Notes from the Field

Young Scientist Newsletter

Indicator Species

Photo Credit: American Craft Beer

July 2018

What is an indicator species?

An **indicator species**, or a **bioindicator**, is any organism that may signal a change occurring within an **ecosystem**, habitat, or location. By looking at a species' presence, absence, or **abundance** in an area it may be possible to draw conclusions about the health of the larger ecosystem and how it is changing. A bioindicator may be a single species (i.e. Monarch butterfly), a group of related species (i.e. butterflies), or a classification of organisms (i.e. insects).

One well-known example is that of the canary in the coal mine. Miners in the early 1900s would take a caged canary with them into the coal mines to monitor for high levels of **carbon monoxide** that are toxic. The canaries are more vulnerable to small amounts of the deadly gas, so if the bird became ill or died the miners were given an early warning of dangerous conditions. The canary served as an indicator of poor air quality and allowed miners to evacuate before the air became deadly.


Photo Credit: Smithsonian Magazine

(**Bold words** can be found in the glossary on page 9)

What makes a good bioindicator?

Not all organisms make good bioindicators. A potential indicator species should be studied and evaluated before being used to make sure it can actually represent a whole community. Here are some criteria to consider:

- ✔ **Abundance and distribution** – are there enough individuals in the area to make observation and monitoring possible and convenient? Is this species easy to find and observe? Are they distributed evenly throughout the study area or concentrated in one spot?
- ✔ **Well-studied** – is this species' life history and ecology well understood? Are the diet, preferred environment, behaviors, and vulnerabilities well known? Will it be cheap and easy to study?
- ✔ **Sensitivity** – is this species stable with a moderate tolerance to environmental conditions? Does it respond to **stressors** in a measurable way (i.e. slower growth, halted reproduction, illness, physical deformity, movement away from stressor or location, etc)? Does this species respond to the stressor or degree of contamination? Does the response of the indicator species reflect the response of the rest of the community?

A rare species, or one that responds to a stressor in a unique way may not be a good bioindicator. It would also be challenging to observe changes in a species that is not well known or that is hard to find and identify.

Examples of Indicator Species

Plants

Fern

Water Lily

Lichen

Insects

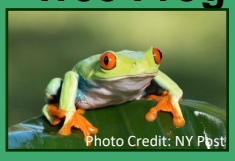
Butterfly

Dung Beetle

Bee

Amphibians

Tree Frog



Salamander

Toad

Birds

Kiwi

Owl

Heron

Fish

Tiger Shark

Coral Reef

Salmon

Mammals

Otter

Bats

Prairie Dog

In other words...

An example of using an indicator species to monitor the health of an ecosystem is using grass to see if there are changes occurring in the soil below ground. In this case, the soil community is the "ecosystem" and grass is the "indicator species". **Botanists** and other scientists have studied both soil and grass and are aware of how they interact, what environmental conditions are ideal for both, and what happens when those conditions change. Grass grows above ground and is widespread which makes it easy to observe. It responds predictably to environmental changes (i.e. drought, flooding, extreme temperatures) and the addition of chemicals (i.e. fertilizers, insecticides, herbicides). These responses are observable and can be measured without complex laboratory testing. Additionally, grass will respond to environmental changes before the below ground community making it a good early indicator of potential broader impacts. Scientists can observe grass, take note of any changes occurring, and make predictions about what might happen below ground or to other organisms in the area.

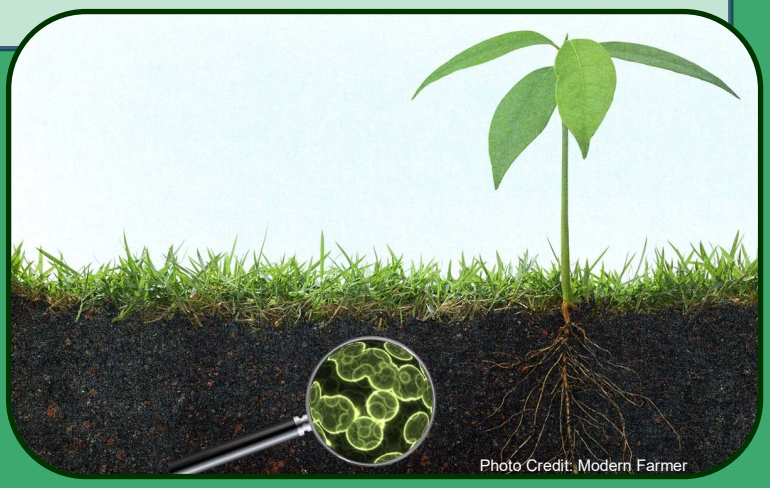


Photo Credit: Modern Farmer

(**Bold words** can be found in the glossary on page 9)

To use or not to use??

Advantages:

- Offers an affordable technique to monitor change compared to chemical and laboratory analysis.

- Allows for continuous observations as opposed to "snapshot" observations gathered through repeated chemical testing.

- Gives scientists the ability to detect smaller changes sooner and respond appropriately.

- Provides straightforward, easy to understand data without minimizing the complexity and interconnectedness of the ecosystem.

- Can show the indirect impacts of pollution and how it impacts the larger food web.

Disadvantages:

- It can be difficult to find a species that fits all necessary **criteria** to be a good indicator species

- May be easy to jump to conclusions with only a small amount of information. This technique also needs follow up studies

- Requires more man-power and time to locate the chosen species and make observations

- The size of the study area or number of observed samples can be limited and therefore not sufficient enough to make generalizations.

Straight from the scientists:

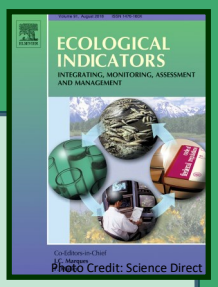
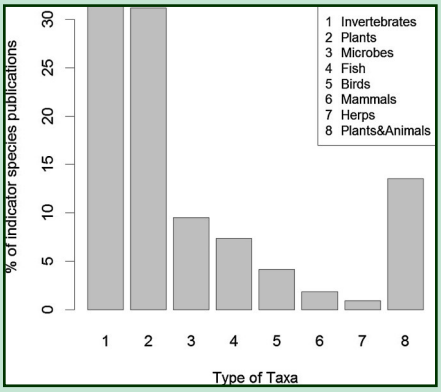


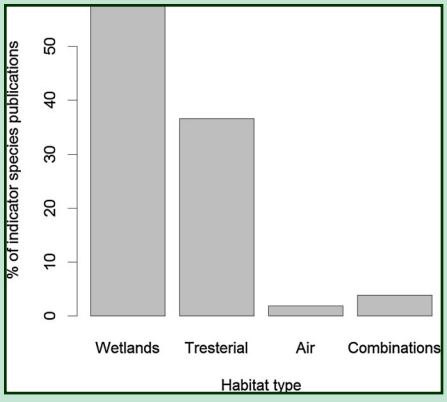
Photo Credit: Science Direct

The following is a summary of "How do ecologists select and use indicator species to monitor ecological change? Insights from 14 years of publication in Ecological Indicators" written by A.A.H Siddig, A.M. Ellison, A. Ochs, C. Villar-Leeman, and M.K. Lau, published in Ecological Indicators in January 2016 (Volume 60, pages 223-230).

As ecologists and environmental scientists work to monitor the effects of climate change, pollution, disease outbreak, and habitat loss, they are faced with both logistical and financial challenges. The use of indicator species (IS) has helped address those challenges and provide valuable insight into changes occurring both locally and globally. It is such a common practice that there is a scientific journal dedicated to the study and use of environmental indicators and indicator species entitled *Ecological Indicators*. Two years ago, a team of researchers from Massachusetts and Maine examined the 1,914 articles published between January 2001 and December 2014 to determine how bioindicators are used, what types of organisms are typically used, and what habitats are most commonly studied using this method.



Through their analysis, the researchers found that 43% of the articles written were based on studies involving indicator species. Only eight IS papers were published in 2001 but that number rose to 159 by 2014 indicating the increased use of this monitoring technique. The 823 IS articles covered topics including overall environmental health and integrity, pollution and contamination, ecological management and restoration, risk assessment, and early warnings of environmental change. Approximately 80% of the studies used multiple related species as indicators rather than a single species. The team also broke the data down into types of organisms used: 46% animals, 30% plants, and 10% microorganisms. The majority of animals used were invertebrates. Over 50% of the discussed studies were conducted in marine and wetland habitats and 35% in terrestrial habitats. Around 13% included more than one habitat and just 2% related to atmospheric research.



The researchers concluded that indicator species are a popular choice when monitoring environmental change because it is a cost-effective tool that can be continually monitored over time and does not rely on expensive, complex chemical analyses. The results are less challenging to explain and provide simple, straightforward imagery for the public. They acknowledge that selecting a good indicator species is a challenge and agree that using multiple species provides a more multi-dimensional picture of the environment.

In the salt marsh

Approximately 40% of coastal marshes in the United States are found in Louisiana. These marshes are a critical habitat that support the seafood industry and protect the state's southern region from storms. Keeping them healthy and thriving is vital to Louisiana's future. Scientists are studying the coastal marshes in all manner of ways and a few are identifying important organisms to serve as indicator species.


Photo Credit: Duke Marine Lab

Periwinkles Snails – These small snails are found in high abundance in salt marsh habitats. They rely on marsh grasses for food and shelter and are tolerant of moderate salinity changes. Periwinkles are an excellent bioindicator because they are easy to find and can be marked for recapture and observation. These snails are vulnerable to environmental changes and contamination and respond in predictable ways when stressed.


Photo Credit: barnegatshellfish.org

Ribbed Marsh Mussels – This bivalve is found along marsh edges and serves as stabilizer to prevent erosion. It has been widely used as a bioindicators for NOAA's Mussel Watch program to monitor the effects of heavy metal contamination. Mussels readily accumulate pollutants into their tissues and scientists have developed technology to examine their cells for adverse reactions to exposure.

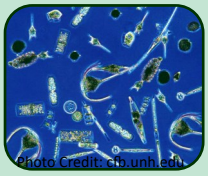


Photo Credit: cho.unh.edu

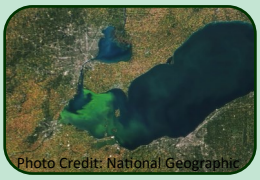


Photo Credit: National Geographic

Phytoplankton – These plant-like microorganisms are present in all aquatic ecosystems and produce oxygen through photosynthesis. One type, often called algae, has been well studied and successfully used as an indicator species of water quality. Past studies have determined how pollution effects both growth and photosynthetic rates allowing their response to environmental changes to be monitored.


Photo Credit: whatsthatbug.com

Salt Marsh Greenhead Horsefly – Setting aside their annoying behavior, greenhead horseflies are well-researched salt marsh inhabitants. They are native to coastal marshes ranging from Texas to Nova Scotia and dependent on both **aquatic** and **terrestrial** habitats. Greenhead horsefly larvae develop over the course of nine to twelve months and are a top predator within the ecosystem. These characters make them useful bioindicators because they are vulnerable to environmental changes and the adults will directly display the impacts of those changes.

(**Bold words** can be found in the glossary on page 9)

Scientist Corner


Photo Credit: Jordan Logarbo

Jordan Logarbo

What is your current position?

I am a Research Assistant in the Brian Roberts Biogeochemistry and Ecosystem Ecology Lab.

What is your educational background and how did you arrive at this position?

I received my B.S. in biology with a concentration in marine biology from Nicholls State University in May 2017. I began working at LUMCON as an intern in the Roberts Lab in the summer of 2016 and continued as a part-time student employee until I graduated the next May. Upon graduation I was hired as a full-time research technician and was soon promoted into the role of Research Assistant.

Who/What inspired you to get into science?

I was inspired to become a scientist first by my dad and him sharing his love of nature with me and my siblings our whole life.

Secondly, I had an amazing teacher in high school, Mrs. Keller, she definitely inspired me to love biology and pursue biological studies in my collegiate career. She loved science and sharing it with all of her students. She's my scientific hero.

What do you enjoy most about your position?

What I enjoy most about conducting scientific research is being able to experience nature and extract information from the environment so that we can better asses the overall health of the marsh.

Have you experienced any challenges along the way? How did you overcome them?

I struggled transitioning from the pace and community of college to the schedule and structure of a full-time job. I often felt alone and missed having friends and the low-key social opportunities campus life provided. At the same time, I was excited to have a job and to be applying the knowledge I gained from school. With support from my family, friends, and new colleagues, I was able to power through those feelings of loneliness and adjust to the new lifestyle changes.

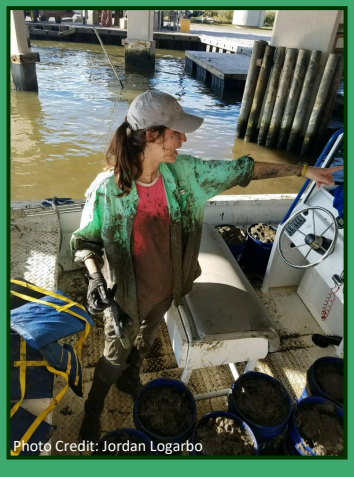


Photo Credit: Jordan Logarbo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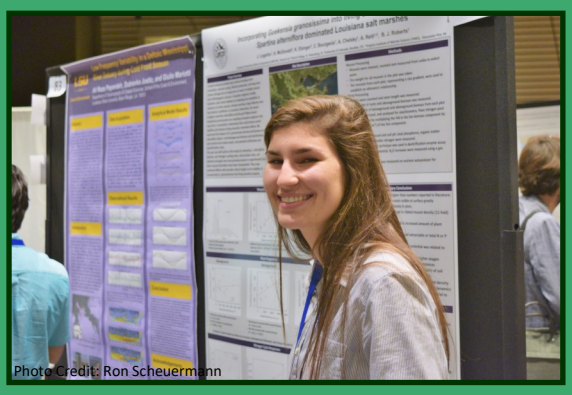
Photo Credit: Ron Scheuermann

Indicator Species Word Search

Find all the words in the word bank!

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ECOLOGY
SPECIES
BIOINDICATOR
OBSERVATION
ECOSYSTEM
CANARY
LICHEN
STRESS
AFFORDABLE
MUSSEL
PERIWINKLE
HORSEFLY
MONITOR
WETLANDS
SALTMARSH

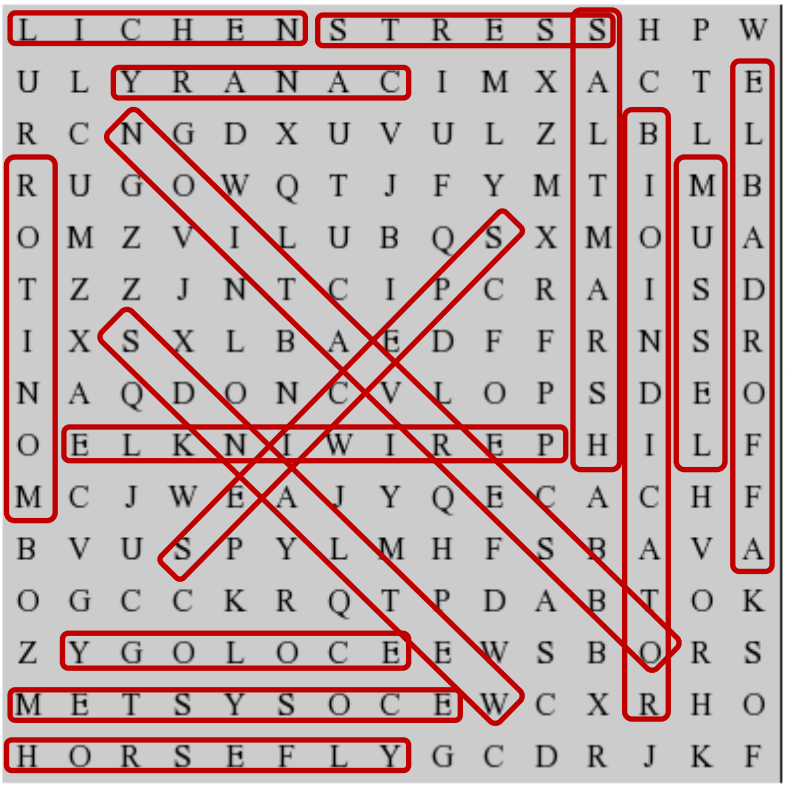
Answer key on page 8

Photo Credit: Coalition to Restore Coastal Louisiana

Answer Key

Indicator Species Word Search

Find all the words in the word bank!



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HORSEFLY
MONITOR
WETLANDS
SALTMARSH

Glossary of Terms

Abundance — the quantity or amount of something.

Aquatic — relating to water. Used to described organisms that live in fresh, salt or brackish water. Examples: whales, fish, oysters, shrimp, sharks, dolphins, etc.

Bioindicator — any organisms, that when observed, may indicate changes within an ecosystem or habitat. Sometimes referred to as an **indicator species**.

Botanist — a scientist that studies plants.

Carbon monoxide — a colorless, odorless, tasteless gas that can be harmful or toxic to many organisms when encountered in high concentrations.

Criteria — a standard or list of qualities by which something is judged or decided.

Ecosystem — all of the living things (animals, plants, organisms), in an area, interacting with each other and with their non-living environment (weather, soil, water, sun, etc).

Indicator species — any organisms, that when observed, may indicate changes within an ecosystem or habitat. Sometimes referred to as a **bioindicator**.

Terrestrial — of, on, or relating to earth. Used to describe organisms that live on land. Examples: humans, deer, dogs, cats, horse, rabbit, etc.

For More Information:

Check out these short YouTube videos:

- **“**Alexandra Cousteau’s Expedition Blue Planet: Indicator Species” - Blue Legacy International
- “120 Second of Science—What is an indicator species?” - Doc Ryan
- “Clean water has bugs in it—Stoneflies and water quality” - Brigham Young University
- “Aquatic insects as environmental indicators” - Michael Plondaya

Other Resources:

- What is an Indicator Species? - Encyclopedia of Life
  http://eol.org/info/465
- What are indicator species? Examples around the World— AnimalWised
  https://www.animalwised.com/what-are-indicator-species-examples-around-the-world-1435.html
- Bioindicators: Using Organisms to Measure Environmental Impacts— Knowledge Project
  https://www.nature.com/scitable/knowledge/library/bioindicators-using-organisms-to-measure-environmental-impacts-16821310
- Examples of Indicator Species—SeattlePI
  http://education.seattlepi.com/examples-indicator-species-4123.html
- The Story of the Real Canary in the Coal Mine—Smithsonian
  https://www.smithsonianmag.com/smart-news/story-real-canary-coal-mine-180961570/
- Greenhead Horse Fly as a Bioindicator of Marsh Health after the 2010 Oil Spill—LSU AGCenter
  http://www.lsuagcenter.com/portals/communications/publications/agmag/archive/2014/summer/greenhead-horse-fly-as-a-bioindicator-of-marsh-health-after-the-2010-oil-spill
- Ribbed Mussel— South Carolina Department of Natural Resources
  http://www.dnr.sc.gov/cwcs/pdf/Ribbedmussel%20.pdf
- Birds as Environmental Indicators— EnvironmentalScience.org
  https://www.environmentalscience.org/birds-environmental-indicators

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