

Rainbow trout (*Oncorhynchus mykiss*)



Photo left: Eric Engbretson, U.S. Fish and Wildlife Service. Right: Ken Hammond, USDA

Common names in English	Rainbow trout. Coast range trout. Redband trout. Kamloops trout. Silver trout. Freshwater salmon. Baiser. Steelhead trout. Hardhead. Kamchatka steelhead. Coast rainbow trout. Coast angel trout.
... and in other languages	Danish: Regnbueørred. Kamchatka-laks. Kamchatka-ørred. Stålhovedørred. Dutch: Regenboogforel. Finnish: Kirjolohi. Teräspääkirjolohi. French: Truite arc-en-ciel. German: Regenbogenforelle. Lachsforelle. Stahlkopfforelle. Icelandic: Regnbogasilungur. Italian: Trota iridea. Japanese: Masu. Nijimasu. Latvian: Varavīksnes forele. Lithuanian: Vaivorykstinis upetakis. Norwegian: Regnbueaure. Regnbueørret. Aure. Polish: Pstrąg tęczy. Portuguese: Truta-arco-iris. Russian: Forel raduzhnaya. Kamchatskaya semga. Mikizha. Spanish: Salmones del Pacífico. Trucha arco iris. Cabeza de acero. Swedish: Regnbåge. Regnbågslox.
Scientific name	<i>Oncorhynchus mykiss</i> . Also commonly known by its former scientific name <i>Salmo gairdnerii</i> . The species is now classified as a salmon and is thus one of the Pacific salmon. Also known as <i>Fario gairdneri</i> , <i>Oncorhynchus kamloops</i> , <i>Parasalmo penshinensis</i> , <i>Salmo gilberti</i> , <i>Salmo irideus</i> , <i>Salmo kamloops</i> , <i>Salmo masoni</i> , <i>Salmo mykiss</i> , <i>Salmo nelsoni</i> , <i>Salmo penshinensis</i> , <i>Salmo purpuratus</i> , <i>Salmo rivulari</i> , <i>Salmo stellatus</i> and <i>Salmo truncates</i> .
Organism group	Ray-finned fishes (Actinopterygii). Salmons (Salmoniformes). Salmonids (Salmonidae).
Size and appearance	1. TWO FORMS OF THE SAME SPECIES <i>Oncorhynchus mykiss</i> has many different names in English, which is not unusual for a species. Just as Swedish, for example, distinguishes between different forms of brown trout <i>Salmo trutta</i> (<i>bäcköring</i> "stream trout", <i>insjööring</i> "lake trout" and <i>havsöring</i> "sea trout"), so in North American descriptions of <i>O. mykiss</i> we often find different common names, in particular <i>rainbow trout</i> and <i>steelhead trout</i> , referring to different life forms, both with the same scientific name. Similar variation can be seen in the German and Danish names for this species, and in Swedish it is known as both <i>regnbåge</i> "rainbow (trout)" and <i>stålhuvudöring</i> "steelhead trout". Rainbow and steelhead trout are thus the same species (<i>Oncorhynchus mykiss</i>). The difference lies in their differing lifestyles, or life history

	<p>strategies, which result in certain differences in colour, body shape and appearance. Rainbows live in fresh waters, while steelheads migrate between rivers and the sea. Which is not to say that a rainbow trout cannot change its way of life and descend to the sea. What is more, there are winter and summer forms of steelhead, depending on the time of year when the fish return to rivers to spawn. Rainbow trout, then, is the name given to the freshwater form of the sea-going (anadromous) form steelhead. Another difference is that steelheads, unlike most other Pacific salmon species, can survive a spawning period and reproduce several years in a row.</p> <p>The form of <i>O. mykiss</i> that has been introduced into Sweden, for cultivation and for stocking in rivers for targeted recreational fishing, was originally the non-migratory form of the species (rainbow trout).</p> <p>2. RAINBOW TROUT: SIZE AND APPEARANCE</p> <p>The body is elongate, similar in shape to that of a brown trout (<i>Salmo trutta</i>).</p> <p>The "rainbow" part of the name comes from the iridescent colours of the males' spawning dress. The non-migratory form of the species found in Swedish waters can most easily be recognized by the broad, reddish purple band along its sides, the pinkish "cheeks", and the black spots on the sides and on the dorsal and caudal fins. In turbid waters, the fish can become almost black, with darker spots.</p> <p>In general, the coloration of the fish varies according to its habitat, its size, and whether or not it is spawning. Rainbow trout living in streams, as well as spawners, are generally darker and their colours more intense, while those in lakes tend to be lighter and more silvery, with a greenish (sometimes steely blue) back and a white underside.</p> <p>When a rainbow trout spawns, the lateral bands turn a deeper red, the fins also become redder, the belly turns grey, and the dark spots become more distinct. As in other salmonids, the male develops a hooked lower jaw during the spawning period.</p> <p>In Swedish waters rainbow trout can weigh up to 15 kg, but normally in the wild they weigh less than 1 kg; farmed individuals weigh more, though rarely over 5 kg. The record for a farmed rainbow trout caught in a put-and-take fishery is reported to be just over 10 kg. In its native North American environment, the species can weigh up to 20 kg. In Sweden, the maximum length is generally said to be around 80 cm, although the figure can vary between about 50 and 80 cm. According to FishBase, the largest <i>Oncorhynchus mykiss</i> recorded have measured 120 cm and weighed in at roughly 25 kg, but these are individuals of the migratory form (steelheads), which are always larger.</p>
May be confused with	Cut-throat trout (<i>Oncorhynchus clarki</i>).
Geographical origin	Western North America: eastern Pacific and fresh waters of the United States west of the Rocky Mountains, from north-western Mexico to the Kuskokwim River in Alaska, and in Canada, in the upper reaches of the Mackenzie River.
First observed in Swedish waters	Was first introduced into Sweden from Germany (albeit unsuccessfully) in 1892.
Occurrence in Swedish seas and coastal areas	Rainbow trout are farmed in both fresh and salt water throughout Sweden, mainly for angling, but also for consumption. According to

	<p>recreational fishermen, it is becoming increasingly common to find rainbow trout in the sea (escapees from fish farms). The Fiskbasen site reports that the species has also been intentionally stocked in the sea, off the Halland coast in south-west Sweden, and individuals from that area have subsequently been found along the Norwegian coast as far north as Trondheim. Similarly, rainbow trout planted in the river Dalälven have turned up in the Gulf of Bothnia and in the Baltic Sea proper, as far south as the Sound and the Belt Sea. (According to another source, escaped rainbows from cage fish farms have also been caught in nets along the coast of Öland – reportedly, fish that had been at large for several years.) Since the 1980s rainbow trout have been present in the sea off the south coast of Skåne, possibly originating from stocks planted in eastern areas of the Baltic. This may suggest that a self-reproducing population is in the process of establishing itself along the Skåne coast.</p> <p>Rainbow trout may only be stocked with a special permit, and then only in waters from which they cannot migrate.</p>
<p>Occurrence in other sea areas</p>	<p><i>Oncorhynchus mykiss</i> has been introduced to most temperate and subarctic regions of the world (except Antarctica). In tropical countries the species is only able to survive in areas above 1,200 m.</p> <p>Rainbow trout is a common aquaculture species throughout Europe, and can be found in rivers, fjords and coastal waters.</p> <p>In the Baltic Sea area, according to Nobanis, the species occurs – as well as in Swedish waters – in Denmark (intentionally introduced from Germany in 1896, occurs in rivers); Finland (intentional introductions, possibly from Germany, in 1898 and in the 1960s, and now to be found in brackish waters); Latvia (intentionally introduced in 1899, occurs in coastal waters, lakes and rivers); Lithuania (deliberately introduced in 1885 and 1965, to be found in lakes); western Russia (intentionally introduced in 1879, for example to Karelia and present-day Leningrad and Murmansk provinces; occurs in lakes); Poland (deliberately introduced in 1882 and 1889, present in lakes and rivers); and Germany (introduced from the United States, intentionally and unintentionally, in 1882).</p> <p>In addition, rainbow trout can be found in Iceland (intentionally introduced from Denmark in 1951, occurs in the sea, lakes and rivers) and Norway (intentionally introduced from Denmark in 1902, now to be found in sea areas, lakes and rivers). In the North Sea area, the species is also present in Belgium, France, the Netherlands and Britain (where the first attempt to introduce the species was made in 1884, directly from the United States). Other countries with populations include Ireland, Spain and Portugal, and the majority of Mediterranean countries.</p>
<p>Probable means of introduction</p>	<p>Aquaculture: intentional cultivation, either for consumption or for stocking in lakes and rivers. Subsequent spread has been unintentional, a result of cultured fish escaping from hatcheries and farms or straying from the waters in which they were stocked.</p>
<p>Habitat(s) in which species occurs</p>	<p>The variant of <i>Oncorhynchus mykiss</i> found in Swedish waters is easy to rear, with modest requirements in terms of temperature and water quality. The species as such is highly adaptable to new environments, including hatcheries, lakes, rivers, ponds and artificial impoundments.</p> <p>Rainbow trout can tolerate water temperatures from almost freezing to roughly 25°C, but does best in waters at around 12°C. It is thus a coldwater rather than a warmwater species. It prefers clean, well-</p>

	<p>oxygenated fresh waters, but also copes well in turbid water with lower levels of oxygen. To spawn, however, it needs flowing, oxygen-rich water. In Sweden the species thrives best in lakes with a pH of over 6.2 and is very susceptible to acidification. Rainbow trout can live at depths ranging from close to the surface to around 200 m. Unlike native Swedish salmonids, they spawn in spring, but there is very little evidence of their reproducing naturally in Swedish waters.</p> <p>The species feeds on crustaceans, snails, aquatic and terrestrial insects, small fish and fish eggs (and also, when farmed, on pellets).</p>
<p>Ecological effects</p>	<p>Problems mentioned in connection with <i>Oncorhynchus mykiss</i> are, above all, the risk of it becoming established and hence competing with native fish species for food and space. There is not considered to be a significant risk of hybridization. Disease transmission, however, is a potential risk.</p> <p>Viral haemorrhagic septicaemia (VHS) is a contagious viral disease that can affect rainbow trout and is transmitted among fish. So far, Sweden, Iceland, Finland and Norway are considered to be free of the form of this disease that chiefly affects the species in fresh waters, but VHS has already been reported from fish farms in Denmark, Germany and other countries. The marine form of the disease (which affects herring and other marine fish species, but only exceptionally rainbow trout) can, however, be observed along the Swedish and Finnish coasts. Fish suffering from VHS exhibit abnormal swimming behaviour (becoming disoriented and "spiralling"), as well as haemorrhaging of various organs. Stocking of farmed fish into the wild has caused outbreaks of the disease in the United States, threatening wild salmonid populations. There are also theories about the disease having been a contributory factor in preventing rainbow trout from establishing self-reproducing populations in Europe.</p> <p>In addition, rainbow trout can act as a carrier of the fish fluke <i>Gyrodactylus salaris</i> and thus pass on this parasite of salmon to wild salmonids. <i>G. salaris</i> is a freshwater parasite, but, depending on salinity and water temperature, can survive for varying lengths of time in brackish water.</p> <p>Feeding as it does on benthic and pelagic invertebrates and fish, <i>O. mykiss</i> competes with native species of fish, amphibians and other organisms for the same food. It has also been reported as competing with indigenous salmonids for spawning grounds and destroying the eggs of such species.</p> <p>Although rainbow trout spawns in spring, whereas Arctic char (<i>Salvelinus alpinus</i>), brown trout and Atlantic salmon (<i>Salmo salar</i>) are autumn spawners, this introduced species may gradually adapt and shift its spawning period to the autumn. This has been observed in Austria, for example. The risk of hybridization between rainbow trout and native Swedish salmonids is extremely small, however, as they belong to different genera with well-established species barriers.</p> <p>What is more, self-reproducing populations of rainbow trout are uncommon in European rivers, although the species does sometimes spawn successfully. There are reported to be eleven self-sustaining stocks in Norway, for instance.</p> <p>On the subject of rainbow trout in Swedish waters, the Department of Aquaculture at the Swedish University of Agricultural Sciences writes: "In Sweden, rainbow trout has been farmed and stocked for around a hundred years, in a great many waters. Self-reproducing populations</p>

have arisen in very few cases indeed. . . . In salmonids, reproduction is generally governed by light (seasonally dependent changes) and changes in temperature. The form of rainbow trout present in Sweden originates from parts of the west coast of North America with very different conditions in terms of climate and light from those found in this country. It may be that the requirements which young rainbow trout have, for example as regards diet and temperature, are not met in Swedish waters, owing to the fact that rainbow trout spawn at the wrong time. . . . There are reports of rainbow trout spawning in many different locations. It is therefore likely that the species also attempts to spawn, for example, in rivers discharging into the Baltic. But in all probability such attempts never produce any surviving offspring."

According to the Swedish National Veterinary Institute (SVA), "the chances of rainbow trout reproducing under Swedish conditions are limited, as in the great majority of cases natural spawning fails".

In general, discussion about the genetic effects of non-native species finding their way into Swedish waters has focused very much on salmonids. Such fish are farmed and stocked on a large scale and, what is more, hatchery-reared fish quite often escape into the wild.

In this context, "genetic effects" means changes in the genetic make-up of native species that can result from the incorporation of genes from the new organisms. The risks associated with introducing non-native populations or genes into the natural environment come under three main headings: extinction, hybridization, and loss of genetic variation.

When closely related species or distinct populations of a single species interbreed, hybridization can result. This can happen if individuals of a non-native species mate with individuals of a native one. The offspring exhibit characteristics differing, to a greater or lesser degree, from those of the native parent. In the long term, this may result in wild populations of a species losing some of their ability to adapt to their environment. Stocked fish, for example, are less well adapted to their new environment than the wild fish with which they mix.

At worst, the introduction and spread of non-native populations or genes may drive native species to extinction. This may happen either because the native species is outcompeted and displaced, or because of genetic changes in the offspring (hybrid) of the alien and native species which mean that the offspring is unable to survive. If the hybrid is fertile, however, the next step may be an exchange of genes with the parent population. Non-native genetic material will then be incorporated into the native species, and in the long run the effect of this could be to eliminate local variants.

Non-indigenous salmonid species that are stocked in Swedish waters, then, may form hybrids with native species. Often these hybrids are fertile, which means that they are able to reproduce in the wild. This is true, for example, of "sparctic char" (also known as "sparctic trout" or "spar", a cross between brook trout *Salvelinus fontinalis* and Arctic char), "larctic char" (lake trout *Salvelinus namaycush* and Arctic char), and "splake" (male brook trout and female lake trout).

Mixing of non-native species or genetic variants with local populations may have implications for Sweden's populations of Arctic char, Atlantic salmon and brown trout. Over time, native salmonid stocks have adapted to conditions in their particular lakes and rivers, gradually becoming genetically distinct from every other stock of the same species. The loss of such local adaptations may leave a population less

	<p>well equipped to survive. Stocking of hatchery-reared fish can also lead to inbreeding depression. This occurs when closely related individuals mate with one another, and may result in offspring that are unviable or have difficulty surviving.</p>
<p>Other effects</p>	<p>Rainbow trout is by far the most popular farmed fish species in Sweden (accounting for some 85 per cent of all cultured fish), as it is easily reared and much in demand as a food fish. Economically, then, it is a very important species and, as the Swedish Aquaculture Association puts it, "rainbow trout forms the base". It is also an economically important and sought-after sport fish (the commonest put-and-take species) – highly prized and "easily caught".</p>
<p style="text-align: center;"><i>FIND OUT MORE</i></p> <ul style="list-style-type: none"> • North European and Baltic Network on Invasive Alien Species: <i>Oncorhynchus mykiss</i> http://www.nobanis.org/speciesInfo.asp?taxaID=909 •  128 kB: North European and Baltic Network on Invasive Alien Species: <i>Oncorhynchus mykiss</i> Factsheet http://www.nobanis.org/files/factsheets/Onchorhynchus_mykiss.pdf • Baltic Sea Alien Species Database: <i>Oncorhynchus mykiss</i> http://www.ku.lt/nemo/directory_details.php?sp_name=Oncorhynchus+mykiss • Alien species in Poland: <i>Oncorhynchus mykiss</i> http://www.iop.krakow.pl/ias/species.asp?197 • ICES Working Group on Environmental Interactions of Mariculture http://www.ices.dk/iceswork/wgdetail.asp?wg=WGEIM •  125 kB: EU-kommissionen: A strategy for the sustainable development of European aquaculture http://www.europa.eu.int/eur-lex/en/com/cnc/2002/com2002_0511en01.pdf •  357 kB: EU-kommissionen: Farmed fish and welfare http://ec.europa.eu/fisheries/publications/farmedfish_en.pdf • Federation of European Aquaculture Producers http://www.feap.info/feap/ • European Aquaculture Society http://www.easonline.org/ • Global Invasive Species Database: <i>Oncorhynchus mykiss</i> http://www.issg.org/database/species/ecology.asp?si=103&fr=1&sts=sss • FishBase: <i>Oncorhynchus mykiss</i> http://www.fishbase.org/summary/SpeciesSummary.php?id=239&lang=English • FAO: Fisheries Global Information System (FIGIS): Cultured Aquatic Species Information Programme <i>Oncorhynchus mykiss</i> http://www.fao.org/figis/servlet/static?dom=culturespecies&xml=Oncorhynchus_mykiss.xml • European Nature Information System Database (EUNIS): <i>Oncorhynchus mykiss</i> http://eunis.eea.europa.eu/species-factsheet.jsp?idSpecies=553&idSpeciesLink=553 •  3,4 MB: Nationaal Natuurhistorisch Museum: Non-indigenous marine and estuarine species in The Netherlands: <i>Oncorhynchus mykiss</i> http://www.marbee.fmns.rug.nl/pdf/marbee/2005-Wolf-ZoolMed.pdf • Scottish Executive Environment and Rural Affairs Dpt: Fisheries Research Services: Rainbow trout http://www.marlab.ac.uk/Delivery/standalone.aspx?contentid=620 • Ittiofauna.org: Il Salmonidi (webbplats om bl.a. laxfiskar i Europa) http://www.ittiofauna.org/webmuseum/pesciossei/salmoniformes/salmonidae/salmonidae.htm • Alaska Department of Fish & Game: Rainbow trout http://www.adfg.state.ak.us/pubs/notebook/fish/rainbow.php • Alaska Department of Fish & Game: Steelhead trout http://www.adfg.state.ak.us/pubs/notebook/fish/steelhd.php • Environment Canada: Do you know steelhead? http://www.pac.dfo-mpo.gc.ca/species/salmon/salmon_facts/steelhead_e.htm • Nova Scotia Fisheries and Aquaculture: Rainbow trout http://www.gov.ns.ca/nsaf/sportfishing/species/rain.shtml • University of British Columbia: Rainbow trout and steelhead 	

<http://www.zoology.ubc.ca/%7Ekeeley/rainbow.htm>

- Canadian Sportfishing: Rainbow trout/ Steelhead
http://www.canadian-sportfishing.com/Tips&Techniques/Species_Info/Default1.asp?Species_Name=RAINBOW TROUT/STEELHEAD
- Ontario Federation of Anglers and Hunters: Ontario's fish: Rainbow trout
http://www.ofah.org/fishing/description.cfm?Species=Cold_Water&FishID=23
- National Wildlife Foundation: *Oncorhynchus mykiss*
<http://www.enature.com/fieldguides/detail.asp?shapeID=994&curGroupID=3&lgfromWhere=&curPageNum=9>
- Mt. Baker-Snoqualmie National Forest Pacific Northwest Fisheries Program: Steelhead
http://www.fs.fed.us/r6/fishing/forests/fishresources/mtbsno_salmon.html#steelhead
- Mt. Baker-Snoqualmie National Forest Pacific Northwest Fisheries Program: Rainbow trout
http://www.fs.fed.us/r6/fishing/forests/fishresources/mtbsno_coldwater.html#rainbow
- Wisconsin Sea Grant: *Oncorhynchus mykiss*
<http://www.seagrant.wisc.edu/greatlakesfish/rainbowtrout.html>
- Virginia Fish and Wildlife Information Service: Virtual Aquarium: Rainbow trout
<http://www.cnr.vt.edu/efish/families/raintrout.html>
- Washington Department of Fish and Wildlife: Salmon facts
<http://wdfw.wa.gov/outreach/fishing/salmon.htm>
- US Geological Survey: NAS-Nonindigenous Aquatic Species: *Oncorhynchus mykiss*
<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=910>
- NatureServe Explorer: *Oncorhynchus mykiss*
<http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Oncorhynchus mykiss>
- Trouts and Seasons of The Mountain Village: *Oncorhynchus mykiss*
<http://www.amago.jp.lv/trout/trout32.html>

IMAGES CREDIT

Foto Eric Engbretson. Published by U. S. Fish & Wildlife Services, Digital Library System
<http://images.fws.gov/>

Foto Ken Hammond. Published by U.S. Department of Agricultural Research Service, USDA
<http://www.ars.usda.gov/is/graphics/photos/dec01/95cs2028.htm>

- This factsheet on *Oncorhynchus mykiss* was created on 30 November 2006
- First update: 15 January 2007
- Translated by Martin Naylor on 22 January 2007