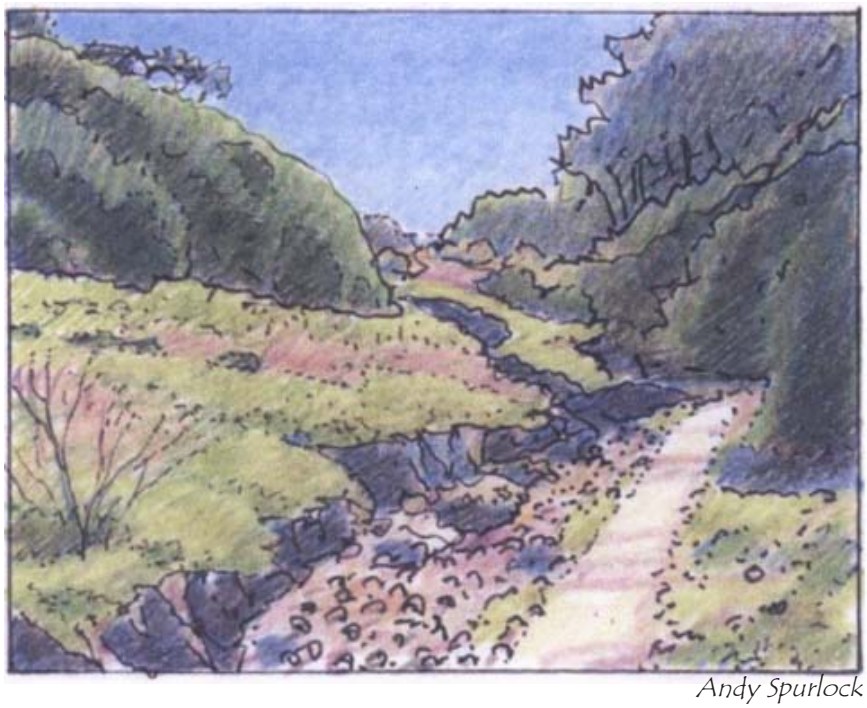
SAN DIEGO CANYONLANDS WATER EDUCATION TOOLKIT



Andy Spurlock

May 2007

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San Diego Canyon Maps

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Unified Port of San Diego

HELLO!

Our coastal canyons are part of San Diego's wetlands. Even though many canyons remain quite dry most of the year, they are still technically wetlands. When water appears, they convey it downhill, toward the Pacific Ocean. They still fulfill the same role as rivers, streams and creeks in less arid regions.

Tragically, wetlands around the globe have been destroyed, mostly by development. Fewer than 50% remain. And here in San Diego, as little as 5% may remain! Why should we care?

- Because all organisms – including humans — rely on productive ecosystems for survival, and wetlands are our most productive ecosystems.
- Because wetlands buffer our oceans against human impacts.
- Because wetlands buffer humans against climatic impacts.

We have forfeited San Diego wetlands – be they coastal canyon, stream banks or estuaries – without acknowledging that we are actually destroying our children's future. We must act to reverse this trend and rebuild our wetlands, *right now*.

Wetlands across the world are vital to conserving water and protecting water quality. San Diego's wetland canyons do these jobs too, as you'll learn about in this toolkit. In addition to these important water-related functions, canyons provide other critically needed benefits…as do wetlands elsewhere. They cool and filter the air, to protect against global warming and reduce pollution. Caring for canyons increases the health and safety or our neighborhoods. They teach us to pay attention to the unexpected, to nature and to human impacts on the planet. Working and playing in them acquaints us with our land and with our neighbors; we become better citizens, better-informed voters. This gets us involved in a way that makes a difference! By putting us in a place that is wilder, with fewer human-made attributes, canyons uplift our spirits.

In all these ways, San Diego's canyons are valuable. Lushly vegetated and loved wetlands reduce environmental costs and solve environmental challenges *inexpensively*. They help raise property values in our neighborhoods and reduce crime and fire threats. Beyond these cost-conscious benefits, canyons deliver an invaluable gift – they give us hope.

The Clean Water Act of 1972

The 1970s were the heyday of environmental legislation. Many laws were passed to protect our land, water and air. Among these was the Clean Water Act. It established a national goal of making our waters safe for fishing and swimming.

35 years later, the goal is ever more elusive. Most of the fresh water in San Diego is entirely unsafe for human contact and the ocean is unsafe for swimming more and more frequently. Moreover, human food sources that derive of these waters are also unsafe.

Even with the Clean Water Act's goals unmet, the federal government has weakened the legislation. It seems unbelievable! Both the Administration and the Judiciary have moved to limit the regulation to always-wet waters, and to exclude wetlands, which are sometimes or even often dry. This, obviously, makes wetlands more vulnerable to development, thereby accelerating the deterioration of aquatic resources. San Diego wetlands – which include its ephemeral streams, coastal canyons and vernal pools – is particularly vulnerable. The government does not understand or accept the crucial connection between water quality and wetlands. It is our job to help our leaders become better informed leaders.

For in the end, we will conserve only what we love.
We will love only what we understand.
We will understand only what we are taught.

– Senegalese environmentalist Baba Dioum

Ask for Help Revitalizing San Diego's Canyons …for the sake of our water!

San Diego County Water Authority
858/522-6600 http://www.sdcwa.org/

California Regional Water Quality Control Board
858/467-2952 http://www.swrcb.ca.gov/rwqcb9/

Metropolitan Water District
(213) 217-6000 http://www.mwdh2o.com/

Port of San Diego
(619) 686-6200 http://www.portofsandiego.org/

City of San Diego Contacts

Open Space Park Rangers	619/235-5262
Water Department	619/515-3500
Water Conservation Program	619/515-3500
Sewage Spills	619/515-3525
Streets Division	619/527-7500
Storm Water Pollution Prevention	619/235-1000
Mayor's Office	619/236-6330
Council District 1	619/236-6611
Council District 2	619/236-6622
Council District 3	619/236-6633
Council District 4	619/236-6644
Council District 5	619/236-6655
Council District 6	619/236-6666
Council District 7	619/236-6677
Council District 8	619/236-6688
City Information	619/236-5555

HOW TO USE THE TOOLKIT FOR INSTRUCTION

The *San Diego Canyonlands Water Education Toolkit* does not contain instructional curricula. However, it does include important water-related information that will enrich instruction in a variety of subjects, as follows:

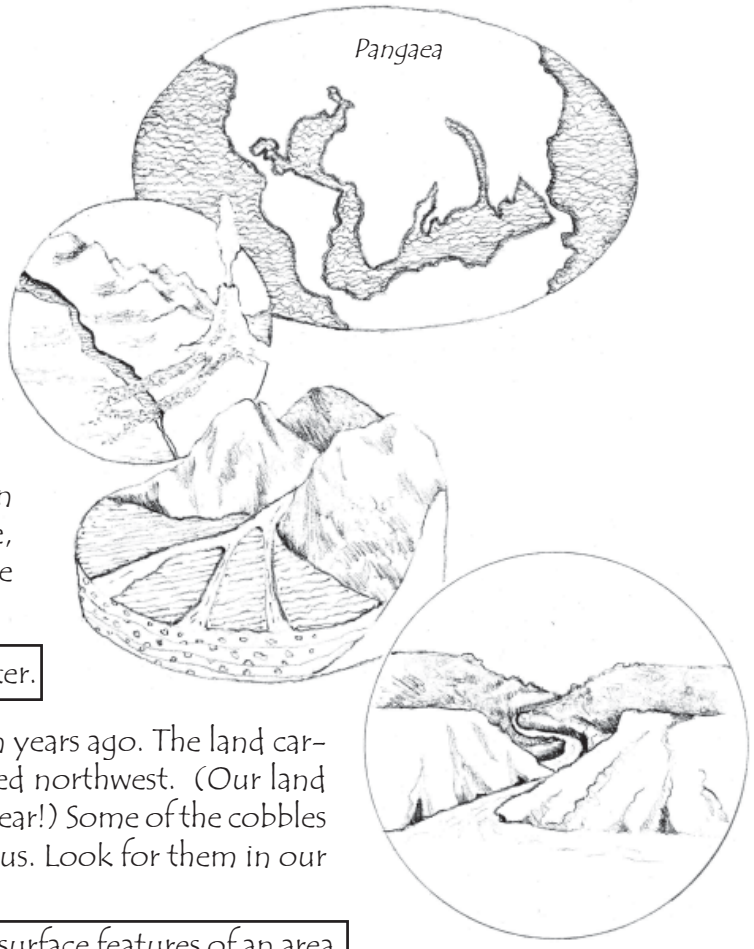
The San Diego County Water Authority offers both small grants and instructional materials. Contact them at 858/522-6719 http://www.sdcwa.org/education/.

"Project Swell" has well-balanced, hands-on water quality and pollution prevention curricula for K-12. Learn more about these resources, developed by San Diego City School District, City of San Diego, Unified Port of San Diego, and San Diego Coastkeeper, at http://www.sandiego.gov/thinkblue/swell/index.shtml, or by calling San Diego Coastkeeper at (619) 758-7743.

WATER MADE CANYONS

Key Concept: Water flows downward, pulled by *gravity*, toward the ocean.

Hundreds of millions of years ago, there was a single super-continent. Called *Pangaea*, it was surrounded on all sides by water. Two hundred million years ago, Pangaea began breaking apart. As the Earth's plates shifted during the Jurassic Period and Age of Dinosaurs, the continents separated. By 155 million years ago, the continents were in four main masses, one of which was North America and Eurasia.



Subterranean activity formed volcanoes in the land that is now Sonora, Mexico. Magma erupted from the volcanoes. It cooled into rocks that are reddish, whitish, and blue-grey. Rivers carried the rocks westward, tumbling them into rounded shapes called "cobbles."

During the Cretaceous Period, about 100 million years ago, Earth's plates continued to collide, squeezing rock up into huge mountains. Over the years, erosion wore down the mountains.

Erosion = the wearing away of earth by water.

The Gulf of California began opening 5 ½ million years ago. The land carrying Baja California and western California moved northwest. (Our land is still moving northwest, at a rate of two inches a year!) Some of the cobbles that began in Mexico are moving northwest with us. Look for them in our canyons!

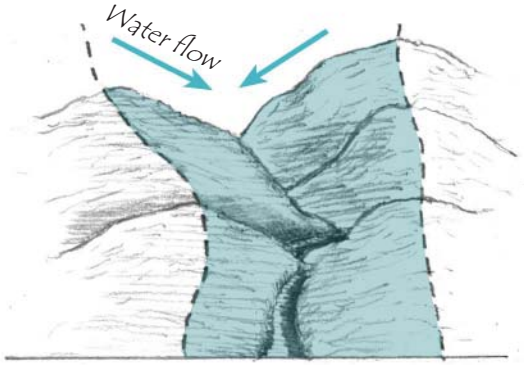
Topography = the surface features of an area

Flat top topography called mesas began forming about 2 million years ago. These flat tops used to be on the sea floor. As the land rose, gravity pulled rain water downhill. Loaded with cobbles, these streams cut canyons of all sizes on their way to the coast. Today, these are our coastal canyons. Additional soil built up in the canyons, often burying the cobbles, except in the stream beds.

Reference: *The Rise and Fall of San Diego, by Patrick L. Abbott, Sunbelt Publications, El Cajon, California, 1999*

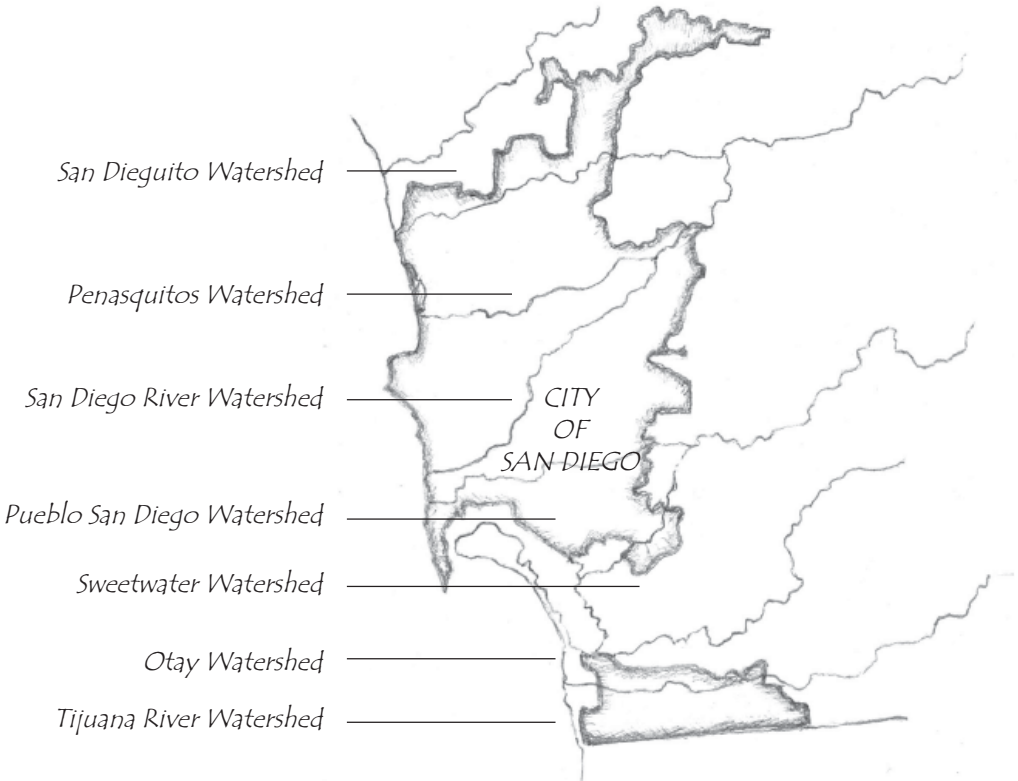
WATERSHEDS

A watershed is an area that drains into the same river or creek. Wherever water flowed into the same canyon creek or river, it created a watershed.



San Diego is made of many little watersheds that connect to larger watersheds. Some watersheds conduct water first to San Diego Bay or Mission Bay. However, all San Diego watersheds ultimately lead to the Pacific Ocean.

The City of San Diego extends across seven main watersheds: The San Dieguito, Penasquitos, (Mission Bay is a sub watershed within Penasquitos) and San Diego River watersheds drain directly to the Pacific Ocean. The San Diego Bay watershed includes the Pueblo San Diego, Sweetwater and Otay sub watersheds. And the Tijuana River is the southernmost watershed. To see which canyons are in each watershed, refer to the San Diego Watershed Map on this CD.



BACTERIA RHYMES WITH CAFETERIA

Soil bacteria are hungry for many of the ingredients in the soil.
Lunch might be parts of a dead leaf or a dead worm.
Just as likely, bacteria provide food for other soil creatures.

Bacteria are teeny. They have only one cell, and are usually longer than they are wide.
As many as a billion bacteria live in a teaspoonful of healthy canyon soil.

Bacteria produce goo that glues soil into little clods. This keeps soil from washing away. Water can move between the little clods and into deep soil, so canyon plants have a supply of water they can use in the summer.

If this page were an acre of well vegetated canyon land,
it would hold 2000 pounds, or a ton of bacteria,
roughly the same weight as 2000 ground squirrels.

Cyanobacteria are nature's erosion-control blanket.
They hold soil together on the surface.

Note how earth crumbles into a vast hole of nothingness
where the cyanobacteria blanket has been broken.
Save cyanobacteria first. If it doesn't work, save yourself!

References:
"Life Underground," by Kate Goff, *http://www.forester.net/ec_9909_underground.html*
Soil Biology Primer, Soil and Water Conservation Society, 7515 Northeast Ankeny Road, Ankeny, Iowa 50021-9764
www.swcs.org, 800-THE-SOIL
Ted St. John, Ph.D., Menifee, California

FOUR GROUPS OF BACTERIA & THEIR JOBS

Group	Decomposers	Mutualists	Diseases	Chemical Wizards
Activity	Eat plant litter and residues from plant roots (carbon)	Partner with plants	Cause harm to plants	Make natural chemicals in the soil into energy
Result	Replenish the soil	Make nutrients for plants	Plants die	Cycle nutrients and degrade pollutants

FUNGI-NESS

Some fungi increase the growth and health of our canyon plants.
Fungi are an important food source for other organisms, such as squirrels, nematodes and mites.
Fungi need oxygen. Soil that becomes compacted supports fewer fungi...and less water.

Boletus dryophilus

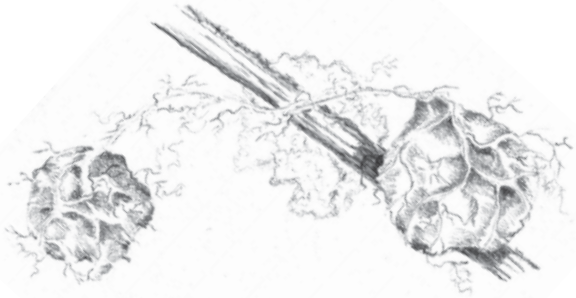
FUNGI INCREASE SOIL'S SPONGINESS

Fungi's microscopic cells grow in long strands called "hyphae."
Hyphae bind soil particles into aggregates,
improving water-holding capacity.
Increased water-holding makes canyon ground spongier.

Fungi help oaks grow. San Diego scrub oaks help hold the soil down, retain soil moisture and prevent erosion, because their roots can extend 25 feet down into the soil.

FUNGI HELP PLANTS THRIVE IN ARID CONDITIONS

Fungi can grow from a few cells to many yards, thus bridging gaps between pockets of moisture.

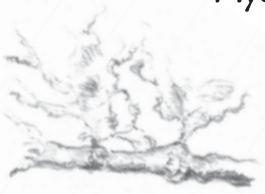


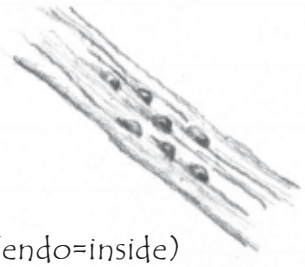
These threads optimize plants' ability to access scarce and infrequent water supplies.

TYPES OF FUNGUS

Type	Decomposer	Mutualist	Disease
Activity	Convert dead organic material into fungal biomass, CO_2, and organic acids.	Fungi partner plant roots	Parasites colonize plant roots or other organisms
Result	Decompose carbon-ring structures in some pollutants. Retain nutrients in soil. Help replenish soil.	Help make phosphorus soluble. Bring nutrients to plants. Keep nutrients from leaving root zone.	Cause reduced production or death. Some limit or even kill plants. Others limit or kill plant pests.

Mycorrhizae increase nutrient and water absorption in plants





Ectomycorrhizae (ecto=outside)
form a sheath around plant cells.

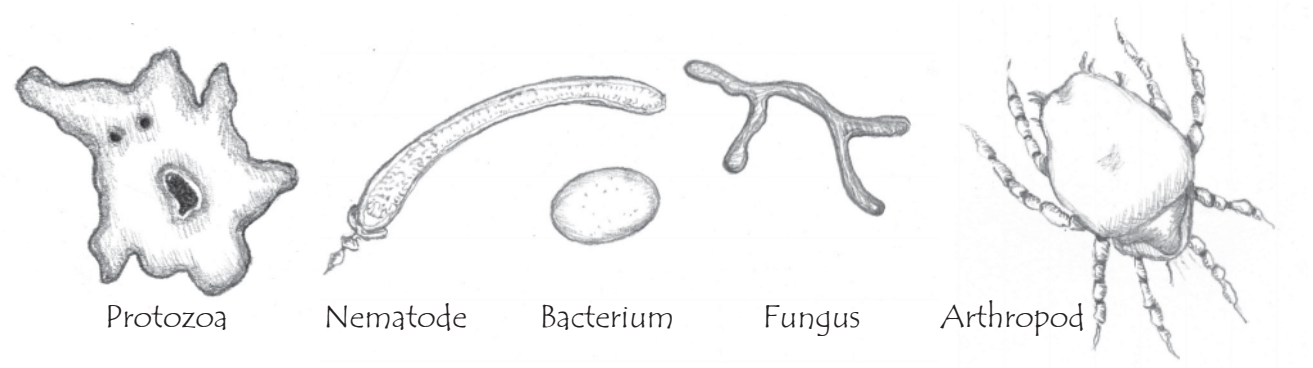
Endomycorrhizae (endo=inside)
grow within root cells

HEALTHY CANYONS DEPEND ON HEALTHY SOIL

The earth I tread on is not a dead, inert mass. It is a body, has a spirit, is organic, and fluid to the influence of its spirit, and to whatever particle of that spirit is in me.

– Henry David Thoreau

A teaspoon of typical healthy soil contains:
600,000,000 bacteria, up to 100,000 protozoa, thousands of feet of fungal filament,
up to 500 beneficial nematodes and dozens of microarthropods.



Protozoa Nematode Bacterium Fungus Arthropod

Soil Degradation

10% of the world's soil has been lost through devegetation, erosion, urban development and other human activities.
Soil is being lost at 17 times the rate it is being formed.
These are reasons it is so important to replace vegetation.

LEARN MORE ABOUT WATER QUALITY

Water Boards

San Diego Regional Water Quality Control Board
9174 Sky Park CourtSuite 100,San Diego, CA 92123-4340
858/467-2952
www.swrcb.ca.gov/rwqcb9/

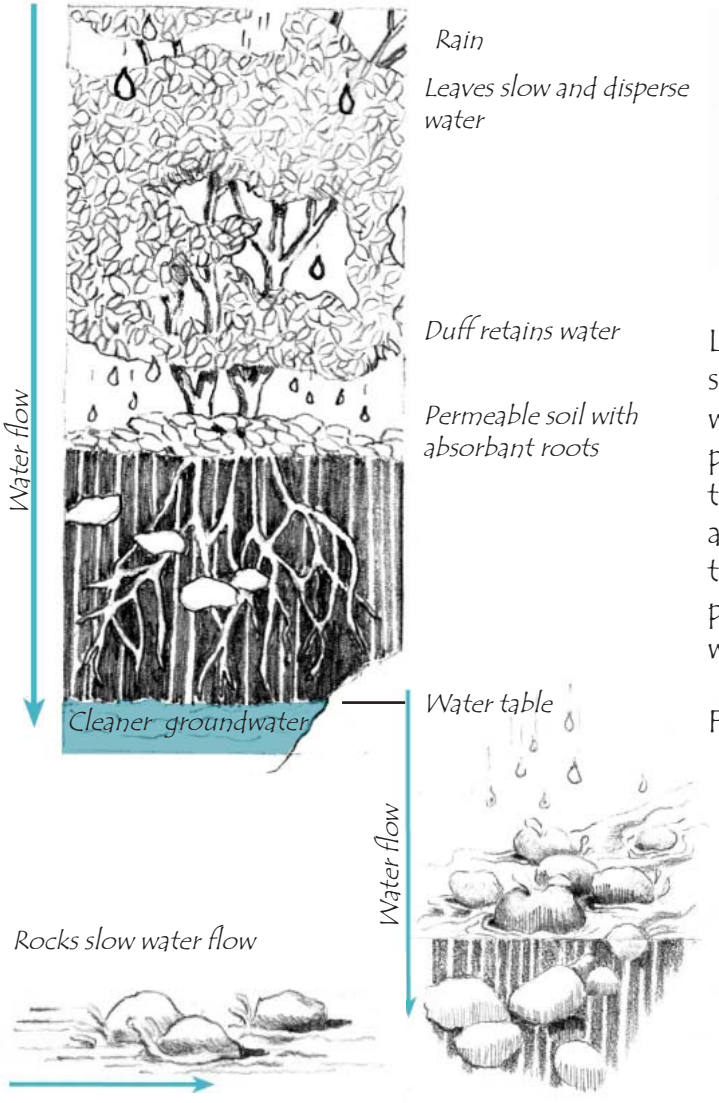
The frog does not
Drink up
The pond in which
He lives.
-American Indian proverb
quoted in Water Wasteland by David Zwick & Marcy Benstock, 1971

HEALTHY CANYONS HOLD WATER

Even though San Diego's canyons were formed by water over the eons, the region has very little water now. San Diego is arid, drier than most large populated American cities. San Diego averages less than 10 inches of rain a year, and relies on water from other regions. San Diego imports over 70 billion gallons of water every year to sustain its thirsty human population. So, obviously, conserving the water that we do receive is tremendously important.

City of San Diego Water Department
Water Conservation Website
http://www.sandiego.gov/water/conservation/

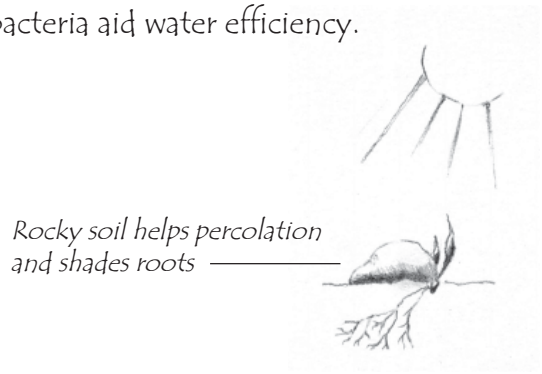
Native San Diego plants and animals use little water. They are much better adapted to scarce rain than most species from other regions and than humans. Over thousands of years, native species here changed to accommodate diminishing amounts of rain. Plants grew more extensive roots systems. Some have leaves that curl during warm weather to minimize exposure to the sun. Leathery leaf types are not as vulnerable to extreme temperatures. All plants made better use of their relationships with fungi, bacteria and other microorganisms. Today native plants are extremely good at surviving long periods of drought.



Sage leaves curl to minimize evapotranspiration

Land covered with native California plants is like a sponge. Long plant roots, duff and porous soils help water work its way deep into the land. Roots are the pathways water follows down into the soil. Lots of the water soaks into the earth to nourish plants and animals over the long months between rains. Water the plants do not use returns to the water table, replenishing groundwater supplies. The rest continues west to the ocean.

Fungi and bacteria aid water efficiency.

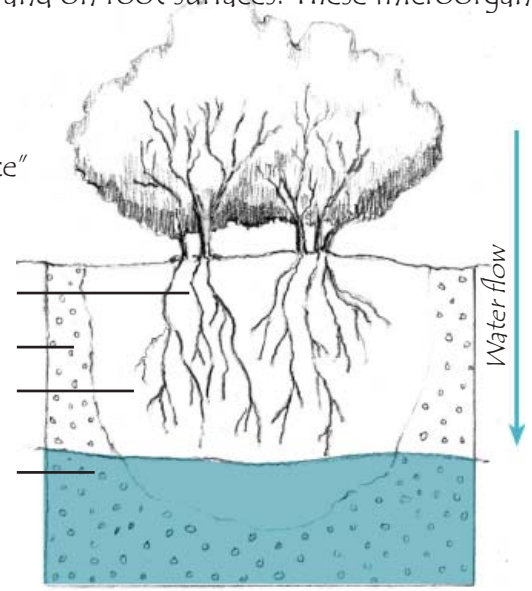


CANYONS CAN CLEAN WATER

Scientists have many times proven the connection between healthy wetlands and improved water quality.

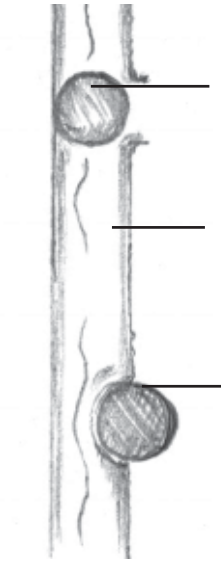
- Canyons intercept polluted runoff before it contaminates coastal waters.
- Dense vegetation traps sediment and pollution in its root system.
- Aerobic (oxygenated) and anaerobic (oxygen free) conditions keep nutrients from fertilizers from accumulating in the water.
- Shallow and intermittent water optimizes sediment-water exchange, to facilitate the chemical degradation of pollutants.
- High productivity in canyons increases mineral uptake by plants, which helps remove heavy metals from the water.
- Decomposers exist in the soil and on root surfaces. These microorganisms degrade organic chemicals.

PHYTO = "plant" in Greek
REMEDIUM = "restoring balance" in Latin



When water follows plant roots down into the soil, plants have a chance to use some of the substances floating in the water. Not only do the plants use the substances in the water, they keep them from flowing into the groundwater or down into the streams and from there to the ocean. This process is called "phytoremediation."

PHYTOREMEDIATION means de-polluting contaminated soils, water or air with plants. The plants can contain, degrade or retain metals, pesticides, solvents, oil and grease, as well as other contaminants. Phytoremediation is clean and efficient. Unlike soil excavation, it does not disrupt the environment. It also increases the soil's sponge-iness. Phytoremediation can benefit plants, animals, water quality, water conservation and humans.



Contaminant
When a plant sucks a substance into its system, it is called **ab**sorption.

Root

Contaminant
When a plant gathers a substance to its roots or leaves, it is called **ad**sorption.

CITY CANYONS DO WATER-RELATED JOBS

Convey storm water and runoff.

Combat water pollution.

Soak up rainwater to prevent flooding and replenish the water table.

Teach us about creeks.

Photos Pam Hayhurst copyright 2005

Contain pipes to convey fresh water and sewer water.

JOIN SIERRA CLUB, SAN DIEGO CANYONS CAMPAIGN

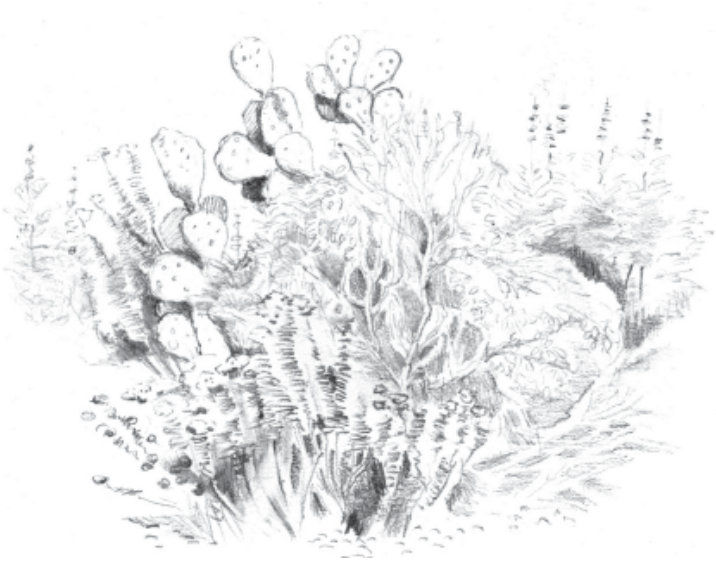
Canyons Campaign
San Diego Sierra Club
3820 Ray Street
San Diego, CA 92104
(619) 299-1741
http://sandiego.sierraclub.org/canyons/

Contact Information:
Eric Bowlby, Sierra Club Canyon Preservation Organizer
Phone: 619-284-9399
Email: savewetlands@cox.net

NATIVE PLANT SPECIES ECONOMIZE WATER

San Diego canyonlands host prominent "plant communities" such as Coastal Sage Scrub, Maritime Chaparral, and Riparian Woodland. A plant community is a group of plants that grow together symbiotically. Like good families and neighbors, they help each other. Typically, one finds them working together to mutual benefit. With long roots – some of which extend as much as 50 feet into the soil – they prevent erosion, clean the water and replenish groundwater. Densely vegetated canyons also clean the air and lower the temperature, keeping energy costs down in our neighborhoods.

During the winter native plants flourish and during summer they survive. Adaptations have made them drought-tolerant. Many are tough and woody. Deep roots work with mycorrhiza and other soil organisms to make the most of every drop of water. Many have small leathery evergreen leaves that grow vertically to minimize exposure to the sun, and curl upon themselves to conserve moisture.



Coastal Sage Scrub

This plant community's shrubs are not as densely-spaced or as rigid as those of chaparral. It grows primarily on western slopes above the beaches, on steep, south-facing wind-exposed slopes, and in areas where the marine layer penetrates inland to canyons. Shrubs, though not as woody as chaparral, adapt to long, dry summers in a number of ways. They remain dormant through the dry season, dropping leaves or producing smaller leaves on secondary shoots during the summer.

Common Species:
California Sagebrush (*Artemesia californica*)
Black Sage (*Salvia mellifera*)
Lemonadeberry (*Rhus integrifolia*)
Coast Sunflower (*Encelia californica*)
California Buckwheat (*Eriogonum fasciculatum*)
Toyon (*Heteromeles arbutifolia*)
Coast Prickly Pear Cactus(*Opuntia littoralis*)

Mockingbird and toyon

Lemonadeberry

California Buckwheat

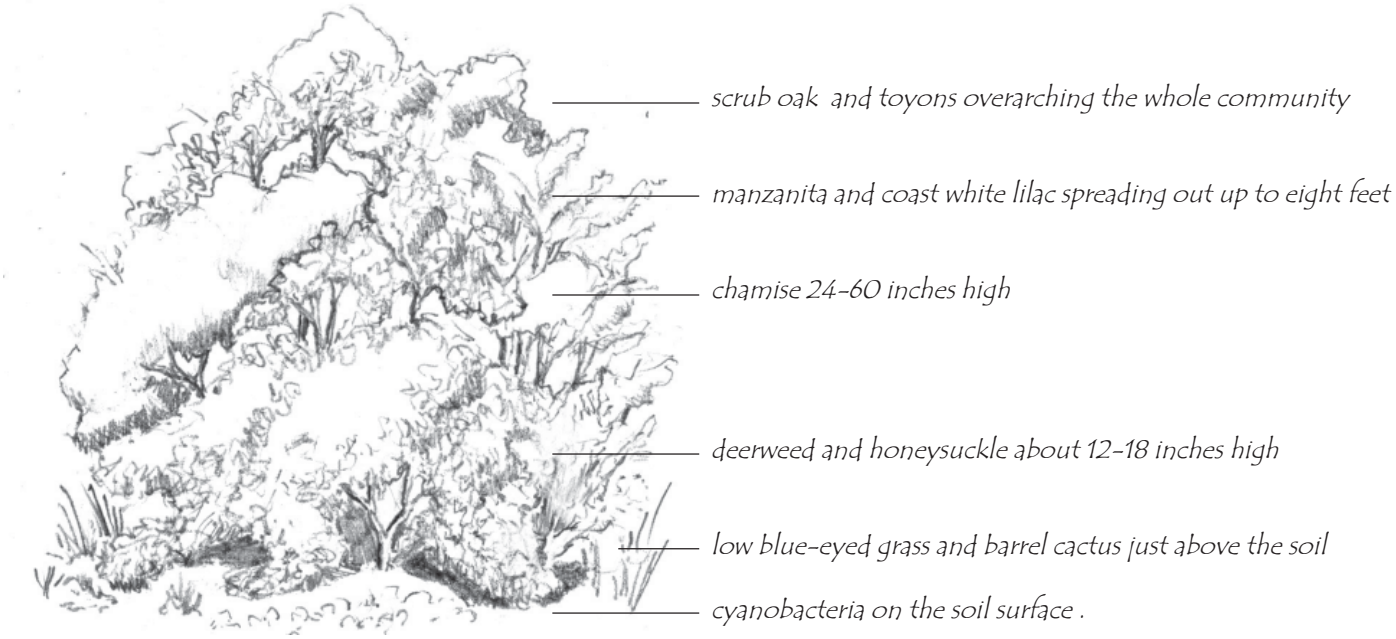
California Sagebrush

Coast Sunflower

Laurel Sumac

TO REMAIN HEALTHY, PLANT COMMUNITIES MUST REMAIN DIVERSE

Healthy plant communities are a lot like any community. They rely on diversity and symbiosis to remain strong. In a plant community, different species occupy different levels above and below the soil level. For instance, in chaparral:



When plants disappear or are removed from these strata, it weakens the overall community. It also reduces the canyons' ability to do important water-related jobs, such as water filtration and water absorption.

Maritime Chaparral

This plant community derives its name from the Spanish word *chaparro*, meaning a thicket. Its vegetation is too high to see over, too low to go under, and too thick to get through. This community occupies dry, rocky or gravelly slopes with either light or heavy soils at an elevation generally above that of coastal sage scrub, but adjacent to it. The boundary between chaparral and coastal sage scrub is not always clear and many species may be found on either side. Chaparral shrubs are typically 6'-12' or so high, and have deep roots for collecting moisture from the substrate.

Common Species:

Nuttall's Scrub Oak *(Quercus dumosa)*
White Coast Lilac *(Ceanothus verrucosus)*
Chaparral Honeysuckle *(Lonicera subspicata)*
Chamise *(Ademostoma fasciculatum)*
Mission Manzanita *(Xyloccocus bicolor)*
Laurel Sumac *(Malosma laurina)*

The thirsty earth soaks up the rain,
And drinks, and gapes for drink again;
The plants suck in the earth, and are
With constant drinking fresh and fair.
–Abraham Cowley (1618–1667), Anacreon

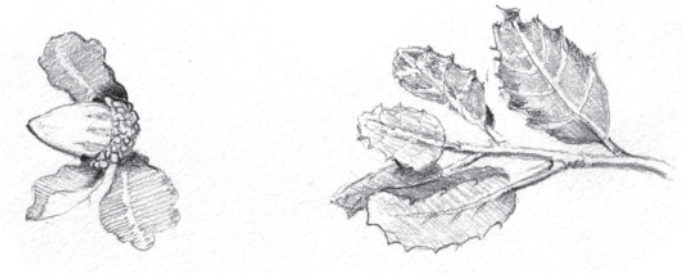
References:
Plant Communities: *http://www.calflora.net/botanicalnames/plantcommunities.html*

Chamise

Mission Manzanita

Chaparral Honeysuckle

Coast White Lilac



Nuthall's Scrub Oak

Riparian Woodland

This rare and disappearing community is dependent on non-seasonal water courses. It often depends on underground water. Tightly knitted to the soil, the species withstand both drought and floods, holding down the soil. Their stalwart presence encourages the watercourse to braid, which helps infiltration.

Common Species:

Sycamore *(Plantanus racemosa)*
Mulefat *(Baccharis salicifolia)*
Deergrass *(Muhlenbergia rigens)*
Arroyo Willow *(Salix lasiolepsis)*
Elderberry *(Sambucus mexicana)*
Cottonwood *(Populus fremontii)*

Water loving Dragonfly

Pollinating bee

INSECTS PROFIT FROM WATER AND DRIVE MANY ECOSYSTEM PROCESSES

Insects disperse seeds, disseminate pollen and eat detritus in the water. Over 300 species of bees pollinate plant species in San Diego. One frequently sees 15 different species on blooming buckwheat. Harvester ants (Pogonomyrex) *heft seeds all over canyons. Many butterflies eat shrubs and herbs that grow in canyons in both adult and larvae stages. Ceanothus silkmoth* (Hyalophora euryalus) *is a fine example. Dragonflies are common in San Diego canyons.*
Michael Wall, Ph.D., San Diego Natural History Museum

Elderberry

Willow

Deergrass

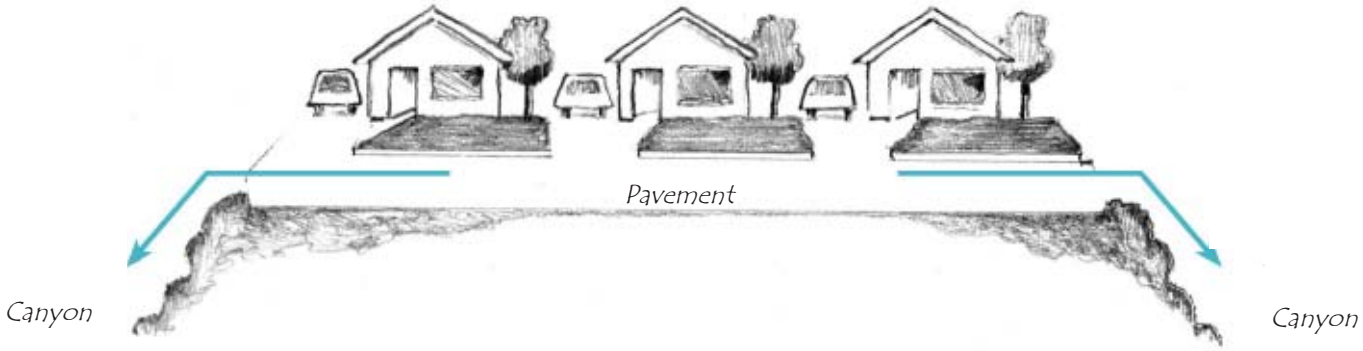
Mulefat

Cottonwood

To Learn More about San Diego's Native Plant Communities
California Native Plant Society, San Diego Chapter
c/o San Diego Natural History Museum
P.O. Box 121390, San Diego, CA 92112-1390 info@cnpssd.org

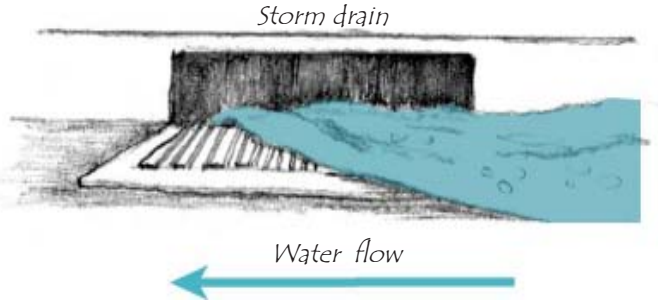
CANYONS MOVE WATER ABOVE GROUND

Water used to flow naturally through the San Diego's gullies, canyons, creeks and rivers. Benefiting from the canyons' "sponge" action, it nourished plants and animals. Development rapidly changed that. Many streets and buildings were built on San Diego's flat mesas. Humans poured pavement and covered soil with hard surfaces through which water cannot seep.



Construction of this type separated water from our native soils. As a result, less land absorbs water. And more water runs over the neighborhoods without soaking in. Paved surfaces increase the volume and velocity of rain flows. Today, some rainwater and garden runoff goes into storm drains and storm drain channels. Still less water soaks into the soil!

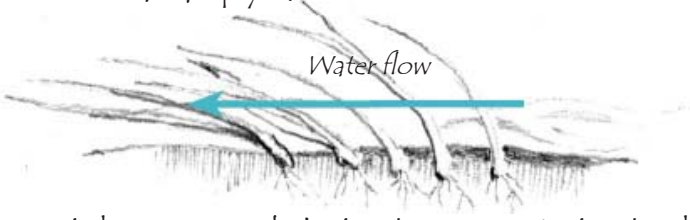
The rest of the water rushes off the streets and into



the canyons. The velocity of the water is very destructive. It causes erosion. Erosion is the wearing away of soil by water,

UNHEALTHY CANYONS CANNOT HOLD WATER

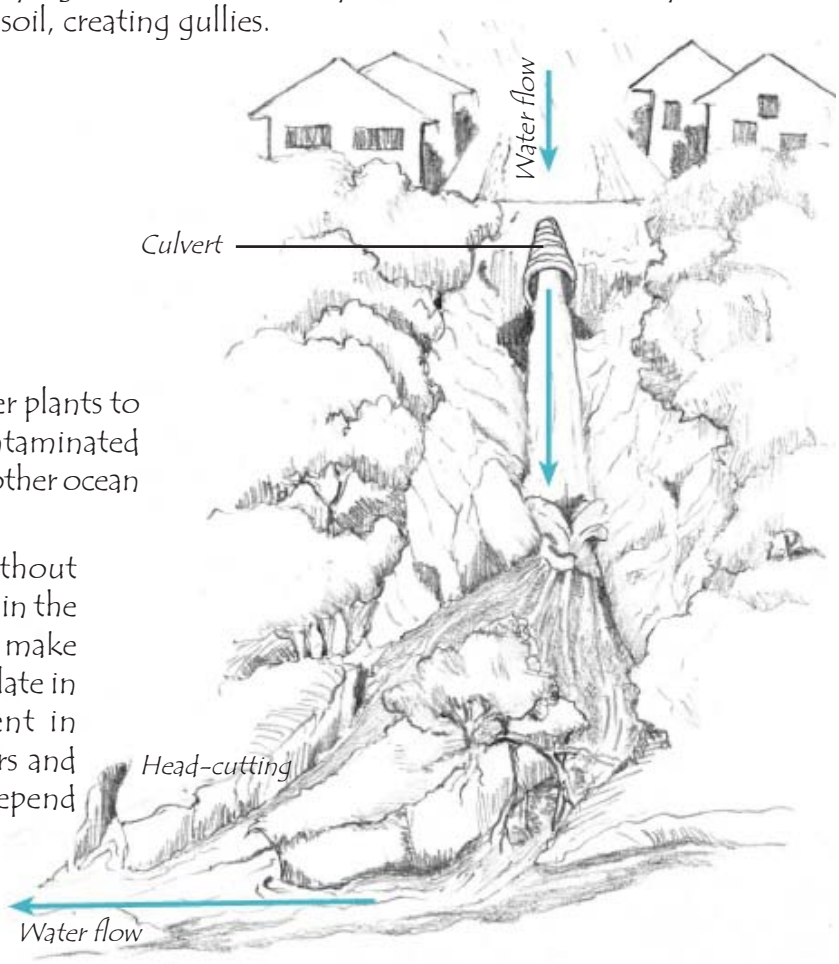
Removing deep-rooted native plants exposes the soil to erosion. Non-native grasses and weeds may move in and take hold, but their roots are shallow and their growing season is short. So they rarely slow down the water enough for it to soak deeply into the soil.



As the soil washes away toward the ocean, only bedrock remains. Bedrock is hard and impermeable. Since water cannot soak in, flows gush faster carrying even more soil away downstream. Over the years, all this water has washed away canyon plants and soil, creating gullies.

With less soil to absorb the water and fewer plants to slow it down and absorb pollutants, contaminated water rushes to the ocean to affect fish and other ocean dwellers.

When storm water flows across land without plants, it picks up loose dirt. Oil and grease in the storm water cling to the dirt. Both quickly make their way into streams where they accumulate in a bunch called sedimentation. Sediment in streams and downstream in estuaries alters and damages habitats that aquatic species depend upon.



FIND OUT ABOUT WETLANDS RECOVERY

Southern California Wetlands Recovery Project
www.scwrp.org
California Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, California 94612
Phone: (510) 286-0922
Fax: (510) 286-0470
e-mail: kbane@scc.ca.gov
Local Watershed Coordinator:
Megan Johnson, 760/943-0350, mjohnson@scwrp.org

CITIES DIRTY OUR WATER

Sources of pollution

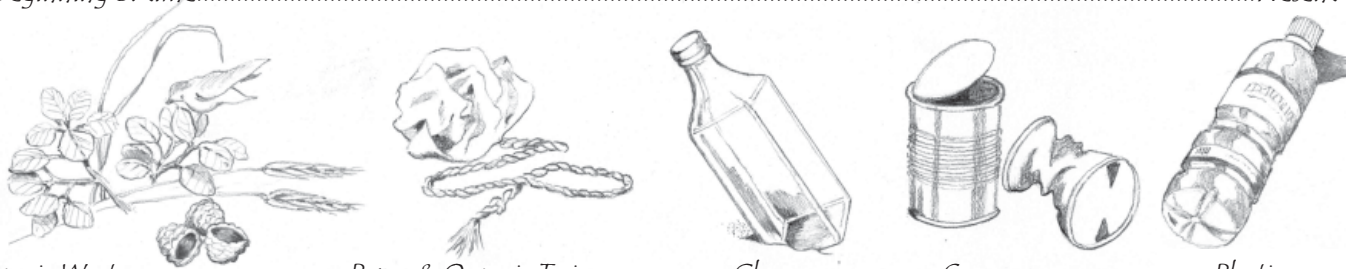
HELP STEWARD THE OCEAN!
San Diego Coastkeeper
2825 Dewey Road, Suite 200
San Diego CA 92106
619/758-7743
www.sdcoastkeeper.org

Many pollutants flow out of our neighborhoods in water.

POLLUTANT	SOURCE	RESULT
Sediment	Construction sites, erosion	Kills aquatic life by clogging gills and suffocating eggs. Destroys wetlands by filling in channels and advancing additional erosion.
Oil and Grease	Vehicles, storage tanks, oil leaks, machinery, kitchen waste	Floating on the water's surface, they block sunlight needed by aquatic fish and plants. Clinging to sand and soil particles, they accumulate on the bottom of streams and estuaries, damaging aquatic habitat.
Heavy Metals	Brake pads, batteries, fuels, paints, pesticides, chain-link fences, rubber and cleaners (e.g. algaecides)	Toxic to fish and other aquatic species in streams, estuaries, bays and the ocean. They accumulate in fish, then we eat them, becoming ill with a wide variety of disabilities.
Nutrients	Fertilizer, animal manure, dog feces	Excessive nutrients accelerate algae growth and cause "eutrophication." This "algal bloom" reduces dissolved oxygen in the water, causing other organisms to die. Nitrogen concentrations in water can also be hazardous to humans.
Chemicals	Fuel, paint, cleaning products and pesticides	Cause tumors, skin lesions and disrupt reproduction. Chemicals can turn water either more alkaline or more acid, harming aquatic organisms.
Trash	Overflowing trash cans, litter	Prevent sunlight from penetrating water, preventing aquatic species from eating and moving. When aquatic species and sea birds eat the trash, it kills or injures them.
Disease-causing bacteria	Human and animal wastes	Contaminates water, leading to respiratory, gastrointestinal and skin ailments

ARCHEOLOGY OF TRASH

The beginning of time.....Present



Organic Waste *Paper & Organic Twine* *Glass* *Cans* *Plastic*

FOSSIL FUEL PRODUCTS CONTAMINATE OUR CANYONS

Much of today's litter is made from plastic, derived from fossil fuel. Unlike cans, glass and paper, plastic floats. This means that plastic containers and other plastic items bob along on the surface of streams, instead of sinking and lodging in canyons where we can pick them up.

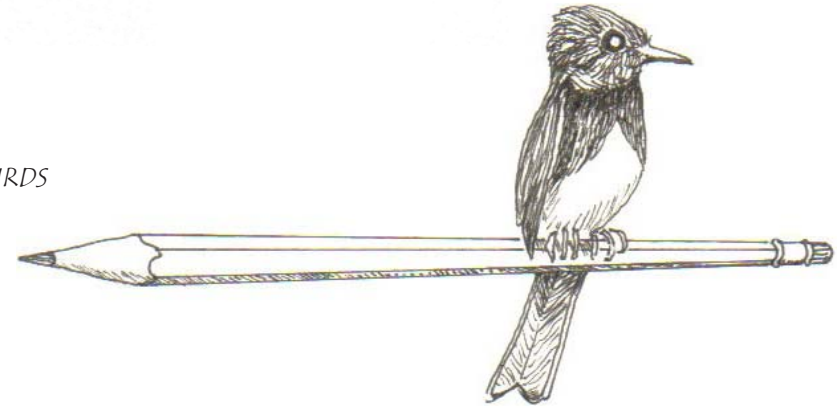
Sometimes canyon animals get stuck in plastic and, without water, or because they cannot move quickly, die.

Plastic debris washes from our canyons, out into the sea. Of an estimated 3.5 million tons of trash and litter off the coast of California, 90% of floating debris is plastic and 60-80% of all marine debris is plastic. Plastic is so durable that it can take hundreds of years for it to break down at sea, and some kinds never truly biodegrade at sea.

Continuing to float, it gets caught in swirling waters called "gyres." The plastic garbage gyre off the western United States is presently twice the size of Texas! Many fish and birds die from eating plastic they think is food.

References: http://www.latimes.com/news/local/oceans/la-oceans-series,0,7842752.special
http://healthebay.org/currentissues/ppi/default.asp

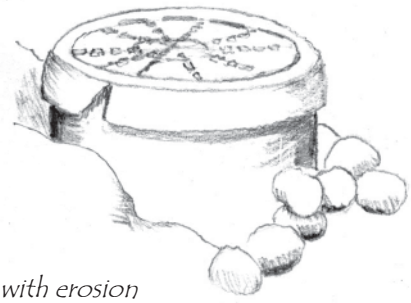
To report pollution
entering City of San Diego storm drains
and/or our waterways
call 619/235-1000.



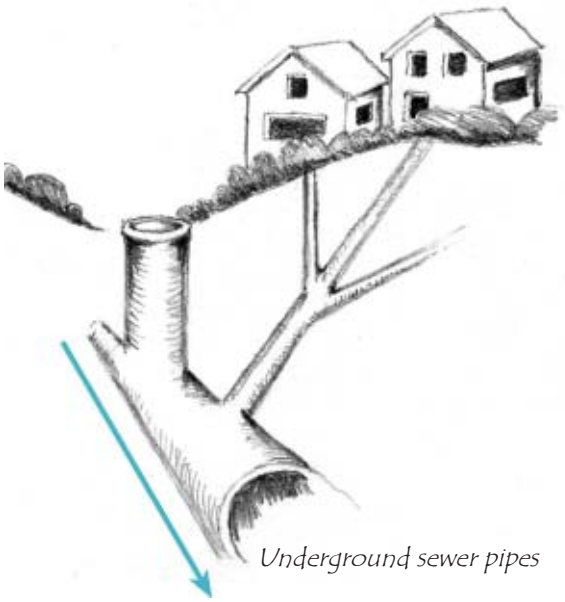
DISCOVER THE CONNECTION OF BIRDS
WITH WATER AND CANYONS
San Diego Audubon Society
4891 Pacific Highway, Suite #112
San Diego, CA 92110
(619) 682-7200
www.sandiegoaudubon.org

CANYONS MOVE WATER BELOW GROUND

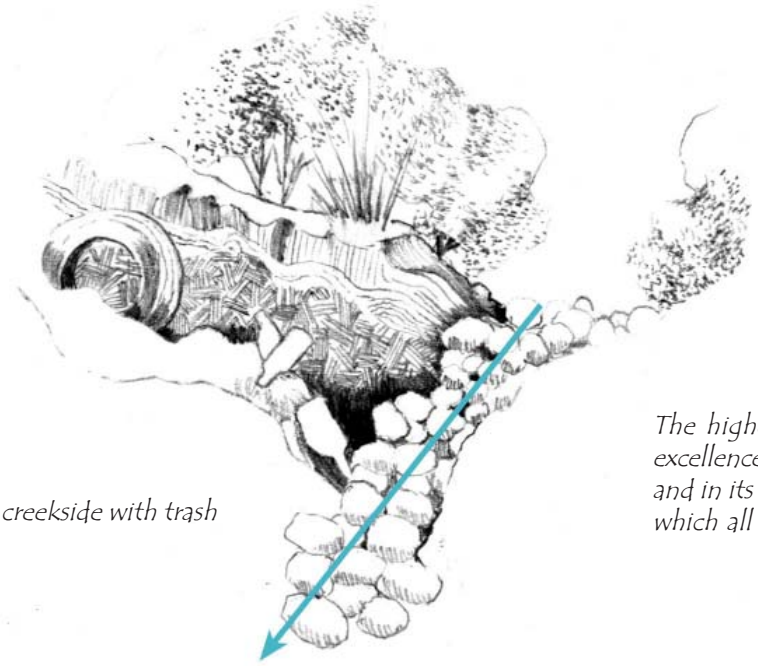
Water also moves through canyons in underground pipes. To transport fresh water and sewer water (water from sinks, showers, baths and toilets), crews installed pipes in canyons, deep under the soil.



Manhole with erosion



Underground sewer pipes



Eroded creekside with trash

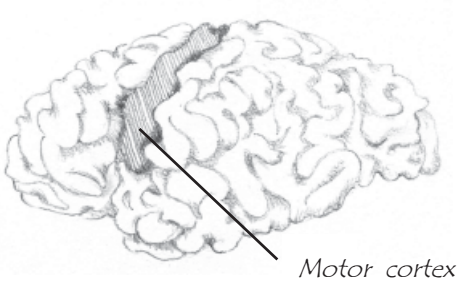
The highest excellence is like that of water. The excellence of water appears in its benefiting all things, and in its occupying, without striving, the low place which all men dislike. Hence it is near to the Tao.
– Lao Tzu (551–479 B.C.)

During construction, they removed plants that held down the soil, which caused erosion.

Lack of native plants deprives wildlife of food and shelter. Fewer plants filter air pollution and fewer plants filter water pollution. Our city is hotter because cooling trees, shrubs, and grasses are no longer there. Clearing the slopes and canyon floor, also made room for invasive plants and other weeds in the canyons. Invasive plants such as Giant Reed *(Arundo donax)* and Pampas Grass (*Cortaderia selloana)* are extremely flammable during drier months. Seasonal non-native grasses – which have replaced deeply rooted evergreen natives – are short-lived and quickly become fire hazards too.

TRAVEL BY FOLLOWING WATER

Too often I would hear men boast of the miles covered that day, rarely of what they had seen.
– Louis l'Amour, novelist



Motor cortex

Ecopsychology = the study of human well-being relative to the health of the planet.

"It is impossible to have well persons residing on a sick planet…Ecopsychology…concerns itself with exploring the motivations, yearnings, needs, and ideals that shape and structure our lives within the environment, focusing on strengthening or even reawakening the reciprocal relationship."

– from *Deep Immersion: The Experience of Water* by Robert Lawrence France

Because water is necessary to all life, animals have navigated along San Diego's canyon streams for millennia. Native Americans also walked along canyon streams, in order to find their way between food sources. When Europeans arrived in San Diego, they followed the same trails made by the Kumeyaay. Some of these early trails through canyons have become our modern freeways.

The Kumeyaay walked *right on the earth*. They were not separated from the soil and water by pavement. They had to pay attention to their footing and watch out for the unexpected. Their ability to navigate by foot was governed by a region of the brain called the "motor cortex."

Today we spend almost all our time on *human-made* surfaces that are disconnected from the land and water underneath. Development and technology separate us from the complex geology, soils and microorganisms that used to be right underfoot.

Grading and pipes and concrete are there to control water, designed to protect us. Yet, pollution, flooding, and closed beaches result. Human-made methods of controlling water are not working. They are killing plants and animals, as well as destroying human health.

While the connection with Earth that the Kumeyaay shared is more and more difficult to achieve, water continues to teach us. We are learning, from water, about the folly of some of our so-called "progress." We find unhealthy water, canyons, beaches, as well as an ocean with pollution and fewer resources. There is less fresh and safe water. It is up to us that we need to become much better stewards of our water and our watersheds.

Re-connecting with our canyons is one such opportunity. Walk the trails. Pitch in, to pick up trash and help tend habitats. Travel by following water…with your feet!

GLOSSARY

Absorb = (verb) gathering a substance onto

Adsorb = (verb) gathering a substance into

Aggregate = (noun or verb) bunch

Aquatic = (adjective) water-related

Archaeology = (noun) the study of artifacts from history

Arid = (adjective) dry, with little moisture

Bacterium (pl. bacteria) = (noun) one celled organism of the phylum Schizomycota

Biology = (noun) the study of living matter

Contaminant = (noun) pollutant, a substance that renders a substance unsafe

Drought-tolerant = (adjective) able to withstand and thrive in dry conditions

Ecosystem = (noun) interaction of a community of species with its environment

Erosion = (noun) the wearing away of earth by water

Fungus (pl. fungi) = (noun) eukarotic organisms of the kingdom Fungi

Geology = (noun) the study of the physical history of the earth

Groundwater = (noun) the water beneath the surface of the ground

Habitat = (noun) a place where species live

Headcutting = (noun) Erosion that eats away at a stream bank upstream

Marine layer = (noun) thick clouds onshore and over the ocean

Nutrient = (noun) a substance the supplies nourishment

Phytoremediation = (noun) de-polluting contaminated soils, water or air with plants

Runoff = (noun) the water produced by irrigating, construction and hoses

Species = (noun) a distinct class of animal or plant with common characteristics

Storm Water = (noun) the water produced by snow, rain, drizzle and mists

Symbiosis = (noun) cooperation for mutual benefit

Topography = (noun) the surface features of an area

Toxic = (adjective) poisoned

Watershed = an area that drains into the same river or creek

Restoring San Diego:
Practical Tips for Volunteer Restoration Projects

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Thanks to Bruce Hanson and Dave Flietner for their help with the document.

Mulefat

#1. Multiplying Mulefat

Published CNPS San Diego Newsletter Nov 2005

Seasonally dry streams in San Diego are often lined with mulefat (*Baccharis salicifolia*), an aromatic member of the Sunflower family that withstands floodwaters and other disturbance. As its Latin name implies, mulefat looks a lot like willow but can grow in drier areas. Like willow, its roots help stabilize stream banks. A mulefat-lined stream is a delightful place of sweet-smelling filtered sunlight. Propagating mulefat is an easy way to jump-start riparian restoration.

To add mulefat to a stream restoration project:

- Choose the right time of year – after the winter rains have moistened the soil.
- Use several mature shrubs close to the restoration site – this helps provide both plants adapted to site conditions and some genetic variation.
- Cut a stem of mulefat at least as long as your arm and as wide as your finger – the stem contains the sugars needed for growth. Thicker stems (> 1" diameter can be a bit shorter). A few cuttings from a single shrub will not harm it.
- Cut the bottom of the stem at an angle, so you remember which part to put in the ground.
- Strip off all of the leaves – this keeps the stem from drying out and dying. At this point, you may place the stems in a bucket of water and wait a week or two before planting.
- Take the stem to the planting site and push the cut end into the moist soil, as far as possible, but leaving at least two buds above the soil surface.
- Wait. New leaves with sprout in about two months. You should have robust plants growing in your canyon in no time!

Photo guides and more information about mulefat:
www.sdnhm.org/fieldguide/plants/bacc-sal.html
www.calflora.net/bloomingplants/mulefat.html (shows male and female flowers)

#2. Using stem cuttings to make container plants

Published CNPS San Diego Newsletter Jan 2006

Volunteer restoration groups on a budget appreciate being able to grow their own container plants. Did you know that there is also a good biological principle behind propagation from cuttings? San Diego is home to a wide variety of plant communities with varying environmental conditions. The resident plant populations have adapted to the particular sites over years of natural selection. Plants from your particular area may be more suited to it than plants of the same species from miles away.

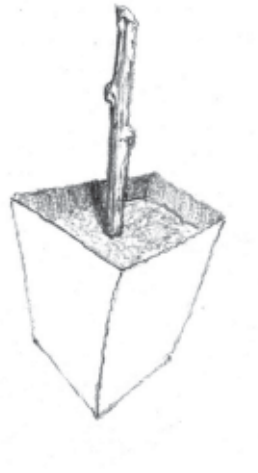
Cuttings are an easy way to propagate plants for many species, especially those with difficult-to-germinate seeds. The process is low in labor and can be successful in the corner of a residential back yard. Keeping notes on which species work for you will help other people.

To grow plants from cuttings:

- Prepare common 1-gallon or 5-gallon size pots by filling with soil and soaking thoroughly. If soil is hard to wet, place the pot in a bowl of water overnight, then let drain.
- Get permission from the property owner before taking samples. Removal of a small number of stems will not hurt a plant.
- Cut a stem about one to two feet long.
- Remove all the leaves, which will otherwise desiccate the cutting
- Push the cut end into the soil all the way to the bottom, leaving two nodes above the soil.
- Place the pots in filtered sunlight (for example, under a tree or a shade cloth)
- Sprinkle the pots every three days or so.
- By the end of a month, the cutting will be sprouting new leaves, or it will be clearly dead. If dead, toss it and reuse the pot for a new cutting.
- Once the plant has a number of new leaves and is growing well, plant it in your restoration site.

Species that are fairly easy to propagate from cuttings:

Sambucus mexicana, Blue Elderberry
Epilobium sp., California fuchsia
Salix sp., Willow
Baccharis salicifolia, Mulefat
Pluchea serricea , Arrow weed
Populus fremontii, Western Cottonwood
Populus basalmifera ssp. trichocarpa, Black Cottonwood
Artemisia douglasiana, Mugwort



#3. Using container plants in a restoration project

Some sites may benefit from introduction of container plants. For instance, the native seed bank might be diminished because extensive grading. Or you might want to get more coverage more quickly than possible by seeding. In weedy areas, using container plants properly will result in a much higher chance for plant establishment than spreading seed alone, which is frequently ineffective due to the weeds and our unpredictable rains.

Appropriate container plants are grown from seed either collected in the wild or propagated from wild-collected seed. Don't use "horticultural varieties" of plants (*e.g. Ceanothus* "Dark Star"), even if they are derived from local species. The reason: horticultural varieties are typically selected from a single or small number of individuals, for a particular characteristic which suits a landscaping requirement. This greatly reduces the genetic variability that wild plants need to survive without care in a natural environment. If used in large quantities, the genes from horticultural varieties may even reduce the fitness of wild populations.

How to use container plants

- Assess your site: is it riparian or upland? Coastal sage scrub or chaparral? With coastal influence or inland? You can figure out what *should* be growing on the site by visiting other natural lands in your area, or by consulting the California Native Plant Society for advice.
- Use container plants grown from seeds collected as close as possible to the restoration site. Don't use horticultural selections.
- Obtain the container plants. You can grow your own, or order from commercial sources (see www.cnpssd.org /horticulture for a list of native plant nurseries).
- Identify water source: even if they are low-water-use plants, container plants *must* be watered when they are planted and several times afterwards. If houses are close by, homeowners may be willing to donate water from a hose tap, especially after you explain the purpose of the project. Other possibilities are carrying the water in using 1-gallon jugs, or from containers transported to the site in a truck or all-terrain vehicle.
- Prepare the hole: use a 'duckbill" shovel or pickax to dig the hole, and arrange the excavated soil into a circular "levee". The goal is to put the plant in the middle of a depression that will retain water. The proper technique is difficult to describe, so you may want to visit a project where you can learn the details.
- Water the hole: fill the hole with water and let it soak in. Do this again as many times as you can. You are creating a "water account" for the plant that will help it to grow deep roots.
- Remove the plant from the container as gently as possible. Contrary to advice for typical landscape plants, don't rip into the root ball of natives; many will not appreciate it.
- Place the plant in the hole; add back soil to the original level of the soil in the container. Tamp the soil around the plant with your hand or foot to eliminate air spaces around the roots. Pour more water on top to further settle the soil around the root ball.
- Rock mulch
- Water some more, until you run out of time or water Then do a rain dance – a good soaking rain will save you lots of labor. In its absence, you need to return to the site in 2-3 weeks and water the plants again; at this point, you will appreciate having well-designed basins around the plants. If you plant in the rainy season (November – February) and get a couple of good soaking rains, you won't have to water through the summer. If you plant outside of this season, watering through the summer will be necessary to help your plants survive.

#4 Using prickly-pear and cholla cactus in restoration

Lazy restorationists, listen up! This is the easiest restoration practice possible, once you learn to spread cholla without injury. It's not so much the spines you need to look out for, but the "glochids" — the tiny deciduous spines that form a ring at the base of the longer spines. Although cacti can be painful, they have excellent wildlife value: coast prickly pear (*Opuntia litoralis*) is the nesting habitat for cactus wren, now uncommon in urban San Diego.

These techniques work for both the pads of prickly pears (*Opuntia* spp.) and or stems of chollas (*Cylindropuntia* spp.). Coast prickly pear and coast cholla (*C. prolifera*) are the most common coastal cacti; for the complete list of our cacti, see http://www.sdnhm.org/research/botany/sdplants/cactaceae.html#Cactaceae.

Avoid propagating Indian fig (*Opunita ficus-indica*). Although common in San Diego canyons, it is an escaped ornamental that hybridizes with natives. This opuntia grows upright, is gray-green, and usually lacks spines, which are less than an inch long if present. Don't plant it, eat it: http://nopales.us/recipes.htm.

These techniques work for both the pads of prickly pears (*Opuntia* spp.) and or stems of chollas (*Cylindropuntia* spp.):

- Choose the right place: cactus like lots of sun. They may grow in the shade of other plants, but only on south-facing slopes. Avoid wet spots or deep shade or they will rot.
- Choose the right source: mature plants from a nearby area are best. Never dig up cactus unless the bulldozers are rolling; instead simply remove a few pads or stems from a large plant.
- Protect your hands: Use a "trash-picker" (hand-operated tongs) to grasp the pad or cholla stem, and place them in a paper sack. Thick gloves will work too, but look where you grab – and where you step.
- Wait a bit: Store the pads/stems in a dry place for anywhere from a couple weeks to several months. This gives the base of the pad time to 'harden off" to resist infection.
- Plant the pad: The pads/stems will root once they are in contact with the soil. You can simply scatter the pads on the ground, or bury the lower quarter or so to improve contact. Stake them or place them under an open shrub like sagebrush to avoid stepping on it.

That's it! The cactus will patiently wait until a rain stimulates it to set roots down into the damp soil.

_____'s Canyon Log

Your Name Here

Date: _____

Explorers write in a log to keep track of their discoveries.

Writers use a log to help them re-live their experiences.


Hold Water


Protect Wildlife


Nourish Native Plants


Feed Humans


Held Crops


Feed Humans' Animals


Hold Pipes


Harbor Invasive Plants


Contain Trash


Deserve Care

I smelled: _____

I saw: _____

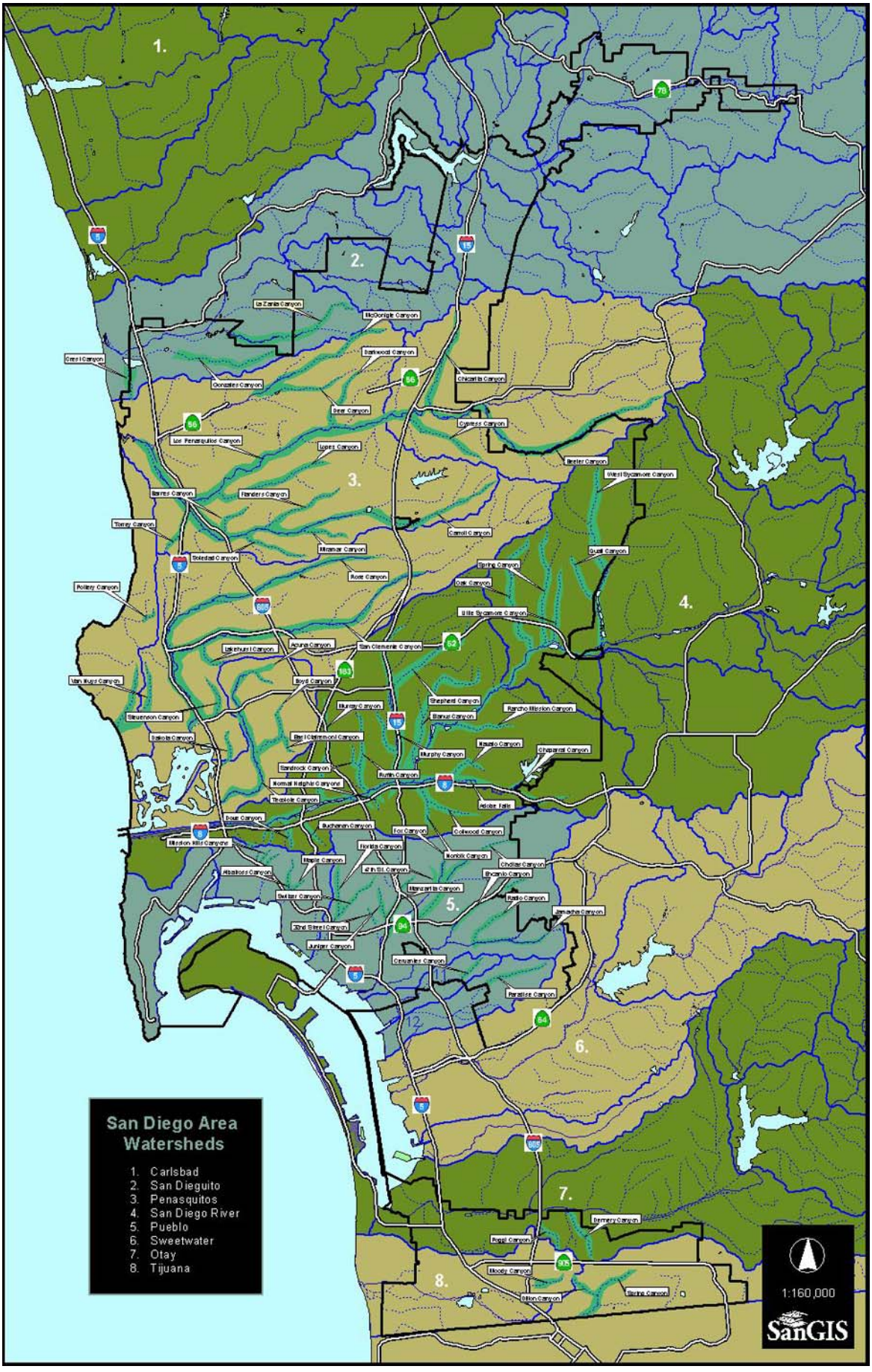
I heard: _____

I felt the textures of: _____

It is morning in the canyon, and I....

In the world there is nothing more submissive and weak than water. Yet for attacking that which is hard and strong nothing can surpass it.

- Lao Tzu (551-479 B.C.)


San Diego Area Watersheds
1. Carlsbad
2. San Dieguito
3. Penasquitos
4. San Diego River
5. Pueblo
6. Sweetwater
7. Otay
8. Tijuana
1:160,000
SanGIS