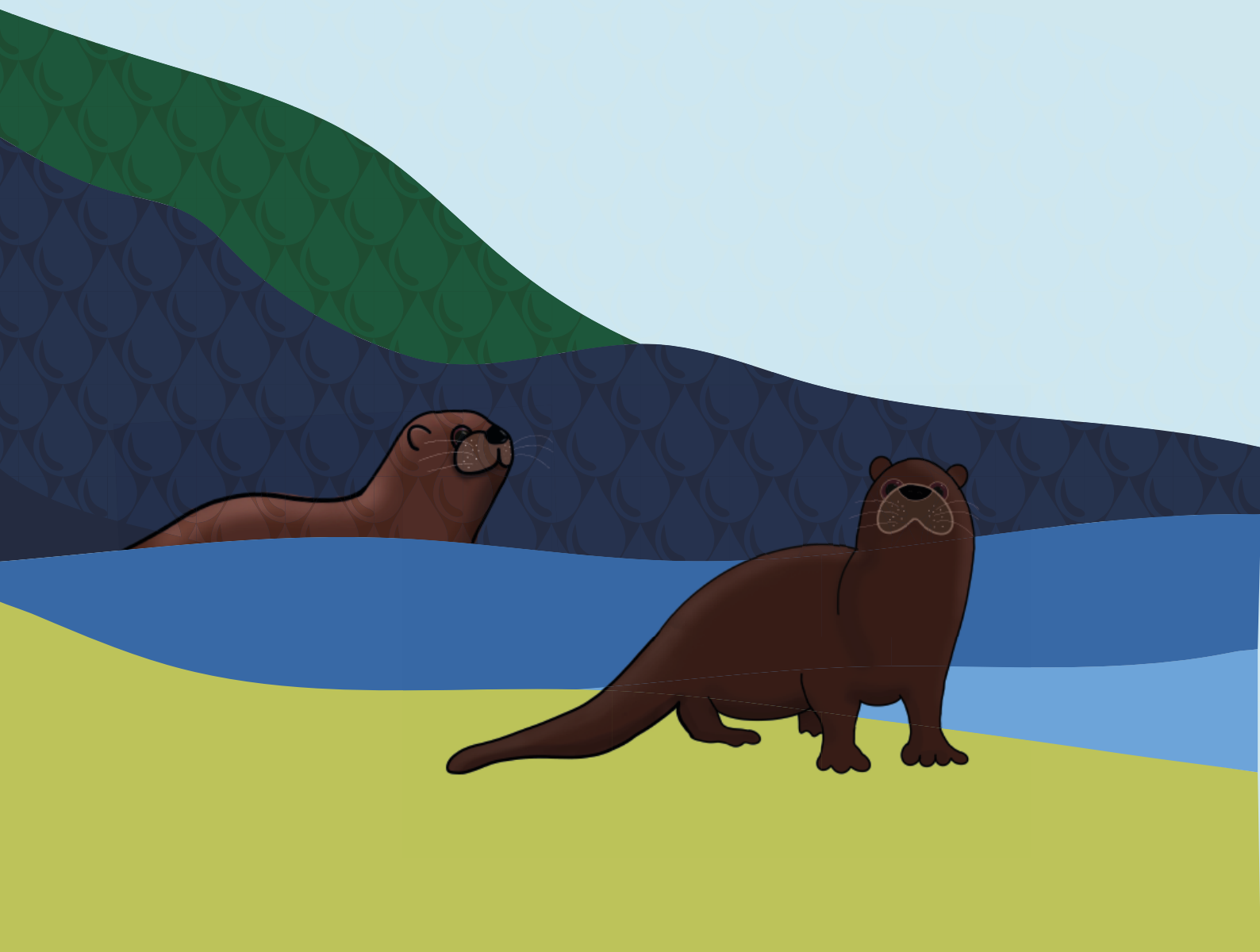
River



This education pack was produced by two long standing partnerships, the Pen Llŷn a'r Sarnau SAC and the Llŷn Partnership, with contributions from a wide range of additional partners.

FOR MORE INFORMATION AND EXTRA RESOURCES

VISIT OUR WEBSITE: **www.tiramor.cymru**

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Welcome

Wales' freshwater habitats are the integral link that connects the land to the sea and completes the eternal cycle of water. The tiny upland rivers, seasonally springing to life as the hills are pummelled with autumn rain, are as rich and necessary as the slow moving bends of the lowland rivers that have been used by communities for centuries.

Wales is a country very familiar with rain. It creates our lush green countryside and feeds our watercourses. Fast flowing and cold, our upland rivers are home to hardy specially adapted species like stonefly nymphs. As the current slows and the river widens downstream, more vegetation can take hold and provide shelter for various larger species like trout. You are never very far from a lake in Wales, and Snowdonia alone has over 250. Looking calm from above, their depths are alive with voracious predators, complex life cycles and fascinating adaptations. Wetlands are the true merging of landscapes. The unique interaction of water, soil, and vegetation creates our network of marshes, bogs, and fens. Of particular interest are Wales' upland bogs, where dying vegetation, submerged and deprived of oxygen, traps carbon and becomes peat.

Freshwater is vital to our lives, providing the water we use daily in our homes, keeping us alive as drinking water, used by thousands of people for recreation, and so intertwined with human life that we can become complacent. Water is not an infinite resource and many people around the world feel the effects of lack of water everyday. We need to understand how the water cycle connects us to the rest of the world and do our best to value, protect, and conserve this most precious resource.

How to use this pack

Each topic begins with a basic introduction and ideas for further study. Every activity within that topic starts with the teachers' guidance sheet and then the learners' worksheets. (These can also be found as separate sheets to be printed directly from the electronic resources).

The symbols below are found in the top right-hand corner of every activity and provide a quick reference guide for preparing and planning:

Booklet type, in this case River

Activity takes place outside or inside

Individual, partner or group activity

Time this activity takes to complete

Time of year this activity is suitable for - spring, summer, autumn, winter, or all year

Where to get more information

This printed pack is intended to act as a starting point for a much bigger collection of activities that will regularly be updated. These resources will be made available on **www.tiramor.cymru** as they are created and further physical additions will be issued as and when funding becomes available. All activities are available as separate downloads on the website.

All URLs correct at time of publishing.

Activities Overview

This provides an overview of all the activities provided in this printed edition of the River booklet.
The progression steps are to be used as a guide. All the activities can be expanded by the teacher to cater for varying levels of abilities and interests. Most activities can be done year round but if there are any that require a specific season they are shown on the activity sheet.

ACTIVITY NAME	TOPIC	PROGRESSION STEP	OUTDOOR INDOOR
River Speed	Invasive Species	PS 3/4	OUTDOOR
Species Survey	Invasive Species	PS 2/3/4	OUTDOOR
Match it	Invasive Species	PS 3/4	INDOOR
Which One Am I?	Invasive Species	PS 3	INDOOR
Ollie Otter's Diary	Otters	PS 2/3	INDOOR
Make Me	Otters	PS 1/2	INDOOR
Observing Otters	Otters	PS 3	INDOOR
Water Wheel	Water Cycle	PS 2/3	INDOOR
Salty Saucers	Water Cycle	PS 2/3	INDOOR
How We Use Water	Water Quality	PS 2/3	INDOOR
Water Quality Detectives	Water Quality	PS 3	INDOOR
Exploring Water Turbidity	Water Quality	PS 3	INDOOR
Hard Water vs Soft Water Test	Water Quality	PS 3	INDOOR

Other booklets in this series:

Land
- Habitat Loss
- Hibernation
- Choughs

Sea
- Strandline
- Food Chains
- Plastic Pollution
- Seagrass
- Pink Sea Fan
- Native Oysters
- Wildlife Recording

Check online for new activities: **www.tiramor.cymru**

Invasive Species

Invasive Species

A non-native species refers to a species that is present in a location that it has never been in before. If this species starts to cause problems to native wildlife then it is termed an invasive non-native species. They can cause problems by out-competing local species for food or space. They may change the physical habitat or spread disease. They may even feed on the local species.

There are many different ways in which invasive non-native species can spread, depending on what it is and its life cycle. Some are purposely introduced, for example, exotic plants in gardens, some come accidentally in cargo ships, and through trade and travel. Once established they spread through the new country by wind, rivers and humans. Invasive non-natives have been identified as one of the top causes of extinctions worldwide. Invasive species have contributed to 40% of extinctions in the last 400 years.

The best solution is to stop invasive species from arriving in the first place. This is done using various methods and is called biosecurity. Biosecurity can happen on an international scale like disinfecting at airports, controls on shipping and customs inspections. On a local scale, stopping the spread and removing the invasive species before they have a chance to damage local populations is most important and can be done by cleaning and disinfecting or by physical removal of the species.

Interesting facts!

- 80% of world trade is carried by ships.
- 7,000 species are transferred in ballast water every hour of every day.
- In 2010 it was estimated that the annual cost of invasive species to Wales was £132,244,000.
- Invasive species are the third most severe threat to European threatened species.
- There are approximately 2,000 established non-native species in the UK, but they do not all pose a threat to native wildlife.

Further research keywords
Alien species, bio-control, island bio-security, ballast water, Himalayan balsam, giant hogweed, GBINNS (Great Britain invasive non-native species), carpet sea squirt, Holyhead harbour, American mink in UK, wireweed.

30–45 mins

River Speed

Equipment required

- Clipboards
- Stopwatches
- Biodegradable paint (optional)
- Water safety equipment - throw line and buoyancy aid

Before arriving at the river

1. Introduce rivers as a means of spreading invasive species throughout countries. This activity demonstrates how fast that can happen.

2. Scout out a location that offers good safe positions to start and end the race where the river is easily seen. Bridges make this a lot easier.

At the river

1. River safety explained. Encourage learners to search the area to collect sticks of similar shapes and sizes. Support learners to measure a distance of 10m or 20m downstream. This is the recording point.

2. Spilt the class into two groups. One half of the learners start upstream (preferably on a bridge).

3. The other half of the learners go to the downstream recording point with stopwatches. Together on the teacher's instruction, the sticks are dropped into the water and the stopwatches started.

4. The stopwatches are stopped as soon as the sticks pass the learners. The groups keep swapping and the experiment is repeated several times. Biodegradable paints could be used to colour code the sticks and the class divided into teams with each team only measuring their colour.

5. This can be done in the classroom: The average times are worked out from all the runs. The learner could then use this information to work out how long things would take to travel from certain towns down to the sea or from one town to the next etc. The distances could either be supplied to the class or groups could use maps to measure the distances for themselves.

Species Survey

The survey activity can be done in two ways, either as a supervised group walk or as a take home activity that each learner can complete with their family.
The results are then discussed in the class.

Below is some information about the species listed on the survey to help start your discussions.

Grey squirrel	Himalayan balsam	Giant hogweed
Originally from Canada and the USA, introduced in the early 20th century. Grey squirrels are much larger than reds and are able to out-compete them for food and nesting sites. Greys also carry the squirrel-pox virus, which they are immune to, but is sadly fatal to reds.	First recorded in 1839, being cultivated in a greenhouse as an annual garden plant. It forms dense thickets, especially in wetlands, which alters the normal balance of the environment. Seeds drop into rivers and contaminate land downstream. The plants explosive seed release, which can send seeds into the air up to 4m away, means it can cover areas rapidly.	The earliest recorded introduction was in 1817 from its native Russia to Kew Gardens. Widely planted in fashionable gardens throughout Britain they quickly escaped and the first ('wild') population was recorded in 1828. Now widely distributed throughout Britain and Europe. They can grow up to 6m tall and **contain chemicals that can cause burns and blisters.** Their sheer size means they swamp all other plants and change the natural species present.
Rhododendron ponticum	**Japanese wireweed**	**Japanese knotweed**
First recorded in Britain, probably originating from Spain or Portugal, in approximatively 1763. Mostly used in botanical gardens and big estates. It forms very dense clumps which stop light reaching native species. Its leaves are toxic to nearly all wildlife and it is thought to carry sudden oak death disease. It is estimated that the plant now covers over 98,700 hectares in Britain.	First seen in the UK in the Isle of Wight in 1973, it has spread along the south and west coasts and has now been found in every country of the British Isles. It is a very fast growing seaweed and its 1m long frond type leaves out-compete native algae and sea grasses for light and space. It has also become a nuisance in shallow harbours and on beaches.	It is thought that Japanese knotweed first arrived in the UK in the 1840s as a specimen for botanical gardens. The thick bamboo-like stems of the plant can regrow from fragments of root left up to 2.5m under ground. Incredibly fast growing, between May and July it can add 10cm a day and can grow to 3m tall. It forms very thick patches which out-compete other plants and its strong stems can grow through man-made structures, damaging brick work and tarmac.

Species Survey

Scientists monitor where and when invasive species are found all over the country. How many items on the list can you find in your local area?

Grey squirrel

Parks, gardens and woodland

Seen: ☐
Where: .....
When: .....

Himalayan balsam

River banks, wasteland and gardens

Seen: ☐
Where: .....
When: .....

Do not touch - can cause skin blisters

Giant hogweed

Widespread especially on river banks

Seen: ☐
Where: .....
When: .....

Rhododendron ponticum

Moorland, woodand and riverbanks

Seen: ☐
Where: .....
When: .....

Japanese wireweed

Seashore, rockpools and harbours

Seen: ☐
Where: .....
When: .....

Japanese knotweed

Urban areas and gardens

Seen: ☐
Where: .....
When: .....

Giant hogweed can grow to the height of 4.5m to 6 meters.

* *Remember not to touch any of the species listed above. Giant hogweed can cause painful blisters and touching any of the plants could help them spread!*

30 mins




Match It

Equipment required

- Copies of cards R_IS_1 (1-3), one per group
- Print out the 'Match It' worksheet, one per group

To complete the activity

1. Split the class into small groups.

2. Provide each group with a pack of cards including 5 species, 5 effects and 5 locations.

3. Support learners to work as a group to match the species, locations and effects and fill these out on their answer sheets.

4. The game can be extended by putting the packs in order of distance travelled, most likely to affect the local area or talking about how they think each species was introduced. Discuss answers with the whole class.

ANSWERS: Match It game

Geographical references in the species names were removed for game play.
Their full names are shown below:

- Mitten crab (Chinese mitten crab)
- Destabilises river banks by creating burrows
- China

- Rhododendron ponticum
- Toxic leaves make area uninhabitable for other species
- Bulgaria, Turkey, Spain, Portugal

- Himalayan balsam
- Out-competes native species for space, light and water
- India and Nepal

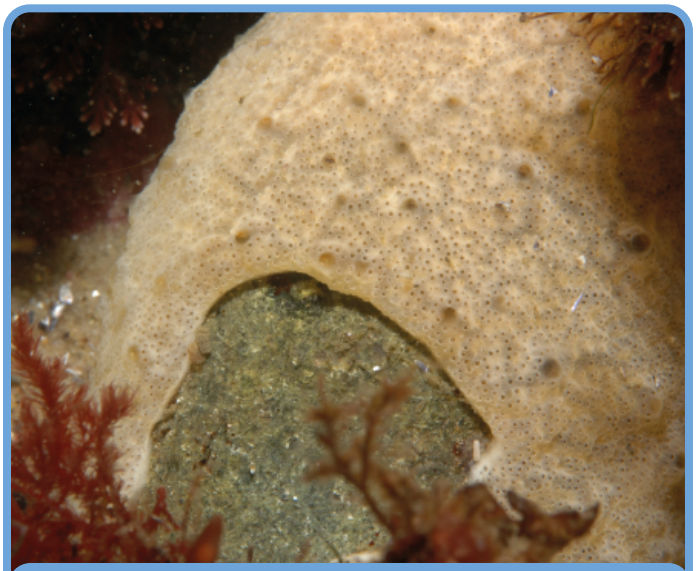
- Carpet sea squirt
- Spreads very rapidly smothering all other species
- Scientists are unsure of origin

- Mink (American mink)
- Eats bird eggs, young birds and other small animals
- USA

Mitten crab

Rhododendron ponticum

Himalayan balsam



Carpet sea squirt

Mink

Destabilises river banks by creating burrows

Toxic leaves make area uninhabitable for other species

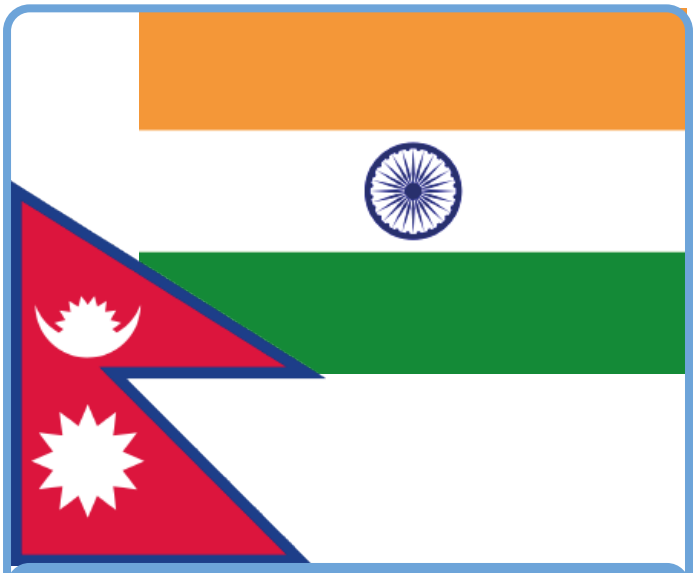
Out-competes native species for space, light and water

Spreads very rapidly, smothering all other species

Eats bird eggs, young birds and other small animals

China

Bulgaria, Turkey, Spain, Portugal



India and Nepal

?

Not known

USA

Match It

Game rules: *As a group, match the species to the effect it has on the environment and the country it originally came from.*

1 *Species:*

Effects:

Comes from:

2 *Species:*

Effects:

Comes from:

3 *Species:*

Effects:

Comes from:

4 *Species:*

Effects:

Comes from:

5 *Species:*

Effects:

Comes from:

There are about 2.5 million grey squirrels in the UK, compared to 160,000 native red squirrels.

30 mins

12

Which One Am I?

Equipment required

- Print out of 'Which One Am I?' worksheet, one per group
- Pens and pencils

Before starting the worksheet

1. This activity would work best if completed after some introductory work on invasive species and after the other activities within this topic, so that the learners are familiar with common invasive species.

To complete the worksheet

1. Split class into partners.

2. Encourage partners to work through the worksheet trying to use the clues to identify which species is being described.

ANSWERS: Which One Am I?

1) Himalayan balsam
2) American mink
3) Giant hogweed

Which One Am I?

Scientists use key features to identify different species. Using the descriptive clues below, work out which invasive species they are describing and tick the right box.

1) Which one am I?

Leaves have jagged edges and a reddish middle line

☐ *Himalayan balsam*

Trumpet-shaped pink flowers that sometimes have white spots inside

☐ *Chinese mitten crab*

Bright green leaves join the stem in layers of 3 to 5 leaves each time

☐ *Giant hogweed*

2) Which one am I?

Mostly nocturnal or active at dusk

☐ *Grey squirrel*

White patches on chin and throat

☐ *American mink*

Tail between 13-23cm and covered in dark brown fur

☐ *Chinese mitten crab*

3) Which one am I?

Sharply divided and serrated leaves with bristles underneath

☐ *Himalayan balsam*

White or pinkish umbrella shaped flowers up to 80cm across

☐ *Giant hogweed*

Very tall, can grow up to 6m tall

☐ *Japanese hogweed*

Himalayan balsam can grow up to 2.5m high from seed in one summer season.

Otters

Introduction

Otters

One of the UK's 66 resident wild mammals, the otter is the largest of the UK weasel family. Males can be over a metre long including the tail and weigh about the same as a toddler. They have a varied diet and their combination of sharp canine teeth and flatter back teeth mean they can easily eat both slippery fish and hard shelled crustaceans. In order to maintain their feeding needs otters establish long territories along river catchments. Otters travel large distances everyday and visit different habitats whilst foraging.

They are largely nocturnal animals meaning that they can occupy areas in good numbers whilst remaining unknown. Most of the day is spent sleeping in their holts (dens built into river banks or tree holes) or in hiding places surrounded by long vegetation. The most obvious signs that otters are living on a waterway are their well worn pathways to and from the river, remains of prey species, footprints in the muddy banks and their oddly sweet smelling droppings which are known as spraint.

Otters were once widespread all across the UK but a combination of pollution in rivers, loss of vegetation along rivers and new drainage schemes meant that by the 1970s otters had disappeared from most British rivers. The news is good though, a combination of reintroduction, clean up of rivers, building artificial holts and increasing the habitat around river banks has meant that populations are successfully re-establishing themselves across the UK.

Rivers still need good management to sustain fish stocks at good levels so that otters can thrive but they are facing a new threat. Many young otters are being killed on roads every year and people are working hard to find solutions like underground tunnels.

The Welsh Otter Survey monitors otter populations in Wales with information gathered about where they live and how the population is changing. The survey results improved since the earliest surveys, with 90% of sites in 2009-2010 but between 2015-2018 figures were down to 71%.

How are otters adapted to life in the water

- They have valves in their ears and eyes that allow them to seal them underwater.
- They have the densest fur of all UK mammals. It consists of two layers and is waterproof.
- They have a powerful rudder-shaped tail to help with swimming.
- They have webbed feet for more powerful swimming and they have fur on their feet to keep them warm and add grip on slippery rocks.
- Long whiskers help them to navigate underwater.

Further research keywords

Lutra lutra, The UK Wild Otter Trust, otter hunts, mustelids, International Otter Survival Fund, vibrissae, apex predator, protected species, otter field signs, otter hovers and couches.

45 - 60 mins

Ollie Otter's Diary

Equipment required

- Rulers
- Graph paper
- Copies of 'Ollie Otter's Diary'

To complete the activity

1. Provide learners with copies of the otter's diary.

2. Support learners to use the information within the diary to create a bar graph showing how much of each prey the otter eats. This can either be done daily or for the whole week.

3. The activity can be extended by creating another graph based on estimates of how far the otter has travelled to get the food everyday. On the map there is a scale and diary details of where the otter has been, so the routes can be measured and then graphed.

4. As a class, the results can be discussed and the distances can be compared to local places that are an equivalent distance so that the learners can get an idea of how far the otters are travelling for food.

Ollie Otter's Diary

Monday:
It was a sunny day today so we decided to go down to the coast to eat some crabs. It seemed to take ages to swim all the way to the estuary and then round to Rocky Bay. There was lots of food though; I ate eight crabs! On the way back I ate a salmon for dinner and two frogs. Time for bed now.

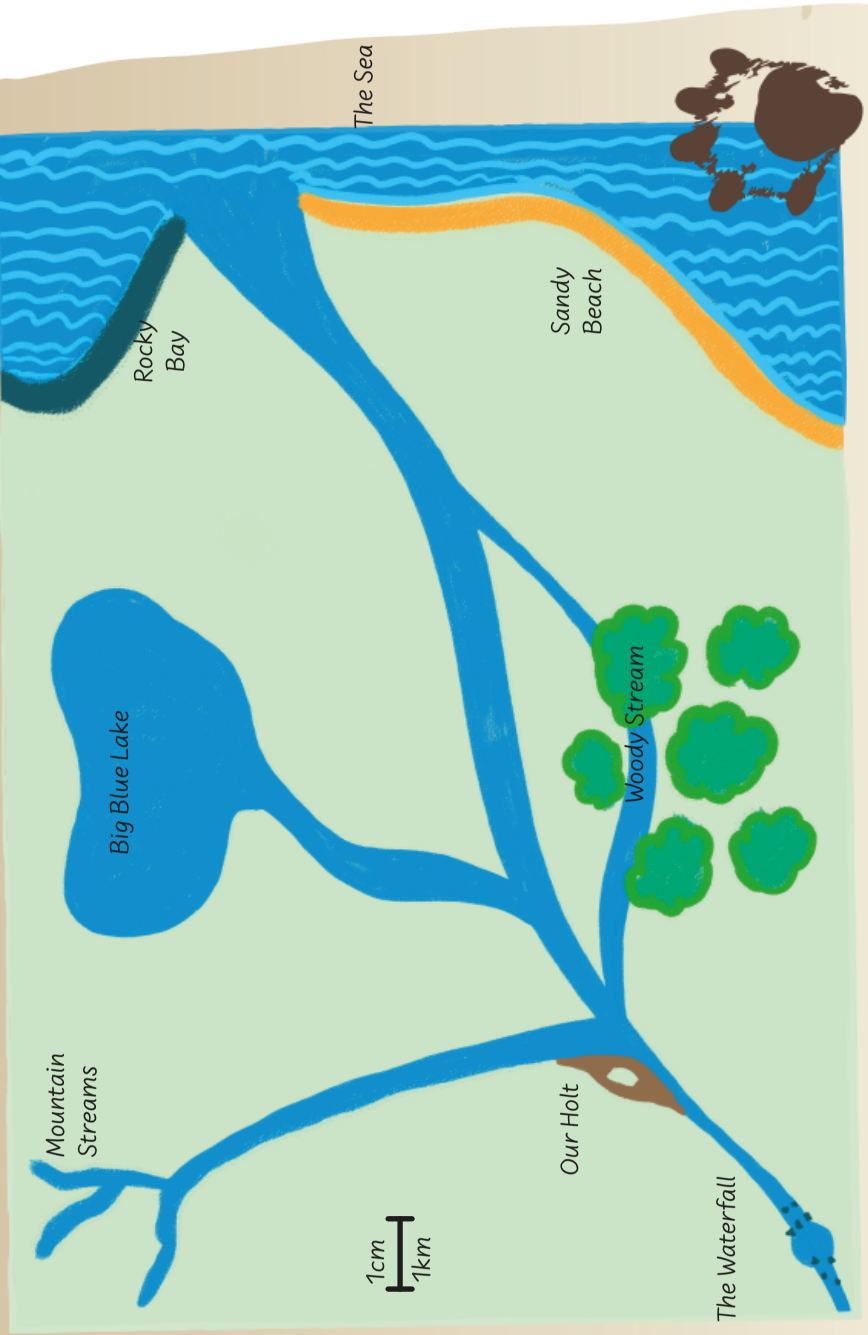
Tuesday:
It was raining a lot today and I didn't feel like going far, so I had three frogs for breakfast and then went for a short swim to Big Blue lake. There were a few trout there so I had two for lunch and then headed home for my two frog dinner.

Wednesday:
I had a very busy day today, lots of swimming. Mum wanted me to help get food for everyone so we swam up to the waterfall to catch salmon. I ate a big one for breakfast. We then went down to Woody Stream to look for frogs. I was so hungry that I had three as a snack. After that we carried on down to Sandy Beach to look for crabs, we found loads so I had four for my dinner. It seemed to take ages to swim back to the holt tonight.

Thursday:
I was really tired today so I didn't want to do much. We went for an early swim around Big Blue lake, ate two trout for breakfast. Then we went to play in the mountain streams. I had my favourite food for lunch, four crayfish! It was really tasty. I had a nap and then went with mum to the waterfall where we had a salmon for dinner. I fell asleep as soon as I got back to the holt.

Friday:
It was a stormy day today so mum decided that we should go to the sea to look for crabs. We headed off down the main river and came across lots of eels. I had three small ones for breakfast. We went right to the edge of Sandy Beach today as far as you can get from the estuary - it was exciting. I had six crabs for lunch and two more in Rocky Bay. Once we got home mum gave us three frogs for dinner and we went to bed.

I drew this map of my home area so that I could remember it forever...



30 - 45 mins

Make Me

Equipment required
- Printed copy of 'Make Me' worksheet, one per learner
- Pens and pencils

Before starting the worksheet

1. An introduction to otters and also to adaptations is needed before learners can complete the worksheet independently but it could be used as a whole class activity to introduce the concept of adaptation.

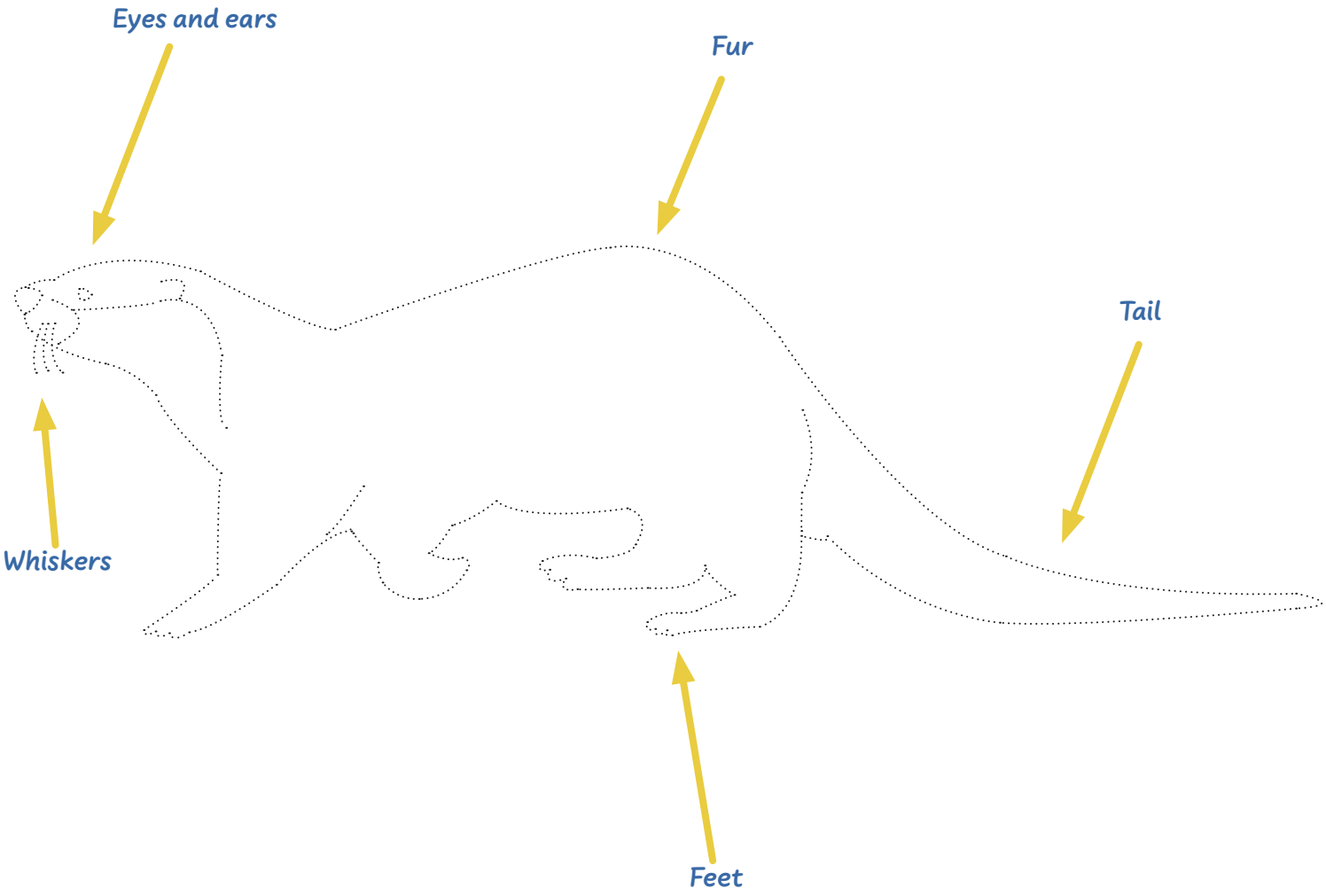
To complete the activity

1. Provide learners with copies of the 'Make Me' worksheet.

2. Support learners to colour in the otter and add information about how all its body parts are specially adapted to its life in and around rivers.

Make Me

Colour in and complete the otter.
Then add labels to the arrows to describe how each part is adapted to the otter's life in the water.



In one 2.5cm square of an otter's body, there are around one million hairs!

60 mins

Observing Otters

Equipment required

- Copy of the 'Spotting Otters' worksheets (2 pages), one per pair
- Copy of the 'Welsh Otter Fact Sheet', one per pair
- Internet enabled devices and internet access
- Access to Hwb and suitable graphing tool (e.g., Excel, Google Sheets, J2E – JiT5)

To complete the activity

1. Provide each pair of learners with copies of the "Otter Spotting' worksheet and 'Welsh Otter Fact Sheet'.

2. Support learners to use the information from the 'Welsh Otter Fact Sheet' to complete the table on their worksheet. Dates should be rounded to the nearest 10 years.

Answers

	1st - First	2nd - Second	3rd -Third	4th - Fourth	5th - Fifth	6th - Sixth
Approximate Year	1970's	1980's	1990s	2000s	2010s	2020s
Sites with signs of otter (%)	20%	38%	53%	72%	90%	71%

3. Once learners have completed their tables, encourage them to create their own line graph or bar chart, using the information from their table. Discuss suitable graphing tools e.g., Excel, Google Sheets, J2E – JiT5.

4. Using the scatter map, support learners to identify areas with high concentrations of positive sites. Discuss patterns. What types of habitats do otters prefer (e.g., rivers, lakes, wetlands)?

5. Ask learners to discuss potential threats that might be impacting otter populations in certain areas? Learners may refer to habitat loss, water pollution, climate change, human disturbance and diseases.

Observing Otters

Using the information provided in the 'Welsh Otter Fact Sheet', complete the following table:

	1st - First	2nd -				
Approximate Year	1970's	1980's				
Sites with signs of otter (%)	20%					

Round all dates to the nearest ten years.

Task

Create a bar graph using your preferred graphing tool.
Use your graph to answer the following questions:

1. Which decade had the lowest percentage of otter signs in Wales?

.....

2. In which decade did otter signs reach their peak in Wales?

.....

3. What is the overall trend in otter populations in Wales over the past few decades? Is it increasing, decreasing, or fluctuating?

.....

Observing Otters

Use the scatter map (Figure 1) to identify areas with high concentrations of positive sites.

- Discuss any patterns.
- What potential threats might be impacting otter populations in certain areas?
- Why do you think this?

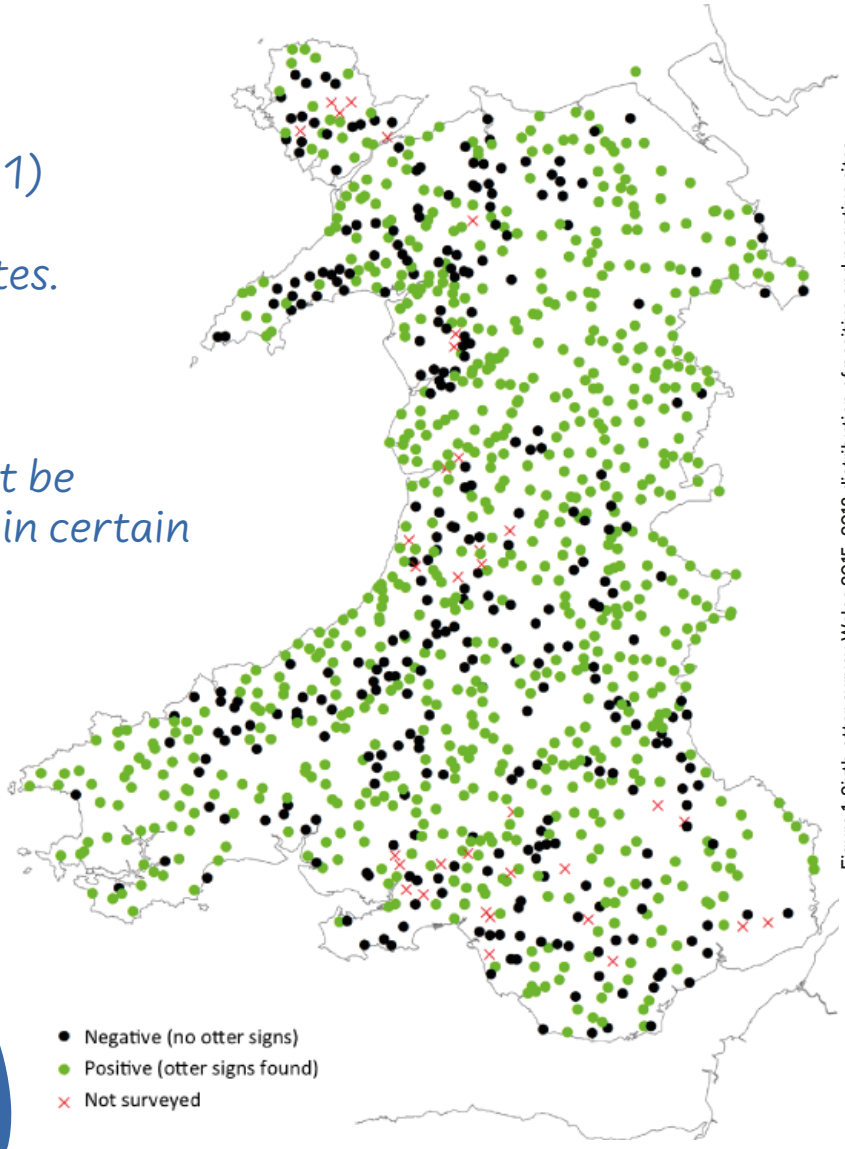


Figure 1: Sixth otter survey Wales 2015–2018 distribution of positive and negative sites

What might have caused the decline in otter populations in the 1970s?

What factors could have contributed to the recovery of otter populations in the 1990s and 2000s? **Why?**

What challenges do otters face in Wales today? **Why do you think this?**

How can we continue to protect and conserve otter populations?

Otters can typically hold their breath for up to 8 minutes.

Welsh Otter

FACT SHEET

The Welsh Otter Survey is a project that monitors the population of Otters in Wales.

Scientists and volunteers work together to gather information about where otters live and how their numbers are changing.

- *In the 1970's, otters had disappeared from most British rivers.*
- *In Wales, over 1,000 sites were visited, with signs of otters found at* **20%** *of sites.*
- *The second survey in 1984 found signs of otters at* **38%** *of sites.*
- *The third survey in 1991 found signs of otters at* **38%** *of sites.*
- *In 2002, otters were found at* **72%** *of sites, with 90% of sites with signs of otters in 2009-10.*
- *Between 2015-2018,* **71%** *of sites showed signs of otters.*

Otter Homes

Otters build cosy homes called 'holts'.

They often choose riverbanks or tree holes, lining them with moss or leaves.

Holts provide otters with a safe and warm place to rest, sleep, and raise their young.

Otter Signs

Otter pathways along the water's edge.

Leftover remains of their prey, like fish bones.

Otter droppings, called spraint, which have a distinctive sweet smell!

Otter footprints in the mud.

Male otters can be over a meter long and weigh about the same as a toddler.

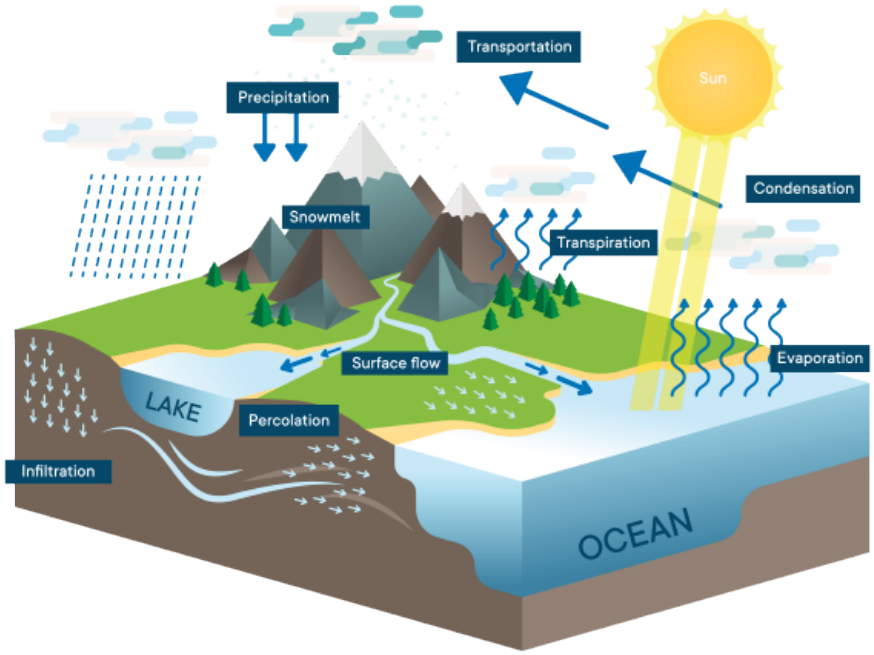
Water Cycle

Introduction

The Water Cycle

The water cycle is a way of showing how water moves around the planet. Water is continually transferring between the atmosphere and the earth's surface, moving around the globe all the time. This is important to understand, not just for our water needs but also because it means that pollutants can easily be carried large distances within the water cycle.

The cycle begins with the sea. The surface layers of the ocean are heated by the sun, turning it into vapour (tiny droplets of water). This vapour rises and cools into clouds. The clouds are then moved by the wind. As the droplets within the clouds collect and get bigger they become too heavy to stay suspended and begin to fall as rain. The water that falls to the earth eventually flows through rivers, over the land surface or through ground water back into the sea and so the cycle begins again.



Key terms

Evaporation - heating liquid water so that it becomes vapour.

Transpiration - water vapour given off by plants.

Condensation - the water vapour cools and becomes liquid again.

Transportation - winds move water around the atmosphere in the form of clouds.

Precipitation - water falling back to earth in many forms e.g. rain, snow, sleet, hail.

Infiltration - water trickles down through the earth's surface and travels by percolation through the rock.

Surface flow - liquid water running across the surface of the land into rivers and sea.

Interesting facts!

- 70% of the earth is covered in water. 97% of all water is in oceans.
- Of the 3% that is fresh water, 2% is inaccessible in ice caps and glaciers, leaving only 1% to travel around the water cycle and for our daily use.
- The same water that existed on earth billions of years ago still exists today. Water that comes from your tap could contain the same molecules that dinosaurs drank.

Further research keywords

Hydrological cycle, aquifer, deposition, (relief, frontal and convectional rainfall), river discharge, runoff, hydrograph, meteorology, dew point, rain shadow, sea surface temperature.

45 - 60 mins

Water Wheel

Equipment required

- Print out of R_WC_ 1 preferably on card, or can be stuck onto a paper plate
- Scissors
- Split pins
- Glue

To complete the activity

1. Provide learners with copies of the water cycle template sheet (R_WC_ 1).

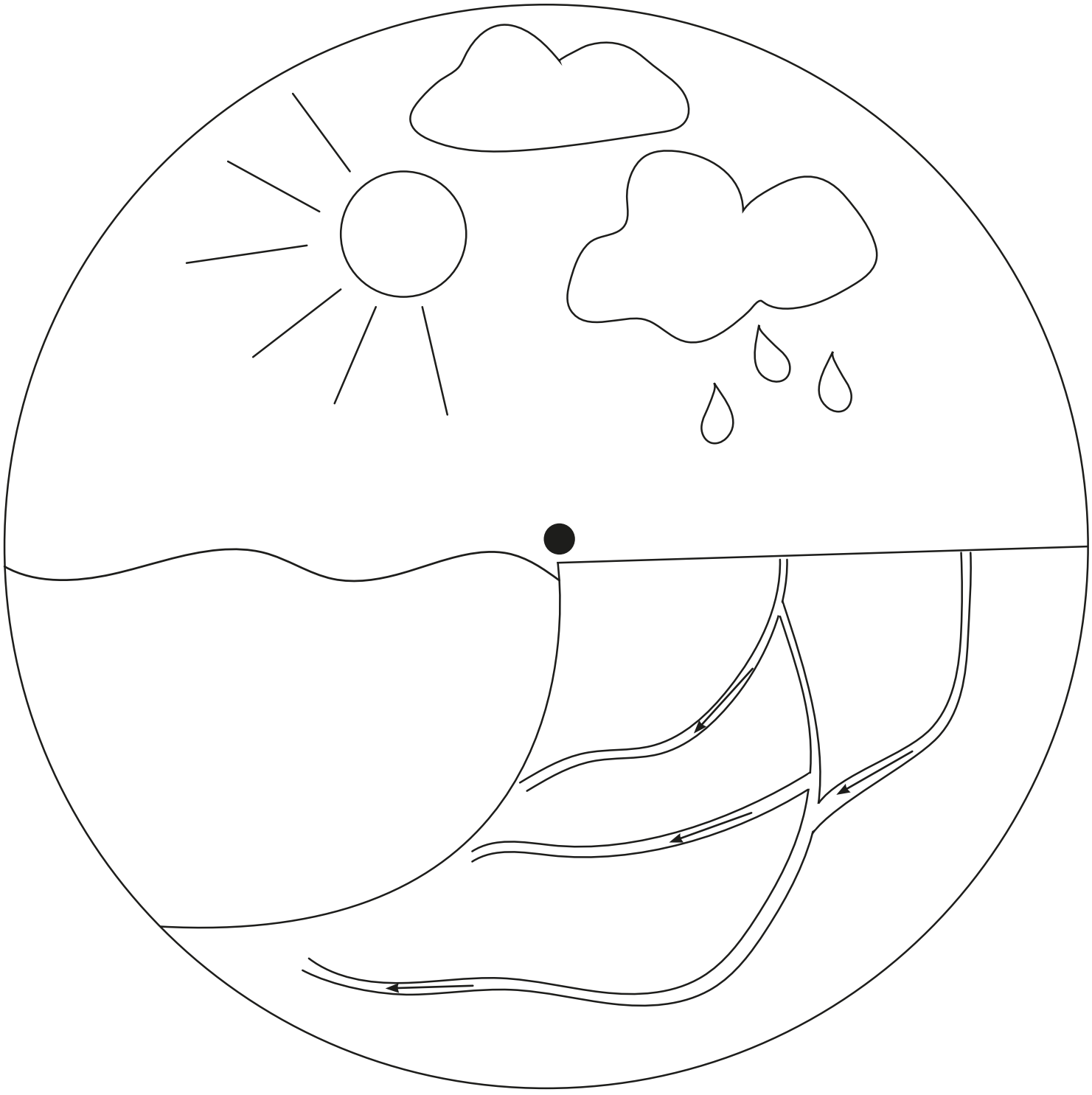
2. Ask learners to colour in and decorate the worksheet. Encourage them to add details like trees, mountains, sea life, different kinds of precipitation etc to make each one unique.

3. Then support learners to cut out the words and the water movement arm.

4. Explain to learners that they will need to align the two black central dots and put the split pin through, so that the arm can be moved around the circle in the direction of the water cycle.

5. Support learners to stick the labels onto the circle in the correct places for the water movement that it refers to. Learners can add extra information or labels to their wheel if they wish.

Water Movement



Evaporation

Precipitation

Condensation

Collection

Salty Saucers

This activity demonstrates the often invisible element of the water cycle, evaporation. Variations in where the saucers are located can be used to demonstrate the power of heat to speed up water loss. The salt and food colouring will crystallise as the water evaporates, providing a really clear demonstration.

Equipment required

- Shallow wide dishes
- Salt
- Water
- Blue food colouring

To complete the activity

1. This can be done in groups or as a whole class activity.

2. Give each group a few different bowls.

3. Ask learners to mix the water and salt together in the bowls, then add a few drops of the food colouring.

4. There's lots of different ways the learners can experiment, by adding more or less water, increasing the quantities of salt and placing the bowls in different locations, some in the sun, some in the shade, some by radiators.

5. Once each group has decided on its variations ask learners to label each bowl.

6. The learners will need to check their bowls twice a day for a few days. The results should be collected and discussed as a class. Which one evaporated faster? What was different about it?

Water Quality

Introduction

Water Quality

Water is one of the most essential resources on Earth, supporting life in countless ways. From sustaining aquatic ecosystems to providing drinking water, its quality directly impacts humans, wildlife and the environment.

Clean, healthy water is vital for maintaining biodiversity, supporting agriculture, enabling industry, and providing recreational opportunities. However, water quality is increasingly threatened by pollution, climate change, and human activities.

Water quality refers to the physical, chemical, and biological characteristics of water that determine its suitability for various uses. Factors such as pH, temperature, clarity, and the presence of nutrients or contaminants play a crucial role. For example, turbidity, or the cloudiness of water, can impact aquatic ecosystems by blocking light needed for photosynthesis, affecting plant growth and reducing oxygen levels. High turbidity, caused by sediment runoff, algae growth, or pollution, can also harm fish by clogging their gills and degrading their habitats. Monitoring turbidity is vital for understanding and improving water quality.

The characteristics of water also vary by region, such as differences in soft and hard water. Soft water, with low calcium and magnesium levels, is more effective for cleaning and kinder to pipes but may lack minerals beneficial for health. Hard water, rich in minerals, supports dietary needs but can lead to limescale buildup in appliances and pipes, increasing maintenance costs. These variations highlight the importance of understanding water quality's impact on daily life and ecosystems.

Aquatic ecosystems, including rivers, lakes, and coastal waters, depend on good water quality to sustain life. These environments provide habitats for a wide range of plants and animals and benefit humans by supporting fisheries, protecting coastlines, and filtering pollutants. However, threats such as pollution, overuse of resources, and physical damage to habitats put these vital systems at risk.

Conserving and monitoring water quality is vital for ensuring clean water and healthy ecosystems, enabling them to continue filtering nutrients and bacteria, absorbing carbon dioxide, and providing food and shelter for countless species. By understanding and addressing these challenges, we can protect these ecosystems for future generations.

Further research keywords

Turbidity, pH levels, sediment runoff, hard water, soft water, nutrients, nitrates, phosphates, algal blooms, ecosystem health, aquatic habitats, biodiversity, pollution, conservation, filtration, water clarity, photosynthesis, light penetration, overfishing, coastal development, limescale, erosion control, wetland preservation, waterborne contaminants, ecosystem services, water monitoring, freshwater ecosystems, marine ecosystems, sustainable water management.

30 mins

How We Use Water

Equipment required

- Print out or share the photos on sheet R_WQ_1 (1-2), one per class/group
- Large whiteboard for discussion notes
- Scissors
- Markers and sticky notes
- Internet enabled devices and internet access

To complete the activity

1. Begin by discussing with learners the different ways water is used everyday. Ask learners to come up with examples, e.g. cooking, drinking, bathing, power generation, or for wildlife. Write their ideas on the whiteboard under two headings: "Uses of Water" and "Sources of Water" (e.g. rivers, lakes, groundwater, reservoirs).

2. Divide the class into groups. Distribute the photos and category labels from sheet R_WQ_1 to each group. Ask each group to sort the images into appropriate categories, discussing why each image fits a category.

3. Provide an opportunity for each group to present their sorted categories and explain their reasoning. Discuss overlaps or ambiguous cases (e.g., watering a garden might be household or agricultural).

4. Using sticky notes, ask learners to brainstorm and add ideas about how water can be saved or better managed in different categories.

Personal/ Household use

Drinking, cooking, bathing/cleaning.

Industrial/ Commercial use

Car wash, energy production (power plant), cooling systems.

Agricultural use

Irrigation of crops, livestock, aquaculture (fish farming).

Recreational use

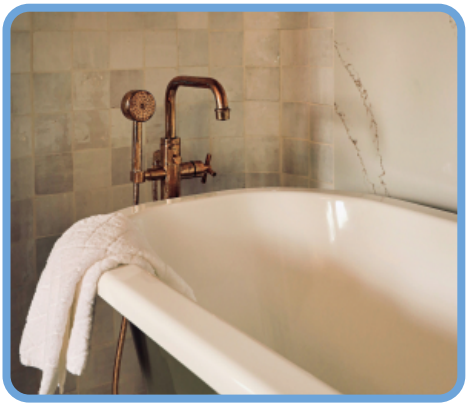
Swimming pool, fishing, water parks

Community use

Firefighting, water fountains, street cleaning

Environmental/ Wildlife use

River, lake and wetlands.

















60 mins

Water Quality Detectives

Equipment required

- Print out the 'Water Quality Detectives' worksheet, one per pair
- Pencils or pens
- Internet enabled devices and internet access

To complete the activity

1. Begin by asking learners:
   - "What do we mean by water quality?"
   - "Why is water quality important for people, animals, and plants?"

2. Share the Dŵr Cymru video 'How we clean your waste water' – www.tiramor.cymru/waterquality (Resource 1). After watching, consider:
   - What makes water safe to drink?
   - What factors could affect water quality before it reaches this stage?

3. In pairs, ask learners to consider:
   - Characteristics of good quality water (e.g. clear, safe to drink).
   - Signs of poor quality water (e.g. cloudy, bad smell, harmful substances).

4. Challenge pairs to list as many factors as they can that affect water quality. Encourage them to think about both natural factors (e.g., sediment runoff, algae growth) and human activities (e.g. pollution, industrial waste).

5. Provide each pair with a copy of the 'Water Quality Detectives' worksheet.

6. Encourage learners to use the internet to research factors that can impact water quality.

7. Support learners to create a mind map titled "How We Can Improve Water Quality." Guide learners to start with "Improve Water Quality" in the centre of the mind map. Next, ask learners to add branches for different areas where action can be taken, such as:
   - At Home (e.g. reducing water waste, avoiding harmful chemicals).
   - In the Community (e.g. organising clean-up events, raising awareness).
   - In Nature (e.g. planting trees near water sources, protecting wetlands).
   - In Industry (e.g. improving waste disposal practices, adopting water-saving technologies).

8. For each branch, encourage learners to add specifications to improve water quality.

9. As a closing task, ask learners to reflect on what they've learnt by writing or sharing one action they can take to improve water quality and why it is important.

Answer Key

Water Quality Detectives

FACTOR	IMPACT ON WATER QUALITY	POSSIBLE SOLUTION
Sediment from soil erosion	Makes water cloudy, reducing sunlight for aquatic plants and clogging fish gills.	Plant trees or use barriers to prevent soil erosion near water bodies.
Fertilisers from farms	Causes nutrient overload in water, leading to algae blooms (eutrophication) that deplete oxygen for aquatic life.	Use organic fertilisers and create buffer zones with vegetation near water sources.
Industrial waste	Releases harmful chemicals into water, poisoning aquatic ecosystems and making water unsafe for drinking.	Reduce nutrient pollution (fertilisers) and monitor water quality regularly.
Oil spills	Coats the surface of water, blocking oxygen exchange and harming birds, fish, and marine life.	Use booms and skimmers to clean spills, and improve safety measures for oil transport.
Plastic litter	Pollutes water, harming animals that ingest it or get entangled, and leaches microplastics into ecosystems.	Ban single-use plastics and organise community clean-ups near water bodies.
Sewage discharge	Adds harmful bacteria and pathogens to water, making it unsafe for human and animal use.	Improve wastewater treatment works and avoid dumping untreated sewage into water.
Stormwater runoff	Washes pollutants like oil, chemicals, and rubbish from roads into water sources.	Build permeable pavements and stormwater management systems, such as rain gardens.

Water Quality Detectives

What impact can the following factors have on water quality?

Factor	Impact on water quality
Sediment from soil erosion	
Fertilisers from farms	
Industrial waste	
Algae growth	
Oil spills	
Plastic litter	
Sewage discharge	
Stormwater runoff	

TASK!

Create a mind map titled
"How We Can Improve Water Quality."

Start with "Improve Water Quality" in the centre of your mind map, then add branches for different areas where action can be taken (e.g. "At Home," "In the Community," "In Nature," and "In Industry"). For each branch, add specific actions to improve water quality.
Use the internet to research creative and practical solutions.

Reflect

Which action do you think is the easiest to do? Why?

Which action would have the biggest impact on improving water quality?

What action can you take to improve water quality? Why is this important?

Over 80% of Wales' waters are classed as good or high quality, helping protect local wildlife.

60 mins

Exploring Water Turbidity

Equipment required (per group)

- Print out or share the 'Water Turbidity' worksheet (2 pages) digitally
- Large clear container (e.g., jar or large glass)
- 3 teaspoons of soil
- Teaspoon
- Torch
- 2 pieces of black paper (enough to surround the container)
- Pencil
- Scissors
- Tape (e.g., Sellotape)
- Plain white paper
- App: "Light Meter LM-3000" or similar (optional)
- Timer (stopwatch, timer app or clock)
- Internet enabled device and internet access (to watch the instructional videos)

To complete the activity

1. Begin with a brief discussion about water turbidity and its impact on ecosystems.

2. Divide learners into small groups (2-4 per group). Ensure each group has the necessary equipment, including jars, soil, black paper, torches, and optional light meters or apps.

3. Guide learners through preparation. You may wish to demonstrate how to cutout the circles from the black paper and attach the paper to the jar.

4. Encourage learners to test the visibility through the jar with clear water before adding soil.

5. Support groups to follow the instructions provided in the' Water Turbidity' Worksheet, recording their results on their worksheet.

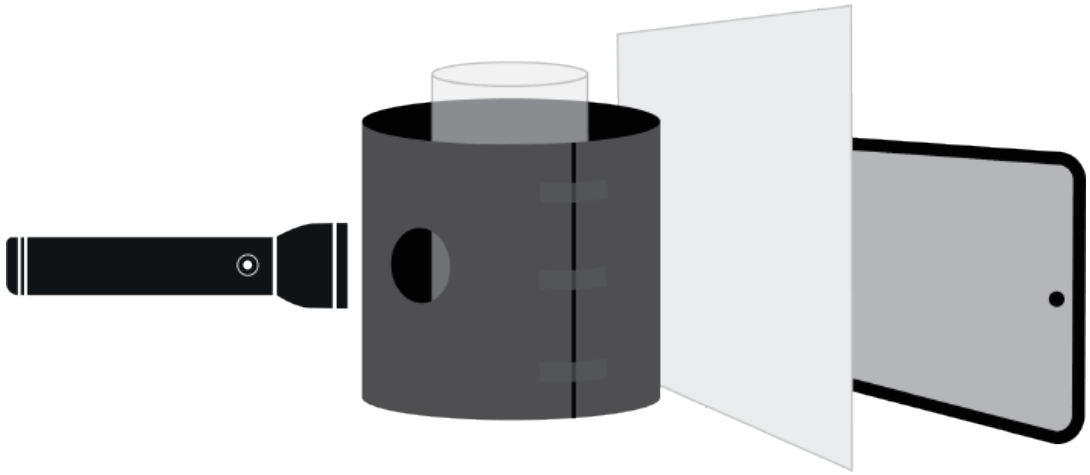
6. After the experiment, invite groups to share their completed worksheets and observations with the class.

7. Guide learners to answer key questions from the worksheet, such as: "What is the relationship between trapped light and turbidity?"

Water Turbidity

Many factors are monitored when looking at water quality e.g. pH level, temperature, salinity, oxygen level, nitrates and phosphates.

We measure turbidity we measure the amount of light that is scattered when light is shined through a water sample. The cloudier the water, the less light is passed through the sample. Water with a high measurement of turbidity can have a significant impact on how aquatic plants and organisms survive due to the lack of light. It can also choke fish gills.



Instructions

1. **Prepare the light aperture**
   A. Take one piece of black paper and draw a circle in the centre using a torch as a template.
   B. Cut out the circle and trim the paper to fit neatly around one side of the jar.
   C. Use this piece as a template to create a second identical black paper.

2. **Attatch the paper to the jar**
   A. Tape the two pieces of black paper around the jar so that the cut-out circles face each other on opposite sides.
   B. Ensure you can see through one circle and out the other. Adjust the paper if necessary, by trimming or repositioning.

3. **Build a diffuser (optional)**
   A. A diffuser evenly scatters incoming light for precise readings. If you're using a light meter app.
   Share the video 'How to Build a Diffuser' – www.tiramor.cymru/waterquality (Resource 2)
   B. To understand how the light metre app works, watch the video 'Getting Started with the Light Meter LM-3000' – www.tiramor.cymru/waterquality (Resource 3)

4. **Begin observations**
   A. Fill the jar with clear tap water and lightly seal the lid.
   B. Draw a picture on white paper and observe it through both circles, to see how water clarity affects visibility.
   C. Record your observations of the water's clarity in the table provided.

5. **Measure and record**
   A. Hold your device close to one circle so the camera or sensor is aligned.
   B. Shine the torch through the opposite circle to measure the amount of trapped light using the app, or visually assess the turbidity if the app isn't available.
   C. Record your results in the table.

Exploring Water Turbidity

6. Add soil and repeat

A. Add 1 teaspoon of soil to the jar, mix well, and wait for 1 minute to allow sediment to settle.
B. Observe the water through the circles, measure trapped light, and assess the turbidity level.
C. Record your findings.
D. Repeat the process by adding an additional teaspoon of soil each time, for a total of 3 teaspoons and 4 observations.

7. Complete the table

For each sample (clear water, water with 1, 2, and 3 teaspoons of soil), record:

A. Look: Describe the colour, clarity, and presence of sediment.
B. Trapped Light: Measure the lux (if using a light meter).
C. Turbidity: Categorise as High, Medium, or Low.

Samples	Look e.g., colour, clear/cloudy, sediment/no sediment	Trapped light (lux)	Turbidity (High/Medium/Low)
Water			
Water + 1 spoonful of soil			
Water + 2 spoonful of soil			
Water + 3 spoonful of soil			

8. Draw a Conclusion

Analyse your results and answer the following question:
What is the relationship between trapped light and the turbidity of the water?

Additional Exploration
Optional

Experiment with other liquids, such as seawater, soapy water, or water mixed with oil. Compare your findings to those from the soil experiment.

High turbidity in rivers can block up to 80% of sunlight, starving aquatic plants of oxygen production and endangering entire ecosystems.

30 mins

The Science of Hard and Soft Water

Equipment required (per group)

- Print out of the 'Hard Water vs Soft Water: The ultimate Test!' worksheet, (3 pages) 1 per group
- 2 identical empty containers with lids (no more than 300cm^3, e.g. water bottles or glass jars)
- Epsom salt (approximately 10 tablespoons)
- 1 teaspoon of soapy liquid (e.g. shower gel or handwashing soap; avoid dishwashing soap)
- Measuring jug or cylinder
- Tablespoon
- Teaspoon
- Plain white paper for notes or reflections
- Timer

To complete the activity

1. Begin with a discussion about the differences between hard and soft water. Explain how hard water contains minerals like calcium and magnesium, while soft water has lower mineral content, affecting how soap forms lather.

2. Organise learners into small groups (2–4 learners per group) and ensure each group has the necessary equipment.

3. Support learners to follow the steps in the worksheet to create"Hard Water"and "Soft Water," observe differences, and record their results. Encourage them to consider how the minerals in hard water affect foam production.

4. Encourage learners to record their findings for each container, including:
   - Look: Describe clarity, colour, or presence of sediment.
   - Foam Production: Note differences in lather formation between hard and soft water.

5. Facilitate a discussion using the reflection questions in the worksheet:
   - What differences did you notice between hard and soft water?
   - How do the minerals in hard water affect foam production?

6. Discuss the concept of a fair trial and identify which factors were kept constant.

7. Invite learners to research and discuss the pros and cons of living in areas with hard or soft water. Ask them to share their preferences and justify their reasons.

Hard Water vs Soft Water
The Ultimate Test!

Have you ever been on holiday or travelled to a different area and noticed that the water tastes different? This is because there are two main types of water: soft water and hard water.

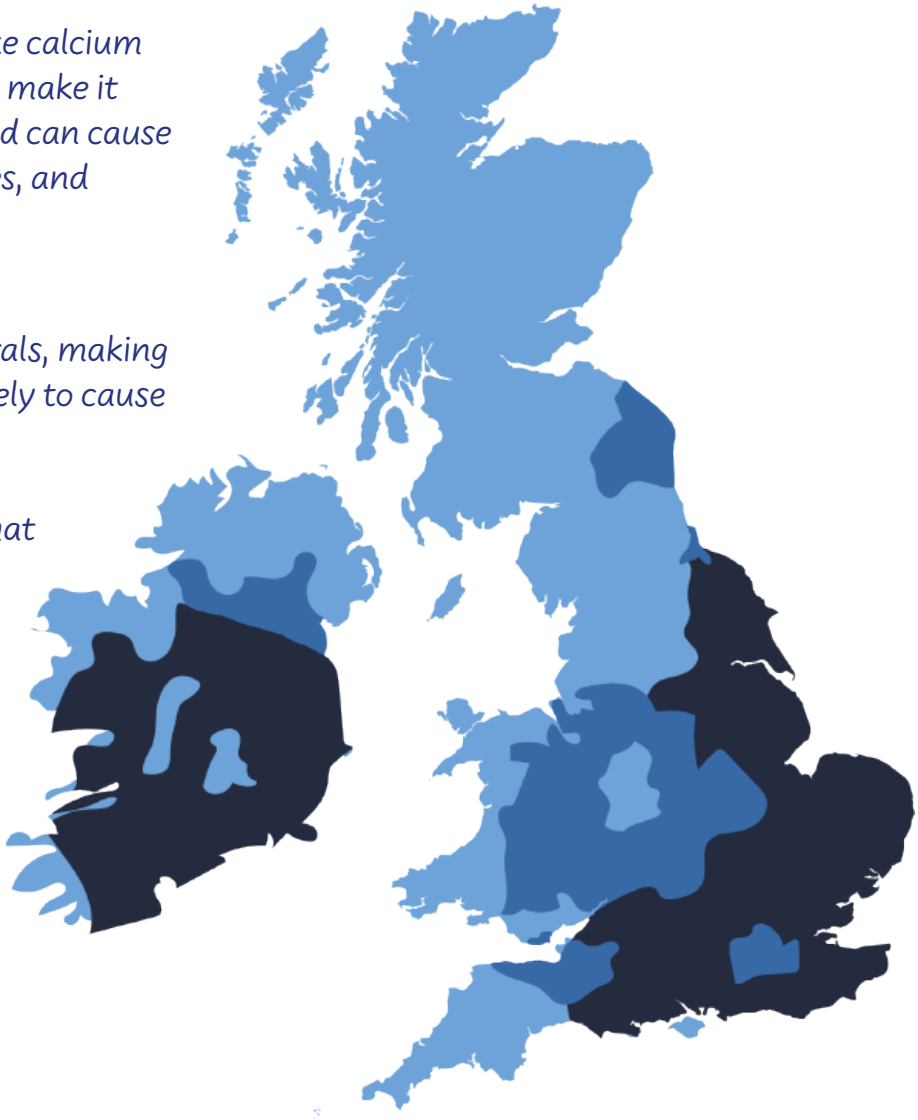
What is Hard Water?

Hard water contains minerals like calcium and magnesium. These minerals make it harder for soap to form foam and can cause limescale buildup in kettles, pipes, and washing machines.

What is Soft Water?

Soft water contains fewer minerals, making it better for cleaning and less likely to cause limescale buildup.

However, it may lack minerals that improve water's taste.



Hard to very hard
Above 250ppm as calcium carbonate equivalent

Medium to hard
150 - 250ppm as calcium carbonate equivalent

Soft to moderately soft
0 - 150ppm as calcium carbonate equivalent

Hard Water vs Soft Water

The Ultimate Test!

You will need

- 2 identical empty containers with lids (no more than 300cm^3, e.g. water bottles or glass jars)
- Epsom salt (approximately 10 tablespoons)
- 1 teaspoon of soapy liquid (e.g. shower gel or handwashing soap; avoid dishwashing soap)
- Measuring jug or cylinder
- Tablespoon
- Teaspoon
- Plain white paper for notes or reflections
- Timer

To complete the activity

1. Label the two containers as 'Hard Water' and 'Soft Water'.

2. Use a measuring cylinder or jug to measure 100cm^3 of water and pour it into the 'Hard Water' container.

3. Add 2 tablespoons of Epsom salt to the container, close the lid, and shake until the salt dissolves. Repeat this process, adding 2 tablespoons at a time and shaking after each addition, until no more salt can dissolve. You will know this has happened when a solid layer of undissolved salt forms at the bottom of the container. This may require up to 10 tablespoons. This container now represents hard water, which contains minerals such as calcium and magnesium, just like real hard water.

4. Add 1 teaspoon of soapy liquid (e.g. hand soap or shower gel) to the 'Hard Water' container. Close the lid and shake the container for 10 seconds.

5. Use a measuring cylinder or jug to measure 100cm^3 of water and pour it into the 'Soft Water' container.

6. Add 1 teaspoon of soapy liquid to the 'Soft Water' container. Close the lid and shake it for 10 seconds.

7. Observe both containers carefully. Compare the clarity, foam production, and any differences between the two types of water.

Record your observations below

Container	Clarity (clear/cloudy)	Foam production (none/some/lots)
Hard water		
Soft water		

Hard Water Vs Soft Water

The Ultimate Test!

Reflect on the experiment by answering the following questions:

What differences did you notice between hard and soft water?

How does the presence of minerals in hard water affect foam production?

In this experiment, only one factor (variable) was changed: the type of water (hard vs soft). All other factors were kept constant. Can you list all the factors that were kept the same to ensure a fair trial?

Additional Task

- Research the pros and cons of living in areas with hard or soft water.
- What kind of water do you prefer? Why?
- Find out where your area falls on the UK hard/soft water map.

Hard water can cause limescale buildup that costs the UK millions in maintenance every year!

Notes

For more information and extra resources please visit:
www.tiramor.cymru
or email:
info@penllynarsarnau.co.uk