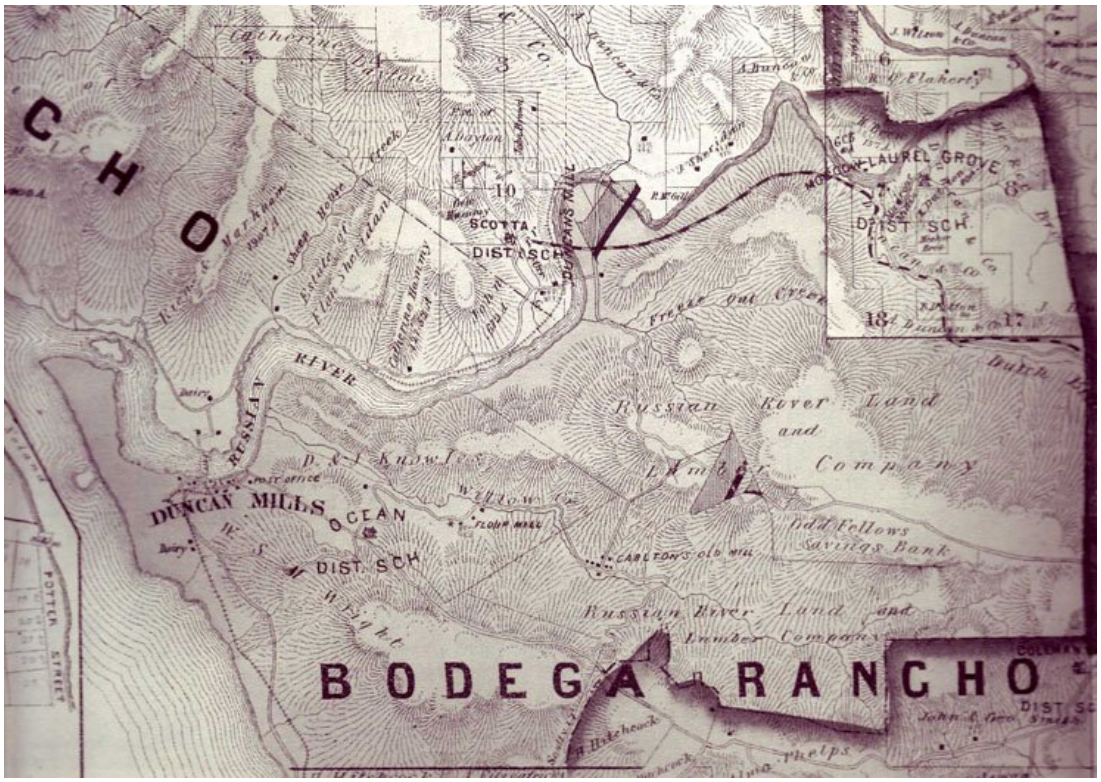
California State Parks



Sonoma Coast State Park
Environmental Living Program
Docent Manual

Developed by Stewards of the Coast and Redwoods
Russian River District State Park Interpretive Association

Environmental Living Program
Sonoma Coast State Park

California State Parks/Russian River District

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Volunteer Welcome:
Sonoma Coast
Environmental Living Program

The Sonoma Coast and Willow Creek Watershed encompass beaches, tidepools, dunes, prairies, oak scrubland and redwood groves. This biodiversity has allowed a variety of wildlife and human cultures to live and thrive, from Pleistocene mega-herbivores to Native Americans. Volunteers in this Environmental Living Program introduce fourth to sixth graders to the natural and cultural history of this area during one- or two-day visits. Volunteer docents lead on-site discussions of the lives of the native people and the fur-traders, loggers and ranchers that followed them, and their impact on the watershed. Docents lead activities to collect and analyze data on the watershed and to recreate lifestyles of the cultural groups who lived here. These experiences are intended to make students more aware of the natural resources in an area and the impact of humans and their cultures on an environment. The volunteers in this program are crucial to convey the importance of stewardship of natural resources to the young people of northern California. This program is managed by the Stewards of the Coast and Redwoods, a non-profit group that provides volunteer support and funding for education and resource management in partnership with California State Parks in the Russian River District .

Environmental Living Program Contact Information

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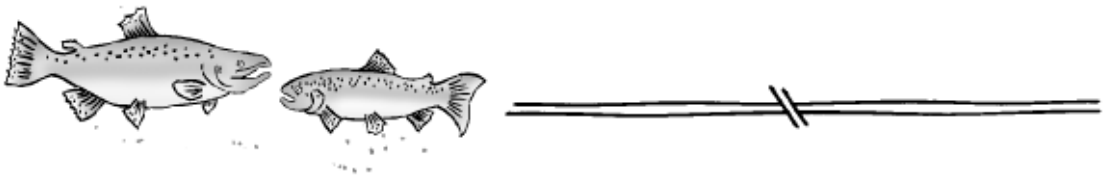
Michele Luna, Executive Director	mluna@mcn.org
Environmental Living Program Coordinator	**(707) 546-5842**
Suzanne Abrams	ssabrams@sbcglobal.net
State Park Dispatch	**(916) 358-1300**
(If you need a Ranger immediately or for law enforcement issues)	
Jenner Visitor Center:	707-865-9757
State Parks contact, Greg Probst	707- 875-2603
State Parks Staff, Bodega Dunes	707-875-9651

Part I

Introduction to Volunteering in

California State Parks



California State Parks

The State Park concept generally is believed to have started in California in 1864 when President Abraham Lincoln signed an Act of Congress transferring the areas then known as the Yosemite Valley and Mariposa Grove of Sierra Redwoods to California. In 1905, however, the lands were returned to the federal government.

Three years earlier, in 1902, the present California State Park System was begun with the establishment of the California Redwood Park at Big Basin in Santa Cruz County. It is only fitting that one of our state's proudest possessions - the magnificent coast redwoods - should have provided the inspiration for the creation of California's first permanent park.

Today, with nearly 300 units, California has the most diversified and one of the largest park systems in the nation. Represented in those units are outstanding examples of the state's unique scenery, including redwoods, deserts, historical units, scenic reserves, recreation areas and mountain parks for the public to enjoy.

The California Department of Parks and Recreation acquires, designs, develops, operates and maintains units of the State Park system. These activities are directed toward the accomplishment of eight principle objectives:

1. Secure and preserve elements of the State's out-standing landscape, cultural and historical features.

2. Provide the facilities and resources which are required to fulfill the recreational demands of the people of California.

3. Provide a meaningful environment in which the people of California are given the opportunity to understand and appreciate the state's cultural, historical and natural heritage.

4. Maintain and improve the quality of California's environment.

5. Prepare and maintain a statewide recreational plan that includes an analysis of the continuing need for recreational areas and facilities and a determination of the levels of public and private responsibility required to meet those needs.

6. Encourage all levels of government and private enterprise throughout the state to participate in the planning, development and operation of recreational facilities.

7. Meet the recreational demands of a highly accelerated, urban-centered population growth, through the acquisition, development and operation of urban parks.

8. Encourage volunteer service in the State Park System.

State Parks Rules and Regulations

While participating as an Environmental Living Program volunteer, keep in mind the State Parks motto: *"*The Best of California Forever*."* Without protection, many areas in the California State Park system could soon perish.

Conveying the parks philosophy, policies and rules generally results in willing cooperation. A small percentage of visitors, however, will continue to resent or resist the regulations. They will require special attention or enforcement action.

As a volunteer, you may encounter situations where you must decide whether a visitor's conduct merits only an explanation of a rule or more formal action. Any acts that may constitute potential hazards to the safety of people or property should be reported promptly to the Jenner Visitor Center or any ranger. State Park Rangers and some lifeguards have peace officer authority. Do not threaten or try to bluff a visitor. Never hesitate to call upon a ranger for guidance or assistance in any situation which threatens to become a problem. Doing so also may preclude or minimize liability in case of an accident.

It is important that each volunteer read and become familiar with rules and regulations of the State Park System. The following is a summary of the more commonly seen violations:

ANIMALS: No person is allowed to hunt, injure or otherwise disturb any animal within the park's boundaries. State Fish and Game regulations govern all activities from the average (mean) high tide area and beyond. Within this authority tidepool creatures are protected from molestation and injury. The federal government has also put in place protective measures regarding marine mammal safety.

COLLECTING: Living and non-living things are protected within State Parks, including all plant life and driftwood. Permits must be obtained from the district's superintendent for any exceptions.

GEOLOGICAL & ARCHAEOLOGICAL FEATURES: Such features are protected from removal, disturbance, injury, disfigurement, defacement, destruction or mutilation.

PETS: Animals must be kept leashed and under control at all times within a State Park unit. **Dogs are not allowed on hiking trails or at the environmental campgrounds.** Certain areas on the Sonoma Coast are closed to dogs, including the bluffs on Bodega Head and Goat Rock beach. Dogs are allowed on a leash at Blind Beach, Shell Beach or Furlong Gulch, to the south of Goat Rock**.**

FIRES: Fires are allowed on the beaches, as long as they are controlled. Fires amongst the dunes or dune grasses are prohibited, as are fires in an area with any type of vegetation.

FIREARMS & WEAPONS: Regardless of the intention of their possession, it is illegal to possess or carry any weapon capable of causing injury.

State Parks Rules and Regulations (Continued)

LITTER: Disposal of any item, other than in a proper trash receptacle, is prohibited.

CLOSED AREAS: Because of significant dangers to the public, certain areas may be closed to public access at the discretion of the district superintendent. On the Sonoma coast, two locations in particular have claimed the lives of a number of park visitors. Goat Rock proper is completely closed to any kind of hiking or climbing activity, and no entry of any type is allowed on the rock outcropping at Duncan's Landing, known as Death Rock.

OFF-HIGHWAY VEHICLES: No vehicles are allowed off-road in a State Park, and all vehicles must be registered through DMV for use on roads.

HORSES: Generally, horses may not be ridden on beaches. Certain areas are exceptions, including the beach south of the Bodega Dunes' day use area.

CAMPING: Camping is allowed only in designated state-operated campgrounds at Wright's Beach, Bodega Dunes, Willow Creek and Pomo Canyon.

CURFEW: Juveniles (under 18 years of age) may not be in Sonoma Coast State Parks after sunset unless accompanied by their parent or guardian.

YEHICLE OPERATION: All rules of the road, as defined by the California Vehicle Code, apply in State Parks.

CRIMINAL ACTIVITIES: Any activity which is defined as criminal, through the California Penal Code, is illegal within a State Park unit. Alcohol-related regulations also apply.

PUBLIC RESOURCES CODE: 'The Department shall protect the State Park System from damage and preserve the peace therein. Any person who violates the rules and regulations established by the Department is guilty of a misdemeanor and, upon conviction, shall be punished by imprisonment in the county jail for a time not to exceed 90 days, or by a fine not exceeding $500, or by both such fine and imprisonment.

California State Parks and Volunteers

As a participant in the Environmental Living Program, you are a volunteer employee of the California State Park System. Introducing students to the Sonoma Coast and Willow Creek Watershed is the primary task, but it must be accomplished within the parameters of the park's larger mission. The park system grew out of the turn-of-the-century view that government can provide for the happiness and recreation of the citizen while preserving vital natural and historical resources. The first park was formed in 1902, with the establishment of the California Redwood Park at Big Basin in Santa Cruz County. In 1927, the State Park Commission was formed for the purpose of selecting sites for future state parks, and a bond issue was authorized to fund necessary purchases. The purchase of selected lands began soon afterward, leading to the creation of a system of park units now numbering 278 areas and representing all varieties of the state's unique scenery, including redwoods, beaches, deserts, historic sites, scenic reserves, recreation areas and mountains.

The Sonoma Coast State Park was one of the first parks created by the commission, and purchase of the unit's first lands was begun in the early 1930s. When the Sonoma Coast State Beach opened in the spring of 1934, roughly 600 acres had been reserved for park's use. These acres included most of the beachfront land between Salmon Creek and the Russian River. The Depression and the Second World War slowed the pace of subsequent park development, but work proceeded in earnest in the late 1940s, with the construction of facilities at Goat Rock, Wright's Beach and Salmon Creek, and the appointment of the park's first permanent staff. Through the years, the park slowly expanded to include most of Bodega Head, North Jenner and the lower portion of the Willow Creek basin, including Pomo Canyon. It contains a total of 5,000 acres, with hiking trails, parking lots, rudimentary restroom facilities, and two developed and two environmental campgrounds. The staff has grown from a total of two rangers in 1948 to a contingent of six rangers, five maintenance workers, several lifeguards and numerous seasonal staff.

In 1985, the park district entered into an arrangement with park volunteers to assist the full-time staff with the fulfillment of the park's mission. Public efforts to protect harbor seals grew under the leadership of Dian Hardy, after untreated sewage was released into the Russian River. A volunteer organization formed under the name, "Stewards of Slavianka," to assist in a wide range of such volunteer and interpretive duties. Since that time, the Stewards role has expanded and its name has changed to reflect this. Today, the Environmental Living Program (ELP) is one of several volunteer activities under the aegis of the Stewards of the Coast and Redwoods.

As a participant in the ELP, you are an unpaid employee of the state Department of Parks and Recreation (DPR) and will not receive pay or goods for work performed, whether the work in question be fund raising, interpretation, staffing sales booths and/or giving demonstrations. All of your services will be on a strictly voluntary basis, and you cannot be required by any of the park staff or anyone else to do any work which you do not wish to do. As a park volunteer you will be covered by the same policies as regular

California State Parks and Volunteers (Continued)

employees regarding liability. A number of state and federal tax benefits are available for volunteers. You may be able to deduct some unreimbursed expenditures made while serving the department, such as automobile mileage, bus and cab fare, parking and toll fees, cost of meals and lodging if away overnight, travel expenses above per diem allowance and expenditures for special uniforms or costumes. You will also be covered by the department's Compensation Insurance in the event you are injured while working in the park. For any of this to be valid, you must complete a form: A Volunteer Record and Service Agreement (DPR 208). These forms are available at Stewards orientation sessions and can be obtained from the ELP coordinator.

The Volunteer Services Agreement (VSA) is a contract between DPR and volunteers. The VSA legally enrolls individual volunteers into the department's Volunteers in Parks Program and entitles them to workers compensation benefits. The VSA includes a description of the work the volunteer will perform, any time commitments, conditions for reimbursement of expenses if reimbursement is to be provided, and the volunteer's official starting date. The document can be modified at any time by mutual agreement, but it must at all times accurately reflect the volunteer's duties. The document is valid for 3 years, with extensions and renewals of the agreement available.

Any volunteer under the age of 18 must have a parental permission form signed by parents or legal guardians, and a parent or guardian must volunteer with anyone under 18. This form is to be attached to the VSA, and will be valid only for the period stated on the VSA. Several Labor Code laws may apply to volunteers under the age of 18. A minor is any person under the age of 18 years who is required to attend school as specified under the provisions of the Education Code (California Labor Code, Chapter 2, Occupational Privileges and Restrictions, Article 2, Minors, Section 1286(c)). An employer can be cited and fined for a Child Labor Law violation that has a direct or immediate correlation to the health, safety or security of a minor or creates "substantial probability of death or serious physical harm to a minor."

When enrolling as a park volunteer with the ELP, you are agreeing to abide by standards of conduct, rules and procedures as outlined below. As a volunteer, you are expected to conduct yourself in a manner that reflects pride in the State Park System. The following information is intended to give you some guidance along these lines.

DEPENDABILITY. You must be both punctual and dependable in fulfilling your duties. If an unforeseen emergency arises, notify the volunteer coordinator immediately. Promptness and reliability are crucial. Teamwork and cooperation keep our volunteer program alive.

APPEARANCE. You must be neat and clean in appearance when acting in a public function.

California State Parks and Volunteers (Continued)

ATTITUDE. Visitors are to be treated in a courteous and professional manner. All visitors are guests, and it is our primary responsibility to see that their visit is enjoyable and safe. If a visitor comes to you with a complaint, explain to him or her the actions you can or cannot take, and report the matter promptly to a ranger or lifeguard. If a visitor asks you to identify yourself, do so. Above all, never give false or misleading information to the public. If you do not know the answer, don't be afraid to say so, but try to be well-informed and helpful. Avoid public criticism of the State Parks Department, staff or policies when performing volunteer duties. If you disagree with something, discuss it with the volunteer coordinator or the supervising ranger.

BEHAVIOR. Immoral conduct, the illegal use of drugs, reporting to work with alcohol on the breath, being drunk or drinking alcohol on duty, or commission of a serious crime are all expressly prohibited, and will result in your being asked to leave the program. Treat your coworkers and park staff with courtesy and respect, obey all lawful orders, report to the park on time and ready to work, and remain alert while on duty. Keep private visiting to a minimum when the public is present. Do not use public contacts to express your private views.

AUTHORITY. As a volunteer, you do not have peace officer authority. You should be familiar with park rules and regulations and, using your best judgment, you should caution park visitors if you witness a violation of these regulations. You are to report all violations of law or park rules that you witness to a ranger or lifeguard. You are, of course, expected to personally comply with all park rules and regulations.

CONFIDENTIALITY. Some information of which you may become aware is confidential and must not be discussed outside the organization. Confidential information includes such things as crime and illegal incidents, rescue and accident reports, disciplinary actions, employee grievances, budget proposals, and proposed policy changes. If you are questioned on these matters, politely but firmly refer the questioner to park staff.

INTERPRETATION. You are required to read this manual in order to become familiar with basic information about the Willow Creek watershed. All volunteers should know and adhere to the standard facts provided herein to provide a consistent interpretive program. A story, legend or conjecture may be included in your presentation, but it must be clearly identified as such. Admit “I don’t know,” rather than relate misinformation. A satisfactory speaking voice and the ability to communicate well are basic requirements for effective interpretation. It is important that you possess the ability to accept constructive criticism to enhance your work. All volunteers are encouraged to repeat training sessions as a refresher, and to share you information and experiences.

In your interpretation, emphasize the interdependence between people and nature, among natural elements, and between historic facts and current interpretations. Familiarity with the history and culture of the area’s human inhabitants, and the flora,

California State Parks and Volunteers (Continued)

fauna and geology of local ecosystems will help you to provide a meaningful experience for students and park visitors. Your discussions may lay the foundation for student appreciation of this natural setting and the importance of preserving it. Getting to know the students and their experiences is useful–find out, for instance, if they have ever been in redwoods before or if they live in an environment radically different from that of the Russian River. Let the students guide the direction of your discussion. The interpretive experience should be fun, both for visitors and interpreters.

Investing some time and effort to learn about and understand the history and ecology of the Willow Creek watershed can be rewarding and enjoyable. To this end, there are a number of published sources of great value available in the county library system and the District Office (see bibliography at end of this manual). Many useful resources also are available at the offices of the Stewards of the Coast and Redwoods. Your membership is encouraged, but not required.

Sonoma Coast State Parks Volunteer Program

Title:	**Environmental Living Program Docent**
Purpose:	To promote and interpret the natural and cultural history of Sonoma Coast State Park and the Willow Creek watershed for park visitors of grade levels 4 through 6.
Duties:	Docents conduct programs to interpret the natural and cultural history of Sonoma Coast State Park.
Skills/ Qualifications:	Docents must be friendly, courteous and possess good communication skills. They must be willing to learn and share their knowledge of the park's resources with students. They must be willing to make a serious time commitment to attend training and meetings.
Reports to:	District Interpretive Specialist/Designee
Time:	Dates and hours arranged with teachers and docents. Visits generally are scheduled in May, June or October to allow for classroom preparation and avoid the rainy season.
Training:	Docents attend Environmental Living Program training provided by State Parks to gain competence in leading interpretive activities.
Benefits:	Learn about the natural and cultural history of Sonoma Coast State Park and the Willow Creek watershed. Become eligible to receive a District or a Statewide Volunteers in Parks Day Use Annual Pass.

General Objectives of Docent Interpretation

1. Provide information for the safe and enjoyable use of the park.
2. Introduce the park's major ecosystems, their components and how they function.
3. Instigate an interest in natural systems and exploration.
4. Convey the measurable importance of natural resources to man, and how man's well-being is inextricably tied to the health of the environment.

Visitors may hope to encounter animals or natural events that are rarely seen. Docents can show how to find signs left by animals or events. They can introduce fundamental environmental concepts when considering visitor questions and provoke interest in the environment. By increasing visitors' awareness of sensory impressions – natural sights, sounds, odors, textures – docents can enrich appreciation of the natural world.

A Few Suggestions for Teaching Children

1. Teach less, share more. Children respond more to observation than explanation. Sharing our ideas and feelings encourages a child to explore his own feelings and perceptions.

2. Be receptive: listen and be aware. New surroundings bring out enthusiasm that you can direct toward learning.

3. Focus the child's attention without delay. Involve everyone as much as you can, by asking questions and pointing out interesting sights and sounds.

4. Look and experience first; talk later. Children become absorbed in whatever they're doing and seldom forget a direct experience. Look. Ask questions. Guess. Have fun!

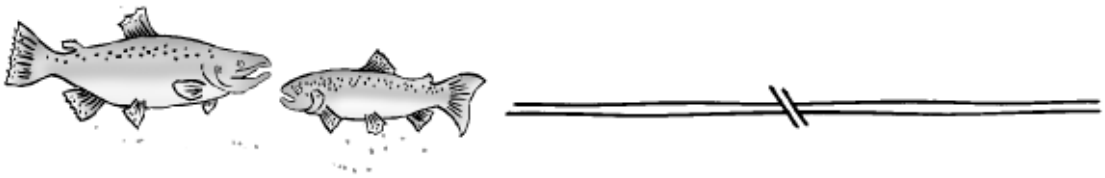
5. A sense of joy should permeate the experience, whether in the form of gaiety or calm attentiveness. Children are naturally drawn to learning if you can keep the spirit of the occasion happy and enthusiastic. Enthusiasm is contagious.

Adapted from Cornell, 1997 (see Bibliography).

PART II

The Environmental Living Program,

Activities and Logistics



Environmental Living Program: Definition and History

In 1970, Lou Hetzel and her second grade students visited Wolfe Cabin in Arches National Park in Utah and said, “Let’s live in it!” Bill Taylor, Interpretive Specialist with the National Park Service and a former teacher made it happen. Since then the Environmental Living Program (ELP) concept has grown throughout the National and State parks.

Environmental Living is a student experience at any cultural, historic, prehistoric or natural site where the interdependence of people and their environment is represented. It relies on pre-site explorations and preparations, role-playing, and problem solving. Students research how a past culture or group of people survived on the site and use this information to role-play and re-create those cultures or eras. An overnight stay culminates their research and preparation.

“I hear and I forget. I see and I remember. I do and I understand.”

Introduction to the Sonoma Coast ELP

The Sonoma Coast and Willow Creek watershed encompasses ecosystems of coastal prairies, dunes, coast redwood groves and the inter-tidal zone. This biodiversity has provided the basis for a variety of wildlife and human cultures to live and thrive, from Pleistocene mega-herbivores to Native Americans.

The Sonoma Coast Environmental Living Program emphasizes student learning and stewardship of the land through role-playing that relates to this natural and cultural history. It is designed as a one- or a two-day (overnight) program for students in grades four through six. Fourth and fifth grade students in the one-day program simulate and recreate the lifestyles of four cultural groups that lived in this region: Southwestern Kashaya Pomo, the Russian American Fur Company, loggers and ranchers. Student groups research the daily activities and land use practices of the cultural group to which they are assigned. On site, they recreate their group’s lifestyle and find local sources of food, shelter, clothing, safety, and entertainment.

The 6th grade program focuses on the Willow Creek watershed. Students study the impact of these peoples and of other environmental factors on the watershed. On site, they collect and compare data, map the watershed and create a timeline of natural and cultural events

These experiences are intended to make students more aware of the natural resources in the environment, the impact of humans and their culture on an environment and its resources, and the importance of stewardship of natural resources.

The Sonoma Coast ELP provides the core to develop a rich integrated curriculum that can meet many of the California standards and learning objectives in history/social science, science, math, language arts, and environmental education.

Sample Schedule for Sonoma Coast ELP

6th Grade - 2 day program

Day 1

8:30	Arrive at Shell Beach parking lot. Teachers organize groups, assign timeline or collage. **Docent sets the theme as a walk back in time, an evidence trail of history. Students pick up a rock (brought or gathered by docents)** to keep with them. Students begin journal.
9:00	Walk to Shell Beach. **Docent discusses geology of the area and leads an activity to show students the concept of subduction.**
9:45-10:00	Snack, bathroom break and divide into cultural groups.
10:00-10:30	Begin Pomo Trail hike. While waiting, students work on journal. During the hike, **docents discuss how the cultural groups lived on the land.** During break—weather permitting—**point out sea stacks, terraces, river and bridge, where sawmill was located and river crossing.**
10:50-11:20	Arrive at Red Hill. Early groups work on journal. Eat lunch.
11:45	Groups rotate among **docents activities on (i) reflections-poetry, (ii) redwood ecology, (iii) plant identification and (iv) watersheds.**
2:45	Begin walk to Pomo Campground.
3:30-3:45	Arrive at Pomo Campground. **Docents depart.** Set up camp and have snack.
4:45	One or two groups cook dinner. Other groups work on timelines, collages and presentations for next day. [If teacher has all groups cook and clean up, then all groups will work on their presentations after dinner.]
6:00	Eat dinner.
6:30	Groups that cooked or set up dinner will work on timelines and prepare their presentation for after dinner and the next morning. Other groups clean up and set-up for campfire.
7:30	Free time or rehearsal for timeline presentations.
8:00	Campfire, presentations
9:00	Prepare for bed. Quiet time.
10:00	Lights out.

Sample Schedule, 2 day program (Continued)

Day 2 (Times to be adjusted based on departure time)

6:30	Wake, wash up, pack gear.
7:30	Make, eat, clean up after breakfast **Docents arrive by 8:00.** Finish timeline and practice presenting for docents or work on journals.
8:30	**Docent stations: (i) streambed structure; (ii) BMI and (iii) timeline preparation.** Depending on schedule, students may also participate in **docent-led water quality tests or riparian habitat assessments.**
11:00	Lunch preparation or begin service project. If no service project is scheduled at this time, students may practice timeline presentation for docents.
11:45	Lunch
12:15	Closing activity: what did we learn? Student presentation of timelines. Discuss connection to the land and conservation. Closing activity.
1:30	Whole class service project or leave site for home.
2:30	Leave for home or arrive home.

Sample Schedule for Sonoma Coast ELP
4th, 5th, or 6th Grade - 1 day program

8:30 Arrive at Shell Beach parking lot, gather and organize as group. **Docent sets the theme as a walk back in time, an evidence trail of history. Students pick up a rock (brought or gathered by docents)** to keep with them during ELP. Explain journal. At end of day, students will share poem or reflection of the day with docents.

9:00 Walk down to Shell Beach where **docent leads discussion of the special geology of the area and an activity to show students the concept of subduction.**

9:45-10:00 Have snack, bathroom break. Divide into cultural groups.

10:00-10:30 Begin hike over Pomo Trail. While waiting, students work on journal. During hike, **docents discuss how their cultural group lived on the land and what impact it had.** During break—weather permitting—**point out sea stacks, terraces, river and bridge, where sawmill was located and river crossing.**

10:50-11:20 Arrive at Red Hill. Early groups work on journal. Eat lunch.

11:45 Groups rotate among **docents activities on: (i) reflections-poetry; (ii) redwood ecology; (iii) plant identification; and (iv) watersheds.**

2:45 Begin walk back to pick-up point.

3:30-3:45 Arrive back at pick-up point.

3:45 Closing activity- What did we learn? Students share their reflections with group. Leave their rocks on the ground in a line. Step over line back into present day.

4:15-4:30 Leave for home.

On-Site Logistics

Rainy Day Schedule
In the event of light rain the event will proceed as scheduled; pack rain gear and boots as needed. In the event of heavy rain, the program will be cancelled. Should heavy rain or flooding be predicted in the program area, Stewards staff will notify teachers and docents as soon as they are made aware of the situation.

Arrival
Groups going to Shell Beach are dropped off by bus or car at the Shell Beach parking lot, where they are met by the docents. Groups going instead to Sunset Rocks, arrive at the first turnout on Goat Rock Road, and hike down to the rocks and back with the docents. They are then driven to the Shell Beach Parking lot to begin the hike up Red Hill and to the Pomo Canyon Campground. Camping equipment and supplies are then driven to Pomo Canyon.

Docents may make arrangements among themselves or with Stewards staff to leave a car at Pomo Canyon, driving together to Goat Rock Road or the Shell Beach parking lot, and shuttling to retrieve cars at the end of the hike.

Who disciplines? Rules students must follow.

The adult members of the visiting group are to provide the discipline so the docents can concentrate on having fun as they do their jobs.

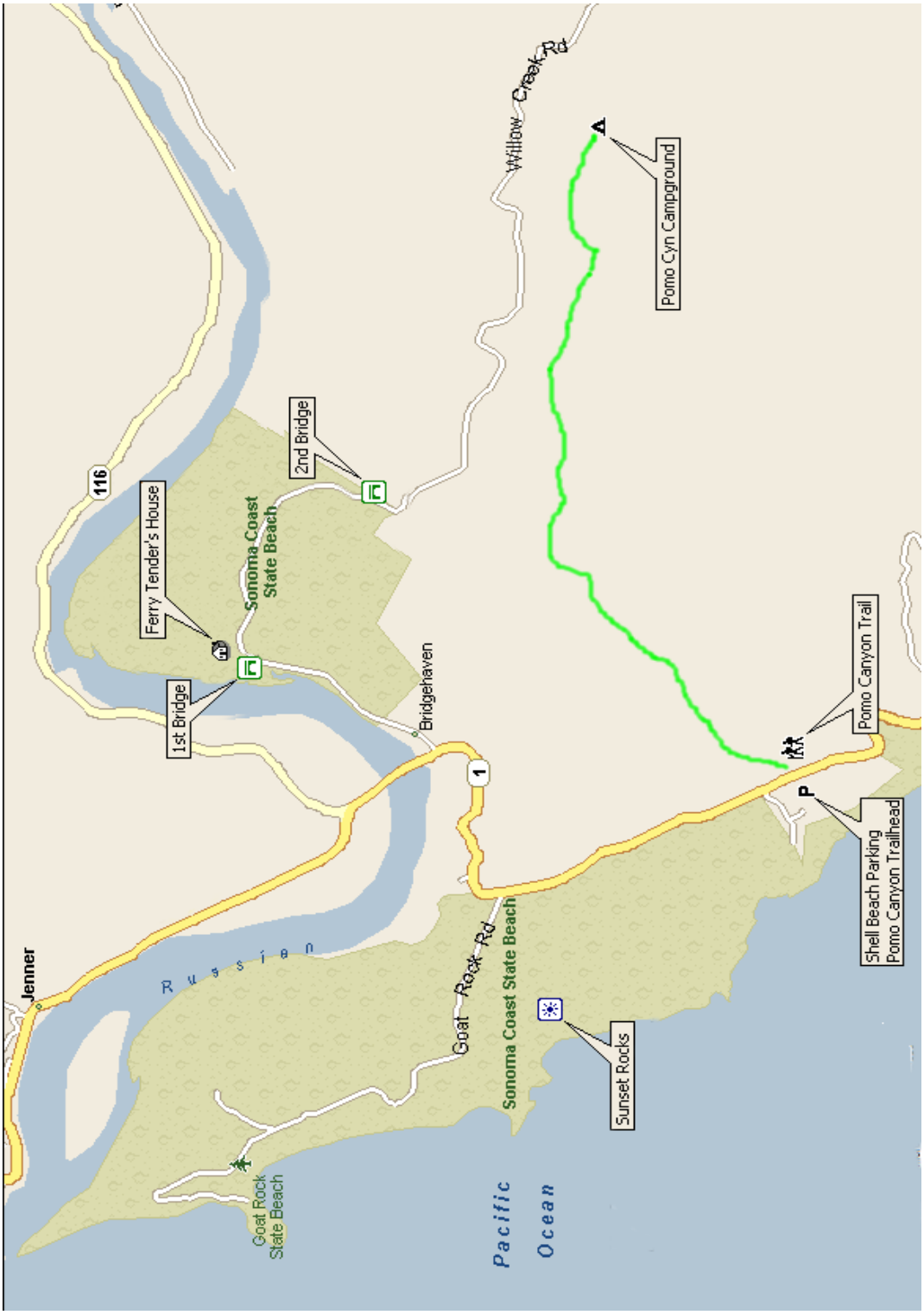
Some rules <u>other adults</u> enforce:
- The docent is the leader and has interesting information to share. Listen to your docents and follow their directions.
- Follow your docents on the trail. Stay with your group. (No one is to race ahead)
- Stay on the trail unless your docent gives you permission to move off it.
- Be respectful of adults and other students.
- Be curious, ask questions.
- Use your senses but put everything back in its place when finished.
- Do not remove anything from the park.

Map: Sonoma Coast State Park
How to get there

Highways. River Road and Route 116 West to Route 1 are the most direct routes when coming on Highway 101 from west and north, but some side roads may be less curvy and faster.

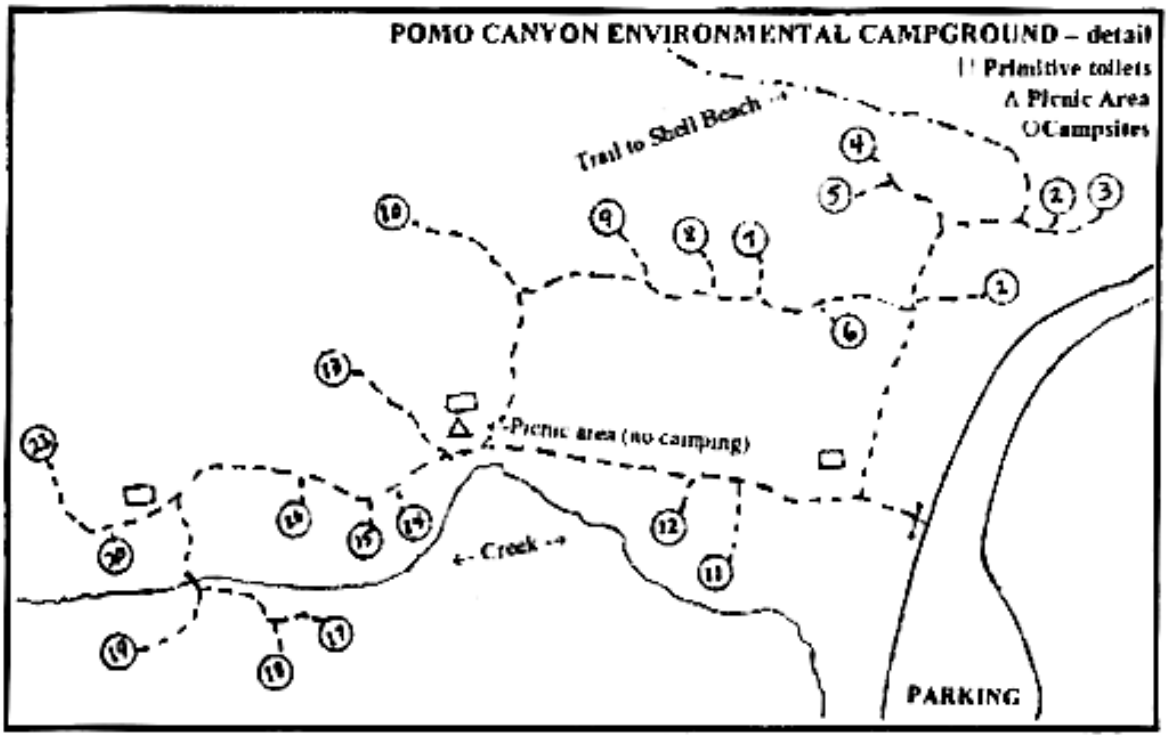
Map: Sonoma Coast, Russian River Area

Finding Shell Beach, Sunset Rocks and Pomo Canyon Campground;
shown to emphasize the primary locations for the ELP



Map: Pomo Canyon Campground

The Sonoma Coast ELPCamp Site



Campsites available for the ELP Program:

Group/Cooking Site – 14 & 15 & 16

Sleeping Sites: 13, 17, 18, 19 (20 & 21 if needed)

Some sites can accommodate up to three tents.

EMERGENCY AT SONOMA COAST AND WILLOW CREEK

IN CASE OF ACCIDENT, CRIME, FIRE, MISSING or LOST PERSONS

OR NEED FOR FIRST AID OR MEDICAL TREATMENT

IF YOU HAVE CELL PHONE ACCESS, CALL 911

IF NOT, USE THE STEWARDS RADIO TO CALL THE JENNER VISITORS CENTER TO REQUEST A CALL TO 911.

To use the radio:

1. Rotate **the switch on top of the radio to the right** to raise the volume.
2. When "1" shows in the view window, **hold in the button on the upper left side of the radio** to call the Jenner Visitor Center.
3. **Describe the situation and your location** and request advice and assistance. **Release the button when you finish speaking** to hear the response. **Repeat if needed.** Stay on the line or available to provide information to the 911 operator. **DO NOT TURN OFF THE RADIO.**
4. **If you get no response,** press the music note key to ring other radios (rangers and life guards) on the system.
5. To check the batteries, look in the upper right-hand corner of the view window. You will see a symbol for a battery. Three bars indicates that the batteries are fully charged. As the batteries get low, the number of bars will decline.

……..

The closest landline is north on Route 1 at the Sizzling Tandoor at Bridgehaven

……..

As a volunteer, you may encounter situations where you must decide whether a visitor's actions merit only an explanation of a rule or more formal action. Any acts that may constitute potential hazards to the safety of people or property should be reported promptly to the Jenner Visitor Center or any ranger. State Park Rangers and some lifeguards have peace officer authority. Do not threaten or try to bluff a visitor. Never hesitate to call a ranger for guidance or assistance in any situation which threatens to become a problem. This may preclude or minimize liability in case of an accident.

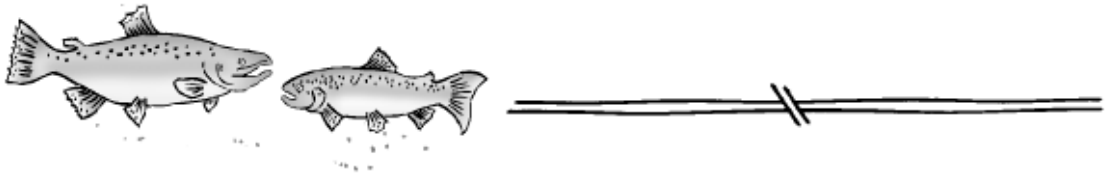
State Park Dispatch **(916) 358-1300**
(If you need a Ranger immediately or for law enforcement issues)

Jenner Visitor Center:	707-865-9757
State Parks contact, Ben Vanden Heuval	707- 875-2603
State Parks Staff, Bodega Dunes	707-875-9651

PART III

Docent-Led Activities

In the Environmental Living Program



Summary: Docent-Led Activities

A. Classroom visit: **Introduction to ELP 36 – 52**
Cultural Groups
Watersheds
Geology
Redwood Ecology

B. Shell Beach: 53 - 57
General Suggestions for Docent Interpretation
Instructions for emergencies
Introduction to the ELP and the geology of this coast
Optional substitute: Sunset Rocks (decided with teachers before visit)

C. Hiking the Pomo Trail: 58 - 64
The four Cultural Groups in the history of Willow Creek
Kayasha Pomo
The Russian American Fur Company
The Loggers
The Ranchers
Break overlooking the Russian River

D. On Red Hill: 65 - 73
Station 1: Reflections, Poetry
Station 2: Plant identification: “Similar But Not the Same”
Station 3: Coast Redwood Ecology
Station 4: Watershed Mapping

E. At Pomo Canyon Campground, Day 2: 74 – 81
Habitat assessment:
1. Streambed Structure
2. Benthic Macroinvertebrates
If scheduled:
3. Water Quality: acidity and temperature
4. The Riparian Environment
The Rocks: Docent’s closing

Classroom Visit: Introduction to ELP
Student Activities

To foster interest and prepare students, a classroom visit by docents will take place two to three weeks before the on-site experience at Willow Creek. The classroom visit will include activities related to (A) cultural groups, (B) watersheds, (C) geology and (D) redwood ecology. They may be whole class activities or stations through which students rotate in their cultural groups. In discussion with Stewards staff and/or teachers prior to your visit, you will decide which activities you will lead for a particular class.

A. Cultural Groups

1. **Clothes:** Docents bring clothes related to each cultural group. Students look at clothes of their group. Why did they wear these items? Ask about utilitarian purpose as well as cultural style. Students decide what they will make or wear to designate their group.
   Pomo: · *Flicker headbands* · *Shells decorating clothing* ·*Shell necklaces*
   Russians: · *Felt or fur hat or wool cap for men; turban or felt hat for women*
   · *Scarf for women* · *Belt of rope or cloth* · *Long skirts for women*
   Loggers: · *Flannel shirts* · *Jeans* · *Spiked boots* · *Suspenders* ·*Caps*
   Ranchers: · *Coveralls* · *Handkerchief* · *Wide brimmed hats* · *Long skirts(women*

2. **Cooking**: students look at *recipes of their cultural group*; create menu for their meal or snack

3. **Map** area where they think their group lived in the Willow Creek watershed to find during onsite visit
   - Indian village-Chalanchawi
   - Russian farm-Kostromitinov Ranch
   - Ranch buildings (some remain)-Wright Ranch barn on coast, Baxman home
   - Loggers—areas they logged, where and how they moved lumber

4. **Impact:** What do students think they will **see on site** related to their cultural group? What would their group have left behind?

Classroom Visit: Student Activities (Continued)

B. Watersheds (background information and activities follow)

1. Plants, Pollution and Purification
2. Aquifer in a Cup
3. San Francisco Bay's Watershed in Your Hands
4. Salmon and Sediment

C. Geology (background information and activities follow)

1. The Rock Cycle: with Rock cycle worksheet or
2. "Sight-seeing" tour (for advanced students)
3. Plate Tectonics—*sponge* demonstration

- Pass out a slightly damp sponge to each student
- Tell students to squeeze the sponge from either side; show uplift in the middle
- Ask students to try to slide their sponges past each other's and note how they do not slide easily, but rather stick together in places, and move in jerking motions (source of earthquakes)

D. Redwood Ecology (activity follows; background information in Reference section)

1. Why did redwoods become the number one tree for logging? (resists decay and insects; lack of resin increases fire resistance; huge trees; straight lumber)
   What was the main thing originally made out of redwood? (shingles for roofs and lumber for building)
   What is made out of redwood and why? (*bring something made out of redwood)*
2. What happens when redwoods are logged and stumps remain? (sprouts reproduce; will see huge trees in rings rising from old stumps)
   What happens when they are logged, but stumps are removed? (don't reproduce)
   Why would stumps be removed? (for ranchers to use as pasture)
3. Activity: If a Redwood Tree Fell Here

Classroom Visit: Student Activities (Continued)

B. Watersheds. Plants, Pollution and Purification

Role of plants in water filtration, grade level 4 - 7

Background: Experiments can be done to show how a plume of dissolved materials can move through soil and enter a groundwater aquifer. But soil and plants have a dual role in this process. Depending on whether materials are dissolved or suspended in the water, soils and plant roots can remove some or all of this material as the water moves down through the soil.

Most suspended materials will adhere to the soil. These may then be broken down and used as food by the plants. Dissolved nutrients, such as nitrogen or phosphorus, chemically bond with some types of soil particles. They are then taken up by plants, thus removing them from the soil before they can enter an aquifer. For the plants, these elements are food; for an aquifer, they are pollution.

Not all materials are absorbed by plants and not all water pollutants are food for plants.
However, sediments from eroding soil, nutrients in human and animal wastes, and some components of household wastewater ("graywater") are excellent plant nutrients.
Plants also use different nutrients at different rates, so that the amount of material they take up will depend on how much is dissolved in the water and how fast the water moves through the soil.

This experiment is a very simplified way to show whether plants will take up certain materials from water moving relatively quickly through their root systems.

Objective: To understand the role of plants in filtering water running in a watershed
.

Materials needed:

1. Six potted plants: pots roughly six to eight inches in diameter with holes in the bottom. These plants need to be moderately dry, as if they had not been watered for a couple of days. Plants with saturated soil will not absorb water, and very dry plants will absorb it all.
2. Six clear containers, such as cups, which will support the plants and allow drainage to be viewed. You will need a separate plant and cup for each of the materials in the water.
3. Soil from outside (anywhere). The best soil is loamy, with smaller particles than sand.
4. Unsweetened powdered drink mix, preferably grape or cherry for color.
5. Vegetable oil.
6. One or two different household cleaners (such as Comet/Ajax and dish or laundry soap). One should be liquid and the other powder.

Classroom Visit: Student Activities (Continued)

Preparation – a day or two before the visit: Set up the potted plants, each in its own cup. Slowly pour six to eight ounces of clean water through the pot, and check the percolation rate through the pot. Loosen or tighten the soil so that water percolates at about one ounce per minute. The rate should be fast enough to prevent long waiting periods, but slow enough not to carry very much soil through the pot.

Classroom Procedure: (ask students to do these tasks)

1. Place the potted plants into the top of their cups. Ask a student to pour clean water slowly through one of the pots and watch it percolate through the bottom of the pot. The water should look as clean as what was poured.
2. Ask a student to add a gram or so of soil to 6-8 ounces of water and stir so that the soil is well suspended and distributed in the water. Pour slowly into another flower pot. The water percolating through should look *much* cleaner than the dirty water poured.
3. Ask another student to add about one ounce of vegetable oil to 6-8 ounces of water, stir (they won't mix completely) and pour into a third pot. See if the vegetable oil percolates through or is caught up by the plant roots.
4. Another student adds some powdered drink mix to 6-8 oz. of water and pours it through a fourth pot. See if the water percolating through retains the color.
5. Another student adds some powdered cleanser to 6-8 oz. of water and pour through a fifth pot. Is the cleanser retained in the soil?
6. Add some liquid soap to the water (an ounce or so in 6-8 oz. water). Does the soap percolate through the soil?
7. Have six students pour some clean water through the soil of the “contaminated” plants at a steady rate (simulating a rain shower). Is more of the “pollutant” rinsed away from the soil by the clean water?

Follow-up Questions:
1. In what ways can plants and soil benefit drinking water quality?
2. We saw plants and soil remove some types of impurities from water. How might the plants remove larger quantities?
3. Can plants and soil remove any type of impurity from water?
4. What other organisms in the soil-plant system might aid the uptake of water pollutants?
5. What is the role of rainwater moving through contaminated soil?

Adapted from EPA, 2009, Role of Plants in Water Filtration.

Classroom Visit: Student Activities (Continued)

B. Watersheds. Aquifer on the Go

Many communities get their drinking water from underground sources, called aquifers. Water suppliers or utility officials drill wells through soil and rock into to supply the public with drinking water. Home owners who cannot get their drinking water from a public water supply have private wells drilled to tap an aquifer under their property. Unfortunately, the ground water can become contaminated by harmful chemicals such as lawn care products and household cleaners that were used or disposed of improperly, or any number of other pollutants. These chemicals can enter the soil and rock, polluting the aquifer and eventually the well. Such contamination can pose a significant threat to human health. Measures to protect against contamination or clean up contaminated aquifers are quite costly.

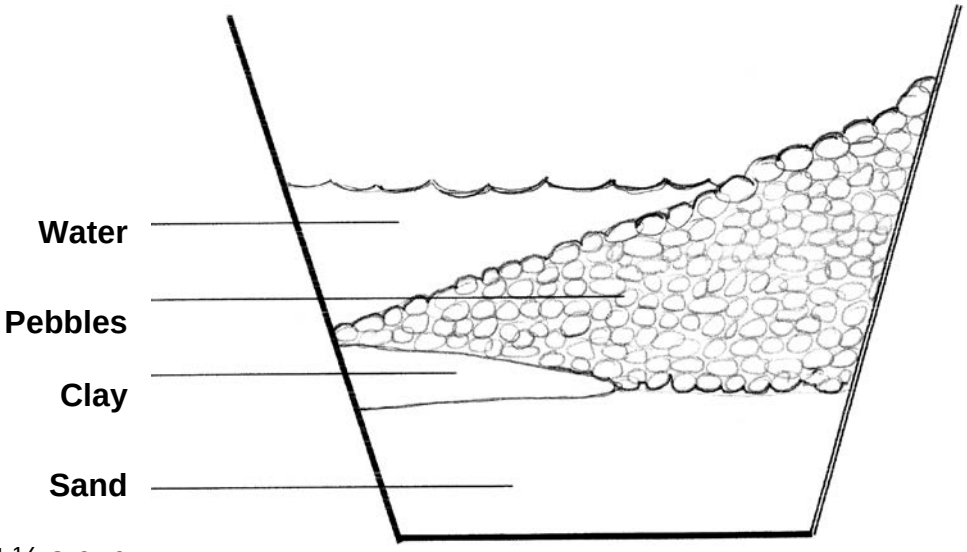
Objective.
To illustrate how water is stored in an aquifer, how groundwater can become contaminated, and how this contamination ends up in drinking water. Ultimately, students should get a clear understanding of how careless use and disposal of harmful contaminants above the ground can potentially end up in the drinking water below the ground. This experiment can be done by each student at their work station, or in groups around the main supplies.

Materials to be available, per student:
- **1 clear plastic cup** that is 2 3/4" deep x 3 1/4" wide for each student
- **1 piece of modeling clay or floral clay** that will allow a 2" flat pancake to be made by each student
- **White play sand** that will measure 1/4" in the bottom of each student's cup
- **Aquarium gravel** (natural color if possible) or small pebbles (~1/2 cup per student) *(As small rocks may have a powdery residue on them, rinse and dry them on a clean towel prior to use. It is best if they do not add cloudiness to water.)*
- **Red food coloring**

1 bucket of clean water and **small cup** to dip water from bucket

Procedure.
1. Have students pour 1/4" of white sand in the bottom of their cup completely covering the bottom of the container. They pour a small amount of water into the sand, wetting it completely but leaving no standing water on top of sand. Let students see how the water is absorbed in the sand, but remains around the sand particles as it is stored in the ground and forming part of the aquifer.
2. Have each student flatten the modeling clay (like a pancake) and cover 1/2 of the sand with the clay (pressing the clay to one side of the container to seal off that side). The clay represents a “confining layer” that keeps water from passing through it. They again pour a small amount of water into the cup, onto the clay. The water remains on top of the clay, only flowing into the sand below in areas not covered by the clay.

Classroom Visit: Student Activities (Continued)



3. Students take about ½ a cup of aquarium rocks to form the next layer of earth. Place the rocks over the sand and clay, covering the entire container. Have students slope the rocks to one side of the cup, forming a high hill and a valley (see illustration). Explain to students that these layers represent some of the many layers contained in the earth's surface. 'Now pour water into your aquifer until the water in the valley begins to rise up the hill.' Explain that these rocks are porous, allowing water to be stored in the openings between them. They will also notice that a "surface" supply of water (a small lake) has formed. This will give them a view of both the (under)ground and surface water supplies which can be used for drinking water purposes.
4. Ask students to put a few drops of food coloring at the top of the rock hill, as close to the inside wall of the cup as possible. Explain to students that people often dispose of farm chemicals, trash and used motor oils in old wells. Those and other activities above an aquifer can end up in drinking water. They will see that the color spreads not only through the rocks, but also to the surface water and into the white sand at the bottom of their cup. This is one way pollution can spread throughout the aquifer over time.

Follow-up
Discuss with students other activities that can pollute aquifers. Assign students the task of locating activities around the school or their own homes that could pollute their drinking water sources if not properly maintained. Allow students to drain off the water in their cups and carry home their container to refill with water and show their parents surface and ground water and how the food coloring illustrates pollution activity above their aquifer can affect all water. Students should discuss with parents what steps they can take as a household to prevent water pollution.

Adapted from EPA, 2004.

Classroom Visit: Student Activities (Continued)

B. Watersheds. The San Francisco Bay's Watershed in Your Hands

Overview
Students first use crumpled paper to create a model demonstrating the basic features of a watershed. They then create the San Francisco Bay's watershed using their hands to represent major geographical features.

Estimated Time
30 minutes

Objectives
Students will be able to describe the major geographical features of San Francisco Bay's Watershed and define the term "watershed."

Materials
- One sheet of 8 ½" X 11" paper for each student (bring paper used on one side for this activity)
- Water soluble markers or watercolors, paintbrushes, and cups of water
- Spray bottles of water
- Overhead of "Watershed in Your Hands" and/or a map of California

Vocabulary
watershed, ridge lines, urban runoff, drainage, erosion

California Science Content Standards
Grade 4
Standard Set 5.c: moving water erodes landforms, reshaping the land by taking it away from some places and depositing it as pebbles, sand, silt, and mud in other places (weathering, transport, and deposition).
Grade 5
Standard Set 3.e: the origin of the water used by their local communities.
Grade 6
Standard Set 2.a: water running downhill is the dominant process in shaping the landscape, including California's landscape

Classroom Visit: Student Activities (Continued)
The San Francisco Bay's Watershed in Your Hands

Background

A watershed is defined as *an area of land that water flows over or through on its way to a larger body of water*. A watershed is the drainage basin for a body of water, such as the San Francisco Bay. Homes, farms, ranches, forests, small towns, big cities and more exist in watersheds. Watersheds can be large or small. Some cross county, state, and even international borders. Larger watersheds are comprised of many small ones. For example, if water from your schoolyard drains into a creek, and that creek drains into San Francisco Bay, you are part of that creek's watershed, which is in turn part of the San Francisco Bay's watershed.

> A watershed starts at mountain peaks and hilltops. Snowmelt and rainfall wash over and through the high ground into rivulets which drain into fast-flowing mountain streams. As the streams descend, tributaries and groundwater add to their volume and they become rivers. As they leave the mountains, rivers slow and start to meander and braid, seeking the path of least resistance across widening valleys, whose alluvial floor was laid down by millennia of sediment-laden floods. Eventually the river will flow into a lake or ocean. Where the river is muddy and the land is flat, the sediments laid down by the river may form a delta, splitting the river into a bird-foot of distributaries which discharge into the sea. The river's estuary, the place where its sweet waters mix with the ocean's salt, is one of the most biologically productive parts of the river – and of the ocean. (McCully, 2001)

The San Francisco Bay watershed covers approximately 40% of the state of California. It begins in the Sierra Nevada mountain range, continues through the Central Valley, and eventually drains into the San Francisco Bay and out into the ocean. By tracing the path of water as it flows through the watershed and into the Bay, one can begin to understand how everyone who lives in the watershed can affect the Bay's health.

Teacher Procedure: Making a Watershed Model

1. Conduct this activity outside or in an area that can get slightly wet (lab area, tables with paper towels nearby, etc.)
2. Pass out a piece of paper and water soluble markers or water color supplies.
3. Instruct the students to crumple their piece of paper into a ball and to gently open it without flattening it out completely. It should look like a landscape with mountains and valleys.
4. Students use one color to draw or paint ridge lines, the highest lines on the paper, which separate one valley from another.
5. Another color should be used to represent rivers or lakes. They may need to guess where rivers or lakes will form on their landscape.
6. A third color should be used to paint or draw in houses, factories, offices, roads, stores, etc.

Classroom Visit: Student Activities (Continued)
The San Francisco Bay's Watershed in Your Hands

7. Either hand out the spray bottles to be passed among students, or walk around the classroom with a spray bottle, lightly spraying the finished maps. The spray represents rainfall. The students should notice where rain travels on their landscape.
8. Lead a discussion using some of the following questions:
• What path does the rain take on your landscape?
• How does this landscape represent the idea of a watershed?
• What happened to human settlements? Was there erosion or urban runoff?
• How should the flow of water affect our choice of building sites within a watershed ?

Watershed in Your Hands
1. Tell the students that they can use their hands to make a model of San Francisco Bay's watershed.
2. You can use a map of California while you are doing this activity to help your students identify major geographical features of the San Francisco Bay's Watershed.
Tell students

- Put your hands together, palms upward, thumbs out slightly, other fingers side-by-side, and curve them to make a bowl.
- Imagine that the tips of your fingers are the snow-capped peaks of the Sierra Nevada Mountain Range.
- Your left thumb is Mount Shasta, your right thumb is the Tehachapi Mountain Range, and the fleshy parts at the bases of your thumbs are the Coastal Range.
- The cracks between your fingers are all the small creeks and rivers trickling down from the Sierras, such as the American, Kern, and Mokelumne rivers.
- The large crease in your left palm (sometimes called your "lifeline") represents the Sacramento River, and the crease in your right palm represents the San Joaquin River.
- Where they run together at the crack between your two hands represents the Delta, and the opening between your arms is the Bay.
- Notice how the small creeks flow into the large rivers, which then flow into the Delta and out into the Bay.

Adapted from Save the Bay, 2009

Classroom Visit: Student Activities (Continued)

B. Watersheds. Salmon and Sediment

Background. Willow Creek is a tributary of the Russian River, which is listed in the U. S. Clean Water Act [section 303 (d)] as being impacted by sediment. Studies show Willow Creek itself is being "... severely compromised by sedimentation problems and dramatic channel aggradation... " (Sediment Production Estimates and Restoration Concepts for the Willow Creek Watershed, Trihey & Associates, 1997). The Environmental Protection Agency and the National Oceanic and Atmospheric Administration have stated that "California waters currently experience significant impacts from forestry. For example, silviculture is the leading source of impairment to water quality in the north coast of California." (EPA/NOAA final findings pursuant to Section 6217 of the Coastal Zone Act). In California…logging and associated operations are the primary causes of both damage to coho salmon habitat and the species' decline.

Habitat for the coho and steelhead has been severely compromised in the Willow Creek watershed. A Department of Fish & Game inventory conducted during 1994-1995 found five steelhead upstream of State Parks property and no coho were found. Only one juvenile coho has been observed since 1990 in the watershed (Trihey & Assoc., 1997). *Adapted from Myers, 2002*.

Talking Points

One of the great things about going out in the wild is seeing signs of the wild animals that live there. We used to see steelhead and coho salmon in Willow Creek—beautiful fish. But none have been seen there for 15 years. On our visit to Willow Creek, we will investigate the tragic mystery of the missing salmon.

But Willow Creek and the Russian River aren't the only places where fish can no longer survive. You may have heard about the collapse of the salmon fishing along the whole northern California coast, both this year and last. Let me read you a piece from the San Francisco Chronicle about the problem, and see if you can begin to gather clues for our investigation. Write down a clue about why fish disappear, if you hear one.

"Most state native game fish face extinction" San Francisco Chronicle – 11/20/2008, by Jane Kay *[emphasis added]*

Most of California's native salmon, steelhead and trout species face extinction by the end of the century unless the state acts quickly to **provide adequate fresh water and habitat**, according to a study released Wednesday by the state's leading salmon expert.

Twenty of 31 species of the prized fishes are in sharp decline, including the Sacramento River winter run of chinook salmon, the Sierra's California golden trout and coastal coho, according to the study by Peter Moyle, a nationally known UC Davis professor of conservation biology.

The fish advocacy group that commissioned the study, California Trout, will use the results to try to help persuade legislators and the governor to direct and help the

Classroom Visit: Student Activities (Continued)

California Department of Fish and Game to better carry out its mission of conserving the state's wild fish.

Decades of lax controls on **farming, logging, grazing, mining and road-building have filled and polluted streams**, the study said, while the **removal of streamside vegetation** on the North Coast, in Sierra creeks and on inland lagoons has **warmed the water and harmed fish**.

For the past 50 years, ocean salmon that spawn in rivers from the Klamath south to the Sacramento have been **blocked by dams and other barriers** and **deprived of water diverted to farms and cities** by state and federal water projects.

In some recent years, salmon returning to the ocean to feed and grow have found a **poor food supply of krill, squid and smaller fish caused by higher water temperatures** that could be related to global warming.

"Our **fish need cold, clean water** to survive, but they're getting less and less of it," Moyle said. "**Dams block access**. **Climate change** is now looming to exacerbate the threat, and it increases the urgency. All of these things are pushing our fish toward extinction..

[**May omit from reading:** *One species, the bull trout, already has disappeared. The fish was last seen in the McCloud River in the 1970s, and scientists link its disappearance to the Shasta and McCloud dams.*

In the 316-page study, Moyle calculated the survival chances into the next decades of 12 kinds of salmon, 11 kinds of trout, eight kinds of steelhead and one species of white fish.

He based the assessment on size of the habit and population, dependence of the fish on human intervention to save it, tolerance to environmental stressors, vulnerability to genetic disruption and likelihood of doing worse under global warming.]

Discussion

In that article, did you hear some of the things that our native fish need to survive?

- Large enough flows of water;
- Cool water;
- Clean water;
- Food in the ocean: krill and squid
- Streamside plants (that shade the water and are homes to bugs eaten by the fish);

What did the article mention that has harmed fish?

- Farming [erosion of hillsides; fertilizer and pesticides]
- Logging [erosion of hillsides; crushed streamside plants]
- Grazing [erosion of hillsides; herds eat streamside plants; manure contamination]
- Mining [erosion of hillsides; some chemical contamination]
- Rad-building [erosion; automobile oils and contaminants]
- Dams and other barriers in rivers [block migrations and spawning; reduce water flows; warm water]
- Global warming [lower rainfall; warmer water; killing small animals that fish eat]

How might any of those things make it hard for fish to survive? [see above]

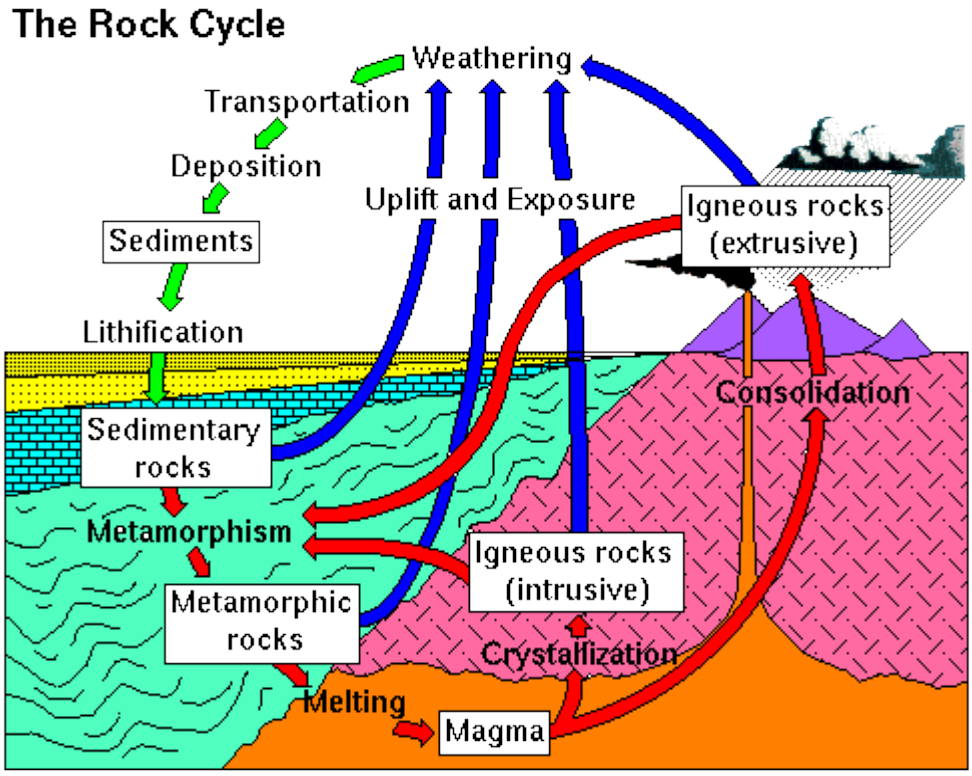
On our visit, we'll look for clues about the disappearance of Willow Creek's fish.

Classroom Visit: Student Activities (Continued)

C. Geology. The Rock Cycle

[**Bring at least one example of each of the three rock types to the classroom**.]

Some people believe that "once a rock, always that rock". But that is not always true. Rocks take different forms at different times. A long time ago our earth was very volcanic. As the earth's surface cooled and vast oceans swept over the earth, the cooled lava was broken or crushed into small pieces. These small pieces became cemented together to become **sedimentary** rocks. These rocks were buried and the heat and pressure within the earth changed them into **metamorphic** rocks. They might even have melted and become **igneous** rocks once more. A rock may change many times and the rock you hold today may look entirely different to someone a long time from now.



Based on how they formed, we classify rocks in three major families: **igneous, sedimentary, and metamorphic**. Each group contains many rock types that have different sizes, shapes and colors.

Classroom Visit: Student Activities (Continued)

Geology: The Rock Cycle

Types of Rocks		
Type	**Characteristics**	**Examples**
 Igneous rocks	**Igneous** rocks are formed when molten material cools. (When a mineral is so hot that it's liquid, it's "molten.") Igneous rock can be formed within the earth or above ground. When minerals are melted—"molten—within the earth's mantle, they're called "magma." Huge pressures within the earth's can force the magma up into spaces between other rocks. When molten material is forced out of the ground, it is called "lava." The hot material crystallizes into different igneous minerals. The characteristics and sizes of the crystals that form depend on what the magma was made from and how quickly it cooled.	*Granite* *Obsidian* *Basalt* *Pumice* *Andesite* *Diorite* *Rhyolite*
 Sedimentary rocks	**Sedimentary** rocks are made up of sediment (that's tiny pieces) eroded from other rock (igneous, metamorphic, or other sedimentary), and even from the remains of dead plants and animals. These materials are deposited in layers, called "strata," and then are squeezed and compressed beneath the earth into new rock. Most fossils are found in sedimentary rocks. Some sedimentary rocks are the softest and easiest rocks to break.	*Sandstone* *Shale* *Conglomerate* *Limestone* *Chert* *Coal* *Gypsum*
 Metamorphic rocks	**Metamorphic** rocks are produced when sedimentary or igneous rocks are transformed by extreme pressure and/or heat, usually deep within the ground. The word "metamorphic" comes from the Greek, and means "to change form."	*Marble* *Slate* *Quartzite* *Schist* *Gneiss*

As huge plates of the earth's crust move, they leave thinner spots for volcanoes to erupt, they are shoved under each other, creating the pressure that forms metamorphic rocks; and they force up masses of rock that become huge mountain ranges. This plate tectonic movement is the driving force of the rock cycle.

Classroom Visit: Student Activities (Continued)

Geology: Rock “Sight-Seeing” Tour

A rock "sight-seeing" tour around the world might well begin in the Hawaiian Islands with a visit to the world's most active volcano, Kilauea (key-lah-way-ah). This famous volcano, like others across the globe, is the birthplace of thousands of tons of rocks.

Igneous rocks are formed when lava or magma cools and hardens.

The volcanic eruptions eject massive amounts of **magma** onto Earth's surface. Remember that magma is nothing more than hot liquid rock and minerals within the Earth—above ground, it is **lava**. As the **lava** cools, it can become many types of **igneous** rock, such as basalt, pumice, or obsidian.

Traveling east from Hawaii, across California to Zion National Park in Utah, we would find the Navajo Sandstone Formation. It is a towering sand dune transformed into rock. It began millions of years ago as tiny grains of sand in a prehistoric desert. Over time, winds carried the sand and deposited it into giant sand dunes. The weight and **pressure** of the new sand crushed the sand underneath together until it was cemented to become a **sedimentary** rock.

Checkerboard Mesa in Zion National Park, Utah is the remains of an ancient sand dune.

Although these sandstone rocks began as a collection of individual grains of sand, the sand grains themselves had to come from somewhere and something else. The sand grains may have broken off a larger rock formed earlier by a volcanic eruption. Or they may have broken off older sandstone rocks.

The world rock tour that began in Hawaii might end in east Greenland even further to the east of us. Millions of years ago there, **magma** deep inside the Earth forced its way into another rock and solidified. This created an **igneous** rock. Then, intense pressure in the Earth caused the rock to up-heave, fold, and crumple, until it became an entirely new rock: a **metamorphic** rock. That new rock now makes up the highest mountain range in Greenland.

Because the Earth is so dynamic, rocks are always changing. Wind, water, the movement of the tectonic plates, pressure and heat within the earth—all change one type of rock into an entirely new rock.

Adapted from: http://science.cc.uwf.edu/sh/curr/rockcyc/rockcyc.htm; Courtesy of the Mineralogical Society of America

The Rock Cycle Worksheet

Name: _____ Date: _____

Pretend you are a rock. Fill in the blanks to tell about your trip through the rock cycle.

Hi. My name is _____ Rock. I started out as magma way down in the earth's _____. One day, a _____ erupted, and out I flew. I went from being magma to _____ very fast! Before I knew what was happening, I started to cool off and soon turned into an _____ rock. Well, I was okay with that. I thought I looked pretty cool.

After a while, I started to notice that I was shrinking. I thought it was my imagination, but I was definitely eroding into _____. The next thing I knew I was splashing around in some water, until finally I got stuck. A whole bunch of other sediment came rushing at me, and I was being buried! I started getting _____ really hard. When it was all over, I noticed that I had changed into _____ rock!

Well, fine. This was a cool new look. I wasn't going to complain, but before I knew it (rocks don't keep time), I started shaking and bumping around. I think you people would call that an earthquake. I started getting super _____ and I thought I was going to melt—but I didn't! My body was killing me from all the _____ of being squeezed!

I think I fell asleep for a while, because when I finally thought to check if I was still in one piece, I discovered that I had changed once again. I thought I looked better than ever. I couldn't believe it, but I had turned into a _____ rock! I don't quite know what to expect next, but I hope I stay this way for a long time!

Adapted from: Tony's Web Work,
http://www.geocities.com/tonyswebquests/worksheet_rockstory.html

Classroom Visit: Student Activities (Continued)

The Rock Cycle Answer Sheet

Name: _____ Date: _____

Pretend you are a rock. Fill in the blanks to tell about your trip through the rock cycle.

Hi. My name is _____ Rock. I started out as magma way down in the earth's __***mantle [upper crust]***_. One day, a _____***volcano***_____ erupted, and out I flew. I went from being magma to _____***lava***_____ very fast! Before I knew what was happening, I started to cool off and soon turned into an _____***igneous***_____ rock. Well, I was okay with that. I thought I looked pretty cool.

After a while, I started to notice that I was shrinking. I thought it was my imagination, but I was definitely eroding into _____***sediment***_____. The next thing I knew I was splashing around in some water, until finally I got stuck. A whole bunch of other sediment came rushing at me, and I was being buried! I started getting _____***crushed /pressed/squeezed***___ really hard. When it was all over, I noticed that I had changed into ___***sedimentary***_____ rock!

Well, fine. This was a cool new look. I wasn't going to complain, but before I knew it (rocks don't keep time), I started shaking and bumping around. I think you people would call that an earthquake. I started getting super _____***hot***_____ and I thought I was going to melt—but I didn't! My body was killing me from all the ____***pressure***___ of being squeezed!

I think I fell asleep for a while, because when I finally thought to check if I was still in one piece, I discovered that I had changed once again. I thought I looked better than ever. I couldn't believe it, but I had turned into a __***metamorphic***_____ rock! I don't quite know what to expect next, but I hope I stay this way for a long time!

Adapted from: Tony's Web Work,
http://www.geocities.com/tonyswebquests/worksheet_rockstory.html

Classroom Visit: Student Activities (Continued)

D. Redwood Ecology. Docent classroom presentation

Coast redwoods are the tallest trees on Earth. They can grow more than 360 feet high and live more than 2,000 years, growing as long as they live. They have many adaptations or characteristics that help them live so long. One adaptation is their special bark, which is a beautiful red color. It has tannic acid, which gives it a bad taste. This keeps insects and other pests from eating the redwoods.

Another adaptation is being able to survive forest fires. The coast redwood's tough, thick bark is fireproof. Their trunks have no branches or leaves until high above the forest floor, out of fire's reach. And, if a fire does burn the tree, it can sprout a new trunk from its base.

Probably the most important adaptation is that coast redwoods can get water from fog. Where redwoods live, there are rainy winters, but little rain the rest of the year. During the summer there is a lot of fog. Unlike most leaves, redwood leaves can soak up fog. This keeps the tops of the trees from drying out and helps them grow all year. The fog also condenses on the leaves and drips to the ground, providing water around the trees.
[Adapted from Save the Redwoods League, 2002.]

Activity: If a Redwood Tree Fell Here
1. This requires a few straight blocks of sidewalk—360 feet long. Bring students to the sidewalk. Ask them to count off as "1," "2," "3," "4," "5," "6," and "7." Give brown chalk to the "1's" through "4's" and green chalk to the "5's" through "7's."
3. Have the "1's" stand side-by-side on the sidewalk, draw a (brown) line across the sidewalk in front of them (perpendicular to the street) and stay at that line.
4. Ask the "2's" to walk forward from that point at a normal pace (about 1-1/2 feet per step), drawing a brown line along beside them, for 40 paces. (The other students follow behind.) Ask the "2's" to draw a line on the sidewalk at that point, and remain at their lines. **(Stay ahead of all students to stop at street corners and lead the crossing.)**
5. Have the "3's" walk from that second line, drawing a brown line, for 40 paces, mark where they reach, and remain at that point.
6. Repeat for the "4's" through the "7's," except that the "5's" through the "7's" draw green, wavering lines, and the "7's" connect all their green lines together at the end.
7. Tell the students to look from the "7's"—where the tree top would reach—to the "1's," where the uprooted base of the tree would lie. Redwoods can reach that length.

Shell Beach: General Suggestions for Docent Interpretation

Guided Walks and Tours

1. Take Charge. Your voice and demeanor set your relationship to the group. Relax.
2. Greet the group. Introduce yourself by name. Ask them to call you by your first name. Tell them what the walk will include and how long it will take.
3. Move out briskly but then set a moderate pace.
4. Generally stay ahead of your group, although there will be times when you will want to walk back into the midst of your group to share discoveries with them.
5. Assemble your group before speaking so everyone hears your interpretation.
6. Be conversational but be heard. Conditions may require you to shout, but try to avoid them. It is difficult to shout and not sound authoritative.
7. Repeat questions, so all can hear.
8. End your talk with a conclusion.

Example: Developing a Walk in a Douglas-Fir Forest

Inventory of elements to be introduced

Mushrooms	Shade	Redwood Orchid	Spider Hole
Douglas-fir	Fir Needles	Banana Slug	

Facts

Mushroom	The decomposers, a parasite or saprophyte, don't manufacture chlorophyll. This is the fruiting body of the plant (it lives underground).
Shade	There are tall trees all around. Not much sun reaches a north-facing slope, so things stay cool and moist.
Redwood Orchid	One of the few wildflowers here; a perennial with bulblike rootstock. Some scent attracts pollinating insects (to insure the species survival).
Spider hole	The Turret Spider is a relative of the Trapdoor Spider. Its web-lined hole > a foot deep. The "turret" keeps rain from flooding the hole.
Douglas-fir	Named after a Scotch botanist, David Douglas, who explored North America in the early 1800's. Cones have bracts (tiny scale-like leaves) that look like a mouse tail and two back legs. Squirrels eat immature cones like we eat corn-on-the-cob.
Fir Needles	Known as forest litter or duff; like cooling garden mulch in varying states of decay; a protective seed bed.
Banana Slugs	Are shell-less snails, eat veggies, including mushrooms, and are eaten by snakes, raccoons, shrews and even some birds.

Outline

1. Shady here, little sun, few plants growing on the forest floor.
2. The Douglas-fir, towering trees, providing the shade.
3. Mushrooms need little sunlight as they help to decompose the vegetation.
4. A Banana Slug has been chewing on this mushroom.
5. Fallen Fir Needles make up most of the forest floor.
6. Cool and moist, a perfect seedbed for Redwood Orchids to germinate.
7. The Spider Hole, "turret" is lined with fir needles.

EMERGENCY AT SONOMA COAST AND WILLOW CREEK

IN CASE OF ACCIDENT, CRIME, FIRE, MISSING or LOST PERSONS

OR NEED FOR FIRST AID OR MEDICAL TREATMENT

IF YOU HAVE CELL PHONE ACCESS, CALL 911

IF NOT, USE THE STEWARDS RADIO TO CALL THE JENNER VISITORS CENTER TO REQUEST A CALL TO 911.

To use the radio:

1. Rotate **the switch on top of the radio to the right** to raise the volume.
2. When "1" shows in the view window, **hold in the button on the upper left side of the radio** to call the Jenner Visitor Center.
3. **Describe the situation and your location** and request advice and assistance. **Release the button when you finish speaking** to hear the response. **Repeat if needed.** Stay on the line or available to provide information to the 911 operator. **DO NOT TURN OFF THE RADIO.**
4. **If you get no response,** press the music note key to ring other radios (rangers and life guards) on the system.
5. To check the batteries, look in the upper right-hand corner of the view window. You will see a symbol for a battery. Three bars indicates that the batteries are fully charged. As the batteries get low, the number of bars will decline.

……..

The closest landline is north on Route 1 at the Sizzling Tandoor at Bridgehaven

……..

As a volunteer, you may encounter situations where you must decide whether a visitor's actions merit only an explanation of a rule or more formal action. Any acts that may constitute potential hazards to the safety of people or property should be reported promptly to the Jenner Visitor Center or any ranger. State Park Rangers and some lifeguards have peace officer authority. Do not threaten or try to bluff a visitor. Never hesitate to call a ranger for guidance or assistance in any situation which threatens to become a problem. This may preclude or minimize liability in case of an accident.

State Park Dispatch **(916) 358-1300**
(If you need a Ranger immediately or for law enforcement issues)

Jenner Visitor Center:	707-865-9757
State Parks contact, Ben Vanden Heuval	707- 875-2603
State Parks Staff, Bodega Dunes	707-875-9651

Shell Beach OR Sunset Rocks: Docent introduction to the hike

Hi, I'm _____. I volunteer for the **California State Parks** and **Stewards of the Coast and Redwoods.**

We are standing in Sonoma Coast State Park in an area with **evidence all around of the geological and biological history of California** and the North American continent. As we hike down to [Shell Beach]/[the Sunset Rocks] we will be **entering another time**, **walking back in history as we find evidence of earlier times**.

To help you remember that you have left this time and culture, **pick up a rock** lined up on the trail. That rock may be millions of years old, present through immense changes in this land and its life. Keep it in a safe place, as you must leave it in the park when you return to the present and go home.

Poison oak: [As the group begins to leave, find a clump of poison oak around the parking lot.] **Without touching it**, do any of you know what this is? Yes, it's poison oak. Please look at it carefully. Although the Kashaya Pomo Indians were not allergic to it, we are. Do NOT allow it to brush against your skin, or even your clothes. You can react to its oils, even from your clothes, and it causes severe blistering and itching that can last for weeks. [Information in Docent Reference Material, appendix.]

During the hike:

Does anyone know how old the earth is thought to be? Geologic evidence shows that the earth is about 4 and 1/2 billion years old. Rocks we'll be looking at today are millions of years old.

Notice different layers of soil: The yellow band is a sand and gravel layer, similar to sediment accumulating today on beaches below. The dark top band is the topsoil layer of organic material from plants growing and decaying. Lower layers are earlier layers.

[Shell Beach only, this paragraph]
Shell Beach is a **special place for geologists** because the rocks that we see here are a **mélange**—a mixture of many different kinds of rocks. Does anyone have a guess as to why there might be so many different kinds of rocks along our coast?

What geological structures do we have coming together at the coast?

San Andreas fault—The **Pacific Plate** is moving north and **under the North American Plate** at the San Andreas fault causing uplift and mixing of rocks to create a **mélange** and level terraces with large rocks. They continue to be formed.

Shell Beach OR Sunset Rocks: Docent introduction (Continued)

Subduction occurring—one tectonic plate is being pushed under another. The rocks were formed on the ocean floor millions of years ago and hundreds of miles away. As the ocean floor spread, the rocks moved toward North America where the North American plate and the Pacific plate come together at the San Andreas fault. Subduction occurs when one plate (the Pacific plate here) moves under the other (the North American plate) and the top plate scrapes sediments off the bottom plate as the bottom plate is diving under.

Demonstration of subduction –

- Pass out one crème sandwich cookie to each student. Show how to carefully twist off the top part of the cookie so that one piece has all of the crème on it.
- Take the piece of the cookie with the crème on top (cream side up) and slowly push it below the other piece of cookie so that the crème scrapes onto the top cookie piece. Now let the students try it.
- Tell the class that much of this land is composed of rocks that were altered during subduction. Now let the students eat the cookies.
- (Adapted from Save the Bay, 2009.)

Sea stacks & rock formations were created when the terraces were at sea level

- Waves washed away the soft mélange, left hard blocks of rock
- Uplift at around 1mm per year here
- Land was underwater, then water recedes; has happened several times
- **Look back at hills/highway—**
  Terrace 4—highway; Terrace 5—standing on; Terrace 6—forming in ocean

Look out towards ocean

Around 13-15,000 years ago a large plain or grassland stretched 10 to 12 miles further out than the shoreline is today. The climate was similar to what it is today.
Grassland savannah with herds of animals migrated from the interior in summers

What animals would we be seeing?

- Columbian mammoth (16000 lbs) bison saber tooth tiger
  short-faced bear camels wolf deer wild horses

Would there be any people?

- Kashaya Pomo (Gualala to Duncans Landing);
  Coast Miwok (Duncans landing south to Bodega Bay area)
- Came from inland (more protected) villages to hunt, fish
  Gathered seaweed, salt, plants, abalone, clam shells

Invasion of Europeans—Europeans conquered native peoples; they **brought European plants** also conquering (overrunning) native plants (i.e. Ice plant, scotch broom, pampas grass)

Sunset Rocks ONLY: Docent introduction

(Prehistory may be social studies focus for sixth-grade students)

How might people and animals use these rocks? Why do we want to be here?

- Shelter from wind, hide from predators, hide to hunt animals that grazed here

Vernal pools

- Look for depressions, low spots on ground between Sunset rocks and rocks to west
- During spring they fill with water/mud—place mammoths could wallow

Look at the rocks carefully, especially at the edges and overhangs. Do you see anything unusual or different?

- **Polishing**—has been proven not to be from weathering (patterns from wind, water are different than these)
- Some is 14 feet off ground

Archaeologist hypothesis:

- **Polishing from mammoths** and other animals rubbing against them to groom, get rid of ticks, lice, mud?
- How tall is a mammoth?
- Measure out 14 feet with tape; how many students in your group to make a mammoth?

I**n recent times, ranching**

- Sheep and cows use rocks for rubbing—this recent polishing is lower on rocks, blacker, more visible;
- Oils from their hides cause polish on rock

Hiking the Pomo Trail: Docent Discussion of Cultural Groups

Format

Each student is assigned to one of the four cultural groups from the history of the Willow Creek watershed area—the Kashaya Pomo, Russian American Fur Company, loggers and ranchers. During the site visit, the students walk and work together in these groups, on the trail, on Red Hill and at Pomo Canyon. During the hike to Red Hill, docents walk with each of those groups to discuss how those earlier peoples lived on this land. A break will be taken at a point sufficiently high to oversee much of the Russian River area. If weather permits, during the break, docents point out specific places that have become visible that had significance for these earlier people.

Cultural Group Timeline (for two-day visits).

After their hike and experience at the stations at Red Hill, students will be preparing a timeline with information about the cultural group to which they are assigned. After the hike, each group is given time to create the timeline and prepare their presentation. Presentations can take the form of songs, skits, poems, etc. One of the stations on Day 2 will be a "Timeline Presentation Practice" to allow students to complete the timeline and practice their presentation. As part of the closing activity, each group will discuss and present their timeline to the class, parents and docents.

To help students prepare the timeline for their cultural group they will need to know:

1. The approximate years the cultural group lived in Willow Creek area;
2. Other groups with which they interacted;
3. How they used the land; and
4. What impact they had on the natural resources in the area.

In addition, as you hike, look for evidence of the different cultural groups to point out to students, such as:

- Goose pens—burnt out redwoods used by ranchers to contain small animals
- Stumps of redwoods from logging—sometimes found within fairy rings
- Ranch buildings
- Non-native plants introduced by ranchers
- Other traces of logging, farming, ranching

The students should have read a short history of their group prior to the on-site visit. A copy of those histories and relevant talking points for each cultural group are included in the following pages. A more comprehensive description of the settlement of this area is included in Part IV, the Docent Reference Material. If you have further information, please feel free to share it with the students.

Hiking the Trail: Docent Discussion of Cultural Groups (Continued)

Cultural Groups: Introduction

During your time here, we hope that you will be immersed in the history of this land. As a member of one of the four cultural groups, you are being asked to look at the land through their eyes. What made this a good place for them to live and work? How did they use the resources they found here?

Kayasha Pomo

General years of habitation—at least 9,000 years ago to present

- 9,000 or more years ago, Native Americans lived in the area. Archaeological deposits in a cave on the Sonoma Coast have been dated to 9,000 years ago. Another older layer has not been dated (Breck Parkman, State Parks Archaeologist).
- The population of the Kashaya Pomo in 1812—the time the Russian Fur Company established Fort Ross—was around 1500 to 2500 people. They lived in villages from just south of the Gualala River to just south of the Russian River.
- Kashaya Pomo descendents still live along the Sonoma Coast and in Sonoma County.

Human Interactions

- Traded with Miwok and other Pomo tribes
- Used clam shells as a form of money
- Lived in villages within Kashaya territory
- Village in Willow Creek area called Chalanchawi; Russians may have established Kostromitinov Ranch near Chalanchawi
- Worked as ranch laborers for the Russian American Fur Company at Fort Ross (1812-1841) and at other Russian ranches including Kostromitinov Ranch at Willow Creek (1833-1841)
- Pomo resisted exploitation by Russians and other Europeans, but their numbers were significantly reduced by the time of the Gold Rush (1849) through disease and exploitation
- Intermarried with Native Alaskans and Russians during Russian occupation
- Forced to move to rancherias at Stewards Point in Northern Sonoma County and Round Valley in Mendocino around 1895; some resisted and continued to live outside rancherias in Sonoma County
- Some worked as laborers for other ranchers and as loggers to make a living after their land was taken over by Europeans (around 1850 to the present)
- Their population had dropped to 400 by 1970; Some still live on rancherias and in the area
- They still gather for celebrations of acorn harvest, strawberry festival; and still gather basket-making materials and shellfish
- Built dome-shaped homes made of poles tied together at top and thatched with mud and reeds and sometimes redwood bark; burned down houses when they moved at the end of the season
- Lived along banks of river and streams during spring and summer
- Moved farther up hillsides to avoid floods in fall and winter

Hiking the Trail: Cultural Groups, Kayasha Pomo (Continued)

Land Uses

- Kashaya lived lightly on the land using its resources for food and shelter
- Hunted elk, deer, bear, other smaller animals and sometimes marine mammals, such as sea otter and seal for food, clothing
- Gathered seeds, berries, fruit, roots, and especially acorns from variety of oak trees. Gathered seaweed and mussels, abalone, clams for food, dyes and money (clam shells)
- Gathered sedge and other plants to make baskets
- Mostly stayed out of redwood forests; sacred and forbidding to them; would use redwood bark to cover their houses
- Created trading routes; some still visible today

Impact on natural resources

- Evidence of Native American occupation is small—arrowheads, evidence of tool making are almost all that is left

Question to students: What is the impact of the Kashaya Pomo on the land? Can we see that impact today? Let students discuss and express opinions.

Hiking the Trail: Docent Discussion of Cultural Groups (Continued)

The Russian American Fur Company

General years of habitation at Willow Creek 1833-1841

- 1809 Russians first came to Bodega Bay to trade with Spanish
- 1812 built Fort Ross
- 1833 built Kostromitinov Ranch in Willow Creek
- 1841 sold their holdings in Sonoma County to John Sutter of Sacramento and abandoned fort and ranches

Human Interactions

- Initially, traded sea otter and seal pelts with Spanish, Mexicans, Americans in Sonoma County for food and other necessities
- After ranches established, also traded products of the ranches for necessities
- Made treaties with Kashaya Pomo: Russians protected them from other Indians and the Spanish missionaries (who forced many native groups into missions), in exchange for the use of their land
- Used Kashaya Pomo, Miwok and other local Native Americans as laborers at the fort and their ranches
- Kashaya intermarried with Alaskan Natives and Russians.
- Sold holdings to John Sutter, but could not legally transfer land

Land Uses

- Began clearing land, cutting trees for farming and grazing on lower Willow Creek watershed and across Russian River
- Grew wheat, barley and other grains; grew fruit trees and vegetables
- Grazed cows, horses, and sheep; also raised chickens, pigs, and goats
- No one knows exactly where in Willow Creek the Kostromitinov Ranch was located, though it is thought to be in the area of Pomo campground. Students can be asked where they think a good place for the ranch might have been.

Impact on natural resources

- Hunted the sea otter almost to extinction
- Cleared some areas of riparian forests
- Introduced non-native species of plants.

Question to students: What was the impact of the Russian American Fur Company on the land? Can we see this impact today? Let students discuss and express opinions

Hiking the Trail: Docent Discussion of Cultural Groups (Continued)

The Loggers

General years of habitation—1848 to 2005

- 1833 Russians most likely first cut redwoods in lower Willow Creek at the Kostromitinov Ranch

- 1848 First timber lease granted by Captain Stephen Smith to Bethuel Phelps
- 1858 Joseph Knowles bought Willow Creek land and leased timber rights
- In1860 Samuel and Alexander Duncan built lumber mill at Duncansville near current day Bridgehaven
- Late 1860s, another sawmill was built in lower Willow Creek meadow area
- 1877 Duncan brothers moved town and mill to modern day Duncans Mill
- 1870s Russian River Land and Lumber Company bought Willow Creek property
- Late1880s logging began, as North Pacific Coast Railroad ran line to Willow Creek
- From 1920s to 1950s little logging occurred
- From 1953 to early 1970s, intense logging of second growth and remaining old growth redwoods by Hammond, Jenson, and Wallin
- 1978 CA State Parks acquired much of lower Willow Creek
- Between 1982 and 1998, Louisiana Pacific logged more than 1,000 acres
- 1998 Mendocino Redwood Co. buys land
- 2005 Conservation agencies purchase and transfer land to CA State Parks

Human Interactions

- Loggers cleared land that ranchers used for farming and grazing
- Logs had to be milled into products, so saw mills needed to be built close by
- Loggers used railroads, the river, and ships to transport lumber to markets

Land Uses

- Narrow-gauge railroad lines brought logs from Willow Creek to sawmills
- Wider-gauge railroads brought sawn timber to Duncans Landing.
- When logging finished, the railroad lines were pulled up and moved elsewhere, but the right-of-ways remained, sometimes becoming roads.
- Loggers cut down redwoods at first to use as shingles for buildings, and later for all aspects of building and furniture
- In the original Phelps/Curry lease, the land was divided into sections. Each section could only be logged once, which encouraged clear cutting.

Impact on natural resources

- Redwood forests became grassland
- Erosion of land and changes in habitat for animals

Question to students: What has been the impact of the loggers on the land? Can we see this impact today? Let students discuss and express opinions.

Hiking the Trail: Docent Discussion of Cultural Groups (Continued)

The Ranchers

General years of habitation—1833 to present

- 1833 to 1841 First ranchers at Willow Creek were the Russians who established the Kostromitinov Ranch, probably near Pomo Canyon Campground.
- 1853 W.S.M. Wright and a later descendent, Sampson B. Wright, grazed livestock in the south Willow Creek watershed. Sampson installed cream separator there
- 1858 Joseph Knowles, his wife, and his brother, David, settled in Willow Creek area, grew grain and livestock and built a flour mill
- 1923 Part of Sampson B. Wright's holdings became the Brown family ranch when Elmer Brown bought land. They ranched there for over 60 years.
- In the 1940's, the Gossage family had a Suffolk sheep ranch, also part of Sampson B. Wright's holdings.
- 1956 James Baxman bought Willow Creek property for a ranch.
- 1961 he sold the property to Poindexter Corporation for logging, but the family leased the ranch back to continue grazing cattle and sheep.
- 1982 the lower Willow Creek was acquired by State Parks, and the Baxman's lost their grazing lease.
- 2005 Mendocino Redwoods Company sold upper Willow Creek to SC Ag Preservation and Open Space District, which turned it over to State Parks. The Baxmans will soon have to give up grazing there.

Human Interactions

- Ranchers coexisted with loggers, using land cleared by loggers, providing leases for logging operations and leasing land from loggers
- Ranchers built flour mills and ground grain into flour for neighbors
- Produced butter, meat, wool, produce for sale
- Sometimes used Native American and others as ranch hands and laborers

Land Uses

- Used land to raise wheat and other grains in the valley and sheep and cattle on the upland meadows
- Built flour mills, ranch buildings

Impact on natural resources

- Planted and brought in non-native species
- Grazing changes the kinds of plants that can survive here
- Erosion from agricultural uses
- With loggers, changed the landscape from forests to grassland and crop land

Question to students: What has been the impact of the ranchers on the land? Can we see this impact today? Let students discuss and express opinions.

Hiking the Trail: Break Overlooking the Russian River Area

Identify significant locations and areas (if weather allows)

Pomo Indians lived in Chalanchawi village somewhere near or in the Pomo Canyon area, but collected shells and fished at the beach. So we may be seeing much of the main area where they lived.

Russians landed in Bodega Bay, not far to the south of us here. They traveled overland below and to the west of us, to Fort Ross. Fort Ross is about 30 minutes north of us (by car, not foot or horse-drawn wagons). The farmhouse at Kostromitinov Ranch was the stage coach stop on that journey. It may have been located in Pomo Canyon near to the Chalanchawi village.

Travelers used the cable ferry to cross the Russian River. The ferryman's house at Willow Creek was where they crossed, so Willow Creek was a major point in the journey. We can see where the ferryman's house used to be.

The loggers developed a symbiotic relationship with ranchers and farmers, who wanted the land to be cleared for crops, cattle and sheep. From the growth you see around us, where would they have found redwoods for logging?

Portable mills were brought near to the areas being logged. Railroads and roads were built to transport logs to the river or ocean to take them to mills or markets. To the west of us here, Highway 1 from Bridgehaven to Duncans Landing is an example of such a route.

Duncans Landing is between us and Bodega Bay to the south. Its cove was the anchor point for winches used to load the timber onto ships bound for San Francisco. Local redwood originally was used to build San Francisco, and following the great San Francisco fire, local timber rebuilt much of the city.

Farming and ranching expanded as the area was logged. What does the topography suggest would be raised here? As you look down, you can see that there is little flatland in the Russian River watershed, which limited what crops could be grown. So cattle, sheep and hay for late-year forage, were most commonly raised in the area, as they still are.

On Red Hill

Student groups will circulate among the four 'stations' set up for each activity. Expect to complete each activity in 40 minutes, giving about 5 minutes for the groups to move among the different stations.

Station 1 - Reflections, poetry

Student journals show haiku and cinquain forms of poetry. You may wish to mention several other forms in introducing this activity. As you circulate among them, should students express an interest or show difficulty in using the two forms shown in their journals, you are encouraged to show them others, as in the following pages, that they may find easier to use.

Docent talking points

There are many different ways to experience nature and the outdoors.
Some today are exercise, learning, observation and appreciation of the natural world.
Another reason people spend time outdoors is to experience the quiet--to reflect, recharge, observe, listen, process and create.

Reflect, Create a Poem (Pages 13 and 14, Student Journal)

This is your time to think about, reflect on what you have experienced so far today. Look back on your experiences, chose something that you have seen, heard, or felt that has made an impression on you. You will use that subject to create a poem. Find a place where you have space away from your friends. There is plenty of space here. Please, no talking. Create the quiet time you need to think and reflect.

Find Descriptive Words

Lumbermen used saws to cut down trees. Kashaya Pomo used nets to catch fish. Your tools to create poetry will be words. In your journal are two pages for this exercise. Please read page 13, as it gives you examples of different poetry forms. These are just examples. You may use any poetry form you know, or I can show you others if you'd like to try something else. Page 14 gives you space to create your poem. You may want to use the note on page 22 in the back of your journal to jot down some ideas and words before you begin your poem.

After you choose your subject think about how it looks, feels, sounds, smells. Think about how it might taste. Then jot down some adjectives, verbs, nouns that describe your subject using your senses. From these words you may create your poem.

NOTE: After they complete their poems, encourage students to share them. Many will want to but if someone does not, please respect that.

On Red Hill : Station 1 - Reflections, poetry (Continued)

If a **cinquan** has five lines, can you guess how many lines a **quatrain** would have?
A **quatrain** is a 4-line poem with two sets of rhyming lines.
If the first line rhymes with the second line,
then the third line rhymes with the fourth line (**AABB**).
If the first line rhymes with the third line,
then the second line rhymes with the fourth (**ABAB**).

For example:
On top of a mountain there sits a green bird. **(A)**
The song that it sings is the best ever heard. **(A)**
When it opens its mouth all the animals cheer, **(B)**
For this song is a sound that all want to hear. **(B)**

To get more ideas, students may wish to look at the examples here and on the following pages, in addition to the haiku and cinquain forms in their journals.

A **sensory poem** is a six-line poem that describes a subject from the point of view of the five senses. The order of the senses can be changed but the ending always describes how the subject makes the author feel.

Line 1: See—Introduce the subject, describe how it **looks** (color, shape, etc)
Line 2: Hear—Describe how the subject **sounds** (noises associated with it)
Line 3: Taste—Describe how the subject **tastes**
Line 4: Smell—Describe how the subject **smells**
Line 5: Feel—Describe what the subject **feels like**
Line 6: Describe **how it makes you feel**

For example:

A lemon is bright yellow, oval and small.
It smells fresh, sweet, citrusy.
It sounds squishy as I bite into it.
It tastes sour as my mouth puckers up.
It feels smooth, yet bumpy as I hold it in my hand.
It makes me feel sunny and refreshed like a summer day.

On Red Hill : Station 1 - Reflections, poetry (Continued)

Free verse has NO formula or set style. One speaks:

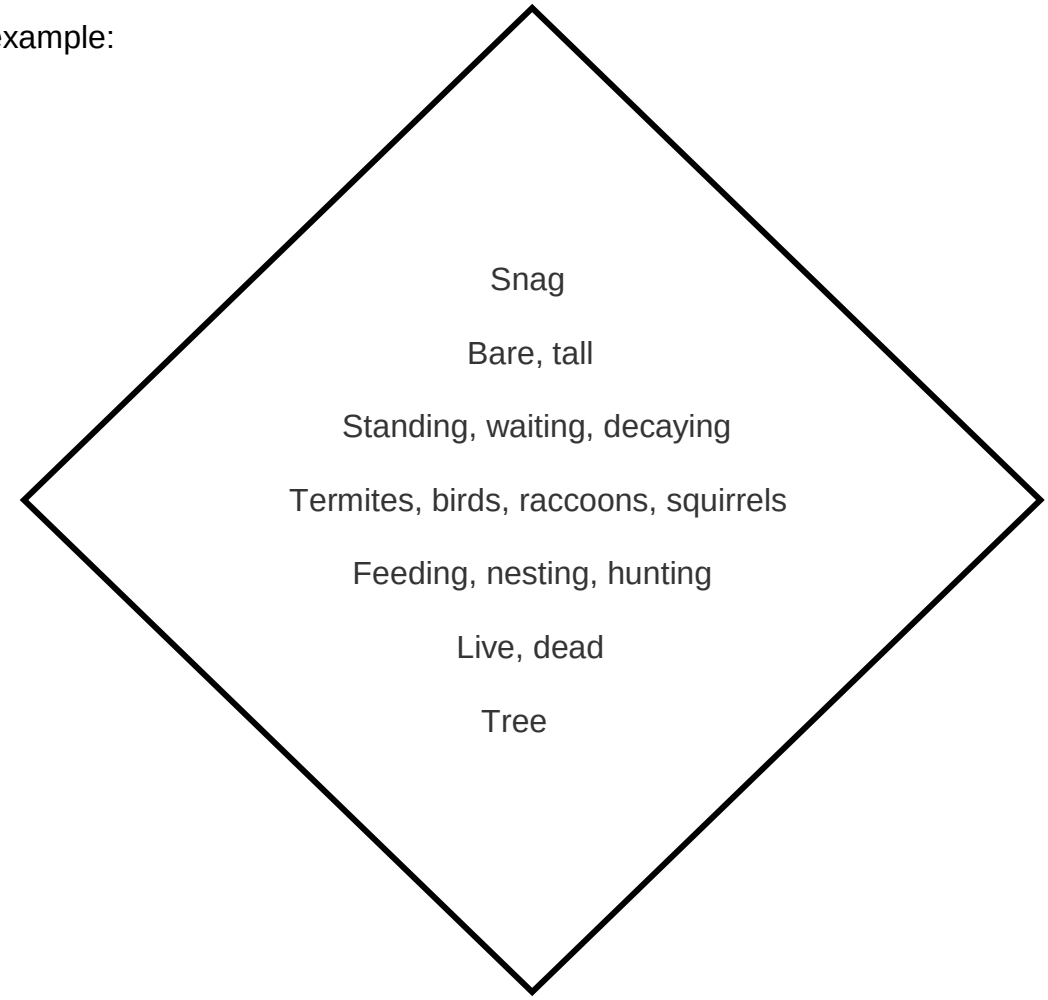
We grow
Tall, strong, silent.
We live
years -- hundreds, thousands.

Hear us.
We welcome you.

Diamonte. A diamonte is a seven-line poem that looks like a diamond.

First line: one word subject (**noun**)
Second line: two **adjectives** to describe the subject
Third line: three words ending in "ing" (**participles**) that tell about the subject
Fourth line: four **nouns** that describe or are related to the subject
Fifth line: three **participle**s (words ending in "ing") that tell about the subject
Sixth line: two **adjectives** describing the subject
Seventh line: one word **synonym** of subject (**noun)**

For example:



On Red Hill : Station 1 - Reflections, poetry (Continued)

Acrostic Poem

Acrostic poems a use the letters in a topic word to begin each line. All the lines of the poem should relate to, describe or tell a brief story about the word. For example:

S hines brightly
U p in the sky
N ice and warm on my skin

T all
R ed
E vergreen
E xcellent

Use words or the name of something found in a forest or at the beach. Use the letters of the word or name to begin each line. Relate the lines to the word or name.

Color Poem

Name at least 2 things that are your **favorite color**. (water is blue, iris are purple etc.)
_____ and _____

Name at least 2 things that **sound like** that color. (green sounds like croaking frogs)
_____ and _____

Name at least 2 things that **smell like** that color. (purple smells like lavender)
_____ and _____

Name at least 2 things that **taste like** that color. (red tastes like cinnamon)
_____ and _____

Is there a **place that reminds you** of that color? (yellow is a sunny beach)
_____ and _____

How does that color **feel**? How does it make you feel? (lavender feels serene)
_____ and _____]

Using the ideas above, a color poem can be created in the style below.

_____ is _____, _____ and _____.

_____ is _____, _____ and _____.

_____ sounds like _____ and _____.

_____ smells like _____ and _____.

_____ tastes like _____ and _____.

_____ is found_____.

_____ feels (makes me feel) like _____ and _____.

On Red Hill: Station 2 - Plant Identification

Similar But Not the Same – Docent Talking Points

Student Journal Pages 11 and 12; background information in Docent Reference section

Classification as way to compare and contrast species, learn what to expect of individuals. Students observe and compare and complete table in their journals.

Characteristics	Coast Redwood	Douglas Fir
Bark	Fibrous; soft fibers up and down tree; lichen growth	Flaky, hard, broad; furrowed ridges; thick puzzle-like pattern
Leaves - individual	Sharp pointed needles; stiff; ¾ to 1 inch; curved; drooping; shiny yellow-green; top needles different from rest	End of needle is soft; fruity fragrance; blue-green
Leaves - arrangement on twig	Two rows on side of twig; flat arrangement; top needles close to twig; scale-like	Needles all way around twig; brush-like
Cones	3/4 inch to 1 inch (olive size); lose seeds in winter; reddish-brown; hanging	1-1/2 to 4 1/2 inches; cinnamon brown; soft; 3-forked bract protruding from cone (like mouse feet & tail); hanging
Other: Roots and Uses	Root network; side roots to 250 feet diameter; no tap root; Uses: Lumber, shelter; outdoor furniture; decks	Tap root; Uses: Lumber, plywood, Christmas trees; deer and elk feed on small trees

On Red Hill : Station 3 - Coast Redwood Ecology Talking Points

Students use Journal, page 22 for notes, and back cover to check off plants. Background information, Part IV, Docent Reference Material

Why are Redwoods special? Why would we bring students to see redwoods?

- Tallest trees on the planet, often more than 300 feet tall: that's longer than a football field. Tallest one measured 378.1 feet (in Humboldt County, 2006).
- One of the world's oldest trees: some are over 2,000 years old
- Healthy stand of redwoods has more biomass than any other ecosystem on earth—one tree in Humboldt has 361,336 board feet of lumber, enough to build 22 five-room houses.
- Restricted range from southern Oregon to the central California coast, rarely more than 30 miles from the Pacific Ocean.
- Drink hundreds of gallons of water per day
- Fog drip provides water to top of highest trees and to soil during dry season
- Has two kinds of needles adapted to allow fog to condense, collect and drip to ground.
- Lateral, shallow roots allow trees to capture water from fog drip
- Roots of trees intertwine to provide stability from wind.
- Have small cones, about the size of an olive, and even smaller seeds. But the primary method of reproduction is stump sprouting, rather than seed sprouting.
- Burls form from injuries or extra growth on tree. Contain many buds which can sprout forming new branches and trees.
- A ring of younger trees formed around a parent tree is called a "fairy ring". Will often see fairy rings as second and third growth. Parent tree is cut down and new trees grow around the stump forming the ring.
- Bark is thick and retains moisture. Tannic acid in bark gives tree resistance to fire and its red color.
- "Goose pens" are formed when fire finds opening in bark and burns some of the inside of tree. Tree can continue to live and grow.

Common plant associations:

All year:

- Tan oak
- California bay laurel
- Lichen
- Douglas fir
- Sword fern
- California hazel
- Redwood sorrel

In Spring

- Fetid adders tongue (slinkpod)
- Trillium

Adapted from California State Parks, 2008. p. 265-268.

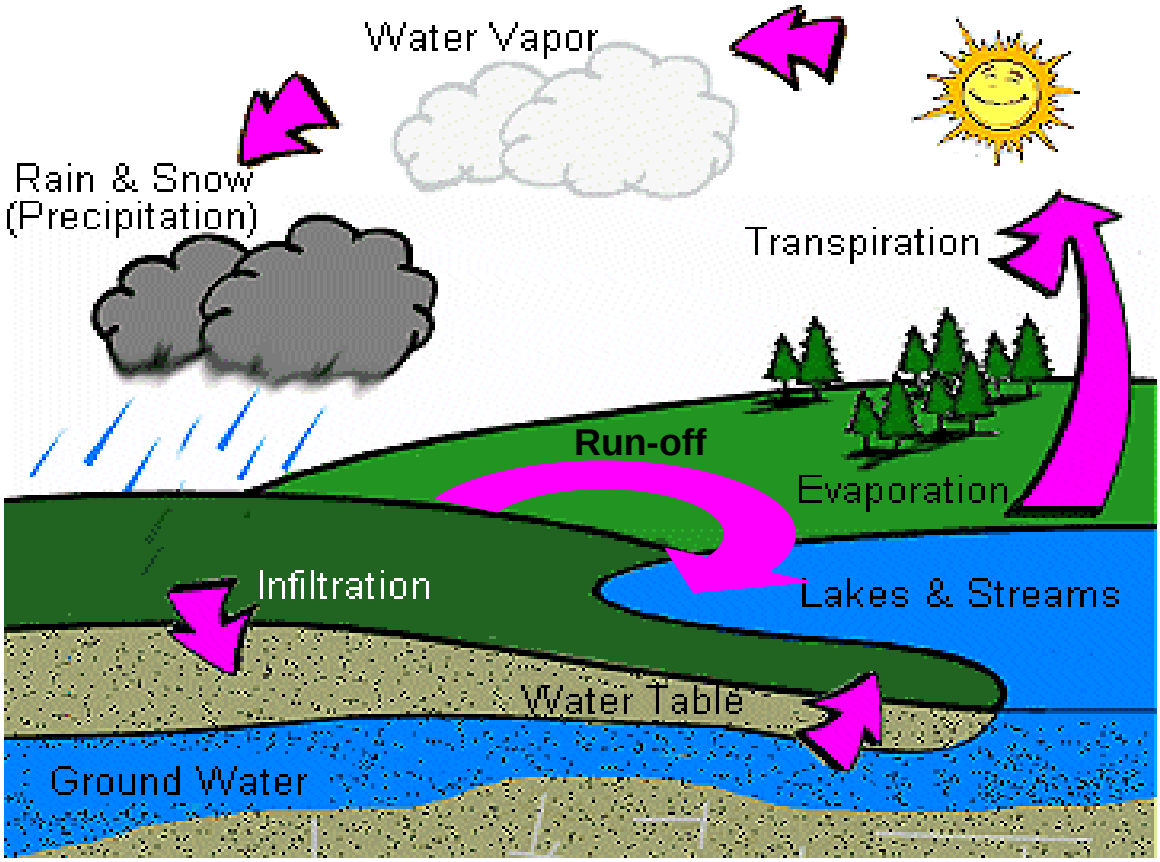
On Red Hill: Station 4 - Watershed Mapping

Docent Talking Points: Review the water cycle

The path water takes as it moves through air, soil, rivers, oceans, and ice is called the “water cycle.” [**Words in bold** are water cycle terms shown on page 7.]

1. Rain falls on the land (**precipitation**) and begins to puddle or **run off**.
2. Small streams join larger streams and then become big rivers.
3. Rivers flow into oceans.
4. Water **evaporates** and turns into water vapor, which forms clouds (**condensation**).
5. Plant roots also take up and release water through their leaves and stems, which is released into the atmosphere (**transpiration**).
6. Water also reaches rivers or streams when raindrops soak into the soil (**infiltration**) and become part of the groundwater (water which flows underground)
7. The groundwater sometimes comes to the surface as springs, or seeps, and flows into streams and rivers.

Have students label the water cycle on page 7 in their journal.



On Red Hill: Station 4 - Watershed Mapping Talking Points (continued)

Review the concept of a watershed

[Words in bold are the watershed terms shown on page 8.]

The first step in learning about a stream is to learn about its watershed. A watershed is an area of land that drains into a particular stream, river, or lake.

1. Water flows downhill from the **divide or ridge**
2. When raindrops fall on the land, they flow down to the lowest elevation by way of **tributaries**
3. Tributaries flow into a **river** or stream, in our case Willow Creek.
4. Willow Creek is a small stream which flows from its **mouth** into the Russian **River.**.

Have students complete page 8 in the student journal.

<u>Watershed Mapping Activities</u>

Have *three large laminated maps and a compass*

1. Start with map covering the entire Russian River (RR) watershed; using the compass to determine north, lay the maps properly aligned, north to south. Have students find on the map what they can see before them.
2. The second map covers the lower RR, south of Healdsburg down to the river's mouth; this map highlights the watersheds.
   Have kids find their school on the map; determine its direction from where we stand
   Show where their school is in relation to the Willow Creek watershed
3. The third is the topographical map focusing on the **Willow Creek watershed**
   Green shaded is forest, shrubs;
   White/unshaded is open land, grassland;
   Blue lines are creeks, rivers;
   Brown lines are contour lines, denote elevation above sea level. The closer together they are, the steeper the slope shown.
   Iso bars are at 100' intervals.
   Numbers are feet above sea level.

Cultural groups of the area

In introducing use of the three maps, ask a question or two about the peoples who are the focus of the student group.

a. **Pomo Indians** lived in Chalanchawi village somewhere near or in the Pomo Canyon area, but collected shells and fished at the beach. What route would they take between the two?

b. **Russians** landed in Bodega Bay, a safe anchorage, and traveled north overland to Fort Ross. Since the Russians built roads along ridge tops, what would be their route from Bodega Bay through to the ranch, and north to Fort Ross?

On Red Hill: Station 4 - Watershed Mapping Talking Points (continued)

c. **The loggers.** Logs from the Willow Creek watershed were brought to sawmills, and the sawn timber was sent by train to Duncans Landing and loaded onto ships bound for San Francisco. Where might that rail line have run?

d. **Farming and ranching** expanded as the area was logged. What areas can you find that would be appropriate to grow crops? Where might the Knowles have built their flour mill?

Alternate activity 1. Our routes

a. Orient the map north to south, Find where Willow Creek is from our location
b. Trace our route from Shell Beach to Red Hill
c. Use iso bars to see how high we are from our starting point (i.e. sea level)
d. Find Jenner and Duncan's Landing on the map; find them from our location
e. Figure out where we will hike to get to Pomo Canyon campground, how far that will be, and what the change in elevation will be.

Alternate activity 2. The watershed

a. Where does water run off in our watershed?
b. Is there evidence of its path on our map?
c. Is there evidence of its path in the real world in front of us?
   - depressions on the hillsides,
   - creekbeds carved by flowing water;
   - where trees live,
   - creekbeds benefiting from the water.
d. At top of watershed, further east, how can we affect the lower watershed (Willow Creek, the Russian River and the Pacific Ocean)?
   Make the connection between inland watersheds and the downstream areas. What we put in the water in Santa Rosa ends up in Jenner and in the ocean.

Alternate activity 3. Drawing the watershed

As a new activity, we will try asking students to draft three-dimensional drawings of the watershed from different points within it. A student may chose to use the maps to imagine the view from Willow Creek, from the Russian River, at a point on one of the hills, or facing north or south or upstream or downstream from the river. Those who have less of a feel for the topography from the maps alone may wish to draw in one direction from the current location, but clearly siting it on the maps. These maps may be drawn in their journals (page 9).

……

Docents walk to Pomo Canyon with the group and leave for the day.

Day 2: Pomo Canyon Campground, Habitat Assessment

The four student groups will take turns participating in two primary activities on streambed structure and BMI's, and preparation for their timeline presentations. If scheduled, a service project, tests of Willow Creek water, and/or riparian habitat assessments are possible.

- If the service project will be conducted before lunch (11 – 11:45 a.m.), only the primary activities and timeline preparations may be scheduled for the morning work session, allowing about 45 minutes for each. If water tests **or** riparian habitat assessments are added, only 30 minutes can be allowed for each.
- If no service project is scheduled before lunch, final timeline practice may take place after breakfast and before lunch. In this case, water tests or riparian habitat assessments can be added, allowing 45 minutes for each of the four activities. If both are added, only 30 minutes can be allocated for each of the five tasks.

Primary Activity 1. Streambed Structure: Docent talking points

A river bottom helps to maintain the health of the animals that live in it. Fungi, bacteria and algae growing on the bottom are eaten by small animals that are the food for fish. And steam beds are where most aquatic animals lay their eggs and grow up.

River beds vary from clear, pebbly runs where streams begin uphill, to wide, slower muddy bottoms where rivers are approaching the sea. But humans have a large impact on the amount of mud or silt in the water. Trees, bushes and other plants hold soil in place, even on steep hills. When plants are killed by logging, quarrying or bulldozing an area, for instance, there is nothing to hold the dirt during rainstorms, and mud runs into streams and rivers. That erosion of hillsides drastically changes the downstream water.

Animals are adapted to the amount of sunlight and clarity of water that is normal for their area. Big increases in mud in the water cut the sun that native plants need and can smother fish eggs, suffocate animals, or bury the small leaf particles they eat, so that they starve. Generally, 85% of salmon eggs will die when 15-20% of the spaces between gravel are filled with sediment. Some worms and midges can live in muddy stream bottoms. But most baby fish and the small animals that they eat need clean gravel and cobblestone beds, without much mud in between. If river bottoms are relatively clean, clear and cool, and there is a mix of large and small rocks to protect them, fish can spawn, lay eggs there and thrive. You'll learn more about what these animals need when you collect the little underwater animals that fish eat.

What we will do now is see if there is a good mix of large and small rocks, and if there is enough space between the cobbles and gravel on the creek bed to allow eggs, small animals and little fish to shelter and grow there.

Day 2: Streambed Structure (continued)

Streambed Structure: Activity

Students form pairs, the Measurer with a *metric ruler*, and the Recorder with a pencil and Student Journal. Ask the Measurers to review the pictures of embeddedness at the bottom of (unnumbered) page 17 in their journals. Tell them that they will look at how much the river rocks are covered by mud or silt.

Ask the Measurers to carefully enter the stream bed (even if it is dry), disturbing the vegetation and creek bottom as little as possible. Have them stand side by side, facing **upstream** away from you, across the width of the creek bed. If the class is too large, have them form two lines, one three-to-five feet behind the other. (For younger classes, have adults help students measure and record the measurements.)

1. Have the Measurers pick up the stone or pebble closest to the big toe of their left foot, even if it is very small. Students measure the rock at its longest length and call that length to the Measurer, who puts a mark in the appropriate row in first blank column of the journal (on unnumbered page 17, column 3) for the size class of that rock. Ask students to return the rock to the stream bottom (no throwing).
2. Next, ask each Measurer to compare the stream bottom immediately around their feet with the three examples of embeddedness on page 17. Have them judge if it seems closest to the very rocky, little dirt picture (0%, far left); muddier but more rock than dirt (30%); or about half rock and mud (50%). The Recorder should enter the percentage in the far right column of the table, top row.
3. Ask them to walk <u>two</u> paces forward, reach for the stone or pebble closest to their left foot, and call its size class to the Recorder.
4. Repeat the forward paces and rock measurements six more times, **on the last measurement also assessing the rockiness (embeddedness).**

Ask students to come out of the streambed, disturbing the bed and banks as little as possible. If a student stirs up the creek, discuss turbidity and its effect on young salmon and their prey.

Have the Measurers and Recorders change equipment and places, with the new Measurers starting at the same starting place across the stream bed, but **facing downstream.** Repeat the sequence for eight measures, again, beginning and ending with assessment of both rock size **and** embeddedness.

On dry land, students sum their observations for each class size (second blank column). Ask them whether this is good habitat for fish eggs and fingerlings. Ask them to discuss what is supportive and what would be problematic.

Day 2: Primary Activity 2. Benthic Macroinvertebrates

Illustrations and comprehensive reference material on macroinvertebrates is provided in Part IV, Docent Reference Material

Docent talking points

Benthic = bottom-dwelling; macro = large enough to be seen by the human eye; invertebrates = animals lacking backbones

Young fish (fingerlings) obtain food from the bottom of streambeds. If they have to search closer to the surface, they are very vulnerable to many predators. So the health of their river bottom food, the benthic macroinvertebrates (BMI's), is crucial to steam-dwelling fish.

Look at your journals, page 15. BMI include insects (they are eight of the first nine animals shown), crustaceans (like crayfish and crabs), snails, earthworms and leeches.

BMI can't travel far, so they can't leave polluted areas. That means that those that are sensitive to pollution die. If the majority of species that we find are pollution tolerant that indicates a polluted environment. If we find few or no species, that can handle it, that is a further indication of a polluted environment.

The scariest pollutants are chemicals--particularly pesticides and herbicides that some people use in gardens and in agriculture--and heavy metals. But rivers aren't harmed only by poisonous chemicals.

For instance, roads, parking lots and buildings are impermeable--rain can't soak into the ground through them. So rainwater doesn't refill the natural underground basins. Those basins, or aquifers, normally would release water slowly into streams in dry periods. Without that stored groundwater, streams dry up more rapidly and for longer periods of the year, killing many of the BMI and fish. Rainwater also quickly floods off of pavment and buildings, creating flooding, eroding stream banks and increasing mud in the water.

Similarly, fertilizer run-off can kill small animals directly, or create algae blooms that decay, decreasing oxygen in the water and wiping out the native plants that provide food and shelter along the stream beds.

Review the *chart of the food chain* to show the role of these creatures in the broader habitat, how their health affects predators up the food chain. Salmon, steelhead and trout all depend on caddisflies, mayflies and stonefish as a primary food. In streams or rivers where those BMI are absent, these fish cannot survive.

In this exercise we are looking to see if plenty of BMI that would be killed by pollution still live in Willow Creek. If they are still here, that's an indication that the creek has pretty good water quality.

Day 2: Benthic Macroinvertebrates, Activity (continued)

Have the kids divide into groups of three (with *two-handled nets*) and two (with *sifters*).

a.) In the groups of three, one stands upstream and stirs up the bottom **just enough to dislodge the BMI**; the two holding the two-handled net scoop up creatures that rise from the bottom.

b.) Paired students operate similarly, with one upstream stirring up the bottom while the second captures the animals with a sifter.

c.) Others lift rocks on the streambed and gently scrape BMI into buckets.

All BMI are collected in *buckets*, which are poured into *trays* with water. Using *plastic spoons and basters*, the animals are distributed into *ice cube trays* for identification.

Using the *dichotomous key*, students answer a series of questions about each animal to identify it. Students enter the identified creatures in their journals, page 16. All creatures are returned to the streambed, as close as possible to their source.

The most common pollutants are excess nutrients and sedimentation:
mayflies, stoneflies and caddisflies are most adversely affected
beetles, craneflies and crustaceans are moderately affected
midges, aquatic worms, leeches and blackflies are least affected

The number of different species is used to indicate the extent of stream pollution.

Observations:	**Indications:**
High diversity, lots of stoneflies, mayflies, dobsonflies, caddisflies; riffle and water penny beetles	Good water quality
Low diversity; lots of scrapers and	Overload of algae growth from organic pollution; or sedimentation (eroded hillsides)
Only 1 or 2 types of BMI; or high number of collectors, midgeflies, worms, leeches or pouch snails	Severe sedimentation or organic pollution
Low diversity, low density, or no BMI's, but the stream looks clear	Toxic pollution (chlorine, acids, heavy metals; oil, pesticides)

Adapted from Murdoch, Tom and Cheo, Martha, 2001, p. 136.

The BMI sampling method consistent with the California Stream Bioassessment Procedure, as used for the upper Russian River habitat, is described in Sustainable Land Stewardship Institute, 2002, p. 4 – 5.

Day 2: Secondary Activity, Water Quality

Acidity. Docent talking points.
All liquids have a level of acidity, which ranges from very acidic—like the acid in a car's battery or lemon juice—to the opposite, which we call "basic"—like the baking soda that we use at home for cleaning or cooking, or like bleach. The rocks and soil along a waterway (and, to a lesser extent, the vegetation that grow along it) create a river's natural level of acidity*. The animals that evolve in a waterway are adapted to those natural ranges of acidity. Many of them, including salmon, are unable to live in water that is much more acidic or basic than the natural range.

Unfortunately, human actions produce a lot of chemicals that change a stream's acidity. The most common are our sources of energy, particularly for cars and industry. Burning fossil fuels like gasoline and coal creates sulfur and nitrogen oxide. These exhausts transform in the air and sunlight into sulfuric acid and nitric acid, which get washed into waterways in the form of "acid rain." In addition to poisoning fish, the acids dissolve metals in the soil. Those heavy metals deform the babies of aquatic animals and prevent the gills of underwater animals from working correctly, suffocating them.

These pollutants aren't visible in the water, so we use what are called "pH tests" to measure their affects. We'll use test strips that change color according to how acidic or basic the water is. By comparing the color of the test strips to a color chart, we can estimate the creek's pH and how it is likely to affect aquatic animals.

Acidity Activity.

Select three students to test the water, and three to analyze it (or more, if you have a larger number of test strip bottles). .

1. Give one test strip to each Tester, **keeping fingers away from the testing end**.
2. Ask the Testers to step carefully into the stream, dip the test strips about halfway into the main current away from the creek banks, and immediately remove them (without shaking them.) Hold the strips level for 30 seconds, then hand them to the analysts.
3. The Analysts hold the strip (**with fingers away from the testing end**) against the pH color chart on the bottle and determine which color is closest to the color of the water. (If the strip color falls between two on the chart, use the average of the two.)
4. 'Please mark the matching pH level in the Notes section at the back of your journals. Now compare the pH count with the acid/base tolerance chart to see which animals would do well in this range.'

*California's has not set a "pH standard" for Willow Creek

Day 2: Secondary Activity, Water Quality (continued)

Acid/base tolerance scale: On the pH scale from 0 to 14:

0 = highly acidic (i.e. battery acid ~ 0.5)
0 to 4: All fish dead
< 4.5: All fish begin to die
0 to 4.5: Caddisflies, mayflies dead
0 – 5.25: Bass, trout, tadpoles dead
< 6.0: Bass, trout, tadpoles begin to die
< 6.5: Caddisfles, mayflies decline
6.5 – 8.2: Optimal pH for most life
> 9: Harmful to salmonids & perch
10.5 – 11: All fish begin to die
> 11: Salmonids dead
> 11.5: All fish dead
14 = very basic (i.e. bleach ~ 12.8)

Adapted from Murdoch, Tom and Cheo, Martha, 2001, p. 167

Water temperature, Docent talking points.

Animals also evolved to live in the temperature ranges of the waterways they inhabit. Water temperature controls how well they can move, when and if they reproduce, and their overall life cycles. Cold-blooded animals in particular—like fish and the little creatures they eat—assume the temperature of the surrounding water and function in those ranges.

Aquatic animals—those that live in water—use gills to pull oxygen out of the water. And temperature affects the amount of oxygen in the water. The warmer the water, the less oxygen it carries, and the fewer species can survive in it. Salmonids—and the mayflies, stonefish and caddisflies that they eat—need low temperatures to get the high amount of oxygen they need. Warmer waters also hold higher concentrations of toxic chemicals, and support the growth of parasites and diseases. Warmer waters can sicken animals that have evolved in areas which are naturally cooler.

Waters get warm in the summer and when water flows are lower. But humans heat waters above those natural levels when we use river water to cool power plants and factories, and to irrigate fields. We will measure Willow Creek's temperature to see if it is in a healthy range for the animals here.

1. Divide students into groups of three (more if you have more thermometers).
2. Have students lower the thermometers gently into the stream flow, and hold them there for 2 minutes. Record the temperature in the Journal Notes page at the back.
3. Is it between 5 – 13 degrees C or 41 – 55 degrees F, the optimal zone for steelhead and trout; or up to 20 C or 58F for the animals they eat?

Day 2: Secondary Activity, The riparian environment.

Docent talking points.

A healthy stream has banks that are fairly stable. The soil is held in place by larger rocks and boulders that have been uncovered by floodwaters and the plants along the shore. This keeps the water clearer and the spaces between streambed cobbles open for little animals and fish eggs.

Rain flushes pollution out of the air. Plants along the watershed catch rain as it runs downhill, directing it down into the ground. This allows the pollutants to break down in the soil, often becoming less dangerous. The rain also runs into underground basins, which release water slowly in the drier periods. Plants shade streams, keeping them cooler. And shrubs that directly overhang stream banks provide cover for aquatic animals—such as fish, frogs and salamanders—from flying predators. Branches that fall into the stream help to slow flooding waters, catch and settle sediment, prevent erosion of the stream beds, and provide protected spots for fish. Dead leaves are food for the small macroinvertebrates that fish eat.

We'll conduct an inventory of this area, to see how healthy the bank shores seem to be.

Riparian environment activity.
Divide students into four groups, two to each side of the creek.
Students walk 15 paces from the center point (one group to the right, one to the left) along the streambed, and mark that outer edge. <u>In their zone</u>, students note:

a.) wood and leaves in the streambed
b.) the #of plants whose roots grip the stream bank
c.) the # of plants that hang directly over the stream (no more than 5 feet up)
d.) the # of plants that shade the stream
e.) if there are
    (i) shrubs,
    (ii) non-woody herbaceous plants, or
    (iii) both
f.) grasses
g.) (i) deciduous trees; (ii) coniferous trees, or (iii) both, beyond their stream banks.

Have the students analyze the different habitat indicators.

- Does the stream have logs, branches or twigs for protection from predators, to slow currents and catch sediment, and to provide shade?
- How much of the stream is shaded in the morning? at mid-day? in the evening? When deciduous leaves have fallen? (Why is this less important)?
- What share of the riparian area has bare earth? Do plant roots restrain erosion?
- Does vegetation buffer an area three times the width of the creek?
- Does the riparian environment seem likely to support plenty of animals, both within and out of the water?

Day 2: Pomo Canyon Campground

Final Timeline Presentations. (Not a docent-led activity)

Service Project (Not a docent-led activity)
Prior to the ELP visit, Park maintenance staff determine which tasks are most needed in the area. Examples of these projects include trail maintenance, fencing repair and removal of non-native plants. Tools are provided by the Stewards. If work is within Pomo Campground, individual groups will participate in shifts; if out of the campground, all the class participates together. Docents may be invited to participate.

The Rocks: Docent's closing

Take out your rock and look at it carefully. Each one is part of this place. Each one is individual, like you and your experience here.

Think about your cultural group. How did they live on the land? What did they use? What did they leave? Each had an impact in some way on this place.

The Pomo: The lived lightly on the land. They left arrowheads but very little else. We don't know exactly where their village was, here in Willow Creek.

The Russians: Their impact was not great. They began cutting trees and grazing the land, but what they left has been dismantled and covered by the people who came after them.

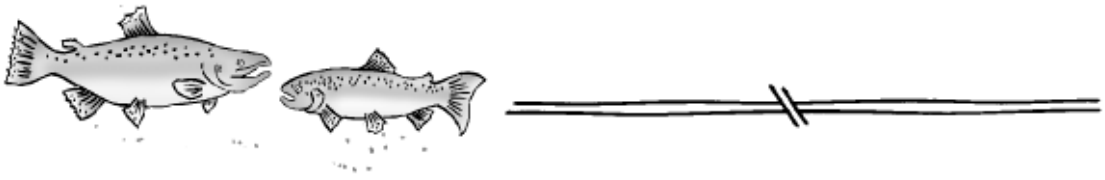
The Loggers: They cut lots of trees, leaving spaces where grazing took place. In some places they emptied the land of trees and in others what trees are left are second-growth. The land looks very different. It is changed.

The Ranchers: They grazed animals, increasing erosion and , and brought in foreign plants, that compete with native plants. The land is changed.

You have become aware of how this place has changed with the people that lived and worked this land. Take all those changes and as you place your rock back on the ground, leave all those changes behind. Your rock is what you leave behind. Step over your rock and you will be back in the present. Look at how the land is being used now. From what you have learned, resolve to be a steward/caretaker of this land now and in the future.

PART IV

DOCENT REFERENCE MATERIAL



Docent Reference Material

The History of Willow Creek Watershed **86-120**

- Native American Settlement and Land Use
- Russian Settlement: 1810-1841
- 19th and 20th Century Euro-American Land Uses

Flora and Fauna of the Sonoma Coast

- **Trees** **121-130**
    - Redwood Ecology
    - Toyon
    - Tanoak
    - Coast Redwood
    - California Laurel or Bay
    - Douglas-fir
    - California Hazelnut

- **Small and flowering plants** **131-141**
    - Poison Oak
    - Cow Parsnip
    - Himalayan Blackberry
    - Indian (Miners) Lettuce
    - Pacific Snakeroot/Sanicle
    - Redwood sorrel
    - Soap Plant
    - Sticky Monkey Flower
    - Subterranean Clover
    - Sweet Cicely
    - Thimbleberry
    - Wild Cucumber
    - Wood rose
    - Yarrow
    - Bracken Fern
    - Sword Fern

- **Animals** **142-154**
    - Chipmunk
    - Douglas Squirrel
    - Gray Squirrel
    - Raccoon
    - Gray Fox
    - Bobcat
    - Coyote
    - Mountain Lion
    - Black-tailed Deer
    - Banana Slug
    - Western Black-legged Tick

Field Guide to Freshwater Invertebrates **155-163**

The History of Willow Creek Watershed

From

Towards a Healthy Wildland Watershed: Willow Creek Watershed Management Plan

Prepared for:
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Occidental, CA 95465
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March 2005

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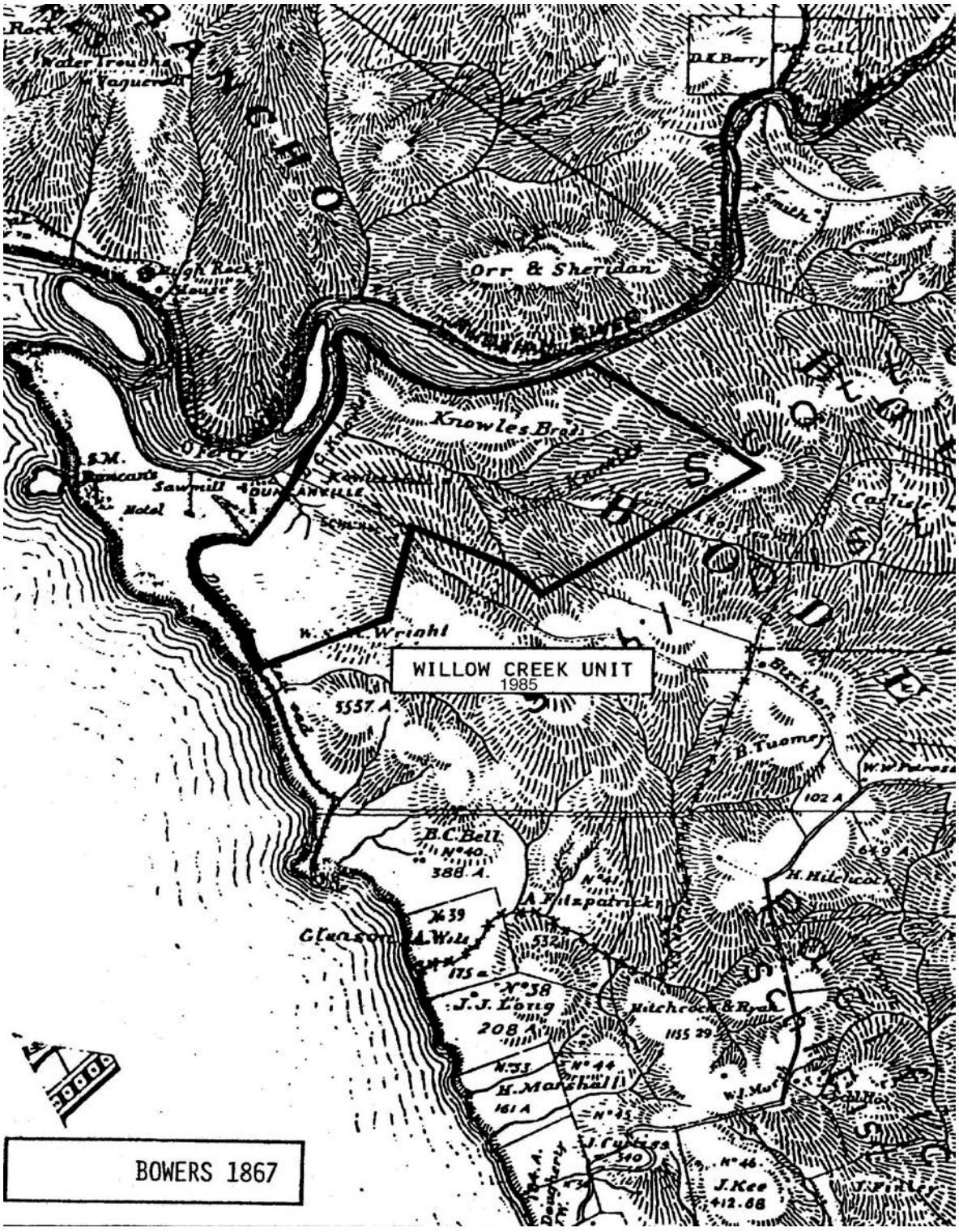
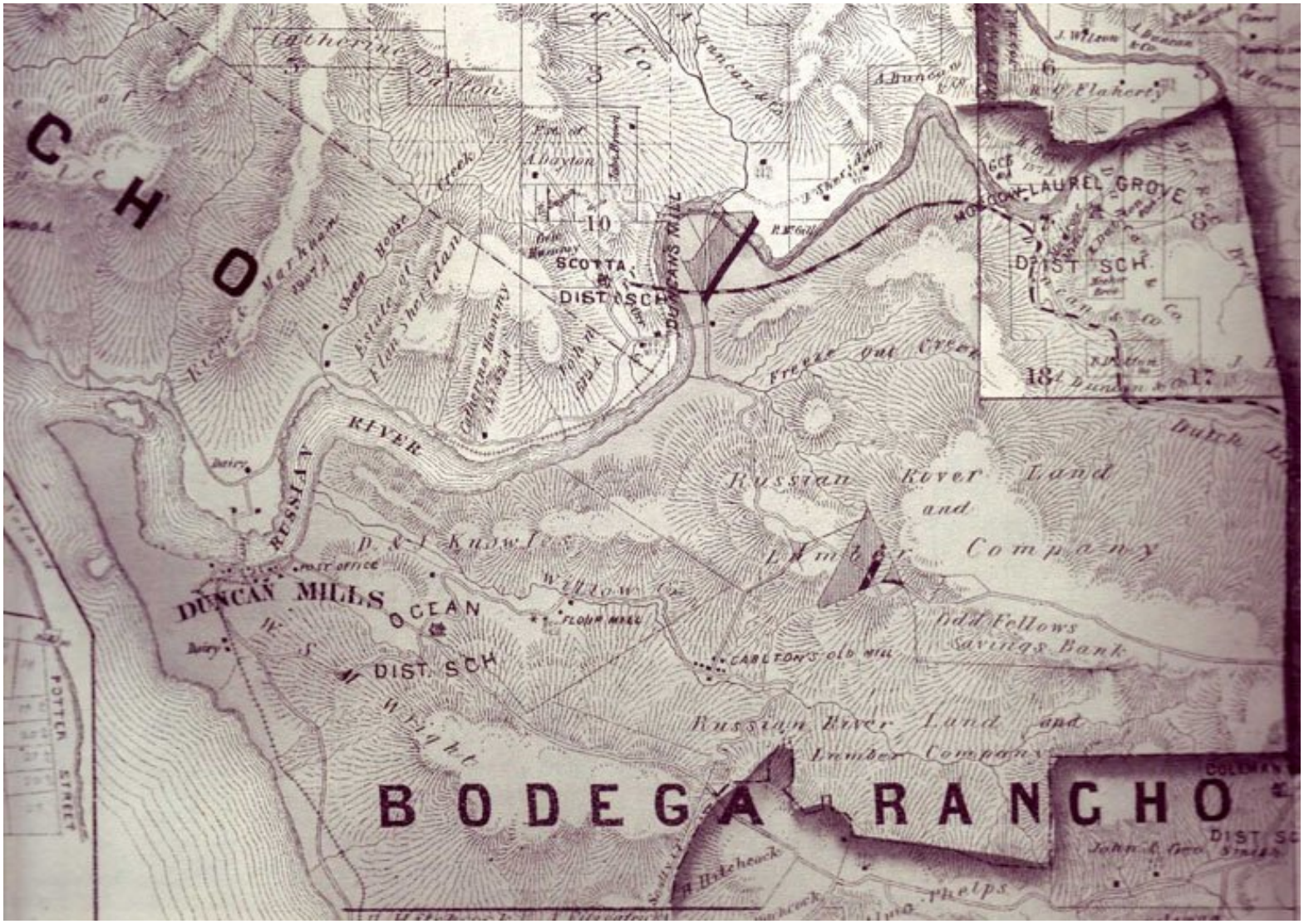


Figure 1: Willow Creek area on Bowers' 1867 map with State Parks' Willow Creek Unit outlined by Stewart in 1986.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Sheep House
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Catherine Hemmy
SCOTTA
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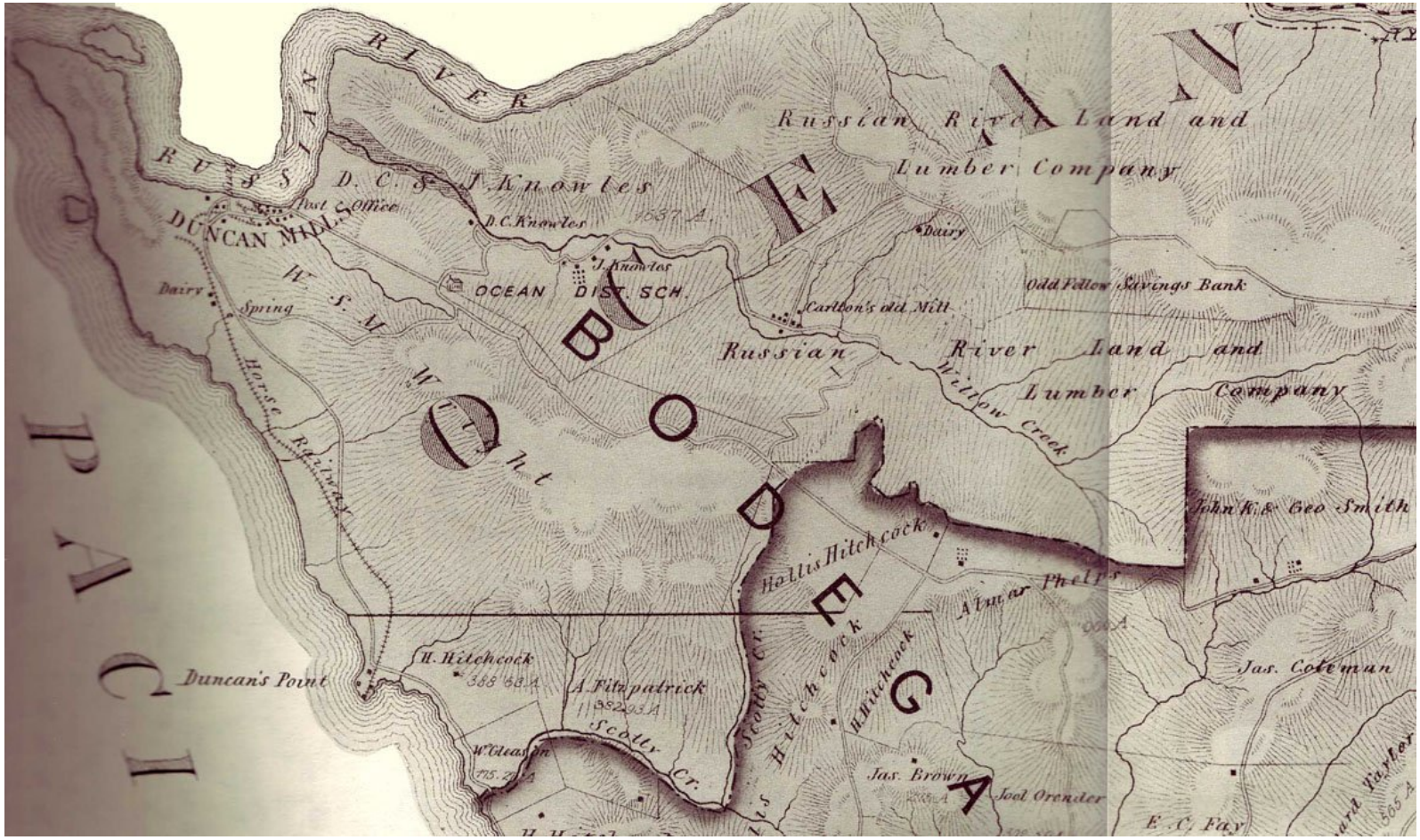
LAUREL GROVE
DIST SCH
Freeze out Creek
RIVER
Russian River Land and Lumber Company
DUNCAN MILLS
POST OFFICE
OCEAN
FLOUR MILL
CARLTON'S OLD MILL
DIST SCH
Odd Fellows Savings Bank
Russian River Land and Lumber Company
BODEGA RANCHO
POTTER STREET
Phelps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D. C. & J. Knowles
Post Office
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J. Knowles
OCEAN DIST. SCH.
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Spring
Carlton's old Mill
Odd Fellow Savings Bank
Russian River Land and Lumber Company
Willow Creek
Horse Ranch
WILLOW
BODEGA
PACIFIC
John K. & Geo Smith
Hollis Hitchcock
Almar Phelps
Duncan's Point
H. Hitchcock
388 68 A
A. Fitzpatrick
382.93 A
Scotty Cr.
W. Deason
Hitchcock
H. Hitchcock
Jas. Coleman
Jas. Brown
Joel Orender
E. C. Fay

Chapter 3: History of Willow Creek Watershed

Introduction

An understanding of human habitation and land uses in the Willow Creek watershed provides a clear record of impacts that have resulted in the present-day limiting factors to the watershed's health. The time of initial occupation is unknown; however, Breck Parkman, Senior Archeologist for State Parks, dates the arrival of the first human inhabitants on the Sonoma Coast over 12,000 years ago after coming across a land bridge from Asia (Parkman pers. comm. 2004). Although a number of prehistoric sites have been identified between the Russian River and Bodega Bay since research began in the early 20th century, little archaeological investigation has been performed in the Willow Creek watershed itself.

Suzanne Stewart coordinated the *Cultural Resources Survey of the Willow Creek Unit, Sonoma Coast State Beach* as part of State Parks' planning for development of Pomo Canyon Campground in the mid 1980s (Stewart 1986). In 1997, a short-term (3-4 day), ground-penetrating radar study conducted by U.C. Berkeley students looked for the Russian settlement in the watershed known as the Kostromitinov Ranch, and currently State Parks is working with a U.C. Berkeley doctoral student on a project to locate the Russian ranch. Unfortunately, researchers have found that high sediment depositions throughout the valley limit discovery of early occupation sites.

Native American Settlement and Land Use

The First People:[1] Prior to 1810

The Kashaya Pomo solely occupied the Sonoma Coast for thousands of years until the coming of the Russians in the early 19th century (DPR 1973:3, citing Kroeber 1925). The heart of Pomo territory was the valley of the Russian River, while the Olamentko tribe of the Coast Miwok settled in the area to the south surrounding Bodega Bay (Kroeber 1925:272-273; DPR 2004:2-69). Projectile points found at Willow Creek are assumed to be 2,000 years old. Parkman postulates that the Kashaya have occupied northern California for the past 7,000 years and the coastal region for over 4,000. Kashaya elders believe that they have been here much longer (Parkman pers. comm. 2004).

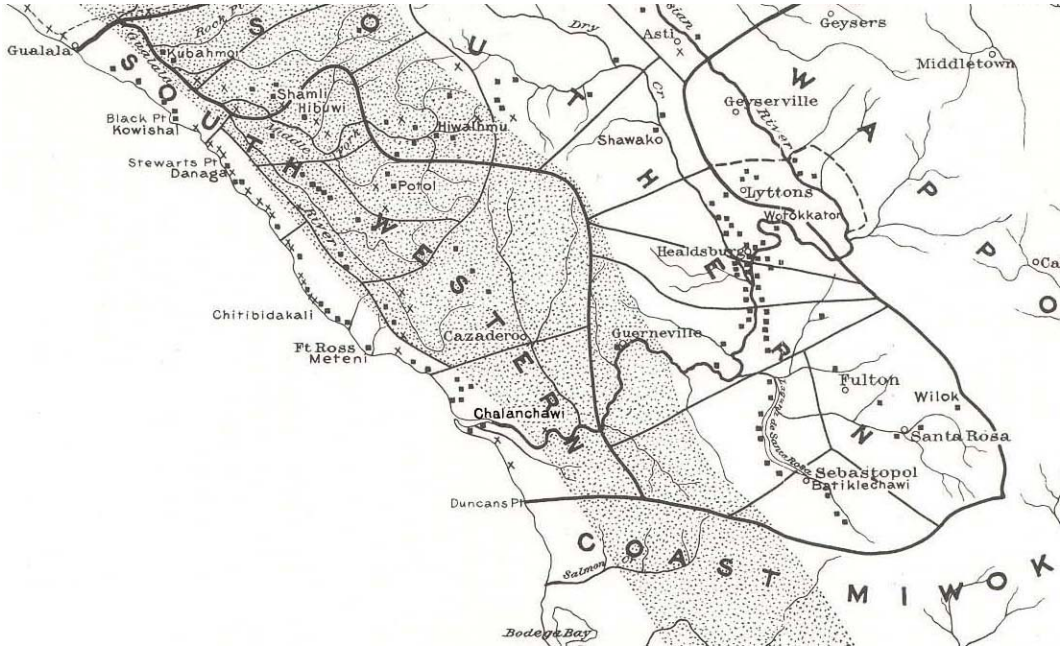
Prior to contact with Euro-Americans, the Kashaya Pomo population is estimated between 550 (Stewart 1986:6, citing Bean and Theodoratus 1978:295) and 1,500 people (Parrish 1998:6), one of the smallest populations of all Pomoan groups. Important resources to the Kashaya were abundant and accessible along the coast; these included a variety of marine fish, shellfish, seaweed, waterfowl, and sea mammals. Along the Russian River and other drainages, including the freshwater marsh

[1] "The First Prople" is the name of an article written about the Kashaya Pomo by elder Otis Parrish (Kalani, et al., Eds. 1998:6).

at the mouth of Willow Creek, reeds, willow roots and shoots, and sedge provided raw materials for baskets, nets, clothing, boats, and shelter (DPR 2004:2-69). The redwood forest was only occasionally visited for products or seasonal campsites. The shredded bark was used for clothing and basketry, and bark slabs were used to make single-family, conical dwellings (Stewart 1986:6).

Chalanchawi Village at Willow Creek

Kroeber reported that "Chalanchawi and Ashachatiu were villages at the mouth of the Russian River and no doubt related." (1925:234). Some authorities, including Kroeber, consider Chalanchawi to have been the capital village of the local Pomo tribelet (Parkman 1985:1). S.A. Barrett (1908) was the first to identify the Kashaya village of Chalanchawi, which he transcribed as *tcala'ntcawi* and described as located at Willow Creek in the vicinity of the current-day Environmental Campground (Stewart 1986:7, citing Barrett 1908:232).



Map of Range of the Kashaya (Southwestern) Pomo[2]

(Source: Kroeber 1925:Plate 36)

Kroeber's map shows the location of Chalanchawi just south of the Russian River, northeast of the mouth of Willow Creek, but the scale does not allow for exact placement. Another potential location is at the confluence of Willow Creek and the Russian River, although this is questioned due to the high occurrence of winter floods. Parkman suggests that Chalanchawi may have been located near the theorized site of

[2] The Kashaya were referred to as the "Southwestern Pomo" by Kroeber (1925:233).

the Kostromitinov Ranch, as precedent for such proximity was set when the Russians established Fort Ross adjacent to the Kashaya village of Meteni (Kroeber 1925:234) in order to facilitate work-trade activities (Parkman pers. comm. 2004).

Both the small population and low-impact land uses associated with the Kashaya inhabitants of the area prior to Euro-American contact resulted in limited impacts to natural resources in Willow Creek.[3] Stewart's research located few prehistoric artifacts. Nevertheless, they did indicate a fairly wide diversity of activities, including tool production and resource processing (Stewart 1986:29).

Kashaya Pomo after Euro-American Contact

The Kashaya were profoundly affected by Euro-American occupation, although they experienced less acculturation pressure than other California Indians. They escaped much of the forced removal to missions, reservations, or ranchos that the other Pomoan and Coast Miwok groups experienced (Parrish 1998:7). Although their lifeways were abruptly altered after settlement of Russian fur traders in the area, the Kashaya's involvement with the Russian community was reportedly peaceful, and residence at their outposts was voluntary (Stewart 1986:18).

There were about 100 Kashaya employed as agricultural laborers at Fort Ross (Stewart 1986:18, citing Bean and Theodoratus 1978:299). The number of Native Americans working at Kostromitinov Ranch in the Willow Creek area is not documented, but the "wooden house for Indians" could have housed a dozen or more. Others may have stayed in small, stout structures built for livestock herders, and some laborers may have commuted from nearby villages (Stewart 1986:18, citing Toumey 1926:206).

It is not clear whether the Kashaya remained living within Willow Creek after the Russians departed in 1841. Only Native American people "adopted" by Euro-American families are noted in the 1850 and 1860 U.S. population census. A single Native American family headed by a man named Garcia who worked at the Duncansville sawmill is listed on the 1870 census, and a more heterogeneous group totaling 20 people is listed in 1880 (Stewart 1986:19).

Although villages were inhabited in the Bridgehaven area in the early 20th century, no census information was gathered regarding Native American occupation in Willow Creek (Barrett 1908:232; Kroeber 1925:234; Stewart 1986:19). Jenner resident, Josephine Navidad Wright, was born in a village on the south side of the river on December 25, 1904, to her Pomo mother, Mary Santos, and her father, Joseph Santos, an emigré from Guam. Steven Smith, Jr., Mary Santos' son by a previous marriage, recalled the village as located near current-day Bridgehaven (Barr 1979a). Today Kashaya and other Native Americans visit the area to collect seafood and plants for

[3] See also discussion of Native American use of prescribed fire practices in Chapter 4 for the improvement of game and plant resource abundance important to their survival, as well as collection of plant resources.

their basketmaking (Stewart 1986:19). Occasionally families gather at a cemetery associated with one village.

Russian Settlement: 1810-1841

By the early 19th century, Russian hunters had virtually decimated the sea otter populations in Alaska. In 1809, Ivan Alexandrovich Kuskov anchored the Russian American Fur Company's ship, the Kodiak, in Bodega Bay. He was soon followed by Alexander Baranov, who led the company south from Alaska to the Sonoma Coast where they continued hunting sea mammals for fur (DPR 1973; CDFG 2002).

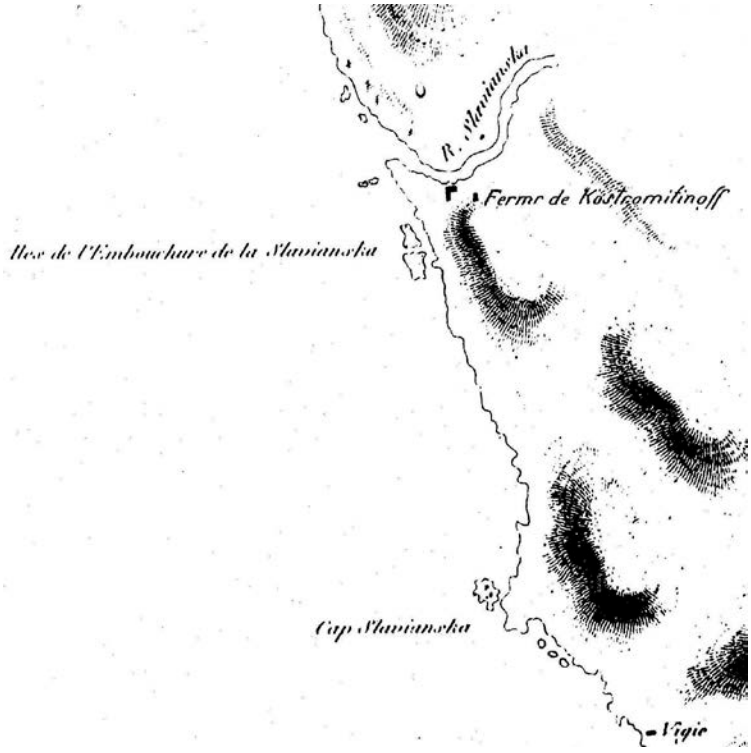
Along with construction of their headquarters at Fort Ross about 10 miles north of the Russian River in 1812, the Russians established the port of Bodega and four main ranches for growing fruits, grains, and livestock. The Kostromitinov Ranch in Willow Creek, the Rumanianyov Ranch at Bodega Bay, the Khlebnikov Ranch near Bodega, and the Tschernisch Farm near Freestone grew wheat, barley, rye, peas, buckwheat, maize, tobacco, flaxseed, hemp, mustard, and poppies for export to their settlements at Fort Ross and Alaska (DPR 2004:2-70).

Kostromitinov Ranch in Willow Creek: 1833-1841

The Kostromitinov Ranch was established in the Willow Creek area in 1833 and operated until 1841. The ranch complex encompassed fields and ranch lands north and south of the Russian River. Its headquarters were likely located in the Willow Creek valley, although the exact location is "a research question that has yet to be resolved" (Stewart 1986:8). It may have been adjacent to the village of Chalanchawi (Parkman pers. comm. 2004). Stewart found only one historic map showing the ranch's location, the 1841 map of Duflot de Mofras; however, due to the scale of the map and the way the ranch's name is written, no location can be pinpointed (Stewart 1986:8).

A late 19th century discussion of agriculture at Fort Ross provides a vague description of the location as "about 100 acres just south of the mouth of the Slavyanka [Russian] River [4] . . . at the half-way point, on or near the river" (Stewart 1986:8, citing Bancroft 1886[ii]:629). Another theory places the ranch near the old Ocean District School in the Willow Creek valley (Stewart 1986:8, citing Haase 1952:59; see Figures 2 and 3: *Historical Atlas of Sonoma County 1877*). The California State Office of Historic Preservation's records place the farm in or adjacent to San Quentin Gulch near current-day Pomo Canyon Campground (Stewart 1986:8, citing Parkman pers. comm. 1985).

[4] Kuskov is credited with naming the Russian River "Slavianka," meaning little Slavic maiden.



Map of Kostromitinov Ranch in Willow Creek
(Source: Duflot de Mofras 1841, from Steve Watros, Department of History, Sonoma State University)

Russian Land Uses

It is presumed that some logging occurred in Willow Creek valley to create areas for grazing and crop production and to construct the ranch's numerous structures, which included a barracks, warehouse, house, two threshing platforms, a winnowing platform, a house for Indian workers, a kitchen with two ovens, and a bathhouse (de Mofras 1841:19; Vallejo 1841:229-9-10). It was referred to as "Halfway House" (Gibson 1976:118), an important station for travelers located midway between the Russian's Bodega outpost at Port Rumyantesev and their headquarters at Fort Ross, and one of the farm's houses was set apart for the use of travelers. There was also a boat for crossing the Russian River (Stewart 1986:9).

Records of agricultural uses in the valley indicate that the Kostromitinov Ranch had grain planted on new plowland along the lower section of Willow Creek. After a decent first harvest in 1834, the ranch suffered a total crop failure in 1836. Although the farm was reported to have superior pasturage in 1840, consisting of 98 to 100 acres of cultivated land primarily growing wheat, the company could buy wheat more cheaply from Mexican California than it could grow it (Moore 1980:9, citing Gibson 1976:139). There was a large corral for livestock (Gibson 1976:118). Russian records indicate that

cattle, sheep, pigs, and horses were in moderate abundance, and it appears that horse breeding was also practiced (Moore 1980:3, citing Fort Ross 1974:13).

Russian Departure

By 1841, the substantial decline of seal and otter populations had resulted in an unprofitable fur trade economy. The Russians sold their holdings at Fort Ross to John Sutter of Gold Rush fame, but the land could not be legally transferred. Sutter dismantled some buildings and took them to Sacramento, the Russians took their easily moveable property for use at other posts, and the Kostromitinov Ranch in Willow Creek valley was abandoned (Stewart 1986:9; DPR 2004:2-70). Their road system, developed as early as 1812, remained as the major transportation artery throughout the 19th century. Remnants of the Russian roads in Willow Creek may still be extant today (Stewart 1986:21).

19th and 20th Century Euro-American Land Uses

Timber Harvest

The first commercial sawmill on the Pacific Coast may have been installed by Captain Stephen Smith, the New England sea captain who received a grant in the mid-1840s from the Mexican government for the 36,000-acre Bodega Rancho, which included land in the Willow Creek watershed (DPR 1973:4). Smith brought the steam-operated mill by ship into Bodega Bay in 1842 (Hansen & Miller 1962:56). [5] He built his adobe on the site of the old Russian farm near the current hamlet of Bodega (Hansen & Miller 1962:51), and he rapidly developed the area around Bodega Bay with roads (DPR 2004:2-70).

First Recorded Commercial Logging in California: Willow Creek mid 19th Century

Redwoods in the Willow Creek area were likely first cut in 1833 by the Russians and used for construction of the Kostromitinov Ranch, but little or no export occurred during this period (Stewart 1986:23, citing Clar 1959:16). The first recorded commercial logging in California was in the Willow Creek area, as evidenced by a lease signed in 1848 and recorded in 1850 (Stewart 1986:20, citing Deeds Book E:84). [6] In the agreement, Captain Stephen Smith and his wife leased all timber rights to Bethuel

[5] Some, however, disagree that Captain Smith's sawmill was the first. Williams reported that J.B.R. Cooper built California's first sawmill in what was to become Sonoma County in 1835. William also reported much earlier (1818, 1821) logging actisvities by fugitive whipsawyers, discontented seamen who had jumped ship at Monterey Bay or San Francisco, then called Yerba Buena (1976:39).

[6] In DPR's Preliminary General Plan, the Phelps/Curry Timber Lease is described as "of 1846" (DPR 2004:2-71). No explanation is provided for the discrepancy between this and Stewart's dates from the Sonoma County Deeds Book.

Phelps for 99 years. That Willow Creek was included in Phelps' operation was noted when Joseph Knowles purchased his Willow Creek acreage in 1858. His deed states that the sale is subject to conditions of the lease to Bethuel Phelps, which was passed on to John Curry and maintained until at least 1867.

In 1860, Curry was assessed for real estate "known as the Mudge and Phelps Mill Tract, it being the timber and lease of said lands containing 17,687 acres." The tract was valued at $8,843 and improvements at $5,000, which Stewart concluded is "unusually high for the time, suggesting considerable construction; some of these improvements may have been built within Willow Creek Unit, given the open, level access to redwood stands." She postulates that the Knowles Mill may have been one of these improvements (Stewart 1986:20-21). Bowers' 1867 map[7] shows "Kowles (sic) Mill" located somewhere between the Knowles brothers' houses in the Willow Creek valley (see Figure 1).

Phelps' leased holdings were divided into sections, and, once cut, he could not return to a section. Stewart believes that the Phelps/Curry logging lease may have significantly impacted timber resources in the Willow Creek watershed, as stipulations (i.e., no returning to a section once cut) encouraged highly intensive logging. Her team noted handcut stumps in San Quentin Gulch and in a grove east of the State Park that could represent this early logging (Stewart 1986:21). The lease allowed construction of sawmills and the digging of wells to bring water to mills; it also allowed grazing for oxen, horses, and cattle, with a combined herd not to exceed 56 head (Stewart 1986:20). It is not known if the Phelps operation engaged in grazing within Willow Creek, but by the 1860s, the Knowles family were running large numbers of livestock in the lower watershed.

Duncan Mills/Duncansville: 1860-1877

In 1848, Samuel Duncan was part of the first company organized to cut lumber in Sonoma County. For several years, they focused operations near Salt Point up the coast from the Russian River (Stewart 1986:11). In 1860, a new lumber mill was established by Samuel and his brother, Alexander, at Duncansville just west of the Willow Creek Unit boundaries on the south side of the Russian River in the area of current-day Bridgehaven (DPR 1973:5; Stewart 1986:11, citing Munro-Fraser 1880:252; see Figures 1, 2, and 3). The company took the name Duncan's Mills, which was later shortened to Duncan Mills (Dickinson 1970:37).

The Duncan brothers recognized the possibilities for transporting cut lumber to the Bay Area in the small, 2-masted ships called dog hole schooners, which were built in San

[7] It is uncertain when Bowers mapped the Willow Creek area. He may have begun as early as the mid-1850s because, according to his 1867 statement, it took him 13 years to map Sonoma County. The inclusion of Duncansville on the map, however, indicates that final mapping of this area was completed in or after 1860 (Stewart 1986:12).

Francisco for that purpose (Hansen & Miller 1962:47). [8] Lumber was hauled by horse train from the mill over a corduroy road that followed the route of present-day Highway 1 south to Duncans Landing, a typical dog hole cove about 2.5 miles south, where it was loaded onto the ships. The Duncan brothers leased the landing from Benjamin C. Bell, whose property was located south of W.S.M. Wright's (see Figure 1). The lease, dated May 23, 1862, was for ten years at $50 per year (*Bodega Bay Navigator* 1993b).

The site of the lumber mill soon grew to a small town of from 100 (Thompson 1877) to 300 (Munro-Fraser 1880) inhabitants (Stewart 1986:11). The settlement included a store, hotel, post office, express agency, and telegraph office (Munro-Fraser 1880:252; Dickinson 1970:37). Their source of timber for milling is unclear, but the proximity of Duncansville to then abundant resources in the Willow Creek watershed would suggest it as a potential source.

Alexander Duncan purchased 3,600 acres of standing timber along Austin Creek in the name of the Duncan's Mill Land and Lumber Association. By 1877, he had persuaded the North Pacific Coast Railroad (NPC) to bring its terminus to the site of modern-day Duncans Mills on the northern bank of the Russian River. He placed the mill and the entire town of Duncansville on rafts and moved upriver to the new railroad termination point (Dickinson 1970:37).

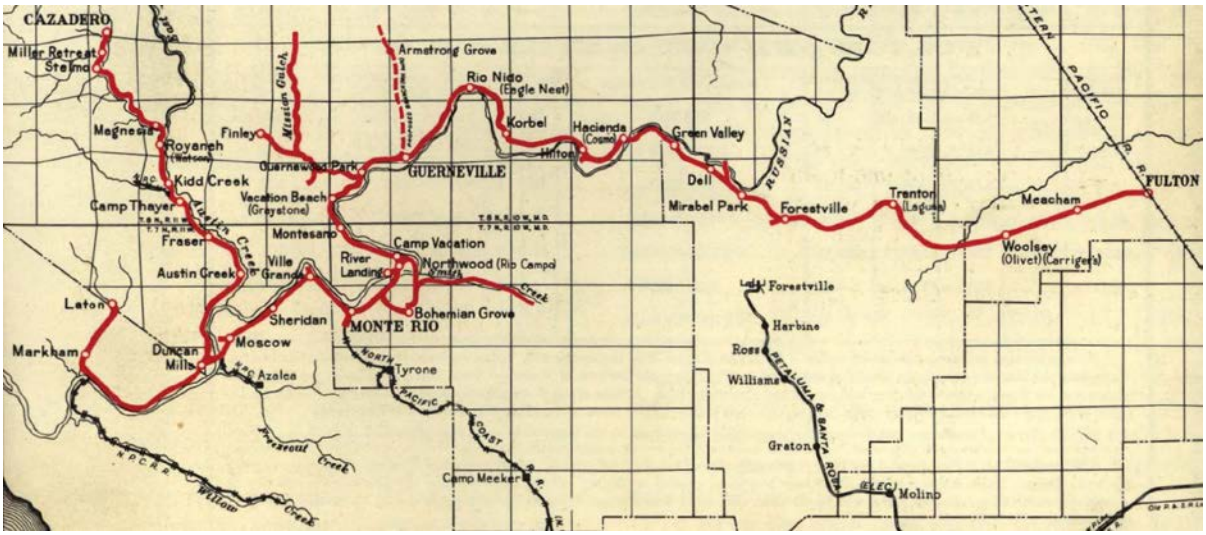
Other 19th Century Lumber Operations in Willow Creek

In the late 1860s, a sawmill was built in the lower Willow Creek meadow area. Narrow gauge rail, constructed in the stream channel, pushed lumber uphill to the headwaters (DFG 2000:1), while steam donkey engines extracted logs to bring them downhill (DFG 2002:58). The rail system later moved finished lumber products over the watershed divide for loading onto the schooners in Bodega Bay bound for San Francisco (DFG 2000:1; DFG 2002:58).

The Carlton and Ross sawmill is shown on Bowers' 1860s map (Figure 1) and in the 1877 *Historical Atlas of Sonoma County* (Figures 2 and 3) as the next parcel upstream (southeast) of the Knowles' property. The Sonoma County Surveyor's 1868 map includes the settlement of Rossville in the location of the Carlton and Ross mill. This operation used a tramway up through the drainage southeast of the Willow Creek Unit, where it connected with county roads (Stewart 1986:21).

By the 1870s, the Russian River Land and Lumber Company (RRLLC), which was owned by the founders of the NPC Railroad, had purchased the property within the watershed to the east and the south of the old Carlton and Ross mill (Stewart 1986:21; Figure 2). It is presumed that this area was also used for logging. When the new narrow gauge NPC spur from present-day Duncans Mills reached Willow Creek in the late 1880s, a new rail route was forged up the valley (Stindt 1974:13), undoubtedly to access timber for the RRLLC.

[8] Dog holes are small indentations in the rocky cliffs along the coast.



Map of Guerneville Branch of the Northwestern Pacific RR

(Source: Stindt 1974:49)

20th Century Timber Harvest Operations

20th century logging activities were analyzed using aerial photography (Trihey 1995:15-17). Closely spaced, immature conifers covering most of the watershed in 1941 indicate it was almost completely logged 20 years or more earlier based on the size and spacing of the trees. Photographs taken in 1953 show that no new timber harvests had occurred between 1941 and 1953, which indicated "high watershed stability" (Trihey 1995:15). The most intense 20th century logging in the upper watershed occurred between 1953 and the early 1970s, with extensive removal of second growth and remaining old growth. Timber rights belonged to the partnership of Hammond, Jenson, and Wallin (O'Neil pers. comm. 2004). According to Trihey and Associates' analysis of 1971 aerial photographs, large tracts of forest within the inner gorge of Willow Creek were clear-cut and tractor-yarded between 1961 and 1971 (Trihey 1995:16).

Louisiana Pacific Corporation (LP) purchased most of the upper watershed in 1979; State Parks had acquired much of the lower watershed in 1978 (see discussion of Recreation and State Parks below). It is unclear how much logging occurred during their tenure; however, according to Willow Creek Road resident, David Dillman, LP logged 900 to 1,000 acres between 1982 and 1992 (*Bodega Bay Navigator* 1992). It was also reported that the watershed was logged 13 times between 1992 and 1999 (*Bodega Bay Navigator* 1999).

Mendocino Redwood Company LLC (MRC) acquired the LP lands in 1998 (*Press Democrat* 2002c), a property consisting of 5,586 acres of coastal ridge bounded by Occidental and Camp Meeker, Willow Creek State Park, Coleman Valley Road, and

Freezeout Road (*Bodega Bay Navigator* 1999). Four watersheds drain from the MRC lands, including Willow, Freezeout, and Salmon Creeks and the Russian River. MRC is currently (2005) negotiating with the Sonoma County Agricultural Preservation and Open Space District and the Trust for Public Land for the transfer of ownership of most of their Willow Creek property to State Parks.

Grazing and Other Agricultural Uses

Lowland areas along Willow Creek were converted from thick riparian forest to grasslands for cattle, sheep, and horses by Russian settlers in the 1830s (Stewart 1986:19; CDFG 2002:11). Fencing, usually rail and post, but occasionally picket, was used to prevent livestock from accessing plowed land (Stewart 1986:19-20). Grains, primarily wheat, and other crops were raised on approximately 100 acres in the valley (Gibson 1976:118).

19th Century Agricultural Uses

Agricultural activities were not predominant again until settlement by the Knowles family. In April 1858, Joseph Knowles purchased 1,623.35 acres on Willow Creek, paying $6,493.40 in cash (Stewart 1986:12, citing Deeds Book 6:650). Joseph, his wife, and his younger brother, David C. Knowles, are the first recorded settlers in the Willow Creek valley. They held most of the watershed now owned by State Parks for more than 30 years, while the southwest portion was the property of W.S.M Wright in the 1860s and 1870s (Stewart 1986:16). [9] According to the 1860 U.S. population census, Joseph raised stock, and David farmed.

In 1861, the Knowles' recorded stock consisted of cattle, horses, and hogs, which shifted to more sheep and lambs in the following decade (Stewart 1986:19). Stock numbers recorded in the 1876-77 county tax records for David and Joseph Knowles imply serious overgrazing unless they were also using neighboring properties, a common practice at the time. Their livestock numbered 11 horses, 18 cows, 14 cattle, 1,400 sheep, 300 lambs, 75 hogs, and 13 dozen poultry. If grazing was occurring only on their land, it would equate to one acre per head of sheep as compared to a standard of at least 3 acres of prime grazing land per head and 10 to 20 acres for poorer land. Much of the grazing likely occurred on upland slopes, since the fertile bottomlands grew grains for the Knowles' flour mill (Stewart 1986:19-20).

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[9] In 1853, W.S.M. Wright and his family arrived in the area after crossing the Great Plains with about 400 head of cattle. He made extensive land purchases for stock raising and general farming. He owned 4,500 acres of Sonoma County, the largest portion being between Bodega Bay and the Russian River (*Bodega Bay Navigator* 1993b). It appears that the Wrights did not, however, inhabit the Willow Creek area but rather used it for grazing and possibly other agricultural purposes. Stewart did not include the Wright property in her investigation of the Willow Creek Unit because no structures were indicated on Wright's property, and no development of park facilities was planned for the area (Stewart 1986:16), although both Wright's Beach and a sign to Wright's Hill still exist along the Sonoma Coast.

Dairying activities in the Willow Creek valley are included on the 1860, 1870, and 1880 censuses. A family of dairymen is reported to the east of the Knowles' property in 1860 and 1880, and a dairyman is included as part of the Joseph Knowles household in both 1860 and 1870. Nearby dairies are also shown in Thompson's 1877 *Historical Atlas of Sonoma County* (Figures 2 and 3). One is north of the Russian River, and the other is located south of Duncansville and west of the horse railroad to Duncans Landing. Although dairying did not appear significant in the Knowles' operation, it was important locally (Moore 1981b:2-3).

By 1861, the Knowles had divided their holdings, and David's property was assessed separately from his brother's. David took 366 acres. Joseph retained the rest (Stewart 1986:16, citing county tax assessment rolls). The 1880 census indicated David's household was a large one that consisted of 8 adults and Knowles' two youngest daughters. The 1900 census reports no members of the Knowles family in the Willow Creek area (Stewart 1986:16), although the Sonoma County official map for 1908 still lists D.C. Knowles as the owner of "Willow Creek Mouth" (Moore 1981b:1908).

20th Century Agricultural Uses

The tradition of raising grains in the valley and sheep and cattle on the upland meadows was continued by succeeding generations of Brown, Mann, Furlong, and Baxman families. In the mid 20th century, Elmer and W.S. Brown operated the Brown Brothers Ranch,[10] where they ran 800 sheep. A short distance south, the Gossage family imported purebred Suffolk sheep during the late 1940s. Both the Brown and Gossage ranches were the former holdings of Sampson B. Wright, a descendent of W.S.M. Wright. Sampson is reported to have installed the first cream separator in the county there (*Press Democrat* 1950:20).

Jim Baxman bought his Willow Creek ranch in 1956 and raised sheep and cattle. After the ranch was sold to Louisiana Pacific, the Baxman family remained as tenant ranchers to the current day, spanning four generations (*Press Democrat* 2002b:A1). The Baxman family ran sheep on the 1,250-acre ranch for three generations but reduced the operation to 500 acres in 1985 in a 5-year lease renewal with the state (*Press Democrat* 1988:B1).

Current Agricultural Uses

Current-day agricultural activities within Willow Creek are mostly limited to the upper watershed outside of State Parks' boundaries. The primary use is for sheep and cattle grazing. Richard Baxman, grandson of Jim Baxman, and his family graze 80 to 100 cattle, with nearly 200 head during calving season, on the property's hillsides (*Press Democrat* 2002b:A19). Grazing activities also occur on a small portion of State Parks'

[10] The D.C. Knowles Victorian farmhouse, which now serves as a maintenance yard for State Parks, is termed either the Brown or Brown-Mann Ranch.

lands. As part of the Red Hill acquisition, State Parks agreed to allow grazing through 2006. There are no other grazing or agricultural activities on State Parks' lands in Willow Creek (O'Neil pers. comm. 2004).

Transportation

19th Century Russian Road System

The Kostromitinov Ranch was on the main route connecting all the Russian outposts. According to Haase, the Willow Creek area was a focal point of this road system:

> *The approximate road from Kostromitinow Farm (located about at the old Ocean District School, Willow Creek Valley) to the Khlebnikow Farm (the town of Bodega) led up the east side of Red Hill to its crest, following it to what is now Furlong Gulch Road. Then it turned eastward along the crest and followed along to the Coleman Valley Road area, then turned eastward again to the Sheep Ridge and continued south along this ridge until it came to Salmon Creek where it turned east again and went up Salmon Creek and out on the little plain of Bodega. … The approximate road from Kostromitinov Farm (Willow Creek) to Tschernisch Farm (near Sebastopol) crossed Willow Creek up to the crest of the eastern mountain following the crest over to Fern Spring. Still following the crest, it ran to the eastern end of the Coleman Valley Road to Occidental and over to Tschernisch Farm*. (Stewart 1986:21-22 citing Haase 1952:59-60).

The Russian road system continued to be the main travel route throughout the 19th century (Stewart 1986:22).

Trains to the Lower Russian River: 1876-1886

The narrow gauge North Pacific Coast (NPC) Railroad, which was later renamed the North Shore Railroad and still later was incorporated into the Northwestern Pacific Railroad, was constructed for hauling lumber from the lower Russian River region to outside markets. It dramatically boosted the area's timber production industry (CDFG 2002:A-3). Among NPC's founders in 1871 were Austin D. Moore and W.H. Tillinghast, owners of the Russian River Land and Lumber Company (Dickinson 1970:19), whose holdings included areas in the Dutch Bill Creek, Freezeout Creek, and Willow Creek watersheds (see Figure 2). Moore, who has been described as the driving force during the early days of the NPC, became President soon after the company's organization (Stindt 1974:10). He left the railroad in 1877 to develop his timber interests (Dickinson 1970:38).

Trains to Willow Creek: 1886-1917

Although early surveys (pre-1876) on the south bank of the Russian River from Duncans Mills "all the way down to the old settlement of Duncan's Mills" near

Bridgehaven were performed (Dickinson 1970:35), the impetus for train service to Willow Creek occurred when John W. Coleman became President of the NPC in 1885 (Stindt 1974:11). His new board of directors included owners of large timber areas in the Austin Creek watershed north of present-day Duncans Mills, and, in 1886, under their direction, service began along Austin Creek up into Austin, the site of present-day Cazadero ((Stindt 1974:13; Dickinson 1970:60).[11] A small branch line led west from Duncans Mills to Markham's and crossed the Russian River at the current Environmental Campground near the mouth of Willow Creek. It then went west between the base of the hills and the river, turned south past the ferry tender's house, and proceeded up the long valley north of Willow Creek (Stindt 1974:13; Stewart 1986:21; see map below). Portions of the current road into Willow Creek were constructed on the old railroad bed (Stewart, citing Mathias pers. comm. 1985).

As a result of the devastation to the whole Bay Area and to the NPC itself caused by the earthquake on April 18, 1906, the railroad was taken over by the Southern Pacific and Santa Fe. In 1907, it was renamed the Northwestern Pacific Railroad (NWP). A number of broad gauge railroads were also part of the takeover, including the rival line of the existing NWP Guerneville Branch (Stindt 1974:15)**.**

Although Willow Creek is included on the published list of NWP narrow gauge lines in 1907, there is a "not oper[able]" notation. A survey of the south side of the river west from the Duncans Mills bridge was completed in May 1908 "to connect with the Willow Creek branch, but nothing ever came of it" (Stindt 1974:15). Dickinson, however, includes a photo of 1912 hikers who appear to have hitched a ride on the quaint locomotive pictured below that brought loaded log cars to the NPC at Willow Creek.

[11] The name Austin was later changed to Ingram's in honor of the first postmaster and then to Cazadero, which means "hunter" in Spanish, in 1889 (Dickinson 1970:60).

1912 “hitchhikers” on the Willow Creek line.
(Source: Dickinson 1970:165)

In 1915, the NWP’s Guerneville Branch broad gauge was extended 2.8 miles along the north side of the Russian River from Duncans Mills to serve Andrew Markham’s extensive lumber operation. Narrow gauge passenger service to Markham’s station was discontinued (Stindt 1974:56). The Willow Creek line was torn up in 1917 (Stindt 1974:15).

Ferry Service at Bridgehaven: mid 1800s-1931

In 1857, William Benitz, owner of the Muniz Rancho, was licensed by the County Board of Supervisors to operate a cable-pulley ferry across the Russian River about one mile upstream of the mouth (Moore 1981b:1857). Mid-19th century maps show a ferry crossing the river at Duncansville to the west of the current-day Highway 1 bridge (Figures 1 and 3). The 1880 census included “R. McKung the ferryman” (Stewart 1986:18).

In 1897, a house for the ferry boat’s operator, referred to as the Toll House, was built farther east near the confluence of Willow Creek and the Russian River near the entrance to the current Willow Creek Environmental Campground (*Press Democrat* 2001a). Photos indicate that the ferry was operated from this area rather than farther west. In January 1910, the *Press Democrat* reported that a James Owen had been appointed the County ferryman, replacing former Supervisor J.J. Button (Moore 1981b:1910).

Ferry crossing the Russian River with ferry tender's house at Willow Creek in background.

(Source: collection of Elinor Twohy)

The children from Markham's on the north side of the river commuted to the Ocean District School in Willow Creek, so it was sometimes called the Markham Ferry (*The Paper* 1982:1B). The Toll House was the home of the last ferryman, Alexander Cuthill, whose brother, Bill, married Lucille Cuthill, the teacher at Jenner's one-room school for 43 years. Alex became the ferry's operator in 1918 and served until his death in 1931.

The ferry was about 15 feet wide and long enough to carry three wagons or autos. Aprons on each end dropped down for loading and unloading. There was a walk on one side and the motor housing on the other. The ferry operated on a two-cable system, one overhead to guide the course and one lower to move the craft. A visible capstan "crawled" the vessel along the lower cable with power furnished by a 4-cylinder gasoline engine (Twohy 2004:1).

Alex Cuthill's widow and son ran the ferry for a short while after his death, but it was put into retirement after the opening of new "Shoreline Highway" bridge at Bridgehaven (*Press Democrat* 1931:A1). There was a huge turnout for the bridge's dedication on October 4, 1931. [12] A replica of the ferry was set afire and floated downstream as part of the ceremony (*Bodega Bay Navigator* 1993a).

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[12] Several other dates for the opening of the bridge were encountered during this research. The date of 1931 is based on an original copy of the *Press Democrat*, dated October 4, 1931, which states, "The Russian … opened today, which marks the passing of the … ferry …." (*Press Democrat* 1931:1]. The ellipses indicate lapses in the text due to deterioration over time.

Residential and Educational Uses

Early Inhabitants of Willow Creek

Residential use of the Willow Creek watershed has been sparse. It is believed to have begun with the Kashaya Pomo village of Chalanchawi, followed by the Russian settlement at Kostromitinov Ranch between 1833 and 1841 and the Knowles family in 1858. In 1897, the ferry tender's house was built near the confluence of Willow Creek and the Russian River (*Press Democrat* 2001a). Both the historic D.C. Knowles residence and the ferry tender's house continue to be occupied to the present day, the former as a maintenance area for State Parks and the latter as a residence for a State Parks' employee.[13]

Ocean District School: mid 1800s-1972

19th century maps indicate an Ocean District[14] School near the southwestern boundary of the Willow Creek Unit. It was connected to both Duncansville and the Willow Creek valley by roads. Its location was several hundred meters upslope from the later school that served children from both sides of the river well into the 20th century (Stewart 1986:31). Stewart found an old roadbed passing through the area of the first school, which could represent the original route through Willow Creek valley seen on Figures 1 and 2. It runs along the base of the hills at a higher elevation than the present road (Stewart 1986:32).

The later Ocean District School's location in Willow Creek valley is indicated near benchmark 28 on Willow Creek Road on the 1943 USGS topographic map (Figure 4) for the Duncans Mills Quadrangle. It is later identified as "ruins" on the 1979 USGS topo (Figure 5) after the school had burned down in 1972 (Stewart 1986:31). Ocean District had another school on the highway just north of Duncans Landing, which is mapped on the 1943 USGS topo. The 1979 USGS no longer mentions the school. The area is simply designated "Ocean View."

Proposed Residential Developments in Willow Creek: 1960s-1970s

By the mid 20th century, development pressures in Willow Creek became intense. In the early 1960s, Utah Mine and Construction Company had obtained State Lands Commission leases and County permits to dredge the estuary of the Russian River to remove gravel for 20 years, renewable for future dredging in increments of 20 years.

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[13] Another house known as the "Knowles Ranch," which burned down in 1988, was probably on the site of Joseph Knowles' ranch. At the time of Stewart's survey (1985), it was leased from State Parks and occupied by the Baxman family. It had been abandoned by 1988 (*Press Democrat* 1988).

[14] Ocean Township, which lies between Salt Point and Bodega Townships, was established sometime after 1876 as one of fourteen townships. Originally, Sonoma County was divided into four townships. Eleven townships had been established in 1856, and readjustments were made in 1859 and 1867 (Finley 1937:201).

After experiencing difficulties with ocean activity and other coastal hazards, they sold to Northern California Aggregates (NCA). NCA planned a technically sophisticated dredging operation to a point five miles upstream to Duncans Mills and a high-density land development (Hechtman 1987:1). In 1969, NCA applied for permits from the County of Sonoma and the U.S. Army Corps of Engineers.

Meanwhile, in the mid 1960s, the Brown-Mann Company sold their lands in Willow Creek to NCA (also known as the Jenner Bay Corporation), including the D.C. Knowles homestead and the coastal terrace between Goat Rock Road and Shell Beach. The area was to be developed into a huge subdivision. The plans showed 40-foot lots with condominiums along Goat Rock Road, a golf course, a sewer plant on the coastal terrace with the sewer outfall at Shell Beach, and a shopping center and Safeway at the intersection of Highways 1 and 116 (*Bodega Bay Navigator* 1989). Willow Creek was part of the high-density (1,100 acre, 2,000 unit) housing development planned by Jenner Bay Corporation.

In 1970, the Jenner Coastside Conservation Coalition was formed to oppose the dredging and subdivision of some 8,000 acres on both sides of the river. With tremendous public support, the coalition was victorious in getting the State Water Resources Control Board to order a “no discharge” requirement on the dredging operation until NCA did extensive environmental studies in the estuary. NCA withdrew its permit applications, and the dredging leases from the State Lands Commission were cancelled.

The issue of development in Willow Creek watershed arose again in 1976 when the Sonoma County Planning Commission approved Jenner Bay Corporation’s tentative map for a 3,600-acre, “large-lot” Willow Creek Ranch residential subdivision. The proposal included 36 homes, each on 100 acres, on lower Willow Creek Road (*Press Democrat* 1976b). The Sonoma County Board of Supervisors approved the map in January 1977 (*Press Democrat* 1977), but the North Central Coast Regional Commission filed suit to stop the development because the County did not have an adopted general plan, the project was inconsistent with the proposed general plan, and the County failed to require an environmental impact report (*Press Democrat* 1978). On February 21, 1978, the Sonoma County Supervisors ruled that the area contained unique features needing preservation and was, therefore, too sensitive environmentally for the proposed subdivision (*Press Democrat* 1978), and the state of California soon thereafter purchased the lower Willow Creek watershed for inclusion within Sonoma Coast State Beach (DPR 2004:4-7).

Current Residential Use: 2004

In addition to State Parks and MRC, current landowners within the Willow Creek watershed boundaries include the Sonoma Land Trust, Sonoma County Agricultural Preservation and Open Space District, and a number of private individuals, mostly in the upper watershed. Part of MRC's negotiations with State Parks for acquisition of their holdings includes reserving several parcels for later residential development. Current Willow Creek land ownership was mapped by the Trust for Public Lands during their negotiations for State Parks' acquisition from MRC.

Recreation and State Parks

The history of the acquisition of the Willow Creek watershed as park land is directly tied to public and agency concern for the watershed's health and preservation. The Willow Creek Unit is managed for recreational pursuits, which include freshwater fishing, kayaking, camping, bird watching, equestrian use, bicycling, and hiking, for wildlife habitat, and for the protection of natural and cultural resources (DPR 2004:2-79). Existing facilities at Willow Creek include environmental camping, restrooms, picnic areas, beach access, and trail access (DPR 2004:2-80).

The California State Park System: A Regional Context

Establishment of public parks began after approval of a $6 million bond issue in 1928 (DPR 1973:5). Armstrong Redwoods was acquired in 1934 as a gift from Sonoma County, with matching funds to purchase almost 700 acres of the Sonoma Coast for under $60 per acre. Much of the coast between the Russian River and Bodega Bay was incorporated into the State Parks' system in 1934 and was classified as a State Beach in 1964 (DPR 2004:ES-1). Sonoma Coast State Beach has become one of the most visited state parks in California, "known for its rugged coastline, sandy coves, sweeping ocean vistas, and a variety of other natural, cultural, and recreational resources" (DPR 2004:ES-1). It extends 19 miles, from Bodega Head near Bodega Bay to beyond the Vista Trail four miles north of Jenner, and currently totals 6,885 acres. It also extends inland, encompassing portions of the lower watershed of the Russian River, including the lower half of Willow Creek.

State Parks' Acquisition of Lower Willow Creek: 1970s

In 1972, the Sonoma County State Park Committee and the California State Parks Foundation launched a $250,000 drive to raise private funds to help purchase state parks on the Sonoma Coast. The money was to provide required matching funds for Senator Randolph Collier's (D-Yreka) successful SB537 funding obtained in 1971 to purchase Penny Island in the Russian River estuary, North Jenner Beach, and other North Coast coves and beaches (*Press Democrat* 1982). The committee also launched a successful "Pennies for Penny Island" campaign that received donations from local school children.

As early as 1974, the Willow Creek area was considered for inclusion in Sonoma Coast State Beach. A State Parks Acquisition Plan map dated February 1974 shows four lower Willow Creek parcels within the acquisition boundary. In 1976, two important bills were added on the final day of the 1975-76 legislative session. Senator Collier proposed SB1617, a so-called "Christmas Tree Bill" appropriating almost $1.5 million for parks in Sonoma, Mendocino, and Lake counties. Added to the Collier bill was a proposed expenditure by Assemblyman Barry Keene (D-Eureka) of $1,258,000 for acquisition of "Willow Creek Ranch, southeast of Jenner" (*Press Democrat* 1976a).

Meanwhile, development in Willow Creek was imminent. The Jenner Bay Corporation subdivision had been approved in January 1977, and it wasn't until February of the following year that the Board of Supervisors rescinded their decision. It was then that the Jenner Bay Corporation and others sold their Willow Creek properties to the state of California for inclusion in Sonoma Coast State Beach. State Parks bought 2,226-acres in lower Willow Creek because of its nearness to the beaches, its protection from ocean storms, its favorable microclimate, and its accessibility for handicapped and elderly visitors (DPR 2004:4-7).

Planning for Recreational Uses the Willow Creek Unit: 1979-1980s

In the late 1970s, the lack of facilities for recreational vehicles along the coast resulted in hundreds of campers being turned away. Rangers at Doran and Westside Parks were quoted as recommending "wide spots on the road" (*Press Democrat* 1977b). In February 1977, State Parks requested a permit to designate an overnight parking area for recreational vehicles at Goat Rock Beach. Staff of the North Central Coast Regional Commission reviewed the proposal and issued their Initial Summary Report and Staff Comments (NCRC 1977a). The plan was not approved, primarily due to lack of enforcement capabilities (*The Times* 1977).

By 1979, the search for new campsites intensified. A "Recreation on the Sonoma Coast" database, dated August 2, 1979, lists the Willow Creek acquisition as containing 3,700 acres with potential recreational uses to include a trail connecting Duncans Mills with Sonoma Coast (Goat Rock), primitive hike-in and small tent camping areas, vehicle access camping area, and use of existing buildings to create an 1880s American working farm historic site. An October 1979 report to the Sonoma County Community and Environmental Services Planning Division concluded that a general plan for the Willow Creek area, including the upper valley, should be prepared and that impacts from camping and other land uses should be carefully considered (Odom 1979:1-2).

Controversy over Proposed Recreational Development: 1981-1983

In 1981, Senator Barry Keene introduced a bill for use of bond funding voters had approved in November 1980. Proposed projects included a boat launching ramp, parking lot, and walk-in camping at Willow Creek. Although funding was proposed for

preparation of general development plans in other state parks, no funding was provided for planning in the Willow Creek Unit (*Russian River News* 1981).

In 1983, State Parks filed an application with the California Coastal Commission for a permit to construct a boat launching ramp, primitive campsites, toilets, parking, and stock fencing. (CCC 1983a:1), and the U.S. Army Corps of Engineers filed a Public Notice requesting public and agency comment on State Parks' request (ACOE 1983a). The public responded that "before any development takes place, a Master Plan for Willow Creek Park should be designed. A Citizens Advisory Committee should be assembled to work with park staff." (Hechtman 1983:1). As a result of the controversy, State Parks removed its request for the boat ramp, and a permit for construction of primitive campsites, toilets, parking, and stock fencing (CCC 1983b:1) was granted (*The Paper* 1983:11). The 11-unit Willow Creek Environmental Campground on the south bank of the Russian River was completed soon thereafter, along with improvements to the County road.

Sonoma Coast Advisory Committee: 1983 to present

In 1983, the Park Commission appointed a citizens' group, the Sonoma Coast State Beach Advisory Committee, to assist State Parks in planning for the future. Members worked with State Parks' staff to develop the Interim Management Plan (1984) for use on State Parks' lands in Willow Creek and the Sonoma Coast.[15] Implementation of the plan began in 1987 with the opening of new trails and picnic areas within Willow Creek (Jenner Coastside Conservation Coalition 1987:2). The Sonoma Coast Advisory Committee continues to meet with State Parks' leadership on a quarterly basis. Its volunteer members represent a diversity of interests, including recreation, protection of sensitive habitats, watershed restoration, fish biology, and long-range planning.

Willow Creek's Park Status Threatened: 1987
In early 1987, members of the public were dismayed to discover that the state's Legislative Analyst had proposed inclusion of the Willow Creek Unit in the annual surplus property bill for possible sale. Letters and phone calls to Assemblyman Dan Hauser were clear—the public would defend Willow Creek as a State Park. By mid March, Assemblyman Hauser issued letters to interested constituents reporting that the Legislative Analyst's office would withdraw its recommendation (Hauser 1987:1).

Development of Pomo Canyon Campground and Pomo Trail: 1985-1990

In 1985, State Parks commissioned Suzanne Stewart's cultural resources investigation to assess potential impacts of the proposed construction of a 27-site campground and associated parking lot at the base of a steep redwood canyon known locally as San

[15] The "interim" plan has guided park management in the area to this day. It will be replaced upon completion of the *General Plan for Sonoma Coast State Beach*.. The draft can be reviewed at www.parks.ca.gov/generalplans.

Quentin Gulch. Termed Pomo Canyon Campground, it was to be connected to 3 campsites on the project area's southern ridge by a 2-mile long hiking trail. The campground opened on Memorial Day weekend in 1990 with 24 campsites, but it had to be evacuated 2 days later due to flooding (*Press Democrat* 1990). It has, however, operated successfully over the years and is extremely popular with campers. It is reported to have suffered damage from pedestrian traffic in the understory near some of the upland campsites (Luna pers. comm. 2004).

Recreational Use of Private Lands—LandPaths/Friends of Willow Creek: 1996-present

In 1996, a group of landowners, community members, and public agency representatives created LandPaths to meet the need for increased public access and responsible land stewardship (LandPaths 2004). LandPaths established a program called Friends of Willow Creek (FOWC), which permits public use of MRC's 5,200-acre Willow Creek property. FOWC members agree to be stewards while on the property and once a year contribute sweat equity to enhance the property's natural resource values (LandPaths & MRC 2004).

Acquisition of Sequeira Ranch (Red Hill): 2000-2003

Red Hill, elevation 1,062 feet, is located east of Shell Beach between the Sonoma Coast and Willow Creek valley on the former Sequeira Ranch. In 2000, the 910-acre Red Hill parcel was purchased with a $1 million grant awarded to the Sonoma County Land Trust by the State Coastal Conservancy and $1.37 million from the Sonoma County Agricultural Preservation and Open Space District. However, State Parks did not take ownership of the property until March 2003.

Acquisition of MRC Lands for Willow Creek Unit: 2001-present

In 2001, the Trust for Public Lands (TPL) began an effort to purchase 3,373 acres in the Willow Creek and Freezeout Creek watersheds. An additional 515 acres was proposed for conservation easements. This important purchase for State Parks would increase the acreage for Sonoma Coast State Beach, as well as connect to the recently protected 910-acre Sequeira Ranch. This effort attracted the attention of many public agencies, nonprofit organizations, and the public at large, who recognize that the acquisition of the upper watershed presents a unique opportunity for the land to become part of Sonoma County's spectacular public landscape (TPL 2002).

After 3 years of negotiations that included many site visits and coordination with State Parks, TPL obtained adequate funding for the purchase from State Parks, the Sonoma County Agricultural Preservation and Open Space District, the Wildlife Conservation Board, and the state Coastal Conservancy. In 2004, Governor Arnold Schwarzenegger halted the state taking title to newly acquired lands due to its inability to properly manage the properties. This decision has added yet another challenge to the process,

but it is hoped that the MRC property will be transferred to State Parks by the spring of 2005.

Conclusion

Recorded human land use in the Willow Creek watershed that began with the Russian road system and was followed by logging and disturbance to the riparian corridor associated with Russian settlement and agricultural uses (grazing and crop production) between 1833 and 1841 set the stage for later activities that have resulted in the limiting factors facing the watershed today. Timbering under the Phelps/Curry lease appears to have resulted in clear-cutting as early as the mid 19th century, and extensive clear-cutting and tractor-yarding are reported in the mid 20th century. Various trains were used to move timber from the watershed, some of which are reported to have been in the creekbed itself. Grazing by the Knowles family is recorded to have been very intensive in the later 19th century.

All of these historic activities have had tremendous impacts on the watershed. With State Parks' takeover of much of the upper watershed, the prognosis for restoration and protection is good. All of the issues that the TAC identified as limiting factors can be addressed under State Parks' management and in partnerships with Stewards, LandPaths, and others in the public and private sectors.

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Flora and Fauna

of the Sonoma Coast

Trees and Redwood Ecology: Docent Reference

What are Redwoods?

What is a redwood tree?
What size are redwoods?
How large are they underground?
How are other trees like the redwoods?
How is the redwood different from other trees?
Are all redwoods exactly the same?

Have you ever put yourself on the legs of an ant before? Did you ever wonder what a blade of grass might look like to such a small creature? Can you imagine lying on the ground, deep in the forest, looking up at the tallest living trees in the world? For a moment you might seem to be like an ant among blades of grass.

A coast redwood, like other trees, is built of many working parts. Beneath the soil grow many roots. They have several jobs. They are like your feet. They give the tree balance and stability. How great an expanse of roots do you think it would take to balance a single coast redwood?

Roots are also like our hands. They are the fingers on the tree that reach for all the nutrients and water they can absorb from the soil. Roots can store minerals for the tree until they are needed. Some plants have one large taproot to bring up water and nutrients from far into the soil. Others, like the coast redwood, grow in moist areas where much water is available near the soil surface. These trees, then, need only a shallow, spreading root system in order to obtain water.

Most coast redwood forests are very dense — many of the trees grow side to side. Try to picture the root systems of these trees as a single network. How might this improve the balance of a single tree? Might this “close-knit” situation also affect the forest as a whole?

Above the ground the coast redwood, like other trees, is equipped with a trunk, branches, leaves, and a means of reproduction. High in the trees, leaves absorb and convert the sun’s energy into sugars and starches that allow the tree to grow new roots and leaves, a taller trunk, and cones to produce new trees.

Although each of these parts has the same function in most plants, those of the coast redwood are distinct in appearance. Some trees very similar to the coast redwood in these characteristics are considered its relatives. Following are some pictures and a chart to help you see how the coast redwood and its relatives are similar yet different.

Redwood Ecology: Docent Reference (Continued)

Another California redwood, the Giant Sequoia, grows naturally in a small range of about 250 miles on the western slopes of the Sierra Nevada. The climate there, with its seasonal fluctuations, is very different from that at the coast. Winters are much colder, and some snow is common. Summers are very hot and dry. What features of the Sequoia help it thrive in an area where its coastal relative cannot even survive? The deeper and farther-spreading root system of the Sierra Nevada species is useful in the dry climate.

Let's consider the leaves of the three living redwood species. How is each unique?

Coast Redwood

Sequoia sempervirens

Giant Sequoia

Sequoiadendron giganteum

Dawn Redwood

Metasequoia glyptostroboides

The Giant Sequoia has leaves that are much smaller than those of the coast redwood. This enables the tree to conserve water. Leaf surface exposed to the sun loses some water due to evaporation. Coast Redwoods grow two distinct types of needles. Treetop needles, located where it is hot and dry, look like tight scale-like spikes (closely resembling the Giant Sequoia), creating less evaporative surfaces. Lower needles, growing within the shady forest canopy, are broader and flat so as to catch more of the available light. These are the needles we usually see; the upper needles come to our attention only when they are blown down from their high homes after a winter storm.

The Dawn Redwood, thought to have been extinct for 20 million years, was discovered in the mid 1940s living in Central China. It has adapted to the seasonal freezing temperatures by losing its leaves during the cold season. Many plants, such as some oaks, maples, and elms, conserve water and energy by being deciduous.

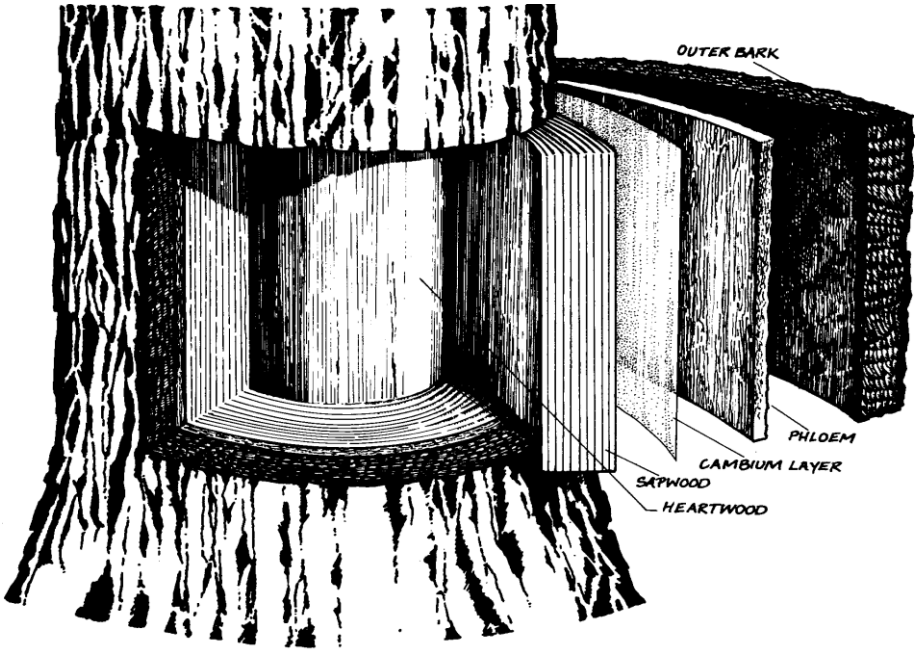
Redwood Ecology: Docent Reference (Continued)

Tree Life

Earth's forests contain thousands of species of trees, each of which is distinguished by the characteristics of its seeds, leaves, and growth. Regardless of species, however, all trees have the same general structure and requirements for survival. They all utilize water, soil, air, and light to manufacture food, increase in size and produce seeds.

The root system of a tree, which in redwoods is 4 to 6 feet deep and as much as 250 feet wide, collects water and minerals from the soil. Root tips are protected with a hard covering that enables them to probe the soil both vertically and laterally. Microscopic root hairs cover the root's surface and literally embrace grains of earth from which they absorb moisture and nutrients.

The root system sends the water and dissolved minerals to the leaves of the tree, where food production takes place. The leaves, in turn, send food back down to the roots, which cannot produce any nutrients on their own. All this transporting of substances takes place through the trunk and branches, where the wood is arranged in several layers that have specific functions in the process. The outermost layer of the tree, the bark, provides protection for the plant; this layer is made up of dead and aging cells that formerly served as conduits for food. The inner bark is the active food transport system, called the phloem, and this layer also stores food for the tree. Beneath the phloem is the cambium, the only part of the trunk that produces new cells. The cambium layer is microscopically thin, its cells continually dividing to add new growth to the layers on either side of it. The cambium does not add to the height of the tree, but adds to its diameter; all upward growth is accomplished by the tips of the branches.



Redwood Ecology: Docent Reference (Continued)

The xylem, or sapwood, of a tree carries water from the roots to the leaves. Like the phloem, this layer also stores food as a reserve supply for the tree, and it receives new cells from the neighboring cambium. As the xylem ages, its water-movement function ceases, fungus-resistant chemicals are deposited, and this woody layer becomes the red heartwood, which constitutes the real strength of the tree. The heartwood is no longer living, but will stay intact so long as the layers of cells around it are nourished.

The heartwood and sapwood layers reveal a tree's record of growth. The rings visible in a cut log or stump show the tree's annual growth; their dark outside edges represent the summer growth of small cells. The wider, lighter-colored interior section of each ring records the spring growth, which is less dense and made up of larger cells than those produced in summer. In very old trees, particularly the giant sequoia, the number of growth rings can be misleading. An annual ring may not have reached the level of the stump, because the rings begin at the tree's crown. In other instances, the pattern of growth rings may be distorted owing to a fire scar or a buttress on one side of the trunk.

Water and dissolved minerals flow through the roots and trunk of the tree in a continuous process known as transpiration. The leaves (or needles, which are a conifer's leaves) pull the water upward through the tree's body as they release water from their many pores through evaporation. This upward movement is aided by the surface tension of water molecules in the tree's circulatory system. Water moving upward through the sapwood could be likened to the mercury in a thermometer; its molecules cling together as they move up or down in the narrow chamber inside the instrument. The water in the long vertical cells of the sapwood behaves similarly, forming an unbroken column from roots to leaves.

At its destination, the water meets chlorophyll, stored in the leaves in millions of cell bodies called chloroplasts. When carbon dioxide from the air and sunlight also reach the chlorophyll, photosynthesis occurs. In this chemical reaction, the life-giving process for the tree, carbon dioxide and water combine to form glucose, the food for the tree. Oxygen, a by-product of photosynthesis, is released into the atmosphere to sustain all nonplant forms of life. The chemical formula for this process is as follows:

$$6CO_2 + 6H_2O + \text{energy} \longrightarrow C_6H_{12}O_6 + 6O_2$$

carbon dioxide water sunlight glucose oxygen

In addition to the products of photosynthesis, each leaf gives off excess water through its underside, adding moisture to the air and keeping the temperature of the leaf cool enough for photosynthesis to continue. Thus, through the combined actions of transpiration, fog drip, and photosynthesis, trees actually increase the moisture in an area, by raising the water table through the action of their roots and by recycling water into the air through their leaves.

Redwood Ecology: Docent Reference (Continued)

The Redwood "Fog Drip" Connection

The coastal redwood rainforest grows naturally in the coastal summer fog belt, which allows the trees to catch the moisture they require during the rainless summer months.

How fog drips occurs:

- During warm weather, fog forms over coastal waters and drifts inland as far as 25 miles.
- As the moist Pacific Ocean air cools, fog forms and condenses into droplets when it contacts the foliage of the tall trees.
- Most of the fog precipitation will occur between midnight and 4:00 am.
- A mature old growth redwood near the ocean can condense fog into as much as 80 inches of water during the months of July, August, and September.

The entire ecosystem depends on fog drip:

- Fog drip can account for over 40% of the water found in the forest.
- Tall redwoods capture more water than they need, allowing for the growth of understory species which themselves can't capture fog.
- Sword ferns, redwood sorrell and rhododendrons are some of the plants that depend on fog drip water for their summer growth.
- Amphibians such as frogs, toads, newts and salamanders thrive in the fog drip-moistened duff in the redwood forest. Their skin needs to be moist at all times.
- Fog drip water soaks into the soil and replenishes groundwater, springs and rivers. Summer water temperatures and water levels are kept cool and adequate for salmon, eel and steelhead.

Without tall trees to catch the fog, the entire ecosystem changes:

- Redwood seedlings cannot grow without summer moisture. They will shrivel and die.
- The microclimate becomes hotter and windier without the tall trees and the fog water they catch, which leads to drier soils and more obstacles for seedlings.
- Summer water levels in streams will be lower without fog drip, which leads to higher water temperatures, leading to very stressful conditions for salmon, steelhead and eels.
- **Eventually the fog itself with diminish.** Hot bare soil radiates heat which will burn off fog before it can roll east to cover the redwood forest region.

Docent Reference: Flora

Toyon
Heteromeles arbutifolia

Toyon is actually a shrub that sometimes grows into a small tree. The evergreen leaves are 4 inches long, shiny dark green on top, lighter green on the bottom. It grows both near streambeds and hillsides and is native to the Pacific Coast range the length of California. The white flowers in summer turn into bright red berries during the winter, hence its other common names, Christmas Berry or California Holly. Conservationists like the Toyon because it is one of the first plants to recover after a fire, helping to prevent erosion.

Did you know? The red berries are too sour to eat, but they make lovely Christmas decorations. Toyon are found in the Armstrong Grove flood plain.

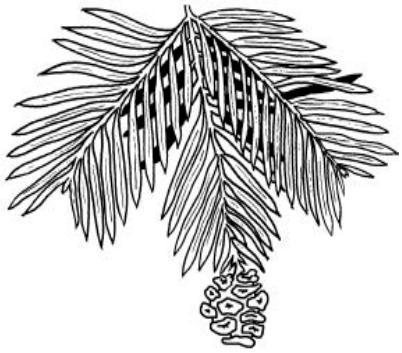
Tanoak

Lithocarpus densiflorus

The Tanoak tree is not a true oak, based on how their catkins grow, but is closely related. It is an evergreen tree that grows slowly to 50 feet. It is native to moist valleys and hillsides along the Pacific coast from southern Oregon to southern California. It sometimes grows in pure stands, but usually is found growing with redwoods, Douglas-firs and oaks. The light green leaves are thick and shiny on top and densely woolly with reddish brown hairs underneath. The prolific acorns closely resemble those of live oaks.

Did you know? Some animals like to eat the acorns and the local Native Americans collected them for food. They would dry them, grind them into flour, and rinse the flour in water to get rid of the bad taste. Then the flour was used to bake bread and cakes. The bark of the Tanoak contains tannin, an organic compound, which was used to soften hides to make leather years ago.

Docent Reference: Flora (Continued)



Coast Redwood
Sequoia sempervirens

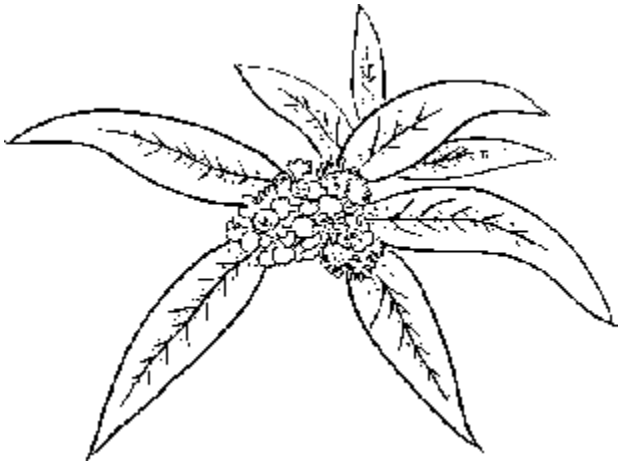
The Coast Redwood is the world's tallest tree and can grow to well over 300 feet tall. This evergreen tree is native to coastal valleys in the fog belt from southern Oregon to the central California coast. It always grows in pure stands and is rarely found more than 35 miles from the Pacific coast. It differs from other trees in that it has two types of evergreen needles; most are flat, except for those at the top of the tree, which are curved to assist in collecting moisture from the air. This giant tree has very small cones, less than 1 inch wide and its seeds are very tiny. The bark of the redwood is very thick and fibrous, which protects the tree from insects, water and fire. Redwoods reproduce both by seed and by sprouting from the base, creating circles of trees (fairy rings) around the stumps of old redwoods.

Did you know? Redwood is a prized lumber because the wood is naturally resistant to insects and rot. The native Pomo Indians used big pieces of redwood bark to cover their houses because it sheds water and provides insulation.

California Laurel or Bay

Umbellularia californica

California Laurel or Bay tree is an evergreen tree native to southern Oregon and northern California. It is often found growing in redwood groves. It is a medium-sized tree, often multi-branched. The shiny green leaves are thick and leathery and very aromatic when crushed. Small yellowish-white flowers bloom in clusters in early spring, followed by round greenish-purple fruit in the fall.



Did you know? Indians ate the nuts after roasting them or grinding them into flour and making small cakes. Placing a piece of leaf inside the nostril is reported to cure headaches, and sometimes a tea was made from the leaves to cure stomach pains. The leaves were also added to a hot bath to cure rheumatism. The Indians also used the leaves to repel fleas.

Docent Reference: Flora (Continued)

Douglas-Fir

Pseudotsuga menziesii

The Douglas-fir is a very tall, evergreen tree native to the Pacific Coast. It grows in pure stands along the Pacific Coast from southern Alaska to San Francisco. The blue-green needles are about one inch long. The reddish-brown bark is very thick and furrowed in broad ridges. The cones are about three inches long, with three-point bracts, which look like the tails and hind feet of little mice hiding in the cones. The needles have a fruity fragrance and are eaten by deer and elk. Other mammals eat the seeds.

Did you know? The Douglas-fir is the #1 lumber tree in the U.S.A. It is also used in the manufacture of plywood, and is often decorated for Christmas.

California Hazelnut

Corylus cornuta

The native hazelnut is not really a tree, but more of a large shrub, rarely exceeding eighteen feet high. Although smaller, the native hazelnut, when roasted, has the same flavor as the commercial hazelnut. The fruit, often paired, mature in late summer and are covered by a tubular, bristly husk, like a little vase. You should wear gloves if you try to husk more than a few of them.

The two-inch long leaves are almost as wide as they are long with rounded bases and pointed tips. Young leaves feel very soft and take on a fuzzy appearance. In shady areas, mature leaves can retain that softness. The tree has slender branches that are spread out and open, giving the tree an airy, delicate appearance. They're a beautiful addition to the understory of a redwood forest. In winter the male catkins elongate and hang down, making a beautiful complement to the horizontal groups of branches.

Flora and Fauna

of the Sonoma Coast

Smaller and Flowering Plants

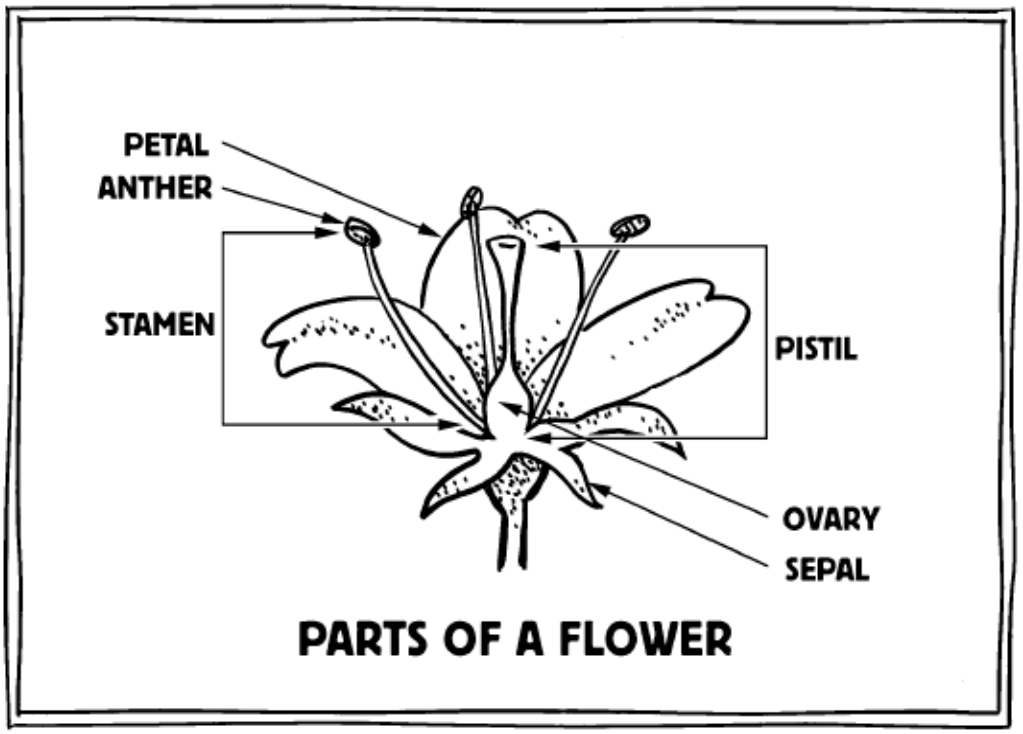
Flowers of the Sonoma Coast and Willow Creek

Flowering plants are plants that usually contain chlorophyll and can produce seeds. Seed producers are subdivided into gymnosperms (naked seed), which include the conifers, and angiosperms (encapsulated seed) which include flowering plants.

Parts of a Flower

The pistil and ovary are the female part of the flower, and the anther and stamen are the male part.

Flowering plants can be subdivided into monocots (short for monocotyledon), which include the lilies and grasses; and the dicots, which include the rose, sunflower, and pea families. The monocots are named that because the sprouting part of the seed consists of one unit, as can be seen in a kernel of corn; in dicots the sprouting part is divided into two parts, as can be seen in a pea. Monocot flowers usually have petals in multiples of three, and their leaves are mostly parallel veined; dicots usually have four, five, or many petals, and leaves are network-veined. Most of the wild flowers with many petals are members of the sunflower, or composite, family. They can have two types: disk flowers, which are in the center, and ray flowers, which are around the edge. Each ray petal is connected to a complete flower with both female and male parts. Many composites, such as dandelion, have only ray flowers.



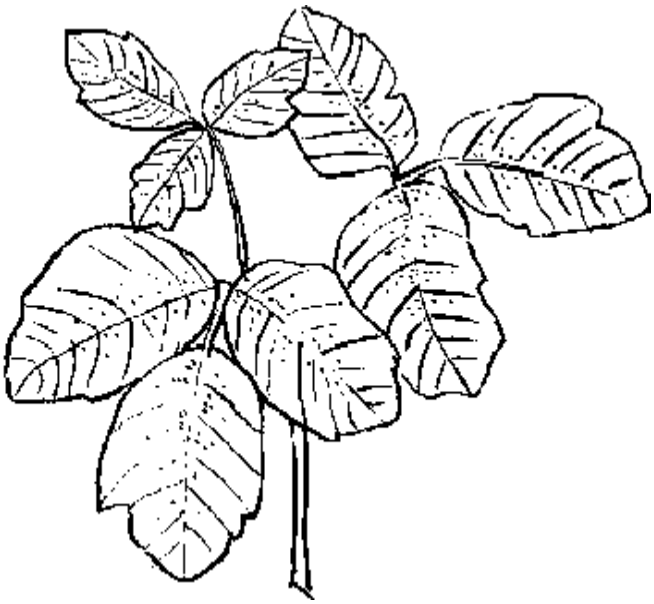
Docent Reference: Small plants

SPECIAL ALERT:

PLEASE SHOW EXAMPLE OF POISON OAK TO STUDENTS BEFORE OR AT THE OUTSET OF HIKING THE POMO TRAIL

Poison Oak

Toxicodendron diversilobum



"Leaves of three, let it be." Small cream or white flowers mature to light green or white berries. Roughly oval leaves are separate and in groups of three. As its species name implies, there is great variety in the leaves, not only in terms of shape, but also in leaf surface shine. The leaves turn red in the fall, or, in dry years, in late summer. Even when the leaves have fallen, the stems can still cause a rash, so if you see a vine or many-stemmed bush without leaves in the woods, don't touch it unless you know for sure what it is. The local Native Americans were immune to poison oak; they used the stems to make baskets, and the sap for dyeing and even tattooing. Poison oak can take the form of vines, bushes or even small trees.

Docent Reference: Small plants (Continued)

Cow Parsnip,
Heracleum Lanatum

The cow parsnip is distinctive, reaching 5' in width and height, with hairy stems and large bud swellings as the leaves emerge. It blooms in June through August, with white flowers in large flat umbels that can be 10" across. It can grow along California's spring stream beds, but thrives through the dry summer and fall. The roots and pith of young stalks were roasted by the Pomo for eating. A poultice of the dried crushed roots relieved swollen legs and headache.

Illustration from Watts, 2002, p. 36

Himalayan Blackberry
Rubus discolor (Non-native)

This plant has white or light pink flowers, about one inch in diameter, with wide petals. The fruit is usually larger and tastier than those of Blue Stem Raspberry or California Blackberry. Leaves have three or five separated leaflets arranged palmately. Young stems do not have a bluish cast, and older stems are thicker and more ridged than those of the native berries, with fewer, larger thorns. This non-native plant is bad, not only because it can crowd out native plants, but also because animals that have adapted to the more numerous and smaller thorns of native berries and roses can get caught in the vine and tear their flesh when they try to pull away.

Docent Reference: Small plants (Continued)

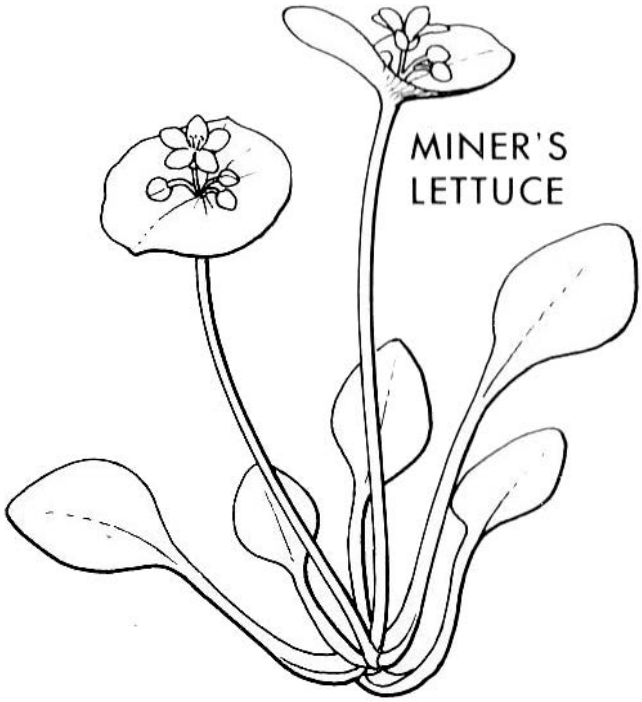


Illustration from Niehaus and Ripper *2002, p. 294*

Indian (Miner's) Lettuce

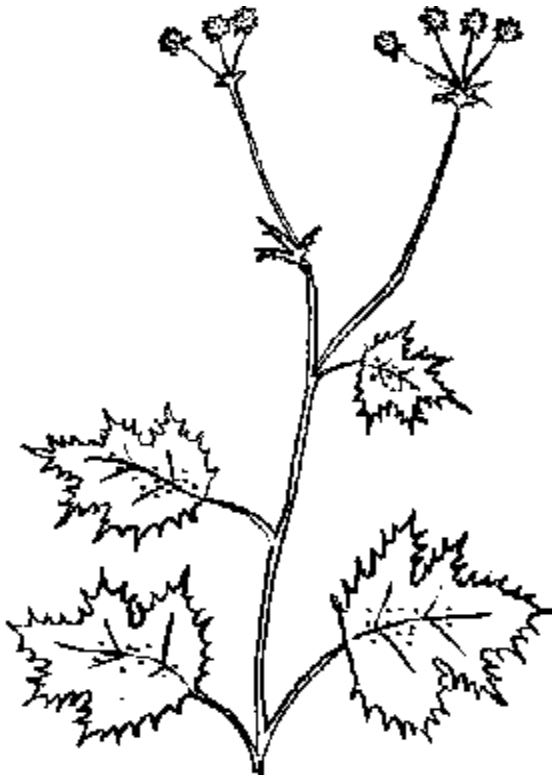
Claytonia perfoliata

Miner's lettuce often covers the ground in moist areas. It is easy to identify by its round leaves at the tips of 3-8 inch long stems. Tiny white flowers form in the center of the leaves from February to May. *Claytonia sibirica* ("Indian lettuce") has more oval and pointed leaves. Miner's lettuce can be eaten raw in salads or boiled like spinach. A tea made from the leaves works as a laxative. [From State of California, 2008, p. 82]

Pacific Snakeroot/Sanicle

Sanicula crassicaulis

Tiny yellow flowers grow in clusters, with bracts at the base of each group, on foot-tall stalks. Basal leaves are three- or five-lobed, toothed, and about two inches in diameter. A typical early three-lobed leaf can be seen in the winter.



Docent Reference: Small plants (Continued)

Redwood Sorrel

Oxalis oregana

The pink, sometimes white, funnel-like flowers, are about one inch in diameter, with five symmetrical petals. They grow individually on short stalks in an upright position. The clover-like leaves are heart-shaped, and are lighter colored close to the central vein; they will fold in hot weather or in direct sunlight. It is very common in redwood groves fairly close to the coast, growing low, and sometimes covering the forest floor like a thick carpet.

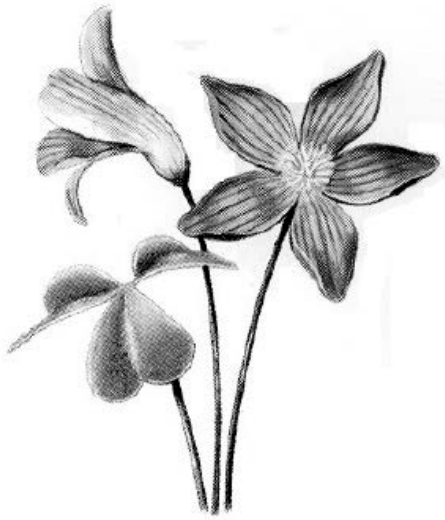


Illustration from Kavanagh, 2005, Raymond Leung, Illustrator

Illustration from Watts, 2002, p. 10

Soap Plant, Soap Lily

Chlorogalum pomeridianum

These plants bloom in late spring and summer, with flowers that open at dusk. The plant was used by Native Americans throughout California. Crushed bulbs produce a lather used as a soap and shampoo. Young bulbs are sweet and were slow-cooked in pit ovens. Young leaves were eaten raw, and their juice was used to make green tattoo markings. Roasted bulbs were used poultices on sores. The sap from bulbs served as a glue to attach feather to arrow shafts and when smeared in baskets, made them watertight. [Balls, 1970]

Docent Reference: Small plants (Continued)

Sticky Monkey Flower

Mimulus aurantiacus

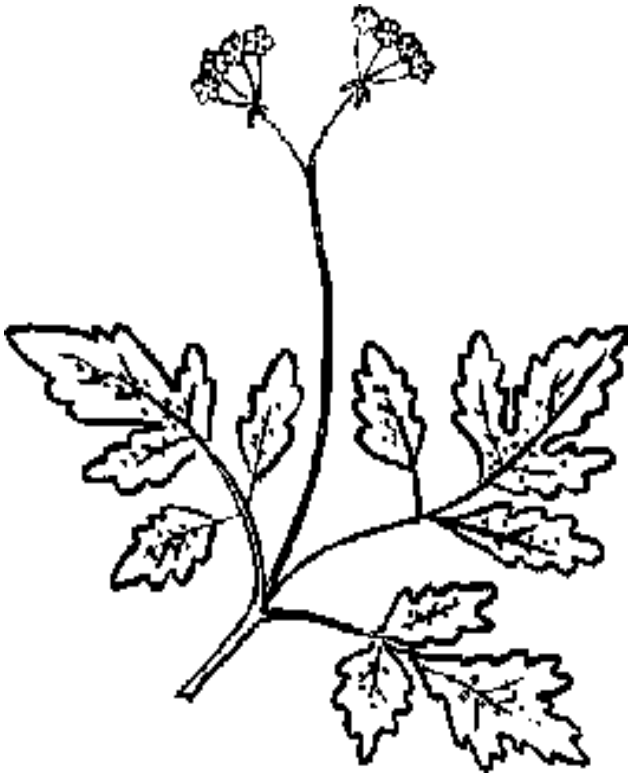
This plant has orange, often pale, tube-shaped flower with five fused petals, the upper two being slightly larger, are about three-quarters of an inch in diameter. The narrow tapered ovate, dark-green, sticky leaves are about one inch long and are oppositely arranged on woody stems.

Subterranean Clover

Subterranean clover was brought to California from northwestern Europe as fodder for ranch animals. Its seeds contain 30-40% protein. Its white flowers appear in early spring. They lack nectar, are self pollinating and hang beneath the canopy of the plant, so that they do not attract insects. Its leaves show a distinctive "water mark." [University of California Sustainable Agriculture Research and Education Program, 2006]

Illustration from Biolib: www.biolib.de

Docent Reference: Small plants (Continued)



Sweet Cicely

Osmorhiza chilensis (Non-native)

A few tiny, white flowers arranged in an umbrella shape on fairly long stems mature to long, narrow, bristly seeds that point downward, clasping the stem. Triangular or diamond-shaped leaflets are in several groups of three and five about one-quarter inch long.

Thimbleberry

Rubus parviflorus

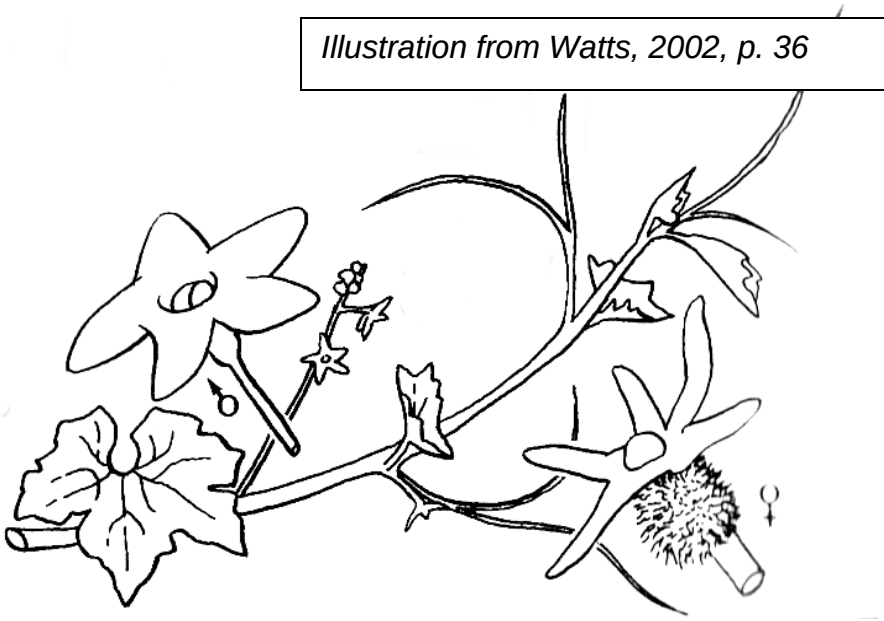
This fairly tall stalky-looking plant has large, soft hairy leaves. The one-inch, white flowers have wide petals, which become light orange to red berries in the fall. The berries are ripe when red, and easily pull off of their attachments. The larger leaves are about three inches in diameter with a rounded maple shape. The many upright jointed stems have no thorns.

Docent Reference: Small plants (Continued)

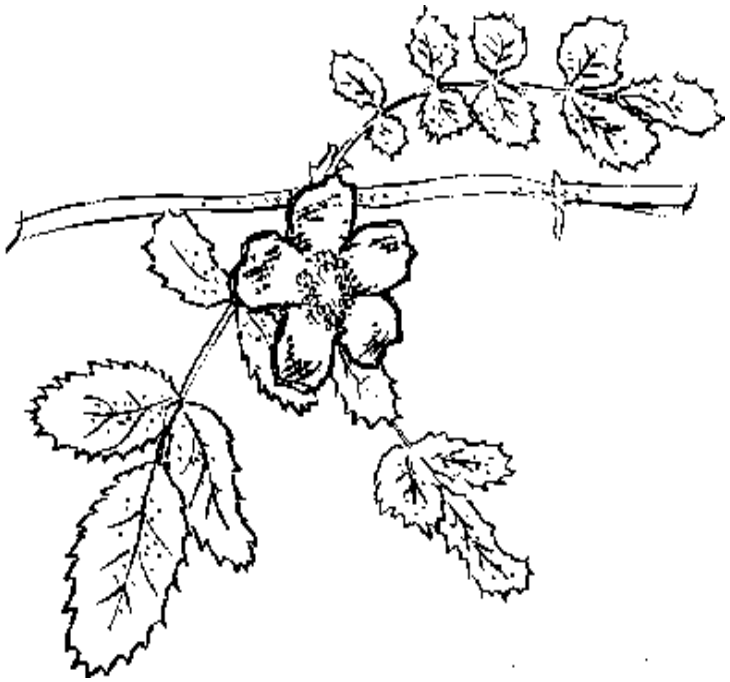
Wild Cucumber, Manroot

Marah fabaceus

Illustration from Watts, 2002, p. 36



The wild cucumber is found in dappled shade and moist soils. It is named for its huge tuberous root. This viney plant grows up to six meters, gripping rocks and trees with long tendrils. It bears green-yellow to white flowers from July to September and prickly seed pods. The Pomo Kayasha used the mashed roots in pools in the river and in tidepools at the beach for poisoning fish. The seeds were pounded, mixed with grease and rubbed on the head to prevent baldness. [Goodrich, Jennie and Claudia Lawson 1980, p. 41; Gifford, E. W. 1967 p. 14]



Wood Rose

Rosa gymnocarpa

A fairly tall shrub with narrow, prickly stems. The pink flowers are about three-quarters of an inch in diameter and have a sweet, powdery odor, sometimes with a hint of cinnamon. In fall, the orange or red rose hips, about three-eighths of an inch long, are prominent. Leaves are pinnate compounds and opposite, with five to nine oval, toothed leaflets about one half inch long that are dropped in the winter. The thin thorns stick straight out.

Docent Reference: Small plants (Continued)

Illustration from Watts, 2002, p. 47

Yarrow,

Achillea millefolium

The yarrow's large, flat-topped clusters of white flowers appear from March through June. It grows well in poor soil and endures drought. This plant appears around the globe, and it has been used throughout history as a medicinal plant. It is best known for staunching bleeding: a common name is "Nosebleed Plant." It was most used for three ailments: applied topically, for wounds and minor bleeding; inflammation, especially in the digestive tract; and for anxiety or insomnia (as a sedative). Its leaves were also cooked as a vegetable. [University of Maryland, Medical Center, 2006]

Docent Reference: Ferns

Bracken Fern

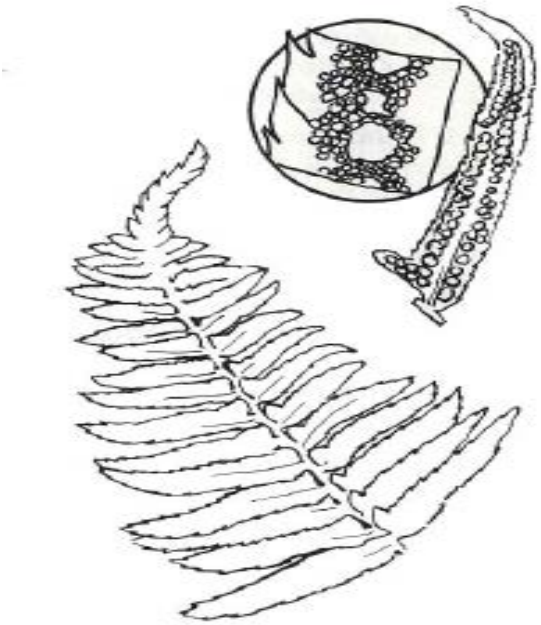
Pteridium aquilinum

This is one of the most widespread plants in the world, growing in dry, open grasslands and in deep, moist forests, from sea level to high elevations. It is unusual in having branched stems. It grows one to four feet high with wide, triangular fronds that are highly divided. In late spring and early summer, conspicuous spores form, following the edges of the pinnae. Most turn yellow and brown and die back in the winter. Some people consider the young fronds a delicacy, but eating too much can be dangerous, and mature plant parts are poisonous.

Sword Fern

Polystichum munitum

The sword fern receives its common name from the small perpendicular projection at the base of its pinnae, or leaflet, which resembles the hilt of a sword. The sword fern is also known as “Christmas Fern.” Sword ferns have been a part of the earth’s plant community for millions of years, since the time of the dinosaur. The sword fern has adapted to a wide range of growing conditions. It thrives best in the damp environment and rich soil of the redwood forest. It is a striking evergreen plant with blades that grow up to five feet in length. Sword ferns reproduce the old fashioned way—not by flowers and seeds, but by spores that are located on the underside of their leaves.



Flora and Fauna

of the Sonoma Coast

Animals

Land Mammals

Mammals share certain characteristics:

1. Mammals have a backbone.
2. Mammals bear live young which nurse from the mother's mammary glands.
3. Mammals are covered with fur or hair.
4. Mammals have adapted to their living conditions, which is evident in their means of locomotion. Mammals that live on the ground are ambulatory (walking) or cursorial (running). They may walk with their heel on the surface (humans or bears) or they may run on their toes (rabbits, bobcats, and coyotes). If they live in the trees (arboreal) they usually have long toes ending in sharp claws, as in squirrels. Bats are the only mammals that are truly able to fly. Burrowing mammals (fossorial) have modified forefeet for digging (broad-footed mole).
5. Except for the whales, mammals' digits (fingers or toes) end in claws, nails or hoofs.
6. Teeth indicate the diet of mammals. Except for baleen whales and anteaters, all mammals have teeth.

Like most animals, wild mammals avoid human contact. You have the best chance of seeing some of these elusive creatures in the early morning or at dusk. Many of them are nocturnal or are starting to feed and move around just before sunrise and sunset. Be alert, move slowly, wear clothing which blends with the surroundings, and be still.

Although it's difficult to see mammals, it's easy to see the signs of their presence: tracks, scat, fur caught on twigs, burrows, bones, paths, grazed areas, beds and dens. Look for these clues when walking and encourage visitors to do so as well. Mammal tracks, for example, are often found near burrows, in mud, in the dust along trails, or under sheltering boulders or logs.

Docent Reference: Land Mammals (Continued)

Chipmunk

Eutamias spp.

Chipmunks are members of the squirrel family. They have pudgy cheeks, large, glossy eyes, stripes, and bushy tails. These large dark chipmunks have blurred side stripes of the same width and light stripes that are yellowish. They are eight inches, including a three-to-five inch tail. They feed on a wide variety of nuts, seeds, fruits, and fungi, which they stuff into their generous cheek pouches and carry to their burrow or nest to store. Chipmunks hibernate, but instead of storing fat, they periodically dip into their cache of nuts and seeds throughout the winter.

Their shrill, repeated, birdlike chirp is usually made upon sensing a threat but is also thought to be used as a mating call by females. Chipmunks are solitary creatures and normally ignore one another except during the spring, when mating takes place. After a 30-day gestation, a litter of two to eight is born. The young stay with their parents for two months before they begin to gather their own provisions for the winter ahead. They live two to three years in the wild.

Adapted from National Geographic, 2009.

Docent Reference: Land Mammals (Continued)

Douglas Squirrel or Chickaree

Tamiasciurus douglasii

This squirrel is reddish gray or brownish gray blending to chestnut-brown on the middle of the back, with white underneath. A white ring surrounds its eye, and a dark stripe separates the upper and under parts. Ear tufts appear in the winter. They are ten to fourteen inches long, including a six inch tail. The tail of the Chickaree is thinner and flatter than that of other squirrels, but still very bushy.

They are very active and noisy, often seen running on the ground or in the trees. Chickarees are capable of both swimming and diving. They are omnivorous and eat whatever food is available, and are beneficial pest controllers. They store food in large quantities for use in autumn and winter. Their winter stores sometimes contain more than 150 pinecones. Unlike many other types of tree squirrel, they lack cheek pouches to hold food.

Douglas squirrels breed from late winter to June. Four to five weeks after mating, they give birth to four to six kits. Babies are blind and totally dependent on their mothers for two or three months.

Chickarees have many predators including several hawks, some owls, weasels, foxes, wolves and the bobcat.

Adapted from Animal Corner, 2009.

Docent Reference: Land Mammals (Continued)

Gray Squirrel
Sciurus griseus

Larger than the Chickaree, gray squirrels are seventeen to twenty-three inches long, including a very bushy twelve inch tail. They are gray with a white belly.

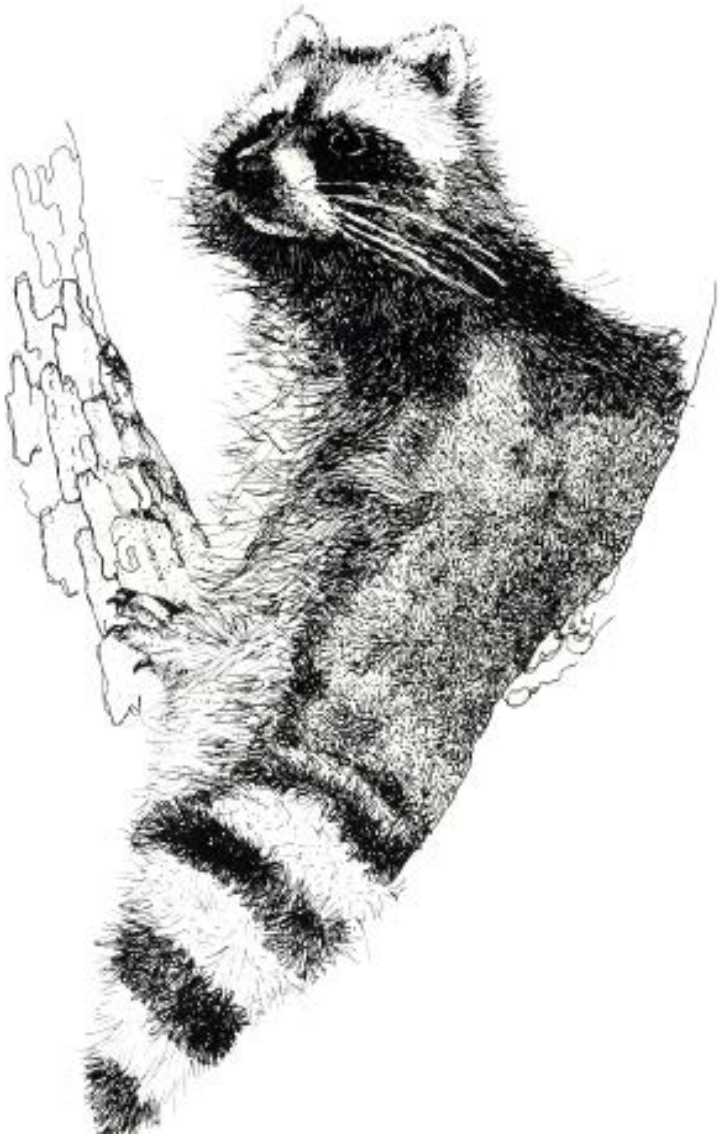
Gray squirrels do not hibernate and are most active in morning and evening. They can often be seen on the ground collecting and storing acorns in shallow holes in the forest floor. They later find these caches by scent. Since not every acorn is recovered, the squirrels help in reforestation. They also strip the seeds out of Douglas-fir cones and dig for truffle-like fungi.

Gray squirrels make their homes in redwood forests and oak woodlands, where their bulky nests—somewhat resembling arboreal nests of wood rats—are often seen in the treetops.

Docent Reference: Land Mammals (Continued)

Raccoon

Procyon lotor

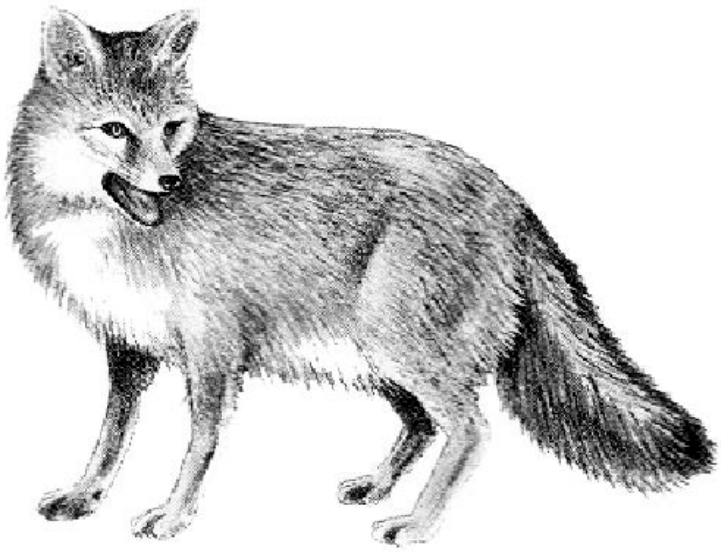


With a back mask across its eyes and its ringed tail, the nocturnal raccoon may be a familiar late-night garbage can marauder. These omnivores seem to eat almost anything, including fruit, eggs, fish, small mammals and insects. They live with equal facility along wild rivers or in densely-settled residential areas. Dens for the young are made in tree hollows, rock dens or caves.

Raccoons are very curious animals. They like to handle everything, especially food, with their sensitive hands. They are also fond of water, and although they may wander far from it while hunting, most of their life is spent near streams, lakes or marshes. Raccoons lack salivary glands to wet their food as they eat. That is why they often dunk their food in water before eating it.

When walking, these animals look ungainly and clumsy. Like a bear, a raccoon walks with its heel on the ground. Their agility, however, is demonstrated as they use their sharp claws in climbing.

Docent Reference: Land Mammals (Continued)



Gray Fox

Urocyon cinereoargenteus

Nocturnal, but sometimes seen in open forests or crossing roads at twilight, the gray fox is much smaller than a coyote. It has a salt and pepper coat and its legs, feet, backs of ears and sides of neck are reddish yellow. It has a long bushy tail.

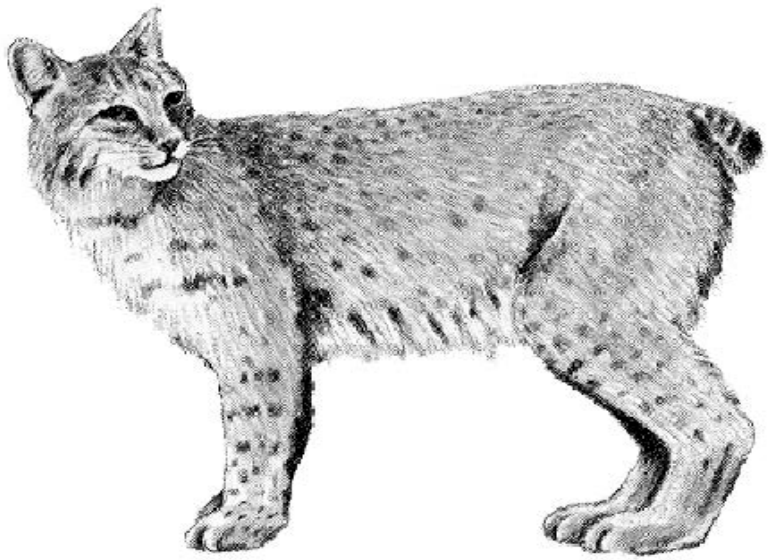
A member of the dog family, the gray fox resembles a small shepherd dog. It is the most abundant and widespread fox in North America. Its chief enemies are eagles, dogs and people. Gray foxes are timid and readily retire, even when smaller animals threaten them. Large raccoons have been seen to drive gray foxes from their food.

Small mammals, birds, and carrion are primary items of their diet, but they take fruits of many plants are taken when available.

Home ranges are several square kilometers in size. There is no direct evidence of territorial defense, but gray foxes generally avoid each other and mark their home ranges with urine and feces, as do most other carnivores.

Length to 45 inches including 8-17 inch tail; weight to 13 lbs.

Docent Reference: Land Mammals (Continued)



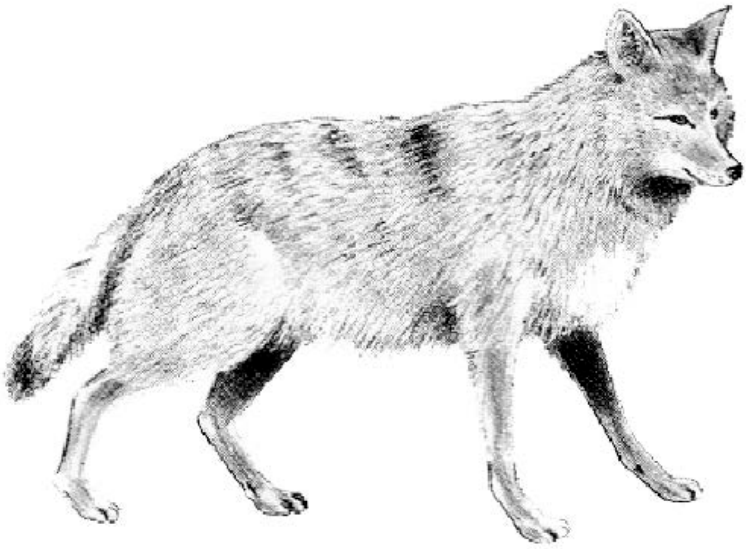
Bobcat *Illustration from Kavanagh, 2002*
Lynx rufus *Raymond Leung, Illustrator*

The large catlike animal lying in a clearing or sunning itself on a rock on chaparral-covered slopes is probably a bobcat or wildcat, especially if it has long legs, a short tail, and sharply pointed ears. Bobcats are seldom seen, however, because their mottled coats blend so well with their surroundings. Although more active at night, bobcats can hunt by day or night, because their pupils close to narrow slits in glaring sunlight and open wide in dim starlight. Bobcats have a reputation for being killers of game birds and poultry. However, investigations have shown that most of their prey consists of rodents and rabbits, making them beneficial pest controllers.

The bobcat prefers rocky or brushy country for hunting and raising its young. But signs are often found in forested areas. The den may be a protected cavity or cave among rocks. The young (average 3 per litter) are born any time in the spring and summer months but most often in April.

Length to 49 inches including 7 inch tail; weight to 39 lbs.

Docent Reference: Land Mammals (Continued)



Coyote, *Canis latrans*

The wily coyote is the source of myth and legend. The coyote is an integral part of American culture. Despite being one of the most persecuted carnivores in North America, it has proven so flexible in its habits, so adroit in escaping the trap and gun, and so prolific, that it persists in good numbers even today. It is one of the few animals in America whose range has actually expanded from its original distribution. It prefers open country, but signs of it have been seen on forested slopes.

Coyotes are heard more often than seen. The setting sun or the first daylight may be greeted by a chorus of yapping howls; often the entire choral effect comes from a single animal.

Generally coyotes make their dens in natural crevices and caves, but they sometimes enlarge a burrow dug by a ground squirrel or a badger. Coyotes mate in February or March and may pair for several consecutive breeding seasons, although they do not usually associate outside of the reproductive season. After a seven-week gestation, the pups are born in April through June, averaging five per litter. They are cared for by both parents. The young disperse in the autumn, and those that survive the heavy toll of poison, traps, predation, and starvation, reach sexual maturity at one year of age.

Length to 52 inches including 15 inch tail; weight to 50 lbs.

Docent Reference: Land Mammals (Continued)

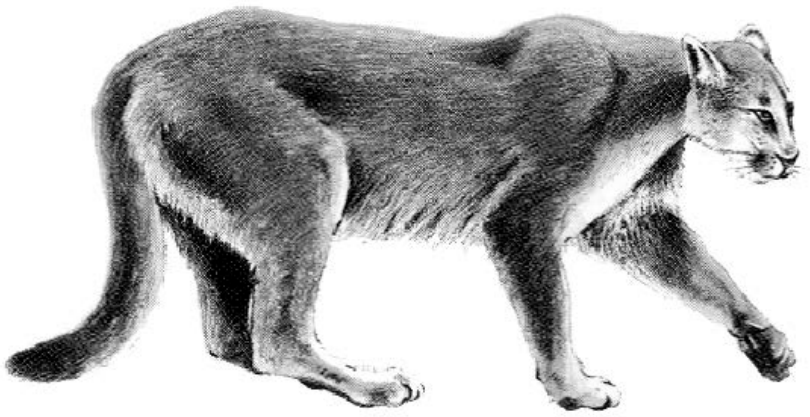


Illustration from Kavanagh, 2002, Raymond Leung, Illustrator

Mountain Lion

Felis concolor

The fearsome mountain lion is California's native big cat. Other names for it include puma, panther, cougar, and catamount. Shy and rarely observed, the mountain lion may be found wherever there are deer. They are not necessarily dangerous to the deer population as a whole, for the deer they kill are frequently diseased or crippled. In addition to deer, the mountain lion preys on smaller animals such as skunks, porcupines, rabbits and large rodents.

Each mountain lion has its own ranges. The home areas of males are larger than those of females and overlap very little. Female home areas overlap substantially with those of other females and with home areas of males. Fighting over ranges is minimized by mutual avoidance, but males do fight occasionally.

Breeding occurs mostly in winter. The cubs, two to three per litter, most frequently arrive in April, although they may be born in any month. The den is generally in a cave or crevice of a big rockslide at the base of a rocky cliff and is often quite accessible.

Length six to eight feet, largest was 9 feet including 37 inch tail; weight to 275 lbs.

Docent Reference: Land Mammals (Continued)

Illustration from Kavanagh, 2002, Raymond Leung, Illustrator

Black-Tailed Deer, *Odocoileus hemionus*

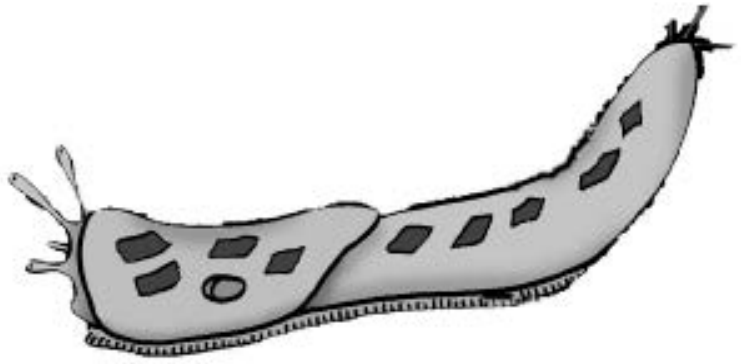
The black-tailed deer are the smallest deer in California. They are distinguished by their broad black tail and restricted white markings. They are a sub-species of mule deer.

The mating season, or “rut,” occurs in September to December. Fawns appear 7 months later, in April to June, when the spring foliage is at peak growth. The fawns are difficult to see due to the camouflage effect of their spotted coat.

By fall the fawns usually lose their spots. A young buck begins to grow antlers the first winter, but his first pair is usually single spiked. The antlers are shed each year in late winter and new antlers start to grow in the spring. By early summer the new antlers are well grown but covered with short hair, or “velvet.” As they mature and harden, the velvet dies and is scraped off against shrubs or saplings. Each successive pair of antlers is larger, until the animal is approximately five or six years old. The number of points on the antlers does not indicate the age of the buck, although up to a certain age older bucks usually have more points.

Black-tailed deer prefer open woodland where they can find acorns, grasses, clover, berries and truffle-like fungi. They are frequently seen on the higher parts of the East Ridge Trail or Pool Ridge Trail in Austin Creek State Park.

Docent Reference: Land Animals



Banana Slug *Ariolimax californicus*

Habitat: Banana slugs live on damp, foggy forest floors on the West Coast of North America only. They like foggy summers and rainy winters. They hide in damp places.

Morphology: (Body parts.) Slugs are believed to have evolved from snails. They need conditions with plentiful moisture. They are invertebrates called Mollusks. They are gastropods (stomach foot) and pulmanates (with lung), without an external shell. The longer set of antennae are eyes and the short set is for smell. If the antennae are broken off they will regenerate within 48 hours. They can dig, climb, swim, move upside down and lower themselves on a cord of slime.

Banana slugs are hermaphrodites. Each slug possesses both male and female reproductive organs. Thirty eggs are laid that can be eaten by birds or shrews. Banana slugs have a high mortality rate. If they reach adulthood, they live three to five years.

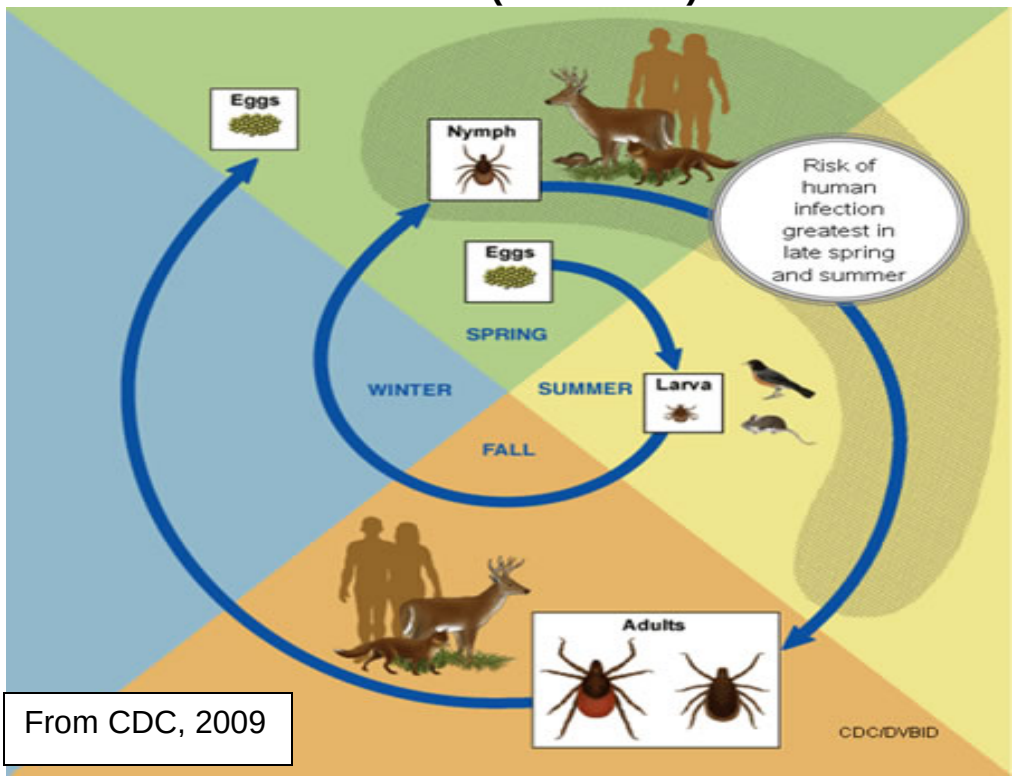
Predators: Banana slugs are eaten by snakes, ducks, foxes and salamanders. They cover themselves with slime and contract to become shorter, fatter, and thicker. This can make predators gag. If picked up, the slime is difficult to wash off.

Job: Slugs clean the forest floor. They eat mushrooms, dandelions, wild flowers, ferns, scat, poison oak, mosses and leaves. They can smell a mushroom ten yards away with their short set of antennae. Redwoods benefit from the nitrogen rich scat produced by the slugs. The slugs will not eat any part of a redwood tree.

Cool Slug Facts

- Slugs have tongues with 30,000 teeth and rasp their food.
- Slugs go about .007 miles an hour.
- Slugs can be both female and male; if no other is around they mate with themselves.
- Slug slime can take away the sting from nettles.
- Slugs can stretch out to 11 times their normal length.
- Slugs mark their own trail so they can find their way home after dark.
- Banana slugs were a food source for the Yurok Indians.

Docent Reference: Land Animals (Continued)

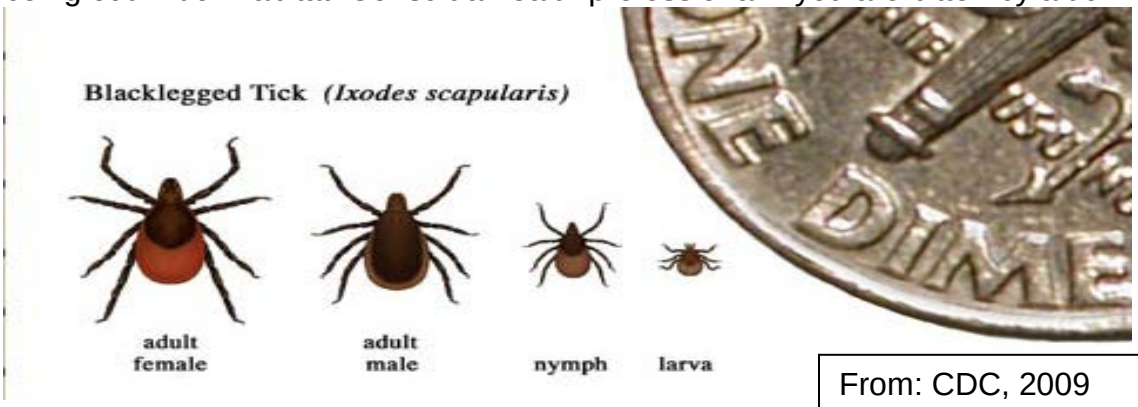


From CDC, 2009

Western Black-legged Tick; *Ixodes pacificus*

The western black-legged tick transmits the bacteria that cause Lyme disease. Western black-legged ticks are most common in the coastal regions and along the western slope of the Sierra Nevada range. Ticks prefer cool, moist environments such as shaded grasses, shrubs, and leaf litter under trees in oak woodlands.

To avoid ticks, stay on the trails and avoid contact with bushes or grasses alongside trails where ticks are common. Check your body for ticks for several days after you being out in tick habitat. Consult a health professional if you are bitten by a tick.



From: CDC, 2009

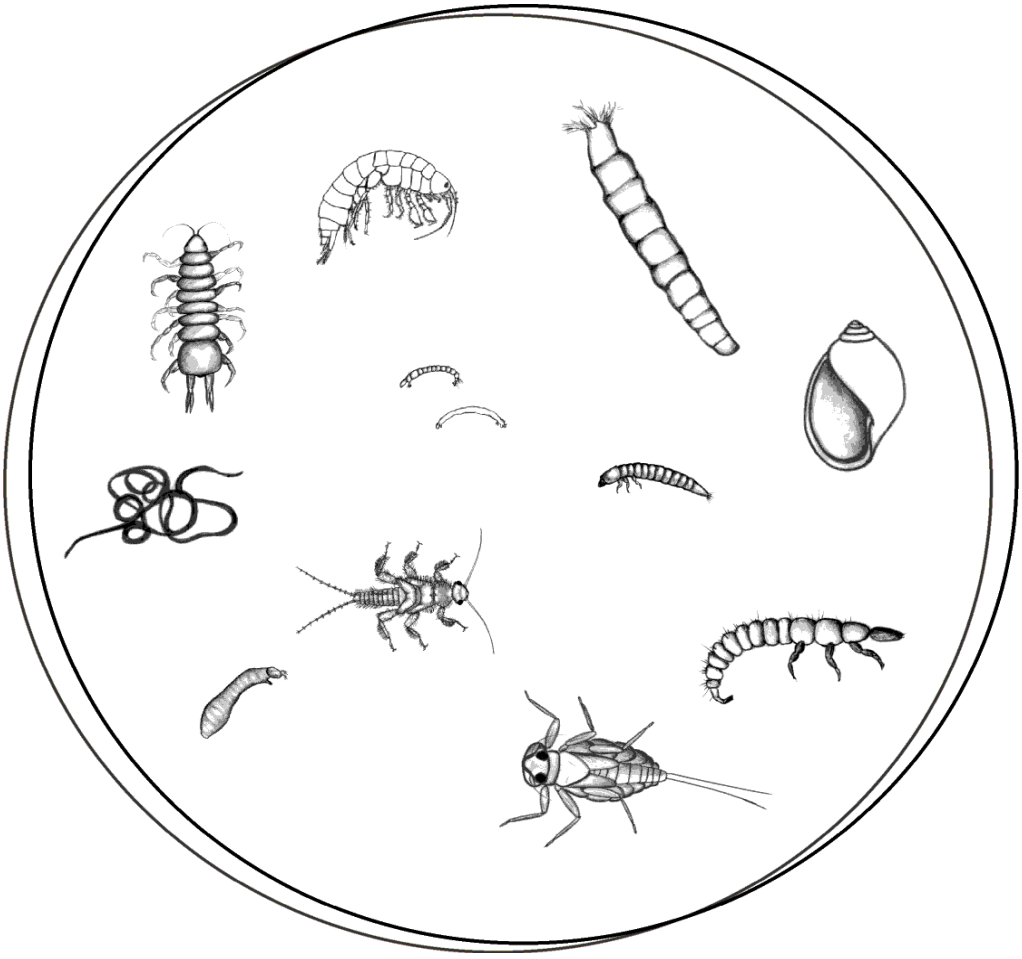
Adapted from: Field Guide to Freshwater Invertebrates

Leska S. Fore, Annabel Wildrick

***(*All illustrations by Wildrek, unless otherwise noted.)*)**

http://www.seanet.com/~leska

The animals living in a stream provide the best indicators of that stream's overall health and ecological condition. We monitor invertebrates because they represent an enormous diversity of body shapes, survival strategies, and adaptations. Many invertebrates require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles. These animals, in turn, provide food for trout, salmon, herons, and kingfishers. Below are descriptions of the invertebrates you might expect to find at an excellent stream site (i.e., a site unchanged by humans), a moderate site, and a poor (i.e., degraded) site.



Petri dish of invertebrates illustrates their approximate, relative size.

Benthic Macroinvertebrates as Biological Indicators of Watershed Health

Excellent stream site. A variety of organisms with different body shapes and ways of surviving exist here. High biodiversity (or taxa richness) indicates a site with low human influence: most of the animals in this guide should be present in a riffle sample. Several different types (or taxa) of stoneflies, mayflies, and caddisflies indicate a healthy site. More than one type of riffle beetle may also be identifiable. Some caddisflies are tolerant of degradation, so a large number of caddisflies does not necessarily indicate a good site, especially if they are the same species.

Moderate stream site. The total number of different types of organisms (taxa richness) declines as degradation increases. About half to two-thirds the number of taxa found at an excellent site are found in a moderate site. The primary change from an excellent site is that there will be many fewer taxa of stoneflies. Mayflies will be present, but probably fewer taxa as well. Several types of caddisflies may be present depending on the type of degradation. The proportions of soft-bodied worms, baetid mayflies, simuliid flies or amphipods may increase. Beetles are probably still present; mollusks are not.

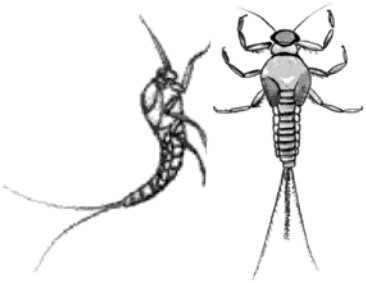
Poor stream site. The total number of taxa will be low. Most of the taxa found are soft-bodied animals, e.g., fly larvae, oligochaetes, nematodes, and in very poor sites, leeches and planaria. Stoneflies are absent entirely. The only mayflies present are probably baetids (a family of mayflies). Caddisflies may be present, but only a few tolerant types. Amphipods are often present. There may be a large proportion of a single type of animal. Animals may be smaller than those found at an excellent site.

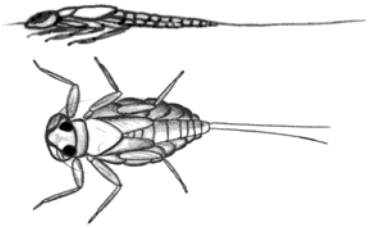
Benthic Macroinvertebrates: Pollution Sensitivity

Pollution-Sensitive	**Moderately Tolerant**	**Pollution-Tolerant**
Stoneflies	Damselflies	Midge flies
Water Penny Beetles	Dragonflies	Worms
Mayflies	Crayfish	Leeches
Dobsonflies	Amphipods	Pouch Snails
Alderflies	Blackflies	
Snipeflies	Caddisflies	
Mussels	Isopods	
Riffle Beetles	Craneflies	

[*From EPA, 2009a]*

Mayfly nymphs (*Order Ephemeroptera*)





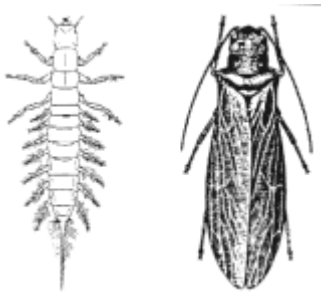
Mayfly nymphs are found only in extremely clean and cold water. They are strong swimmers and move like dolphins. They are almost exclusively vegetarian, either scraping algae or chewing dead leaves. They remain in the water for about one year before transforming into winged adults to mate and lay eggs. Mayfly adults do not eat. Adaptations include flat bodies to fit between and underneath rocks on stream beds, where the current is weak, or in the "boundary layer" on top of underwater rocks. (As water flows over the rock, a layer less than an inch thick forms on the rock's surface in which the current flows very slowly.) Gills at the base of the legs or backs, often visible along the abdomen, allow underwater breathing. Long 'tails' sense the movement of approaching enemies. If an animal has three tails it's a mayfly; but some have two tails.

Mayfly diversity declines as streams are degraded; mayflies are particularly sensitive to mine waste. The three basic types of mayfly nymphs are classified by their life style. Burrowing nymphs burrow in the stream bottom sediments and are typically longer and lighter in color than the other types of mayfly nymphs. Clinging nymphs have very long, fragile tails, and are typically brown like the rocks they cling onto. Free-swimming nymphs are fast swimmers and are usually dark colored. Colors among these three groups vary, but tan, brown and black are common. All three types share the characteristic of three tails, though tail length may vary. Note: Tails are most easily seen on a submerged organism, but may break off during collection.

Stonefly nymphs (*Order Plecoptera)*

Stonefly nymphs are typically found on or near stones in extremely clean and cold streams. They live in swift water, swirling brooks and waterfalls. They breathe through abdominal gills and clamber over rocks using their strong claws, two on each foot. They are rather primitive and may have been among the first insects to develop flight. Adult males and females emerge from the water to mate and locate each other by drumming with their abdomens. Their flat bodies fit between and under rocks. Stoneflies look similar to mayflies but are stockier and have two tails instead of three. They also appear somewhat less fragile than mayflies because they possess a more rigid-looking exterior. They are often yellowish and brown or black in color and may be brilliantly patterned. Many are predators that hide and stalk their prey between stones and cobble. Diversity of these animals declines rapidly at the first signs of human disturbance.

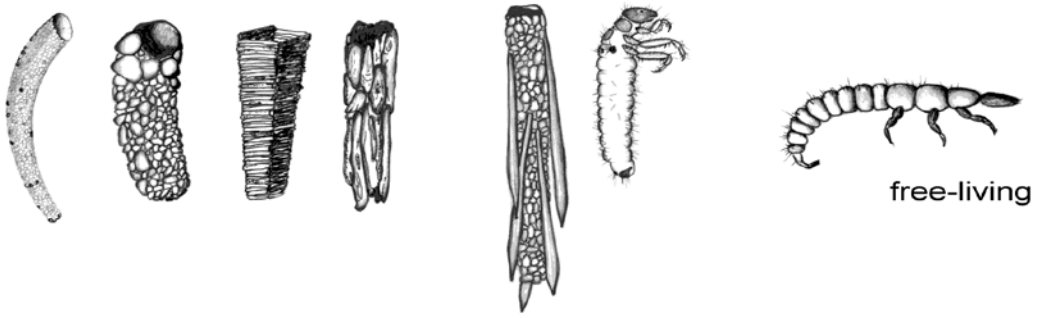
Alderflies **(Order Megaloptera, Family Sialidae)**



Alderfly larvae possess a single tail filament with distinct hairs; the body is thick-skinned with 6 to 8 filaments on each side of the abdomen and the gills are located near the base of each filament. They are brownish. Females deposit eggs on vegetation that overhangs water; the larvae hatch and fall directly into water. The larvae are aggressive predators, feeding on other adult aquatic macroinvertebrates. They are eaten by other larger predators. Alderfly larvae generally are intolerant of pollution.

Illustration, nymph and adult, EPA, 2009

Caddisfly larvae **(Order Trichoptera)**

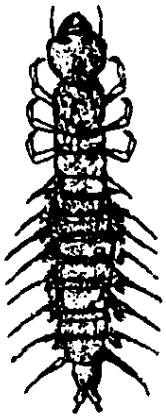


Caddisflies use silk to build underwater cases from gravel, twigs, needles or sand. Different species build distinct cases. They will retract into this case when threatened or startled, but often lose them when removed from a stream. Body color varies from yellow and green to brown. These larvae tend to curl up slightly when placed on a flat surface. Their heads are tough; they have short antennae and strong biting mouths. Some Caddisfly capture food in nets, others scrape algae or shred leaf litter. Free-living caddisfly larvae do not build cases; many are predators and move quickly to capture other animals for food. Caddisflies emerge after one year to mate as winged adults. Some caddisflies are very sensitive to human disturbance; others are tolerant.

Adult mayfly, stonefly, caddisfly

All three of these groups leave the water to mate as winged adults. Large swarms of mating mayflies and caddisflies often occur when all the individuals of a single species emerge at the same time. Stoneflies crawl out of the water and mate on the ground. The females of all three groups fly upstream and drop their eggs onto the water or dive into the stream to attach them to rocks or leaves.

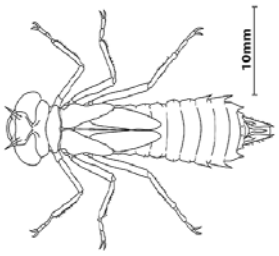
***Dobsonfly larvae* (Family Corydalidae)**

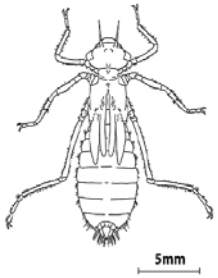


Dobsonfly larvae are often found clinging to rocks in the more swift areas of the riffle. They spend much of their time hunting for prey. They breathe through gills underneath their bodies and range in size from ¾ to 4 inches. They are stout with tough skin and six legs. The many appendages on their rear section are called "lateral appendages." They have a set of “pincers” and tail hooks. If you catch a dobsonfly larva, grasp it directly behind the head to pick it up. This makes it impossible for the larva to pinch you

Dobsinfly larvae by Kentucky Water Watch, 2009

Dragonfly Nymph* (Order Odonata, suborder Epiprocta*)
And Damselfly Nymph (Suborder Zygoptera)





Dragonfly larvae by Kentucky Water Watch, 2009

Damselfly larvae by Ron Newman 2009

Dragonfly and Damselfly nymphs are the dominant insect carnivores of the ponds, and consume everything from tiny water fleas to small fish. They are mostly found near aquatic vegetation or in the calmer areas of streams. They molt many times and remain in the water for one to three years before transforming into winged adults. Their lower lip extends out with hooks on the end for seizing prey. Large, hinged legs allow them to spring upon their prey, while their variable-colored bodies provide camouflage.

Dragonfly nymphs have large eyes and are often flat on their undersides. The abdomen may be stout and somewhat diamond-shaped, without tails. The body length may be 1-1 ½ ", and the six legs quite long. The nymphs have internal gills for which water is sucked into the body and then expelled. This expulsion can be quite rapid to provide an emergency means of locomotion.

Damselflies undergo incomplete metamorphosis, with an aquatic nymph stage. The female lays eggs in water, sometimes in underwater vegetation, or high in trees in bromeliads and other water-filled cavities. Nymphs are carnivorous, feeding on daphnia, mosquito larvae, and various other small aquatic organisms. The gills of damselfly nymphs are large and external, resembling three fins at the end of the abdomen.

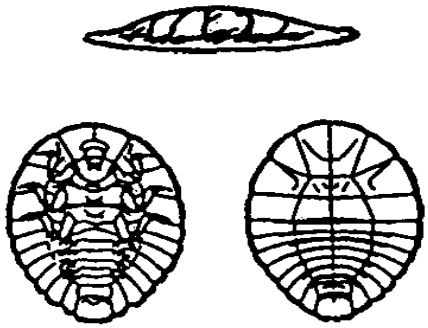
***Riffle beetles* (Order Coleoptera)**

Most beetles are easily distinguished by the set of hard wings that meet in a straight line down their backs. Underneath lies a set of softer wings that re used for flight. Water-dwelling beetles generally come to the surface to breathe, and feed on insects and tadpoles. Some are fierce predators that will attack fish much larger than themselves. They have hard shells for protection, a rounded shape to maneuver through water and are flat to squeeze between and under rocks for protection. Their paddle-like feet aid in swimming. They are light or dark brown for camouflage.

Riffle beetle larvae are specially adapted to cling to smooth rocks in fast-flowing water (riffles). They have a hard exterior, a cylindrical shape and a small tuft of white filaments at the rear. After emergence, adults fly for a short time but return to the water to feed in the same habitat as the larvae. Both the larvae and adults are rather small (1/16" - 1/8"), dark-colored, and tend to drift to the bottom of a sample so they may be hard to see. Riffle beetles collect and gather a variety of different foods.

To find these beetles, watch the net closely for movement. If you are uncertain if you have a riffle beetle or a terrestrial beetle, put it in water. If it seems well adapted to water and fits the rest of this description, it is probably a riffle beetle.

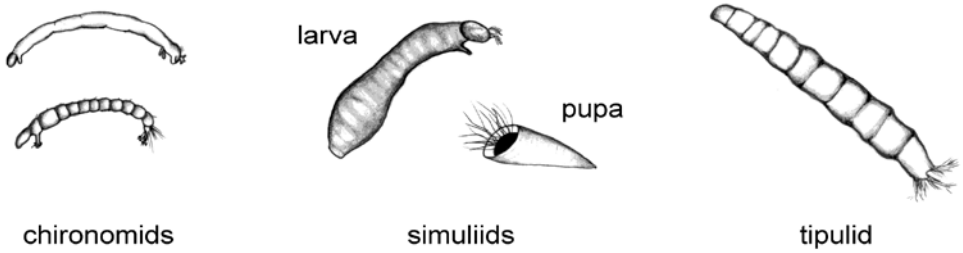
***Water penny beetle larvae* (Family Psephenidae)**



Water pennies are round, tan, brown, black or copper-colored beetles that look like pennies (although they are smaller) and live on the undersides of rocks. Their legs are not visible until you turn them over. They breathe through a set of gills located on the undersides of their bodies. Unlike many beetles, they are vegetarian, feeding mainly on algae on stones.

Illustration by Kentucky Water Watch, 2009

***Fly larvae* (Order Diptera)**



There are many species of true flies; we focus on the three most familiar families. Midge larvae (or chironomids) are very small, often C-shaped, and have a spastic squirming movemen. Black fly larvae (or simuliids) are dumbbell shaped and soft. They attach themselves to the substrate and prefer soft sediment. Crane fly larvae (or tipulids) are large and fleshy with very short "tentacles" at one end.

Midge larvae (Family Chironomidae) are very small, 1/8 to ½ inch long, and often C-shaped. Midge Larvae are found anywhere water collects. There are about 2000 midge species in the world. Midge larvae are often red, though they can be brown or whitish. The best way to identify them is by their small size and spastic squirming action. Some float at or near the surface with their body in a U-shape. Others lie in muddy creek bottoms in tubes made of mud, sand or plant debris, held together by silk. They feed on small plant particles that they catch in bristles near their mouths. They have a pair of small 'prolegs' just below the head for feeding. They transform into tiny flies, and do not bite. Midge larvae are very tolerant of pollution; they can feed on organic pollution particles. They can live in water having low levels of dissolved oxygen as they can rise to the surface to breathe. Note: These are very small, slender organisms, so check your net closely and inspect leaves and other debris.

Blackflies (Family Simuliidae) lay their eggs in the cool rapids of streams, since the newly hatched larvae need high levels of dissolved oxygen and fast-moving water. The larvae attach to the rocky bottom by a small sucking disk at the ends of their abdomens.

A larva also anchors a silken thread from its body to rocks to draw itself back should it be swept off. Two fan-shaped brushes near the mouth strain food from the water. Black fly larvae are small (1/16" - 1/4"), slightly bulbous at one end and gray or brownish in color. They are a good food source for trout and other fish that live in cool streams. In the late spring, black fly larvae transform into flying adults. The female adults need a blood meal as they prepare to lay eggs, and they become vicious biters.

Crane fly (Tipulidae) larvae are segmented and worm-like, ranging from 1/2 to 2-1/2 inches. They can be found in a large variety of colors, including white, brown and green. Some are almost translucent, so you can see the insides of the organism move when it crawls. These larvae have a soft, fleshy appearance and very short tentacles (small "arms" or projections) at one end which can be seen more easily if the larva is placed in water or squeezed gently. They may be as thick or slightly thicker than a pencil.

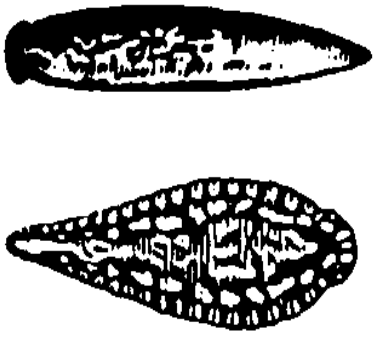
Aquatic worms (*Phylum Annelida and others*)

planaria nematode oligochaete

Flatworms (planaria), roundworms (nematodes), and freshwater earthworms (oligochaetes) are properly called worms. Nematodes and oligochaetes are long and thin and writhe like snakes. They may be smooth or bristly; round or flat, and range in size from 1/4" – 5". They do **not** have legs.

Many aquatic worms look similar to earthworms. In streams you may also find very long, slender worms (such as horsehair worms), or flatworms, like planaria, which are small, sticky and soft-bodied. Many of these can slip through the net quite easily, so watch closely. If you locate a worm and it is not a midge larva, leech, or black fly larva, it should be recorded under the category of "aquatic worms." These worms will typically "wriggle" in a snake-like fashion. Colors vary greatly in this category (red, white, brown are common). These animals generally are very pollution tolerant.

***Leeches* (Class Hirudinea)**



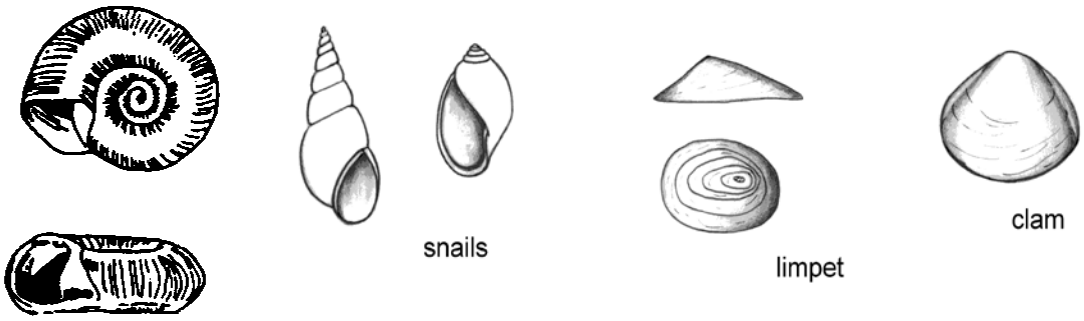
Leeches are usually small, 1/2" - 4" when extended, dark in color, and flat. They tend to cling to smooth stones and boulders with their circular "sucker." Leeches generally have the appearance of being segmented, with the lines running perpendicular to the length of their body. They may be long and tapered, or short and tear-drop shaped. They move by extending and contracting their tough muscular bodies, so they may appear quite long. Do not confuse these with the flat, soft-bodied planaria.

Illustration by Kentucky Water Watch, 2009

Crustaceans

Amphipods (or “scuds”) are very fast swimmers that look like shrimp. They have many appendages and look fuzzy. High proportions of these animals are present in very degraded sites. Isopods (or sowbugs) are usually found creeping through leaf litter.

Molluscs* (Classes Gastropoda & Pelecypoda*)



<u>Right-opening snails,</u> by Kentucky Water Watch, 2009

Most snails and limpets eat algae and other plant matter they scrape from rocks using their sharp tongues. Some snails breathe underwater through gills, others breathe above water by taking air into lung-like structures, and still others can breathe both ways. Snails have shells for protection, variable-coloring for camouflage, teeth on their tongues for scraping food, and a large, muscular foot.

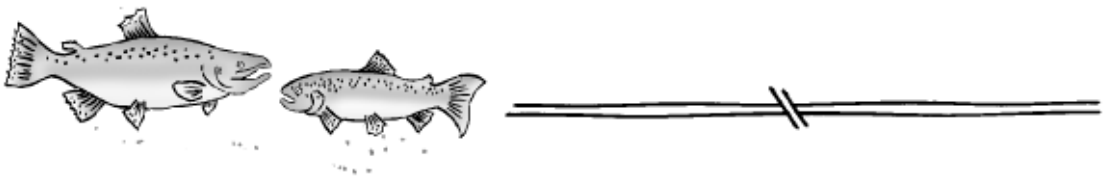
The more-sensitive snails (shown at the left, above) can be distinguished from the less-sensitive pouch snails (shown to their right) by their openings. When the pouch snail is held point-up with the opening facing you, that opening will turn to the left. When holding up the flatter, gill-breathing, pollution sensitive snails with the opening up and facing you, the opening will turn to the right.

As larvae, freshwater mussels (or clams) may hitch a ride by attaching themselves to migrating fish. Mussels are very sensitive to sediment because they feed by filtering stream water through their shells. Mature mussels indicate an undisturbed site and may be up to 40 years old.

PART V

Bibliography

and Information Sources



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Activities and games [try the Splash Game]: www.epa.gov/owow/nps/kids/

Biodiesel for kids – what is it? www.biodiesel.org/pdf_files/kids_sheet.pdf

Composting for kids; games and information that can get families started
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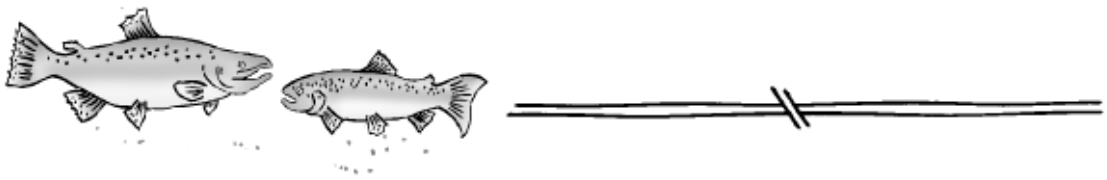
Notes



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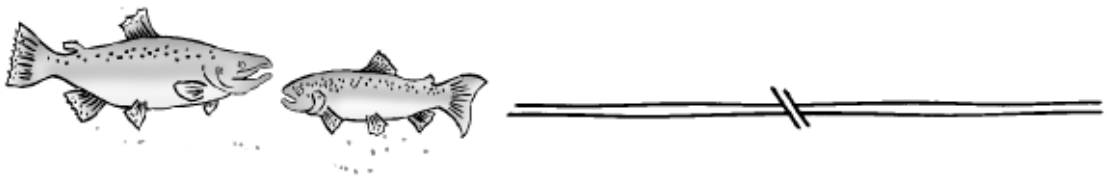

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