National Park Service. Groups share their statements and their comparison of the values with the class.

Part 2

Students review their Top Ten List of Environmental Rights and the Land Use Statements. They work individually to identify the Land Use Statements that support their Top Ten List.

Students select two Land Use Statements. They write their original response (agree or disagree) to the statement. They determine their current response for both statements.

Students write a paragraph for each statement that explains her/his before and after responses.

Land Values Worksheet #2



1. Record two statements that support land uses values of the United States military.

2. Record two statements that support land use values of the National Park Service.

3. Identify two statements that support your list of Top Ten Environmental Rights.

Monitoring

SUMMARY OF INSTRUCTIONAL ACTIVITIES



📍 **Tools of the Trade** - page 3

- ▶ Students learn how to use a compass, digital camera, and record data.
- ▶ Students enhance skills in topographical map reading.

📍 **Monitoring** - page 5

- 📍 ▶ Students conduct qualitative monitoring at Milagra Ridge

📍 **Redommendations to Management** - page 8

- ▶ Students work in groups to compare their qualitative monitoring with past photographs.
- ▶ Students send the National Park Service a proposal that includes recommendations for applying monitoring to endangered species management.

Monitoring

Natural resource managers need a systematic method to record information and detect changes that occur in natural systems over time: year after year, season after season, or at some other regular time interval. Monitoring is the regular collection and analysis of data at regular intervals over time, to predict or detect natural and human-induced changes, and to provide the basis for appropriate management response. The collection of baseline information on natural resources, as well as the initiation of long-term monitoring programs to alert management to changes, are essential parts of the natural resource program in a national park. In Golden Gate National Recreation Area, park staff monitor approximately 2 percent of a site. This conforms to constraints in time and personnel. There are many different methods of monitoring. Specific management objectives determine which method is used.

QUALITATIVE MONITORING

Qualitative monitoring tracks the quality of the natural resources in a site. The quality of natural resources includes plant health and size, as well as the general appearance of an area. Photomonitoring is one type of qualitative monitoring. Photomonitoring (as opposed to random picture taking) is the photographing of a site from precise documented locations at specific times of the year. The purpose of this form of monitoring is to visually document the changes in a landscape over a period of time. By photographing at the same time of year, seasonal changes are eliminated from the documentation. In addition to these monitoring photos, many sites in the park have a site journal in which the stewards of that area record in writing and drawings the changes that occur.

QUANTITATIVE MONITORING

Quantitative monitoring is used to get more detailed information about changes in an area. Information on the diversity of plant or wildlife species, or the number of individuals of a particular species, may be gathered. Use of a vegetative transect is one method of quantitative monitoring. Transects require precision and consistency. During transect monitoring, plants are sampled every one-fifth of a meter for 10 meters, using a sampling rod. Any plant species touching the rod at a given point is recorded. Plants are identified using a dichotomous key and the information is recorded. The percentage of cover for each species found on the transect can then be calculated.

Another method of quantitative monitoring is quadratic monitoring. A quadrat is a rectangle of one square meter or less. The quadrat is placed randomly in the site and information regarding the percent cover of each species that lies within the quadrat is recorded.

Tools of the Trade

SUMMARY

Students learn how to use a compass, digital camera, and record data in class. Students will master basic compass skills, topographical map reading, and the use of a meter wheel.

TIME

Part 1: 50 minutes

Part 2: 20 minutes

MATERIALS

- ▶ Topographical maps of Milagra Ridge
- ▶ 2 meter wheels ▶ compasses
- ▶ clipboards ▶ 2 cameras
- ▶ film ▶ pencils
- ▶ GGNRA Work Performed Data Sheet
- ▶ monitoring point location information
- ▶ photos from previous year
- ▶ photo monitoring pictures
- ▶ digital cameras and accompanying diskettes

Lesson

Part I

Teacher divides class into groups. Each group receives a digital camera with diskette inserted and photomonitoring pictures. Each student receives a compass.

Teacher familiarizes the students with proper compass use. If there are students who have used a compass before, they should help their classmates who are less familiar with it. The students can begin by learning to face north. Students line up the "N" on the dial of the compass with the black arrow (called the "travel" or "directional" arrow) on the face of the compass. Holding the compass flat and with the directional arrow pointing in front of them, the students spin slowly around until the red end of the suspended needle falls within the red outline of an arrow. (This is called "putting the red in the shed.") Once the red is in the shed, they are facing north.

Teacher demonstrates the use of the digital camera. Students are warned not to drop the camera, as it is very fragile and will break if dropped. (It is best for them put the strap around their necks when they are using it.)

Part 2

Teacher gives each group a topographical map of Milagra Ridge.

1. They use the map to answer the following questions:

- a. What is in the SW corner of this map?
- b. Which way does Milagra Creek flow?
- c. What are the contour intervals of this map?
- d. Where is the Pacific Ocean in relation to the map?
- e. What is the general direction of the roads and trails on Milagra Ridge?
- f. Where is the highest point on the map and to what landmark is it closest?
- g. If you were standing at the Former Missile Silos in which direction would you look to find the Former Oxidation Pond?

2. Determine the landscape features located at these points:

- a. Direction: 90° from the center of the Carmel Ave. cul-de-sac.
Distance: 3,250 feet
- b. Direction: 0° from the center of the Carmel Ave. cul-de-sac. Distance: 1,850 feet
- c. Direction: 42° from the "S" in Sharp Park Rd. Distance: 1,450 feet
- d. Direction: 240° from the "C" in Milagra Creek. Distance: 1,700 feet
- e. Direction: 172° from the "H" in Highlands. Distance: 2,150 feet
- f. Direction: 133° from the "E" in Manor Village. (Manor Village is located in the NW corner of the map.) Distance: 1,600-1,700 feet. What is the approximate elevation at this landmark?

○ Monitoring

SUMMARY

Students spend four hours on Milagra Ridge primarily conducting photomonitoring.

TIME

4 hours

○ Program

Welcome

Park staff welcome students to Milagra Ridge. A few students share questions from their journals. (These questions are used as discussion topics during the station rotations.) The class discusses key concepts of invasive plants, quantitative monitoring, and qualitative monitoring.

Stations

Students rotate through qualitative and quantitative monitoring stations. Staff and students clean up stations.

Conclusion

Staff and students form circle and students write questions. Each student shares one question with the group. Staff thanks students for their work.

STATION I - PHOTOMONITORING

Procedures:

- ▶ Students work in groups to locate and photograph the monitoring point. One student uses the diagram with the monitoring points to lead the group to the first monitoring point. A second student uses the compass and the list of photo coordinates to line up the angle for the first photo. A third student takes the photograph and a fourth student completes the photomonitoring log. The remaining students are responsible for agreeing on the angle for each photo, guiding the photographer, and collaborating on the correct information for the photomonitoring log. Students repeat the photomonitoring for all the monitoring points and coordinates, shifting responsibilities for each photo.

- ▶ Park staff stimulate discussions about disturbance, possible effects, and the advantages/disadvantages of qualitative monitoring methods. Include the following questions: Why are the photographs taken from these positions? (What is the logic behind the positioning? What features are included/excluded from the photos?) What can you predict about insect and animal populations from the information you are gathering regarding the appearance of the restoration site? How many years' worth of photos are necessary to get a good picture of any trends in the restoration site? Are there any drawbacks to photomonitoring? (Varying quality of photos, inexact angles, photos taken at different times of day/year.) What are some ways that photomonitoring benefits a restoration project? (Brings restoration to life for interested parties: new employees, funders, and people who cannot see the project in-person).

STATION 2 - VEGETATION MONITORING

Procedures:

- ▶ Park staff introduce the station by discussing the fragility of an ecosystem and the effects of human impact on it. Park staff ask the students to think about the background reading that explained different types of monitoring. How might the quadrat be used for monitoring? Do you think it is for qualitative or quantitative monitoring? Quantitative.
- ▶ Park staff hand out a quantitative monitoring log to each student.
- ▶ A student tosses the quadrat into the area to be monitored.
- ▶ The group counts the number of different species growing within the quadrat. Using the plant key and the visual aids, students identify the species and determine if they are indigenous or exotic. Students agree on an estimation of the percent of the quadrat area that each species covers. If the students have difficulty estimating percent cover, they may draw some examples on the whiteboard (a pie chart of 50 percent, 30 percent, and 10 percent, etc.).
- ▶ One student records on the whiteboard the numbers and percentages that are found.
- ▶ Students toss the quadrat and repeat the data gathering process at least three times.

- ▶ Some questions for discussion:

Is it better to have some bare ground or total plant cover inside the quadrat? (Bare areas can be a natural part of a healthy, evolving system. The soil is an abiotic component of the ecosystem; the plants and the soil are interdependent.) What is monoculture? Have we found any monocultures within the quadrat? Is an ecosystem with a monoculture or a high diversity of plants healthier? Why? What can you predict about insect and animal populations from the information regarding plant cover? How many quadrats would you have to analyze to get a good representation of the restoration site as a whole?

- ▶ Staff and students clean up stations.

🕒 Recommendations to Management

SUMMARY

Students use the National Park Labs web site to compare their work with past photographs. They determine the purpose of monitoring and its importance at Milagra Ridge. The class writes a proposal to the National Park Service with recommendations for applying monitoring to endangered species management.

TIME

100 minutes

MATERIALS

- ▶ Computers with Internet access
- ▶ Monitoring log
- ▶ Milagra Ridge Management Plan

🕒 Lesson

Students use the National Park Labs web site to compare their work with past photographs. They interpret any changes since last year.

Students determine how photomonitoring contributes to the well being of Milagra Ridge. They should be stimulated to think about scientific methodology and the ramifications of its use in management practices, land development, environmental law (Endangered Species Act), and long term effectiveness in meeting specified goals.

They address the following:

- ▶ Advantages and disadvantages to photomonitoring
- ▶ Ways that photomonitoring benefits a restoration project
- ▶ Status of insect and animal populations
- ▶ Plant diversity and density
- ▶ Ways to determine whether to continue or change current restoration strategies

Students review the Milagra Ridge Management Plan. They compare the plan to their Top 10 List of Rights and their list of physical evidence from the Environmental Justice lesson from the Perspectives module.

Students create a list of recommendations for improving the management of Milagra Ridge and the protection of its endangered species. Groups submit their recommendations to Golden Gate National Recreation Area for consideration.

Culminating Project: Applying Knowledge

CLASSES CHOOSE ONE PROJECT



🕒 Student Exhibitions - page 1

🕒 (facilitated by park staff and classroom teacher)

- ▶ Individuals or small groups of students create exhibitions illustrating an aspect of their experience in the program.
- ▶ Students give presentations for NPS staff, other students, and teachers.
- ▶ NPS staff award participation certificates to students.
- ▶ Students learn about summer internships and job opportunities in local parks and environmental organizations.
- ▶ Students display their exhibitions in their schools, in park visitor centers, on the National Park Labs web site, at restoration fairs, and/or at community centers.

or

🕒 Neighborhood Restoration - page 3

🕒 (facilitated by park staff and/or a cooperating community agency)

- ▶ *Students apply concepts learned during the program while participating in a restoration or beautification project in their school or a local park.*
- ▶ NPS staff award participation certificates to students.
- ▶ Students learn about summer internships and job opportunities in local parks and environmental organizations.

Culminating Activity

Option 1: Student Exhibitions

SUMMARY

Whether classes choose the student exhibitions or the neighborhood restoration project, the culminating activity is an opportunity to reflect on the concepts learned during the program and celebrate the students' contributions to habitat restoration. Students learn how they can continue working for the health of the environment through paid and unpaid internships offered by the National Park Service and other agencies.

TIME

Part 1: Two 50-minute class periods plus 30 minutes for preparation

Part 2: One 50-minute class period plus 90 minutes for preparation

MATERIALS

- ▶ Sample exhibits from previous years
- ▶ New or recycled materials to create exhibitions
- ▶ Reference material such as plant information cards, nursery handbook, textbooks, curriculum guide
- ▶ Scissors, straight-edge, colored pencils, pens, etc.
- ▶ Notes and assignments from National Park Labs activities
- ▶ Digital pictures of students participating in National Park Labs activities
- ▶ Internship announcements
- ▶ Certificates

● ● Program (facilitated by NPS staff and teacher)

Part 1, Day 1 (facilitated by teacher)

Teacher congratulates students on accomplishing a great deal of vital restoration work. In order to share the knowledge they have gained during their restoration project, students will make an exhibition covering a specific aspect of what they learned. Exhibitions will be displayed in their school, at park visitor centers, on the National Park Labs web site, at restoration fairs, and/or at community centers.

Students refer to the journal questions they formulated during the National Park Labs lessons. Have any of these questions been answered? Students now formulate five new questions about any aspect of the program. The teacher helps the students determine which of these questions would be good topics for exhibitions.

The teacher divides students into small teams to create the exhibitions. (Some students may elect to work independently but should still complete a comprehensive exhibition.) Each group meets for a short time and decides on a topic for their display. The teacher approves the topics before students are allowed to proceed.

Each group sketches a plan for their exhibition and divides the work among the group members. The teacher approves the plan before students begin work on the actual exhibitions.

Part 1, Day 2 (facilitated by teacher)

Students work in their teams to complete their exhibitions.

Part 2:
Creating Exhibitions (facilitated by NPS staff)

Park staff greet the class, congratulate the students, and thank them for their hard work during the program.

Students present exhibitions.

Staff give certificates to each student and the teacher.

Students learn about summer internship opportunities and enjoy refreshments.

Culminating Activity

Option 2: Neighborhood Restoration Project

SUMMARY

Whether classes choose the student exhibitions or the neighborhood restoration project, the culminating activity is an opportunity to reflect on the concepts learned during the program and celebrate the students' contributions to habitat restoration. Students learn how they can continue working for the health of the environment through paid and unpaid internships offered by the National Park Service and other agencies.

TIME

2 hours

90 minutes for preparation

MATERIALS

- ▶ Internship announcements
- ▶ Certificates

Program (facilitated by NPS staff and/or a cooperating agency)

Preparation

Park staff arrange with a local agency for the class to work on a restoration or beautification project at an area near their school. The class may do a project on their school grounds.

Students, teacher and staff meet at the chosen project site.

Welcome

Park staff or cooperating agency staff welcome students to the site, introduce the project, and explain the work procedure.

Project

The class works on the project. During the work, park staff help the students make intellectual connections between today's project and the restoration project the students completed in Golden Gate National Recreation Area.

Discussion

When the work is complete, students discuss the similarities and differences between this work and what was done in Golden Gate National Recreation Area. Which project is more important? Who are the stakeholders in each project? Who has access to which open spaces? Park staff ask the students to recall the Case of the Pampas Grass scenario. What other options might have been proposed for this open space?

Reflection

Students refer to the journal questions that they formulated during the National Park Labs lessons. Have any of these questions been answered? How have the students' views changed during the program? Park staff help the students understand that learning is a lifelong process, and often, questions lead not only to answers but to more questions. Students now formulate five new questions they have about any aspect of the program.

Conclusion

Park staff give certificates to each student and the teacher. Students learn about summer internship opportunities and enjoy refreshments.

Invasive Plant Removal Worksheet #4



- Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs.
- Locate the section titled Can YOU Use a Dichotomous Plant Key?

At each step in a dichotomous key you are asked to choose between _____ for the plant you're trying to identify.



MYSTERY PLANT #1

What is a simple leaf?

What is the common name for this plant?



MYSTERY PLANT #2

What is an inflorescence?

What is the Latin name for this plant?



MYSTERY PLANT #3

What are rhizomes?

Draw a picture of this plant on the back of this page.



MYSTERY PLANT #4

What are dissected leaves?

This plant is a member of what family?



MYSTERY PLANT #5

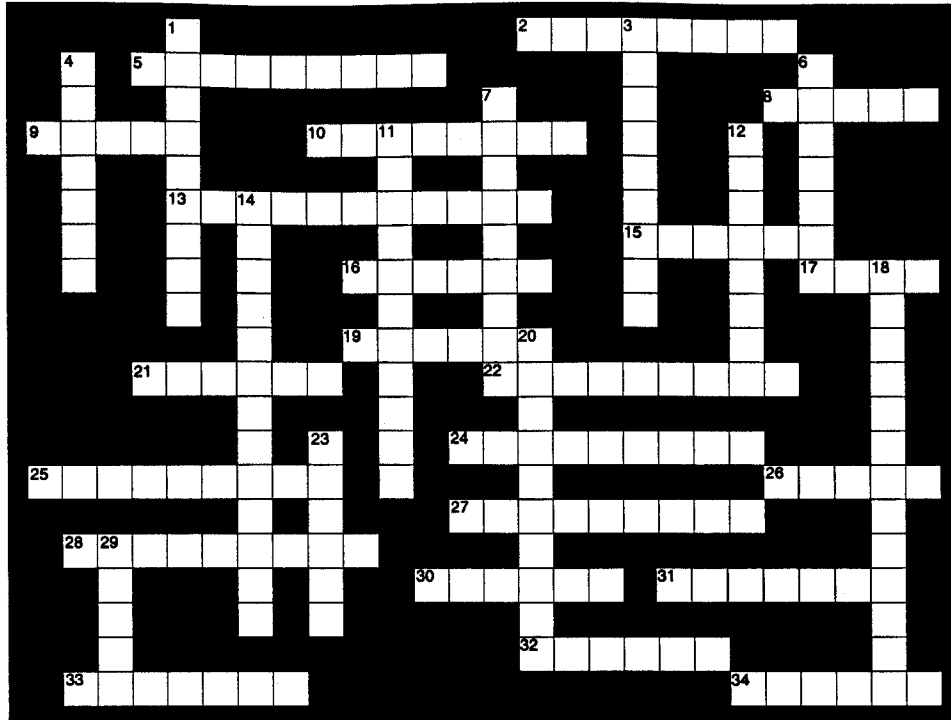
What are pedicels? _____

In what part of the world does this plant originate?

Vocabulary Word Puzzle



Directions: Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs/. Find the Glossary. Find the words that match the definitions.



ACROSS

- | | |
|---|---|
| 2 One leaf contains several leaves | 21 A leaf with only one segment |
| 5 To sprout | 22 A plant with thick, fleshy leaves |
| 8 Leaves with round or wavy edges | 24 Plants that lose leaves when it gets cold |
| 9 The leaf itself | 25 Leaves not directly across from each other |
| 10 Leaves directly across from one another | 26 A convex-shaped inflorescence |
| 13 Taking over natural range of native plants | 27 Leaves that look feathery |
| 15 Plants that die after 1 year | 28 Male and female flowers on one plant |
| 16 Female part of a flower | 30 Leaves with straight, smooth edges |
| 17 Where the leaf attaches to the stem | 31 Circular cluster of leaves at plant base |
| 19 A tuft of hair | 32 Sweetish liquid in flowers |
| | 33 Having no stalk |
| | 34 Male part of a flower |

DOWN

- | | |
|--|--|
| 1 Plants that resprout without being replanted | 12 Liquid extract |
| 3 Lying flat or trailing along the ground | 14 Loss of water from plants |
| 4 Leaves shaped like a hand | 18 The flowering part of a plant |
| 6 Petals of a flower | 20 Progressive changes in nature |
| 7 Species with male and female plants | 23 A plant with nitrogen-fixing bacteria |
| 11 Leads to fertilization and seed production | 29 Leaves that are egg-shaped |

Planting Worksheet #1



Directions:

1. Locate a flowering plant near your school. Examine the textures and colors of the leaves, stem and petals of the plant. Complete the following.

- a. Draw and label the plant in the box below.
- b. Match the part with its function on the left.

_____ where photosynthesis occurs

_____ develops into a fruit

_____ absorb nutrients

_____ receives pollen

_____ supports the flowers and leaves

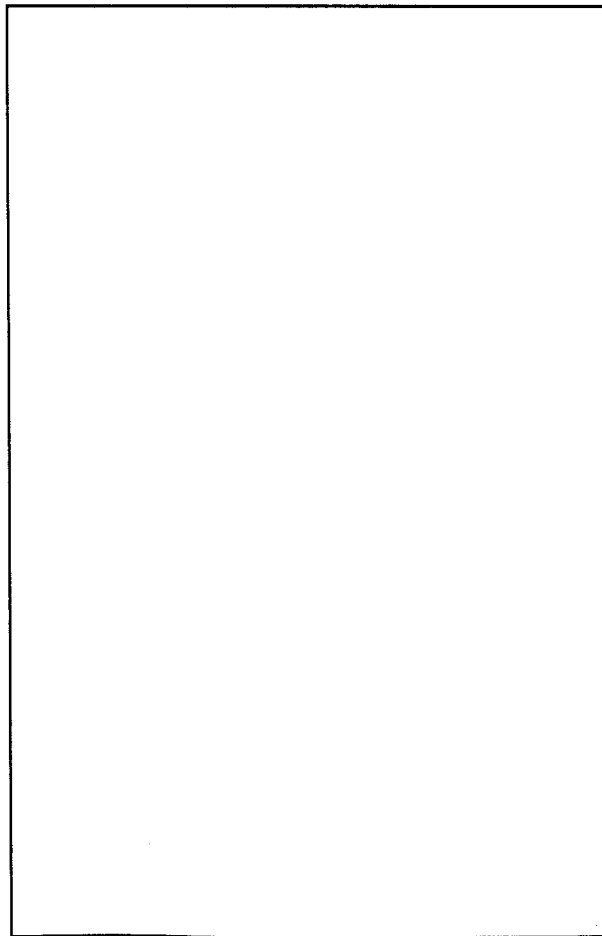
_____ protects flower buds

_____ supports the anther

_____ attract insects with color

_____ connects the stigma and ovary

_____ releases the pollen



2. Describe the process of pollination in detail.

Planting Worksheet #2



Directions: Go to Golden Gate National Recreation Area's National Park Labs web site: www.nps.gov/goga/parklabs. Locate the section titled Plant Guide and complete the following:

1. Create a chart below that categorizes and sorts the plants in the Plant Guide. Use at least 5 categories.
2. Explain how and why you chose the categories.

2. Write two questions about plant adaptation.
