

HANFORD & THE RIVER

High School Environmental Science

Produced by Columbia Riverkeeper

The Hanford Nuclear Site (“Hanford” or “Hanford Site”) is the most contaminated place in the Western Hemisphere, where the United States discharged billions of gallons of radioactive waste near the banks of the Columbia River and directly into the River. Waste has contaminated the groundwater, and dozens of underground storage tanks have leaked high-level nuclear waste. Vast areas of groundwater are contaminated with nuclear and chemical waste, and, in some places, this groundwater is flowing into the Columbia River.

The 586-square-mile Hanford Site is a legacy of nuclear weapons production during World War II and the Cold War. But, nuclear activities were confined to a minor part of the site, leaving much of the site relatively undisturbed. The resulting “accidental nature” includes shrub-steppe habitat, cliff habitat, wetlands and river systems, and the most productive spawning ground for wild Chinook salmon on the main stem of the Columbia River.

The materials in this curriculum allow teachers and students to explore Hanford and the Hanford Reach of the Columbia River. This curriculum includes lesson plans, Teacher’s Guides and Student Worksheets along with primary documents and supplemental materials to help facilitate student learning. The lessons permit students to analyze Hanford’s history, ecology, and the risks and rewards of cleanup.

The lessons also allow students to learn about Hanford’s ecology through the eyes of Hanford’s threatened and endangered species. Specifically, the curriculum allows students to investigate the connection between the cleanup of Hanford and Hanford’s impact on human health and the environment.

The lessons are based on an inquiry approach, which engages the students in known and unknown science concepts, has them explore and investigate, then reflect and explain their thinking and reasoning, applying and extending their new knowledge.

Teachers can use this curriculum in a variety of ways. They could use a handful of documents to supplement existing readings and lesson plans. They could also use the materials to create a new teaching unit lasting anywhere from a day to a week.

This curriculum allows students to go beyond hearing about Hanford, the shrub steppe habitat, or endangered species. Researching the species of the Hanford Reach and researching the risks and rewards of cleanup and the stakeholders, enables each student to become an investigator.

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 High School Environmental Science
Lesson 1: Hanford History & Ecology

	<p>Subject Area: Environmental Science; History Description: 1 hour 30 minutes (2 classes)</p>
Washington State Standards:	<p>Environmental and Sustainability Learning Standards - Standard 1: Ecological, Social and Economic Systems Standard 2: The Natural and Built Environment</p>
Lesson Overview	<p>In this lesson, students will:</p> <ul style="list-style-type: none"> • Learn about Hanford’s history and ecology. • Focus their learning on the history of the Hanford Site, explore the natural resources at Hanford, and discuss how Hanford’s history and ecology are inter-related. • Next they will learn about the status of Hanford’s current ecology and habitats and Hanford’s threatened and endangered species.
Learning Objectives:	<p>At the end of this lesson students will be able to:</p> <ul style="list-style-type: none"> • Understand why the United States government chose Hanford as a location for plutonium production. • Identify ecosystems and habitats present at Hanford. • Explain why Hanford is an important resource for threatened or endangered species.
Engage & Encounter	<p>A great way to start learning about Hanford’s history and ecology is to take a trip to Hanford to tour the B Reactor or the Hanford Reach National Monument.</p> <p>Students can also learn about the history of the Hanford through publications and video.</p> <ul style="list-style-type: none"> • Hanford & the River, published by Columbia Riverkeeper, pages 4-5. http://columbiariverkeeper.org/our-work/hanford-report/ • The Hanford Story, produced by Department of Energy. http://www.youtube.com/watch?v=rbd-xaYd4rs. • History of the Hanford Site, published by PNNL, pages 3-4. http://ecology.pnnl.gov/library/History/Hanford-History-All.pdf <p>There are many options for guest speakers about the history and ecology of Hanford, including Columbia Riverkeeper, Washington State Department of Ecology, and the Department of Energy.</p>
Explore & Investigate	<p>Students will work in a group to research a habitat and a threatened or endangered species within the habitat. Students will explore the value of Hanford’s habitats to their species and special adaptations.</p>

Reflect and Explain Assessment	As a class, the students will share their habitat rankings. They will hypothesize how Hanford operations may have changed their chosen habitat.
Apply & Extend	As a class, students discuss what they think would happen if their studied habitat were destroyed or their species were to go extinct. How would this affect people/economy, other wildlife? Students will give a presentation about the importance of preserving their habitat based on its importance to their studied species.
Assessment	Have students reflect on the Habitat Ranking. What habitat component has been preserved at Hanford? What habitat component needs improvement? Are some of the habitat components strong across different habitats, are some of them weak? What part of the habitat has Hanford affected most?

Teacher's Guide – Hanford History & Ecology

Day 1

Engage: A great way to start learning about Hanford's history and ecology is to take a trip to Hanford to tour the B Reactor, <http://manhattanprojectbreactor.hanford.gov>, to the Columbia River Exhibition of History, Science and Technology (CREST) museum, <http://www.crehst.org/visit-2/>, or to the Hanford Reach National Monument. http://www.fws.gov/refuge/Hanford_Reach/.

Ask students to learn about the history of the Hanford through publications and video. Prior to class, students should read:

- Hanford & the River, published by Columbia Riverkeeper, pages 4-5. <http://columbiariverkeeper.org/our-work/hanford-report/>
- The Hanford Story, produced by Department of Energy. <http://www.youtube.com/watch?v=rbd-xaYd4rs>
- History of the Hanford Site, published by Pacific Northwest National Laboratory, pages 3-4, <http://ecology.pnnl.gov/library/History/Hanford-History-All.pdf>

Guest speakers are available to facilitate a lesson on Hanford's history, including speakers from Columbia Riverkeeper, Washington State Department of Ecology, and U.S. Department of Energy.

As a class, review Hanford's history and location with the following suggested focus questions.

- What were the main reasons the United States government chose to locate Hanford in central Washington? Compare and contrast the qualities of Hanford versus where students live.
- What was produced at Hanford? Why? (Be sure to discuss not only the initial purpose of the Manhattan Project and the continuing production throughout the Cold War era).

Have students work independently in a computer lab to research the ecology of Hanford and learn about Hanford's special features: desert ecosystem, shrub steppe habitat, white bluffs, wetlands, Rattlesnake Mountain and riparian habitat. They should extend their research to learn about the threatened and endangered species that inhabit Hanford.

Suggested readings include:

- Hanford Reach National Monument, Wildlife & Habitat, http://www.fws.gov/refuge/Hanford_Reach/

Then have students return to a class discussion. Focus your students' attention to the ecosystem by asking the following questions.

Teacher's Guide – Hanford History & Ecology

- What did the landscape look like before the United States government created Hanford?
- When you think of contaminated habitats, what images come to mind. How does Hanford compare with your image of a contaminated site?

When you think of a healthy ecosystem, what images come to mind? How does Hanford compare with your image of a healthy ecosystem?

Explore: Students will explore the unique habitats of Hanford.

Start this activity by asking the students to brainstorm and list the types of habitat available at Hanford. These may include:

- Shrub-steppe
- Wetland
- Riparian
- White bluffs
- Desert
- Rattlesnake Mountain

Separate the class into groups. Ask each group to research a habitat and to complete the ***Habitat Description*** worksheet before the next lesson.

Teacher's Guide – Hanford History & Ecology

Day 2: Students will have completed the *Habitat Description* worksheet before class.

Reflect: Now have students return to their groups to complete the *Habitat Component* worksheet. Give the students 20 minutes to complete this task.

In order for the student groups to evaluate the fitness of a habitat for a specific species, have each group work in the computer lab to:

- Research the needs of animals native to the area. Identify the specific habitat needs of the animal-food, water, cover and places to raise young.
- Place a value on each of the habitat components and the impact of humans.
- Rate the habitat in terms of each component on a scale of 1 to 10, with 1=poor and 10=excellent.

Once the students have completed the *Habitat Component* worksheet, have the class share their findings and evaluate the quality of the site for this animal. To do this, have students report their findings and compile the results of their Habitat Component analysis in the following chart on a projector/board.

When students report their findings, they can also give a presentation about the importance of preserving their habitat based on its importance to their studied species.

Habitat Components

<i>Name of Species</i>	<i>Food</i>	<i>Water</i>	<i>Cover</i>	<i>Places to Raise Young</i>	<i>Total</i>
<i>Deer (example)</i>	10	10	4	6	30

Teacher's Guide – Hanford History & Ecology

Apply: As a class, discuss what would happen if their studied habitat were damaged by pollution or destroyed or their species were to go extinct. How would this affect people/economy, other wildlife?

Assessment: Ask each student to reflect on the class-compiled Habitat Ranking. What habitat component has been preserved at Hanford? What habitat component needs improvement? Are some of the habitat components given a high score across different habitats, are some of them weak? What part of the habitat has Hanford affected most?

Habitat Description - Student Worksheet

Research the habitats at Hanford. Choose a habitat to research further and answer the following descriptive questions.

Student Name:

Group Name:

Habitat:

1. *Vegetation – what types, quantity, invasive species*
2. *Animals – species, status, diversity*
3. *Water – sources, locations, currents*
4. *Human impacts – proposed development, contamination, recreation*
5. *Topography/ Geography – elevation, formation history, features*
6. *Identify any 6 species in this habitat including:*
 - a. *Plant*
 - b. *Mammal*
 - c. *Bird*
 - d. *Fish*
 - e. *Invertebrate*
 - f. *Rare, threatened or endangered.*
7. *Explain how human needs and attitudes have caused changes that have affected this habitat.*
8. *How is this habitat unique within the broader Hanford ecosystem?*

Hanford Habitat Components - Student Worksheet

Name:

Habitat:

Species:

Choose one of the animal species found in your habitat. Identify the specific needs of your chosen species. Rate how well you think this habitat satisfies your species' needs. Rate the habitat in terms of each component on a scale of 1 to 10, with 1=poor and 10=excellent.

Part I: Natural History

Description of Species:

Specific Needs of Animal

- *Food*
- *Water:*
- *Cover (nesting, wintering, storage, resting and protection:*
- *Places to Raise Young:*

Part 2: Habitat Component Rating

A. Food

- *Does this site provide food for this animal?*
- *If yes, list foods found on this site?*
- *Is food available during all seasons that the animal resides here:*

Rate "Food" resources from 1 to 10: _____

B. Water

- *Does the site provide adequate water for this animal?*
- *If yes, what is the water source in this habitat?*

Rate "Food" resources from 1 to 10: _____

Hanford Habitat Components - Student Worksheet

C. Cover

Animals require different types of cover. Place “yes” next to those cover types that your animal requires, then decide if this site meets the needs for the animal. If yes, list possible places where the animal may find cover on your site.

Cover Type	Needed by Animal?	Found on Site?	Locations on the Site.
Breeding/nesting			
Nursery			
Roosting/resting			
Hibernating			
Protection			
Other			

Rate overall “Cover” resources from 1 to 10: _____

D. Places to Raise Young

- Does the site provide adequate places to raise young? Explain.

Rate “Places to Raise Young” from 1 to 10: _____

Part 3. Management

Add your ratings for Food, Water, Cover, Places to Raise Young and Human Capability. What is the total rating for this animal at this site? Your answer will be between 1 and 40. _____

Can this site be improved for this animal? If yes, how?

Are there Human Activities on this site and are these activities compatible with this animal inhabiting this site? Explain.