PROMPTS TO DEEPEN OBSERVATION

I use the prompts "I notice," "I wonder," and "It reminds me of" to focus my observation and inquiry. This is my most essential practice.

In any moment, it is possible to learn about your surroundings through observation. It is also easy to walk through the world caught up in your own thoughts and worries, looking without truly seeing. The difference between these two experiences is conscious, focused attention. Inspired by Kerry Ruef's Private Eye Project, I use three prompts—"I notice," "I wonder," and "It reminds me of"—as the foundation of my practice because they lead to conscious attention.[1] If you incorporate these prompts into your explorations, you will not have to go far to discover something beautiful, or to gain a deeper understanding of anything you see.

> "If I have ever made any valuable discoveries, it has been owing more to patient observation than to any other reason."
>
> —Isaac Newton

To begin, find something small to observe: a leaf, stick, or rock. Then take a moment to slow down. Thich Nhat Hanh has said, "We will be more successful in all our endeavors if we can let go of the habit of running all the time, and take little pauses to relax and re-center ourselves. And we'll also have a lot more joy in living."[2] So many things are constantly making a bid for your attention and focus. If you find some stillness and space before beginning, you will have a larger capacity to be present. To slow down, I use a simple mindful breathing exercise: for about five cycles, I focus on the in and out flow of my breath. I do this before I begin journaling, and again at intervals throughout a day of nature observation. It does not take much time, and it helps me to regain focus, concentration, and appreciation.

Then try each of these prompts in succession. Though it may feel strange, say everything you think out loud. Doing so will weave what you see into the fabric of your memory, and it will help you to articulate your thoughts more clearly.

I NOTICE

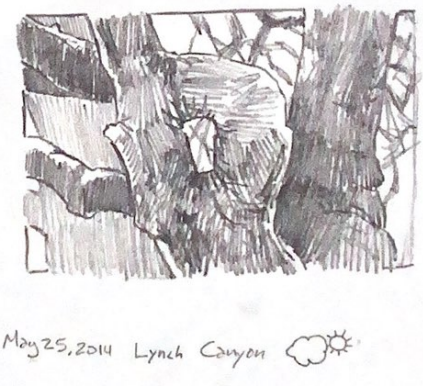
Examine whatever you are looking at. Start to say observations out loud. Do not filter anything out: if you see it, say it. Look at structure, behavior, color, interactions. Change your perspective: look up close or far away and see what else you can observe. If you find yourself running out of observations, challenge yourself to discover something new, or just say "I notice…" until an idea pops out. Pay attention to what surprises you. This gives you insight into ways that the world is different than you had thought.

I WONDER

After observing your object, start to come up with questions about it and say those out loud, too. Your questions might be connected to an observation you made earlier, or they could be about any aspect of what you're observing. There is no need to worry about answering the questions yet. Just get them all out there. It's okay if you continue to make—and say—observations as you come up with questions.

IT REMINDS ME OF

Last, say out loud everything that your object reminds you of. Allow yourself to be uninhibited in this step. Say anything that comes to mind: the object may have jarred your memory, reminding you of an experience you've had or a piece of information you already know, or the way it looks physically might remind you of something. Try looking at individual parts of the object, then back up and examine it as a whole.



REFLECTING ON THE PROCESS

Take a moment now to look at your object and think about how much you were able to learn in a short amount of time.

> "I see no more than you, but I have trained myself to notice what I see."
>
> —Sherlock Holmes

Anything you might learn or remember from this experience was made accessible by attentive, focused observation. Saying what you notice out loud forces you to focus on one thing at a time as you turn what you see into an articulated thought.

Asking questions deepens your engagement with the subject and broadens your focus to stretch beyond what you already know. This helps develop your curiosity and your ability to seek out the edges of your understanding.

Saying what you are reminded of connects what you observe in the moment to what you already know. Children often say, "It looks like…" when they encounter something they have never seen before. By placing your observations and ideas within the framework and knowledge of the world that you already carry, you will gain a stronger memory of your experience. This part of the process can also lead to scientific understanding. If the bowl of a poppy reminded you of a radar dish, perhaps there is some similar function that they share.

Use these prompts anytime you wish to know more about something in nature. Once you are familiar with each of them, you need not always use them in the same order. Often an "it reminds me of" statement will lead you to ask a question, which might prompt you to make further observations.

If you are exploring with other people, get everyone in on the act. Listen to their observations and build on or modify what you hear. The social aspect of this kind of group observation is a lot of fun, and others may make observations or have ideas you didn't think of.

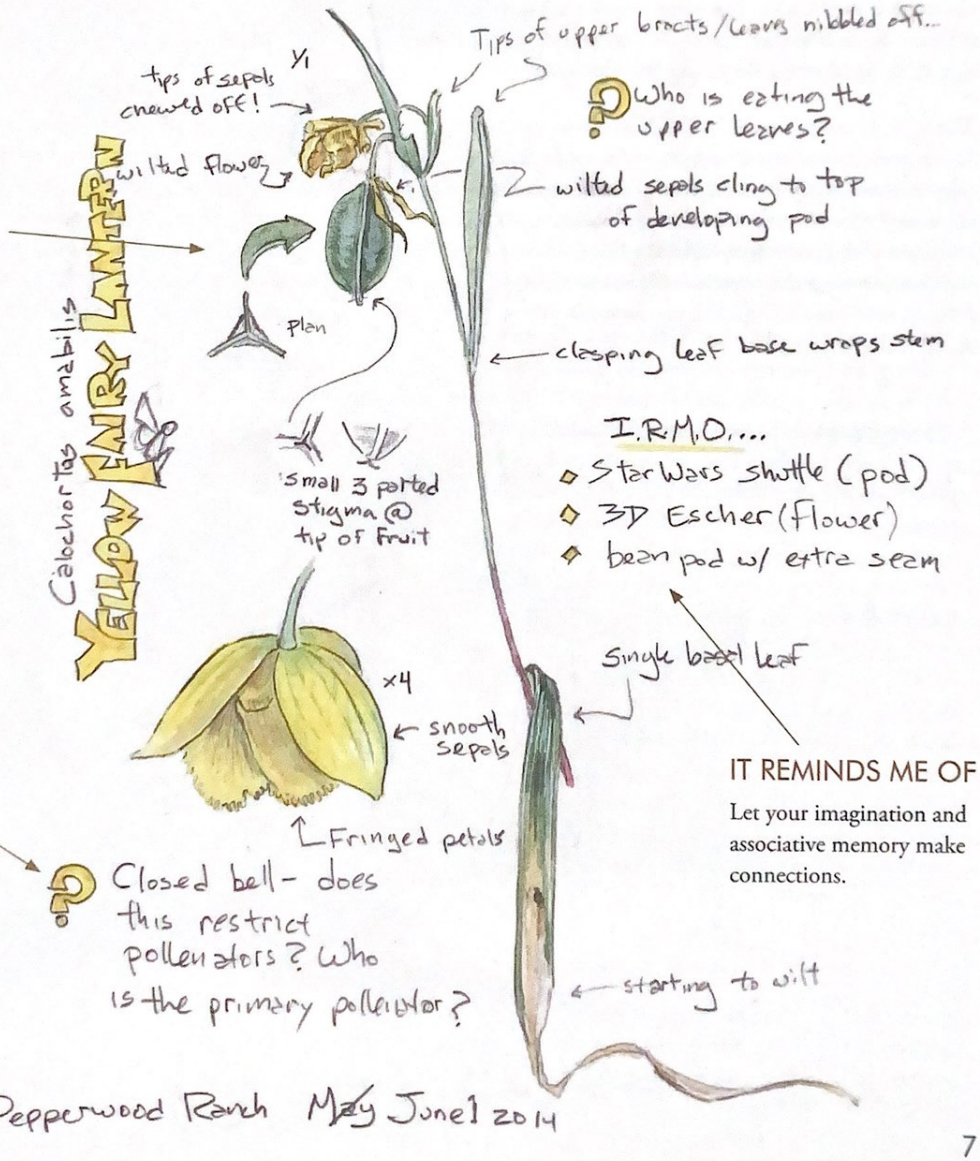
These prompts become even more powerful when you use them in your journal. Pick any subject in nature and record as much as you can. Pay attention to what it feels like to explore in this way. As you begin to intentionally and attentively observe the world around you, let yourself fall into wonder. Carry intentional curiosity and follow your questions down the path of discovery.

I NOTICE

Start with objective observations. Note how this study incorporates scale (most of it is drawn life-size and enlargements are noted) and multiple views of the seedpod structure.

I WONDER

Keep track of your questions on the page as they come to you.



IT REMINDS ME OF

Let your imagination and associative memory make connections.

INTENTIONAL CURIOSITY

You can train yourself to be more curious. Be active, bold, intentional, and playful in your questioning. Seek out mysteries and the world opens itself to you.

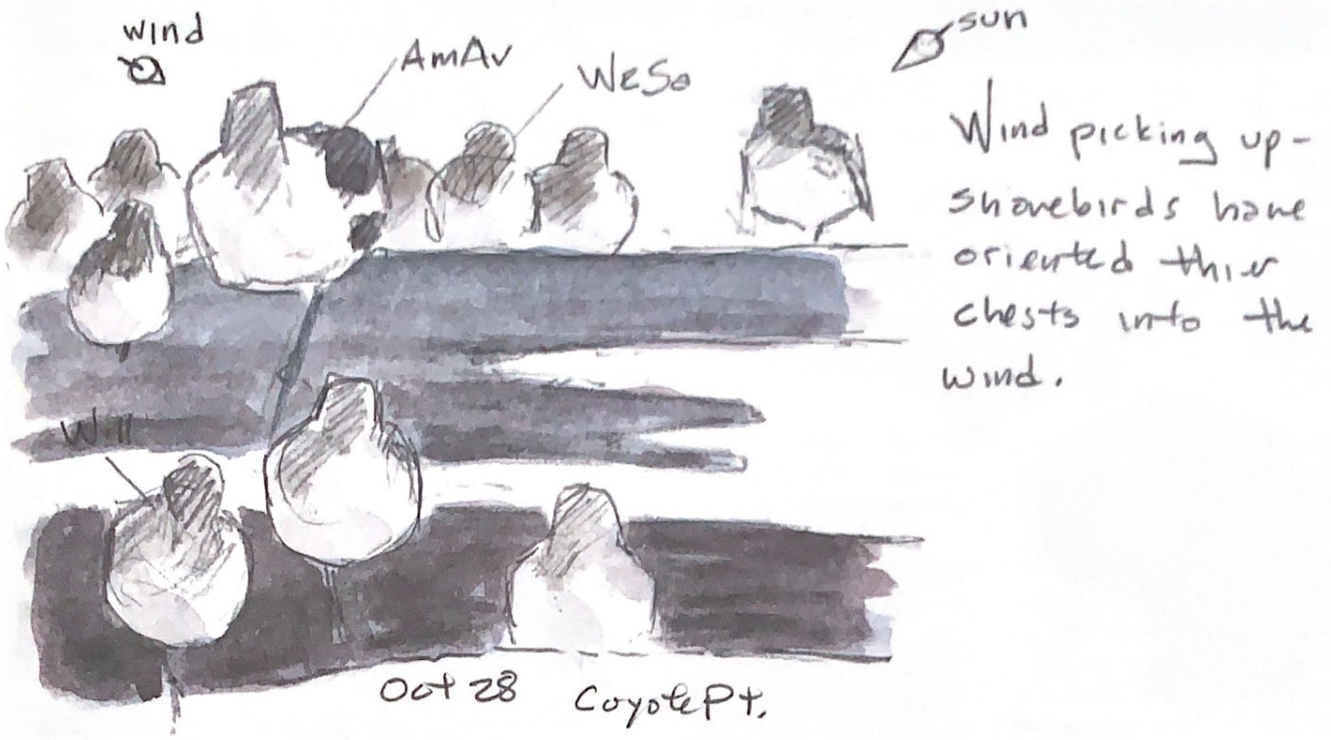
THE JOY OF CURIOSITY

There is a marsh near my house that I visit frequently to watch wildlife. On one visit, I was making observations and became interested in the directions that shorebirds face while resting. Over the course of an afternoon I watched the birds move, noting their positions relative to wind and sun. As I watched and recorded my observations, patterns began to emerge. I decided that these birds were pointing their breasts into the wind. On a subsequent afternoon I spent quality time with a group of ducks resting along the shore. I was already primed to think about sun, wind, and body direction from my previous exploration but there was something different happening here. The ducks tended to orient their breasts toward the water and their backs to the land, often with their heads turned over their backs. This pattern makes sense when I think of predator alarm response. The shorebirds take to the air at the first sign of danger, but the ducks slip into the water.

Throughout this process I felt heightened focus and awareness. The experience was one of delight and wonder. It also made me want to know more. How do ducks orient when they are away from the water's edge or when the wind really picks up? I will be heading out again with these questions in my mind. It was the process of intentionally, actively questioning that opened all of this to me. I would have missed it if I had not been playfully engaging the world with my questions.

> "The fairest thing we can experience is the mysterious. It is the fundamental emotion that stands at the cradle of true art and true science. He who does not know it and can no longer wonder, no longer feel amazement, is as good as dead, a snuffed-out candle."
>
> —Albert Einstein

Curious investigation stimulates the reward center in your brain. It triggers the release of dopamine and activates the hippocampus, a brain region involved in forming new memories. As a result, in a state of heightened curiosity you will learn more easily—and not only about what caught your attention in the first place. Surprisingly, people in intense states of curiosity are also primed to absorb unrelated information that they were not innately curious about.[3] Essentially, interest in one thing creates a curiosity vortex



that sucks up unrelated material, making it easier to assimilate and remember.

Develop your curiosity and find that the mysteries that have drifted just outside of your attention come into focus, enrich your world, and stimulate a cascade of delight and inquiry.

EMBRACING MYSTERY

We are born into curiosity, a quality that can either be developed or degraded by experience and can always be enhanced by practice. Think of curiosity as a skill that you can improve over time. You can train yourself to find rich questions hiding everywhere.

Spending time with children can be a delightful reminder of just how many questions are possible. On a walk in Muir Woods National Monument I overhead part of a conversation between a boy and an adult:

Child: "How come the redwood trees are so big?"

Adult: "They grow taller than other trees so they can get more sunlight."

Child: "Why do they need to get sunlight?"

Adult: "All plants need sunlight. They get their energy from the sun. Sun is like food for trees."

Child: "Why don't the other trees just grow taller too?"

Adult: "Because they can't."

Child: "Why?"

Adult: "Enough with the questions already."

The admonishment to stop asking questions usually happens when adults reach the boundary of their understanding. Yet we don't only do this to children: silently and unconsciously, we suppress our own internal curiosity when we run out of answers to our own questions.

Rather than step into the realm of the unknown, embrace our ignorance, genuinely wonder, and look for an answer, we ignore the questions. Perhaps it is psychologically safer to stand on known ground; in schools, students and teachers are often expected to know the answers to all questions. If a pupil doesn't have an answer, it is assumed he or she wasn't paying attention or didn't study hard enough. Now, as adults, fighting for status in social and professional situations, the vulnerability of not knowing is still a threat. In any profession, answering "I don't know" can be viewed as a weakness. Some naturalists can name every species they see. Some doctors have a prescription for every ailment. Some consultants can produce an answer for every question. There is a special word for these sorts of experts: liars. No one knows it all. This pressure to look smart and competent keeps us from publicly wondering and admitting when we do not know the answer. It can also prevent us from trying new things, being open to new ideas, or learning new skills. Being aware of the pressures that stifle our curiosity helps us to push back against them. Not knowing the answer is okay. In fact, it is where the fun begins.

ASKING QUESTIONS

Embrace your curiosity. When mysteries are given the dignity they deserve, coming up with and "dancing with" a rich and interesting question can be as pleasurable as answering one. If you can come

back from a stroll in the woods with a new and provocative question in your head, you have tapped into a rich part of being alive.

"What species is that?" is one of the first questions many people ask of nature. Identifying plants or animals is challenging and fun. Species names are useful for communicating with other people, but they can also be a trap. Many birders will stop looking once they have identified a bird. The name is not the thing. Identifying a species is only the tip of the iceberg of inquiry. It is not necessary to know something's name to ask an interesting question or make a discovery about it. Ask as many questions as you can, and don't worry if an answer seems beyond your reach at first. The process of asking questions in and of itself is important.

By asking a rich question, you engage your brain to explore more deeply and to focus on a chosen topic. A question provides structure within which to organize observations and related thoughts, and it prompts you to look for other details that are germane. Suppose that you notice that the iridescent sheen of a mallard's head shifts between purple, green, and blue. To help focus your exploration, you transform the observation into a question: "How do the colors on a mallard's head change with different light angles?" With this question in mind, you find yourself walking around a pond, observing backlit, sidelit, and frontlit ducks and watching individuals swim back and forth across your field of view. You form a giant protractor with your arms, capturing the angle between the sun and the bird from each observation spot. Time disappears as the pattern emerges in front of you. This discovery unlocks deeper questions. Do males orient themselves relative to the sun and a female in order to display a specific color? If so, do males compete for this spot? How are hummingbird display flights oriented relative to females and the sun? The next time you see a group of mallards displaying, your brain will be ready for the next step in the investigation. In this way, a question pulls you into a more sustained and focused exploration.

> "What we observe is not nature itself, but nature exposed to our method of questioning."
>
> —Werner Heisenberg

Many of the most fascinating questions in science have never been studied, and there are perhaps even more questions that have never even been asked. Challenge yourself to ask as many questions as possible. If you are struggling to come up with questions, try a couple of the following strategies to help heighten your curiosity.

MOVE FROM OBSERVATIONS TO QUESTIONS

As you make observations, see if there are any questions that pop up in relation to them. Try to focus on questions you might be able to explore in the field rather than questions like "How much does it weigh?" or "How long does it live?"

LOOK FOR PATTERNS

Practice searching for patterns as you scan the environment. Patterns are clues to mechanisms or processes at work in nature, and asking questions can be a useful way of identifying them. Imagine you encounter a flock of ducks floating in a pond. Start asking questions that would identify patterns at work: "How are they oriented?" "Are they all facing the same way?" "How does this change as the wind direction shifts?" "How close are they to each other?" "Are there any differences between the ducks at the center of the group versus those on the edges?" Looking for trends, similarities, and differences will lead you to many different questions.

USE THE SIX INTERROGATIVES

Who, what, where, when, how, and why questions are just as useful for a scientist as they are for a journalist. Use them to focus on different types of information:

1. "Who" focuses on identity and identification: "Who made this nest?" "What kind of bird is that?"

2. "What" focuses on describing events, broad trends, phenomena, behaviors: "What foraging strategies is this bird using?" "What is happening here?" "What happens when the sun comes out?"

3. "Where" focuses on location, whether local or large-scale geography: "Do I spot this species at the forest edge or deep in the woods?" "Is this bird a resident or is it migrating?" "Where is it going next?" "Where will it spend the night ?" "Is this nest hole oriented for protection from the wind or water?"

4. "When" focuses on timing: "What part of the nesting cycle are we in?" "How does the approaching winter play into what the bird is doing right now?" "How long can this cormorant hold its breath?" "How long does it take for the newt to crawl over a log? "How long do elephant seals move on land before pausing to rest?" "Does that change if they are traveling up a slope versus down a slope?"

5. "How" focuses on mechanism or process: "How do those pelicans fly so close to the water without hitting the surface?" "How do bushtits weave such delicate nests?"

6. "Why" focuses on reason or meaning: "Why are the wings tilted up like that?" "Why is that bird on such an exposed perch?" "Why is this bird singing in the middle of winter?" "Why" questions can be asked of any observation and are a good follow-up to other questions, to push inquiry deeper.

SEEKING ANSWERS

It is not necessary to answer every question you stumble upon, but if you do choose to investigate, your approach must match the type of question you have asked.

Science is a tool for studying observable experiences and phenomena—the stuff you can see, hear, taste, feel, or measure. "What causes the sea to change color near the horizon?" "How many holes are in this tree?" "What time do moths begin to fly in the evening?" "How long is this earthworm?" These questions can be explored and in some cases answered through observation and experimentation.

Some things cannot be observed, measured, or tested. "What is God?" "What is kindness?" "How do trees feel about the wind?" "Does the Gray Wolf have a soul?" These questions are outside of the realm of science. It is an important part of the human experience to consider them, and you can use disciplines like poetry, theology, and philosophy to explore them.

> "To observe and to not ask questions is to… sleep."
>
> —Todd Newberry

Some of the questions you come up with may not be answerable in the field, but they may have been asked before and studied by other people. Write these in your journal so you can look them up later. Use field guides, natural history books, and published research to identify organisms and learn basic natural history information. While I was working on *The Laws Guide to Drawing Birds* (Heyday, 2012), I was baffled by the variation of how wing feathers overlap.

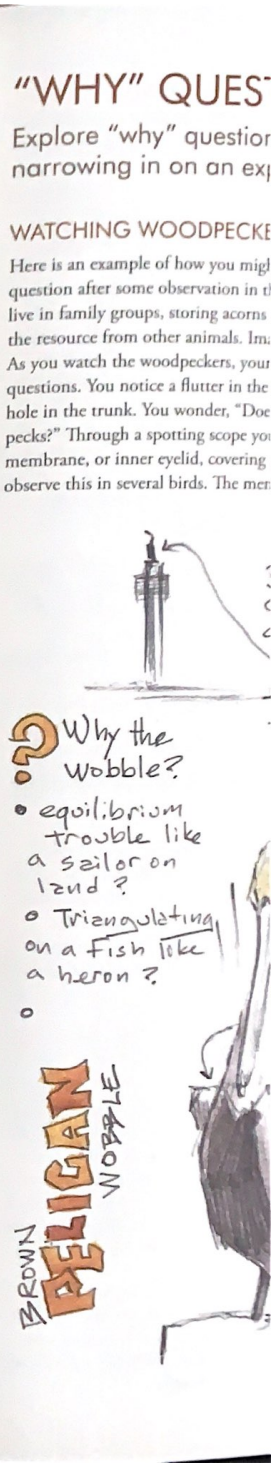
I discovered that another naturalist had extensively explored this topic—and had published the results in the *Proceedings of the Zoological Society of London* in 1886. What a delight. Not only was my question answered but I felt a kinship of curiosity with someone from over a century ago.

If your question can be addressed through observation, engage in a focused study. For example, while watching a grebe dive below the water, you might wonder how long it stays underwater and how long it stays up between dives. You can answer these questions through direct observation. Imagine another example: if you find a branch and notice that there are lots of aphids on its green leaves, you might ask, "Are there generally more aphids on green leaves or on brown leaves?" Within a few minutes of poking around you will have an answer.

If you are able to answer one of your questions, do not stop there. Use that answer as a springboard to formulate a deeper follow-up question and keep observing, or return to the same place in the future in different conditions to see if your answer to that question has changed. Keep asking deeper questions: "On the green leaves, are there more aphids on the top of the leaf or on the underside?" If that too can be answered, go even deeper. Things get really interesting when you get a few questions into an idea.

"Who," "what," "where," "when," and "how" questions may be answered by direct observation (though not always). If you cannot directly observe your subject, you may still be able to infer a possible answer by making related observations. "Why" often comes out after a few cycles of questioning. While it is easy to wonder "why" a phenomenon occurs, it is not possible to observe the answer definitively. You can, however, move toward an answer through a different approach: making explanations and investigating alternative hypotheses.

> "We cannot create observers by saying, 'observe,' but by giving them the power and the means for this observation and these means are procured through education of the senses."
>
> —Maria Montessori



"WHY" QUESTIONS: COULD IT BE?

Explore "why" questions by eliminating alternative hypotheses, systematically narrowing in on an explanation but always leaving room for further study and insight.

WATCHING WOODPECKERS

Here is an example of how you might stumble upon a "why" question after some observation in the field. Acorn Woodpeckers live in family groups, storing acorns in granary trees and protecting the resource from other animals. Imagine you see such a colony. As you watch the woodpeckers, your observations lead to questions. You notice a flutter in the eye as an individual pecks a hole in the trunk. You wonder, "Does it cover its eye each time it pecks?" Through a spotting scope you can see the pale nictitating membrane, or inner eyelid, covering the eye as the bird drills. You observe this in several birds. The membrane does not deploy all the time and seems to be associated with stronger strikes and flying woodchips. You have learned something directly from nature in this observational study.

Then you notice that there are no acorns stored at the bottom of the tree. You ask yourself, "Is this just the case on this one tree or is it a pattern?" This is another question that you can answer by direct observation. Six other trees show the same pattern. While not a large sample, it is the evidence you have at the time. Here, in this place, in this moment, it seems that Acorn Woodpeckers are avoiding the bases of the trees.

You can stop there, or you can ask why. It is possible to observe *where* the woodpeckers have drilled holes. It is not possible to observe *why* or ask the woodpeckers why. You can step closer to understanding, though, by making testable explanations, investigating them through observation and experimentation, and eliminating those that seem unlikely based on the evidence.

EXPLORING "WHY" BACKWARDS

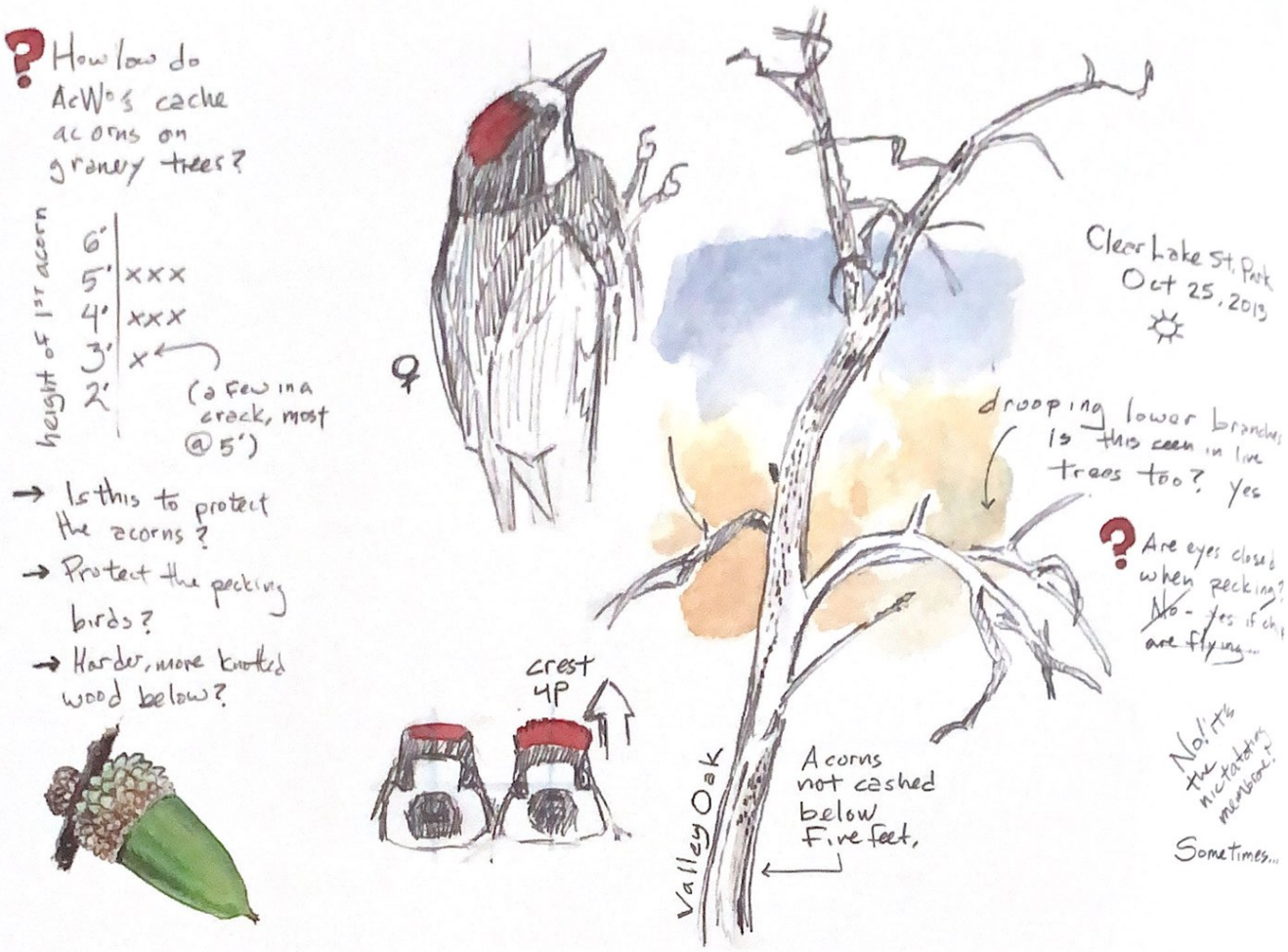
Come up with as many explanations for a phenomenon as you can, and begin each one with "Could it be that…?" Framing your thoughts in this way helps you to creatively generate ideas and hold each of them as a tentative possibility instead of latching onto the first plausible explanation that comes to mind. The result is a list of "alternative hypotheses."

While you cannot directly prove any of these hypotheses to be true, you may be able to determine that one or more is likely false. Some explanations may be easily crossed off the list. Others will be difficult or impossible to investigate with the resources you have on hand. Some explanations, such as the supernatural, cannot be tested because they involve processes or forces that are outside of the observable, physical world. These ideas may or may not be true, but regardless, science is mute on the untestable. If your intent is to explore "why" scientifically, focus on the explanations you can test through observation and investigation.

TESTING YOUR EXPLANATIONS

To test each explanation, predict what you would expect to observe should that hypothesis be fully or partly true. A useful way to phrase these predictions is "If this explanation is true, I would expect to observe…" Then poke around, explore, and see if the observations you expect are present. If what you see differs from what you expected to see, it may be possible to disconfirm that explanation or, in other words, show that it is not or might not be true.

Yet your ability to disconfirm a hypothesis is only as good as the assumptions behind your predictions. For example, one possible



explanation for the lack of acorn storage at the base of trees is that the woodpeckers might be more exposed to terrestrial predators there, so they avoid the location.

This explanation banks on the assumption that predation from terrestrial predators is significant enough that birds would avoid the area. If an assumption—like this one—is wrong, you may fool yourself into thinking you can eliminate a hypothesis. With each prediction, write down the assumptions you are making and keep them in mind so you can give each explanation a fair test.

> "I have not failed. I've just found ten thousand ways that won't work."
>
> —Thomas A. Edison

CAN YOU "PROVE" BY ELIMINATION?

Imagine that you are able to eliminate every alternative hypothesis you can think of except one. Your remaining hypothesis has withstood all of your attempts to disconfirm it: the predictions you make, based on this hypothesis, are all corroborated by observation. Have you then proved that remaining hypothesis or explanation to be true? No. Just because you cannot disconfirm a hypothesis does not make it true. It is impossible to take one explanation and prove that it is the answer. There might be another cause that correlates with the hypothesis you have explored. There could be another explanation that you have not yet considered. It is also possible that one or more of your assumptions about the basic conditions of the world were wrong.

"Proof" is a term from the world of mathematics. A mathematician can set the rules of universe—the conditions and assumptions within which a problem is solved. We do not have this luxury when studying the physical world.

When making scientific explanations, we must accept uncertainty. Given this uncertainty, how can we move forward? In the world of science, a tried and tested hypothesis that generates valid predictions can be granted provisional acceptance. That means it is good for now but can always be overturned or revised in the face of future evidence, reevaluations of underlying assumptions, or a better explanation. Though humble, this framework for problem solving is rigorous and powerful, and it has resulted in most of the advances in science and technology that we have today.

We can never truly answer "why," but this step-by-step process of learning what does not work brings us closer to inferring what does. Exploring questions in this way is a playful, creative, and stimulating process. Framing this process in your journal will help you to organize and remember your thoughts.

CASE STUDY: ASKING AN EGRET "WHY"

Let's look at an example of how you could explore a "why" question in your journal in the field. There are three steps: formulating alternative hypotheses, making predictions, and testing your predictions.

On a trip to Elkhorn Slough, my companions and I found over forty egrets and herons crowded at one end of a narrow island. The flock included Great Egrets, Snowy Egrets, Great Blue Herons, and one Sandhill Crane (a rarity in the area). We wondered why they were so concentrated in this location.

1 Create a list of possible explanations, or alternate hypotheses. This will likely be an incomplete list, as there may be some other hypotheses that you have not thought of. Here are some hypotheses we came up with. Can you think of others?

- Food may be more available (easier to catch or more abundant) at the end of the island.
- The food there may be of higher quality.
- These types of birds regularly flock together so a cluster of egrets just attracts more birds.
- That end of the island is higher and the birds have retreated there to avoid the high tide.
- Something else we did not think of…

2 Some hypotheses give rise to observable or testable predictions. "If this hypothesis is true, I would expect to see…" Testable predictions can be checked against real-world observations. If a hypothesis cannot generate testable predictions, it cannot be explored scientifically.

Here are two testable predictions that arise from the hypothesis that the birds are congregating at that end of the island because food is more available there, along with assumptions about the set of conditions that would make that explanation plausible.

- The birds at the end of the island would be feeding. (This assumes the birds had not already fed.)
- Feeding birds would strike at prey more frequently than birds feeding elsewhere. (Assumes strike frequency correlates with prey availability.)

3 Test the predictions. We observed that most of the birds at the end of the island were not feeding. Those that were did not make more strikes per minute than birds feeding in other areas. The fact that the observations we made did not line up with our predictions suggests that the food availability hypothesis is not the best explanation—that is, if our underlying assumptions were correct.

We explored the other hypotheses and we were able to disconfirm a few. Our observations supported the high-tide hypothesis, but it relied on unproven assumptions. While we did not find an answer to why the birds were congregated at the end of the island, we had a rich and enjoyable experience exploring the question. We also made observations we never would have made had we not asked "why."