Napa River Ecological Reserve Curriculum Guide

History, art, and ecology activities for grades K-12.

Napa River Eco Reserve Curriculum Guide

Partners and Contributors

Napa County Regional Parks and Open Space District (NCRPOSD)
The Napa County Regional Park and Open Space District is a special district that was approved by the voters of Napa County in November of 2006, with jurisdiction over all of Napa County including both unincorporated and incorporated areas. A five-member elected Board of Directors governs the work of the District. Directors are chosen by the voters of the portion of the County they are elected to represent. The District receives funding through grants and donations from the County of Napa, other public agencies, private foundations and many individuals.

The District is dedicated to preserving and facilitating enjoyment of the open space resources of Napa County. It has three main goals:

- Preserve, restore and protect open space lands, natural resources and special habitats
- Provide opportunities for outdoor recreation through the development of a system of parks, trails, water resource activities, open space and related facilities
- Provide historical, cultural and environmental educational programs

These goals are tightly inter-related, since the successful preservation of open space resources depends on public engagement and support. Outdoor recreation is an effective way to engage the public and gain their support. Outdoor, hands-on education is also essential, especially for the children who will be the next generation of leaders responsible for stewarding the special places and resources that make Napa County what it is.
The District has no land use regulatory authority or power of eminent domain. Instead, the goals of the District are pursued through partnerships, mutually-beneficial agreements and lots of volunteer support.
This guidebook is tailored to the Napa River Ecological Reserve, a small, State-owned area for which the District has assumed most maintenance and restoration responsibilities.

Napa County Resource Conservation District
The RCD was established in 1945 to help the community make informed decisions about stewarding natural resources in Napa County. Our organization supports natural resource management solutions through partnerships with individuals, organizations, and agencies. We facilitate natural resource conservation and enhancement through community engagement, scientific research, and technical and financial assistance. We are committed to utilizing voluntary, cooperative and scientifically sound methods to ensure that the watersheds within the district are sustained, conserved, restored and protected within a landscape of productive agriculture, growing cities, and wild lands.
The RCD strives to connect people with one another and their watersheds by offering opportunities to improve water quality and wildlife habitat, engaging the community in hands-on habitat enhancement projects, providing presentations toclassrooms and community organizations; leading field-days and hikes; coordinating workshops and watershed symposiums; and offering a forum for grape growers to discuss sustainable grape growing practices (Napa Sustainable Winegrowing Group). The RCD also distributes a quarterly newsletter, hosts a website dedicated to conservation, develops and distributes a variety of conservation publications, is a leader in the Environmental Education Coalition of Napa County (EECNC), and constantly seeks new and innovative ways to engage the community in natural resource conservation. For more information about the RCD and to sign up for our quartely e-newsletter, visit *www.naparcd.org*.

Funding for the creation of this guide was provided by the Napa County Wildlife Conservation Commission and the California Coastal Commission.

Introduction

Napa River Ecological Reserve Curriculum Guide

This guide was created to encourage the use of the Napa River Ecological Reserve as a learning laboratory for students of all ages. The 73-acre Reserve is the last sizable section of riparian vegetation in the Napa Valley and provides habitat for a diverse community of birds, butterflies, mammals and plants. Valley oaks that surrounded the native Wappo tribe and early European settlers of the Valley can still be found in the diverse habitats within the Reserve. The Reserve's ecological and historical significance make it an ideal location for students to learn about watershed function and ecology, biodiversity, ecological restoration, the history of the people and industries of Napa Valley, and appreciation for the need to conserve natural areas.

The activities in this guide will allow students to develop an understanding and appreciation for the natural environment through activities in three main categories: art, ecology, and history. The activities will give participating classes the opportunity to see, hear, feel, and appreciate the Napa River Watershed in a hands-on way that classroom lessons alone cannot provide.

The activities in the guide align with established classroom curriculum standards and contain notes on how to alter the lessons for multiple grade levels. Many of the activities in this guide also contain lesson extensions that can be brought back into the classroom so that the knowledge gained while at the Reserve can continue to grow. The guide concludes with a list of volunteer opportunities, stewardship project ideas, and other local resources that can help your students become involved with natural resource appreciation and conservation.

Table of Contents

Table of Contents

Napa River Ecological Reserve: An Oasis in the Heart of the Wine Country

By Teresa LeBlanc

This article was originally printed in Outdoor California magazine, July - August 2001 and was borrowed from the Dept of Fish and Wildlife website: www.dfg.ca.gov

A very special place lies within the wine-growing region of the Napa Valley. Surrounded by vineyards, the 73-acre Napa River Ecological Reserve (NRER) retains a remnant of riparian forest, with both an ecological and historical perspective. Just east of the town of Yountville and minutes from the Central Coast Region office, NRER is the last sizable section of riparian vegetation left in the Napa Valley and provides habitat for approximately 150 species of birds, numerous butterflies and various mammals. It also supports a diversified plant community of 238 plants, including the federal and state endangered Sebastopol meadowfoam (Limnanthes vinculans).

A human community of private and public owners gives NRER a one-of-a-kind story. Its riverine components brought it statewide attention, and the Wildlife Conservation Board purchased the Napa River Ecological Reserve in 1976. Since more than 90 percent of California riparian habitat has disappeared, the Fish and Game Commission gave it ecological reserve status to protect these plant communities. NRER has a long human history, dating from when the native Wappo tribe used it as a hunting and gathering area. Later, these riverside woodlands became part of George C. Yount's Mexican land grant, "Caymus Rancho" in 1836. The present location of the Yountville Cross Road, the southern boundary of NRER, also served as the southern perimeter of Yount's 11,900-acre holding. During the years 1858 through 1879, annual church gatherings took place with an estimated 4,000 people in attendance, within an open grassy area known as the "Yountville Campgrounds." These participants brought cattle, chickens, sheep and other livestock to sustain their stay. Many brought their own camping equipment; those who didn't borrowed materials for tent cabins from local merchants. The last organized religious gathering took place in 1974, while the property was still in private ownership. That gathering site is located in the interior portion of NRER, just off the trail where you can find a small bench facing the area.

Instead of grazing cattle and campfires, resident acorn woodpeckers swoop from oak to oak, nesting communally or defending territory. Follow them with your eyes as they fly to "granary trees." These are storage places, usually within snags or dead limbs in which the woodpeckers have drilled holes and placed their collected acorns. At times, the acorns themselves may attract predatory insects that offer opportunistic foraging by the birds. Other species like the Stellar's

and western scrub jays bury acorns in the fertile soil litter. When these acorns go unretrieved, the birds' benign neglect is NRER's gain: the acorns grow long tap roots, generating future oak trees. Another avian seed collector, the white-breasted nuthatch, caches seeds within the oak's rough bark and branches. Its sharp, curved claws help it move about the tree and around limbs, challenging gravity as it searches for food. Overall, the oaks provide many elements critical to NRER's aerial inhabitants.

Hosting resident, wintering and fall migrant species, NRER is well known to birders from as far away as Europe. The warm summer months typically attract locals with the cooler temperatures vegetation and hydrology provide. The Napa River flows through the area, supplemented by Conn and Rector Creeks. Conn Creek was dammed to create Lake Hennessey, which is part of City of Napa's water supply. By late summer, it typically does not have visible flows but does support various species of willow trees that may reveal a Wilson's warbler, or Annas' and Allen's hummingbirds in the spring.

Large valley and coast live oaks and California bay trees dominate NRER. Some valley oaks have been aged between 250 to 280 years. Many are mantled with grayish-green lace lichens, which are not actually plants but a symbiotic combination of fungus and algae. Several species of willow including sandbar, polished and arroyo, are found along the banks and provide important habitat for insects, birds and necessary shade elements for fish. Other trees include white alder, Fremont's cottonwood and Oregon ash. Wild rose, common snowberry, Santa Barbara sedge, poison oak and both native and non-native blackberries primarily compose the understory. Large, twisting native grapevines (Vitis californica) wrap sinuously around the larger trees.

The word "riparian" alone cannot describe the diversity of the Napa River Ecological Reserve. This riparian habitat ranges from oak woodland, grassland and swale-type habitats. Given the structure and ecological aspects of riparian vegetation it's no wonder that approximately 70 species of birds nest within NRER including the yellow-breasted chat, a Department of Fish and Wildlife (DFW) "Species of Special Concern." The area is accessible during late spring, summer and fall seasons. With high seasonal rainfall, the river may rise and inundate NRER's interior during the winter. It is a natural cycle, given the vegetation is well adapted to flooding and gives NRER a well-deserved rest. At times, during El Niño years, the river has breached its western levee, imprinting a high-water mark evident within the lower canopy.

NRER remains a place where communities converge. It draws a large following in terms of its public and wildlife use. Although owned and managed by the DFW, NRER has welcomed assistance from public agencies, non-profit organizations and private citizens.

Whether you are birdwatching, hiking, fishing or just appreciating a piece of local history, the Napa River Ecological Reserve is a worthwhile visit. NRER continues to provide an opportunity to showcase the state's overall natural diversity, and to educate visitors about the importance of riparian habitats.

Some Interesting Facts about Creeks

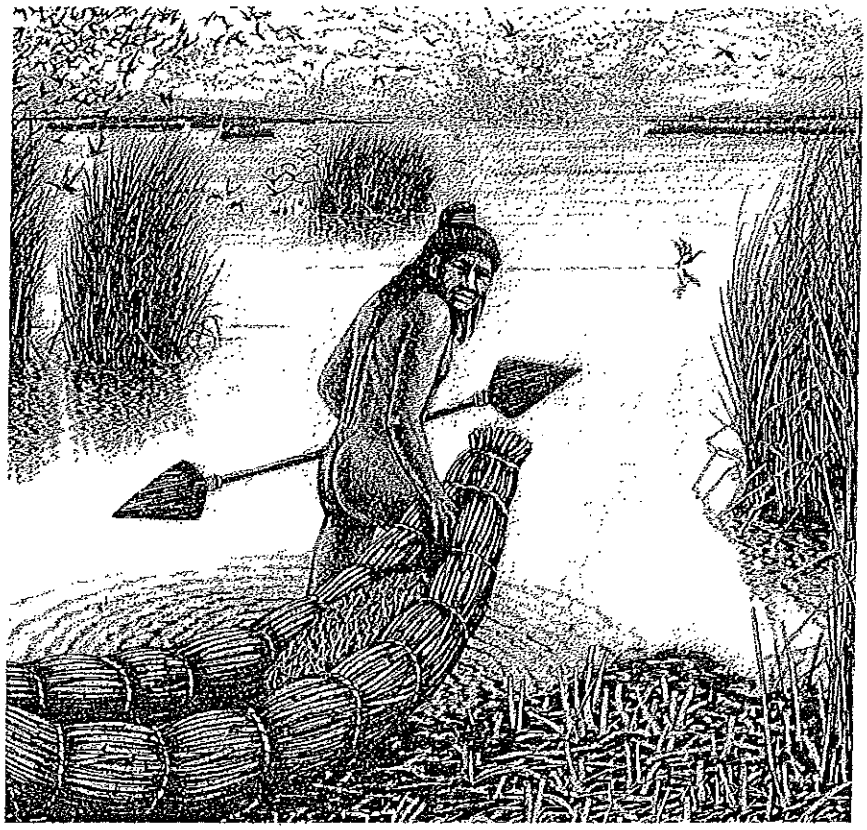
- The U.S. Council on Environmental Quality has said about creeks that "no ecosystem is more essential to the survival of the nation's fish and wildlife."
- Creeks, in contrast to most California habitat, receive enough water in summer to support high plant growth and species diversity. The plants in turn support a large variety of insects and other plant eaters, which in turn support lots of birds and animals.
- The vegetation along creeks forms long, narrow belts between the creeks and adjacent land. These belts of riparian (streamside) vegetation support a greater diversity of species than either adjacent habitat. They provide roosting, nesting, and escape habitat for species that live in adjacent areas. They also serve as trails or migration corridors between higher and lower ground for deer, raccoons, birds, amphibians, and insects.
- In California, riparian areas support 135 species of birds, of which 13 are threatened or endangered. About 25 percent of our mammal species depend on riparian habitats, as do 83 percent of our native species of amphibians.
- The riparian systems of the western United States contain about 42 percent of the mammals of North America, 38 percent of the reptiles, and 14 percent of breeding birds.
- Riparian plants are crucial to life in the stream. The vegetation shades and cools the water; the leaves and debris contribute nutrients for aquatic animals; the roots hold banks together to help prevent erosion.
- Salmon and steelhead are an important indicator of the health of waterways. If the fish aren't surviving, neither is the creek. When a creek is healthy enough for anadromous fish (fish that live much of their lives in the ocean, but spawn in freshwater), its prognosis is a lot more promising.
- In cities and towns, creeks not only support wildlife, but provide recreational, aesthetic, and economic benefits for people. When left above ground, they increase property values near them, serve as official or unofficial playgrounds and greenbelts, and help define neighborhoods as well as provide natural pathways that link diverse communities.
- The channelizing and burying of waterways done on behalf of flood control has been one of the greatest threats to urban creeks. The age of stream channelization began with the federal Flood Control Act of 1938. The federal-local cost-sharing arrangements were so attractive that from the 1940s to the early 1970s "channel improvement" projects were constructed on 34,240 miles of waterways in 1,630 projects by the U.S. Army Corps of Engineers and the Soil Conservation Service. In a 1973 report to Congress, the consulting firm Arthur D. Little estimated that another 200,000 miles of waterways were modified by states, counties, and towns.
- Channelization is expensive. Channelizing one mile of San Pablo Creek in Richmond would cost $8.45 million. The current proposed Army Corps projects in California will cost $96 million per year, and yet it's been estimated that for every $5 the federal government spends on channelization, $4 in damage results because development is encouraged in flood plains.

- Historically, creeks often served as a city's water supply. Today they carry urban runoff, the major cause of toxic pollution in creeks. Oil dripped from cars, plastic cups and bottles, and almost anything else that ends up on city streets eventually gets washed into nearby creeks.
- If you wash your car on the street, the soap washes into a creek where it may be deadly to fish and other creek inhabitants. If you wash your car in a car wash, drain water goes to a sewage treatment plant, where it is rendered harmless.
- You can make a game out of spotting creeks in the landscape. Look for lines of trees or shrubbery in the lowest point in the area. Look also for deciduous trees, such as cottonwoods and alders since many native trees grow along creeks. You can also listen for the sound of creeks gurgling under manhole covers.
- Creeks are a symbol of how we care for our resources. They are a part of the natural and cultural history of our cities, tying us to earlier times.

Human History of the San Francisco Bay Area

The Ohlone Indians

The Ohlone people lived in the Bay Area for at least 4,000 years before the Europeans arrived. The Ohlones were not one tribe but were made up of about forty independent groups, or tribelets, each with its own territory and chief.



From *The Ohlone Way* by Malcolm Margolin

The entire Ohlone population numbered about 10,000 by the time Europeans arrived in the Bay Area in the late 1700s. The Ohlone people lived very differently than we do today. Their main source of food came from the land near their homes and the nearby water. Since they were able to gather enough food to live on, there was no need for farming. Food was literally all around the Ohlones and they gathered acorns, nuts, berries, greens, and different kinds of plant roots, which they prepared in their small villages. They found shellfish in the mudflats and caught many types of fish, birds, and other animals that lived around the shoreline of the Bay and in nearby streams.

The Arrival of Europeans

The first European to gaze upon San Francisco Bay was Don Gaspar de Portola, who, in 1769, was stunned at the sight when he crossed over Sweeney Ridge near Pacifica. Imagine what he saw—a sparkling bay surrounded by green hills, flowing streams, vast wetlands, and countless birds; there were no bridges, airplanes, or freeways. Soon after Portola's visit the Spaniards built a mission and fort in San Francisco. By the 1790s

most of the Ohlone people had been taken by the Spanish to Mission Dolores in San Francisco. In the missions many Ohlone died from European diseases, to which they had no resistance and in a very short period of time the Ohlone way of life had been almost completely destroyed.

Very few Europeans settled in the Bay Area prior to the gold rush of 1849. In 1848 the population of the Bay Area consisted of only 400 Europeans. Yet, only two years later, more than 25,000 people lived here. This increase in population resulted in enormous changes to the ecology of the area. Some animals, like the grizzly bear, were hunted to extinction, and the land was changed so much that the habitats of many animals and plants were destroyed or altered beyond recognition.

How Has the Estuary Changed?
The gold miners, merchants, farmers, and their families who came to the Bay Area changed the land and the Bay itself drastically to suit their purposes. Since 1850, farmers have diked and filled many of the freshwater marshes to create farms. The saltwater marshes were filled in to build homes and factories, or diked for salt production. The destruction of marshes eliminated an extraordinary amount of fish and bird habitat. Nearly 90 percent of the Bay's original marshes have been destroyed.

As development increased, streams that once overflowed during the rainy season were forced to flow through concrete channels in order to prevent flooding. More and more water was taken from the Sacramento and San Joaquin Rivers to supply water to farmers and to provide water for the growing population in cities. As the Sacramento and San Joaquin Rivers provide most of the water that flows into the Bay, this was a huge change. The amount of freshwater flowing into the Bay today is now half of what it used to be.

Other impacts to the Bay include pollution from sewage and industry, which has contaminated its animals and sediments, and the introduction of alien species of plants and animals. (*Alien* means that these creatures are not native to this area, but were brought here from other places.) These alien species have transformed food webs, and, by aggressively taking their habitat or food, threatened the existence of native species.

Population and Pollution
In 2003 the population of the Bay Area was 6.6 million people; by the year 2020, it is estimated there will be an additional 1.4 million people living here. The ever-growing population in the Bay Area causes pollution problems. Sewage from homes was a major source of pollution up until the 1950s, when sewage was first sent to treatment plants before being discharged into the Bay. Industrialization and the creation of factories provided jobs but also resulted in different kinds of pollutants entering the Bay.

Today, a large amount of pollution enters the Bay from a source called *urban runoff*. Urban runoff is all the water that flows off city streets and other paved surfaces. It includes the water we use to care for our lawns and gardens, and the water we use to clean our cars and driveways. Urban runoff was once thought to consist of rainwater and to be relatively clean. Today, it is considered to be a serious threat to water quality.

Natural History of the San Francisco Bay Area

Where Does the Water in the Bay Come From?
The Bay has its beginnings in the thousands of freshwater creeks, streams, and rivers that flow from the peaks and western slopes of the Sierra Nevada mountains. These tributaries flow into the Sacramento River and San Joaquin Rivers, converging at the San Francisco Delta and flowing into the Bay. This means that water from streams in Red Bluff or even creeks in Fresno eventually reaches San Francisco Bay. It means that water pollution that has its origin in a large number of distant farms, towns, and cities will also reach the Bay.

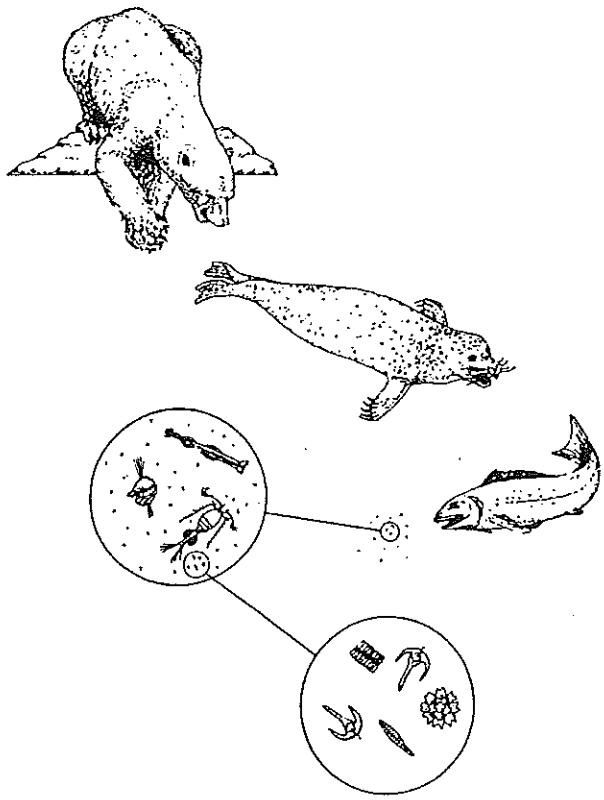
Water in the Bay moves in, out, and around in several ways. The water moves around mainly because the Bay is really a wide river valley that is flooded by a mixture of salty ocean water and freshwater. Salty ocean water rushes into the Bay through the Golden Gate and mixes with the incoming freshwater of the Sacramento and San Joaquin Rivers. Two high and two low tides also mix up water in the Bay each day. Each day the tides carry 407 billion gallons of water in and out of the Bay through the Golden Gate.

How Was the Bay Formed?
If you were alive 15,000 years ago, during the last ice age, and looked from the East Bay toward what is now San Francisco, you would have seen a dry, shallow valley surrounded by hills. At that time the Bay did not exist. During the ice age much of the Earth's water was frozen, and sea level was more than 200 feet lower than it is now. During the last ice age you would have had to walk on dry land all the way to what are now the Farallon Islands (they were mountains then) in order to see the ocean!

When the glaciers melted, about 10,000 years ago, a number of things happened. Melting ice flowed across the land in great sheets of water, and eventually formed the Sacramento and San Joaquin Rivers. These rivers flowed into the valley we now know as San Francisco Bay and out of the Bay through the Golden Gate. The enormous amount of water released from the glaciers also caused sea level to rise, and when that happened, salty ocean water began to force its way through the Golden Gate, where it mixed with the freshwater. The long ago drowning of the shallow valley and mixing of the saltwater and freshwater created what we now call the San Francisco Estuary.

What Is an Estuary? What Kinds of Animals Live There?
A place where freshwater mixes with saltwater is called an estuary, and together the San Francisco Bay and Delta form our estuary. The mixing of fresh and saltwater that takes place in estuaries provides a large number of environments or habitats in which plants and animals can live, which in turn results in a large number of different types of plants and animals living in them. The San Francisco Estuary is home to more than 230 different types of birds, 150 different types of fish, and 43 different types of mammals.

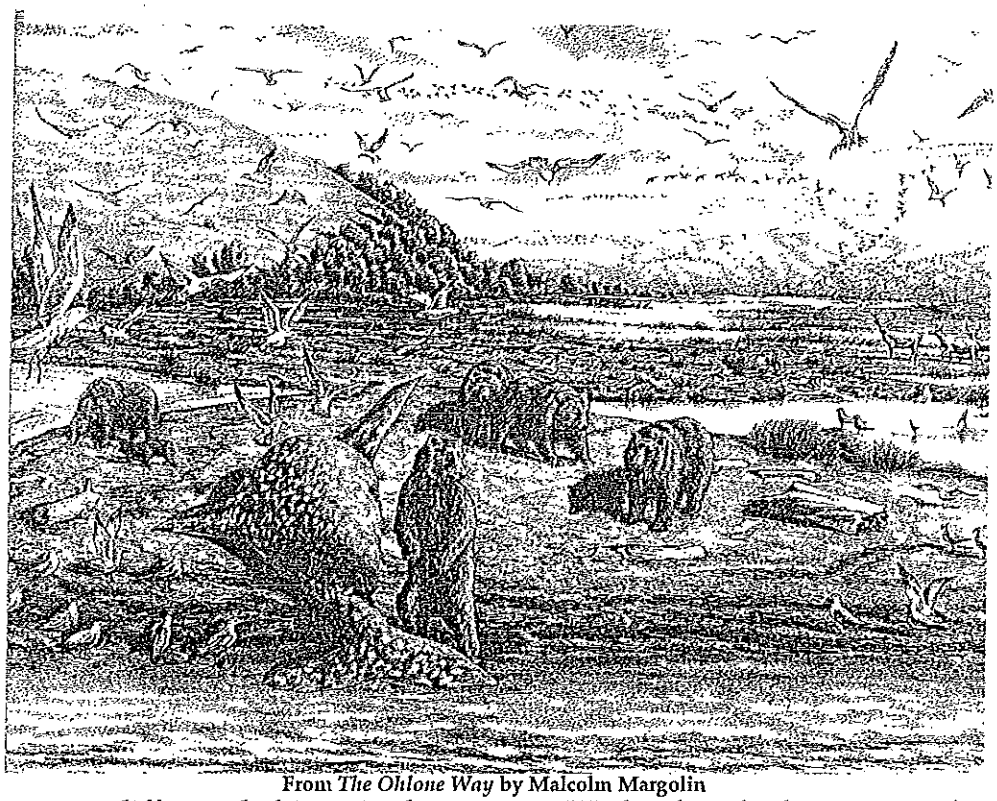
What Do These Animals Eat?
Is there enough food for all of these creatures? Yes, there is, because these animals live on different types of food. The smallest creatures, and the ones that form the food base that supports all other life in the Estuary, are small, floating plants called *phytoplankton*. These small plants are fed upon by small, floating animals called *zooplankton*. These small floating animals are fed upon, in turn, by larger animals such as jellyfish and clams and other shelled animals that don't have spines (invertebrates), and fish, birds, and seals, sea lions, and other mammals that do have spines (vertebrates). These creatures also feed upon each other in intricate ways. This description of who eats whom is called a *food chain*.



This description of who eats whom is called a *food chain*. Graphic courtesy of Roger Myers.

In addition to providing homes to creatures that live here year-round, the estuary is a necessary stop for a number of migrating birds and fish. Millions of birds fleeing the cold of Canada and Alaska spend the winter in the estuary before flying north again to breed and raise their young. Ducks and geese for example, depend on finding food in the shallow mudflats of the shoreline.

Many species of fish depend upon the estuary as they travel between the ocean and freshwaters of the delta, foothills, and mountains. For certain fish, such as salmon, the estuary functions as a nursery, providing food and shelter for their young.



From *The Ohlone Way* by Malcolm Margolin

There are many different habitats in the estuary. Wetlands, which are areas that are sometimes covered with water, and mudflats, which are revealed at the Bay's edge when the tide goes out, are important habitats to many plants and animals.

Wetlands are breeding and nursery grounds for most of the fish and shellfish we harvest, and provide homes to many animals and plants that are unable to survive anywhere else in the world. Wetlands are also important because they serve as natural water filters and can actually clean the water of sediment and certain pollutants. Wetlands protect the land from the full fury of storms, and they also help prevent floods by slowing water flow and holding water in place when water levels rise higher than usual.

Mudflats provide homes to many kinds of shrimp, clams, crab, worms, and snails. These small creatures are important because they provide food for the birds that peck and scoop in the mud for their dinners when the tide is out. When the tide comes back in, fish—such as perch, bass, and topsmelt—feed in the shallow water.

Napa River Watershed History

I. The Napa River Watershed

1. Describe the Napa River Watershed-48 streams. It's more than just water. Vegetation (plants hold the soil in place), water, fish, animals. Currently, home to about 110,000 people, but what did the watershed used to look like? **(For each time period below, go through the following questions: 1. What did they put into the river? 2. What did they take out of the river? 3. What did they use the river for?)**

II. The Napa River Watershed: 10,000 years of human settlement

1. The Wappo Indians (they called themselves the Onastis, which means Outspoken People, Spainards gave them the name "guapo", and whites changed it to "Wappo." Their word for Napa was "Talahalusi", meaning beautiful land.
2. At the peak of their existence, up to 40,000 Indians were living along the Napa River. They had semi permanent settlements, and moved along the river to a network of camps and settlements.
3. The Indians did modify the landscape. They regularly burned the grasses along the valley floor to make it easier to hunt. They also harvested large quantities of grasses, willows, and thules for baskets and rafts. Many people today think that the Valley was pristine, but in fact it was modified by the Indians.
4. They used the river for transportation, drinking water, fishing and bathing. Up to 8,000 steelhead and Chinook spawned in the watershed each year
5. Indians revered the river, and never dumped anything in it. They would put their garbage in piles called "mittins"
6. The Indians were decimated by European diseases (smallpox), massacres, and forced marches to lands further north. They were viewed by the first Europeans as savages, and less than human, so it was OK to treat them this way.

III. Early European Settlement (1820-1850)

1. The valley floor was transformed by early Europeans. Large scale cattle grazing began-no fences, but open range. Farms and homes began to appear along the river. They had to grow all their own food.
2. The river was used for irrigating their crops, drinking water for cattle, fishing and transportation
3. What did they put back into the river? The slaughtered remains of thousands of cattle and their garbage. This was the first time the Napa River became polluted by people (mostly in Carneros b/c the tides would wash much of it out into the bay and the ocean).
4. In Napa, a City had begun. The location of Napa was chosen b/c it was the furthest location up the Napa River that large boats could come (3rd St. Bridge). River and steamboats were common along the Napa River
5. The people in Napa dumped their garbage and leftover food into the River, along with toilet waste and raw sewage. Water quality begins to decline drastically in a very short period of time.

IV. Growth and Industry in the Napa River Watershed (1850-1940)

1. Napa was growing quickly. It was a stopover for lots of miners heading up to the Sierras during the Gold Rush. Provided raw materials for the growth of San Francisco and Oakland.
2. Tanneries and slaughterhouses developed along the River, in Napa and South to Carneros. Why there? More industry needed more people, so the towns expanded. St. Helena and Calistoga began to expand as well.
3. People used the river for transportation, washing, water for industry

4. People dumped their sewage directly into the river. Wastes from the slaughterhouses were dumped directly in the river too, along with the chemicals from the tanneries, which settled onto the bottom of the river. They are still there today, and get resuspended during high flows. The toxic legacy lives on from thoughtlessness and lack of knowledge about water pollution and human health.
5. Beginning in Calistoga, each town would dump their untreated raw sewage directly into the River (St. Helena, Oakville, Yountville, and Napa). The tanneries and slaughterhouses dumped their wastes directly in to the river too (blood, guts, chemicals, etc).
6. By 1940, the pollution had become so bad, that the paint would peel off the houses along the River from the fumes. Yuck! People began to demand that something be done about it. All this happened within only 100 years!

V. 1940 to 1970…The tides begin to turn

1. The **people** demanded that something be done about the terrible state of the Napa River. Fishermen were strong advocates of restoring the polluted river.
2. In 1940, the first primary treatment of sewage waste was built along the Napa River.
3. During WWII, however, the country was focusing on the war. A major shipbuilding/maintenance facility began at Mare Island. Here, they used lots of paints/chemicals to get the ships ready. The country was focused on winning the war, not so much on water quality.
4. This process introduced things like battery acid, lead paint, sulfuric acid and other chemicals on a large scale directly into the river. These things are still there, at the bottom of the river. (Toxic legacy).

VI. Wineries and Agriculture Makes its mark: (1970-present)

1. As more wineries and vineyards were developed, more and more oak woodlands were removed. The bare ground was much more vulnerable to erosion. Riparian areas along creeks were cleared, right to the top of the streambank.
2. As vineyards expanded, they moved into the hillsides, clearing more trees and creating even more erosion.
3. More and more vineyards meant more and more pumping of water from the river and creeks to irrigate the vines.
4. Dams were built on many of the tributaries (48) to make it easier to collect the water for irrigation. This meant that there was less water flowing into the River.
5. Lots of sediment was making its way into the river. (Explain why sediment is bad)
6. By the mid 1970's, there were no more fresh water fish in the Napa River. People had had enough
7. In 1997, the Steelhead Trout was listed on the Endangered Species list. This brought lots of attention to the Napa River watershed. It forced people to change to improve water quality and habitat for the fish.

VII. Clean Water Act and the road to recovery:

1. In 1969, the Cuyahoga River caught on fire and burned b/c it was so polluted. This helped galvanize nationwide attention to water pollution in America. 1970 was the first Earth Day celebration which also helped.
2. In 1971, the CWA was signed. It funded the construction of sanitation districts nationwide, and also came down on "point source polluters", large manufacturing/chemical/refinery plants that discharged their waste directly into rivers and streams.
3. The CWA had a very positive effect on water quality by targeting the large scale polluters. This was the easy and logical place to begin when trying to improve water quality. No skin off the backs of ordinary people.

VIII. The current state of affairs and what you can do. (Pollution Soup Activity from the Aquatic Outreach Institute curriculum)

1. What are the pollutants of concern in the Napa River watershed today? Explain sediment, nutrients, and pathogens.
2. How do they get there? How do they impact the "beneficial uses"? Explain beneficial uses
3. Who is responsible for this form of non point source pollution?
4. What can be done to prevent it? (Make list of things that students can do)

Items and Pictures Used

Map of Napa County
Map of the Napa River Watershed
Picture of Wappo Indians
Display board of Indian artifacts
Indian fishing trap
Pictures of steelhead and Chinook salmon
Pictures of early European settlement
Pictures of old fishermen and their catch
Pictures of good and poor spawning gravel

	SP	S	F	W
WARBLERS				
Orange-crowned Warbler*	a	a	u	r
Nashville Warbler		o	o	
Yellow Warbler*	c	c	a	
Yellow-rumped Warbler:				
"Myrtle"	u		o	c
"Audubon's"	c		a	a
Black-throated Gray Warbler	r	o	c	
Townsend's Warbler	r		r	
Hermit Warbler		r		
MacGillivray's Warbler	r	o	u	
Common Yellowthroat	o	o	c	
Wilson's Warbler*	c	u	c	
Yellow-breasted Chat*	u	u	o	
TANAGERS				
Western Tanager*	u	c	c	r
GROSBEAKS AND BUNTINGS				
Black-headed Grosbeak*	c	c	o	
Lazuli Bunting	r	r	r	
TOWHEES AND SPARROWS				
Rufous-sided Towhee*	a	a	a	a
California Towhee*	a	a	a	a
Chipping Sparrow*	u	o	u	
Lark Sparrow	r	o	o	
Savannah Sparrow	o	r	u	o
Fox Sparrow	u		c	c
Song Sparrow*	a	a	a	a
Lincoln's Sparrow	c		c	c
White-throated Sparrow	r		r	o
Golden-crowned Sparrow	a		a	a
White-crowned Sparrow	a		a	a
Dark-eyed Junco*	o	u	c	c
BLACKBIRDS, MEADOWLARKS, AND ORIOLES				
Red-winged Blackbird*	c	c	u	u
Tricolored Blackbird	r			
Western Meadowlark	r	r	r	r
Brewer's Blackbird*	u	u	r	r
Brown-headed Cowbird*	c	c	u	
Bullock's Oriole*	c	c	u	
FINCHES				
Purple Finch*	u	u	u	u
House Finch*	a	a	a	a
Pine Siskin	u		u	u
Lesser Goldfinch*	c	c	a	a
American Goldfinch	o	r	c	u
WEAVERS				
House Sparrow*	u	u	r	r

The following species have been observed two or fewer times at the Napa River Ecological Reserve:

Western Grebe
American White Pelican
Lesser Scaup
Common Goldeneye
Barrow's Goldeneye
Bufflehead
Hooded Merganser
Peregrine Falcon #
Common Snipe
Short-eared Owl
Calliope Hummingbird
Yellow-bellied Sapsucker
Pileated Woodpecker
California Thrasher
Chestnut-sided Warbler
Swamp Sparrow
Harris' Sparrow
Lawrence's Goldfinch

Please report any unusual sightings or corrections to:

Napa-Solano Audubon Society
c/o Ann or Duane Smith
1162 Green Valley Rd.
Napa, CA 94558
Telephone (707) 253-1007

May 1995

Published by the
Napa-Solano Audubon Society
with a grant from
Napa's Gasser Foundation.

BUTTERFLIES OF THE NAPA RIVER ECOLOGICAL RESERVE

SWALLOWTAILS

Pipevine Swallowtail
Anise Swallowtail
Western Tiger Swallowtail
Pale Swallowtail
Two-tailed Swallowtail

WHITES AND SULPHURS

Checkered White
Cabbage Butterfly
Dappled (or Creamy) Marble
Sara Orangetip
Alfalfa Butterfly

COPPERS, HAIRSTREAKS, BLUES

Purplish Copper
Sylvan (or Dryope or Western Willow) Hairstreak
Gray Hairstreak
Pygmy Blue
Eastern Tailed Blue
Western Tailed Blue
Acmon Blue

BRUSHFOOT BUTTERFIES

Western Meadow Fritillary
Mylitta Crescent
Field Crescent
Chalcedon Checkerspot
Satyr Anglewing
Mourning Cloak
Red Admiral
Painted Lady
West Coast Lady
Buckeye
Lorquin's Admiral
California Sister
Ringlet
Monarch

SKIPPERS

Sleepy Duskywing
Funereal Duskywing
Propertius Duskywing
Checkered Skipper
Common Sootywing
Fiery Skipper
Sandhill Skipper
Woodland Skipper
Rural Skipper
Umber Skipper

Compiled by Murray Berner for the Napa-Solano Audubon Society

BIRDS
(and butterflies)
OF THE
NAPA RIVER ECOLOGICAL RESERVE
Napa, California

Yellow-breasted Chat
—by Linda Adams

NAPA-SOLANO AUDUBON SOCIETY

Welcome to the Napa River Ecological Reserve

The Napa River Ecological Reserve is 73.11 acres of riparian forest and meadows located east of Yountville on the north side of Yountville Cross Road between Highway 29 and the Silverado Trail. This habitat is a remnant of the riparian community that once existed along the Napa River, and the reserve presents an opportunity to view the flora and fauna of relatively undisturbed bottomland beside both the Napa River and Conn Creek. The land was purchased by the Wildlife Conservation Board in 1974 and is managed by the California Department of Fish and Game, which has a cooperative maintenance agreement with the Napa County Department of Public Works.

The Napa River Ecological Reserve has become an important habitat for many species of birds and other wildlife. Large meadows, which are sometimes flooded in winter, occupy both the eastern and western sides of the reserve, with access to the forested interior over a seasonal footbridge across the Napa River. (The footbridge was constructed by Jared Young Boy Scout Troop #58 in 1989.) The Napa River and Conn Creek, which meet here, rise substantially in response to winter rains, restricting access to the interior of the reserve in winter months. The meadows are important to wildlife such as browsing deer and provide habitat for California quail and many species of finches and sparrows, including Lincoln's sparrow. The interior is a haven for birds, including breeding, wintering, and migrating species. It is the most southerly point in Napa County where it is confirmed that yellow-breasted chats breed. Wood ducks nest near the river. Varied thrushes and red-breasted sapsuckers winter here. Willow flycatchers and several western warbler species settle in for temporary feeding on their migration routes. Acorn woodpeckers, scrub jays, white-breasted nuthatches, Anna's hummingbirds, and dozens of other species live here year-round.

A total of 146 bird species has been sighted in the reserve, with 67 species known to nest here. The following checklist of bird was compiled by Ann and Duane Smith of the Napa-Solano Audubon Society, primarily from major field research by Murray Berner. The list is in accordance with the 6th ed. (1983) of the American Ornithologists' Union Check-list of North American Birds.

Seasons

SP - Spring – March through May
S - Summer – June through August
F - Fall – September through November
W - Winter – December through February

Abundance Codes

a - abundant; a common species which is very numerous
c - common; frequently seen in small numbers in proper habitat
o - occasional; seen only a few times during a season
u - uncommon; present but not certain to be seen
r - rare; known to be or have been present, but not every year

Other Codes

* - Nests or has nested in the reserve
\# - Threatened or endangered

	SP	S	F	W
CORMORANTS				
Double-crested Cormorant	o	r	o	u
HERONS AND EGRETS				
Great Blue Heron	u	u	u	u
Great Egret	r	r	o	o
Snowy Egret	r	r	o	o
Green Heron*	u	u	o	
WATERFOWL				
Canada Goose	o	o	o	u
Wood Duck*	u	u	c	o
Mallard*	c	c	c	u
Common Merganser	o			o
VULTURES				
Turkey Vulture	c	c	c	c
OSPREY, KITES, EAGLES AND HAWKS				
Osprey	r	r	r	
White-tailed Kite*	u	u	u	o
Northern Harrier	r	r	r	r
Sharp-shinned Hawk	u	r	u	u
Cooper's Hawk	u	o	u	u
Red-shouldered Hawk*	u	u	u	u
Red-tailed Hawk*	u	u	u	u
Golden Eagle	r	r	r	r
FALCONS				
American Kestrel*	u	u	u	u
Merlin	r		o	o
GALLINACEOUS BIRDS				
Ring-necked Pheasant*	u	o	o	o
California Quail*	a	a	a	a
RAILS				
Virginia Rail*	r	r	r	o
PLOVERS				
Killdeer	o	o	o	o
SHOREBIRDS				
Greater Yellowlegs	o			r
Spotted Sandpiper	r		r	r
GULLS AND TERNS				
Mew Gull	o			o
Ring-billed Gull	o			u
California Gull	r			r
Caspian Tern	r	o	r	

	SP	S	F	W
DOVES				
Rock Dove	r	r	r	r
Mourning Dove*	c	c	c	u
OWLS				
Common Barn Owl*	r	r	r	r
Western Screech Owl*	u	u	u	u
Great Horned Owl*	u	u	u	u
SWIFTS AND HUMMINGBIRDS				
Vaux's Swift	o	r	r	
White-throated Swift	r	r	r	r
Anna's Hummingbird*	c	c	u	u
Rufous Hummingbird	r			
Allen's Hummingbird*	u	u	r	
KINGFISHERS				
Belted Kingfisher*	u	u	u	u
WOODPECKERS				
Acorn Woodpecker*	a	a	a	a
Red-breasted Sapsucker	o	r	u	u
Nuttall's Woodpecker*	c	c	c	c
Downy Woodpecker*	u	u	u	u
Hairy Woodpecker	r	r	r	
Northern Flicker*:				
"Yellow-shafted"	r			r
"Red-shafted"	c	o	a	a
FLYCATCHERS				
Olive-sided Flycatcher	r		r	
Western Wood-Pewee*	c	c	u	
Willow Flycatcher#		o	c	
Pacific-slope Flycatcher*	c	c	u	
Black Phoebe*	u	c	c	o
Say's Phoebe			r	r
Ash-throated Flycatcher*	c	c	r	
Western Kingbird*	r	o	r	
SWALLOWS				
Tree Swallow*	u	u	u	r
Violet-green Swallow*	a	a	a	r
Northern Rough-winged Swallow*	u	u	u	
Cliff Swallow*	a	a	o	
Barn Swallow	u	u	o	
JAYS AND CROWS				
Steller's Jay	u			r
Scrub Jay*	a	a	a	a
American Crow*	c	c	c	c
Common Raven	u	o	c	c

	SP	S	F	W
CHICKADEES AND TITMICE				
Chestnut-backed Chickadee*	u	u	c	c
Plain Titmouse*	a	a	a	a
BUSHTITS				
Bushtit*	c	c	c	c
NUTHATCHES AND CREEPERS				
Red-breasted Nuthatch		r	r	r
White-breasted Nuthatch*	c	c	c	c
Brown Creeper*	u	u	u	u
WRENS				
Bewick's Wren*	c	c	c	c
House Wren*	c	c	c	r
Winter Wren	r		u	u
Marsh Wren	r	r	r	r
KINGLETS				
Golden-crowned Kinglet			r	r
Ruby-crowned Kinglet	u		c	c
BLUEBIRDS AND THRUSHES				
Western Bluebird*	c	c	u	u
Swainson's Thrush*	u	u	r	
Hermit Thrush	u		c	c
American Robin*	c	c	a	a
Varied Thrush	u		u	c
WRENTITS				
Wrentit*	c	c	c	c
MOCKINGBIRDS				
Northern Mockingbird*	u	c	u	u
PIPITS				
American Pipit			r	o
WAXWINGS				
Cedar Waxwing	u	o	a	c
SHRIKES				
Loggerhead Shrike		r	r	r
STARLINGS				
European Starling*	c	c	a	a
VIREOS				
Solitary Vireo*	c	u	u	
Hutton's Vireo*	u	u	u	u
Warbling Vireo*	c	c	c	

The Napa River Ecological Reserve Plant List was compiled by Jake Ruygt of the California Native Plant Society from extensive field research and from a prior list of Craig Thomson (a former employee of the California Department of Fish and Game.)

If any unlisted plant species or any species shown on the ending addendum are located while you journey through the reserve, please contact Jake Ruygt, 253-1839.

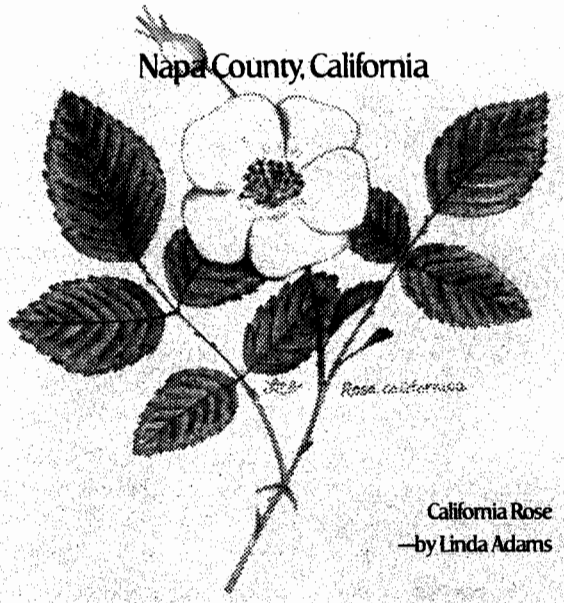
January 1996
Published by the
Napa -Solano Audubon Society
with a grant from
Napa's Gasser Foundation

PLANTS

OF THE

NAPA RIVER ECOLOGICAL RESERVE

Napa County, California



California Rose
—by Linda Adams

NAPA-SOLANO AUDUBON SOCIETY

Welcome to the Napa River Ecological Reserve

On entering the reserve, the visitor is offered the opportunity to feel a little like a time traveler. As you cross the river, the activities of modern-day Napa Valley disappear, although they are never more than a few hundred feet away. This riparian (river) plant community is a relict of that which once occupied a larger part of the valley, following the river and its many tributaries. The extent of this community was once governed by the reach of natural flooding and may have been as wide as a half mile in parts of the valley. The 73.1 acre reserve is the best remaining example of this life-sustaining ecosystem. Conn Creek joins the Napa River inside the reserve and together they form an interesting mosaic of channels, potholes, and marshy swales. The interior is sometimes isolated by winter storms which make the bridge impassable. If so, please return another day.

Several kinds of trees dominate this plant community and grow to admirable dimensions:

—Valley oak, recognized by its round-lobed leaves, is considered one of the largest of all oaks. Here, the largest of these trees are 4′ to 5′ in diameter, about 80′ tall, and 225-300 years old. They are deciduous, dropping all their leaves in winter. The acorns they produce (called "mast") were a vital food source for Native Americans.

—Coast live oak is an evergreen oak identified by a round-headed canopy of oval-shaped leaves toothed around the edge. It reaches as much as 60′ in height and 150-200 years in age in the reserve.

—California bay, with its lance-shaped, aromatic leaves, is also common in the reserve, particularly along the banks of the river. It can reach over 90′ in height in the reserve.

Other trees found along the banks include big-leaf maple, Oregon ash, white alder, and Fremont's cottonwood. Two kinds of willows, polished and arroyo, are common on the streambed, where they often stand in water after winter rains.

The meadows in the reserve are dotted by the flowers of shrubs and perennials in spring. California rose and common snowberry form thickets around some of the openings, and California buttercup, milkmaids, and goldenrod can be showy in some areas. The most common grasslike plant seen is actually not a grass. It is Santa Barbara sedge, which spreads by underground rhizomes and forms an evergreen turf two feet tall.

Enjoy your visit, and please do not collect the plants or animals from the reserve.

FLOWER COLOR

bl - blue	**or - orange**	**rd - red**
gr - green	**pk - pink**	**yl - yellow**
lv - lavender	**pr - purple**	**wh - white**

gr-wh - greenish-white; or yl - orange and/or yellow; etc.

BLOOMING SEASON

Months abbreviated as follows:

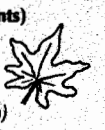
Ja, Fb, Mr, Ap, My, Jn, Jl, Ag, Sp, Oc, Nv, Dc

HABITAT

- **Gr- Grassland (interior meadow and east edge of reserve)**
- **OW- Oak Woodland (interior of reserve)**
- **Rp- Riparian (streambanks to streambeds)**
- **Sw- Swale (seasonally flooded depressions)**

OTHER CODES

- *** - Plants which are not native to California, although they are naturalized**
- **◆ A plant that is illustrated nearby**

	Color	Blooms	Habitat
HORSETAILS *(Equisetaceae)*			
Smooth Scouring Rush ◆ *(Equisetum laevigatum)* 			OW
FERNS			
Fragile Fern *(Cystopteris fragilis)*			Rp
Goldback Fern *(Pentagramma triangularis)*			Rp
DICOTS (Broad-Leaved Plants)			
MAPLE *(Aceraceae)*			
Big-Leaf Maple ◆ *(Acer macrophyllum)* 	wh	Mr-My	Rp,OW
SUMAC *(Anacardiaceae)*			
Poison Oak ◆ *(Toxicodendron diversilobum)* 	wh	Ap-My	Rp, OW
CARROT *(Apiaceae)*			
Bur-Chervil * *(Anthriscus caucalis)*	wh	Ap-Jn	Ow
Poison Hemlock * *(Conium maculatum)*	wh	Ap-Jl	Rp,Ow
Queen Anne's Lace * *(Daucus carota)*	wh	My-Sp	Sw,Gr
Jepson's Coyote Thistle *(Eryngium aristulatum v. arist.)*	gr	My-Sp	Sw
Sweet Fennel * ◆ *(Foeniculum vulgare)* 	yl	My-Sp	Rp
Cow Parsnip *(Heracleum lanatum)*	wh	Ap-Jl	OW
Oenanthe *(Oenanthe sarmentosa)*	wh	My-Oc	Rp, Sw
Gairdner's Yampah *(Perideridia gairdneri s. gairdneri)*	wh	Jn-Ag	Sw
Purple Sanicle *(Sanicula bipinnatifida)*	pr	Mr-My	OW
Pacific Snakeroot *(Sanicula crassicaulis)*	yl	Mr-My	OW
Hedge Parsley * *(Torilis arvensis)*	gr-wh	My-Jl	Rp

DOGBANE *(Apocynaceae)*			
Periwinkle * ◆ *(Vinca major)*	bl	Mr-Jl	Rp,OW
GINGER *(Aristolochiaceae)*			
Dutchman's Pipe ◆ *(Aristolochia californica)*	gr-pr	Ja-Ap	OW
MILKWEED *(Asclepiadaceae)*			
Narrow-Leaved Milkweed ◆ *(Asclepias fascicularis)*	pn-gr	Jn-Sp	Gr
SUNFLOWER *(Asteraceae)*			
Douglas' Mugwort *(Artemesia douglasiana)*	gr	Jn-Sp	Rp
California Aster ◆ *(Aster chilensis)*	pu-yl	Jl-Nv	OW
Douglas' Baccharis *(Baccharis douglasii)*	wh	Jl-Ag	Gr,Sw
Coyote Brush *(Baccharis pilularis)*	gr-wh	Dc-Ja	Rp,Gr
Italian Thistle * ◆ *(Carduus pycnocephalus)*	pk	My-Jl	Rp,Gr
Yellow Star Thistle * *(Centaurea solstitialis)*	yl	Jn-Sp	Gr
Chicory * *(Cichorium intybus)*	bl	My-Oc	Gr,Sw
Bull Thistle * *(Cirsium vulgare)*	pk	Jn-Sp	Rp,Gr
Horseweed *(Conyza canadensis)*	gr	Jn-Sp	Rp
Western Goldenrod *(Euthamia occidentalis)*	yl	Ag-Nv	Gr,Sw
Cotton Batting Plant *(Gnaphalium stramineum)*	yl-gr	Mr-Oc	Rp,Sw
Hairy Gumplant *(Grindelia hirsutula var. hirsutula)*	yl	Ap-Jl	Gr
Rosilla *(Helenium puberulum)*	yl-gr	Jn-Oc	Rp
Holozonia *(Holozonia filipes)*	wh	Jn-Oc	Gr,Sw
Hairy Cat's Ear * *(Hypochaeris radicata)*	yl	My-Nv	Rp,Gr
Prickley Lettuce * *(Lactuca serriola)*	yl	My-Sp	Rp,Gr
Slender Cottonweed *(Micropus californicus v. calif.)*	gr	Ap-Jn	Gr
Bristley Ox-Tongue * *(Picris echioides)*	yl	Jn-Dc	Rp
Rhagadiolus * *(Rhagadiolus stellulatus)*	yl	Ap-My	OW
Common Grounsel * *(Senecio vulgaris)*	yl	Jn-Nv	OW,Gr
Milk Thistle * *(Silybum marianum)*	pr	My-Jl	Rp,Gr
California Goldenrod *(Solidago californica)*	yl	Jn-Oc	Rp
Soliva *(Soliva sessilis)*	gr	Ap-Jl	Gr
Prickley Sow Thistle * *(Sonchus asper ssp. asper)*	yl	Mr-Nv	Rp
Common Sow Thistle * *(Sonchus oleraceus)*	yl	Jn-Nv	Rp
Feverfew * *(Tenacetum parthenium)*	wh	Jn-Sp	Rp
Salsify * *(Tragopogon porrifolius)*	pr	Ap-Jn	Gr
Narrow-Leaved Mule Ears *(Wyethia angustifolia)*	yl	Ap-Jl	Gr,Sw
Cocklebur *(Xanthium strumarium)*	gr	Jl-Oc	Rp
BIRCH *(Betulaceae)*			
White Alder ◆ *(Alnus rhombifolia)*	gr	Ja-Ap	Rp
BORAGE *(Boraginaceae)*			
Common Fiddleneck ◆ *(Amsinckia menziesii v. intermedia)*	or	Mr-Jn	Gr
MUSTARD *(Brassicaceae)*			
Winter Cress *(Barbarea orthoceras)*	yl	Mr-Jn	Gr
Black Mustard * *(Brassica nigra)*	yl	Ap-Jl	Rp,Gr

3

Field Mustard * ◆ *(Brassica rapa)*	yl	Ja-My	Rp,Gr
Shepherd's Purse * *(Capsella bursa-pastoris)*	gr-wh	Fb-Oc	Rp
Bitter Cress *(Cardamine oligosperma)*	wh	Fb-My	Rp,OW
Milkmaids ◆ *(Cardamine californica v. integr.)*	wh	Ja-Ap	OW,Gr
Mediterranean Mustard * *(Hirshfeldia incana)*	yl	My-Oc	Gr
Wild Radish * *(Raphanus sativus)*	pr,wh	Fb-Jl	Rp,Gr
Western Yellow Cress *(Rorippa curvisiliqua)*	yl	Jl-Sp	Rp,Sw
Water Cress * *(Rorippa nasturtium-aquaticum)*	wh	Mr-Nv	Rp
Hedge Mustard * *(Sisymbrium officianale)*	yl	Ap-Jl	Gr
WATER STARWORT *(Callitrichaceae)*			
Bolander's Water Starwort ◆ *Callitriche heterophylla v. bol.)*	gr	Ap-Ag	Rp
HONEYSUCKLE *(Caprifoliaceae)*			
Blue Elderberry *(Sambucus mexicana)*	wh	My-Sp	Rp,OW
Common Snowberry ◆ *(Symphoricarpus albus v. laev.)*	pk	My-Jl	Rp,OW
PINK *(Caryophyllaceae)*			
Mouse-Eared Chickweed * *(Cerastium glomeratum)*	wh	Fb-My	Rp,Gr
Common Chickweed * ◆ *(Stellaria media)*	wh	Fb-Sp	Rp,OW
HORNWORT *(Ceratophyllaceae)*			
Hornwort *(Ceratophyllum demersum)*	gr	Jn-Ag	Rp
GOOSEFOOT *(Chenopodiaceae)*			
Spearscale ◆ *(Atriplex triangularis)*	gr	Jn-Nv	Rp
Lamb's Quarters * *(Chenopodium album)*	gr	My-Oc	Rp,Gr
Wormseed * *(Chenopodium ambrosoides)*	gr	Jn-Dc	Gr
MORNINGLORY *(Convolvulaceae)*			
Western Morninglory ◆ *(Calystegia occidentalis ssp. occid.)*	wh	Ap-Jl	OW
Field Bindweed * *(Convolvulus arvensis)*	wh	My-Oc	Rp,Gr
DOGWOOD *(Cornaceae)*			
Brown Dogwood *(Cornus glabrata)*	wh	My-Jn	Rp
GOURD *(Cucurbitaceae)*			
California Manroot *(Marah fabaceus)*	wh	Fb-My	Rp,OW
TEASEL *(Dipsacaceae)*			
Fuller's Teasel * *(Dipsacus fullonum)*	wh	My-Jl	Sw
SPURGE *(Euphorbiaceae)*			
Caper Spurge * *(Euphorbia lathyris)*	gr	all	Rp
Oblong-Leafed Spurge * *(Euphorbia oblongata)*	gr	Fb-My	Rp
Petty Spurge * *(Euphorbia peplus)*	gr	Fb-Ag	Rp,OW
PEA *(Fabaceae)* ◆			
Golden Wattle * *(Acacia longifolia)*	yl-gr	Ap-My	Rp

4

French Broom * (*Genista monspessulana*)	yl	Mr-My	OW
Hairy Pea * (*Lathyrus hirsutus*)	rd+lv	My-Jl	OW
Jepson's Pea (*Lathyrus jepsonii v. californica*)	wh+lv	Ap-Jl	Rp
Bird's Foot Trefoil * (*Lotus corniculatus*)	yl	My-Sp	Rp
Spanish Trefoil (*Lotus purshianus*)	pk	My-Oc	Rp,Gr
Summer Lupine (*Lupinus formosus v. formosus*)	pk	Ap-Oc	Rp,Gr
Miniature Lupine (*Lupinus bicolor*)	bl+wh	Mr-My	Gr
Spotted Medic * (*Medicago arabica*)	yl	Ap-Jn	Rp
Black Medic * (*Medicago lupulina*)	yl	Ap-Jl	Rp
Bur Clover * (*Medicago polymorpha*)	yl	Mr-Jn	Rp, OW
White Sweet Clover * (*Melilotus albus*)	wh	My-Sp	Rp
California Tea (*Rupertia physodes*)	wh	Ap-Jn	Rp,OW
Scarlet Wisteria * (*Sesbania tripetii*)	rd		Rp
Shamrock * (*Trifolium dubium*)	yl	Ap-Jl	Rp
Rose Clover * (*Trifolium hirtum*)	pk	Ap-My	Gr
Subterranean Clover * (*Trifolium subterraneum*)	wh+rd	Ap-My	Sw
Common Vetch * (*Vicia sativa v. nigra*)	pk	Ap-Jn	Gr
Purple Vetch * (*Vicia bengalensis*)	pr	My-Jn	Rp
Spring Vetch * (*Vicia sativa ssp. sativa*)	rd	Ap-Jl	Gr
Winter Vetch * (*Vicia villosa ssp. varia*)	pr	Ap-Jn	Rp,Gr
BEECH (*Fagaceae*)			
Coast Live Oak (*Quercus agrifolia v. agrifolia*)	gr	Mr-Ap	Rp,OW
Valley Oak ◆ (*Quercus lobata*)	gr	Mr-Ap	Rp,OW
GENTIAN (*Centianaceae*)			
June Centaury (*Centaurium floribundum*)	pk	My-Ag	Sw
American Cicendia (*Cicendia quadrangularis*)	yl	Mr-My	Gr
GERNANIUM (*Geraniaceae*)			
Long Beaked Filaree * (*Erodium botrys*)	lv	Mr-My	Gr
Red-Stem Filaree * (*Erodium cicutarium*)	pk	Fb-My	Rp,Gr
White-Stem Filaree * ◆ (*Erodium moschatum*)	pk	Fb-My	Rp
Cut-Leaved Geranium * (*Geranium dissectum*)	pk	Mr-Jn	Rp,Gr
Robert's Geranium * (*Geranium robertianum*)	pk	Ap-Jn	Rp
BUCKEYE (*Hippocastanaceae*)			
Buckeye (*Aesculus californica*)	wh pk	My-Jn	OW
MINT (*Lamiaceae*)			
Common Henbit * (*Lamiun amplexicaule*)	pk	Fb-Ag	Gr
Red Henbit * (*Lamium purpureum*)	pk	Fb-Jn	Rp
Horehound * (*Marrubium vulgare*)	wh	My-Jl	Rp
Lemon Balm * (*Melissa officianale*)	wh	Jn-Sp	Rp,OW
Field Mint ◆ (*Mentha arvensis*)	lv	Jn-Oc	Rp
Pennyroyal * (*Mentha pulegium*)	lv	Jn-Sp	Rp,Sw
Peppermint * (*Mentha X piperata*)	lv	Ag-Oc	Rp
Rigid Hedge Nettle (*Stachys ajugoides v. rigida*)	pk	My-Jn	Rp,OW

LAUREL (*Lauraceae*)			
California Bay (*Umbellularia californica*)	yl	Nv-My	Rp,OW
DUCKWEED (*Duckweed*)			
Duckweed (*Lemna minima*)	gr		Rp
Valdivia Duckweed (*Lemna valdiviana*)	gr		Rp
FALSE MERMAID (*Limnanthaceae*)			
Sebasopol Meadowfoam (*Limnanthes vinculans*)	wh	Ap-My	Sw
LOOSETRIFE (*Lythraceae*)			
Hyssop Loosetrife (*Lythrum hysoppifolia*)	lv	Ap-Oc	Gr,Sw
MALLOW (*Malvaceae*)			
Bull Mallow * (*Malva nicaeensis*)	pk	Mr-Sp	Gr
Checker Bloom ◆ (*Sidalcea malvaeflora ssp. lacin.*)	pk	Mr-My	OW,Gr
MYRTLE (*Myrtaceae*)			
Blue Gum * (*Eucalyptus globulus*)	wh		Rp
OLIVE (*Oleaceae*)			
Oregon Ash ◆ (*Fraxinus latifolia*)	gr	Mr-My	Rp
Olive * (*Olea europaea*)	gr		OW
EVENING PRIMROSE (*Onagraceae*)			
Dense Willow Herb (*Epilobium densiflorum*)	pk	My-Ag	Sw
Northern Willow Herb (*Epilobium ciliatum ssp. ciliatum*)	wh,pk	Jn-Sp	Rp,Gr
Panicled Willow Herb (*Epilobium brachycarpum*)	pk	Jn-Sp	Gr
Yellow Water Weed (*Ludwigia peploides ssp peploides*)	yl	My-Oc	Rp
WOOD SORREL (*Oxalidaceae*)			
Wood Sorrel * ◆ (*Oxalis laxa*)	yl	My-	Rp
POPPY (*Papaveraceae*)			
California Poppy (*Escscholtzia californica*)	or,yl	Fb-Sp	Rp
POKEWEED (*Phytolaccaceae*)			
Pokeweed * (*Phytolacca americana*)	wh, pk	Ag-Oc	Rp
PLANTAIN (*Plantaginaceae*)			
English Plantain * (*Plantago lanceolata*)	gr	Ap-Ag	Rp,Gr
BUCKWHEAT (*Polygonaceae*)			
Common Knotweed * (*Polygonum arenastrum*)	wh	Jn-Oc	Rp,Gr
Willow Weed ◆ (*Polygonum lapathifolium*)	wh,pk	Jn-Oc	Rp
Common Smartweed (*Polygonum hydropiperoides*)	wh	Jn-Oc	Rp,Gr
Water Smartweed (*Polygonum punctatum*)	wh	Jn-Sp	Rp
Clustered Dock * (*Rumex conglomeratus*)	gr	Ap-Oc	Rp
Curly Dock * (*Rumex crispus*)	gr	Fb-Nv	Rp,Sw

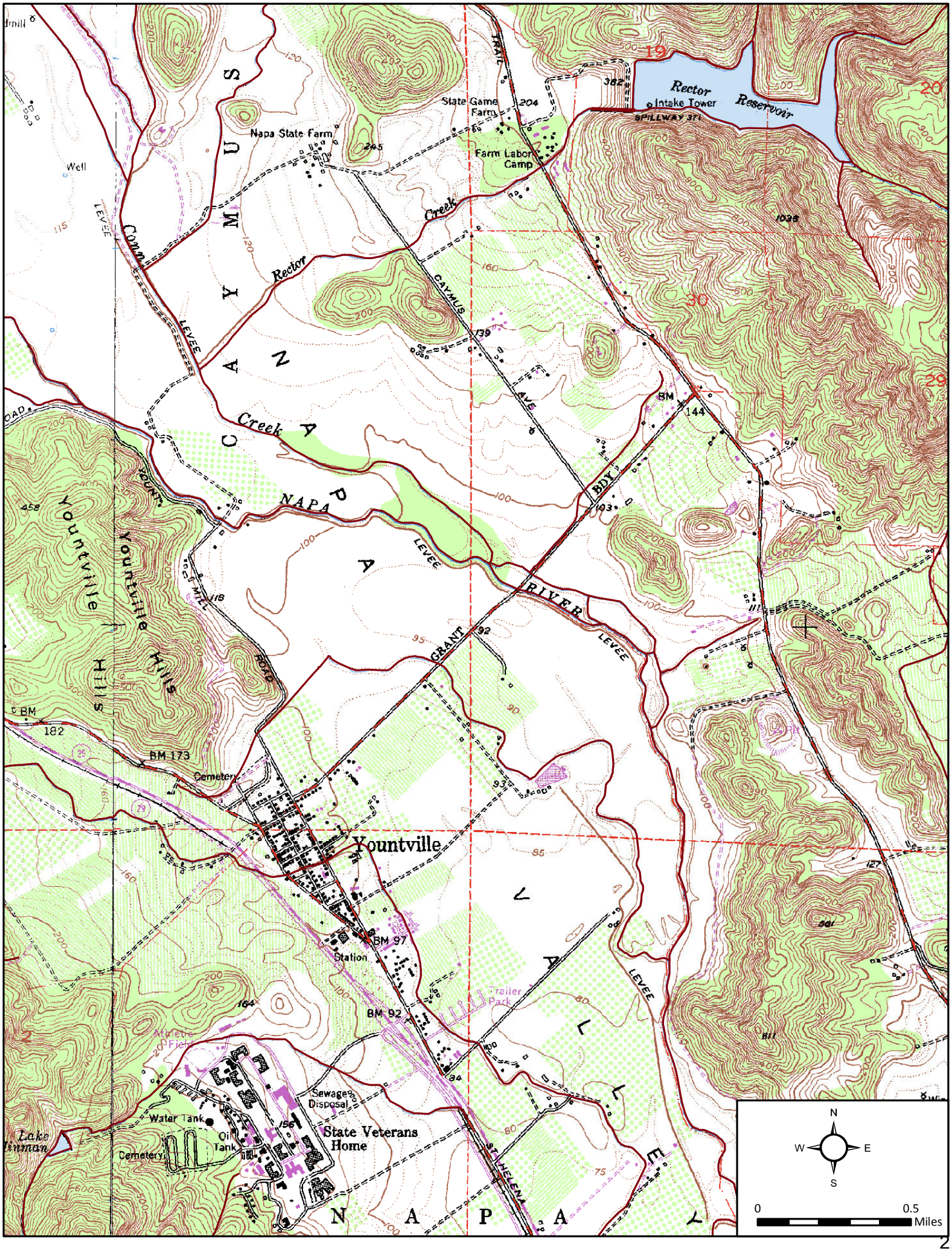
Willow Dock *(Rumex denticulatus v. transitorius)*	gr	My-Sp	Rp
PURSLANE *(Portulacaceae)*			
Miner's Lettuce *(Claytonia perfoliata ssp. perf.)*	wh	Fb-My	OW
PRIMROSE *(Primulaceae)*			
Scarlet Pimpernel * ◆ *(Anagallis arvensis)*	or	Mr-Jl	Rp,Sw
BUTTERCUP *(Ranunculaceae)*			
California Buttercup *(Ranunculus californicus)*	yl	Fb-My	OW,Gr
Bird's Foot Buttercup *(Ranunculus orthorhynchus v. bl.)*	yl	Fb-My	Sw
ROSE *(Rosaceae)*			
Utah Serviceberry ◆ *(Amelanchier pallida)*	wh	Ap-Jn	OW
Hawthorn * *(Crataegus mongyna)*	wh		OW
Apple * *(Malus sylvestris)*	wh	Mr-My	OW
Ninebark *(Physocarpus capitatus)*	wh	My-Jl	Rp
Cherry Plum * *(Prunus cerasifera)*	wh	Mr-Ap	OW
California Rose *(Rosa californica)*	pk	My-Ag	Rp,Gr
Dog Rose * *(Rosa canina)*	pk	My-Jn	OW
Himalaya Berry * *(Rubus discolor)*	pk,wh	My-Ag	Rp,OW
California Blackberry *(Rubus ursinus)*	wh	Mr-Jl	Rp
MADDER *(Rubiaceae)*			
Cleavers * *(Galium aparine)*	wh	Mr-Jn	Rp,OW
Field Madder * *(Sherardia arvensis)*	lv	Ja-Jn	Gr
WILLOW *(Salicaceae)*			
Fremont's Cottonwood *(Populus fremontii)*	gr	Mr-Ap	Rp
Sandbar Willow *(Salix exigua)*	gr	Mr-Ap	Rp
Polished Willow *(Salix laevigata)*	gr	Mr-My	Rp
Arroyo Willow *(Salix lasiolepis)*	gr	Fb-Ap	Rp,Sw
SNAPDRAGON *(Scrophulariaceae)*			
Round-Leaved Fluellin * *(Kickxia spuria)*	yl	Jn-Sp	Rp
California Figwort *(Scrophularia californica)*	rd	Fb-Jl	Rp,OW
Moth Mullein * ◆ *(Verbascum blattaria)*	yl	My-Sp	Rp
Wand Mullein * *(Verbascum virgatum)*	yl	My-Sp	Rp
Greater Water-Speedwell * *(Veronica anagallis aquatica)*	lv	Ap-Sp	Rp
QUASSIA *(Simaroubaceae)*			
Tree of Heaven * *(Ailanthus altissima)*	wh	My-Jn	Rp
NIGHTSHADE *(Solanaceae)*			
Small-Flowered Nightshade ◆ *(Solanum americanum)*	wh	Ap-Nv	Rp
NETTLE *(Urticaceae)*			
Stinging Nettle *(Urtica dioca ssp. holosericea)*	gr	Jn-Ag	Rp

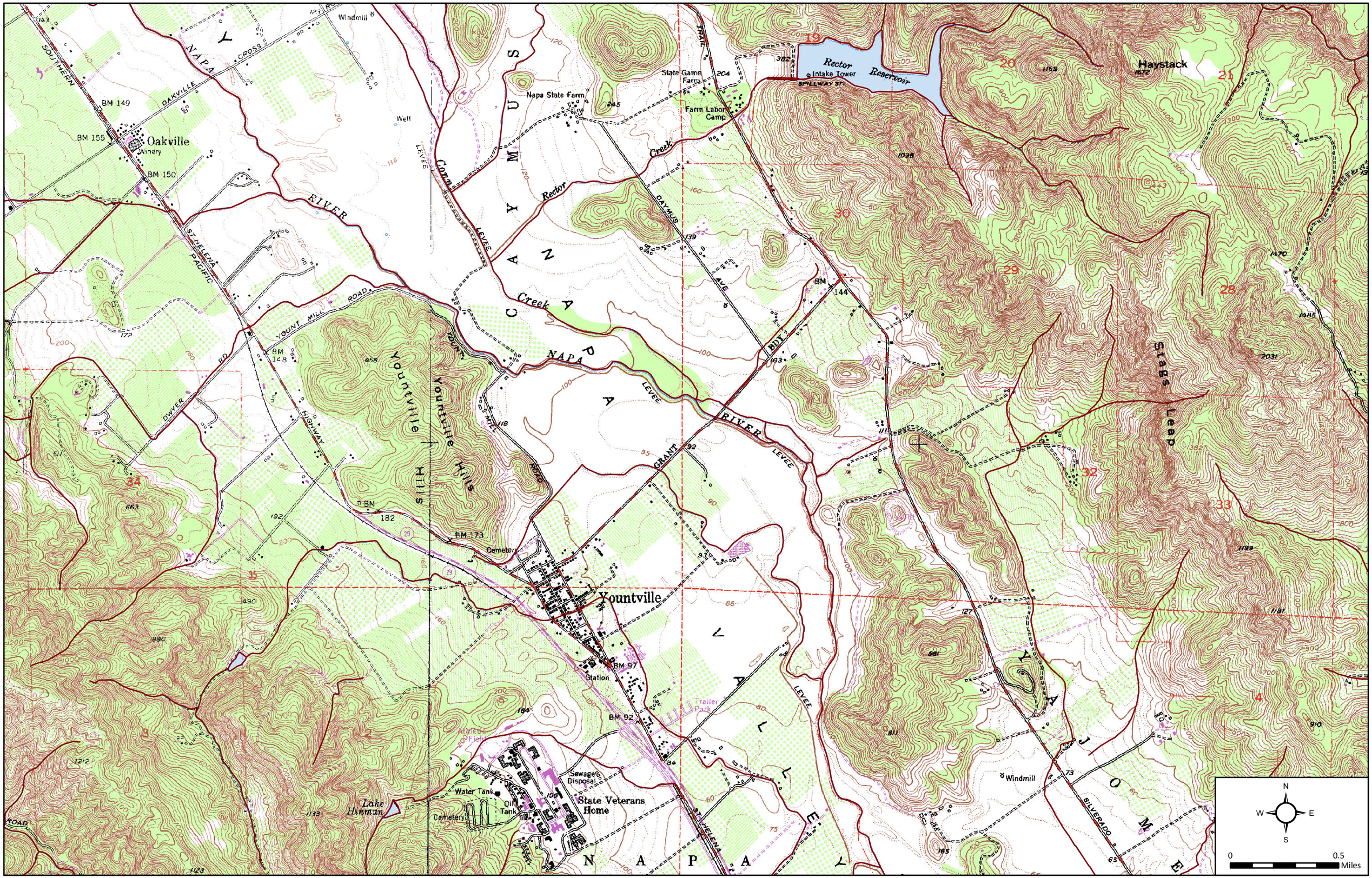
VERVAIN *(Verbenaceae)*			
Garden Lippia * *(Phyla nodiflora v. rosea)*	pk	My-Oc	Sw
GRAPE *(Vitaceae)*			
California Grape *(Vitis californica)*	gr	My-Jn	Rp
Wine Grape *(Vitis vinifera)* *	gr	Ap-My	Rp
MONOCOTS (Grass-like leaves)			
WATER PLANTAIN *(Alismataceae)*			
Water Plantain *(Alisma plantago-aquatica)*	wh	My-Ag	Rp,Sw
AMARYLLIS *(Amaryllidaceae)*			
Harvest Brodiaea *(Brodiaea elegans)*	pr	Ap-Jn	OW,Gr
White Hyacinth *(Triteleia hyacinthina)*	wh	Ap-My	OW
Ithuriel's Spear *(Triteleia laxa)*	bl,pr	Ap-Jn	OW,Gr
SEDGE *(Cyperaceae)*			
Santa Barbara Sedge ◆ *(Carex barbarae)*	gr	My-Jn	Rp,OW
Dense Sedge *(Carex densa)*	gr	Mr-My	Sw
Dudley's Sedge *(Carex dudleyi)*	gr	Ap-My	Sw
Torrent Sedge *(Carex nudata)*	gr	Mr-Ap	Rp
Tracey's Sedge *(Carex ovalis)*	gr	Mr-Ap	Sw
Rough Sedge *(Carex senta)*	gr		Sw
Small-bracted Sedge *(Carex subbracteata)*	gr	Ap-My	Sw
Foothill Sedge *(Carex tumulicola)*	gr	Ap-My	Rp
Tall Nut Grass *(Cyperus eragrostis)*	gr	My-Nv	Rp,Sw
Needle Spikerush *(Eleocharis acicularis v. acic.)*	gr	Ap-Dc	Sw
Creeping Spikerush *(Eleocharis macrostachya)*	gr	My-Sp	Rp,Sw
Common Tule *(Scirpus acutus v. occidentalis)*	gr	My-Ag	Rp,Sw
River Bulrush *(Scirpus fluviatilis)*	gr	My-Ag	Rp
IRIS *(Iridaceae)*			
Blue-Eyed Grass *(Sisyrinchium bellum)*	bl-vl	Mr-My	Gr
RUSH *(Juncaceae)*			
Baltic Rush ◆ *(Juncus balticus)*	gr	Ap-Ag	Rp,Sw
Toad Rush *(Juncus bufonius)*	gr	Ap-Sp	Rp,Sw
Mariposa Rush *(Juncus dubius)*	gr	My-Jl	Sw
Pacific Bog Rush *(Juncus effusus v. pacificus)*	gr	My-Ag	Rp
Slender Rush *(Juncus occidentalis)*	gr	Mr-Jn	Rp
Pointed Rush *(Juncus oxymeris)*	gr	My-Ag	Sw
Mexican Rush *(Juncus mexicanus)*	gr	Ap-Ag	Gr
Spreading Rush *(Juncus patens)*	gr	My-Jl	Rp,Gr
Brown-Headed Rush *(Juncus phaeopcephalus v. panic.)*	br	My-Ag	Sw
ARROW-WEED *(Juncaginaceae)*			
Flowering Quillwort *(Lilaea scilloides)*	gr	Mr-Oc	Sw
LILY *(Liliaceae)*			
Gold Nuggets *(Calochoruts luteus)*	yl	My-Jl	Gr

Pink Star Tulip *(Calochortus uniflorus)*	pk	Ap-Jn	Sw
Camas *(Camassia quamash)*	bl	Ap-My	Sw
Indian Soap ◆ *(Chlorogalum pomeridianum)*	wh	My-Ag	OW,Gr
GRASS *(Poaceae)*			
Colonial Bentgrass * *(Agrostis capillaris)*	gr	Jn-Jl	Rp
Giant Reed * *(Arundo donax)*	gr		Rp
Wild Oats * *(Avena fatua)*	gr	Ap-Jn	OW,Gr
Slough Grass *(Beckmannia syzigachne)*	gr	My-Jl	Sw
Small Quaking Grass * *(Briza minor)*	gr	Ap-Jl	Gr
Hairy Chess *(Bromus commutatus)*	gr	My-	Gr
Ripgut Grass * *(Bromus diandrus)*	gr	Mr-Jn	Gr,OW
Soft Chess * *(Bromus hordeaceus)*	gr	Ap-Jl	Rp,Gr
Bromegrass * *(Bromus stamineus)*	gr	Ap-Jl	OW
Bermuda Grass * *(Cynodon dactylon)*	gr	Jn-Ag	Rp
Dogtail Grass * *(Cynosurus echinatus)*	gr	Ap-Jl	OW
California Oatgrass *(Danthonia californica)*	gr	My-Jl	Gr,Sw
Barnyard Grass * *(Echinochloa crusgalli)*	gr	Jn-Oc	Rp
Blue Wild Rye *(Elymus glaucus ssp. jepsonii)*	gr	My-Ag	Rp,OW
Meadow Fescue * *(Fescue arundinacea)*	gr	My-Jn	Rp,OW
Velvet Grass * *(Holcus lanatus)*	gr	My-Ag	Sw
Meadow Barley *(Hordeum brachyantherum ssp. br.)*	gr	My-Ag	Rp,Gr
Alkali Rye Grass *(Leymus triticoides)*	gr	Jn-Jl	Rp,Gr
Mediterranean Barley * *(Hordeum marinum ssp. gusson.)*	gr	Ap-Jl	Gr
Farmer's Foxtail * *(Hordeum murinum ssp. lepor.)*	gr	Ap-Jn	OW,Gr
Rice Cutgrass *(Leersia oryzoides)*	gr	Jl-Oc	Rp
Italian Ryegrass * *(Lolium multiflorum)*	gr	My-Ag	Gr
Perennial Ryegrass * *(Lolium perenne)*	gr	My-Sp	Rp,Gr
Foothill Needlegrass *(Nassella lepida)*	gr	Mr-My	Gr
Purple Needlegrass ◆ *(Nassella pulchra)*	gr	Mr-My	OW,Gr
Knotgrass * *(Paspalum distichum)*	gr	Jn-Oc	Rp
Harding Grass * *(Phalaris aquatica)*	gr	Jn-Sp	Gr
Smilo Grass * *(Piptatherum miliaceum)*	gr	Ap-Oc	Rp
Semaphore Grass *(Pleuropogon californicus)*	gr	Mr-My	Rp
Annual Bluegrass * *(Poa annua)*	gr	Ja-Jl	Rp,Sw
Kentucky Bluegrass * *(Poa pratensis)*	gr	Ap-Ag	Rp
Rabbit's Foot Grass * *(Polypogon monspeliensis)*	gr	Ap-Ag	Rp,Sw
Six Weeks Fescue * *(Vulpia bromoides)*	gr	Mr-Nv	Rp,Gr
Slender Fescue * *(Vulpia octoflora)*	gr	Ap-Jn	Gr
BUR-REED *(Sparganiaceae)*			
Bur-Reed ◆ *(Sparganium eurycarpum ssp. eur.)*	gr	My-Ag	Sw
CAT-TAIL *(Typhaceae)*			
Broad-Leaved Cat-tail *(Typha latifolia)*	gr	Jn-Jl	Rp

The following plants have also been reported for the reserve, although they have not been seen in recent years.

Achyrachaena mollis	(Blow Wives)	G
Air spp.	(Hairgrass)	R
Agrostis exarata	(Western Bentgrass)	R
Allium unifolium	(One-Leaved Onion)	OW
Bellardia trixago	(Bellardia)	R
Bromus madritensis ssp. rubens	(Foxtail Chess)	R
Chamaescyce serpyllifolia	(Thyme-Leaved Spurge)	Sw
Cuscuta spp.	(Dodder)	
Deschampsia elongata	(Slender Hairgrass)	
Dichelostemma congestum	(Ookow)	OW
Digitaria sanguinalis	(Crabgrass)	R
Elodea canadensis	(Waterweed)	R
Geranium molle	(Dove's Foot Geranium)	G
Hoita macrostachya	(Leather Root)	R
Medicago sativa	(Alfalfa)	R
Melilotus indicus	(Yellow Sweet Clover)	R
Mimulus cardinalis	(Scarlet Monkeyflower)	R
Mimulus guttatus	(Seep-Spring Monkeyflower)	R
Oenothera ovata	(Sun Cup)	G
Paspalum dilitatum	(Knotgrass)	R
Phacelia spp.	(Phacelia)	
Polypogon interruptus	(Beard Grass)	R
Polypodium calirhiza	(Polypody Fern)	R
Potentilla spp.	(Cinquefoil)	
Rumex pulcher	(Fiddle Dock)	G
Silene gallica	(Windmill Pink)	R
Trifolium wildenovii	(Tomcat Clover)	R
Verbascum thapsus	(Common Mullein)	R
Xanthium spinosum	(Cocklebur)	R
Zigadenus fremontii	(Fremont's Star Lily)	OW


Rector Reservoir
Intake Tower
SPILLWAY 371
State Game Farm
Napa State Farm
Farm Labor Camp
Well
Rector Creek
Napa Creek
CAYMUS
Yountville Hills
Yountville
BM 173
Cemetery
BM 97
Station
BM 92
Trailer Park
Athletic Field
Sewage Disposal
Water Tank
Oil Tank
Cemetery
State Veterans Home
Lake Hennan
NAPA VALLEY
NAPA RIVER
GRANT
HELENA
LEVEE
TRAIL
N
W
E
S
0
0.5
Miles


Oakville
Winery
Yountville
State Veterans Home
Rector Reservoir
Intake Tower
Haystack
Stags Leap
Napa State Farm
State Game Farm
Farm Labor Camp
Rector Creek
Napa River
Yountville Hills
Lake Hinman
Cemetery
Water Tank
Oil Tank
Sewage Disposal
Trailer Park
Windmill
Well
Station
Southern Pacific
St. Helena Highway
Yount Mill Road
Dwyer Rd
Silverado Trail
Napa Valley
Napa County
Caymus Levee
Grant Levee
Bdy Levee
Napa Cross
Oakville Grade
BM 149
BM 155
BM 150
BM 148
BM 182
BM 173
BM 97
BM 92
BM 144
N
W
E
S
0
0.5
Miles

Napa River Eco Reserve Connection

What is a Watershed?

To complete this activity, please use one or both of the topographic maps of the Eco Reserve located in the Background section of this guide. Conn Creek and the Napa River both flow through the Reserve and can be seen on these maps, though their entire watersheds are not visible on the maps. Rector Creek, which is relatively close to the Reserve, is a creek for which students can draw the entire watershed boundary by looking at the topographic lines on the map (as described in the activity instructions). This creek's watershed includes Rector Reservoir, which is used by the Town of Yountville for a portion of its water supply.

Noteworthy features on the land that students can see in-person and on-map while visiting the Eco Reserve include: the Napa River, Conn Creek, and the flat meadow at the entrance of the Reserve.

What is a Watershed?

The word means a parting, a shedding of waters. But a watershed is also a gathering place. A watershed is measured by the hilltops and ridges that are its boundaries. It is shaped by the hills, valleys, and plains that are the landscape and is tempered by the forests, fields, lakes and marshes that are habitats for its creatures. Most of us know a watershed through its streams and rivers that connect forest with farm, farm with city and city with lake - each of us changes the watershed day by day, bit by bit, as we go about the business of our lives.

A watershed, said Peter Warshall, has "walls of hills and mountains; a floor of river or lake; and roof of rain clouds". The rain erodes the walls into the watery floor and then evaporates back into the roof. Streams do not always rise in the mountains and flow to the sea. Rain falling on every square inch of land within a watershed contributes to streams as they wind their way downhill. (The rain may flow on the surface of the land, or it may soak into the ground and then flow to a stream, river or lake.)

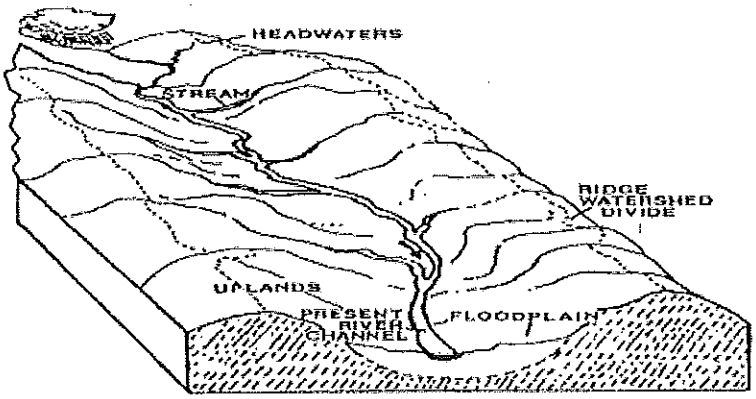
The critical thing to remember about watersheds is that the rivers, the hills and the bottom lands are all part of a system. Every activity on the land, in the water or even in the air has the potential to effect the watershed system.

A change in the watershed affects our lives - a change that we make in the landscape affects the watershed. It's all connected. Nature's changes can be as quiet as branches building up behind a fallen log and changing the path of a stream. Or they can be as dramatic as a winter flood. Our actions, too, can be subtle or very dramatic; but they all affect someone or something. When we cut forests, clear land, lay concrete and asphalt, and build houses and towns we cause changes in the watershed. Those changes mean the water cycle works differently.

Rain striking the ground has fewer place to soak in gradually - run-off is faster and more violent...causing erosion and flooding. Water quality deteriorates as water drains from farms and cities carrying pesticides, animal waste, oil, and heavy metals into our groundwater, streams, lakes, and eventually, oceans.

The activities of your neighbor up the hill will affect what the rain carries into your yard. And what you pour or spread on the ground, what ends up in your septic system or driveway, affects what ends up down stream from you, in the nearest stream or river, in the groundwater, or in the San Francisco Bay. The watershed, the water cycle and our lives are all connected. Any action, anywhere affects the land, the water and ulitimately, us. We all live downstream.

Watershed



Source: Master Watershed Stewards, Ohio State University extension 1997

Delinating a Watershed

A number of articles in this newsletter talk about the value of a watershed approach to monitoring. But before we can get started on watershed-wide monitoring studies, the first step is to define your watershed's boundaries.

The U.S. EPA defines a watershed as "a geographic area in which water, sediments, and dissolved materials drain into a common outlet" - a stream, lake, estuary, aquifer, or ocean. Theis area is also called the drainage basin, drainage area or catchment of the receiving water body. (Editor's note: Sometimes the word watershed is used to refer to a watershed boundary, or dividing line. In this sense, for example, the North American Continental Divide, the boundary between all waters flowing to the Atlantic Ocean and the Pacfic Ocean can be called a watershed. However, in this article, and in the other articles in this newsletter, the term watershed is synonymous with drainage basin).

Since water flows downhill, watersheds are defined by topography; to draw a watershed boundary, you essentially connect high points and ridges on a topographic map. But even though the concept is simple, the actual task can be quite challenging for people without extensive experience in interpreting topographic maps - especially if the watershed lies in an area of varied and complex terrain.

Watersheds within Watersheds

The watershed of a large river, lake or estuary can be divided into numerous subwatersheds or subbasins. The watershed of the Mississippi River covers the entire central United States and is made up of hundreds of smaller subwatersheds, down to the individual watershed of the smallest creek. The drainage areas of estuaries can also be enormous.

How a monitoring group defines its watershed will depend on the group's goals, are of interest, funding, and resources. For example, if you are dealing with a lake, are you interested in only the immediate shoreline area or the entire watershed encompassing the land drained by all the inflowing streams? For a river system, do you want to monitor the watersheds of tributaries? And the tirbuataries of the tributaries? When definig as estuarine watershed, you need to decide when to study just the primary coastal drainage areas contributing direct runoff to the estuary, or whether to include inland areas also.

Obtaining Maps

Before undertaking the potentially daunting task of delinating your watershed boundaries "from scratch" on a topographic map, check to see whether a government agency such as your local conservation district, planning department or state environmental agency has already done the work for you. Most liekly, such agendies can provide you with maps showing the boudnaries of at least the major watersheds. For smaller subwatersheds, you may need to draw the boundaries yourself. You'll need one or more U.S. Geological Survey topographic maps, preferably in a 1:24,000 scale. These can be ordered directly from USGS (call 1-800-USA-MAPS for catalog), or obtained at sporting good stores, college book stores, or state conservation agencies. The maps generally cost less than $4 each; however, a large watershed may require many maps. (In urban areas, you should also consult a map of the sewer system. Storm sewers may conduct runoff in a different direction than you would predict by looking at surface topography).

If you are not familiar with reading and interpretating a topographic map, see the next pages for some pointers.

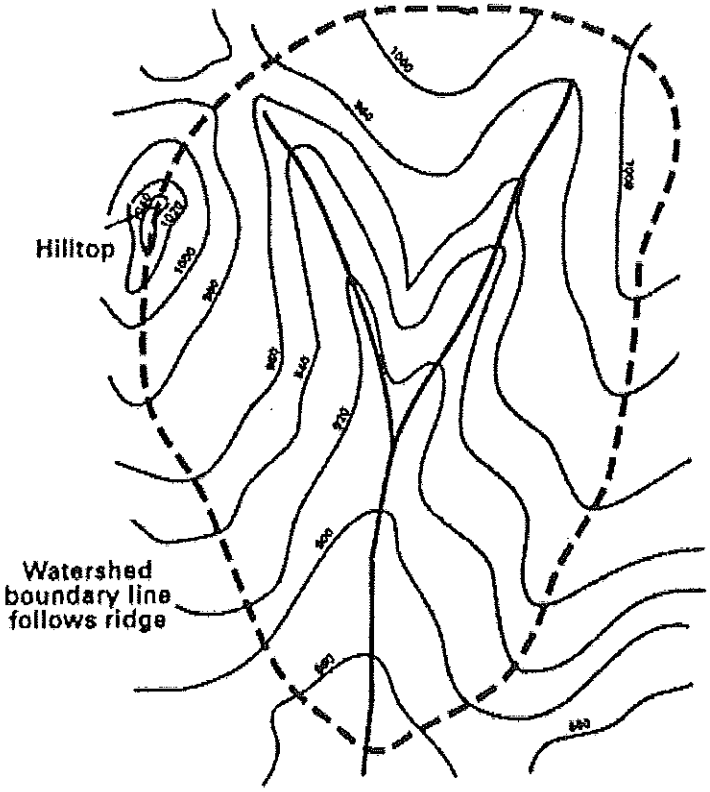
Delineating Watershed Boundaries

Now that you've obtained topographic maps of your area, following the steps below to draw your watershed boundaries.

- Locate and mark the downstream outlet of the watershed. For lake watersheds, this will be the lake outlet. For rivers and streams it will be the futhest downstream point that you are interested in.
- Locate all water features (streams, wetlands, lakes, and reservoirs) that eventually flow to the outlet. Start with major tributary streams and wetlands, then include smaller streams and drainage channels. To determine if a stream is flowing to or from a lake or river, compare the elevation of land features to that of the water body.
- Use arrows to mark the direction of stream or wetland flow..
- Now that the tributary waters have been identified, the watershed boundaries can be drawn. Find and mark the high points (hills, ridges, saddles). Then connect these points, following ridges and crossing slopes at right angles to contour lines. This line forms the perimeter of the watershed.
- If desired, sub-watersheds can be delineated by locating internal drainage divides that are bounded by ridges at lower elevations than the primary watershed boundary.

For some purposes, exact watershed boundaries may not be needed. For example, teachers who want to draw approximate boundaries to use as a classroom example can do so by looking at the pattern of stream flow and drawing dividing lines between stream systems.

Some of the steps outlined above for delineating a watershed are easier said than done. For the inexperienced, expert guidance is strongly recommended. Field checking the boundaries is also helpful (an additional benefit is that going out into the field allows you to identify human alterations such as road ditches, that could change the direction of water flow and affect the boundaries). Finally, bear in mind that delineating a watershed is an inexact science - any two people, even if both are experts, will come up with slightly different boundaries.



Reading a Topographic Map

Basic terms and conventions:

- Contour lines are brown; water features are blue, vegetation is green, cleared areas (fields, developed areas, and farmland) are white, and roads, buildings and other non-natural features are black. Urban areas are gray.
- All points along any one contour line are at the same elevation. Contour lines never cross each other.
- Elevation, in feet above sea level, is indicated on contour lines and on the summit of many hills and mountains.
- The difference in elevation between two adjacent contours is called the contour interval. It is usually given in the map legend. I the contour interval is 20 feet, you would need to climb or descend in elevation 20 feet to go from a point on one contour to a point on the next.

Recognizing features on the map:

- Slopes: Contour lines that are closely spaced represent steep slope, and those that are widely spaced represent shallow or flat areas.
- Valley and ridges: Contour lines that represent a valley or depression usually are v-shaped, with the tips of the V's pointing toward higher elevations. Lines that show a ridge are also shaped like V's (or rounded V's), but in this case the V's point toward lowest elevations.
- Hills: Hills and mountains appear as a series of successively smaller, irregularly shaped concentric circles. The smallest circle represents the highest point.
- Water flow: Water flow is perpendicular to contour lines. Streams tend to form in the v-shaped contours on side slopes, with the V's pointing in the direction of higher ground (upstream). When two streams converge, the v formed by the point where the two come together points downstream.

References:

Ammann, Allen and Amanda Lindley Stone, *Method for the Comparative Evaluation of Non-tidal Wetlands in New Hampshire.* 1991 Available for $12.50 from New Hampshire Department of Environmental Services, PIP, PO Box 95, Hazen Drive, Concord, NH 03302-0095

What is a Watershed? University of Rhode Island Cooperative Extension, Fact Sheet no 89-1. 1989. For a copy send a business sized SASE with 52 cent postage to Linda Green, Watershed Watch, 210B Woodward Hall, University of Rhode Island, Kingston, RI 02881-0804.

Williams, Scott. *A Citizen's Guide to a Lake Watershed Surveys: How to Conduct a Non-point Source Phosphorous Survey.* 1992 Maine Department of Environmental Protection; Congress of Lake Associations. To order, send a check for $2.00 made out to COLA, plus a 9x12 SASE with $1.20 postage to COLA, PO Box 391, Yarmouth, ME 04096.

Ann Baughman (Tip of the Mitt Watershed Council), Kathleen Leyden (Shore Stewards Partnership, Maine State Planning Office) and Nancy Trautmann (Cornell Center for the Environment) contributed to this article.

Napa River Eco Reserve Connection

Eco Reserve Scavenger Hunt

The goal of this scavenger hunt is to allow students to get familiar with the Eco Reserve, and allow them some unguided time to explore the reserve and observe natural items located there. Most of the items in the hunt are items that students should be familiar with from school and home discussions. Teachers should check their students' understanding of valley oak leaves, coast live oak leaves and oak galls before embarking on the hunt. This is a good opportunity to mention that oak trees are some of the more common trees found in Napa County, and that they are the keystone species in the oak woodland community, which supports a diverse array of mammals, reptiles, amphibians, insects, and other plants. Most of the items on the list will be found quickly by students. Pine cones are the hardest items to find. Teachers can have students notice that there are few pine trees in the Reserve, but cones may travel to the Reserve via the waterways. Please dispose of all trash collected by students in receptacles located at the entrance to the Reserve.

Instructions:

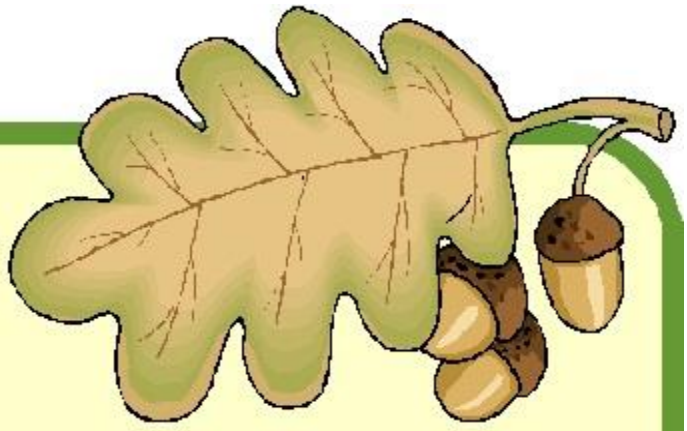
1. Introduce purpose of activity and collection boundaries. At the Eco Reserve, students can safely search for items along the main trails and along the banks of the River (when water levels are low – typically, between April and October).

2. Provide students with collection bags and scavenger hunt list.

3. Allow students approximately 20 minutes to conduct search.

4. Gather students in a group to discuss the hunt. Discuss the significance of each of the items with regards to the history of the watershed. What was easy to find? What was difficult? What items from nature did Native Americans rely on? Does everyone understand what lichen is (a mutualistic relationship between fungus and algae)? Do students find these items around their school or homes? Would students find this items in another part of the country?

Scavenger Hunt



__Coast Live Oak leaf

__Valley Oak Leaf

__ Acorn

__ Oak Gall

__ Pine cone

__ Moss

__ Clover leaf

__ Lichen

__ Seeds or seed pod

__ Smooth/shiny rock

__ Y-shaped twig

__ Trash

__ One yellow flower

__ One white flower

__ Dead bug parts

Napa River Eco Reserve Connection

Silent Stalking

The meadow at the entrance is the safest spot for silent stalking at the Eco Reserve. In late April and May, there may be periods when the vegetation is waste high, so caution students to wear pants and check for ticks after the activity when this is the case.

SILENT STALKING

BIO KEY

Game/Simulation
Predator/Prey
Stalking/Listening Skills

OVERVIEW

By playing the roles of predators and prey in a game, the youngsters learn the importance of keen hearing and silent stalking skills.

BACKGROUND

Many predators must stalk their prey to get close enough to strike without warning. A mountain lion creeps quietly along a ledge until it comes within striking distance of a deer. A wading bird such as an egret or a heron stealthily pursues camouflaged frogs and darting fish until a sudden thrust of the bird's sharp bill can reach the prey. The slightest noise or careless movement on the part of the predator will alert the prey to its presence. The prey also must move cautiously and silently, for it must avoid being detected by a predator. A good sense of hearing and the ability to pinpoint the direction from which sounds come are important survival adaptations for both predators and prey.

CHALLENGE: VISIT THE WATER HOLE WITHOUT BEING "CAPTURED" BY A PREDATOR.

Published by
Delta Education
12 Simon Street
Nashua, NH 03061-3000
(603) 598-7170

Developed by
Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley, California 94720

MATERIALS

For each game group (five to ten players):
1 blindfold or OBIS mask
1 spray mister*
8 flags*
1 nine-meter length of light rope* (sash cord or clothes line)
1 3″ x 5″ index card for each "prey" (See the "Preparation" section.)
1 flashlight* with fresh batteries* (for night use)

For all the groups:
1 "OBIS Mask" Equipment Card*

For the game variations:
cotton* or ear plugs
masking tape*
wax paper*
cut rubber bands or elastic*

* Available from Delta Education.

PREPARATION

Group Size. *Silent Stalking* works best with five to ten players. If you have more than ten participants, divide the group into smaller groups (of no less than five players), and set up a game circle for each group.

Time. Plan on thirty to forty minutes for this activity during daytime or nighttime.

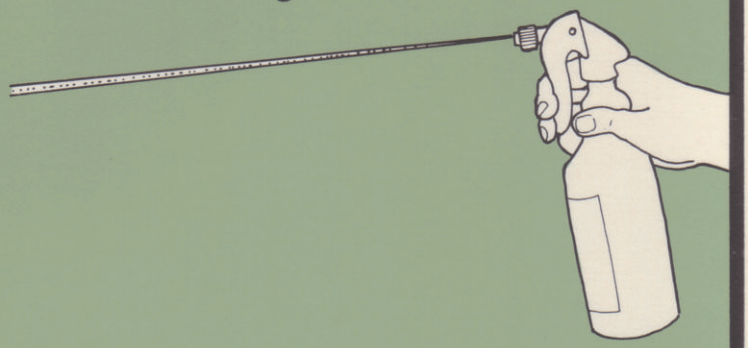
Site. Choose a fairly open, level site (a forest clearing, field, or vacant lot) that is noisy to walk on. Dry leaves and underbrush, gravel, pebbles, and crunchy snow make noisy walking surfaces.

Materials

1. Masks. Make an OBIS mask for each game group. (The common blindfold often invites peeking.) See the "OBIS Mask" Equipment Card.

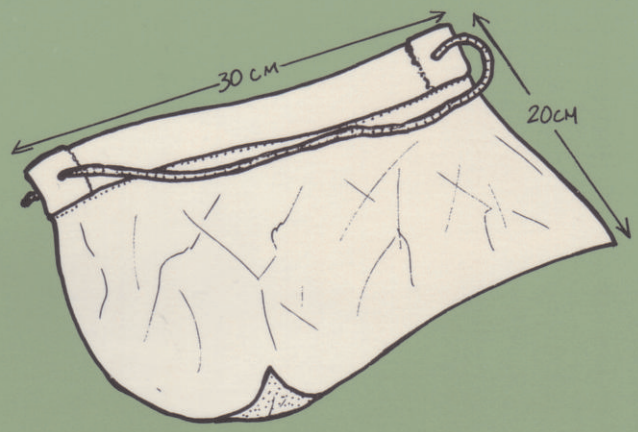
2. Flashlights. When this activity is conducted at night, it is advisable to have a flashlight with fresh batteries available for each game group leader.

3. Spray Misters. Adjust the spray nozzles so that the spray misters squirt a narrow stream of water at least four to six meters in length.



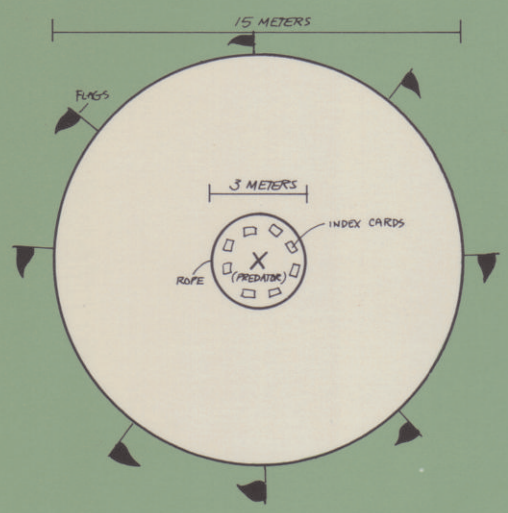
4. Index Cards. Write the word *water* on an index card for each "prey."

5. Wax Paper Masks. Place a strip of tape across the long edge of a 30 cm x 20 cm piece of wax paper, and attach a cut rubber band or a piece of elastic to each end of the tape.



Game Circle. Mark the outline of a large circle at least fifteen meters across with the flags. Use the piece of light rope to mark off a smaller circle about three meters across in the center of the large circle. This small circle represents the

"water hole." Place the labeled index cards just inside the edge of the "water hole."



ACTION

1. Tell the youngsters that they will play a game in which they assume the roles of ***predators*** (animals that eat other animals) and ***prey*** (animals that are eaten by other animals). The "prey" must get a drink at the water hole without being caught by the "predator."

2. Show the youngsters the circles laid out on the ground. Tell them that the area outside the large circle is the forest, and the small circle is the water hole. The area between the small circle and the large circle is a clearing that the prey must walk across to get a drink (that is, pick up one of the index cards with *water* written on it).

3. Give the youngsters these rules:

a. One member of the group is the predator; the other members are prey.

b. The predator stands with a spray mister in the center of the water hole (the small circle) and puts on the mask. (Her ears should remain uncovered.)

c. The prey spread out around the edge of the forest (outside the large circle).

d. When everyone is ready, the masked predator starts spinning around while the prey walk around the edge of the forest. After spinning four times, the predator yells: "STOP!" Everyone, including the predator, stops.

e. Now the prey move silently toward the water hole. The predator listens for the approaching prey and tries to "capture" them by hitting them with a stream of water from the spray mister before the prey can pick up a water card and return to the forest. The predator is allowed to "strike" (squirt the mister) only twice for each prey (that is, in a game with six prey, the predator gets only twelve strikes). The prey must pause after each step to see if the predator hits them.

f. A referee (the group leader or a youngster) judges each strike as either a "hit" or a "miss" and keeps track of the number of strikes the predator makes. "Hit" prey must sit down at the spot where they were hit, and remain quiet and still until that round ends so that the predator can concentrate on detecting the remaining prey.

g. The game ends when all of the prey have been captured, have returned to the forest with a "drink," or when the predator has used up all her strikes.

4. When everyone understands the game, select the predator and start playing. Play several rounds and suggest that at the end of each round the captured prey try to figure out what gave them away.

5. Suggest playing other rounds using some of the following variations. Ask the youngsters to predict the outcome before playing.

- Simulate a hearing loss due to injury or age by placing ear plugs or cotton in one or both of the predator's ears.

Published by
Delta Education
12 Simon Street
Nashua, NH 03061-3000
(603) 598-7170

- Play the game on several different surfaces: a quiet one, a noisy one, a downhill slope, an uphill slope, or in shallow water.
- Get down on your hands and knees to simulate four-legged animals.
- Play the game on a windy (noisy) night.
- Use wax paper masks to obscure the vision of the prey. (See the "Preparation" section.)

STALKING TALK

1. Ask the participants how they would change their bodies to be more successful as prey and as predators.

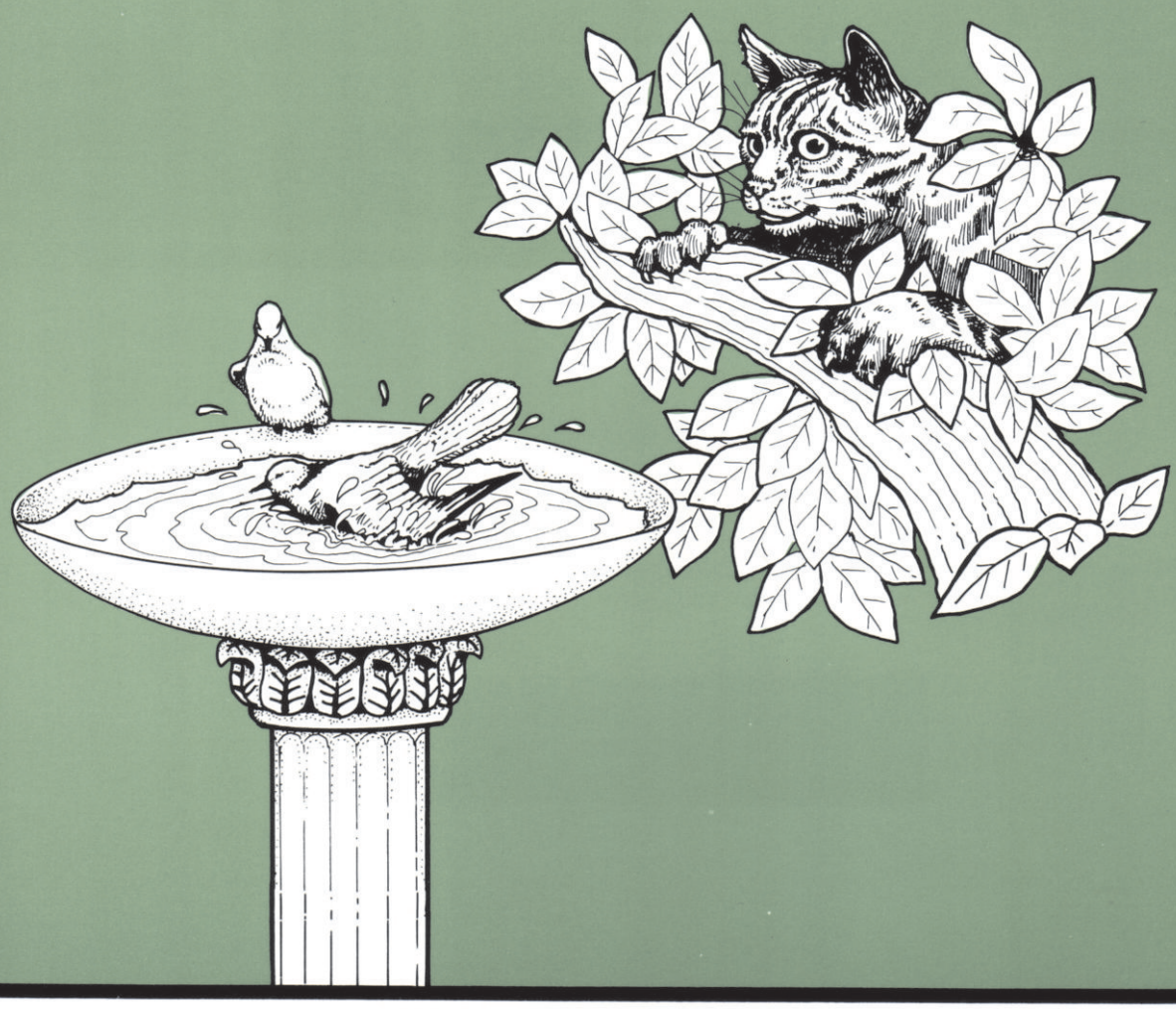
2. Ask the most successful prey to demonstrate their silent-stalking skills for the rest of the group.

BRANCHING OUT

1. Challenge the participants to see how close they can get to a bird, cat, fish, butterfly, squirrel, or lizard. At night, the youngsters could stalk night crawlers (worms), owls, frogs, or raccoons.

2. Encourage the kids to watch animals stalking their prey—a cat stalking a bird, a bird stalking insects or worms, or a friend trying to catch fish.

3. Ask youngsters with cameras to see who can get the closest picture of a given animal. (No telephoto lenses, please!)



Developed by
Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley, California 94720

Silent Stalking
OBIS MASK
Equipment Card

MATERIALS FOR ONE MASK:

1 piece of tracing paper (or other light paper)
1 manila folder, construction paper, or other cardstock
pair of scissors
stapler
tape
cut rubber band or piece of elastic
cloth for shield
pencil or sharp object for punching holes

MAKING YOUR MASK

1. Trace the mask outline below to make a pattern.

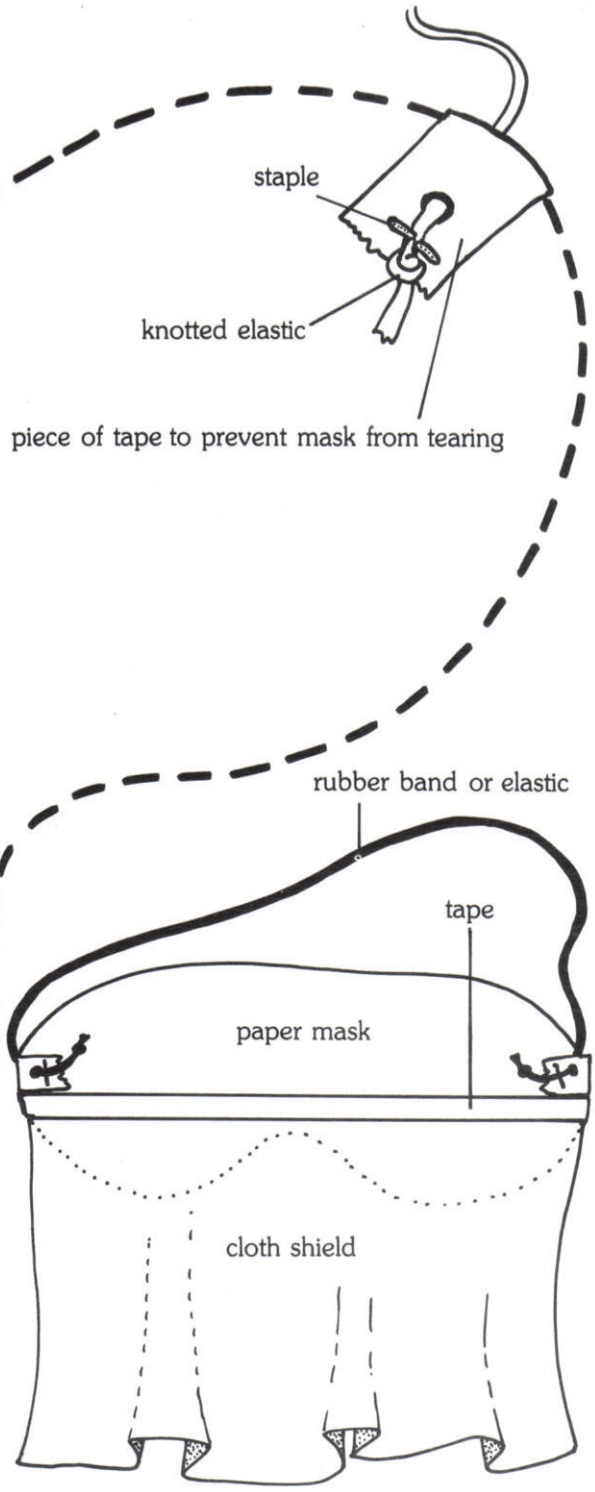
2. Use the pattern to cut a mask out of the heavy paper you have selected.

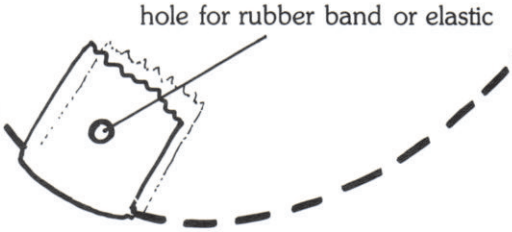
3. Reinforce the elastic attachment area with a couple pieces of tape.

4. After pulling the elastic through the holes, tie a knot at each end of the elastic.

5. Staple the elastic to the mask as shown.

6. Tape a cloth shield across the front of the mask.





Published by
DELTA EDUCATION

Napa River Eco Reserve Connection

Water Striders

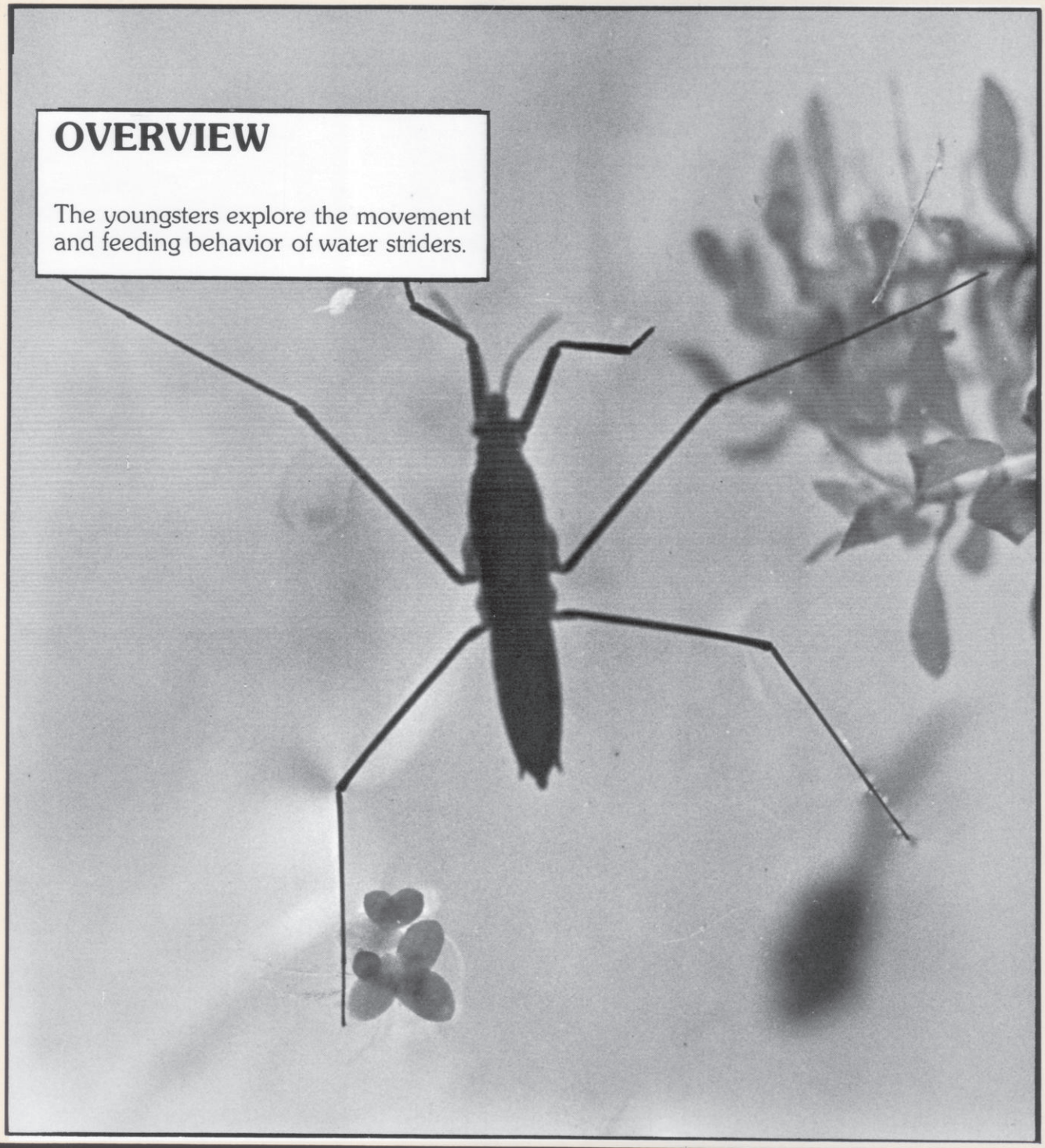
The meadow at the entrance is a great spot for sweep netting for terrestrial insects. Water striders can found on the River, Take students along the path at the top of the bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.*

*Please use your own discretion regarding water safety. If water is deep or moving quickly, exercise caution.

WATER STRIDERS

BIO KEY

Aquatic Organism Investigation
Insect Behavior
Experiment



OVERVIEW

The youngsters explore the movement and feeding behavior of water striders.

BACKGROUND

The darting movement of the water strider is a common sight at many streams, brooks, and ponds. Striders are insects that move across water using their middle legs as oars, and steering with their rear legs. A strider can walk on water because it has long legs covered with hundreds of tiny hairs that distribute its weight over a large area of water. The surface tension of water supports striders just as it can support a carefully placed sewing needle.

Published by
Delta Education
5 Hudson Park Drive
Hudson, New Hampshire 03051
(603) 889-8899

Developed by
Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley, California 94720

Water striders are voracious feeders, eating insects (dead or alive) and other tiny animals that land on the water's surface. Like all members of the waterbug family, striders have long, thin beaks for mouths. The beak is used as a straw to suck body juices from prey. Striders locate their food by both sight and their ability to detect the vibrations tiny animals create when struggling to escape from the water. Striders may wait for food to drift by or may actively "skate" across the water searching for food. Water striders breed during the spring and early summer. During these seasons it is common to see striders riding "piggy-back" as they mate.

CHALLENGE: INVESTIGATE WATER STRIDERS' MOVEMENTS AND FEEDING BEHAVIORS.

MATERIALS

For each buddy team:
1 sweepnet*
1 observation tray*
1 bug box* or magnifying lens*
1 clear plastic cup*
2 half-meter-long sticks or flags*
1 meter tape* or meter stick*

For the group:
pipe cleaners*
bright acrylic or thick tempera paint in a small plastic container
1 copy of the "Aquatic Observation Aids" Equipment Card*
1 copy of the "Sweepnet" Equipment Card*
1 two- to three-gallon bucket (or large dishpan*) for every four to six kids

* Available from Delta Education.

PREPARATION

Group Size. This activity works best with groups of less than fifteen kids. For large groups, you will need an assistant to help you conduct the activity and an activity site that is large enough and contains enough striders for a larger number of youngsters.

Time. Time limits are difficult to set for this activity. Plan on one or more activity periods totaling one to two hours. The activity works best on warm, sunny days.

Site. Select a freshwater site with banks that are not too steep or slippery. There should be at least two striders for every youngster. Find a level area near the site for sharing observations. You will also need a grassy or bushy area nearby for sweepnetting insects to use in the "Strider Feeding Behavior" investigation. If necessary, obtain permission to use the site.

Materials. See the "Aquatic Observation Aids" Equipment Card and the "Sweepnet" Equipment Card in this folio for instructions on making and using the equipment.

The sweepnet is used in this activity as both an aquatic dip net and a terrestrial sweepnet. Practice using the sweepnet with an underhand scooping motion to catch striders before conducting the activity.

Safety. When working around the water, use the buddy system. (See the "Safety" section of the *Leader's Survival Kit* folio.)

Conservation. Establish some rules of procedure to promote respect for the activity-site environment. Refer to the "Conservation—Take 'Em Back Alive!" section in the *Leader's Survival Kit* folio.

ACTION

Catching and Observing Striders

1. Divide the group into buddy teams, and establish the limits of the activity site.

2. Announce to the kids that they will be exploring the movement and feeding behavior of water striders.

3. While emphasizing the need for gentle handling, show the youngsters how to:

- slowly and quietly approach wary striders.
- use an underhand scooping motion to net the striders.
- transfer a netted strider into an observation tray.
- use a magnifying lens or bug box lid to view the strider.
- use a clear plastic cup to view striders from the side.

4. Give each team a net, an observation tray, and a lens or bug box. Challenge each team to catch two striders. Suggest that the buddy without the net can help by herding striders toward the net. Circulate among the teams, and encourage the kids to closely observe their captured striders by asking questions such as:

- How many legs do striders have?
- What parts of their legs do striders place in the water for support?
- Which legs do striders use to move?
- Are striders wet or dry?

5. After ten to fifteen minutes, gather the youngsters to share observations.

Strider Movement

1. Ask the teams if they think striders tend to stay in one place or travel long distances. Encourage the kids to suggest ways to find out.

2. Explain that an individual strider's movements are easier to follow if the strider is marked in some way.

Demonstrate this strider-marking technique:

a. Herd a strider from an observation tray into a plastic cup.
b. Bend the tip of a pipe cleaner back on itself so no sharp wire is exposed. Use the pipe cleaner to dab a small dot of thick tempera or acrylic paint on top of the strider's rear end (abdomen). Let the paint dry.
c. Emphasize that only a *small dot* of paint is needed—no "slopping" the striders with paint! Avoid getting paint on the strider's legs.

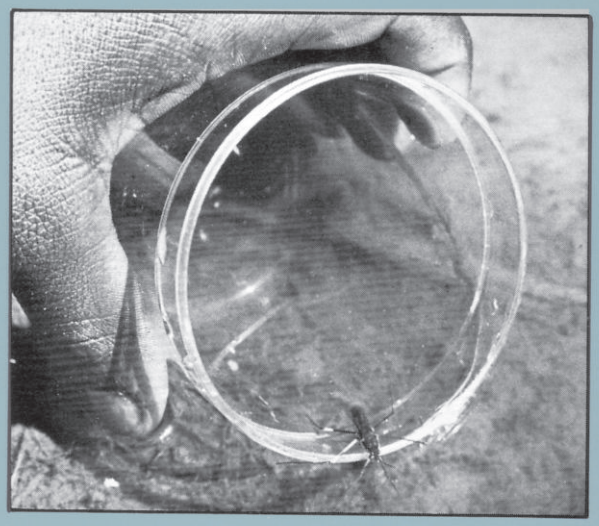
Have each team mark their striders.

3. Demonstrate the following method for releasing striders. Lower the plastic cup into the water so the cup slowly fills with water. Then tip the cup so the marked strider "pours" out with the water. Hand out two half-meter sticks or flags, and a meter tape to each team. Ask the teams to select a spot in the stream or pond at which to release one of their marked striders. Each team should place a stick at that point.

4. Explain that when you yell, "Let them go!", each team will release one marked strider and follow its movements. Caution the teams not to interfere with their striders after releasing them. Explain that after five minutes, you will yell

Published by
Delta Education
5 Hudson Park Drive
Hudson, New Hampshire 03051
(603) 889-8899

"Stop!" Each team should then place their second stick at the farthest point reached by their strider. Then each team will measure with the meter tape the distance travelled by their marked strider.



5. Allow time for each team to set up, and then signal for the release. After five minutes, signal the stop. After the teams measure the distances, call them together to compare travelling distances of the marked striders.

6. Suggest that each team release a second marked strider in a different spot, e.g. in strong currents, in the sun or shade, or in the middle rather than at the edge of the water. Ask the teams to watch their striders for three to five minutes to discover where striders spend most of their time. Have the teams share their discoveries.

Strider Feeding Behavior

1. Tell the youngsters that they are going to offer striders small insects in order to observe strider feeding behavior.

2. Have the kids fill the buckets or dishpans three-quarters full of water, and catch about six striders for each bucket.

3. Take the group to a grassy or bushy area and demonstrate the sweepnetting technique. (First, shake the net vigorously to remove water remaining from netting striders.) Let the teams net some insects and then return (keeping the insects in the nets) to the strider site.

4. Ask the teams to first dunk the netted insects, net and all, in the water to slow the insects down. Then have the teams release the insects into the buckets by turning the nets inside out. Wet insects can also be released directly into the pond or stream near a bunch of striders.

5. Challenge the teams to discover how the striders catch and eat their food. Caution the youngsters to remain still while observing the striders. After the kids have observed the strider grabbing insects, suggest that each team take a closer look at feeding behavior by using a clear plastic cup to gently scoop up a strider that has caught an insect.

6. After ten to fifteen minutes, call the teams together to share their discoveries.

STRIDING AHEAD

Ask the youngsters how they think striders eat. Because this process is difficult to figure out, kids usually come up with some wild ideas. If this is the case, ask the kids how people would eat if their mouths were like straws. Then call attention to the strider's beak. Explain that striders jab their beaks into prey and suck out body juices. Ask the kids to look for a strider's beak sticking into an insect.

Release the striders at the end of the activity.

STRIDERS REVISITED

Return within a few weeks to locate marked striders. How far have the marked striders moved from the area where they were released?

Developed by
Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley, California 94720

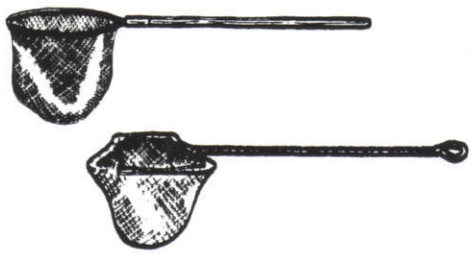
AQUATIC OBSERVATION AIDS:
For Aquatic Activities
Equipment Card 2 Side 1

Bug Boxes

A bug box is a small, clear plastic box with a magnifying lens for a lid. To use the bug box, place an object or organism in the box and replace the lid to magnify the contents. When exposed to direct sunlight a closed bug box heats up rapidly, so release organisms promptly after observing them. The lid can also be used separately as a magnifying lens.

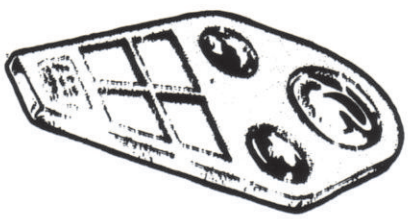
Dip Nets

Nets can either be made or bought. Aquarium nets work fine. You may want to extend the reach of an aquarium net by attaching a dowel, a stick, or a similar extension to the handle. A gradual, gentle scoop of the net is usually more successful and less damaging to organisms than a sudden, violent scooping motion. To prevent eye accidents, ask that the nets never be raised above shoulder level.



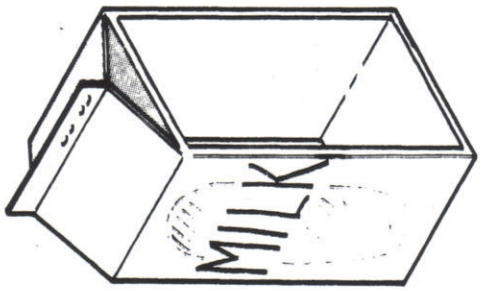
Magnifying Lenses

To use a magnifying lens, hold the lens close to one eye and move either your head or the object back and forth until you can see the object clearly.

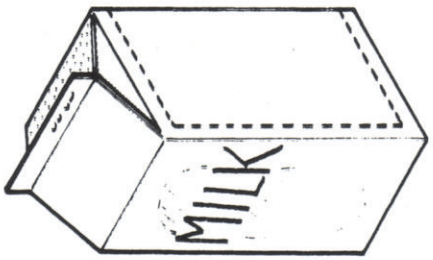


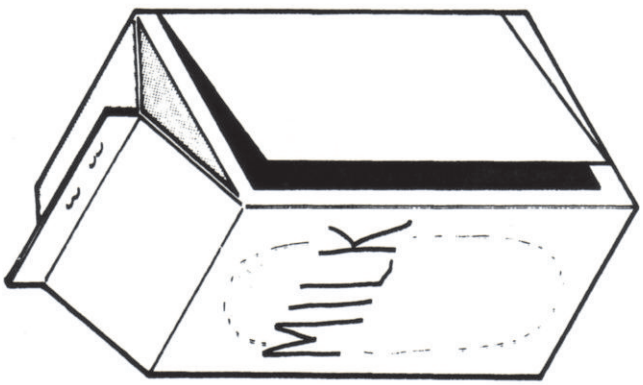
Observation Tray

Any container that will hold water can serve as an observation tray. Containers with light-colored bottoms are best for easy viewing of organisms that have been added. Half-gallon milk cartons can be made into deluxe observation trays. To make one, staple the pouring spout closed and cut out the carton wall on the same side as the stapled pouring spout.



To make a hinged-top observation tray, just cut along three sides (two short and one long) of the carton wall on the same side as the stapled spout.

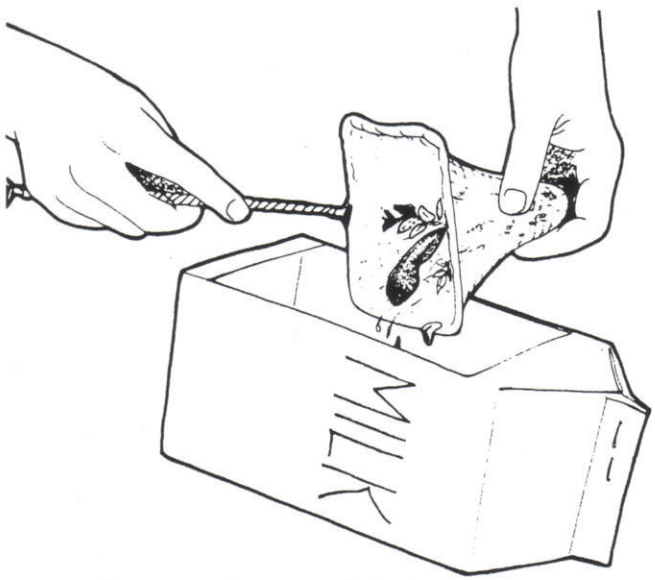




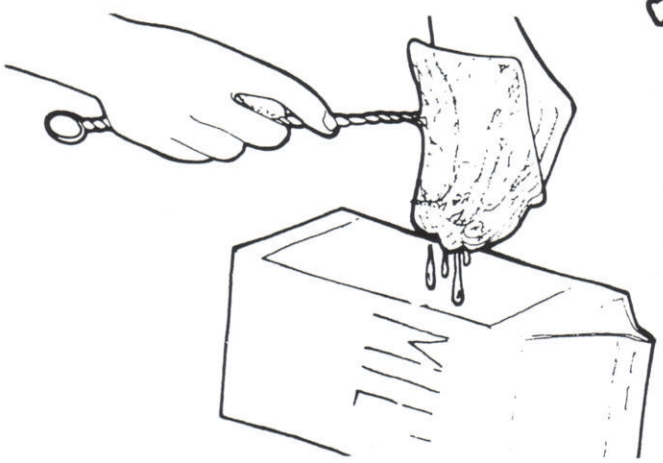
Published by
DELTA EDUCATION

AQUATIC OBSERVATION AIDS:
For Aquatic Activities
Equipment Card 2 Side 2

Transferring critters to observation trays. When using a net to transfer critters, first swish the net through the water without releasing the organisms. (You can use the pond or stream you are investigating.) The rinsing removes any sediment you may have netted. Fill your observation tray about one-half full of water (preferably water from the organism site). Hold the net hoop over the tray,



turn the net inside out, and dip the net bag into the water in the tray.

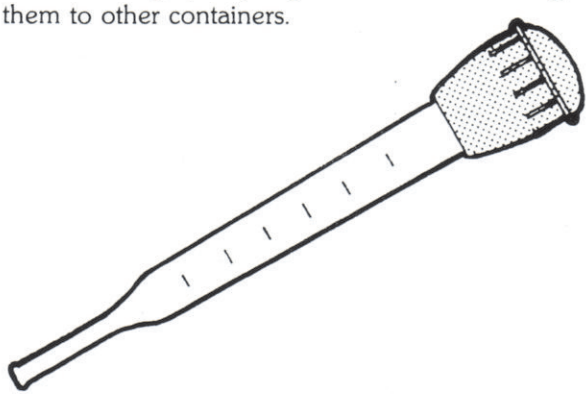


This will release netted organisms into the tray.

Spoons and Clear Plastic Cups

Spoons and cups are useful for transporting tiny organisms and observing them at a close range.

Simply dip up tiny organisms with a spoon or cup and place the organisms in a container partially filled with clear water. Turkey basters are also useful for sucking up tiny organisms and transferring them to other containers.



Note: All of these aids are available from Delta Education.

Published by
DELTA EDUCATION

SWEEPNET

Equipment Card Side 1

Note: Commercially available sweepnets* are more durable and we suggest such an investment for schools, camps, or clubs.

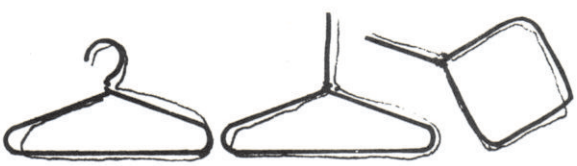
MATERIALS FOR ONE SWEEPNET:

2 wire coat hangers or 1 piece of heavy-duty wire
1 dowel or broom handle about one meter long and 1.5 cm in diameter
1 piece of nylon netting* (mosquito netting), .75 square meter
1 needle and thread for sewing (or a sewing machine)
filament or duct tape*
1 pair of pliers

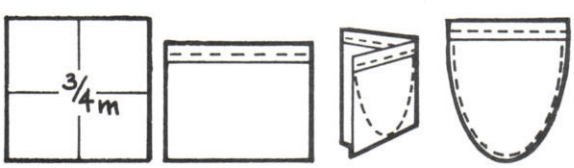
* Available from Delta Education.

MAKING A SWEEPNET:

1. Preparing the Hoop. Take the wire coat hangers, straighten the hooks and pull the hangers together into a square (one hanger on top of the other). The pliers make this job easier.

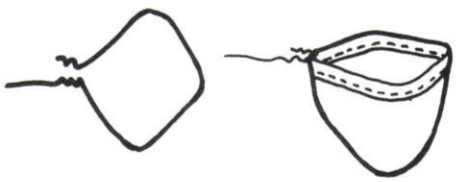


2. Preparing the Bag. Your net should be approximately .75 meter in circumference at the top, tapering down to a point. A sewing machine speeds up construction, but older kids can hand sew the nets if sufficient time is provided. Sew like this:

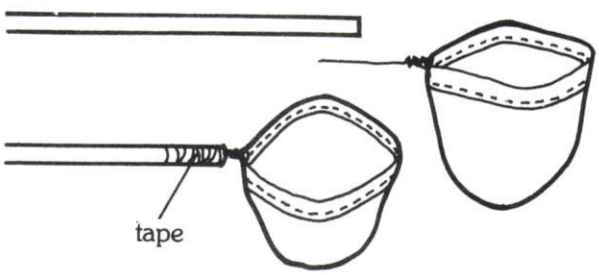


Fold one edge down and sew | Fold square in half and sew | Cut off excess

3. Assembling the Net. Open the wire square (both squares, if you used two hangers) and thread the net on the wire (or wires).



Attach the wire hoop to the stick.



USING A SWEEPNET:

While a sweepnet can be used to pursue and capture an animal that has caught your eye, this is not the most efficient use of the net. A sweepnet is best used as a random sampling tool. You walk at moderate speed across a grassy area, sweeping the net back and forth in pendulum fashion, in front of you. The net should just brush across the top of the grass. The idea is to sweep any animals that are buzzing around in front of you into the nets, so you must turn the net in your hand to capture animals on both right and left swings of the net. After you have made fifteen to thirty swings of the net, make a quick swing around your head to concentrate the animals at the bottom of the net, and grab the top of the net in your hand to keep the catch from escaping.

Published by
DELTA EDUCATION

SWEEPNET

Equipment Card 2 Side 2

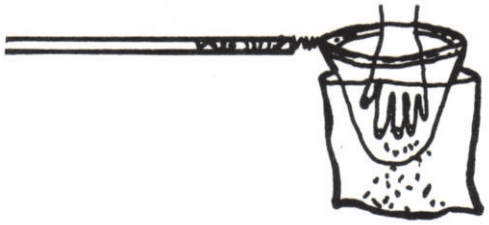
TRANSFERRING ANIMALS FROM THE NET TO AN OBSERVATION BAG:

1. Concentrate the animals in the bottom of the net.

2. Pinch the net closed, keeping the animals in the bottom of the net.

3. Turn the net inside out while holding the animals.

4. Place the net in a plastic bag, then release and shake the animals into the bag.



5. Grab the top of the bag.

6. Twist the top of the bag a couple of times and tuck the top under your belt or into an open pocket while you continue to sweep.

Published by
DELTA EDUCATION

Napa River Eco Reserve Connection

Creek Detectives

Many different species of wildlife that can be found in the Eco Reserve or the surrounding area, including: deer, raccoons, coyote, gray foxes, bobcats, mountain lions, jackrabbits, skunks, squirrels, mice, rats, opossums, beaver, river otters, herons, egrets, ducks, woodpeckers, hawks, owls, scrub jays, crows, and blackbirds.

You can find more wildlife in the brochure at the beginning of this guide called "Birds and Butterflies of the Napa River Ecological Reserve."

Take students along the path at the top of the bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to spread out, work independently, and make observations about sight, sounds, smells, human influences, and plant life.

*Please use your own discretion regarding water safety. If water is very deep or moving very quickly, please watch students carefully.

Activity 16

Creek Detectives

Summary: *Students spend some time discovering wildlife in and around the creek*

Background

The wildlife that lives near your creek can be elusive. While sitting quietly near the creek, one will almost always have the opportunity to see some bird life. But most wild animals, and especially mammals, avoid humans at all costs.

The best way to "see" the wildlife that lives around the creek is to become detectives. While maybe never laying eyes on the actual animal, students can become adept at looking for the signs of life that have been left behind. Tracks, scat, hair, nests, dens, holes, chewed leaves or branches all provide clues to the wildlife that inhabit the region. The more students practice, the better they can become at finding and interpreting the clues around them.

Grades: K-5

Time: 20-30 minutes

Setting: Creek

Materials:
- Science journal or clipboard and paper
- Pen or pencil

Key Concept:
- Tracks, feathers, and other signs help students discover wildlife at a creek.

Objectives:
Students will
- Observe the creek area using their senses.
- Record sightings or signs of wildlife.

Supports California Content Standards:
SCIENCE
- Life Science
- Investigation and Experimentation

MATH
- Number Sense
- Algebra
- Statistics and Data Analysis
- Mathematical Reasoning

LANGUAGE ARTS
- Writing
- Listening and Speaking

HISTORY/SOCIAL SCIENCE
(for details see the Standards Matrix)

Activity

1. In the classroom before you head out to the creek, have the student brainstorm what animals they might see at a creek. Let them know that the quieter they are, the more likely it will be to get a glance at some wildlife.
2. Also remind them that they are detectives and that wildlife can leave behind signs such as feathers, scat, a footprint and more. Student should be on the look out for these clues.
3. As soon as you get down to the creek, choose a place along a creek (at least a 50-yard stretch) that has easy access, and no poison oak or nettle. Either assign students a spot or let them choose where to sit. They should sit a little distance away from another student. They will be near all their classmates, but should not talk to or disturb anyone else's quiet time
4. Explain to the students that you would like them to be detectives here at the creek. They will have 10 minutes to spend with the creek, paying attention to the creek and its wildlife from their sitting position. They can note down in their science journals or on the clipboard any sounds they hear, signs of animals they might have noticed and any other details.

Discussion

- Back at the classroom, give anyone the opportunity to share anything they detected and learned about the creek and its wildlife.

Branching Out

Language Arts:

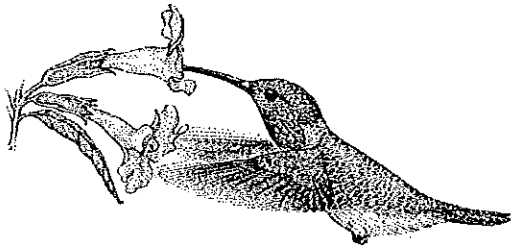
- Students can write about the feelings they experienced at the creek.
- Write a poem about the creek and its wildlife.
- Imagine what it would be like be very small and take a trip down the creek on a leaf boat and write about the adventures you would have with the animals that live there.

Mathematics:

- As a group count the number of different animals or signs of wildlife they encountered at the creek.
- Sort the animals into groups, mammals, birds, reptiles, amphibians and invertebrates

Arts:

- Write lyrics for a song about the creek and its wildlife.
- Use the sounds of animals they heard at the creek to compose original music. What rhythms did they hear? What feelings did the sounds create?



Napa River Eco Reserve Connection

Riparian Bird Adaptations

All of the birds mentioned in this activity can be found at the Eco Reserve. Consult the guide called "Birds and Butterflies of the Napa River Ecological Reserve" to learn more about the birds that you can commonly find at the Eco Reserve. Consider gathering grasses, seeds, and small vegetation needed for the activity from the reserve, and discussing the actual sources of food that exist for birds in the Reserve: fish (especially the small and abundant California roach), insects (flies, mosquitos, beetles, caterpillars, butterflies), seeds, and fruits. Consider bringing binoculars to the Reserve and allowing students quite time to observe birds. The riparian tree canopy is a great spot in which to see birds and listen to their calls.

Activity 21

Riparian Bird Adaptations

Summary: *Students will learn how the special beak and feet adaptations of different riparian birds help them survive.*

Background
The wetlands, marshes, mudflats and riparian areas around the San Francisco Bay provide crucial habitat to rest, eat, nest, and raise their young for many species of birds. Aquatic habitats are especially vital to the survival of migratory birds. Seventy-five percent of all shorebirds that migrate along the Pacific Flyway stop to feed or breed around the San Francisco Bay.

A bird's physical characteristic tells much about its life. Birds' specialized beaks and feet provide clues to what the bird eats and the type of habitat it lives in. The narrow, tubular beak of the hummingbird is perfect for gathering nectar from flowers, while the strong thick beak of the waxwing opens seeds and cones. Songbirds have feet that allow them to perch in small branches. Hawks, owls and other predatory birds have sharp talons and point-tipped beaks that catch and pierce their prey.

Different species of birds may share physical similarities. Webbed feet found on both waterfowl and diving birds. Diving birds, however, have long, sharp-pointed beaks to pierce and grab fish, while most waterfowl such as ducks have broad flat bills with toothed edges for feeding on aquatic vegetation. Long-legged and long-beaked birds--such as egrets, herons, and curlews--wade in wetlands marshes, and along shorelines, picking up small insects, crustaceans or fish with their beaks.

These different adaptations, and thus diets, of birds allow them to live in the same area at the same time (coexist) without competing for food. This is why you may see many types of birds feeding together in one area. They are able to share the resources of an area because they each require different foods at different depths and locations.

Grades: 1-5

Time: 30-40 minutes

Setting: Classroom

Materials:
- 5 sets of tools (slotted spoon, tweezer, drinking straw, tongs, scissors)
- Picture of a parrot (showing the beak)
- 5 sets of foods (picture of a small rodent, cup of water labeled nectar, bowl of water with grasses and leaves, small seeds, small plastic fish)
- Copies of Riparian bird beaks and feet worksheet for each group

Key Concept:
- Adaptations help an animal to survive in its habitat.

Objectives:
Students will
- Make connections between some tools and bird beaks.
- Use the tools to see which works best for a certain food.
- Answer questions about adaptations in beaks.

Supports California Content Standards:
SCIENCE
- Life Science
- Investigation and Experimentation

MATH
- Statistics and Data Analysis

LANGUAGE ARTS
- Reading
- Writing
- Listening and Speaking

HISTORY/SOCIAL SCIENCE
(for details see the Standards Matrix)

Activity

1. Place your students into 5 small groups.
2. Have each group pick up a set of tools; their set should include a straw, slotted spoon, tweezers, scissors, and tongs. Each student in the group should get a different tool
3. Have each group pick up a "plate of food". The full set of "food" for each group should include sunflower or another kind of small seed, small plastic fish, a dish of water with grasses floating on top, a cup of water labeled nectar and a picture of a mouse or other small rodent.
4. Instruct your students that these tools represent bird beaks and they need to figure out what type of beak would be best to eat a certain type of food. You might want to use an example of a parrot, which eats nuts - what kind of tool would students use to crack open a nut? – Does that tool looks like the shape of the parrot beak?
5. Give them about 10 minutes in their groups to explore their foods with their tools. Rejoin as a whole group and discuss what they discovered.
6. Now give each group the Riparian Bird Beak and Feet sheet. They will need to look at the bird's beak to figure out what kind of food it would eat and write it in. Also have them look at feet as an adaptation, some feet and legs are good for wading in the water to catch fish, others have sharp claws for catching mice. On the sheet there is a space for students to note this.

Discussion

- Are some beaks better at eating a particular food item than other beaks?
- How are the bird's feet important for its feeding success?
- What happens to birds when habitats around the San Francisco Bay are destroyed?
- Can the birds that are adapted to live and find food in a creek move to a different habitat?
- How does trash in a creek and riparian habitat harm birds?

Branching Out

Language Arts:

- Go to a creek and have student observe any birds they find, they can record their behaviors and notice items they are feeding on.
- Study other adaptations of birds, such as wing size and shape, or feathers.

Mathematics:

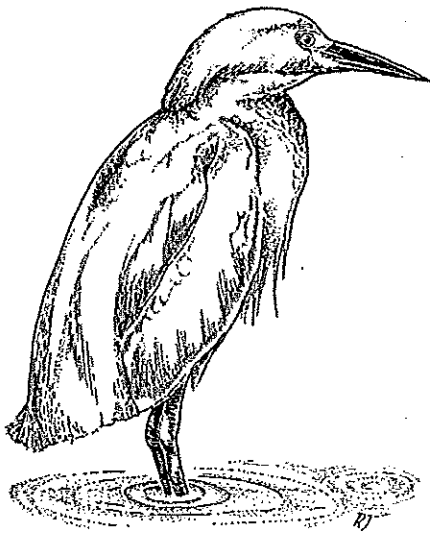
- Make a chart of the birds you saw on your walk to the creek. Sort them by types of feet and beaks.
- Keep an ongoing list and count of birds you see around your school, and compare that list to your list of birds from the creek.

Arts:

- Students can create their own binoculars to watch birds, give them two toilet paper roll inserts and some string. Staple the two cardboard inserts together and punch a hole on either side for the string.
- Create a field guide of local creek birds, student can draw illustrations and write about adaptations, behavior and diet.

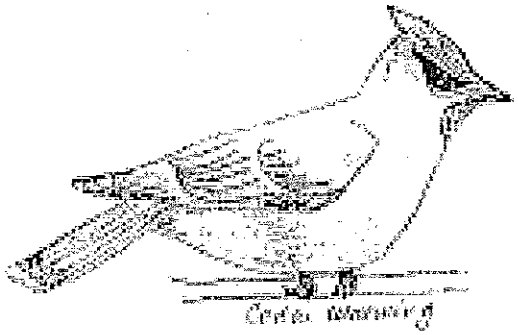
Riparian Bird Beaks and Feet

Below are different birds that live in a Riparian Area. Look closely at their beaks and figure out what food they eat. Look at their feet and legs and write what they are adapted for.



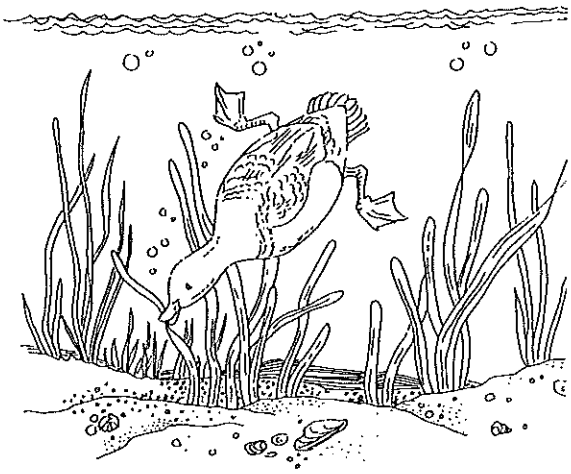
Egret

What type of food does it eat?
Describe the beak:
What do you notice about its feet and legs?



Cedar Waxwing

What type of food does it eat?
Describe the beak:
What do you notice about its feet and legs?

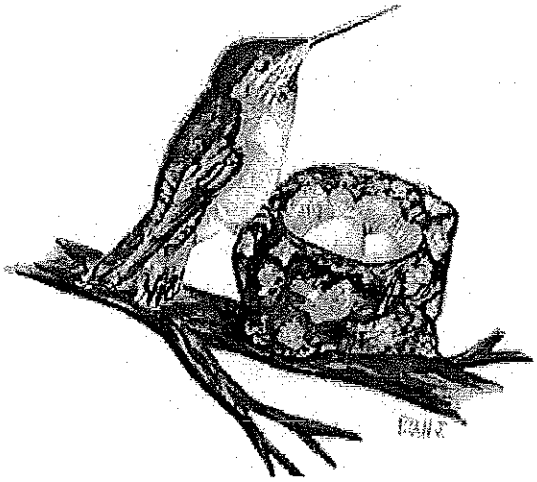


Duck

What type of food does it eat?
Describe the beak:
What do you notice about its feet and legs?

Great Horned Owl
What type of food does it eat?
Describe the beak:
What do you notice about its feet and legs?

Humming bird
What type of food does it eat?
Describe the beak:
What do you notice about its feet and legs?



Importance of Riparian Areas to Wildlife

Riparian habitats offer many benefits to wildlife: They provide safe travel corridors and are critical links between different habitats and areas of undisturbed land. Creeks and the habitat surrounding a creek provide rich food for large and small animals, both herbivores and carnivores. Also, many animals come to a creek to breed including many species of insects, reptiles and amphibians. Creeks and the riparian area are nurseries for these young who live and thrive in different niches of the creek until they mature.

One of the most important reasons riparian areas are so diverse in wildlife is because they contain many microhabitats, allowing a variety of animals to visit or live there year round. Listed below are some microhabitats of the riparian zone and some examples of wildlife adapted for life there.

On Land:

Upland Habitat: This is the area of usually woodland forest that surrounds the channel of the creek on either side. The dense trees and vegetation make great nesting cavities for woodpeckers, wood ducks, owls or other raptors. The close proximity to water and diversity of vegetation makes it great for herbivores such as rabbits and deer.

Ecotone Habitat: This is the area between the stream channel and the vegetated bank. This transitional area can also be called the flood plain. Birds such as swallows and kingfishers occupy this area and swoop at the water in search of food. Small mammals, amphibians and insects also make this area their home.

In Stream:

Running Water: In this habitat few can handle the tugging of water but if you look closely you will see animals that have adapted to these conditions. Stonefly nymphs live in the running water and feed on leaves and debris carried by the current. Caddisfly larvae build a home to surround them made out of debris and rocks, which helps to anchor them in this area. Trout can also be found in the running water areas.

Quiet Water: This microhabitat begins when a creek reaches a flatter area and starts to slow down. Plants can fix their roots more easily here and many species of wildlife that inhabit a pond also inhabit this area of a creek. This includes newts and frogs, turtles, aquatic insects, ducks and other water birds.

Surface of Creek: Within the quiet waters, many insects have adapted to live at the surface of the creek. The most well known being a water strider, who have non-wettable hairs on their feet and lower half of their hind legs that don't break the water surface film.

Mud: The muddy bottom of a creek can be home to many insect larvae, worms, freshwater clams and mussels. The mud is also important for some animals to lay dormant in during colder months.

Napa River Eco Reserve Connection

What is a Seed?

The best time for collecting and examining seeds at the Eco Reserve is in late summer thru late fall. The meadow at the entrance of the Eco Reserve is an opportune spot to let kids walk through in big white socks to collect seeds. Students can also collect seeds from the riparian vegetation along the banks of the River. Warn students of the presence of poison oak – its seeds should not be collected. Consider bringing gloves to collect the spiky fruits – like those from teasel or thistle. The students may enjoy dissecting these sharp fruits since they normally would not touch them. A diversity of seed types can be found among plants at the Reserve. Collect buckeyes, radish seeds, acorns, walnuts, rose hips, alder catkins, box elder seeds (helicopters), snowberries, blackberries and grass seeds to demonstrate a nice variety of seed examples.

What is a Seed?

Grade: Third

Location(s)
Fall River Elementary School Grove
Burney Elementary School Grove
Any Outdoor Location Where Seeds Can Be Found

Activity Length:
30-60 minutes

Materials:
Seed Journal Sheets
White Socks
Hand Lenses

Preparation:
None

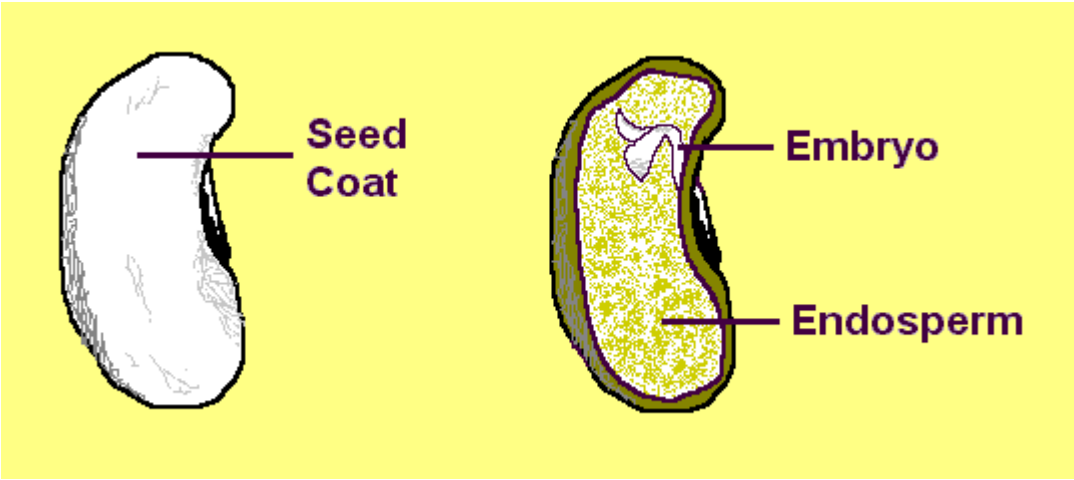
Activity:

- Discuss the parts of a seed (see info sheet attached)
- Gather seeds (You may want to try having students collect seeds by wearing white socks while walking in the area. Seeds will stick to the bottoms of the socks.)
- Compare seeds
- Complete the attached Seed Journal worksheet

Compiled by FRJUSD teachers and Spring Rivers Foundation.

Parts of the Seed

Plant seeds come from flowers and fruits in many shapes and sizes. The fruit of a plant contains many seeds. Think about the number of seeds in a watermelon. When the fruit leaves the plant it starts to decay. This allows the seeds inside to reach the soil where they can grow into new plants. These seeds are sometimes pushed into the soil by rain. Animals like squirrels and chipmunks bury seeds as well.



Look at the diagram of the seed. When seeds are planted in the soil they absorb water. As temperatures become warmer the cells of the embryo inside the seed begin to divide and the embryo grows. The embryo uses the stored food within the endosperm to grow and it eventually breaks through the seed coat. The roots sprout and it is now a new plant. The sprouting of a new plant is called germination.

The roots of this new plant take in minerals and water to help it grow. As the stem grows up, leaves begin to appear. The leaves help the plant make its own food. The plant becomes an adult plant that will develop flowers. The flowers develop seeds and the reproduction cycle begins again.

http://www.myschoolhouse.com/courses/O/1/125.asp

Name_____ Date_____

Comparing Seeds

Name of Plant	Name of Plant
Number of Seeds	Number of Seeds
Type of Seeds	Type of Seeds
Drawing or sample of Seeds	Drawing or sample of Seeds

Name of Plant	Name of Plant
Number of Seeds	Number of Seeds
Type of Seeds	Type of Seeds
Drawing or sample of Seeds	Drawing or sample of Seeds

Napa River Eco Reserve Connection

Seeds of All Kinds – Sort and Hunt

The best time for collecting and examining seeds at the Eco Reserve is in late summer through late fall. The meadow at the entrance of the Eco Reserve is an opportune spot to let kids walk through in big white socks to collect seeds. Students can also collect seeds from the riparian vegetation along the banks of the River. Warn students of the presence of poison oak – its seeds should not be collected. Consider bringing gloves to collect the spiky fruits – like those from teasel or thistle. The students may enjoy dissecting these sharp fruits since they normally would not touch them. A diversity of seed types can be found among plants at the Reserve. Collect buckeyes, radish seeds, acorns, walnuts, rose hips, alder catkins, box elder seeds (helicopters), snowberries, blackberries and grass seeds to demonstrate a nice variety of seed examples.

A note about teasel seeds and removal efforts at the Reserve:

According to the University of Illinois's Prairie Research Institute, "A single teasel plant can produce over 2,000 seeds. Depending on conditions, up to 30-80% of the seeds will germinate, so each plant can produce many offspring. Seeds also can remain viable for at least 2 years. Seeds typically don't disperse far; most seedlings will be located around the parent plant. Parent plants often provide an optimal nursery site for new teasel plants after the adult dies. Dead adult plants leave a relatively large area of bare ground formerly occupied by their own basal leaves that new plants readily occupy. Seeds may have the capacity to be water-dispersed, which may allow seeds to be dispersed over longer distances. Immature seed heads of cut-leaved teasel are capable of producing viable seed." This makes teasel very hard to eradicate and the Open Space District has been working for years to remove teasel from the Reserve.

Quick & Easy Habitat Education Activities

Seeds of All Kinds Sort

Developed by Heidi Bohan/ Starflower Foundation

Third Grade **3-3**
30-40 Minutes
Outdoors/Indoors
Ideally spring- early winter

Description: Students learn about the life cycle of the bigleaf maple seed which is found in a winged 'samara'. They observe other different native plant seed types and discover the actual seeds in berries, capsules, nuts, seed-heads, samaras and cones. This activity is designed to be followed by the *Seeds of All Kinds Hunt* activity.

Objectives:

- Students understand that seeds come in many forms, sometimes not easily seen.
- Students study and sort many different seeds.

Print Materials:

- 'How-to-do Activity: Seed Samples'
- Images: 'Bigleaf Maple Seed Cycle' poster, 'Seeds of All Kinds' poster, 'Seeds of All Kinds Poster Overlay'
- Master: 'Seeds of All Kinds' graphic organizer, 'Bigleaf Maple Seed Cycle' drawing

Kit Materials:

- 'Seed Samples' (see 'How-to-do Activity')
- 'Wheat Samples': seedhead, groats, flakes, flour*- in individual baggies

Teacher supplied:

- Fresh berries (6 of each species) to be used as part of 'Seed Samples'. Suggestions: Fall and winter- rose hips, salal berry, snowberry, evergreen huckleberry; Spring- salmonberry, strawberry; All seasons- blueberries, blackberries, strawberries*
- Copies of 'Seeds of All Kinds' graphic organizer
- Optional: Copies of 'Bigleaf Maple Seed Cycle' drawing: 1 per student

**Available in grocery stores*

Vocabulary

Germinate: *to cause to sprout or develop*
Reproduce: *to produce new individuals of the same kind*
Reproduction: *the process by which plants or animals give rise to offspring*
Seed: *the fertilized part of a flowering plant that can produce a new plant*
Sprout: *to grow, spring up, come forth; to send out new growth*

Washington State EALRs

Science 1.1 Properties: Understand how characteristics are used to categorize life in living systems.
Science 1.2 Structures: Understand how components describe living systems.
Science 1.2.1 Identify parts of a system and how they go together; describe the function of a part of a system such as a natural or living thing.
Science 1.2.6 Know that living things are made of small parts. Observe how living things look different under a magnifier.
Science 3.3.4 Understand how humans and other living things depend on the natural environment.

Science Kit: Plant Growth & Development

Before activity: Organize students into 6 study groups (See 'How-to-do Activity'). Place fresh berries for students to study into sets of 6 separate plastic baggies (see Materials for suggested seeds). This allows students to find seeds in fresh berries.

Activity:

- Gather in habitat area. State that, "Most plants reproduce by seeds. Reproduce means 'to make more of themselves'."
- Show image of 'Bigleaf Maple Seed Cycle'. Read from poster label and discuss the bigleaf maple seed cycle.
- Show 'Seeds of all Kinds' poster with a variety of seeds. "There are thousands of types of plants in the Pacific Northwest, and thousands of different kinds of seeds. These are some of the many types of native seeds from the Pacific Northwest". Discuss and describe the differences in their characteristics (size, color, etc.) and types (pod, cone, nut, etc.)
- Discuss how seeds are very important, and not just for making new baby plants. They are important to animals, including humans, as food. "We love to eat seeds!" Explain. (Bread, peanut butter, cookies, popcorn, corn on the cob, peas, chocolate, vanilla, etc.) Show 'Wheat Samples: seedhead, groats, flakes, flour', which are used for cookies, cereal, muffins, pancakes and breads. Discuss examples of seeds that are food for people. Discuss how seeds are important for wildlife (many birds and small animals eat seeds).
- Divide students into 6 study groups. State that, "Some seeds are easy to see and others are harder." (i.e., seedheads with clearly visible seeds versus ones that are inside a shell, fruit, cone, etc.) Point out a seed on the poster, or a sample, that is easy to see (grass, nuts), then ones that are harder to see (berries, pods).
- Pass out a set of 'Seed Samples' and a baggie of fresh berries to each of the six groups (each group should have five or more seed types) and ask students to point out the seeds. For example:
    - Fresh or dried berries- have students find the seeds inside the berry.
    - Cattail catkin- have students look for the tiny seeds and discuss how many seeds.
    - Douglas fir cone- look for the seeds under the bracts of the cone.
    - Oregon Ash samara- look for the seed inside the hull.
    - Hazelnut- show example of the seed inside the nut.
- Pass out 'Seeds of all Kinds' graphic organizer. Ask students to draw a picture of one of their seed samples in its correct box on the graphic organizer. Have them repeat the process for each of their seed samples.
- Summarize: Seeds come in many different forms, and can be of all sizes and shapes. Some seeds are hidden and some seeds are not. Seeds are important food for people and wildlife.
- Optional: Students can color in the 'Bigleaf Maple Seed Cycle' drawing.

Extension: Place a fresh closed cone (fir, pine, etc.) in a paper bag. Place in a warm spot and observe how many seeds are released.

BIG LEAF MAPLE SEED CYCLE

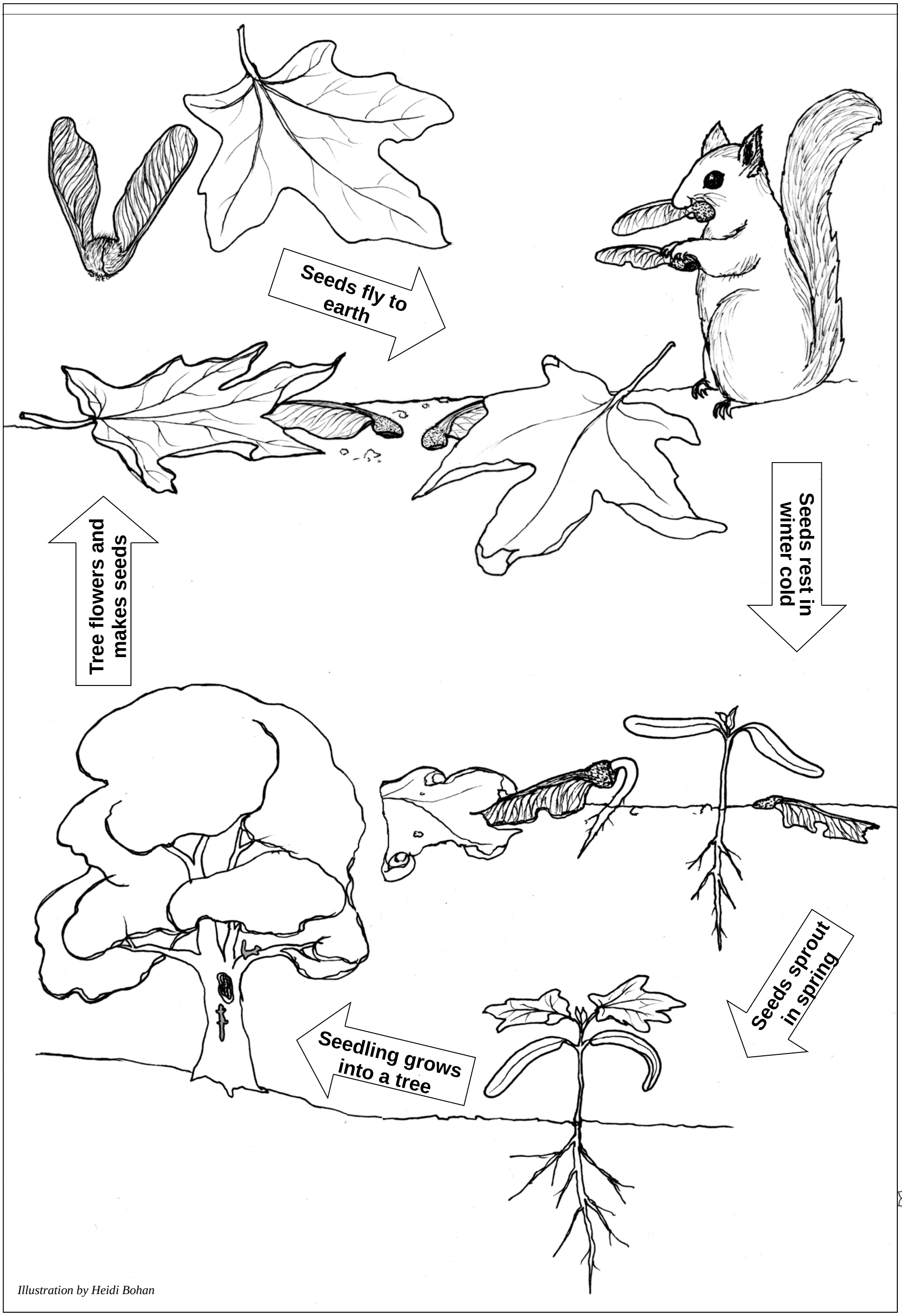


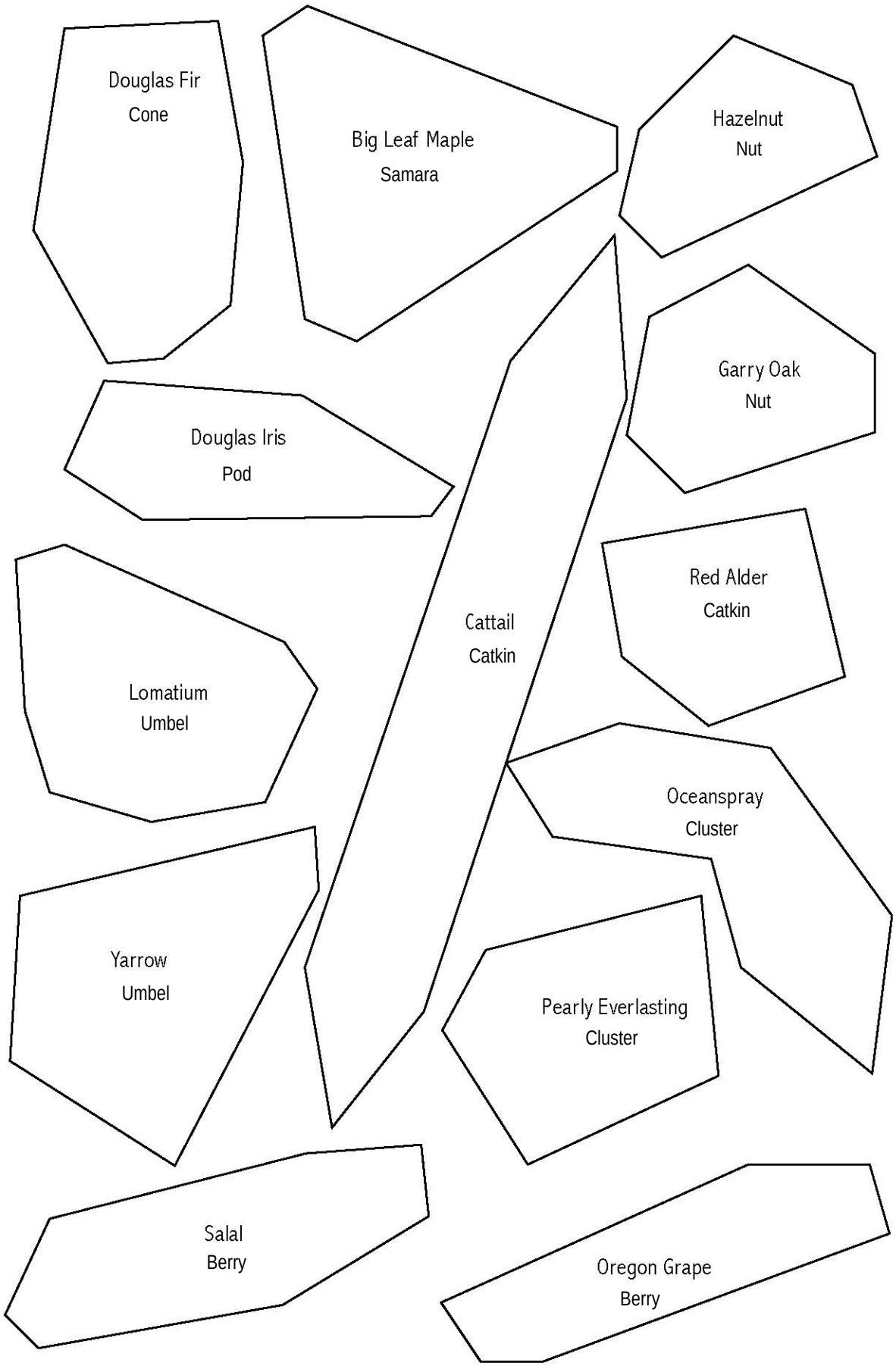
Illustration by Heidi Bohan

SEEDS OF ALL KINDS

Photos by Heidi Bohan

Seeds of All Kinds

Poster Overlay



Quick & Easy Habitat Education Activities

Seeds of All Kinds Hunt

Developed by Heidi Bohan/ Starflower Foundation

Third Grade 3-4
30-40 Minutes
Outdoors: Ideally spring- early winter

Description: Students go into the habitat area and use a scavenger hunt form to locate seeds based on their characteristics. The habitat area is set up in advance to help lead students to a variety of seeds that match these characteristics. This activity is designed to follow the *Seeds of All Kinds Sort* activity which introduces students to a variety of seed characteristics.

Objectives:
- Students use reading and observation skills to locate seeds that match descriptions on a form.
- Students observe and describe many different characteristics of seeds

Print Materials:
- 'How-to-do Activity: Suggested Plants'
- Master: 'Seed Scavenger Hunt'

Kit Materials:
- Foam core clipboards: 1 per student

Teacher supplied:
- Labels copied, cut and prepared for hanging (see 'How-to-do Activity')
- Copies of 'Seed Scavenger Hunt': 1 per student
- Student journals and pencil: 1 per student

Vocabulary
Seed: *a fertilized part of a flowering plant that can produce a new plant*
Characteristic: *a distinguishing trait or property, something that identifies a thing*

Washington State EALRs
Science 1.1 Properties: Understand how characteristics are used to categorize life in living systems. **1.1.6** Understand characteristics of living organisms. Identify observable characteristics of living organisms.
1.2 Structures: Understand how components describe living systems.
2.1.1 Ask questions about organisms based on observations of the natural world. Recognize the question being answered in an investigation.
Reading 1.1 Use word recognition and meaning to read and comprehend text. **1.2** Build vocabulary through reading.
Communication 1.1 Focus attention. **1.2** Listen and observe to gain and interpret information.

Science Kit: Plant Growth & Development

Before activity: Go to habitat area and locate plants that have seeds on them (see 'How-to-do Activity' for details). Label at least 6-10 seed bearing plants with their name or a number.

Activity:
- Bring students to the habitat area and gather in outdoor classroom or gathering area.
- Ask students to make seasonal observations. Notice seeds on the plants. State that, "Seeds are present during all seasons, but are more common in summer and fall." Note the time of year and make observations about how many seeds can be seen.
- Tell students they will be doing a scavenger hunt to find seeds. State that many plants have labels attached to them and that this indicates they have seeds. Other plants may have seeds as well.
- Pass out clipboards and 'Seed Scavenger Hunt' student worksheets.
- "We will look for seeds that match the clues that are listed on the worksheet. These 'clues' are called characteristics and help to describe a seed. All of the plants that have labels on them have seeds. There may be other plants that have seeds that don't have labels. Look to see if they are the same as the plants with labels."
- Say, "Once you find a plant with a label, look at the seeds. On your worksheet look for a clue that matches your seed. Then, write down the name of the plant in the space next to the clue. Some seeds may match several characteristic descriptions and it is okay to write down a plant name in more than one description. If you find a plant with seeds that doesn't have a label, look around for one just like it that does. If there isn't one, create an imaginary name and remember where the plant is to show others later.
- Begin scavenger hunt. Assist students in locating plants and matching their seeds to the appropriate descriptions. After about 10 minutes, ask students to finish filling out their form.
- Go through the habitat as a group and share results. If students did not find a plant to match a description discuss why. If seeds are not present discuss why (e.g., nuts and berries may only last a short while before wildlife eat them; cones occur on conifers which may not be present in your habitat or may not be mature enough to be producing them, or it may be the wrong season). What might be a plant whose seed matches that description, even if it is not present in the habitat?
- Student journal**:** Find and draw a picture of a pod, cone, berry, etc. Write an expository description about its characteristics such as color, shape, texture, type. Label where the actual seed is located in the seedpod, cluster, catkin, berry, cone, nut or samara.

HOW-TO-DO ACTIVITY- SEEDS OF ALL KINDS HUNT
SUGGESTED PLANTS

Labeling Plants for Activity

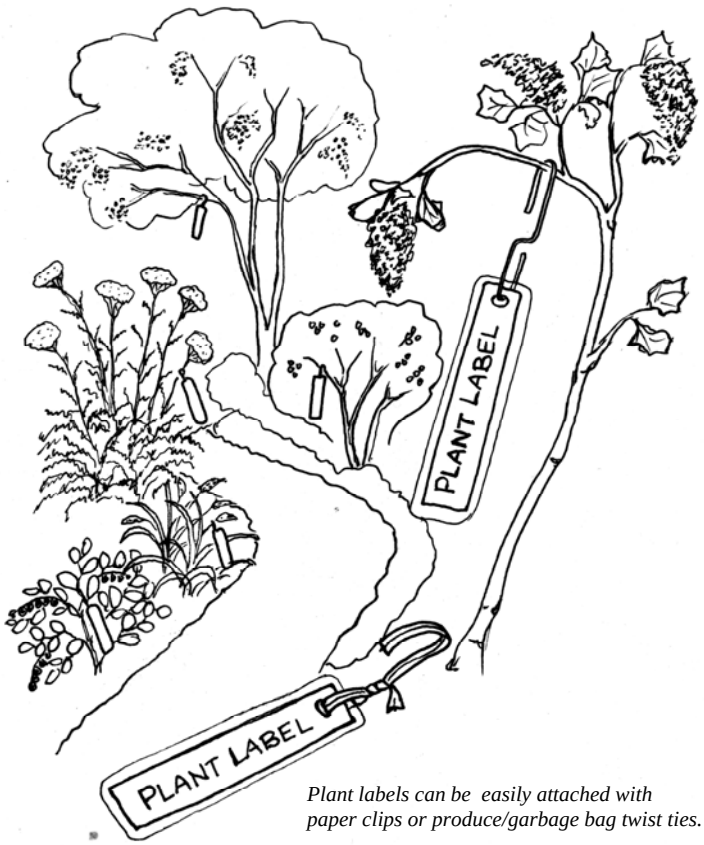
The following are common native plants, listed by habitat type and season, from which you are likely to find seeds matching the descriptions on the student worksheet 'Seed Scavenger Hunt'. They are listed by the habitat type in which they are found and season in which they bear seeds.

Look for a variety of seeds with different characteristics matching the clues on the scavenger hunt form. Provide a range of plants that include as many different clues as possible.

After locating at least six plants with seeds on them in your habitat, identify each with a 'plant label' which students will use during the activity. Use Native Plant ID cards, field guide, personal or expert knowledge to identify.

Write the name or number on paper then laminate and cut into labels. Use a hole punch to create a hole, and use 'twist ties', paper clips, wire or twine to attach labels to the plants.

If you are unable to identify a plant, simply number the plant, (or give it a fun imaginary name). The name is usually less important than other botanical and ecological knowledge when teaching and learning about plants.



Plant labels can be easily attached with paper clips or produce/garbage bag twist ties.

MEADOW PLANTS

Plant Species	Fall	Winter	Spring	Summer	Possible Clues Note: All seeds are food for wildlife
Pearly everlasting	X	X		X	White, fluffy, can fly in the air, smaller than a pinhead
Iris			X	X	In a seedpod, brown
Wild Rose	X	X	X	X	In a seedpod, red, a berry
Sedge	X	X		X	Brown, smaller than a pinhead
Fireweed	X	X			Fluffy, white, can fly in the air, smaller than a pinhead
Goldenrod	X	X		X	Fluffy, can fly in the air, smaller than a pinhead
Lupine	X		X	X	Brown, in seed pod
Camas			X	X	Brown, smaller than a pinhead
Nodding onion, wild onion	X			X	Brown (black), smaller than a pinhead
Yarrow	X	X		X	White, fluffy, smaller than pinhead, in a cluster
Red columbine	X			X	In a seedpod, smaller than a pinhead, (not red)
Grasses	X	X		X	Brown, white, in a cluster, smaller than a pinhead
Asters	X	X			White, fluffy, smaller than a pinhead, can fly in the air
Willow			X	X	In a cluster, brown, smaller than a pinhead

FOREST PLANTS

Plant Species	Fall	Winter	Spring	Sum-mer	Possible Clues
Vine or Big leaf maple	X	X		X	Flies through the air, has wings, a nut
Snowberry	X	X			Berry, white
Hawthorn	X			X	Berry, red
Red alder	X	X	X		Brown, flies through the air, has wings
Douglas fir Western hemlock Red cedar	X	X		X	Brown, has wings
False lily of the valley	X			X	Berry, brown, red
False Solomon's seal	X			X	Berry, brown, red
Red huckleberry	X			X	Berry, red
Bleeding heart	X		X	X	In a seedpod
Salal Oregon grape	X			X	Berry, blue
Bitter cherry	X			X	Berry, red
Oceanspray	X	X	X	X	Brown, smaller than a pinhead, in a cluster
Goat'sbeard	X	X		X	Brown, smaller than a pinhead, in a cluster
Evergreen huckleberry	X	X			Blue, berry
Wild rose	X	X	X	X	Berry, red, black
Red elder			X	X	Red, berry, in a cluster
Red flowering currant	X			X	Berry, blue

WETLAND PLANTS

	Fall	Winter	Spring	Sum-mer	Possible Clues
Cattail	X	X		X	Brown, fluffy, flies through the air, white
Sedges and rushes	X	X		X	Brown, smaller than a pinhead, in a cluster
Tufted hairgrass	X			X	Smaller than a pinhead, brown, in a cluster
Camas	X	X			Brown, smaller than a pinhead, in a seedpod
Aster	X			X	White, flies through the air, fluffy
Red osier dogwood	X	X			White, berry, not red
Pacific ninebark	X			X	Brown, in a cluster
Goat'sbeard	X			X	Brown, smaller than a pinhead, in a cluster
Twinberry	X			X	Berry, blue, red, in a cluster
Douglas spirea	X	X		X	Brown, in cluster, fluffy
Red elderberry			X	X	Red, in a cluster, a berry
Willow			X	X	In a cluster, fluffy, brown, smaller than a pinhead
Black cottonwood			X	X	Fluffy, flies through the air, smaller than a pinhead, white, brown

Seed Scavenger Hunt

Find a seed that matches the clue.

Write down the name of the plant on which you see it.

Can fly in the air: _____

Is in a seed pod:_____

Is smaller than a pinhead: _____

Is in a cluster: _____

Is food for wildlife: _____

Is white: _____

Is red: _____

Is brown/black:_____

Is blue: _____

Has wings: _____

Is in a berry: _____

Is fluffy: _____

Is germinating: _____

Is in a cone: _____

Student name:

Seed Scavenger Hunt

Find a seed that matches the clue.

Write down the name of the plant on which you see it.

Can fly in the air: _____

Is in a seed pod:_____

Is smaller than a pinhead: _____

Is in a cluster: _____

Is food for wildlife: _____

Is white: _____

Is red: _____

Is brown/black:_____

Is blue: _____

Has wings: _____

Is in a berry: _____

Is fluffy: _____

Is germinating: _____

Is in a cone: _____

Student name:

Napa River Eco Reserve Connection

Creek Plant ID

This activity emphasizes the importance of a healthy riparian area for fish and wildlife. The Napa River Eco reserve is one of the last remaining intact stretches of riparian forest in the Napa Valley. To emphasize this point, show students the attached aerial photo that shows a dark corridor of trees around the river surrounded by development on all sides. When looking at this photo, ask students to name reasons that a healthy riparian corridor is so vital for any stream.

To introduce students the plants that are typically present in riparian areas in Napa County, take students for a walk around the interpretive plant loop located to the west of the main path through the Eco Reserve. Along this loop they can see and touch the native plants that are common in the Reserve while learning the common and scientific names of each plant.

Additionally, students can use Pacific Tree Finder Guides to identify plants found along the river in the Eco Reserve. A set of these guides can be borrowed from the Napa RCD.

Activity 23

Creek Plant ID

Summary: *Students use field guides and to identify and inventory native and nonnative plants at a creek and create their own local guides.*

Grades: 3-12

Time: 1 hour

Setting: Classroom

Materials:
- *Pacific Tree Finder* identification books, one for each group
- Blank paper folded in half
- Crayons or colored pencils
- Clipboards
- Branch of a native riparian tree

Key Concept:
- Plants can be identified and grouped by certain characteristics.

Objectives:
Students will:
- Identify different plants and trees at the local creek
- Make observations, rubbing and note characteristics of the plants
- Create a local Riparian plant field guide

Supports California Content Standards:
SCIENCE
- Life Science
- Investigation and Experimentation
- Ecology
- Structure and Function in Living Systems
- Evolution

MATH
- Number Sense
- Statistics and Data Analysis

LANGUAGE ARTS
- Reading
- Writing
- Listening and Speaking

HISTORY/SOCIAL SCIENCE
(for details see the Standards Matrix)

Background

The stream together with the land adjacent to the stream is called the **riparian corridor**. Riparian corridors are an important resource and support a diversity of habitats and a variety of aquatic and terrestrial plants and animals.

A healthy riparian corridors can:
- Reduce erosion and sedimentation
- Act as a buffer for urban runoff pollution.
- Support populations of birds and other animals
- Provide food, shelter, and migration routes for animals, including amphibians and reptiles
- Provide food and cover for other wildlife that move between upland areas and the stream

Historically the creeks that now run through urban areas had relatively wide corridors of natural vegetation. Most of these riparian corridors have been altered by stream channelization and urban development, resulting in the removal of native and in many cases all, vegetation. Homes, businesses, farms, parks and other land uses—along with the need for flood control-- have encroached on the natural riparian corridor. Our urban creeks now have narrow (if any at all) bands of vegetation. Often native plants have been replaced by non-natives, or taken over by invasive species.

Common native riparian trees includes willow (*Salix* sp.), alder (*Alnus* sp.), box elders (*Acer negundo*), Fremont cottonwood (*Populus fremontii*), bigleaf maples (*Acer macrophyllum*), western sycamore (*Platanus racemosa*), and oaks (*Quercus* sp.).

Activity

1. Find out what the students already know about plants that grow near creeks. Ask them why do so many trees and other plants grow by creeks? Why are trees and other plants necessary for the creek to be a healthy environment?
2. Introduce the term **riparian corridor.** Often you can trace the path of a creek by following the "green path" made by its associated trees and plants. This path of green plants along a stream bank is called the riparian corridor. The plants in it are flourishing because of the moisture that the stream provides both above and below the ground.
3. Introduce the terms **native** and **nonnative** and explain that some plants occur naturally in an area and are called natives and others have been brought into an area (or introduced) and they are called non-natives or aliens.
4. Using a branch and leaves from a native tree, demonstrate the use of the *Pacific Tree Finder* to identify the tree that the branch came from. This will help the students (or adult helpers for each group) learn how to use the book to identify trees in the field.
5. Divide the class into groups of four and give each group a clipboard, paper folded in half for drawing or rubbings, and crayons or colored pencils. They will also need a *Pacific Tree Finder* field guide.
6. Have the groups identify as many plants as they can and create their own field guide of riparian plants for your local creek. They will need to make a rubbing or drawing of the leaves and write down any identifying marks or characteristics.
7. Back in the classroom they can put all their pages together and create a field guide.

Discussion

- At the creek site, did students notice any erosion? Did the site where they noticed erosion have many plants or trees?
- Do they think any of the trees or plants they identified would be good shelter for wildlife? What kind of wildlife?
- Which trees and plants from their field guide would be good for shading the creek to keep it cool?
- Was one plant more plentiful then others? Why do they think this has happened?

Branching Out

Language Arts:

- Students can become 'naturalists' and teach each other about the plants at the creek. Make a list of plants that you know you will find at the creek. Have each student choose one plant to research. Return to the creek and let the students take the class on a tour. Stop at the different plants for a informative talk from a student
- Contact your local native plant society for a classroom visit. Have them speak to your student about the variety and importance of riparian plants.

Mathematics:

- Students can research populations and censuses from 20 or more years ago about riparian plants. Have them create statistics on how much riparian corridor depletion has happened over the 20 years.
- Students can create a bar graph showing populations of plants in your own creek.

Arts:

- Create a mural of the riparian plant community
- Have students think of environmental awareness campaigns about riparian plant and tree loss. For example they could create posters on paper recycling in your school.

Napa River Eco Reserve Connection

Habitat Loss and Salmon

Connect this activity to the Eco Reserve by explaining what great habitat the Eco Reserve is for Salmon and other fish of the watershed. Explain to the students there is a Chinook salmon population in the Napa River and they need healthy riparian areas, shade, cool water, food, and clean spawning gravel in order to survive.

The Napa RCD monitors salmonid populations by collecting data on the number of smolts migrating to the ocean each year. A smolt is a young steelhead or salmon that is migrating downstream to begin the saltwater phase of its life. The RCD uses an 8-foot rotating fish trap located in the Napa River to catch, measure, and release these fish in order to generate population estimates and collect genetic samples. In addition to salmonids, data is collected on other Napa River fishes. To view the latest fish population data, visit the Biological Monitoring section of www.naparcd.org.

Activity 19

Habitat Loss and Salmon

Summary: *Students learn about changes in habitat of a creek and analyze data on the declining winter run salmon population.*

Grades: 2-8

Time: 40 minutes - 1 hour

Setting: Classroom

Materials:
- Recycled paper, one piece for each student
- A copy of *The Salmon Story* for each group of students
- A copy of *Winter Run Chinook Salmon in the Sacramento River Drainage* for each group of students

Key Concept:
- Changing a habitat affects wildlife populations

Objectives:
Students will
- Role play as salmon in a population and habitat destruction activity
- Read informational text about salmon
- Create a graph of population changes in salmon

Supports California Content Standards :
SCIENCE
- Life Science
- Earth Science
- Investigation and Experimentation
- Ecology

MATH
- Algebra
- Mathematical Reasoning
- Statistics and Data Analysis

LANGUAGE ARTS
- Reading
- Writing
- Listening and Speaking

HISTORY/SOCIAL SCIENCE
(for details see the Standards Matrix)

Background
One of the most diverse areas in the world, California has about 30,000 species of insects, 63 freshwater fish, 46 amphibians, 96 reptiles, 563 birds, 190 mammals, and 8,000 plants. Despite our apparent richness, about 20% of these species are listed as endangered, threatened, or "of special concern."

Most scientists agree that habitat loss is the number one threat to wildlife. The diversity of wildlife is being reduced as our ever-increasing human population pollutes or completely destroys the environments these animals need in order to survive. In the San Francisco Bay Estuary, this is especially true. Since the discovery of gold trumpeted the beginning of the population explosion in California, 85% percent of the historic tidal wetlands are now under airports, housing developments, landfills, industrial parks, marinas, and salt ponds. All but a few percent of the Delta's freshwater marshes have disappeared as levees and dikes were built to allow farmers to grow crops. And half of the freshwater that used to flow to the Estuary to mix with the waters of the Pacific are drawn off for cities and farms in other parts of the State. The remaining habitat must contend with increased pollution loads as people dump, drain, bury and find ways to dispose of their waste.

Many species, such as the grizzly bear, antelope, and Xerces blue butterfly, have completely disappeared from the Bay Area. Others are teetering on the edge: more than a dozen species are listed as threatened or endangered. Understanding the detrimental effects of population growth and slowing habitat loss will mean the difference between life and death for the wildlife that remains.

Activity Part One

1. Take an informal poll of the students. How many think that:
    - Their street was once much different than it is now?
    - The San Francisco Bay was different 200 years ago?
    - There were large populations of grizzly bears, bald eagles, and mountain lions here?
2. Discus what students think has happened to much of the wildlife. Are they threatened or extinct? (Discuss these terms)
3. Give each student a piece of paper and have them draw a picture of a riparian area with plants and a creek.
4. Once they are all done, gather together. This piece o f paper is now going to be their habitat.
5. Ask the students to explain to you what a habitat is and why it is important. You want to make sure you get at least these 5 answers - Water, Air, Space, Food, Shelter. Without these 5 things an animal including us cannot live.
6. Use a clear space in the room or outside. Have the students place their papers on the floor and stand on them. They have become Chinook Salmon.
7. Read to them some of the scenarios listed below, after you read one, pull some of their habitats (pieces of paper) away from under them.
8. They can join another student on their habitat square. If a student has two feet on the piece of paper, they are fine and stable. If one foot is on and one foot is off, they have become threatened. With two feet off and no habitat left, they will be extinct.
9. Proceed with the scenarios until many of the students are "Threatened" but none are "Extinct".

Examples of Scenarios

- Someone has moved into the land that is near the creek. With the construction of the house a lot of dirt and debris has gotten into the creek and caused that area of the creek not to be good habitat for you (Remove a couple of paper squares)
- You and your food thrives in cooler water temperatures, more and more riparian trees are being cut down or destroyed. This is causing the creek temperatures to rise and make it not good habitat for you. (Remove a couple of paper squares)
- A truck had an oil spill on the road way but the road is close to the creek and oil seeped through a drain and into the creek causing a huge section of the creek to be very unhealthy to live in. (Remove a couple of paper squares)
- There was very little rain this year and some farms upstream needed to pull water away from the creek. You are becoming limited to areas that are deeper for you to find the food you need. (Remove a couple of paper squares)
- In one section of the creek it was decided to channelize the creek - put it in concrete. You are not able to find very much shelter or food in this area and it is not suitable habitat for you. (Remove a couple of paper squares)

Discussion

- What were some of the reasons the habitat of the salmon was being destroyed?
- How did the students acting as Salmon feel? Where they crowded?
- How can the students make an impact on stopping some of these scenarios from happening and impacting wildlife?
- What would have happened if the game continued? Would anyone have gone extinct?

Activity Part Two

1. Place your students into pairs or small groups. Provide each group with a copy of *The Story of the Salmon* and *Winter Run Chinook Salmon in the Sacramento River Drainage* and have them read it.
2. Give each group a copy of the graph paper worksheet. After reading the article and the data have the students, using the graph paper, graph levels of winter run Chinook salmon believed to be living from 1700 to the present, with NUMBER OF SALMON on the vertical axis, and YEARS on the horizontal axis.

Discussion

- What has been the trend in the winter run salmon population?
- What explains the decline of salmon? (E.g. dams block fish migration, and even if fish ladders are provided fish cannot always find them. Also, dams change rivers by blocking the downstream migration of spawning gravel, and typically the decrease in flow created by dams causes water downstream to be much warmer than the salmon can tolerate.)
- How are populations cyclic? What effects populations to decrease and then increase again?

Branching Out

Language Arts:

- Have students write up a history of their creek or the Bay. Students can try to find information on when parts of the creek were put underground or had their banks cemented, what types of fish or other animals used the creek, or when people began living along the creek and how the creek was integrated into their lives. For example, think about these facts about Strawberry Creek in Berkeley, which help bring its past alive. A waterfall once occupied the current site of the University's Stadium, and a wooded portion of the creek below a railroad trestle near Bonar Street and University Avenue used to be called "Irish Gulch," due to the many fights that occurred there between students from a nearby Catholic grammar school. To help with your research, refer to your *Local Watershed Information* packet for information specific to creeks near your school, and contact some of the historical societies listed in the *Resources for Teachers* section of this binder.
- Students could compile the information they uncover into a written or oral report, or the information could be included with oral history interviews in booklet form.

Mathematics:

- Have students research another local animals' population changes and graph it as well. Are the population changes similar salmon? Have them decide if one is more adaptive to urban changes then the other.

Arts:

- Students can create posters about saving threatened animals to post around the school and the community.

The Story of the Salmon

The survival of salmon is tied to the health of the Bay and the rivers. Salmon and steelhead reach maturity at sea and return to the rivers to spawn. Young salmon spend the early weeks of life in rivers and move quickly through the Delta and Bay to the ocean. Salmon are a major component of the Bay and Delta ecosystem. Aquatic insects and larvae provide food for salmon and steelhead, and these fish become food for other animals. Ohlone Indians depended on salmon runs for food. When Europeans first arrived in California, they were fascinated by the great runs of spawning salmon. The fish seemed limitless. People said that there were so many salmon you could walk across the river on their backs.

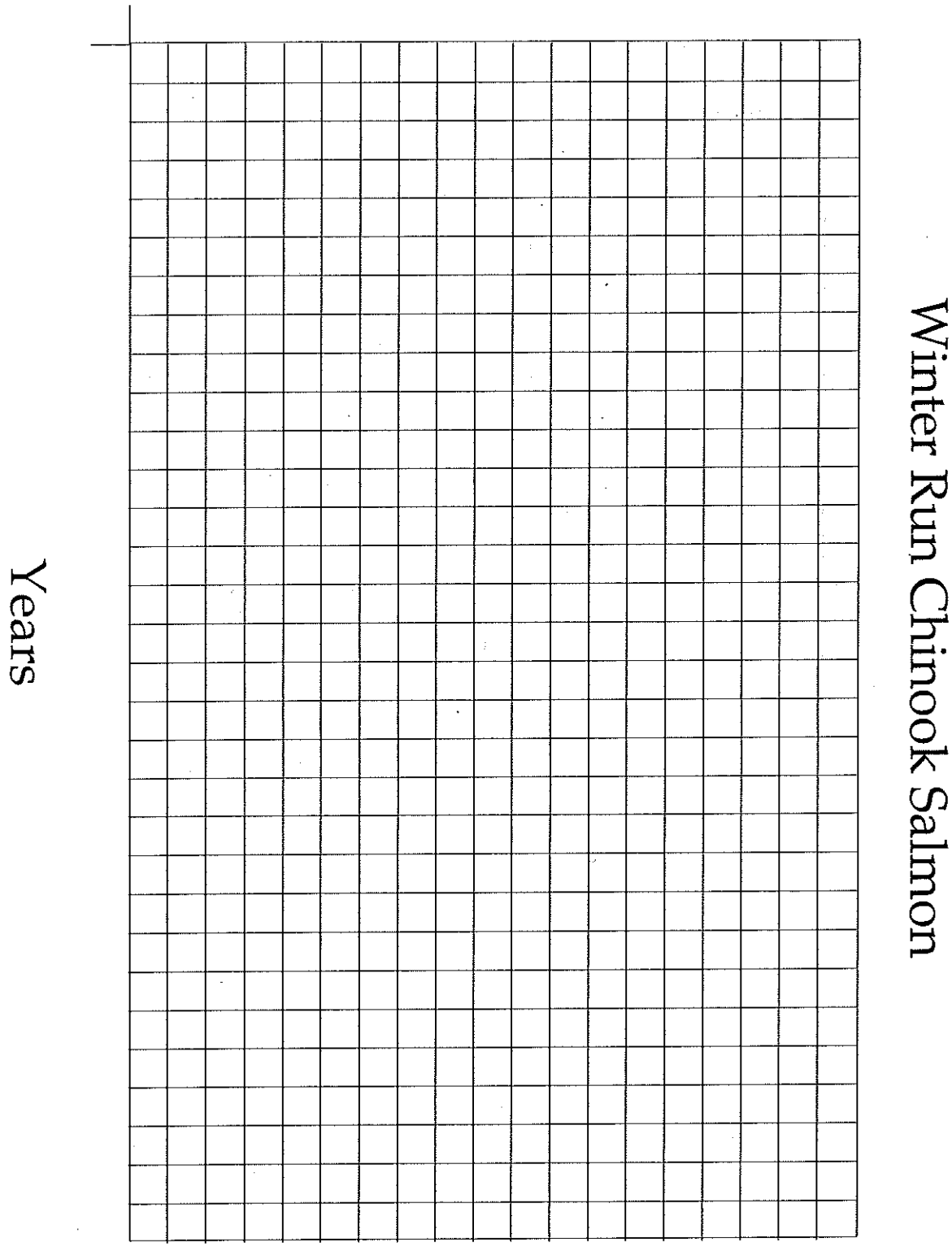
Since the first Europeans settled in California, changes made by humans in the environment have been a continuous threat to these salmon. When gold was discovered in 1848, hydraulic mining clouded many miles of river with silt and destroyed salmon spawning habitat. In the 1880s, commercial fishing for salmon intensified. In the 1950s and 1960s, rivers were dammed for hydroelectric power and for a vast agricultural water supply project, called the Central Valley Project, designed to divert water for crop irrigation. The Red Bluff Diversion Dam on the Sacramento River was particularly responsible for further decline in salmon populations. Highways were built along stream valleys, causing vast hill slopes to be logged and whole mountains to be pushed aside, which contributed more sediment to the streams. During the late 1970s and again in the late 1980s there was a drought. Less water was released from the dams, and the gravel necessary for salmon spawning could no longer move downstream. Fewer salmon returned in the following years. Now the winter run Chinook salmon are so few in number they are thought to be nearly extinct. In 1991 only 191 adults returned to the Sacramento River to spawn. Thirty years ago this salmon population numbered between 100,000 and 200,000 individuals.

Winter Run Chinook Salmon Populations in the Sacramento River Drainage

Date	Number of Salmon in the Winter Run	What Was Happening
1700	~100,000 (estimated)	Rivers and the Bay in a natural condition. The salmon population in a relatively unimpaired state. Salmon were harvested by Native Americans. This continued more or less unchanged until the late 1800s.
1967	57,000	Shasta Dam, built in the early 1940s, closed off the upper portion of the Sacramento River to salmon. Miles of spawning habitat were lost, including the McCloud, Pitt, and Little Sacramento Rivers. Red Bluff Diversion Dam (just south of Red Bluff, CA) built in the mid-1960s, impeded access to another section of the Sacramento river south of the Shasta Dam. Water temperatures below the dam became too high for successful hatching of salmon eggs.
1970	32,000	The salmon smolt (youngsters) should have returned to the river as adults during this year but were not able to due to the Red Bluff Dam built in 1965
1979	2,000	Low precipitation for several years, which caused upstream reservoirs to become nearly empty. The salmon population made a significant decline.
1982	1,200	As a result of the drought of the late 1970s, less water was released from dams, causing increased temperatures in the creek river and reduction of river areas. This resulted in less spawning success.
1989	500	Winter run Chinook salmon were declared endangered.
1991	200	Lowest population level was during the 1990's. During the early part of this decade there was a huge toxic spill in the Sacramento River. Also many years of drought took toll on local creeks.
1997	1,800	More creek awareness and improved conditions in freshwater habitats, resulting in populations starting to increase.
2003	8,500	Favorable oceanic conditions for the salmon causing significant population recovery in the ocean. This leads to good spawning returns to the Sacramento River.

Source: Endangered and Threatened Species: Endangered Status for Winter Run Chinook Salmon. National Oceanic and Atmospheric Administration.

Number of salmon



Napa River Eco Reserve Connection

Riparian Plant Community

The Eco Reserve is the last sizable stand of riparian forest in the Napa Valley. The path along the top of the river bank in the Reserve is a great place to walk with students to show them typical riparian plants. Using the plant diagrams in this activity, students should be able to identify several native riparian plant species. If you would like to identify even more of the trees along the river bank, you can borrow a set of Pacific Tree Finder guides from the Napa RCD.

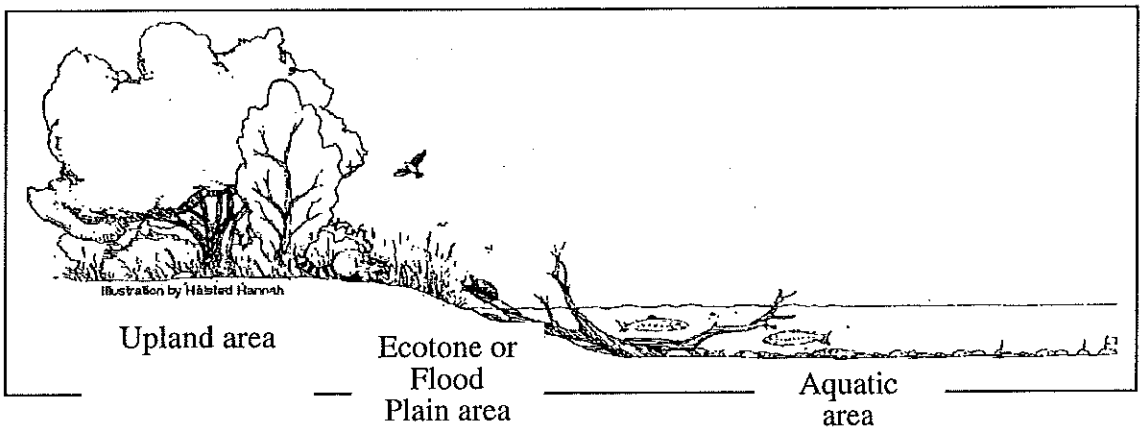
If you would like students to see plants in the aquatic area, the ecotone, and the upland area that are mentioned in this activity, start in the river bed on the gravel bar covered with willow species. Tell the students that these willows are often underwater and this is their preferred environment. Show them how the plants change as you climb the path up the bank because plants have specific places where they like to grow based on their water needs.

You can also take students on a walk around the interpretive plant loop just to the west of the main path through the Eco Reserve to learn the common and scientific names of more native plants.

Riparian Plant Community

Riparian areas are valuable ecosystems that support diverse communities of life. The riparian zone is the area found on the edges of creeks, ponds and lakes. Plant communities that grow in the riparian zone grow best when their root systems are in or near the level of high ground water.

The riparian plant community is three distinctive communities: plants in the aquatic areas; plants in the ecotone; and plants in the upland area. Plants adapted for the aquatic area are accustomed to having wet root zones. In the ecotone or flood plain area, plants are adapted to grow in areas of moist soils and a high water table. The upland area also has moist soils, but the vegetation is riparian species of trees and shrubs.



Riparian vegetation provides cover for aquatic and terrestrial animals. Shade created by the riparian vegetation moderates water and air temperatures. This vegetation limits water contamination, slows water speed and filters and collects large amount of sediment and debris. Uncontrolled sediments can kill fish and macroinvertebrates, and destroy critical aquatic habitats.

Stream food webs depend on organic debris from plants for nutrients. Many macroinvertebrates make use of the plant material that falls in the creek as their main source of food (as well as shelter). In small creeks, a large percentage of the food energy for organisms comes from the vegetation along the stream. The leaves, needles, cones, twigs, wood, and bark dropped into a creek are a storehouse of ready to use organic material that can be processed by aquatic organisms.

Native Bay Area Creek Plants

Trees

Acer macrophyllum, Big leaf maple
Acer negundo var. californicum, California box elder
Aesculus californica, California buckeye
Alnus oregonia, Red alder
Alnus rhombifolia, White alder
Cornus nuttallii, Pacific dogwood
Fraxinus oregona, Oregon ash
Juglans hindsi, California black walnut
Platanus racemosa, Western sycamore
Populus sp., Poplar or Cottonwood
Quercus agrifolia, Coast live oak
Quercus garryana, Oregon oak
Quercus lobata, Valley oak
Salix laevigata, Red willow
Salix lasiandra, Yellow willow
Salix scouleriana, Scouler willow
Sequoia sempervirens, Redwood
Umbellularia californica, Bay or Pepperwood

Shrubs and Vines

Baccharis douglasii, Salt marsh baccharis
Calycanthus occidentalis, Spicebush fescua
Clematis lasiantha, Pipe-stem clematis
Clematis ligusticifolia, Wild clematis
Cornus glabrata, Brown or Smooth dogwood
Cornus stolonifera, Redtwig dogwood
Corylus cornuta, var. *californica*, Western hazelnut
Dirca occidentalis, Leatherwood
Euonymus occidentalis, Native euonymus
Lonicera hispidula var. vacillans, Wild honeysuckle
Lonicera involucrata, Twinberry honeysuckle
Myrica californica, Bayberry or California wax myrtle
Physocarpus capitatus, Ninebark
Prunus emarginata, Bitter cherry
Prunus subcordata, Pacific plum
Rhododendron occidentale, Western azalea
Rhus trilobata, Squaw bush
Ribes aureum, Golden currant
Ribes divaricatum, Wild gooseberry
Ribes menziesii, Canyon gooseberry
Ribes sanguinium, Red flowering currant
Rosa californica, California rose
Rubus parviflorus, Thimble berry
Rubus spectabilis, Salmon berry
Rubus vitifolius, California blackberry
Salix coulteri, Velvet willow
Salix hindsiana, Sandbar willow
Salix lasiolepis, Arroyo willow
Sambucus callicarpa, Red elderberry
Sambucus caerulea, Blue elderberry
Sambucus velutina, Mexican elderberry
Symphoricarpos albus, Snowberry
Toxicodendron diversilobum, Poison oak

Grasses, Sedges, Rushes

Calmagrostis nutkaensis, Sand reed grass
Carex nudata, Sedge
Eleocharis macrostachya, Spike rush
Elymus triticoides, California blue rye
Elymus condensatus, California blue rye
Equisetum hyemale, Common horsetail
Equisetum telmateia, Giant horsetail
Festuca californica, California fescue
Glyceriz leptostachya, Manna grass
Hystrix californica, Squirreltail
Juncus effusus, Rush
Muhlenbergia nigens, Muhley grass
Phalaris californica, Canary grass
Scirplus microcarplus, Bulrush
Typha sp., Cattails

Ferns

Adiantum pedatum, Five-finger fern
Athyrium filix-femina, Lady fern
Blechnum spicant, Deer tongue fern
Dryopteris arguta, Wood fern
Pityrogramma triangularis, Goldback fern
Polypodium californicum, California ground fern
Polystichum munitum, Western sword fern
Woodwardia fimbriata, Giant chain fern

Herbaceous and Flowering Plants

Aralia californica, Elk clover
Artemisia douglasiana, Sagebrush
Asarum caudatum, Wild ginger
Dicentra formosa, Western bleeding heart
Epipacatis gigantea, Stream orchid
Fragaria californica, California strawberry
Heuchera micrantha, Alum root
Mimulus cardinalis, Scarlet monkey flower
Mimulus guttatus, Seep-spring monkey flower
Montia perfoliata, Miner's lettuce
Oxalis oregana, Redwood sorrel
Rumex salicifolius, Willow-leaved dock
Tolmiea menziesii, Piggy-back plant
Trillium sp., Trillium

Native Riparian Plant Graphics and Fact Sheets

CATTAIL
Typha domingenis

- Common along freshwater marshes, lakes, and slow streams
- Long slender leaves reach 6 to 9 ft.
- Has cinnamon-brown flower clusters; blooms in June and July

SWORD FERN
Polystichum munitum

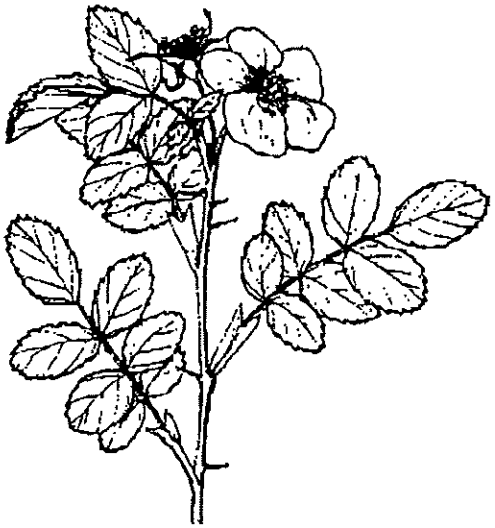
- Common in damp woods, mosty below 2,500 feet
- 24 to 56 inches tall
- Evergreen

BLACKBERRY
Rubus ursinus

- Common in meadows, canyons, and damp places
- Leaves in groups of three; oval, doubly toothed and prickly
- Evergreen trailing prickly shrub, rooting flower stem up to 20 feet high
- White flowers, produces edible fruit, blooms March to June

WILD ROSE
Rosa californica

- Occurs near streams below 6,000 feet
- Leaves composed of five to seven oval slightly-toothed leaflets
- Erect, branched shrub armed with stout prickles; three to five feet tall



POISON OAK
Toxicodendron diversilobum

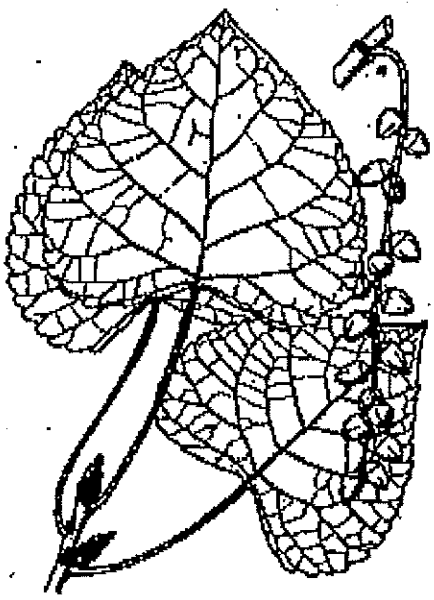
- Common in thickets and wooded slopes along streams (causes painful dermatitis to humans)
- Three-part lobe leaflets; leaves of three
- Fruits are important food source for wildlife
- Erect shrub, 3 to 6 feet tall

RED WILLOW
Salix laevigata

- Occurs along streams below 5000 feet
- Leaves are pointed and finely toothed; light green on top, paler and cloudy on the underside
- Tree with rough bark and reddish-brown twigs; 15 to 45 feet tall

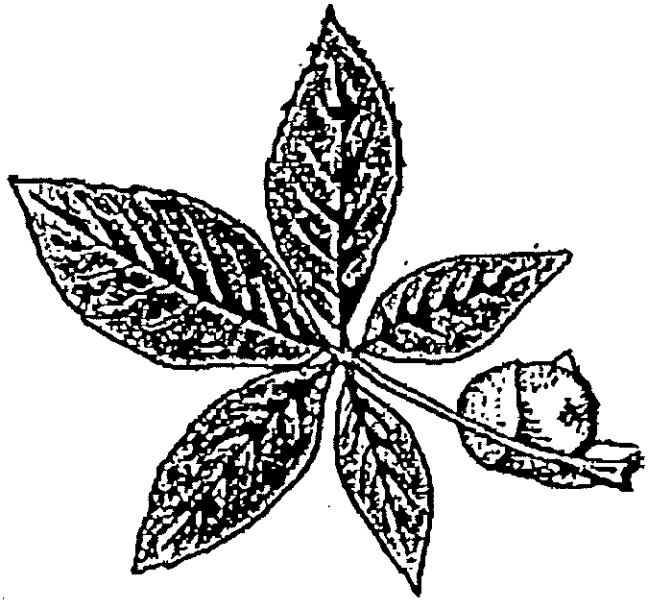
BLACK COTTONWOOD
Populus trichocarpa

- Common along streams below 9,000 feet
- Finely toothed pointed leaves on long stems; dark green above and pale beneath
- Tall open crowned deciduous tree with grayish bark—180 to 240 feet tall



BUCKEYE
Aesculus californica

- Common in canyons and on dry slopes
- Palmate leaves with 5 to 7 leaflets
- Large deciduous bush or tree with broad round top, to 21 feet



CALIFORNIA BAY
Umbellelaria californica

- Common in riparian corridors below 5,000 feet
- Long, oblong, aromatic leaves
- Tree with broad crown up to 90 feet, or erect shrub in drier places

VALLEY OAK
Quercus lobata

- Occurs on floodplains, valleys, and slopes below 2,000 feet
- Leaves have two to five rounded lobes
- Deciduous tree with open head, 35 to 100 feet tall, thick bark in cube-like plates

Common Riparian Plants in Napa County

Trees

BALD CYPRESS FAMILY - TAXODIACEAE
- Coast Redwood - *Sequoia sempervirens*

BIRCH FAMILY - BETULACEAE
- White Alder - *Alnus rhombifolia*

HORSE CHESTNUT FAMILY - HIPPOCASTANACEAE
- California Buckeye - *Aesculus californica*

LAUREL FAMILY - LAURACEAE
- California Bay - *Umbellularia californica*

MAPLE FAMILY - ACERACEAE
- Big-leaf Maple - *Acer macrophylla*
- Box Elder - *Acer negundo*

MYRTLE FAMILY - MYRTACEAE
- Blue Gum Eucalyptus - *Eucalyptus globulus* (native to Australia)

OAK FAMILY - FAGACEAE
- Valley Oak - *Quercus lobata*
- Coast-live Oak - *Quercus agrifolia*
- Canyon Oak - *Quercus chrysolepis*

OLIVE FAMILY - OLEACEAE
- Oregon Ash - *Fraxinus latifolia*

PEA FAMILY - FABACEAE
- Black Locust - *Robinia pseudoacacia* (native to Eastern U.S.)
- Acacia - *Acacia sp.* (native to Australia)

PINE FAMILY - PINACEAE
- Douglas Fir - *Pseudotsuga menziesii*

ROSE FAMILY - ROSACEAE
- Cherry Plum - *Prunus cerasifera* (native to SE Europe)

SIMAROUBA FAMILY - SIMAROUBIACEAE
- Tree of Heaven - *Ailanthus altissima* (native to China)

WALNUT FAMILY - JUGLANDACEAE
- California Walnut - *Juglans californica*

YEW FAMILY - TAXACEAE
- California Nutmeg - *Torreya californica*

WILLOW FAMILY - SALICACEAE
- Fremont's Cottonwood - *Populus fremontii*
- Red Willow - *Salix laevigata* (sometimes shrub)

Common Riparian Plants in Napa County

VINES

DOGBANE FAMILY - APOCYNACEAE

PERIWINCKLE - *VINCA MAJOR* (native to Europe)

GRAPE FAMILY - VITACEAE

California Grape - *Vitis californica*

Wine Grape - *Vitis vinifera* (native to Europe)

GINSENG FAMILY - ARALIACEAE

English Ivy - *Hedera helix* (native to Europe)

PIPEVINE FAMILY - ARISTOLOCHIACEAE

Dutchman's Pipe - *Aristolochia californica*

SHRUBS

DOGWOOD FAMILY - CORNACEAE

Brown Dogwood - *Cornus glabrata*

American Creek Dogwood - *Cornus sericea*

GINSENG FAMILY - ARALIACEAE

Spikenard - *Aralia californica*

GRASS FAMILY - POACEAE

Giant Reed - *Arundo donax* (Native to Eurasia)

HONEYSUCKLE FAMILY - CAPRIFOLIACEAE

Blue Elderberry - *Sambucus mexicana*

Snowberry - *Symphoricarpos albus var. laevigatus*

ROSE FAMILY - ROSACEAE

California Rose - *Rosa californica*

Ninebark - *Physocarpus capitatus*

California Blackberry - *Rubus ursinus*

Himalayan Blackberry - *Rubus discolor* (native to Eurasia)

Utah Serviceberry - *Amelanchier pallida*

SUNFLOWER FAMILY - ASTERACEAE

Coyote Bush - *Bacharis pilularis*

SUMAC FAMILY - ANACARDIACEAE

Poison Oak - *Toxicodendron diversilobum*

SWEET-SHRUB FAMILY - CALYCANTHACEAE

Spicebush - *Calycanthus occidentalis*

WILLOW FAMILY - SALICACEAE

Arroyo Willow - *Salix lasiolepis*

Sandbar Willow - *Salix exigua*

Common Riparian Plants in Napa County

HERBS, RUSHES, AND SEDGES

BUCKWHEAT FAMILY – POLYGONACEAE

- Willow Weed - *Polygonum lapathifolium*
- Common Smartweed - *Polygonum arenastrum*
- Water Smartweed - *Polygonum punctatum*
- Curly Dock - *Rumex crispus* (native to Eurasia)

CARROT FAMILY – APIACEAE

- Cow Parsnip - *Heracleum lanatum*
- Fennel - *Foeniculum vulgare* (native to Europe)
- Poison Hemlock - *Conium maculatum* (native to Europe)

CATTAIL FAMILY – TYPHACEAE

- Cattail - *Typha latifolia*

COFFEE FAMILY – RUBIACEAE

- Goose Grass - *Galium aparine*

DUCKWEED FAMILY – LEMNACEAE

- Duckweed - Lemna minima

FIGWORT FAMILY – SCROPHULARIACEAE

- California Figwort - *Scrophularia californica*
- Seep-spring Monkey Flower - *Mimulus guttatus*
- Speedwell - *Veronica anagallis*

GRASS FAMILY – POACEAE

- Blue Wild Rye - *Elymus glaucus*
- Creeping Wild Rye - *Leymus triticoides*
- Semaphore Grass - *Pleuropogon californicus*

HORSETAIL FAMILY – EQUISETACEAE

- Horsetail - *Equisetum sp.*

LILY FAMILY – LILIACEAE

- Soap Plant - *Chlorogalum pomeridianum*
- Camas - *Camassia quamash*

NETTLE FAMILY – URTICACEAE

- Stinging Nettle - *Urtica dioca*

PEA FAMILY – FABACEAE

- White Sweet Clover - *Melilotus albus* (native to Eurasia)
- California Tea - *Rupertia physodes*
- Vetch - *Vetch sp.* (most native to Europe)

PLANTAIN FAMILY – PLANTAGINACEAE

- English Plantain - *Plantago lanceolata* (native to Europe)

POKEWEED FAMILY – PHYTOLACCACEAE

- American Pokeweed - *Phytolacca americana* (native to E. North America)

PURSLANE FAMILY – PORTULACACEAE

- Miner's Lettuce - *Claytonia perfoliata*

Common Riparian Plants in Napa County

RUSH FAMILY - JUNCACEAE (ROUND stems)

Baltic Rush - *Juncus balticus*
Toad Rush - *Juncus bufonius*
Mariposa Rush - *Juncus dubius*
Slender Rush - *Juncus occidentalis*
Mexican rush - *Juncus mexicanus*
Spreading rush - *Juncus patens*

SEDGE FAMILY - CYPERACEAE (usually have EDGES)

Santa Barbara Sedge - *Carex barbarae*
Torrent Sedge - *Carex nudata*
Dense Sedge - *Carex densa*
Tracey's Sedge - *Carex ovalis*
Rough Sedge - *Carex senta*
Small-Bracked Sedge - *Carex subbracteata*
Tall Nut Grass - *Cyperus eragrostis*
Needle Spikerush - *Eleocharis macrostachya*
Common Tule - *Scirpus acutus var. occidentalis*
River Bulrush - *Scirpus fluviatilis*

SUNFLOWER FAMILY - ASTERACEAE

Mugwort - *Artemesia douglasii*
Mule Fat - *Bacharis salicifolia*

TOMATO FAMILY - SOLANACEAE

Nightshade - *Solanum americanum*

WATER PLANTAIN FAMILY - ALISMATACEAE

Water Plantain - *Alisma plantago-aquatica*

Napa River Eco Reserve Connection

Measuring Stream Velocity

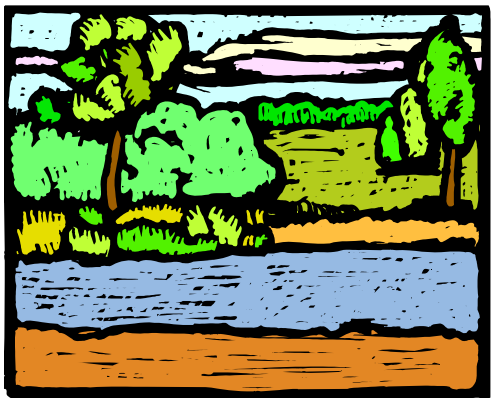
The Eco Reserve is a great place to get students in the water measuring stream velocity in a hands-on, fun way. Take students along the path at the top of the bank and find the easiest path for them to follow to the edge of the river. For much of the year (Please use your own discretion! If water is too deep or moving too quickly, please do not have students enter the water!) the water level is low enough that this activity can be done very safely. The students doing the measuring, timing, recording, and those just observing the activity can sit or stand on the gravel bed beside the river and have a great, safe view of the stream velocity activity taking place.

Measuring Stream Velocity

Measure the distance from the upstream flag to the downstream flag and record it below:

Distance (in feet): _____

Release the tennis ball at the upstream flag. Using a stopwatch, record the time (in seconds) it takes the tennis ball to reach the downstream flag. Repeat the measurement two more times **for a total of three measurements**. Record your **3** measurements below:



Time 1: _____

Time 2: _____

Time 3: _____

Average Time: _____

Calculating Velocity

Calculate the velocity as distance traveled divided by the average amount of time it took the float to travel the distance.

Velocity (feet per second) = Distance (ft) / Average Time (sec)

Example: If the distance measured from flag to flag is 10 feet and the ball took an average of 25 seconds to get there, the velocity is 0.4 ft/sec.

Your Calculation:

Distance (ft) / Average Time (sec) = Velocity (feet per second)

_____ / _____ = _____ ft per sec

Napa River Eco Reserve Connection

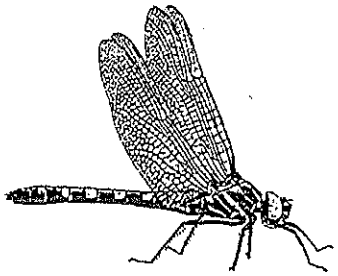
Meet Your Creek Survey

The Eco Reserve is a great place to get students to conduct a creek survey to "meet the creek." Take students along the path at the top of the bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to make observations about sight, sounds, smells, human influences, and plant life.

Students can easily measure pH, temperature, and even wade into the water to search for benthic macro invertebrates. Students should look for the macro invertebrates in the riffles (fast-moving water that is moving over the rocks and being aerated) between each pool.

To observe creek plant life, students can identify plants growing in the river itself, and also walk along the path at the top of the bank to identify the plants that like the drier areas of the riparian corridor.

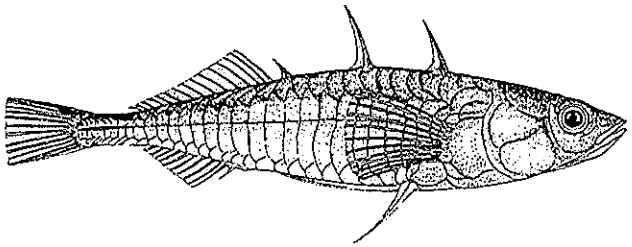
*Please use your own discretion! If water is very deep or moving very quickly, please watch students very carefully when they measure pH, temperature, etc.!

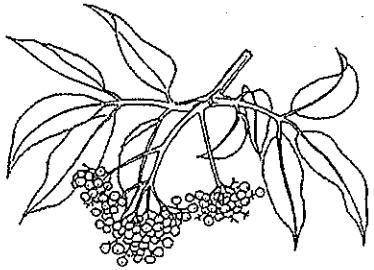


Creek Guide

For _____ Creek

This book belongs to _____





Meet Your Creek

When I first met _____ Creek
the thing that impressed me most was:

Use Your Senses

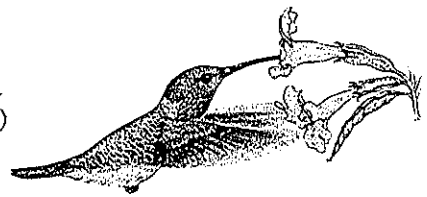
I saw _____

I heard _____

I smelled _____

I touched _____

(Don't taste anything without an expert's approval—many poisonous things are out there, and the water is not drinkable.)



Physical Measurements

Air Temperature _____ °C / _____ °F

Water Temperature _____ °C / _____ °F

pH _____

Dissolved Oxygen _____ ppm

Nitrates_____ppm

Phosphates _____ ppm

Turbidity _____ JTU's

Other: _____

Rate of Flow _____ feet per second

_____ *x 60 =* _____ *feet in 1 minute*

_____ *x 60 =* _____ *feet per hour*

_____ *÷ 5280 =* _____ *miles per hour*

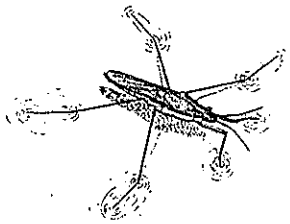
Width 1. _____ 2. _____ 3. _____

Depth 1. _____ 2. _____ 3. _____

Give a brief description of the location where you took your samples.

Animals in the Creek

Check off the organisms you find.

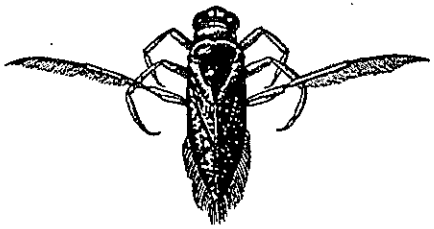


1. Do Not Tolerate Pollution

- ❑ Stonefly Larvae
- ❑ Caddisfly Larvae
- ❑ Mayfly Nymph
- ❑ Riffle Beetle
- ❑ Alderfly Larvae
- ❑ Dobsonfly Larvae
- ❑ Water Penny Larvae
- ❑ Other_____

2. Tolerate Some Pollution

- ❑ Dragonfly Larvae
- ❑ Damselfly Larvae
- ❑ Scud
- ❑ Water Scorpion
- ❑ Water Strider
- ❑ Cranefly Larvae
- ❑ Water Boatman Adult
- ❑ Backswimmer Adult
- ❑ Whirligig Beetle Larvae
- ❑ Whirligig Beetle Adult
- ❑ Water Beetle Larvae
- ❑ Burrowing Water Beetle Adult
- ❑ Crawling Water Beetle Adult
- ❑ Diving Beetle Adult
- ❑ Water Scavenger Beetle Larvae
- ❑ Giant Water Bug Adult
- ❑ Other_____



3. Pollution Tolerant

- ❑ Blackfly Larvae
- ❑ Water Snails
- ❑ Pouch Snails
- ❑ Midge Larvae
- ❑ Mosquito Larvae
- ❑ Flatworm (Planaria)
- ❑ Leeches
- ❑ Aquatic worms
- ❑ Other_____

Urban Stream Observation

Site Location:
Which direction is upstream?

Water Tests

Temperature:_____ °C _____ °F

pH: _____

How did the water smell?

❑ rotten egg or sulfur ❑ chlorine
❑ musty, moldy ❑ other
❑ earthy or grassy ❑ no unusual smell

Notes: _____

What did the water look like?

❑ scum (green) ❑ foamy
❑ muddy (brown) ❑ milky or cloudy
❑ clear ❑ colored sheen (oily)
❑ other

Notes: _____

How did the water move?

❑ pools (still water) ❑ riffles/rapids
❑ waterfalls/cascades ❑ bends
❑ snags (fallen branches) ❑ other

Notes: _____

Look at the material under the water. Is it...

❑ silt (very fine sand) ❑ sand
❑ gravel ❑ cobbles (small pebbles)
❑ boulders ❑ bedrock
❑ cement ❑ other

Notes: _____

Animals in the Creek

Tally the number of different kinds or species of organisms you found for each category:

Tolerate Pollution _____	Tolerate Some Pollution _____	Do Not Tolerate Pollution _____

How many different kinds of organisms did you find?

Which category of organisms did you find the most of?

What do these insects tell you about the health of your creek? _____

_____

_____

Calculate the Pollution Tolerance Index:

How many different kinds or different species of organisms did you find that:

1. Do Not Tolerate Pollution _____ x 3= _____
   +
2. Tolerate Some Pollution _____ x 2 = _____
   +
3. Tolerate Pollution _____ x 1= _____

Total: _____

Stream Quality Assessment_____

23 and above=Excellent
17-22=Good
11-16=Fair _____
10 or less=Poor

Urban Stream Observation

The sides of the stream are:

- ❑ muddy
- ❑ rocky
- ❑ logs or stumps
- ❑ tree roots
- ❑ sandy
- ❑ rock ledges
- ❑ cement
- ❑ vegetation

Notes: _____

If algae is in the stream, is it:

- ❑ everywhere
- ❑ floating
- ❑ in spots
- ❑ attached to the bottom
- ❑ emergent (rooted in the streambed, but breaking the surface of the water)

What shape and color is the algae? _____

Notes: _____

Estimate the percentage of streamside plants:

- ❑ trees %_____
- ❑ grasses %_____
- ❑ vines %_____
- ❑ other %_____
- ❑ shrub %_____
- ❑ herbaceous plants %_____
- ❑ bare ground %_____

Notes: _____

What are the human influences here?

- ❑ dams
- ❑ bridges
- ❑ diversions
- ❑ retaining walls
- ❑ other
- ❑ storm drain infall
- ❑ concrete box channel
- ❑ pipes
- ❑ trash

Notes: _____

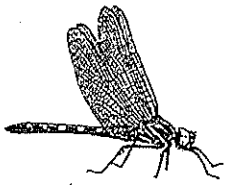
Animals in the Creek
Insect Observation

Name of Aquatic Insect::_____

Describe or Draw what it looks like:

Describe how it moves:

List any adaptations you can see that it has:



Urban Stream Observation

Litter: average number of small and large items (count them)

paper, small trash	cans, bottles	tires, carts , etc.
❑ 0—5	❑ 0—5	❑ 0—5
❑ 5—10	❑ 5—10	❑ 5—10
❑ 10—50	❑ 10—50	❑ 10—50
❑ over 50	❑ over 50	❑ over 50

Notes:_____

How is the land around the stream used?

❑ farming	❑ logging	❑ commercial	❑ industrial
❑ parks	❑ mining	❑ water storage	❑ grazing
❑ homes	❑ factories	❑ commercial	❑ stores
❑ natural areas			

Notes:_____

What are the visible sources of water pollution?

❑ freeway	❑ industrial	❑ residential
❑ restaurant	❑ trash	

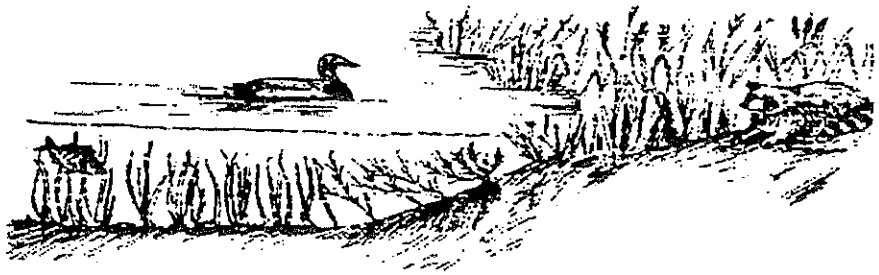
Notes:_____

Animals

List evidence of or individuals collected or observed on site. (Look for tracks, scat, homes, chewed leaves, half-eaten nuts, feathers, skin, bones.)

Macroinvertebrates:_____
Fish: _____
Amphibians: _____
Reptiles:_____
Birds: _____
Mammals: _____

Notes:_____



Urban Stream Observation—Part 4

Additional Notes: _____

Creek Plants List

California native plants are very important to creek health. They provide food, shelter and shade. Can you identify some of the native plants on your creek? Some of the more common ones are:

Native Creek Trees

____ California Bay Laurel
____ Red Alder
____ Willow
____ Oak
____ Sycamore
____ Big Leaf Maple
____ Coast Redwood
____ Buckeye
____ Other

Native Creek Plants

____ Poison Oak
____ Miner's Lettuce
____ Blackberries
____ Cattails
____ Sedges
____ Tules (Bulrush)
____ Horsetails
____ Algae
____ Ferns
____ Snowberry
____ Toyon
____ Wild Strawberry
____ California Rose
____ Wild Cucumber
____ Other

Non-Native Trees

____ Eucalyptus
____ Fir
____ Pines
____ Other

Non-Native Plants

____ Periwinkle
____ German Ivy
____ French Broom
____ Scotch Broom
____ Other
____ Sweet Fennel
____ Stinging Nettle
____ Poison Hemlock

Napa River Eco Reserve Connection

Benthic Ecology and Macro Invertebrates

The stretch of river habitat within the Eco reserve is home to many benthic macro invertebrate (BMI) species for students to observe. Take students along the path at the top of the bank and find the easiest path for them to follow to the edge of the river. Students will need nets and need to be supervised while they wade into the water to get BMI samples. The best place to look for BMI look for the macro invertebrates in the riffles (shallow, fast-moving water that is flowing over rocks and being aerated) between each pool. Riffles have ample food and oxygen, so they will typically be home to the most diverse organisms. Students should be sure to sink the net into the river bed to get the BMI that dig into the river bottom or attach to the rocks that make up the riverbed.

The ID guides within the activity should cover any of the BMI your students will find in the river. Magnifying glasses and/or bug viewers will greatly help in identifying the BMI found in the river.

Benthic Ecology and Macroinvertebrates

Benthic Ecology
Aquatic insects are an important part of the food web in the highly diverse ecosystem that is a stream. Benthos (also called benthic macroinvertebrates) are animals without backbones that depend on the bottom material of streams and creeks for food and shelter. Benthos are an important link in the food chain because they provide food for other animals. They also help to break down and recycle parts of dead animals and other types of organic matter found in creeks. It is important to understand the interactions and interdependencies between these different benthos to fully realize how the stability of one group of insects can be dependent upon the health of others.

Benthos can be grouped into categories by their techniques for eating:

- Shredders: Shredders bite and cut larger plant material, such as leaves, into little pieces called detritus. Stonefly nymphs are shredders, and the shredded particles that these insects make are eaten by collectors, such as caddisflies.
- Collectors: Collectors, like caddisflies and black flies, collect or filter from the water the small particles of organic material created by the shredders. Some have appendages that act like nets, coated with sticky substances that trap food particles. Others burrow into the bottom of the stream to gather the small particles.
- Scrapers: Scrapers, like snails and beetles, wander about the stream scraping algae and other organisms from stone and plant surfaces.
- Predators: Predators catch live animals for food. They are active, aggressive, and usually obvious. Examples are dragonfly and damselfly nymphs. Some predators are piercers, and suck the body fluid out of their prey, while others are engulfers and eat their prey whole.

Adaptations to the Stream Environment
All benthos must obtain oxygen while spending most or all of their time underwater. Most benthos have some type of gill apparatus, allowing them to extract oxygen from the water. Another method of obtaining oxygen, used by diving beetles, is carrying a small bubble of air on the body that must be replenished by surfacing every few minutes.

Benthos must also keep themselves from being washed away by the continuous current. Some benthos hang tightly onto rocks or plants, some dig into the bottom and others have a streamlined body shape to keep a low profile. Most stream benthos either have strong legs with tiny hook-like forms on the ends, or they can attach themselves to rock or leaves with suction or a self-made adhesive. For example, caddisflies obtain rocks, twigs, and mud from the stream bottom with which to build their homes, and many glue their homes to the creek bed. Waterpennies have suckers on their lower surfaces. Dragonfly and mayfly larvae make burrows in sandy or muddy bottoms to keep from being swept away. Many

stream benthos, such as mayfly larvae, have a flat shape which gives flowing water less opportunity to force the organism off of the surface to which it is attached.

Benthos and Water Quality
Benthos have been used for over 100 years to detect pollution in streams and rivers. These animals can be used to estimate the water quality in rivers and streams by knowing which species of benthos should be present and in what numbers. When certain species that should be found in a stream are missing, their absence indicates that something is wrong. This is because benthic invertebrates are affected by whatever washes over them. Levels of pollution are evident in changes in benthic invertebrate populations over time. Monitoring of pollutants can be done by using chemical tests, but sampling benthos is an inexpensive and relatively uncomplicated monitoring system that can easily be done by students and private citizens.

Indicators of Water Pollution
Pollutants in water can affect certain species more quickly than others. A large variety of species (high species diversity) usually indicates clean water. Low species diversity can indicate polluted water or a greatly disturbed environment. Some species can't tolerate pollution; their presence is an indicator of clean water. Certain species are more tolerant of polluted conditions and are more commonly found in high proportions where quality has been degraded.

Species that can exist in a variety of conditions are dragonfly nymphs, cranefly nymphs, scuds, clams, crayfish, sowbugs, damselfly nymphs and beetle larvae. Many of these animals are inconspicuous insect larvae and nymphs (immature forms).

There are other physical factors important in maintaining a healthy stream environment. The type of stream bottom (silt, rock, or cement), average depth of water, temperature of the water (related to the percent of the stream that is shaded), amount of dissolved oxygen, and pH will determine the kinds of animals that can live there. The clarity of the water determines how much light can enter the stream and can be an indicator of pollution. The types of aquatic plants present can also be indicators of stream pollution.

	Predominant in Clean Water	**Predominant in Polluted Water**
Fish	trout, salmon	carp, sunfish
Bottom Animals	stonefly larvae, mayfly nymphs, caddisfly larvae, dobsonfly larvae, waterpennys, riffle beetles, snails	leeches, aquatic worms, midge larvae, pouch snails, blackfly larvae
Algae	small amount of algae	abundant algae

Stream Quality Assessment Using Macroinvertebrates
When assessing the quality of a stream from its macroinvertebrate population, the following aspects of a stream should be examined:
1. The diversity of organisms collected in a sample (how many different species).
2. The percentage of each organism in the sample.
3. The relative pollution tolerances of the organisms in the sample.

Using the Pollution Tolerance Index to Assess Water Quality
The pollution tolerance index (PTI) is based on the concept of indicator organisms and tolerance levels. Indicator organisms are those organisms that are sensitive to water quality changes, and respond in predictable ways to changes in their environment-- their presence or absence indicates something about water quality. This provides a quick and easy means of sampling riffle and other shallow areas in order to detect moderate to severe stream quality degradation.

Group 1 Taxa	Sample Group 2 Taxa	Sample Group 3 Taxa
Pollution Sensitive	Somewhat pollution tolerant	Pollution tolerant
Tolerance Index Value= 3	**Tolerance Index Value= 2**	**Tolerance Index Value= 1**

Procedure:
- Sample a 3'x3' section of stream for aquatic insects. For best results, use a 3' wide kick net for this method.
- Record the presence of each type of organism collected and group by pollution tolerance level.
- Calculate the PTI by multiplying the number of types of organisms in each tolerance level by the index value for that level. Repeat this calculation for each Taxa Group.
- Add the 3 numbers together (#of types in Group 1 x 3, + # of types in Group 2 x 2, + # of types in Group 3 x 1) = PTI

Cumulative Index	Stream Quality Assessment
Value 23 and above	Excellent
17-22	Good
11-16	Fair
10 or less	Poor

Problems in Streams
The problems affecting streams can be grouped into three general categories:
1. *Physical*: stream alterations, such as reduced flow and temperature extremes. The result of these physical impacts to a stream range from a general reduction in the total numbers of all organisms, to a reduction in the number of species.
2. *Organic pollution and enrichment:* the introduction of large quantities of human and animal wastes from dogs and cats, as well as fertilizers. Mild organic enrichment usually reduces total diversity, resulting from a marked increase in the types and numbers of macroinvertebrates that feed directly on organic materials. The shredders benefit under these circumstances, as excessive blooms of algae and other aquatic plants provide a plentiful food supply that favors these detritus feeders. In extreme cases, organic pollution can result in oxygen depletion. Oxygen depletion occurs when the number of bacteria that decompose dead plant material exceeds normal limits. These bacteria can remove all of the

oxygen from the water, killing other organisms. Under these conditions, only organisms that can tolerate extremely low oxygen levels can survive.

3. *Toxicity:* toxins that end up in creeks include a wide array of pollutants, such as chlorine (drained from swimming pools), acids (leaking from car batteries), metals (such as car parts, washing machines, and grocery carts which sometimes end up in creeks), pesticides (from garden use), and motor oil (from do-it-yourself oil changers and leaking cars).

Importance of Riffle/Run

The riffled areas are the most productive portions of streams and are where the majority of stream-dwelling macroinvertebrates live. Riffles occur in shallow water when the streambed is uneven, causing the water to splash. A run is when the water flows smoothly and quietly, unbroken by rocks. Riffle-dwelling macroinvertebrates generally require a plentiful supply of oxygen that is free of pollutants.

There are a great number of microhabitats in riffles, in part due to the ample food and oxygen supply that flows through riffles. Therefore, sampling in riffles is suggested. However, if there are no riffles available other habitat types may be sampled, such as undercut banks, overhanging vegetation, pools, and any parts of the stream bottom that are accessible.

The time of year can also make a big difference in the number of organisms found in the stream. Organisms are most abundant in the fall, before the rains of winter come and scour the streambed. Late spring and summer are also good times to sample.

This chart will give you an idea of the types of organisms commonly found in fast moving riffles, in medium water flow, and in slower moving water or pools.

Fast Flow Rocks & Stones Few or no plants	**Moderate Flow** Stones & Gravel Plants & Detritus	**Slow Flow** Mud Plants & Detritus
Blackfly larva Stonefly nymph Caddisfly larva Mayfly nymph	Mayfly nymph Midge larva Caddisfly larva Scud Snail Fish	Mayfly nymph Beetle larva Leech Dragonfly nymph Clam Snail Fish

SUBJECTS: Life Science
FRAMEWORK CONCEPTS: How are living things classified, how do the structures of living things perform their function, interact with each other, contribute to maintenance and growth, how does energy flow in ecosystems, what are the responsibilities of humans to ecosystems

5—Bugs as Barometers of Stream Health

Activity Summary: Students will learn about the aquatic animals that indicate whether water is polluted or clean by conducting an investigation on a local creek. Students will collect, observe, identify and tally stream insects and measure other stream parameters.

Time: one 45 minute in-class session. One field trip to a stream near the school. If possible, one field trip to a stream in a natural setting.

Materials:

Supplied

1. Student work sheets
2. Aquatic insect sheet:
   "Macroinvertebrate Indentification Guide"

You Obtain **(or borrow the stream inventory kit from AHI to obtain italicized items)**

1. Copies of student work sheets and aquatic insect sheets for each student
2. Pens or pencils
3. Measuring tape (for streamflow measurement)
4. Several oranges or wine corks
5. *Small aquarium nets*
6. *White containers (reused yogurt and cottage cheese containers will do)*
7. *Bug boxes*
8. *Magnifying lenses*
9. *(optional) Laminated aquatic insect identifying cards*

Background Information for the Teacher

BENTHIC ECOLOGY

Benthic macroinvertebrates (also called benthos) are animals without a backbone that depend upon the bottom material for food and/or shelter, and are usually easy to see. The most common groups of benthos include insects, clams, snails, worms and crustaceans. Many benthos have life cycles that require them to live in the water for their entire existence (for example crayfish and riffle beetles) while others have cycles that require them to eventually leave the water permanently to feed

and/or reproduce (mayflies and dragonflies). The body temperature of benthos is always the same as the surrounding water. Benthos are important in the food chain as they provide food for other animals (such as fish and other benthos) and they recycle parts of dead animals and other types of organic matter (such as crustaceans and worms).

Aquatic insects are an important part of the food web in the highly diverse ecosystem that is a stream. These organisms help to decompose the leaves and other organic material found in streams. They can be grouped into categories by their techniques for eating.

Shredders: Shredders bite and cut larger plant material, such as leaves, into little pieces called detritus. Stonefly nymphs are shredders, and the shredded particles that these insects make are used by collectors, such as caddisflies.

Collectors: Collectors, caddisflies and black flies, collect or filter from the water the small particles of created by the shredders. Some use devices like nets coated with sticky substances, and others burrow into the bottom of the stream to gather the small particles.

Scrapers: Scrapers, such as snails and beetles, wander about the stream scraping algae and other organisms from stone and plant surfaces.

Predators: Predators catch live animals for food. They are active and usually obvious, such as dragonfly and damselfly nymphs. Some predators are piercers, and suck the body fluid out of their prey, while others are engulfers and eat their prey whole.

It is important to understand the interaction and dependance between macroinvertebrates to fully realize how the stability of one group of insects can be dependant upon the welfare of another.

ADAPTATIONS TO THE STREAM ENVIRONMENT

Two functions that all stream bethos must perform are:

1. Obtaining oxygen while spending most or all of their time underwater, and
2. Keeping themselves from being washed away by the continuous current.

In order to obtain oxygen, most benthos have some type of gill apparatus, allowing them to extract oxygen from the water. Another method of obtaining oxygen, used by diving beetles, is to carry a small bubble of air on the body, which must be replenished by surfacing every few minutes.

Methods of keeping oneself from being swept away in the current include: hanging on tight, digging in, and keeping a low profile. Most stream benthos either have strong legs with tiny hook-like devices on the ends, or they can attach themselves to rock or leaves with suction or a self-made adhesive. For

example, caddisflies obtain rocks, twigs, and mud from which to build their homes from the stream bottom, and many glue their homes to the bottom. Waterpennies have suckers on their lower surfaces. Dragonfly and mayfly larvae make burrows in sandy or muddy bottoms to keep from being swept away.

Additionally, most stream benthos, such as the mayfly larvae, have a flat shape, as this gives the flowing water less opportunity to force the organism off of the surface it's attached to.

BENTHOS AND WATER QUALITY

Benthos have been used for over 100 years to detect pollution in streams and rivers. Benthos are used to estimate the water quality in rivers and streams by knowing which species of benthos should be present, and in what abundances. (Abundance is the total number of any given species in an area.) When certain species that should be found in a stream are missing, their absence indicates that something is wrong.

Monitoring of pollutants can be done by using chemical tests, which, unfortunately, have their drawbacks. First, they are quite expensive. Second, a chemical test only shows is happening in the stream at the moment the sample is taken. The fact that someone poured oil down a stormdrain a week previous goes undetected.

Sampling of benthos, on the other hand, is inexpensive, relatively uncomplicated, and can easily be done by students and other private citizens. The sampling of benthic organisms allows groups other than the government to assess the health of their streams.

The collection and analysis of benthic invertebrates also demonstrates with greater sensitivity what impacts the animals that live in that stream may have undergone. These impacts are evident when the number of species and total number of animals collected changes over time. This is because the benthic invertebrates, being rather restricted in their immediate habitat, are affected by whatever washes over them.

INDICATORS OF WATER POLLUTION

Pollutants in water can kill certain species more readily than others. A large variety of species (high species diversity) usually indicates clean water. Low species diversity can indicate polluted water or a greatly disturbed environment. Some species can't tolerate polluted water; their presence is an indicator of clean water. Certain species are more tolerant of polluted conditions and are more commonly found in high proportions in polluted water.

	Predominant in Clean Water	Predominant in Polluted Water
Fish:	trout, salmon	carp, sunfish
Bottom Animals:	stonefly larvae, mayfly nymphs caddisfly larvae, dobsonfly larvae waterpennys riffle beetles snails	leeches, aquatic worms midge larvae, pouch snails, blackfly larvae
Algae:	small amount of algae	abundant algae

See also handout "Macroinvertebrate Indentification Guide", included

Species that can exist in a variety of conditions are dragonfly nymphs, cranefly nymphs, scuds, clams, crayfish, sowbugs, damselfly nymphs and beetle larvae. Many of these animals are inconspicuous insect larvae and nymphs (immature forms).

There are other physical factors important in maintaining a healthy stream environment. The type of stream bottom (silt, rock or cement), average depth of water, temperature of the water (related to the percent of the stream that is shaded), amount of dissolved oxygen, and pH will determine the kinds of animals that can live there. The clarity of the water determines how much light can enter the stream and is a direct indicator of pollution. The type of aquatic plants present is also an indicator of pollution.

Stream Quality Assessment Using Macroinvertebrates

When assessing the quality of a stream from its macroinvertebrate population, any or all of the following aspects of a stream may be examined:

1. The diversity of organisms in a sample (how many different species).
2. The percentage of each organism in the sample.
3. The relative pollution tolerances of the organisms in the sample.

Importance Of Riffle/Run

The riffled areas are the most productive portions of streams and are where the majority of stream-dwelling macroinvertebrates live. Riffles occur in shallow water when the stream bed is uneven, causing the water to splash. A run is when the water flows smoothly and quietly, unbroken by rocks. Riffle-dwelling macroinvertebrates generally require a plentiful supply of oxygen that is free of pollutants.

Species Flow Preferences Chart

Fast Flow Rocks & Stones Few or no plants	Moderate Flow Stones & Gravel Plants & Detritus	Slow Flow Mud Plants & Detritus
Blackfly larva Stonefly nymph Caddisfly larva Mayfly nymph	Mayfly nymph Midge larva Caddisfly larva Scud Snail Fish	Mayfly nymph Beetle larva Leech Dragonfly nymph Clam Snail Fish

There is a great deal of microhabitat in riffles, in part due to the ample food and oxygen supply that flows by. Therefore, sampling in the riffle is suggested. However, if there are no riffles available, other habitat types may be sampled, such as undercut banks, overhanging vegetation, pools and any parts of the stream bottom that are accessible.

The time of year can make a big difference in the number of organisms found in the stream. Organisms are most abundant in the fall, before the rains of winter come and scour the streambed. Summer is also a good time to sample.

PROBLEMS IN STREAMS

The problems affecting streams can be grouped into three general categories:

a. Physical—stream alterations, such as reduced flow and temperature extremes. The result of these physical impacts to a stream range from a general reduction in the total numbers of all organisms to a reduction in the number of species.

b. Organic pollution and enrichment—the introduction of large quantities of human and animal wastes (dogs and cats), as well as fertilizers. The result of mild organic enrichment is usually a reduction in diversity, resulting from a marked increase in the types and numbers of macroinvertebrates that feed directly on organic materials. The shredders benefit under these circumstances as, because of the organic enrichment, excessive blooms of algae and other aquatic plants provide a plentiful food supply that favors these detritus feeders. In extreme cases, organic pollution can result in oxygen depletion. Oxygen depletion occurs when the number of bacteria that decompose dead plant material exceeds normal limits. The large numbers of bacteria can remove all of the oxygen from the water, killing other organisms. Under these conditions, only organisms that can tolerate extremely low oxygen levels can survive.

c. Toxicity—Toxics that end up on creeks include a wide array of pollutants, such as chlorine (drained from swimming pools), acids (leaking from car batteries), metals

(such as cars, washing machines and grocery carts, which sometimes end up in creeks), pesticides (from garden use), and oil (from do-it-yourself oil changers).

Preparation:

Look over the enclosed background information and discussion questions. We recommend doing the calculations in the activity beforehand to ensure they go smoothly in class.

Assemble the materials necessary to conduct the activity.

Procedure:

Part 1. Field Trip

Take the students to two sites if possible; the first to a relatively undisturbed environment, such as a local park, and the second to a stream near the school. Using the enclosed worksheets and insect sheets, have the students compare the aquatic organisms and other stream features between the two sites. (If it is not possible to visit both sites, take a trip to your local stream and analyze the data students collect there.)

Have small aquarium scoop nets, bug boxes, magnifying lenses, white containers (reused yogurt and cottage cheese containers will do), stream insect identifying sheets and student work sheets available. A stream inventory kit containing these items is available for loan from AHI.

Pre-field trip classroom discussion

1- Begin with a brief discussion about invertebrates. How are they different from other animals? (They do not have backbones but usually exo-skeletons instead, and their bodies stay at the same temperature as the surrounding water.) How are they similar? (They need oxygen, food, a safe place to live, they cannot survive in a toxic environment.)

2- Tell the students that the dragonfly nymph (a nymph is a flightless, immature stage in an insect's life cycle) becomes a dragonfly, and the mayfly nymph become a delicate fly called a mayfly. Explain how aquatic insects can be grouped by what they eat (see Background information.)

3- Discuss adaptations the stream organisms have to their environment. (They can breathe underwater or carry air in a bubble underwater; they have strong legs or suction devices to stay attached to the stream bottom so they are not washed away.)

4- Ask: What kinds of animals might we see in the stream? Explain that you are going to study the underwater environment because they form the basis of the aquatic food chain. A lack of diversity of small aquatic organisms indicates a problem. Show the students the insect sheets (included) that will be used to identify the insects.

Who We Are

In 1922, 54 anglers and conservationists from Chicago, Ill., joined together to promote clean water. The group named itself the Izaak Walton League of America, after the 17th century author of the literary classic, "The Compleat Angler". Ever since, the League has created a long history of achievement in conservation and outdoor recreation.

As true grassroots voices throughout the United States, the League is committed to promoting a centrist, common sense approach to conservation that reflects the public's continued interest in the protection and responsible use of our natural resources. League members promote conservation in our local communities, in states and watersheds, and nationally.

What We Do

The League's Watershed Programs engage in hands-on, local conservation action, such as monitoring streams and wetlands. For more than 30 years, the League has developed innovative watershed education programs for groups and individuals and provided networking and technical assistance through its Watershed Literacy Assistance Center. The League motivates citizens to clean up streams, monitor stream health, restore degraded streambanks, plant trees, and protect dwindling wetland acreage.

We invite you to become an active steward of our nation's streams, rivers and wetlands. To help stewards like you, the League has developed a variety of handbooks and videos about stream monitoring, habitat restoration, and wetland stewardship. This field guide for aquatic macroinvertebrates is one of many tools designed to assist your watershed stewardship program. If you would like to learn more about our educational resources, League chapters active in your community, or our toll-free technical assistance, please contact the League at (800) BUG-IWLA or visit our Web site at www.iwla.org.

The Izaak Walton League is a great way to get involved locally in environmental protection. Citizen action at the local level does make a difference!

Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878
Phone: 301-548-0150
Fax: 301-548-0149
Technical Assistance: 800-BUG-IWLA
Email: sos@iwla.org
Web: www.iwla.org/sos

References

McCafferty, W.P. 1981 *Aquatic Entomololgy. The Fisherman's and Ecologists Illustrated Guide to Insects and Their Relatives.* Science Books International, Boston, MA.

Merrit, R.W., and K.W. Cummins, editors. 1996. *An Introduction to the Aquatic Insects of North America.* 3rd edition. Kendall/Hunt Publishing Company, Dubuque, IA.

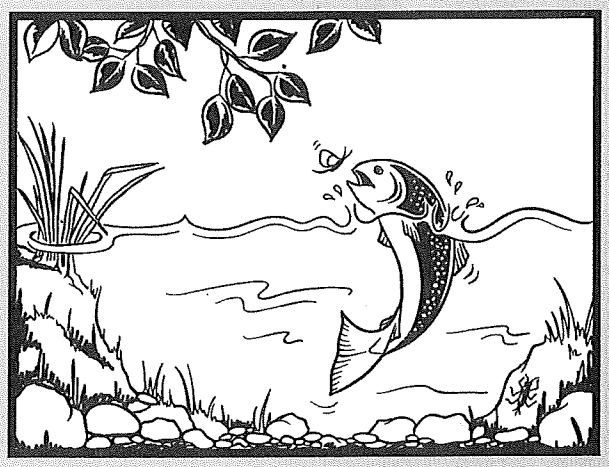
Voshell, J.R. 2002. *A Guide to Common Freshwater Invertebrates of North America.* The McDonald & Woodward Publishing Company, Blacksburg, VA.

The League wishes to thank the following experts for their advice and comments:

J. Reese Voshell, Jr., Ph.D., Department of Entomology, Virginia Polytechnic Institute & State University

Phil Emmling, Environmental Chemistry & Technology Program, University of Wisconsin, Madison

Izaak Walton League of America



A Volunteer Monitor's Field Guide to Aquatic Macroinvertebrates

Biological Monitoring

Water quality monitoring is an essential step in the process of conserving and restoring local waterways. Evaluating the biological community of a stream is a sensitive and cost effective way to assess water conditions. The League has a protocol that uses the presence of benthic macroinvertebrates to measure water quality.

- Macroinvertebrates are large enough to see with the naked eye (macro) and have no backbone (invertebrate).
- Benthic macroinvertebrates live in the benthos, or stream bottom, and include insect larvae, crustaceans, mollusks, and worms.

Stream-bottom macroinvertebrates are good indicators of water quality because they differ in their sensitivity to water degradation. Some benthic macroinvertebrates are very sensitive to pollution and cannot survive in degraded water. Others are less sensitive to pollution and can be found even in very degraded streams. Macroinvertebrates are relatively immobile and cannot avoid pollution events or other forms of stress often missed by other sampling methods. If water quality is generally poor, or if a polluting event occurred within the past several months, it will be reflected in the macroinvertebrate population.

Biological monitoring (biomonitoring) is fun and easy. The Izaak Walton League's Save Our Streams (SOS) methodology involves getting into the stream, using a net to collect macroinvertebrates, sorting and identifying the catch, and using easy calculations to determine an ecological score for water quality.

Using This Field Guide

This field guide is a handy reference tool designed to help volunteer monitors identify aquatic macroinvertebrates when conducting a water quality survey. The macroinvertebrates are grouped into biological categories to provide basic identification information that can be used with a variety of monitoring protocols across the United States. Although macroinvertebrates can tolerate different levels of degradation in different geological areas, the symbols used in this field guide indicate the relative sensitivity categories (sensitive, less sensitive, and tolerant) for each based on the League's SOS biomonitoring protocol. Most macroinvertebrates are presented at the order level for easy and accurate identification in the field.

The drawings in this field guide display common features that characterize each organism type. Most aquatic insects listed include diagrams of the larval and adult life cycles. The larval stage occurs in the water and is therefore used for biomonitoring. The adult stage is terrestrial and often flies near the surface of the water. While not included in the rating for the final SOS water quality score, the adult stage for some of the organisms is included for the curious.

When identifying macroinvertebrates in the field, simply match the illustrations with the specimens in hand. Read the description provided to verify the identification. Rely primarily on body shape and number of legs and tails because different organisms can vary considerably in size and color. For more information on biomonitoring, please visit our Web site at www.iwla.org/sos.

Mollusks

○ **Gilled Snails** (Class Gastropoda). Length: 1/4" – 1". Shell opening covered by thick plate called an operculum and usually opens to the right when the narrow end of the snail is pointed up. When monitoring, do not count empty shells. Gill-breathing snails are different from lunged snails in Group Three. They require high levels of dissolved oxygen found in healthy streams.

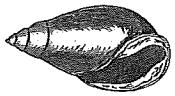

Gilled Snail

◐ **Clams and Mussels** (Class Bivalvia). Length: 1/8"– 5". Fleshy body enclosed between two clamped shells. Clams are usually buried in the stream bottom and if they are alive, the shells cannot be pried apart without harming clam. When monitoring, do not count empty shells. Certain species are sensitive to some types of pollution.

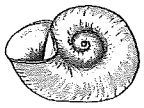

Fingernail Clam


Unionid Mussel

● **Lunged Snails** (Class Gastropoda). Length: up to 2". These snails obtain oxygen from the air and have no operculum. Most shells open to the left when narrow end is pointed up. When monitoring, do not count empty shells. They can tolerate severe organic or nutrient pollution that consumes all oxygen in the water.

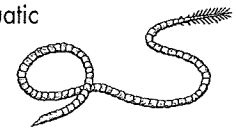

Lymnaea Snail


Physa Snail


Helisoma shell

Worms

● **Aquatic Worms** (Class Oligochaeta). Length: 1/4" – 2". Can be very tiny and slender or look similar to earthworms. They can slip through the seine net quite easily. Worms do not have legs, distinct head or any mouthparts. Aquatic worms can represent organic pollution when they dominate the majority of the sample collection (and when they occur with high numbers of red midge larvae).


Tubicifid Worm

● **Leeches** (Class Hirudinea). Length 1/4" – 2". Slimy, soft body usually has brown or gray pattern (can be colored) on top and two suckers on the bottom of the body, one in the front and one in the rear. A leech can be confused with a flatworm. The flatworm has many segments in their body, which look like fine lines across the body. Some leeches can tolerate several days without dissolved oxygen and large numbers can indicate oxygen depletion or pollution.


Leech

Symbols

The symbols located on the left of each organism indicate macroinvertebrate sensitivity categories designated by the Izaak Walton League's SOS program. Adaptations may be required for specific geographic locations and conditions.

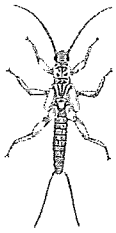
○ **Group One: Sensitive.** These organisms will not be found in abundance where water quality is degraded. Their dominance generally signifies good water quality.

◐ **Group Two: Less Sensitive.** These organisms can exist in a wide range of water quality conditions.

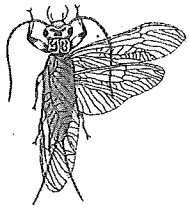
● **Group Three: Tolerant.** These organisms can be found where water quality is degraded. Their dominance usually signifies poor water quality.

INSECTS

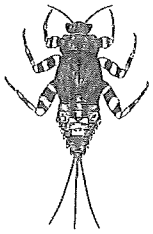
○ **Stoneflies** (Order Plecoptera). Body length: ½" – 1½". Six legs, with two claws on the tip of each, antennae, two hair-like tails. No gills on rear half of body. Structurally similar to mayfly nymphs, but have two tails instead of three. Almost all species of stoneflies are very sensitive to pollution.


Slender Winter Stonefly (Larva)

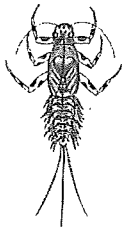

Common Stonefly (Larva)


Common Stonefly (Adult)

○ **Mayflies** (Order Ephemeroptera). Body length: ¼" – 1". Brown, cream, or whitish-colored gills on sides or top of rear half of body, which may be flat disks, pointed filaments, or feathery tufts. Larvae also have six clawed legs, antennae, and usually three long, hair-like tails (but sometimes only two). Tails may be webbed together or break off during collection. Tails are most easily seen on submerged organism. Most species are very sensitive to pollution and therefore indicate good stream health.

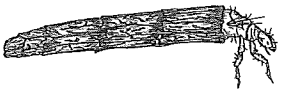

Spiny Crawler Mayfly (Larva)


Pronggilled Mayfly (Adult)

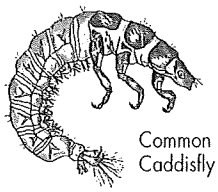

Pronggilled Mayfly (Larva)

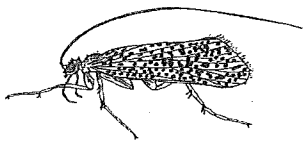
○ **Caddisflies** (Order Trichoptera), except Common Net Spinning Caddisfly. Body or case length: ½" – 1½". Six legs with claws on upper third of body, two hooks at back end. May be found in a stick, rock or leaf case with its head sticking out. May have finger-like gill filaments on the rear half of body. Larva has caterpillar-like appearance and tends to curl up slightly on a flat surface. Most species are sensitive to pollution.


Free Living Caddis (Larva)

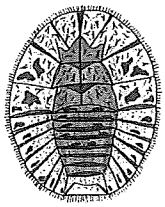

Giant Case Caddis (Larva)

◐ **Common Net Spinning Caddisflies** (Order Trichoptera). Body length: up to 1". Six legs with one claw on each tip and three hard plates on top of upper third of body adjacent to legs. Two hooks at back end. Body is caterpillar-like and strongly curved. Color varies from bright green to dark brown, gill tufts on underside. More tolerant of degraded water than other caddisfly larvae. They become very abundant in streams with moderate levels of organic and nutrient pollution, which provides more food in suspension for them to catch. *

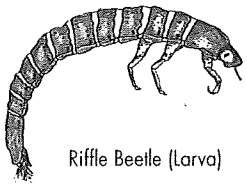

Common Net Spinning Caddisfly (Larva)

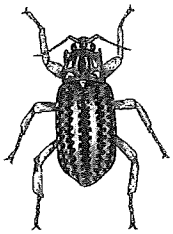

Common Net Spinning Caddisfly (Adult)

○ **Water Pennies** (Order Coleoptera). Length: up to ½". Larvae look like flat, oval discs because plates extend from all sides, covering head and legs. They cling to rocks, especially on undersides, and are best found by direct inspection of rocks at the river's edge. Like most clingers, they cannot survive where rocks are covered with excessive algae, fungi, or inorganic sediment.


Water Penny (Larva)

○ **Riffle Beetles** (Order Coleoptera). Body length: 1/16" – ⅛". Very small, dark colored, with six legs. To find these beetles, watch the seine net closely for movement because they blend well with rock and leaves. If uncertain beetle is aquatic or terrestrial, submerge in water to see how it adapts. Most require high levels of dissolved oxygen found in healthy streams.

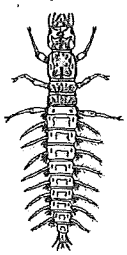

Riffle Beetle (Larva)

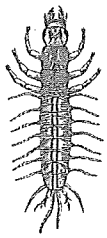

Riffle Beetle (Adult)

○ **Water Snipe Flies** (Order Diptera). Length: ¼" – 1". Body is pale to green color and mostly cylindrical, with the front tapering to a cone-shaped point. Larvae have many caterpillar-like prolegs (stubby, unsegmented legs) and two stout, pointed tails with feathery hairs at back end. Most species are very sensitive to pollution. *


Water Snipe Fly (Larva)

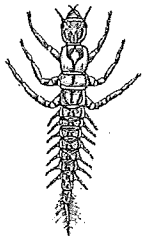
◐ **Dobsonflies/Hellgrammites and Fishflies** (Order Megaloptera). Body length: ¾" – 4". Stout body with large pinching jaws, six legs, and paired cotton-like gill tufts along underside. Larva also has eight pairs of pointed appendages and a pair of stubby, unjointed legs (prolegs), each with a pair of claws, on the rear end of the body. Spend most of their time hunting for prey in the swift areas of the riffle. To avoid getting pinched, grasp larvae directly behind the head. Fishfly larva has two hooks on the tail end with a lighter reddish-tan color or yellow streaks. They are found only in healthy to moderately healthy aquatic environments. *


Dobsonfly (Larva)

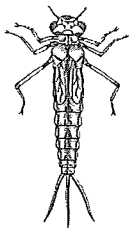

Fishfly (Larva)

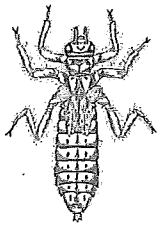

Fishfly (Adult)

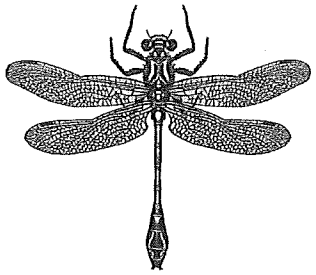
◐ **Alderflies** (Order Megaloptera). Body length: up to 1½". Looks similar to a small hellgrammite, but has no gill tuffs underneath. Alderfly has six legs, seven pairs of pointed appendages on rear half of body, and one long, thinly branched tail at back end. They can be found in a wide range of water quality conditions, ranging from healthy to poor.

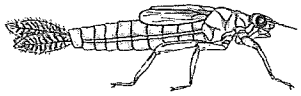

Alderfly (Larva)

◐ **Damselflies and Dragonflies** (Order Odonata). Body length: ½" – 2". Both of these have large eyes, six legs with two claws on each, and a large lower lip that covers much of the bottom or front of the head. Damselflies are slender with three tails that resemble leaves at the end of the body. Dragonflies have stocky bodies without tails on the end. Both are easily found around stream vegetation and calmer areas along the stream's edge. Primarily less sensitive, some are very sensitive to tolerant of water pollution.


Dameselfly (Larva)

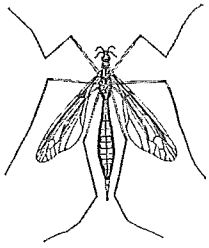

Clubtail Dragonfly (Larva)


Clubtail Dragonfly (Adult)

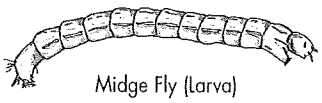

Spreadwinged Damselfly (Larva)

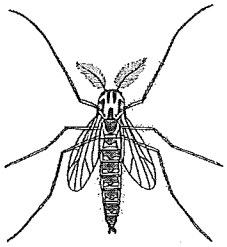
◐ **Crane Flies** (Order Diptera). Length: ⅓" – 2½". The worm-like, plump body of the crane fly larvae can be found in a variety of colors, including translucent (clear), white, brown and green and grows slightly thicker than a pencil. Body is segmented with small tentacles at back end. The head is usually not seen because it is pulled back into front end of body. Crane Fly species are ecologically diverse, so different tolerances are expected.


Crane Fly (Larva)

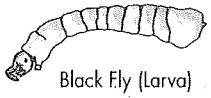

Crane Fly (Adult)

● **Midge Flies** (Order Diptera). Length: up to ¼". The worm-like segmented body has a distinct head with two small, stubby, unjointed legs on each end of the body, often whitish to clear, but occasionally bright red. These true flies are best identified by their spastic squirming action. They are very small, slender organisms that can easily slip through the seine net unnoticed. They can indicate poor stream health caused by some type of pollution if found in large numbers.


Midge Fly (Larva)


Midge Fly (Adult)

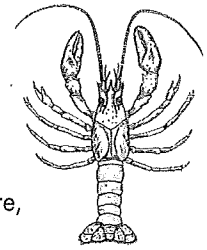
● **Black Flies** (Order Diptera). Length: up to ¼". Larva is small and slightly bulbous at the rear of body (like the shape of a bowling pin). This true fly has a distinct head and fanlike mouth brushes might be visible. It will often curl into a "u" shape when held in hand. They indicate moderate organic or nutrient pollution when they dominate the sample collection.


Black Fly (Larva)

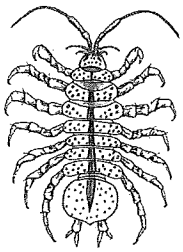

Black Fly (Adult)

CRUSTACEANS

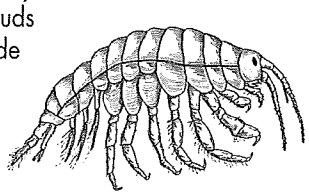
◐ **Crayfishes** (Order Decapoda). Length: up to ½" – 5". The crayfish resembles a lobster with ten legs (unless broken off), and the two front legs have very large claws or pinchers. They are also known as crawdads. They can withstand wide ranges in temperature, pH, and alkalinity, but are sensitive to certain toxic substances.

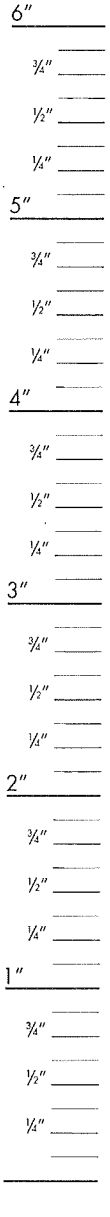

Crayfish

◐ **Aquatic Sow Bugs** (Order Isopoda). Length: ¼" – ¾". The sow bug's gray oblong body is flat, segmented, and has an "armored" appearance. They have seven pairs of legs, two long antennae and are most easily found along the stream's edge. Sow bugs may be confused with scuds, however sow bugs are flattened top to bottom and scuds are flattened side to side. They are less sensitive, especially to organic waste.


Sow bug

◐ **Scuds** (Order Amphipoda). Length: ⅛" – ¼". The scud, or side swimmer, has seven pairs of legs and resembles a small shrimp. Body is usually somewhat translucent with some silvery-gray or tan coloration. Scuds may be confused with sow bugs, however, scuds are flattened side to side and sow bugs are flattened top to bottom. Scuds can tolerate a wide range of water quality conditions.


Scud



* Sensitivity ranking updated from 1995 version.
Drawings by Daryl Ratajczak
Spring 2003

Printed on recycled paper

Napa River Eco Reserve Connection

Lone Sit

Take students along the path at the top of the Napa River bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to spread out, work independently, and make observations about sight, sounds, smells, human influences, and plant life. You may also choose to have students sit at the top of the bank along the trail. This location also will guarantee that they will see and hear wildlife.

*Please use your own discretion regarding water safety. If water is very deep or moving very quickly, please watch students carefully.

Lone Sit (5min intro, 10-20min walk and sit, 5-10min sharing/close)

Background: Students may be more likely to utilize their field notebooks if they are isolated from their classmates. This activity can be paired with several reflection prompts and is a good way to get students to work independently.

Field Day Connections: Any

Theme Connections: Poetry, writing, drawing, etc.

Classroom Connections: Any

How Does the Activity Run?

- As a circle activity, ask a mentor to share a selected poem and/or introduce a reflection topic relevant to the field day activities.

- Describe to the students the purpose of the lone sit and let them know that it is an individual activity. Emphasize the importance of being quiet. Tell them the quieter they are, the more likely it is they will see wildlife.

- Have the students line up and spread the mentors throughout the line, with a mentor leading the group and a mentor following. Ask a mentor to stay behind so they can gather the students at the end of the activity.

- Have the lead mentor spread individual students along the path as the group walks the chosen route. Divide the mentors evenly along the path so they can keep an eye on the students. After 15 minutes or so have the mentor who stayed behind gather students as he/she works their way towards the lead mentor.

- When all the students reach the lead mentor, form a circle and facilitate the closing activities/sharing.

Tips and Cautions for Smooth Facilitation: Find a suitable route for the activity before leading the lone sit. Make sure students are clear from potential hazards (poison oak, etc). Spread the students out far enough from each other as to limit interaction (at least 15ft). If short on time, try to have the route end near the bus.

Materials Needed: Field notebooks, pencils, prompt specific supplies

Napa River Eco Reserve Connection

Nature Journaling

Take students along the path at the top of the Napa River bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to spread out, work independently, and make observations about sight, sounds, smells, human influences, and plant life. You may also choose to have students sit at the top of the bank along the trail. This location also will guarantee that they will see and hear wildlife.

*Please use your own discretion regarding water safety. If water is very deep or moving very quickly, please watch students carefully.

Field Notebooks:
A Guide to Nature Journaling With Youth

The first and greatest challenge in nature journaling with students is to excite them to participate. The challenge we have is that most of our students do not yet have a connection to nature. Usually it is people that have grown up enjoying the outdoors that find nature journaling fulfilling in their **adult** lives. To inspire **youth** to be open to nature journaling is an entirely different challenge. This document already assumes that there is value in using a nature journal as a tool to solidify and expand a student's experience with ecological restoration. The focus is on how to use journaling in a way that is real and meaningful to you and your students. It is also designed to help you build your own skills as an artist, and provide you with an example of journaling activities that are "field tested."

Creating a Journaling Environment

The environment you create for journaling will in many ways dictate the results you see from your students. The "culture" of the group, time you give to journaling, and the way you present the activity to the group all influence your students' response to the journals. A comfortable environment for journaling can be created by group culture and by making it independent. Cultivating a "culture" of support amongst the group from day one helps students feel more willing to participate and to share. When you are not doing group activities, you want to encourage, or force, the journals to be an independent activity. There are many ways to do this and it will, as most everything, depend on your style and what you are comfortable with. The point is that the stigma surrounding this activity is diminished when you are on your own, which means not just 5 feet away from the next person, but more like 20. Another way of creating a supportive environment is to split the class into random or selected groups. In this case each leader or mentor can take their group to a different spot, so you've already divided the group considerably. A small group can also feel like a safer place for students to let down their guard.

Here are some tips for splitting up the group:

- Have the group stand in a circle facing out, tell them to walk twenty paces and then stop and do a journal entry, be it drawing, poetry, etc.
- Go on a walk (perhaps back to the bus) and spread the students out along the way, dropping adults off once and a while as well, and keeping one adult with the student that was dropped off at the beginning. (See "Lone Sit Activity")
- Assign each student a 10-foot square spot and have him or her journal in only that spot. Maybe that spot is his or her spot for the whole year, two visits, whatever it is.

Providing Guidance

The guidance you provide comes three fold: good prompts, good modeling, and good support.

Good prompts are key, especially in the beginning as students are just learning about nature journaling. The prompt provides direction and helps to control the way the students feel about the journals. A prompt that is too vague will not provide enough direction, and a prompt that is too "touchy-feely" may alienate students and cause them to play the journals off as another artistic stereotype. Prompts can be chosen to support the activities of the day. For example, if you have been planting native trees and shrubs, choose a prompt that will make students look closely at the plants. There are many prompts/activities in this guide that are tried and true and can help you get started.

In general you have to know what you are teaching to be an effective teacher. Often times people say, "How can I teach poetry if I'm not a poet?" While it is true that a professional poet will have more experience teaching poetry, with the same prompts, your knowledge of the students, and your ability to teach in general will give you enough tools to get started. So try for yourself the different activities and materials you will be using, be it poetry or drawing, so that you can better help your students.

Good modeling means that you and all other mentor figures journal with the students.

- Talk to the leaders ahead of time to tell them you expect them to participate.
- If they are not comfortable tell them that the students are not either. Find out what might make them more comfortable, as it may teach you a better way to reach them.
- Make journaling a part of trainings or meetings.
- Keep their journals separate from the students' so that you can have them for those activities (unless a leader wants to take it home).

Good support is making students feel welcome to ask you or other leaders for help. Try to check in with students individually about the journals. You also want to support the feel of the activity: making sure that if people are being loud and distracting that you deal with it, either by working along side a distracting student, or moving them. There will often be students that just will not enjoy the journals. You want to make sure that these students do not take away from the experience of those that do enjoy the journals.

Inspiration and Incentive

A good way to encourage students to actively use their journals is to show that there is a real use for the journals. Sharing your own work, or bringing a professional from the community to lead an activity, can be a good way to show that a journal can be a real tool. Some people keep a journal every year and can look back on them to remember events, or appreciate their progress as an artist.

Create an environment where students feel like they can improve. Often times we give blanket encouragement to students because it is so hard to motivate them to create art and we want to be as supportive as possible. Try to critique a student's art as you would correct an essay. We insist on a certain level of writing skill, yet drawing "can't be graded." Then neither should creative writing. Of course there is a balance between criticism and encouragement, but there is a way to provide both. When a student shares their work with you privately, instead of immediately saying "Oh yeah that's great," ask them to explain the picture to you. You can say something like, "Oh great. So it's an oak gall right? Good. Do you have it with you? Lets take a look at it. So you got the shape down pretty well, did you think about trying to do some shading on it? Okay, well this is good, thanks for sharing it with me. Try some shading next time." This can even develop into a relationship with the student that becomes rewarding for both parties.

Incentives are sometimes the best way to inspire students. We are goal-driven and need to see that there is a purpose for what we are doing. Incentives come in many forms and will largely depend on your relationship with the students, their age, and how much money you have.

- Bring professionals from the community out to lead poetry or drawing workshops.

- Using the journals as a place to take notes on experiments, lectures, etc can help make a connection to the journals, but can also provide an incentive to be active in the journals if you follow-up on the activity. For example: having an open-journal "pop-quiz" could be a good way to review material and show the students that they are being held accountable for their journals.
- Show the students where their work is going: either telling them they will be doing an assignment from the journal, or that there is this great opportunity for them to publish and here is an actual example of what that looks like.
- Maybe you tell them that you are going to check their journals to see that they are using them. In this case you can tell them to make a "personal" section in their journal, where they can write whatever they want and you will not read it.
- Following through on the incentive can provide more incentive. For example: if you ask the students to submit their work to publish in your newsletter, publish it, and then distribute the newsletter to the students so that they, and their classmates, can see that you were not joking and will be inspired to submit next time. (Note: there are mini-grants that can help fund publications, and local city offices, libraries, art centers are good places to show students work.)

Breaking Down Stereotypes

A large part of the challenge in journaling with youth is breaking down the stereotypes around creating art. One of the best ways to do that is to go around it, and not make it sound like the nature journal is for art. What you call the journal may influence how open students are to participating. Call it a field log, field journal, field notebook, chart book, or some other more scientific name. In general, be aware of how you talk about the journal and the tone of voice you use. Remember that most of your students are probably coming to you with their own stereotypes about journaling. At the same time if students hear people that they respect talking about the journals in an honest way, it may help to open them up. You may be able to do more "touchy-feely" activities with the students later on, once they know, trust, and respect you (hopefully).

One of the keys for students to feel connected to their journals is seeing that it is cool, or at least not lame. A great way to do this is through modeling behaviors. What that means is that you, and any other adult mentor figure, model the type of journaling you want to see from the students. This means participating in the activity. Because of the negative stereotypes around making art, it is really important for students to see their peers doing the activity that they do not think is cool. What it also means, and what many adults will be less comfortable with, is that you share your challenges with the students. It is great for students to see their adult peers struggling with the same skills that they struggle with. It is also important that the way we share supports the overall message. If you have just told a student "we can all draw, it's just a matter of practice," they will not believe you if during the sharing you say, "well I can't draw but here it is."

Sharing

Sharing is often times the hardest part of the journaling process, and because of this you should not force anyone to share their work if they are uncomfortable. That said, there is a certain level of coaxing that it will take to get students to share. One good way to start is to have the students share in small groups, and then bring them into a large group and offer another opportunity to share. An adult who can ensure that nobody's work is made fun of should oversee these small groups. These groups, whether large or small, can be a powerful resource and can foster more,

and better, work. Students admitting their struggles, and being proud of their accomplishments is an important part of the journaling process.

One of the best ways to help create this type of supportive environment is to lead by example, as we have mentioned before. Also important is to be very clear from the beginning about your expectations from the group: telling them right away that sharing can be a hard thing to do, so we all need to be supportive. Thus, there is also a job in "comment control", meaning that the leaders should be ready to say something if there are negative comments made. Another way to open students up is to have them share what they did verbally, and not have them actually show their work. In small groups talk about how each student would like to use the journal this year and ask them what they want to get out of the journaling time this year. Then, maybe at the last field day, talk about how they might like to keep using it at home.

I. Introducing a Nature Journal

One of the best places to start with students is to talk about what a Nature Journal is. This is your big chance to present the journal as a tool, more than a sketchbook, or diary. Talk about how nature journals have been used in the past (Muir, Lewis and Clark, Darwin), and how they are used now. Then show the students how the journals will be used in the field. Start with very basic prompts that are interesting, and not touchy feely. The first thing students might do is to decorate their cover. Concentrate on the journal as a tool, not a piece of artwork. Students need to feel that this is not just busy work, so be honest with them about why you are having them do this. Introduce the journal as a tool for recording data, taking notes, and observation.

- Recording data is a great way to engage students during activities that are less hands-on. For example, if you are doing water quality sampling have students enter their data in their journals.
- Taking notes can range from classroom style note taking to free-form annotations of things a student finds interesting.
- Observation can be internal (recording thoughts/feelings about a place or thing), external (recording sights and sounds), textual (recording through words), pictorial (recording through drawings, pictures, paintings), or a combination. Focusing on observation takes away the feeling that this is an art project, and is not cool, or that if you cannot draw you cannot do it.

These are just some of the ways that you can use the journals and of course there are many more, but the important thing is that all of the uses are building a students' connection to the journal. By using the journals in a variety of ways you build the students' investment and pride in what they create inside. If you are only working in the journals for an hour every month, your may not be able to teach these students how to draw better, it may be creating a connection to their journals. In any case, take it lightly, your students will only enjoy it if they want to, so do not force it. Make sure that students write their full names, and school they are from either on the cover or inside the cover. Show examples of professional and student work, and examples of how their work will be used.

II. Scientific

A good way to start every entry is to record the basic information about where they are: the date, time, place, weather, etc. Discuss why this is important information. For example: if we are planting native grasses, and you record the time of year you can look back on your journal as a tool to know when it is best to plant native grasses. Depending on the goals of your program you

can have students compile lists throughout the year, for example, all of the native plants that you find at your site, or a bird list. If there is a monitoring component to the program, have students use their journals as a logbook.

Scientific Activity: Native Plant Scavenger Hunt: Hand out a sheet that has a list of native plants, and have each group search for them.

Science Activity: Gather leaves from different plants and make leaf pressing in your journal. Catalog the species name, whether the leaf is simple or compound, whether the margin is toothed, serrated, or entire…etc.

III. Mapping

Mapping can be a fun way to explore a new site. It can include drawing and writing, but is not as touchy-feeling as a straight drawing or poetry activity. You can do mapping that is very scientific: ex: charting where the existing elderberry shrubs are on site. The map can be very real in this way. For example, if you are mapping where there are native plants on the site verses where there are weeds, you can have students plan where they should concentrate their restoration efforts. A map can also be artistic, mixing symbols with illustrations and words.

Mapping Activity: An "event map" traces our route through a landscape. You should note changes in altitude, vegetation, rocks, etc. Imagine how water flows: when it rains how does water move through the site? Where would animals go to eat and drink? Where would they hide from predators or make a nest? An event map is similar to a map that would have been made hundreds of years ago; it develops as you move along. You are not taking an aerial photo of the site so the map may not be proportional. What it does is chart the vital information of a site. Make a note of points of interest, things that struck you because of their appearance, sound, smell, touch, etc.

IV. Drawing

To start ask the students how many of them draw everyday, not just doodling in class, but drawing. Drawing and writing are just like every other talent: it takes practice. You cannot expect to pick up a pen with a 30-minute time frame and create a Picasso or a Frost. We all drew when we were 5 years old, and if you do not draw now it is probably because you were never encouraged and so you quit, and have not seriously tried to draw since. Over our lives we have a tendency to give ourselves one chance. Maybe once a year we try to draw a picture and we are not happy with it and say, "Yep, I still can't draw." But if you drew the same object once a week, you would see improvements. Everyone can draw, they are just not always happy with the results. Assure the students that we are not, at this point, artists: we have not practiced enough. If you want, ask your students how many of them WANT to be able to draw better. If they do not, then do not focus on it.

Why is drawing still a useful tool now that we have photography? Photos, as do drawings, capture a moment. But in drawing you are forced to focus more on the object, and so you connect more, know more, about that object. Just as you will notice more about the landscape riding a bike than you will driving by in a car, you will find that you notice the details of the object you are capturing more than if you just took a picture. Art is a continuum. You cannot be an effective, realistic, painter if you can't draw. Thus you always start with pencil drawing before moving to color. Similarly you do not play pro baseball before playing little league. That said, think about the order in which you introduce activities. You may want to do a drawing

activity before you do colored pencils or watercolor. On the other hand, you may or may not have enough time for students to "master" pencil drawing, so do not deny a student the experience of working with brush and color because of this.

Drawing tips:

- Breaking down complex objects into a series of simple forms, like triangles and squares, will help simplify the task.
- All objects have unique textures that explain the objects' purpose, history, etc. Instead of covering the entire object with detailed texture, you can suggest the texture by doing some details in the foreground, and suggesting the rest with quick lines or dots, or leave some spots blank in background.
- Objects become smaller as they go further away. In landscapes there is always a horizon line (where the ground meets the sky) where all lines will run. Objects appear lighter and less detailed further away.
- Warming up with quick 5, 10, and 30-second sketches will help loosen you up, like stretching before playing a sport.
- Drawing leaves can be easier, and more scientific, by starting with the veins because they are more or less symmetric.
- When drawing animals from life, have multiple drawings going at once so that when the animal switches back to a particular position, you can work on the drawing that captures that position.

Drawing Activities:

- Set up a "still life" with a variety of objects found in the field. The power of a still life is that it is still, so you can work on the details, the form, texture, shading, and perspective.
- Draw your pet at home; focus on capturing a paw, nose, eye, or any other specific piece. This will help you focus on drawing what you see, and move away from stereotypes.
- Draw five objects that you find on the ground. Try to draw them in life-size and in 5 minutes each.
- Warm-up-Blind contour: Have students choose a small object: leaf, rock, stick, etc. Have them cover their drawing tool with one hand so that they cannot see what they are drawing. Give them a time limit, maybe one minute, to draw the object without looking at their paper and without lifting their drawing tool. The focus is on drawing what you see, not what you know. For example: we know that cars have four wheels, but from certain views you can only see two and part of a third, so that is all you draw. These are going to be funky looking drawings and so it can also be a fun activity to help start the drawing process. Another way to do this is to pair students up, have the drawer cover their eyes and have the other partner describe the object that the drawer selected. Then have the drawer and describer switch.
- Warm-up-Gesture Drawings: Gesture drawings are one of the best ways to get started. These are very quick sketches that help in many ways: they warm you up and get your muscles re-thinking about drawing (just as you would do in playing a musical instrument after 10 years of not playing), they help to get an object down on the page quickly so that you can get the proportions right before investing a lot of time in the details. In a lot of ways it can be the foundation of a more finished drawing. Gesture drawings can also help your speed in capturing an image, so that if you see a bird, insect, or other fast moving item, you can capture it un-stereotypically. Drawing quickly also forces you to concentrate on the most important elements. Gesture drawings are shortly timed drawings of specific objects: leaves, seeds, rocks, etc. It is okay to look. Give students 5,

then 10, 20, and 30 seconds to draw the same object, starting over from scratch each time. Have them label their times.

V. Watercolor

Watercolor is a fun, and relatively easy (materials wise), medium to work with outside. In a nature journal, watercolors are a nice way to add interest, and also add another descriptive layer to the object you are observing. Sketching your painting before you start will help organize the elements of your painting before you commit to color. Watercolor takes practice, and lots of it, so be patient. (Note that many of the drawing activities can be used with watercolor.)

Watercolor Tips:

- Wait until one color dries before you apply another so that it doesn't bleed, unless that is the effect you are looking for.
- Always work from light to dark in watercolor because, unlike oils or acrylics, the light paint will not show over a darker paint, or will turn into another color all together. This means that you have to plan your painting ahead of time.
- The more water you load into your brush, the lighter your pigment will be on the page.
- Mixing colors if often made easier by having small plastic "palettes" that will hold color.
- Have tissue on hand to absorb any excess water.
- In a journal you are working with a pre-set paper, but there is special watercolor paper that you should first lightly wet with a sponge, tape down on a hard surface, then let to dry. This tightens the paper and gives you a nice border when you're done.

VI. Photography

Photography is an easy sell with students. There is far less stigma about taking pictures than there is about drawing one. Polaroid cameras work well for this activity as they provide quick results and can easily be taped into a journal. This can be a good way to connect students to their journals as photos have a certain intrinsic value. There is an obvious problem with photos however, as the film expense is quite high. There is also a form of photography called pin-hole photography. With pin-hole you can construct your own camera and take pictures of still objects/scenes in black and white. You can find out more information on the internet. A digital camera provides an inexpensive way for students to take many photos without having to commit to ones that they do not like. You can print several photos after the field day and bring them next time for students to tape in their journals.

Photography tips:

- Often, there is a temptation to just take a picture of something that we like without thinking about composition. Refer to "composition" found in "General Tips" at the end of this document.
- For a different perspective, zoom in or get as close as possible to the object you are photographing. Try filling the entire frame with the object.
- Write notes on or near the photos to record the date, time, place, and subject.

Photography Activity:

- Take a picture at the field day and then write the story behind the photo. If there is a crunch on time, have them write the story at home, or in the classroom.
- As a group, take photos and look for objects to make a montage of the day's events.

- Take a series of photographs of the same object from many perspectives. Try lying on the ground, or standing on a rock. Take one step closer to or further from the object for each new photo. Compare what perspective(s) worked well for that object and ask why.
- Close your eyes (or wear a blindfold) and use non-visual senses to guide you to your next photos. What did you hear, smell, or feel that prompted you to take a picture? (Use a spotter to avoid running into hazards)
- As a group, decide what object you want to photograph, and have each person take one photo of that object. On the next field day, or on the same day if using a Polaroid, compare each other's photos. Focus on how they are similar and dissimilar rather than on which one is "best."
- As a group, or as individuals, choose a location that you are interested in photographing. Mark this spot with a large stick in the ground and take a photo from this location on every field day. Compare how your spot has changed throughout the year.
- Draw or paint the object you took a photo of and compare the two.

VII. Poetry

Students are typically more open to writing their thoughts or memories than they are to drawing them. Schools typically place a higher standard upon writing and students have therefore had more incentive to practice and can easily see the need for good writing. Students are easily motivated to record their experience through a story so this may be a good place to start.

Poetry on the other hand takes a more "delicate" approach. You may start by asking the group what they know about poetry and if any of them write poetry. Their knowledge of poetry may be limited to "roses are red, violets are blue…" so exposing them to other types of poems is a must. Read examples of poems that rhyme, ones that do not, read poems that are pages long, and read haiku. As with any other media, having professionals come in to lead the activity can be a big help and inspiration. A professional may also have ideas on how students can publish their work. To start off, as with visual arts, provide an example of a professional or student poem. Your choice of poems and the style in which you read it should be influenced by the group you are working with. If you have struggled with opening up the group to journaling it is not going to help to choose a really "touch-feely" poem. If the students have already tuned you out you cannot inspire them. While you are reading the poem have students gather "word pools" words that they like or that catch their attention. This gives you a starting point when you ask for their thoughts about the poem. A word pool also gives the students a tool to use when they write their own poems. You can also have the group generate a word pool from the days' activities. Once you have read the poem and asked the group for their thoughts, go over the structure of the poem to give the students a template for their poems. As always give students the option to share. You can offer to read their poems anonymously or they can have a friend read it for them.

Poetry Activities:

- Introduce a model poem, collect a word pool and have them write a poem, then introduce a new poem and start over. This keeps the students engaged. If you give them a prompt, and then set them off alone, they may do a five-minute poem and be done. This way you ensure that they are writing, but you also expose them to multiple types of poetry at once so that when you do let them go off on their own, they have multiple poems to try.
- Have students choose five different plants and re-name them based on their characteristics.
- Haiku is a great form of poetry for students. It has a structure; it's quick and often funny. Haiku was started in Japan and the subjects of the poems were often derived from nature.

The structure of the poem is in three lines: the first has 5 syllables, the second 7, and the last has 5. The last line often takes the subject to a higher place, or is humorous.

- Seed Senses: Have each student find a seed and record as much detail as they can about the way the seed looks, feels, smells, sounds, and even tastes (if you know it's safe). The poem could start: My seed is, or my seed becomes…
- The Ode: Have students choose a plant, animal, insect, etc that they want to write an ode to. Have them compare the characteristics of the one object to another. For example: Ode to the Eucalyptus: Your patchy, flakey bark is like my skin after a sunburn….
- Have each student find a rock, feather, shell, etc. Have them draw the outline of the object on their page, and then write a poem describing the object. Write the words inside the outline they just drew.

Poetry Tips:

- Remind students that they control where their poem goes.
- Because starting a poem can be the most daunting part, provide good starting words or phrases. Give them the option of starting their poem with " I am the blank who or that blanks." Often times your model poem can give you that template.
- Encourage students to add details and be specific. For example: …like the blades of the deer grass. Or, "… like the smoothly arching blades of the deer grass."
- Read poems/stories from other cultures: Native American, Hmong, African American, etc. If you have a group that is largely Latino, choose some poems or stories from Latino authors. You can also encourage students, even if they don't speak two languages, to use other languages in their poems. Or if a student feels more comfortable writing in a language besides English, allow them that, and if they want to translate it, great.
- Choose the poems you share at the beginning based on your group and your topics of the day. Let the poems you choose to share shape the activity you choose.

General Activities:

- Gather five leaves from five different plants, draw them, make notes of important characteristics, and write how this plant is adapted to photosynthesis.
- Have students use their journals as a "cheat sheet" for a game of Native Plant Pictionary. Have a student draw a leaf, seed, or stem of a plant and have the other students guess the name.
- Have students gather interesting items throughout the day in their pockets. For the journals have them record these objects. They can be used for drawings or can help to create images or words for poetry. If there is not enough time at the field day to do the journaling, have the students collect items and then do the reflection back in the classroom or at home.
- Record the tracks that you see at the site by drawing them into your journal. Then ID the drawings by using a key either in the classroom or at the field day.
- Site/Group Journal: Have a place where the whole group creates and adds to a journal with photos, drawings, stories, leaf pressings, etc. This can be an effective tool in the classroom as well: a way to catalog the school year, a project, etc.
- Draw, Stop, Write…Find an object, landscape, etc. to draw. When a thought takes you, stop and write it down, then go back to drawing, and so on. The point is that you are not distracted by your thoughts.
- Have students record the weather in class through out the year. Note changes in temperature, landscape, etc. For example, if there is an agriculture field near the school record when they plant, when you see them spray, and harvest. Knowing the cycles of your own area is a good way to connect with the place, and your journal.

General Tips:

- **Give options.** Use the talents of the other adults with you. Say, "John is going to be under that oak doing watercolor, Jenny will be by the hay bales doing poetry, and Karen will be leading a nature walk."
- Composition: The rule of thirds: Divide the picture (whether it's a drawing or a photo) into thirds horizontally and vertically. The general rule is that objects placed on those imaginary lines create stronger compositions than centered images. This applies to photography, drawing, and painting.
- Go to the first thing that catches your eye. Whether for photos, drawings, or poems, this is probably the most immediately compelling part, to you, of the place you are in and may be to others as well.
- A bird feeder can be a useful journal/observation tool. You can keep a log of how many, and what types of birds use the feeder.
- Give enough time to the activity. If you are buying nice journals and nice supplies, make an investment in time that supports this financial investment.
- Know your students. Once you have a feeling for the group you can plan activities that are more appropriate for that group. For example: If you are having trouble opening a certain group up, or you can tell that they just are not enjoying the journals, change the way you journal. Keep the journals as a part of the day, but make them more interactive. Break into small groups and take them on a hike where you ID plants, or look for mammal tracks, or just do some watercolors.
- If students are overly pressuring each other to share say, "You can only volunteer yourself."
- Have the journal be a size that students can easily carry and use throughout the day for notes, data entry, etc. Maybe something that can fit in a pocket.

In the end the real goal of nature journaling is for it to be a rewarding experience for both leaders and students. As teachers we have to face the reality that students come to us with negative stereotypes about expressing themselves and misconceptions about their own abilities. We cannot ignore these facts if we are going to inspire students to record and build upon their experiences in the natural world. The techniques and activities in this guide are meant to help you achieve this goal.

Napa River Eco Reserve Connection

Art of the Environment

Take students along the path at the top of the Napa River bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to spread out, collect items for the art project, and develop their own art piece. You may also choose to have students collect items from the top of the bank along the trail, or in the meadow. Both of these locations offer space to construct an art piece as well. You may consider having one group of students work in each of these three spaces, and see how the different setting (open meadow, riparian canopy, open river) inspires different work.

*Please use your own discretion regarding water safety. If water is very deep or moving very quickly, please watch students carefully.

Art of the Environment

Background: This activity offers students the opportunity to explore an area with purpose, express a feeling or statement through creating a temporary art piece, and work as a team.

Time Required: 30-60 minutes

How does the Activity Run?

- Before they start, show them some pictures of other environmental artists' work for inspiration. Andy Goldsworthy book is a good one.
- Define the area students are allowed to explore and create their art piece within.
- Form student groups. 2-3 works well, although larger groups do well making larger pieces.
- Tell the students they have ___ minutes to explore the area and collect natural objects for their art piece.
- They will need to come up with a plan together, a vision of what they want to create and what they want it to "say", as well as a title for their piece. Then they will create it as a group.
- Photograph each group's art piece with the students or allow the students to photograph their own.

Be sure to tell the students:

- They must use only found objects and must respect the land (don't break branches or tear off leaves)
- The installation must be able to be removed with NO TRACES left.
- They must stay within the boundaries we defined

Tips and Cautions for Smooth Facilitation:
Make sure the area has enough material for students to use.
Be aware of, and point out, any hazards in the area such as Poison oak.
Have enough cameras, students may wish to photograph the process of creating their piece.

Napa River Eco Reserve Connection

Observe, Draw, Describe

Take students along the path at the top of the Napa River bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to spread out, work independently, and make observations about sight, sounds, smells, human influences, and plant life. You may also choose to have students sit at the top of the bank along the trail. This location also will guarantee that they will see and hear wildlife.

*Please use your own discretion regarding water safety. If water is very deep or moving very quickly, please watch students carefully.

Activity #4: Observe, Draw, Describe

To him that watches, everything is revealed.

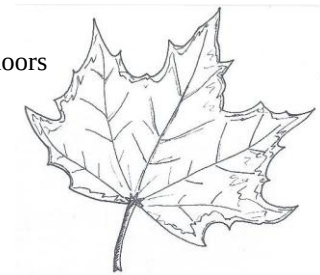
– Italian Proverb

Summary

This activity is a basic building block for exercises in description. Encourages students to slow down and observe. Students are asked to observe an object in nature, noting its physical features, drawing the object, and then putting the features into words.

Materials

Writing journal, writing utensil, and the great outdoors



Time Required

30 minutes

Procedure

1. Tell students you are going to begin to exercise their sense of observation; specifically their sense of sight. Take them outside and ask them to quietly observe their surroundings.

2. Have students sit as a group and introduce students to the importance of sight observation. See *Consider This!*

3. Ask students to look around their environment and to focus on one object whether big or small. Students can choose to observe a small physical object such as a leaf, a rock, or a larger object such as a tree or hillside. (*Tip:* As an initial exercise it is encouraged to have students start small, focusing on "the little details.")

Consider This!

Ask students how often they make note of their surroundings and the details of people, places, and objects around them. Tell them that observation can provide major insight into questions unanswered and mysteries unsolved. (Think Sherlock Holmes) And all it requires is taking the time to make note of their surroundings. Observation is a habit, and the old adage that one can make a habit in a month applies to observation. Challenge your students to actively engage in sight observation for the remainder of the day, week, or month.

4. Once their objects are located and depending on the age and independence of your students, allow them to spread out and establish their own space for greater observation.

5. Students should take a few minutes to simply observe their object and engage in an internal discussion about the quality of the object. Teachers can encourage this process by asking students as they observe basic questions about their object (What color is it? What is its texture? Is it big or small? What is its shape?).

6. Students should then draw the object in their journal. Allow them 10 minutes and encourage them to take their time and draw the intricacies of their object. *Drawing is only half dexterity, the remainder is observation.*

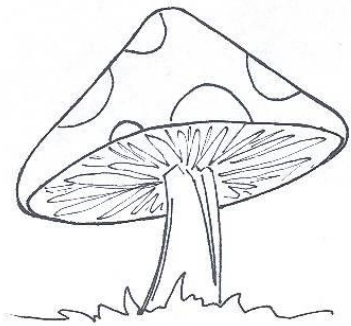
7. On the opposite page, have students now describe in words what they see. Eloquent language is not important, nor is accuracy of language, more important is acknowledgement of all the small details of their object.

8. Teacher can have students share with partners, groups, or as a class, or can choose to move on to their next activity at this point.

9. *Optional:* Ask students to reflect on process of observation (observations they have about the process of observation!).

Conclusion

10. Remind students of the observation challenge for the remainder of the day, week, or month.



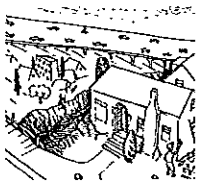
Napa River Eco Reserve Connection

Jig Saw Creek Poetry

Take students along the path at the top of the Napa River bank and find the easiest path for them to follow to the edge of the river. For much of the year the water level is low enough and the river is calm enough that this activity can be done very safely.* The flat gravel bar in the river bed is a great place for students to sit, get comfortable, and make observations about sight, sounds, smells, human influences, and plant life that could inspire their poetry. You may also choose to have students sit at the top of the bank along the trail. This location also will guarantee that they will see and hear wildlife to inspire their poetry.

*Please use your own discretion regarding water safety. If water is very deep or moving very quickly, please watch students carefully.

Activity 13



Jigsaw Creek Poetry

Summary: *Students create poetry about creeks and urban runoff through mixing around the descriptive words from their classmates.*

Background

The following passage is excerpted from *A Personal History of River of Words* by Pamela Michael

Children are experts at creating visions of places they've seen only in their imaginations-places made real by the very act of creation. So what happens when you ask those selfsame kids to imagine places that are very real, to find the poetry in water and earth and stone? And what if they are asked not just to explore the simple beauty of a place, but to reveal its environmental wisdom, and find their connection to it?

You get children finding their place in the natural world. You get children who know that water doesn't just come from a tap. You get children who know their "ecological address" as well as they know the name of their street or their town. You get hope.

This hope was the genesis of River of Words, an international poetry and art contest for children in kindergarten through twelfth grade that invites students to explore their own watershed, discover its importance in their lives, and express what they've learned, felt and observed in words and images. The program was sparked by former US Poet Laureate Robert Hass' commitment to environmental education. His vision was strong enough to inspire a group of hardcore environmental activists-a feisty bunch of dam-fighters at International Rivers Network (IRN), a grassroots group committed to protecting the integrity of watersheds-and a freelance writer like me to leap with both feet into the wonderful world of children's poetry and art.

Grades: 2-6

Time: 30-45 minutes

Setting: Classroom

Materials:
- Different colored paper – one color per group
- 5 strips of paper in each color about 2" by 8-1/2" for each group.
- Tape
- Paper and pens or pencils

Key Concept:
- Poetry can be used to describe the students interaction with and knowledge of a creek

Objectives:
Students will:
- Think of descriptive words from their creek experience
- Switch them around with another group and create a poem

Supports California Content Standards:
LANGUAGE ARTS
- Reading
- Writing
- Listening and Speaking

HISTORY/SOCIAL SCIENCE
(for details see the Standards Matrix)

The jump from activism to art wasn't such a great leap, in fact. River of Words' innovative approach to environmental and arts education was just a different kind of activism, springing from the same roots as most environmental advocacy work-an attempt to reveal the links between people and nature, the physical and the spiritual-then sharing what you've uncovered (networking) with others, and inspiring them to continue the process in their own communities (grassroots organizing).

When Robert Hass and I finally met, it was as if we'd been working on the same idea all along. "A contest, yes, I'd thought about that, too." He concurred. "But let's make the theme 'watersheds,' and keep it watersheds. Learning about our own watersheds gets to the essence of how we have to understand our home grounds, which is critical if we're ever to have a hope of managing them effectively. Let's get kids' imaginations working from that perspective right from the start."

We encouraged teachers to partner up with other teachers-a science teacher and an English teacher, say-as well as with others in their communities-bird watchers, writers, park rangers, water department employees, photographers, farmers, and so on. Every community, we reasoned, has untapped numbers of folks who might jump at the chance to take kids on a field trip or give a classroom presentation. Most school systems, however, have no vehicle, for engaging such people: one doesn't just knock on the schoolhouse door and say, "I know how to read animal tracks," or "I can identify all our native plants." River of Words, from the start, was as much about building community partnerships as it was about education, nature and the arts.

Activism is difficult work, filled with long hours of writing and research, legal wrangling, statistical analysis- and often-disappointment and loss. Like most environmental activists struggling to save a species or ecosystem or culture, International River Network's staff of had precious little time to actually spend on or near rivers-they were too busy saving them. The humor, love, and tender observations of the children's art and poetry reminded them why their own work was so essential, why it was worth the long hours and low pay; many remarked that they were revitalized by the entries, and that the children's work had renewed their sense of hope for the future.

The children who participate in River of Words each year have gained much, as well. Aside from learning the ecology and value of their watersheds, their imaginations find much to celebrate, honor and nurture. Robert Hass believes that neither poetry nor science alone can make the next generation better stewards of the earth. "We need both things-a living knowledge of the land and a live imagination of it and our place in it-if we are going to preserve it. Good science and a vital art and, in the long run, wisdom."

River of Words participants have given us a unique and encompassing view of our world as seen through the eyes of its children. They have expressed their concerns, dreams, wishes and fears in words and pictures that astound and delight. Now that we know what these children have to say. The question for the rest of us is: what do we have to say to them? Do we know our place in the watery world? Robert Hass again: "There is no reason we cannot give our kids hope, and a sense of pride, and

love of our amazing earth, and a sense of purpose, and we need to begin now. River of Words is the seed of a place to start."

Activity

1. Divide your class into groups of five students. Give each group five strips of paper (about 2" by 8-1/2") that are the same color. Each group should have a different color.
2. Ask the students to write a sentence or phrase on their strip of paper that reflects both: a) how they felt when they had visited the creek, and b) how a creek and water quality can change for better or worse because of human interaction. Give them about 5 minutes to write.
3. When everyone has finished, gather the strips of paper from one group and exchange them with another group. For example, trade the five blue strips with the red strips.
4. Give each group some scotch tape, and instruct them to work together with the new sentences they have been given. After reading all of the sentences, they should tape them in an order that sounds like a poem.
5. When all groups are finished, they should read their new "jigsaw poem" to the rest of the class. You can put the poems up on a wall, and/or type out a copy for everyone to have. You will be surprised how beautiful the poems sound, and how easy and unthreatening they were to create.
    - Contact River of Words to get information about participating in their annual student contest: *River of Words, 2530-C San Pablo Ave., Berkeley, CA 94704. (510/548-POEM), info@riverofwords.org.*

Discussion

- Do students like the poems? Why?
- How were human interactions portrayed in the poems, were they all good, all bad or a little of both?
- What do the poems have in common? How are they different?
- Why is poetry a good way to describe a creek and its conservation issues?

Branching Out

Language Arts:

- Contact a local arts education group and bring a working poet or artist into the classroom to help inspire your students.
- Spend time reading the poetry of some outstanding poets whose work is accessible to your age group, and speaks about the issues you are studying.
- Create journals for poetry, in which you include the work of others as well as your own.
- Expose students to various poetry styles such as free verse, rhyme, poems written from the animal's point of view, poems for two voices, and haiku poetry.

Arts:

- Have students paint a picture that represents their poem
- Students can create a collage of natural items from the creek site as a visual aid to their poem

Here are two other poetry styles that you may want to try with your students:

Nouning

Noun title:	dragon fly
2 adjectives:	buzzing, bright
3 verbs:	seeking, scanning, searching
Phrase:	a mosquito's
Repeat noun:	dragonfly

Windsparks

Line 1:	"I dreamed"
Line 2:	"I was....."
Line 3:	Where
Line 4:	Action
Line 5:	How

Examples

I dreamed	I dreamed
I was a dragonfly	I was a heron
In a slimy, gooey marsh	High above the wetlands
Flying quickly through the air	Searching the water for fish
Intensely	Silently

Napa River Eco Reserve Connection

Animal Cinquain

Have students write their poems about one of the many different species of wildlife that can be found in the Eco Reserve or the surrounding area, including: deer, raccoons, coyote, gray foxes, bobcats, mountain lions, jackrabbits, skunks, squirrels, mice, rats, opossums, beaver, river otters, herons, egrets, ducks, woodpeckers, hawks, owls, scrub jays, crows, blackbirds, and more!

You can find even more wildlife in the brochure at the beginning of this guide called "Birds and Butterflies of the Napa River Ecological Reserve."

The meadow on the west side of the main trail running through the Eco Reserve or the gravel bar at the base of the river bank are both great locations to have students sit and write their cinquain peoms.

NYSDEC Environmental Education

Animal Cinquain

There are three formats for a cinquain poem:

Format 1:
Line1: One word
Line2: Two words
Line 3: Three words
Line 4: Four words
Line 5: One word

Format 2:
Line1: A noun
Line2: Two adjectives
Line 3: Three -ing words
Line 4: A phrase
Line 5: Another word for the noun

Format 3:
Line1: Two syllables
Line2: Four syllables
Line 3: Six syllables
Line 4: Eight syllables
Line 5: Two syllables

The worksheet on the next page can be used to guide your students in developing a cinquain about an animal. The example poem uses format 2.

The worksheet could be used in conjunction with a visualization activity such as Project WILD's "Animal Poetry" on page 282 or "Stormy Weather" on page 85. Alternatively, students could research an animal before doing a visualization exercise or writing the poem.

Animal Cinquain

Answer these Questions:

1. What is the animal's name? _____

2. What are some adjectives that describe the animal?

   _____

   _____

3. What are some things that it does: How does the animal move, find food, eat, find shelter, find water?

   _____

   _____

4. How does it make you feel when you see it or think of it? What role does it play in the environment?

   _____

   _____

5. What is another word or words that identify, or name, the animal? _____

Write the Poem:

_____
Animal's Name

_____,_____
Two adjectives describing the animal

_____ _____ _____
Three action words that end in "ing"

_____
A short phrase about the animal

_____
Another name or word for the animal

Example:

Red Fox
Sleek, Furry
Seeking, Creeping, Pouncing
Efficient Rodent Eater
Hunter

Napa River Eco Reserve Connection

Native Plant Fairytale

There are many native plants at the Eco reserve that the students could choose for their "fairytale" plant. An ideal location to conduct this activity would be along the interpretive plant loop where students can see roughly a dozen native plants labelled with their common and scientific names. Students could choose their favorite plant and sit along the path near it to observe it and use it as inspiration for their story.

Native Plant Fairytale

Time Needed: 60 Minutes

How Does the Activity Run?

Your task is to write a fairytale story about a year in the life of a native plant that you learned today at the Eco Reserve. This story should allow you to learn plant science and express your knowledge in a fun and creative way.

Please write your story from the plant's perspective, as if you were the plant. Each member of the mentor group should be encouraged to offer ideas for the story's plot, character names, setting, word usage, humor and background information. One member of the group should be responsible for writing and the mentor is responsible for making sure everyone's ideas become part of the story.

The story should be a mixture of facts and fantasy. A successful story will include facts: plant name, size, shape, color, texture, reproduction technique, wildlife benefits, historical usage by Native Americans and anything else that makes your chosen plant unique.

Here are a few questions that you can answer and incorporate into your story: Who eats you? What do you need to live and how do you get it? Do you have any neighbors? Do your friends ever visit? If so, who are they and what time of year do they come? What does it feel like to have so many visitors in a relatively short amount of time? How do you benefit your visitors and how do they benefit you?

A successful story will also include fantasy: Where does the plant live? What is the plant named? Who are the plant's friends and family? What are the plant's hobbies, strengths and challenges? What does the plant find funny? Is there an epic quest that the plant is embarking on? These are just ideas and I encourage you to incorporate into your story all of the neat, clever and fun ideas that you and your group may have.

Tips and Cautions for Smooth Facilitation: Teachers and chaperones must make sure that each student is included in the writing process. Before writing, go over some fun plant facts or sotry ideas so that students are better prepared to write.

Materials Needed: Paper or a notebook, plant guides, and pencils.

Napa River Eco Reserve Connection

Personal Environmental Ethics

The Eco Reserve is an inspiring place where students can truly see why it is so valuable to preserve and restore wild lands. As the last sizeable remaining stretch of riparian forest along the Napa River, the Eco Reserve is a wonderful environment to think about living sustainably and looking for solutions for global environmental challenges.

The best places in the Eco reserve to conduct this activity would be the meadow just to the west of the main trail running through the Reserve or any particular spot where the students feel inspired.

Personal Environmental Ethics

Time Needed: 45-60 minutes

Directions:

- Have everyone sit with their paper or notebook
- Introduce the topic by talking about the effect humans have on the environment, the concept of "low" or "positive" impact, give examples and ask for examples of things students have done on their own
- Have each student create their own personal code of environmental ethics
- Invite volunteers to share part or all of their code and the reasoning behind it with the class.

Tips and Cautions for Smooth Facilitation: Be open-minded to students comments and attitudes, but prepared with an arsenal of knowledge on environmental impacts and sustainable practices

Alternative Method: Ask students to think of an environmental issue that is important to them-something they would like to help solve. Examples: global climate change, acid rain, deforestation, overfishing of the oceans, etc. Have them design a poster with a slogan or image that could help motivate others to take action against this environmental threat. Have the students share these posters with the class.

Materials Needed: Paper or a notebook, pens or pencils

Napa River Eco Reserve Connection

What's the Difference?

This activity requires you to collect natural objects that the students will examine using all of their senses. There are many different spots in the Eco Reserve where items well-suited to this activity can be collected. As you leave the parking lots and head down the main trail through the Reserve, you will see walnut trees, which can provide shells for the students to examine. Along the trail you will also see multiple oak trees, which will provide oak galls and acorns for the students to observe. Along the path at the top of the riverbank are additional oak species as well as buckeye trees, which produce nuts that would also be perfect for this activity. You will also find many types of leaves, the shells of dead insects, flowers, grasses, feathers, and more.

Please use fallen or found materials before removing living parts from any of the plants at the Reserve.

Activity #5: What's the Difference?

The artist is the confidant of nature, flowers carry on dialogues with him through the graceful bending of their stems and the harmoniously tinted nuances of their blossoms. Every flower has a cordial word which nature directs towards him.

- Auguste Rodin

Summary

This activity challenges students to use not only their sight skills but also those of touch and smell. Students are each given a similar object and asked to study it. The object is then mixed with a number of other similar looking objects; students examine all of the objects in order to distinguish their original.

Materials

A number of similar objects (examples: pine cones, leaves, rocks, flowers)

Time Required

15 minutes

Procedure

1. Seat students in a circle outside and hand them their object and ask them to quietly observe it (if you are in a location where there are lots of rocks or Douglas fir cones, etc., students can get their object on their own).

2. Give students 2-3 minutes to mentally note all the features of their object. Encourage them to use all senses available to them (although tasting objects may be inappropriate). It is important for later discussion that you do not tell students that you are going to take the objects from them.

3. Collect all the objects and place them in a non-see through bag or a pillow case. Mix up the objects. Then pass out the objects so each student again has one.

4. To maintain order, tell students on your signal that they will pass their object to the right of the circle and this process will continue until all students have their original objects. When a student is reunited with his or her original object they can remain in the

circle passing around the objects or the teacher can have them move out or into the middle of the circle.

5. Once all students have retrieved their object, engage students in a discussion about the challenges of the activity. Questions can include:

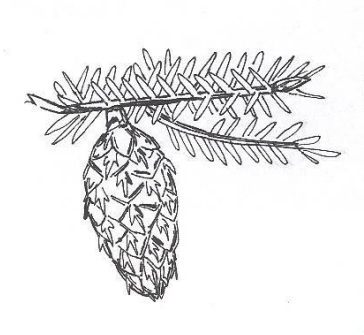
    a. Was that easy or difficult? Why?

    b. If you could do it over again, what details about your object would you have paid more attention to?

    c. Did you use more senses than just your sight?

Conclusion

6. *Optional:* Have students return their object to its original location or collect them. Now ask them to draw or describe their object in their nature writing journal.



Napa River Eco Reserve Connection

Create Your Own Plant

There are many native and invasive plants at the Eco reserve that the students could use as inspiration to create their own plants. An ideal location to conduct this activity would be along the interpretive plant loop where students can see roughly a dozen native plants labelled with their common and scientific names. Students could walk the path to observe the traits of different plants and determine what characteristics they want their own creation to exhibit.

Encourage students to look at the non-native plants, many of which are invasive, and think about the traits those plants have developed to help them survive. Students may want to combine some native and invasive plant qualities to create their own unique plant.

Activity #6: Create Your Own Plant

Nature uses human imagination to lift her work of creation to even higher levels.

- Luigi Pirandello

Summary

Students create their own plant. This activity encourages students to use their imagination to create original details and features. Teachers can encourage students to use established vocabulary to create and describe their plant or students can create their own features and vocabulary.

Materials

Nature journal, writing utensil, colored pencils, markers or crayons

Time Required

40 minutes

Procedure

1. *Optional*: Teachers can introduce the lesson by showing students unique plants and sharing interesting stories about the plants. This introduction gets students to start thinking about unique qualities of plants. Example: Venus flytrap, Rafflesia arnoldii, Corpse flower. (Teachers may choose to use this step at the end of the activity as it may stifle creativity.)

   For examples of unusual plants:
   http://www.divinecaroline.com/22167/37205-eight-world-s-mostunusual-plants

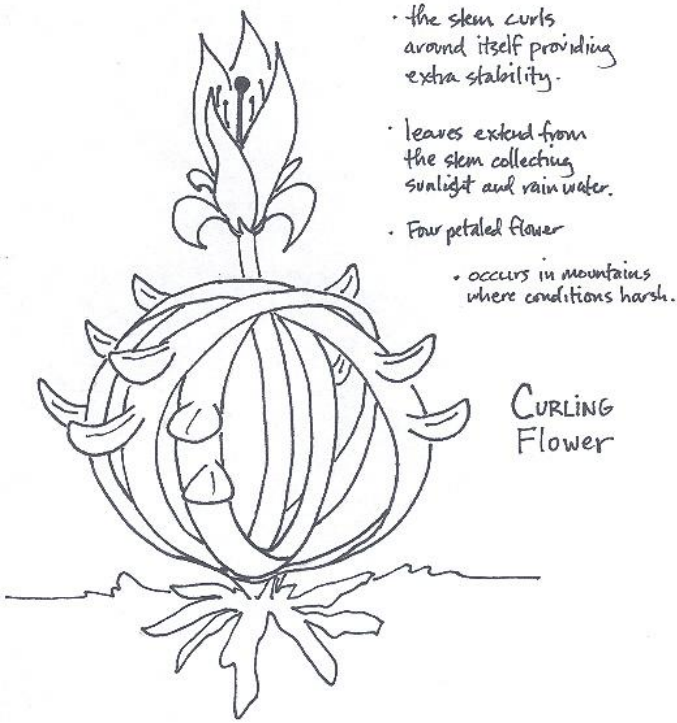
2. Tell students their assignment is to create their own plant in their journal. They should draw the plant as well as provide a description about their plants features, adaptations, unusual characteristics and history.

Consider This!

Teachers can provide as many parameters for this activity as they believe appropriate. For example, teachers can ask students to create plants that are consistent with reality, or instead, they can allow students to make up features and descriptive vocabulary. Think Avatar.

This activity can also be adapted for other forms of life: mammals, insects, amphibians, ecologies, etc.

3. *Optional:* Have students share their plant with a partner. Without showing the partner the descriptive characteristics, have the partner describe the plant using his or her own vocabulary. Then have the creator of the plant describe the characteristics as they were intended. This step offers opportunity for conversation about how people have different ways of describing objects; different perspectives and perceptions. This can be done in partners or as a group activity.



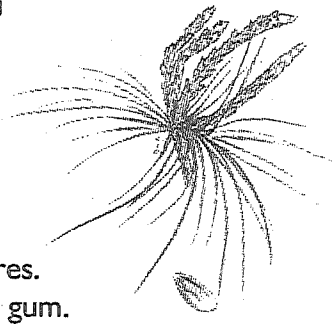
Napa River Eco Reserve Connection

Native American Uses of Native Plants

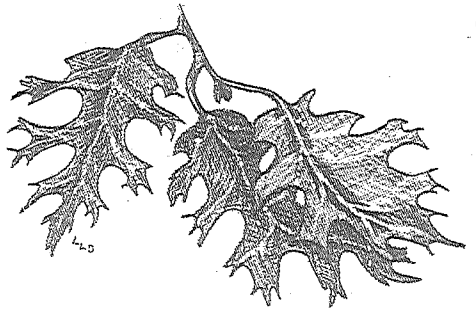
The Eco reserve was once a hunting and gathering area for the Wappo people of the Napa valley. The Wappo found many uses for native plants in their daily lives. The attached guidebook was created for the native plant garden at Bothe State Park, but can easily be used at the Eco Reserve. You can find some of the species in the guidebook along the interpretive plant loop, and many more along the trail that runs along the top of the riverbank.

If you are not adept at identifying your native plants, you may want to bring a set of Pacific Tree Finders or other plant guides that will aid you in correctly identifying each plant. Pacific Tree Finders can be borrowed from the Napa RCD office.

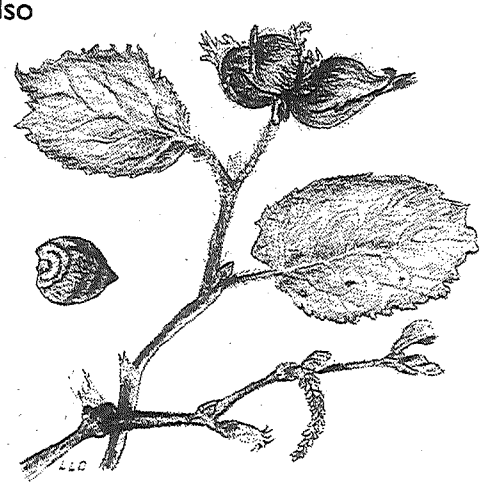
1. Ghost Pine. *Pinus sabiniana.* The Wappo name is Nayo (pronounced nigh'yo). The nuts were cracked with hammerstones and eaten raw or roasted. The roots were unearthed with a digging stick and used for weaving large, twined baskets, a "good work basket for pounding acorns". The large, clawed cones were used to fuel fires. The pitch was chewed like gum.



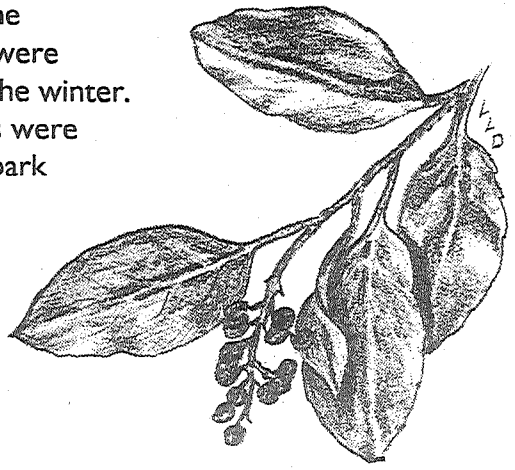
2. California Black Oak. *Quercus kelloggii.* Khothi so (ka ho'th sho). Acorn. Khothis (kho'tish). Acorns were the 'staff of life' or the most important food crop for the Wappo; those of the Black Oak and the Tanbark Oak were preferred. Acorns were gathered in large quantities and stored in specially built granaries or caches. Shelled acorns were pounded in a mortar and leached in a sand basin beside a creek to remove the bitter tannin. The meal was made into mush, soup and bread.



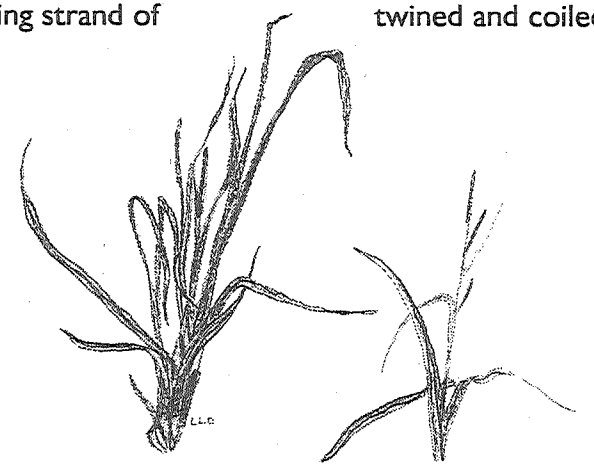
3. Hazelnut. *Corylus cornuta* var. *californica.* Miti sohol (me te show'ho). The nuts were dried in their shells and eaten later as desired. They were sometimes roasted prior to consumption. The shoots were used to make baskets in which babies were carried; they were also used for the rods of burden baskets and animal traps. The wood does not become brittle and withstands wear; "makes a good digging stick".



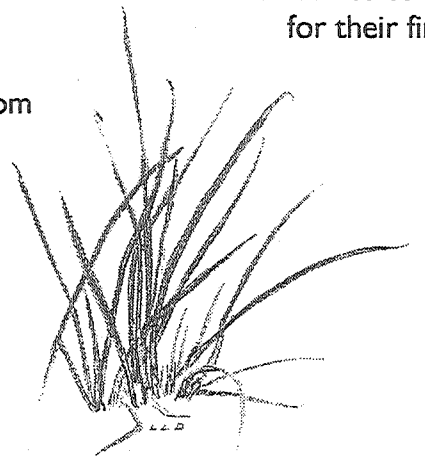
4. Madrone. *Arbutus menziesii.* Napayoko (na pa yo'ko). The berries were eaten fresh or parched by tossing in a basket with hot coals, then eaten whole. The cooked berries were also stored for the winter. Healing infusions were made from the bark and leaves.



5. Sedge. *Carex barbarae.* Chate (cha'tey). Sometimes known to basket makers as White Root or Cut Weed, the roots were noted for their pliability, strength and durability, surpassing any other weaving material that was available. The long, straight, light-colored roots, averaging 2-5 feet in length, were first split lengthwise into fine, threadlike strands. Then they were peeled, cleaned and stored in coils. Later they were used as the woof or pliable sewing strand of twined and coiled baskets.



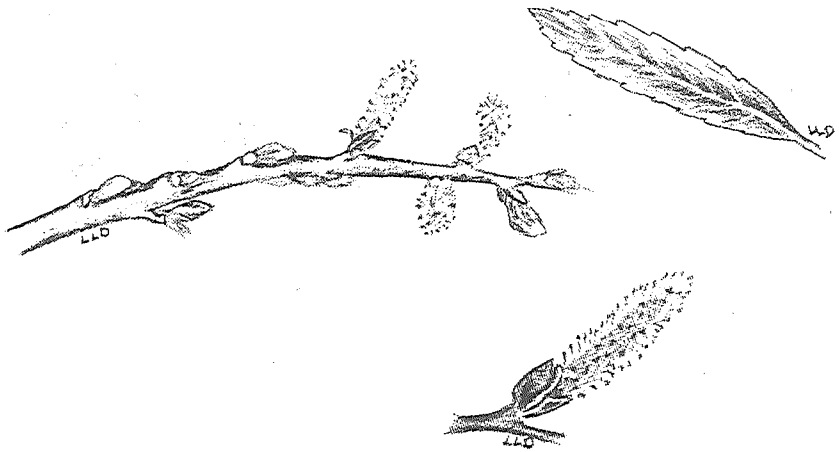
6. Pacific Rush. *Juncus effusus* var. *pacificus.* The Wappo name is unknown. The stalks were used to string disk-shaped, clamshell beads for their final shaping and polishing. The clamshells were obtained from the coast, and the beads served as native currency.



Poison Oak. *Toxicodendron diversilobum.* Kicu ma (kee'see mah). A black stain from the leaves was used to dye bulrush roots. The roots were used as an element in basketry. People vary in their sensitivity to the allergen in poison oak. The best protection is to know what this plant looks like in all seasons and avoid it.

7. Cat-Tail. *Typha angustifolia.* The Wappo name is unknown. The roots and new shoots were eaten raw or roasted. The immature stalks, much like celery, were eaten raw. In addition the tops, male flower clusters loaded with pollen, were eaten raw.

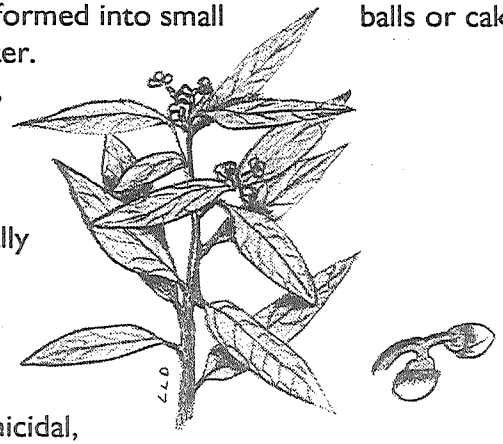
8. Sandbar Willow. *Salix hindsiana.*
Chupe pote (chew pey po'te). Tea was made from the tender, young shoots in the springtime and used to treat diarrhea. Shoots were used in making baby and acorn baskets and fish traps. They were important material for the warp or foundation of coiled and twined baskets. They also served as the framework for the living shelters which were oval or round and thatched with grass. The bark had medicinal uses, much like aspirin.



9. Toyon. *Heteromeles arbutifolia.* Unu ciwa hoe (oo noo tsaw'wa hoe). The berries of this shrub were eaten after being baked or roasted in a basket of hot coals. The berries of the Toyon and Madrone were the last harvest of the year.

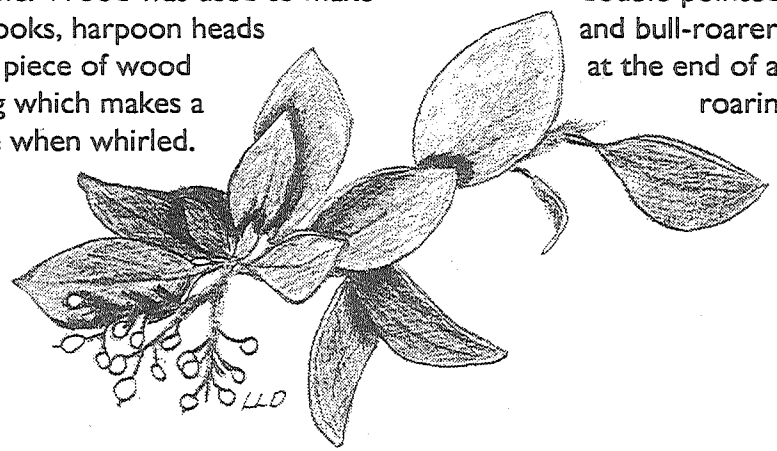
10. Angelica. *Angelica tomentosa.* The Wappo name is Ciwhel (tsee'whel) for the flower and Kupis (coo'pis) for the root. Immature flowers and green shoots were eaten raw. Root scrapings were rubbed on painful areas to relieve discomfort. The aromatic fumes of the root were inhaled to treat colds. A tea was made from the roots to reduce fevers. Angelica was a sacred plant with many ceremonial uses. Sections of roots were worn to protect against poisoners (evildoers) and general misfortune. Ground up roots were rubbed on the arms to insure good luck in gambling and hunting. Scrapings of the root were smoked.

11. California Bay. *Umbellularia californica.* Cuse (chu'shey). Nuts were roasted in their shells in hot ashes and then ground into flour, formed into small balls or cakes and stored for eating later. When clover was eaten, the cakes or balls were consumed to prevent bloat. Leaves were boiled and used externally with sagebrush for the treatment of rheumatism. Branches of leaves were rubbed over the body as a germicidal, placed above doorways to keep sickness away and rubbed over the body to neutralize the work of poisoners.

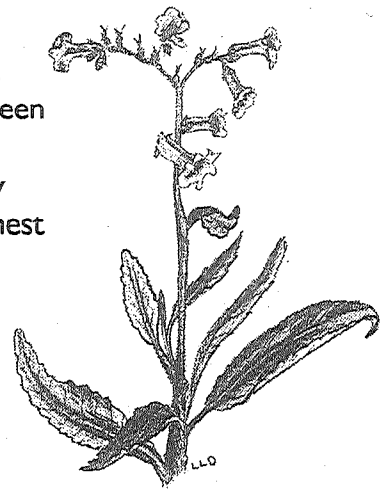


12. Soap Root. *Chlorogalum pomeridianum.* Eu kali (ew kal'e). The root was chewed and applied to the exterior of baskets to make them more durable. It was also used as an adhesive. The root was mashed for shampoo. Leaves were used to line underground ovens. The bulb was used as a soap and to stupefy fish. They were also eaten after being baked very slowly in an earth oven.

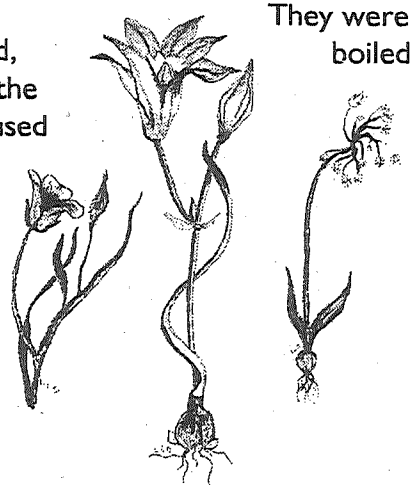
13. Manzanita, Common and Stanford. *Arctostaphylos manzanita; A. stanfordiana.* Cano (cha'no); Mota cano (mo'ta cha'no). Berries were eaten fresh or dried and ground into meal. They were made into a drink as well, not unlike apple cider. Leaves were used in a tea to treat diarrhea and stomach trouble. Wood was used to make double-pointed fishhooks, harpoon heads and bull-roarers, a flat piece of wood at the end of a string which makes a roaring noise when whirled.



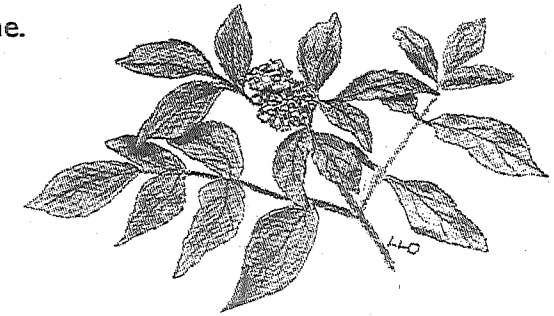
14. Yerba Santa. *Eriodictyon californicum.* The Wappo name is unknown. The leaves and green shoots were highly esteemed for upper respiratory ailments like coughs and colds. The leaves were chewed to treat a cough. A tea was made from green shoots and leaves for treatment of colds and sore throats. Freshly mashed leaves were put on the chest like a poultice.



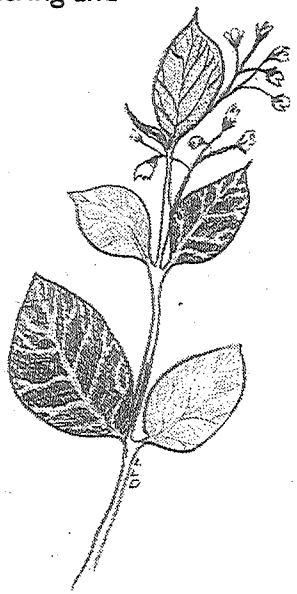
15. Bulbs and Corms. *Allium unifolium, Brodiaea* spp. and *Calochortus* spp. Hol a we (hol'ah way). Generally called "Indian Potatoes" by the Native Americans, these plants were identified by their flowers. Bulbs were gathered in large quantities with the use of digging sticks. They were either eaten raw or cooked (baked, boiled or roasted). The leaves as well as the bulbs of wild onions were used to flavor other foods.



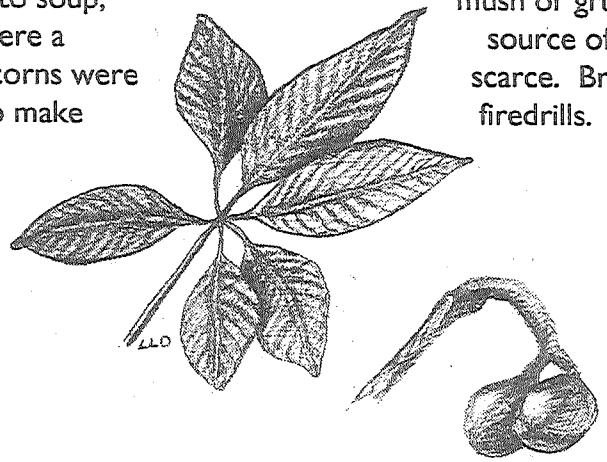
16. Blue Elderberry. *Sambucus caerulea.* Kate (kah'tey). The ripe berries were eaten fresh or cooked like acorn mush. They were also dried and stored for winter use. A tea was made from the blossoms and used to treat children's fevers. The branches were made into whistles and split-stick dance rattles. The wood was also fashioned into staves that were used by the women in their split-stick dice game.



17. Indian Hemp. *Apocynum cannabinum* var. *glaberrimum.* The Wappo name is unknown. In addition to milkweed, wild hemp was a source of fiber for string and rope. The fibrous stems were made into twine that was used for nets, belts and tumplines, a strap passed across the forehead to support a large burden basket carried on the back.

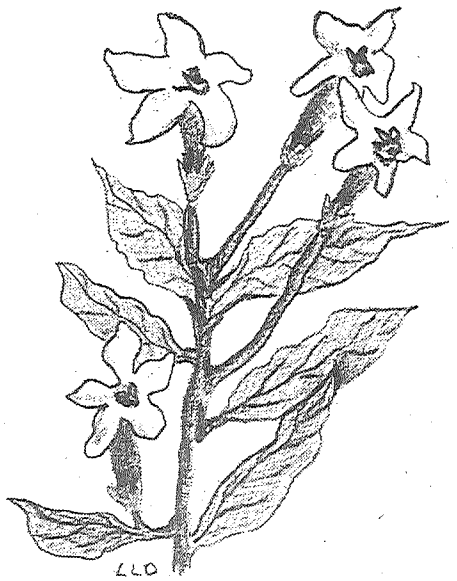


18. Buckeye. *Aesculus californica.* Sumoto (shu mow'tow). The nuts of Buckeye are poisonous if eaten raw. They are edible, however, if pounded, leached repeatedly in a sand basin and baked for several hours. After that, they were made into soup, mush or gruel. Buckeye nuts were a source of food only when acorns were scarce. Branches were used to make firedrills.



19. Redbud. *Cercis occidentalis.* Phopiel (poe pie'el'). The stems and twigs provided long, straight switches for basketry. They were strong, pliable and durable. They were peeled and then split lengthwise, leaving two continuous strips of red bark with white sapwood in between. Prepared in this fashion, they were used to make the reddish-brown patterns in basketry.

20. Wild Tobacco. *Nicotiana bigelovii.* Luce (lew'shay). Wild tobacco was not mixed with any other plant; it was smoked by itself. The leaves of this annual were gathered at the time of flowering, dried in the sun, crushed and kept in a leather pouch for later use. It was smoked for ceremonial and medicinal purposes.



NOTES

Illustrations by Lois L. Drobot

Napa River Eco Reserve Connection

What Happened Here Before?

The Eco Reserve is in a perfect location to get students thinking about what happened in the valley before we lived here. Students will have a great view of the hills of volcanic rock on the east side of the valley and the hills on the west side of the valley composed of former oceanic crust. Students can also find a collection of unique rocks, including obsidian at the Eco Reserve.

In addition to geology, students can think about the changing land uses in the valley over time. In this guide, you will find an aerial photo of the Eco Reserve that shows development all around the Reserve. Ask students to think about what the valley looked like before and imagine what it could like in the future in we practiced more ecological restoration and conservation.

"What Happened Here Before"

TEACHER'S PAGES

Creating a Bay Timeline

Overview

In this activity students will begin by reading a poem by Gary Snyder and completing a homework assignment to learn about his presentation of the history of California. Students will then read about the geological history of the San Francisco Bay and will work in groups to create an artistic representation of a timeline of the Bay.

Central Questions

What were some of the major events in the history of California that affected its natural resources and physical characteristics? What is the geological history of the San Francisco Bay and its watershed? What role have plate tectonics, sedimentation, volcanoes, and climate change played in the formation of the Bay?

Estimated Time

Part I: Poetic Review
1 homework assignment
Part II: Artistic Interpretation
1 reading assignment, 1-2 class periods to create mural

Objectives

Students will be able to:

- Interpret a poem, identifying and defining key words and phrases, describing a theme, and linking the structure to the content.
- Describe the history of California and its wealth of natural resources.
- Comprehend that geology is a dynamic process.
- Understand how plate tectonics, sedimentation, climate change, and volcanic activity have shaped the Bay.
- Explain the formation of specific landscapes around the Bay.

Materials

Part I: Poetic Review
For each student:

- 1 copy of student worksheet with Gary Snyder's poem "What Happened Here Before"

Part II: Artistic Interpretation
For each student (for reading assignment):

- 1 copy of "Bay Today, Gone Tomorrow"

For each group (for mural):

- 1 blown-up copy of picture of the Bay
- Ruler
- Pencils
- Art supplies (crayons, color pencils, paints, etc.)

California Science Content Standards

Grade 6

Standard Set 1.e: major geologic events, such as earthquakes, volcanic eruptions, and mountain building result from plate motions.

Standard Set 1.f: how to explain major features of California geology in terms of plate tectonics (including mountains, faults, volcanoes).

Standard Set 2.a: water running downhill is the dominant process in shaping the landscape, including California's landscape.

Standard Set 2.b: rivers and streams are dynamic systems that erode and transport sediment, change course, and flood their banks in natural and recurring patterns.

Standard Set 2.d: earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

Grade 7

Earth and Life History (Earth Science)

Standard Set 4.a: Earth processes today are similar to those that occurred in the past and slow geologic processes have large

cumulative effects over long periods of time.
Standard Set 4.b: the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impact of an asteroid.
Standard Set 4.c: the rock cycle includes the formation of new sediment and rocks. Rocks are often found in layers with the oldest generally on the bottom.

Grades 9 - 12

Earth Sciences Standard 9.a: the resources of major economic importance in California and their relation to California's geology.

Language Arts

Grades 6 - 12

Reading

Students read and understand grade-level-appropriate material. *(See Standards for details)*

Teacher Procedure

Part I: Poetic Review

1. Pass out copies of Gary Snyder's poem "What Happened Here Before" and worksheets as a homework assignment.

2. Tell students that they are to read the poem carefully at least two times through before beginning the assignment. Then they should fill out the worksheet accompanying the poem. The worksheet requires the students to find one key word from each time frame in the poem and do a little research in the library or on the internet to define their key word.

3. Give the your class some examples of appropriate key words, citing a few words from the vocabulary list. The key words should be words describing the Earth's physical characteristics or natural resources (examples: slate, schist, manzanita, blacktail hare, etc.).

4. Each student should answer the following questions about the poem regarding its meaning and the meaning of the key phrase "WE SHALL SEE/WHO KNOWS/HOW TO BE."

   Questions:
   - What did you think of the poem?
   - How did the poem make you feel?
   - What are some of the key words you found and what are their definitions?
   - Which key words did you not know before the presentations and how do they play a part in the poem?
   - What specific images from the poem teach us about the history of California?
   - What do you think is the poet's message?
   - What does the poet seem to think about how we treat the Earth today?
   - What do you predict California will look like in the future and how would you write a verse of the poem for the future time period? (Have the students read some verses aloud.)

5. The next day in class, lead a discussion about the poem before collecting the students' homework assignments.

Part II: Artistic Interpretation

Teacher Procedure

1. Pass out "Bay Today, Gone Tomorrow" article to students the day before and tell them to read it for homework.

2. Tell the students to pay special attention to the geologic processes that shaped today's Bay and to create a list of geologic processes mentioned in the article that have shaped the Bay.

3. In class the next day, divide class into 4 groups.

4. Pass out art materials to groups.

5. Explain that they are to read the article and create a free-form artistic mural detailing the history of the formation of today's San Francisco Bay. Their pictures should show the changes in their time period.

6. Assign each group to a specific time period/ era in the formation of the Bay and have the

group brainstorm the most important parts of their time period. Then each group will design and create their mural on the blown-up picture of the Bay.

- Group 1: volcanic eruption and plate tectonics, Bay Block
- Group 2: river systems, siltation, and sedimentation process
- Group 3: glaciation and end of ice age processes, sea level rise and drop
- Group 4: predictions of future changes….

7. Tell the groups that each group should create their mural to explain visually the processes they are assigned. They may use specific words, phrases, and quotes from the article. Also, ask them to label their time period on their mural.

8. When students are ready, have them display their murals in the room so they can see the other groups' work. Ask them what order the murals should go in to create a timeline for the history of the formation of today's Bay.

9. Have each group present their murals to the class, explaining what geologic processes occurred during their time period, etc.

Class Discussion/ Wrap-Up

1. Relate the article by Glen Martin to the poem by Gary Snyder. Each deals with almost incomprehensible amounts of time. How does each writer give us perspective on our place in geologic time? What are the similarities and differences between the poem and the article?

2. Ask the students to make predictions of what the Bay may look like thousands of years from now.
   - What changes may take place?
   - What geologic processes might cause these changes?
   - What are some things that we humans are doing that are affecting the Bay and its natural resources? (bay fill, wetland development, water diversion from the Delta, water pollution)
   - What are some things that we can do to protect our resources and prevent the types of changes we have caused?

Additional Resources

Geologic Bay History
http://squall.sfsu.edu/courses/geol103/labs/estuaries/partII.html

"What Happened Here Before"

Student Pages

Part I: Literary Comprehension

1. Read the poem "What Happened Here Before" by Gary Snyder carefully at least two times before beginning the assignment. On a separate sheet of paper write out one key word from each time period within the poem. Do a little research either in the library, on the internet, or in encyclopedias or dictionaries to define the terms you selected. The terms selected should be key words within that section of the poem, describing the Earth's physical characteristics, natural resources, or wildlife. (examples: schist, manzanita, blacktail hare, etc.)

Part II: Literary Analysis

Answer the following questions on a separate sheet of paper.

1. What do you think is(are) the overall theme(s)/message(s) of this poem?

2. What do you think the poet was trying to achieve by separating the poem into segments of time?

3. What are the Feather, Bear, and Yuba?

4. What historical event do you think the phrase "tossed up trees and boulders with big hoses" is referring to?

5. What could "sunlight grown heavy and tasty/ while moving up food-chains/ in search of a body with eyes and a fairly large/ brain" mean?

6. What do you think the phrase "the land belongs to itself./'no self in self: no self in things'" means?

7. Interpret the phrase "WE SHALL SEE/ WHO KNOWS/ HOW TO BE."

8. How did the timeline presented in this poem make you feel?

9. Did you like or dislike the poem? Why?

WHAT HAPPENED HERE BEFORE

by Gary Snyder

—300,000,000—
First a sea: soft sands, muds, and marls
— loading, compressing, heating, crumpling,
crushing, recrystallizing, infiltrating,
several times lifted and submerged,
intruding molten granite magma
deep-cooled and speckling,
gold quartz fills the cracks—

—80,000,000—
sea-bed strata raised and folded,
granite far below.
warm quiet centuries of rains
(make dark red tropic soils)
wear down two miles of surface,
lay bare the veins and tumble heavy gold
in streambeds
slate and schist rock-riffles catch it –
volcanic ash floats down and dams the streams,
piles up the gold and gravel—

—3,000,000—
flowing north, two rivers joined,
to make a wide long lake.
and then it tilted and rivers fell apart
all running west
to cut the gorges of the Feather
Bear, and Yuba.

Ponderosa pine, manzanita, black oak, mountain yew,
deer, coyote, bluejay, gray squirrel,
ground squirrel, fox, blacktail hare,
ringtail, bobcat, bear,
all came to live here.

—40,000—
And human people came with basket hats and nets
winter-houses and underground
yew bows painted green,
feasts and dances for the boys and girls
songs and stories in the smoky dark.

—150—
Then came the white man: tossed up trees and
boulders with big hoses,
going after that old gravel and gold.
horses, apple-orchards, card-games,
pistol-shooting, churches, county jail.

We asked, who the land belongs to.
And where one pays the tax.
(two gents who never used it twenty years,
and before them the widow
of the son of the man
who got him a patented deed
on a worked-out mining claim,)
laid hasty on the land that was deed and acorn
grounds of the Nisenan?
Branch of the Maidu?

(they never had a chance to speak, even,
their name.)
(and who remembers the Treaty of Guadalupe Hidalgo.)

the land belongs to itself.
"no self in self: no self in things"
Turtle Island swims
in the ocean-sky swirl-void
biting its tail while the worlds go
on-and-off
winking

& Mr. Tobiassen, a Cousin Jack,
assesses the county tax.
(the tax is our body-mind, guest at the banquet
Memorial and Annual, in honor
of sunlight grown heavy and tasty
while moving up food-chains
in search of a body with eyes and a fairly large
brain—
to look back at itself
on high.)

now,

we sit here near the diggings
in the forest, by our fire, and watch
the moon and planets and the shooting stars—

my sons ask, who are we?
drying apples picked from homestead trees
drying berries, curing meat,
shooting arrows at bales of straw.

military jets head northeast, roaring, every dawn.
my sons ask, who are they?

WE SHALL SEE
WHO KNOWS
HOW TO BE

Bluejay screeches from a pine.

BAY TODAY, GONE TOMORROW

S.F. region's defining feature is just a transitory puddle in geologic time

by Glen Martin, San Francisco Chronicle Staff Writer
Monday, December 20, 1999

If you had planned to stroll to Ocean Beach 17,000 years ago, you would have been well advised to pack a lunch. And maybe dinner and the next day's breakfast, too.

That's because the coast was very far away. From where San Francisco sits, the beach was 26 miles west, about six miles past today's Farallon Islands.

The islands themselves, of course, were not islands at all — they were peaks.

And San Francisco Bay? Well, there was no bay. And that would remain the case for several thousand years.

The site of the present bay was a series of broad valleys, each with a tributary stream that poured into a mighty, sediment-swollen river that originated in the Sierra Nevada. This river drained through the Central Valley, the Carquinez Strait, Raccoon Strait and the stony ramparts that are now the Golden Gate.

A bay, in fact, is something of an anomaly for the San Francisco region.

"During the past 600,000 years, the bay has only existed during three brief periods totaling about 15,000 years," observes Ken Lajoie, a senior geologist with the U.S. Geological Survey in Menlo Park who counts the Bay Area's geology among his specialties.

"The present bay has existed near its (current) size only for the last 4,000 years," he says. And if the past is any indication, it will be around for only another 1,000 years or so.

5,000-YEAR LIFE-SPAN

The geological history of San Francisco Bay is really the story of several bays — each of which lasted only about 5,000 years — and of the tens of thousands of years between, when the land supported big rivers and lovely valleys.

It is a story that involves the cataclysmic raising and lowering of the Pacific Ocean, stupendous volcanic eruptions, the creation of mountains through the grinding, compressing and upheaval of tectonic plates and the inundation of entire landscapes by vast floods.

It is also a story of life — of primeval forests of cedar and pine, of great Pleistocene mammals such as mammoths and giant ground sloths, and of the people who hunted them with nothing more than flint-pointed spears.

The very dimensions of the story can't help but give one a certain perspective, observes Lajoie, who notes that even the most dramatic of the Earth's features — bays, rivers, mountains — are ephemeral in the context of geologic time.

'NOTHING IS PERMANENT'

"We tend to think that the Earth's features don't change, but geologically speaking, the fact is that nothing is permanent, or even around very long," he says.

Today's bay formed when the last ice age waned. At the height of the last glaciation about 17,000 years ago, large amounts of water evaporated from the oceans and fell as snow, not rain, compacting into huge continental glaciers. Sea level lowered by about 300 feet, and big expanses of the present continental shelf were exposed.

As the glaciers retreated, sea levels began rising, with rates ranging from three feet per century to 15 feet per century. About 10,000 years ago, the ocean began sneaking through the Golden Gate, forming the nascent San Francisco Bay.

"The bay only reached its present size within the last few hundred years," says Lajoie.

Even while the melting glaciers worked to form a large bay, other factors conspired to restrict its size. "The bay would be about twice its present size if sediments hadn't partially filled the subsiding basin it now occupies," Lajoie observes.

But to understand the forces that shaped the bay, you have to go further back in time — close to a million years further.

The sedimentary record indicates that the interior of California didn't always drain through the bay basin, as is now the case. Minerals from the Sierra Nevada began appearing in the basin somewhat less than 600,000 years ago — a blink in the context of geological time.

Prior to that, a vast inland sea called Corcoran Lake occupied much of the Central Valley, draining through the Salinas River into Monterey Bay.

VOLCANIC ERUPTION

About 760,000 years ago, a tremendous volcanic eruption occurred in what is now the Bishop area. A great caldera was created, and massive amounts of volcanic ejecta were deposited in the lake.

But this ash didn't make it into the bay until tectonic shifting in the Earth's crust caused the Bay Area to subside and the south end of the lake to rise about 560,000 years ago.

This caused the lake to spill over the ridge that separated it from the bay basin. The flow carved the Carquinez Strait and drained the lake. It could have happened so fast that it would have been a single, catastrophic event, says Lajoie — a great gush of water roaring to the sea.

Since then, tectonic activity — upthrusting of the Earth's crust — has plugged the Central Valley's outlet through the Salinas River. Now, everything that flows into the Sacramento and San Joaquin valleys ultimately pours out the bay.

Another eruption, this from Mount Lassen and much smaller than the Long Valley Caldera near Bishop, also contributed sediments to the bay.

"This occurred about 435,000 years ago," says Lajoie. "Sediments from the event are called the Rockland Ash, and can be seen clearly in the sea cliffs at Fort Funston on the San Francisco coast."

As the ice from the last glaciation melted, the Sacramento and San Joaquin rivers became great, braided streams choked with sediment.

"All that glacial outwash was dumped in the Central Valley and the Delta," says Lajoie. "There was so much sediment that huge dune fields blew out of the river near Antioch about 15,000 years ago. The same thing happened where Oakland now sits."

Oakland, in fact, is built over a deposit of dune sand known as the Merritt Sand. There was no bay at that time, but those sediments ultimately covered much of the bay basin.

SOURCES OF SILT

A good deal of fine silt and clay still comes into the bay from the Sacramento-San Joaquin river system. But the lion's share of sediment — mostly sand and gravel — issues from Alameda Creek, which drains Livermore Valley through Niles Canyon.

"Many people find that surprising," says Lajoie, "because the biggest source of ongoing bay sedimentation isn't even directly adjacent to the bay — it's Livermore Valley. There's a huge alluvial fan of sediment deposited by Alameda Creek that spreads out beneath the bay from the Coyote Hills to the shore of Palo Alto."

Other things have helped the bay become a prime sediment trap — things of a tectonic nature. Mountains have built on both the San Andreas and Hayward faults, sharply defining the limits of the estuary. The process continues today, with the continuing uplifting of the Santa Cruz Mountains, which straddle the San Andreas Fault.

Simultaneously, the land just west of the Hayward Fault is subsiding; meanwhile, structural rock underlying the South Bay is slowly sinking and gradually tilting eastward.

As the Santa Cruz Mountains and the Berkeley Hills ascend, they are squeezing the zone of bedrock between them, known as the Bay Block.

"The interesting thing about the Bay Block is that it is basically free of faults at this point," observes Lajoie. "But as it continues to be compressed, it might eventually develop new fault lines."

CHANGES CONTINUE

The change has been dizzying — and it won't abate. It will continue, regardless of the level of human activity. Erosion and plate tectonics will grind on inexorably. And another ice age is not merely likely, Lajoie observes — it is inevitable.

Lajoie says there is increasing evidence to indicate that ice ages are triggered by perturbations in the Earth's orbit, subtle movements caused by the gravitational effects of Jupiter and our moon.

MASSIVE AMOUNTS OF DUST

"The planets formed by sweeping up massive

amounts of dust and debris when the solar system formed, but a lot was left over," says Lajoie. "It appears concentrated in a disk around the sun."

The Earth's orbital plane tips through this debris disk every 100,000 years or so, Lajoie observes. The dust occludes sunlight, reducing the amount of thermal energy that reaches the planet's surface.

That probably isn't enough to start an ice age by itself, he says.

"The oceans distribute solar energy globally, but the margins are very fine," he said. "The orbital parameters can't do it by themselves — but they're triggers. When the balance is finally thrown off in the oceans, glaciation can occur very quickly."

But what about global warming? Couldn't the ongoing atmospheric loading of heat-trapping gases like carbon dioxide forestall another ice age and guarantee the longevity of the bay, orbital wobbles notwithstanding?

Lajoie doesn't think so.

"I'd prefer that we maintain a cautious attitude about releasing greenhouse gases, but I don't think they could overcome the orbital signal," he says. "I think it's just too strong."

Our distant descendants, then, might well have to forgo bay views if they plan to live in San Francisco.

"When glaciation occurs, the bay drains, and everybody ends up walking to the Farallones," Lajoie says.

THE MAKING OF A BAY

Three geological processes have shaped San Francisco Bay: the rise and fall of sea level, the shifting of tectonic plates and the deposition of sediment from rivers. All work in concert to form an estuary that is in constant flux — and that periodically disappears for tens of thousands of years.

— Sea Level Rise

During the height of the last Ice Age 17,000 years ago, sea level dropped by 300 feet, and there was dry land west of what is now the Farallon Islands.

Melting glaciers caused sea levels to rise, and the current bay began to form around 10,000 years ago. It has existed near its current size only for the the last 4,000 years.

—The Bay Block

Shifting tectonic blocks continue to shape the bay. The rising Santa Cruz Mountains and Berkeley Hills are compressing the Bay Block, a vast slab of Franciscan rock underlying the south bay and its sediments. Though the Bay Block is essentially free of faults, it is expected that this compression will ultimately cause new faults to form.

CORCORAN LAKE

About 760,000 years ago, much of California's Central Valley was a great freshwater inland sea known as Corcoran Lake. The lake's outlet was the Salinas River, ultimately draining to Monterey Bay.

Then about 560,000 years ago, tectonic uplifting allowed the lake to rise sufficiently to cut through the soft soils of what is now the Bay Area. The Carquinez Strait was rapidly carved.

The uplifting also plugged the Salinas Valley outlet, leaving San Francisco Bay as the Central Valley's only outlet. Sediment deposited by Central Valley rivers limits the size of the bay.

Napa River Eco Reserve Connection

Turning Acorns into Food

There are many valley trees in the Eco Reserve from which you may collect acorns. The bigger valley oak trees along the top of the River's bank usually produce a big crop. Best time to collect valley oak acorns from the preserve is usually late October or early November.

Turning Acorns into Food

Teachers and students can work together to turn acorns collected from the Napa River Ecological Reserve into food that everyone can enjoy. The process of turning acorns into food has several steps, and teachers can involve the student in as many as possible.

1. Collect acorns

There are several large Valley Oak trees that produce acorns during most years. Teachers can scout out the trees in early October to see which ones have the most acorns on this. At this time of year, the acorns will be mostly green in color. Acorns should be collected when the fruits have turned brown – usually this occurs in late October to early November. Acorns can be collected from the branches or from the ground after they've been released by the tree. For best success, collect acorns that feel dense and have no noticeable insect damage (holes or other bite marks). Once acorns are collected, store them in a location where they can dry and are not susceptible to being taken by animals. Store them with bay leaves to reduce insect damage.

An acorn collecting field trip to the Eco Reserve should include a visit to the pool in the River upstream of the parking area (swimmers can often be found using the pool in sunny days). There are stones around the pool that have evidence of being used as grinding stones – the tool that Native peoples probably used for grinding acorns into meal.

2. Turn acorns into flour

After letting acorns dry for a month or so, use the instructions below to create acorn flour.

3. Use flour to make food. Here is a recipe for Acorn Muffins:

Source: http://blog.allisonlehman.com/2012/11/relish-maple-acorn-muffins/

Ingredients	Instructions
• 2 eggs • ½ teaspoon sea salt • ¾ cup brown sugar • 1 ½ tablespoons pure maple syrup • ½ teaspoon baking soda • ¼ teaspoon baking powder • ½ cup butter, melted • 1 ¼ cups acorn flour • 1 ⅓ cups oat flour • ¾ cup corn starch • 1 cup sour cream • ¼ cup + 1 tablespoon milk • ¼ cup walnut pieces	1. Preheat your oven to 350°F and grease or paper your muffin tins. 2. Whisk together the flours, corn starch, sea salt, brown sugar, baking soda, and baking powder. 3. In a separate bowl, whisk together the eggs, maple syrup, melted butter, sour cream, and milk. 4. Slowly add the wet ingredients to the dry ingredients, always stirring to prevent clumps. Just as it's almost completely combined, add the walnut pieces and finish stirring until the mix is fully combined. 5. Fill the muffin tins ¾ full and bake until lightly browned and a toothpick comes out clean, about 25-35 minutes. 6. Let cool for 5-10 minutes, then enjoy.

Instructions for making acorn flour below are excerpted from Beverly R. Ortiz's book *It Will Live Forever* (1991). Ortiz's book provides a thorough description of how California native people turned acorns into food.

Julia F. Parker's New Way Acorn

Cracking

Crack 4 pounds of acorn with a hammer. When cracking, tap shells lightly enough that the nutmeats will split into halves or thirds, but won't shatter into small pieces.

Shelling

Remove shells by hand, returning shells and any bad nuts to the earth.

Cleaning

To loosen skins, lay acorn on a cloth on a table in the sun.
Split grooves open by pressing down with the sharp edge of a knife held lengthwise in the groove.
Sprinkle the acorns with water and allow to dry.
Rub handfuls of nutmeats between hands to remove skins.
Scrape any adhering skins off with a knife.

Taking bad nuts into account, 4 pounds result in about 4 cups of whole, cleaned acorn.

Blender crushing

Measure out 4 cupfuls of whole, cleaned nutmeats.
Put 1 cupful (5½ oz.) in a blender and break up at low speed. The acorn will jump all around in the blender.
Once the nutmeats are broken up, switch the blender to high speed and run until no more acorn falls from the edges onto the blades.

147

Mix acorn up with the handle of a wooden spoon, making sure to include the acorn nearest the bottom, which tends to get sticky.
Repeat blending and mixing until acorn is reduced to fine flour. (If acorn gets oily as blended, add a few whole nutmeats at low speed to absorb the oils.)
Remove the now fluffy flour and set aside in a bowl.
Add second cupful and repeat process.
Add third cupful and repeat.
Add fourth cupful and repeat.
This results in 5 fluffy cupfuls of flour.

Note

If there are chunks of acorn in the flour, it needs to be run through the blender again. Don't put more than a cup of acorn in the blender at a time—any more might cause the motor to burn out.

Leaching

Put flour into a 5-pound flour, sugar or salt sack. Fill the sack full of water and allow it to drain so the flour is saturated. Tie the sack to a faucet and turn the faucet on just past a drip, so that a very slow, steady stream of water drips over the outside of the sack (which serves as a waterbreak) all night long.

Cooking

Place leached acorn (when wet, it reduces again to 4 cups) in a stainless steel pot.
Add 3 cups water and mix with acorn.
Cook at high heat, stirring frequently. While acorn cooks, gradually add 7 more cups of water.
Keep stirring.
Let the acorn boil for 15 minutes, until it has the consistency of tomato soup. For cornmeal mush consistency, add less water.
Makes 11½ cups *nuppa*.
If using fresh (newly gathered) acorn, increase the amount of water used, as fresh acorn thickens more than older acorn.

Napa River Eco Reserve Connection

Scavenger Hunt Through Time

All of the items on the scavenger hunt list can be found at the Eco Reserve. The instructions for the activity specifically indicate where some of the rarer items can be found. To extend the scavenger hunt, teachers and students may read portions or all of the *Napa Valley Historical Ecology Atlas* (2012). The book contains evocative photos, maps, and descriptions of the various changes that the Napa River and its watershed have undergone over the past 300 years.

Scavenger Hunt Through Time
How have humans depended on the Napa River watershed, how have humans changed the Napa River watershed?

The goal of this scavenger hunt is to show students items in nature that are important to the history of our watershed, its people, and the changes it has undergone through time. The first eight items in the hunt are items that students should be familiar with from Native American history lessons. These items were used regularly by Native Americans for food, shelter, dyes, baskets, and tools. Obsidian can be found in the creek gravels. The grinding stones can be found in the pool that is used for swimming that is located just upstream of the intersection of the River and the main River access trail. The last four items serve to demonstrate the changes the watershed has undergone since the early 1800s with the arrival of Spanish, Mexican, and eastern American cultural influences. The Berm is the hill that was constructed in the early 1900s to prevent the River from flooding the agricultural fields along the banks of the River. Blackberry and bullfrogs (most tadpoles at the Eco Reserve are bullfrog tadpoles) are two nonnative species that are invasive in California and have altered native plant and animal community interactions. Trash results from people upstream and people who visit the Eco Reserve for recreation. Trash in our waterways impacts fresh and ocean water quality, and is a challenge for our communities to address. Students often have great suggestions for how communities should prevent trash from entering our waterways.

Instructions:
1. Introduce purpose of activity and collection boundaries. At the Eco Reserve, students can safely search for items along the main trails and along the banks of the River (when water levels are low – typically, between April and October).
2. Provide students with collection bags and scavenger hunt list, and note that not all items should be collected to share with group (fish, tadpole, grinding stone, berm).
3. Allow students approximately 20 minutes to conduct search.
4. Gather students in a group to discuss the hunt. Discuss the significance of each of the items with regards to the history of the watershed. What was easy to find? What was difficult? What other items from nature did Native Americans rely on? Do our communities still rely on natural items from the Napa Valley? Would Native Americans from 300 years ago be able to recognize the Valley today?

1	Obsidian	
2	Acorn	
3	Wild rose branch	
4	Fish	
5	Berry	
6	Sedge	
7	Grinding stone	
8	Willow leaf	
9	Berm	
10	Blackberry	
11	Tadpole	
12	Trash	

Napa River Eco Reserve Connection

Making Plant Dyes

This is a two part activity that is both a hands-on history and art lesson. The collection of plant material and background history lesson should take place at the Eco Reserve and the dye-making should be done in the classroom.

The following pages give some background about the Native American use of plants to make dyes. The Wappo people that used the Eco Reserve as a hunting and gathering area often used poison oak leaves to dye baskets, but we have compiled a list of less itchy plants that students can collect while at the Reserve to take back to the classroom. These plants are listed in the "Procedure" section of the activity.

Either before or after doing this activity, it would be beneficial for the students to learn more about the life and culture of the Wappo people that call the valley home. To learn more, students can start by visiting the following two websites:

http://score.rims.k12.ca.us/activity/wappo/

http://www.suscolcouncil.org/NativeHistory.html

Making Plant Dyes

Adapted from Montana State University Big Sky Institute's Activity "Dyeing Fabrics With Plants" by Linda Different-Cloud

Background: For centuries, people have used plants as a source of natural fabric dyes. Native Americans use this natural gift from the Earth to dye cotton, animal skins, porcupine quills, and wool. Native American regalia, whether it is worn at council meetings, ceremonies, or powwows, is always decorated: headdresses, waistcloths, robes, leggings, moccasins, armbands, anklets, knife sheaths, arrow quivers, pouches, shawls, pipes, and drums. The materials, designs, and colors vary greatly with the tribe or nation. Within the tribe designs vary according to clan.

Porcupine quills were often used, even in regions where no porcupines can be found, because they were part of the extensive trade networks of Native peoples. Bird quills, long hair from the tails or hides of animals, claws, teeth, beads and feathers are also dyed and used. Most of the symbols used have great meaning to the tribe or individual. The range of colors obtained from plant materials is probably not as great as from commercial dyes, but the colors were softer and often more permanent.

Remember, there are many distinct tribes across the country, and they all used different plants to make natural dyes. Each tribe also has very different designs that they use and each design has its own meaning.

There were also many different plants used as mordants to strengthen and "set" the color. Roots of Yucca glauca, ash, and some insects are all used as mordants.

Procedure:

Wool is one of the most commonly dyed materials, but in the classroom, you may use any white material. Have each student bring an old t-shirt, or several old t-shirts can be cut into 10-inch squares and each student given a single square to dye. Gather plants at the Eco Reserve and bring plants from home that will make good sources of dye.

From home, students could bring: coreopsis, goldenrod, onion skins, strawberries, blackberries, raspberries, spinach, beets, rhododendron leaves, acorns, marigolds, red cabbage, elderberries, black-eyed Susans, bloodroot, birch bark, walnut shells and many others.

At the Eco Reserve, students can find the following plants to make natural dyes: blackberries (late summer), the hips of the wild rose (late summer), cottonwood leaf buds (early spring), elderberry berries (late summer/fall), walnut shells (fall), wild grapes (fall), and sandbar willow bark (the bark is red and can be harvested at any time of year).

How to Dye fabrics With Plants:

1.) Collect your plant materials when they are at the peak of color.
2.) Chop all plant materials into small pieces (1 inch or smaller) and place them into a large pot or pan. Make sure to use a pan that you no longer use for cooking.

3.) Measure the amount of plant materials and place twice as much water as plant material into the pot with the chopped-up plant parts.
4.) Bring the mixture to a boil and then simmer it, stirring occasionally for at least an hour.
5.) Strain out the plant material and set the dye bath aside.
6.) Place your fabric into a mordant bath- such as salt water (1 part salt to 16 parts water) or a vinegar bath (1 part vinegar to 4 parts water).
7.) Allow the fabric to absorb the mordant and simmer it for an hour or more.
8.) Remove the fabric from the fixative and wring it out thoroughly.
9.) Place the wet fabric into the dye mixture and simmer it until the desired color is achieved. The dry product will be lighter than the wet product, so go for a slightly darker color when wet.
10.) Remove the fabric from the dye with rubber gloves.
11.) Wring the fabric thoroughly and hang it up to dry.
12.) Launder naturally dyed fabrics in cold water and separate from other laundry!

Additional Resources

The Environmental Education Coalition of Napa County (EECNC)
www.napaenvironmentaled.org
EECNC curates an Environmental Education Guide to connect Napa County teachers with local agencies, non-profit organizations, and businesses that provide local environmental education opportunities, such as field trips, guest speakers, and service projects. The guide makes it easy for teachers to identify relevant projects by connecting curriculum standards with the various programs available.

EECNC also raises funds through its annual Earth Day event to provide support for buses to take students on environmental field trips. In the fall of each school year, the funds are offered through a first come, first served bus grant program.

Watershed Information Center and Conservancy of Napa County
www.napawatersheds.org

Save the Bay
www.savesfbay.org/watershed-curriculum

CREEC- California Regional Environmental Education Community
http://www.creec.org/

California Department of Water Resources
www.water.ca.gov/education

California Coastal Commission
www.coastal.ca.gov/publiced/pendx.html

California Education and the Environment Initiative (EEI)
www.calepa.ca.gov/education/eei

USGS Water Science School
http://ga.water.usgs.gov/edu

Water Education Foundation
www.watereducation.org

Project WILD
www.projectwild.org