



**Scottish
Water**

Always serving Scotland

Pollution

Third and fourth level

Description of module

The focus here is on water pollution. After a preliminary look at the subject as a whole, there are three activities about freshwater and one about pollution of the seas, specifically oil pollution.

Main experiences and outcomes

Numeracy and mathematics

I can work collaboratively, making appropriate use of technology, to source information presented in a range of ways, interpret what it conveys and discuss whether I believe the information to be robust, vague or misleading.

[MNU 3-20a](#)

Having recognised similarities between new problems and problems I have solved before, I can carry out the necessary calculations to solve problems set in unfamiliar contexts.

[MNU 4-03a](#)

I can evaluate and interpret raw and graphical data using a variety of methods, comment on relationships I observe within the data and communicate my findings to others.

[MNU 4-20a](#)

Sciences

I can sample and identify living things from different habitats to compare their biodiversity and can suggest reasons for their distribution.

[SCN 3-01a](#)

I understand how animal and plant species depend on each other and how living things are adapted for survival. I can predict the impact of population growth and natural hazards on biodiversity.

[SCN 4-01a](#)

Having taken part in practical activities to compare the properties of acids and bases, I have demonstrated ways of measuring and adjusting pH and can describe the significance of pH in everyday life.

[SCN 3-18a](#)

I can monitor the environment by collecting and analysing samples. I can interpret the results to inform others about levels of pollution and express a considered opinion on how science can help to protect our environment.

[SCN 4-18a](#)

Social studies

I can develop my understanding of the interaction between humans and the environment by describing and assessing the impact of human activity on an area.

[SOC 4-10a](#)

I can evaluate the suitability of finance options available for setting up and supporting different types of businesses.

[SOC 4-21a](#)

Having considered the financial needs of individuals and businesses, I can evaluate, prepare and present financial information and documents to assist in making appropriate financial decisions.

[SOC 4-21b](#)

Technologies

I can use ICT effectively in different learning contexts across the curriculum to access, select and present relevant information in a range of tasks.

[TCH 4-03b](#)

Throughout my learning, I can make effective use of a computer system to process and organise information.

[TCH 4-04a](#)

I can apply skills of critical thinking when evaluating the quality and effectiveness of my own or others' products.

[TCH 4-11b](#)



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Activity 1

Learning intention

- Pupils gain an overview of what is meant by water pollution

Success criteria

- Pupils are able to spot the true statements in the fun activity that follows the main learning session
- Pupils show that they have learnt items from the Resource Sheet that they did not know before.

Suggestions for teachers

1 Resource sheets 1a and 1b

A preliminary discussion on pollution, and on water pollution in particular, will draw out what pupils already know. A paper copy of resource sheets 1a and 1b could be given out after discussion to reinforce the main points and to fill in any gaps; pupils could be asked to go through the sheet ticking any facts that their class did come up with, and drawing a 'thought bubble' beside any facts they didn't know and so need to remember. When completed, this is a useful formative assessment sheet.

2 Resource sheet 2

Resource sheet 2 could either be given out as a paper copy or (preferably) shown on an interactive whiteboard. This is a short section containing three 'lies' and the pupils are challenged to spot them.

3 Truth and lies

The pupils are asked to write their own short section containing mainly the truth, but also three 'lies', hidden in such a way as to deceive others, if possible. This could be a homework activity. The sections can be used in a variety of ways in class. For example, each pupil could be given three counters each, then groups of four pupils formed.

Each pupil could each read out their paragraphs in turn, and each listener could challenge a statement made by the reader by placing a counter on the table. If the statement turns out to be true, then the pupil reading would claim the counter; if the statement was false, and the challenge therefore justified, the challenger takes back and keeps the counter. The winner at the end is the pupil with the most counters. (A more complex version would have a chairperson/banker who would see fair play, and also reward a correct challenge by awarding an extra counter to the challenger. Still only three challenges allowed).

4 Discussion

Pupils will have a good grasp of the essentials by this stage, so the original resource sheet could be returned to for assessment purposes. Pupils could either score for themselves – tick the items that they had marked with a thought bubble if they have learnt the fact by now - or pairs could test each other. A plenary could focus on what the pupils regard as the main messages, and also on how far the whole class has progressed in its knowledge.



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Activity 2

Learning intention

- Pupils understand that types of pollution can have different effects

Success criterion

- Pupils' reports show understanding of the main points

Suggestions for teachers

The following have most value if they are used as preparation for a field trip to a local pond or loch (activity 3).

1 Acid and alkalis

Pupils will probably be used to testing for pH. A simple experiment could be to observe what happens to duckweed in water samples of various alkalinities and acidities. Solutions of, say, pH 4, 5, 6, 7, 8, 9 and 10 could be prepared for the pupils to test: to observe the indicator colours. Pupils could be reminded that the pH of distilled water is 7, and then asked to predict what would happen if water animals or plants were put in each solution. Duckweed could be put in each jar, and observations made at the end of a week (and 2, 3, 4 weeks if possible) to see how accurate the descriptions were. Pupils could write reports in the standard way.

2 Adding acids and alkalis

The pupils would be more involved if they could add their own acids and alkalis to the jars, and then test for pH. Normal safety procedures would need to be followed in all of this, of course.

3 Discussion

In following discussion, the link with pollution would need to be made: a variety of chemicals, including acids and alkalis, can get into the water system and cause great damage to ecosystems. Acid rain is rain with a pH of under 5.6, so pupils will make the link between the acid they poured into plain water and just how polluted acid rain can be. Animals vary in their sensitivity to acidity in the water, for example:

- at pH 6 and below, all freshwater shrimps die
- at pH 4.5 and below most frogs, insects and fish will die

4 Visibility

Pollution can also cause water to be cloudy, and pupils can see how that affects visibility fairly simply by filling a tank, and then trying to read a laminated sheet of text through it. Either milk or soil (stir) could be added until reading becomes impossible. More scientifically, a light meter at one side of the tank and a light at the other would give quantitative results. Discussion should emphasise the fact that plants need light in order to live, and without plants there can be no animal life. Reports could be written in the normal way.



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Activity 3

Learning intention

- Pupils understand how invertebrate species can be used to estimate the degree of pollution in a local stream, pond or loch

Success criterion

- Pupils arrive at a reasoned judgement of the degree of pollution

Suggestions for teachers

This requires a field trip.

1 Lesson and study notes

There are excellent, detailed lesson and study notes to be found on the Nuffield Foundation website at:

www.nuffieldfoundation.org/practical-biology/monitoring-water-pollution-invertebrate-indicator-species

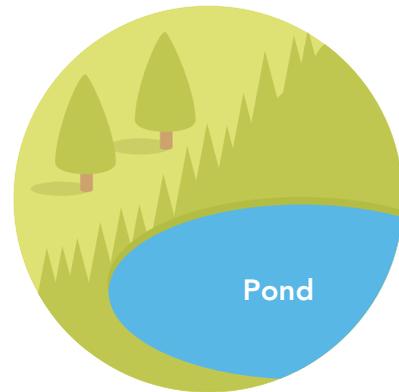
These notes are so good, and complete, that anyone interested is simply directed to those pages. They detail:

- equipment needed
- safety precautions
- a lesson plan
- activities at the stream, pond or loch
- species identification guides

A version of the invertebrate indicator species guide is included with this module as resource sheet 3

2 Water samples

Water samples taken during the trip could be tested for acidity or alkalinity back at the class, and photographs of species could be looked at in detail for identification purposes later. Photographs and videos are very valuable means of recording such trips.



3 Recording

Apart from the normal means of recording, there will be much visual information that would make a storyboard a useful record. Pupils could be given copies of some of the photographs to include in their storyboards. Alternatively, pupils could prepare a PowerPoint slide show of photographs and stills from any video recording, which could be shown at an assembly. In any record, pupils should include an estimation of the degree of pollution in their area, and the source of the pollution if it can be pinpointed.

4 Campaigning

Depending on circumstances, perhaps the pupils could become involved in a campaign to improve the freshwater environments in their area. See next activity.



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Activity 4

Learning intention

- Pupils understand what we can do to improve our freshwater recreation areas

Success criteria

- Pupils are able to take a full part in the cardsort activity and justify their decisions
- Pupils can show their understanding by drawing their impression of the ideal waterside scene (or a dystopian version)

Suggestions for teachers

1 Cardsort activity

Groups of pupils could carry out the cardsort activity in groups in order to decide what they see as valuable qualities for a waterside area. These qualities are largely taken from the criteria for awarding a Blue Flag at beaches, so preliminary work could include looking at the Keep Scotland Beautiful website:

www.keepsotlandbeautiful.org

Here pupils can see which beaches are considered the best, and why. The cardsort is resource sheet 4: pupils could sort the cards into Vital, Desirable, Unimportant sets.

2 Top two

Each group could decide on its top two requirements, and share these with the rest of the class, justifying their choices. Each group could do the same with their two least important items. Time could be given if groups feel they need to tweak their choices after the class discussion.

3 Blue Flag Scheme

Pupils could be told about the Blue Flag Scheme here. Perhaps the class might like to discuss an equivalent for freshwater areas? Perhaps a system for areas with all the amenities (blue flag), beautiful areas with no amenities (green flag?) and terrible areas (brown flag?).



As a follow up, pupils could draw labelled pictures of either the eutopian or dystopian sites showing desirable

and undesirable features; perhaps groups of two for this, sharing the work.

4 Write a letter

Pupils could write to their local council to suggest any possible improvements to freshwater amenities, and/or they could invite a local council officer to speak about the issues, or representatives from Scottish Water, Keep Scotland Beautiful, Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH) or other bodies.

5 Survey

Pupils could carry out a survey of freshwater habitats within, say, a five mile radius of their school, and rate each site according to their own criteria. Again, local radio might be interested, and the local press might print any maps and reports produced during the study. Teachers would need to check school and local authorities procedures before contacting media.



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Activity 5

Learning intention

- Pupils become aware of the harm done to drains and the environment when unsuitable materials are flushed away

Success criterion

- Pupils show their awareness when explaining why they are running campaigns

Suggestions for teachers

The following activities are based on Scottish Water's 'Keep the cycle running' materials, which can be accessed at: www.scottishwater.co.uk/cycle

1 Bag it and bin it

The materials about 'bag it and bin it' could be read through as a class, and the pupils challenged to come up with a two-minute item to be performed on local radio to promote correct disposal. Local radio stations are usually very helpful in this regard. With the pupils in groups of four, ask them to prepare a piece that will involve all of the group.

It could be:

- 'Top Gear style' - with each pupil contributing a section
- In the form of an interview – one pupil asking each of the others a question, so that, together, all of the answers provide a complete picture
- In the form of a dramatised sketch. For example: 'Stop! What are you doing throwing those cotton buds down the loo?' 'Why, what's wrong with that? – they're only little' 'Well...' and so on.

2 Newspaper article

Alternatively, what the groups produce could be made into an article for a local newspaper, either as something for the letters page, or as a full article. Both radio and newspaper items are excellent ways of developing persuasive writing, as in the CfE outcomes:

- I can persuade, argue, evaluate, explore issues or express an opinion using a clear line of thought, relevant supporting detail and/or evidence (LIT 3-29a)
- I can persuade, argue, evaluate, explore issues or express and justify opinions within a convincing line of thought, using relevant supporting detail and/or evidence (LIT 4-29a)

Teachers would need to check school and local authorities procedures before contacting media.



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Activity 6

Learning intention

- Pupils extend their knowledge of the harm done to drains and the environment by fats, oils and grease

Success criterion

- Pupils show their awareness when explaining why they are running campaigns

Suggestions for teachers

1 Separate campaign

A separate campaign from that described in activity 6 could be developed using the related materials. Go to www.scottishwater.co.uk/cycle

In this case, the campaign is aimed at preventing people throwing fats, oils and grease down drains. These make the handy acronym **FOG**:

Fats **O**ils **G**rease

There is a useful short video of congealed fat in sewers on the webpage to use as an introduction to the topic.

2 Fats and oils

Pupils may not be aware of the properties of fats and oils, in which case simple demonstrations may be shown of:

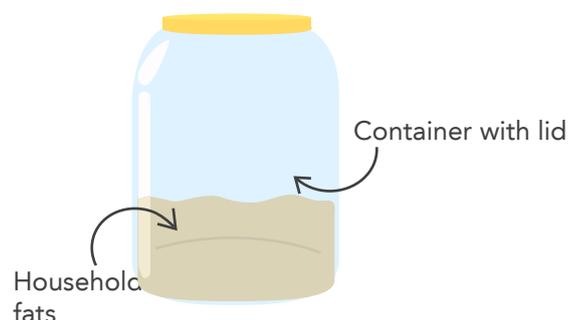
- Olive oil beginning to solidify in a fridge (take temperatures)
- Butter melting
- Lard melting when heated (take temperatures) and solidifying when poured into cold water
- Both lard and olive oil floating on water
- A plate of pork sausage and chips that has been in the fridge

The point to be made that oils, grease and fats are very similar chemically.

3 Household fats

The ideal way to dispose of household fats is to pour them into a container to solidify, put a lid on and bin the lot. It can sometimes be difficult or fiddly to do this, though: some pupils might have experienced pouring hot fat into a yoghurt pot, for example – this makes an interesting, if greasy, modern sculpture. Using something like a Tupperware container can be fine, but it is necessary to decant it afterwards before disposing of the fat or oil.

These issues could be described to the pupils and a solution suggested: as an enterprise activity, to encourage householders to dispose of these fats responsibly, pupils could make 'fat traps' and sell them. The fat traps can be made quite simply from a standard size can, opened so as not to leave a sharp edge, thoroughly washed out, and sealed with a plastic lid – the type of lid sold to cover pet food tins so that they can be kept in the fridge.





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Activity 6 continued

There is a lot of advice in schools about how to set up and run an enterprise activity, and pupils will no doubt be familiar with "The Apprentice" so details are not given here. For reference, there are some useful pages at: <https://education.gov.scot/improvement/learning-resources/enterprise-in-education>

4 Enterprise

The suggestion is to set up a company to make and market fat traps. As a start, pupils could decide on a snappy name, for example:

- GunkDumps
- Fogbogs
- GooLoos
- etc.

5 Design brief

As part of a design brief, pupils could design stickers or paper labels to attach to the tins, giving information on how to use their fat traps, along with an attractive company logo. Other advertising, marketing and finance would also need to be taken care of, of course.

This fits in very well with any other conservation activities that may be ongoing in school or the community, and demonstrates the **reduce, reuse, recycle** philosophy.

6 Real responsibility

Part of the ethos of enterprise education is to give pupils real responsibility. Perhaps teachers might like to discuss the relevant outcomes with the pupils:

- I can understand the necessity for budgeting and determine ways to manage finance, considering possible investment opportunities, savings, risks or borrowing needs (Third Level).
- I can evaluate the suitability of finance options available for setting up and supporting different types of businesses (Fourth Level) and come up with their own success criteria: how will they know that they have attained these levels? This could form part of the evaluation of the success of the scheme at the "shareholders' meeting."

7 Survey

A simple survey could be carried out about how households dispose of fats, oils and grease, perhaps something along the lines of:

I dispose of	Fats	Oils	Grease
by putting them in a container	Never	Never	Never <input checked="" type="checkbox"/>
	Sometimes	Sometimes <input checked="" type="checkbox"/>	Sometimes
	Always <input checked="" type="checkbox"/>	Always	Always

Surveys carried out before and after the enterprise activity should (hopefully) show a change in behaviour: another measure of the effectiveness of the scheme.



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Resource sheet 1a

Pollution sources

Pollution can come from many sources. Here are five of them.

Sewage and waste water 1

Sewage is the term used for waste water that contains faeces, urine and laundry or dishwasher waste.

There are billions of people on Earth, so treating sewage is extremely important.

Sewage disposal is a major problem in developing countries as many people in these areas don't have access to sanitary conditions and clean water.

Untreated sewage water in such areas can contaminate the environment and spread diseases such as diarrhoea.

Sewage in developed countries is carried away from the home quickly and hygienically through sewage pipes.

In richer countries such as ours, sewage is treated in waste water treatment works, where it is made safe.

People sometimes flush chemicals and medicines down the toilet, or things made from substances that do not biodegrade quickly, like plastics.

Marine dumping 2

Dumping of litter in the sea can cause huge problems. Animals and birds that live in or near the sea can get trapped by things like plastic ring packaging for drinks, pieces of netting and fishing line. That is often fatal.

Different items take different lengths of time to degrade in water:

- Cardboard – Takes 2 weeks to degrade.
- Newspaper – Takes 6 weeks to degrade.
- Photodegradable packaging – Takes 6 weeks to degrade.
- Styrofoam (polystyrene) – Takes 80 years to degrade.
- Aluminium – Takes 200 years to degrade.
- Plastic packaging – Takes 400 years to degrade.
- Glass – It takes so long to degrade that we don't know the exact time.

Oil pollution 3

Oceans are polluted by oil on a daily basis from oil spills, routine shipping, run-offs and dumping.

Oil spills make up about 12% of the oil that enters the ocean. The rest come from shipping travel, drains and dumping.

An oil spill from a tanker is a severe problem because there is such a huge quantity of oil being spilt into one place.

Oil spills cause a very localised problem but can be catastrophic to local marine wildlife such as fish, birds and sea otters.

Oil cannot dissolve in water and forms a thick sludge in the water. This suffocates fish, gets caught in the feathers of marine birds stopping them from flying and blocks light from photosynthetic aquatic plants.



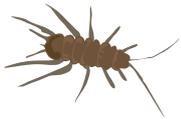
Pollution

Resource sheet 3

Invertebrate indicators of pollution

Different invertebrates will live in the water according to how polluted it is. Unpolluted water is clear and contains plenty of oxygen.

Polluted water may be cloudy and often contains less oxygen.

 <p>Mayfly</p>  <p>Stonefly</p>	<p>If you find these minibeasts there is NO POLLUTION</p>
 <p>Water Shrimp</p>  <p>Caddis Fly</p>	<p>If you find these minibeasts but none from group A then there may be SLIGHT POLLUTION</p>
 <p>Water Slater</p>	<p>If you find these minibeasts, but none from groups A or B then there is probably MEDIUM POLLUTION</p>
 <p>Sludge Worm</p>  <p>Rat Tailed Maggot</p>	<p>If you find these minibeasts, but none from groups A, B or C then there is A LOT OF POLLUTION</p>
<p>NO LIFE</p>	<p>No life. If you find no minibeasts at all then the water is VERY POLLUTED</p>



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Resource sheet 4

Cardsort

Information about local plant, bird and mammal species should be displayed

There should be a map of the area on display

There should be no industrial effluent, waste water or sewage in the water

There should be no disease-carrying micro-organisms in the water

There should be no litter in or near the water

Waste bins should be available and regularly emptied

Toilets should be available and cleaned regularly

Dogs must be kept on a lead, and any mess left by them picked up by the owner, and disposed of in the bin provided

First aid equipment should be available

There should be a supply of drinking water available

There should be wheelchair access

There should be footpaths to all frequently visited areas

There should be changing facilities and showers