

Family Salmonidae

Trout

Salmonids are medium- to large-sized fishes that inhabit a wide range of habitats with clear, cold, and well-oxygenated water. They are native to the northern hemisphere but have been widely introduced for aquaculture, commercial, and recreational fisheries in cold waters worldwide. They have a very diverse and fascinating evolutionary biology, grow to a commercial size, and have good-tasting flesh with few bones. Nevertheless, few groups of fish have been so heavily impacted by human activities. The most significant challenge for salmonid conservation is stocking non-native salmonid species, or populations, for recreational and commercial purposes. In Europe, salmonid stocking has resulted in the genetic pollution of many native populations. Recent molecular studies suggest that genetic pollution of trout is limited in West Asia, as mostly rainbow trout are stocked. However, the over-exploitation of water sources, river regulation (dams, weirs), poaching, and climate change pose significant threats to many trout populations in the region.

Until the late 20th century, virtually all trout native to the West Palearctic were identified as *Salmo trutta*. Many species described in the 19th century are now treated as valid, and many new species have been described in the 21st century, especially from Türkiye. Recent genomic studies indicate that trout populations in the Mediterranean and Ponto-Caspian regions diverged relatively recently, within a timeframe of 0.5–2.5 million years ago. This resulted in minimal to no mitochondrial DNA divergence. Standard molecular approaches, such as cytochrome oxidase

1 barcoding, have been unsuccessful in recognising the diversity of trout in West Asia. This is because all populations have relatively recently separated and, therefore, are not comparable with the evolutionary age of other species of fishes in the region. Species richness, high rates of phenotypic morphological and ecological diversification, and a very low genetic divergence between species make studies on the evolution of trout attractive and challenging. It is evident that recent gene flow and isolation of the populations of trout, particularly in the Mediterranean and Persian Gulf basins, have resulted in the evolution of small morphological differences, which has led to the recognition of a high number of species. Furthermore, natural hybridisation between different trout lineages has probably played an important role in the origin of several populations. This phenomenon requires further investigation into the species of West Asia. In conclusion, the available genomic evidence supports the view that trout are distributed in many isolated populations, which can be distinguished by details in colour and morphology. Should trout be classified as a multi-species taxon or better recognised as populations of one species (*Salmo trutta*) with small differences? This is a debated question and we are curious to follow the research on this in the coming years.

Some authors treat Coregonidae and Thymallidae as subfamilies, a view that is not adopted here. **Further reading.** Stearley & Smith 1993 (systematics); Stearns & Hendry 2004 (evolutionary biology); Geiger et al. 2014 (barcoding); Hashemzadeh Segherloo et al. 2021 (genomic data).

Key to genera of Salmonidae in West Asia

1a - Lateral-line scales very elliptical, reduced to little more than nerve tube, smaller than scales in adjacent rows, with no or little overlap with scales in front or behind.

.....*Salvelinus*

1b - Lateral-line scales roughly circular, as large as or larger than scales in adjacent rows, overlapping with scales in front and behind.

.....2

2a - Caudal with black spots at least on upper lobe, usually on whole fin; flank with a pinkish to red midlateral stripe or band.

.....*Oncorhynchus*

2b - Caudal plain; flank without red midlateral stripe or band.

.....*Salmo*



Oncorhynchus mykiss; Litani drainage, Lebanon; 160 mm SL.

Oncorhynchus mykiss

Common name. Rainbow trout.

Diagnosis. Distinguished from species of *Salmo* by: ● wide, pink to red stripe from head to caudal base (except in sea-run form) / ● caudal with black spots at least on upper lobe, usually on whole fin. Size up to 1000 mm SL.

Distribution. Widespread or stocked from fish farms, especially in Türkiye and Iran. Unclear where established. Native to Kamchatka and south to lower Amur drainage and Pacific basin of North America south to northern Mexico.

Habitat. Stocked in cold lakes, rivers, and streams. Usually not stocked in water with summer temperatures above 25°C or in ponds with very low oxygen concentrations. Spawns on gravel in fast-flowing water.

Biology. Anadromous, lacustrine, and resident forms. Often spawns first time at 1 year, 3–5 years in north, usually in February–May when temperatures rise above 10–15°C. Farmed trout mature August–April, depending on strain. Makes short spawning migrations. Anadromous and

lake forms may undertake long migrations to spawning streams. Females build redds in gravel bottom of moderate to fast-flowing streams or rivers. Breeding populations will not be established if peak juvenile emergence coincides with flood season and cold summer temperatures, and if temperatures do not fall below 13°C. In agonistic behaviour, *O. mykiss* fry dominate *Salmo* fry of similar size, and juvenile and adult *Salmo* dominate similar size rainbow trout. Feeds on a wide range of aquatic and terrestrial invertebrates and small fish. At sea, feeds on fish and cephalopods. Feeding is negligible below 5°C and above 25°C water temperature.

Conservation status. Non-native; introduced for recreational fisheries and as escapees from fish farms.

Further reading. Smith & Stearley 1989 (systematics, nomenclature); Behnke 1992 (diversity); Stearley & Smith 1993 (phylogeny); Zelinsky & Makhrov 2001 (chromosomes); Fausch et al. 2001 (invasion success); Yoğurtçuoğlu et al. 2021c (Türkiye).

Too many species of trout? Twenty-five trout species native to West Asia have been identified, with one non-native species also present. Most of these species have been described based on narrow morphometric and meristic differences and small details in colour and colour pattern. Sympatric trout with different life histories have been treated as distinct species without clear evidence that they are not simply life-history forms. The majority of species have been described by a single population, and none of the species is well-supported by molecular characters, as they are all very young. It is acknowledged that trout in West Asia live in numerous, often small populations, and genomic data demonstrate that these are isolated from each other. This is also the case in other fish species. If we apply the same approach to other fish species, we could describe hundreds or thousands of cyprinids, minnows, loaches, and others isolated for several thousand years. This raises the question of whether we are constrained by the theoretical challenge of distinguishing between populations and species. Many additional trout species will likely be described,

as many isolated populations remain unnamed. Alternatively, could we find ways to tackle the number of trout species by distinguishing between species and isolated populations with some private characters? Unfortunately, or happily, there is a lack of consensus on how to distinguish, describe and recognise trout species as valid. This allows discussions, diversity of opinions, and pluralism, which are all important for scientific progress. Nonetheless, it is important to remember that a species description is only a hypothesis regarding the relative and consistent distinctiveness of a set of individuals. The descriptions are influenced by several factors, including the prevailing attitudes and the authors' perspectives. **Further reading.** Hashemzadeh Segherloo et al. 2021 (genomic data).



In high-altitude streams, such as in the Pontic mountains, *Salmo* are often the only fish species.

Keys to species of *Salmo* in West Asia

Marmara and Black Sea basins

1a - Red spots on flank absent in individuals larger than 210 mm SL; black spots on flank usually polygonal.

.....*S. abanticus*

1b - Red spots on flank present in individuals of all size groups; black spots on flank roundish.

.....2

2a - Number of black spots on flank decreasing with size in male.

.....*S. rizeensis*

2b - Number of black spots on flank increasing or remaining stable with size in male.
.....3

3a - Number of black spots on flank increasing by size in male; interorbital width 8–9 % SL.
.....*S. fahrettini*

3b - Number of black spots on flank not increasing by size in male; interorbital width 7–8 % SL.
.....4

4a - Number of red spots on flank increasing by size in male.
.....*S. labrax*

4b - Number of red spots on flank not increasing by size in male.
.....5

5a - Black spots on back and flank in females fewer than 60; adipose height 8–9 % SL; anal length in females 12–15 % SL.
.....*S. brunoi*

5b - Black spots on back and flank in females more than 80; adipose height 4–8 % SL; anal length in females 14–17 % SL.
.....*Salmo* sp.

Caspian Sea basin

This key allows to identify resident and Sevan trout only. Anadromous individuals (flank with numerous x-shaped black spots; a prominent hook at the tip of lower jaw in male) are all identified to *S. caspius*. *Salmo araxensis*, *S. ardahanensis*, and *S. murathani* are likely to represent resident populations of *S. caspius*, but the case needs to be re-examined.

1a - Flank brown, grey, yellowish or greenish; black spots usually restricted to back and upper part of flank, rarely on midlateral flank, then usually grey or pale-brown; parr marks distinct, flank with many red/orange spots in individuals smaller than 350 mm SL.
.....2 (= *S. caspius*)

1b - Flank silvery or grey; with many, very large black spots and/or blotches on midlateral flank in individuals of all size groups; parr marks, distinct up to about 100 mm SL; usually without red spots, red spots present in *S. aestivalis* (Lake Sevan).
.....4

2a - Four dark bands on flank in female larger than 230 mm SL.
.....*S. murathani*

2b - No dark bands on flank in female larger than 230 mm SL.
.....3

3a - 19–21 gill rakers; 112–119 lateral-line scales; adipose almost reaching the base of caudal fin in male larger than 170 mm SL.
.....*S. ardahanensis*

3b - 21–22 gill rakers; 103–114 lateral-line scales; adipose not reaching the base of caudal in male larger than 170 mm SL.
.....*S. araxensis*

4a - Flank with black and red spots in all size groups.
.....*S. aestivalis*

4b - Flank with black spots only, red spots in juveniles.
.....5

5a - Flank with small or middle-sized black spots, not larger than 10 mm in diameter in individuals larger than 300 mm SL.

.....*S. ischchan*

5b - Flank with very large, densely set black blotches, larger than 10 mm in diameter in individuals larger than 300 mm SL.

.....*S. gegarkuni*

Mediterranean basin

1a - 7–9 parr marks; no dark-brown or grey bands on flank.

.....*S. kottelati*

1b - 9–13 parr marks; four dark-brown or grey bands on flank.

.....2

2a - Red spots absent on flank in individuals larger than about 70 mm SL, 21–25 gill rakers.

.....3

2b - Red spots present on flank in individuals of all size groups; 18–21 gill rakers.

.....5

3a - Head dorso-ventrally flattened; black spots absent on flank in individuals larger than 200 mm SL; 23–25 gill rakers.

.....*S. platycephalus*

3b - Head not dorso-ventrally flattened; black spots present on flank in individuals of all size groups; 21–24 gill rakers.

.....4

4a - 11–12 parr marks; 14–15 scale rows between end of adipose base and lateral line; head length 25–27 % SL; caudal peduncle depth 10–11 % SL.

.....*S. labecula*

4b - 9–10 parr marks; 11–13 scale rows between end of adipose base and lateral line; head length 26–30 % SL; caudal peduncle depth 9–10 % SL.

.....*S. ekmekciae*

5a - 22–23 gill rakers; a large (larger than pupil) white ring around red spot.

.....*S. opimus*

5b - 18–21 gill rakers; a narrow (equal or smaller than pupil) white ring around red spots.

.....*S. chilo*

Euphrates and Tigris drainages

1a - 19–20 scales between lateral line and adipose; 32–35 scales rows between lateral line and dorsal origin.

.....*S. tigridis*

1b - 13–17 scales between lateral line and adipose; 24–33 scales rows between lateral line and dorsal origin.

.....2

2a - Black and red spots on flank irregularly shaped.

.....3

2b - Black and red spots on flank roundish.

.....5

3a - Flank brownish; 116–123 scales along lateral line counted until end of hypural complex; 28–30 scales rows between lateral line and dorsal origin.

.....*S. munzuricus*

3b - Flank silvery or grey; 103–118 scales along lateral line counted until end of hypural complex; 24–28 scales rows between lateral line and dorsal origin.

.....4

4a - Red spots on flank larger than pupil; 3–7 black spots on opercle; no black spots on top of head; 1–2 dark-brown or grey bands on posterior part of flank in individuals larger than about 230 mm SL.

.....*S. baliki*

4b - Red spots on flank smaller than pupil; 8–17 black spots on opercle; 5–18 black spots on top of head; 4 dark-brown or grey bands on flank in individuals larger than about 230 mm SL.

.....*S. okumusi*

5a - Few black spots on back and upper part of flank; number of black spots not increasing with size.

.....*S. euphrataeus*

5b - Numerous black spots on back, middle and upper part of flank; number of black spots increasing with size.

.....6

6a. - Adipose depth 8–10 % SL in male; lateral line with 117–125 scales counted until end of hypural complex; flank brownish in life.

.....*S. trutta* (based on introduced population)

6b. - Adipose depth 3–8 % SL in male; lateral line with 109–116 scales counted until end of hypural complex; flank silvery in life.

.....*S. fahrettini*

Trout on speciation pathways? Trout populations are found in numerous lake basins. In many cases, there are resident trout in the lake tributaries and trout in the lake itself. In larger lakes with sufficient food resources, individual lake trout may grow larger than stream trout, become silvery, slender, lose the red spots, and become piscivorous or planktivorous. Trout populations in lakes adapt to pelagic life by undergoing changes similar to those observed in anadromous trout. As anadromous-resident trout, large lake trout typically join their siblings at spawning sites. Despite these similarities, the two trout forms are not distinct species. They represent different life-history forms of a single population. However, life-history strategies are subject to distinct selective challenges. Assortative mating would allow them to adapt better to their particular environments, whether in the lake or the stream. Furthermore, as all male trout prefer to mate with large females, large male lake trout can monopolise female lake trout, leading to assortative mating over time. This process should lead to the reproductive isolation of lake trout from resident trout. However, fully reproductively isolated trout species within one lake-stream system are rarely documented. The lake-stream system's instability may interrupt the speciation process too often. Fluctuating environmental conditions and unbalanced ratios between lake and resident trout at the spawning places lead to hybridisation. This process acts against the isolation of both "kinds" of trout. The permanent activity of small male trout, which engage in sneaking, may inhibit the ability of large male lake trout to monopolise the attention of large females. If trout species cannot engage in assortative mating due to sneaking behaviour, spatial and temporal segregation is the only mechanism that allows them to reach reproductive isolation and speciate. This pattern is observed in sympatric trout species, with each species spawning at different times and locations. In West Asia, the only documented example of multi-species lake trout is Lake Sevan in Armenia.



Salmo abanticus; aquaculture, Lake Abant, Türkiye; ~225 mm SL.

Salmo abanticus

Common name. Abant trout.

Diagnosis. Distinguished from other species of *Salmo* in Marmara and Black Sea basins by: ● flank silvery in life with many black spots and polygonal blotches much larger than pupil scattered on whole flank in individuals larger than 210 mm SL / ● no red spots on flank in individuals larger than about 210 mm SL / ○ maxilla short, reaching slightly behind posterior eye margin in male larger than about 230 mm SL / ○ 103–121 lateral-line scales counted until end of hypural complex / ○ 26–28 scale rows between dorsal origin and lateral line. Size up to 500 mm SL.

Distribution. Türkiye: Lake Abant basin. Introduced into several ponds and reservoirs in Türkiye for recreational fishing; establishment remains uncertain except for a confirmed population in Ulugöl (Ordu Province).

Habitat. Lacustrine, spawns in springs in lake itself and in lake tributaries.

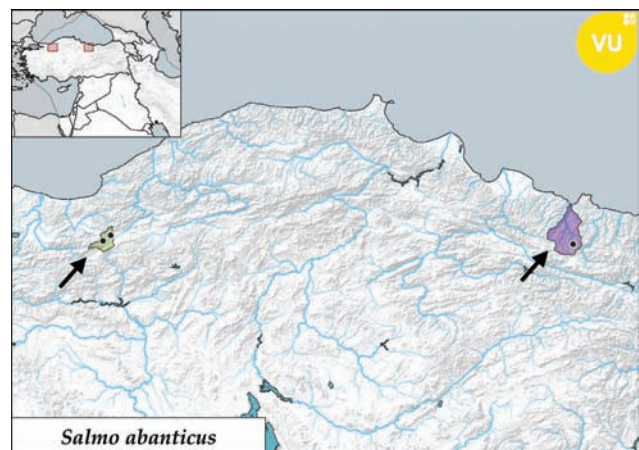
Biology. No data.

Conservation status. VU; situation appears to be relatively stable, but species may be conservation dependent, and a

stock of this species is maintained in captivity to produce juveniles for stocking.

Remarks. Genomic data support recognising this species as distinct from *S. labrax* and *S. rizeensis*.

Further reading. Tortonese 1954 (description); Uysal & Albaz 2003 (artificial reproduction); Turan et al. 2010 (diagnosis); Hashemzadeh Segherloo et al. 2021 (genomic data).



Salmo aestivalis; Lake Sevan, Armenia; ~200 mm SL. © J. Schöffmann.

Salmo aestivalis

Common name. Sevan spring trout.

Diagnosis. Distinguished from other species of *Salmo* in Caspian basin by: ○ flank silvery with black and red spots in individuals of all size groups / ○ parr marks distinct up to about 100 mm SL, absent or indistinct in larger individuals. Size up to 500 mm SL and 1.9 kg.

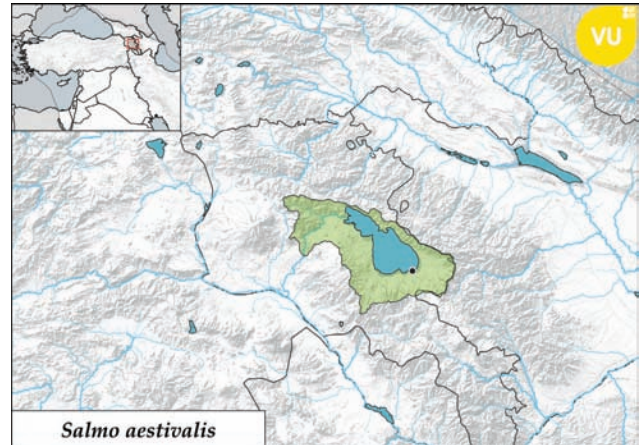
Distribution. Armenia: Lake Sevan basin.

Habitat. Lacustrine, spawns in lake and in mouths of tributaries.

Biology. Spawns in spring and early summer. Feeds mainly on benthic gammarid crustaceans.

Conservation status. VU; might by CR; may be extinct in the wild, surviving only through artificial propagation and stocking.

Further reading. Levin et al. 2022 (Sevan trout).



Salmo araxensis; Aras drainage, Türkiye; male, 265 mm SL.

Salmo araxensis

Common name. Aras trout.

Diagnosis. Distinguished from other species of *Salmo* in Caspian basin by: ○ background colour of flank greyish to brownish in life / ○ few black spots scattered on back and upper part of flank, often ocellated with a roundish narrow white ring / ○ 21–22 gill rakers / ○ 103–114 lateral-line scales / ○ 10–13 parr marks, distinct up to about 130 mm SL / ○ adipose not reaching base of caudal in male larger than 200 mm SL / ○ no dark band on flank. Size up to 276 mm SL.

Distribution. Türkiye: Kırkpınar, Alacasu, Porsuklu, and İncilipınar in upper Aras drainage.

Habitat. Headwaters with clear and fast-flowing water, with stone and gravel bottoms.

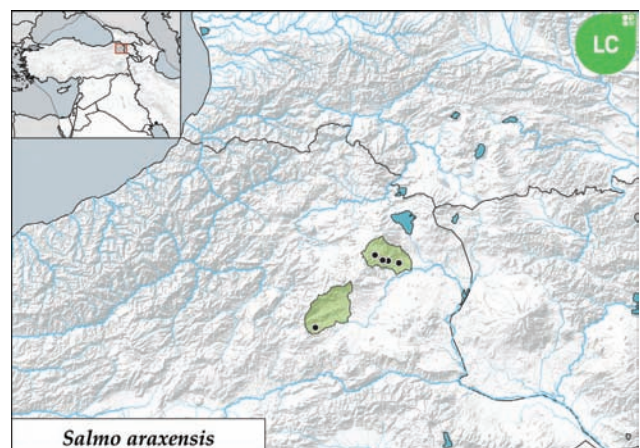
Biology. No data.

Conservation status. LC.

Remarks. This species is likely conspecific with *S. caspius*; see the discussion there. More research is needed to resolve

the case of Kura and Aras trout, all of which (except Lake Sevan trout) are likely to be conspecific.

Further reading. Turan et al. 2022b (description).





Salmo ardahanensis; Kura drainage, Türkiye; 222 mm TL.

Salmo ardahanensis

Common name. Ardahan trout.

Diagnosis. Distinguished from other species of *Salmo* in Caspian basin by: ○ background colour of flank yellowish to dark-brown in life / ○ black spots few to numerous, roundish, medium size (approximately equal to pupil), ocellated, scattered on back, middle and upper part of flank in some individuals, restricted to back and upper part of flank in others / ○ number of black spots not or slightly increasing with increasing size in most males / ○ 19–21 gill rakers / ○ 112–119 lateral-line scales / ○ adipose large, almost reaching to caudal base in male larger than about 170 mm SL / ○ no dark bands on flank. Size up to 280 mm SL.

Distribution. Türkiye: Upper Kura drainage.

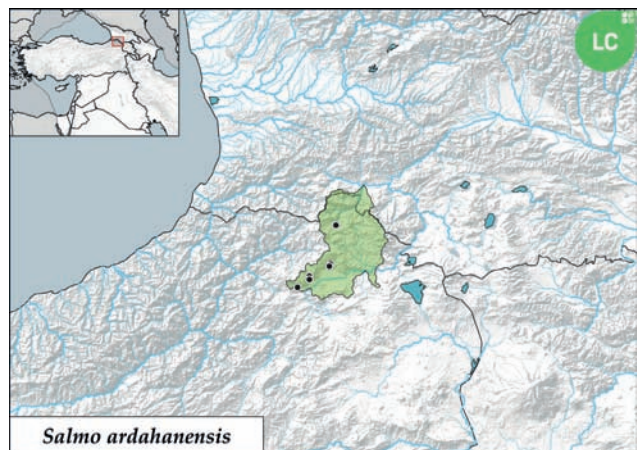
Habitat. Headwaters with clear and fast-flowing water, with stone and gravel bottoms.

Biology. No data.

Conservation status. LC.

Remarks. This species is likely conspecific with *S. caspius*; see the discussion there. More research is needed to resolve the case of Kura and Aras trout, all of which (except Lake Sevan trout) are likely to be conspecific.

Further reading. Turan et al. 2022b (description).



Salmo baliki; Murat, Euphrates drainage, Türkiye; male, 216 mm SL.

Salmo baliki

Common name. Murat trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris drainages by: ● red spots on flank larger than pupil / ○ red spots on flank irregularly shaped / ○ background colour of flank greyish or brown / ○ usually one, rarely two grey spots or blotches behind eye and on cheek / ○ 3–7 black spots on opercle / ○ few black spots on back and upper part of flank, absent on predorsal area / ○ no black spots on top of head / ○ number of black and red spots not increasing with size / ○ 1–2 dark-brown or grey bands on posterior part of flank / ○ 107–118 lateral-line scales counted until end of hypural complex / ○ 24–28 scales rows between lateral line and dorsal origin. Size up to 270 mm SL.

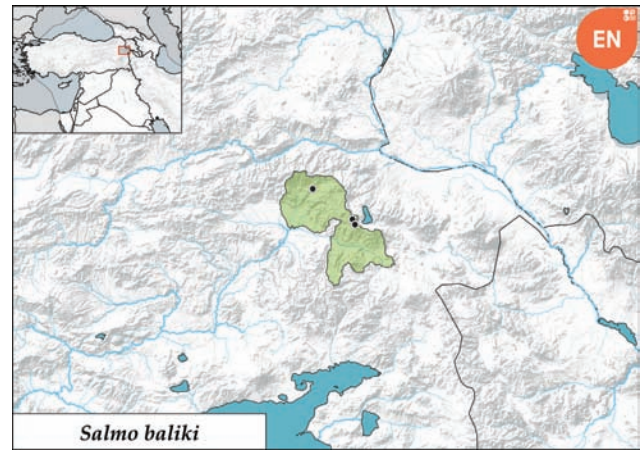
Distribution. Türkiye: Sinek and Cumaçay in upper Murat drainage, potentially in adjacent streams.

Habitat. Headwater streams with cold, clear water, moderate current, gravelly and pebbly bottom.

Biology. No data.

Conservation status. EN; appears to be declining within its very small range.

Further reading. Turan et al. 2021b (description).



Salmo brunoi; Nilüfer drainage, Türkiye; ~150 mm SL.

Salmo brunoi

Common name. Nilüfer trout.

Diagnosis. Distinguished from other species of *Salmo* in Marmara and Black Sea basins by: ○ one black spot in post-orbital and suborbital area, greater than pupil / ○ 2–4 black spots on opercle, usually smaller than pupil / ○ less than 60 black spots on body, approximately smaller or equal to pupil, often ocellated, scattered on back and upper part of flank (missing in predorsal area) / ○ less than 40 red spots, smaller than pupil, irregularly shaped, surrounded by an irregularly shaped narrow ring, organised in 2–4 irregular longitudinal rows / ○ number of black and red spots not increasing with size / ○ interorbital width 7–8 % SL / ○ anal height 12–15 % SL in male / ○ adipose height 8–9 % SL. Size up to 187 mm SL.

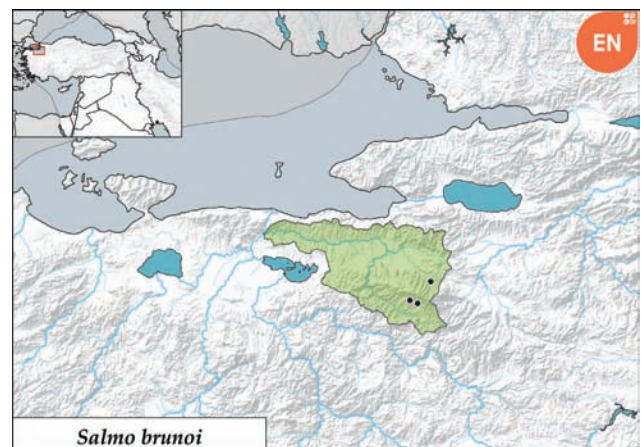
Distribution. Türkiye: Aras, Deliçay, and Ericek, potentially all tributaries to Nilüfer in Susurluk drainage.

Habitat. Clear and fast-flowing streams with a substrate of gravel and pebbles.

Biology. No data.

Conservation status. EN; appears to be declining within its very small range.

Further reading. Turan et al. 2024c (description).





Salmo caspius; Fereydunkenar, Caspian Sea, Iran; anadromous individual, ~400 mm SL.



Salmo caspius; Karaj drainage, Lake Namak basin, Iran; ~140 mm SL.

Salmo caspius

Common name. Caspian trout.

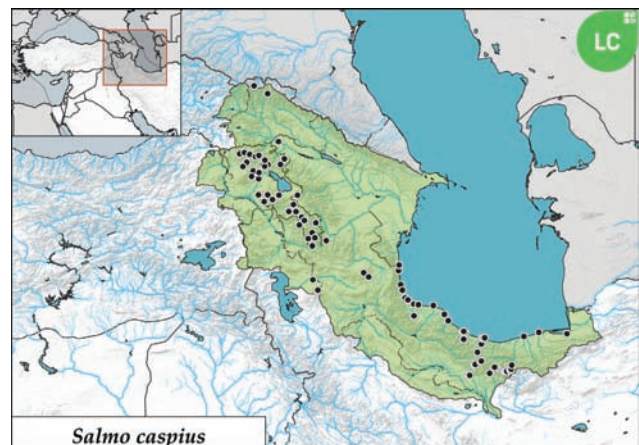
Diagnosis. Resident populations distinguished from Lake Sevan trout by: ● flank brown, grey, yellowish or greenish (silvery without orange spots in anadromous form) / ● black spots usually restricted to back and upper part of flank, rarely on midlateral flank, then spots usually grey or pale-brown / ● parr marks distinct up to about 350 mm SL / ○ flank with many red spots in individuals smaller than 350 mm SL. Anadromous individuals larger than 350 mm SL distinguished from Lake Sevan trout by: ● flank with very small, irregularly shaped, black blotches (vs. many, very large, roundish spots) / ● caudal truncate (vs. emarginate). Size up to 1300 mm SL in anadromous form, usually up to 300 mm SL in resident form.

Distribution. Caspian, Lake Namak, and Lake Urmia basins. Kura and Aras drainages north to Volga and Ural. Introduced in Western Kavir, and Karun (Iran). Records not shown on map as details are lacking.

Habitat. At sea, along coast to 50 m depths. Locally resident in lakes. Migrates to mountain streams. Resident part of populations in streams and headwaters with fast currents, cold,

clear water, and stony or gravelly bottoms. Spawning sites usually in upper reaches of fast-flowing rivers and streams.

Biology. Anadromous, lacustrine, and resident forms. First spawn at 3–5 years, females 1 year later than males. Spawns October–December. Before construction of dams and river regulation, two migration waves, first in summer–autumn, peaking in October, with adults spawning in same autumn and returning to sea in December; second in late



autumn–winter, peaking in December–February, with adults spawning in following autumn after about 10–12 months in river. Eggs hatch in 6–8 weeks. Anadromous individuals in Terek drainage probably spawn once in life, but some females from other populations spawn up to 4 times. Parrs spend 2–4 years, sometimes more, in rivers and then migrate to sea. Commonly spends up to 4 years at sea before returning to rivers. Parr and resident adults feed on a wide variety of aquatic and terrestrial invertebrates. Anadromous and large lacustrine individuals feed mainly on fish but also on large crustaceans.

Conservation status. LC.

Remarks. The northern range of *S. caspius* remains unclear, as *S. trutta* appears to have naturally invaded the upper Volga. The diversity of trout in Caspian basin has been greatly confused by the description of *S. ardahanensis*, *S. araxensis*, and *S. murathani* from Türkiye and the restriction of *S. caspius* and *S. ciscaucasicus* to anadromous populations. We strongly disagree with this approach. In all well-studied cases of Salmonidae, anadromous and resident individuals are conspecific, and this should have

been the null hypothesis to be rejected by data. That an anadromous trout is (was) reproductively isolated from sympatric resident trout should have been demonstrated, as the opposite is the only demonstrated situation in Salmonidae. Reversing the burden of proof leads to a situation where each population could, in principle, be described as a separate species—and others are asked to prove the opposite. Although sympatric anadromous and resident *Salmo* species cannot be completely excluded, such a finding would be the first and only case in Salmonidae in riverine ecosystems. We await further studies on Caspian trout to resolve the case, but in the meantime, we have to accept the different species as valid. *Salmo ciscaucasicus* from the European Caucasus is probably a synonym of *S. caspius*.

Further reading. Berg 1949b (biology, morphology, distribution; as *S. t. caspius*); Dorofeyeva 1967 (morphology, taxonomy); Belyaeva et al. 1989 (biology, fisheries); Danilov-Danilyan 2001 (conservation); Turan et al. 2020 (Cytochrome b phylogeny); Hashemzadeh Segherloo et al. 2021 (genomic data); Turan et al. 2022b (restriction to anadromous populations).



Salmo chilo; Tekir, Ceyhan drainage, Türkiye; ~300 mm SL.



Salmo chilo; Tekir, Ceyhan drainage, Türkiye; ~120 mm SL.

Salmo chilo

Common name. Ceyhan trout.

Diagnosis. Distinguished from other species of *Salmo* in Mediterranean basin by: ● dorsal head profile strongly convex / ● snout blunt / ● mouth conspicuously subterminal, with fleshy maxilla and lower lip / ○ maxilla short, depth of upper jaw 2.5–2.9 times in length of maxilla / ● size of adipose equal in male and female / ● length of maxilla equal in male and female / ○ 10–13 parr marks, distinct up to about 200 mm SL / ○ a narrow (equal or smaller than eye pupil) white ring around red spots / ○ 7–13 black spots on opercle / ○ 1–12 black spots behind eye and on cheek (more than one spot in individuals larger than about 160 mm SL) / ○ four broad bands on flank distinctive in all size groups / ○ few red spots on flank in individuals of all size groups / ○ 108–114 lateral-line scales counted until end of hypural complex / ○ 24–26 scale rows between dorsal origin and lateral line / ○ 15–17 scale rows between anal origin and lateral line / ○ 13–14 scale rows between adipose origin and lateral line / ○ 18–21 gill rakers. Size up to 300 mm SL.

Distribution. Türkiye: Göksu, Tekir, Fırnız, Göçüksu, and other tributaries of upper Ceyhan and Sarız, a tributary to upper Seyhan.

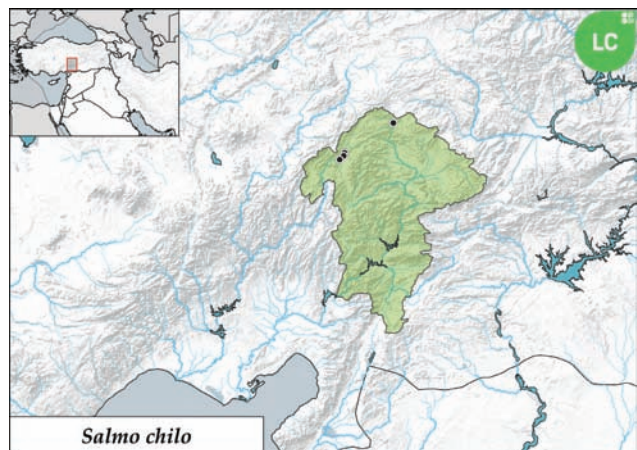
Habitat. Mountain streams, usually spring-fed, with cold, clear water and moderate currents, gravel, and pebble beds.

Biology. Spawns November–February.

Conservation status. LC.

Remarks. The very limited genomic data suggest a relatively weak genetic differentiation for this species, making it very close to or even identical to European *S. farioides* and *S. lourosensis*. Admittedly, increased sample sizes and taxon sampling will be required to assess the validity of retaining the species more rigorously. However, its genetic differentiation is weaker than that observed between other recognised trout species elsewhere.

Further reading. Turan et al. 2012b (description); Alp et al. 2003 (spawning time); Hashemzadeh Segherloo et al. 2021 (genomic data).



Lake form of *Salmo caspius* from Lake Çıldır in Türkiye. Recent authors have ignored the possibility that the three life-history forms of this trout might also occur in West Asia. © M. Özuluğ.

Life-history traits in trout. The diversity of trout species is often confounded due to the diversity of life-history traits. The life history of trout species follows several similar patterns and has been demonstrated to be an intraspecific diversity within all well-studied trout (*Salmo*, *Oncorhynchus*, and *Salvelinus*). It is therefore rejected that different trout species should be recognised only based on morphological characters connected to life-history types. Classically, three distinct groups of trout have been identified:

1) Anadromous trout (sea trout). These trout hatch in streams, grow there for 2–4 years, undergo smoltification and migrate to the sea or estuaries to forage. They exhibit accelerated growth and larger size than their siblings, remaining in streams. After a few years, (often after one year) they return to their native stream to spawn. Additionally, they frequently enter lower reaches of streams and rivers to overwinter in freshwater, even if they have not yet reached maturity. Sea trout are absent from the Mediterranean but occur in the Black Sea and Caspian basins.

2) Lake trout. They also hatch in streams and follow the same life history as sea trout, smoltify, and migrate to the lake to forage, grow large, and return to their native stream to spawn. This is the case in lake trout populations in West Asia, but some populations also spawn in the lake.

3) In nearly all spawning streams, some individuals do not migrate and remain there as resident trout. In West Asia, most species include only resident, non-migratory individuals.

The various life-history forms of trout are not reproductively isolated and do not represent different species. Only the resident and/or lacustrine forms are known in some species. In others, all three forms occur, and all their offspring appear to have the potential to smoltify and migrate to foraging habitats. The environmental conditions that an individual trout experiences during its lifetime influence the life-history strategy it will adopt and the life history it will develop (e.g., food availability). However, genetic factors also appear to influence whether some species, populations or individuals have the potential to develop different life histories. This plasticity of life-history strategies is observed in some populations of *S. caspius* and *S. labrax*, while most populations of these species consist of resident fish only.

In contrast to the evidence from around the world, it has been proposed that West Asian residents, lake and anadromous individuals belong to separate species that lives in the same area (i.e., behaving as distinct species as in *S. labrax* and *S. rizeensis* as well as in the four Kura-Aras species listed in this book). The hypothesis of one species with two life-history forms (migratory and resident) has not been tested nor rejected in both cases. The close relationship of *S. labrax* and *S. rizeensis* demonstrates the need for a review based on many populations and high-resolution molecular methods. Based on a small sample size and genomic data, it had been suggested that they are conspecific and should be treated as one species as soon as further studies confirm these data. The case of the trout species in the Kura and Aras rivers will require further investigation in the future. However, it is anticipated that only one species will be identified. **Further reading.** Turan et al. 2010 (Black Sea trout); Ninua et al. 2018 (Cytochrome b data); Hashemzadeh Segherloo et al. 2021 (genomic data); Turan et al. 2022b (Caspian trout).



Salmo ekmekciae; Degirmenözü in Köprüçay drainage, Türkiye; 330 mm SL. © J. Schöffmann.

Salmo ekmekciae

Common name. Köprüçay trout.

Diagnosis. Distinguished from other species of *Salmo* in Mediterranean basin by: ○ black spots on flank in individuals of all size groups / ○ one small black spot in postorbital and suborbital areas, larger than pupil / ○ head length 26–30 % SL / ○ caudal peduncle depth 9–10 % SL / ○ 7–17 black spots on opercle / ○ 9–10 parr marks / ○ 4 broad dark bands on flank / ○ maxilla short and narrow / ○ 108–118 lateral-line scales counted until end of hypural complex / ○ 21–25 scale rows between dorsal origin and lateral line / ○ 16–18 scale rows between anal origin and lateral line / ○ 11–13 scale rows between adipose origin and lateral line / ○ 22–24 gill rakers / ○ head not dorso-ventrally flattened. Size up to 350 mm SL.

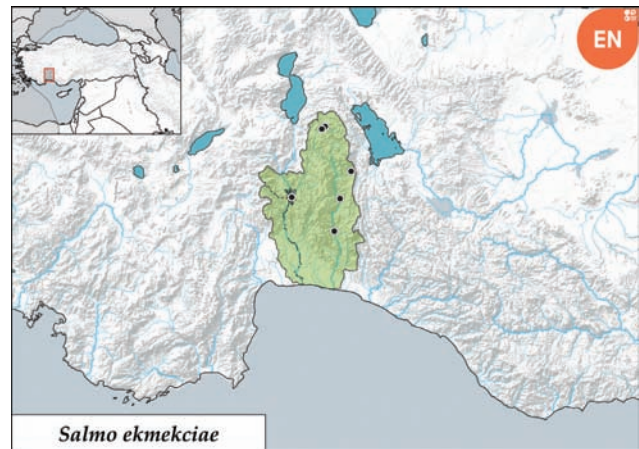
Distribution. Türkiye: Köprüçay drainage.

Habitat. Headwater streams, usually fed by springs, with cold and clear water with moderate currents and substrate of stones and pebbles.

Biology. Spawns December–January.

Conservation status. EN; appears to be declining within its very small range.

Further reading. Küçük et al. 2024a (description).

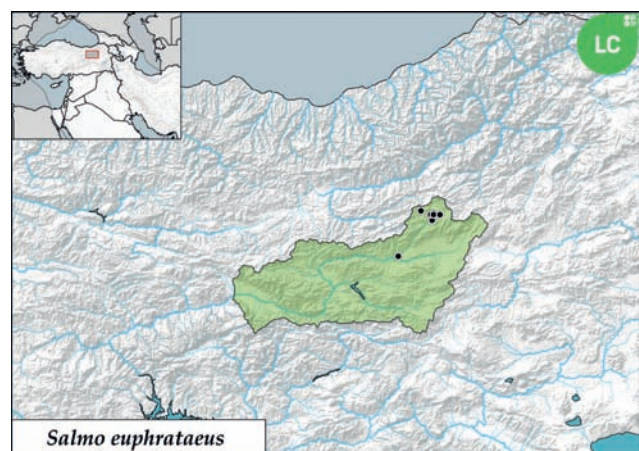


Salmo euphrataeus; upper Euphrates drainage, Türkiye; ~170 mm SL.

Salmo euphrataeus

Common name. Northern Euphrates trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris drainages by: ○ flank brownish in life / ○ one black spot behind eye / ○ 2–9 black spots on opercle / ○ 0–54 roundish black spots on flank, restricted to back (usually missing in predorsal area) and upper part of flanks / ○ number of black spots not increasing with size / ○ 13–53 small red spots on flank, round in male and irregularly shaped in female / ○ adipose dark-grey / ● mouth gape length 14.3–16.5 % SL in male, 12.3–14.9 in female / ○ adipose large, with 0–4 orange spots on its posterior margin / ○ 10–12 parr marks, distinct up to about 200 mm SL / ○ 112–120 lateral-line scales counted





Salmo fahrettini; Euphrates drainage, Türkiye; 232 mm SL.

until end of hypural complex / ● 26–31 scale rows between lateral line and dorsal origin. Size up to 260 mm SL.

Distribution. Türkiye: Şenyurt, Erzincan, Kuzgun, Rize-kent, Ağırçık, Sırlı (Karasu drainage) in northern Euphrates.

Habitat. Headwater streams with cold, clear water, moderate current, gravelly and pebbly bottom.

Biology. No data.

Conservation status. LC.

Remarks. Genomic data suggest that natural hybridisation between Mediterranean and Black Sea trout has played a role in the evolution of *S. euphrataeus*. However, the diversity, biogeography and relationships of the Persian Gulf trout still need to be better understood.

Further reading. Turan et al. 2020 (Cytochrome b phylogeny); Hashemzadeh Segherloo et al. 2021 (genomic data).

Salmo fahrettini

Common name. Euphrates trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris drainages by: ○ flank silvery in life / ○ back, middle and upper part of flank with numerous, roundish black spots (>80) increasing in number with size / ○ one black spot in postorbital and suborbital areas / ○ numerous roundish red spots on flank (>70 in adult individuals), smaller than pupil, increasing in number with size / ○ no black spots on top of head / ○ no dark-brown or grey bands on flank / ○ head length 24–28 % SL / ○ maxilla length 8–10 % SL in male / ○ adipose depth 3–8 % SL in male / ○ lateral line with 109–116 scales counted until end of hypural

complex / ○ 27–30 scale rows between dorsal origin and lateral line / ○ 20–23 scale rows between anal origin and lateral line / ○ 15–17 scale rows between origin of adipose and lateral line. Size up to 232 mm SL.

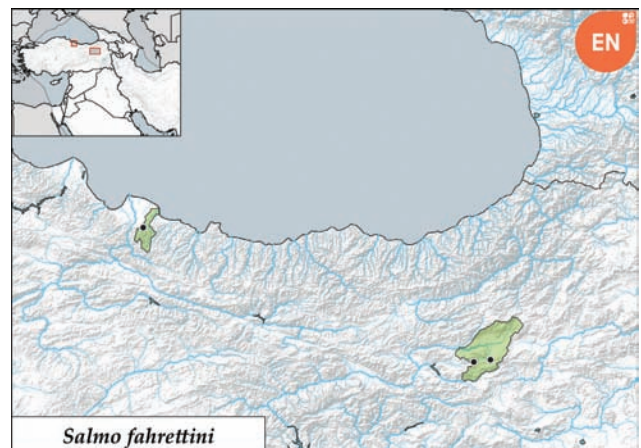
Distribution: Türkiye: Ömertepesuyu and Tekke in northern Euphrates drainage and Terme drainage, east of Samsun, in Black Sea basin.

Habitat. Headwater streams with cold, clear water, moderate current, gravelly and pebbly bottom.

Biology. No data.

Conservation status. EN; the quality of its habitats is steadily declining due to pollution and water abstraction, and its population appears to be already quite low.

Further reading. Turan et al. 2020 (description); Yılmaz et al. 2021 (record from Terme).



Lake Sevan trout. There are sympatric “kinds” of trout in Lake Sevan (Armenia) and some northern European lakes (e.g., Lough Melvin in Ireland, Lake Ohrid in North Macedonia and Albania). These are reproductively isolated, differ in morphology, and have different feeding habits, spawning sites, and/or spawning seasons. As their offspring also develop only into the “kind” of their parents, they represent different species. To ascertain whether different sympatric “kinds” might be species or life-history forms, genomic data can be employed to elucidate their reproductive isolation. Five ecologically and phenotypically divergent “kinds” of trout have been described from Lake Sevan basin. Four lacustrine “kinds” with different temporal-spatial spawning strategies and divergent morphology and colouration evolved alongside a fifth “kind,” a resident trout inhabiting the lake’s tributaries. The partitioning of spawning resources in space and time accompanied the diversification of the Sevan trout. *Salmo gegarkuni* spawns in autumn and winter in lake tributaries, *S. aestivalis* spawns in spring in the lake and the mouth of tributaries, *S. ischchan* spawns in autumn and winter near springs in the lake, and *S. danilewskii* is dwarf (up to 320 mm vs. more than 500 mm in other populations) spawning in autumn and winter in gravel beds in the lake. A recent study of complete mitogenomes in conjunction with genome-wide SNP data has revealed the monophyly of the four lacustrine “kinds” in contrast to the resident trout, all derived from *S. caspius*.

Three genomic clusters were identified for the five “kinds”—(i) a resident trout inhabiting tributaries (*S. caspius*), (ii) *S. gegarkuni* + *S. aestivalis*, and (iii) *S. ischchan* + *S. danilewskii*. These genomic clusters are genetically differentiated, which precludes their determination by environmental factors during ontogeny. A few outlier SNPs under selection were discovered that could be responsible for assortative mating based on visual recognition. The Holocene climatic oscillations and the desiccation of tributaries may have played an important role in the origin of lacustrine spawning. Based on zero-to-low F_{ST} values, a measure of genetic variation, and the recent lake isolation (20 kya), *S. danilewskii* appears not reproductively isolated from *S. ischchan*. It is evident that river-spawning *S. gegarkuni* was isolated from the lake-spawners earlier than those that diversified into different “kinds” along a temporal axis separating spring-spawning *S. aestivalis* from autumn and winter-spawning *S. ischchan*. The reasons for the poor molecular support of spring-spawning *S. aestivalis* as a distinct evolutionary group from autumn/winter-spawning *S. ischchan* remain unresolved. It is possible that both species were not fully reproductively separated. Alternatively, the separation may have been so recent that it could not be well-detected by the molecular markers applied so far, or artificial breeding may have blurred their historical differences. Lake Sevan trout warrant further investigation, but unfortunately, the extinction of all the Sevan trout spawning in the lake makes it now difficult or impossible to study their ecology and evolution in detail. A comparable adaptive radiation occurred in Lake Ohrid, where four sympatric species exhibited spatial and temporal differences in their use of spawning sites. These have vanished in the 20th century. **Further reading.** Sušnik et al. 2007 (Ohrid trout); Levin et al. 2022 (Sevan trout).



Salmo gegarkuni; Issyk-Kul, Kyrgyzstan; ~350 mm SL. © J. Schöffmann.



Salmo gegarkuni; Lake Sevan basin, Armenia, ~250 mm SL. © J. Schöffmann.

Salmo gegarkuni

Common name. Gegarkuni.

Diagnosis. Distinguished from other species of *Salmo* in Caspian basin by: ● flank with very large, densely set, black blotches, larger than 10 mm in diameter in individuals larger than 300 mm SL / ○ flank silvery, without orange spots except in juveniles / ○ parr marks distinct up to about 100 mm SL, absent or indistinct in larger individuals. Size up to 800 mm SL and 16 kg.

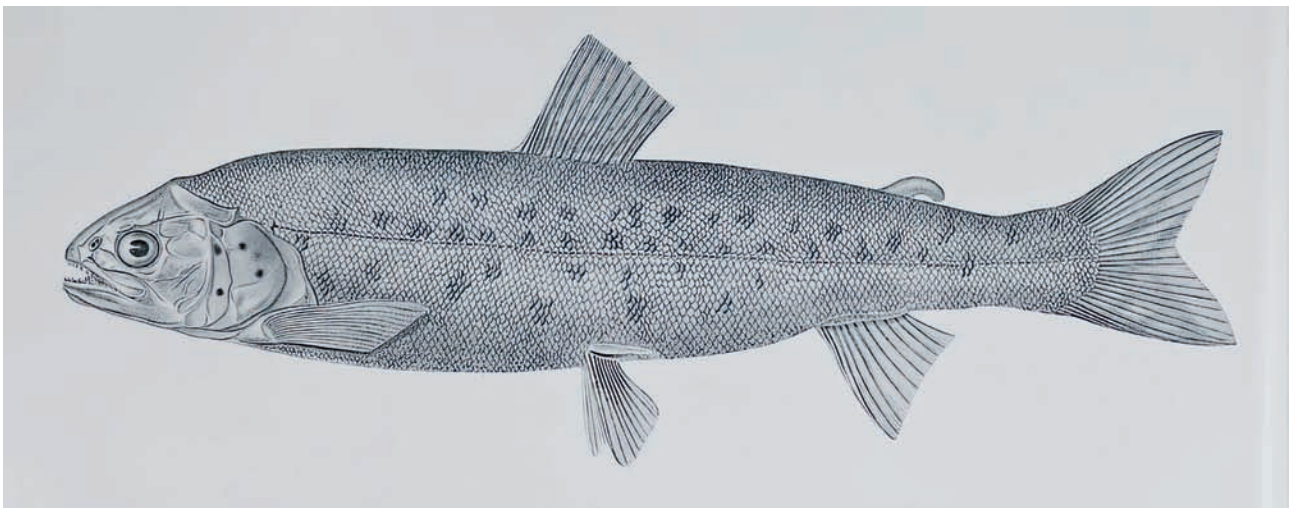
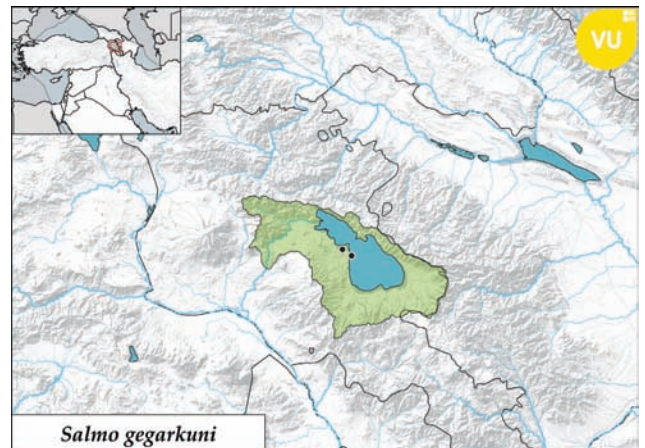
Distribution. Armenia: Lake Sevan basin. Locally introduced to lakes and reservoirs in Armenia, Georgia, and Azerbaijan, as well as to Lake Issykul (Kyrgyzstan) and from there in 1980th to Charvak reservoir (Uzbekistan).

Habitat. Lacustrine, spawns in inflowing streams.

Biology. Spawns in autumn–early winter. Feeds mainly on benthic gammarid crustaceans.

Conservation status. VU; might by CR; may be extinct in the wild, surviving only through artificial propagation and stocking.

Further reading. Levin et al. 2022 (Sevan trout).



Salmo ischchan; Lake Sevan, Armenia. Modified from Kessler 1877.

Salmo ischchan

Common name. Sevan trout.

Diagnosis. Distinguished from other species of *Salmo* in Caspian basin by: ○ flank with small or middle-sized black spots, smaller than 10 mm in diameter in individuals larger than 300 mm SL / ○ flank silvery, without orange spots / ○ parr marks present up to about 100 mm SL. Size up to 760 mm SL and 15 kg.

Distribution. Armenia: Lake Sevan.

Habitat. Lacustrine, spawned in lake, in gravel, close to springs and in mouth of inflowing streams.

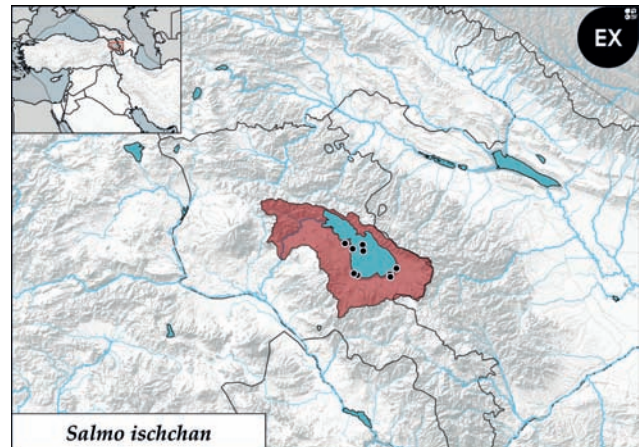
Biology. Spawned in autumn–early winter. Fed mainly on benthic gammarid crustaceans.

Conservation status. Extinct.

Remarks. The name *S. danilewskii* has been used for small individuals feeding on gammarids and plankton. *Salmo*

danilewskii is a synonym, and these fish were most likely small individuals of *S. ischchan*.

Further reading. Levin et al. 2022 (Sevan trout).



The end of Lake Sevan's trout diversity. The abundance of Sevan trout declined significantly in the 20th century due to human impacts. A critical 18.5 m drop in the lake water level and a reduction of >42 % in the lake's volume for hydropower purposes resulted in the shrinkage of spawning sites for trout spawning in the lake. Furthermore, temperature and oxygen regimes, as well as the hydrochemical composition of the water in the lake, also changed significantly after the drop in the lake level. These alterations, coupled with overfishing, poaching, and the impact of non-native *Coregonus*, have led to the decline of Sevan trout populations, which eventually resulted in the extinction of the two lacustrine forms known as *S. ischchan* and *S. danilewskii* in the 1980s. Only two species survived, namely *S. aestivalis* and *S. gegarkuni*. However, they are rarely found in the lake and are largely kept alive by farming and stocking. **Further reading.** Aghasyan & Kalashyan 2010; Gabrielyan 2010 (conservation); Levin et al. 2022 (Sevan trout).



Salmo kottelati, Alakır stream, Türkiye; male, ~105 mm SL.

Salmo kottelati

Common name. Alakır trout.

Diagnosis. Distinguished from other species of *Salmo* in Mediterranean basin by: ○ black spots on flank numerous, scattered on back, middle and upper part of flank (on lower part of flank in some individuals) in male larger than about 160 mm SL, and female larger than about 160–190 mm SL / ○ in male and female smaller than about 160 mm SL, black spots few, restricted to upper part of flank / ○ few to numerous red spots on back and flank / ● 7–9 parr marks / ● no dark-brown or grey bands on flank / ● number of black and red spots increasing with size in male, decreasing with size and age in female / ○ head length 29–33 % SL in male, 26–32 in female / ○ mouth slightly sub-terminal / ○ length of mouth gape 13–19 % SL in male, 12–15 in female / ○ 105–113 lateral-line scales counted until end of hypural complex / ○ 24–29 scale rows between lateral line and dorsal origin / ○ 17–19 scale rows between lateral line and anal origin / ○ 13–15 scale rows between lateral line and adipose insertion / ○ 18–20 gill rakers. Size up to 210 mm SL.

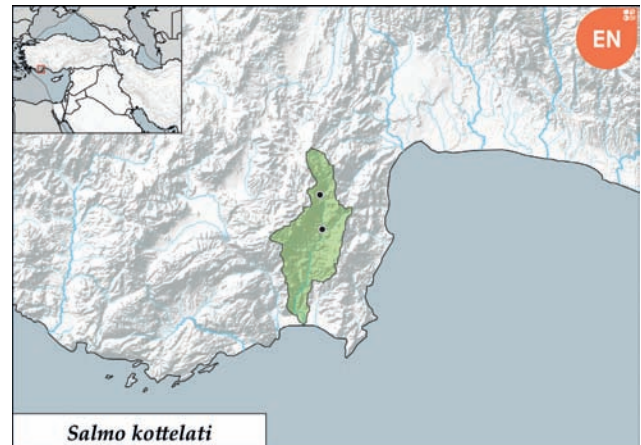
Distribution. Türkiye: Alakır drainage southwest of Antalya.

Habitat. Headwater streams with cold, clear water, moderate current, gravelly and pebbly bottom.

Biology. No data.

Conservation status. EN; appears to be declining within its very small range.

Further reading. Turan et al. 2014b (description).



Salmo labecula; Ecemiş, Seyhan drainage, Türkiye; ~150 mm SL.

Salmo labecula

Common name. Eastern Mediterranean trout.

Diagnosis. Distinguished from other species of *Salmo* in Mediterranean basin by: ○ black spots present on flank in individuals of all size groups / ○ flank without red spots in individuals larger than about 70 mm SL / ○ black spots numerous (more than about 50), smaller than pupil, irregularly shaped, scattered on middle of flank, usually absent on back / ○ 11–12 parr marks, distinct up to about 150 mm

SL in male, about 200 mm SL in female / ○ four broad, dark-brown or grey band on flank, absent or indistinct in individuals smaller than approximately 200 mm SL / ○ 2–10 black spots behind eye, 6–13 on opercle / ○ maxilla and supramaxilla narrow, depth of upper jaw 2.8–3.8 times in length of maxilla / ○ 109–115 lateral-line scales counted until end of hypural complex / ○ head length 25–27 % SL / ○ caudal peduncle depth 10–11 % SL / ○ 23–25 scale rows between dorsal origin and lateral line / ○ 16–17 scale rows

between anal origin and lateral line / ○ 14–15 scale rows between adipose origin and lateral line / ● 21–23 gill rakers / ○ head not dorso-ventrally flattened. Size up to 450 mm SL.

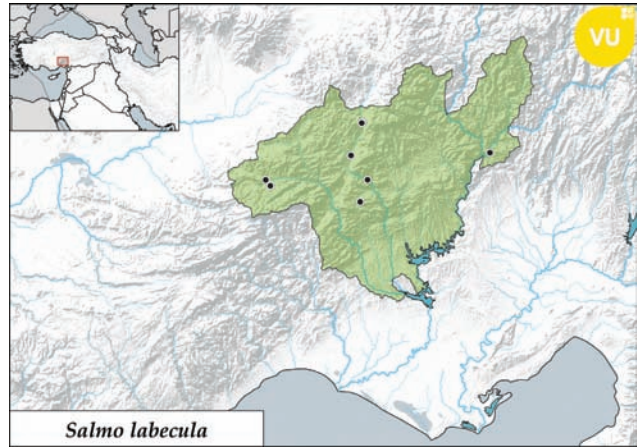
Distribution. Türkiye: Ecemiş, lower Zamantı and Çakıt in Seyhan drainage.

Habitat. Headwater streams usually springs-fed, with cold and clear water, moderate current, gravel, and pebble substrate. Occasionally also enters reservoirs.

Biology. Spawns December–January.

Conservation status. VU; found in more than 5 independent populations, thought to be in decline, mainly due to overfishing.

Further reading. Turan et al. 2012b (description); Küçük et al. 2024 (distribution).



Salmo labrax; Çoruh drainage, Türkiye; ~130 mm SL. © M. Özuluğ.



Salmo labrax; Crimea, Ukraine; ~300 mm SL.

Salmo labrax

Common name. Black Sea trout.

Diagnosis. Distinguished from other species of *Salmo* in Marmara, Black Sea and Caspian basins by: ○ background colour of flank brownish to silvery in life (silvery in anadromous individuals) / ● black spots on flank ocellated, few and scattered on upper third of flank in most individuals, number not increasing with size and age / ○ red spots few or

many, usually irregularly shaped and ocellated / ○ number of red spots on flank increasing by size in male / ● head about 0.9–1.2 times in body depth at dorsal origin / ○ maxilla short, reaching slightly beyond posterior eye margin in individuals larger than 150 mm SL, upper edge convex posteriorly / ○ body depth at dorsal origin 23–27 % SL / ● dorsal in front of mid-point of body / ○ 110–121 lateral-line scales counted until end of hypural complex / ○ 27–32 scale rows between dorsal origin

and lateral line / o 15–23 scale rows between anal origin and lateral line / o 16–20 gill rakers. Size up to 1150 mm SL.

Distribution. Marmara and Black Sea basins.

Habitat. At sea, at depths of down to 50 m, usually along coasts and near estuaries. Migrates to mountain streams. Locally resident in lakes. Resident part of populations in streams with fast currents, cold, clear water, and stony or gravelly bottoms. Usually in lower and middle reaches of main rivers and streams. Also, in very short coastal streams (less than 5 km). Observed in Çoruh up to 340 km from sea. Usually spawns in middle reaches of rivers.

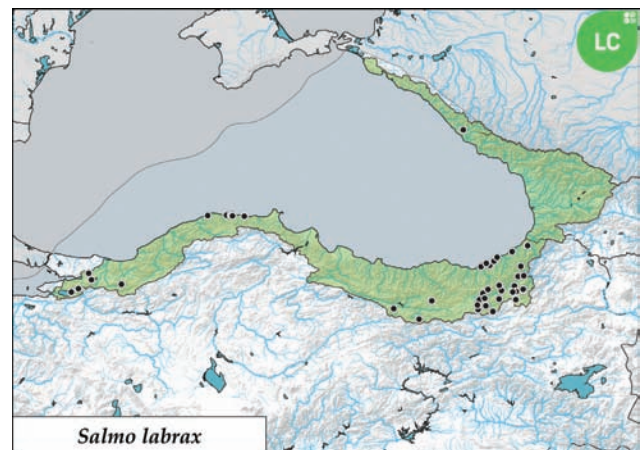
Biology. Anadromous, lacustrine, and resident forms, with most individuals remaining in freshwater. Smallest adult female recorded about 160 mm SL. Spawns October–January. Spends 2–4 years in rivers and streams, then smolts migrate to sea or matures in freshwater. Spends 2–4 years at sea. Some anadromous individuals return to rivers in April–May, where they spend summer; usually spawning migration starts in September–October, gregarious during migration. Other anadromous individuals begin to migrate shortly before spawning. Eggs hatch in 6–8 weeks. Parr and resident adults feed on a wide variety of aquatic and terrestrial invertebrates. Anadromous and large resident individuals feed mainly on fish and large crustaceans. Anadromous individuals feed in rivers.

Conservation status. LC.

Remarks. *Salmo labrax*, *S. coruhensis*, and *S. rizeensis* are often recognised as three species from the Black Sea basin. Genomic data suggest they did not differentiate earlier than during the last or pre-last glacial period. They occur in

many sedentary populations, some of which are also occasionally or frequently anadromous. All are closely related by recent genomic data and microsatellite and cytochrome b mtDNA studies. Furthermore, the morphological differences described between the species are minor and overlapping. We follow the latest study on this species complex and treat *S. coruhensis* as a synonym of *S. labrax* but keep *S. rizeensis* as a valid species. That means *S. rizeensis* is not the resident form of *S. labrax*, but resident populations of two species occur in sympatry.

Further reading. Berg 1949b (biology); Salmanov & Dorofeyeva 2001 (morphology); Bernatchez 2001 (genetics); Turan et al. 2010 (description of *S. coruhensis*); Ninua et al. 2018 (Cytochrome b data); Hashemzadeh Segherloo et al. 2021 (genomics); Ninua et al. 2023 (synonymy of *S. coruhensis*, microsatellite data).



Many *Salmo* species inhabit spring-feed streams and rivers such as the upper Köprüçay.



Salmo munzuricus; aquaculture, Munzur, Euphrates drainage, Türkiye; male about 400 mm SL.



Salmo munzuricus; Murat, Euphrates drainage, Türkiye; male, 205 mm SL.

Salmo munzuricus

Common name. Munzur trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris drainages by: ● adipose very large, length about equal to length of anal base in adults, as large as dorsal and anal in a 400 mm SL male / ○ flank with many irregularly shaped black and red spots / ○ flank brownish / ○ black spots mostly along middle of flank, absent from back / ○ number of black spots increase with size / ○ adipose usually with very narrow white margin, red submargin followed by a white band or spots, an and inner red band in male / ○ head length 24–27 % SL / ○ maxilla length 8–10 % SL / ○ length of mouth gape 10–13 % SL / ○ 116–123 scales along lateral line counted until end of hypural complex / ○ 15–17 scales between lateral line and adipose / 28–30 scales rows between lateral line and dorsal origin. Size up to 400 mm SL.

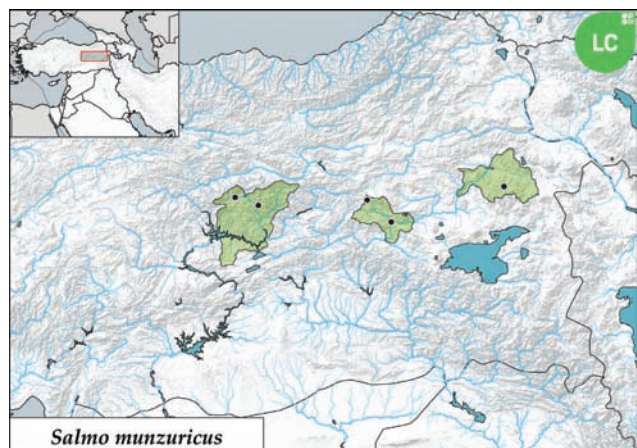
Distribution. Türkiye: Munzur and Murat in upper Euphrates drainage. Also, in Keban Reservoir and a tributary south of Keban drainage.

Habitat. Headwater streams with cold, clear water; moderate current, gravel, and pebble substrate. Inhabits reservoirs.

Biology. No data.

Conservation status. LC.

Further reading. Turan et al. 2017e (distribution); Turan et al. 2020 (Cytochrome b phylogeny); Turan et al. 2021b (distribution).





Salmo murathani; Aras drainage, Türkiye; female, ~210 mm SL. © M. Özuluğ.



Salmo murathani; Aras drainage, Türkiye; male, ~180 mm SL. © M. Özuluğ.

Salmo murathani

Common name. Sarıkamış trout.

Diagnosis. Distinguished from other species of *Salmo* in Caspian basin by: ○ background colour greyish on back and upper part of flank, yellowish on lower part of flank and belly in life / ○ black spots numerous in male, and in female larger than 230 mm SL, irregularly shaped, small to medium (smaller than pupil), ocellated, surrounded by a large white ring, scattered on back, middle and upper part of flank, and anterior part of lower flank / ○ number of black spots increasing with increasing size / ○ adipose of moderate size, not reaching caudal base / ○ 114–122 lateral-line scales counted until end of hypural complex / ○ 12–14 parr marks, distinct up to about 200 mm SL, vertically elongate on anterior, roundish on posterior part of flank / ○ four dark bands on flank in female larger than 230 mm SL. Size up to 255 mm SL.

Distribution. Türkiye: Lake Çıldır, upper Aras, Keklik, Kızılçubuk, Arpaçay, and Maksutçuk in Aras drainage.

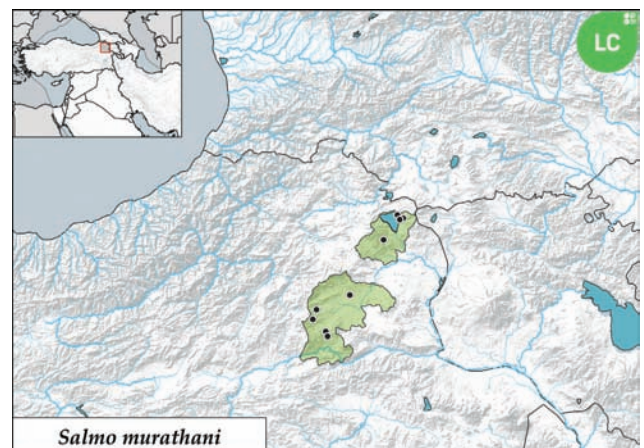
Habitat. Clear and relatively slow-flowing water with stony and pebbly bottom.

Biology. No data.

Conservation status. LC.

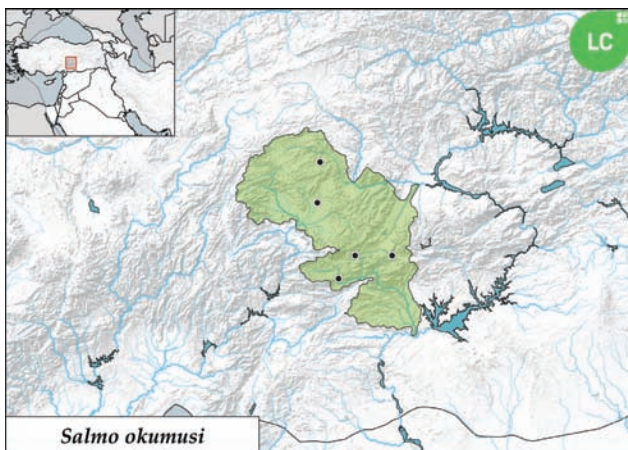
Remarks. This species is most likely conspecific with *S. caspius*; see the discussion there.

Further reading. Turan et al. 2022b (description).





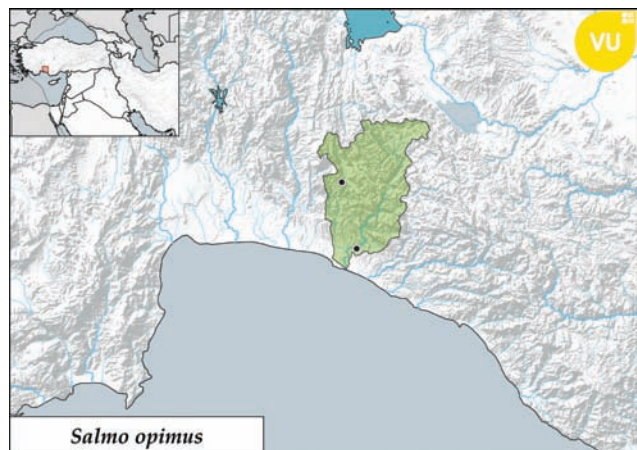
Salmo okumusi; Gökpınar, Euphrates drainage, Türkiye; ~140 mm SL.



Salmo okumusi

Common name. Western Euphrates trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris drainages by: ● flank and back covered by numerous irregularly shaped small red spots and dots, imparting a peppered or slightly marmorate pattern / ● 5–18 black spots on top of head / ○ four broad dark-brown or grey bars on flank, very faintly marked or indistinct in small individuals but distinct in individuals larger than about 230 mm SL / ○ flank greyish / ○ black and red spots on flank irregular shaped / ○ red spots on flank smaller than pupil / ○ 1–22 small black spots in postorbital and suborbital area, smaller than pupil in individuals larger than 120 mm SL / ○ 8–17 small black spots on opercle, smaller than pupil in individuals larger than 120 mm SL / ○ adipose grey, with three or four red to orange spots on its free edge / ○ 10–11 parr marks, distinct up to about 210 mm SL / ○ 103–112 lateral-line scales



counted until end of hypural complex / ● 26–28 scale rows between lateral line and dorsal origin. Size up to 280 mm SL. **Distribution.** Türkiye: Göksu, Lake Gökpınar basin (in Tohma drainage), and Sürgü in Euphrates drainage.

Habitat. Headwater streams with cold, clear water, moderate current, gravelly and pebbly bottom.

Biology. Spawns in November.

Conservation status. LC.

Further reading. Turan et al. 2014b (description); Turan et al. 2020 (Cytochrome b phylogeny).

Salmo opimus

Common name. Alara trout.

Diagnosis. Distinguished from other species of *Salmo* in Mediterranean basin by: ● predorsal area slightly convex in individuals larger 170 mm SL / ○ four broad, dark-brown or grey bands on flank / ○ 10–12 parr marks distinct even in



Salmo opimus; Alara drainage, Türkiye; 270 mm TL. © J. Schöffmann.

the largest size / ○ one black spot behind eye / ○ 0–5 black spots on opercle, usually 2–3 (smaller than pupil) / ○ 0–50 black spots on flank, smaller than pupil, irregularly shaped, located mostly on anterior, upper part of flank, also on back and below lateral line in some individuals / ○ red spots few, small, irregularly shaped / ○ a large (larger than eye pupil) white ring around red spots / ○ red spots present on flank in individuals of all size groups / ○ maxilla short, maxilla, and lower lip not fleshy / ○ maxilla and supramaxilla wide (depth of upper jaw 2.6–3.2 times in length of maxilla) / ○ adipose larger in male than that in female / ○ 112–120 lateral-line scales counted until end of hypural complex / ○ 24–26 scale rows between dorsal origin and lateral line / ○ 16–18 scale rows between anal origin and lateral line /

○ 13–15 scale rows between adipose origin and lateral line / ○ 22–23 gill rakers. Size up to 270 mm SL.

Distribution. Türkiye: Alara, a coastal Mediterranean drainage.

Habitat. Headwater streams, usually spring-fed, with cold, clear water and moderate currents, with gravel and pebble beds.

Biology. No data.

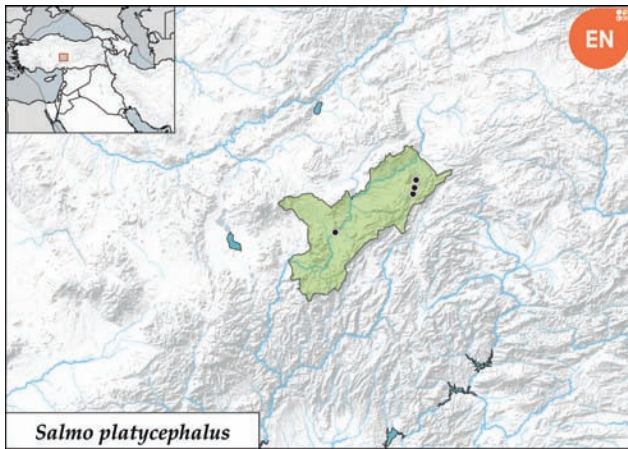
Conservation status. VU; believed to decline due to many threats in its small range.

Remarks. Was thought to be widespread in Ceyhan, but all these populations have recently been identified as *S. chilo*.

Further reading. Alp et al. 2003 (spawning time); Turan et al. 2012b (description).



Salmo platycephalus; Zamanti, Seyhan drainage, Türkiye; 240 mm SL.

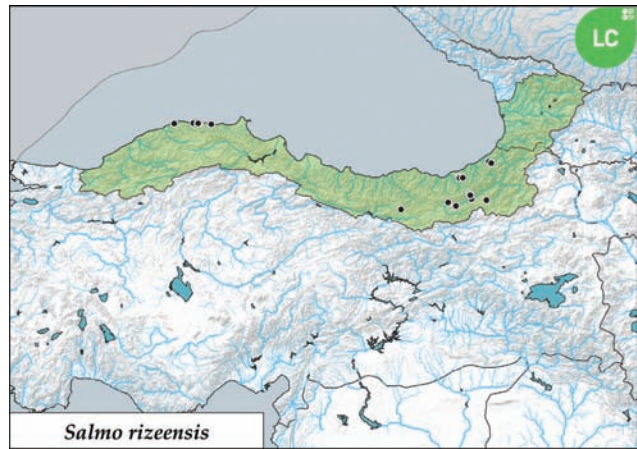


Salmo platycephalus

Common name. Flathead trout.

Diagnosis. Distinguished from other species of *Salmo* in Mediterranean basin by: ● head dorso-ventrally flattened / ● flank marbled or mottled without red spot in individuals larger than 70 mm SL, without black spots in individuals larger than about 200 mm SL / ● 12–13 parr marks up to about 70 mm SL / ○ lower jaw enclosed laterally by fleshy maxilla / ○ four broad dark-brown or grey bands on flank, indistinct in individuals smaller than about 170 mm SL / ○ one black spots behind eye / ○ 7–16 very indistinct black spots on opercle / ○ maxilla short, narrow anterior part short / ○ maxilla and supramaxilla wide (depth of upper jaw 2.2–2.7 times in length of maxilla) / ○ 110–116 lateral-line scales counted until end of hypural complex / ○ 23–25 scale rows between dorsal origin and lateral line / ○ 17–18 scale rows between anal origin and lateral line / ○ 13–15 scale rows between adipose origin and lateral line / ● 23–25 gill rakers. Size up to 600 mm SL.

Habitat. Clear and moderately fast-flowing streams with rocky and pebbly bottoms.



Biology. Spawns October–middle December.

Distribution. Türkiye: Soğuksu, Uzunyayla, and Karagöz in upper Zamantı drainage.

Conservation status. EN; believed to decline due to many threats in its small range.

Further reading. Behnke 1968 (description); Sušnik et al. 2004 (phylogenetic position); Kara et al. 2011 (morphology, biology); Turan et al. 2012b (diagnosis); Hashemzadeh Segherloo et al. 2021 (genomics).

Salmo rizeensis

Common name. Pontic brook trout.

Diagnosis. Distinguished from other species of *Salmo* in Marmara and Black Sea basins by: ○ flank brownish in life / ○ black spots on flank usually smaller than pupil, ocellated, restricted to back and upper part of flank, absent in front of dorsal / ○ few black spots, number decreasing with size / ○ few red spots, small, ocellated, usually organised in three or four irregular rows along middle and lower part of flank / ○ number and size of red spots not changing with size /



Salmo rizeensis; Çoruh drainage, Türkiye; ~150 mm SL. © M. Özuluğ.

● maxilla long, reaching beyond eye in adults and juveniles / ○ upper edge of maxilla straight or slightly convex posteriorly in male / ○ head 1.2–1.4 times in body depth at dorsal origin in male / ● adipose slender, upper edge straight or very slightly convex anteriorly / ○ 114–120 lateral-line scales counted until end of hypural complex / ○ 26–30 scale rows between dorsal origin and lateral line / ○ 18–21 scale rows between anal origin and lateral line / ○ 14–17 scale rows between adipose origin and lateral line / ○ 16–19 gill rakers. Size up to 250 mm SL.

Distribution. Black Sea basin from Georgia to Sakarya in Anatolia.

Habitat. Streams with cold, clear, fast-flowing water, and a substrate of rocks, stones, and pebbles.

Biology. Spawns mid-September–mid-October. Resident and not undertaking long spawning migrations. Smallest spawning female observed about 110 mm SL. Smallest male with mature gonads about 90 mm SL, usually 140–170 mm SL. Do not appear to feed during winter.

Conservation status. LC.

Remarks. See discussion in chapter about *S. labrax*.

Further reading. Turan et al. 2010 (description); Ninua et al. 2018 (Cytochrome b data); Turan et al. 2020 (Cytochrome b phylogeny); Hashemzadeh Segherloo et al. 2021 (genomics).



Salmo tigridis; upper Tigris drainage, Türkiye; 210 mm SL.

Salmo tigridis

Common name. Tigris trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris by: ● flank greenish in life / ○ few black spots on flank, smaller than pupil, ocellated / ○ few red spots on flank, usually in 1–3 along lateral midline, smaller than pupil, usually irregularly shaped and ocellated / ● adipose without red or black spots / ○ maxilla short, reaching posterior eye-margin or slightly beyond in individuals larger than 200 mm SL / ○ head 1.0–1.1 times in body depth at dorsal origin in both sexes / ○ 108–116 lateral-line scales counted until end of hypural complex / ● 32–35 scale rows between dorsal origin and lateral line / ● 19–20 scale rows between adipose origin and lateral line / ○ 22–26 scale rows between anal origin and lateral line / ○ 17–19 gill rakers. Size up to 400 mm SL.

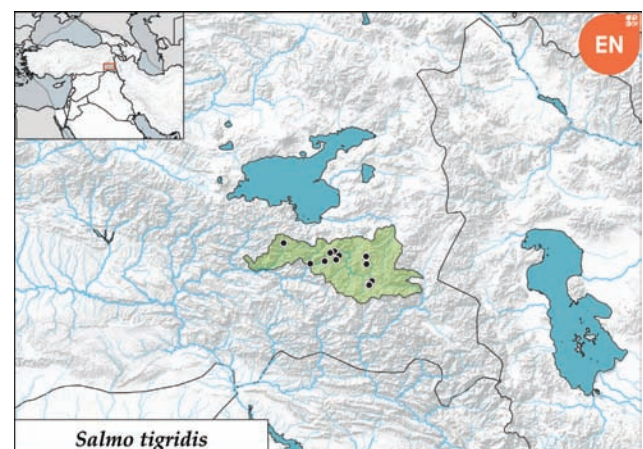
Distribution. Türkiye: Çatak and Müküs in upper Tigris drainage south of Lake Van.

Habitat. Headwater streams with cold, clear water, moderate current, gravel, and pebble bottom.

Biology. No data.

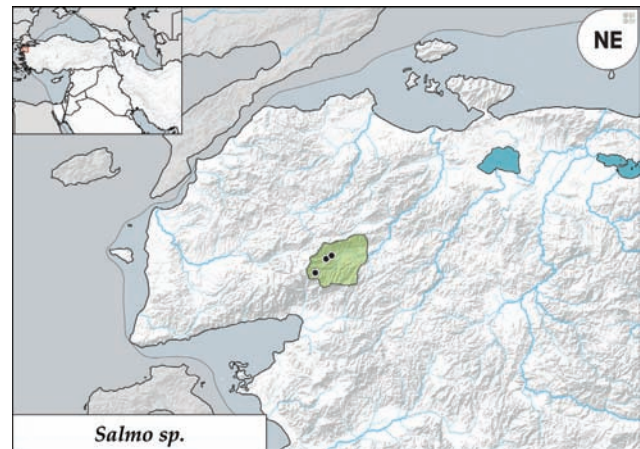
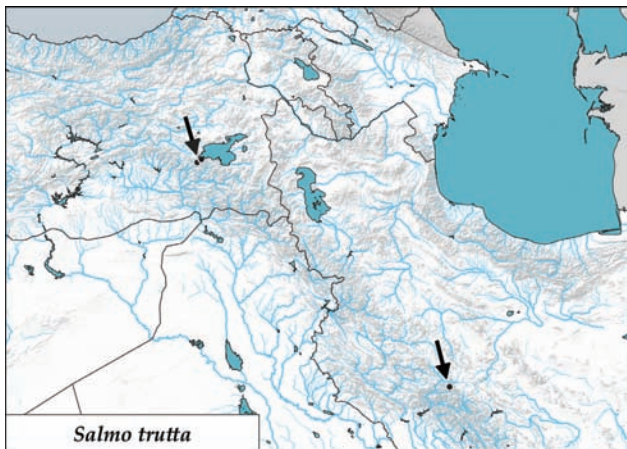
Conservation status. EN; appears to be declining within its very small range.

Further reading. Turan et al. 2011 (description); Turan et al. 2020 (Cytochrome b phylogeny).





Salmo trutta; Sapur, Lake Van basin, Türkiye; male, 258 mm SL.



Salmo trutta

Common name. Atlantic trout.

Diagnosis. Distinguished from other species of *Salmo* in Euphrates and Tigris (based on materials from Türkiye) by:
 ○ 15–17 scale rows between lateral line and end of adipose base / ○ 28–33 scale rows between lateral line and dorsal origin / ○ lateral line with 117–125 scales counted until end of hypural complex / ○ adipose depth 8–10 % SL in male / ○ black and red spots on flank roundish / ○ numerous black spots on back, middle and upper part of flank / ○ number of black spots increasing with size / ○ flank brownish in life. Size up to 900 mm SL in native range. Anadromous and lacustrine individuals usually 450–600 mm SL, resident individuals usually 200–300 mm SL.

Distribution. Türkiye: introduced into Arpet (a tributary of Botan in upper Tigris) and Sapur (a small tributary of Lake Van), but it appears to have become vanished in these areas due to poaching. Iran: introduced and established in Lake Gahar in Karun drainage. Native to Atlantic, North, White, and Baltic basins, from Spain to Chosha Bay (Russia). Present in Iceland and northernmost rivers of Great Britain

and Scandinavia. In Rhône drainage, native only to Lake Geneva basin, which it entered after last glaciation. Native to upper Danube and Volga drainages. Introduced throughout Europe, North and South America, southern and montane eastern Africa, Pakistan, India, Nepal, Japan, New Zealand, and Australia.

Habitat. Cold streams, rivers, and lakes. Spawns in fast-flowing rivers and streams. Lacustrine populations migrate to tributaries and lake outlets, rarely spawning on stony, wave-washed lake shores. Spawning sites are usually characterised by downward movement of water into gravel. Sea and lake trout forage in pelagic and littoral habitats; sea trout usually close to coast, not far from mouth of natal river.

Biology. Unstudied in Anatolian populations.

Conservation status. Non-native.

Further reading. Elliot 1994 (ecology); Bernatchez 2001 (phylogeography); Klemetsen et al. 2003 (life history); Kaya 2020c (record from Tigris and Lake Van drainages); Guinand et al. 2021 (multi-species opinion piece on *Salmo* taxonomy); Hashemzadeh Segherloo et al. 2021 (genomic data).



Salmo sp., Gönen drainage, Türkiye; 220 mm SL.

***Salmo* sp.**

Common name. Marmara trout.

Diagnosis. Distinguished from other species of *Salmo* in Marmara and Black Sea basins by: ○ caudal peduncle depth in male 8–10 % SL / ○ size of adipose equal in male and female / ○ numerous black spots on back and flank in adult female / ○ red spots present on the body in individuals larger than 200 mm SL / ○ number of red spots does not increase with increasing size in male / ● 109–121 lateral-line scales counted until end of hypural complex size up to 287 mm SL. **Distribution.** Türkiye: Ayazma, a headwater stream in Karamenderes drainage and upper tributaries of Gönen on Biga Peninsula.

Habitat. Headwater streams with cold, clear water; moderate current, gravelly and pebbly bottom.

Biology. No data.

Conservation status. NE.

Remarks. This species was described as *S. duhani* in 2021, but the name is a *nomen nudum* and is not valid from the description. We suspect that it will be re-described soon.

Further reading. Turan & Bayçelebi 2020 (record as *S. pelagicus*); Turan & Aksu 2021 (invalid description as *S. duhani*).



Salvelinus fontinalis; aquaculture, Germany; ~300 mm SL. © A. Hartl.

Salvelinus fontinalis

Common name. Brook charr.

Diagnosis. Distinguished from species of *Salmo* and *Onco-rhynchus* in West Asia by: ● lateral-line scales very elliptical, reduced to little more than nerve tube, smaller than scales in adjacent rows, with no or little overlap with scales in front or behind / ● back, dorsal and caudal with pale-brown

or grey spots or vermiculated / ○ pectoral, pelvic and anal with white margin followed by a black submarginal line / ○ flank with pink or red spots, some bluish / ○ juvenile with 8–10 parr marks. Size up to about 500 mm SL.

Distribution. Very locally stocked in Caucasus and Türkiye. Unclear if established. Native to North America from Hudson Bay basin and northeastern Canada south to

upper Mississippi, east to coast of New Jersey and northern Georgia. Widespread in North and South America, Europe, Asia and southern Africa. Found throughout Europe, especially in high-altitude streams and lakes, but rarely confirmed as established. Established populations documented from high-altitude lakes and streams in Corsica, Italy, Czech Republic, southern Germany (list probably not exhaustive).

Habitat. Cold and moderately to rapidly flowing mountain streams. In North America, northern populations also in lakes and rivers. Spawns in gravel in fast-flowing streams or in lakes. Occasionally established in nutrient-poor lakes, high mountains or acidic streams.

Biology. Lives up to 15 years. First spawns at 1–2 years in central and southern Europe, 3–4 years in northern Europe. Spawns in October–November, earlier in north, usually at 3–10°C. Females build redds. Eggs hatch in spring. Only non-anadromous populations in Europe. Anadromous in North America. Feeds on aquatic invertebrates and small fish. Territorial, of equal size, dominated by *Salmo trutta*, whose presence limits its distribution. Artificial hybrids with *Salmo trutta* (tiger trout) are occasionally stocked.

Conservation status. Non-native; introduced for recreational fisheries.

Further reading. Scott & Crossman 1973 (biology); Jenkins & Burkhead 1993 (biology).



A drainage of İyidere in eastern Black Sea basin is a typical cold trout stream into which anadromous *S. labrax* migrated to spawn before the construction of dams.



Uzunyala in upper Zamantı drainage, Türkiye, the habitat of *Salmo platycephalus*. © J. Schöffmann.

Family Lotidae

Burbots

A small family of mostly marine fishes with three genera and approximately 5 species within the diverse order Gadiformes. They are widely distributed, mostly in cold seas of the Arctic, Atlantic, and Pacific Oceans. *Lota* is the only freshwater member of the family, distinguished from marine genera in West Asia by the presence of a single central barbel on the lower jaw, two dorsals, and one anal with 64–84½ total rays. Additionally, the body is

marbled dark-brown and lacks a prominent nasal barbel. A single individual of *Lota lota* was caught in 1920 in the Kura in Azerbaijan, and another record was made in 1921 from the lower Sefid in Iran. At the time, there may have been a small population in the region, but the two individuals were likely the result of accidental migration from the northern Caspian Sea. No populations appear in West Asia, and the species was never native or is now extinct in the region. **Further reading.** Coad 2016b (distribution in Iran).



Lota lota; lower Odra, Germany; ~300 mm SL.