

# That's Predictable

Duration:  
Classroom:  
Introduction  
30 min.  
Student Work  
2 weeks

Setting:  
Classroom

Core Standards:

6th Grade  
Science ILOs:  
1d, 1g, 1h, 1i, 2a,  
2c, 2f, 4b, 4c, 4d,  
5a, 6b, 6c

7-8 th Grade  
Science ILOs:  
1e, 1f, 2b, 2d, 3b,  
4a, 4b, 4c, 4d, 5a,  
5c, 6a, 6b, 6c, 6d,

8th Grade  
Science: 2.3a,  
2.3c

High School  
Science ILOs;  
1a, 1b, 1c, 1e, 1f,  
2a, 2b, 2e, 3c, 4b  
4c, 4d, 5a,

Earth Systems  
Science: 4.2b,  
4.2d

Biology: 1.2d,  
1.3b, 1.3c, 1.3d,  
1.3e

Utah Studies:  
1.3a, 1.3d

Geograph for  
Life: 5.1d

NR Science I:  
3.2c,

NR Science II:  
4,1a, 4.1b, 5.2c

**Purpose:** To predict how an [ecosystem](#) will change as a result of major changes in the abiotic and/or biotic factors.

**Summary:** In this exercise, students will be asked to research and report on ecosystem changes that occur as a result of changes in an aquatic environment.

**Background:** For background information, see:

- The Resource page provided which includes a table showing the changes to an aquatic ecosystem and the ecosystem response.
- The Chemical Properties section of the [Utah Stream Team Manual](#) which discusses abiotic factors in an aquatic ecosystems including how each chemical property changes due to natural and human influences, and why the factor is important in aquatic ecosystems.
- The Biological Properties section of the [Utah Stream Team Manual](#) which discusses macroinvertebrates and riparian vegetation in an aquatic ecosystem.
- The Physical Properties Section of the [Utah Stream Team Manual](#) which discusses stream flow and stream structure and how those are affected by human activities.

**Materials:**

- Access to the library and other reference materials
- Access to the internet
- The [Utah Stream Team Manual](#)
- Other reference sources (see a list on the Resource page)
- Results from the Stream Side Science Activities (optional):
  - What's in the Water?
  - Riparian Review
  - Who Lives in the Water?

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## Classroom Activity:

1. Ask the students to review all the abiotic and biotic factors in an aquatic ecosystem. Optional: Refer to the activities What's in the Water?, Who lives in the Water? and Riparian Review.
2. Discuss the role that these factors play in the environment. Have the students discuss how a change in abiotic or biotic factors would affect the aquatic ecosystem.
3. Explain to the students that they will choose a change in abiotic or biotic factors in an aquatic ecosystem and explore it further in the form of a written paper, presentation or other format of the teacher's choice. For ideas, see the Resource page.
4. To help the students get started choose a topic and, with the class, form a hypothesis of what might happen to the ecosystem as a result of the abiotic or biotic change. With the class, develop a list of sources where they will be able to find more information.

### **Suggested points that students may include:**

- Geographic scale of problem – e.g., watershed scale vs. backyard scale.
- Magnitude of problem – e.g., slumping of entire hill slopes vs. loss of banks in small sections.
- Reversibility of changes – e.g., loss of topsoil from a major avalanche vs. loss of vegetation in an avalanche.
- Driving factors for changes – e.g., erosion from a construction site.
- Natural forces – e.g., floods, tornadoes, droughts, global warming.
- Economics – e.g., developers of housing developments or logging/mining interests.
- Politics or regulations – e.g., requirements by law.
- Cost/benefits – i.e., who or what will benefit, who will pay (consider costs and benefits to society, to individuals, to ecosystem functions or to different components of ecosystems).
- Have the students research further on their topic for changes that have occurred in their area.

# That's Predictable

## Applying the Information

5. Use the information in the students' papers to hold a debate for or against each of the changes in abiotic or biotic factors.

6. Have the students take action in their community on one of the topics they researched. For example:

- Work with local agencies to restore a section of a stream. (<http://www.ut.nrcs.usda.gov/>)
- Conduct a service project such as a "stream clean-up"
- Make a website
- Educate the public about the issue at a public forum or through educational materials at a public location such as a park or mall
- Participate in volunteer monitoring through USU Water Quality Extension (<http://extension.usu.edu/waterquality>)

### **1. Do you think that ecosystems will always be changed if there are small changes in abiotic or biotic factors?**

## Further Discussion:

- *Change is a natural part of ecosystems, and all healthy ecosystems are to some extent "self-correcting." For example, an early snowstorm may cause many trees or branches to fall, but in a healthy riparian system or healthy forest the trees will eventually regrow and any openings in the forest canopy will fill again. In fact, many ecosystems depend on some degree of disturbance. For example, sprouting young cottonwoods in riparian areas often depend on a flood event.*
- *Some disturbances in ecosystems are more important than others. For example, the accidental introduction of a tiny mussel into the Great Lakes has led to extremely clear waters from these efficient filter feeders, but also to changes in food availability for other organisms, and economic impacts when huge mats of these mussels attach to intake pipes, docks and boats.*

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## 2. What could be done to protect aquatic ecosystems from these changes?

*Protecting through laws and regulations: Some potential problems are so severe that we regulate them with laws. A few examples are:*

- *“Point source” water pollution: EPA and Utah’s Division of Water Quality regulate how much and what kind of pollutants can be dumped into our lakes and rivers from factories, municipal treatment plants, and large animal feeding operations. All point sources must have a “discharge permit” in Utah.*
- *Modification of a stream [channel](#): No one in Utah can modify a stream channel (e.g., take gravel from the channel or channelize the stream banks) without a permit from the state Division of Water Rights.*

*Protecting through voluntary approaches: In many cases, rather than regulating behavior with laws, we depend on people making the right decisions on how to best manage their own lands and activities. These are often called “Best Management Practices.” Because these practices are voluntary, it becomes especially important that citizens are well educated on how their activities affect the environment and why.*

*For aquatic systems, some Best Management Practices include:*

- *Healthy riparian areas and [buffer](#) strips along streams and canals that shade the water, protect the banks from erosion, and filter runoff of pollutants.*
- *Grassy swales or retention basins that slow the flow of urban runoff and promote infiltration rather than surface runoff.*
- *Lawn care practices that avoid over fertilizing lawns and gardens and watering lawns only when needed.*
- *Cleaning up pet waste so it is not washed into streams.*

# Notes

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# Student Page

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Topic selected: \_\_\_\_\_

Hypothesis of how the ecosystem will change:

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Resources for more information: \_\_\_\_\_

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According to your research, what would be the expected changes? Did this fit your hypothesis? \_\_\_\_\_

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Did this project leave you with additional questions? \_\_\_\_\_

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# Changes from Abiotic and Biotic Factors

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The following resource pages provide tables outlining an abiotic or biotic change, how the ecosystems may respond and possible websites or organizations to look to for more information.

NOTE: Many of the impacts listed on the following pages appear to have mostly detrimental effects on the natural biota or ecosystem. Keep in mind, however, that humans often derive positive benefits from these same activities. For example, [irrigation](#) diversions allow agriculture to flourish in much of the west, and also may result in new riparian habitat forming along irrigation canals. The challenge to society is to find ways to minimize the impacts while retaining the benefits.

## OTHER SUGGESTED RESOURCES:

- Library
- Newspaper and magazine articles
- Scientific journals
- Talk to a specialist in the area (e.g., Natural Resource Conservation Service, Utah State Geological Survey, Department of Environmental Quality, USU Extension)
- University researchers or professionals (such as consultants) working in these areas
- Watershed coordinators (lists available from Utah Division of Water Quality)

# Abiotic Changes

| ABIOTIC CHANGES   | ECOSYSTEM RESPONSE  | WEBSITES FOR MORE INFORMATION  |
|---|---|--|
| <p><b>Stream channelization:</b> caused when stream banks are “hardened” with rip rap or “protected” by berms.</p>  | <ul style="list-style-type: none"> <li>-Loss of habitat in the stream.</li> <li>-Increased velocity.</li> <li>-Changes in natural stream <u>sinuosity</u>.</li> <li>-Reduced fish and <u>macroinvertebrate</u> diversity from loss of spawning habitat, loss of macroinvertebrate habitats, or loss of flood fed side <u>channels</u> which are important for native fish reproduction.</li> <li>-Loss of riparian plants, and associated wildlife.</li> </ul>  | <p><a href="http://library.wrds.uwyo.edu/wrp">http://library.wrds.uwyo.edu/wrp</a></p>   |
| <p><b>Pollutants entering the system. Many activities, including industrial discharges, agricultural runoff, improper cleanup of pet waste and over-fertilization of lawns.</b></p> | <ul style="list-style-type: none"> <li>-Loss of “<u>beneficial uses</u>” (such as recreation, irrigation, or aquatic habitat) of our natural waters due to increased pollution. May also change color and smell of water.</li> <li>-Loss of pollution sensitive species, replaced by pollution tolerant species.</li> <li>-Often fewer species (less diversity).</li> <li>-Health issues for humans using water for recreation or drinking.</li> </ul>  | <p>Food and Agriculture Organization of the United Nations <a href="http://www.fao.org">http://www.fao.org</a> (search for pollutants, runoff, fertilizer)</p> <p>Duluth Streams <a href="http://www.duluthstreams.org/understanding/impact.html">http://www.duluthstreams.org/understanding/impact.html</a></p> |
| <p><b>Construction of dams for irrigation, flood control, recreation.</b></p>   | <ul style="list-style-type: none"> <li>-Change in flow patterns throughout a year, with fewer floods.</li> <li>-Change in temperature (surface of reservoirs become warmer, deeper waters remain cooler).</li> <li>-Change in sediment load (reservoirs are sediment traps).</li> <li>-Impacts on warm water fish if downstream temperature decreases, loss of native fish that depend on back channel flooding.</li> <li>-Clearer water downstream of dams may support salmonids and other sport fishes not found elsewhere in the river.</li> </ul> | <p>Environmental Protection Agency <a href="http://www.epa.gov">http://www.epa.gov</a> (search for dams, irrigation, flood control)</p>  |



# Abiotic Changes, Continued

| ABIOTIC CHANGES  | ECOSYSTEM RESPONSE   | WEBSITES FOR MORE INFORMATION  |
|--|--|--|
| <p><b>Development (increase an impervious surface area)</b></p>  | <ul style="list-style-type: none"> <li>-More pollution from urban <a href="#">runoff</a>.</li> <li>-Less groundwater recharge.</li> <li>-Higher flows and more floods during rain events.</li> <li>-Loss of pollution sensitive species, replaced by pollution tolerant species.</li> </ul>  | <p>Raritan Basin Watershed Management Project <a href="http://www.raritanbasin.org">http://www.raritanbasin.org</a> (search for impervious surface area)</p> <p>Utah State University Water Quality Extension <a href="http://extension.usu.edu/waterquality">http://extension.usu.edu/waterquality</a> (search for impervious surface area)</p> |
| <p><b>Climate Changes: Changes in runoff (rain event, snowmelt). Changes in maximum stream flow (big snow year). Drought.</b></p>  | <ul style="list-style-type: none"> <li>-Change in flows.</li> <li>-Loss of native fish if spawning areas silted in.</li> <li>-Possible bank <a href="#">erosion</a>.</li> <li>-Change in sediment load.</li> <li>-Change in temperature.</li> <li>-Loss of habitat, impacts to coldwater fish as temperature increases, impacts to wildlife forage and cover.</li> </ul>   | <p>Environmental Protection Agency (climate change) <a href="http://www.epa.gov/climatechange/">http://www.epa.gov/climatechange/</a></p>  |
| <p><b>Mining oil, gas, and coal: Changes in groundwater movement and exposure of groundwater to pollutants, disturbance of surface, release of salty or polluted water to surface.</b></p> | <ul style="list-style-type: none"> <li>-Pollution increase determined by mining operations.</li> <li>-Increased sediment runoff may occur from surface disturbance; water draining from mines may be extremely <a href="#">acidic</a> and carry heavy metals; water <a href="#">discharged</a> from coal bed methane wells can be very salty.</li> <li>-Loss of native fish if spawning areas silted in.</li> <li>-Sensitive species replaced by more tolerant species.</li> </ul> | <p>Environmental Protection Agency (surface coal mining activities under clean water act) <a href="http://water.epa.gov/lawsregs/guidance/wet-lands/mining.cfm">http://water.epa.gov/lawsregs/guidance/wet-lands/mining.cfm</a></p>  |

# Biotic Changes

| BIOTIC CHANGES   | ECOSYSTEM RESPONSE  | WEBSITE FOR MORE INFORMATION   |
|--|---|--|
| <p><b>Introduced species to a stream or riparian area.</b></p>                                       | <ul style="list-style-type: none"> <li>-Depends on species.</li> <li>-Competition for food and habitat impacting native fish.</li> <li>-Uncontrolled growth of introduced species and other organisms.</li> </ul>   | <p>Environmental Protection Agency<br/> <a href="http://www.epa.gov">http://www.epa.gov</a> (search for invasive species)</p> <p>Utah Department of Agriculture and Foods<br/> <a href="http://ag.utah.gov">http://ag.utah.gov</a> (search for nuisance species)</p> |
| <p><b>Loss of riparian area: due to land use such as logging, urban landscaping, or grazing.</b></p> | <ul style="list-style-type: none"> <li>-Loss of wildlife and bird habitat.</li> <li>-Increase in water temperature (reduced shading).</li> <li>-Increase in sediment load and pollutant runoff.</li> <li>-Impacts on coldwater fish as temperatures increase, loss of native fish if spawning areas are silted in.</li> </ul> | <p>USDA/Forest Service<br/> <a href="http://www.srs.fs.usda.gov">http://www.srs.fs.usda.gov</a> (search for logging)</p> <p>Kansas State University<br/> <a href="http://www.ksre.ksu.edu/">http://www.ksre.ksu.edu/</a> (search for grazing)</p>                    |



