Biology 321: Ecology **Fall 2010, Dr. Paradise**

How to critically read and present scientific literature

You will be asked to **critically evaluate** original scientific papers. My goals in having you read these papers are for you to understand how scientific information is generated, how ecologists test hypotheses, and to improve your ability to critically evaluate scientific evidence.

Scientific literature comes in two basic forms: **primary** and **secondary** literature. The papers you will be reading are from the primary literature: papers that report original research. The secondary literature consists of papers and books that review, integrate, and summarize the primary literature. When first faced with using the primary research literature, the prospect may seem overwhelming. Finding pertinent journal articles is not easy and may involve scanning many abstracts, a fairly long search, and encountering concepts you don't understand. Once an article has been located, or as is sometimes the case in this class, provided, there is the problem of reading it. Use the guide below to help you **dissect** scientific papers to **extract** information and concepts from them.

The burden of assessing published material lies with you, the reader. Take the time and energy and you will gain more and be further along than the person who depends on the author for interpretation. After completing a critical reading of a journal article, you should be able to paraphrase the significance of the paper in 3 or 4 sentences. You should also be able to both praise and criticize several points of the paper. Critical evaluation does not necessarily mean a negative evaluation; rather, it should recognize both the **strengths** and **weaknesses** of the paper. Keep in mind that the authors don't have all of the answers or all of the time and money needed to discover them; and they sometimes make mistakes. Learn to evaluate their work as you would that of your peers.

Before reading the article, ask: What am I looking for in this article? Knowing what I do about the subject, what gaps need to be filled, what knowledge needs to be expanded, and what controversial points need to be corroborated? What themes and concepts from class will I expect to be illustrated in this paper? **Generate expectations** of a journal article before you read it. This will help your analysis of the work in front of you, plus keep you more interested in the material. Then:

1. Read the authors' **names**. Where and with whom are they working? What is their expertise?
2. Read the **Title**. It should summarize the work of the article, help you to clarify your expectations of the paper, and it should be an attention-getter (it may have already accomplished that task!).
3. Read the **Abstract** carefully. It is a summary of the questions, general approach used, results, interpretation, and conclusions. Abstracts can be difficult to read as an entire publication must be summarized in an understandable way in about 200 words.
4. Picture time: flip through the article and study the **figures and tables**, including the legends. It will be necessary to consult the Methods and Results section to clarify figures and understand the experimental design. It should be clear to you by now whether this paper will satisfy the assignment. Go over each of the figures and provide <u>detailed, critical analyses</u> of each figure.
5. Read the **Methods**, which describes the study system (organisms, locations, time period) and techniques used (observational and/or experimental design and statistical tests). You should consider whether the design and methodology were sound.
6. Read the **Introduction** to learn about the general subject, past work in this field, and how the study will fit into the big picture of ecology. It should be very clear what the objectives were, what their paper will tell you, and why it is important.

7. The **Results** should adequately, objectively, and accurately describe the data presented in the paper, in prose and in figures and tables. The figures and tables should clearly, succinctly, and attractively present the results of the paper. Remember that great data presented clumsily or sloppily will not be seen as great, only clumsy or sloppy.
8. The **Discussion** is where the results are interpreted, related to relevant theory, and put into context of the questions and big picture. The authors should explain the results and how their analysis relates back to the hypotheses and questions. There should also be a description of how the work has advanced our understanding of the subject. Unsubstantiated speculation should be avoided, but authors will often discuss new hypotheses generated from the present work and alternative interpretations of the results.

After reading a paper, you should be able to answer the following questions:

1. What questions are being asked? **How does the study relate to the themes of ecology and the topic in the syllabus?** Are there other hypotheses that could explain the same phenomena? Are hypotheses mutually exclusive?
2. What methods were used? Can you think of better ways to answer the same questions? (Be realistic when you think about that – researchers have limited supplies of time and money.)
3. Does the interpretation of the data seem objective and accurate?
4. Are the conclusions justified by the data? Were the original questions answered?
5. What are the implications of the results for general issues and understanding in this field?
6. Are there further studies suggested by this work that might help to clarify things?

Here are some practical **suggestions** to help you get the most out of the papers:

1. Keep good notes and organize the notes for easy future referencing.
2. Read the paper twice. Initially, read it quickly to get a general understanding of the question, methods, results, and significance. Your second reading should be more critical and skeptical.
3. Pay attention to the data, tables, and graphs. The data are the backbone of the paper and you need to understand them. Compare your impression of them with the author's interpretation.
4. **Make comments**. Highlight or underline the parts that you think are important. Write notes in the margin. Use a question mark to note things that you don't understand.
5. **Read critically**. What assumptions do the authors make? Are they valid? Can the methods really answer the questions posed? Are the arguments logical? Are alternatives considered?
6. **Don't get bogged down.** A scientific paper should tell a story and the plot is more important than the details. Skip difficult parts to avoid losing the story line. Come back to them later to see if you can reason them out. If you can't, see me in my office or ask about them in class.
7. For the purposes of this class, assume that the statistical analyses were appropriate and performed correctly. (If you have a strong background in statistics, you are welcome to question the analyses, but if not, don't waste time worrying about the stats.)