Riparian, Channel, and Environmental Inventory (RCE)

Adapted from: "The RCE: a riparian, channel, and environmental inventory for small streams in the agricultural landscape" by Robert Peterson, Freshwater Biology, volume 27, 1992 AND "Adaptation of the RCE" by Marian Norris. Senior Thesis, Allegheny College, 1997.

Grade Level: Intermediate to Advanced

Duration: 35-40 minutes

Setting: field site within a stream channel

Summary: Students observe, estimate, and assess the physical and biological characteristics of 100 meters of stream channel and riparian zone.

Objectives: Students will become familiar with the basic functions of riparian zones. They will become proficient with the RCE Inventory and understand how the physical and biological conditions of a stream channel and riparian area are related to each other and linked to overall waterway health.

Vocabulary

Riparian zones, buffer, biota, Riparian, Channel, and Environmental Inventory (RCE), debris dams, channel, channel bars, bank undercutting, substrate, riffles, pools, detritus

Related Module Resources:

- "Riparian Buffer Basics" Fact Sheet
- Tree ID Activity

Materials (Included in Module):

- Tape measure
- RCE Data Sheets
- RCE Glossary Sheets
- RCE Illustrated Guides

For Riparian Observations Extension:

- Data Sheets
- 5 tape measures
- Tree Field Guides
- 8 plastic cups
- 1 trowel

Additional Materials (NOT Included in Module):

- Clipboards

For Riparian Observations Extensions Only: Thermometer(s) and macroinvertebrate sampling, sorting, and identification materials, colored pencils

ACADEMIC STANDARDS (ENVIRONMENT & ECOLOGY):

7th Grade

4.1.7.D. Explain and describe characteristics of a wetland.
- Describe the different functions of a wetland.
- Identify specific characteristics of wetland plants and soils.

**NOTE: Riparian areas frequently contain wetlands or are considered to be wetlands.*

4.1.7.E. Describe the impact of watersheds and wetlands on people.
- Explain the impact of watersheds and wetlands in flood control, wildlife habitats and pollution abatement.

4.3.7.B. Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.

4.6.7.A. Explain the flows of energy and matter from organism to organism within an ecosystem.

Identify and explain the characteristics of biotic and abiotic.

4.6.7.C. Explain how ecosystems change over time.
- Explain a change in an ecosystem that relates to humans.

4.7.7.C. Explain natural or human actions in relation to the loss of species.

Identify natural or human impacts that cause habitat loss.

4.8.7.C. Explain how human activities may affect local, regional and national environments.
- Explain how a particular human activity has changed the local area over the years.

10th Grade

4.1.10.B. Explain the relationship among landforms, vegetation and the amount and speed of water.
- Analyze a stream's physical characteristics.
- Explain how vegetation affects storm water runoff.
- Explain how the speed of water and vegetation cover relates to erosion.

4.1.10.C. Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
- Describe and explain the physical factors that affect a stream and the organisms living there.
- Identify terrestrial and aquatic organisms that live in a watershed.
- Identify the types of organisms that would live in a stream based on the stream's physical characteristics.

4.1.10.D. Describe the multiple functions of wetlands.
- Describe wetlands in terms of their effects (e. g., habitat, flood, buffer zones, prevention areas, nurseries, food production areas).
- Explain how a wetland influences water quality, wildlife and water retention.

4.1.10.E. Identify and describe natural and human events on watersheds and wetlands.
- Identify the effects of humans and human events on watersheds.
- Analyze wetlands through their indicators (e. g., soils, plants, hydrology).

4.3.10.B. Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices.
- Explain how human practices affect the quality of the water and soil.

4.8.10.C. Analyze how human activities may cause changes in an ecosystem.
- Analyze and evaluate changes in the environment that are the result of human activities.
- Compare and contrast the environmental effects of different industrial strategies (e. g., energy generation, transportation, logging, mining, agriculture).

12th Grade

4.1.12.C. Analyze the parameters of a watershed.
- Interpret physical, chemical and biological data as a means of assessing the environmental quality of a watershed.
- Apply appropriate techniques in the analysis of a watershed (e. g., water quality, biological diversity, erosion, sedimentation).

4.1.12.D. Analyze the complex and diverse ecosystems of wetlands.
- Explain the functions of habitat, nutrient production, migration stopover and groundwater recharge as it relates to wetlands.
- Describe and analyze different types of wetlands.

4.1.12.E. Evaluate the trade-offs, costs and benefits of conserving watersheds and wetlands.
- Evaluate the effects of human activities on watersheds and wetlands.

BACKGROUND:

Riparian zones are the areas adjacent to waterways. Ideally, these areas consist of trees and shrubs. When such streamside forests are intact, they filter out sediment, nutrients, and pollution from runoff before it reaches the stream's water. Riparian zones also stabilize stream banks and beds, regulate stream flow, and provide wildlife and aquatic habitat as well as beautiful recreation areas. Riparian canopies produce shade to regulate stream temperature and light conditions. In a word, forested riparian zones **buffer** or protect the physical, biological and chemical integrity of streams. Unfortunately, due to centuries of agriculture, industry, and other human activities, streamsides have been greatly altered. Crop fields now extend to the banks of many waterways, replacing the trees and shrubs that once protected the streams or rivers; cows and other livestock trample the banks of countless streams, damaging vegetation and eroding bank stability; homeowners with waterfront property have beautiful views but are actually contributing to the demise of the waterways they love by removing trees or maintaining manicured lawns up to the banks.

These and other human activities have altered waterways to varied degrees. A few riparian areas remain untouched and intact. Therefore, it is useful to have a tool or survey that allows us to compare the level of riparian disturbance in different areas. The **Riparian, Channel, and Environmental Inventory**, or **RCE**, was developed by a Swedish ecologist to do just that.

The RCE quickly assesses the physical and biological conditions of small streams in low-lying, agriculturally influenced and/or physically modified areas in temperate regions. We have slightly modified the inventory to better reflect Western Pennsylvania and Southwestern New York watershed conditions.

The RCE Inventory characterizes the physical and biological conditions of stream and riparian areas because the physical structure of a waterway is closely linked to its biotic health. For example, a channel that is undergoing a lot of erosion typically has an unstable bed and low habitat diversity. Fewer habitats support fewer organisms so we would expect lower **biodiversity**, or variety of life, in badly eroded channels. A low RCE score reflects these poor conditions. To determine such a score, the RCE divides the physical and biological conditions of a stream and associated riparian area into sixteen characteristics: land use, riparian zone width, completeness, vegetation, **debris dams**, **channelization**, channel and gravel **bars** and **braids**, streambank stability, **bank** and **band undercutting**, **substrate**, stream bottom, **riffles** and **pools**, and **biota** including aquatic vegetation, fish (**darters** and **sculpins** in particular), **detritus**, and bottom-dwelling aquatic insects. [φ]

The inventory assesses these characteristics over 100 meters of a stream. Thus, its results give us a snap shot of the physical and biological conditions of just *one site* within the watershed. This is insufficient evidence upon which to base conclusions about the *entire* watershed. However, the score determined by the RCE will be useful when making comparisons among sections of the same waterway or among different waterways. The inventory numbers can also be compared over the years to see if changes in a waterway's physical parameters, biota, associated land use, or riparian areas have occurred.

Furthermore, the inventory was developed to assess *physical* disruption of the channel and riparian area. It does not assess the impact of chemical disruptions such as point source pollution coming from storm drainpipe discharges. Therefore, the results of the RCE are most informative when used in conjunction with chemical and/or biological testing. Together, the results of these different tests will help you develop an overall assessment of your sample site.

[φ]See glossary on next page for definitions of bold terms.

GLOSSARY

band undercutting: A pattern of undercutting or erosion of stream banks such that the unstable top of the bank hangs over the lower portion, leaving 'bands' or evidence of previous erosion events on the banks.
bank undercutting: A more specific term for undercutting, or the erosion of stream banks such that the unstable top of the bank hangs over the lower portion.
***bar:** A sand or gravel deposit in a streambed that is only exposed during periods of low flow.
biodiversity: The variety of living things.
biota: Living organisms and ecosystems.
***braids:** Stream channels characterized by alternating division and rejoining.
buffer: An area of vegetation along a stream or lake that protects the soil from wind and rain erosion, slows water runoff, and traps sediment and other pollutants.
channel: The area of streambed that would fill in the event of a flood, i.e., not just the portion currently filled with water.
***channelization:** The straightening or deepening of waterway channels to increase water flow and decrease flooding risks.
***darter:** Small, colorful fish that "dart" along stream bottoms; generally indicators of good water quality.
***debris dam:** A collection of fallen trees, logs, and twigs wedged in the stream channel.
detritus: Dead, partially or fully broken down particulate organic matter such as decomposing fallen leaves or twigs.
pool: Deeper, typically calm areas of streams, commonly on the outside of bends.
riffle: Shallow, rapid areas of waterways, commonly in straight sections between bends.
Riparian, Channel, and Environmental Inventory (RCE): A tool used to assess the physical and biological conditions of small, temperate, agricultural landscapes.
***riparian zone:** The areas adjacent to waterways, ideally consisting of trees and shrubs, that, when intact, protect the stream from excess sediment, nutrients, and pollution from runoff, stabilize streambanks, decrease erosion, and provide habitat for aquatic and terrestrial organisms.
***sculpin:** Spiny, large-headed, broad-mouthed, often scaleless fish; generally indicators of good water quality.
substrate: The bottom of the stream channel; can be rocky, sandy, muddy, etc.
***undercutting:** The erosion of stream banks such that the unstable top of the bank hangs over the lower portion
watershed: The total land area that drains into a particular waterway. The name of the watershed is usually the same as the name of the waterway into which area water drains.

*see exemplary images of these terms on the "Illustrated Guide to RCE Terminology".

OVERVIEW:

Students select a 100-meter section of stream channel and associated riparian area and use the Riparian, Channel, and Environmental Inventory (RCE) to estimate and assess its physical and biological characteristics. The resulting total RCE score is used to stimulate discussion about what might be done to improve or restore the selected riparian area.

NOTE TO TEACHERS: It is best to do the RCE after students are familiar with the field site and when the stream is at relatively low flow. Ideally, this will allow students to do the inventory without getting into the stream because they will already be acquainted with the aquatic life, substrate, and detritus. Low flow conditions will make the physical characteristics of the stream (e.g., riffles, braiding, bars, etc.) more prominent and easier to observe.

PROCEDURE:

Teacher Preparation:

1. Make an appropriate number of copies of the RCE Data Sheet for your students or groups of students.
2. Identify a stream and associated riparian area to be used for the inventory.
3. Have students find a partner and distribute one clipboard with an RCE Data Sheet, a Glossary Sheet, and an Illustrated Guide to RCE Terminology on each.

Student Experiment or Activity:

1. Select a 100-meter stretch of the waterway. The class may assess the same waterway section or different 100-meter lengths.

2. Complete the "BASIC DATA" section of the data sheet. To determine the "Initial Rating," ask the students to look at their surroundings and decide if they would rate the stream and riparian area as excellent, very good, good, fair, or poor based on their initial observations and why.

3. Proceed to the "INVENTORY" section of the data sheet.

4. Read the first numbered characteristic, e.g., "1. Land-use pattern beyond the immediate riparian zone."

5. Carefully observe the 100 meters of stream channel and riparian area that you have selected and notice the most striking features of the first characteristic.

6. Read the phrases listed below the characteristic and select the one phrase out of the four that *best* describes that aspect of the stream and riparian area at your sample site. Note that even if none of the phrases match what you see, you must choose one phrase for each characteristic. Record your estimate by placing an X on the line next to that phrase. Consult the glossary and the Illustrated Guide to RCE Terminology to help you accurately estimate the characteristic. The highest score for each characteristic varies from 15-30 depending on the value of the characteristic in the overall index.

7. Repeat steps 5, 6, and 7 for all other numbered characteristics (2 through 16).

8. After all 16 characteristics have been estimated, add the scores of the "X-ed" phrases together to determine the total RCE score. The highest total RCE score possible is 360; the lowest possible score is 16.

9. Classify your total RCE score using the table below.

RESULTS

Class	Score	Evaluation	Recommended Action
I	293-360	Excellent	Monitoring and protection
II	224-292	Very good	Selected alterations and monitoring
III	154-223	Good	Minor alterations needed
IV	86-153	Fair	Major alterations needed
V	16-85	Poor	Complete restoration needed

DISCUSSION:

What were some of the most striking features of the stretch of stream we assessed? *Allow students to list some of these features.*

What RCE evaluation did the stream receive based on the RESULTS table above? *Allow students to share their scores.*

How does this evaluation compare to your initial predictions? *Allow students to compare and share their initial and RCE-based evaluations.*

If the initial predictions and RCE–based evaluations differed greatly, why was there such a disparity? What did the RCE take into account that you might not have considered when making your initial judgments? *Students may not have considered factors such as debris, bars, substrate texture, vegetation, or aquatic life when making initial assessments. These estimations might have been based solely on stream bank conditions or the presence or absence of streamside vegetation. It is important to consider many factors when doing assessments.*

If students were assessing different sections of a stream, how did the scores of the upstream sections compare to those of the downstream sections? Why were there differences? Do these differences reflect variations in land use from one section of the stream to the next? *Allow students who looked at upstream sections to respond and then proceed to the more downstream sections.*

The 100-meter section of stream channel and riparian zone we looked at is described as (insert your RCE Evaluation) by the RCE Inventory. Which factors most influenced this rating?
Allow students to brainstorm factors.

Which characteristics received low scores (i.e. 1 or 5) and have room for improvement?
Allow students to list characteristics that received low ratings.

The Results table suggests that our site requires (insert the Recommended Action for your RCE score) because the aspects you just listed need improvement. What might we as a class do to ameliorate those aspects of this stream section?
Allow students to brainstorm how they might help improve the poor aspects of the stream section. For example, the class might initiate a streamside restoration project involving tree planting, willow cuttings, fencing to keep livestock away from the stream, etc.

Ask if any of the students live near a stream or waterway. Have them describe the riparian zone near that waterway. How do they think it would score on the RCE? What might they do to ameliorate that particular riparian zone and stream section?
Allow students to respond.

Why do scientists use the RCE? *See background.*

Did the students think using the RCE was a useful way to determine the health of their waterway? *Answers will vary.*

What other types of testing/studies could you do to help determine the health of a stream?
Biological and chemical monitoring, Pollution Tolerance Index (PTI), etc.

EVALUATION:

- Define riparian area and why riparian buffers are important to maintaining stream health.
- Explain how different land uses affect riparian areas.
- Describe how the physical characteristics of a waterway are linked to its biota.
- Correctly complete data sheet.
- Answer discussion questions above.

EXTENSIONS AND MODIFICATIONS:

- Complete the Riparian Observations data sheet while out in the field conducting the RCE to make the most of the field experience. Divide the students into nine teams and have each team investigate one question on the Riparian Observations Data Sheet. You will need five tape measures, eight plastic cups, and tree guides for questions 1-5 and 7-9. These materials are included in the module. Question 6 requires macroinvertebrate sampling, sorting, and identification materials not included in the module. Schools participating in the Creek Connections Water Monitoring program should already have these materials. Schools lacking these materials need not complete Question 6.
- Compare different waterways or different sections of the same waterway using the RCE.
- Compare RCE scores for different waterways or different sections of the same waterway to the various land uses represented for those sections on topographic maps.
- Conduct chemical and biological tests to complete the "picture" of your sample site.
- Have students design and implement riparian restoration projects involving tree planting, streambank stabilization, or other ideas they might have.

- Have students write essays about the changing land use at your sample site over the a last 100 years and how that has affected the riparian area's ability to buffer

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

DATA SHEET: RIPARIAN, CHANNEL, AND ENVIRONMENTAL INVENTORY (RCE)

(modified from Petersen, 1992 by FCEEP for FCEEP, 1997 [now Creek Connections])

BASIC DATA

Stream name: _____ **Watershed**[φ]**:** _____

Date: _____ **Time:** _____

EXACT Location:

_____

_____

Observers:

_____

_____

Approximate stream width: _____ **m** **Approximate stream depth:** _____ **m**

Stream flow condition: high medium low very low **Days since last significant rain:** 0 1 2 3 4-7 8+

Initial Rating: excellent very good good fair poor

INVENTORY

Determine the condition of the stream CHANNEL and RIPARIAN ZONE at which you are standing and up to **50 m upstream and downstream (100 m total)**. Estimate the average condition over that distance and select ONE of the four scores for each characteristic. Indicate your selection by writing an X next to your choice. Refer to the **Glossary** for definitions of the [φ]ed terms and **the Illustrated Guide to RCE Terminology** for exemplary images of the [*]ed terms.

I. LAND USE

1. Land-use pattern beyond the immediate riparian zone[φ*]

Undisturbed, consisting of forest and/or natural wetlands	30 _____
Permanent pasture mixed with woodlots and wetlands; few buildings and roads	20 _____
Mixed row crops and pasture, or mixed grass lawn and homes	10 _____
Mainly row crops, or mostly streets, pavement, buildings, and parking lots	1 _____

2. Width of riparian zone from stream edge to field

Marshy or woody riparian zone >30 m wide	30 _____
Marshy or woody riparian zone varying from 5 to 30 m	20 _____
Marshy or woody riparian zone 1-5m	5 _____
Marshy or woody riparian zone absent	1 _____

3. Completeness of riparian zone

Riparian zone intact without breaks in vegetation along entire 100m zone you are evaluating	30 _____
Areas without vegetation occur at intervals of > 50 m (fragmented riparian zone)	20 _____
Areas without vegetation frequent with some erosion (gullies and scars) every 50 m	5 _____
Many areas without vegetation, erosion occurring (gullies, scars) along entire length; or no vegetation	1 _____

4. Vegetation of riparian zone within 10 m of the channel[φ]

>90% plant density of mature trees or shrubs, or native marsh plants	25 _____
Mixed young tree species along channel and mature trees behind	15 _____
Vegetation of mixed grasses and sparse young tree or shrub species	5 _____
Vegetation consisting mostly of grasses, few trees and shrubs; low plant density; or no vegetation	1 _____

II. PHYSICAL STRUCTURE OF STREAM

5. Debris dams[φ*](a natural collection of fallen trees, logs, limbs, and rock material that are wedged in or along channel)

Channel with old debris dams - old logs and rocks firmly set in place	15 _____
Logs and rocks present but back filled with some sediment	10 _____
Debris dams loose, probably moving with floods	5 _____
Debris dams sparse, easily moved; or debris dams absent	1 _____

6. Channel[φ] (*Not depth of water but how high the water can rise before it floods its banks*) width to depth ratio (ability to contain high flows)

Divide:

Channel Width
---------- = Answer
Channel Depth

if answer is <7; ample for present and annual peak flows	15 _____
if answer is 8-15; adequate, overbank flows rare	10 _____
if answer is 15-25; barely contains common high flows	5 _____
if answer is >25 or stream is artificially channelized; overbank flow common	1 _____

7. Channel bars[φ]
   - Little or no channel width enlargement (bank erosion, undercutting[*]); coarse-grained bars[φ*] present — 15 _____
   - Some gravel bars, pore spaces between rocks well washed with little silt present — 10 _____
   - Sediment bars of rocks, sand, and silt common — 5 _____
   - Channel divided into braids[φ*] around sediment bars; or stream is channelized[φ] — 1 _____

8. Stream-bank stability
   - Banks stable, of rock and soil held firmly by grasses, shrubs, and tree roots — 25 _____
   - Banks firm but loosely held by grass and shrubs — 15 _____
   - Banks loose, held by a sparse layer of grass and shrubs — 5 _____
   - Banks unstable, of loose soil or sand easily disturbed — 1 _____

9. Bank undercutting[φ]
   - Little or none evident or restricted to areas with tree root support — 20 _____
   - Band undercutting[φ*] only on curves or narrow channel areas — 15 _____
   - Band undercutting common, some banks falling in — 5 _____
   - Severe bank undercutting[φ] along channel, banks falling in — 1 _____

10. Stony substrate[φ]; feel and appearance
   - Stones clean, rounded without sharp edges (smooth pebbles, cobbles); may have blackened color — 25 _____
   - Stones without sharp edges and with slight gritty feel — 15 _____
   - Some stones with sharp edges, obvious gritty feel — 5 _____
   - Stones bright; silt and grit covering them, sharp edges common — 1 _____

11. Stream Bottom
   - Various sized rocks, gravel, and sand mixture; open spaces common between rocks — 25 _____
   - Loose stony bottom with some silt having settled in spaces between rocks — 15 _____
   - Mixture of silt, sand, and gravel; open spaces between rocks sparse; bottom firm in places — 5 _____
   - Uniform bottom of sand and silt held loosely together, easily moved, little or no stony substrate — 1 _____

12. Riffles[φ] and pools[φ]
   - Riffles distinct, occurring at intervals of 5-7 times the stream width (not channel width) — 25 _____
   - Riffles and pools irregularly spaced — 20 _____
   - Long pools separating short riffles — 10 _____
   - Riffles and pools absent or stream channelized — 1 _____

III. BIOTA[φ]

13. Aquatic vegetation
   - When present consists of moss and patches of algae — 15 _____
   - Algae dominant in pools, larger plants along edge, some in center — 10 _____
   - Algal mats present, some larger plants, few mosses — 5 _____
   - Algal mats cover bottom, larger plants dominate the channel — 1 _____

14. Fish
   - Darters[φ*] and sculpins[φ*] present in most riffles — 20 _____
   - Darters and sculpins scarce and difficult to locate — 15 _____
   - No darters or sculpins, other species in riffles — 5 _____
   - Fish absent or scarce — 1 _____

15. Detritus[φ]
   - Mainly consisting of leaves and wood without sediment covering it — 25 _____
   - Leaves and wood scarce; fine organic debris without sediment — 10 _____
   - No leaves or woody debris; coarse and fine organic matter with sediment — 5 _____
   - Fine organic sediment - black in color and foul odor (anaerobic) — 1 _____

16. Bottom-dwelling aquatic insects
   - Many species present in riffles and pools, on rocks and sand/gravel — 20 _____
   - Many species but only in riffles and on rocks — 15 _____
   - Few species present in riffles and pools, on rocks and sand/gravel — 5 _____
   - Few if any species and only in riffles and pools, on rocks and sand/gravel — 1 _____

TOTAL: _____

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