ENVS 15 – Natural History of the UCSC Campus

Class time and location: Tuesdays 8:30am-12:30pm (*Thurs, July 6th instead of Tues, July 4th), Nat. Sciences 2 229
Instructor: Alex Jones
Email: asjones@ucsc.edu Phone: (831) 334-0515
Class Webpage: eCommons ENVS 15 Summer 2017
https://ecommons.ucsc.edu/portal/site/c27236c2-d031-40fe-84c7-f8ff352f34a9
Office Hours: Tuesdays 12:30-1:30 pm or by appointment in Nat Sci 2 room 463

Course Description:
This course will address different aspects of the natural history (geology, ecology, plants, animals, human history) of this amazing campus. By practicing skills of observation and awareness, this course aims to further develop your ability to learn about the natural history of any place as well as to further develop your appreciation and respect for the natural world.

"Those who contemplate the beauty of the earth find reserves of strength that will endure as long as life lasts. There is something infinitely healing in the repeated refrains of nature -- the assurance that dawn comes after night, and spring after winter."

(All quotes by Rachel Carson)

"Those who dwell, as scientists or laymen, among the beauties and mysteries of the earth, are never alone or weary of life."

"One way to open your eyes is to ask yourself, "What if I had never seen this before? What if I knew I would never see it again?"

Grading/Evaluations:

- **50% Attendance and participation**. We go out EVERY WEEK, rain (ha!) or shine.
- **40% Field Journal Assignments and Final Project.** Each week I will give you four field assignments that will take ~4 hours and are intended to help develop your observation skills.
- **10% Quizzes.** Identification, theory, questions on the reading, species we've seen in class. Weeks 2-5.

Course Materials: (Bring these with you every week)

- ***The Natural History of the UC Santa Cruz Campus***: 2008; 2nd ed. edited by Haff, Brown, and Tyler, for sale at the Baytree Bookstore and on reserve at the Science Library. Though I've listed this as "recommended", you should really read it; it's great. Expect (at least extra-credit) quiz questions based on the reading and be prepared to discuss. Did I mention that it's great?
- **One field guide**: Choose one from a list attached to this syllabus; borrowing from the/a library is fine.
- **Small notepad**: For taking notes during class.
- **Field journal and pen/pencil**: Though the best are stitched or hard bound and smaller than standard paper, (but not too small, as tiny notebooks are difficult to draw & press plants in), please pick one where you can tear out the pages because you'll be turning them in for you weekly journal assignment.
- **A hand-lens/loupe**: Can be purchased from Bay Tree Bookstore—ask to purchase one at the register; ~$8.
- **Binoculars**: Highly recommended. The UCSC Ken Norris Center may have a few pairs for loan—come see me after class. You will need a pair when we go birding. Please beg to borrow them if you can't buy a pair. If you're interested in purchasing a pair, www.eagleoptics.com has great ones.
- **Backpack**: To put all this stuff into.

You will need for ALL class meetings:

- **Appropriate clothing, food/water, etc.:**
  - Dress warmly and in layers and be prepared for all kinds of conditions.
  - Wear comfortable walking/hiking shoes---closed-toed, no sandals.
  - Bring snacks and water if you tend to get hungry/thirsty.
  - Be prepared for poison oak and insects – we will be off trail often.
  - Camouflage: Earth tones are best; shoes that allow you to walk quietly.
- **Jungle Etiquette:**
  - "Be here now": avoid talking about people or events that are not here and now. Talk quietly if you must and remember that silence is sacred.
  - I have no patience for cell phones (texting, etc. during class), though they are fine to use for photos.
  - Following jungle etiquette has its rewards

DEETS

- **Weekly class time:** We will spend the majority of class time exploring various parts of our wild campus, including the southern, core, and northern areas. Time in the field will focus on direct observation and interpretation of various elements and organisms within the natural world. Expect a mix of focused group and individual activities as well as ample time for exploration. We will likely move slowly as we settle into Mountain Time. We will name things. We won't be satisfied with just naming things—we will want to move past mere introductions and get to know the lives and stories around us. We'll inquire about what we're seeing, hearing, smelling, touching, and tasting. We will start each class at either our regular Norris Center classroom in Natural Sciences 2 room 229 or alternative sites listed in the syllabus. These will be announced in class the week prior and also posted as an announcement on eCommons. Class will usually begin with announcements and sometimes a short lecture and quiz. Quizzes may also happen in the field during class or near the end of class time. Each week we'll wrap up with a reminder about the week's journal and reading assignments. I think we'll enjoy all this.

- **Field Journal Exercises:** These assignments are designed to allow you ample time with a specific place on campus—a place you'll adopt as your own (or that will adopt you), a place, or spot, you'll sit on: Your sit spot. By the end of the Quarter this one location, and please don't stress about finding the perfect site, will prove to you that you can learn an incredible amount about the world (and about yourself) by looking closely at what's going on in one (in any) spot. Weekly assignments will have you focus on a different aspect of your sit spot, including its topography; its vegetation; its animal inhabitants; its trails big and small, faint and worn; and will ask you to stretch your awareness and to question, question, question. Pictures (drawings, etc.) say a thousand words. A thousand words say a thousand words. Most entries will be less than a thousand words. Lose yourself in your place, in your writing, sketching, documenting and speculating, come-to hours (2, or more if you fall asleep) later, look forward to the next time. Weekly journal assignments will be posted on eCommons in the Field Journal Assignments folder within the main Resources and Assignments folder. Please read the descriptions of the upcoming assignments at the start of each week so you can make a plan for how you'll complete the field journal assignments on time.

- **Quizzes:** Weekly quizzes, beginning in Week 2, will allow us to review and reckon with the in-class observations we'll be making. Quizzes will be cumulative in content—for example, a quiz during Week 5 could cover species and habitats we've seen in the field during Weeks 1-4. These quizzes are not designed to destroy you. These quizzes will allow you to practice the names of things. They will include extra credit questions that will encourage you to do the readings (which are great, and from which you'll learn quite a bit). The quizzes will encourage you to pay close attention to the world around you, if you're into that whole external motivation thing. They might even be enjoyable. Be present in class, take your learning seriously, read the book, and your performance on the quizzes will merely demonstrate your level of interest and your desire to learn more about the world around you.

- **Readings:** Your textbook, *Natural History of the UC Santa Cruz Campus* (Haff et al. 2008), is great. The fact that it exists for a college campus—your college campus—is incredible, and is a genuine testament to all there is to discover daily as you walk from class to class to dorm to dining hall to meadow to forest to class to Wilder Ranch to the ocean and back to class. Weekly readings will prepare you for the next week's class topic and will hopefully get you excited to learn more. I call these readings "recommended"---you will not be quizzed on their content beyond the joy of extra credit questions. I do this only because Summer Session is so short, and I want to maximize the time you spend in the field at your sit spot doing your Field Journal Exercises. There also may be occasional supplemental readings, such as peer-reviewed literature, species or group-specific terminology/diagram sheets, poetry, whatnot. These supplemental readings will be posted on eCommons and announced in class.

- **Final Project:** This will be something you work on as part of your field journal assignments for the last couple weeks of the session. Essentially you will be creating field guide content (a page or several pages) for a species or small object that you're readily able to observe at your sit spot—something that won't scamper, scurry, bolt, disappear, go subterranean or stratospheric after you look at it for a moment; something that you can really get to know first-hand. We will compile all our field guide pages into a single class field guide that will be available in pdf form at the inevitable end. More details to come, in class and on eCommons. **Due by 5 pm on Friday, July 28th. Scan and email to Alex at asjones@ucsc.edu**

- **Resources:** We have many. The Ken Norris Center for Natural History has its collections, as well as a library of field guides to consult. I will post other resources on eCommons and feel free to come ask me for more.

- **You:** This class is not a blow-off. It is demanding. The more you show up, and I do mean Show Up, the more you will get out of this class, and the less bored you will be for the rest of your life. Bold statement. Not a joke.

WEEKLY SCHEDULE & ASSIGNMENTS

Week 1: 6/27 Introduction to Natural History/Field Journaling/Geology and Topography of Campus
Meeting time: 8:30 am-12:30 pm
Place: NS2 229
Quiz: NONE
Due at beginning of class: NOTHING
Lecture: Intro to class, logistics; field journaling, geology
Field Trip: Limekilns, sinkholes, and outcrops
HW:

Field journal exercises: #1, #2, #3, #4, #5
Recommended Reading Assignment: Chap 1 Human History pp. 1-32; Chap 2 Geology 37-48; 71-89; Chap 3 Plants 110-131; Plant parts and families handouts (see Resources folder in eCommons)
Study for QUIZ: Week 1 class + Week 1 species list (if applicable)

Week 2: 7/6 (*Note that this is a Thursday, not a Tuesday) Plants/Human History**
Meeting time: 8:30 am-12:30 pm
Place: NS2 229
Quiz: Week 1 class + Week 1 species list
Due at beginning of class: Field Journal Exercise #1, #2, #3, #4, #5
Field Trip: Upper Campus
HW:

Field journal exercise: #6, #7, #8
Recommended Reading Assignment: Chap 7 Amphibians: 199-218; Chap 8 Reptiles: 223-239; Chap 6 Invertebrates: 179-195
Study for QUIZ: Week 2 class + Week 1-2 species list

Week 3: 7/11 Reptiles and Amphibians/Invertebrates (*NOTE CHANGE OF MEETING LOCATION*)
Meeting time: 8:30 am-12:30 pm
Place: Porter Squiggle
Quiz: Week 2 class + Species list 1-2
Due at beginning of class: Field Journal Exercises #6, #7, #8
Field Trip: Cave Gulch and Mima Meadow
HW:

Field journal exercises: #9, #10, #11, #12
Recommended Reading Assignment: Chap 10 Mammals: 278-310
Study for QUIZ: Week 3 class + Week 1-3 species list

Week 4: 7/18 Mammals/Landscape Tracking
Meeting time: 8:30 am-12:30 pm
Place: NS2 229
Quiz: Week 3 class + Week 1-3 species list
Due at beginning of class: Field Journal Exercise #9, #10, #11, #12
Norris Center Lab: Mammal specimens; functional morphology
Field Trip: Mammal sign on campus—locations TBD
HW:

Field journal exercises: #13, #14 + Final Project
Recommended Reading Assignment: Chap 9 Birds: 242-269
Study for QUIZ: Week 4 class + Week 1-4 species list

Week 5: 7/25 Birds/Synthesis and Reflection (*NOTE CHANGE OF MEETING LOCATION*)
Meeting time: 8:30 am-12:30 pm
Place: UCSC Arboretum—main back gate (see map in eCommons Resources folder)
Quiz: Week 1-4 class + Week 1-4 species list
Due at beginning of class: Field Journal Exercises #13, #14
Field Trip: Arboretum and Lower Moore Creek
HW: KEEP GOING OUTSIDE!

******Final Project due by 5 pm on Friday, July 28th: scanned and email to Alex at asjones@ucsc.edu******

Official Summer Session and Support biz

Support resources
Disabilities Resource Center (**drc.ucsc.edu**) and Learning Support Services (**www2.ucsc.edu/lss**) and CAPS (Counseling and Psychological Services; **caps.ucsc.edu**) are open and active all summer.

Summer Session Students with Disabilities
If you qualify for classroom accommodations because of a disability, please submit your Accommodation Authorization Letter from the Disability Resource Center (DRC) to me as soon as possible, preferably within the first week of the Summer Session. Contact DRC by phone at **831-459-2089** or by email at **drc@ucsc.edu** for more information.

Important dates
For all important Summer Session dates, see the Summer Calendar (http://summer.ucsc.edu/calendar/calendar-spreadsheet.html). Here are three important dates, the first two I hope you don't need:
Add Deadline—Thursday, June 29th
Drop Deadline (refund) – Monday, July 3rd
Withdraw Deadline (no refund) —Friday, July 14th
Deadline to Change Your Grading Option—Friday, July 7th
Grades posted—Thursday, August 3rd

Academic advising
Academic advising is offered all summer; hours will vary by college. Contact your college to find out when advising is being offered or visiting **advising.ucsc.edu**.

Online Instructor Evaluations
*****You will get +0.5% on your final grade for completing an online evaluation*****

ENVS 15: Summer 2017 Field Journal guidelines

As described in the beginning of the syllabus, your field journal is a vital piece of your academic evaluation. More importantly, if you discipline yourself to generate thorough, organized entries using the format that is detailed below, your journal/notebook for this class will be MUCH more useful to you after this class is long over. You should use a spiral bound notebook with perforated edges so you can rip pages out—if you have some other kind of notebook that you can easily tear pages from, that's fine too. EVERY WEEK, you will rip out and turn in your newly completed journals at the start of class. The following week, I will give them back to you and collect a new set.

Proper Journal Format: The Grinnell Style

For all entries in your field journal/class notebook, you will use a format developed by Joseph Grinnell, a biologist who founded UC Berkeley's Museum of Vertebrate Zoology in the early 1900s. His philosophy, which has been adopted by thousands of field scientists today, was that field notes were mainly for the use of *others* and so a standard format was necessary to facilitate fast retrieval of information. Although few others will probably refer to your notes for this particular class, one very important other will: your *future self*. **In order for your notes to be of maximum use to even yourself, it is of paramount importance to include the *context* of any notes or journal entries you make.** Context covers a broad set of things, such as the date, your location, your name, and the objective of your entry. But context can also include descriptions of the terrain around you, the weather conditions, and the time of day. It may even include your own summary reflections after witnessing an event in nature, or after completing a reading or having a discussion in class.

Some general journal guidelines.

- Your heading (name/date/location) needs to be written atop **EVERY** new page for multiple page entries. This is the most often overlooked part of keeping good field notes. Try to develop this habit right away. I will remind you of this and ultimately I will deduct points from your journal if you don't keep this habit up.
- Don't forget to state the journal entry's context at the start of each entry (see below)
- Record the date in your journal in an unambiguous way by writing it like this: **3 Apr 2012** (day followed by the three-letter abbreviation for month and a four-digit year). Avoid writing dates like 4/3/12 (in some places this would be interpreted as March 4, not April 3, so please get in the habit of writing dates as described above).

Observing in the field—the process

Step 1. Slow down, make yourself comfortable, and be patient—the longer you observe, the more detail you see. Focus outward, set aside your preconceptions, and see things as they are rather than how you expect them to be. Unless you are setting out to focus at a particular scale, allow yourself to scan at a variety of scales—from the few square inches of soil at your feet to the entire visible landscape.

Step 2. Observe, describe, and record. Use words, sketches, and maps to produce a snapshot of the ecological story in front of you. Be as *specific*, *descriptive*, and *detailed* as possible. Be patient; it takes practice to balance the looking and the writing.

Step 3. Try to interpret what you see. Don't speculate wildly, but instead ask questions based on what you see. Then, look back, consider possible answers, or "spin the wheel"—that is, look for different ways to ask questions that can be answered through further observation.

Recording field observations

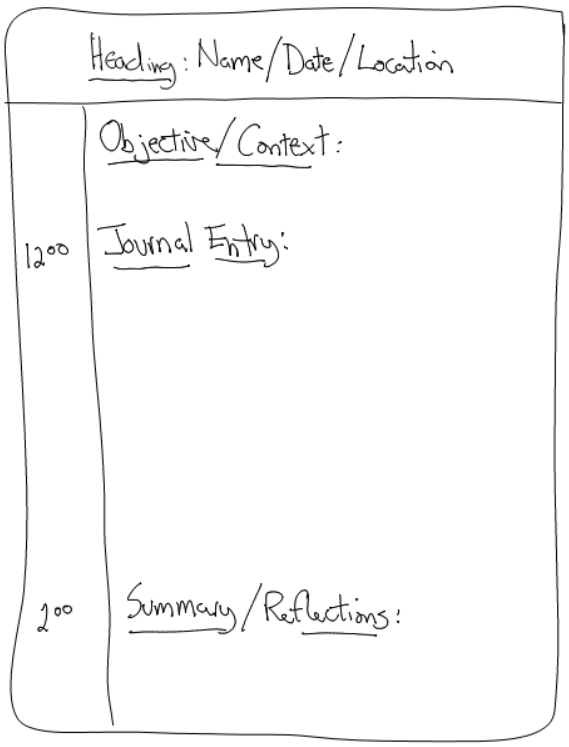
It is essential to learn to keep clear and accurate records to ensure that your observations have lasting value.

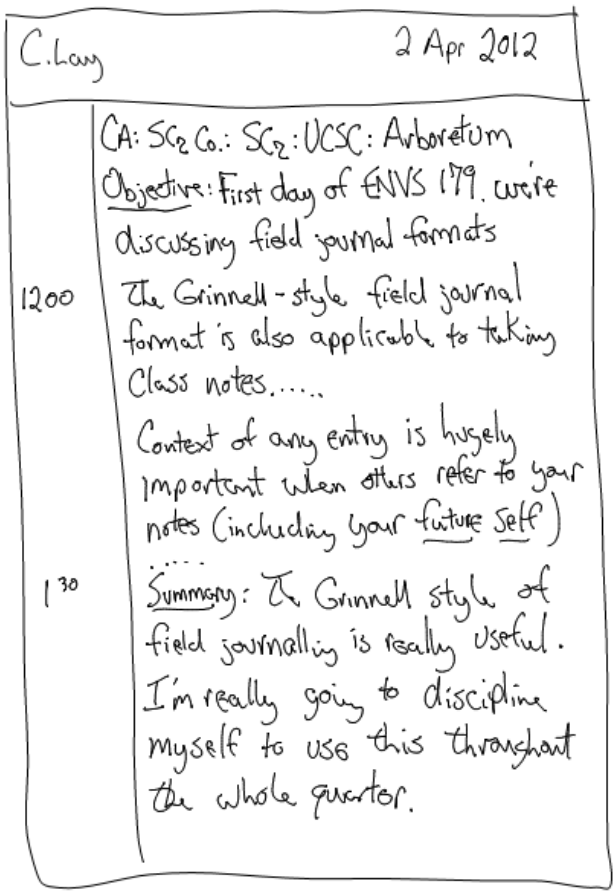
Style. It is best to record your field observations first hand, while the subjects are there in front of you. Write in present tense to capture the action as it happens. Use complete sentences or at least complete thoughts; random fragments and phrases are hard to understand later. Minimize use of abbreviations and explain those that you use. The bottom line is: be concise but complete and clear, so that anyone can read and understand what you write. While it is okay, in the context of this class, to include personal reflections on your observations, try to remember that this isn't a diary---focus on looking outward. Finally, all entries must be in dark, waterproof ink and do your best to write legibly!

Content. A complete field observation record includes some or all of the following elements:

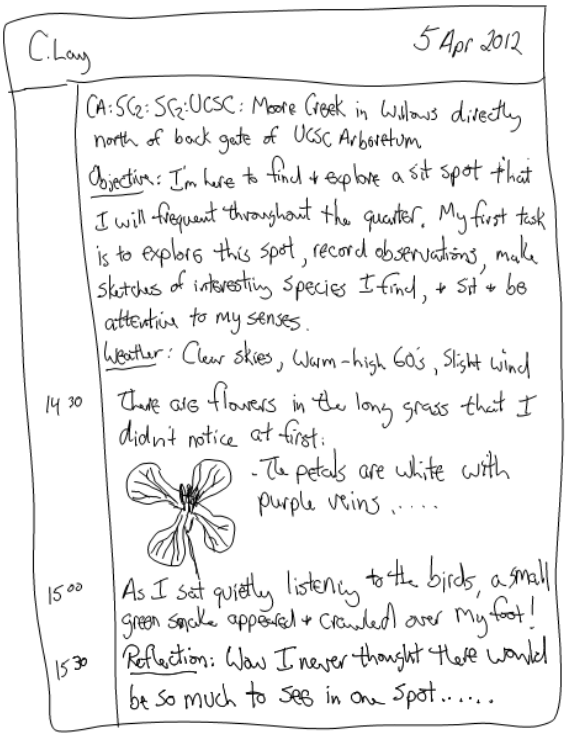
1. <u>Heading</u>
   At the top of each page record the date, location, page number, and your name.
2. <u>Description of the context</u>
   What are you about to do? What are your objectives and your methods?
   At what *scale* are you observing (landscape, stand, organism, single flower)?
   When are you observing?
   Where are you observing? (Use words, maps...)
   What are the conditions (sky, weather, wind, tide)?
   What is the terrain (slope, vegetation, soil, aspect)?
3. <u>The observations themselves</u>
   Who is there? Describe and/or identify the species, genders, ages, etc.
   How many? Count or estimate the relative numbers or population size.
   How are the organisms distributed with respect to habitats & other organisms?
   What are they doing? Describe the behaviors.
4. <u>Summary and reflections</u>
   What patterns did you notice? What are the possible reasons for these patterns? What questions might you try to answer next time?

Here is a sample generic journal page depicting the basic Grinnellian format as applied to this class





Here is a specific example of how to use Grinnell style for your class notes



Here is a specific example of how to use Grinnell style for your Field Journal Exercises; this example is much shorter and provides much less detailed information than your journals hopefully will.

<u>The Core Routines of a Naturalist</u> –modified from *Coyote's Guide to Connecting with Nature*, by Jon Young, Ellen Haas, Evan McGown

- **Befriend one place**. Find a "sit spot" in the natural world that you visit all the time and get to know it as you would your best friend. Let this be a place where you sit still, alone and quiet and attentive to the world of nature around you.
- **Share your stories with your community**. After spending time in nature, tell your story to others, or by writing or drawing in a journal. Sharing your stories recreates your experience in your "mind's eye". You may often remember more of your experience as you tell it. You will motivate others with your stories as well as be motivated by their stories. A tradition of story sharing will inspire you further along your naturalist path.
- **Use and expand all your senses as fully as you can**. Pay attention. Practice the sense meditation—powerfully use your imagination to envision that you have the eyes of an owl, the ears of the deer, the nose of a coyote, the hands of a raccoon. Quiet your thoughts and come to your senses.
- **Be a detective and track everything as a clue to a mystery to be solved**. Ask questions about everything, and push your questions until they yield answers. Like a good scientist, gather evidence, develop hypotheses, test them, refine them…
- **Wander through the landscape without time, destination or agenda**. Be in the present moment. Let curiosity lead you off the beaten path. It is there where you will make many new discoveries that expand your awareness.
- **Draw maps—orient yourself to the compass directions, and use your mind's eye to perceive the landscape from a bird's eye view**. Draw maps to locate features of your landscape.
- **Explore Field guides and other reference material**. Go home with questions and use resources to feed your curiosity. Treat field guides as elders, as they are the amalgamation of many great naturalists and their hard work. They are treasure chests of knowledge and experience.
- **Journal your experience**. Keep a regular record, in drawings and in words, of your experience outdoors. Keep sketches, maps, captions, stories that describe your landscape. Keep it up through all the seasons until it is a habit you can't live without.
- **Listen to the birds**. Notice the vocal signals and body language of birds and other animals, including humans. Every time an animal (including us) moves in the forest, it is like dropping a pebble into the clear surface of a pond. Concentric rings of disturbance go out. It is often birds that react to these concentric rings. They often give us immediate feedback about the whereabouts of other animals as well as our own attitudes and body language.
- **Be thankful**. Find in yourself a grateful heart and express gratitude for any and all aspects of nature and life. Begin any interaction with your world with thanksgiving. See what happens.

(A Few) Recommended Field Guides (don't get me started)

Geology/Weather:

- Alt, D D. and D.W. Hyndman. 2000. *Roadside Geology of Northern and Central California*. Mountain Press Publishing Company.
- Pough, F. 1998. *Peterson Field Guide to Rocks and Minerals.* Houghton Mifflin Company, Boston.
- Day, J.A. and V. Schaefer. 1998. *Peterson Field Guide to the Atmosphere.* Houghton Mifflin Company, Boston.

Plants:

- Lyons, K., M.B. Cooney-Lazaneo, and H. King. 1988. *Plants of the Coast Redwood Region.* Looking Press, Boulder Creek, CA.
  - Outdated nomenclature and incomplete, but a great introductory guide to local and northern CA flora.
- Collins, S.J. 2013. *Flora of the UC Santa Cruz Campus.* UCSC Natural Reserves.
  - Great little guide to common campus plants produced as an internship project; updated nomenclature. Download a pdf copy from eCommons.
- Baldwin, B.G., D.H. Goldman, D.J. Keil, and R. Patterson. 2012. *The Jepson Manual: Vascular Plants of California* 2nd edition. UC Press, Berkeley.
  - This is the ultimate reference for CA plants. It is large and in charge. And heavy. And the best.
- Martin, A.C., H.S. Zim, and R. Freund. 2001. *Wildflowers (Golden Guide).* St. Martin's Press, New York.
  - Good, colorful, introductory guide to common North American wildflowers. Not comprehensive and nomenclature outdated.

There area also several great mini-guides (4"x6") by the Nature Study Guild: The Redwood Flower Finder, The Fern Finder, and The Pacific Tree Finder, for example. See http://www.naturestudy.com/pcfinders.html.

Fungi & Lichens:

- Arora, D. 1986. *Mushrooms Demystified.* 10 Speed Press, Berkeley, CA.
- Arora, D. 1991. *All that the rain promises, and more*. 10 Speed Press, Berkeley, CA.
- Brodo, I., S.D. Sharnoff, and S. Sharnoff. 2001. *Lichens of North America.* Yale University Press, New Haven, CT.

Invertebrates:

- Borrer, D.J. and R.E. White. 1998. *Peterson Field Guide to Insects*, 2nd ed. Houghton Mifflin Company, Boston.
- Kaufman, K. and E. Eaton. 2007. *Field Guide to Insects of North America.* Houghton Mifflin Company, Boston.
- Glassberg, J.. 2001. *Butterflies though Binoculars: The West*. Oxford University Press, NY.
- Biggs, K. and R. Bruun. 2009. *Common Dragonflies of California* 2nd ed. Azalea Creek Publishing, Sebastopol, CA.
- Powell, J.A. and C.L. Hogue. 1980. *California Insects*. UC Press, Berkeley.

Herps:

- Stebbins, R.C. 2003. *Peterson Field Guide to Western Reptiles and Amphibians* 3rd ed. Houghton Mifflin Company, Boston. [Make sure you get the 3rd edition!]

Birds:

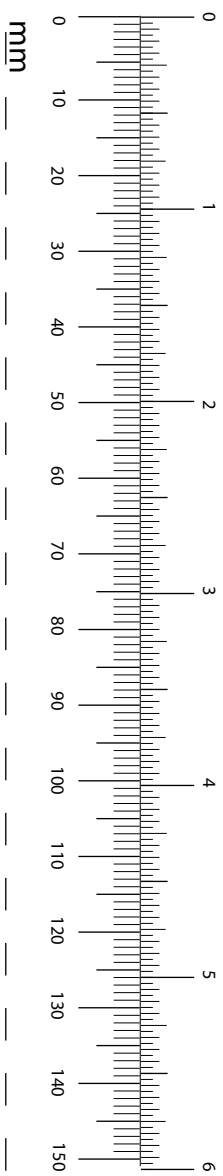
- Dunn, J.L. and J. Alderfer. 2011. *National Geographic Field Guide to the Birds of North America* 6th ed. National Geographic, Washington, D.C.
- Sibley, D. A. 200. *The Sibley Guide to Birds*, 1st ed. Alfred A. Knopf, New York.
  - Make sure to get 1st edition—2nd edition's first printing run has some major problems with color and text.
- Jacobs-Schwartz, B. 2016. *Field Guide to Bird of UC Santa Cruz.* UCSC Natural Reserves, Santa Cruz, CA.
- Crossley, R., J. Liguori, and B. Sullivan. 2013. *The Crossley ID Guide: Raptors*. Princeton University Press, Princeton.
- Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. *The Birder's Handbook*. Simon and Schuster, New York.
  - Not an identification guide, but chock full of excellent natural history information and essays on a huge range of topics.

Mammals:

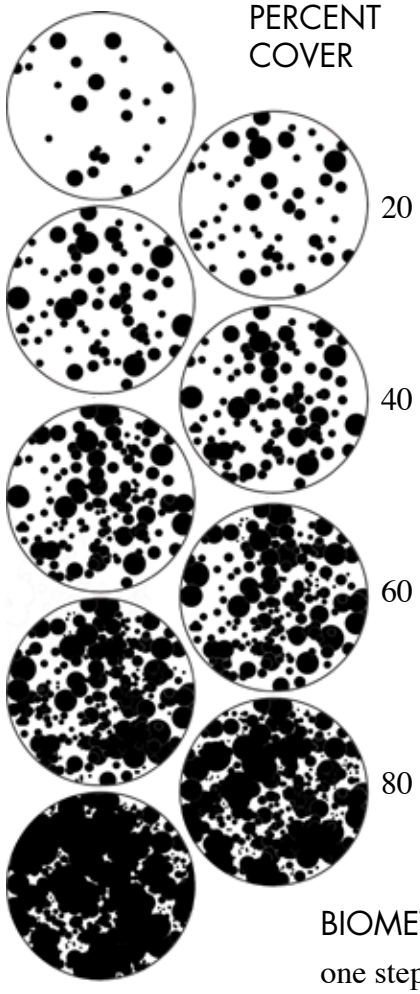
- Reid, F.A.. 2006. *Peterson Field Guide to Mammals of North America* 4th ed. Houghton Mifflin Company, Boston.
- Elbroch, M. 2003. *Mammal Tracks and Sign: A guide to North American species.* Stackpole Books, PA.
- Ingles, L.G. 1990. *Mammals of the Pacific States: California, Oregon, Washington*. Stanford University Press, Palo Alto, CA.
- Murie, O.J. and M. Elbroch 2005. *Peterson Field Guide to Animal Tracks* 3rd ed. Houghton Mifflin Harcourt, Boston.
- Russo, R. and P. Olhausen. 1987. *Pacific Coast Mammals: A Guide to Mammals of the Pacific Coast States, Their Tracks, Skulls and Other Signs*. Nature Study Guild, Berkeley, CA.

Spiders

- Hash, M. 2016. *Field Guide to Spiders of UC Santa Cruz*, 2nd ed. UCSC Natural Reserves, Santa Cruz, CA.
- Ubick, D., P. Paquin, P. Cushing, and V. Roth. 2005. *Spiders of North America: an identification manual.* American Arachnological Society, Keene, NH.
- Adams, R.J. 2014. *Field Guide to the Spiders of California and the Pacific Coast States.* University of California Press, Oakland.

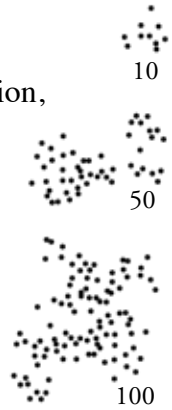


PERCENT COVER



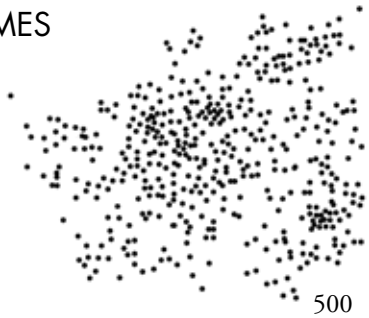
JOURNAL ELEMENTS

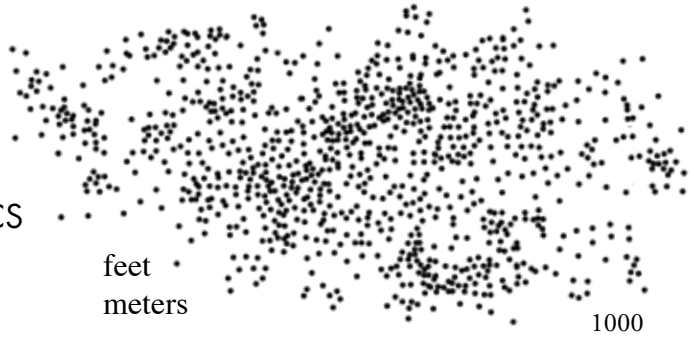
Metadata: date, location, weather
Objective observation: writing, illustration, diagram, blueprint (plan/elevation)
Personal insight: diary, poetry, art
Questions (I wonder, could it be)
Connections (it reminds me of)
Quantification & scale: estimate, count, measure (1/1, x3)
Lists



INVESTIGATION FRAMES

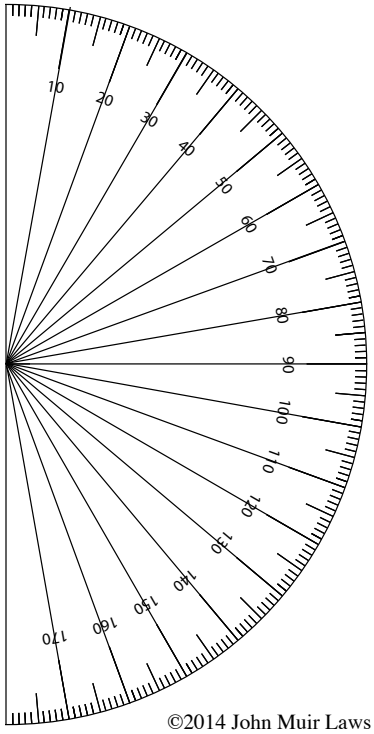
Individual-species acct.
Zoom in, Zoom out
Behavior storyboard
Comparison
Collection
Timeline
Mapping





BIOMETRICS

one step = feet
one step = meters



BEAUFORT WIND SCALE

0 Calm <1 mph (< 1 km/h) Smoke rises vertically. Flat, glassy water.

1 Light air 1–3 mph (1.1–5.5 km/h) Smoke drift indicates wind direction. Leaves and wind vanes are stationary. Ripples without crests.

2 Light breeze 4–7 mph (5.6–11 km/h) Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move. Small wavelets. Crests have glassy appearance, not breaking.

3 Gentle breeze 8–12 mph (12–19 km/h) Leaves and small twigs constantly moving, light flags extended. Large wavelets. Crests begin to break; scattered whitecaps.

4 Moderate breeze 13–17 mph (20–28 km/h) Fairly frequent whitecaps. Dust and loose paper raised. Small branches begin to move. Small waves with breaking crests.

5 Fresh breeze 18–24 mph (29–38 km/h) Branches of a moderate size move. Small trees in leaf begin to sway. Moderate waves of some length. Many whitecaps. Small amounts of spray.

6 Strong breeze 25–30 mph (39–49 km/h) Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over. Long waves begin to form. White foam crests are very frequent. Some airborne spray is present.

7 High wind, moderate gale, near gale 31–38 mph (50–61 km/h) Whole trees in motion. Effort needed to walk against the wind. Sea heaps up. Some foam from breaking waves is blown into streaks along wind direction. Moderate amounts of airborne spray.

8 Gale 39–46 mph (62–74 km/h) Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded. Moderately high waves with breaking crests forming spindrift. Well-marked streaks of foam are blown along wind direction. Considerable airborne spray.

9 Strong gale 47–54 mph (75–88 km/h) Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. High waves whose crests sometimes roll over. Dense foam is blown along wind direction. Large amounts of airborne spray may begin to reduce visibility.

10 Storm, whole gale 55–63 mph (89–102 km/h) Trees are broken off or uprooted, structural damage likely. Very high waves with overhanging crests. Large patches of foam from wave crests give the sea a white appearance. Considerable tumbling of waves with heavy impact. Large amounts of airborne spray reduce visibility.

©2014 John Muir Laws