

WATER: River Bugs (*aka Aquatic Benthic Macroinvertebrates*)



Of all known animals, more than 95% are **invertebrates**—animals without a backbone. **Vertebrates**, in contrast, are animals with a backbone or vertebral column, including birds, mammals (*humans*), reptiles, amphibians, and fish. Because many invertebrates stay in one area and are easy to collect, they are widely used to assess freshwater ecosystem health and pollution levels.

Freshwater **macroinvertebrates**—organisms large enough to see *without* a microscope—are an important food source for fish, amphibians, and birds. They also play a vital role in aquatic ecosystems by breaking down and recycling organic material. Aside from a few species such as mosquitoes and gnats, most are harmless to humans.

Like humans, macroinvertebrates go through different life stages as they grow and develop. **Larvae** are often worm-like and undergo major changes before becoming adults, while **nymphs** resemble smaller versions of the adult form and change more gradually as they mature.

During sampling in the *San Diego River*, we collect aquatic benthic macroinvertebrates— bottom dwelling organisms that live in the water. By disturbing the silty riverbed, we uncover species with different levels of **sensitivity to pollution** and habitat disturbance.

Because of their sensitivity and ecological importance, macroinvertebrates are excellent indicators of **water quality**. A healthy river contains a variety of both sensitive and tolerant species, while the absence of sensitive species often signals poor water quality.

These organisms are used more than any other group to assess the health of freshwater ecosystems. Because many invertebrates remain in one area and are relatively easy to collect, they provide reliable indicators of pollution levels and overall environmental conditions in a specific habitat.

Water Quality Indicator



This guide introduces **aquatic benthic macroinvertebrates** commonly found in the San Diego River. These are small animals—like insects, worms, and crustaceans—that live on the river bottom and play a vital role in the ecosystem. The guide uses a color-coded *Water Quality Indicator* to show how much pollution each species can tolerate. By identifying which macroinvertebrates are present or missing, we can quickly assess the health of the river and detect signs of pollution or environmental changes.

The list starts with the most sensitive species (green), then moderately tolerant (yellow), and finally the most pollution-tolerant (red). Use the shortcut links on the left to find specific animals and click on species to learn more about its characteristics, adaptations, and role in the river ecosystem.

The species list is organized by sensitivity to pollution: green (sensitive species) come first, followed by yellow (moderately tolerant species), and then red (pollution-tolerant species). Within each color group, animals are listed alphabetically. This structure makes it easy to identify which species indicate clean water and which can survive in more polluted environments.

- **GREEN:** Highly sensitive species. These animals require very clean, well-oxygenated water to survive. Their presence is a strong sign of excellent water quality.
- **YELLOW:** Moderately tolerant species. These animals can survive in water with some pollution, but still need decent conditions. Finding these species suggests the river is somewhat healthy but may have some pollution.
- **RED:** Pollution-tolerant species. These animals can live in dirty, low-oxygen water where most others cannot. If only red group species are found, it usually means the river is highly polluted.

GREEN: Common Local Aquatic Benthic Macroinvertebrates

Caddisfly Larva

SENSITIVE

Size: 3mm-30mm

Food: Detritus

Cycle: Egg

Predator: Fish

Fun Facts: Trichoptera, (caddisflies) are insects with aquatic larvae and terrestrial adults. Adult caddisflies have short lifespans and are popular in fly fishing because they are a favorite food of many fish.

Caddisfly larvae use silk to construct protective cases, often reinforcing them with gravel, sand, twigs, bits of plants, or other debris in their environment. These cases provide shelter from predators and fast currents, making survival easier. Caddisfly larvae have diverse feeding strategies: some are predators, others shred leaves, graze on algae, or collect tiny particles from the water using silk nets they spin. This variety in feeding helps caddisflies play multiple roles in aquatic ecosystems.

~ Arthropoda/Insecta/Trichoptera



Copepods

SENSITIVE

Size: 0.5mm-5mm

Food: Plankton

Cycle: Egg, Nauplius

Predator: Fish

Fun Facts: Copepoda, (oar foot in Ancient Greek), refers to their paddle-shaped swimming legs. These tiny crustaceans are found world-wide, in both freshwater and saltwater. They reproduce quickly, with females frequently seen carrying egg sacs attached to their bodies. Copepods serve as a crucial food source for many fish and are vital links in aquatic food webs.

~ Arthropoda/ Crustacea/Copepoda



Copepods usually have one eye like a cyclops; in fact, the most common freshwater copepod's genus is named after Cyclops. The character "Plankton" from SpongeBob is based on a marine Copepod. After hatching, the Copepod enters the Nauplius stage, which is so different from the adult form that it was once considered a separate species until 1832. Because they have hearts, Copepods absorb oxygen directly into their bodies and need high levels of dissolved oxygen. They can be used as bio-indicators for higher oxygen levels.

Damselfly Nymph

SENSITIVE

Size: 13mm-68mm

Food: Plant detritus

Cycle: Eggs, Nymph

Eggs: Lay eggs

Predator: Fish

Fun Facts: Damselfly nymphs have three leaf-like gills at the end of their abdomen, while dragonfly nymphs breathe through internal gills. Damselfly nymphs swim with fish-like movements, using their gills as a tail fin for propulsion. Their slender bodies are designed to anchor themselves securely in fast-moving water, helping them avoid being swept away by currents.

~ *Insecta/Odonata/ Zygoptera*



Damselfly nymphs are more sensitive to low dissolved oxygen levels and suspended fine particulate matter, and indicate good water quality. Damselfly nymphs are slender compared to dragonfly nymphs. Their abdomen terminates in three caudal gills. Damselfly nymphs range in color from black, brown, green, and yellow. In combination with body shape, the mottled patterns are very well camouflaged.

Daphnia

SENSITIVE

Size: 0.2mm-5mm

Food: Filter Feeder

Cycle: Egg, Juvenile, Adolescent

Predator: Fish

Fun Facts: Because their carapace (shell) is mostly transparent, it's possible to observe their beating hearts and, occasionally, even the movement of their blood under a microscope.

~ *Crustacea/Branchiopoda /Cladocera/Daphnia*



Daphnia can be found in almost any permanent body of water. They are mainly freshwater and densely populate most rivers, lakes, and ponds. Because of their thin membranes and transparent carapace, scientists observe the physiological effects of drugs (alcohol, caffeine, etc.) and pollutants on the body. Some reproduce asexually. They require clean water because they are sensitive to toxicity and changes in water chemistry.

Dobson Fly Larva

SENSITIVE

Size: 25mm-90mm

Food: Mayflies, caddisflies, stoneflies, chironomid

Cycle: Egg, Larva

Predator: Fish

Fun Facts: Primarily nocturnal, they ambush prey in the middle of riffles, where abundant oxygen and turbulent water stir up potential food. Male antennae are especially elongated, extending even beyond the mandibles.

~ *Insecta/Megaloptera/Corydalidae*



Adult males have long, curved mandibles—though not all species have them. These insects live only in clean or moderately clean environments because they're sensitive to pollution.

Gilled Snail

SENSITIVE

Size: 3mm-60mm

Food: Plant detritus

Species: Consist of Marine, Land and Freshwater

Eggs: Lay eggs

Predator: Fish

Fun Facts: These snails have gills—hence the name “Prosobranchia,” which means their gills are located in front of the heart. Their trapdoor-like **operculum** attaches to the upper surface of the foot. When closed, it separates the shell aperture from the animal's soft parts. The shell opens to the **right**.

~ *Mollusca/Gastropoda/Prosobranchia*



Gilled snails are important indicator species, recognized by their right-opening shells that maintain a consistent shape throughout their lives. Because they require high levels of dissolved oxygen, their presence indicates a clean, healthy river. Because they cannot survive in polluted water, the presence of gilled snails indicates excellent water quality.

Mayfly Nymph

SENSITIVE

Size: 2mm-30mm

Food: Bloodworms, snails

Cycle: Nymph (incomplete metamorphosis)

Predator: Fish

Fun Facts: There are over 3,000 known mayfly species worldwide. Their young, called "naiads" or "nymphs," live in freshwater and signal a clean, oxygen-rich environment.

Mayflies spend only a single day as adults, but can remain nymphs for years. Their name comes from their mass emergence in May, while "Ephemeros" means "lasting a day" and "ptera" means "wings." As one of the oldest insects, mayflies have long tails and wings that never fold flat over their bodies. Nymphs are easy to spot by their thick wing pads and three long tails.

~ *Insecta/Pterygota/Ephemeroptera*



Stonefly Nymph

SENSITIVE

Size: 6mm-30mm

Food: Detritus

Cycle: Eggs, pupa, larvae

Predator: Fish

Fun Facts: Plecoptera comes from Greek, meaning "braided wings"—a nod to the way adults fold their two hind wings into pleats over their abdomen so they fit under the front wings. Stoneflies are well-represented in the fossil record, with ancestors dating back about 60 million years.

Nymphs resemble wingless adults with external gills under their abdomen and thorax. Nymphs have two long, thin tails and are almost always on submerged stones or rocks. These animals are intolerant of pollutants and prefer quick-moving, clean water.

~ *Coleoptera/Plecoptera*



Water Beetle Nymph

~ *Insecta/Coleoptera/Dytiscidae/dytiscus*

SENSITIVE

Size: 3mm-45mm

Food: Detritus

Cycle: Eggs, pupa, larvae

Predator: Fish

Fun Facts: Insects have the highest species diversity than all other animals. Beetles have the highest diversity of all insects. Some water beetles collect dissolved air bubbles on their patches of non-wettable hairs.

The word "Beetle" comes from Old English "bitula" which means "to bite," referring to the prominent, strong jaws found in adult beetles. "Coleoptera" comes from Greek "koleon" meaning sheathed and "ptera" meaning wings. This refers to the hardened front wings that cover the hind wings in a protective casing. Found more in still water than in flowing water.



Water-Penny Larvae

~ *Insecta /Coleoptera/Psephenidae*

SENSITIVE

Size: 5mm-10mm

Food: Algae

Cycle: Larvae

Predator: Fish, Birds and Mammals

Fun Facts: The larvae spend their time clinging to the undersides of submerged rocks in fresh flowing bodies of water – mostly rivers and streams but occasionally lakes with high wave action. As adults, they are capable of flight.

Water penny larvae cling to the undersides or sides of stones and other submerged objects in flowing, unpolluted water. Biologists can gauge the health of a stream by taking a census of the aquatic insects that live in it. Because water pennies cannot tolerate pollution, high sedimentation, and high amounts of algae and fungi, their presence or absence in a stream is an indicator of the stream's water quality.



YELLOW: Common Local Aquatic Benthic Macroinvertebrates

Dragonfly Nymph

MODERATE

Size: 13mm-68mm

Food: Tadpoles and small fish

Cycle: Eggs, Nymph, Instar

Predator: Fish

Fun Facts: Both adults and nymphs are voracious predators. The majority of their lives are spent as nymphs. They have to molt up to 15 times to become sexually mature and reproduce for a few days or weeks.

Dragonfly nymphs can look similar to damselfly nymphs, but there are a few key differences. Dragonfly nymphs have internal gills, while damselfly nymphs have three feather-like gill tails extending from the end of their bodies.

Dragonfly nymphs are also generally shorter and thicker in shape. They can move surprisingly fast using a form of jet propulsion — expelling water from their bodies to rapidly propel themselves through the water.

~ *Insecta/Odonata/Anisoptera*



Fingernail Clam

MODERATE

Size: 5mm-12mm

Food: Filter Feeder

Cycle: Eggs

Predator: Fish, Birds, and Mammals

Fun Facts: Fingernail clams, also called pill clams or pea clams, are members of a family of small to tiny freshwater clams that are common but rarely noticed. Two, mirror-image shells hinged together.

Fingernail clams are found in a variety of aquatic habitats, usually in places with mucky or sandy substrates, and usually at or just under the bottom substrate. Some types of fingernail clams will also crawl around on submerged aquatic plants or other objects, using their muscular foot. Different species have different habitat preferences. They have tubelike siphons that draw water and tiny, drifting food particles into the shell cavity. They remove unwanted organic matter and clarify the water.

~ *Bivalvia/Sphaeriida/Sphaeriidae*



Flatworm / Planarians

~ Eumetazoa/Platyhelminthes/Turbellaria

MODERATE

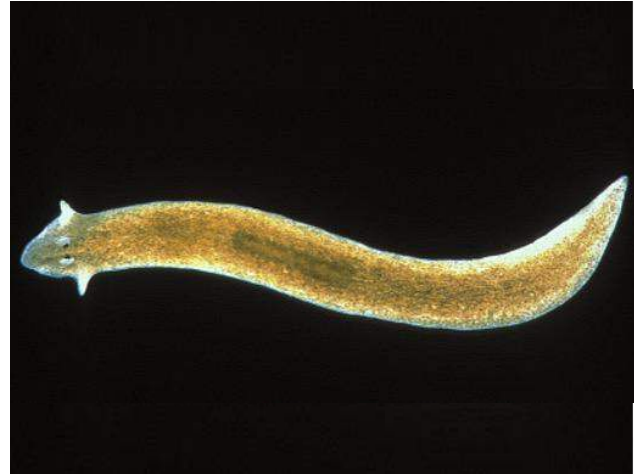
Size: 5mm-20mm

Food: Carnivores, Scavengers or Herbivores

Cycle: Eggs

Predator: Fish, birds

Fun Facts: The other members of this phylum are parasites and need to live within other organisms, but flatworms live outside a host. There are 200 freshwater species in North America identified by the triangular head and the “cross-eyed” eye spots. If a flatworm is cut into several pieces, the pieces may grow into complete flatworms.



The digestive tract only has one hole that functions as both mouth and anus. “Turbellaria” refers to the minute turbulence in the water the tiny hairs on the flatworm cause as the organism glides on surfaces. Since they need dissolved oxygen which enters the flatworm over the surface of their body, they require moderately clean water. If flatworms are present and there is a lack of other species, it indicates a high level of pollution from organic matter.

Leeches

~ Annelida/Clitellata/Hirudinea

MODERATE

Size: 4mm-450mm

Food: Blood, worms, snails

Cycle: Eggs are brooded by parents

Predator: Fish

Fun Facts: Leeches are segmented worms closely related to earthworms; both have a clitellum (smooth thick section near the head).



Just like worms, leeches move by stretching and elongating their bodies, and have suckers on both ends. Only a few are blood suckers, many predate or prey on insect larvae by using a piercing proboscis (a slender, tubular organ in the head). Most species are moderately tolerant of pollutants and low dissolved oxygen.

Scud

~ Crustacea/Malacostraca/Amphipoda/Gammaridea

MODERATE

Size: 5mm-20mm

Food: Algae and detritus

Species: 1,900 fresh water species

Eggs: Egg mortality is 25–50%

Live Cycle: No larva stage. Young resemble adults.

Fun Facts: Named for Norwegian word “skudda” – meaning “push.” “Amphi” means “both” and “poda” means “foot” which describes the two types of legs, those that are longer designed for walking and the shorter ones for swimming.



Like fleas, scuds are streamlined with arched, laterally flattened bodies that help them move efficiently through water. Their front section contains the eyes, antennae, and mouth, while seven pairs of thoracic legs are used for climbing and walking—two ending in claws. Gills are located at the base of these legs, and specialized abdominal limbs help circulate oxygenated water over them. The abdomen has six segments with shorter legs used for swimming and jumping. Scuds prefer dark environments and rely heavily on their antennae to sense touch and smell.

Seed Shrimp

~ Anthropoda/Crustacea/Ostracoda

MODERATE

Size: 1mm

Food: Plankton and detritus

Cycle: Egg, Nauplias, Juvenile

Predator: Both aquatic and terrestrial

Fun Facts: Some ostracods have bio-luminesces. A species found off the coasts of Japan were “placed in jars during WWII to read maps at night. Ostracods are some of the oldest crustaceans found. Fossil records date back to around 440 million years ago.



These tiny, seed-shaped crustaceans enclosed in a bivalve-like shell. Unlike many aquatic animals, they lack gills and instead absorb oxygen through branchial plates. Ostracods swim with their antennae and small appendages, while fine sensory hairs on their shells help them sense their surroundings. When threatened, they quickly retract their antennae, snap their shells shut, and sink to the bottom for protection. Although they look like miniature clams, ostracods are actually more closely related to shrimp and other crustaceans, sharing the jointed appendages typical of the subphylum Crustacea.

Water Boatman

MODERATE

Size: 13mm

Food: Tadpoles and small fish

Cycle: Eggs, Nymph, Instar

Predator: Fish, birds

Fun Facts: Water Boatman can't breathe under water. They take bubbles of air under its wings and around its abdomen making it so buoyant that it must grab vegetation in order to stay underwater. They also pick up dissolved oxygen from the water.

Boatman prefer still water with aquatic plants and are more active in the dark. They move by rowing their flattened third pair of legs and grab plant stems in a head-down position. Their legs have small hairs called filaments to help them paddle. To attract mates, the males rub an area on their front legs against their head to "chirp" underwater. Both the eggs and adults are eaten by birds and humans. The eggs have been referred to as an Egyptian and Mexican delicacy. In Mexico the eggs have been harvested to make a dish called "hautle".

~ *Insecta/Hemiptera/Corixidae*



Water Mite

MODERATE

Size: 2mm-3mm

Food: Parasitic

Species: 1,900 fresh water species

Eggs: Egg mortality is 25–50%

Live Cycle: No larva stage. Young resemble adults.

Fun Facts: "Mite" comes from old English meaning very small coin, and it stuck with mites because of their size and shape. Water mites are some of the most abundant and diverse groups of benthic arthropods, composed of 6,000 described species.

~ *Arachnida/Trombidiformes/Hydrachnidia*



Water mites are related to spiders. Larvae are the only water mite life stage to have parasitic relationships with other organisms. Larval mites parasitize other benthic invertebrates and have been used to control mosquito populations. A few species of water mites are even cannibalistic.

RED: Common Local Aquatic Benthic Macroinvertebrates

Aquatic Worm

~ *Oligochaeta/Lumbriculida/Lumbriculidae*

TOLERANT

Size: Vary

Food: Algae

Cycle:

Predator: Trout and Crayfish

Fun Facts: Little is known about these organisms. They belong to a family of microdrill oligochaetes common in freshwater environments, including streams, lakes, marshes, wells and groundwater. They can survive in low to no dissolved oxygen.



Many aquatic worms can build cocoons to preserve themselves when conditions become uninhabitable. We can often observe their long digestive tract through their translucent skin. Some aquatic worms lack gills or lungs and breathe through their skin. They also use their skin to taste their surroundings!

Black Fly Larva

~ *Diptera/Simuliidae/Simulium*

TOLERANT

Size: 5mm-8mm

Food: Blood

Cycle: Egg, Larva, Pupa

Predator: Fish, frogs

Fun Facts: Most black flies feed on the blood of mammals, although the males feed mainly on nectar. Black flies, a common nuisance to humans, also spread diseases like River Blindness. Most cases of River Blindness are found in sub-Saharan Africa, Yemen and South America.



They use tiny hooks at the ends of their abdomens to cling to the substrate and silk holdfasts to secure themselves. The foldable fans surround their mouths to funnel food particles to feed. Trout prey when they emerge from the water, ready to fly. They harbor a unique bacterium in their guts that thrives better in more polluted waters. But Black fly larvae cannot survive when pollution causes a major lack of dissolved oxygen.

Crayfish, Crawdads, Crawfish

~ *Malacostraca/Decapoda/Cambaridae*

TOLERANT

Size: 10mm-150mm

Food: Invertebrates, Detritus, Tadpole

Cycle: Egg, Larvae, Juvenile

Predator: Birds, fish

Fun Facts: San Diego's most common crawdad is the Louisiana Red Swamp Crawfish (*Procambarus clarkii*). Introduced to California in the early 1900s, they quickly spread. They can live up to 5-6 years. Many people boil them for food or use them as game fishing bait.



Crawfish are common in other parts of the country and indicate healthier rivers, but the invasive species found locally can tolerate low dissolved oxygen, varied salinity levels, and drought. It is tolerant of various water conditions and grows quickly. Some can withstand ranges in temperature, pH, and alkalinity.

However, they can be sensitive to toxic substances, such as metals and pesticides/herbicides.

Lunged Snail

~ *Mollusca/Gastropoda/Pulmonata/Viviparidae*

TOLERANT

Size: 3mm-50mm

Food: Plant detritus

Species: Consist of Marine, Land and Freshwater

Cycle: Eggs

Predator: Fish

Fun Facts: Does not have an Operculum (the trap door that closes up the shell), however can create mucus seal that allows it to aestivate in substrate when conditions are poor and trap air in its shell. Most pulmonated are hermaphroditic, and have both female and male reproductive parts.



The shell of a lunged snail opens to the **left**. If these snails are found in abundance, it indicates a high level of river pollution. They can withstand high levels of organic and nutrient pollution that reduce dissolved oxygen because their lungs allow them to breathe air.

Midge Fly Larva (Bloodworm)

TOLERANT

Size: 2mm-20mm

Food: Plankton, organic matter, and detritus

Cycle: Eggs, Larva Stage 1, 2, and 3, Pupa, Fly

Predator: Fish

Fun Facts: Called “bloodworms” because they are red and wiggle even though they are not closely related to worms. They are red because their bodies have hemoglobin – the same as in our blood – to deliver dissolved oxygen to their bodies. The way they move or wiggle also resembles worms.

~ *Insecta/Chironomidae/Diptera*



Midge fly larvae can live for up to three years before becoming adults. Fish will leap out of the water to catch the adult Midge Flies, which resemble mosquitoes: small, soft-bodied, with long, narrow wings and long, skinny legs. Unlike mosquitoes, Midges do not bite people and fly in large groups called dances. Chironomidae, from ancient Greek, means “pantomimist” or putting on a dance show, like a swarm of flies. They are tolerant of pollution and low oxygen levels due to the abundance of hemoglobin.

Mosquito Larva

TOLERANT

Size: 4mm-18mm

Food: Microorganisms, bacteria, algae, plankton

Cycle: Eggs, Larva, Pupa, Adult: 2 days to 2 weeks

Predator: Fish, birds, bats, dragonflies, frogs

Fun Facts: Mosquitoes can transfer many types of diseases to humans during their biting, and are responsible for the most deaths caused by any animal taxon worldwide. Adult females require a blood meal to develop their eggs.

~ *Insecta/Diptera/Culicidae*



Mosquitoes lay their eggs on the surface of stagnant water. The eggs can survive for a few months in dry conditions. When the eggs hatch, the larvae are motile and feed on algae and organic material, but stay near the surface to breathe with a short snorkel-like siphon at the rear of their abdomen.