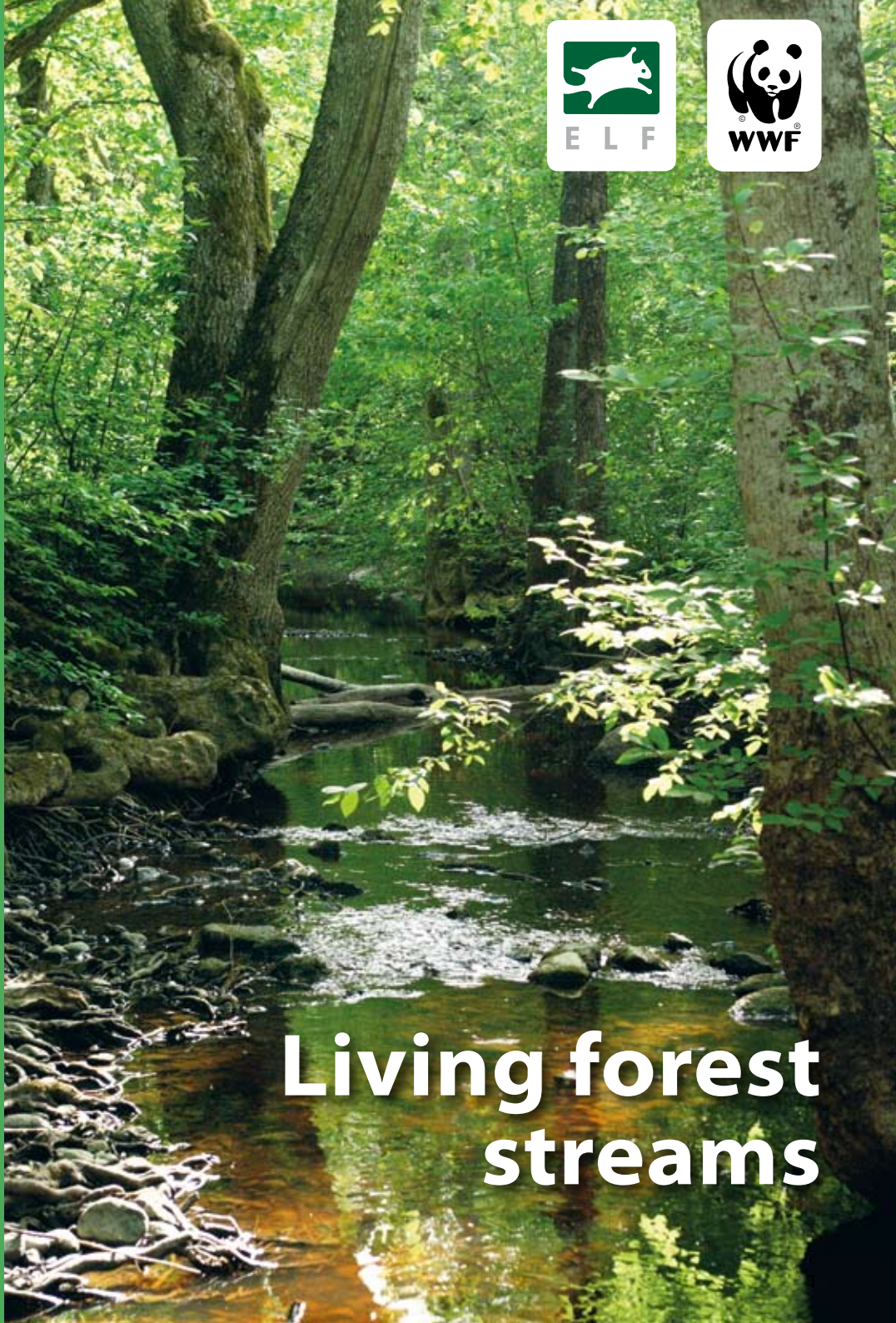
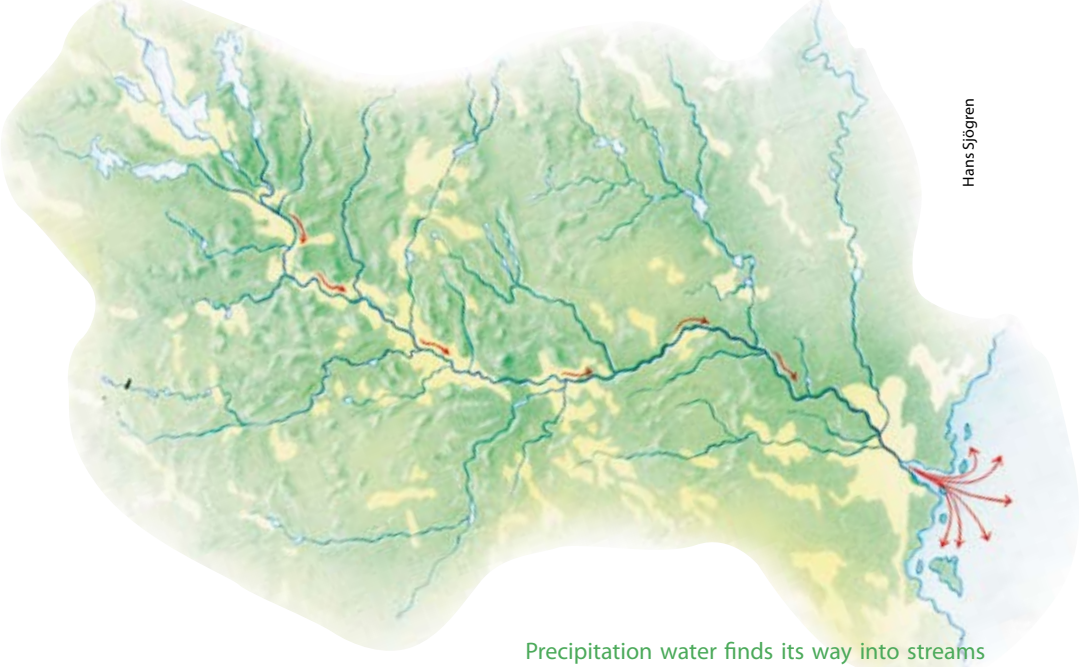


Living forest streams



Hans Sjögren

Precipitation water finds its way into streams and rivers and through them into the sea. The configuration of the catchment area of a watercourse determines how rapidly or slowly it flows and how straight or winding it is.

Running water is an integral part of the hydrological cycle of the Earth, bringing water drained from land back into the world ocean. Without vigorous watercourses, life on terrestrial parts of the globe is not possible. Flowing water is a connecting link between landscapes, a habitat for numerous species and a preserver of healthy ecosystems for us all.

One can say that running water is an inextricable part of our landscapes, both shaping and being shaped by them. In this leaflet we will introduce you to the diversity of life in forest watercourses.

Do you know that:

1. Stream waters provide habitat for many different plant and animal species.
2. Many rare and valuable fish species are actually very numerous in natural streams.
3. Floodplains act as water purifiers and reduce maximum high water levels.
4. There are thousands of species associated with water: no one knows their exact number.
5. In natural conditions, each square metre of a watercourse may contain fish.
6. Freshwater pearl mussels found in clean cool streams are our most long-lived creatures.

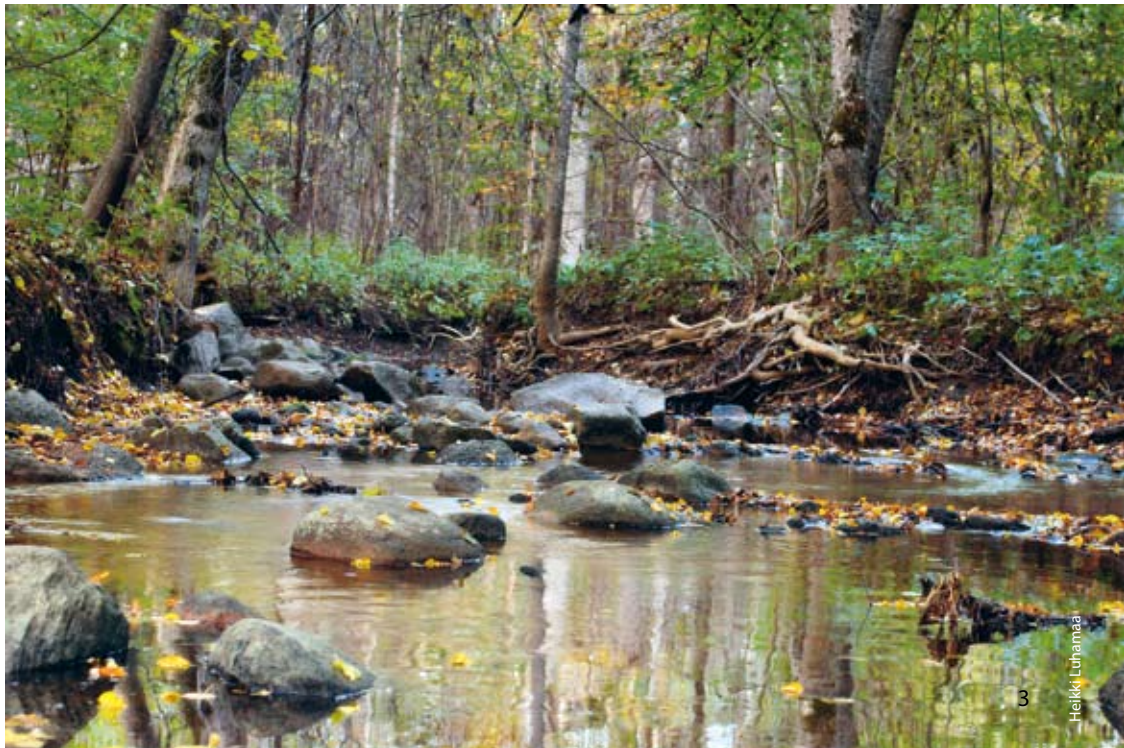
Water and forest are inseparable

The amount of water in soil influences vegetation growth and determines forest type: swamp and floodplain woodlands tend to occupy inundated and overmoist areas, while heathy forests favour dry regions. Watercourses regulate the amount of water in ecosystems either bringing it or taking it away and thus shaping the terrestrial water regime.

Flowing waters connect landscapes and habitats acting as migrationroutes for plants and animals. Forest in riparian zone is both a part of the stream ecosystem and a transition area between aquatic and terrestrial habitats. The roots of trees, growing in riparian zone, stabilize stream banks and diversify their structure. Trunks and branches fallen into the water, in their turn, diversify morphology of the stream channels. Flood waters bringnutrients and moisture to riparian zone enhancing the fertility of bank soils and creating favourable environment for species-rich forest communities. Biodiversity is increased by the variability of water regimes and light and soil conditions.

Richness of aquatic and riparian biota increases the value of watercourses to provide many so-called 'ecosystem services'. One such service is, for example, the abundance of fish, which is easy to measure in economic size units. Less easily measurable, but nonetheless perceptible assets are recreation areas. Most ecosystem services, however, cannot be directly glimpsed or perceived, but are nevertheless important for the preservation of our living environment. Inundated floodplains even out water levels and purify water. During a high water period water spills over to the floodplain and during a dry period it retreats back into a river or a stream, reducing the risk of both flooding and drought. In a flooded area, water disposes of plankton and gives away a considerable amount of nutrients dissolved in it. In this way, natural watercourses maintain the water regime of the surrounding communities and purify water.

Streams in a natural condition have varied beds and riparian areas.



Heikki Luhamaa

Landscapes are essential

The condition of a waterbody reflects the condition of the surrounding landscape, as bodies of water are very susceptible to changes in riparian environments.

Most of the water in our watercourses comes from precipitation leached through the soil. Thus, the properties of the soil determine the properties of the water in stream. Streams with hard alkaline water originate from calcareous soils, while those with soft water sensitive to acidification take its source from noncalcareous ones. In the same way the condition of the water is influenced by land-use in the catchment area. Clear-cutting and turning permanent grasslands into arable fieldsconsiderably increases the amount of plankton and nutrients in water, contributing to its eutrophication.

The outward appearance of a stream shows how many and what kind of species the stream hosts. The more diverse a water channel is the more species and organisms can live there. Trunks and branches fallen into the water as well as rocks found in the riverbed are one of the key factors of biotic richness. They help a watercourse to sort bottom materials, carve the banks and shape the channel. The bed configuration of a species-rich stream is varied and may include sand, rocks, tree trunks and branches.

Constant natural fluctuations in the level and amount of water ensure continuous alteration of the entire watercourse along with riparian forests. This preserves and facilitates biodiversity.

Branches and trunks that have fallen into the stream channel provide food and shelter to numerous running water species.

Riparian areas are important

The characteristics of the water and land interface are important for a stream ecosystem. The amount of leaf litter (leaves, needles, twigs, etc.) in the water impacts greatly aquatic biota. Since there are very few other sources of organic material, plant litter is the crucial primary link in the food chain of a stream. It provides nutrition to bacteria, protozoa and aquatic insects, which, in turn, are food for stream predators, the top representatives of which are trout, otters and black storks.

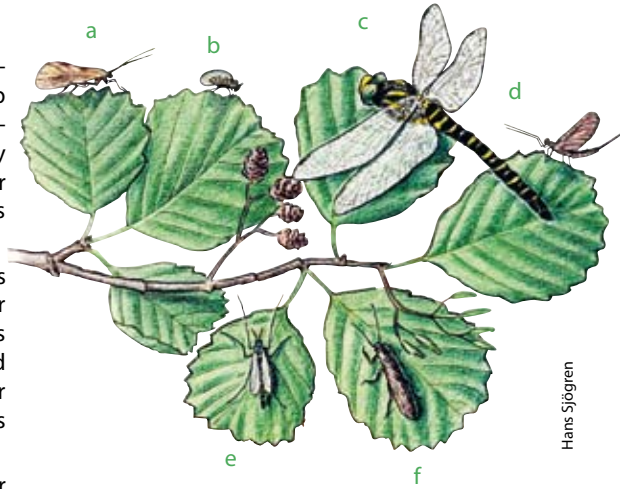
The amount of leaves fallen into the water determines the size of the animal population in a stream.

Shady riparian groves protect the aquatic environment from direct sunlight and help keep water temperatures low. The coolness of water during the hot summer months is vitally important to many running water species. For example, trout die if water temperature stays above 24 degrees Celsius for a week.

Trees fallen into the water from the banks diversify the channel and provide shelter and habitat to many creatures. The roots of riparian trees prevent bank erosion and slumping. Hollows between roots harbour many species, the most famous of which is the crayfish.

Riparian groves also act as an important filter trapping nutrients and plankton that the surface water carries from the catchment area towards the stream. The removal of riparian trees can cause clear stream water to become murky and eutrophic due to the increased concentration of nutrients and silt.

Riverside groves are usually characterised by a very diverse biota: one can find here rare bird, moss and lichen species. In addition to terrestrial species, banks covered with forests are also vital for various adult aquatic insects for which they serve as resting and feeding places.



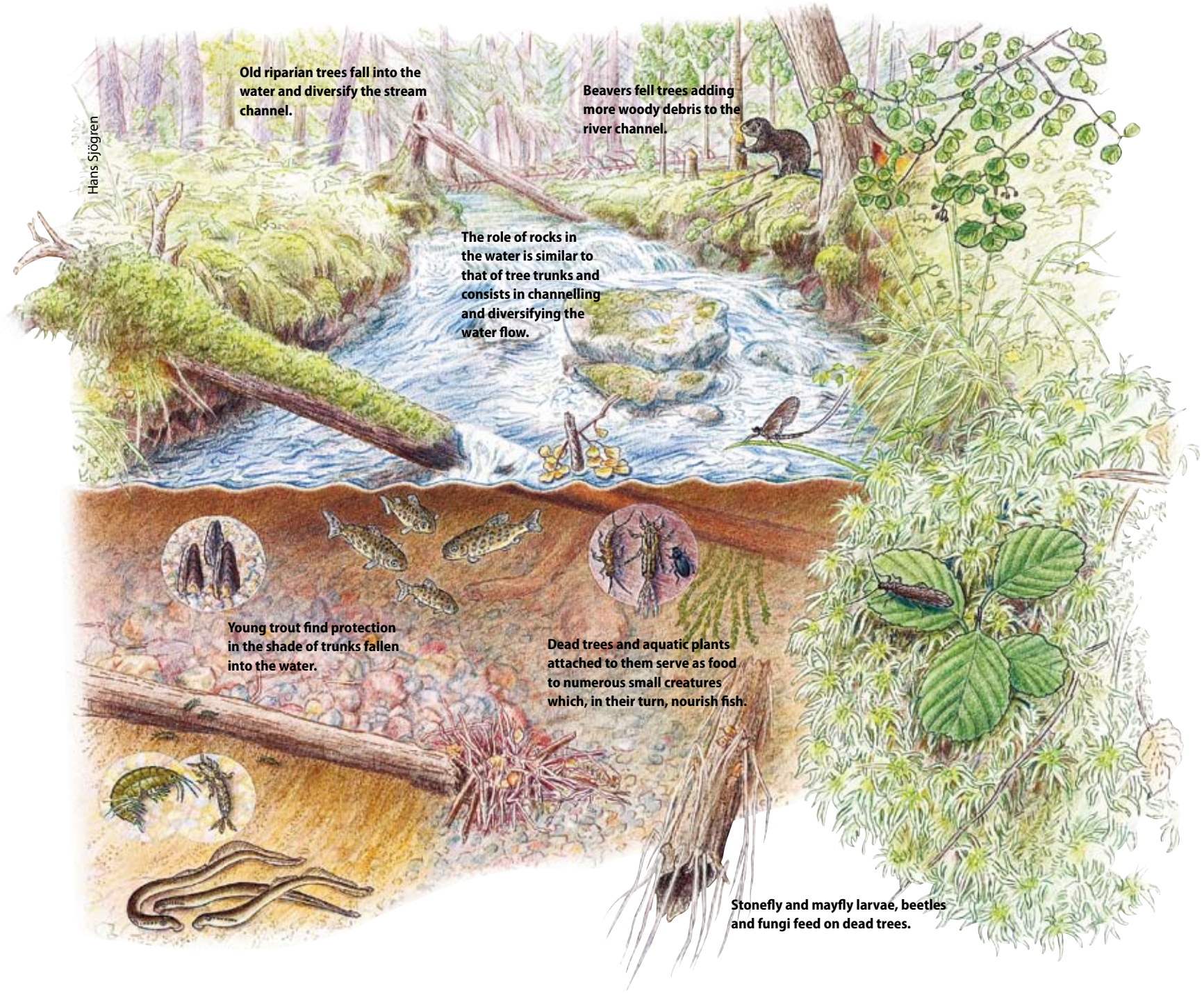
Riparian trees and shrubs offer resting places for newly emerged aquatic insects:
a) caddysfly
b) black fly
c) golden-ringed dragonfly
d) mayfly
e) chironomid
f) stonefly

The roots of riparian trees stabilise the banks and provide habitat for the aquatic biota.

Multiplicity of life forms

Natural streams flowing through forests are teeming with life. The number of bugs alone at the bottom of such a stream may reach thousands of insects per square metre! Coarse-structured, well-permeable riverbed soils are inhabited by mussels and insect larvae. They are the middle link of the stream food chain feeding on plant litter and themselves being prey for larger animals. Without hordes of little insects and crustaceans there would be no fish, birds and mammals in our streams: just a thick layer of foliage at the stream bottom.

Cool, nutrient-poor and oxygen-rich waters and shelters between fallen trees accommodate not only graylings, trout and lampreys but also roach, for example.



Logs at the bottom sieve particles carried by underflows. Coarse material accumulated behind logs is suitable for the spawning of trout and for pearl mussels, while the bottom formed by fine materials is suitable for mayfly larvae, amphipods and lampreys.

Life in flowing water

Living in constantly flowing water is full of possibilities on the one hand and fraught with challenges on the other.

Species with limited movement ability have developed various ways to find food. Trichoptera larvae use fine trapping nets to catch tiny organisms carried by the current, whereas black fly larvae grasp food bits with the help of cirri growing on their heads.

One of the main challenges for running water creatures is to stay in one place. Nature has invented various ways to do so. Baetidae larvae have an extremely thin body which helps reduce water pressure. Heptageniidae larvae have a flattened body and hold themselves in the stream by pressing themselves against the bottom. Simuliidae larvae use little hooks located at the back to attach themselves to stones. As an additional instrument they have a kind of safety belt: a tiny thread drawn from the back of the body which prevents them from drifting when the main fastening fails.

It is clear that most aquatic creatures are constantly drifting downstream. Evolution, however, has taught aquatic animals that the place where they have grown up tends to be more suitable for habitation than any other random place. That is why many species try to deposit their offspring in their own native places. For the majority it means the need to travel back against the current, which is a serious challenge for species with a limited ability to swim. Mayflies solve this problem by leaving the water upon maturity and simply flying back upstream for breeding. Pearl mussels entrust their dissemination to trout in which gills their larvae move along a watercourse. As pearl mussels and trout need similar habitats, the probability of getting into a right place is high.

Mayfly *Baetis rhodani* inhabits forest streams; its slender body is designed for living in running water.

Dead trunks give life

It has been long known that dead trees are an important source of forest biodiversity. The same is true for streams, in which tree trunks and branches form additional habitats, provide shelter and protection and diversify the channel. Ditched streams tend to contain very little underwater timber. In many places, this has started to affect the abundance of different species (trout, for instance). The role of rocks found in the channel is similar to that played by fallen trees, although streams "improved" by man contain very few of those as well.

Different eating habits

Aquatic animals can be classified according to their eating habits. Leaves fallen into the water are first softened by fungi and bacteria without being torn apart. Then scrapers, like some mayfly larvae, start peeling off and eating microorganisms from leaves and shreddersStoneflies and amphipods chomp off larger pieces. Plant particles and microscopic animals that get into the water flow in the course of this process are sieved by filtering creatures: caddisfly larvae, for instance, catch bigger morsels, while bivalves prefer finer titbits. Gathering creatures, such as britts, collect crumbs left from others and sunk to the bottom. Predators that catch the above-mentioned herbivores may be both insects and fish.

Many little insects feed on leaf litter and are themselves good food for fish.

What they say

Many aquatic animals serve as indicators of the condition of their living environment. For example, mayflies are a biological instrument for measuring water acidity, because their different species are able to tolerate different acidity levels. Thus, the presence of species of Baetidae or Potamanthidae indicates that the water is oxygen-rich and alkaline.

A species of mayfly called *Ephemera danica* needs clear and oxygen-rich water.

Freshwater pearl mussels are evidence that the stream has been in a natural condition for a long time and that its water is clear and rich in oxygen. In much the same way as tree rings, their shell rings allow water quality investigators to take a look into a distant past.

Amphipods are crustaceans who spend their entire life in water and who are very sensitive to both acidity and pollution. Since they are also a key food source for fish, their presence gives reason to assume that the water is pure and potentially full of fish.

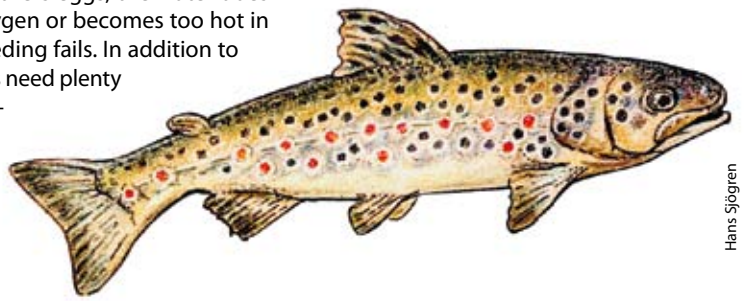
Amphipods purify water environment and are an important nutrition source for fish.

Endangered fish

Natural rivers and streams are vitally important for the survival of such species as salmon, trout and river lampreys.

Sea trout and salmon are migratory fish which reach their maturity in the sea but come back to spawn in their native waters. In order to be able to breed they need rapidly flowing, oxygen-rich cool water, abundant animal food and coarse, well-aerated river bottom. Eggs are laid into the bottom gravel of the watercourse in autumn, and fry hatch in spring. Having spent two years in a river, young fish head for the sea, from which they come back to spawn the same river years later. However, if the stream bottom is covered with a lot of fine sediment which smothers eggs, the water does not have enough oxygen or becomes too hot in the summer, the breeding fails. In addition to that, young salmonids need plenty of shelters to find refuge from birds and predatory fish.

Trout live in cool and clean streams and rivers.



Hans Sjögren

Hans Sjögren

The brook lamprey is a purely running water species.

Lampreys are primeval animals which belong to the group of Cyclostomata (jawless fish). They have no bones and have a funnel-like sucking mouth instead of the jaw. Brook lampreys spend their entire life in running water, while river lampreys, like salmon and sea trout, spend their mature years in the sea. In order to spawn, lampreys need the same conditions as trout. Lamprey larvae, called ammocoetes, live up to 5 years hidden in the sandy stream bottom or decomposed leaves, feeding on decaying matter or algae.

Jakob Bergengren

Pearl mussels can only live in rivers and streams that are in their natural condition.

Beavers as land improvers

Beavers have been part of aquatic ecosystems from the time immemorial. In Estonia, they disappeared in the 19th century because of hunting. In the 1950s beavers were returned to our streams and have now become quite usual almost everywhere in the continental part of the country.

Beavers are well adapted for aquatic existence and can live in both standing and running water. They are herbivores and eat aquatic plants as well as bark and thin branches of deciduous trees growing along riverbanks. Being skilled builders, they construct lodges for themselves with underwater entrances. To ensure the safety of these entrances, they create dams in the stream.

Beaver activities slow down water flow completely changing the living conditions of other species. Trees fallen into the water increase the amount of dead timber in the channel. Trees left in the dammed area die and become a habitat for insects, which, in their turn, feed woodpeckers.

Bodies of water deepened and ditched by man are perfect places for beavers to build their dams and raise the water level, which makes these creatures enemy number one for land improvement. Since there is no need or possibility for them to considerably dam streams flowing along natural channels, beaver influence on them is quite small.

Long-lived pearl-makers

One of the most exciting and nowadays also rarest species dependent on pure running water and gravel bottom is the freshwater pearl mussel. Its larvae live the first half a year in trout gills, migrating together with the fish. Then they free themselves and hide deep in the stream bottom, where they gradually develop into adult bivalves. A free ride in fish gills is a clever travel mode for the species which is almost entirely immobile.

Freshwater pearl mussels are one of the most long-lived creatures and can reach an age of 300 years. Rarely they produce pearls. References to pearl hunting in bygone days can be found in various parts of Europe. This activity, but mostly the ever more deteriorating condition of the watercourses, led to the near disappearance of the species.

Lennart Henrikson

Human activity preventing the spreading of species is often more important than that of beavers.

Hans Sjögren

Small predators

At dusk, bats start hunting for food over streams. Here they can find plenty of flying insects to eat and then use hollows in old deciduous trees growing along the banks as their resting places.

In the same time, water shrews closely related to and having much in common with common shrews go searching for food in the stream. Greatly dependent on water, they are wonderful swimmers and can remain under the surface for up to 20 seconds. Similar to beavers, they live in burrows with underwater entrances. Water shrews live in small groups and, like common shrews, feed on any animals they are able to capture: aquatic insects, crustaceans, amphibians and little fish.

Heikki Luhamaa

Birds throughout the year

Running water is an important feeding place for birds. In summertime, watercourses are teeming with birds. In winter months, dippers come to our rapid streams from the north. This species is well adapted for living in clear, rapidly flowing waters. Dippers hunt in the rapids, where they suddenly plunge into the water and, walking along the bottom, search for insect larvae.

Small biota-rich streams are important feeding places for black storks which are very afraid of humans. When ditched streams dry in the summer these birds are forced to fly for food to distant watercourses lying dozens of kilometres away from their nests. That often proves to be too hard for a stork couple and the nesting fails. The scarcity of suitable biota-rich feeding streams is one of the main reasons behind the constantly dwindling population of black storks.

Hans Sjögren

Golden-ringed dragonflies are adapted for living in cool running water.

Home for dragonflies

Of 54 dragonfly species in Estonia nine favour running water as their habitat. Four of them require watercourses with shady banks, rapid currents and clean gravel bottoms. Majority of dragonfly larvae spend two years in the water, but some species may remain in cool streams in larva form for up to five years. This prolonged larval stage makes the species very susceptible to changes occurring in a watercourse.

Among Estonian dragonflies, golden-ringed ones are most strongly associated with small streams. One of their typical characteristics is a long ovipositor with which they, like trout and lampreys, lay eggs deep into the bottom soil thus preventing their drifting but, at the same time, making them dependent on the quality of bottom soil.

Aquatic mosses

It is very difficult for plants to grow on soils that are alternately inundated and then drained in times of summer low water. Such extreme conditions are intolerable for most of the plants. Exceptions are dichelyma moss and sickle dichelyma moss, for example. These species are well adapted to the natural water level fluctuations. They cannot survive in human-altered streams where water levels fluctuate more abruptly and in different rhythms or altogether randomly.

Dichelyma moss *(Dichelyma capillaceum)* grows on the banks of streams which are in their natural condition.

Henrik Welbull


Heikki Luhamaa

Virgin, natural and human-altered watercourses

Just as forests may be classified into virgin, natural and cultivated ones, so can be streams. Virgin watercourses have been virtually untouched by man and are characterised by rich and stable biota. Natural watercourses bear certain traces of human influence but, similar to virgin watercourses, their biota retains much of its diversity. Human-altered watercourses have been significantly influenced by humans, and their species composition has been drastically changed. They provide few habitats for creatures requiring natural living conditions. Estonia is a country where human interference in nature has been very strong and where one can find practically no virgin watercourses. Moreover, natural bodies of water are also lessening in number.

What you can do to improve the state of bodies of water:

- Think before you act: plan forest works carefully!
- Do not cut the forest growing on stream banks.
- Cultivated forests in riparian areas should be left to recover in a natural way until they look as if they have not been touched by man. These areas should contain both trees and shrubs as well as plenty of dead trees of various ages.
- Avoid using forest machines and other motor vehicles on non-frozen forest soils as well as on streams and their banks.
- Wherever possible, do not remove trees that have fallen into the water.
- Remove fish migratory barriers. Of special importance are impassable road culverts and dams.
- Put those rocks, that were taken out from the river in the course of land improvement or other operations, back into the river bed.
- Close ditches that are not needed for land improvement. In this way the restored wetlands will purify the water flowing into bodies of water.

Natural streams are characterised by bank and bed diversity which cannot be found in cultured streams.

Heikki Luhamaa

Esi- ja tagakaane fotod: Heikki Luhamaa

E L F

The Estonian Fund for Nature (EFN) is a non-governmental, politically and economically independent environmental organisation. The purpose of the EFN is to protect the Estonian nature and living environment. The main focus is on the activities connected with forest, sea, wetland and species preservation. The EFN has initiated and supported the creation of national parks and ecological reserves and has prepared thorough inventories of the natural riches of Estonia.

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