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## **Stickleback Species Pairs**

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*Restricted to only a few  
lakes, these fish have  
fascinated scientists  
around the world.*



Ministry of Environment, Lands and Parks



## What are stickleback species pairs?

The fish known collectively as "stickleback species pairs" are small, freshwater fish which are of particular scientific interest because of their evolutionary history and their extremely limited distribution. They are descended from the ocean-dwelling Threespine Stickleback, which is common in coastal marine waters throughout the Northern Hemisphere. Populations of freshwater sticklebacks are often found in low-elevation coastal lakes and streams, but it is only in a very few locations that marine sticklebacks have evolved into species pairs – two distinct but closely related species living side-by-side in the same lake.

## Why are they at risk?

Stickleback species pairs are at risk because their natural distribution is restricted to southwestern British Columbia, where the already large human population is growing rapidly. The entire worldwide distribution of these fish is now restricted to five small lakes – one on Vancouver Island and the others on Texada Island. A species pair that once inhabited a sixth lake, on Lasqueti Island, went extinct in the mid-1990s as a result of the introduction of catfish to this lake. This event highlighted how vulnerable these fish are. We have now lost forever one-sixth of the species pairs.

The coastal lakes that stickleback species pairs inhabit are like tiny islands in a sea of land and salt water, all of which is uninhabitable for these fish. The sticklebacks are dependent on humans not to destroy or degrade these lakes, which are very sen-

sitive to the effects of settlement and industrial activities. Although the lakes are in relatively rural parts of the province, they have already been affected by human activities such as logging, land clearing, water removal, road building, septic tank inputs and introduction of exotic species. The opportunity to enjoy and study these rare species will be lost if steps are not taken to protect their habitats. The sudden extinction of the Lasqueti Island pair emphasizes the extreme susceptibility of these wonderful "made in BC" fish.

## What is their status?

Stickleback species pairs are among the rarest and most threatened species in the world. Unlike many species that are rare in Canada but found elsewhere, the stickleback species pairs exist nowhere outside this corner of our province. One pair – the two species that formerly inhabited Hadley Lake on Lasqueti Island – is now officially extinct. The rest of these unique sticklebacks are abundant and healthy in the five lakes in which they are currently found,

but because their populations are so localized, they remain at risk. They are on the provincial Red List of species being considered for legal designation as Endangered or Threatened. The BC Conservation Data Centre has also placed stickleback species pairs in their highest risk class,

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Category 1, defined as "critically imperilled because of extreme rarity." At the national level, the Committee on the Status of Endangered Wildlife in Canada

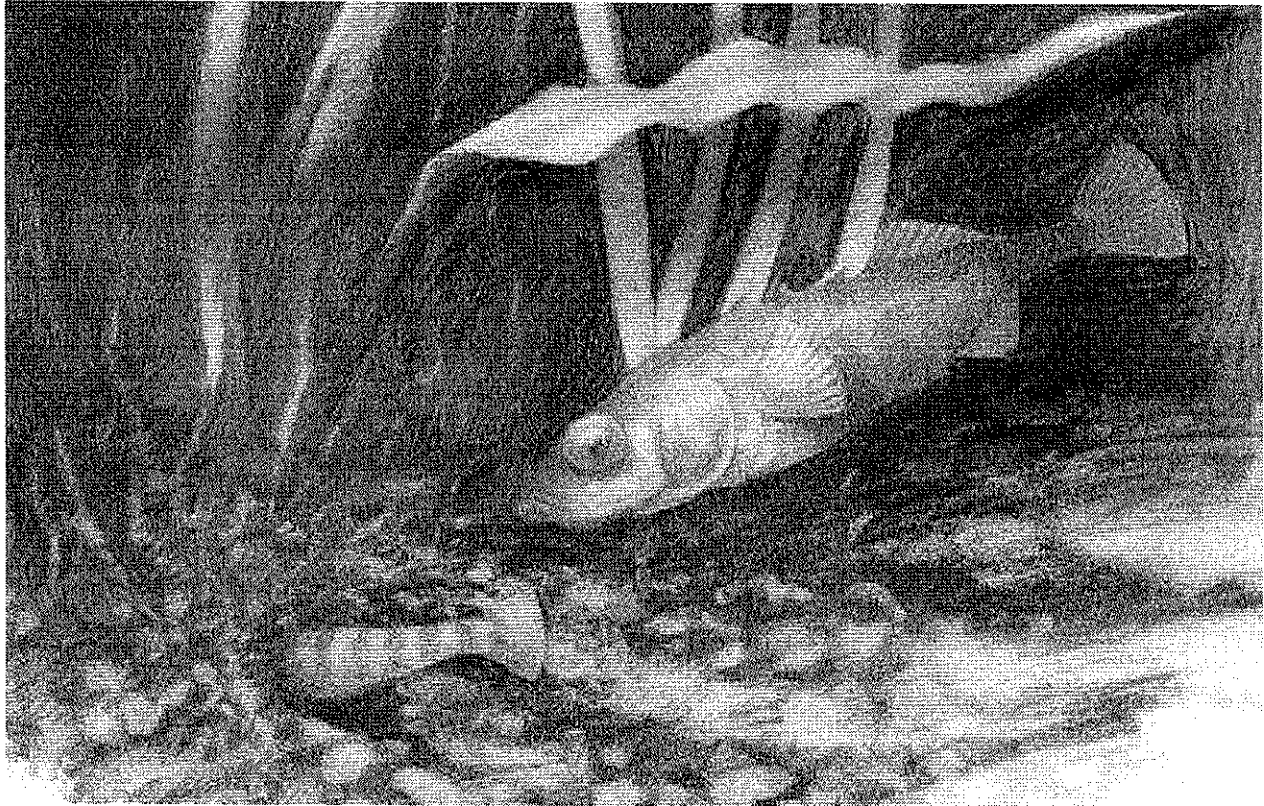
(COSEWIC) has designated the Enos Lake stickleback species pair as Threatened and will soon be determining the designation for the Texada Island pairs.

Stickleback species pairs present a difficult taxonomic (classification) problem for biologists. They are very closely related to, and are descended from, the Threespine Stickleback, *Gasterosteus aculeatus*, but are clearly different species. This raises the question of whether they represent two species of fish living in five (previously six) lakes, or 12 distinct species, now reduced to 10 by the Lasqueti extinctions. Or whether the answer lies somewhere between these possibilities. More research must be done before the stickleback species pairs can be given scientific names. Scientists at the University of British Columbia hope to solve this mystery by comparing the DNA (genetic material) of fish from the different lakes. Regardless of their findings, however, the status of the stickleback species pairs will remain "critically imperilled."

## What do they look like?

Sticklebacks are minnow-like fish usually not more than 70 millimetres in length at maturity. Their common name is derived from the three spines that project upward from the back. Their distinctive armour also includes two stout pelvic spines that project sideways from the belly. These sharp spines, which can be retracted or locked open, present an excellent defence against predators. In addition to spines, sticklebacks have small plates of armour along their sides, and the head region is protected by external bony structures. Despite all the armour, the fish appear quite delicate and are not very powerful swimmers.

Each stickleback species pair is made up of a benthic species and a limnetic species, so named because of where each is found and what they tend to eat. Benthic means associated with the bottom of the lake. Limnetic means associated



A BENTHIC MALE STICKLEBACK WATCHES HIS MATE ENTER THE NEST OPENING

with the water column above the lake bottom. When they are very young it takes a trained eye to tell them apart, but by the time they reach maturity, benthics and limnetics take on quite distinctive features.

Limnetics are delicate, slender, streamlined fish with light-coloured bellies and silvery sides. As adults, limnetics live in the offshore regions of the lake where they feed on plankton. Their colouring allows them to blend into their background when viewed from any angle. Camouflage is especially important for small fish living in the middle of a lake, since there is no place for them to hide from predators. At maturity, limnetics are considerably smaller than benthics, yet have longer, sturdier spines, and lateral plates that are more heavily armoured.

Benthics are much more robust than

limnetics. Their chunky bodies appear almost cumbersome. Additionally, their armour is sometimes reduced to the point where they have only one or two spines, and fewer lateral plates than limnetics. Benthics generally have a dark, mottled colouring that

*In spring and early summer, males shed their camouflage for striking mating colours.*

makes them very difficult to see against the bottom vegetation that is their favoured habitat.

Internal characteristics, particularly feeding structures called gill rakers, can also be used to tell benthics from limnetics. Gill rakers are stiff, finger-like parts of the gill that project into a fish's throat, forming a comb-like sieve that can trap food items. Benthics have only a few short gill rakers. Lim-

netics have many long gill rakers that form a fine-toothed comb that allows them to eat very small plankton.

In the spring and early summer both limnetic and benthic males shed their camouflage for striking mating colours. Males develop bright red throats and brilliant blue eyes and bodies. This colouring makes them attractive to females in much the same way the peacock's bright plumage appeals to the peahen. After mating season, males regain their camouflaged appearance.

#### **What makes them unique?**

Stickleback species pairs are among the youngest species on earth. Scientists believe they have evolved since the end of the last glaciation, approximately 13 000 years ago. The evolution of a new species is usually thought to take millions of years. The speed with which these distinct fish species evolved has intrigued and excited scientists from

around the world. Newspapers, magazines and academic journals have published the story of the discovery of these species, and have followed the ongoing scientific study of the stickleback species pairs.

Typically, marine sticklebacks enter freshwater streams to reproduce. After hatching, young sticklebacks return to the sea to grow and mature. During the last Ice Age, marine sticklebacks likely gained access to and bred in new streams as the glaciers receded. Scientists believe that, after a while, some of the young sticklebacks in each stream no longer returned to the sea to complete their life cycle, but instead stayed resident in fresh water until their death. This process appears to have been repeated many times along the west coast of North America, with the result that freshwater populations in coastal streams and lakes are now common. No one is certain how stickleback species pairs evolved, but scientists think they may be the result of a "double invasion." The theory is that marine sticklebacks gave rise to an initial freshwater lake population which eventually became cut off from the sea for some period of time. When shifting sea levels restored access to the sea, marine sticklebacks had the chance to "invade" the lakes a second time. It is thought that barriers to movement between marine and freshwater environments may have been in place long enough that by the time marine sticklebacks invaded a second time, individuals from the initial invasion no longer recognized them as potential mates. With no interbreeding, a second distinct freshwater species could then evolve from the marine form. This theory suggests that benthics evolved during the initial invasion and that limnetics arose from the second invasion.

As straightforward as the double invasion process sounds, it involved

plenty of luck, as conditions had to be almost perfect for it to work. This may explain why species pairs have not been found elsewhere. One issue that has captured a great deal of attention is the possibility that the process occurred independently in each lake, such that each ended up with a different species pair. In other words, the species pair in Paxton Lake may be different than the pair in Enos Lake. As researchers examine DNA of these fish they will determine whether the double invasion may have occurred at the same time in different locations. Biologists are also working to understand the current ecological processes that allow benthics and limnetics to coexist.

Stickleback species pairs are a scientific treasure. They are a remarkable research subject that will help us understand the biological and physical processes that have given us the tremendous diversity of organisms we see around us.

### How do they reproduce?

In the spring, male sticklebacks change from drab, timid fish that scurry for cover at any sudden movement, to brightly coloured suitors and highly aggressive territory defenders. From April to June, males stake out territories in the shallows of the lake and begin to build nests of debris, small sticks and vegetation held

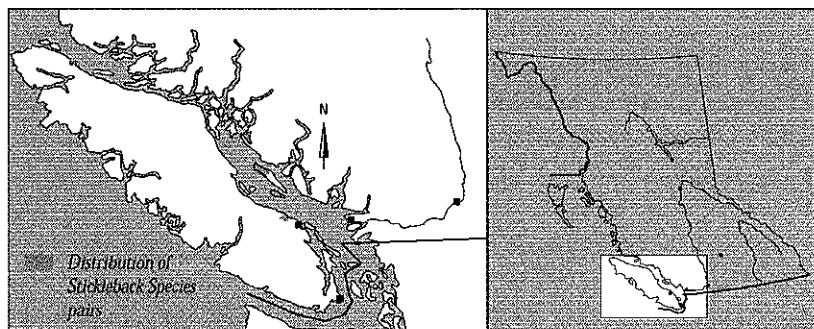
together with glue-like secretions from their kidneys. The nest is a small, roundish "blanket" placed over a shallow trench that the male scoops out with his mouth. The blanket is well-camouflaged against the surface on

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which it is built, and is rarely larger in diameter than twice the length of the male. It has a hole in the centre through which the female must squeeze to deposit her eggs.

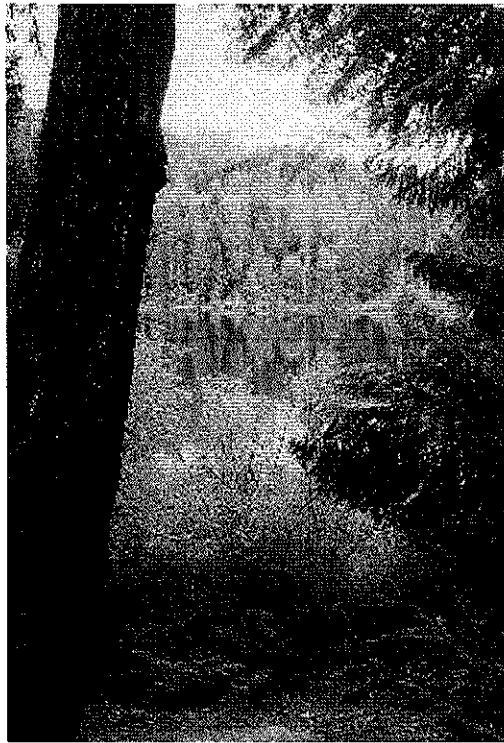
Sticklebacks are renowned for their elaborate mating dances, as well as the males' eye-catching mating colouring. When a female with her abdomen swollen with eggs approaches his territory, the male darts quickly back and forth in a "zig-zag" dance. He then chases the female and nips or bites at her belly. If sufficiently attracted to the male, she responds with a "head up" display, by hovering in place while pointing her head upward. The male then leads the female to the nest and shows her the opening. The female enters to deposit her eggs, and the male quickly follows behind her to fertilize them.

Male sticklebacks try to mate with as many females as possible over a period of three or four days. A large limnetic female might carry 50 to 60 eggs and a large benthic up to 200 eggs. Some limnetic males have been observed with more than 1000 eggs



in one nest. Despite the fact that limnetics and benthics breed at the same time of year, they almost never interbreed.

After the female deposits her eggs in his nest, parental care becomes the responsibility of the male, who expends significant effort in fulfilling his duties. He must fan the eggs with his pectoral fins for a period of about one week. If he fails to keep well-oxygenated water flowing over the eggs, the embryos will die. The male must also vigorously defend the nest, and he does so fearlessly, whether the intruder is an invertebrate, another stickleback or even a human. Males continue to protect the young after they hatch, sometimes for more than a week.



STICKLEBACK PAIRS HAVE EVOLVED IN SMALL COASTAL LAKES LIKE THIS. Todd Hatfield photo

### What do they eat?

Limnetic and benthic sticklebacks eat quite different foods. As adults, limnetics feed primarily in the surface waters away from the lake margins. There they hunt in loose schools for copepods, Daphnia (water fleas) and insect larvae – small invertebrates called zooplankton that are barely visible to the human eye. Limnetic sticklebacks are well adapted to catching these tiny but relatively fast-moving prey. It is fascinating to watch a limnetic stickleback as it draws itself into an S-shape, then strikes forward, opening its mouth at the last moment to engulf a copepod. As young juveniles, limnetics feed at the lake edges among the reeds and submerged plants where they can seek cover if approached by a potential predator, such as a Cutthroat Trout. Toward late summer, limnetics become large and swift enough to escape preda-

tors and their spines are sufficiently big to act as a deterrent. Limnetics then move as schools into the open water to forage for plankton. Benthics, on the other hand, forage along the shallow margins of the lake for larger prey such as snails, clams, dragonfly nymphs, amphipods and the worm-like larvae of midges called chironomids. These invertebrates are found attached to plants, or crawling along rocks or through the mud. Benthics feed by swimming slowly in a start-and-stop fashion over the bottom. They move forward, then pause and hover over a spot. If a prey item is detected on a plant or

*Sticklebacks are fascinating creatures that represent a significant treasure to the world's scientific community.*

rocky surface, the fish darts forward and grabs it. Benthics eat similar food types throughout their life, gradually shifting to much larger prey as they get bigger themselves.

### Where do they live?

Stickleback species pairs are currently found in Priest, Balkwill, Paxton and Emily lakes on Texada Island, and in Enos Lake near Nanoose Bay on Vancouver Island. A now extinct species pair lived until recently in Hadley Lake on Lasqueti Island.

Stickleback species pairs may exist elsewhere, but biologists have surveyed many lakes along the coast of British Columbia, Washington and Alaska for these unique fish, and found them nowhere else. It is possible that species pairs used to exist in other coastal lakes and went extinct before biologists discovered them.

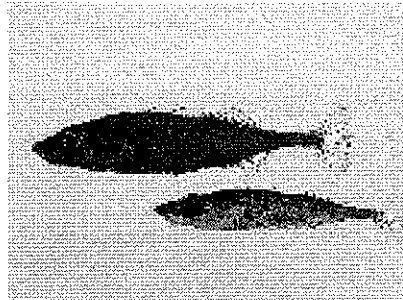
### What can we do?

The lesson in the demise of the Hadley Lake stickleback pair is that preservation of our native fish fauna will come about only through a combined process of public education, strong legislation and proper enforcement.

It is unlikely that catfish were introduced to Hadley Lake with malicious intent. Such introductions can have a variety of sources, such as children capturing live animals at one site and letting them go at another; anglers introducing small fish into lakes in the belief that they are providing better prey for their favourite trout or will improve angling opportunities; aquarium enthusiasts dumping their stock into local lakes; and mistakes being made in the management of natural resources. Legislation alone is not going to prevent such mishaps, even



**BENTHIC MALE STICKLEBACK.**  
*Don McPhail photo*



**BENTHIC (TOP) AND LIMNETIC (BOTTOM) MALE STICKLEBACKS.**  
*Don McPhail photo*



**FEMALE BENTHIC (TOP) AND LIMNETIC (BOTTOM) STICKLEBACKS IN SPAWNING CONDITION.**  
*Don McPhail photo*




**LIMNETIC MALE STICKLEBACK.**  
*Don McPhail photo*

when coupled with proper enforcement. While legislation and enforcement are only part of the answer, public education is probably the most essential ingredient for long-term fish and wildlife conservation.

The question is, how can we create and foster an interest in species like these? Sticklebacks are not the stuff of the evening news. They do not have the mythical stature of Pacific salmon, nor are they ever likely to provide much economic return. But salmon have not always enjoyed the status they have today, and the shift in attitude has come about largely as a result of public education. Salmon are now held in extremely high regard and many citizens volunteer their time to restoring and protecting salmon habitat. The challenge now is to extend this educational success to other species in our native fauna. Public knowledge and awareness probably represent the best hope for preserving indigenous species like the stickleback species pairs.

Sticklebacks are fascinating creatures in their own right and represent a significant treasure to the world's scientific community. However, you don't have to be a scientist to enjoy them. Even casual study of their behaviour and habits amply repays the amateur naturalist. If you are interested in protecting stickleback species pairs or other native fish fauna, there are a variety of actions you can take. You can start by learning more about

these fish and the habitats they rely on. You can take a stewardship role in preserving and managing fish habitat. And you can encourage the study of native species in our public schools. As interesting as these fish are to scientists, it will not be science that preserves sticklebacks for future generations – it will be the diligent work of concerned citizens acting as stewards of the lakes inhabited by stickleback species pairs. 

**FOR MORE INFORMATION ON STICKLEBACK SPECIES PAIRS, CONTACT:**

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**FOR INFORMATION ON RARE SPECIES AND ECOSYSTEMS, CONTACT:**

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