Recently molted mayfly larvae have lightly colored soft exoskeletons, making them vulnerable to predation and injury before the exoskeleton hardens.

Ecology

When we think of Alaskan wildlife, our minds usually leap to the big and the fuzzy: brown bears and caribou, otters and eagles, king salmon and killer whales. We don't often contemplate the tiny and wriggly. But without aquatic insects, Alaska would be a poorer place by far. Aquatic insects help form the foundation for countless food chains. They help create soil and enrich estuaries and the ocean. As pollinators they enable many plants to produce seeds. Alaska's ecology as we know it would collapse if all our aquatic insects were to vanish.

Emergence

If you spend time near an Alaskan stream or pond in the right season, and if you pay close attention, you'll get to witness aquatic insects leaving the water behind and taking to the air. This process is called emergence. It happens in different ways for different insects.

Some insects, including many mayflies, stoneflies, dragonflies and damselflies, crawl from the water onto rocks, logs, branches, or stems. There they may pause for some time while their bodies make final adjustments. Finally, under pressure from within, the exoskeleton splits—usually along the back. The soft insect slowly pushes out, eventually pulling its abdomen free. Then it rests for some time while its wings lengthen and become firm, and its new exoskeleton hardens.

Other aquatic insects emerge directly from the water surface. Good examples of these are Mosquitoes, mayflies, and Chironomids. Their pupae rise to the surface, where unwettable hairs help keep them buoyant. The back of the exoskeleton splits and the bug oozes up and out, pausing for a moment before flying free. Some aquatic insects emerge while underwater.

Don't be discouraged if you miss the main event. Even if you don't see the bugs emerging, you may notice their abandoned exoskeletons on rocks and vegetation near the water.

Life spans

We're most familiar with the winged adult stages of aquatic insects such as dragonflies, Mosquitoes, and mayflies. Many of these exist for only a brief time (weeks or days) before dying. In fact, mayflies, which may live only a few hours as adults, are often used as metaphors for things that are fleeting. Their scientific name, Ephemeroptera, even means "short-lived-wings."

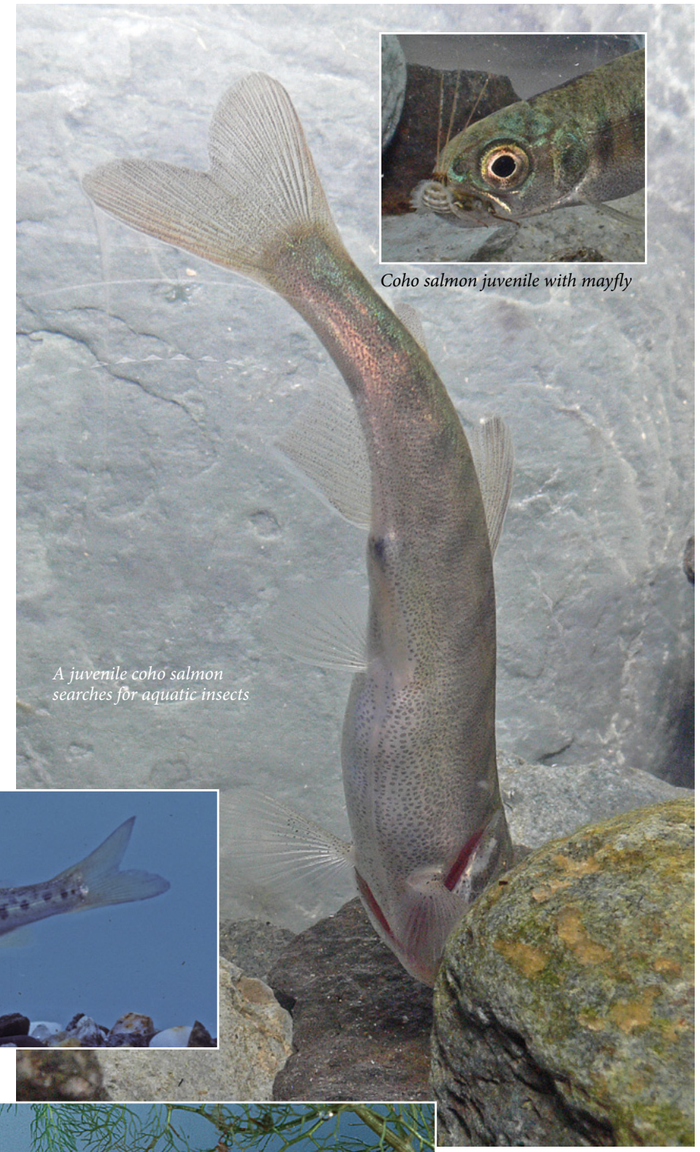
But adulthood in insects is not really proportional to adulthood in humans. Especially among the aquatic insects, which can survive as larvae underwater through the winter, most of an insect's life is spent in the larval stage, which may last for months or years. Some dragonflies, in fact, can live several years as larvae before they ever emerge as adults—but adults live only for one season.

Aquatic insects as food

Hundreds of Alaskan animals—from fish to birds to amphibians to mammals—feed on aquatic insects. There are even some plants that feed on them.

Fish food

Aquatic insects are important food for Alaska's freshwater fish. In fact, all Alaskan freshwater fish, including all six species of salmon, feed on aquatic insects at some point during their lives. Some fish such as grayling, are bug specialists. During Arctic summer days, when the sun rarely sets and insects are active, grayling can feed on adults and larvae round the clock. King salmon born in the Yukon's headwaters rely on aquatic insects to sustain their 2,000 mile long journey to the ocean. Chum and pink salmon fry feed on aquatic insects in their estuarine nurseries. Landlocked sockeye (red) salmon, called kokanee, eat aquatic insects as adults. Throughout their lives, trout, char, and many whitefishes feed on aquatic insects. Even fiercely piscivorous (fish-eating) northern pike start their lives as small, insect-eating fry.



A juvenile coho salmon searches for aquatic insects

Coho salmon juvenile with mayfly

Arctic grayling one year old

Young northern pike

Bird food

Over half of Alaska's common bird species probably include aquatic insects in their regular diet. They take the larvae from the water, pluck emerging adults near streams and ponds, or glean adults at rest or nab them on the wing. Some of these birds are particularly dependent on aquatic insects.

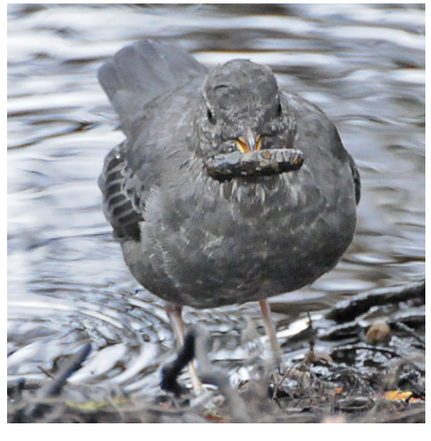
During the short but intense summers of northern Alaska, when long daylight hours keep the tundra warm, insects can grow, develop, and reproduce rapidly. This provides a burst of food at just the right time for many Arctic-nesting shorebirds, such as phalaropes and sandpipers. Adults and juveniles feast on aquatic Chironomid larvae, Crane Fly larvae, and other fly larvae, along with other aquatic and terrestrial insects.

Caddisflies don't always find secure retreats inside their cases! This solitary sandpiper has captured a caddisfly larva by the head and is shaking the case off.

A female harlequin duck and her chick cruise along the edge of a stream looking for an aquatic insect meal.

Because harlequin ducks are usually seen on salt water, they seem like unlikely birds to rely on aquatic insects. In fact, these tough little ducks nest along fast-moving freshwater streams and forage much of the summer on mayflies, stoneflies, caddisflies, Chironomids, and others. Once hatched, the fuzzy ducklings plunge into the rapids with their mothers, catching the same prey.

American dippers probably know aquatic insects better than any other Alaskan birds. These compact little gray songbirds live their whole lives in and near fast-moving mountain streams throughout Alaska, and they catch almost all their food—including aquatic insects, worms, fish, and fish eggs—



American dippers seem to especially like caddisflies. They will "shuck" caddisflies from their cases by shaking or pounding them against rocks or ice.

underwater. Dippers catch aquatic insects by ducking their heads underwater and searching the stream bottom with their keen eyes, then pouncing on or chasing down their prey. Sometimes they dive and "fly" underwater, holding their own against strong currents, or turn over stones to catch insects hiding below.

Birds that nest near water often rely on aquatic insects to feed their growing chicks. Bohemian waxwings are known to capture emerging adult aquatic insects such as mayflies, stoneflies, and even adult dragonflies. Rusty blackbirds feed on the ground along the edge of the water, where emerging insects are easy pickings. Bank swallows also capture many adult aquatic insects. Northern waterthrushes are closely tied to moving water, finding and catching aquatic insects. Some birds of prey

This American dipper is preparing to feed a stonefly larva to its chicks in a nearby nest.

Dragonflies are especially important food for some birds, such as this rusty blackbird, that nest near lakes and ponds

Once its aquatic stage is complete, a mayfly larva may crawl ashore to emerge. The emerged insect is called a subimago, a stage that looks much like the adult but with cloudy, slightly-fringed wings. For the next day or two, the subimago will stay close to the stream, until it molts its exoskeleton for the last time, becoming a reproductive adult. During this time it may be vulnerable to predation by birds such as this hermit thrush.

Swallows, such as this violet-green swallow, are often seen hawking recently emerged aquatic insects over streams and ponds.

savor aquatic insects. American kestrels are very small falcons that specialize in "hawking" or snatching insects from the air. Dragonflies are favorite prey of recently fledged young and migrating kestrels.

Among the most productive bird habitats in Alaska are the thickets of alder, willow, and cottonwood lining the shores of lakes and streams and covering gravel bars in large braided rivers. Countless warblers, such as this yellow-rumped warbler, and other songbirds glean adult aquatic insects from the foliage of these riparian thickets.

Amphibian food

All eight of Alaska's amphibian species feed on insects at some point in their lives. Northwestern salamanders, long-toed salamanders, and rough-skinned newts all feed on aquatic insects when they themselves are aquatic larvae. After they metamorphose to adults, they continue the insect feast. Wood frogs, Columbia spotted frogs, and western toads, plus non-native Pacific chorus frogs and red-legged frogs, feed heavily on insects as adults.

Most of Alaska's frogs and toads, such as this wood frog, feed on adult aquatic insects when they return to lay their eggs in ponds.

Mammal food

Amazingly, there is an Alaskan mammal that subsists largely on aquatic insects. The water shrew is a tiny mammal that frequents ponds and streams. Although it looks mouselike, it's not a rodent. Water shrews are outstanding swimmers and divers. They can use their sense of smell underwater, by blowing bubbles from their noses, then pulling the air back in to detect the scent of prey.

Photo ©B. 'Moose' Peterson/arden.com

The water shrew frequents ponds and streams and feeds mostly on aquatic insects.

Bats aren't usually associated with Alaska, but there are five species of these flying mammals in the state, and all five feed on insects. Little brown bats and silver-haired bats, in particular, are known to forage over water, and to feed on adult aquatic insects such as Mosquitoes and caddisflies.

Plant food

Aquatic insects also feed some of Alaska's carnivorous plants. Sundews are common plants of bog habitats throughout the state. They capture insects with sticky hairs, then exude digestive liquids and absorb nutrients from the dissolving bug. Bladderworts have an even more clever style of hunting. Urn-shaped growths on the bladderwort stem are vacuum-powered traps. When an insect brushes against sensitive hairs near the trap entrance, it is sucked into the interior of the bladder where it is slowly digested.

Sundew plants often line the edges of bog and tundra ponds throughout Alaska. Adult aquatic insects, such as this Hudsonian Whiteface dragonfly, often fall prey to these carnivorous plants.

Orchids attract many insects, such as this Dance Fly, to drink nectar. When an insect reaches in to sip the sweet substance, packets of orchid pollen called pollinia stick to it, and are carried to the next orchid the insect visits. You can see the pollinia attached to this Dance Fly's head and proboscis.

Pollinators

When we think about what insects contribute to our lives, we often overlook a very critical service: pollination. Pollination is the process of fertilizing female flower parts with pollen from male flower parts, allowing the female flower parts to develop seeds and fruits. Many plants have evolved to rely on insects as pollinators, and many aquatic insects are important to pollinating some of our most important and beloved plants. Adult Flower Flies, Mosquitoes, Chironomids, and some moths that have aquatic or semi-aquatic stages, are important pollinators.

Aquatic insects as decomposers

As munchers of dead salmon, fallen leaves, and other debris, aquatic insects break things down. This helps release into a stream nutrients that would otherwise be tied up in debris. Thus, aquatic insects are important in the nutrient and carbon cycles, contributing to the richness of streamside soils, as well as nutrient flow from streams into lakes, estuaries, and the ocean.

Aquatic insects and us

Have you ever eaten Alaskan salmon? Have you enjoyed watching swallows swoop or ducks dabble? If so, you've benefited from aquatic insects, which are important food for young salmon and birds alike. But aquatic insects affect human life in more direct ways than founding food chains. They bite us, bug us, teach us, entertain us, and even help us catch fish.

Aquatic insects as parasites

It's a rare Alaskan—or visitor to Alaska—who has not donated blood to an aquatic insect. Almost all of Alaska's notorious biting insects are aquatic or semiaquatic during their larval stages. Mosquito and Black Fly larvae live under water: Mosquitoes usually in still water and Black Flies in running water. Horse Flies and Deer Flies, and the tiny Biting Midges known as "no-see-ums" lay their eggs in or near water, and the larvae mature in the water or in very moist environments such as mud or silt.

One of Alaska's most annoying bugs is the adult Biting Midge. These tiny "no-see-ums" are not easily repelled by "Mosquito" repellent and can get through most window screens and bug nets. Despite their meager size (as small as this letter "o"), they have well-developed cutting teeth and mandibles that inflict painful bites as the bugs search for capillaries.

Across much of the world, the bites of blood-sucking insects such as Mosquitoes can transmit diseases that cause serious harm to human and animal health. Fortunately, at least for now, Alaska's climate keeps us relatively free of such diseases. For example, our chilly weather and short seasons prevent the malaria-causing organism *Plasmodium falciparum* from completing its growth cycle within its Mosquito host, and the particular Mosquito species that carries the malaria organism does not quite reach Alaska. Unfortunately, one of the consequences of climate change is a warmer Alaska, which could, in time, lead to more insect-borne diseases invading the state.

Indicators of water quality

Streams, ponds, and other surface waters are the lifeblood of Alaska's environment, and the health of our waters directly affects the health of our communities. Keeping track of water quality is an important part of monitoring the state of our environment. To do this, we can enlist the aid of aquatic insects as tiny water quality technicians.

Aquatic insects make great monitors. They are abundant and easily sampled. Because sensitivity to pollution varies among species—some are extremely susceptible, others more hardy or pollution-tolerant—they can indicate water health issues. Insects' short life cycles also allow their populations to respond fairly quickly to environmental change.

Simply collecting and analyzing a water sample doesn't give the best picture of the health of a stream or pond. Pollutants may enter the water occasionally (such as after a spill or a storm) and be there for only a short time, so they can be missed by "snapshot" water samples. As full-time residents of their home waters, aquatic insects form a community that reflects what has happened to the stream over time.

To "listen to the insects" in a stream or pond, scientists collect samples from different habitats. They then count and identify the different types of bugs. The resulting data represent that water body's invertebrate demographics. Future samples can then be compared to standards for healthy waters, or with that water body's baseline data, to see if there are trends. Is the abundance of pollution-tolerant species on the rise? Have sensitive species all but vanished within the last three years? The answers to such questions help us find out if the health of a given stream is stable, or if it is threatened by pollution, climate change, or other factors.

"The big three"

Changes in water quality can be the first sign of deteriorating stream health. Three groups of aquatic insects are considered especially important in monitoring water quality of streams. Most caddisflies, mayflies, and stoneflies are sensitive to pollution, low oxygen levels, and other problems. Changes in the populations and species diversities of these groups can indicate deteriorating stream health—or improving conditions. Their populations and diversities can also be used to help get a rough idea of the quality of a newly-monitored stream: when caddisflies, stoneflies, and mayflies are collectively the dominant insect groups in a sample, the stream is considered relatively healthy.

Caddisfly

Mayfly

Stonefly

Education

Aquatic insects are also great teachers. Every year, throughout Alaska, students of all ages take field trips to local streams and ponds, where they swoop nets through the water, then empty the contents into pans on the shore. After the initial squeals of surprise and squeamishness at the myriad little crawlies they've captured, the students sort the critters into ice-cube trays. They gaze through magnifying glasses, taking notes and making sketches, marveling at mayfly nymphs' waving gills and the cleverly constructed cases of caddisfly larvae.

In the field and in the classroom, the tiny invertebrates teach endless lessons: about insect anatomy, about classification, about adaptations to aquatic life. Through studying aquatic insects, students become aware of stream food chains and food webs, and nutrient cycles. Perhaps most importantly, they learn how water connects our human world to the lives of insects.

Capturing, holding and releasing an adult dragonfly can be a life-changing experience.

Alaska "flies"

Alaska's major game fish include salmon, trout, char, grayling, whitefish, and pike. Most such large fish are predatory, so flyfishers trying to catch them will usually fish with "streamers" (fishing flies that imitate small fish) or other large patterns.

But flyfishers seeking aquatic insect "specialists" such as grayling will often use flies that imitate aquatic insect larvae or adults, such as this Black Fly pattern.