RiverWebs
Teachers Guide

RiverWebs is a versatile media package for anyone teaching about ecosystems, food webs, rivers, watersheds, experimentation, invasive species, benthic macroinvertebrates, and scientific creativity. Most unique to RiverWebs is its use of an engaging true personal story to portray the scientific endeavor as what it truly is: a human endeavor.

Four video-based resources to choose from:

1. Classroom documentary	9-12, college	45 min.	An immersive look into both the process of real-life science and the human passion and creativity behind the science. Can be complemented with discussion, classroom activities, field exercises
2. Interactive inquiry video	5-12, college	25 -35 min.	An interactive watch-discuss-watch format that uses questions and clues to pursue a conclusion that illuminates both stream food webs and scientific experimentation
3. Stream food web video	5-12, outreach	7 min.	A versatile short video to illustrate stream food webs and the central role of insects
4. Television documentary	AP, college	56 min.	The original made-for-PBS RiverWebs documentary with rich story elements

Find guides, activities, and curriculum for each video-based resource inside

Applicable National Science Standards:

Standards Category	Grades 5-8	Grade Levels 9-12
Science as Inquiry	Abilities necessary to do scientific inquiry **Understanding about scientific inquiry***	Abilities necessary to do scientific inquiry **Understanding about scientific inquiry***
Life Science	Structure and function in living systems **Populations and ecosystems*** Interdependence of organisms **Diversity and adaptations of organisms***	**Interdependence of organisms*** **Matter, energy, and organization in living systems*** Behavior of organisms
Science in Personal & Social Perspectives	Populations, resources, and environments	**Science and technology in local, national, and global challenges** Environmental quality Natural and human-induced hazards
History & Nature of Science	Nature of science **Science as a human endeavor***	Nature of scientific knowledge **Science as a human endeavor***

***Bold standards are those most strongly served by the RiverWebs video resources**

Using the classroom documentary

The RiverWebs documentary is 45 minutes in length, and designed to fit into a classroom period and complemented with associated activities in the same or subsequent classes. If you have only one class period to present RiverWebs, you may also consider using the shorter interactive inquiry video, which allows more time for discussion and activities.

Background:

Rivers and wetlands are some of the earth's most diverse, imperiled, and little-known ecosystems. Through a personal story, RiverWebs illustrates the vibrant communities in streams, how they can be organized into food webs, and how intimately they are connected to their surrounding landscapes through linkages among food webs, primarily through movement of insects and other invertebrates. RiverWebs also shows how these food web linkages are determined by the behavior of consumer species, and how competition and niche differentiation can determine patterns in food webs.

RiverWebs also illustrates how stream-forest food web connections are vulnerable to changes that we make to the land, or watershed, and how we change the composition of species in and around rivers. The two examples given in RiverWebs are the destruction of streamside forests and the impacts of introduced sportfish (rainbow trout), two practices that are widespread throughout North America and the world. In fact, most U.S. states conduct government stocking of rainbow trout and other nonnative sportfish.

The learner will recognize:

1. Freshwater food webs are connected to terrestrial food webs
2. Ecologists use observation to form questions and hypotheses
3. Ecologists use experiments to test ideas and hypotheses
4. Freshwater ecosystems are impacted by non-native species
5. Freshwater ecosystems are affected by changes to the land and forests that surround them

Vocabulary (see Appendix A):

Aquatic, terrestrial, riparian, invasive, insect emergence, nonnative, watershed

Equipment:

Projector, DVD player/computer, RiverWebs DVD

Engage:

Briefly introduce RiverWebs. Make it relevant to the students. Ask a few provocative questions that touch on RiverWebs themes (these questions don't need immediate answers):

- Why are streams and rivers important?
- What kinds of animals live in streams and rivers?
- Are rivers ecosystems?

- What does a river ecologist do?

If you are going to participate in some of the alternative activities, let your students know that this background knowledge is critical for the success of these activities.

Explore:
Show the RiverWebs Classroom Documentary

Explain / Elaborate:

As a class or in groups, explore discussion questions in Appendix B relating to natural history, experimentation, invasive species, or habitat impacts.

Evaluate:

Use a quiz or follow-up discussion to test students learning

Using the RiverWebs interactive inquiry video

The RiverWebs interactive inquiry video consists of video segments and classroom discussion that is 25-35 minutes in length. This watch-discuss-watch format makes for a more interactive and teacher-lead viewing experience, and fits well into a short classroom period, and can be complemented with associated activities in the same or subsequent classes.

Note: the inquiry video can be effectively used to precede the classroom documentary, which adds the human story

Background:

Scientists must often come up with creative ways to test ideas and hypotheses that they have. The RiverWebs inquiry video engages students in the question: why would someone build a mesh greenhouse over a stream? The answer to this question involves both the fundamentals of scientific inquiry and the basics of stream food webs.

Rivers and wetlands are some of the earth's most diverse, imperiled, and little-known ecosystems. Using questions and clues, the RiverWebs inquiry video illustrates how scientists use both observations and experiments to pursue understanding. The video also illustrated the vibrant communities in streams, how they can be organized into food webs, and how intimately they are connected to their surrounding landscapes through linkages among food webs, primarily through movement of insects and other invertebrates.

Play Sequence #1	**GREENHOUSE SHOT**
DISCUSSION #1	• **Is the greenhouse art or science? It's probably both, but it was built by scientist, a river ecologist named Shigeru Nakano, and it was built to answer a question. What question was it?** ○ ***Key question: Why would you put a greenhouse over a stream?*** • **To answer this question, we need to know a little more about rivers, so lets take a look through the eyes of Shigeru Nakano**
Play Sequence #2:	**STREAM FOOD WEB SEQUENCE**

DISCUSSION #2	• **Key points:**
	  ○ **Insects are a central part of almost all river food webs!**
	  ▪ **They are important food for fish**
	  ▪ **No insects = no trout (or many other stream fish)**
	• **Does that give us any insight into why this scientist, Shigeru Nakano, built a greenhouse over a section of stream? WELL, NOT YET…**
	  ○ **…but lets take a closer look at those fish, and a closer look at the scientific process**
	  ▪ **One thing you need to know for this sequence is that**

	charr are a type of trout
Play Sequence #3:	CHARR FEEDING EXPERIMENT
DISCUSSION #3	• Okay, so maybe that's more than most of us wanted to know about charr, but that is a good example of how scientists use experiments to answer questions • Does that give us any insight into why Nakano built a greenhouse over a section of stream? NOT REALLY, BUT HERE'S A HINT: THE DRIFT NET USED TO REMOVE THOSE INSECTS FROM THE WATER COLUMN WAS MADE OUT OF MESH, AND SO WAS THE GREENHOUSE! ○ Now, let's take a closer look at those insects
Play Sequence #4:	INSECT EMERGENCE SEQUENCE
DISCUSSION #4	• So, are we getting an idea of what that question was that Nakano was asking? • But lets look at some work of another researcher who was asking similar questions
Play Sequence #5:	EEL RIVER SEQUENCE
DISCUSSION #5	• So, that pretty much gave away Nakano's question. He was interested in how important stream insects are to forest predators, like birds, bats, and spiders, and how important forest insects are to stream predators, like trout and charr • Nakano had observed all of this with his own eyes and had taken meticulous data on these observations, but Nakano was a scientist, and scientists don't always rely on observation alone…if you're going to establish a cause-effect relationship, you really need to test the existence of that relationship…and not just simply observe the relationship
Play Sequence #6:	GREENHOUSE SEQUENCE

DISCUSSION #6	• So, that's it. That's how Nakano answered his question of how strong these food web linkages were between streams and forests
	• That work was first published in 1999, and really changed the way ecologists looked at river food webs, and solidified the importance of these reciprocal exchanges that are so important for these food webs
	  ○ And this work also helps understand how to conserve river ecosystems
	  ▪ We have spent centuries straightening rivers, levying riverbanks, cutting down riparian forests, and tinkering with food webs, without much knowledge of how those activities can sever some of these food web connections…
	  ▪ So, now let's watch one last sequence, that puts these stream-forest food web linkages in more of a conservation context
	  • And keep in mind that rainbow trout are

	native to Oregon and Western North America, but they are the most widely introduced exotic sportfish in the world. They have been introduced to waters in all 50 states and over 100 countries, including Japan where this research you're about to see took place.
Play Sequence #7	**RAINBOW TROUT/DEFORESTATION SEQUENCE**
DISCUSSION #7	• **That's just a couple ways that human activities can impact these food webs through these cascading or reverberating effects.** • **A big part of conserving rivers is restoring and maintaining their connections to forests, and vice versa, and also being cognizant of how extensively food webs can exist**

Using the RiverWebs television documentary in the classroom

- The RiverWebs television documentary is 57 minutes in length
    - For classes shorter than 1 hour, you have 3 options:
        - Present the RiverWebs documentary in 2 class periods
            - 1st class period – play movie until 36:35
            - 2nd class period – advance movie chapters until 36:35, and play until 57 minutes (playing time: 20 minutes)
        - Present a shortened RiverWebs documentary, by skipping 2 chapters of more personal/dramatic content, and reducing the film to 49 minutes
            - After the heron catches the fish at 36:30, just shuttle ahead 2 chapters until 44:14, with Kurt and Mary dialogue beginning with "he was interested in the Eel, I'll bet"
        - Present only the 8 minute "Stream Food Web Sequence" from the Extra Features menu, which is a condensed introduction to stream food webs
- The RiverWebs documentary is in English and Japanese, with subtitles
    - If necessary, extra English voiceovers over Japanese statements can be chosen by selecting "Play Movie w/ voiceover"
    - A seating arrangement which allows viewers to see and read bottom of screen will be helpful

Appendix A – Useful Vocabulary

- **Charr** – A group of fishes in the salmon family, which are very closely related to trout. Examples of charr are dolly varden charr, white spotted charr, brook charr (commonly called "brook trout"), bull charr, arctic charr
- **Watershed** – a drainage basin for a specific river system and its tributaries, which includes all of its enclosed land and water
- **Food web** – a network of co-existing predator and prey organisms
- **Experiment** – A manipulative test of a hypothesized cause-effect relationship, which is generally achieved by adding, removing, or varying isolated one or more independent variable(s)
- **Insect emergence** – The process through which aquatic insects transform from aquatic larvae and pupae into winged terrestrial adults, which mate and then deposit eggs back in the water, where larvae will hatch and grow. Aquatic insects include dragonflies, mosquitos, damselflies, mayflies, caddisflies, stoneflies, craneflies, and midges.
- **Riparian** – the zone adjacent to rivers and streams, and the inhabiting organisms living
- **Native** – species that have naturally distributed and adapted to a given geographic area
- **Species introduction** – the intentional introduction of non-native species to a geographic area. Introduced species are often recreationally or economically important, such as game animals or agricultural crops
- **Ecological niche** – the unique ecological role an organism plays in an ecosystem, especially with where it lives and feeds, which generally minimizes competition with other organisms
- **Terrestrial** – living on the land
- **Aquatic** – living in water
- **Channelization** – The straightening of natural river channels, which generally involves streambank deforestation, and the installation of stone or concrete retaining walls or levies

Appendix B – Discussion Questions

- <u>Natural history questions</u>
    1) How did the white spotted and dolly varden charr co-exist in the Poroshiri River?
        - *Answer: when food (drifting insects) was scarce, dolly varden charr picked insects from the streambed to minimize competition with white spotted charr (an example of niche or resource partitioning)*
    2) What is the common life cycle of aquatic insects?
        - *Answer: eggs hatch in water, larvae grow on the bottoms of streams (or lakes/ponds), larvae (or sometimes pupae) emerge from water and transform into adults, adults mate, females deposit eggs back in water*
    3) What are some aquatic insects that emerge from streams?
        - *Answer: dragonflies, mosquitos, damselflies, mayflies, caddisflies, stoneflies, craneflies, and midges*
    4) How do forests feed stream food webs?
        - *Answer: 1) forests shed leaves and other plant material which feed aquatic organisms, especially invertebrates (shredders and collectors). 2) forest insects fall into streams and are eaten by aquatic organisms, especially fish*
    5) How do streams feed forest food webs?
        - *Answer: 1) stream insects emerge and are eaten by spiders, birds, bats, lizards and other predators (e.g., frogs, snakes). 2) stream fish are eaten by birds (herons, mergansers, kingfishers, ospreys, eagles), bears, snakes, and other predators*
- <u>Field experiments</u>
    1) Why did Shigeru Nakano and Kurt Fausch use fine mesh nets to reduce the amount of drifting insects in the Poroshiri River?
        - *Answer: to test the hypothesis that reductions in drifting insects caused the observed niche shift (streambed feeding) by dolly varden charr*
    2) Why did John Sabo and Mary Power build mesh enclosures on the streambank of the Eel River?
        - *Answer: to test the hypothesis that reductions in emerging insects would lower growth rates and densities (lizards per unit area) of lizard predators*
    3) Why did Shigeru Nakano cover the Horonai River with a mesh greenhouse?
        - *Answer: 1) to test the hypothesis that reductions in emerging stream insects would lower densities (# per unit area) of birds, bats, and spiders. 2) to test the hypothesis that reductions in falling forest insects would lower growth rates and densities of charr*
- <u>Invasive species</u>
    1) How did the introduced fish, rainbow trout, impact the stream-forest food web connections?
        - *Answer: rainbow trout competed with dolly varden charr for forest insects, which caused dolly varden charr to switch to feeding on streambed insects,*

which reduced the amount of these insects that emerged to forest predators, like streambank spiders

2) What are other effects introduced fish, like rainbow trout, can have?
    - *Answer: introduced fish can outcompete native fish for food and habitat, they can prey upon native organisms, and they can hybridize with closely related native fish species*
3) Are rainbow trout in [your state/province/country]? Are they native to [your state/province/country]?
    - *Answer: ask your regional or local state fish biologist for this information*
4) Why are rainbow trout introduced worldwide?
    - *Answer: rainbow trout are introduced by because they are a prized sportfish and are easy to raise in hatcheries*
5) What other fish species have been introduced to [your state/province/country]? Why?
    - *Answer: ask your regional or local state fish biologist for this information (likely introduced fish are carp, brown trout, bluegill, northern pike, largemouth and smallmouth bass)*

- <u>Habitat changes</u>
    1) How does streambank deforestation and channelization affect the connections between stream and forest food web?
        - *Answer: channelization and streambank deforestation can reduce the amount of terrestrial insects falling into streams, and generally disconnect streams from their streamside forests*
    2) Are there any examples of channelized or deforested streams in [your watershed or town]?
        - *Possibilities: streams along roads and agricultural fields are commonly straightened and reinforced with stone, rip-rap, or concrete so that they no longer move and migrate naturally within their valley*
    3) What other examples of river habitat changes are in [your state/province/country]? How do you think they affect river ecosystems?
        - *Possibilities: dams and diversions are among the most obvious modifications that change the physical and thermal habitat of rivers; sediment from erosion areas is another big impact to stream habitat; chemical pollution and nutrients from agriculture and urban areas are a less visible impact to water quality*
- <u>For debate</u>
    1) Should the stocking of rainbow trout or other nonnative fish species continue in the public waters of your state/province/country?

Appendix C - Resources for Teachers

- Curricula
  - LeafPack – learning activity and field trip for learning about aquatic invertebrate communities
- Books
  - Streams: Their Ecology and Life by Colbert E. Cushing & J. David Allan
  - Stream Ecology: Structure & Function of Running Waters by J David Allan
  - Methods in Stream Ecology by F. Richard Hauer & Gary Lamberti
- Websites
  - EPA watershed programs: www.epa.gov/owow/watershed/
  - Project WET: www.projectwet.org