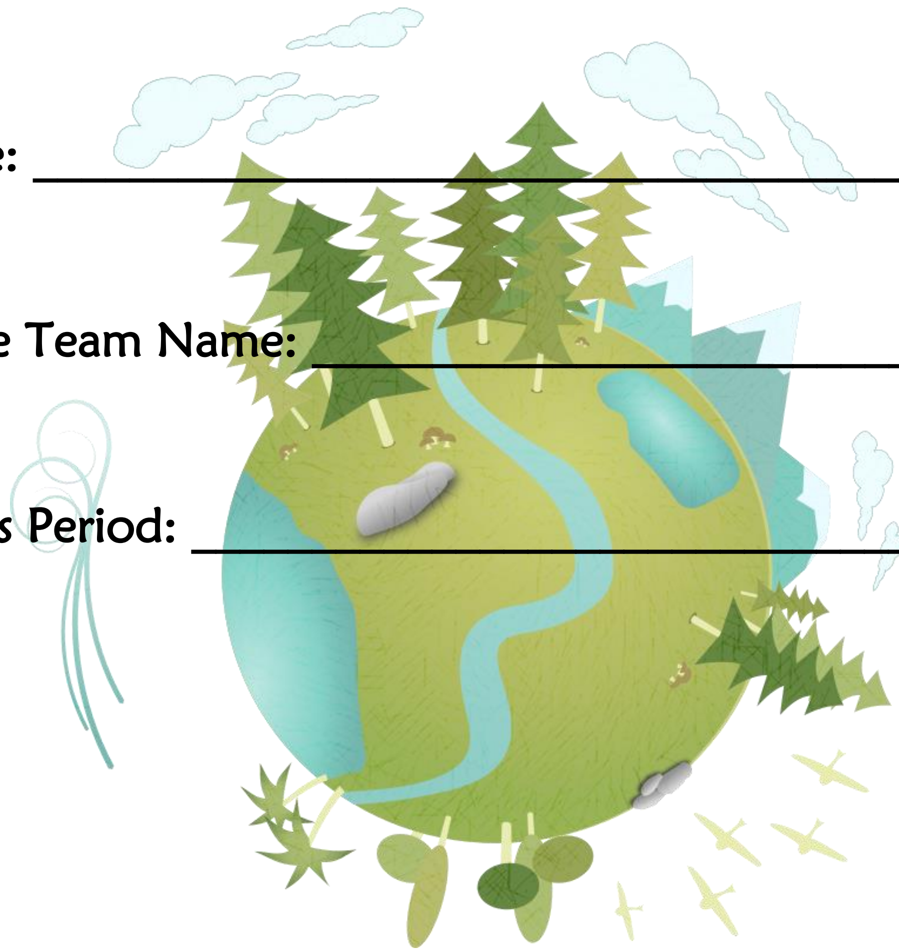
Nature's Design

Student Field Notebook

Name: ____

Science Team Name: ___________________________________

Class Period: ____



JACK LONDON
STATE HISTORIC PARK

Developed and brought to you by Jack London Park Partners

This program is made possible with the generous support of the California State Parks Foundation and the Benziger Family Winery and Impact 100

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Dear Student,

Welcome to the Nature's Design field science program for 7th grade at Jack London State Historic Park (JLSHP). Our goal for this project is to gain a better understanding of our local ecosystem and how we humans fit into it. Over 100 years ago, famous author Jack London worked with experimental techniques to replenish soils depleted from chemical fertilizers and raise livestock in ways that were more humane and environmentally friendly than the mainstream methods being used at the time. He believed it was vitally important to work with nature and not against it.

With a respect for the scientific process, Jack combined his personal research with the work of local scientists like Luther Burbank, to achieve his goals of sustainability. Today, Jack London's Beauty Ranch serves as a place of recreation and learning. In honor of Jack's early farming efforts and scientific curiosity about nature, this program asks students to continue his quest to understand how we can live and work in harmony with the natural world. As we face modern challenges like climate change and habitat loss, understanding how we can help our ecosystems become more resilient to unexpected change is more important than ever.

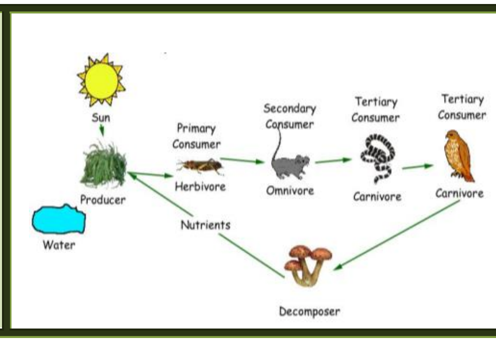
Over the course of 3 visits, you and your classmates will conduct ecological research on our local habitats, using field research methods to collect data on three important biological communities; plants, arthropods, and birds. We will conduct studies in your schoolyard and in the forests of JLSHP, comparing the variety of life in a wild area and a suburban location. Our goal is to identify what makes one site more biologically rich than another. Finally, you will be challenged to put your research to the test in a landscape design project that asks you to creatively re-design your school campus in a way that can better support habitat health and sustainability. Prizes will be awarded to the top 3 designs! I look forward to working with you on this important project.

See you in the field!
Kristina Ellis
Education Manager, Jack London State Historic Park

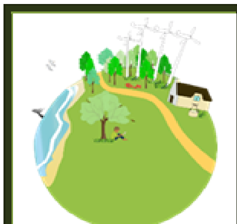
Ecology (from Greek οἶκος, "house" or "living relations"; -λογία, "study of")

Ecology is the branch of biology that studies the relationships between plant and animal communities and their interactions with the non-living components of their ecosystems. Ecology focuses on several important connections and questions, including:

- How does energy and matter move through an ecosystem?
- What are the diversity levels of plant and animal species within an ecosystem?
- How do organisms interact with each other between trophic levels; i.e. producers & consumers, predator & prey relationships, decomposers & carrion eaters…?
- How can we improve ecosystem health and resiliency?



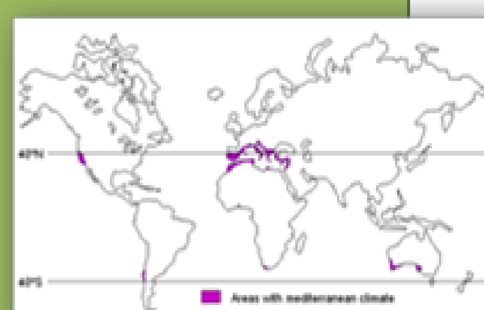
Today, more areas within society are looking to ecology and ecologists for knowledge and direction on sustainable growth and how to navigate the effects of climate change in our communities. We often think of environmental fields such as resource conservation and land restoration, however, professionals in the areas of community health, agriculture, economics, private business, and even city planning are beginning to seek answers to questions like:



- How can we shrink our impact on the environment?
- How can we build businesses and housing in a way that includes nature?
- Should schools have more green space?
- How can we protect our drinking water?
- What can we do to help the planet?

Climate Influences Ecosystems

Most of California is comprised of a Mediterranean climate zone, which is completely different to that of the rest of the country and even the world. Only 4 other locations on the planet share our special climate type; the Mediterranean Basin, Western Cape South Africa, South and Southwest Australia, and Central Chile. All five regions are home to the most significant levels of plant diversity and endemism in the world and have been designated by scientists as "biodiversity hotspots."



Field Research

Also known as "field work," this involves the observation and gathering of information outside of a laboratory, library, or other controlled environment. Ecologists use many different methods for collecting data on the habitats and **species** they wish to study. Below are several of the methods we will use in our project:

- **Observation:** Very simply, observation involves watching nature. Scientists from all fields will employ this simple yet very effective method. We can learn a lot about a plant, animal, or **habitat** by observing it over time and making notes on behaviors, changes, and other activities.

- **Survey Sampling:** Ecologists know they cannot count and identify every individual plant or animal within a habitat. Instead, they will try to get an overall picture of things by conducting multiple sample studies that are spread out over a designated area. We will use the survey sampling method when working to identify the plant **communities** found in our two study sites (your schoolyard and Jack London State Historic Park).
- **Mapping:** When conducting research over a wide area, it is important to be able to pinpoint exactly where a specimen was identified. This is especially important when conducting research over a long period of time. Field scientists will often plot sample sites and observations on a map of their study site. To be accurate, GPS (global positioning system) units are often used.
- **Modeling:** Ecological systems are made up of a huge number of **biotic** (living) and **abiotic** (non-living) elements that interact with each other in countless and unpredictable ways. To simplify these complex systems, scientists will often create physical or mathematical models to help understand things better. Using data gathered from the field, ecologists will simplify the **ecosystem** to a limited number of key components and study the relationships in question (i.e. relation of water availability to plant growth-rates, predator/prey relationships, etc.). Models can then be used to predict what might happen over time, within the real ecosystem. Following your field research, you and will be challenged to build an ecological model of a landscape design that will enhance the ecosystem of your schoolyard over time.

Plants – VEGETATION SAMPLING USING QUADRATS

Why plants?

Plants are the backbone of any ecosystem. As **autotrophs** (producers), they harness the sun's energy and make it available to the rest of the food web, providing a foundation for all animal life. Whether an animal can adapt to a particular habitat or not is primarily driven by the food sources that are available to them. Therefore, the plant communities present within an area can give us large clues into the **heterotrophs** (consumers) that may also be present.

How will we measure?

One of the most common methods used for sampling plant communities is the **quadrat** method. A quadrat is simply a frame that is laid down in a specific area. They may be square, rectangular, or circular, and of a size that is appropriate to the vegetation type you are measuring. In our study, we will be focusing on the forest floor. Which dimensions will be most appropriate for our field trip? See table.

Vegetation type	Quadrat Dimensions
Mosses	10 x 10 cm
Herbaceous	31.6 x 31.6 cm
Forest floor herb	1 x 1 m
Shrub	3.16 x 3.16 m
Forest/Tree	10 x 10 m

Example of appropriate dimensions for a quadrat

Since it is almost impossible to count every plant within a habitat, scientists like to take quadrat samples throughout a designated area. When we are in the field, we will divide our large study area up into random sample sites and each science team will survey one location. Teams will be given a quadrat frame to use and will be asked to identify the plant species within its borders and to measure the richness and abundance of the individual species we find. This type of random sampling ensures that we get a good representation of the different plant communities present in the area being studied.

Arthropods-*Arthropoda*; "those with jointed feet"

Why Arthropods?

Arthropods are **invertebrates** with an **exoskeleton**, segmented bodies, and many jointed legs, including insects, arachnids, and myriapods ("many feet" – i.e. millipedes and centipedes). They are found in every corner of the planet on land, in ponds, streams, lakes, and even the ocean (the most common marine example is a lobster). This phylum of creatures comprises approximately 85% of all known animals in the world. Today, roughly 1.3 million species have been identified but scientists believe that we still have around 7 million more species to discover!

**Beating sheets are often 3'x3' squares of canvas and used to collect invertebrates from bushes and branches.*

Arthropods perform an incredible number of critical functions and are vital to the health of ecosystems across the globe. They not only serve as the largest source of non-plant food for the animal kingdom, they also pollinate flowering plants, aerate soil, and help to decompose dead and decaying matter returning vital nutrients to the soil. The famous biologist E.O. Wilson has referred to arthropods as "the little things that run the Earth."

Many experts feel that if we ever lost this important group of creatures, entire ecological systems would collapse within months. In July 2016, the IUCN (Int. Union for Conservation of Nature) stated that 1,010 species of arthropods are critically endangered and in need of our protection. Today that number is growing. Some of the leading causes currently identified are the widespread use of pesticides and monoculture (single species crops, lacking diversity) and possibly even the rise in atmospheric CO_2 levels. Studies continue.

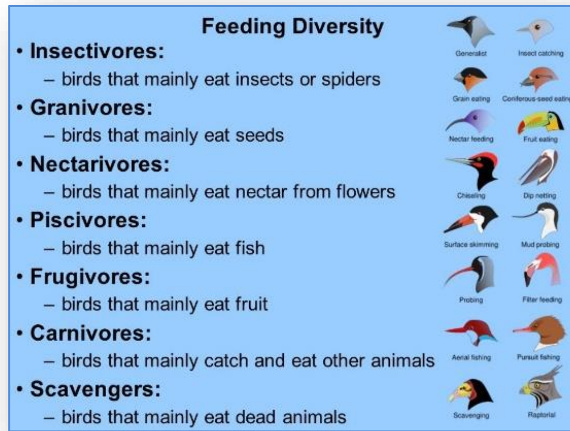
How will we measure?

We will conduct careful catch-and-release observations in the field, including the use of collection jars, hand lenses, field guides, and *beating sheets. If the opportunity arises, we may also look for aquatic arthropods. The goal will be to identify as many different species as we can.

Birds – SPECIES IDENTIFICATION AND COUNT

Why Birds?

Birds are an incredibly diverse class of organisms occupying different levels of the **trophic** pyramid with a range including **consumers** like seed eaters and nectar feeders, **apex predators**, and scavenging **decomposers**. Birds are also unique in that their feeding habits range from **generalist** (an animal that can eat many different types of food, like a crow) to extreme **specialist** (animals that eat mainly one specific food type, like a hummingbird).



From Woodland Park Zoo

Much like insects, birds cover a wide range of important **niches** and tasks within their habitats. Nectarivores like hummingbirds, will pollinate flowers. Insectivores like swallows and flycatchers, along with carnivores like eagles and hawks, all help to keep consumer population levels in check. The important task of decomposition is aided by carrion eaters like turkey vultures and condors. Finally, the ability to fly allows birds to cover a great deal of ground, making them excellent seed dispersal units and pollinators of plant reproduction over vast areas. Some species, like the Whimbrel, migrate thousands of miles every year.

Because they touch so much and are so important in the functioning of ecosystems, birds are considered **keystone species**. This means that if they were to disappear from an ecosystem, many other species of animals and plants would be directly affected. Woodpeckers are a great example of this. As they excavate dead trees for insects and larva, they end up creating cavities that will later be used as shelter by other birds or small mammals. They are like the carpenters of the forest.

How will we measure?

At each study site, we will conduct a brief bird walk. Our goal will be to identify as many different bird species as we can and keep a clear count of individuals within each species identified. Your team will have a set of binoculars and field guides to share that will help you in your observations.

Responsibility in Research

One of our goals for this program is to find ways we can exist more cooperatively with nature. During our research, we will be using the "Leave No Trace" philosophy to guide us. Below are some guiding principles from the Center for Outdoor Ethics (https://lnt.org/learn/7-principles):

Plan Ahead - Be Prepared
Schedule your trip to avoid times of high use.
Visit in small groups when possible. Consider splitting larger groups into smaller groups.

Travel on Durable Surfaces
Concentrate use on existing trails (don't walk off-trail).
Walk single file in the middle of the trail, even when wet or muddy.

Dispose of Waste Properly
Pack it in, pack it out. Inspect your study sites for trash or research equipment.
Pack out all trash and litter.

Leave What You Find
Preserve the past: examine, but don't touch historic structures & artifacts.
Leave rocks, plants and other natural objects as you find them.

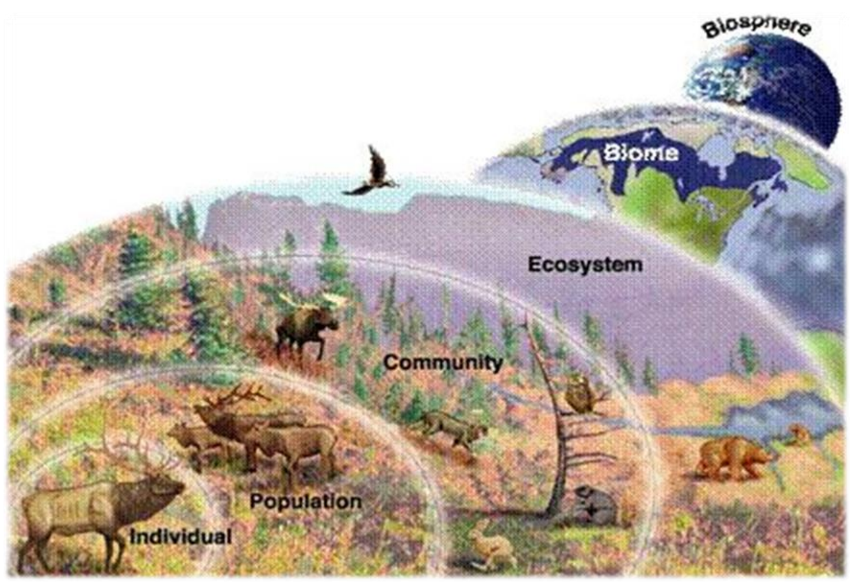
Respect Wildlife
Observe wildlife from a distance. Do not follow or approach them.
Never feed animals! It damages their health and alters natural behaviors.
Any arthropods collected for observation will be carefully returned to the spot they were found.

Be Considerate of Other Visitors
Respect other visitors and protect the quality of their experience.
Be courteous. Yield to other users on the trail.
Let nature's sounds prevail. Avoid loud voices and noises.

Important vocabulary

abiotic - nonliving factors in the environment. Some abiotic factors of an environment include light, temperature, soil, climate and atmospheric gases.
abundance – refers to the number of individuals per species within a community.
apex predator – a predator that resides at the "top" of a food chain (a.k.a. top predator). These animals have no natural predators which hunt them.
autotroph - an organism that can receive nutrition by forming organic substances from simple inorganic substances, like carbon dioxide and solar energy; most common example is photosynthesis in plants.
biodiversity (biological diversity) – refers to the number of different species of plants and animals within an ecosystem.
biodiversity "hot spot" – refers to biogeographical regions that hold significant reservoirs of biodiversity and are often threatened with destruction and/or significant loss of species.
biotic - pertaining to life or living things.
carnivore - organism that eats primarily meat for energy
carrion – referring to dead and decaying flesh
community - region occupied by a group of interacting organisms or various species in a common location (i.e. a forest community, desert community…)
consumer - organism that eats another organism as food for energy.
decomposer - organisms that break down organic material.
ecology - the study of how living (biotic) and nonliving (abiotic) parts of the environment interact with each other.
ecosystem - a system formed by the interaction of a community of organisms with their physical environment.
endemic – refers to organisms which are native only to a particular region and are not found anywhere else.
exoskeleton – a rigid protective covering for the body of some invertebrates like arthropods. Provides external support and structure.
food chain -An interconnected chain of organisms that indicate which are predators and which are prey in relation to one another.
generalist – a species that can thrive in a wide variety of environments and make use of a variety of resources, particularly for food (i.e. raccoons, pigeons, and coyotes).
habitat - the natural environment of a plant or animal.
herbivore - organisms that eat plants for energy.
heterotroph – organisms which cannot manufacture their own food and must consume organic substances like plant and/or animal matter.
individual – single, separate organism within a group.

interdependence – the mutual dependence between things in an environment. Many organisms rely on others for survival, as with the relationship between consumers and producers or predator and prey.
invertebrate - an animal lacking a backbone, such as an arthropod or mollusk.
keystone species – species whose role within an ecosystem has a disproportionate effect on other organisms; often a dominant predator whose removal would result in an explosion of a prey population, who would then be able to overexploit other resources and cause a decrease in overall diversity (i.e. mountain lions and mule deer).
niche - the ecological role an organism plays within a community.
omnivore - organism that eats plants and meat for energy.
organism - anything that has living characteristics and is composed of one or more cells.
population - all the organisms that constitute a specific group or occur in a specified habitat.
producer - organisms capable of producing their own food/energy from non-organic compounds via photosynthesis or chemosynthesis.
quadrat – a small sample-area of habitat, often 1 sq. meter, selected at random to be studied for the distribution of plants and animals within the habitat.
richness – a count of the different species represented in an ecological community.
specialist - species that can only thrive within a narrow range of environmental conditions; not tolerant to significant changes in climate or habitat conditions. Species that have a very limited diet (i.e. hummingbirds, salamander, some bees).
species – taxonomic classification ranked just below genus; a group of closely related organisms that are very similar to each other and usually capable of interbreeding and producing fertile offspring.
trophic – referring to feeding habits or food relationships of different organisms in a food chain.



A great space to jot down any additional notes or helpful vocabulary you learn during your program:

Field Trip Checklist

During your field trip to Jack London State Historic Park you will be exploring and conducting field research in a naturally wooded area. To be prepared and make your experience more comfortable, bring the following items with you on your visit.

- ☐ **Water!!! (12-16 oz. We will hike into and out of our study location)**
- ☐ **Long pants**
- ☐ **Good walking shoes (they will get dirty)**
- ☐ **Hat or visor (optional)**
- ☐ **Sunscreen**
- ☐ **Waterproof jacket (if it rains)**
- ☐ **No heavy backpacks; small or light pack to hold water and notebook is fine**

☆ Remember, we will be exploring in the natural world. Long pants and sleeves will help to protect your legs and arms. Be prepared to get a little bit dirty.

Your field trip date: __________________

??? Before We Begin…

As we have already stated, our overall goal for this project is to conduct a general survey of two different habitats to see which contains the highest levels of biodiversity. We then want to think about what that might mean for the environment as a whole. However, you may be curious about something else. Maybe you are interested in turkey vultures. Would one location necessarily have more vultures present than the other? You can pose an additional question that you would like to research as we go through this project together. Begin by jotting down a few things you already know about the subject of your question.

What I know already about the topic:

My research question:

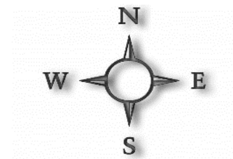
My hypothesis:

Field Study #1
Schoolyard

DATE	
LOCATION	
TIME OF DAY	
OVERALL WEATHER CONDITIONS	
TEMPERATURE	

MAP OF SCHOOL YARD STUDY LOCATIONS

Before our first investigation, paste (or draw) a simple map of your schoolyard here. As we conduct our research, you will mark the locations of each study site where we measure, collect, or observe the species being studied. Be sure to orient the top or your map to true north.



SCHOOL YARD BIRD SURVEY DATA SET #1		**AREA OF SCHOOL YARD:**	**DATE:** **TIME:**	
SPECIES NAME	**LOCATION SPOTTED**	**BEHAVIORS** (flying, preening, perching, calling, eating, hunting…)	**TALLY COUNT**	**TOTAL**
Mourning Dove	phone wire, rooftop, fence post	perching, preening, calling	𝍷𝍷𝍷𝍷 𝍸	9

SCHOOL YARD BIRD SURVEY DATA SET #1		**AREA OF SCHOOL YARD:**	**DATE:** **TIME:**	
SPECIES NAME	**LOCATION SPOTTED**	**BEHAVIORS** (flying, preening, perching, calling, eating, hunting…)	**TALLY COUNT**	**TOTAL**

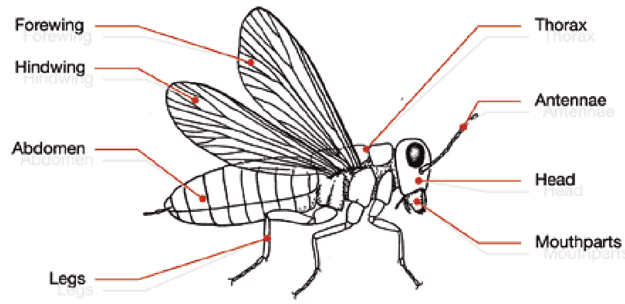
SCHOOL YARD ARTHROPOD SURVEY - Date: Time: Area of school yard:

SPECIES	LOCATION	SAMPLING METHOD			TALLY COUNT	TOTAL
		Beating	Dip Net	Observed		

SPECIES	LOCATION	SAMPLING METHOD			TALLY COUNT	TOTAL
		Beating	Dip Net	Observed		

Scientific Illustration

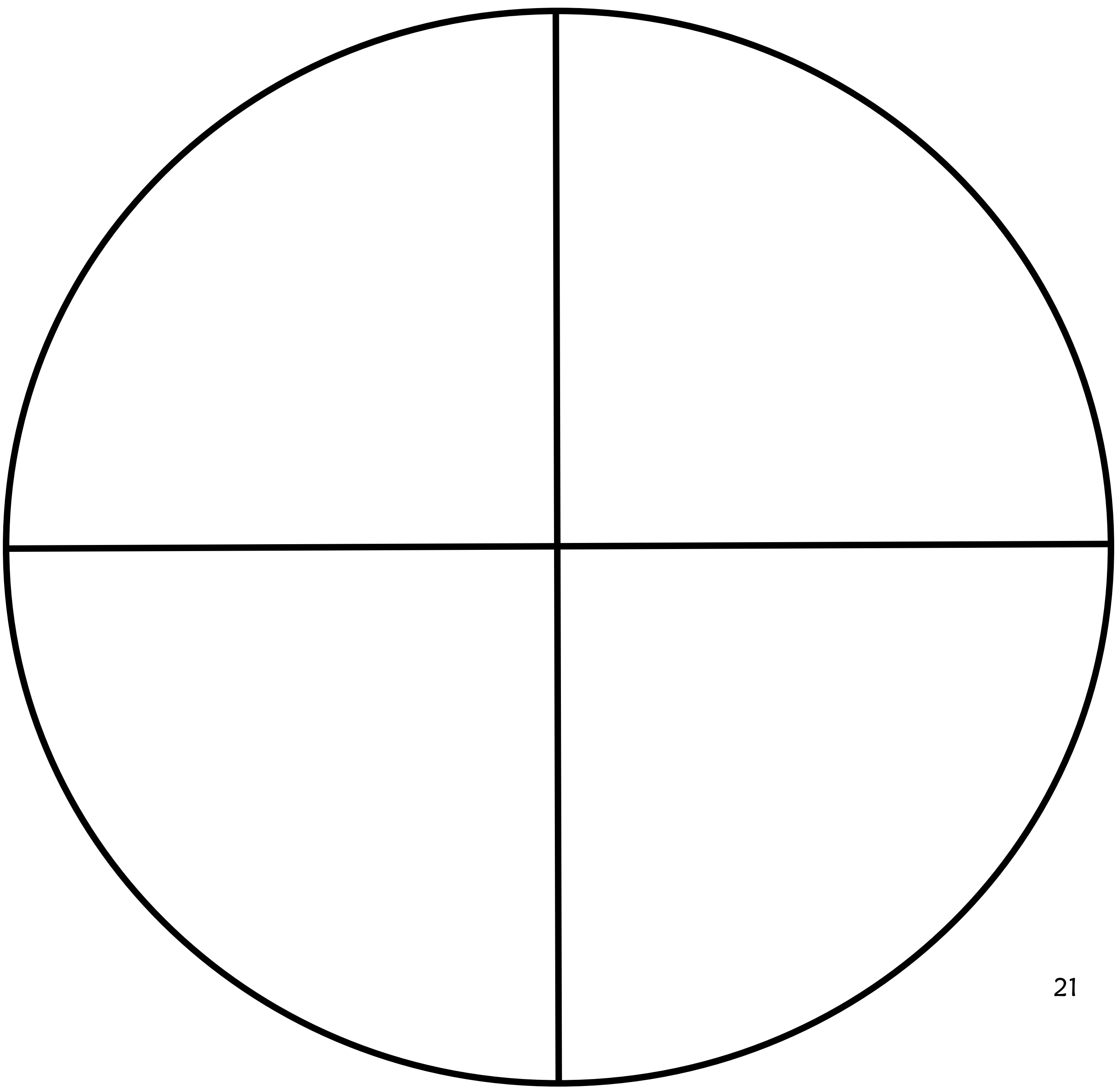
Scientists often create accurate illustrations of the specimens they are observing. Good illustrations are precisely labeled to convey information, like the diagram to the right. Draw only what you directly observe.



QUADRAT PLANT MAP

To keep your plant map legible, use symbols (or initials) to represent the species you are identifying. You can choose any symbol/initials you want for each species, just remain consistent with all your observations (i.e. ◊ can = sword fern & a star can = Calif. poppy). You will place that symbol on the quadrat map below, relative to the location in which you observe the plant on the ground. Fill in the legend to the right. Everyone in your team must agree to use the same symbols so that your maps look the same.

Species	Identifier	Density *(how many of each species)*
Calif. Poppy	★	16
TOTAL		



SPECIES MASTER LIST FOR SCHOOLYARD

In the lists below, write the name of each species your team found and the total number of **individuals** (qty.) per species. At the bottom of each list, you will record the total number of species observed (not individuals). This is how to calculate the **richness** (a.k.a. diversity) of a species present within a habitat.

OPTIONAL: You can also calculate the ***relative abundance*** *of a species. This can tell us how common or rare it is, compared to other species within a defined community. To find abundance, use the calculation below:*

Abundance → $\frac{\text{\# of species A}}{\text{Total \# of species}}$ = ________ x 100 = ____%

Birds **qty.**	**Arthropods** **qty.**	**Plants** **qty.**
Bird richness =	**Arthro. richness =**	**Plant richness =**

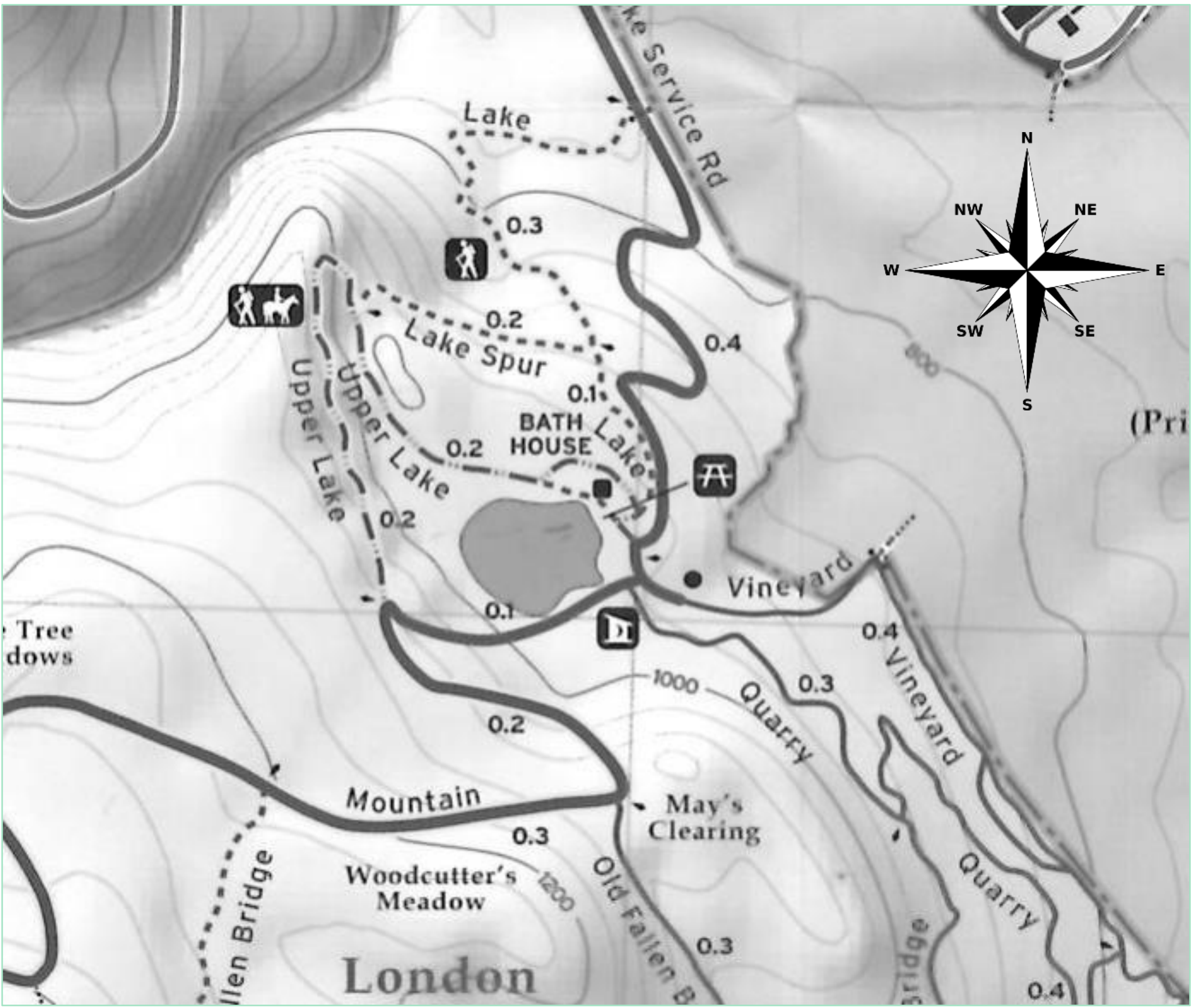
Additional species here:

Field Study #2
Jack London State Park

DATE	
LOCATION	
TIME OF DAY	
OVERALL WEATHER CONDITIONS	
TEMPERATURE	

MAP OF JLSHP STUDY LOCATIONS

As we conduct our research, you will mark the locations of each study site where we measure, collect, or observe the species being studied.



JACK LONDON STATE PARK BIRD SURVEY - DATA SET #2		GENERAL SURVEY AREA:	DATE: TIME:	
SPECIES NAME	**LOCATION SPOTTED**	**BEHAVIORS** (flying, preening, perching, calling, eating, hunting…)	**TALLY COUNT**	**TOTAL**

JACK LONDON STATE PARK BIRD SURVEY - DATA SET #2		GENERAL SURVEY AREA:	DATE: TIME:	
SPECIES NAME	**LOCATION SPOTTED**	**BEHAVIORS** (flying, preening, perching, calling, eating, hunting…)	**TALLY COUNT**	**TOTAL**

JACK LONDON ST. PARK ARTHROPOD SURVEY - Date: Time: Area of park:

SPECIES	LOCATION	SAMPLING METHOD			TALLY COUNT	TOTAL
		Beating	Dip Net	Observed		

SPECIES	LOCATION	SAMPLING METHOD			TALLY COUNT	TOTAL
		Beating	Dip Net	Observed		

Scientific Illustration

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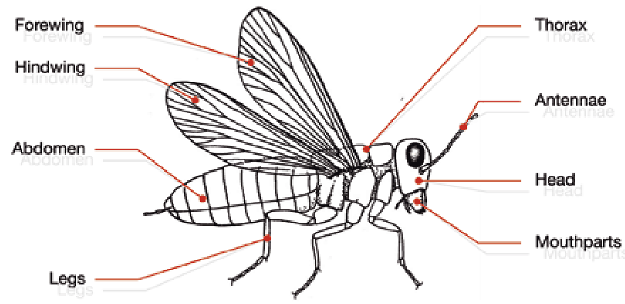

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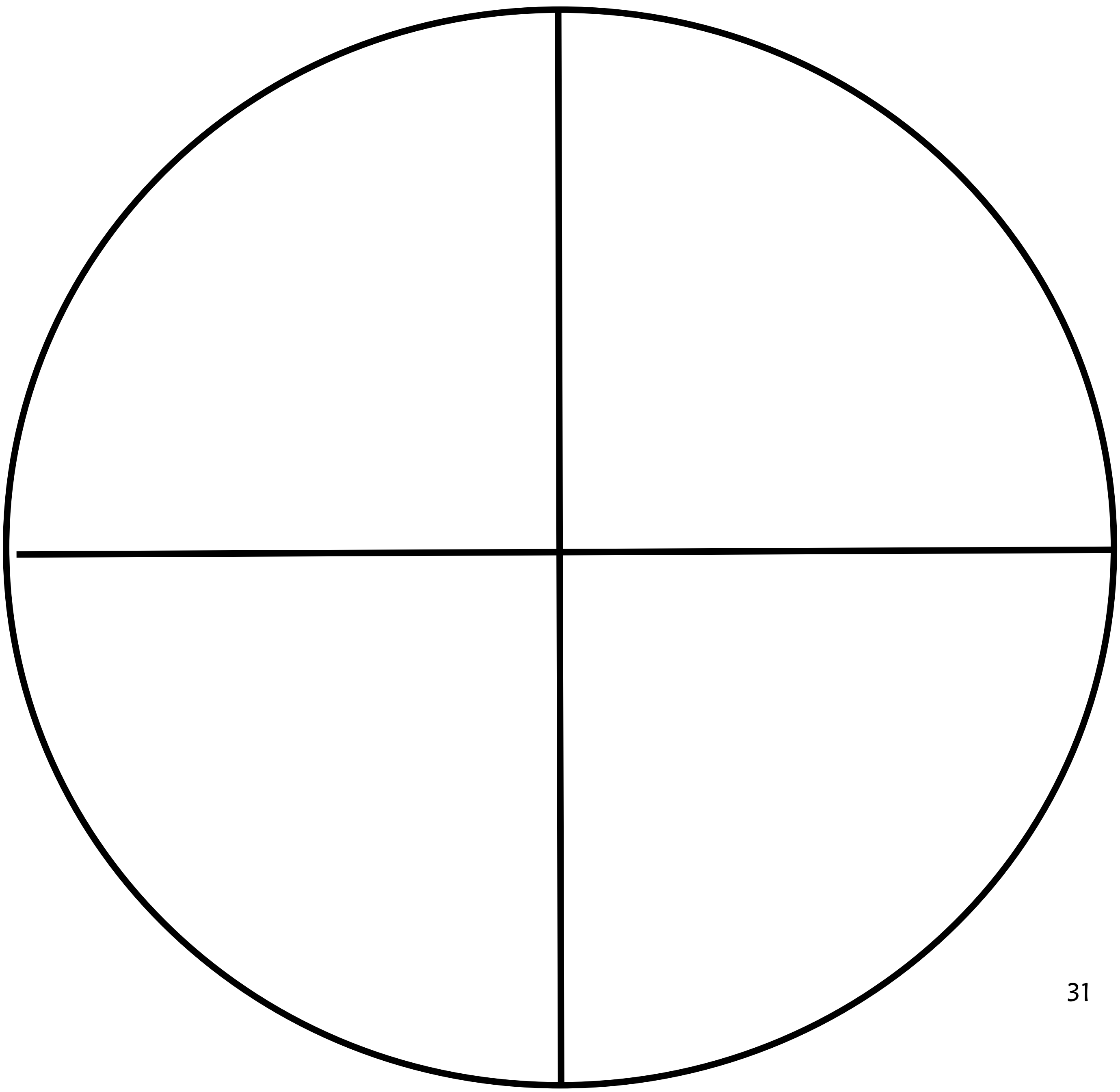
TOTAL		

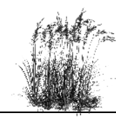


SPECIES MASTER LIST FOR JACK LONDON STATE PARK

In the lists below, write the name of each species your team found and the total number of **individuals** (qty.) per species. At the bottom of each list, you will record the total number of species observed (not individuals). This is how to calculate the **richness** (a.k.a. diversity) of a species present within a habitat.

OPTIONAL: You can also calculate the ***relative abundance*** *of a species. This can tell us how common or rare it is, compared to other species within a defined community. To find abundance, use the calculation below:*

Abundance → # of species A = _________ x 100 = ____%
Total # of species



Birds	qty.	Arthropods	qty.	Plants	qty.
Bird richness =		**Arthro. richness =**		**Plant richness =**	

Additional species here:

SUMMARY OF FINDINGS

Consider your data. What story can they tell us about the two habitats we have been studying? Are we missing any information? What are some ways we could make this investigation more scientific or effective? Write a summary of your findings below. Consider also your personal research question (if you chose one – write this conclusion summary on the back of this page).

Which habitat supports greater levels of biodiversity? Why? Is this important?