TURTLES IN SCHOOLS

TERM 3 WORKBOOK

Photo credit: Bellingen Riverwatch

1 Million Turtles

COMMUNITY CONSERVATION PROGRAM

TURTLES IN SCHOOLS

Produced by the
1 Million Turtles Community Conservation Program
and funded by
The Foundation for National Parks and Wildlife.

In the pages that follow, you will find a comprehensive set of lesson plans. Our initiative is not just about imparting knowledge but fostering a deep connection between students and their natural environment and instilling a sense of responsibility and awareness of freshwater turtles and their conservation.

As we embark on this educational venture, we extend our gratitude to educators, students, and all those who champion the cause of conservation. The Turtles in Schools Program is not just a curriculum; it is a movement to inspire the next generation of environmental custodians.

Thank you,

1 Million Turtles Community Conservation Program

Test your Understanding

Read the following passage and answer the questions on the following page:

The health of our local rivers, creeks, and wetlands depends on maintaining water quality. Water quality can be measured by various parameters like pH, dissolved oxygen, salinity, temperature, and nutrient levels (ammonia, nitrate, nitrite, and phosphorus). Healthy water quality is essential for all organisms in the ecosystem, including freshwater turtles. However, a hidden group plays a crucial role in the connection between water quality and these turtles: macroinvertebrates. Macroinvertebrates are small animals without backbones, like water bugs and insect larvae. Different macroinvertebrate species have varying sensitivities to changes in water quality. Some thrive in clean, well-oxygenated water, while others can tolerate slightly more polluted conditions. This sensitivity makes macroinvertebrates excellent indicators of water quality.

Freshwater turtles occupy various positions within the food web, including primary consumers and secondary consumers. Australian freshwater turtles species rely upon macroinvertebrates as a food source to varying degrees. Some species like the Murray River short-necked turtle, are omnivores and feed on both plants and macroinvertebrates. Others, like the Eastern long-neck turtle, are specialised carnivores that consume macroinvertebrates and fish.

By monitoring both water quality and macroinvertebrate populations, we gain valuable insights into the health of freshwater ecosystems. A decline in macroinvertebrate diversity serves as an early warning sign of potential water quality issues that could impact freshwater turtles and the entire food web. This knowledge allows us to make informed decisions about water management, ensuring clean water for ourselves and a healthy environment for all its inhabitants, including freshwater turtles.

Test your Understanding

Questions:

Q1: What are some examples of water quality parameters?

Q2: What is a macroinvertebrate? What can macroinvertebrates tell us about water quality?

Q3: Explain the significance of monitoring both water quality and macroinvertebrate populations for the conservation of freshwater turtles.

Test your Knowledge

Questions:

Q1: Which of the following is NOT a water quality parameter commonly measured in freshwater ecosystems?
(a) Temperature
(b) Salinity
(c) Species richness
(d) pH

Q2: What does species abundance refer to?
(a) The number of different species present in the ecosystem.
(b) The total biomass of all organisms in the ecosystem.
(c) The relative frequency or proportion of individuals of each species in the ecosystem.
(d) The variety of habitats available to different species in the ecosystem.

Q3: Which of the following organisms is typically a primary consumer in a freshwater food chain?
(a) Herbivorous fish
(b) Carnivorous fish
(c) Scavenging insects
(d) Decomposing bacteria

Q4: A food web illustrates:
(a) The flow of energy from one organism to another in a straight line.
(b) The interconnected feeding relationships among organisms in an ecosystem.
(c) The competition between different species for resources.
(d) The hierarchy of trophic levels within an ecosystem.

Test your Knowledge

Questions:

Q5: How might changes in macroinvertebrate populations impact the availability of food for freshwater turtles?

Q6: Draw an aquatic food chain and label the different trophic levels. Include a freshwater turtle in your drawing.

Classroom Activities

ACTIVITY

What I Know (K), What I Want to Know (W), What I Learnt (L)

Materials:

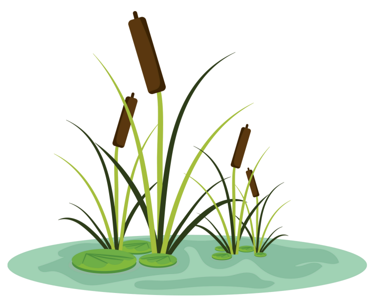
- Large chart paper divided into 3 sections labeled "K" (Know), "W" (Want to Know), and "L" (Learnt).
- Markers or pens

Instructions:

(1A) Brainstorm what you Know (K) about wetlands and freshwater turtles. Write them in the “What I Know” column.

(1B) Write questions of “What I Want to Know” in the Want to Know (W) column.

What I Know (K)	Want to Know (W)	What I Learnt (L)



LESSON 1

TERM THREE

WATER QUALITY PARAMETERS

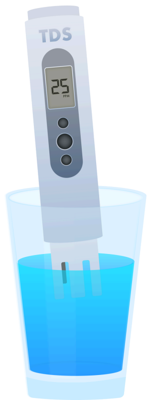
- Learning Intentions
- Background
- Activities
- Curriculum Mapping

Photo credit: Marilyn Connell

Learning Intentions

(1) Describe water quality parameters and explain how they relate to wetland health.

(2) Use applications (such as Google Earth) to plan scientific investigations, through the identification of sites for wetland sampling.



Describe

Identify

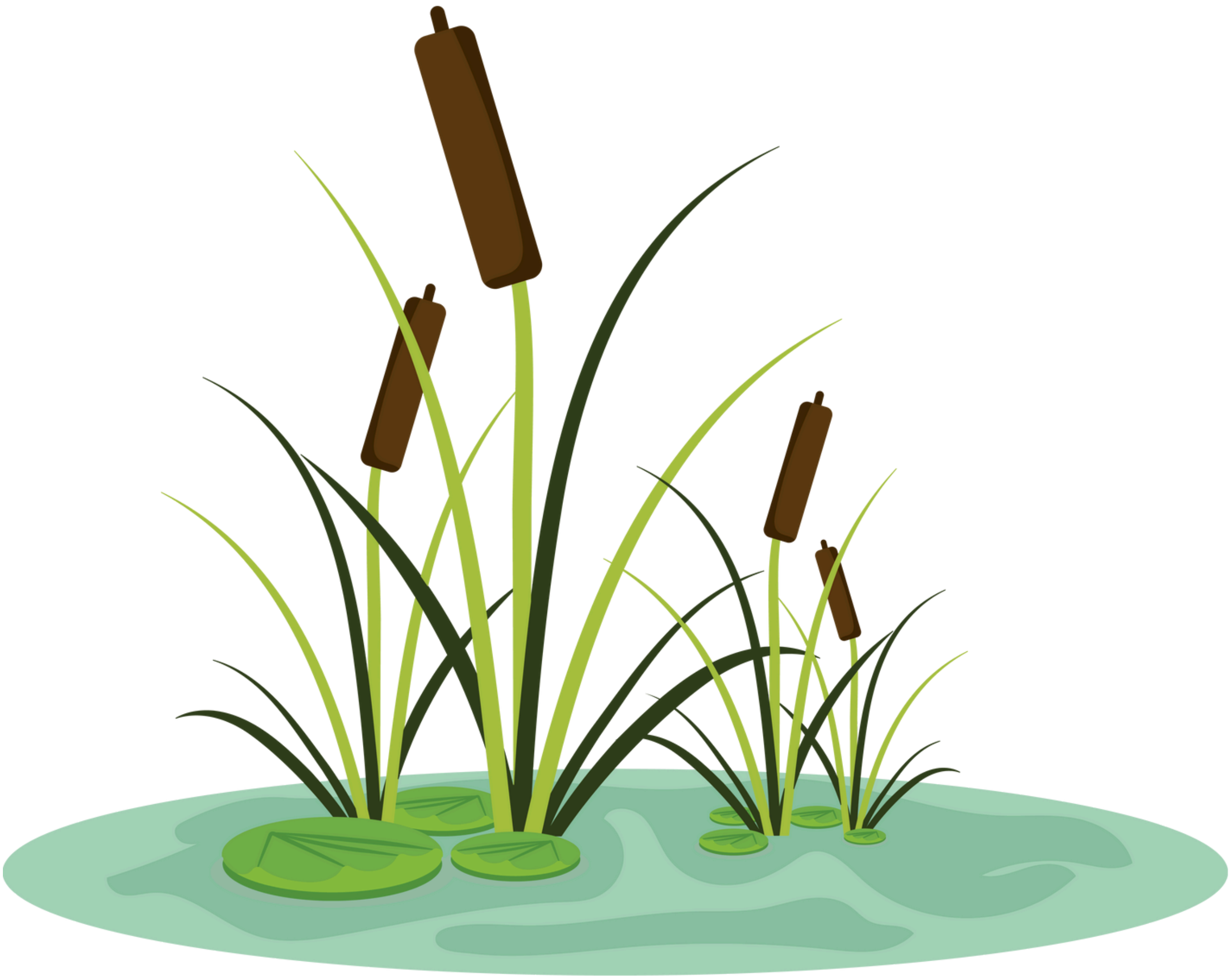
Background Information

Why do we test water quality?

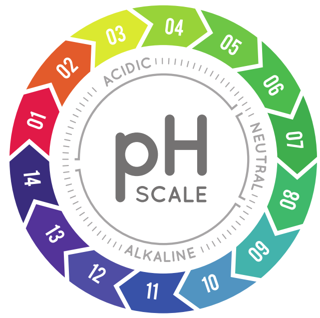
Water quality testing can tell us how healthy the water is in our local rivers, creeks and wetlands.

The health of the aquatic habitat can be influenced by:

- Land clearing, agriculture, roadworks and erosion;
- Farming practices where fertilisers and pesticides leach into the water;
- Pollution;
- Weeds and feral animals which cause bank instability;
- Urban development (such as the construction of roads and suburbs).



Water quality parameters



pH:

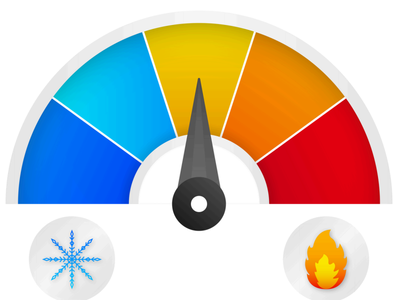
pH is a measure of how acidic or alkaline the water is. The pH scale ranges from 0 to 14, with 7 classed as neutral, less than 7 classed as acidic and values greater than 7 classed as alkaline.

- Different aquatic organisms have specific pH ranges within which they thrive. Extreme pH levels (too acidic or too alkaline) can stress or harm aquatic life, affecting their physiology and behaviour.
- Changes in pH can be indicative of human activities, such as industrial discharges, acid rain, or agricultural runoff. Monitoring pH levels over time can help detect long-term trends and assess the overall health of the wetland.

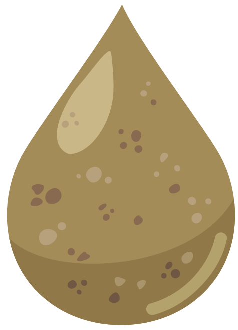
Temperature:

Temperature is how hot or cold the water is, and is measured in degrees Celsius. Measuring the temperature of a wetland is important because:

- Temperature directly affects the metabolic rates of aquatic organisms. Different species have optimal temperature ranges for growth and reproduction.
- Temperature affects the solubility of gases in water, including oxygen. As water temperature increases, its capacity to hold dissolved oxygen decreases. This is crucial for the survival of aquatic organisms, as they rely on dissolved oxygen for respiration.
- Temperature plays a role in determining the types of species that can thrive in a particular wetland. Some species are adapted to specific temperature ranges, and changes in temperature can influence the composition and diversity of the aquatic community.

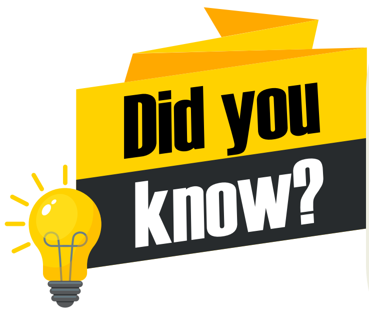


Turbidity:



Turbidity measures how murky or cloudy the water is, and is usually caused by suspended particles.

- High turbidity levels can reduce water clarity, potentially impacting light penetration and photosynthesis in aquatic plants.
- Turbidity may also reduce visibility, making it more challenging for predators to locate prey. Aquatic organisms adapted to clear water conditions may be negatively affected by increased turbidity.
- High turbidity levels can indicate increased erosion and runoff. Monitoring turbidity helps assess the impacts of land-use changes, construction activities, or other factors contributing to sedimentation.



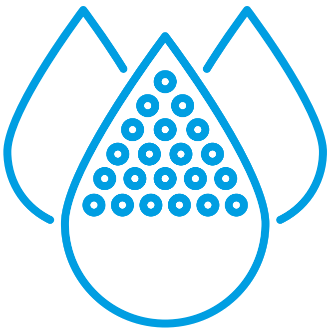
Some Australian freshwater turtles breathe through their cloaca. They are often referred to as “bum breathers”. These species rely on clear, highly-oxygenated water. Increased sedimentation may cause the species to rely on aerial breathing and increase exposure to predation and shorter dive durations.

Dissolved Oxygen:

- Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in water. It is crucial for the survival of organisms as they rely on oxygen for respiration.
- Low dissolved oxygen levels can be indicative of increased organic matter decomposition. Microorganisms breaking down organic material consume oxygen, potentially leading to hypoxic (low oxygen) or anoxic (no oxygen) conditions harmful to aquatic life.
- Anthropogenic pollutants, such as nutrient runoff or organic pollutants, can lead to oxygen depletion. Monitoring dissolved oxygen levels helps identify potential pollution sources and assess the overall health of the wetland ecosystem.

Salinity:
Salinity refers to the concentration of dissolved salts in water. Salinity can have significant implications for the health and functioning of aquatic ecosystems.

- Different species of aquatic organisms have varying tolerances to salinity levels. Some organisms, such as certain types of fish and invertebrates, are adapted to specific salinity ranges.
- Salinity influences the osmotic regulation of aquatic organisms. Changes in salinity can affect the balance of water and salts within the cells of organisms.
- Salinity can affect the types of plant species that can thrive in a wetland. Some plants are adapted to saline conditions, while others prefer freshwater. Changes in salinity can lead to shifts in vegetation composition and structure.
- Elevated salinity levels in wetlands can be indicative of human activities such as agriculture runoff, industrial discharges, or improper waste disposal. Monitoring salinity can help identify potential sources of pollution and guide conservation efforts.



Ammonia:
Ammonia is a nitrogen compound commonly found in aquatic ecosystems, originating from sources such as agricultural runoff, wastewater discharge, and decomposing organic matter.

- Elevated levels of ammonia can be toxic to aquatic organisms, particularly fish and invertebrates.
- Ammonia serves as a nutrient for algae and aquatic plants. Excessive ammonia can lead to algal blooms and eutrophication, causing oxygen depletion and harm to aquatic life.
- Monitoring ammonia levels in water bodies is important for assessing water quality and identifying sources of pollution, such as agricultural activities or wastewater treatment plants.

Nitrate:
Nitrate is a form of nitrogen found in water bodies, primarily from agricultural fertilisers, animal waste, and sewage discharges.

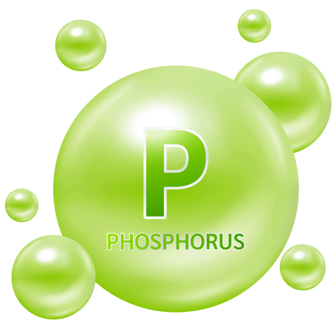
- High nitrate levels can promote excessive algal growth, leading to algal blooms and oxygen depletion in aquatic ecosystems.
- Monitoring nitrate concentrations is crucial for protecting water quality, safeguarding human health, and preventing eutrophication of water bodies.

Nitrite:
Nitrite is an intermediate compound in the nitrogen cycle and is often found in conjunction with nitrate in aquatic environments.

- Elevated nitrite levels can be toxic to aquatic organisms, particularly fish, by interfering with their ability to transport oxygen.
- Nitrite contamination is often associated with sources such as agricultural runoff, sewage discharge, and industrial effluents.
- Monitoring nitrite concentrations helps assess water quality and identify potential sources of pollution, allowing for timely intervention and mitigation measures.

Phosphorus:
Phosphorus is a nutrient essential for plant growth, but excessive phosphorus can lead to eutrophication and degraded water quality.

- Sources of phosphorus in water bodies include agricultural runoff, wastewater discharge, and soil erosion.
- Elevated phosphorus levels can promote algal blooms, which can deplete oxygen levels, produce toxins harmful to aquatic life, and degrade habitat quality.
- Monitoring phosphorus concentrations is vital for managing nutrient inputs, preventing eutrophication, and preserving the ecological health of aquatic ecosystems.



How to test water quality parameters

pH: Use pH strips or pH indicator to measure the acidity or alkalinity of the water. Follow the instructions provided with the testing kit to dip the strip or add the indicator solution into the water sample, then match the colour displayed to determine the pH.

Temperature: Temperature testing is done using a thermometer. Submerge the thermometer into the water sample and wait for the reading to stabilise.

Turbidity: You can use a Secchi disc to test turbidity. A Secchi disc is a circular disk with alternating black and white quadrants.To test turbidity with a Secchi disc, lower the disc into the water sample until it disappears from view. Note the depth at which the disc disappears from sight. Deeper disappearance indicates higher turbidity, while shallower disappearance indicates clearer water.

Dissolved Oxygen: Dissolved oxygen testing usually involves using a dissolved oxygen meter. Submerge the meter in the water and read the value displayed.

Salinity: You can use a hydrometer to test salinity. Follow the instructions to submerge the hydrometer into the water sample and record the reading displayed.

Ammonia, Nitrate, Nitrite and Phosphorus: Testing typically involves using a test kit. Follow the instructions provided with the kit to the add reagents to the water sample, which react with ammonia, nitrate, nitrite or phosphorus to produce a colour change. Compare the colour to a chart provided to determine the concentration of each.

Experimental Design

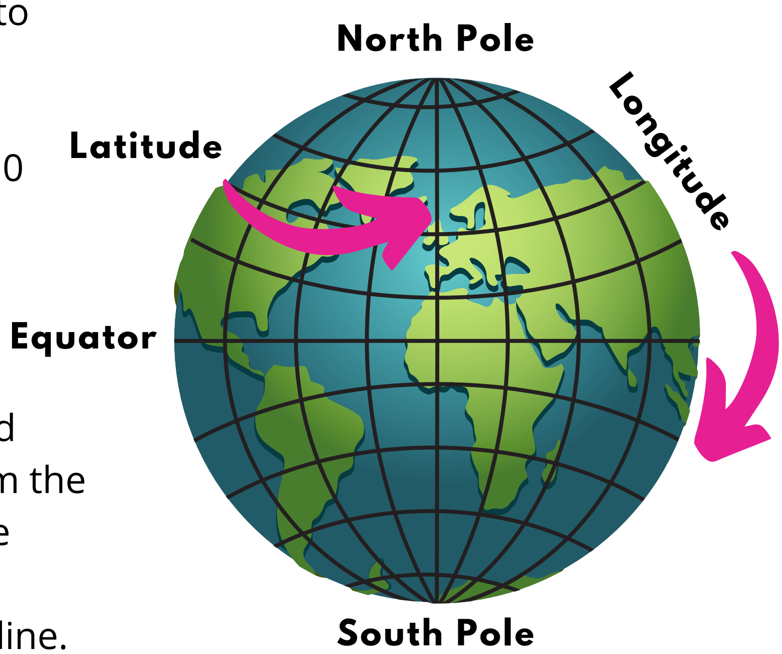
Experimental design refers to the process of planning and organising an experiment in order to gather data and draw conclusions to answer a research question.
The experimental design usually has the following components:

1. **Research Question:** The research question is the central inquiry that the experiment seeks to address. It should be clear, specific, and relevant to the topic of study.
2. **Hypothesis:** A hypothesis is a testable statement that predicts the outcome of the experiment based on prior knowledge, observations, or theoretical principles. It typically consists of an "if-then" statement that proposes a cause-and-effect relationship between variables.
3. **Methods:** The methods section describes the procedures and techniques used to conduct the experiment and collect data. It includes detailed step-by-step instructions for implementing the experimental protocol, including experimental setup, sampling procedures, data collection, controls and variables, statistical analysis.
4. **Expected Outcomes:** The expected outcomes describe the anticipated results or findings of the experiment based on the hypothesis. Expected outcomes provide a basis for evaluating the success of the experiment and determining whether the results support or refute the hypothesis. They also help anticipate potential implications and applications of the research findings.

Understanding GPS and Latitude-Longitude

GPS (Global Positioning System) helps us find locations on Earth using latitude and longitude coordinates.

Latitude: These lines go sideways, like belts around Earth. The Equator is the main line, dividing Earth into the Northern and Southern Hemispheres. Latitude lines are measured in degrees, starting at 0 degrees at the Equator and increasing as you move north or south.



Longitude: These lines go up and down, like steps on a ladder, from the North Pole to the South Pole. The Prime Meridian, passing through Greenwich, England, is the main line. Longitude lines are also measured in degrees, starting at 0 degrees at the Prime Meridian and increasing east or west.

Using GPS, we can find our latitude and longitude coordinates anywhere on Earth. Latitude tells us how far north or south we are, and longitude tells us how far east or west. These coordinates help us know exactly where we are on a map or GPS device.

For example, let's say you're at the Sydney Opera House in Australia. The latitude might be around 33.8568° S (that means you're 33.8568 degrees south of the Equator), and the longitude might be around 151.2153° E (meaning you're 151.2153 degrees east of the Prime Meridian).

GPS and latitude-longitude coordinates help us navigate and find places accurately, whether it's exploring new places or finding our way home.

Classroom Activities

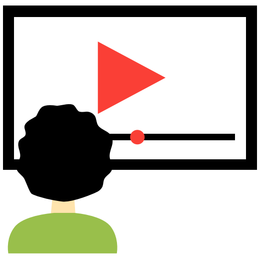
ACTIVITY 1

(1A) Watch the following video. The video gives an example of water quality testing by the Environmental Protection Authority in Victoria.

Link to video: https://www.youtube.com/watch?v=94YcjbYBchc [Copy and paste into browser]

(1B) Discuss what you learnt from the video as a class. Write your ideas on the whiteboard.

(1C) Complete the Video Reflection worksheet.



Video

Discuss

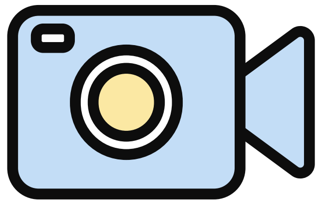
ACTIVITY 2

(2A) Complete the water quality parameter worksheet. This worksheet will test your knowledge on what each parameter is measuring.

Video Reflection

Three things I learnt while watching

3



Two questions I have from the video

2

One fact I found most interesting

1

Water Quality Parameters

Define the water quality parameters in the boxes below.

Temperature

pH

Dissolved oxygen

Turbidity

Salinity

Water Quality Parameters

Define the water quality parameters in the boxes below.

Ammonia

Nitrate

Nitrile

Phosphorus

Classroom Activities

ACTIVITY 3

(3A) In groups, collect information about local environmental organisations, catchment authorities and local council and how they are engaged in water quality testing at your local wetland. Use the internet, books, and articles in your research.

(3B) Collate the following information:

- Names and contact information of the group, council or catchment authority conducting water quality testing.
- The mission, objectives, and activities of each group related to water quality monitoring.
- Any recent water quality reports or findings published by these groups.

(3C) Compose a letter to one of the groups, council or catchment authority to ask them if your class can be involved in their next water quality testing day at your local wetland.
Demonstrate in your letter your current understanding of water quality parameters and explain why joining them in the field would be beneficial to you and your class.

A worksheet for your letter has been provided on the following page.

Classroom Activities

ACTIVITY 4

(4A) In Lesson 2, you will be visiting your local wetland and will be testing the water quality. Prior to the wetland visit, you will need to design your own water quality experiment.

(4B) In small groups, use Google Earth to view your local wetland. Brainstorm potential research questions related to water quality at the wetland. Think about factors that could affect water quality (i.e. human activities).

(4C) Select one of the research questions and develop a hypothesis and experimental design. Your experimental design should include:

- Identification of sampling sites within the wetland. You can use Google Earth for this. Write down the GPS coordinates of your site(s).
- Hypothesis.
- Identification of the water quality parameters to be measured (i.e. pH, turbidity, temperature) and how you intend to measure them.
- Prediction of the expected outcomes based on your hypothesis.

Water Quality Experiment

Research question:

Hypothesis:

GPS coordinates of site(s):

Water quality parameters to be measured:

Water Quality Experiment

Methods:

Expected outcomes:

WATER QUALITY TESTING

LESSON 2

TERM THREE

- Learning Intentions
- Background
- Activities
- Curriculum Mapping

Photo credit: Dr Donald McKnight

Learning Intentions

(1) Conduct water quality testing.

(2) Collect water samples for eDNA analysis.

Background Information

eDNA Testing

Environmental DNA (eDNA) refers to genetic material (DNA) shed by organisms into their environment.

eDNA allows us to monitor native and invasive species and conduct broad-scale biodiversity monitoring.

Benefits of eDNA sampling:

- Eliminates the need to directly observe or capture organisms.
- Less invasive and cheaper than traditional sampling methods as no special sampling permits or specialised personnel are required.
- Can detect species earlier, allowing for effective management outcomes.
- Can detect species that are low in abundance or cryptic.
- Can be used to detect species in areas that are difficult to access with traditional sampling methods, such as trapping.
- Scientists can study many areas quickly and easily.
- Sampling can be conducted in any weather.
- Fosters community engagement as it is a citizen science friendly method.

Background Information
eDNA Testing

How do we target what is in the water?
DNA barcodes - a specific gene region (DNA segment) is targeted for the organisms that we are interested in detecting. This is referred to as a DNA barcode.

A common “universal” region or barcode can be targeted across multiple species, but it needs to be specific enough to exclude animals that we don’t want to detect.

The DNA segment can have small variation among individuals of the same species, but greater variation for different species.

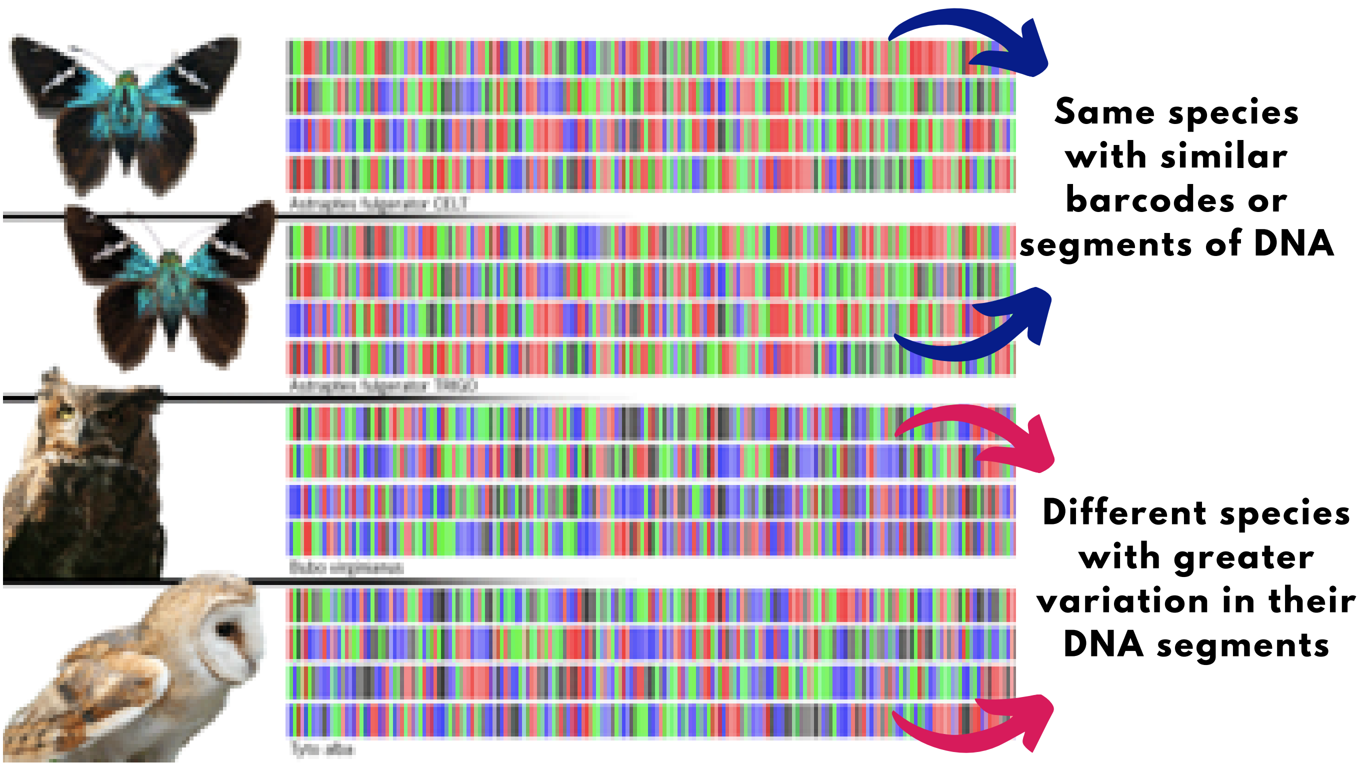


Image credit: Suz Bateson, University of Guelph

Background Information

eDNA Testing

How do we find out who is in the water?

In the laboratory:

1. DNA fragments in the water samples are amplified using PCR (Polymerase Chain Reaction). This process is used to make many copies of the specific DNA region.
2. Scientists then read the DNA sequences.
3. Species are then identified by comparing the DNA fragments to a database with reference sequences to determine which animals DNA are present in the sample and the sampling site.

Background Information

eDNA Testing

How to collect an eDNA sample:

The following steps are from the Great Australian Platypus Search: eDNA Water Sampling Tutorial and Safety Video by EnviroDNA and Odonata Foundation

Important - you do not need to enter the water to collect your sample. Entering the water prevents contamination of the sample.

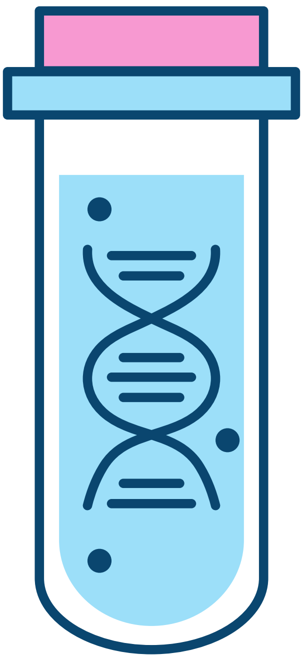
1. Open your sampling pack. In your pack you will have:
    i. A pair of gloves for you to wear that will help minimise any contamination.
    ii. Large syringe that will be used to sample the water.
    iii. Disc filters that are used to filter the water and capture DNA.
    iv. Smaller syringe with preservative.
2. Document the location of your sampling. This includes the name of the waterbody, the date of sampling and the name of the person doing the sampling. For some eDNA projects, you may also be given a site code which is used by researchers to identify the location you are sampling.
3. Put on your gloves.
4. Label each disc filter. You will collect two samples from your site so will need to label the disc filters 1 and 2.
5. Draw water out of the waterbody using your large syringe. Avoid sediment and algae as much as possible because these will clog the filter.

Background Information

eDNA Testing

How to collect an eDNA sample: Continued

6. Record the volume of water collected through the syringe. You may choose to adjust the amount of water in your sample to 50ml so that it is easy to calculate.
7. Screw on the disc filter to the top of the syringe.
8. Force the water in the syringe through the filter. The DNA will become trapped in the filter.
9. Repeat steps 5 to 8 until no more water can filter through. Be sure to document how much water you filter.
10. Remove excess water from the filter. Fill the syringe with air, screw on the filter and squeeze out any excess water.
11. Add the preservative to the disc filter. Adding the preservative helps to prevent degradation of the sample. Screw the disc filter with the sample onto the end of the small syringe and gently add the preservative into the filter.
12. Record the volume of water you filtered through the syringe into your data sheet.



Classroom Activities

ACTIVITY 1

(1A) Watch the following videos:

The first video from EnviroDNA explains what eDNA is and how it is used.

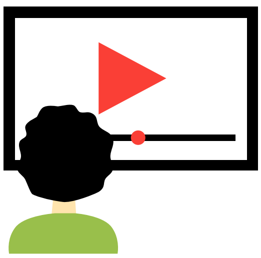
Link to video: https://www.youtube.com/watch?v=TQdTV1rAlWY&t=120s [Copy and paste into browser]

The second video from Odonata explains how eDNA is sampled from waterbodies as part of the Great Australian Platypus Search.

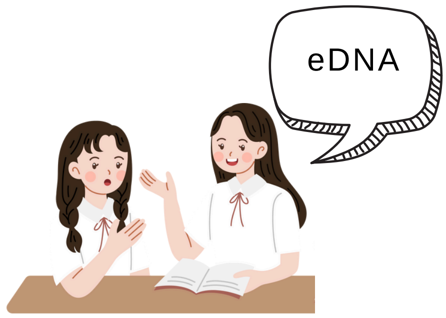
Link to video: https://www.youtube.com/watch?v=30G16kOFN7U&t=248s [Copy and paste into browser]

(1B) Discuss what you learnt from each video as a class. Write your ideas on the whiteboard.

(1C) Complete the Video Reflection worksheet.



Video



Discuss

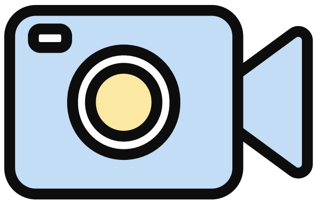
ACTIVITY 2

(2A) Research the species listed in the worksheet below and circle those that may be detected in the eDNA sample you collect from your local wetland.

Video Reflection

3

Three things I learnt while watching



2

Two questions I have from the video

1

One fact I found most interesting

What species are in your local wetland?

As a class, research the species listed below and circle those that may be detected in the eDNA sample you collect from your local wetland.

Tandanus tandanus

Retropinna semoni

Myuchelys purvisi

Chelodina longicollis

Neosilurus mollespiculum

Galaxias truttaceus

Elseya irwini

Notesthes robusta

Macquaria ambigua

Chelodina oblonga

Ornithorhynchus anatinus

Emydura macquarii

Maccullochella peelii

Rheodytes leukops

Nannoperca vittata

Carettochelys insculpta

Tandanus bostocki

Epidogalaxias salamandroides

Crinia pseudinsignifera

Chelodina expansa

Crinia glauerti

Litoria meiriana

Macquaria australasica

Lates calcarifer

Anguilla reinhardtii

Craterocephalus stercusmuscarum

Crocodylus johnsoni

Anguilla australis

Elusor macrurus

Elseya albagula

Classroom Activity

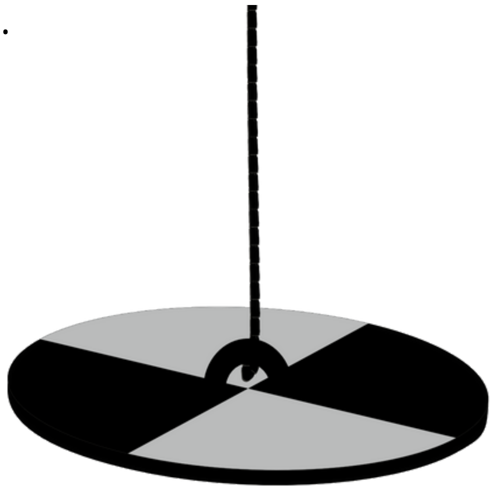
ACTIVITY 3

(3A) Make your own secchi disc! Watch the following video from the Chesapeake Bay NERR Virginia on how to make your own secchi disc.

Link to video: https://www.youtube.com/watch?v=sbQ2nVt_5GY

Equipment:

- Secchi disc design (on the following page).
- White plastic plate.
- Black sharpie and coloured sharpie.
- Hole punch.
- Eye bolt.
- Metal nuts and washers.
- Metal butterfly nut.
- Black tape.
- String.
- Tape measure.



Method:

1. Cut a 20cm diameter circle out of your plastic plate.
2. Draw a cross on your plate, dividing it into quarters.
3. Colour in two of the quarters black, using a black sharpie. You will need to colour in two sections which are diagonal to one another, like the image above.
4. Punch a hole in the centre of the plate.
5. Cover the top of the eye bolt with black tape.
6. Insert the eye bolt through the hole in the plate. The bottom of the eye bolt should be on the underside of your plate.
7. Feed on the nuts and bolts and secure with a butterfly nut.
8. Attach string to top of the eye bolt.
9. Lay out your string and measure 10cm up from the eye bolt using the black sharpie. Continue to mark 10cm intervals up the string. Mark 50cm intervals using a different colour sharpie.

Wetland Activity

ACTIVITY 1 - Water Quality Testing

(1A) In groups, conduct water quality testing at pre-selected locations (from lesson 1) around the wetland.

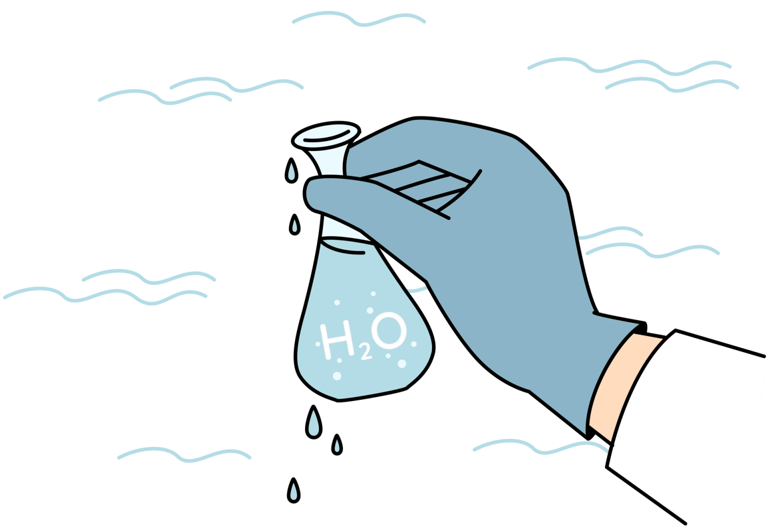
Equipment:

- Clipboards with recording sheets and experimental design
- GPS
- Gloves
- Water quality test kits (i.e. Pond Master Test Kit)
- Secchi disc.
- Waterproof thermometer.
- Hydrometer.

ACTIVITY 2 - eDNA Testing

(2A) Collect a sample of water from the wetland to be sent for eDNA analysis. Wear gloves when collecting the sample to prevent cross-contamination.

(2B) Follow the steps identified in the worksheet below.



Water Quality Monitoring

Aim: ____

____

Equipment:

- Water quality testing kits.
- Secchi disc.
- Waterproof thermometer.
- Hydrometer.
- Gloves.
- GPS.
- Recording sheets.

Method:

- Locate your site at the wetland., using the GPS coordinates you identified on Google Earth.
- Put gloves on.
- Test the water quality parameters identified in your experimental design.
- Record your results.
- Add any observations about your sampling or the site in the comments box.

Water Quality Recording Sheet

Date:

Wetland Name:

Sampling site description:

Parameter	Result	Comments

Classroom Activity

ACTIVITY 4 -

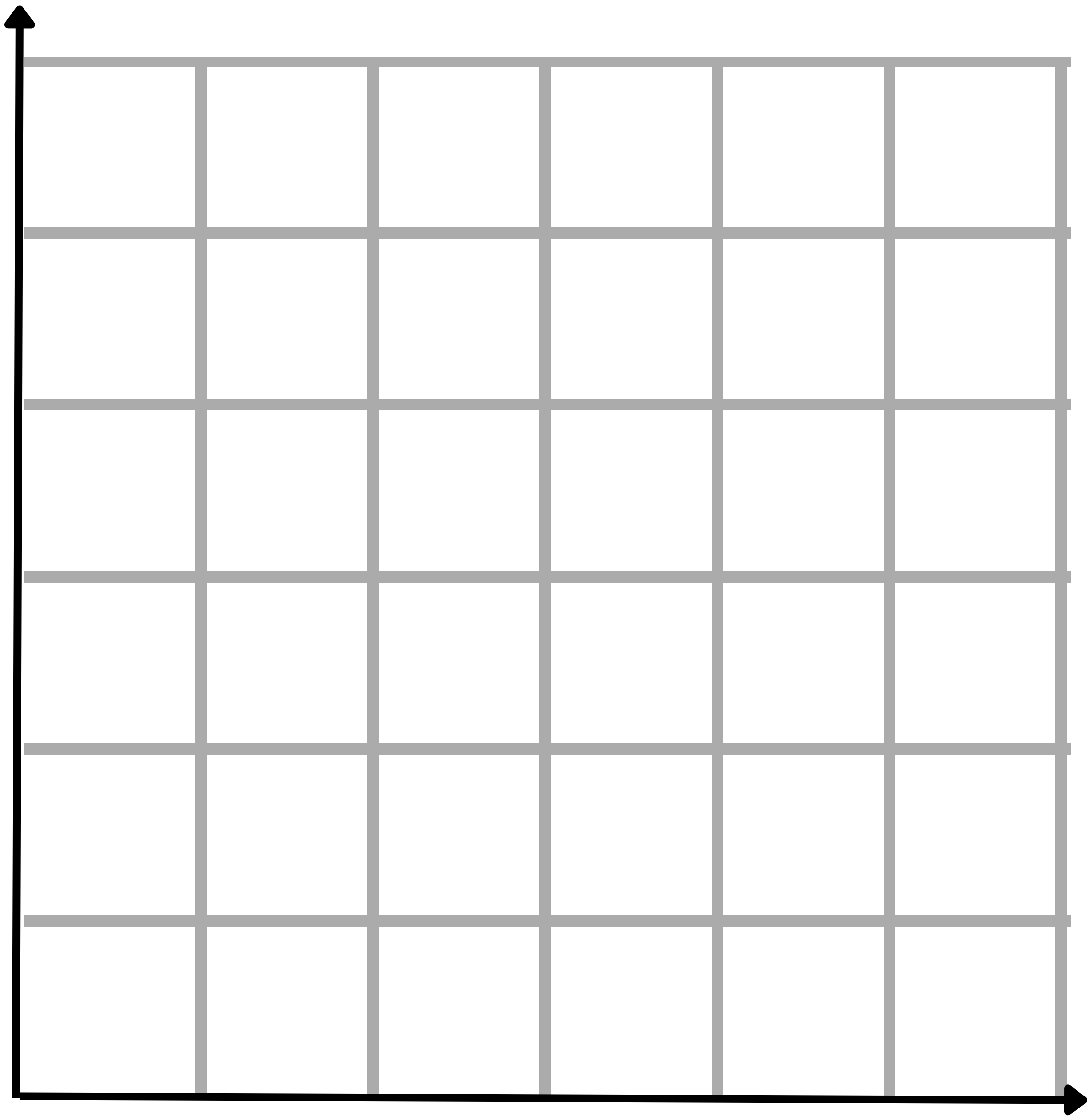
(4A) Revisit your experimental design and your research question.

(4B) Graph your data, based on your research question.
For instance, if you have sampled two sites and were interested in comparing the turbidity at the two sites, you may choose to create a bar graph of your data with one bar per site.

(4C) Interpret your findings and accept or reject your hypothesis based on your results.

Graph Your Data

Draw a graph of your water quality data.



Interpret your findings

Interpret your graph and answer your research question based on your data.

Do you accept or reject your hypothesis? Explain why.

MACROINVERTEBRATES

LESSON 3

TERM THREE

- Learning Intentions
- Background
- Activities
- Curriculum Mapping

Learning Intentions

(1) Define a macroinvertebrate;

(2) Describe how macroinvertebrates can be used to assess wetland health.

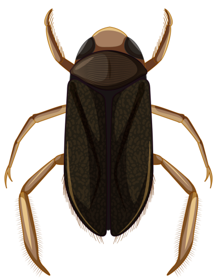
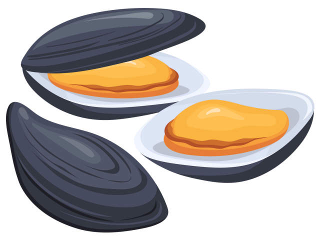
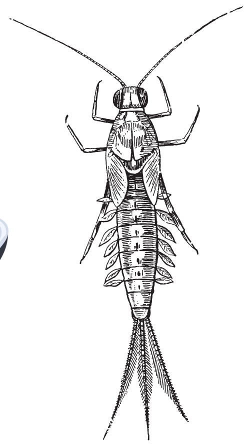
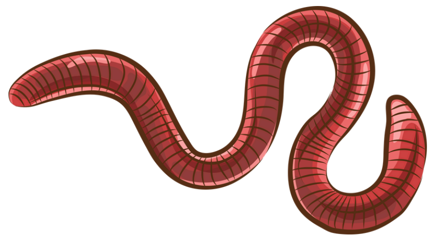
Define

Describe

Background Information

What are macroinvertebrates?

Macroinvertebrates (also known as water bugs) are small animals without a backbone that are large enough to see without a microscope. Water bugs spend all or part of their life in the water and are a source of food for fish, frogs, birds and freshwater turtles. Some common water bugs are beetles, snails, dragonfly and damselfly nymphs, mayfly and stonefly nymphs, yabbies, shrimp, worms and mussels.


What can macroinvertebrates tell us about the health of our water bodies?

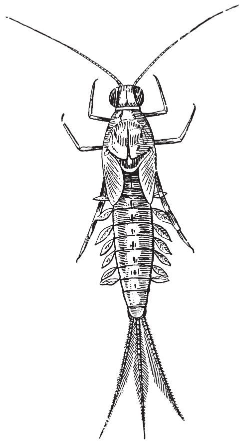
The presence of different water bugs within a water body can serve as an indicator of its overall health. Water bugs exhibit diverse tolerances to alterations in the aquatic environment, such as changes in temperature, turbidity and pH. The SIGNAL (Stream Invertebrate Grade Number - Average Level) score associated with a water bug signifies the species' level of tolerance.

SIGNAL scores:

- A SIGNAL score of 6-10 indicates the species is very sensitive to changes in their environment.
- A SIGNAL score of 1-5 indicates the species is very tolerant of environmental change.

Macroinvertebrate SIGNAL scores:

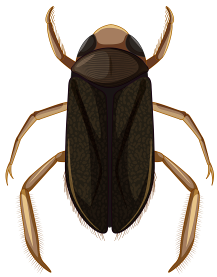
SIGNAL scores are indicated in the brackets.
Garland, I. and Coleman, K. (2020) Waterbug Blitz Education Resource for Australia Schools. National Waterbug Blitz, NSW.



Very Sensitive Bugs - Stonefly nymph (10), Mayfly nymph (9)

Sensitive Bugs - Alderfly larvae (8), Caddisfly larvae (8), Riffle beetle & larvae (7), Water mite (6).

Tolerant Bugs - Beetle larvae (5), Dragonfly nymph (4), Water strider (4), Whirligig beetle and larvae (4), Freshwater yabby (4), Damselfly nymph (3), Fly larva and pupa (3), Midge larva and pupa (3), Freshwater mussel (3), Nematode (3), Freshwater sandhopper (3), Freshwater shrimp (3), Water scorpion/Needle bug (3).



Very Tolerant Bugs - Diving beetle (2), Flatworm (2), Hydra (2), Water treader (2), Freshwater worm (2), Freshwater slater (2), Waterboatman (2), Backswimmer (2), Bloodworm (1), Leech (1), Mosquito larva and pupa (1), Freshwater snail (1).

Anatomy of a Macroinvertebrate

Head: The eyes, mouth, and antennae are located on the head.

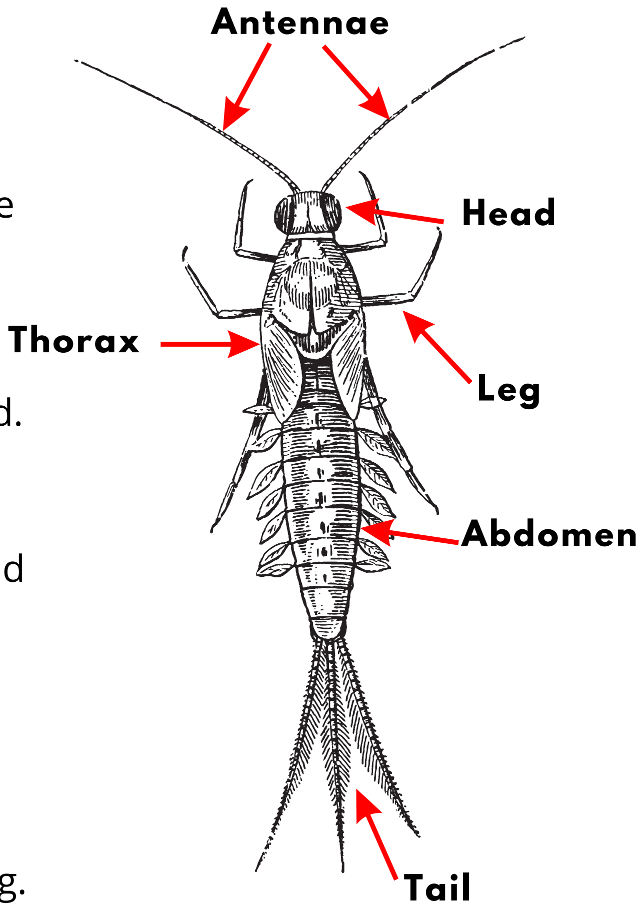
Thorax: The thorax is the middle part of a macroinvertebrate's body, kind of like their middle section. This is where their legs are attached.

Abdomen: The abdomen is the back part of a macroinvertebrate's body, behind the thorax. Inside the abdomen, they have their digestive system and sometimes even their breathing parts.

Tail: Some macroinvertebrates have a tail-like structure at the end of their abdomen. It helps them swim and move through the water.

Antennae: Antennae are like little feelers on the macroinvertebrate's head. They use them to sense things around them. With their antennae, macroinvertebrates can detect food, find mates, and even feel vibrations in the water.

Legs: Macroinvertebrates have legs attached to their thorax, and they use them for walking, crawling, or swimming.



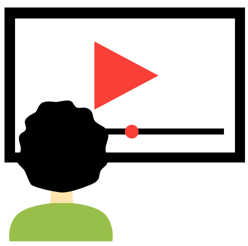
Classroom Activity

ACTIVITY 1 -

(1A) Watch the following video. The video gives an overview of macroinvertebrates and how to identify different organisms.

Link to video: https://www.youtube.com/watch?v=HtE70kzYDPM [Copy and paste into browser]

(1B) Complete the Video Reflection worksheet.



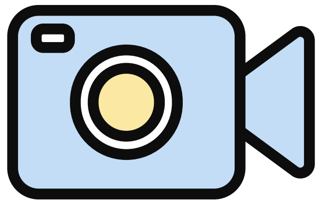
Video

Discuss

Video Reflection

3

Three things I learnt while watching



2

Two questions I have from the video

1

One fact I found most interesting

Classroom Activity

ACTIVITY 2 -

(2A) Explain the importance of macroinvertebrates and how they are used to assess wetland health.

ACTIVITY 3 -

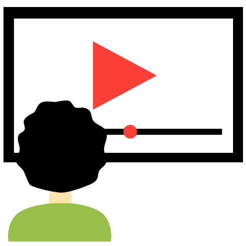
(3A) Explore the National Waterbug Blitz website.

Link to website: https://www.waterbugblitz.org.au/ (Copy and paste into browser).

(3B) Explore the websites content, including the *Meet the Bugs* page and *How to Video.*

Link to video:
https://www.waterbugblitz.org.au/cb_pages/resources.php?category_id=3915 (Copy and paste into browser).

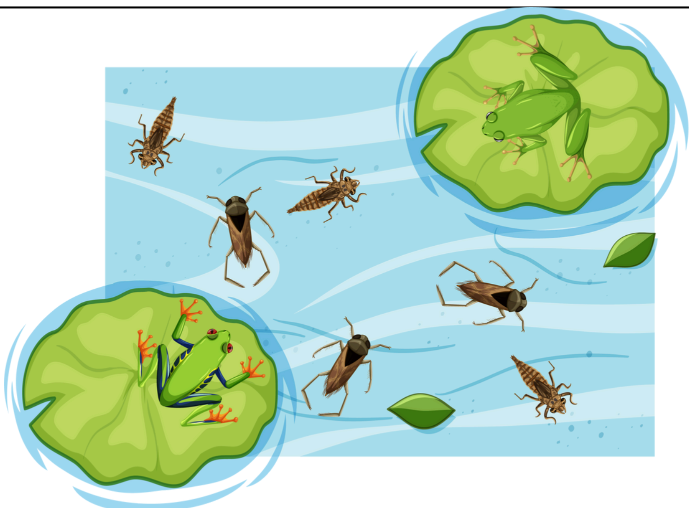
(3C) Complete the Video Reflection worksheet.



Video

Macroinvertebrates

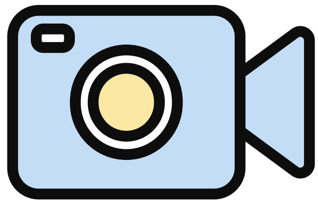
Explain the importance of macroinvertebrates and how they are used to assess wetland health



Video Reflection

3

Three things I learnt while watching



2

Two questions I have from the video

1

One fact I found most interesting

Classroom Activity

ACTIVITY 4 -

(4A) In Lesson 4, you will be visiting your local wetland and will be sampling macroinvertebrates from the same sites you sampled during your water quality experiment.

(4B) Prior to the wetland visit, you will need to design your own experimental design. In small groups, brainstorm potential research questions related to macroinvertebrate presence at the wetland. Think about factors that could affect the macroinvertebrates that you see (i.e. human activities).

(4C) Select one of the research questions and develop a hypothesis and experimental design. Your experimental design should include:

- Identification of sampling sites within the wetland. You can use the same sites you selected for your water quality testing.
- Hypothesis.
- Prediction of the expected outcomes based on your hypothesis.

Macroinvertebrate Monitoring

Research question:

Hypothesis:

GPS coordinates of site(s):

Expected outcomes:

MACROINVERTEBRATE SAMPLING

LESSON 4

TERM THREE

- Learning Intentions
- Background
- Activities
- Curriculum Mapping

Learning Intentions

(1) Conduct water bug survey at your local wetland;

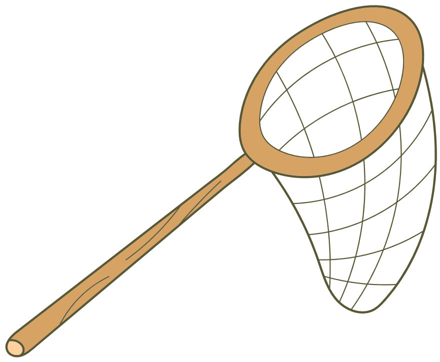
(2) Identify macroinvertebrates from your local wetland.

Wetland Activity

ACTIVITY - Macroinvertebrate Sampling

(1) In groups, conduct macroinvertebrate sampling from the same sites selected for water quality testing.

Equipment:



- Dip nets
- Buckets
- Large trays for sorting
- Ice cube trays for smaller sorting
- Spoons, pipettes
- Measuring ruler.
- Eppendorf tube (or similar) for collection of subset of water bugs for classroom activities.
- The Waterbug App for identification (downloaded

from Google Play or iTunes).
More information can be found on the National Waterbug Blitz website. https://www.waterbugblitz.org.au/Get-Involved (Copy and paste into browser).

Water bug Collection:

- Pour clean wetland water into a bucket near the water's edge.
- Stand at the water's edge and using circular sweeping motion, sweep the dip net through the water multiple times.
- Be sure to sample all habitat types.
- Rinse the sample until water runs clear and transfer collected water bugs to a bucket.
- Rinse any mud or silt from the dip net before re-sampling.
- Transfer water bugs into buckets into large sorting trays. Keep water bugs in the shade.

Wetland Activity

ACTIVITY - Macroinvertebrate Samping (Continued)

Sorting Water bugs:

- Observe water bugs swimming in the large tray.
- Fill the ice cube trays with clean water.
- Transfer the water bugs into the ice cube trays using spoons, sorting the water bugs as they go.

Recording and Identification:

- Identify the types of water bugs collected using the Waterbug App.
- Document the abundance of each water bug using the ALT Waterbug Field Sheet (downloaded from the Waterbug Shop.

Link to field sheet: https://www.embraceecology.com.au/waterbugshop/alt-waterbug-field-sheet (Copy and paste into browser).

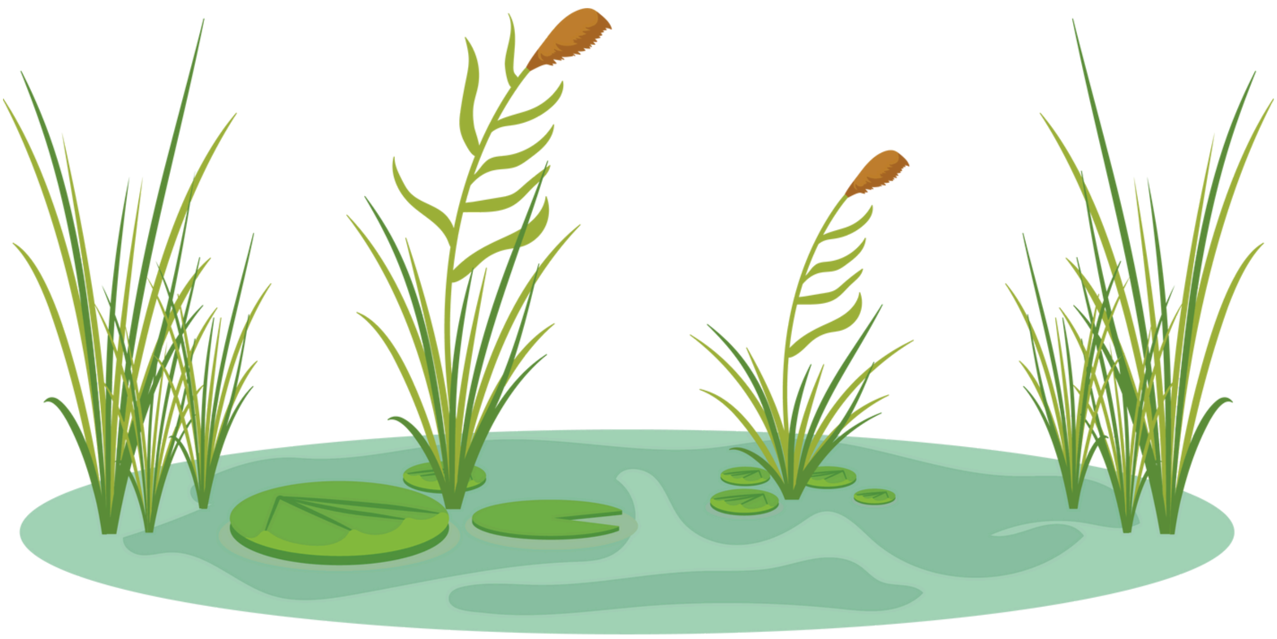
Wetland Activity

Viewing waterbugs:

- Use the camera on your mobile phone or iPad to capture an image of one of the macroinvertebrates. Teachers may decide to purchase a macro lens for their class to attach to their phones when taking photos.
- Draw a biological drawing of one of the water bugs. In your drawing, magnify the water bug so that your drawing is 3 times the actual size of the water bug.
- Label the parts of the water bug.

Pack up:

- Return water bugs to the location they were sampled from.
- Wash large sorting trays, ice cube trays and dip nets.



Macroinvertebrate Surveys

Aim: ______________________________

____

Equipment:

- Dip nets
- Buckets
- Large trays for sorting
- Ice cube trays for smaller sorting
- Spoons, pipettes
- Eppendorf tube
- Water bug identification sheets

Method:

- Pour clean wetland water into a bucket near the water's edge.
- Stand at the water's edge and using an upward-sweeping motion, sweep the net through the water.
- After each sweep, check the dip net and transfer collected water bugs to a bucket.
- Rinse any mud or silt from the dip net before re-sampling.
- Transfer water bugs into large sorting trays for identification.

Macroinvertebrate

Name of macroinvertebrate:

____

Macroinvertebrate SIGNAL score:

____

Draw your chosen macroinvertebrate to 3 times its actual size.
Identify and name the body parts of your macroinvertebrate.

Classroom Activity

ACTIVITY 1 -

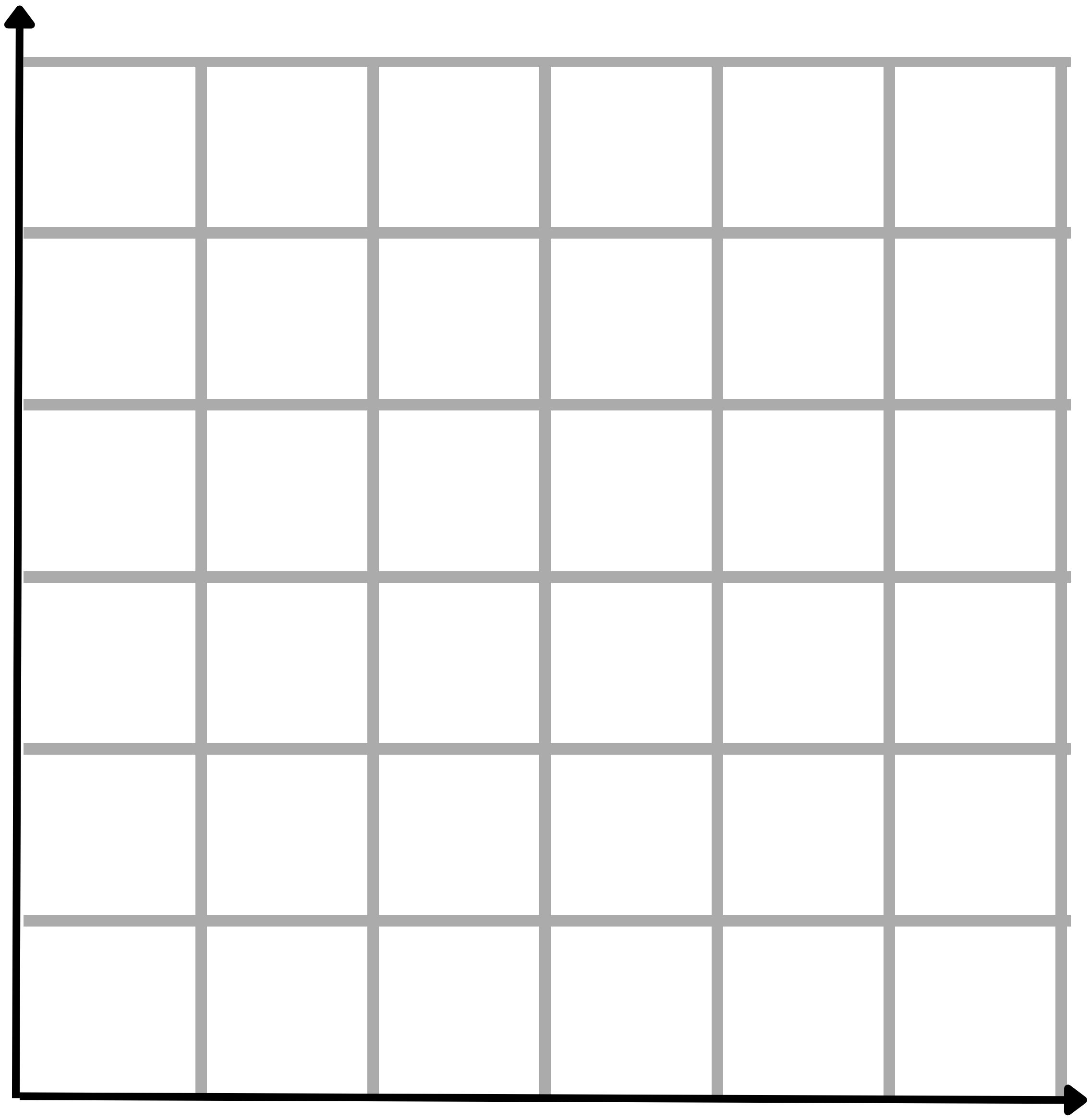
(1A) Revisit your experimental design and your research question.

(1B) Graph your data, based on your research question.
For instance, if you have sampled two sites and were interested in comparing the abundance of water bugs (from the ALT Waterbug Field Sheet) at the two sites, you may choose to create a bar graph of your data with one bar per site.

(1C) Interpret your findings and accept or reject your hypothesis based on your results.

Graph Your Data

Draw a graph of your macroinvertebrate data.



Interpret your findings

Interpret your graph and answer your research question based on your data.

Do you accept or reject your hypothesis? Explain why.

ABUNDANCE AND SPECIES RICHNESS

LESSON 5

TERM THREE

- Learning Intentions
- Background
- Activities
- Curriculum Mapping

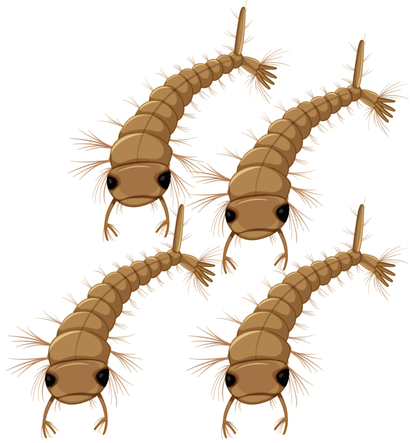
Learning Intentions

(1) Calculate the abundance and species richness of macroinvertebrates.

Background Information

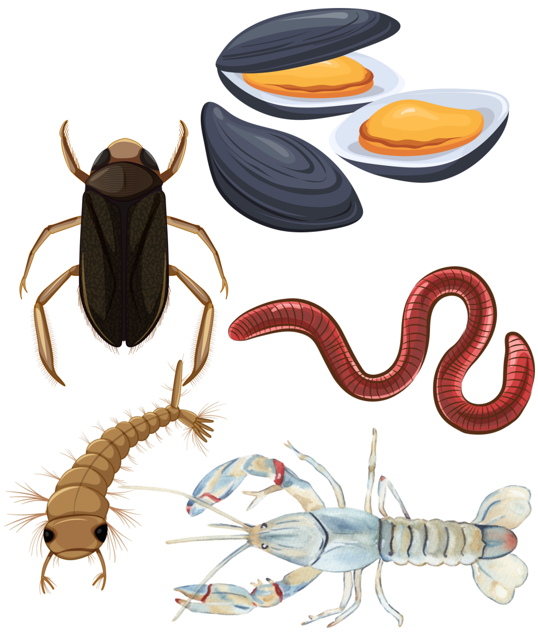
Species Abundance:

- Species abundance refers to the number of individuals of a particular species present.
- For instance, in a wetland area, you might observe 20 frogs, 15 ducks, and 10 turtles. The abundance of frogs is 20, ducks is 15, and turtles is 10.



Species Richness:

- Species richness refers to the total number of different species present.
- If the wetland area is home to frogs, ducks, dragonflies, fish, turtles, and aquatic plants, then the species richness of the wetland is six (counting all the different species).



Classroom Activities

ACTIVITY 1

(1A) Calculate the abundance and species richness of macroinvertebrates sampled from the wetland (all sites combined).
Abundance - Calculate the total number of individuals per species, sampled from the wetland. You will have an abundance value for each species.
Species richness - Calculate the number of different species sampled from the wetland.

ACTIVITY 2

(2A) Determine the health of each site using the SIGNAL (Stream Invertebrate Grade Number - Average Level) score equation, from the Waterbug Blitz Education Resource.

Link to Waterbug Blitz Education Resource, page 40:
https://www.peekdesigns.com.au/wp-content/uploads/2020/08/WaterbugBlitzEducationResource-FINAL.pdf
(Copy and paste into browser).

(2B) Compare the score for your site to those of your classmates and interpret your findings.

Abundance and Species Richness

Abundance - Calculate the total number of individuals per species, sampled from the wetland.

Species richness - Calculate the number of different species sampled from the wetland.

LESSON 6

TERM THREE

DATA COMPARISON AND INTERPRETATION

- Learning Intentions
- Background
- Activities
- Curriculum Mapping

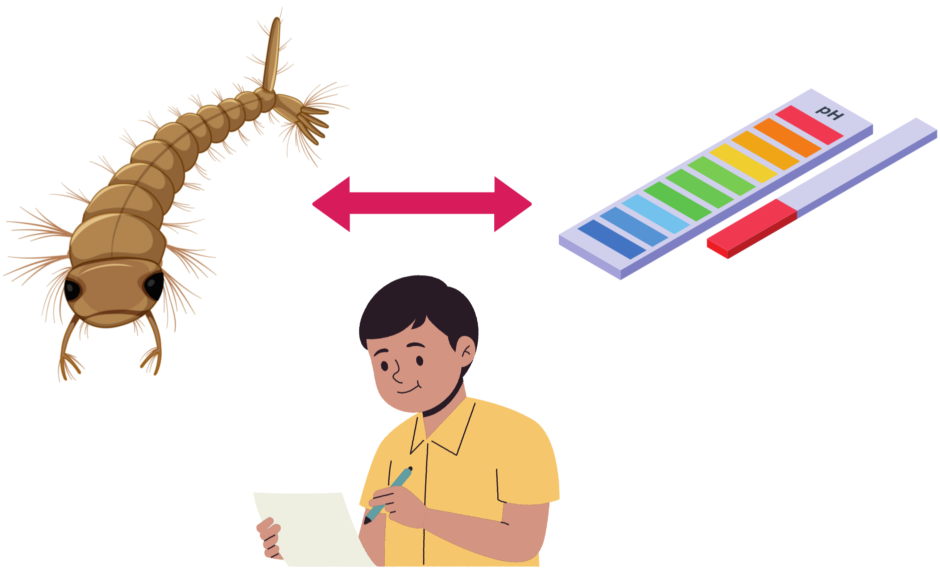
Photo credit: Marilyn Connell

Learning Intentions

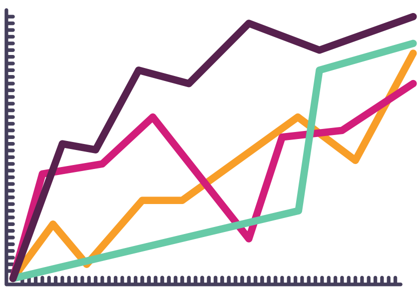
(1) Compare the data collected from water quality testing and the water bugs survey.

(2) Graph dependent and independent variables in a line graph and discuss the relationship between the two and interpret findings in relation to wetland health.

(3) Interpret the results of eDNA sampling (conducted in Lesson 2).



Compare



Graph

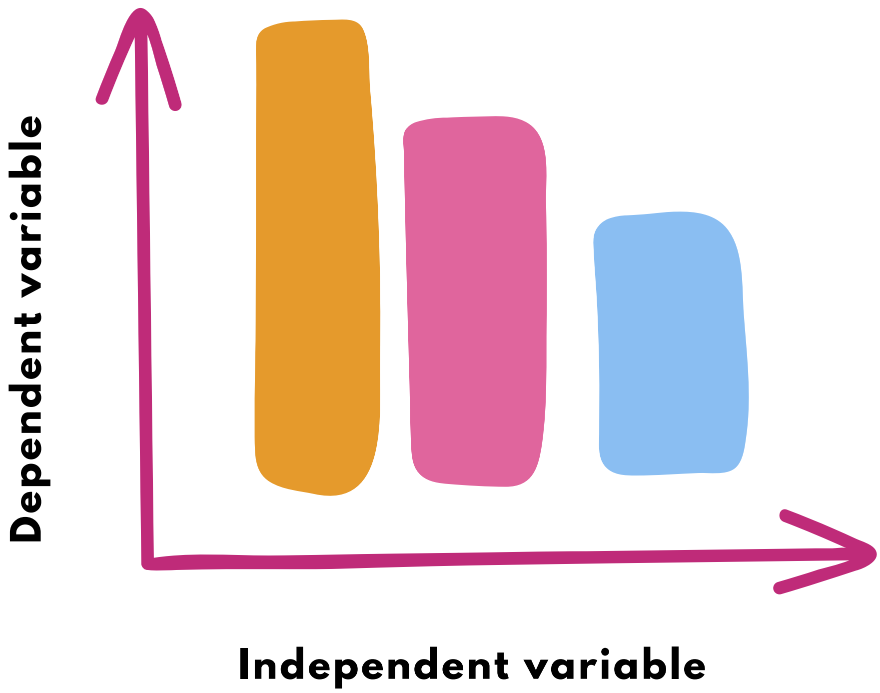
Interpret

Background Information Variables

A variable is something that can change or vary in an experiment or investigation. It's like a piece of the puzzle that can be different from one situation to another. Scientists use variables to understand how things work and to solve problems.
There are two main types of variables: independent variables and dependent variables.

Independent variable: *a variable that is unchanged by other variables being measured.*

Dependent variable: *the variable that changes as a result of the independent variable.*



Classroom Activities

ACTIVITY 1

(1A) Identify independent and dependent variables in both the water bug survey and water quality testing.

(1B) Collate the water bug abundance data and water quality data from the different sites sampled by you and your class.

(1C) Using the class dataset, graph how the abundance of water bugs is impacted by water quality parameters. You may choose to graph only one water quality parameter and water bug, or create multiple graphs for each.

(1C) Discuss how changes in water bug populations may correlate with changes in water quality parameters.

ACTIVITY 2

(2A) Interpret the results of your eDNA testing.

(2B) Compare your findings with your prior worksheet "What species are in your wetland?" to see if any of the species you identified appeared in your sample.

(2C) Compare your findings with existing literature concerning species distributions. Identify species within their inherent distribution and those that occur outside their expected range.

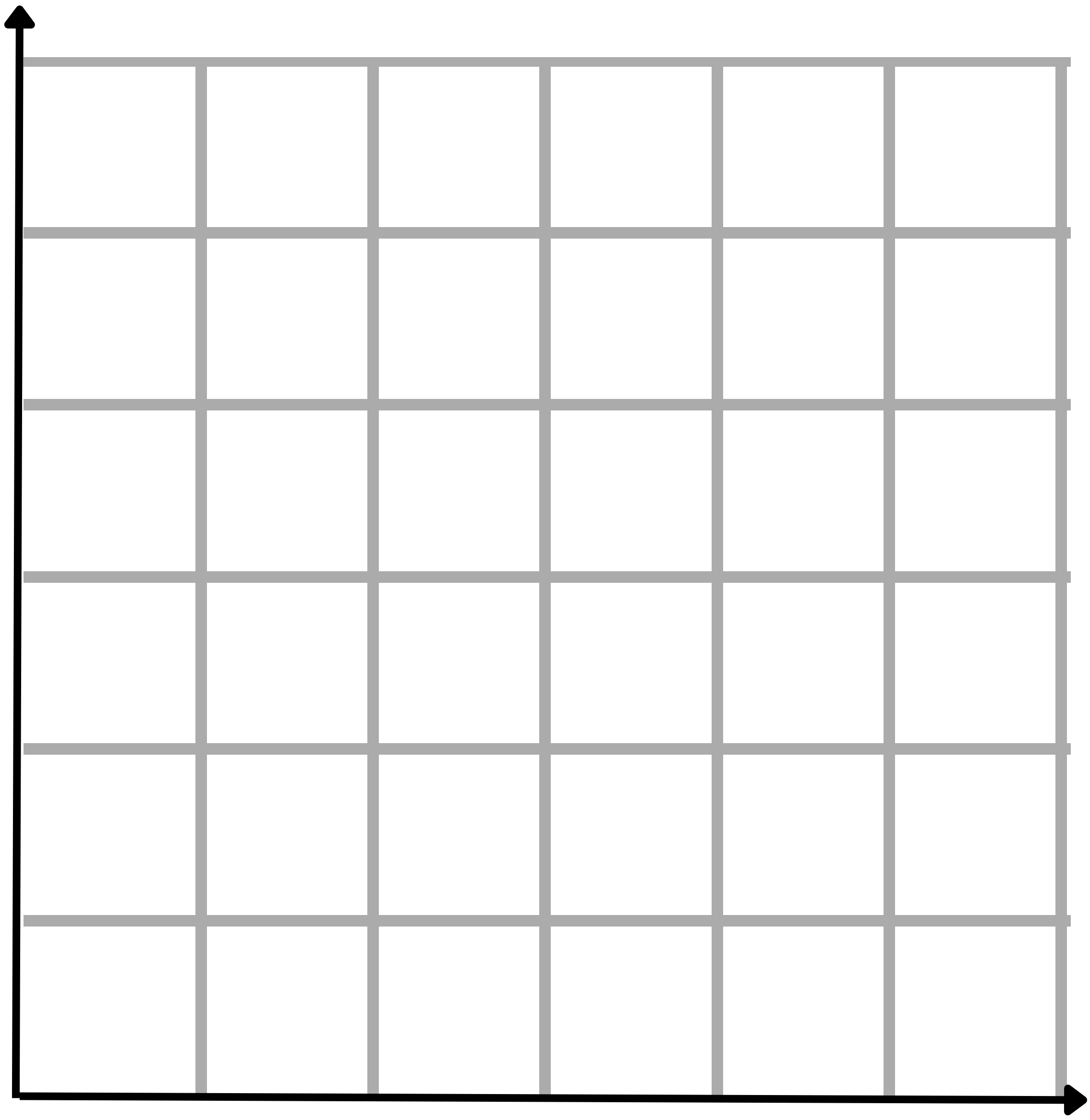
Class Dataset

Fill in the table below with the data from your class. An example has been given in red.

Group Number	Water Quality Parameter	Water Quality Parameter Value	Water bug	Abundance
1	Turbidity	1 metre	Mayfly nymph	3

Graph Your Data

Draw a line graph of the data.



Interpret your findings

Explain the relationship between your water quality data and macroinvertebrate data.

Classroom Activities

ACTIVITY 3

(3A) As a class, discuss your results.
Q: What do the sensitivity scores tell us about the health of the wetland?

Q: What do the water quality results tell us about the health of our local wetland?

Q: How might the results impact the freshwater turtles at the wetland?

(3B) Suggest ways to improve the health of the wetland.

FOOD CHAINS AND FOOD WEBS

- Learning Intentions
- Background
- Activities
- Curriculum Mapping

LESSON 7

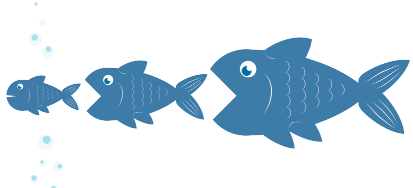
TERM THREE

Photo credit: Marilyn Connell

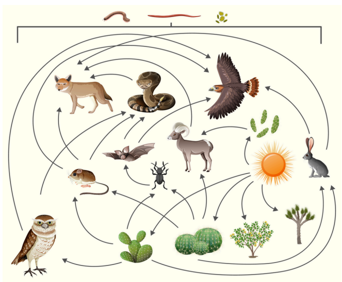
Learning Intentions

(1) Differentiate between a food chain and food web and identify organisms at different trophic levels.

(2) Describe the diet of Australian freshwater turtles and how it varies among species.



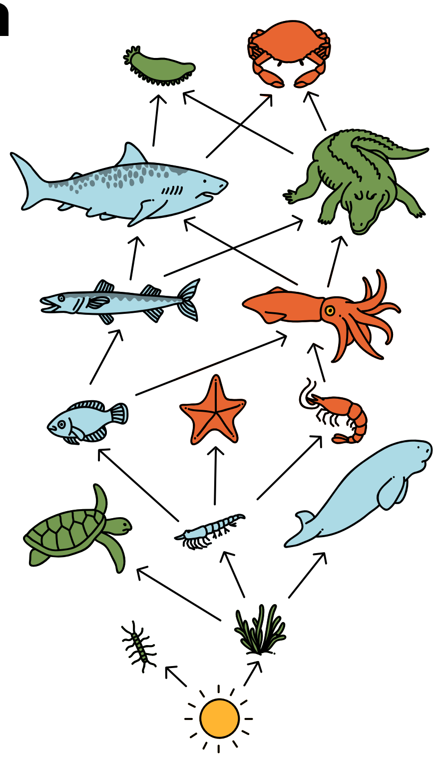
Differentiate



Describe

Photo credit: Dr Donald McKnight

Background Information



Food Chain:
A food chain is a linear sequence that shows the transfer of energy and nutrients from one organism to another. It starts with a producer, which is eaten by a primary consumer, which is then eaten by a secondary consumer, and so on.

Food Web:
Food webs consist of many interconnected food chains. A food web shows the feeding relationships among different organisms. In a food web, organisms can have multiple predators or prey.

Herbivores:

- Herbivores are animals that primarily eat plants.

Omnivores:

- Omnivores are animals that consume both plant and animal matter as part of their diet. They have a flexible diet and can eat a wide variety of food sources, including fruits, vegetables, meat, and insects.

Carnivores:

- Carnivores are animals that primarily eat other animals for food.

Detritivores:

- Detritivores are organisms that feed on decaying organic matter, such as dead plants and animals. They play a crucial role in breaking down and recycling nutrients in ecosystems.

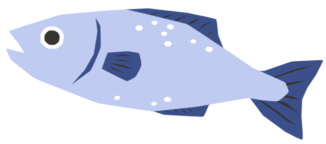
Scavengers:

- Scavengers are animals that primarily feed on dead and decaying animals or carrion. They help clean up the environment by consuming carcasses.

Trophic Levels:

Trophic levels refer to the positions that organisms occupy in a food chain or food web. Trophic levels represent the different levels of energy transfer and nutrient flow.

1. **Producers** - such as plants occupy the first trophic level as they convert sunlight into energy through photosynthesis.



2. **Primary consumers** – animals which feed on plants (herbivores).
3. **Secondary consumers** – animals which eat primary consumers.

4. **Tertiary consumers** – larger carnivores that eat secondary consumers.
5. **Decomposers -** such as bacteria and fungi, break down dead plants and animals into nutrients that can be used by producers. They play an important role in recycling nutrients in ecosystems.

Photo credit (turtle): Dr Donald McKnight

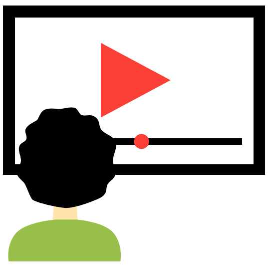
Classroom Activities

ACTIVITY 1

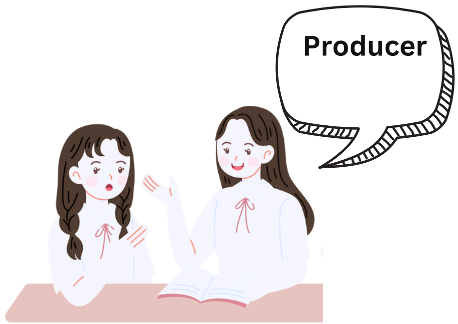
(1A) Watch the following video as a class which gives an overview of food chains and food webs.

Link to video: https://www.youtube.com/watch?v=YuO4WB4SwCg
[Copy and paste into browser]

(1B) Complete the Video Reflection worksheet.



Video



Discuss

ACTIVITY 2

(2A) Research the diet of an Australian freshwater turtle species.

(2B) Search for information using various forms of literature (i.e. articles, books or printouts).

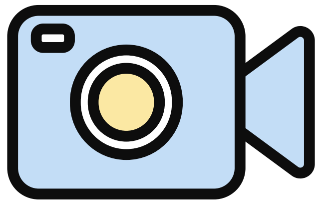
(2C) Answer the following questions about the species diet:
Q1: What prey items does the species eat?
Q2: Is the species a herbivore, omnivore or carnivore?
Q3: How does the species anatomy (i.e. neck length, jaw structure) support the diet?
Include references and/or a bibliography.

(2D) Present the information to your class.

Video Reflection

3

Three things I learnt while watching



2

Two questions I have from the video

1

One fact I found most interesting

Australian Freshwater Turtle Diet

Species (common name and scientific name):

What prey items does the species eat?

Is the species a herbivore, omnivore or carnivore?

How does the species anatomy support the diet?

Classroom Activities

ACTIVITY 3

(3A) Design a food chain flip book. Your flip book should include your Australian freshwater turtle species from the previous activity.

Creating a Food Chain Flip Book -
Materials:

- Blank index cards or multiple sheets of A4 paper.
- Scissors.
- Colouring pencils.
- Staple or bulldog clip.

Instructions:

1. If you are using A4 sheets of paper, divide your paper into quarters and cut out each quarter.
2. On each quarter or index card, draw one organism from the food chain along with its name and position in the chain (e.g., "Secondary Consumer: Murray River short-neck turtle, *Emydura macquarii*").
3. Number each page of your flip book.
4. Staple or bulldog clip the pages together along one edge to create the flip book.

Classroom Activities

ACTIVITY

What I Know (K), What I Want to Know (W), What I Learnt (L)

Materials:

- Large chart paper divided into 3 sections labeled "K" (Know), "W" (Want to Know), and "L" (Learnt).
- Markers or pens

Instructions:
(1A) Revisit your Know, Want to Know and Learnt chart and complete the Learnt (L) column.

What I Know (K)

Want to Know (W)

What I Learnt (L)

Photo credit (turtle): Dr Donald McKnight