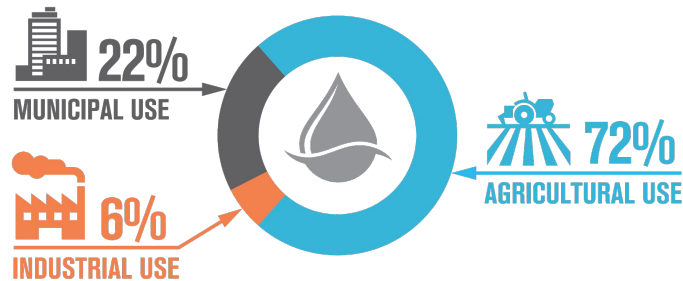
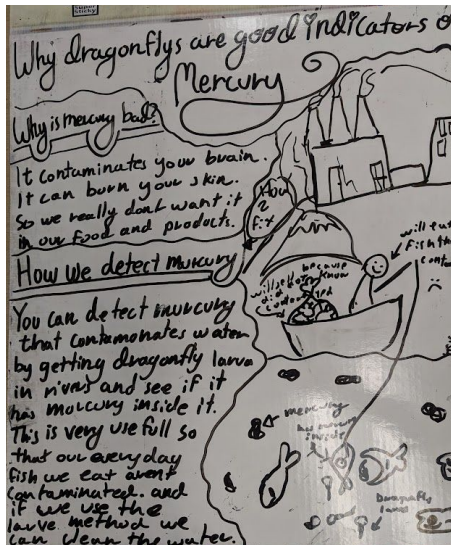


Local Issues With Global Significance

Developing Data Literacy Through Place-Based Learning



SOURCE: ADNR, 2020



Rachel Carpenter
Master Science Teacher
Wakefield Middle School, Tucson, AZ
Master Teacher Fellow, Noyce Borderlands Education Center
BIORETS Teacher Fellow



The BIORETS Santa Cruz River program is for middle and high school science teachers. The focus is on teachers conducting ecological research alongside University of Arizona professors and graduate students on the Santa Cruz River.

Teachers learned from a wide array of stakeholder groups including county, city, and water utilities staff, and non-profit organizations working with the Santa Cruz River. Teachers worked concurrently to develop curriculum to bring the Santa Cruz River back to the classroom. Lessons and activities, including field trips, were implemented during the following school years.



NSF Award #2143228 BIORETS: Conserving water resources and riparian biodiversity in a changing desert climate



THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE, LIFE & ENVIRONMENTAL SCIENCES

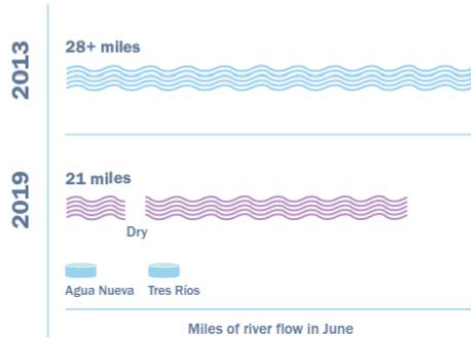
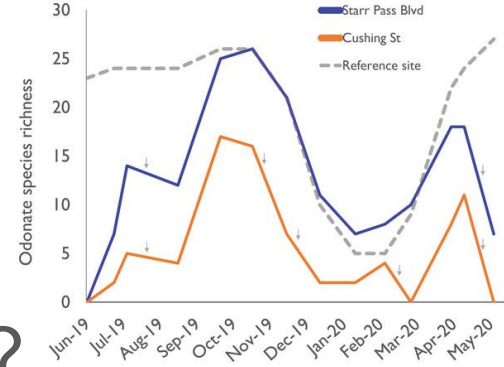
**Natural Resources
& the Environment**

Essential Questions



How can we describe a place?

What stories do these data tell?



Standards

6.L2U3.11 Use evidence to construct an argument regarding the impact of human activities on the environment and how they positively and negatively affect the competition for energy and resources in ecosystems.

6.L2U3.12 Engage in argument from evidence to support a claim about the factors that cause species to change and how humans can impact those factors.

6.L2U1.13 Develop and use models to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors.

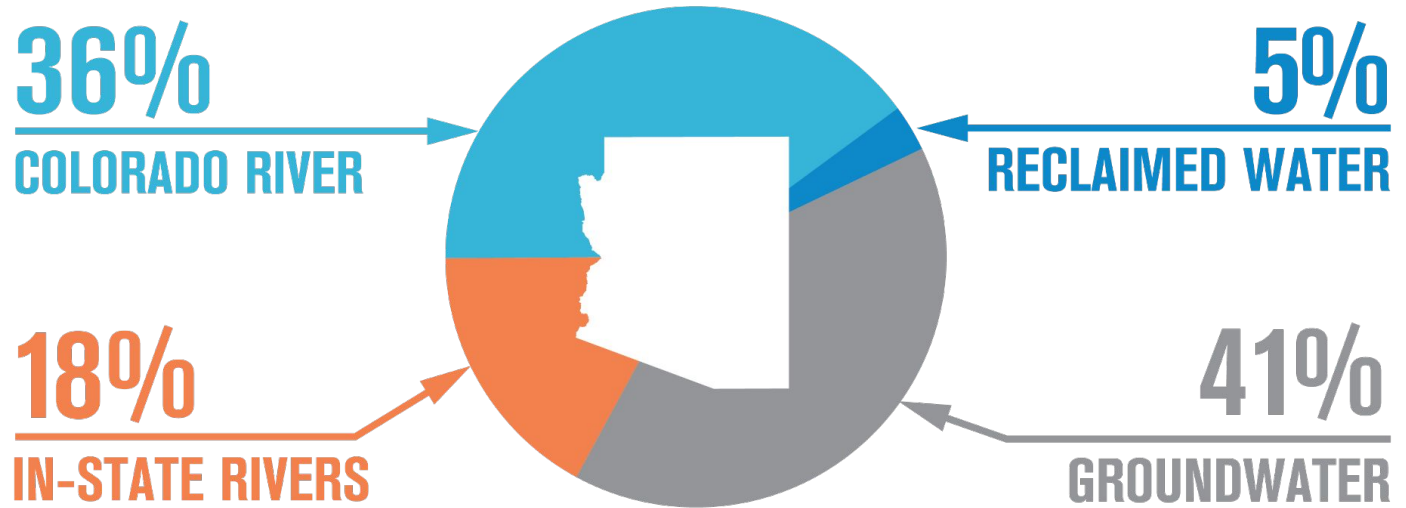
P1: All matter in the Universe is made of very small particles.

Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Warm Up: Study the image. Make two observations, one inference, and ask one question.

ARIZONA'S WATER SUPPLY



SOURCE: ADWR, 2020

I noticed that there is a image of how many water is used. I also noticed ground water is the most used. In 5th grade we made Charts of how something is used & how many its used. Is it in Arizona only?

I notice that this graph is about where Arizona gets it's water.

I notice that the Ground water is where we get the most water.

I infer that arizona going to more rivers so we can more water.

Why is reclaimed water so low?

The graph shows Arizona's water supply from like rivers and ground water. Colorado river supplies Arizona 36% from just that one river so that's the second best water supplier.

Observation: I notice it is in a category.

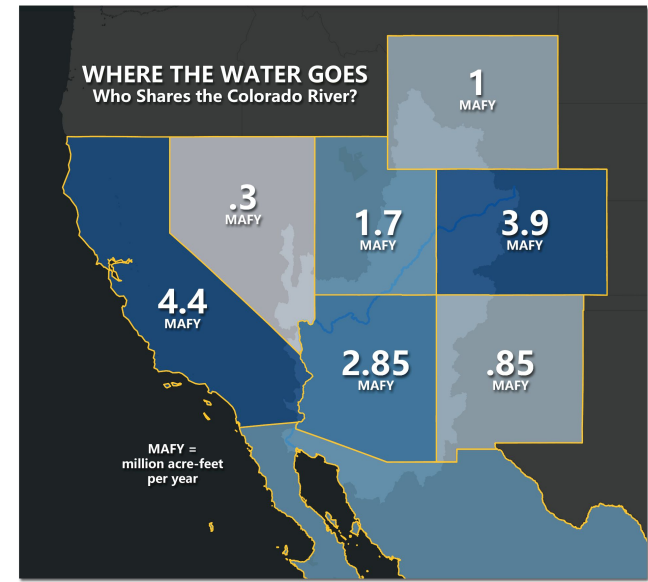
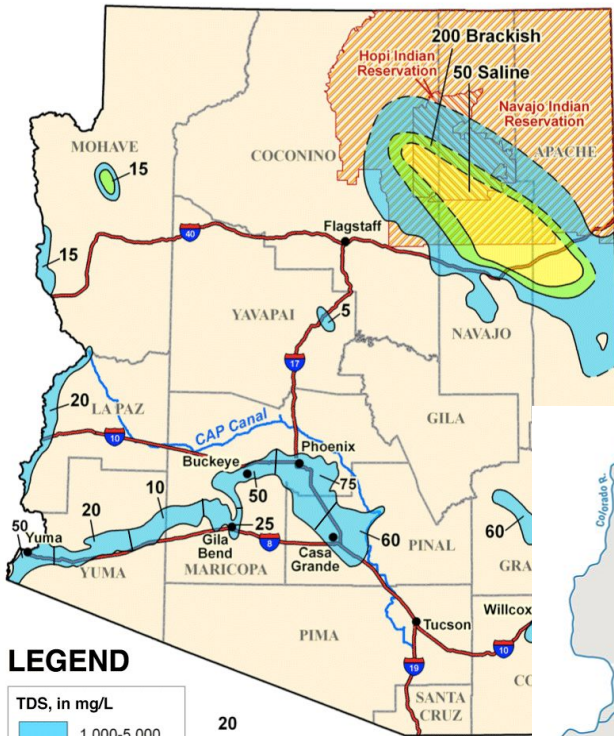
infer: the numbers have percents.

observe: the categories are colored differently.

infer: the categories are about arizonas water supply.

Question: I wonder what kind of water supply they are talking about.

Central Arizona Project (CAP)

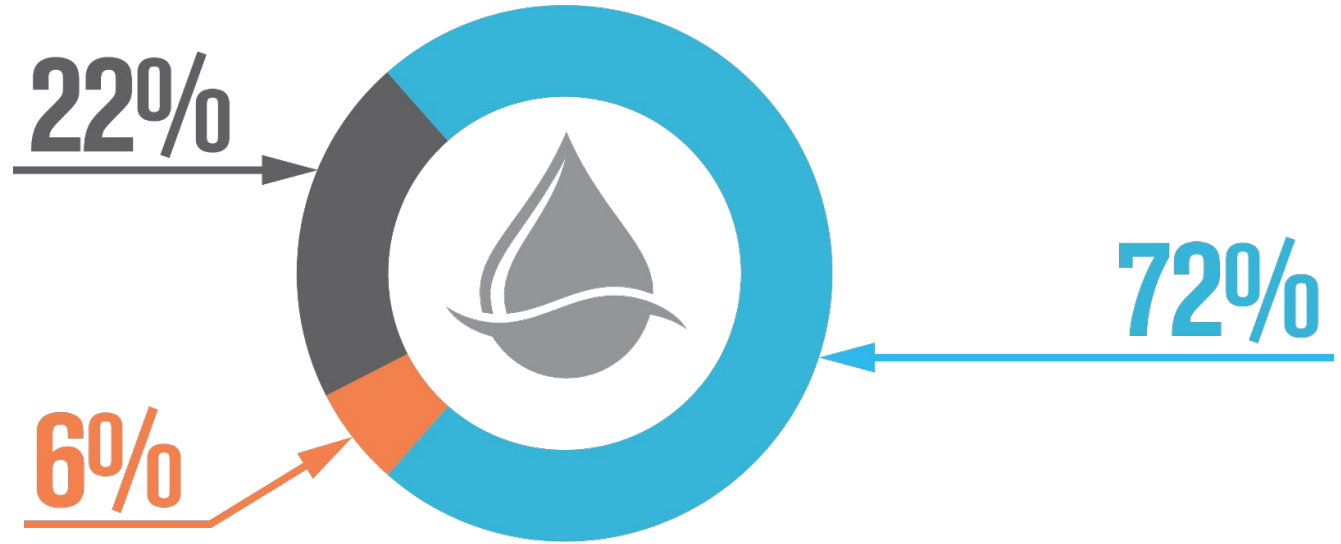


What do you know about water in Arizona?

- Where it comes from
- How it is used

Water in Arizona

Study this graph of water use in Arizona. What do you notice? What do you think the different categories might represent?



SOURCE: ADWR, 2020

Warm Up

I think the graph shows that out water is used at different parts of AZ like at pima at Tucson and phoenix and at other small towns

Warm Up

1-11-23
I noticed that the water of the color blue is how many water we use on house. The grey one may be how many human use by drinking. The last bit may be from just how water is used by plants.

3 questions

- Did people from the back in the old times just drink from the river without even cleaning the water?
- How is waste water treated
- How much water falls during a storm

1/11/23

I notice this graph is only talking about water.

I notice that there's more blue water than gray and orange.

I think blue stands for stores that use it.

I think gray stands for homes, schools, etc.

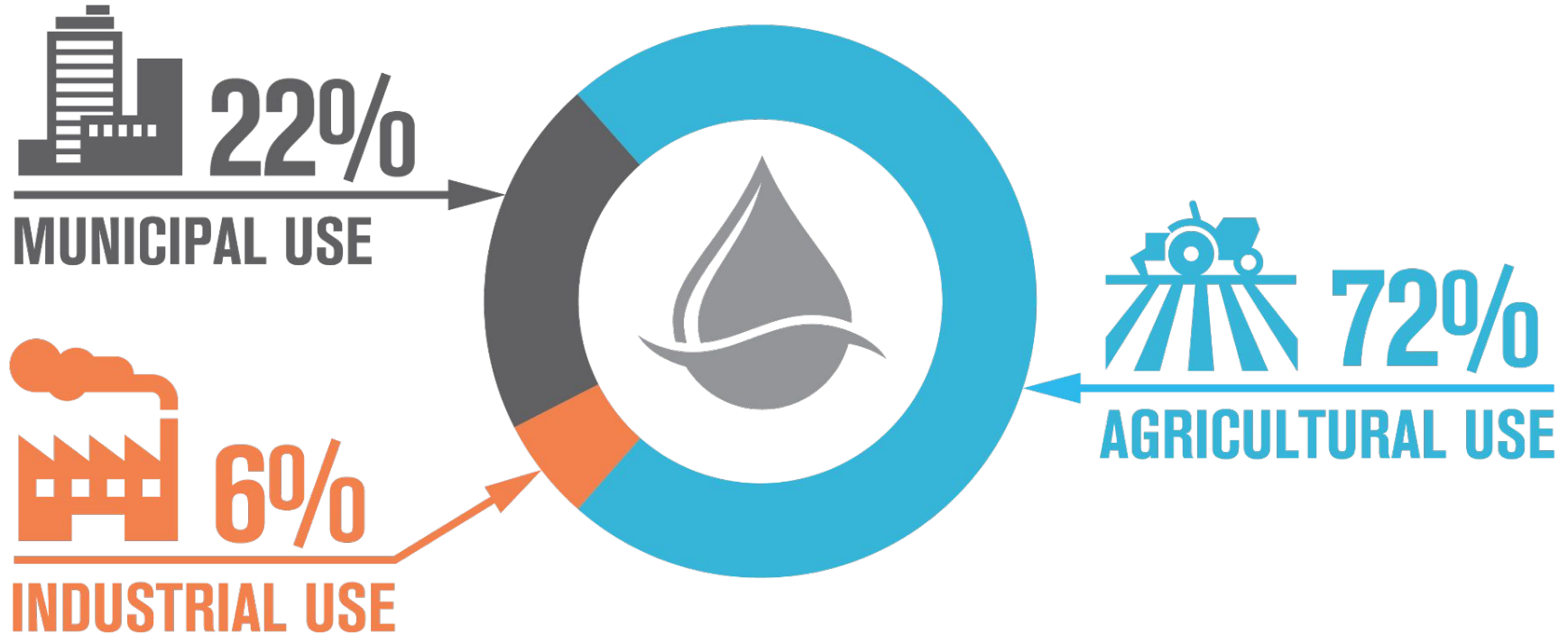
I think orange stands for Arizona's yourself.

Is the Santa Cruz river the only working river that is actually Arizona rivers?

Is the Santa Cruz river soaking in the ground?

How many insects are in the Santa Cruz

What do you notice? What questions do you have?



SOURCE: ADWR, 2020

Tucson's “secret” water storage



It's important to know...
I'm still wondering...

It's important to know in 1980
arizona passed the ground water
management.

Something important to know is that
when water droughts the water supply
decrease because there is not any
more water.



question: I wonder how water droughts?

1. what will happen if the
calorado river dries
2. what if the sons plan
of conserving water stops
and people do their own thing
3. question is what if the
river randomly fills up
a lot

I'm still wondering...

- Why is the Colorado River not considered surface water in the graph of Arizona water sources?
- Why does most of our water come from groundwater?
- How do our sources of water change throughout the seasons?
- What do the reservoirs look like?
- Why doesn't Arizona collect the rainwater and use that as a source of water?
- Can we take saltwater out of the ocean water and use that in Arizona?

I'm still wondering...

- What percentage of Arizona water goes where?
- Is the water in the reservoir purified?
- Why is Colorado River water going down? Is it our fault?
- How come Arizona can get so much water from the Colorado River?
- Who else is using the water from the Colorado River?
- How is reclaimed water used?

I'm still wondering...

- How much water do we use per year?
- Can we store water for the dry times?
- Why don't we use much reclaimed water (as a water source for Arizona)?
- When will we run out of water?
- What can we do in Arizona to prevent running out of water?



-  Effluent-dependent flowing stretches
-  Direction of flow of water
-  Water treatment plant
-  Santa Cruz River Watershed



Warm Up: study these images of the Santa Cruz River before and after the water treatment plants were upgraded.

What changes can you observe? In what other ways do you think the ecosystem by the river changed?



Cloudy water, before upgrade



Clear water, after upgrade

I notice that the color of the water change color.

I notice before you can't see in the water and after you can see through it.

What I think that change is the animals cause before animals didn't like drinking or being in it but now they like drinking and being the water.

The Santa Cruz river looked bigger in the past than it looked cloudy and in the future the water is clear there's more vegetation and looks more healthy the plant life looks different.

Warm Up
I see that the other water cleared a lot since it got cleaned. The cloudy water is really dark & nasty looking. When was the picture of the cloudy water taken? The clear water looks less water than the cloudy one.

I observe that the lake's water is very dirty and that's bad because animals live and drink from before and after the lake is ~~more~~ cleaner but after the lake is now a pond because it's so short now and a lot of trees and bushes are now surrounding the pond.

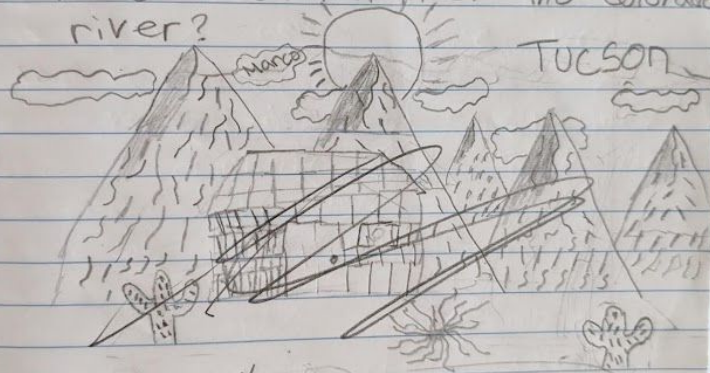
Why is the river dirty?

1/1a/22

Why don't animals cross the river?

Is the river hot or cold?

Is the Santa Cruz river
more dirty than the Colorado
river?



Does it rain
more in certain areas
in rain garden or
equal rain on each
plant?

Warm Up

Why are rivers important?

Why is the Santa Cruz River important to us?



Arizona's Santa Cruz River named 4th-most endangered river in America

KJZZ | By [Spencer West](#)

Published April 18, 2024 at 11:53 AM MST



Reviving the Santa Cruz: efforts to restore Arizona's endangered river

Local groups push for Urban National Wildlife Refuge designation.



by [Katya Mendoza](#)

% Post



© Michael Grecco/istockphoto.com. This is a still from the video 'The Santa Cruz River: A Journey of Restoration'.





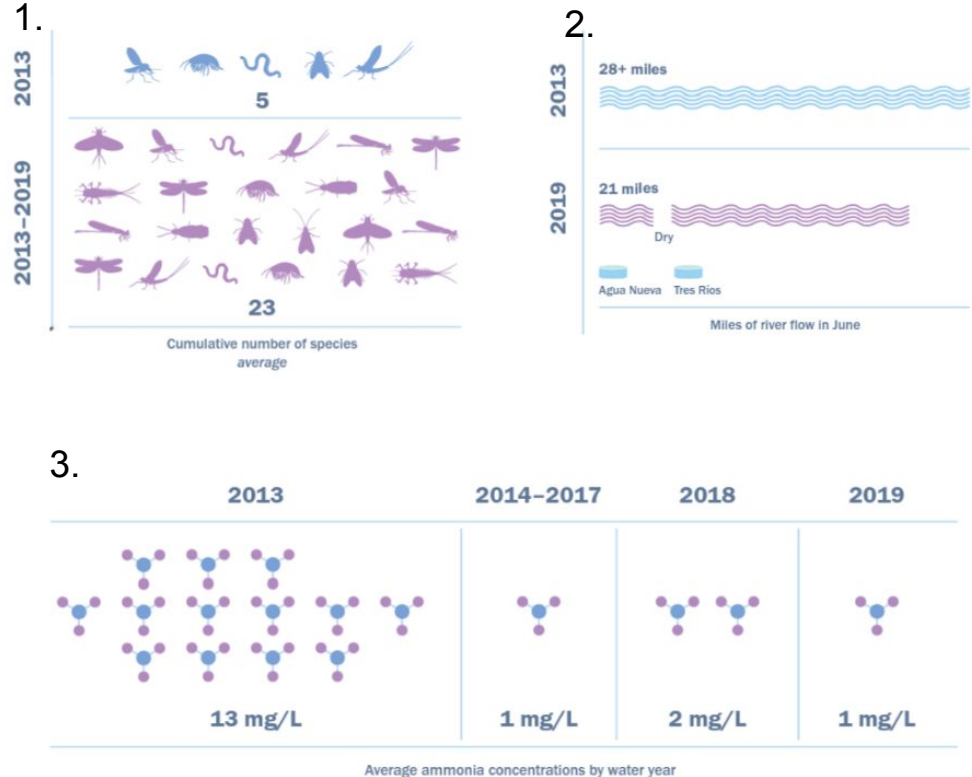




These graphs represent data collected from the Santa Cruz before the water treatment plants were upgraded in 2013 and in the years after.

Study the graphs.

- What does each graph show and measure?
- What does the data show?
- What has changed?
- Describe the changes.

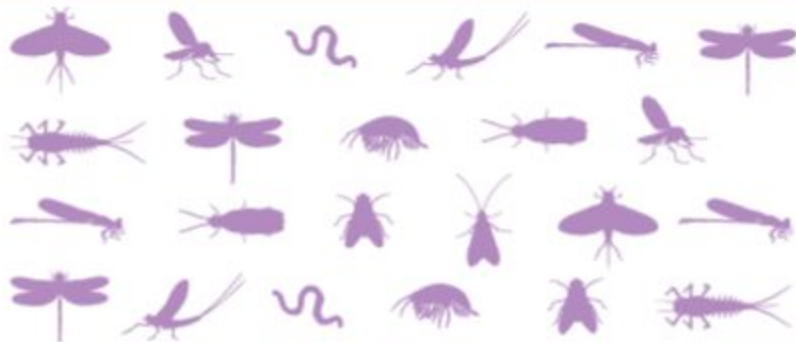


2013

2013-2019



5



23

Cumulative number of species
average

AQUATIC INVERTEBRATES THRIVE IN CLEANER WATER

Aquatic invertebrates are sampled at four river locations, and the data reflect an average of all sites combined. Diversity has increased: the average number of species found doubled from 5 in 2013 to 10 in 2019. The cumulative number of unique species has also increased: 2019 had 23 species on average, nearly five times more than the 2013 average of 5 species. Increasing diversity trends may be stabilizing, as no new species were found in 2019.

2013

28+ miles



2019

21 miles



Dry



Agua Nueva

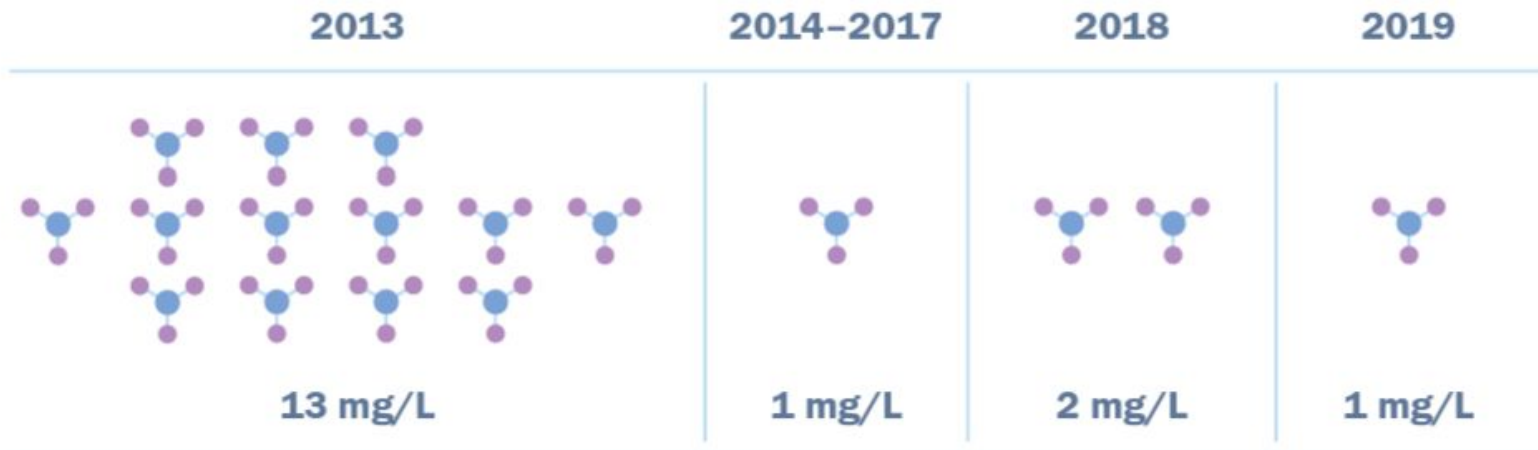


Tres Ríos

Miles of river flow in June

CLEANER WATER REDUCES THE RIVER'S FLOW EXTENT

Since the wastewater treatment upgrades, river flow extent is shorter and more variable, especially in June, the driest time of year when miles of flow are lowest. In June 2013, the river flowed uninterrupted for over 28 miles. In June 2019, flow decreased to 21 miles and was dry for a 1.3 mile stretch between the Agua Nueva and Tres Ríos facilities. Now occurring every June since 2014, this dry stretch has ranged from 0.3 to nearly 2 miles in length. Variability in flow extent is complex and impacted by many factors. Cleaner water infiltrates the riverbed more easily to replenish the aquifer. Infiltration also increases after seasonal floods scour the riverbed. Indeed, the longest dry stretches were in years with larger and more recent peak floods.



RIVER'S WATER QUALITY IMPROVED SINCE 2018

Many metrics demonstrate the river's improved water quality since the wastewater treatment upgrades. Most significant is the reduction in ammonia, a form of nitrogen common in effluent and toxic to fish at high concentration. Measured at four locations, average ammonia concentrations declined from a toxic 13 mg/L in 2013 to 1 mg/L in 2014–2017. For unknown reasons, in 2018, average ammonia levels increased to 2 mg/L, mostly in samples taken between the Agua Nueva and Tres Ríos facilities. Notably, average ammonia levels returned to 1 mg/L in 2019.

Removing ammonia is a complex process. The Agua Nueva and Tres Ríos Water Reclamation Facilities both use a five-stage process that features alternating oxygenated and oxygen-free zones. Pima County has optimized processes to better maintain the delicate balance of oxygen needed for maximum ammonia removal. They aim to remove additional ammonia during treatment of biosolids at the Tres Ríos Facility when new technology is installed in 2020 and 2021.

1. Years ago there were fewer species of insects living in the river it went up by 15 more species.

2. In 2013 the river used to go just fine and by 2013 it's kind still the same but half way it's dry.

3. Anomia was a lot in 2013's by 2018 it's going by 2 and I think it less now

→ In 2013 the river was over 30 miles then in 2019 the water separated and it's only 21 miles

↑
In 2013 only 5 species then in 2019 23 species where in the water.

In 2013 the water had so much bacteria so less species

1. In 2013 there where only 5 species of life at the santa cruz river than in 2019 it went up to 23 species at the santa cruz river

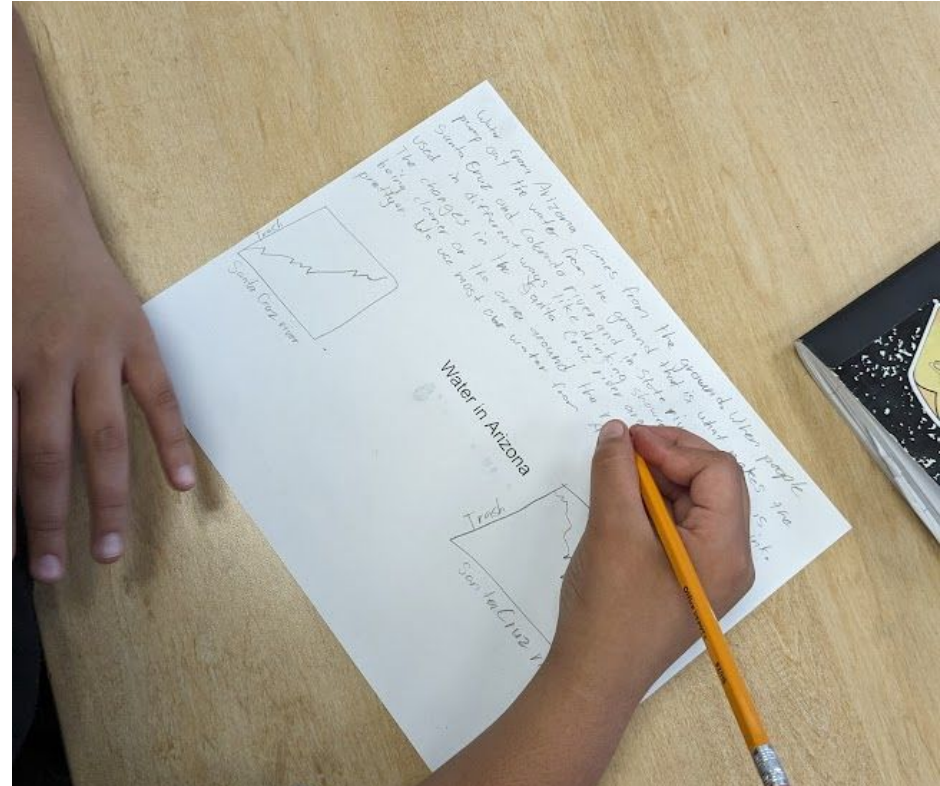
2. In 2013 the river had a lot of water and no dry spots than in 2019 there was one dry spot but clean water

3. in 2013 there was 13 anomia concentrations but in 2019 it went from 13 to 1 in just 6 years

What do you know about water in Arizona?

- Where it comes from
- How it is used
- How it affects biodiversity

Water in Arizona



Around 150 species of dragonflies have been found in Arizona

60 species have been seen along the Santa Cruz River



ARIZONA DRAGONFLIES

[Home](#) [Species](#) [Species compared](#) [Locations](#) [News/Events](#) [Quiz](#) [Resources](#) [About](#) [Feedback](#) [Search](#)

Species

Suborder

- ☐ Anisoptera (Dragonfly)
- ☐ Zygoptera (Damselfly)

Broad-winged Damsels (Calopterygidae)



American Rubyspot
Hetaerina americana



Canyon Rubyspot
Hetaerina vulnerata

Spreadwings (Lestidae)

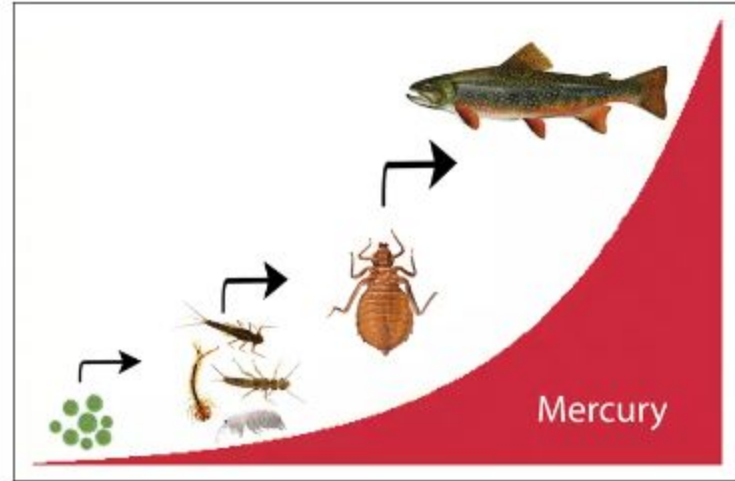




Dragonflies as Metal Detectors

Why are dragonfly larvae such good indicators of mercury in waterways?

- They spend most of their lives in aquatic environments
- They feed on small underwater organisms during their larval stage
- Their diet causes mercury to build up in their bodies over time
- They're easy to collect and identify



The bioaccumulation of mercury through the aquatic food chain, starting with microscopic organisms, then macroinvertebrates, then dragonfly larvae, then fish.

NPS

Mercury in Dragonflies

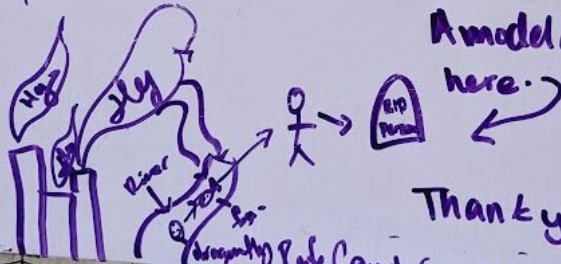
Cast:

Santonio - Fish
Crystal - Human

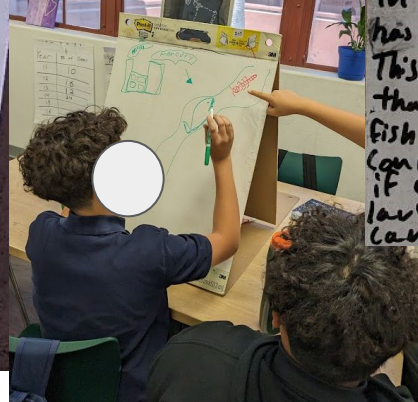
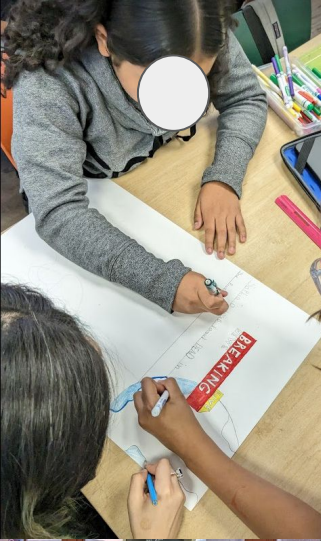
Yollett - Dragonfly
Larva

Elantra - Litter

The mercury comes from burning fossil fuels. Mercury (Hg , element 80) is a natural occurring element, it comes from the earth's crust. The mercury is used in fossil fuels. The gas goes from the factory to the river water, which goes to the larvae. The larvae gets eaten by a fish and the fish gets eaten by a human. The human has a high exposure to Hg , so they get sick.



Thank you 😊



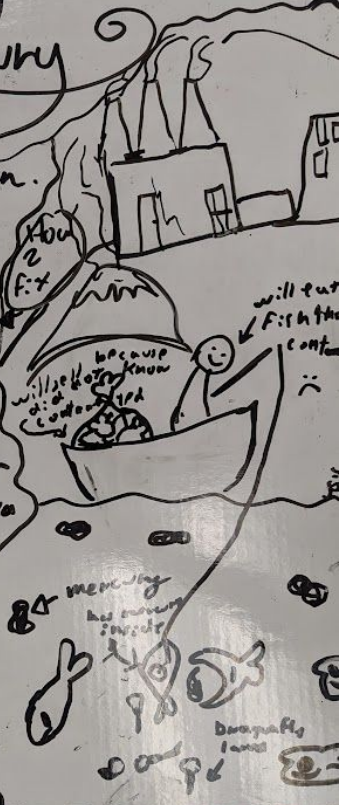
Why dragonflies are good indicators of Mercury

Why is mercury bad?

It contaminates your brain.
It can burn your skin.
So we really don't want it in our food and products.

How we detect mercury

You can detect mercury that contaminates water by getting dragonfly larva in rivers and see if it has mercury inside it. This is very useful so that our everyday fish we eat aren't contaminated. and if we use the larva method we can clean the water.



Mercury in water body
The build up of mercury
in dragonfly larvae
gives people a better
idea of air and water
quality.

Where does mercury come from?

Mercury comes from rocks in the earth's crust. Mercury is deposited by coal mainly in the factories. We don't know where the mercury goes to the ocean where fish and microscopical cells consume them. And then the dragonfly larva also consumes the mercury and then it just passes until it gets to fish and then to us which does not affect us at all it is just if it builds up in our system we can really get sick or it oxidizes.

What is Mercury?

Mercury is a chemical element. It is also known as quicksilver and formerly hydrargyrum from the words hydor 'water' and argyros 'silver', which is its chemical symbol, is derived from.

Diagnosics As metal detectors

July 24th
1988
post date.

Pierson
Miller

Jake
Rivera

A Lady
(unknown)

Mel
K'beli

Count Pke
ovie
enter
sing

runy usage
ered due
it be 199
toxic
anical

DAILY NEWS

PIERSON M.
found dead at 18

Hg =
Mercury

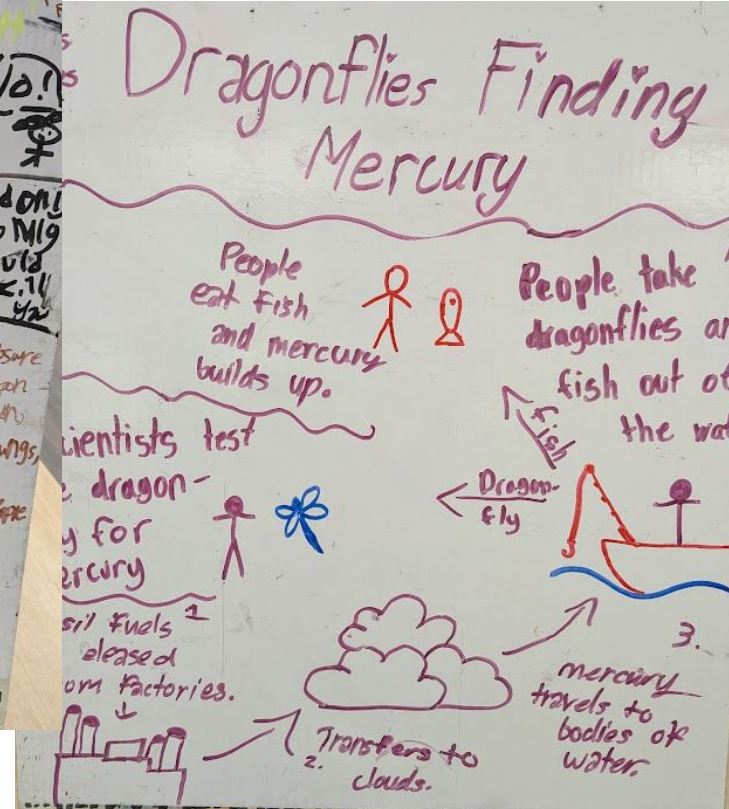
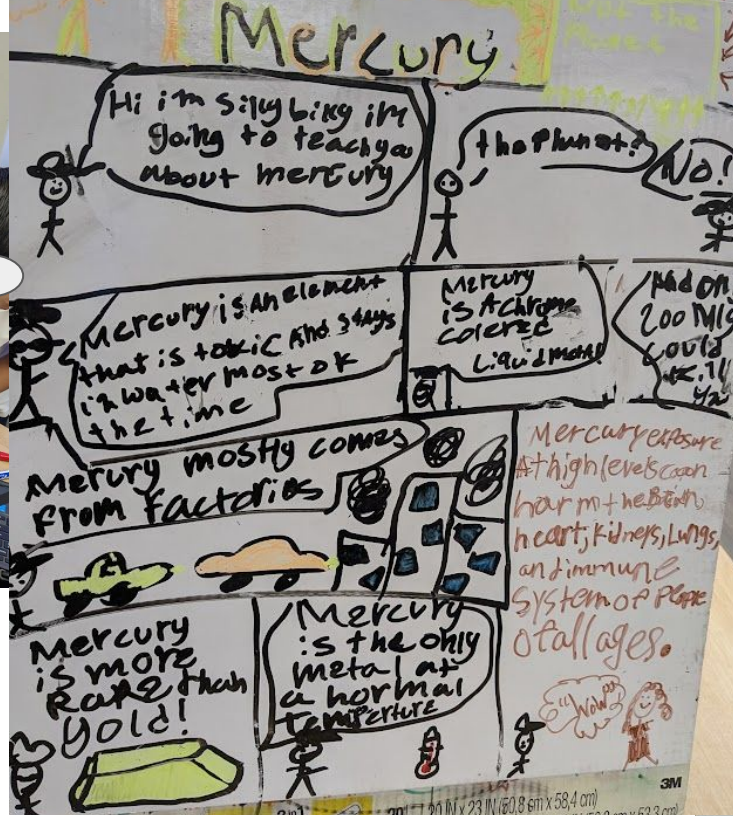
Fossil Fuels

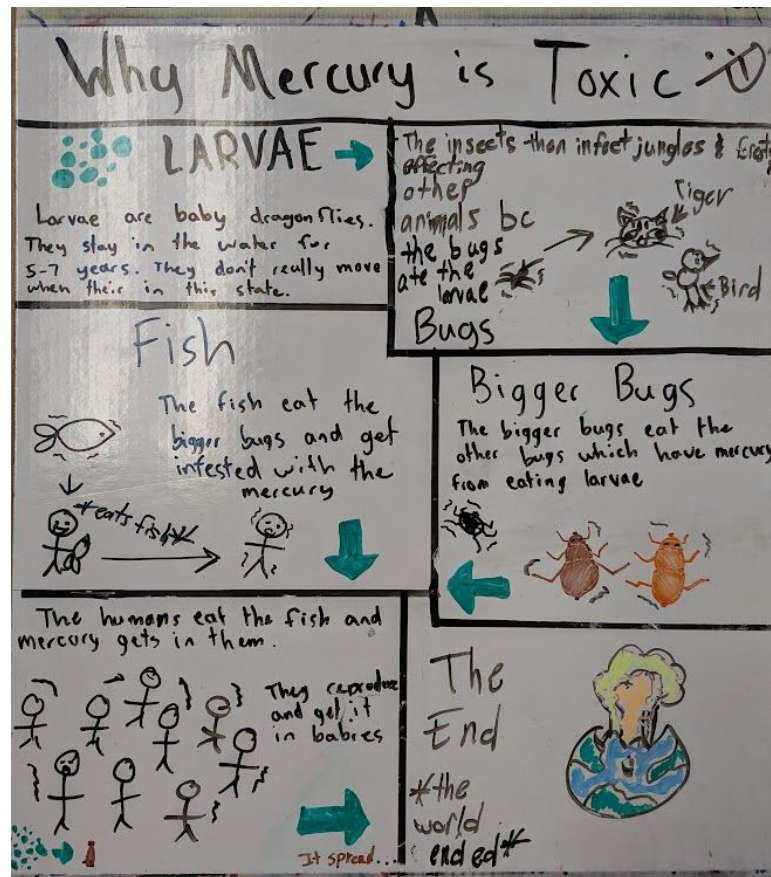
A diagram illustrating bioaccumulation. On the left, a factory with two smokestacks is shown. The top smokestack is labeled "Fossil Fuels" and the bottom one is labeled "Mercury". Both smokestacks are emitting clouds of smoke. An arrow labeled "Inhalates" points from the smoke clouds to a dragonfly on the right. The dragonfly is labeled "Dragonfly Larvae".

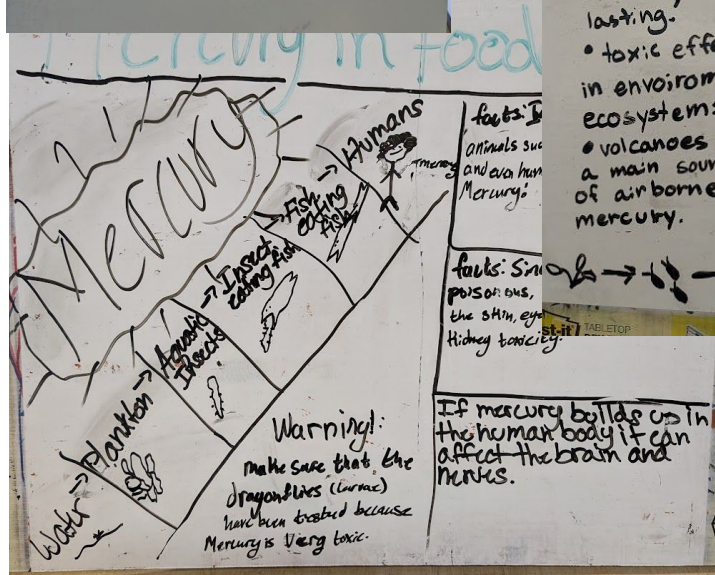
How Mercury is indicated from Dragonfly larvae

Dragonflies
eat small insects
that have absorbed
mercury.









Dragonfly Project

Mercury	Dragonfly	effects to us
• Effects fish bird + wild life. • causes disease. • mercury is long-lasting. • toxic effects in environment ecosystems. • volcanoes are a main source of airborne mercury.	• Eat a lot of smaller insects. • The fastest flying insect. • Flap their wing 30x the second. • Dragonfly larvae are an indicator of mercury in the environment.	• builds up in our tissues & organisms. • reduced reproductive system. • impaired growth & development. • decreases animals survival which effects us.

facts: Since poisonous, the skin, eye, kidney toxicity.

facts: In animals such as humans Mercury.

facts: If mercury builds up in the human body it can affect the brain and nerves.

Dragonflies as metal Detectors.

Over View

Dragonfly Larvae

Dragonfly larvae Diets causes Mercury to Build up in them over time. So humans collect them and test them so they can check the level of mercury in the water. It also helps that dragonflies spend most of their lives in the water and that there are a lot of them. Mercury is very dangerous for humans and can cause damage to the brain, nervous system, kidneys, gastrointestinal tract. The DMP is a national wide study that works with citizen scientists and community volunteers to collect dragonfly larvae for mercury analysis.

Formation

In 2009, our school has 172 collected dragonfly larvae at more than 100 parks. Dragonflies live in streams, wetlands, ponds, and other water bodies. Dragonflies spend most of their lives in the water as larvae. In this form, they are an indicator of mercury in the environment.

Important! Mercury is very dangerous to wildlife!!

Arizona Dragonfly Infographic

- Scientific drawing of AZ dragonfly (draft in journals first)
- food web/ place in ecosystem
- life cycle
- Importance of dragonflies
- Other interesting info

azdragonfly.org/species

Internet Archive: Di... Nearpod Physical General Life Earth and Space Sc... 6th Grade PLC Meet... Programs

ARIZONA DRAGONFLIES

Home **Species** Species compared Locations News/Events Quiz Resources About Feedback Search

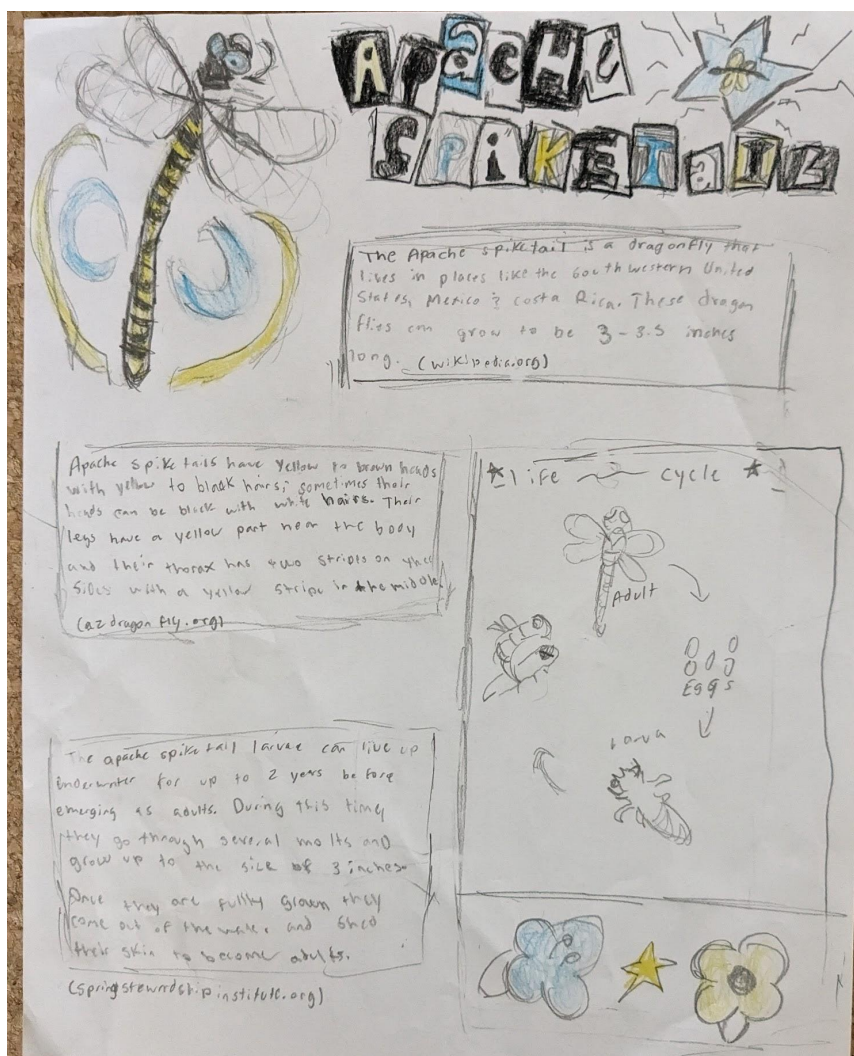
Search

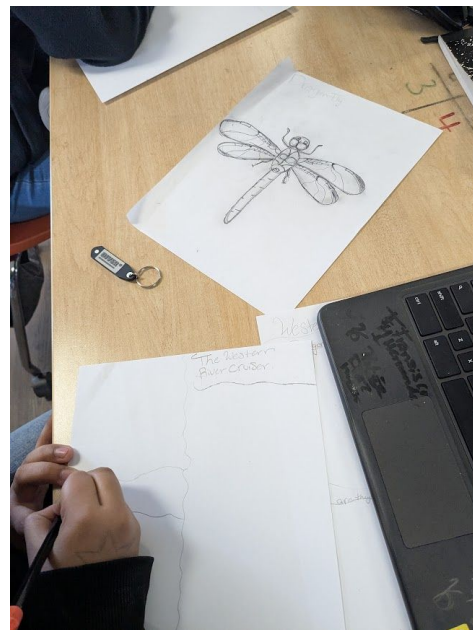
Species
Species Gallery

All Species
Amazon Darter
American Darter

Species
Suborder
☒ Anisoptera (Dragonfly) **Apply**
☐ Zygoptera (Damselfly)

Broad-winged Damsels (Calopterygidae)





Kibeli M.
4/15/14

Dragonfly Information

Drawing AZ



Roseate-Skimmer-Information

Family = Skimmers
Species = Ferruginea

Facts

1. Native to Americans
2. Comes From USA / Brazil.

* **Roseate** *

* **Skimmer** *

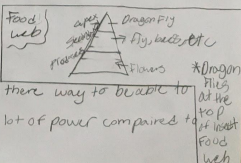
Dragonfly Information!

• Dragon Fly life Cycle

Egg → Larva → Adult

- Dragonflies are important because (live up to 5 years) they are predators who particularly eat mosquitos and Flies too help get rid of all of them.
- Dragonflies are interesting because there way to breathe to fly so fast, they can accelerate a lot of power compared to their body.

Food web

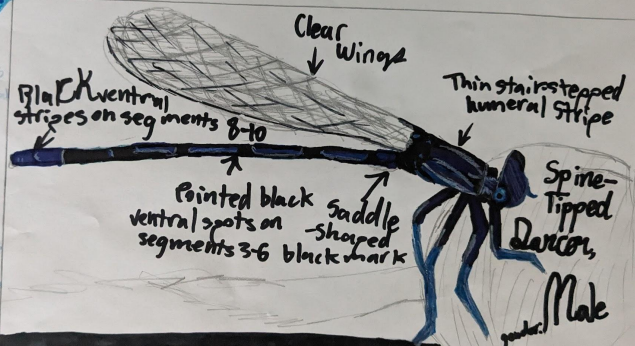


The average length of a Spine-Tipped Dancer is 36 mm

The blue markings on Blue-Tipped dancers are some other don't species bring gray & cool temperatures.

Spine-Tipped dancers are from the top of the web

The face & top of the male's thorax are blue violet & the sides of the thorax are white.



AVERAGE LENGTH: 36 mm

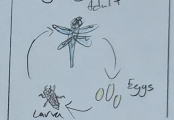
These dragon flies are mainly found near streams, creeks, & rivers.

By: Sing Jie Hoon

Dragonflies

(Pictured Dancer is shown to the left)

Dragonfly life cycle

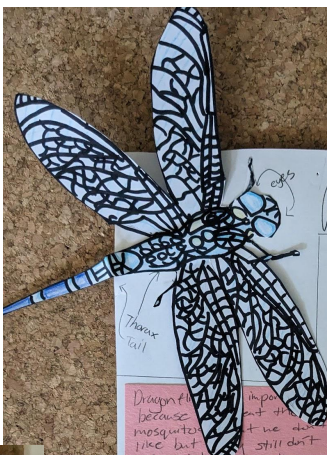


Food web



How the recovery is getting transferred through to the top of the food web

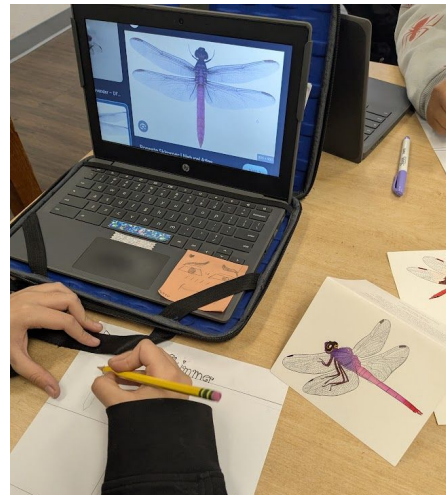
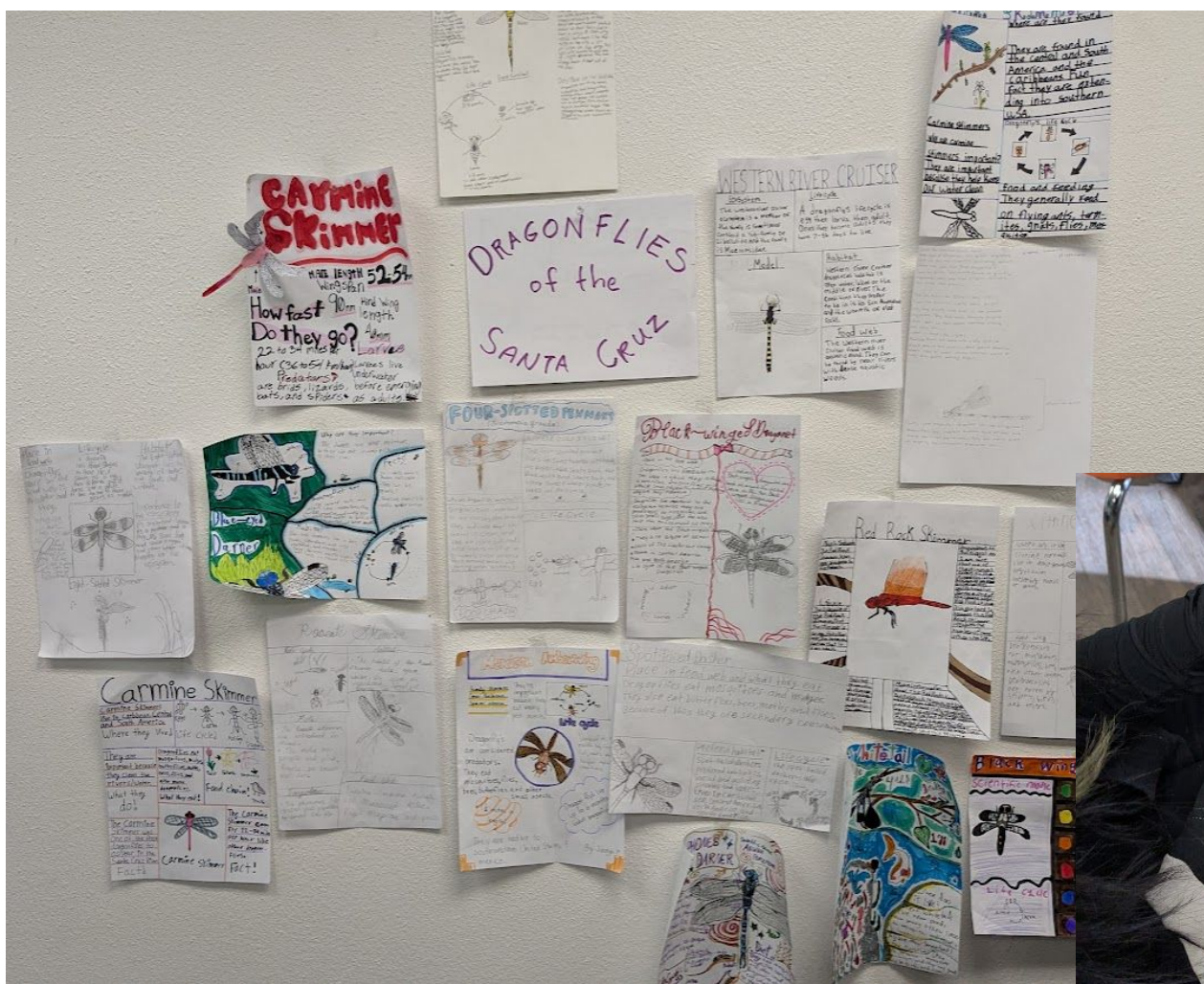
The dragonfly larvae starts to inhibit the populations from the recovery in Asia (Mats that was close to 100% then other bugs eat the dragonfly larvae and the dragonfly larvae is spending through bugs and then the Asia eat the bugs that eat the larvae then be out the Asia)



Throat call

Dragonflies are important because we don't have mosquitoes like but we still don't overpopulate and reduce the birds and fish eat them (a balanced space)

Dragonflies are interesting because they are one of the most fast fliers in the world! They go 30 miles per hour.



Warm Up



What do you observe?



What do you wonder
(question)?



What might each
different row mean?

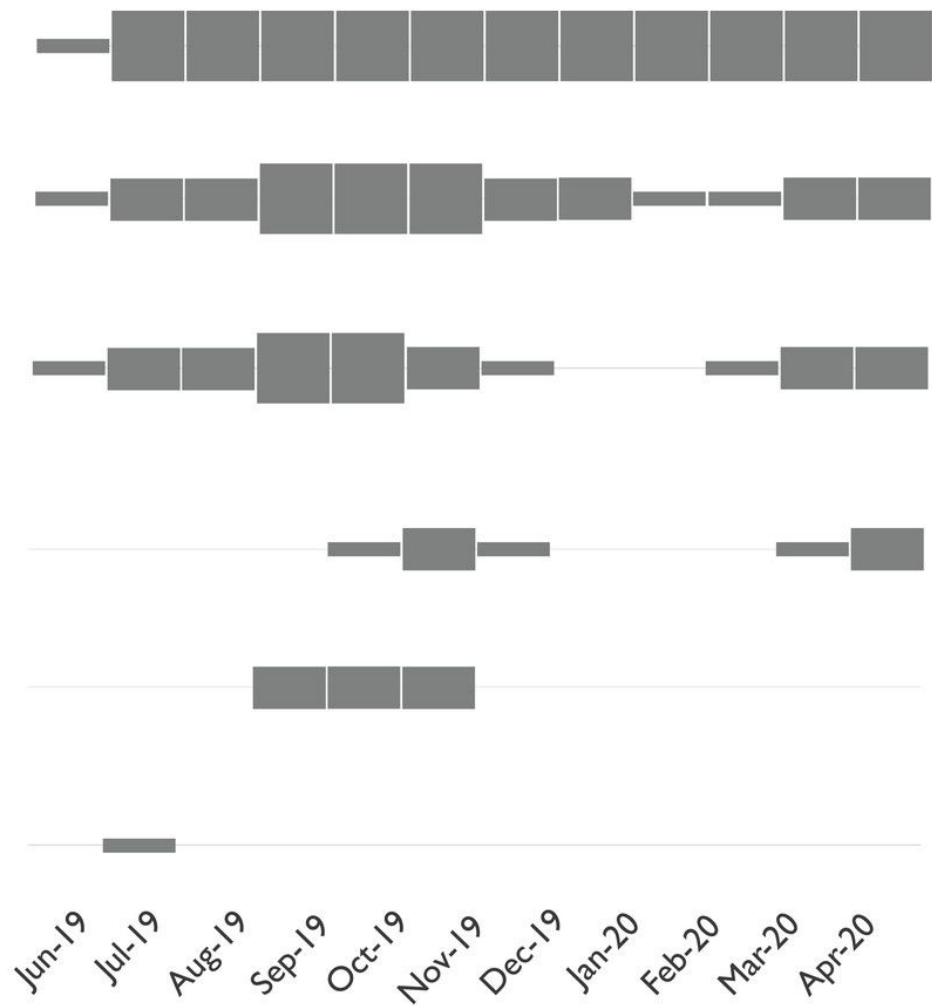


What might the
thickness of the bars
mean?



What new
information do you
have?

Does this change
any of your
answers to the
previous slide?



What new information do you have?



Enallagma civile



Sympetrum corruptum



What can you infer?



Orthemis ferruginea



What questions do you have?



Hetaerina americana



Perithemis intensa



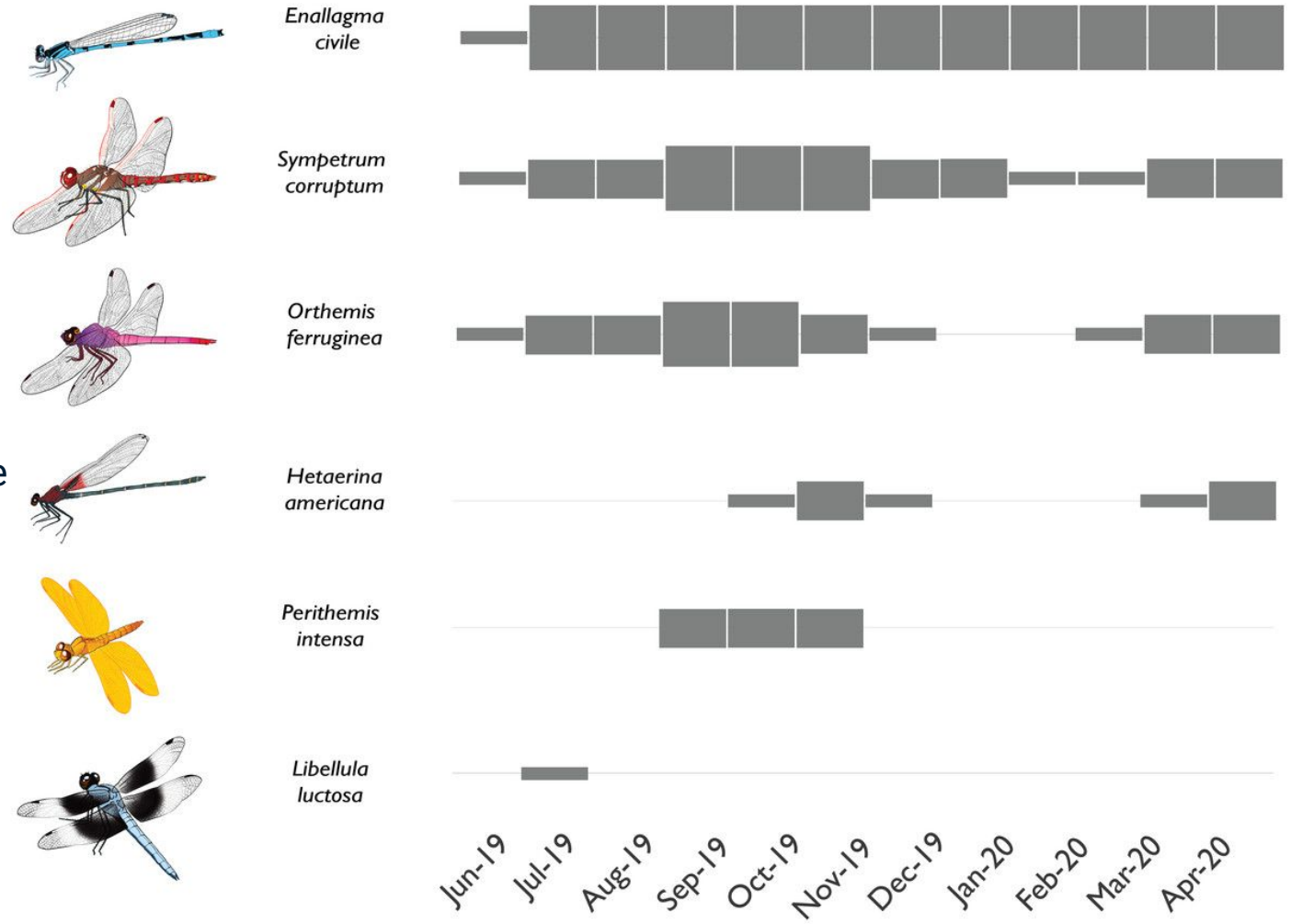
Libellula luctosa



Jun-19 Jul-19 Aug-19 Sep-19 Oct-19 Nov-19 Dec-19 Jan-20 Feb-20 Mar-20 Apr-20

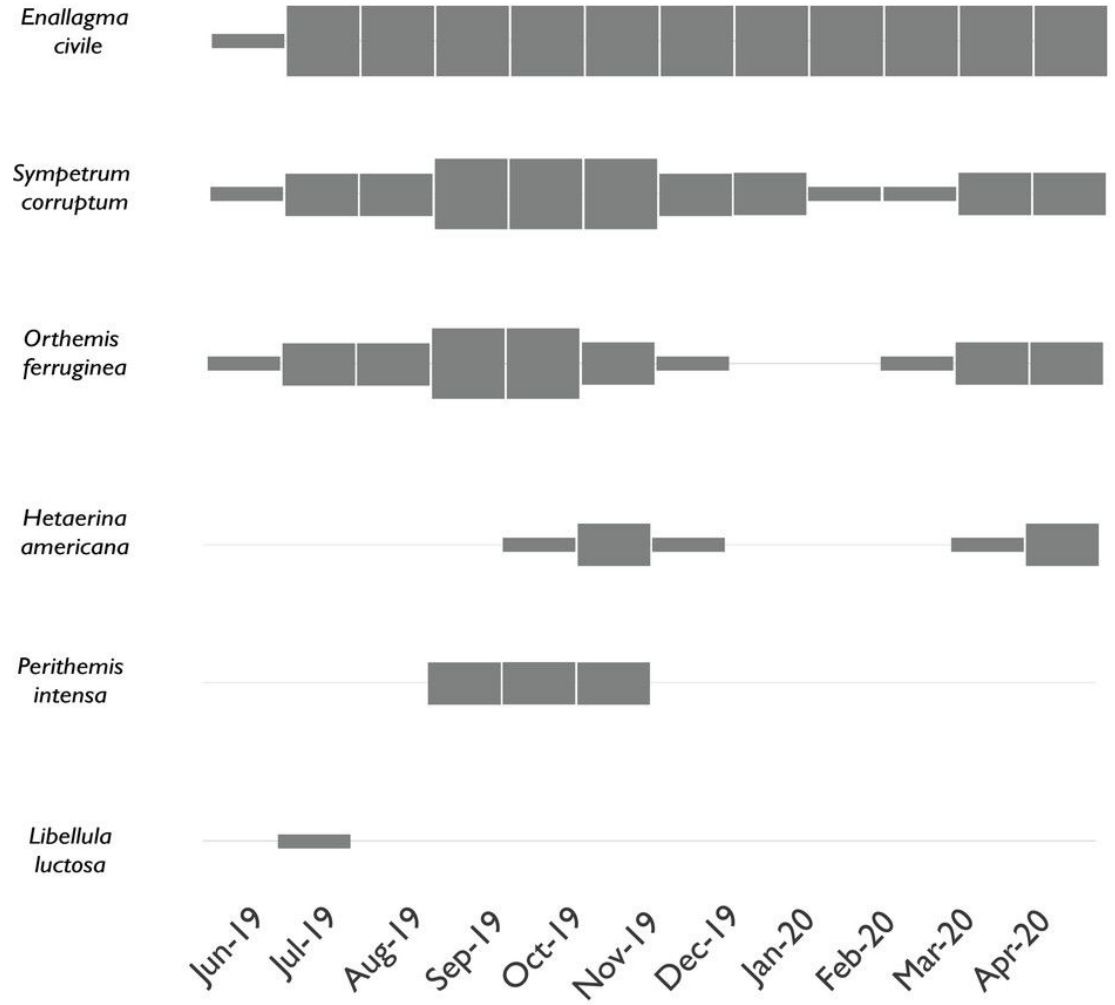
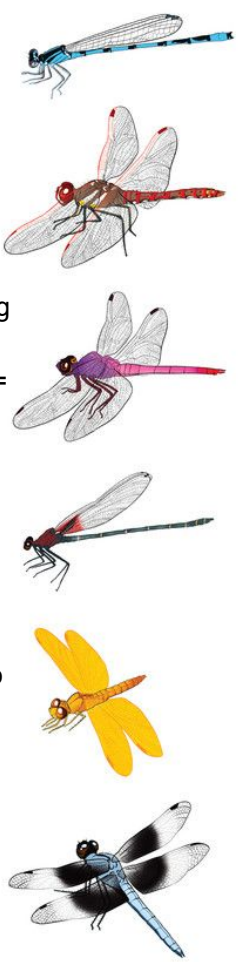
Figure Caption:
Phenology of selected dragonflies in a newly-flowing reach of the Santa Cruz River.

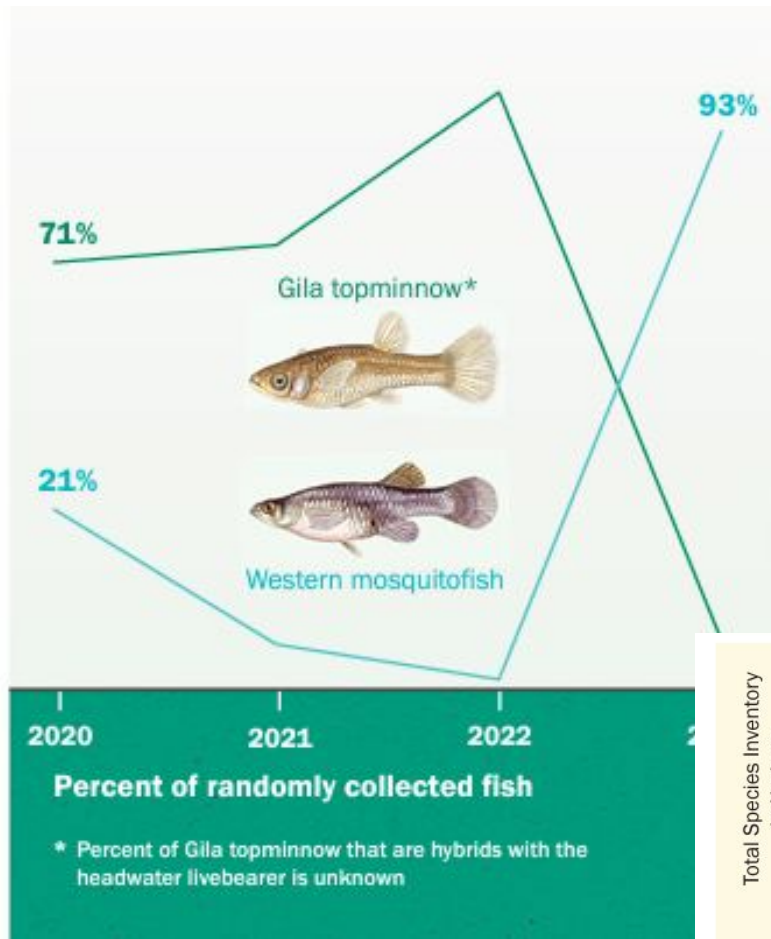
Phenology is the study of how seasonal and climate changes affect the life cycles of plants and animals. It involves observing and measuring recurring events, such as when leaves appear, flowers bloom, and birds migrate.



Phenology of selected dragonflies in a newly-flowing reach of the Santa Cruz River.

Phenology plot illustrating the presence and abundance of different dragonfly species through time in the newly flowing Heritage reach of the Santa Cruz River. Thin gray box = rare; medium gray box = uncommon but breeding; thick gray box = common and breeding. Some species rapidly colonized the new reach quickly and were abundant through the study (e.g., *Enallagma civile*) or were at least abundant during warmer weather (e.g., *Sympetrum corruptum*, *Orthemis ferruginea*). Other species took longer to colonize and had limited seasons of adult flight activity (e.g., *Hetaerina americana*, *Perithemis intensa*). Other species were vagrants that appeared once or twice but failed to establish populations (e.g., *Libellula luctosa*).





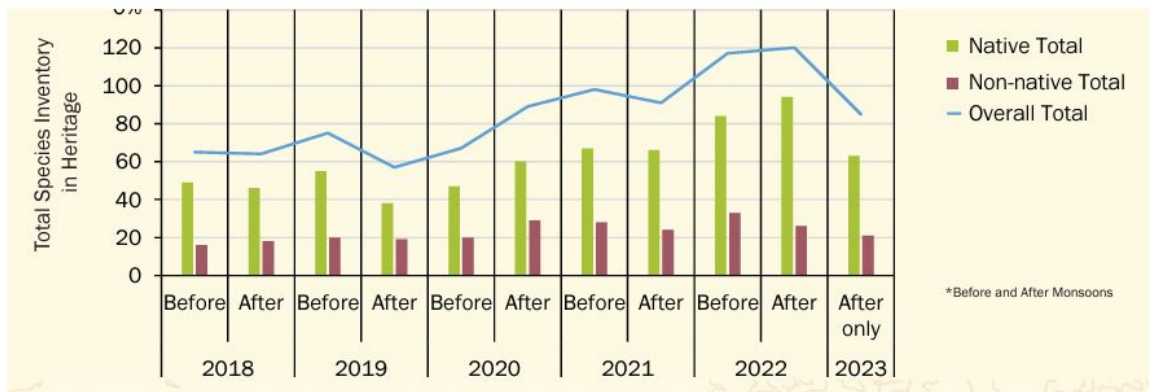
Graph of the Week (GOTW)

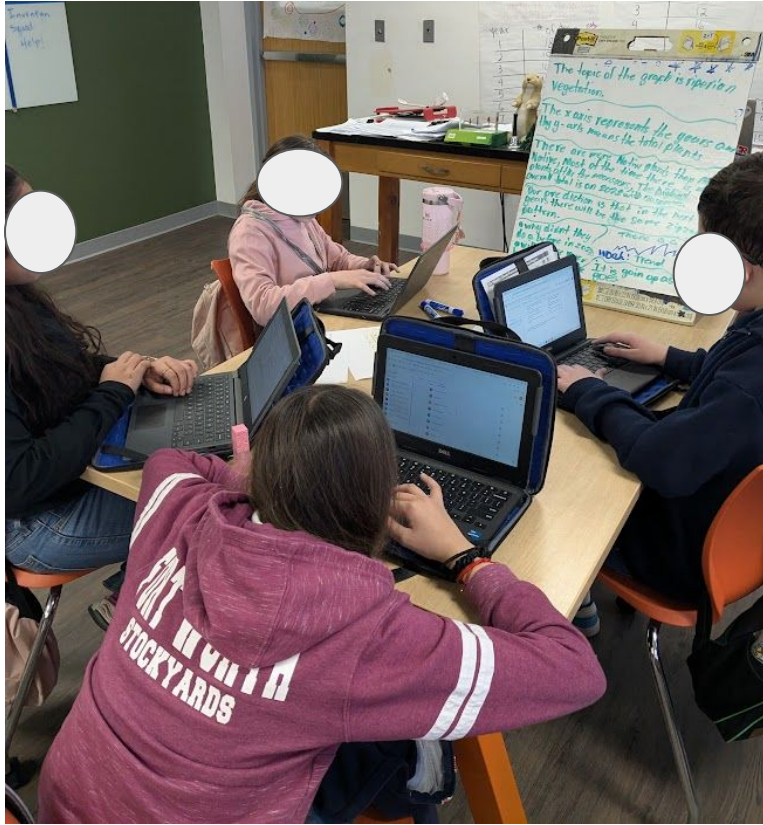
Analyze the graph below and write a reflection on what you think the graph is communicating to you. To guide you with your response, start with some observations.

- What is the topic of the graph?
- What quantities are being compared?
(If there are x- and y- axes, what do they represent?)
- What are some observations that you can make based on the graph?
- What do you foresee happening in the next 10 years?
- What is a question you have about this topic?

Questions to ask when reading graphs:

- Is there an upward or downward trend?
- Are there any sudden spikes in the graph?
- What is being compared in the graph?
- What prediction can I make for the future?
- What inferences can I make about the graph?





The topic of the graph is riparian vegetation.

The x-axis represent the years and the y-axis measures the total plants.

There are more native plants than non-native plants. Most of the time there is a sharp drop in the number of native plants after the monsoon. The prediction is that in the future there will be the same pattern.

How? There is a gain up to 100 in 2023.

Riparian Vegetation.

- It measures non-native and native plants before and after monsoons
- People are planting more native vegetation
- **Supple drop in 2023 from 120 to about 50**
- More native than non-native
- Non-native might get higher

Topic of the graph: native & non-native species in Tucson 2018-2023 during monsoon season

Native total of plants to non-native total

The gets very low hitting a total of 20 in heritage

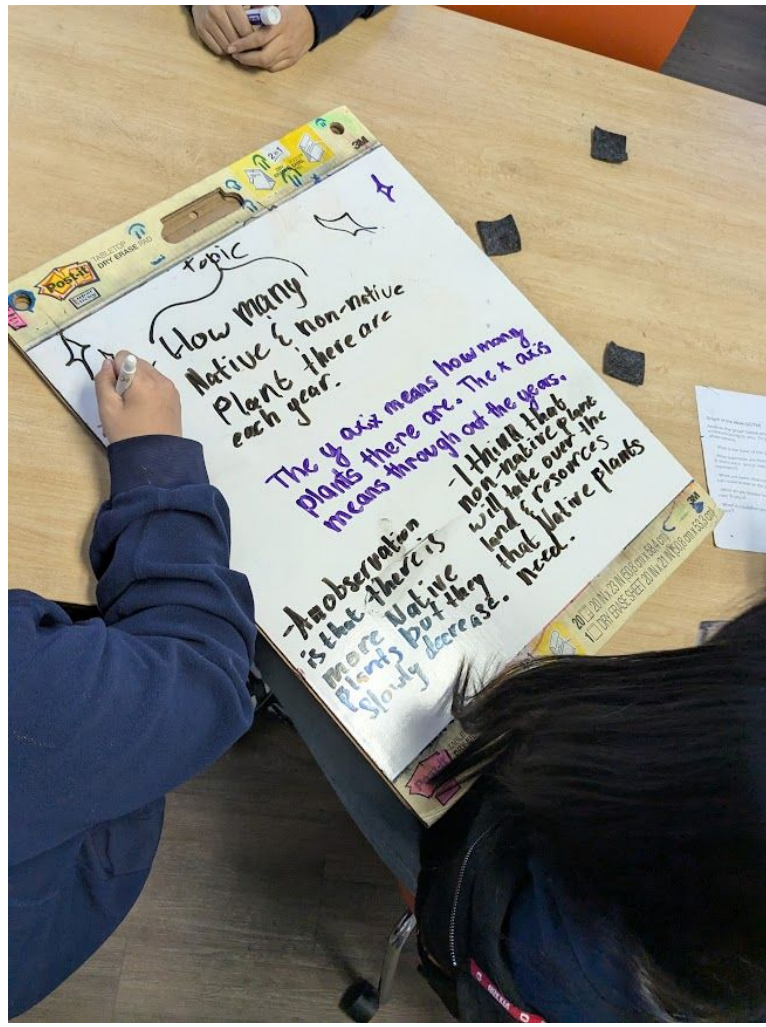
2019 after the monsoons gets up to almost 100 in 2022.

es the overall total get lower in 2023

Observations:

- The native total gets up to almost 100 in 2022.
- The trend of the graph is upward.
- The highest peak on the chart is 120.

for yes above presents to you...



Wakefield Ecosystem Testable Question

- Question
- How will you answer your question?
- What data will you collect?
- How will you collect your data?
 - Number, times, tools, measurement, etc
 -

question

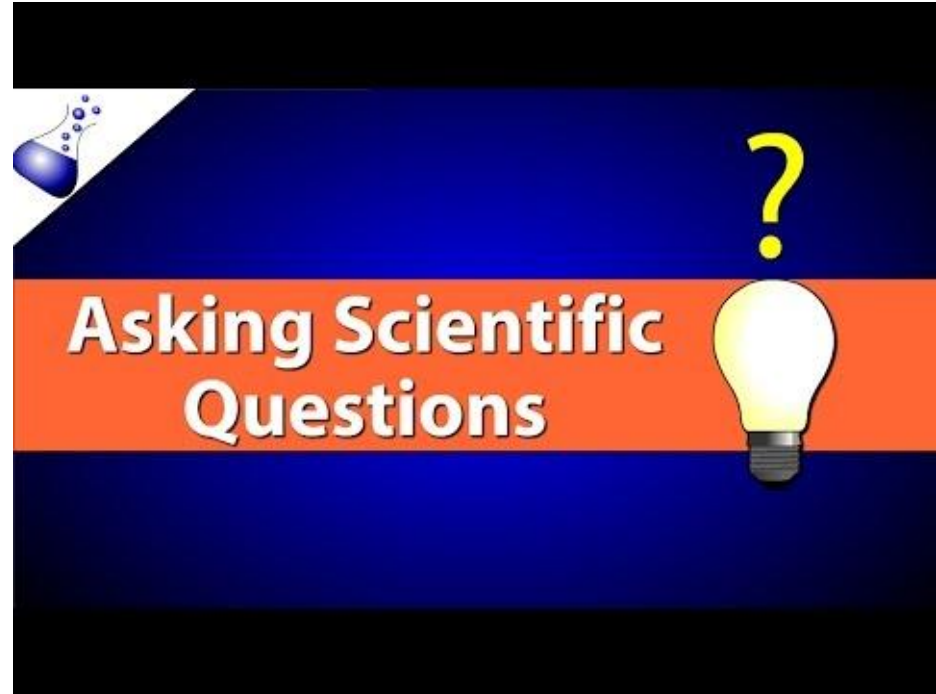
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how we would test it



scientific, testable questions:

- can be answered through direct observation or experimentation
- examine relationships between phenomena



Planning

- Procedures (what will you do?)
- Data sheet (how/where to record data)
- Roles (who is doing what)

DESERT LOCATION

Weather Conditions: Record weather data

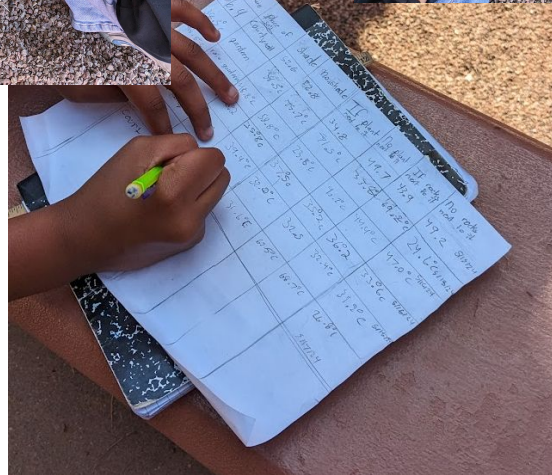
Temperature	
Humidity	
Wind Speed	

Birds: Record the number of different birds

Birds I hear	
Birds I see	
Merlin app birds	

Plant and Soil Data

Transect	5 meters	10 meters	15 meters
plants desert area			
surface temp (° C)			
soil pH			
soil moisture			
subsurface soil			



Lucy's Warbler Nesting Boxes



Desert Haven Park Nestboxes installed January 2023

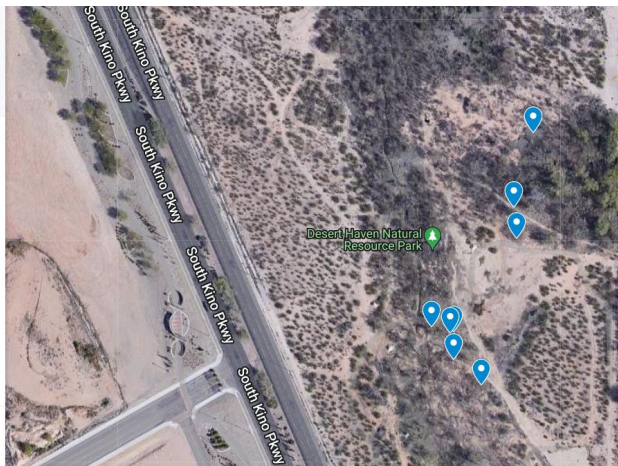
7 views

Published on February 2

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Untitled layer

- Nestbox 1
- Nestbox 2
- Nestbox 3
- Nestbox 4
- Nestbox 5
- Nestbox 6
- Nestbox 8
- Nestbox 7



LUWA Boxes at Wakefield ...

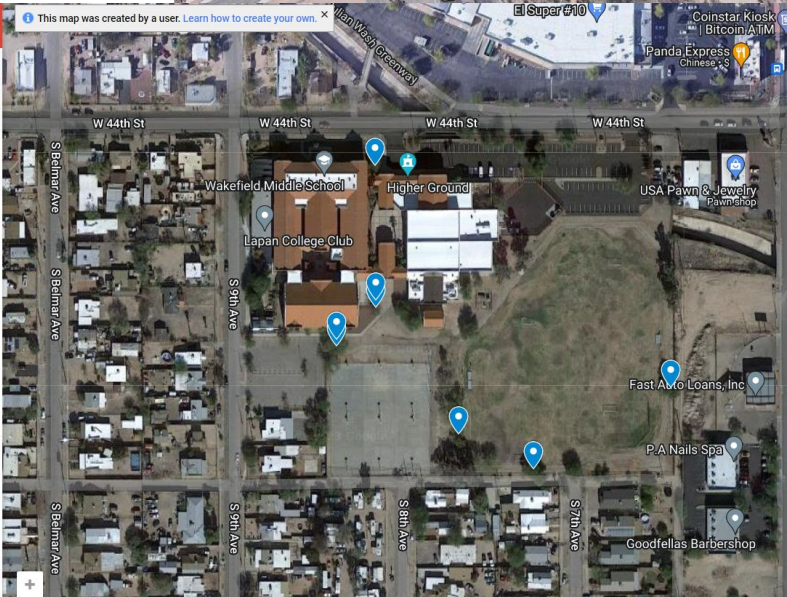
10 views

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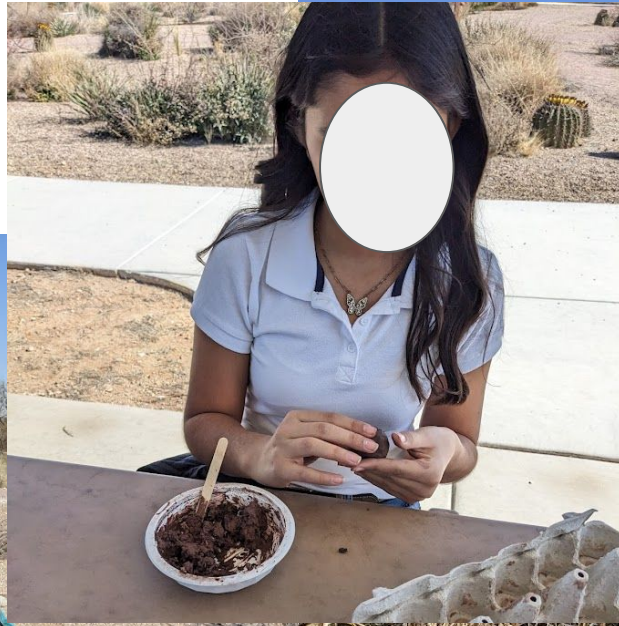
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Untitled layer

- Box 11
- Box 12
- Box 13
- Box 10
- Box 9
- Box 14
- Box 15
- Box 16



Desert Haven



Living River of Words

Rocco

I'm a rock under the river and sometimes the water runs too fast I move
Sometimes I see shoes like Nikes, Adidas, Vans and converse
I see tongues from animals that are thirsty
There was a time I saw an umbrella sedge from so small and short to big and tall
The river has changed throughout the years then I notice something
Everything doesn't stay the same, everything changes
People lose thing and others receive things
And time goes by fast
One day your 5 years old
The next 17 years old.

Journey

As the water washes over me
And insects move around above me
And fish swim around me
And the sand is washing away under me
I am still
Though life is moving all around me
I am still
I wait
The water will take me away
Through twists and turns
Through rapid and through calm
I will move until the water lets me down
Then I stop
And I notice I am not a solid form
Rather many pieces
All unique
Yet all still me
I have changed
But I'm still me

MISS SUNFLOWER

I feed animals, see the sun

I produce food for myself

The river gives me water

As it becomes colder

I die

And have no meaning I leave my seeds

when I die

So they can grow .

The way of the river

As the river flows there's change it can change its speed
It could Change its color but it can never change it's sound
It could never change its helpful use for the plants and animals around it
But now that it is dry you can no longer try to get it back
As i could change my appearance or my actions
But i can never change my smile or my laugh
As if that part of me is gone you could try to put the water back in the river
As it'll take years or even forever this chapter is for the better

Thank you!

Please reach out with questions, comments, or connections

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Evaluation code



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NSF Award #2143228 BIORETS: Conserving
water resources and riparian biodiversity in a
changing desert climate



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COLLEGE OF AGRICULTURE, LIFE & ENVIRONMENTAL SCIENCES

**Natural Resources
& the Environment**