

San Diego Field Guide Project: An Integrated Study in Urban Ecology



Authors: Jay Vavra, Tom Fehrenbacher

Subjects, Grade Level: Biology, Humanities, Mathematics; 11th Grade

Essential Question: *How can we be better environmental stewards of the San Diego Bay?*

Duration: 16 weeks

Brief Description, products: Students conduct an environmental assessment of the fauna along the intertidal zone of San Diego Bay. They publish a comprehensive Field Guide including scientific studies, creative writing, photographs, and histories of human development, industry, environmental measures, mapping and other changes to Bay. Student research is used environmental agencies and other groups to help evaluate the health of the Bay and devise solutions to improve its ecology.

CA State Standards/ domains addressed:

Biology, U.S. History, American Literature, Pre-Calculus

Assessments: Along with conventional subject-matter tests, expectations for critical thinking, planning and organization, problem solving and presentation skills require ongoing project-specific performance evaluations though the use of journals, self-reflections, rubrics, process analysis sheets, deadline completion check-offs, and culminating presentations of learning.

Field Guide Project • DRAFT 3/06

About the Authors

Dr. Jay Vavra has been a science educator in community colleges and high schools for seven years. Dr. Vavra has taught marine science to graduate-student and postdoctoral candidates for the National Science Foundation in Antarctica and for the Office of Naval Research at Catalina Marine Science Center. Dr. Vavra recently joined the Board of Directors of the San Diego Chapter of Marine Technology Society. Dr. Vavra received his doctorate from the Marine Biology program at USC.

Tom Fehrenbacher has been teaching English, United States history, government, economics, and social studies for 15 years. He received his Bachelor's Degree in psychology from the University of Notre Dame in 1975 and a Master's Degree in anthropology from San Diego State University in 1985. Tom Fehrenbacher is credentialed in English and social studies with supplementary certifications in Gifted and Talented Education, Language Development Specialist, Language Arts Peer Coach, Advanced Placement and International Baccalaureate Programs.

Though not an author of this project description, the team's mathematics teacher, Rod Buenviaje, was a partner in the project. Rod has taught mathematics at High Tech High since the school's beginning in 2000. Over those years, Rod has developed projects that meaningfully integrate mathematics with other subjects and that apply math to real world situations. Last year, in the development of our baseline study of the Boat Channel, Rod Buenviaje facilitated the compilation of the data collected from our biological investigations. In addition, Rod Buenviaje's classes assisted in the study of the history of the Boat Channel through the completion of an area map in order to compare topographical change over time.

Project Description

This project integrates biology, math, and the humanities in a study of the biogeography of San Diego Bay. Eleventh grade students in the core academic classes of biology, mathematics and humanities at High Tech High conduct an environmental assessment of the fauna along the intertidal zone of San Diego Bay. Using extensive GIS-assisted analysis of species abundance and diversity, students consider human impact upon different sites within the Bay. Students establish a faunal baseline, chart changes over time and measure the abundance and diversity for comparison between sites. To provide a complete picture of their fieldwork, the student-produced Field Guide includes, not only scientific studies, but also creative writing, photographs, and histories of human development, industry, environmental measures, mapping and other changes to the Bay. Student research is used by the City of San Diego, State of California, environmental and other groups to help evaluate the health of the Bay and seek solutions to improve its ecology.

Essential Question:

How can we be better environmental stewards of the San Diego Bay?

Field Guide Project • DRAFT 3/06

Content / Topics Addressed

Biology

1. Species identification
 - a. Semi-permeable membranes regulate cellular interaction with surroundings
 - b. Enzymes are proteins that catalyze biochemical reactions
 - c. Cells can be prokaryotic or eukaryotic
2. Evolution of animal taxa.
 - a. Pairs of chromosomes separate and segregate in meiosis
 - b. Only certain cells undergo meiosis
3. Species abundance and diversity.
 - a. Biodiversity is sum total of different kinds of organisms
 - b. Effects that cause changes in an ecosystem
 - c. Causes of population fluctuation
 - d. Cycling between abiotic resources and organic matter in the ecosystem
 - e. Ecosystem stability is due to producers and decomposers
 - f. Loss of energy in food web
 - g. Physiological and evolutionary adaptation
4. Evolution
 - a. Natural selection acts on the phenotype rather than the genotype
 - b. Heterozygous can carry and maintain lethal alleles
 - c. Mutations are constantly being generated in a gene pool
 - d. Variation results in some having a chance to survive
 - e. Evolution is the result of genetic changes in constantly changing environments
 - f. Natural selection determines the differential survival of groups of organisms
 - g. Genetic diversity allows more to survive in changing environments
 - h. Genetic drift
 - d. Speciation via reproductive or geographic isolation
 - e. Relationship between fossil evidence and evolution
 - f. Range of evidence for predicting probable evolutionary relationships
 - g. Molecular clocks, to estimate time scale of evolutionary relationships
5. Animal Physiology
 - a. Homeostasis
 - b. Integration of organ systems
 - c. Role of nervous system in communication within and with surroundings
 - d. Feedback loops of the nervous and endocrine systems
 - e. Role of neurons in transmitting electrochemical impulses

Pre-Calculus

1. Mapping Techniques
 - a. Evolution of cartography
 - b. Law of sines
 - c. Law of cosines
 - d. Unit circle

Field Guide Project • DRAFT 3/06

- e. Geographic Information Systems
- 2. Species Distribution
 - a. Data collection and analysis
 - b. Right triangle trigonometry
 - c. Using Microsoft Excel to graphically represent data
 - d. Distribution curves and standard error
 - e. Surface area of 3-D objects
- 3. Tide Charts
 - a. Trigonometric functions
 - b. Wave periods and amplitudes.
 - c. Functional modeling

U.S. History

- 1. Significant events in the founding and expansion of the nation
 - a. Exploration and contact
 - b. Colonization
 - c. Westward expansion
 - d. Civil War and Reconstruction
 - e. Immigration
 - f. Economic development and industrialization
 - g. Urban growth
- 2. Significant events and philosophical and religious ideas
 - a. Enlightenment and Age of Reason
 - b. Role of religion
 - c. Political formation and the Constitution
 - d. Great awakenings, Civil War revivals, social gospel
 - e. Mormon exodus
 - f. Imperialism
 - g. Religious pluralism
 - h. Materialism
 - i. Environmentalism

English Language-Arts

- 1. Reading
 - a. Word analysis and vocabulary
 - b. Reading strategies: prediction, questioning, summary, and clarification
- 2. Reading Comprehension
 - a. See organizational patterns, arguments, and positions advanced
 - b. Define features of different types of public documents
 - c. Clarify facts presented in consumer, workplace, and public documents
 - d. Make reasonable assertions about the author's arguments
 - e. Critique validity and truthfulness of arguments set forth in public discourse

Field Guide Project • DRAFT 3/06

3. Writing

- a. Demonstrate command of standard English
- b. Practice and refine steps of the writing process
- c. Produce coherent, focused and reasoned texts
- d. Narrate events and locate scenes
- e. Provide descriptions and sensory details documents
- f. Use strategies to organize and record information

4. Literary Response

- a. Respond to historically or culturally significant works
- b. Analyze characteristics of poetry, reflections, and essays
- c. Analyze textual meaning for commentary on life
- e. Analyze recognized works of American literature
- f. Analyze the clarity and consistency of political assumptions

5. Listening and Speaking

- a. Listen with attention and understanding
- b. Deliver focused and coherent presentations
- c. Recognize strategies used to inform
- d. Use effective and interesting language
- e. Use rhetorical devices and structure

6. Deliver multimedia presentations:

- a. Produce presentation combining text and image
- b. Select appropriate medium
- c. Use selected medium carefully
- d. Test for audience response and revise

Learning Goals

Students will understand:

1. how active concern and awareness can improve our environment
2. how the study of ecology can inform our decisions
3. how biology means more than the study of the human body
4. how to interpret and record baseline measurements
5. how mathematics can be used to locate place in the environment
6. how mathematics can be used to analyze, compile and represent field data
7. how mathematics can be used to calculate and predict tides
8. how the Industrial Revolution and Westward Expansion dramatically changed our natural environment
9. how changes in values and religious ideas can result in very different approaches to the treatment of our environment
10. how the tradition of America's nature writers can inform our perspectives and decisions

Field Guide Project • DRAFT 3/06

11. how the principles of holism (connection, complexity and compassion) can be used to make environmental decisions and laws

Students will be able to:

1. produce a Field Guide that identifies species, quantifies faunal baseline, and charts changes over time
2. produce a Field Guide that integrates perspectives from the humanities through reflections, creative contributions, and the development of conclusions and recommendations

Products

Students will produce the following:

1. Field Guide
 - a. table of contents
 - b. fauna
 - i. introduction to biology
 - ii. taxonomy
 - iii. evolution
 - iv. dichotomous tips
 - v. species descriptions
 - c. biodiversity & biogeography
 - i. geography
 - ii. history of mapping
 - iii. biogeography
 - d. places and spaces
 - e. summative analysis
 - i. biodiversity
 - ii. collapse factors & place
 - f. glossary
 - g. references
2. Field Guide Community Event
 - a. Welcome and Introduction
 - b. Field Guide Purpose
 - c. Selected Presentation of Content
 - d. Question and Answer
 - e. Expert Panel Feedback
 - f. Community Open Forum

Field Guide Project • DRAFT 3/06

Project Timeline

WEEK	BIOLOGY	HUMANITIES	DELIVERABLES
1	Topic and Field Introduction	Topic Introduction	(review previous student work)
2	Field Survey Introduction	Nature Reflection Introduction	Observation sheets, nature reflections
3	Comparative Physiology and Evolution	Darwin, Scopes, Intelligent Design debate	Field observation of change proposals / debate reflections
4	Mapping Techniques & Survey Site location	Description and Place	Maps / Location descriptions
5	Intertidal Surveys	American Nature Writing	Survey data / poetry
6	“	“	“
7	Field Guide Review/ Species Writing	Industrial Revolution	Descriptions / Nature Reflections
8	Species Writing	“	“
9	Educational Field Trips	Educational Field Trips	Trip Reviews
10	Field Data Compilation	Focus Author Application	Charts & Graphs / Conclusion and Recommendations
11	Special Assignments in Biology	Special Assignment in Humanities	Special Assignment Submission Due
12	Writing in Biology	Language Arts Peer Review	Written Product Revision
13	Project Review of Biology submissions	Project Review of humanities submissions	Peer review, text editing due
14	Project Assembly and Integration of submissions	Project Assembly and Integration of submissions	Format, organization, and table of contents completed
15	Product Completion	Product Completion	Field Guide to print
16	Community Event preparations	Community Event preparations	Organization, role assignments due
17	“	“	Oral presentation critiques& revision due
18	Field Guide Publication and Community Event	Field Guide Publication and Community Event	Field Guides available at Community Event

Project Activities

Introduction to Lesson Strands

The Timeline provides a general understanding of the order and timing of this Project. However, flexibility is advised. The low tides necessary for good site surveys do not occur with the regularity of a school calendar. Events taking place in the school may make a field trip departure impossible. Flexibility is necessary to coordinate and integrate the subject matter from different classrooms at different points in each classroom’s respective curriculum. The phases outlined below take place over many

Field Guide Project • DRAFT 3/06

weeks. They do not start and stop at the neat points in the timeline, but continue throughout the semester in cycles of direct instruction, discovery and revision. The Project begins with classroom instruction and the introduction of material, continues through the fieldwork of data collection and nature reflection, and culminates in review, revision and preparation of the fieldwork for publication. Each of these phases, detailed below, includes specific lesson plans and suggestions for the Project's completion.

Phase 1: Preparing for the Work

A positive and engaging introduction to the topic, focus, and work of the project will greatly increase the chances of success. The importance of the environment, the beauty of nature, the possibility of real field work all work to “hook” the students. At this time, an introduction to the physical location, in our case the San Diego Bay, and to the project's overall long range goals are important. Exemplars from previous student work or from professional publications will help students understand the scope and importance of the work.

Learning specific content is necessary at the start. Vocabulary, key concepts, previous studies, and the opinions of experts provide a basis for successful fieldwork.

For suggestions regarding content introduction, see the following strands:

Biology: Comparative Physiology (Strand 7)

Humanities: Educational Field Trips (Strand 6), Industrial Revolution (Strand 1)

In addition to content and concepts, discipline-specific practices and methodologies are reviewed prior to the first field trip. Questions that might be asked include:

1. What are the expectations for student exploration, research, data collection, and reflection upon arrival at the site?
2. What “information” does the particular discipline value? How is this accomplished?
3. What are the expectations for the process? For the product? For success in the field?

For suggestions regarding these topics, see the following strands:

Biology: Sub-sampling a Biological Community (Strand 10)

Humanities: Nature Writing in America (Strand 2)

Phase 2: Experiences in the Field

Effective constructivist practice brings students quickly to actual experience. After the introduction to content and methodology, field experiences can begin. In our case, mapping, survey site transect studies, and nature reflections comprised the core of the Project. These field experiences were not taken in isolation. We maintained a continuing cycle of classroom preparation, field experience, and post-trip analysis. Students prepared in advance for their next field trip by reviewing new techniques, authors, or concepts. After each trip, students engaged in lab work, analysis, and reflection to “capture” the material.

Field Guide Project • DRAFT 3/06

For suggestions, see the following strands:

Biology: Surveying the Shore at Low Tide (10.2)

Humanities: Survey Site Nature Reflections (5), Special Assignments (8)

Phase 3: Making Meaning of the Work

The analysis and compilation of data, production of graphs and charts, and creation of meaningful reflections and conclusions take place upon completion of the field experience. Recapturing the field experience entails not only the selection of important material and results, but requires that this information be well compiled and presented. Integrating the various pieces into a table of contents, pagination, formatting, page layout, and photo selection will require unexpected amounts of time. As no project is complete without sharing the results with a larger audience, a community event is essential. To complete this event, planning and preparations, as well as numerous rehearsals will be required. It is important to finish the “written work” first, as this can be used as the source and focus of the oral presentation.

For suggestions, see the following strands:

Biology: Survey Data Analysis (10.3), Field Guide Writing (11)

Humanities: Focus Author (3 and 4) , Peer Review, Class Critique and Class Constructed Rubrics (7)

Lesson Strand 1: Industrial Revolution

In the following series of lesson plans, students discover how human approaches to the environment have changed over time. By first examining our current situation, students give consideration to the standard of living we have achieved, as well as the pollution and separation from the environment that we have created. Going into America’s past, students look at the attitudes of Native Americans toward land use and ownership. We then look at Westward Expansion and the ideas found in the concept of Manifest Destiny. Finally, the strand concludes with an examination of today’s land use by ranchers and cowboys. Instead of finding the popular and romantic cowboy of the past, current environmentalists take a critical look at frequently destructive practices of modern range use.

Lesson Plan 1.1: Consequences of the Industrial Revolution

Pre-Write Essential Question: What changes has the Industrial Revolution produced? (Depending upon your students’ prior knowledge, it may be necessary to provide some information about the Industrial Revolution itself. This can be done briefly, at this point, as the discussion of various components of the Industrial Revolution will continue as the lesson series progresses.)

Brainstorm Discussion: Answers to pre-write questions are posted on the board, overhead, or LCD projection. Ask students to support their answers and provide important points and elaboration.

Clustering: Student answers are clustered into groups, e.g., positive consequences of the Industrial Revolution on one side and negative or destructive consequences on the other.

Field Guide Project • DRAFT 3/06

Further clusters can be accomplished under headings such as: causes, effect, motivations and justifications.

Follow-up Questions: As this particular strand will focus upon land use, questions that may anticipate the next lesson are assigned here, such as: What attitudes toward the land and the environment did the people have who brought about the Industrial Revolution have? What motivated people at this time in history? How did these motivations, attitudes, and beliefs differ from those of the people who already occupied the land? Why do you think so?

Lesson Plan 1.2: Who Owns the Land?

Share-out: Share answers to the previous lesson's Follow-up questions. Students may pair and share their answers before a general share-out. During class-wide share-out time, student recount what their partner has told them, rather than reading their own answers. This approach addresses the frequently overlooked applied learning skill of listening—a critical skill for later teamwork.

Writing Activity: What do you know about how Native Americans viewed and treated the land?

Share-out and Introduction to the Reading: At this point, student responses are shared directly. Comments and elaborations will facilitate a transition to the lesson's reading, "Chief Seattle Address." (While this very beautiful piece may not be the work of Chief Seattle, the text itself is worthy of consideration. See, for example, <http://www.bigisland.com/~stony/seattle.html>)

Discovery of Material: Students read independently. "Found Poetry" is a very effective activity with this particular text. Students are asked to select no more than five words in a row from the text. They may wish to add words of their own to provide flow and transitions. The resulting poems provide "snapshots" of the work. Each individual poem becomes a personal addition to the main work under consideration.

Share-out: Student "Found Poetry" is read to the class as a whole. (A pair and share activity will work very well here, also.)

Follow-up Questions: These questions provide students an opportunity to reflect upon their understanding at this point. The writing may be done at the end of class, for homework, or as a prewriting activity for the next day's lesson.

The Questions: How do Native Americans view land? What important points does the text make? What important recommendations, precautions, and advice does the text give? With the arrival of European-Americans, how was the land treated differently? What environmental problems were created with this new approach? How did the Native American view differ from the European-American view of the land? Why? Are our reasons for land use and ownership appropriate or justified? How have you come to these conclusions?

Lesson Plan 1.3: Westward Expansion, the Homesteaders, and Manifest Destiny

Discussion Questions 1: How did the colonial Americans feel about land? After the Revolution, what plans did the new Nation have for expansion? What traditions continued regarding settlement and expansion after the Revolution? How did the new Americans feel about their plans for expansion? What reasons did they give for the Westward Expansion?

Commentary: The teacher may wish to discuss or add to the concept of Manifest Destiny: that Americans should spread over the entire continent because God had given it to the Americans so that a great experiment in liberty and self-government might be conducted.

Discussion Questions 2: How do the views of the new Americans conflict with the views of the Native Americans? Why? What viewpoints were expressed by the Native Americans? How did their viewpoint about the land differ from the new arrivals?

Commentary: Refer to Native American views on land ownership, discussed earlier in this lesson strand. Provide additional information here as appropriate.

Debate: Several formats are available. The teacher may wish to use a formal structure complete with a proposition such as, “Agreed, that the new arrivals had every right to take and use the land as they saw fit.” Alternatively, one might take a more informal discussion-driven approach to debate.

Write-up: How did the new Americans’ very different beliefs about land use and settlement change America? How did their attitude about the land and the environment differ from that of Native Americans? How does this attitude continue to this day? How has this attitude contributed to the problems we face with our environment? Are we willing to examine the assumptions behind Manifest Destiny critically? Will we need to look critically at our past assumptions, if we are to become better stewards of the land and environment?

Note: The student writing completed here may be used later in the Project discussion of changing land use patterns. If so, then the interested teacher may wish to refer to Strand 7: Peer Review, Class Critiques, and Class Constructed Rubrics for suggestions on preparing text for publication.

Lesson Plan 1.4: Welfare Cowboys

The conflict between American land use and environmental destruction can be starkly seen today on cattle ranches of the West. In this lesson, students consider an article in which the “environmentalists take on ‘welfare cowboys.’”

Follow-up discussion: Share previous lesson’s write-up on differing land use and settlement strategies through a pair and share activity or class-wide share.

Field Guide Project • DRAFT 3/06

Text Introduction Questions: Where is there conflict between the private use of land and the public's need for a safe environment? Or, how might this debate over the best use of the land be seen today?

Text: "Last Roundup on the Range?" or other suitable text on land use. Select a strategy for reading the text.

Discussion Questions: These may be done individually or in groups.

Why is the American Cowboy regarded so highly?

How big a problem for the environment is cattle ranching?

What perspective does the cattle industry offer?

Why are environmentalists critical of the Bureau of Land Management and the Forest Service?

Why is the cattle industry a difficult opponent for environmentalists?

What point do environmentalists make regarding subsidies and free grazing?

How do cattlemen respond to this criticism?

What solutions are being considered?

Share-out: Answers to the above questions might be shared in small groups, class-wide, or in some other form. During this time, a critical question is: To what extent do American attitudes found in Manifest Destiny continue to support the cowboys in their argument with the environmentalists?

Write-up: Consider the previous discussion. The cowboy represents Americans' attachment to the Wild West, freedom, and individualism. However, as the article points out, the cowboy is also very much at the center of a very serious environmental problem. How much are cowboys allowed to continue their practices of land use because they represent a highly romanticized past? How much should land use decisions take into account past precedent? If a practice is found to be destructive, at what point, should we consider new approaches?

Note: The student writing completed here may be used later in the Project discussion of changing land use patterns. If so, then the interested teacher may wish to refer to Strand 7: Peer Review, Class Critiques, and Class Constructed Rubrics for suggestions on preparing text for publication.

Lesson Strand 2: Nature Writing in America

European explorers and new arrivals recorded their observations of this continent from the very beginning. This literary tradition continued through the colonial period, the Revolution, westward expansion, the industrial revolution, and the twentieth century to the present. From John Smith's observations of the Chesapeake Bay, to John Audubon, Crevecoeur, Emerson, Thoreau, Whitman, Jeffers, Snyder, Carlson, Dillard, and Berry, a long tradition of insightful observation and commentary upon natural America awaits

Field Guide Project • DRAFT 3/06

discovery. Nature writing can be found to accompany and enrich an era of America's past. The strand that follows starts with the work of Thoreau. While he is essential to the naturalist tradition, an earlier writer might have been selected. We started with Thoreau due to our place in history when the Field Guide Curriculum began. The lesson plans below can be used for any author.

Lesson Plan 2.1: Thoreau's Contribution to the Nature Writing

Essential Questions: What is nature writing? Who has written about nature in American history? What does our nature writing say about the place we live? What messages does such writing have for us today?

Thoreau Introduction: Some students may have little knowledge of Henry David Thoreau. A brief introduction may be appropriate at this point. Actively engaged in the antislavery movement, resisting the call to a profession or career, Thoreau spent his years doing odd jobs, observing nature, and participating in causes and in which he believed. Indeed, Henry David Thoreau would be considered an activist today. In this introductory lesson to nature writing in America, students will find in Thoreau a keen observer of nature. They will find an author who applies his observations to the human condition and the life we lead in ways that are both simple and profoundly insightful.

Text Introduction: "Why I Went into the Woods" from Walden. Thoreau's experiences at Walden's Pond near Concord have been discussed previously. Questions regarding the writer's intent when writing about nature are important now: Why do people write so frequently about this subject? What is unique about their writing? The text can be read independently, or in groups through reciprocal teaching or another favorite strategy.

Discussion Questions:

Why does Thoreau 'go into the woods'?

Why does Thoreau find simplicity important?

How does Thoreau describe the battle of the ants?

How does Thoreau relate this battle to humans? What points does he make about us?

What does Thoreau have to say about perfection? How is it achieved? What benefit does it provide?

Why does Thoreau leave the woods?

What new observations does Thoreau have about life after his time in the woods?

Share-out Discussion: These questions may be answered individually, in pairs, or in groups. In discussing the answers, ask students how Thoreau went about writing the text itself. Refer to specific paragraphs in the text where transitions are made. Note when the work is purely descriptive, when it becomes commentary, when advice or conjecture. (The next lesson will use these ideas about text structure to construct the "Thoreau Formula.")

Write-up: Evaluate this text. What did you like about it? What did you not like? What points was Thoreau trying to make? Did he do so successfully or not? Do you agree with Thoreau's views? Did his description of nature seem accurate? Were the conclusions he made about life well drawn from his original observations?

Field Guide Project • DRAFT 3/06

Lesson Plan 2.2: Constructing the Thoreau Formula

Share-out Discussion: Use pair shares and then class-wide share-out to review the previous lesson's *write-up*. During the course of this discussion, ask students to point out specific features in the text from which their conclusions are drawn. How is Thoreau going about his writing? How might each paragraph be labeled for content?

Text Analysis: Ask students to look over Thoreau's text again. By numbering the paragraphs and working in groups, students can be asked to construct a "headline" for each paragraph. The headline should announce in a few words exactly what Thoreau is "doing" in that paragraph.

Share-out: Have each group post their results for their numbered paragraphs. Compare the results from the different groups and come to a general consensus.

Example from "Why I Went into the Woods"

- par. 1 Thoreau states the reason he leaves
- par. 2 Humans live like ants
- par. 3 Humans should live simply
- par. 4 Ant battle is described
- etc...

Formula Construction: By looking at these headlines, ask students to see if they can further condense or combine these paragraph headlines into categories. Ask students to respect the integrity of a given paragraph, but to see if that paragraph can be clustered with other paragraphs in which Thoreau has the same purpose or intent.

For the text in question, the following formula might be constructed:

- Introduction, reason, setting (Thoreau tells why he went into the woods)
- Human problem or concern (Thoreau discuss battles, wars and the need for simplicity)
- Nature Observation (Thoreau provides a detailed description of the ant battle)
- Application of Observation (Thoreau applies the ant battle to human conflict)
- Advice (Thoreau returns to civilization to offer advice to others)

Independent Practice: With this newly constructed "formula" in hand, students can be asked to use it as a format or outline for their own piece of writing. In effect, students are asked to write as if they were Thoreau. While the best application of this process will occur later when we travel to the survey sites, an immediate "backyard" assignment will reinforce the lesson.

Note: The above two lesson plans can be used with a wide variety of authors and poets. We have examined and "deconstructed" the poetry of Emerson, Dickinson, and Frost. We have used this strategy to find inspiration and texts for emulation with other nature writers including Rachel Carlson, Annie Dillard and Wendell Barry.

Field Guide Project • DRAFT 3/06

Lesson Strand 3: Steinbeck (Focus Author)

The tradition of nature writers in America offers a rich heritage of reflective thought regarding our place in the environment. This literary tradition culminates in important writers of the 20th century. Two such writers, John Steinbeck and Jared Diamond, have been used to focus, guide, and integrate students' survey work in biology with reflective work in humanities for the Field Guide's final pages. In our first year, we used the work of John Steinbeck to integrate our work. We were fortunate enough to follow a scientific reenactment of his trip to the Sea of Cortez. In our next year, we studied Diamond's recent book, Collapse, in order to arrive at an inclusive vision of the Bay for our Field Guide's conclusions, recommendations, and suggestions. The following two strands provide classroom ideas for the integration of subjects through the holistic perspectives of John Steinbeck and Jared Diamond.

Lesson Plan 3.1: Steinbeck's The Log from the Sea of Cortez

Author and Text Introduction: Students are likely to have some familiarity with the work of John Steinbeck, either through the films of his novels or the novels themselves. However, many may not be familiar with Steinbeck's work with Ricketts and his travels to the Sea of Cortez on a research vessel. Some teacher introduction for The Log from the Sea of Cortez will be helpful at this point.

Sample Text Questions:

Why did Steinbeck and Ricketts have trouble getting a boat?

Why are there no pictures or photos?

What is the tone of the book?

Why is Steinbeck writing this book?

Is there any other man-made creation today that holds the same level of significance as boats hold for Steinbeck?

Summarize Steinbeck's characterization of Tony. Can you relate to Tony at all, and why or why not?

Discussion: Providing students an opportunity to discuss the text will greatly increase their understanding and interest. Steinbeck's work in The Log is speculative, with random conjectures and ideas following one upon the other. It does not provide the reader with a smooth narrative flow. As such, The Log from the Sea of Cortez may not be as approachable as his novels. More time with this text will be necessary.

Write-up: On page 15, Steinbeck states, "This species (hermit crab) typically does thus and so, but we do not objectively observe our own species as a species, although we know the individuals fairly well. When it seems that men may be kinder to men, that wars many not come again, we completely ignore the record of our species. If we used the same smug observation on ourselves that we do on the hermit crab, we would be forced to say...." Complete Steinbeck's thought.

Lesson Plan 3.2: Reenactment of Steinbeck's Sea of Cortez Journey

Field Guide Project • DRAFT 3/06

Project-driven curriculum provides students with the opportunity to frame problems, generate questions, and develop their own areas of interest. During the course of the project's delivery, look for opportunities which allow students to "construct their own understanding." An exercise which allows this, and which might later be incorporated into a KWL Chart (what do we Know, what do we Want to learn, and what have we Learned) is independent student research. In the example that follows, students are asked to pose their own questions. Answers to these questions may come from texts, the internet, or, when available, experts beyond the classroom. These question and answer sessions can be accomplished via "live" interviews or electronically through instant messaging or email.

Problem Framing / Topic Formations: Introduce the topic by reviewing previous lessons and asking students what they already know about the subject. Then ask students what they would like to learn, what they don't know, and what they would like to learn about. In this lesson plan, we asked students, "Based on what you've read, what questions do you have about the Steinbeck's trip? Knowing that scientists are currently reenacting the Steinbeck adventure, what questions would you like to ask them?"

Example: Students generated the following questions after our introduction. These were then emailed to a group of scientists who were in the process of reenacting Steinbeck's adventures.

How much of a reenactment is this? Are you learning from Steinbeck's mistakes, or doing an exact replication of the original trip? Are you bringing a designated cameraman? Do you have more advanced technology than the initial voyage? Are you going to be better prepared than the previous rather "makeshift" approach? Will you take into account Sparky and Tiny's misnavigation (their tendency to let the boat drift off an exact course)? How much actual science do you plan to do? What type of vessel do you have? How, if at all, are the members of your crew similar to Steinbeck's crew? Who is on your boat? Are they as colorful? Are there some who are less than adept? Is there anyone similar to Tony? What inspired you to make this journey? Has everyone on the crew read the book first? Do you have a writer (Steinbeck) on board? Will you be writing your own log like Steinbeck's? A book? Will you publish your writing after the trip? Will you writing reflections on things other than scientific findings, like Steinbeck? Particularly like Steinbeck's life lessons? How much do you agree with Steinbeck's rants? Do you have the same reverence for your boat as Steinbeck has for his? For the Law of the Sea? Do you think you will discover any sea monsters? Do any members of your crew believe in sea monsters? How is the trip going? Are there problems? What effect does the delay have on your trip? What sorts of mechanical problems have you encountered or anticipate happening? Is there a "Sea-Cow" on board? With gallons of formaldehyde, oxygen, and sharp instruments on the open sea, do you worry for your safety? Did you have a big send off from Monterey? Do you expect the same from San Diego? Do you feel your boat trip is less authentic given you have been delayed (you would have been dead on)? Will your itinerary be the same? Will you still refuel in San

Field Guide Project • DRAFT 3/06

Diego, given the cost of gas here? Will you visit with our Navy in town? How does your experience of arriving into SD Bay contrast with Steinbeck's arrival? Will you have anything to do with Sea World? How much beer are you taking? What's your policy on drinking? Do expect to drink the same amount of beer that the original crew did? Will you see any porpoises?

Response and Discussion. The re-enactors responded to the questions. We held several discussions based upon their answers. Students offered opinions and insights regarding the answers and generated more questions for the re-enactors. In the process of our electronic conversations with the scientists, students arrived at a better understanding of both Steinbeck's original work and what motivates people to do that work today.

Lesson Plan 3.3: Steinbeck's Concept of Holism (making connections)

A concluding lesson served to connect Steinbeck's thinking to current environmental considerations is undertaken. Steinbeck's idea of holism provides a framework in which the principles of complexity, connection, and compassion are integral to the discipline's perspectives on the environment. In this framework, individuals who wish to make changes to our environment might do well to consider the complexity of doing so, how one system is likely to be connected to another, and how every step taken should demonstrate compassion for all living creatures. Steinbeck's holism served as our "integrating principle" for the first Field Guide. By applying his framework to our results, students were better able to draw conclusions and make recommendations for the Field Guide's final pages.

Pre-write Question: What positions regarding the environment does Steinbeck take?

Discussion: Students will have many ideas from reading *The Log*. Post these ideas on the board and cluster them into groups. If possible, anticipate the ideas of complexity, connection, and compassion.

Text: Using a reading strategy at your discretion, provide students with this summary of Steinbeck's thinking. Please note that this text is used as a basis for environmental law.

Steinbeck's Holism: Science, Literature, and Environmental Law

Robert R.M. Verchick Copyright © 2003 Board of Trustees of the Leland Stanford Junior University

Abstract: Holism, the principle that a part is understandable only in relation to the whole, animates the study of ecology. Steinbeck was deeply influenced by ecological principles and developed a holistic methodology in his writing to comprehensively describe and evaluate the relationships among humans, social institutions, and the non-human world. Steinbeck appropriated values from both the natural sciences and the humanities to inform his methods. From the sciences, he borrowed the concepts of connection and complexity to examine the relativity and dynamism he observed in human and non-human behavior. From the humanities, particularly literature, he borrowed the ethic of compassion and empathy to provide a practical and normative goal for human endeavor.

Field Guide Project • DRAFT 3/06

Steinbeck did not assign weights or rankings to the values of connection, complexity, and compassion. But he did believe that to accurately understand or evaluate an event one must consider each of these values and its relationship to the others. This article has argued that such integrated thinking would improve environmental policy and legal analysis. The scientific notions of connection and complexity recommend an incremental, adaptive approach to environmental policy, guided by norms from outside science. These norms should derive from an ethic of compassion, which seeks to understand the interests of diverse, even non-human, constituencies. The failure of environmental law to incorporate holistic thinking has led to individual disappointments in environmental protection, including the crash of California's sardine fisheries (caused by the failure to see connection and complexity in the ecosystem) and the trend toward using oversimplified statistics in assessing public health (caused by the failure to adopt compassion). We can reach more satisfying and comprehensive results when considering disputes from many angles at once.

Text Application: The goal is to arrive at an understanding that Steinbeck states that the environment is complex, that systems are connected, and that compassion should be the basis of action. This conclusion may be reached by comparing the clusters done at the beginning of class with word from the abstract itself.

Using the field experiences you have participated in, the data you have gathered, the ecological systems you have studied, and the nature reflections you have made, consider the following questions:

1. What examples of environmental complexity have you found? Why are they so?
2. What examples of connection within the environment have you found? Why are these connections essential?
3. Why is the principle of compassion important? How might this principle be applied to decision making?

Note: The student writing completed here may be used later in the Field Guide's conclusion. If such a decision is made, then the interested teacher may wish to refer to Strand 7: Peer Review, Class Critiques, and Class Constructed Rubrics for suggestions on revision and preparation for publication.

Lesson Strand 4: Jared Diamond (Focus Author)

In our second year, we chose Jared Diamond, author of Guns, Germs, and Steel, as our focus author for his remarkably applicable recent book, Collapse. In this work, Diamond provides a comprehensive examination of the factors behind many different civilizations' collapse. Diamond's understanding of the human relationship to the environment, the cost and consequences of civilizations, and the potential for a particular civilization's success or failure provided an integrated framework for our field efforts and reflections.

Lesson Plan 4.1: Introduction to Jared Diamond

Opening Discovery Activity: Given Jared Diamond's current importance to the fields of anthropology, sociology, biology, geography, biogeography and more, students were

Field Guide Project • DRAFT 3/06

asked to research Diamond on their own. Quick Google searches provided the class with a good introduction to Diamond.

Share-out: Individual responses, pair shares, group searches, or the single computer classroom's results are shared to provide an awareness of Diamond's work.

Follow-up Activity: Applying Diamond to our work. Students may be asked, at this point, why Diamond was selected. What about his views and his work would make him an appropriate model for use in our Field Guide? The answers to this probing question will not only place importance upon the author, but also allow students to begin to see the potential applications of Diamond's work for both their field survey work and their reflective writing.

Independent Research: Diamond's recent book, Collapse, is creating a stir in the bookstores. What is this book about? Why are people interested in reading it?

Lesson Plan 4.2: Diamond Five Factors of Collapse

The following classical Madeline Hunter "Five Step Lesson Plan" will help students practice the applied learning skills of problem solving and issue framing. (Hunter, Madeline. Mastery Teaching: Increasing Instructional Effectiveness in Elementary, Secondary Schools, Colleges and Universities. Corwin Press: Thousand Oaks, Ca. 1982.)

Pre-Write Activity: What possible factors might have lead to the collapse of civilizations in the past?

Discuss: Brainstorm answers and post. Weigh the importance of answers, cluster, and select as a class the most important.

Reading: Several reading strategies can be used for this material. Students may do so independently or in groups via reciprocal teaching, final word, or another reading strategy.

Questions for Consideration:

Why do we ask the questions of survival?

When we look at history through Diamond's perspective, what factors contribute to collapse?

Why did the Mayan Civilization collapse?

Why did the Pitcairn Civilization collapse?

Why isn't a harsh environment enough to cause collapse?

Why did Japan survive?

If environmental factors destroyed societies in the past, are they as likely to do so now?

Why is it harmful when one group has control over others in the society?

Why is it bad if the elite isolate themselves?

How is elite isolation seen in America?

Why couldn't the Dutch elite isolate themselves from the rest of society?

Field Guide Project • DRAFT 3/06

What does it mean to examine core values in Greenland?
What core values reappraisal do Americans need to make?

Checking for Understanding: Students may develop answers to these questions working in small groups or independently. After completion, share answers in a class-wide discussion. Take advantage of opportunities to provide elaboration and greater understanding during this activity.

Write-up / Independent Practice: Diamond has suggested several different reasons for the collapse of civilizations in the past. Which of these reasons do you think is most important? Why do you think this is the case? How might this factor contribute to possible problems for us in the future?

Note: More such lessons can be constructed using selected excerpts from Diamond's Collapse.

Lesson Plan 4.3: Applying Diamond to the Field Study

In this Lesson Plan, students are asked to apply Diamond's factors for collapse to survey sites of the San Diego Bay.

Share-Out: The previous lesson's write-ups are shared. Attention is given, at this point, to the different "reasons" or factors that the students have selected as important. These factors are posted and clustered on the board. The following five factors can be defined:

1. Human Environmental Destruction
2. Climate Change
3. Enemies
4. Change in Trading Partners
5. Social / Elite Isolation

Group Work: Students are placed into groups. Each group is in charge of clarifying their understanding of one of the collapse factors listed above.

Group Presentations: Upon completion, each group shares its information for comment by the class as a whole. The goal is for each group member to own and understand her group's concept.

Group Discussions about Field Site Locations: Students are asked to reflect upon and then examine each of the survey sites visited. Given the conditions present there, which of Diamond's factors might be most applicable? Students must refer to their work in biology, transect data, and field observation to support their answers.

Group Presentations: Upon completion, each group shares its information for comment by the class as a whole. If reasonable, with sufficient evidence from all the disciplines, a pairing of Diamond factor and site location may be made. Allow students to determine whether the proposed matches warrant further consideration.

Field Guide Project • DRAFT 3/06

Brainstorm and Outline: Students are asked what steps or parts might be included a Field Guide entry which applies one of Diamond's factors to a particular location.

Answers are posted on the board and organized in outline form, possibly as follows:

- Description of location
- Discussion of Diamond factor
- Application of location features to Diamond factors
- Possible aggravating or mitigating developments
- Recommendation and Solutions

Group Writing Assignment: Within each group, assignments are made for the completion of this writing project. Students may serve as researchers, writers, editors, and fact checkers. See *Strand 7: Peer Review, Class Critiques and Student Constructed Rubrics* for strategies to revise and prepare student writing for publication.

Lesson Strand 5: Survey Site Nature Reflections

The following exercises were conducted during the student's field experience at each of our Bay survey site locations. Just as each location provided a different view, ecology, and use of the Bay, each of the following reflective experiences helps students develop the critical thinking skills of perspective. In each of these exercises, students select a spot along the Bay to sit quietly alone in order to reflect and record their thinking. Each reflective field experience described in the lesson plans below is anticipated and prepared for through classroom readings, discussions and questions. Students may be asked to comment upon selected texts, emulate the writings of selected authors, or respond to specific prompts or questions.

In addition, the student writing from these field reflections is discussed and reviewed in the classroom through class critiques and peer review session prior to submission to the Field Guide. This process is discussed in Strand 7: Peer Review, Class Critique, and Class Constructed Rubrics.

Lesson Plan 5.1: Nature Reflection Version 1 (30 minutes)

Remain alone. Sit quietly. Close your eyes. Open your eyes.

First impression: What are you feeling? What are you thinking? What do you hear? What do you smell? What do you see? Write.

Second impression: Remain alone, sit quietly, close your eyes, open your eyes. Focus upon something very close to you. Stare at it for a while. What do you see? What is happening? Why is it there? What does it remind you of? Write.

Third impression: Remain alone, sit quietly, close your eyes, open your eyes. Focus upon something far, far away. Stare at it for a while. What do you see? What is happening there? Why is it there? What does it remind you of? Write.

Field Guide Project • DRAFT 3/06

Last impression. Remain alone, sit quietly, close your eyes, open your eyes. You are getting ready to leave your place, a place you have studied, a place that has been all yours, a place where you have been alone. You may choose to write a poem, a personal reflection, a comment about the Bay as both a place of nature and a place that shows great impact from the industrial revolution. Write about what you are feeling now.

Lesson Plan 5.2: Nature Reflection Version 2 (30 minutes)

Remain alone. This is not a writing assignment to be completed, but an experience that gives you a chance to think and reflect. Do not use headphones or cell phones. This is a time for you to listen to the sounds of the Bay and a chance to think or reflect.

Close your eyes. Rest, but do not fall asleep. Reflect. Open your eyes.

First impression. Write. What are you feeling? What issues do you need to write about so that you can appreciate the experience? Write about these feelings and problems now.

Stop writing. Look out at the Bay and observe the human industrial activity there. What do you see occurring? Are there fishing boats? Military facilities? Factories? How are people using the Bay to make money?

Close your eyes. Rest, do not fall asleep. Reflect upon the questions. Open your eyes. Write. How are humans using the Bay for commercial advantage? What industries are present? What is their impact? What military facilities are present? What is the impact?

Stop writing. Look out at the Bay and observe the recreation taking place. Are people jogging along the side? Are there restaurants? people fishing? fishing boats? yachts?

Close your eyes. Rest, but do not fall asleep. Reflect. Open your eyes. Write. How are people enjoying the Bay? What activities do you see going on? What does it cost to enjoy these activities? What impact upon the Bay do these activities have? What interactions does these recreational activities have with the industrial activities.

Stop Writing. Reread everything you have written so far. What comes to your mind? What other things would you like to write about?

Close your eyes. Rest, but do not fall asleep. Reflect. Open your eyes. Write. If you have seen a boat with a unique name, a tree with interesting bark, a thought that is new, a feeling to express, consider writing about it. Write a poem.

Sketch a scene. Then write about your sketch. If you wish to talk about the field experience so far and what you are learning, write about it. You are soon leaving this place. How do you feel now?

Stay in your location. Enjoy the Bay. Enjoy the tranquility. You will soon be called to come back to reality.

Field Guide Project • DRAFT 3/06

Lesson Plan 5.3: Nature Reflection Using Student Constructed Formula (30 minutes)

This highly effective nature reflection format uses the inspiration provided from classroom readings of important nature writers. In *Strand 2: Nature Writers in America* the development of the Thoreau Formula was outlined. Prior to departure, review the steps the selected author took in the writing of their nature reflection. The interested teacher may wish to outline these steps so that student can refer to these suggestions when in the field. See sample outline from the *Thoreau Formula Lesson Plan* below.

Upon arrival at your location: Sit quietly. Write.

Introduction, reason, setting (Tell the reader why you are here.)

Continue to sit quietly. Write.

Human problem or concern (What problem, concern or need do you wish to discuss?)

Continue to sit quietly. Write.

Nature Observation (Describe in detail the nature that surrounds you. You may wish to look very closely at something. Examine insects, a leaf, look under a rock.)

Continue to sit quietly. Write.

Application of Observation (How can you apply what you have observed to your concern? What came to your mind when you were observing? Did any ideas or possibilities stir? If so note them here.)

Continue to sit quietly. Write.

Advice (Before you leave this place, what advice do you have for others? What has the quiet told you about life? What have you learned here?)

Lesson Plan 5.4: Cumulative Nature Reflection (at least 30 minutes)

Choice # 1. Using one or more of Jared Diamond's five factors that have contributed to the collapse of past human civilizations, write about how you see one or more of these factors causing problems (or not) in the scene before you.

Diamond's Five Factors: Human environmental damage
 Climate change
 Enemies
 Trading Partner Change
 Social elite (ruler) Isolation

Choice # 2. Philip Leibson wrote the following poem upon viewing the skyline of Chicago. Write one of your own viewing the skyline of San Diego.

*A city of 60 silver domes, streets paved with lead, a crystal theater,
a man arriving on a special evening when the days are getting shorter and
multicolored lamps are lighted all at once.*

Has anyone before lived an evening identical to this?

*A city that he dreamed of as a young man and arrived at in old age—desires
are already memories.*

Field Guide Project • DRAFT 3/06

*A city where perfect violins and telescopes are made.
A city of aluminum towers, where the past is told in the corners of the streets, the banisters of steps, the gratings of windows.
A treacherous city which gives form to desire.
You believe you are enjoying the city but become its slave.
A city of signs, scales, dolphins, cornucopia. The wares in the stalls are signs of other things.
The embroidered headband stands for elegance, the guided palanquin power, the ankled bracelet voluptuousness.
A city in which a succession of streets, of houses along streets, of doors and windows of houses, follow one another in your memory like notes of a musical score, immutable in their succession.
This city must be memorized.
A city of transportation, with dirigibles flying in all directions, multiple levels of elevated and underground railroads, ramps, and highways, above a deep subterranean lake.*

Choice # 3: Place and Feeling. Close your eyes. How are you feeling at this moment? What do the sounds, feel of the air, temperature of this place remind you of? How would you describe this place? What does it tell you about our relationship with the Bay and nature?

Choice # 4: Sketch and Tell. If you wish, sketch a scene. Perhaps you can draw a map of your location in the world. Or, you might want to depict the Coronado Bridge, or the skyline before you. After you have finished your drawing, write a story about it or a description of it.

Lesson Strand 6: Educational Field Trips

In addition to field trips to local survey locations, other important points of interest might be visited, including local museums, research centers, businesses and industries, as well as popular recreational and Bay-related entertainment sites. In delivering this curriculum, we traveled aboard the Hornblower Cruises, toured the Midway Aircraft Carrier, visited local shops and restaurants along Harbor Drive, and received guided tours of the Institute of Creation Science and Natural History Museum. A sample lesson plan for our Institute / Museum Field Trip follows.

Lesson Plan 6.1: Institute of Creation Science and the Natural History Museums

Pre-field trip activities are essential. We take several steps in the classroom to prepare for upcoming field trip. Once the adventure has begun, there is likely to be little opportunity for direct instruction. Ongoing note-taking might be expected, but kept to a minimum. Certainly Follow-up activities are to be expected and essential to the overall understanding of the field trip and the development of the Project.

Review and Discuss: The Evolution vs. Creationism Debate. Scopes Monkey Trial, Creation vs. Evolution Debate, current events and news stories including Kansas and Texas textbook adoptions and the teaching of biology.

Field Guide Project • DRAFT 3/06

Key Discussion Questions: What does the theory of evolution state? What explanation does creationism give? Why are these two ideas in conflict? How did this conflict appear in the past? How does it continue to appear?

Field Trip Observation Questions: (provide these prior to departure)

At the Institute of Creation Science:

What explanation is proposed? Why? What evidence is provided to support this explanation? How are conflicting ideas addressed? How does the Institute go about making its case?

At the Museum of Natural History:

What theory is proposed? Why? What evidence is provided to support this theory? Are conflicting ideas addressed? If not, why not? How does the Museum go about making its case?

Post Field Trip Write-up:

These two places proposed very different explanations about the origins and development of life on earth. How do these accounts conflict with each other? What place in nature does the Institute of Creation Science give humans? How does the Museum of Natural history view human's place in nature? How does each of these differing ideas lead humans to relate and treat nature? Do the viewpoints represented by these places led to different "attitudes" about nature? How? Why? What are the consequences of these different attitudes?

Share and Critique: See *Strand 7: Peer Review, Class Critiques and Student Constructed Rubrics* for strategies to revise and prepare this work for the Field Guide.

Lesson Strand 7: Peer Review/Class Critiques/Student Constructed Rubrics

Written pieces for the Field Guide are started early and continue throughout project delivery. Therefore, the following class "critiques" may be interspersed as needed and when appropriate. Upon completion of a writing assignment, the following review activities may be used to provide opportunities for instruction in the mechanics of writing, text significance, quality and quantity, and other aspects of good writing..

It is important to remember that the teacher is not the only "corrector" in the classroom. In fact, dependence upon the teacher as the only one capable of review, removes responsibility from students and leads to the "good student" syndrome. This syndrome occurs when students blindly redo teacher-correction without thinking, because, these corrections are the teacher's. To avoid this problem, to increase the quantity of corrected material, to help students develop revision skills themselves, and, in short, to help students become better writers, it is essential to implement some form of peer review in the classroom.

With the dual goals of making student better writers and preparing student writing for publication in mind, the following, closely related strategies are suggested.

Field Guide Project • DRAFT 3/06

Lesson Plan 7.1: The Basics of Peer Review

In this highly structured approach to peer review, students are provided with the work of another student for review and correction. During this time, it is important that students focus upon the task before them. If students are correcting each others work at the same time, they may become more concerned with the marks they are receiving than those they are giving. This problem can be avoided by selecting papers from an entirely different class for correction.

H.O.C.s (Higher Order Concerns)

H.O.C.s involve issues of content, structure, clarity and meaning. H.O.C. issues are frequently quite specific to the content requirements of the paper. In order to review H.O.C.s it is helpful to define particular “categories” for consideration. Each category can be defined and discussed for the expectations it holds prior to the actual review. For instance, under the category of “Introduction” students might be asked if the writer adequately introduced the topic by including certain features and information. A discussion of what a good introduction looks like can then take place. Examples of good introductions can be read aloud, their essential components exposed and analyzed. Ask students to read texts with ideas that are controversial, interesting or provocative. This activity allows the teacher an opportunity to highlight, further refine, and expand upon important concepts by using the student work as a “spring board.” In addition, students will make the conceptual leap from “critic” to “creator” by considering the discussion held at this time when they revise their own texts.

Other possible H.O.C. categories:

- Does it make sense?
- Is it structured in a logical manner?
- Is the content appropriate?
- Does it include all the required sections or parts?
- Are there better ways of saying it?
- Is the writing important or significant?
- Does the writing exhibit quality? Is it well done?

A grid can be placed on the back of the written work, which allows students a place to make notations regarding their H.O.C. corrections. A simple H.O.C. grid might include the following

Category / Points Earned / Comments / Questions / Reviewer's Initials

All parts present
Intro
Body
Conclusion
Clarity
Significance
Total pts.

Field Guide Project • DRAFT 3/06

Please note: While it may be tempting to first look at student writing for basic errors in grammar or mechanics, every effort should be made to avoid this tendency at this point in the process. If minor concerns are addressed too soon, the reviewer is giving tacit approval that the larger and more important content of the text is just fine and therefore worthy of such attention.. In other words, if the section is poorly conceived, illogical, or unnecessary, why should the reviewer even bother to check for minor corrections there?

L.O.C.s (Lower Order Concerns)

L.O.C.s include problems in grammar, spelling and mechanics. As with H.O.C.s, a grid can be composed with specific categories of interest and importance. Possible categories include punctuation, verb tense, verb-subject agreement, sentence fragments, run-on sentences, sentence transitions, paragraph cohesion and more. When the number of categories is limited, the entire paper may be corrected for L.O.C.s. However, if a broader look at these concerns is required, a common section of the paper may be selected and “boxed off” for review. Upon return of the original drafts, the expectation for the original writer will be to carry these corrections to all parts of paper.

Lesson Plan 7.2: The “Ron Berger” Critique

Inspired and adapted from the work of Ron Berger, teacher and author of An Ethic of Excellence, this classroom strategy helps students look critically at each other’s work in a positive and helpful atmosphere.

In this critique session, the original author presents his or her work to the class as a whole. The steps to the “Ron Berger” Critique are simple and straightforward. After presentation of the work, students are asked to respond using the following three steps:

“Something positive.”

“Something helpful.”

“Something specific.”

In saying something “something positive” students start their review by not placing blame or fault upon the original author. This step allows the process to proceed in an atmosphere of trust and cooperation.

In saying “something helpful” the reviewer notes an area in the work that could be improved. By being helpful, the reviewer finds that the work has merit at it stands, but could have even more if “this or that” were considered.

In saying “something specific” the reviewer provides specific advice and suggestions for the improvement of the work. With the outright negative comment circumvented, the reviewer provides examples, specifics, and constructive ideas in which the original author may find excitement, too.

Note: The “Ron Berger” Critique requires practice to perfect. The challenge is to steer the student down the center. By going too far to one side, students can take on a super-

Field Guide Project • DRAFT 3/06

sweet attitude that in effect mocks the proceedings. On the other side, the caustic and the negative can lie just beneath the surface of the format. The teacher will need to carefully moderate, even participate, in the proceeding to set a tone of helpful and constructive criticism.

Lesson Plan 7.3: Class Constructed Rubric

The class-constructed rubric might be seen as an extension of the “Ron Berger” Critique, which then evolves into a structured peer review session. Thus, the class constructed rubric combines elements from the previous two lesson plans. In this strategy, students not only decide what is important, but they also place a value upon that importance, and then go about the review and scoring of papers accordingly.

Step 1. Sample Set. A sample set of papers (4 or 5) are read aloud or rotated throughout the room for silent reading. As these papers will be used to establish a rubric, it is recommended they be anonymous and represent the complete array of submitted work. With an anonymous “full set,” students are encouraged to be as forthright and critical as possible. After students have each had a chance to read or hear all the papers, the room is ready for Step 2.

Step 2. Critique Session. Select a specific paper and, in a modification of the Ron Berger Critique, ask the students what was exceptional about it. Cluster these answers on the board, overhead, or projection. Ask the students what could be most improved about the given paper. Cluster these answers. Proceed through each of the sample papers.

Step 4. Arrangement. Arrange and organize the clusters. Certain clusters will have received numerous notations and others only a few. Eliminate those comments that seem too specific or that can be “folded into” a larger concern. Separate your clusters into two major fields, H.O.C.s and L.O.C.s.

Step 5. Grid Arrangement. Focusing upon the H.O.C. field first, select the cluster with the most comments. Find a word which best characterizes the selected cluster. Use this word to name a rubric category. (The words inside the cluster can be used to define that category.) Continue rubric construction with several more H.O.C. categories and a selected number of L.O.C.s.

Step 6. Weighting. With the grid or rubric categories selected, their value must be determined. Are some categories worth more than others? Why? After discussion, and most likely a good deal of haggling, award points to the various categories established.

Step 7. Review Session. Distribute papers and proceed with a review and grading session as discussed in the *Lesson Plan 7.1: The Basics of Peer Review*.

Lesson Strand 8: Special Assignments: Providing Opportunities for Enrichment with a Project-driven Curriculum

Field Guide Project • DRAFT 3/06

Projects can provide students with opportunities for enrichment and furthering their interests in specific areas. During the development of the Field Guide, students have done additional assignments, including short stories, travelogues, reviews, humorous essays, and histories on specific subjects.

In our first year, students undertook the detailed history of the Boat Channel's development and construction. They attended lectures sponsored by the San Diego Historical Society, approached local historians, and conducted research on the Internet. This year, a major additional assignment was to write the history of mapping of the San Diego Bay, as follows:

1. Assignment Approval / Topic Formation: What is the assignment's essential question? What is the focus of the assignment? What style or genre should the assignment take? What is the anticipated length?

Students may come up with their own ideas, or teachers may offer suggestions. In any case, this conversation will necessary prior to the start of work. Individual or small group conferences will need to continue through the course of the work.

2. Resource Location: The internet may not be enough. Community resources, local university libraries, museums, foundations and historical societies may hold necessary resource materials. Students may need assistance in approaching and securing contact with some of the individuals who staff these institutions. Introductions to volunteers and librarians, appointments, and assignment discussions with these individuals may be necessary.

3. Assignment Review and Revision: Ongoing conferences with students undertaking these special assignments will be necessary. Ongoing class or peer review of these assignments may not be topical or appropriate for the larger class. As class-wide instruction and guidance may not address their particular topics, students will likely have questions not covered by the class. As such, individual teacher feedback and conferences will be essential.

4. Example / Additional Points: In the development of an article entitled "A History of Mapping of the San Diego Bay," each of the above steps was necessary. A copy of Lloyd A. Brown's book, *The Story of Maps*, and other articles on cartography were provided. Students were introduced to a San Diego State University graduate student in GIS (Global Information Systems) technology, and a research volunteer at the San Diego Historical Society. While email communication served admirably in the case of the graduate student, it was necessary to arrange an appointment schedule and admissions monies to the Historical Society. As often happens in independent research, the work tended to grow beyond the bounds of the assignment. Consequently, it became necessary to eliminate superfluous research and refocus student attention on the assignment. As the work did not receive timely attention by the class, the writers of this piece needed conferences for review and critical feedback.

Field Guide Project • DRAFT 3/06

Lesson Strand 9: Comparative physiology: Evolution of organ systems

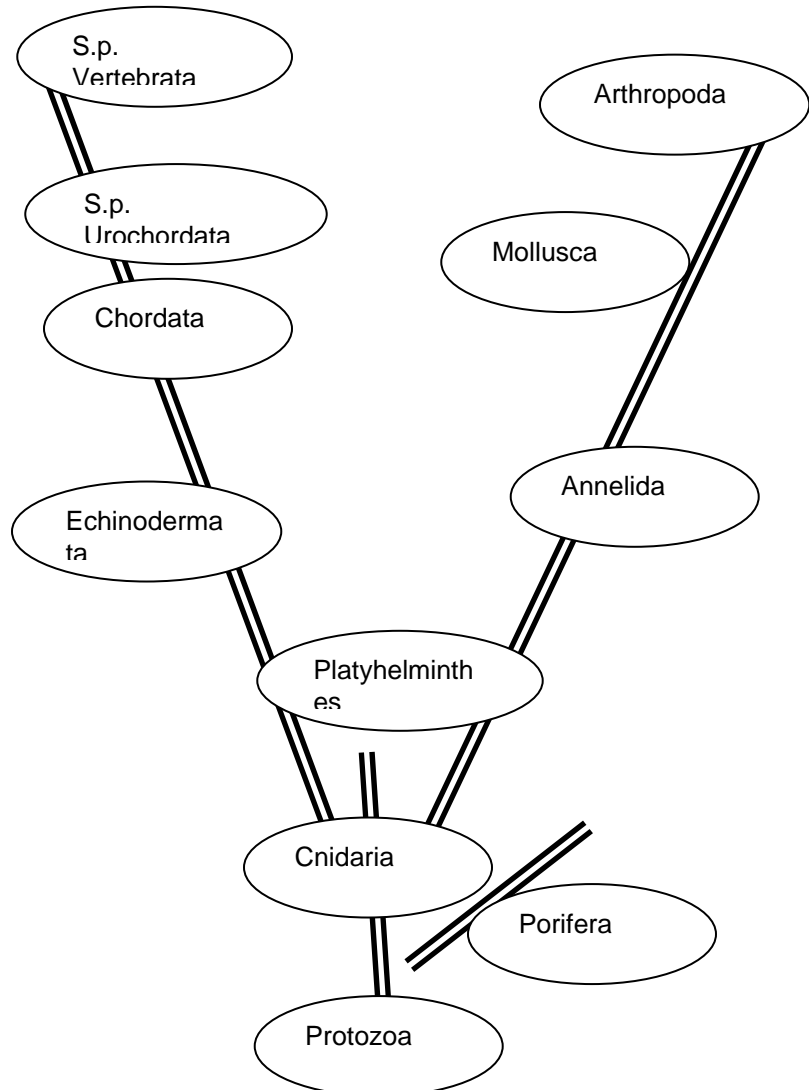
Most students don't realize that the vast majority of animals do not have a spine. The invertebrates are cold, squishy, crunchy, spineless wonders that make up more than 98% of the world's living fauna. To introduce physiology, students will take a phylogenetic approach to survey the major invertebrate phyla, leading up to the Chordata. In other words, they will worm their way around the evolutionary tree from the primordial ooze into the highest branches just below "us."

The groups to be studied exhibit tremendous morphological, physiological and ecological diversity. Because of the diversity encountered in the Field Guide project, students can take a comparative look at life's natural experiment to explore the many biological concepts and themes demonstrated by the invertebrates.

During this section of the class students should be able to identify the major invertebrate phyla by understanding the key characteristics of each phylum and the relationship of those key characteristics to the phylogeny and ecology of each group.

Phyla

1. Porifera
2. Cnidaria
(formerly Coelenterata)
3. Platyhelminthes
4. Echinodermata
5. Annelida
6. Mollusca
7. Arthropoda
8. Chordata,
Subphylum Urochordata
9. Chordata,
Subphylum Vertebrata



Field Guide Project • DRAFT 3/06

Procedure:

1. Choose a partner
2. Choose a phylum.
3. Design a PowerPoint presentation with the following:
 - a. Define etymology of phylum name and important marine Classes within phylum.
 - b. Describe common members.
 - c. Describe general morphology of the primitive/general form within phylum.
 - d. Define major organ systems (at least 3) and how they are related to groups more primitive and advanced than your phylum.
 - e. Relate the above organ systems to humans.
 - f. Other interesting information “Barnacles of the phylum arthropoda have the largest muscle fibers of any animal.”
 - g. Commercial properties

Lesson Strand 10: Ecological assessment: Sub-sampling a biological community

Purpose:

There are many reasons why a biologist may need to determine the species abundance and diversity of a particular community or ecosystem—for example, to determine the allowable take for a fishery or to determine the natural state of a habitat before a planned environmental disturbance or development activity.

Biologists sub-sample communities in a variety of ways. A bat or bird specialist may hang fine nets between trees to “catch” local species to determine something about the species abundance and diversity. For a fixed population of creatures, such as those along the rocky intertidal zone, sampling is quite a bit easier. However, there are many challenges in designing and implementing the optimal method to determine the population structure of a particular creature in its habitat.

Lesson Plan 10.1: Developing a method to survey the intertidal zone

In order to survey the animals of the rocky intertidal zone determine how a biologist might sub-sample this habitat. Describe in detail the approach you plan to take in conducting your survey. Here are some considerations to take into account:

1. Materials needed.
2. Statistical methods to be used.
3. Random or targeted approach.
4. Timed or untimed.

Students will also make a diagram of the survey approach(es).

Lesson Plan 10.2: Surveying the shore at low tide

Field Guide Project • DRAFT 3/06

Students will apply survey techniques that they have developed to determine species abundance and diversity in the habitat of choice. The considerations from Lesson 1 must be taken into account when conducting the actual survey.

It is important that students record all necessary information for each survey. This information may include date and time of day, location, GPS coordinates, tide height, weather conditions, and data recorders (student names).

Lesson Plan 10.3: Survey data analysis

Following the intertidal surveys students will conduct data analysis of the transect data with Excel. First, they need to set up a spreadsheet and enter all of the accumulated data. They can then generate graphs showing species distribution and abundance compared to a variety of parameters, including site, tide height, location from the ocean, or other features.

Students can also compare different survey techniques done in the same region to assess the accuracy of the approaches. Because of the additional variables with different survey techniques, it is very important for long term studies that only a single method be employed.

The standardized method for our intertidal study of San Diego Bay was the following:

In order to quantify the species at a given location, we had to have a system by which we would measure them. The first step was to create a grid by which we could count and quantify the creatures within the grid. A 0.5 meter by 0.5 meter square frame made of PVC pipe made the outline of our grid. Due to the sheer size of a 0.25 meter² square, only the corners of the 0.25 meter² plot were used. By stringing line across our plot, four 10 cm by 10 cm squares were made at each of the four corners of the 0.25 meter² plot. The next step was to know where to place the plot in order to count the creatures at the different tidal heights along the beach. To begin, a tide chart from Scripps Institution of Oceanography was then used to find the exact time at which the low and high tide would be at a 0 foot tide height. A pole was then placed in the ground to mark the 0 foot spot. Once we knew where the 0 foot mark was, five ropes were laid perpendicular to the water line approximately 2 meters apart from each other to create transect lines on the shore. Along each transect line at the 0 foot tide mark a plot was placed on the ground. Next was to observe the creatures underneath each plot. Only the 10 cm by 10 cm squares at the 4 corners of the plots were used to observe what was inside of them. For each of the 10 cm by 10 cm squares, the composition of the ground (rock or sand), and the type and number of a particular species were recorded. Once each of the four corners had been recorded, the plot was then moved.

To address the intertidal zonation at each site a novel method was developed to precisely find the location of the -1', 0', +1', +2', +3', and +4' tide heights. From the marker pole that was placed at the 0' tide height, one foot was measured up from the bottom of the pole. At that point, a laser attached to a bubble level was

Field Guide Project • DRAFT 3/06

leveled and then shot until it hit somewhere on the transect line +1 up the slope from the previous survey mark. The point where the leveled laser hit the transect line was the +1 foot tide height location. The plots were then moved up the transect line and everything was surveyed once again at the +1 foot tide height mark. This method alleviated the necessity to wait for the tides to come in and out. The process was repeated until all of the tide heights along the transect line were surveyed (from -1' or 0' to +5'). Once this happened, the transect line was picked up and in a leapfrog fashion was placed another 2 meters down the beach. When the transect line was placed down again, all of the steps repeated until a substantial portion of a particular beach had been surveyed. Each site included 15 to 30 transects. While the survey data of the living creatures was being collected, the geographic portion of the survey had to also be created. For each of the sites that were surveyed, GPS units were used to mark the boundaries of a particular survey site. These were obtained by collecting the GPS coordinates for each of the corners of the area being surveyed and then plotting out the area on a computer. Once we had a polygonal plot of the survey area, the location could be then geo-referenced to satellite imagery and other survey plots to generate the maps that showed the distribution of species across San Diego Bay. There was one instance in which we had access to a system called a differential GPS. While normal GPS units have an accuracy of approximately 20 feet, a differential GPS has accuracy to within 8 inches. After collecting data and using algorithms that correct for atmospheric interference, extremely accurate survey results can be collected. At the Coronado survey locations, we were able to use this system to map out the locations of the individual plots; a feat nearly impossible with normal GPS units.

(Except from Perspectives of San Diego Bay: A Field Guide)

Sample Lesson Series 11: Field Guide Writing

Lesson 11.1 - Etymology: Origin of a name

Purpose:

Every organism known to science is classified by a system created more than a hundred years ago known as taxonomic classification. From the Greek *taxis*, meaning “order”, and *nomi*, “method”, taxonomy does just that: It orders living things by a very specific method. This classification places organisms in different groups. An individual organism, such as a specific type of wolf, or ape, or butterfly, is referred to as a *species*, a group of closely related species is called a *genus*, a group of related genera (plural of genus) is called a *family*, closely related families belong to an *order*, related orders to a *class*, classes to a *phylum*, and phyla to a *kingdom*. In this manner, every organism is given its classification by science. For example, the grey periwinkle, a tiny coastal rock-snail, is classified as belonging to the kingdom *Animalia* (animals), phylum *Mollusca* (the mollusks), class *Gastropoda* (the gastropods or the snail like organisms), order *Mesogastropoda*, family *Littorinidae*, genus *littorina* (all of the grey periwinkle’s close relatives), and, finally, the specific grey periwinkle, species *planaxis*.

Field Guide Project • DRAFT 3/06

These scientific names come about from different influences. Most genus or species names of an organism refer to some physical attribute or behavior of that organism. The Western Grebe, for example, is known as *Aechmophorus occidentalis*, which means “Western Spear Bearer”, a good name for western bird with a long, sharp beak. Others, however, might refer to original Latin or Greek names for organisms. *Canis*, for example, is Latin for “dog”, while *lupis* is Latin for “wolf”. *Canis lupis* therefore aptly means “Wolf Dog”. Others still are named after geographical regions, such as the American coot, *Fulica americana*, or in honor or respect for people, groups, or organizations. In such cases where, more often than not, there is no Latin or Greek translation, these names are “Latinized” to make them appear Latin, such as in the *californica* example above. Think not, however, that all names are serious and uptight. Names such as *Agra cadabra*, *Hebejeebie*, and others have managed to be snuck in by the occasional scientist with a sense of humor.

(excerpt from Two Sides of the Boat Channel: A Field Guide)

Procedure:

Select 5 species that are within the field study. They can be from the same phylum or be representatives of different phyla. Determine the etymology for both the genus and species names. Include:

1. Common name
2. Scientific name (genus and species)
3. Name of person who named the organism and what year this was done.
4. Genus translation and language of origin.
5. Species translation and language of origin.

Lesson 11.2: Species Write-up

After reviewing existing field guides, have students list the important characteristics that should be included for each creature. These may include species range, morphology, communication, and feeding.

The following is the final format used for *Perspectives*. See the notes added at the end by student editors to ensure uniformity of writing for each species described.

Common Name _____ Genus species _____

Class _____ Order _____ Family _____

Morphology: Size. Color. What they look like. Sexual dimorphism (differences between genders)

Communication (birds and mammals only): What they sound like.

Range: Geographic distribution

Feeding: What they eat.

Field Guide Project • DRAFT 3/06

Locomotion: How they move around.

Reproduction: Mating season. How do they reproduce? How many offspring per reproduction cycle? At what age? Describe the eggs.

Etymology:

EXAMPLE: *Anas platyrhynchos* (L. *Anas* Duck; L. *platyrhynchos* Flat Beak.)

Other: Commercial properties or other interesting information (e.g., endangered species)

References.....Where did you find your information?

Notes:

Set font to Times New Roman

Set font size to 8

Single-spaced

Paragraph, but with *incomplete* sentences that are as short as possible (Ex: Change “House finches can breed anytime between March and August” to “Breeds between March and August”)

Shorten/Lengthen to ½ page, not including works cited.

Make sure to include ALL sections (communication only for birds and mammals)

Taxonomical names are italicized, not bold, not underlined (nothing should be underlined)

Section names (ex: Morphology:) should be bolded followed by a colon.

Lesson 11.3 - Dichotomous Key

A couple is walking down the beach at low tide and see a fascinating creature. They want to know what it is, but do not have a background in zoology. Luckily, they have access to the following dichotomous key to help them in their identification quest. A dichotomous key is merely a written tool to classify an object using a series of linking questions. The many connected questions will lead any reader to the identity of the unknown object through simple observation. For example, pretend that you are staring at three different pieces of sport equipment. All you need to do is to answer the questions, then follow the directions and you will be able to identify the ball you are looking at.

1. Is the ball round?
 - a. No – The ball is a football.
 - b. Yes – Go to question 2.
2. Is the ball orange?
 - a. No – The ball is a baseball
 - b. Yes – The ball is a basketball.

Field Guide Project • DRAFT 3/06

This simplistic example hopefully gives you a general idea of how to use and construct your own dichotomous key. If you carefully examine the creature that you are looking at and identify unique features then you will be able to create a dichotomous key.

The key should lead the reader to the animal that they are looking at. This key may take a while to create due to the complicated nature of life. You may make two different keys for this book. One is for all vertebrate animals (animals that have a backbone) and one for invertebrates (animals that do not have backbones).

See the Ron Berger critique above (Lesson Plan 7.2) for peer review of written work.

Assessment

Tests in mathematics, reading, writing, biology, and history are readily available. However, assessing critical thinking, planning and organization, problem solving and presentation skills requires ongoing project-specific performance evaluation via journals, self-reflections, rubrics, process analysis sheets, deadline completion check-offs, and culminating presentations of learning. The most important goal of environmental awareness remains the most difficult to capture in quantification. We propose that a hands-on field experience will better instill an active concern and stewardship for the environment than a didactic approach. The final test for environmental awareness, however, does not belong to any classroom assessment but rests with our survival.

Assessment Ideas

Many classical assessments can be used to enhance and evaluate this project. Matching these assessments to content delivered will measure and reinforce student acquisition of content standards. However, projects are constructed to incorporate content in the larger context of critical thinking and applied learning skills. In order to measure these student abilities, successful projects employ a continuing stream of process assessments. Each step along the way to the larger project goal is expected, noted, and sometimes measured. Records of student effort, cooperation, and completion rates are continually kept. By doing so, casual workshop atmospheres are imbued with expectations that provide direction and order to students frequently at different places or at different tasks. Ongoing process checks can also be used to find problems before it becomes too late, to ascertain when it is time to move on, and to pace re-teaching or direct instruction.

Such process checks can be as simple as quick oral “pulse taking” at the end of the day. Such general class discussion will frequently reveal problems and set back, as concerned students express their needs for more time or instruction. Such oral assessment is likely to be for the benefit of instruction rather than for direct student assessment.

In logs or journals students might answer a series of prompts such as:

What did you complete today?

What went well today? What did not?

How well did you work toward the reaching the target?

Field Guide Project • DRAFT 3/06

Do you need more time? Why?

Such written work allows quieter students a chance to voice their concern. In addition, log questions can be tailored to the specific requirements of the assignments. Such questions can also be more probing about individual behavior and responsibility. Logs and journals allow for individual assessment rewards.

Long-term projects, which include a series of steps that must be completed in order, require timelines with completion check off dates. While it is advisable to allow for the occasional postponement, ongoing process activities (as mentioned above) will be necessary to achieve check off dates.

Quality is important for each project step as well as the final culminating product. As these final products differ depending upon the project, each product assessment will differ. It is useful to develop rubrics to assess these products. A rubric's categories can reflect the broad range of aspects of a given project, as well as the quality and distinction found within each category. Final product rubrics should be reviewed and discussed early in the project, so that students will know what they will be held accountable for. Rubric review might entail the creation and construction of rubrics by the students themselves. In that case, teachers and students have collectively agreed upon the project's expectations.

Supporting Diverse Learners in this Project

Several strategies can be employed to address the needs of diverse learners in the project-driven classroom. In fact, a classroom project orientation will actually provide opportunities to address the need of basic, accelerated and advanced learners.

Within the project's delivery of conventional lesson plans, techniques can be employed to help address diverse learning needs:

- heterogeneous grouping (by placing different learners in the same group, students will work together in learning the material)
- basic - advanced pair shares (pairing students with different ability levels allows the basic student to experience a tutorial, which the advanced is given the opportunity to teach the material)
- task / question sequencing (by providing a series of progressively more difficult tasks, students can proceed to the level in which they feel most challenged)
- text variety (by providing text with different reading levels, students can select texts which are approachable and somewhat challenging)
- checking for understanding (concluding the conventional lessons by checking for understanding allows for discussion, clarification, and review of points not understood)
- re-teaching (reflective teaching leads to the cycle of inquiry regarding classroom practices; when teachers ask if objectives were achieved, reflect upon their lessons and make revisions, students of all ability levels benefit)

Projects offer many opportunities to address diverse learning needs:

- student selection (when students are allowed to choose topics of their own interest, increased engagement and learning are more likely)
- independent research and practice (on many days, the project-driven classroom will find students working independently or in small groups; these extended periods of time provide excellent opportunities to work one-on-one with students who may be struggling)
- enrichment topics (a broad and multifaceted project presents many different topics for exploration; accelerated and advanced students may wish to take undertake project work on one of these topics)
- critiques and peer review (essential in the production of authentic work, this activity allows all students to actively engage in the assessment of student work; in doing so, students identify areas for improvement of their own work)

Teacher Reflections

Project-driven curriculum can be accomplished in the single-subject classroom or by integrating topics from diverse disciplines. Each approach has its rewards and consequences. While the single-subject project can be quickly and independently

Field Guide Project • DRAFT 3/06

implemented, it may not have the authenticity of an integrated project. Likewise, the integrated project will be more meaningful, but will require a great deal of advanced planning and ongoing coordination between teachers.

Implementing a project-driven curriculum requires having “several irons in the fire” at the same time. While the beginning of the year may start with traditional approaches, by the end of the year the classroom is likely to be completely “project-driven.” While the implementing teacher will likely be required to move back and forth between formatted lessons and workshops, the general mix will move from format to workshop.

It is important throughout the delivery that check-ins or checkpoints be calendared in advance and take place. By doing so, the implementing teacher can gauge the degree of work that has been done in the workshops and provide additional direct or more formatted instruction as needed. Ongoing critiques or peer reviews also provide information about progress to date. Students will often require more time than expected to complete the project. It is therefore not a bad idea to leave plenty of “cushion” after each checkpoint and at the end of the year.

Perhaps the best advice is to “dive in.” The water will be cold at first, but it will warm in time. Allow extra time to make adjustments and revisions. When planning the project, make every effort to make your conventional or directed lessons directly applicable to the larger goals of the project. Wrap your lessons around a theme that serves the purposes of your final project. In the curriculum presented here, the production of a Field Guide required lessons in United States history about land use and the environment. The product of a Field Guide led us to America’s tradition of nature writers. Content is not studied merely for the sake of itself, but for the information it can provide toward the larger goal: the development of a Project.

Good luck!

Appendix 1: Sample Process Log

Student Report

Remained on task through out the assignment. Followed suggestions and guidelines of the prompts. Produced good work. Did not use cell phone, headphones, or other electronic media. Remained alone during reflection.

Student Notes

Self-Assessment

<i>Completed all category descriptors, completed notes, attached excellent work.</i>	<i>5 pts</i>
<i>Completed all category descriptors, completed notes, attached good work.</i>	<i>4 pts</i>
<i>Failed to complete some category descriptors, remained alone, completed notes, attached excellent or good work</i>	<i>3 pts</i>
<i>Failed to complete some category descriptors, remained alone, completed notes, attached fair work.</i>	<i>2 pts</i>
<i>Failed to complete category descriptors including not remaining alone, completed notes, attached excellent or good work</i>	<i>1 pt</i>
<i>Failed to complete category descriptors, did complete notes, did not attach any or adequate work.</i>	<i>1 pt</i>
Total Points	

Teacher Report

Comments: _____

<i>Notes are accurate, category descriptors fulfilled, field observation agrees, excellent or good work is attached.</i>	<i>5 pts</i>
<i>Notes are accurate, category descriptors fulfilled, field observation agrees, fair work is attached.</i>	<i>4 pts</i>
<i>Notes are accurate, some category descriptors not fulfilled, field observation agrees, work is attached.</i>	<i>3 pts</i>
<i>Notes are accurate, some category descriptors including remaining alone are not fulfilled, work is attached.</i>	<i>2 pts</i>
<i>Notes are not accurate, field observation does not agree, work is attached</i>	<i>1 pt</i>
<i>Notes are not accurate, field observation does not agree, work is not attached</i>	<i>0 pts</i>
Total Points	

Appendix 2: Field Guide Project Presentation Rubric

Group Scoring Component (list members): _____

1. Group is well organized; leader introduces all members of the group; individual presentation order has been determined in advance; questions are called for after each individual presentation; presentation flow is maintained positively by the group's leader.

Exceptional (3pts) *Acceptable (2pts)* *Need Improvement (1pt)*

2. Field Guide Section: Section is introduced by a group member. Section's interrelationship and connection to other Field Guide components is explained and justified. Group's specific topic is defined and outlined.

Exceptional (3pts) *Acceptable (2pts)* *Need Improvement (1pt)*

3. Field Guide Visuals: Visuals are presented by another group member. Visuals' attributes are reviewed and demonstrated. Technological features are presented. The main point or purpose for each visual is discussed and explained.

Exceptional (3pts) *Acceptable (2pts)* *Need Improvement (1pt)*

4. Field Guide Factuals: Section scientific facts and mathematical components are presented by another group member. If Section is reflective or summative, appropriate supporting factors are defined.

Exceptional (3pts) *Acceptable (2pts)* *Need Improvement (1pt)*

5. Question and Answer: Group (or remaining presenter) call for questions from panelists. Answers are given with insight and understanding of the content. Answers give consideration to issues of complexity, connections to other variables and compassion for all life on the planet.

Exceptional (3pts) *Acceptable (2pts)* *Need Improvement (1pt)*

Total Points (10 pts required)

Individual Scoring Component

Poise: eye contact, effective movement and hand gestures, posture

Delivery: clear and distinct, positive tone of voice

Information: logical, interesting and persuasive

Question and Answer: listens and responds appropriately

Collaboration: insightful reflection on questions regarding project development, coordination, and final completion

Content: insightful answers to questions about global warming, assigned subtopic, interrelationship between subtopics, complexity and compassion

Habits of Mind: insightful reflection and response to questions requiring perspective, evidence, connection and supposition

5pts 4pts 3pts 2pts 1pt *5pts 4pts 3pts 2pts 1pt* *5pts 4pts 3pts 2pts 1pt*

5pts 4pts 3pts 2pts 1pt *5pts 4pts 3pts 2pts 1pt*

Appendix 3:

Standards Addressed the San Diego Bay Field Guide Project

Relevant California History Standards

11.1 Students analyze the significant events in the founding of the nation and its attempts to realize the philosophy of government described in the Declaration of Independence.

1. Describe the Enlightenment and the rise of democratic ideas as the context in which the nation was founded.
4. Examine the effects of the Civil War and Reconstruction and of the industrial revolution, including demographic shifts and the emergence in the late nineteenth century of the United States as a world power.

11.2 Students analyze the relationship among the rise of industrialization, large-scale rural-to-urban migration, and massive immigration from Southern and Eastern Europe.

1. Know the effects of industrialization on living and working conditions, including the portrayal of working conditions and food safety in Upton Sinclair's *The Jungle*.
2. Describe the changing landscape, including the growth of cities linked by industry and trade, and the development of cities divided according to race, ethnicity, and class.
3. Trace the effect of the Americanization movement.
5. Discuss corporate mergers that produced trusts and cartels and the economic and political policies of industrial leaders.
6. Trace the economic development of the United States and its emergence as a major industrial power, including its gains from trade and the advantages of its physical geography.

11.3 Students analyze the role religion played in the founding of America, its lasting moral, social, and political impacts, and issues regarding religious liberty.

1. Describe the contributions of various religious groups to American civic principles and social reform movements (e.g., civil and human rights, individual responsibility and the work ethic, antimonarchy and self-rule, worker protection, family-centered communities).
2. Analyze the great religious revivals and the leaders involved in them, including the First Great Awakening, the Second Great Awakening, the Civil War revivals, the Social Gospel Movement, the rise of Christian liberal theology in the nineteenth century, the impact of the Second Vatican Council, and the rise of Christian fundamentalism in current times.
3. Cite incidences of religious intolerance in the United States (e.g., persecution of Mormons, anti-Catholic sentiment, anti-Semitism, persecution of the Native Americans).
4. Discuss the expanding religious pluralism in the United States and California that resulted from large-scale immigration in the twentieth century.

Appendix 3: Standards Addressed in the Field Guide Project

11.4 Students trace the rise of the United States to its role as a world power in the twentieth century.

2. Describe the Spanish-American War and U.S. expansion in the South Pacific.

11.5 Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.

7. Discuss the rise of mass production techniques, the growth of cities, the impact of new technologies (e.g., the automobile, electricity), and the resulting prosperity and effect on the American landscape.

11.6 Students analyze the different explanations for the Great Depression and how the New Deal fundamentally changed the role of the federal government.

3. Discuss the human toll of the Depression, natural disasters, and unwise agricultural practices and their effects on the depopulation of rural regions and on political movements of the left and right, with particular attention to the Dust Bowl refugees and their social and economic impacts in California.

4. Analyze the effects of and the controversies arising from New Deal economic policies and the expanded role of the federal government in society and the economy since the 1930s (e.g., Works Progress Administration, Social Security, National Labor Relations Board, farm programs, regional development policies, and energy development projects such as the Tennessee Valley Authority, California Central Valley Project, and Bonneville Dam).

11.8 Students analyze the economic boom and social transformation of post-World War II America.

2. Describe the significance of Mexican immigration and its relationship to the agricultural economy, especially in California.

6. Discuss the diverse environmental regions of North America, their relationship to local economies, and the origins and prospects of environmental problems in those regions.

7. Describe the effects on society and the economy of technological developments since 1945, including the computer revolution, changes in communication, advances in medicine, and improvements in agricultural technology.

11.9 Students analyze U.S. foreign policy since World War II.

7. Examine relations between the United States and Mexico in the twentieth century, including key economic, political, immigration, and environmental issues.

11.11 Students analyze the major social problems and domestic policy issues in contemporary American society.

5. Trace the impact of, need for, and controversies associated with environmental conservation, expansion of the national park system, and the development of environmental protection laws, with particular attention to the interaction between environmental protection advocates and property rights advocates.
6. Analyze the persistence of poverty and how different analyses of this issue influence welfare reform, health insurance reform, and other social policies.

Relevant California English Language-Arts Content Standards

Reading

1.0 Word Analysis, Fluency, and Systematic Vocabulary Development

Students apply their knowledge of word origins to determine the meaning of new words encountered in reading materials and use those words accurately.

Vocabulary and Concept Development

- 1.1 Trace the etymology of significant terms used in political science and history.
- 1.2 Apply knowledge of Greek, Latin, and Anglo-Saxon roots and affixes to draw inferences concerning the meaning of scientific and mathematical terminology.
- 1.3 Discern the meaning of analogies encountered, analyzing specific comparisons as well as relationships and inferences.

2.0 Reading Comprehension (*Focus on Informational Materials*)

Students read and understand grade-level-appropriate material. They analyze the organizational patterns, arguments, and positions advanced.

Structural Features of Informational Materials

- 2.1 Analyze both the features and the rhetorical devices of different types of public documents (e.g., policy statements, speeches, debates, platforms) and the way in which authors use those features and devices.

Comprehension and Analysis of Grade-Level-Appropriate Text

- 2.2 Analyze the way in which clarity of meaning is affected by the patterns of organization, hierarchical structures, repetition of the main ideas, syntax, and word choice in the text.
- 2.3 Verify and clarify facts presented in other types of expository texts by using a variety of consumer, workplace, and public documents.
- 2.4. Make warranted and reasonable assertions about the author's arguments by using elements of the text to defend and clarify interpretations.
- 2.5 Analyze an author's implicit and explicit philosophical assumptions and beliefs about a subject.

Expository Critique

Appendix 3: Standards Addressed in the Field Guide Project

2.6 Critique the power, validity, and truthfulness of arguments set forth in public documents; their appeal to both friendly and hostile audiences; and the extent to which the arguments anticipate and address reader concerns and counterclaims (e.g., appeal to reason, to authority, to pathos and emotion).

3.0 Literary Response and Analysis

Students read and respond to historically or culturally significant works of literature that reflect and enhance their studies of history and social science. They conduct in-depth analyses of recurrent themes.

Structural Features of Literature

3.1 Analyze characteristics of subgenres (e.g., satire, parody, allegory, pastoral) that are used in poetry, prose, plays, novels, short stories, essays, and other basic genres.

Narrative Analysis of Grade-Level-Appropriate Text

3.2 Analyze the way in which the theme or meaning of a selection represents a view or comment on life, using textual evidence to support the claim.

3.3. Analyze the ways in which irony, tone, mood, the author's style, and the "sound" of language achieve specific rhetorical or aesthetic purposes or both.

3.4. Analyze ways in which poets use imagery, personification, figures of speech, and sounds to evoke readers' emotions.

3.5. Analyze recognized works of American literature representing a variety of genres and traditions:

- a. Trace the development of American literature from the colonial period forward.
- b. Contrast the major periods, themes, styles, and trends and describe how works by members of different cultures relate to one another in each period.
- c. Evaluate the philosophical, political, religious, ethical, and social influences of the historical period that shaped the characters, plots, and settings.

3.6 Analyze the way in which authors through the centuries have used archetypes drawn from myth and tradition in literature, film, political speeches, and religious writings.

3.7 Analyze recognized works of world literature from a variety of authors:

- a. Contrast the major literary forms, techniques, and characteristics of the major literary periods
- b. Relate literary works and authors to the major themes and issues of their eras.
- c. Evaluate the philosophical, political, religious, ethical, and social influences of the historical period that shaped the characters, plots, and, settings.

Literary Criticism

3.8 Analyze the clarity and consistency of political assumptions in a selection of literary works or essays on a topic (e.g., suffrage, women's role in organized labor). (Political approach)

3.9 Analyze the philosophical arguments presented in literary works to determine whether the authors' positions have contributed to the quality of each work and the credibility of the characters. (Philosophical approach)

Writing

Appendix 3: Standards Addressed in the Field Guide Project

1.0 Writing Strategies

Students write coherent and focused texts that convey a well-defined perspective and tightly reasoned argument. The writing demonstrates students' awareness of the audience and purpose and progression through the stages of the writing process.

Organization and Focus

1.1 Demonstrate an understanding of the elements of discourse (e.g., purpose, speaker, audience, form) when completing narrative, expository, persuasive, or descriptive writing assignments.

1.2 Use point of view, characterization, style (e.g., use of irony), and related elements for specific rhetorical and aesthetic purposes.

1.3 Structure ideas and arguments in a sustained, persuasive, and sophisticated way and support them with precise and relevant examples.

1.4 Enhance meaning by employing rhetorical devices, including the extended use of parallelism, repetition, and analogy; the incorporation of visual aids (e.g., graphs, tables, pictures); and the issuance of a call for action.

1.5 Use language in natural, fresh, and vivid ways to establish a specific tone.

Research and Technology

1.6 Develop presentations by using clear research questions and creative and critical research strategies (e.g., field studies, oral histories, interviews, experiments, electronic sources).

1.7 Use systematic strategies to organize and record information (e.g., anecdotal scripting, annotated bibliographies).

1.8 Integrate databases, graphics, and spreadsheets into word-processed documents.

Evaluation and Revision

1.9 Revise text to highlight the individual voice, improve sentence variety and style, and enhance subtlety of meaning and tone in ways that are consistent with the purpose, audience, and genre.

2.0 Writing Applications (Genres and Their Characteristics)

Students combine the rhetorical strategies of narration, exposition, persuasion, and description to produce texts of at least 1,500 words each. Student writing demonstrates a command of standard American English and the research, organizational, and drafting strategies outlined in Writing Standard 1.0.

Using the writing strategies of grades eleven and twelve outlined in Writing Standard 1.0, students:

2.1 Write fictional, autobiographical, or biographical narratives:

a. Narrate a sequence of events and communicate their significance to the audience.

b. Locate scenes and incidents in specific places.

c. Describe with concrete sensory details the sights, sounds, and smells of a scene and the specific actions, movements, gestures, and feelings of the characters; use interior monologue to depict the characters' feelings.

Appendix 3: Standards Addressed in the Field Guide Project

- d. Pace the presentation of actions to accommodate temporal, spatial, and dramatic mood changes.
 - e. Make effective use of descriptions of appearance, images, shifting perspectives, and sensory details.
- 2.2 Write responses to literature:
- a. Demonstrate a comprehensive understanding of the significant ideas in works or passages.
 - b. Analyze the use of imagery, language, universal themes, and unique aspects of the text.
 - c. Support important ideas and viewpoints through accurate and detailed references to the text and to other works.
 - d. Demonstrate an understanding of the author's use of stylistic devices and an appreciation of the effects created.
 - e. Identify and assess the impact of perceived ambiguities, nuances, and complexities within the text.
- 2.3 Write reflective compositions:
- a. Explore the significance of personal experiences, events, conditions, or concerns by using rhetorical strategies (e.g., narration, description, exposition, persuasion).
 - b. Draw comparisons between specific incidents and broader themes that illustrate the writer's important beliefs or generalizations about life.
 - c. Maintain a balance in describing individual incidents and relate those incidents to more general and abstract ideas.
- 2.4 Write historical investigation reports:
- a. Use exposition, narration, description, argumentation, exposition, or some combination of rhetorical strategies to support the main proposition.
 - b. Analyze several historical records of a single event, examining critical relationships between elements of the research topic.
 - c. Explain the perceived reason or reasons for the similarities and differences in historical records with information derived from primary and secondary sources to support or enhance the presentation.
 - d. Include information from all relevant perspectives and take into consideration the validity and reliability of sources.
 - e. Include a formal bibliography.
- 2.6 Deliver multimedia presentations:
- a. Combine text, images, and sound and draw information from many sources (e.g., television broadcasts, videos, films, newspapers, magazines, CD-ROMs, the Internet, electronic media-generated images).
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

Written and Oral English Language Conventions

Appendix 3: Standards Addressed in the Field Guide Project

The standards for written and oral English language conventions have been placed between those for writing and for listening and speaking because these conventions are essential to both sets of skills.

1.0 Written and Oral English Language Conventions

Students write and speak with a command of standard English conventions.

1.1 Demonstrate control of grammar, diction, and paragraph and sentence structure and an understanding of English usage.

1.2 Produce legible work that shows accurate spelling and correct punctuation and capitalization.

1.3 Reflect appropriate manuscript requirements in writing.

Listening and Speaking

1.0 Listening and Speaking Strategies

Students formulate adroit judgments about oral communication. They deliver focused and coherent presentations that convey clear and distinct perspectives and demonstrate solid reasoning. They use gestures, tone, and vocabulary tailored to the audience and purpose.

Comprehension

1.1 Recognize strategies used by the media to inform, persuade, entertain, and transmit culture (e.g., advertisements; perpetuation of stereotypes; use of visual representations, special effects, language).

1.2 Analyze the impact of the media on the democratic process (e.g., exerting influence on elections, creating images of leaders, shaping attitudes) at the local, state, and national levels.

1.3 Interpret and evaluate the various ways in which events are presented and information is communicated by visual image makers (e.g., graphic artists, documentary filmmakers, illustrators, news photographers).

Organization and Delivery of Oral Communication

1.4 Use rhetorical questions, parallel structure, concrete images, figurative language, characterization, irony, and dialogue to achieve clarity, force, and aesthetic effect.

1.5 Distinguish between and use various forms of classical and contemporary logical arguments, including:

a. Inductive and deductive reasoning

b. Syllogisms and analogies

1.6 Use logical, ethical, and emotional appeals that enhance a specific tone and purpose.

1.7 Use appropriate rehearsal strategies to pay attention to performance details, achieve command of the text, and create skillful artistic staging.

1.8 Use effective and interesting language, including:

a. Informal expressions for effect

b. Standard American English for clarity

c. Technical language for specificity

- 1.9 Use research and analysis to justify strategies for gesture, movement, and vocalization, including dialect, pronunciation, and enunciation.
- 1.10 Evaluate when to use different kinds of effects (e.g., visual, music, sound, graphics) to create effective productions.

Analysis and Evaluation of Oral and Media Communications

- 1.11 Critique a speaker's diction and syntax in relation to the purpose of an oral communication and the impact the words may have on the audience.
- 1.12 Identify logical fallacies used in oral addresses (e.g., attack *ad hominem*, false causality, red herring, overgeneralization, bandwagon effect).
- 1.13 Analyze the four basic types of persuasive speech (i.e., propositions of fact, value, problem, or policy) and understand the similarities and differences in their patterns of organization and the use of persuasive language, reasoning, and proof.

2.0 Speaking Applications (Genres and Their Characteristics)

Students deliver polished formal and extemporaneous presentations that combine traditional rhetorical strategies of narration, exposition, persuasion, and description. Student speaking demonstrates a command of standard American English and the organizational and delivery strategies outlined in Listening and Speaking Standard 1.0. Using the speaking strategies of grades eleven and twelve outlined in Listening and Speaking Standard 1.0, students:

2.1 Deliver reflective presentations:

- a. Explore the significance of personal experiences, events, conditions, or concerns, using appropriate rhetorical strategies (e.g., narration, description, exposition, persuasion).
- b. Draw comparisons between the specific incident and broader themes that illustrate the speaker's beliefs or generalizations about life.
- c. Maintain a balance between describing the incident and relating it to more general, abstract ideas.

2.2 Deliver oral reports on historical investigations:

- a. Use exposition, narration, description, persuasion, or some combination of those to support the thesis.
- b. Analyze several historical records of a single event, examining critical relationships between elements of the research topic.
- c. Explain the perceived reason or reasons for the similarities and differences by using information derived from primary and secondary sources to support or enhance the presentation.
- d. Include information on all relevant perspectives and consider the validity and reliability of sources.

2.3 Deliver oral responses to literature:

- a. Demonstrate a comprehensive understanding of the significant ideas of literary works (e.g., make assertions about the text that are reasonable and supportable).
- b. Analyze the imagery, language, universal themes, and unique aspects of the text through the use of rhetorical strategies (e.g., narration, description, persuasion, exposition, a combination of those strategies).

Appendix 3: Standards Addressed in the Field Guide Project

- c. Support important ideas and viewpoints through accurate and detailed references to the text or to other works.
 - d. Demonstrate an awareness of the author's use of stylistic devices and an appreciation of the effects created.
 - e. Identify and assess the impact of perceived ambiguities, nuances, and complexities within the text.
- 2.4 Deliver multimedia presentations:
- a. Combine text, images, and sound by incorporating information from a wide range of media, including films, newspapers, magazines, CD-ROMs, online information, television, videos, and electronic media-generated images.
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.
- 2.5 Recite poems, selections from speeches, or dramatic soliloquies with attention to performance details to achieve clarity, force, and aesthetic effect and to demonstrate an understanding of the meaning (e.g., Hamlet's soliloquy "To Be or Not to Be").

Relevant California Biology/Life Science Standards

Cell Biology

1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:
- a. Students know cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.
 - b. Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.
 - c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

Genetics

2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:
- a. Students know meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.
 - b. Students know only certain cells in a multicellular organism undergo meiosis.

Ecology

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:
- a. Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.

Appendix 3: Standards Addressed in the Field Guide Project

- b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
- c. Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.
- d. Students know how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.
- e. Students know a vital part of an ecosystem is the stability of its producers and decomposers.
- f. Students know at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.
- g.* Students know how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.

Evolution

7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:
- a. Students know why natural selection acts on the phenotype rather than the genotype of an organism.
 - b. Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.
 - c. Students know new mutations are constantly being generated in a gene pool.
 - d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.
8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:
- a. Students know how natural selection determines the differential survival of groups of organisms.
 - b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.
 - c. Students know the effects of genetic drift on the diversity of organisms in a population.
 - d. Students know reproductive or geographic isolation affects speciation.
 - e. Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.
 - f.* Students know how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.
 - g.* Students know how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.

Physiology

9. As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:
- a. Students know how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.
 - b. Students know how the nervous system mediates communication between different parts of the body and the body's interactions with the environment.
 - c. Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.
 - d. Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.
 - e. Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.
 - f.* Students know the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.
 - g.* Students know the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance.
10. Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:
- a. Students know the role of the skin in providing nonspecific defenses against infection.
 - b. Students know the role of antibodies in the body's response to infection.
 - c. Students know how vaccination protects an individual from infectious diseases.
 - d. Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.