

Water quality

Water quality and degree of pollution is established from the number of animal groups found and the sensitivity of these animals to pollution. Numerous animal groups indicate clean water. Stone fly nymphs are the most sensitive animals to pollution, whereas Hover fly larvae, Phantom crane fly larvae and Moth fly larvae are the least sensitive animals to pollution. Numerous sensitive animals indicate clean water.

How to use the scheme -

1. Start reading under the headline ANIMAL GROUPS - continue till You encounter an animal group found.
2. Read under the headline WHAT DID I FIND? and REMARKS! till You encounter a statement in accordance with Your findings.
3. Read the water quality mark to the right and in the column showing the number of animal groups that You found.

ANIMAL GROUPS - decreasing sensitivity to pollution downwards	WHAT DID I FIND ?	REMARKS !	NUMBER OF ANIMAL GROUPS FOUND (diversity)				
			0-1	2-5	6-10	11-16	17-20
Water quality - marks							
Stone fly nymphs - except pollution tolerant <i>Nemoura cinerea</i> & <i>Leuctra fusca</i> *	2 - more Stone fly species	pollution tolerant <i>Nemoura cinerea</i> & <i>Leuctra fusca</i> do not count		7	8	9	10
	one species only	pollution tolerant <i>Nemoura cinerea</i> & <i>Leuctra fusca</i> do not count		6	7	8	9
	only <i>Nemoura cinerea</i> and/or <i>Leuctra fusca</i>	go to Mayfly nymphs					
May fly nymphs - except pollution tolerant <i>Baetis rhodani</i> & <i>Cloeon dipterum</i> **	2 - more May fly species	pollution tolerant <i>Baetis rhodani</i> & <i>Cloeon dipterum</i> do not count		6	7	8	9
	one species only	pollution tolerant <i>Baetis rhodani</i> & <i>Cloeon dipterum</i> do not count		5	6	7	8
	only <i>Baetis rhodani</i> and/or <i>Cloeon dipterum</i>	go to Caddis fly larvae					
Caddis fly larvae, the Stone fly nymphs <i>Nemoura cinerea</i> / <i>Leuctra fusca</i> and the May fly nymphs <i>Baetis rhodani</i> / <i>Cloeon dipterum</i>	2 - more species	go to Caddis fly larvae		5	6	7	8
	one species only		4	4	5	6	7
	no species	go to Freshwater shrimps					
Freshwater shrimps	present		3	4	5	6	7
	not present	go to Water lice					
Water lice	present		2	3	4	5	6
	not present	go to Buzzer midges					
Buzzer midges - with gills, Tubifix red worms	present		1	2	3	4	
	not present	go to Hover fly larvae					
Hover fly larvae, Phantom crane fly larvae and Moth fly larvae	present		0	1	2		
	not present	go to No living animals					
No living animals			00				

* *Nemoura cinerea* and *Leuctra fusca* tolerate the same higher level of pollution as Caddis fly larvae - therefore they must be treated as caddis fly larvae.

** *Baetis rhodani* and *Cloeon dipterum* tolerate the same higher level of pollution as Caddis fly larvae - therefore they must be treated as caddis fly larvae.

Water quality mark given = _____ - read the significance of the mark in the scheme below.

How to use the scheme -

1. The water quality found corresponds to a particular DEGREE OF POLLUTION - e.g. 10 corresponds to **I** og 8 to **I-II**.


WATER QUALITY - marks	DESCRIPTION OF THE QUALITY OF WATER	DEGREE OF POLLUTION
10	particularly fine - not polluted at all	I
9	very fine - only slightly polluted	
8	good - weakly polluted	II
7	quite good - relative weakly polluted	
6	moderate - moderately polluted	III
5	medium - medium polluted	
4	quite bad - relative strongly polluted	IV
3	bad - strongly polluted	
2	very bad - very strongly polluted	
0-1	extremely bad - extremely polluted	
00	poisoned	

Estimation of water quality by animal identification

Name (stream/lake): _____

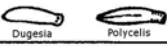
Date: _____ (Mark the animals You find!)

1. Hydras **Hydrozoa**




Hydra

2. Flatworms **Turbellaria**



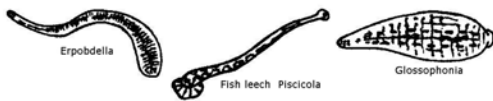
Dugesia Polycelis

3. Red worms **Oligochaeta**



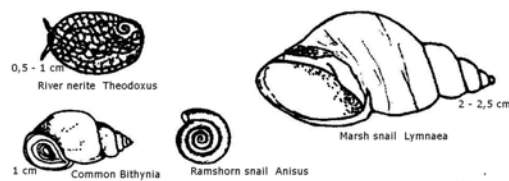
Stylaria Tubifex Nais

4. Leeches **Hirundinea**



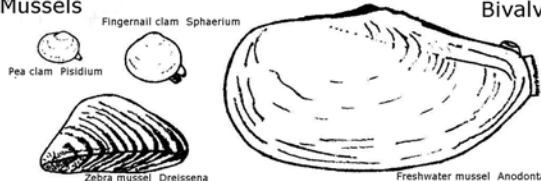
Erpobdella Fish leech Piscicola Glossiphonia

5. Snails **Gastropoda**



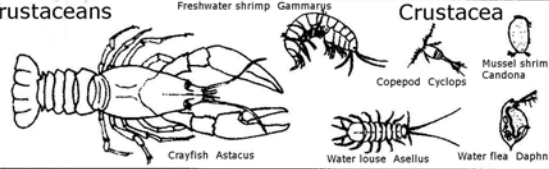
0,5 - 1 cm River nerite Theodoxus
1 cm Common Bithynia
2 - 2,5 cm Marsh snail Lymnaea
Ramshorn snail Anisus

6. Mussels **Bivalvia**



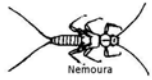
Finger nail clam Sphaerium
Pea clam Pisidium
Zebra mussel Dreissena
Freshwater mussel Anodonta

7. Crustaceans **Crustacea**



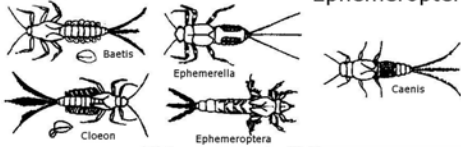
Freshwater shrimp Gammarus
Crayfish Astacus
Copepod Cyclops
Water louse Asellus
Water flea Daphnia
Mussel shrimp Candona

8. Stoneflies - nymphs **Plecoptera**



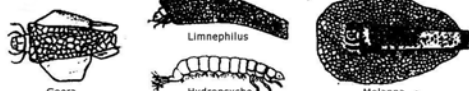
Némoura

9. Mayflies - nymphs **Ephemeroptera**




Baetis
Ephemerella
Cloeon
Ephemeroptera
Caenis

10. Caddis flies - nymphs **Trichoptera**




Goera
Limnephilus
Hydropsyche
Molanna

11. Alder flies - larvae **Megaloptera**




Stalis

12. Buzzer midges - larvae (small, light coloured, greenish or reddish, no gills) **Diptera**



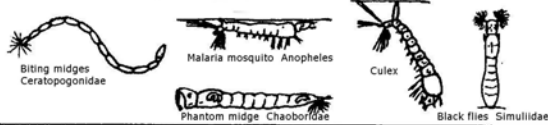
head Chironomidae

13. Buzzer midges - larvae (large, red, with gills) **Diptera**



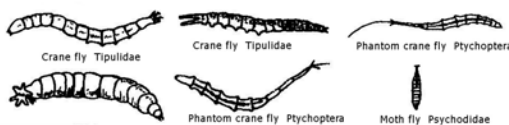
gills Chironomidae

14. Biting mosquitoes & Phantom midges - larvae **Diptera**



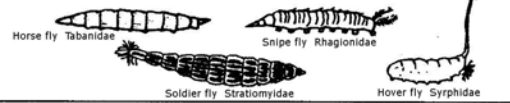
Biting midges Ceratopogonidae
Malaria mosquito Anopheles
Phantom midge Chaoboridae
Culex
Black flies Simuliidae

15. Other mosquitoes - larvae **Diptera**



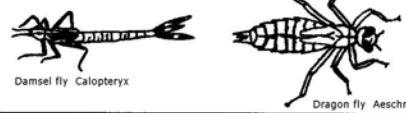
Crane fly Tipulidae
Crane fly Tipulidae
Phantom crane fly Ptychoptera
Phantom crane fly Ptychoptera
Moth fly Psychodidae

16. Flies - larvae **Diptera**



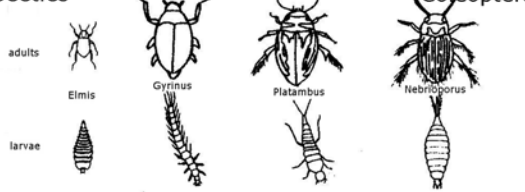
Horse fly Tabanidae
Soldier fly Stratiomyidae
Snipe fly Rhagionidae
Hover fly Syrphidae

17. Dragonflies - nymphs **Odonata**



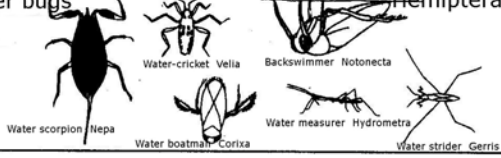
Damselfly Calopteryx
Dragon fly Aeschna

18. Beetles **Coleoptera**



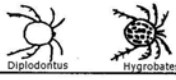
adults
Elmis Gyrrinus Platambus Nebrioporus
larvae

19. Water bugs **Hemiptera**



Water scorpion Nepa
Water boatman Corixa
Water-cricket Vella
Backswimmer Notonecta
Water measurer Hydrometra
Water strider Gerris

20. Water mites **Acari**



Diploodontus Hygrobatas

Number of animal groups found = _____ ... continue on the back page

Locality:

Date:

Team:

Chart

	BEFORE watermill	AFTER watermill
Temperature °C		
Oxygen mg/l		
Conductivity μS		
Salinity ppt		
pH-value 0 - 14		
Flow speed m/sek		
Nitrate (NO ₃)	-	
Phosphate (PO ₄ ³⁻)	-	

	PRESENT	NOT PRESENT
Trees along bank		
Submersed macrophytes		
Benthic algae on surfaces/grains		

Description of the physical and chemical variables

	Method	Courses for variations	Reference values
Oxygen	Measured in mg O ₂ /l with electronic equipment	High oxygen level indicates high level of photosynthesis, low respiration and / or good physical aeration (turbulence). Oxygen content decreases when temperature increases. Maximum content in freshwater is 14,63 mg oxygen /l at 0°C.	<i>Oxygen demands mg/l</i> Salmon and trout >6-7 Trout dies with < 4 Pike and eel > 4-5
Temperature	Measured in °C with electronic equipment	Temperature is basically controlled by the input of energy from the sun and mixing of water from different streams, drain water and subsoil magazine water Cold water has a higher density than warm water.	<ul style="list-style-type: none"> • Springs 7- 8 °C all year round <i>Average summer</i> • Upstream watercourse: ca. 10°C • Downstream watercourse: ca. 17°C <i>Day and night variations in downstream watercourses: 12 - 25°C</i>
Salinity	Measured in ‰ salt with equipment.	Salinity is the amount of dissolved inorganic ions in water. ‰ signifies gram of dissolved inorganic ions per thousand gram water. ‰ is the same as ppt (parts per thousand). Many elements in seawater occur in constant proportions no matter the salinity, eg. Na ⁺ and Cl ⁻ The higher salinity the higher density of seawater.	<u>surface ocean waters</u> Atlantic Ocean: 34 - 36‰ North Sea: 30 – 34‰ Northern Kattegat/Skagerak: 20 - 30‰ Southern Kattegat: 14 - 20‰ The Sound; The Belts: 10 - 14‰ Southern Baltic: 7 - 10‰ Northern Botnic Bay: <5‰
Conductivity	Measured in µSiemens with electronic digital meter	The conductance is a measure of the total ion amount in the water. This value also includes the inorganic plant nutrients needed for plant growth.	Nutrient deficient lake (oligotrophic): 50 - 100 Medium rich lake (mesotrophic): 100 – 200. Nutrient-rich lake (eutrophic): 200 – 500.
pH-value	Measured at a scale from 0 – 14 with a pH - meter. pH = - log [H ⁺]	The pH value expresses the amount of H ⁺ ions in water. Many ions ~ low pH-value (acid water); less ions ~ high pH-value (alkaline water). High pH-value (>8,5) during daytime indicates high level of photosynthesis. Low pH-value indicates low calcium content in the water - high value the opposite.	Brown coloured lakes: 5,5 – 6 Unpolluted oligotrophic lakes: 6,5 – 8,5 Eutrophic lakes: 7,5 - 11
Flowspeed	Flow speed is given in m/sec and is measured by a flow meter.	Flow speed decreases towards the bottom, the surface and banks of the stream – this is due to friction with the environment. Flow speed is also reduced in front of and inside macrophytes. The flow brings down oxygen from the atmosphere into the water. Obstacles in the stream like stones and the fall of water from one level to another will create turbulence which dissolves oxygen from the air into the water.	Average Danish water course – summer: 0,1 – 0,5 m/sec
Nitrat NO₃⁻	Measured in mg nitrate/l water with a Hach chemical analyses equipment (spectrophotometer)	Ammonium ions (NH ₄ ⁺) are oxidised to nitrite (NO ₂ ⁻), which are oxidised to nitrate (NO ₃ ⁻). Nitrate is an important nutrient for plants. Nitrite may accumulate in water with low oxygen content. Nitrite is toxic even in small concentrations. Nitrate is often the limiting factor for phytoplankton growth in the ocean – in freshwater Cyanobacteria will take over primary production when nitrate is used up by other phytoplankton. Cyanobacteria are able to extract N ₂ from the atmosphere and convert it to nitrate	Uncontaminated oligotrophic lakes: 0 – 0,5 Unpolluted eutrophic lakes: 0 - 5 Polluted eutrophic lakes: 0,1 – 10 Cleaned wastewater: 2 – 3 <i>Maximum levels for cleaned wastewater</i> max. 8 mg N /l Nitrogen includes all N from ammonium, nitrite, nitrate og ammonia.
Phosphate PO₄³⁻	Measured in mg PO ₄ ³⁻ /l water using the Hach chemical analyses equipment	Phosphate is an important nutrient to plants. It is often the limiting nutrient to plant growth in freshwater. Becomes unavailable to plant growth when linked to iron ions (Fe ³⁺) during oxygenated conditions in the bottom sediment. Released as a plant nutrient when the sediment becomes anaerobic. No matter the oxygen level phosphate is also linked to aluminium and therefore unavailable to plant growth	<i>Ortho-phosphatecontent:</i> Unpolluted oligotrophic lakes: 0 – 0,01 Uncontaminated eutrophic lakes: 0 – 0,3 Polluted eutrophic lakes: >0,3 Cleaned wastewater: 0 – 1 <i>Maximum levels for cleaned wastewater:</i> max. 1,5 mg phosphate/ of water

Programme for examination of Esrum Stream - high school

The aim of the day's programme is to do an investigation of Esrum Stream, which primarily takes its water from Esrum Lake. Esrum Lake is a natural mineral-rich lake (eutrophic). Streams and rivers have a large contact surface with the surrounding land. This means that the eutrophic water flow is supplied with large amounts of dissolved ions, particularly plant nutrient ions and organic matter from the surroundings. It influences the water's chemistry and thus also the living conditions for plants and animals in the stream.

The water course never stands still and the transport of water is unidirectional downstream. These physical relationships influence the composition of animals and plants which often show special adaptations to the physical environment. The unidirectional flow of water also means that the water course acts as link and transport route between land, lakes and sea.

Our investigation is an assessment of whether Esrum Stream is influenced by pollution or not. We use the sensitivity of animals to pollution and the diversity of animal groups together with presence and non-presence of animals to make our assessment.

You'll be instructed in how to perform the field investigations but be sure to keep up with doing all the investigations. Use the checklist below to ensure that you follow the whole programme.

All the results are to be filled into the attached chart below.

We end the day by discussing together our combined results and making conclusions on the ecological relationships inferred by our results, as well as assessing the stream's general state of pollution.

The full programme is aimed at a 3. grade high school class with high level biology, and with enough time available and few participants. The programme will be reduced according to grade, level, number of participants and time available.

In the laboratory at Esrum Møllegård we will present a PowerPoint show on the ecology of streams.

From the bank of Esrum Stream we obtain the following physical and chemical data:

Oxygen content in surface water BEFORE and AFTER the watermill.

Temperature BEFORE and AFTER the watermill.

Conductivity BEFORE and AFTER the watermill.

Salinity BEFORE and AFTER the watermill.

Flow speed BEFORE and AFTER the watermill in the middle of the water flow.

Water samples in plastic bottles BEFORE and AFTER the watermill for determination of nitrate, phosphate and pH-value in the laboratory.

In the stream we collect invertebrate animals with a net and put them in a bucket:

Large stones: Scrape stone surfaces with margin of net.

Water plants, root mats etc.: move net through the vegetation.

Bottom substrate: take samples with your net and sieve them carefully in watersurface.

Small stones: collect a stone the size of a fist or larger.

Brink:: search underneath overhanging vegetation along the bank