Stream Science Service Learning: Restoration Module

Stream Science Service Learning: Restoration Module

Objectives
Students will:
- Research riparian restoration in California
- Identify plant specimens using leaf morphology and reference material
- Conduct a plant survey at a stream location, identifying plants and measuring their height
- Summarize and report their results in a scientific format

Grade Levels
9 -12

Adult/Student Ratio
Normal class size

Where
Classroom and stream site where restoration is planned or has taken place (creeks must have safe public access)

Skills
Analyzing, formulating hypotheses and questions, generalizing, graphing, predicting, researching, writing a report in scientific format.

Key Words
Restoration, riparian

California Standards, Grade Nine through Twelve
Biology 6.a., 6b., 6e.
Investigation and Experimentation 1.a., 1.c., 1.d., 1.e. 1.h., 1.i., 1.n.

Overview
The primary purpose of this restoration module is to engage students in evaluating the success of riparian restoration projects through the monitoring of plants and birds. These monitoring activities can stand alone or supplement other stream science service learning activities such as macroinvertebrate, chemical or physical monitoring. Hopefully, teachers will find activities that best fit their curriculum and student interest.

The two activities, monitoring plant survival and monitoring bird populations, are intended to provide information about how a riparian area has responded to river restoration efforts. The plant survival component is specifically designed to evaluate the survival and growth of planted trees and shrubs. Prior to monitoring, it is important to know the number and types of trees and shrubs that were planted. That way, students can determine which species of plants survived and how well they are growing. The field activity in this module is based on a restoration project on Sutter Creek at Lions

Park. A list and map of the species planted was provided by the restoration managers. This protocol is based on that information. If another site is monitored, then similar information would need to be gathered to determine restoration success. The bird monitoring is more generic and could be conducted at any site, prior to or after restoration efforts.

Evaluating restoration success is an ideal scientific pursuit for high school students. They learn:

- sampling procedure
- data collection, analysis, and comparison
- scientific reporting
- taxonomy
- biodiversity
- ecological function

Background

River Restoration

Water is a valuable commodity in California. After centuries of efforts to procure and move water to benefit the growing population of California, a small percentage of riparian habitat remains (Katibah 1984). In recent decades, over 4000 restoration projects were attempted, making California one of the most active U.S. regions for river restoration (Kondolf et al. 2007). Monitoring restoration success is not always incorporated into the project. In fact, according to a national database (National River Restoration Science Synthesis), less than a quarter of projects include a monitoring component.

Procedures for Monitoring River Restoration

Restoration success can be evaluated by monitoring numerous components of the aquatic and riparian habitats, including physical, chemical, biological and photo monitoring. If trees and shrubs were planted as part of the restoration, then several different measures may be used to determine success, including:

- survival
- height
- area of cover
- weed control.

A more ultimate sign of recovery is whether wildlife are using the stream and its adjacent riparian habitat. Two popular methods for measuring wildlife use are benthic macroinvertebrate monitoring (see the Biological Section) and bird counts. Ideally, these methods would be conducted prior to restoration so you could compare habitat use before and after restoration. However, a school could consider multiyear monitoring of creeks even if restoration has not been conducted or is not planned yet.

Before-the-Field-Trip-Activities

Activity 1: Importance and History of Riparian Restoration (Optional)

Time: One to two class periods and several days of homework

Materials: Literature on riparian restoration (Resources listed below are suggestions that are available online)

- California Riparian Habitat Restoration Handbook, July 2009, particularly Sections II, III, VII and Case Studies
- CDFG's Salmonid Stream Restoration Manual, particularly Section XI, Riparian Habitat Restoration
- CalPIF (California Partners in Flight). 2008. Bringing the Birds Back: A Guide to Habitat Enhancement for Birds in the Sacramento Valley (R. DiGaudio, K. Kreitinger and T. Gardali, lead authors). California Partners in Flight Regional Conservation Plan No. 2, http://www.prbo.org/calpif.
- RHJV (RIPARIAN HABITAT JOINT VENTURE). 2004. Version 2.0. The riparian bird conservation plan: a strategy for reversing the decline of riparian associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/pdfs/riparian.v-2.pdf.
- Seavy, N., Gardali, T., Golet, G., Griggs, F., Howell, C., Kelsey, R., Small, S., Viers, J., & Weigand, J. (2009). Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research *Ecological Restoration, 27* (3), 330-338

Objectives: Students will

- understand the importance of riparian habitat
- evaluate the status of riparian habitat in California
- learn restoration techniques

Instructions

1. Prior to class, decide how students will access the literature on riparian restoration. Depending on the learning goal, you might want students to conduct their own literature reviews or you may want to assign one reference to the whole class, or several references to teams. Many of the references are lengthy, so you might need to remind students of study skills such as scanning table of contents, headings and subheadings for relevant information.
2. As homework, students read and write a summary of a reference article on riparian restoration. Use the key concepts and potential source information listed below as reading outlines. Students should come to class ready to discuss and share.

Name _____ Date_____

California Riparian Habitat Restoration Handbook, July 2009, Section II

Key Concepts:

- definition of riparian habitat
- physical, ecological factors that characterize riparian habitat
- value to wildlife and human communities
- value of riparian plants
- horticultural vs. process restoration
- mitigation vs. restoration
- different goals of restoration

CDFG's Salmonid Stream Restoration Manual, Section XI, Riparian Habitat Restoration

Key Concepts:

- natural riparian community
- value of vegetation to fish and wildlife
- value to humans
- human impacts to riparian habitat
- common exotic invasive plants and ways to remove
- restoration methods
- keys to successful restoration

CalPIF (California Partners in Flight). 2008. Bringing the Birds Back: A Guide to Habitat Enhancement for Birds in the Sacramento Valley

Key Concepts:

- bird use of riparian habitat
- riparian habitat 'layers'
- reasons to enhance riparian habitat
- why birds are good indicators of habitat health
- ways to improve bird habitat
- methods of determining successful habitat enhancement

RHJV (RIPARIAN HABITAT JOINT VENTURE). 2004. Version 2.0. The riparian bird conservation plan

Key Concepts:

- importance of riparian habitat to birds
- goals of riparian bird conservation plan
- focal riparian bird species
- Valley Foothill Riparian habitat
- Problems affecting riparian birds
- Focal bird species' status and habitat requirements (choose one)
- "Did you know" and "How you can help" facts about riparian habitat

Why Climate Change Makes Riparian Restoration More Important than Ever

Key Concepts:

- how climate change likely affects riparian ecosystems
- adaptation to climate change
- enhancing ecological resilience
- reasons riparian restoration can enhance resilience
- restoration strategies that improve adaptation to climate change

Name _____ Date_____

Reading Notes

Resource Assigned:

Key Concepts

Name_____ Date_____

Activity 2: Plant Identification[1]

Time: One class period, homework, and then time for verification of identification

Materials:

- CDFG's Salmonid Stream Restoration Manual, Section XI, Riparian Habitat Restoration (for homework, access online)
- Plant material, particularly small branches with several leaves. Each plant should be numbered so students can reference it later for identification. (contact STE leader for help in collecting appropriate species, see list below)
- Tree and Shrub Field Guides (see Resources List for options)
- Dissecting Microscopes or Hand Lenses (optional)
- Identification Student Worksheet

Objective: Students will

- Draw plant specimens, identify key features,
- Use online resources and field guides to identify plants
- Learn morphological features that distinguish different plant taxa

1. Divide class into groups; assign one plant per group for identification.
2. Provide a brief review of key characteristics for identifying plants from leaves. Students should make notes on their drawings to indicate these features. This should include leaf shape, leaf attachment to the stem, leaf edges, and leaf composition.
    a. Leaf shape: Common shapes are cordate (heart-shaped), elliptic (ends rounded and widest at middle), linear (several times longer than wide), oval (length less than twice the width), oblong (two to three times longer than wide)
    b. Leaf attachments: Opposite (leaves are attached opposite to each other on the stem) or alternate (leaves alternate in attachment to stem)
    c. Leaf edges: Entire (no indentations on edges), lobed (deep rounded indentations), or serrate (sharp teeth)
    d. Leaf composition: Simple (one leaf arises from the stem in a single segment) or compound (leaf coming from stem is divided into discrete leaflets)
3. Students draw leaves, taking notes of identifying characteristics. Set a time and then have students switch plant material.
4. In class, or for homework students review field guides and the CDFG's Salmonid Stream Restoration Manual, Section XI, Riparian Habitat Restoration to tentatively identify plants.
5. Provide actual identification for each plant specimen. Discuss any problems with identification.

[1] Investigation and Experimentation 1.a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

Name_____ Date_____

Extension: Develop a Plant Key

1. Students use their knowledge of plant characteristics to make a key for the plant species used in the lab. Discuss how keys work using a specific characteristic to group plants, then additional features to distinguish species.

Name_____ Date_____

Plant Identification Worksheet

Plant Specimen Number: _____

Tentative Identification_____

Confirmed Identification_____

Make sure to label key identifying characteristics of the plant.

Plant Specimen Number: _____

Tentative Identification_____

Confirmed Identification_____

Make sure to label key identifying characteristics of the plant.

Field Trip Activity

Activity: Monitor Restoration Success[2]

Time: Half Day (without travel time)

Materials:

- Restoration Assessment Form – one per team
- Photocopy of Map of Restoration Area – one per team
- clipboards, pencils
- permanent marker
- flagging tape
- plant identification material – live specimens and/or illustrations
- boots
- gloves

Prior to field trip, determine which plant species were planted as part of the restoration project. Fill out Part 2 of the Restoration Assessment Form with these species. An example and blank form are provided. Copy form front-to-back so that Part 1 and 2 are on the front side, and Part 3 is on the back side.

If possible, determine how many plants of each species were planted. This will allow the students to determine the percentage of plants that survived.

Discuss appropriate field trip behavior. Make sure students know their assignments and are dressed appropriately.

Field Instructions

1. Provide a short review of the history of the restoration project, previously discussed in class.
2. Divide class into different teams of 3-5 students to collect data. Hand out the map to each team.
3. Find a spot where students can view the restoration area and help them locate the extent of the restoration area on their maps. You may want them to mark and label certain landscape features on the map so that they are able to easily mark and label plants on the map.
4. Fill in top portion of Restoration Assessment Form.
5. Review Part 2 of form. Assign specific plants for each team to locate, tag, and map. Students should be familiar with these plants from class activities. If necessary, review identification with live plant material or illustrations. Students will tally number of plants they found alive.
6. Review Part 3 of form. For each plant, they will write a plant code on their flagging tape, then tie around a branch of the plant (not around the main trunk). Record the

[2] Investigation and Experimentation 1.a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
Biology 6.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.

plant code in Part 3, then estimate the height of the plant using the height code shown on the form.

7. Using the map, students record the location of each plant, using the plant code from Part 3. This will help scientists and students keep track of plant growth in subsequent years.
8. Send student out into the restoration area, noting any possible safety issues (e.g. poison oak, unstable slopes) or inaccessible areas (e.g. blackberry patches).
9. Teachers and restoration team leaders should move between groups to help with plant identification and mapping.

RESTORATION ASSESSMENT FORM

Part 1.

CREEK:	LOCATION:
DATE:	TIME:
PARTICIPANTS:	TEAM LEADERS:

Part 2.

Fill in the following table for the plants you were assigned to find. If you could not find any of your assigned plants in the area, mark '0' for the number of plants found alive.

CODE	SPECIES NAME	NUMBER OF PLANTS FOUND ALIVE
BB	Button bush	
BL	Bay Laurel	
BLM	Big Leaf Maple	
BLU	Bush Lupine	
CD	Creek Dogwood	
DB	Dog Bane	
EB	Elderberry	
MF	Monkey Flower	
MO	Mock Orange	
OA	Oregon Ash	
RB	Redbud	
SB	Spice Bush	
GW	Grey Willow	

Part 3. For every assigned plant you found alive, tag it with tape that indicates the plant code (like SB for Spice Bush) and a number (start with 01, go to 02, 03 etc.) Then estimate the height using the categories below.

Tag Code	Height Code
Example: SB01	2

Height Code	Meters	Feet (approx.)
1	< 1/2	<0.8
2	½ - 1	0.8 – 3.3
3	1-2	3.3 – 6.5
4	2-5	6.5-16.4
5	5-10	16.4-33
6	10-15	33-49
7	15-20	49-65
8	20-35	65-115
9	35-50	115-164
10	>50	>164

Tag Code	Height Code

RESTORATION ASSESSMENT FORM

Part 1.

CREEK:	LOCATION:
DATE:	TIME:
PARTICIPANTS:	TEAM LEADERS:

Part 2.

Fill in the following table for the plants you were assigned to find. If you could not find any of your assigned plants in the area, mark '0' for the number of plants found alive.

CODE	SPECIES NAME	NUMBER OF PLANTS FOUND ALIVE

After Field Trip Activity

Activity: Evaluate Restoration Success[3]

Time: One class period and homework

Materials:

- Restoration Assessment Forms – completed from field trip
- Photocopy of Map of Restoration Area – completed from field trip
- Document Camera

Instructions

1. Review ways in which the success of a restoration project can be evaluated. Discuss the data they collected in the field and how they could best report success.
2. Working as teams, brainstorm and record 'measures of success'. Discuss whole class and determine which measures to report. Possible measures from the data could be:
    a. Total number of plants alive
    b. Total number of different plant species that were alive
    c. Percentage of plants that survived
    d. Percentage of each species that survived
    e. List of plant species that survived
    f. List of plant species that did not survive
    g. Change in plant growth (if previous year's data are available)
3. Discuss why some measures might not be accurate or useful. For example, some students may conclude that the maps could be used to determine percent cover. Discuss why this analysis would not be accurate.
4. Team members present their results to class. Teams should write down all results so they can write up individual reports.
5. Provide any necessary information to students. For example, to determine plant survival in percentage form, students need to know how many plants of each species were originally planted.
6. Assign restoration report as homework. Include sections for introduction, lab and field analysis, results and discussion.

[3] Investigation and Experimentation 1.a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
Biology 6.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.

Resources

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Vocabulary

All definitions are from the U.S. Environmental Protection Agency.

Assessment
A fact-based evaluation or judgment

Benthic
Living on the bottom of a stream

Benthic Macroinvertebrates
Animals without backbones, living in or on the sediments, a size large enough to be seen by the unaided eye.

Biosurvey
Collecting, processing, and analyzing a representative portion of the resident aquatic community to determine its structural and/or functional characteristics.

Canopy
The overhead branches and leaves of streamside vegetation.

Community
All the groups of organisms living together in the same area, usually interacting or depending on each other for existence.

Habitat
A place where the physical and biological elements of ecosystems provide a suitable environment including the food, cover, and space resources needed for plant and animal livelihood.

Restoration
The National Research Council (NRC) in its 1992 report, *Restoration of Aquatic Ecosystems*, defined restoration as the "return of an ecosystem to a close approximation of its condition prior to disturbance."

Riparian
Of, adjacent to, or living on the bank of a river, stream or sometimes, of a lake or pond

Taxon (plural: taxa)
A taxonomic category or group, such as a phylum, order, family, genus, or species

Watershed
Land area from which water drains to a particular surface waterbody