Ecology, Development, & Sustainability

Environmental Science Lab Manual, Instructor Edition

Second Edition

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INTRODUCTION:

The first edition was based entirely on my experience teaching in a small and selective private school in Washington D.C. During the two years that followed I used this manual in a small local college where students brought a more diverse set of skills to class and my contact with them was limited to only one day a week. Consequently, I had to re-work many activities to make them understandable to students who had a more limited understanding of chemistry and higher math. I also had to make the time needed for each activity more uniform so that each could be completed in 2-3 contact hours. Despite these changes, ambitious students can still find much to challenge them in the "advanced study" sections. The second edition also contains five new activities*, four of which were designed for classes that do not meet every day. Some introductory passages were also updated to keep up with energy policy and technology. Website navigation instructions for the online activities in Part II were also updated to keep up with ongoing re-arrangement of links and pages. For this teacher's edition, the "Instructor's Guide" was incorporated into the lab manual so that instructors have all they need in one book.

To facilitate balance, the manual is organized into three sections that are summarized in the title; the natural environment (ecology), the man-made environment (development), and strategies for maintaining a more viable relationship between these two components (sustainability). The student edition has only 96 pages, but unlike other environmental science manuals it incorporates human-centered topics connecting environmental issues with the human condition. These activities (mostly in Part II) are designed to give students a more realistic perspective on the trade-offs that allow you to sustain both the environment and a reasonable standard of living.

Most lab manuals contain between 30 and 40 labs and activities. This one officially contains only 24, but this does not necessarily mean that you will run out of experiments: Some activities in this manual (notably 1-3, 1-5, 2-2, 3-8, and 3-10*) are composites that can supply material for at least two lab reports.

About the Author: Antonio Chaves graduated from the University of Maryland in 1982 with a B.S. in fish and wildlife. After serving two years in the Peace Corps, he stayed in Ecuador to work in the shrimp-farming industry. Eventually, he made his way back to college and earned a Ph.D. in zoology at Texas A&M University in 1999. Dr. Chaves currently teaches biology, chemistry, and environmental science in the Washington D.C. area, and uses his spare time to write articles on science and education policy.

* Three of the new activities were incorporated into Lab 3-8 (Energy Conversion Efficiency) and another new activity was incorporated into Lab 1-3 (Net Primary Productivity and BOD). Lab 3-10 is available only as a "supplement" in the disk of the instructor's edition.

FOR INSTRUCTORS:

The lab manual contains more than enough activities to satisfy the lab requirement for a semester college course that incorporates one 3-hour lab per week. Below are the 15 labs that I used for the 12-week course I taught at Washington Adventist University:

WEEK	ACTIVITY	LAB MANUAL
1	Physical Conditions and Dissolved Oxygen	1-2
2	Carbon Cycling Between Fish and Producers	3-1
3	Net Primary Productivity and BOD (Parts A & B)	1-3
4	Quantifying Urban Sprawl	2-1
5	Transportation (Parts A & B)	2-2
6	Energy Conversion Efficiency (Parts A, B, & C)	3-8
7	Evaluating Soil Texture	1-1
8	Development and Quality of Life	2-3
9	Risk Factors and Health Outcomes in Africa	2-5
10	Solution Chemistry of Natural Waters	1-4
11	Assessing Toxicity with Yeast Assessing Pollution Remediation with Yeast	3-3 3-4
12	Net Primary Productivity and BOD (Part D); Dose-Response to Carbon Dioxide (discussion); and Household Energy Consumption (discussion)	1-3, 3-2, 3-8

Many of these activities (such as 1-1, 1-3, 2-1, 2-2, 2-3, 2-5, and 3-1) require more than one class meeting, but due to the three hours set aside for lab it was usually possible to start on a new activity during the same period that another activity had been completed. The two activities "discussed" on week 12 (3-2 and 3-8) required little or no classroom time, but still carried the same weight as all the other lab assignments.

If you are teaching in a school where classes meet on daily basis, you may also include the following five activities:

WEEK	ACTIVITY	LAB MANUAL
?	Net Primary Productivity and BOD (Part C)	1-3
?	Diurnal and Seasonal Pond Dynamics	1-6
?	The Nitrogen and Phosphorus Cycles	1-7
?	The Population Dynamics of *Paramecia*	1-8
?	Feed Conversion in Mealworms	1-9

The following four activities involve unusual equipment. Unless you have more than one DC wattmeter, these activities are suitable only as demonstrations or for classes of 8 students or less:

WEEK	ACTIVITY	LAB MANUAL
?	Energy Density of Rechargeable Batteries	3-5
?	Fuel Cell Dynamics	3-6
?	Energy Conversion Efficiency (Part D)	3-8
?	Photovoltaic Cell Dynamics*	3-9

The following two activities are suitable only for honor students or those who have taken at least one semester of college-level chemistry:

WEEK	ACTIVITY	LAB MANUAL
?	Buffering Capacity of the Carbonate Ion	1-5
?	The Chemistry of Flue Gas Desulfurization	3-10

A Note on Equipment: Even though product guidelines can be found at the end of each lab description in the "Instructor's Guide" section, it should be noted that the two items you will need the most (but may not already have) are an oxygen meter (Labs 1-2, 1-3, and 3-1) and a DC wattmeter (Labs 3-5, 3-6, 3-8 Part D, and 3-9*). Watt-hours can be roughly estimated with a multimeter and a stopwatch only if the voltage and amperage remain constant—not likely if you are drawing current from a small battery or a solar cell. Therefore, if you want readings that are both accurate and user-friendly, a DC wattmeter is well worth the $50-$60 investment. A reliable oxygen meter will cost more. Please refer to the "Instructor's Guide" sections for Labs 1-2, and 3-5 for more complete information on purchasing these items.

* The Addendum provides an alternate procedure that allows you to substitute multimeters for the DC wattmeter. Since multimeters are commonly available, this option could make it possible for more students to participate in the photovoltaic activity.