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Purpose:

To introduce the basics of identifying California fishes using a key. Keying is a detail-oriented task, essential for any organismal biologist. It requires you to follow instructions carefully and explicitly. Pay great attention to detail and use the resources available (see the end of this handout). Almost every aspect of fisheries biology starts with the premise that you can and have correctly identified a specimen in hand.

When keying fishes, I am not as concerned with you getting the right answer as I am with why you got your answer. In other words, knowing that a given body is a green sunfish is of relatively little value: being able to properly identify any green sunfish that you encounter, using a key, is of much greater value.

Being able to key rapidly and with 100% accuracy is a valuable and marketable skill.

Introduction:

One of the most common problems facing any field-oriented biologist is that of identifying a specimen. Imagine you go fishing and you catch a fish. What is it?

There are various resources available to help identify the specimen and which you use depends a lot on how sure you want to be of the answer.

For many recreational fisheries, the State or other organization may publish a field guide to the local fauna. This often consists of figures or photographs with a few accompanying notes to aid in identification. Field guides are often based on easily recognizable field characters, i.e., things that are visible with the specimen in hand such as color markings or distinct morphological features like elongate fins. This works well in many cases, particularly when there are a small number of possibilities.

However, field guides are not so handy when dealing with preserved specimens (because obvious characters like color seldom preserve well or for long) or when the fauna consists of many similar species. In the latter case, the biologist is forced to page through all of the possibilities looking for a match.

Furthermore, the description in a field guide is not a truly accurate description of a species. Rather it is a rough guide to the species. The true description of a species lies in a single paper, part of the primary literature, that provides an extensive and exacting description of the first specimen(s) of a species. This specimen is called the holotype and it is ultimately what a species is, i.e., whatever the holotype specimen has, is what defines that species – the holotype IS the species.

Given that it is rather impractical for you to compare the creature you have just found with either (a) the holotype, or (b) a lengthy description of the holotype, scientists have come up with a more practical aide to identification, namely the dichotomous scientific key.

How to use a key: Most keys are based on alternative characters, hence the name **dichotomous key**, meaning that you are given a binary choice: does the organism match the first or the second criteria? In a well constructed key, the organism will ALWAYS match one of the two choices. You match your animal to one of the two choices, and then follow the path indicated. For example,

- 1a. The fish is blue2
- 1b. The fish is not blue.....3

- 2a. The fish is round..... Blueroundfish, page 23
- 2b. The fish is square..... Bluesquarefish, page 24

- 3a. The fish is round..... Redroundfish, page 25
- 3b. The fish is not round...Redlongfish, page 26

Let's assume we have in hand a long red fish. We start at 1a and ask if the fish in hand is blue. It is

not, so we go to the 1b option, which says to go to question 3. At question 3 we ask, is the fish round? No. So we go to 3b. Is the fish "not round". Yes, so we have identified the fish as the "Redlongfish" a description of which appears on page 26.

Keep in mind that a key is just a guide. While many (and ideally most) specimens will be "keyable" using a properly constructed key, the ultimate authority for what is and what is not a particular species rests with the original description and if one REALLY needs to know the positive identification of a specimen, then the original description should be consulted.

SUPER-IMPORTANT POINT: A key is constructed only with the local fauna in mind. It has no universal truth to it and in fact using a key for a region other than that for which it was constructed will often yield wrong answers. Think about this deeply and often.

California fishes

California has a relatively small fauna of freshwater fish and a large fauna of marine fish. The fisheries biologist is likely to encounter both and must be proficient at being able to key out either kind of fish. Unfortunately, there is no single key to all the fishes of California. Instead we have a key to the freshwater fishes, namely

Moyle, P.B. (2002) Inland Fishes of California (Revised and Expanded Edition). University of California Press, Berkeley.

and a key to the marine fishes, namely

Miller, D.J. and R.N. Lea (1976) Guide to the Coastal Marine Fishes of California. Fish Bulletin No. 157. Reprint with 1976 Addendum. California Department of Fish and Game.

The purpose of this lab is to introduce you to those keys and to give you a little practice in using them.

And in answer to the obvious question of how do you know which key to use, the answer is not obvious. You must know whether the fish came from a freshwater or a marine habitat before you can apply the correct key. Some fishes, such as those found in estuaries, might be in both keys. If that is the case, can you then just use either key? NO! You must use the key from the habitat in which the fish came from. Think about this deeply and often.

Can you use older keys, such as Kimsey and Fisk (1960). Yes and no. There is some value in looking at older keys, but much has changed since Kimsey and Fisk was made and you are responsible for the current information.

To Do:

CAREFULLY LOOK OVER THE KEY IN MOYLE (pages 79-94) so that you understand how it is structured and where to find things. You are not required to memorize the key, but you are required to know what each of the characters mentioned in the key means. Make yourself intimately familiar with this key.

Then, answer the following questions using Moyle as much as possible, but other sources if necessary (see end of this handout). Turn in your answers on a sheet of paper with your name on it. Write and draw clearly and neatly. You do not have to be an artist, but your work has to be understandable.

Do not "guess" at these answers. **Guessing at an answer will earn you an F for this exercise.** Find out the correct answer. If you cannot find the correct answers, you need to work and think harder.

1. Draw a typical, hypothetical fish, labelling the following parts:

dorsal fin
anal fin
pelvic fin
pectoral fin
caudal fin
adipose fin

nostril
 eye
 lateral line
 anus
 maxillary bone
 caudal peduncle [Note: this is a region, not a single spot]
 origin of the pelvic fin
 insertion of the pelvic fin
 (NOTE: in some copies of Kimsey & Fisk, the diagram is incorrectly labelled. The insertion is the "back end" of the attachment of the fin)

2. The first checklist of California fishes was by Shapovalov and Dill (1950). It listed 101 species. The current key contains more species. Why (give at least two reasons)? [Hint: the answer is NOT that new species have evolved – that does not happen in that kind of a time frame]
3. What is a barbel? [Hint: use the glossary in Kimsey and Fisk]
4. What is the caudal peduncle?
5. How EXACTLY is body depth defined? DO NOT GUESS!!!! [Notice that the glossary of Kimsey and Fisk does not contain this word and though it is on Fig. 1 of Kimsey and Fisk, that does not contain the EXACT definition. Where do you look for the definition and what is it?]
6. List the character numbers from Moyle's key necessary to uniquely identify a centrarchid, i.e., a sunfish (a member of the family Centrarchidae) in California as distinct from members of other families of fishes. In other words, write down the sequence of numbers you would trace through the key starting at the beginning of the key, not the beginning of the Centrarchidae, if you were trying to identify an animal that turned out to be a member of the Centrarchidae. (e.g., 1a, 2b, ...)
7. Could you use the same key elsewhere where sunfish are found, e.g., in Illinois, to successfully identify a fish as a centrarchid? [Hint: sunfish are found in many other places in North America, but how about the other fish in the California key? Are they also found in Illinois? What effect does their distribution have on your answer? Think very carefully about this answer. I am NOT asking if a particular species of sunfish looks identical in different locations – assume that they do look identical. This question is NOT about variation within a species; it is about the limitations of keys]
8. The number of fin rays may be listed as II3. What does this mean?
9. Carefully draw and describe a frenum. This is one of the most important characters for identifying California freshwater fishes.
10. Which families of California freshwater fishes contain species that have adipose fins? [Hint: if you use Kimsey and Fisk for this question, you will get the wrong answer!]
11. What is the difference between the length of the pelvic fin and the length of the base of the pelvic fin? Use a diagram AND words to explain your answer.
12. a. You enter the world of "HardwareLand". In it, after careful surveying, you find six different species of screws. You recognize that size is not a useful character for distinguishing species of screws because, like fish, screws exhibit indeterminate growth meaning that over time a little screw will grow into a bigger screw. In contrast, you notice particular characters which are consistent between species, e.g., color, thread pattern (complete, incomplete), head shape (flat, domed), and the type of indentations on the head (e.g., slot, Phillips ('+'), Robertson (square)). Construct a dichotomous key for the group of 6 screws (A-F) in HardwareLand.
 - b. Now you go sampling in HardwareLand and discover screw G. According to your key, to which species does screw G belong?
 - c. Sadly, a foreign truck races through HardwareLand and has a small accident. Some hardware falls off the truck. In the wreckage, you find screw H. According to your key, to which species does screw H belong?

- d. Also in the wreckage, you find screw I. According to your key, to which species does screw I belong?
- e. Why is your answer in part (d) problematic?
- f. What does this tell you about your ability to identify introduced species using a key?
13. Is there a **necessary** relationship between the evolutionary relationships of a group of organisms and a key to those organisms? [Hint: the answer is no. Why? Think about what you did in the previous question... you made a key of a bunch of inanimate screws that have no evolutionary relationships... think about it!]
14. Is it possible for a species to appear as a terminal taxa **twice** on a well-thought out key? Under what circumstances? Give at least two such situations. [Hint: the answer is yes, look at Moyle's key to the salmonids. Also, look at California Sheephead in the top of plate 30 in Eschmeyer and Herald or Kelp Greenling on plate 22 of Eschmeyer and Herald]

Resources:

- Eschmeyer, W.N. and E.S. Herald (1983) Pacific Coast Fishes. Houghton Mifflin, New York.
[Excellent field guide to marine fishes]
- Hart, J.L. (1973) Pacific Fishes of Canada. Fisheries Research Board of Canada Bulletin 180.
[very useful book for keying California marine fishes, why?]
- Hubbs, C.L. and K.F. Lagler (2004) Fishes of the Great Lakes Region. Revised Edition. University of Michigan Press, Ann Arbor.
[THE classic fish identification guide. Most modern guides derive from this. In particular, the Chapter "Anatomy, Terms, and Methods of Counting and Measuring" is extremely important for correctly keying fishes – read it! If you do not, you will make mistakes and remain puzzled for the rest of eternity]
- Kimsey, J.B. and L.O. Fisk. (1960) Keys to the freshwater and anadromous fishes of California. California Fish and Game 46(4):453-479.
[Old key to California freshwater fishes; useful glossary at end]
- Lamb, A. And P. Edgell (2010) Coastal Fishes of the Pacific Northwest. Revised and Expanded Second Edition. Harbor Press, Madeira Park, British Columbia.
[great photographs of marine fishes]
- McGinnis, S.M. (2006) Field Guide to Freshwater Fishes of California. Revised Edition. University of California Press, Berkeley.
[useful photos, diagrams and information of freshwater fishes; portable; no key]
- Page, L.M. and B.M. Burr (1991) Freshwater Fishes. Houghton Mifflin, New York.
[field guide to all freshwater fishes of North America]

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