

Freshwater pearl mussels

Freshwater pearl mussels (*Margaritifera margaritifera*) are a very rare **species** of shellfish. They are similar to mussels found at the seaside, but they only live in freshwater - in rivers and streams. As their name suggests, they can grow a pearl inside, although not many of them do. The pearl mussel is now struggling to survive for three main reasons:

1. People illegally kill the mussels for pearls.
2. Mussels need clean water, but many of the rivers and streams where they live became polluted as human populations and industries grew.
3. People destroyed the mussels' **habitat** by carrying out engineering works to change rivers and streams.



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Freshwater pearl mussels

Over half of the world's breeding freshwater pearl mussels live in Scotland, so they are **globally important** as well as being important for Scotland.





Freshwater pearls were once highly prized. They were one of the reasons Julius Caesar invaded Britain in 55BC. In the 16th Century all valuable pearls had to be kept for the King, and there are freshwater pearls on the Scottish Crown jewels, including the biggest pearl ever found - the Kelly/Kellie Pearl.

The most famous, and one of the biggest pearls in Scotland - the Abernathy Pearl - is about the size of a Malteser™. It is on display in a jeweller's shop in Perth.

The Honours of Scotland - the Scottish crown jewels

Pearl fishing was once an important industry in Britain, but during the 20th Century people started to notice that there were fewer and fewer mussels, and by the 1990's 90% of the population was gone.



Pearl fishing kit

The biggest problem was pearl fishing itself - sometimes hundreds or even thousands of mussels had to be killed by pearl fishers to find just a few pearls. If an irresponsible pearl fisher killed all the adult mussels in a colony it meant there were none left to breed and produce new mussels, so the colony would die out. Some professional pearl fishers learned how to open shells and check for pearls without killing the mussels, but there were too many amateur pearl fishers who still used the old-fashioned method of cutting them open.

Freshwater pearl mussel shells

The freshwater pearl mussel is a **bivalve mollusc**, meaning it has a shell made up of two parts that are hinged together. These can be closed to protect the animal's soft body within. When the mussel is young the shell is yellowish-brown in colour, and it gets darker with age.



From juvenile to adult - pearl mussels have a lot of growing to do.

Pearl mussels are **filter feeders**. Their **gills** act like lots of microscopic nets and they 'catch' tiny bits of animals and plants which are floating in the water. They suck the water in through one tube (called a **siphon**), filter edible material out of the water with their 'nets', and squirt the water out through another tube.

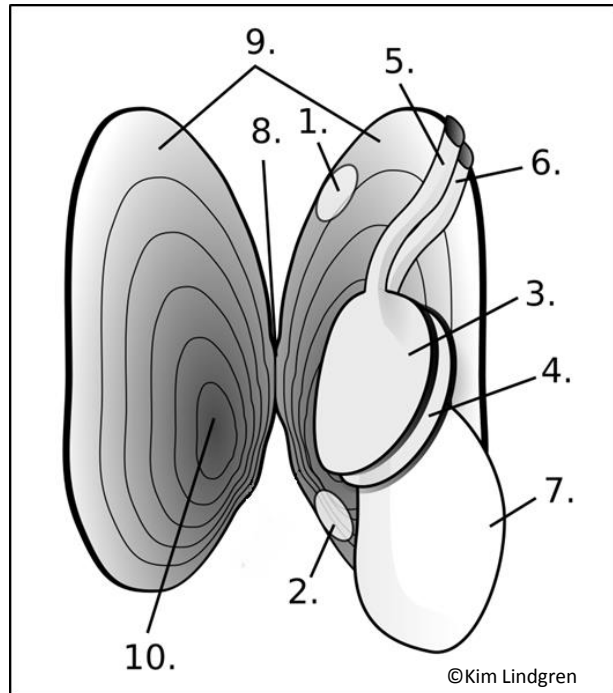
An adult mussel can filter up to 50 litres of water a day - as much water as you use when you have a shower. All together these mussels clean so much water that the environment is improved for other species, such as salmon and trout.



Large beds of pearl mussels contain 1000's of mussels, and 50 thousand mussels can filter enough water to fill an Olympic swimming pool every day!!

The anatomy of a pearl mussel

- 1. & 2. Muscles for opening and closing the shell
- 3. Front gill
- 4. Back gill
- 5. Syphon for squirting out
- 6. Syphon for sucking in
- 7. Foot
- 8. Hinge
- 9. Mantle
- 10. The shell's thickest part, the umbo



©Kim Lindgren

The inner surface of the shell, or **mantle**, is pearly white, sometimes mixed with rainbow-like colours that seem to change as you move. This is called "**mother of pearl**". People used to use mother of pearl to make buttons, jewellery, and to decorate objects such as musical instruments, cutlery handles, pictures and furniture.



Mother of pearl from inside the shell of a freshwater pearl mussel was sometimes used as decoration



The colours are caused by **iridescence**, as the light bounces off the mantle at different angles. This is the same effect you sometimes see on soap bubbles, birds' feathers (think of a peacock), shiny beetles, or on butterflies' wings.



Freshwater pearls come in many shapes, sizes and colours...



..while cultured pearls are much rounder, and are similar in colour.

As well as looking pretty, mother of pearl protects the soft parts of the mussel from any parasites that get into the shell, by growing over them and covering them. As the layers build up a **pearl** may be formed. The pearl gets bigger as more and more layers grow over it.

Unlike cultured pearls (pearls that are specially grown in captivity) most freshwater pearls are not shiny and round - and sometimes they can be dull and brown, and not worth any money.

Freshwater pearl mussels are some of the longest-living **invertebrates** in existence - they can live to over 100 years old. They get bigger by growing an extra layer on their shell every year - so they have growth rings, just like trees!!

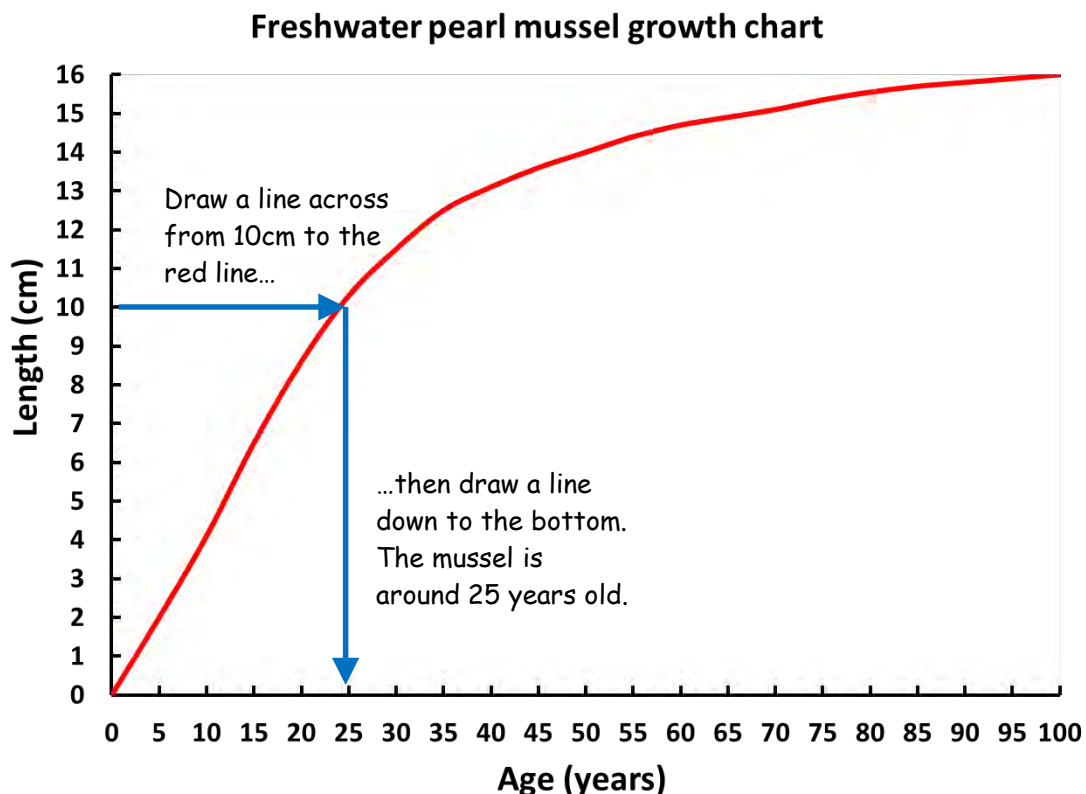
ACTIVITY: HOW DO YOU FIND OUT HOW OLD A MUSSEL IS?

Freshwater pearl mussels grow very quickly to begin with, and you can easily see their growth rings until they are 6 to 10 years old. After that growth rate starts to slow down and the rings are too thin to count. To find out the age of an older mussel, you need to measure it.

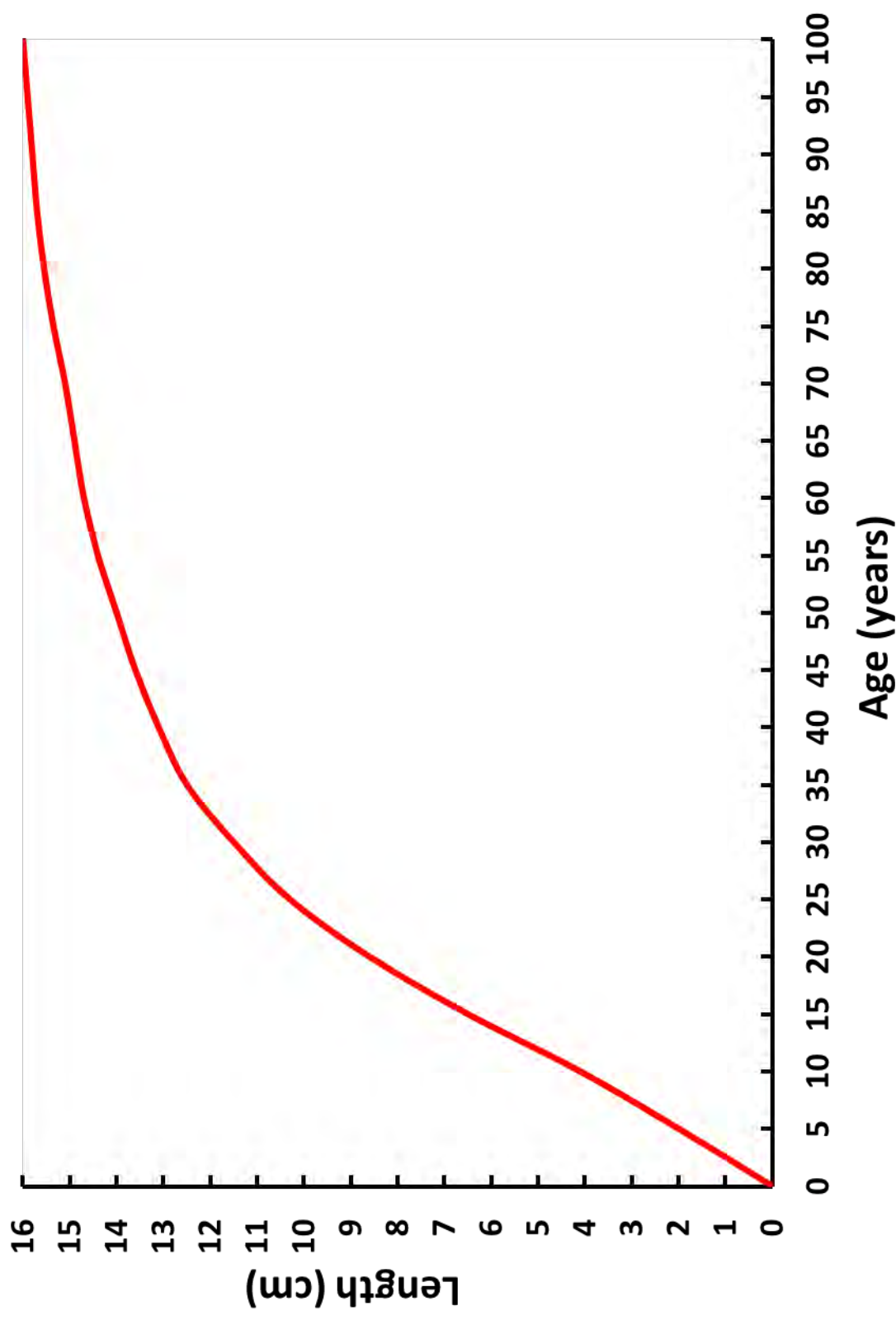
Instructions:

1. Measure how long the shell is from end to end.
2. Match the length to the left hand side of the graph.
3. Using a ruler, draw a line straight across until it meets the red line.
4. Then draw another line straight down to the bottom of the graph- this tells you how old your mussel is.

Example: Your mussel is 10cm long...



Freshwater pearl mussel growth chart



Here are some mussel shells for you to measure....



Here are some mussel shells for you to measure....



Here are some mussel shells for you to measure....



Here are some mussel shells for you to measure....



ACTIVITY: HOW DO YOU FIND OUT HOW OLD A MUSSEL IS?

Contd..

Now that you have found out how old the mussels are:

- Which page/group has the youngest mussel?
- Which page/group has the oldest mussel?

Do you know what an average is? The average is the "middle" number out of a set of numbers, and it tells us something about that group of numbers. For example, imagine some people in your class were eight years old, some were nine years old and some were aged ten. If the average age of the class was nine it would tell us that most people in the class are around nine years old.

You can use your measurements to find out the average age of the mussels you measured?

- Add up the ages of all the mussels for your page/group - who had the oldest total group?
- If you had five mussels in your set, divide the total number by five, for example...

$$10 + 25 + 40 + 50 + 75 = \text{total } 200 \text{ years}$$

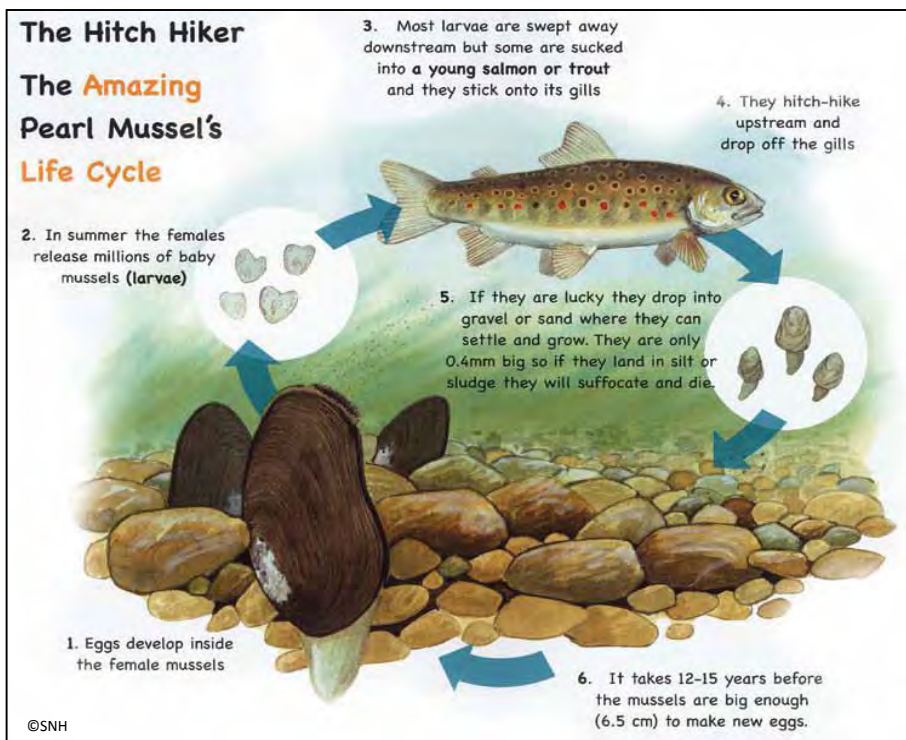
$200 \div 5 = 40$ years so the average age of mussels in that group is 40 years old.

If you have a bigger group - more numbers to add up - then your average will be more accurate. Try adding up all the mussels' ages and finding out the average.

You could try finding out the average size of the mussels too...

Freshwater pearl mussel lifecycle

Each mussel starts off as a tiny **larva** that looks like a tiny mussel, measuring less than a 10th of a millimetre long - that's less than the thickness of a piece of paper! The adult mussel releases one to four million larvae, known as **glochidia**, in the summer. The glochidia are **parasitic** and their **hosts** are juvenile fish from the **salmonid** family, which includes the **Atlantic salmon** and **sea trout**. Their shells are held open until they are inhaled by a fish, then they snap shut on the fish's gills. This does not harm the fish.



The chances of a larva meeting a suitable fish are very low; only four glochidia in every million will do so. Nearly all are swept away by the river and die.



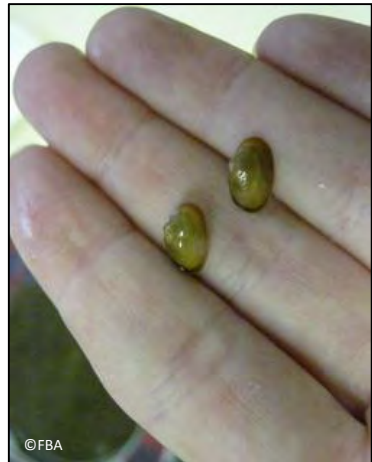
Once attached to the gills of a fish, the glochidia live and grow in this oxygen-rich environment until the following spring, when they drop off.



Glochidium on a gill



They are now **juvenile** mussels. If they are to continue to live and grow they must land on clean gravel or sand, where they can burrow themselves in completely. If they land in mud they will suffocate and die.



Juvenile freshwater pearl mussels



In the gravel bed they grow very slowly. They become adults when they are 10-15 years old, but they keep growing all their lives. Freshwater pearl mussels can live for over 100 years and grow up to 15 cm long.



Adult freshwater pearl mussel

Freshwater pearl mussels and the river ecosystem

Freshwater pearl mussels are part of the river **ecosystem**. An ecosystem is made up of a **community** of all the living organisms (plants, animals and microbes), along with the non-living parts of their environment (things like air, water and soil). The living and non-living parts of the ecosystem are all closely linked together, so if something changes it can affect everything else in the ecosystem.

Freshwater pearl mussels, fish and many insect larvae like the same conditions:

- They like fast flowing, cool, clean water, with lots of oxygen in it so they can breathe. Chemicals, oil and rubbish can all pollute a river and can be poisonous. **Nutrients** from fertilisers used on farmland encourage tiny plants, called algae, to grow. These can cover mussels and smother them.



Too many nutrients in the water can cause algae to grow, covering freshwater pearl mussels

- They like cool water. They are **adapted** to live at cooler temperatures, and warm water can be bad for them. Cool water also holds more oxygen for them to breathe. Overhanging trees will shade the river and stop the sun from heating it up too much.

- They like clean sand and gravel, found in the sheltered spots behind large stones and boulders. Salmon lay their eggs in gravel, in **redds**, but some fisheries have taken away the large stones to make more gravel for fish - and this has taken away the shelter for other creatures.

- They need **silt**-free water and river beds as very fine sediment particles blocks gills and makes breathing and feeding difficult. Overgrazing and deforestation can lead to mud and silt being washed into streams and rivers. Cattle walking on the river bank or in the river can stir up mud, which can stick fish spawning gravels together and make it difficult for salmon to make their redds.



©Sue Scott/SNH

Clean water with overhanging trees is good for freshwater pearl mussels.



©SNH

A muddy ditch can wash small particles into the river, making it difficult for mussels and fish to feed or breath.



Freshwater pearl mussels are part of the **food web**. The small particles of waste they produce (**faeces**) can be eaten by insect larvae, that are then eaten by fish. The faeces also contain nutrients for plants.



*Example:
Freshwater pearl
mussels, fish and
insect larvae can
feed on particles of
dead plant material
from this pondweed.*

*The waste produced
by these animals
provides food for
the pondweed.*

Because they are so sensitive to pollution, freshwater pearl mussels are **indicator species**; when rivers are good enough for pearl mussels the whole environment must be good enough for wildlife. They are also an **Umbrella species**, meaning that if they are protected, other species are also protected under the same conditions.

ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS

Instructions:

Lay the picture cards out, or get students to hold them up. Use strings to join cards together that are linked through food webs or ecosystem requirements.

SUGGESTED LINKS

1. Juvenile salmon and trout

- need insect larvae for food
- insects from overhanging trees fall into water and provide food
- grow into adult salmon and trout
- are hosts to juvenile FWPM so required for successful FWPM breeding
- hide from predators behind rocks and boulders, and in beds of adult FWPM
- hatch and feed in sand/gravel, and feed in beds of adult FWPM
- need cool, clean water and steady water flow and depth

2. Insect larvae

- provide food for juvenile and adult salmon and trout, and adult FWPM (through waste products from feeding)
- shelter and feed in beds of adult FWPM, and sand/gravel, and behind rocks and boulders
- need detritus from juvenile and adult salmon and trout, adult FWPM and overhanging trees for food
- need cool, clean water and steady water flow and depth

3. Adult salmon and trout

- need insect larvae for food
- also, insects from overhanging trees fall into water and provide food
- grow from juvenile salmon and trout
- lay eggs in sand/gravel
- need cool, clean water and steady water flow and depth

ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.

4. Juvenile freshwater pearl mussels

- need detritus from juvenile and adult salmon and trout, insect larvae and overhanging trees for food
- grow into adult FWPM and need a population of adult FWPM to produce them
- live and grow in sand/gravel, sheltered behind rocks and boulders
- need cool, clean water and steady water flow and depth
- filter water, maintaining clean water

5. Adult freshwater pearl mussels

- need detritus from detritus from juvenile and adult salmon and trout, insect larvae and overhanging trees for food
- grow from juvenile FWPM and need steady recruitment to maintain population
- live and grow in sand/gravel, sheltered behind rocks and boulders
- need cool, clean water and steady water flow and depth
- filter water, maintaining clean water

6. Overhanging trees

- provide food for juvenile and adult salmon and trout, juvenile and adult FWPM,
and for insect larvae through detritus and falling insects
- provide shade which maintains cool water

10. Steady water flow and depth

- maintains sand/gravel substrate
- maintains cool clean water

ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.

Discuss "what happens if...?" and remove links:

- a dam is built (e.g. hydro-electric) and alters the flow so there are periods of fast flow/low flow/shallow water
- a dam or weir is built and stops adult fish from migrating upstream
- salmon poachers net migrating fish as they swim upstream
- there is a storm and salmon eggs are washed away in high flow
- overhanging trees on the riverbank are cut down
- the channel is dredged to remove stones and gravel
- cows are allowed to drink from the river, and poach the riverbank
- forestry or overgrazing on land near the river cause run-off of silt and nutrients
- a factory releases poisonous waste into the river
- an illegal pearl fisher kills all the adult mussels



ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.



ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.



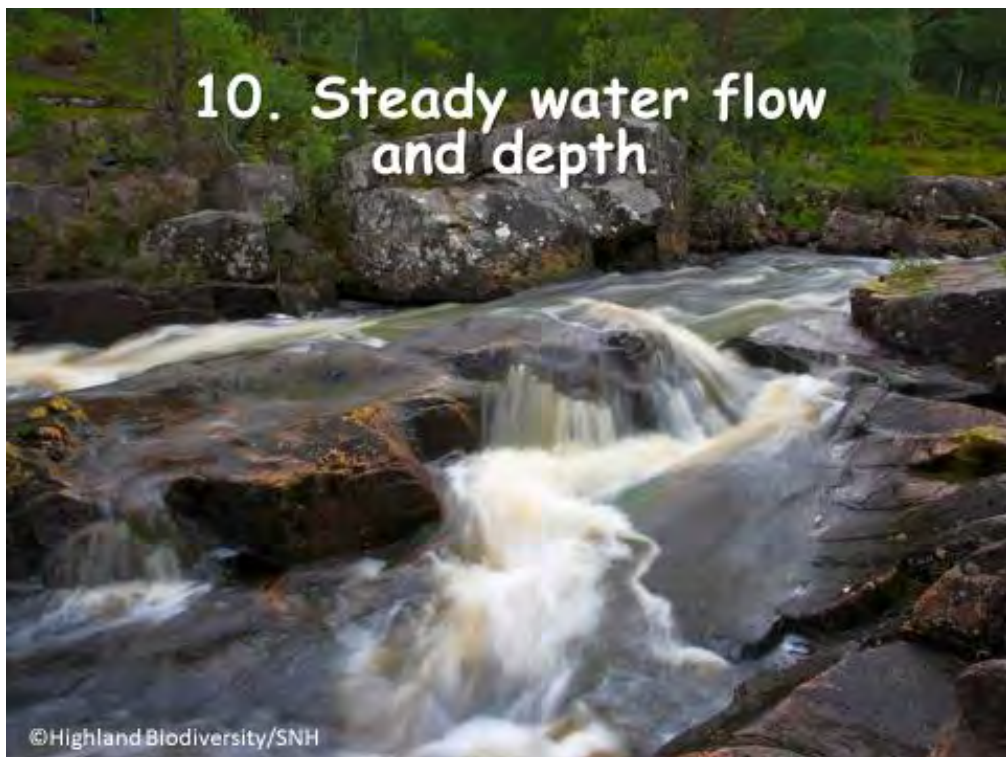
ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.



ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.



ACTIVITY: FOOD WEB AND ECOSYSTEM LINKS Contd.



WILDLIFE CRIME

Freshwater pearl mussels need to be left alone to grow into big adults. They are **protected by law**, so it is illegal to kill, injure, or even recklessly disturb freshwater pearl mussels, or to damage their **habitat**. It is also against the law to sell freshwater pearls. If you are caught breaking the law you can be fined up to £2000 or sentenced to six months in prison.

Wildlife and habitats can be threatened by wildlife criminals. Look out for:

- People acting suspiciously around rivers and streams, such as people searching in rivers with a glass-bottomed bucket.
- Finding dead pearl mussel shells in and around rivers.
- Suspicious vehicles, parked where they wouldn't normally be.



Illegally killed pearl mussels

If you see someone suspicious, **NEVER** approach them as they might be dangerous. You should tell the police as soon as possible - try to give a description of who and what you saw, and the vehicle registration number if there is one.

People who study pearl mussels carry special survey licenses and have permission to work in rivers. They won't mind if they have to show the police their licence - they'll just be happy that you're being vigilant and caring about freshwater pearl mussels.

SOME THINGS TO THINK ABOUT:

Do you know what a species is?

Do you know what a habitat is?

What other species share a habitat with pearl mussels?

Do you know what an invertebrate is? Can you name five more invertebrates?

Where do you think the material to make the shells comes from?

Why do freshwater pearl mussels grow so slowly?

Why do salmon and trout need clean water?

GLOSSARY

adapted: How an animal or plant becomes suited to its environment.

bivalve mollusc: A marine or freshwater animal with a soft body inside two shells that are hinged together.

community: A group of interacting living creatures.

ecosystem: Made up of a community of all the living organisms (plants, animals and microbes), along with the non-living parts of their environment (things like air, water and soil).

faeces: A waste product from an animal's digestive tract (poo).

filter feeder: Animal that feeds by sieving food particles from water.

food web: Feeding connections (what-eats-what) in an ecological community.

gill: Organ that takes oxygen out of water, allowing underwater creatures to breathe.

glochidium (singular), glochidia (plural): The microscopic larvae of freshwater mussels.

habitat: The type of environment in which plants and animals live.

host: An organism that a parasite feeds off and sometimes lives in.

indicator species: A species that is sensitive to changes in the quality of its environment, so its presence or absence can be used to show whether conditions are good or bad

invertebrate: Animal that does not have a backbone.

iridescence: When something seems to change colour as the angle you look at it changes, producing a display of rainbow-like colours.

juvenile: Young, not fully grown.

larva (singular), larvae (plural): The newly hatched, earliest growth stage of some animals.

mantle: The inside layer of the shell. The shell grows as more and more layers of mantle are added.

mother of pearl: The strong, iridescent inner-shell layer produced by some molluscs; it is also what makes up the outer coating of pearls.

nutrients: Chemicals that an organism needs to live and grow.

parasite: A species that feeds off or lives in another species.

redd: A hollow in a riverbed made by a trout or salmon to spawn in.

salmonid: A fish of the salmon family.

silt: Very fine sediment, smaller than sand.

siphon: A tube used to suck in, or blow out, water or air.

species: A group of organisms capable of breeding and producing young.

umbrella species: A species whose conservation protects other species that use the same habitat.

ACTIVITY Discussion: What is a river?

How many words do you need to describe a river?

Think about rivers where you live; rivers that you have visited; rivers you have seen through the window of a bus or train; rivers that you have seen pictures of in books and on the internet; rivers that you have seen on television and in films...

Is a river wide or narrow?

Is a river fast or slow?

Is a river long or short?

Is a river warm or cold or frozen?

Is a river wet (lots of rain) or dry (in the summer)?

Is a river smooth, or bubbly, or rippled, or are there rapids and white water?

Is a river noisy or quiet?

Is a river straight or does it meander?

Is a river deep or shallow?

Is a river rocky or sandy or muddy, or are there lots of plants?

Is a river clear, or is it brown or green or blue?

Is a river bank steep or shallow?

Is a river bank natural (grass/trees) or man-made?

Is a river urban (does it go through a town) or is it rural (it goes through the countryside)?

Is a river important for e.g. people/animals/fish/birds/insects?

Is a river useful? E.g. drinking water for people or farm animals? For boating/canoeing/white-water rafting? Fishing? Paddling? Playing?

Is a river natural or has it been changed by people?



ACTIVITY Discussion: What is a river? Contd.

Make a word cloud using all the words on your list

<http://www.whiteboardblog.co.uk/2011/09/8-word-cloud-makers-for-teachers/>

Make a river montage

Collect river-related pictures from magazines, newspapers, books or the internet, or draw pictures and use them to make a poster. You could use maps, pictures of rivers, of creatures that live in rivers, and people using rivers.

If you have a river near you, you could use the pictures to make a poster showing the route of that river, and how the river and its uses change as it flows from source to sea *OR* make a descriptive "map" of your river using the words from your list.

ONLINE RESOURCES

The PIP project has its own website, which will be updated regularly with project news, photos and links to resources. You can also check out Mo the Mussel's Twitter feed - and he would really appreciate hearing from you.

www.pearlsinperil.org.uk

[@MoTheMussel](https://twitter.com/MoTheMussel)

River Runners: the web version of the now out-of-print SNH booklet. It describes how pearl mussels, salmon and lampreys are all linked by a river's complex 'web of life' whereby each can be dependent on another for its continued survival.

<http://www.snh.org.uk/publications/online/NaturallyScottish/riverrunners/Whatisapearlmussel.asp>

"Maggie , my story" is a booklet produced by the Freshwater Pearl Mussel Practical Measures Project (2013) in Ireland and Northern Ireland. Aimed at young readers, the booklet tells the story of Maggie the Mussel's lifecycle, history and threats to her species' survival. High resolution pdfs of this file, and the accompanying activity book, are available online.

<http://www.rafts.org.uk/pearls-in-peril/>

British Pathé film clips show pearl fishing in 1935 in the River Doon (length 1m 19s), and in 1961 in the South Esk (length 2m 35s).

<http://www.britishpathe.com/video/the-mussels-secret/query/river+pearl+mussels>

<http://www.britishpathe.com/video/pearl-fishing>

Another World Radio, Northern Ireland presents an interview with PhD student and freshwater pearl mussel researcher, Conor Wilson. Conor explains his work with mussels — which he does for Quercus at Queen's University Belfast. He'll be spending a good time alone in the rivers of Northern Ireland, tracking down mussels, reintroducing new mussels into the environment, zapping fish, and avoiding the temptation to search for a fortune in pearls (length 36m 40s).

<https://anotherworldradio.wordpress.com/2008/08/18/ep-30-mussels/>

ONLINE RESOURCES Contd.

Tobar an Dualchais (Kist o Riches): a series of recordings in English and Gaelic. A search for "pearl fishing" lists 14 recordings of interviews with and songs from pearl fishers and travellers.

<http://www.tobarandualchais.co.uk/en/>

Partnership for Action Against Wildlife Crime in Scotland (PAW Scotland). An overview of crimes against pearl mussels, how they are protected by law, and what you can do to prevent wildlife crime.

<http://www.scotland.gov.uk/Topics/Environment/Wildlife-Habitats/paw-scotland/types-of-crime/fresh-water-pearl-mussels>

If you want to know more about freshwater pearl mussel ecology, there is a SNH booklet available.

<http://www.snh.gov.uk/docs/B337911.pdf>

Make an origami freshwater pearl mussel, and add some origami fish to create your own paper-folded ecosystem.

<http://www.freewebs.com/faltkunst/plan-pearlmussel-v2.pdf>

<http://www.origami-resource-center.com/origami-fish.html#fish>

FURTHER READING

The Scottish Pearl in its World Context (in Peril). Fred Woodward. 1994. Published by Diehard, Edinburgh ISBN 0 946230 27 7

In this book you will find, not only everything you may wish to know about Scottish pearls and pearl fishing and our own freshwater mussel, but all things pearl and mussel on a worldwide basis.

The River and the Road: Journal of a Freshwater Pearl-fisher. Peter James Goodwin. 1985. Published by Hale. ISBN 978 0 70902341

The story of one man's discovery of the compelling beauty of freshwater pearls and his enthusiasm for the wild and itinerant life which a pearl fisher must pursue. Together Goodwin and his companions endured the unpredictable results of their calling: sometimes bitter disappointments, sometimes uproarious celebrations of prize finds.

The Summer Walkers: travelling peoples and pearl-fishers in the Highlands of Scotland. Timothy Neat. 1996. Published by Canongate. ISBN 9781841581996.

The Summer Walkers is the name the crofters of Scotland's North-west Highlands have for the Travelling People - the itinerant tinsmiths, horse-dealers, hawkers and pearl fishers who made their living 'on the road'. This book explores a vanishing way of life; it presents stories, poetry and songs, it explores customs and superstition, the ethnic origins of the Travellers and their secret 'cover tongue'.

THE PARL

A pearl, such a prince would choose
to set neatly in gold,
an oriental pearl, certainly
I never saw its equal,
perfectly round from each aspect
With delicate smooth sides.
Time and again, considering jewels
would I select this singular pearl.
But I lost the pearl in a garden.
It rolled away beneath the grass,
leaving me felled by love's blow
from the living pearl unblemished.
Now let us go, the precious pearles a fishing,
The occasion serves us well, while here we stay
To catch these muscles, you call toytes, of Tay:
Its possible if no ill eye bewitch us
We jewels find, for all our days t'enrich us...

(14th Century poem, anon.)