Small-scale rainbow trout farming

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Summary

The concept of this practice is to guide the reader through the necessary basic information of both investment in and day-to-day operation of a small-scale rainbow trout farm.

Description

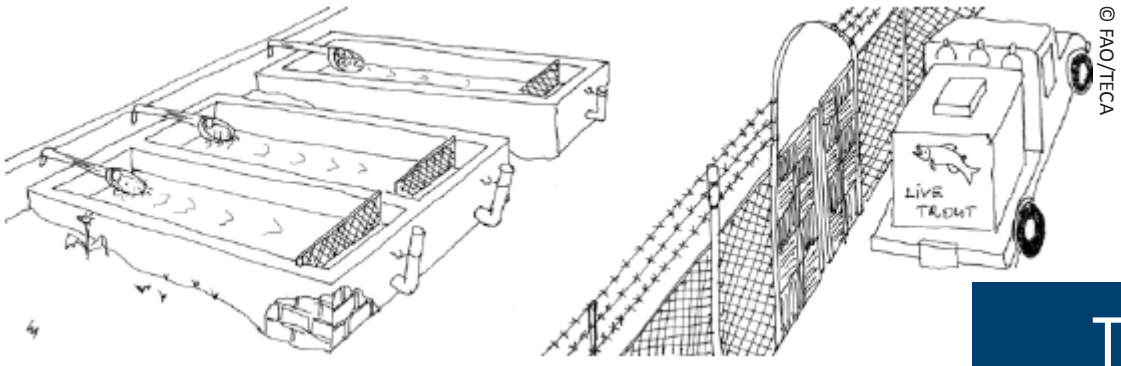
Trout farming is an ideal option for sustainable use of water resources in mountainous regions because here both surface and underground waters are suitable for this purpose.

In regions where income-generating and employment opportunities are scarce, trout farming could help to ensure employment and steady incomes (Figure 1). In addition to the production, trout farming could also ensure increased income and employment through angling tourism, restaurants (Figure 2) and related services. The combination of short explanations together with illustrations is aimed for easy understanding. However, it is suggested that users of this practice consult subject specialists, who will help to avoid unnecessary failures and their financial consequences.

1. Important trout species

There are 206 species in the family of Salmonidae. Salmonids (salmon, trout, char and whitefish) are found in practically all continents, partly because they are indigenous there and partly because they have been introduced. Among trout, brook trout, brown trout, lake trout, sea trout and rainbow trout are the most widely known species. Brown trout is native to Europe and West Asia (Figure 3). An important market

Figure 1. Direct income generation through food production



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and sport fish, it has been introduced to many different countries all over the world.

According to their habitat, taxonomists distinguish three forms of brown trout. They are the actual brown trout (*Salmo trutta m. fario*), lake trout (Salmo trutta m. lacustris) and sea trout (*Salmo trutta m. trutta*) (Figure 3).

Brook trout, together with lake trout (*Salvelinus namaycush*), belongs to the "char" subgroup of salmonids, which distinguishes it from trout and salmon. The brook trout is one of the most well-known sport fish (Figure 5) and is native to the northeast of the United States of America and the east region of Canada. It has been introduced to many countries of South America, Oceania and Asia, and to practically all of the countries of Europe and the former Soviet Union.

1.1 The rainbow trout

Rainbow trout (Oncorhynchus mykiss) is a highly commercial sport and market fish (Figure 5). A normal adult rainbow trout weighs about 2 to 3 kg, while its maximum size, weight and age are 120 cm total length (TL), 25.4 kg and 11 years, respectively. Rainbow trout live in the upper, cold water

Figure 2. Trout farming can support angling tourism and Supplying trout to local restaurants generates tourism

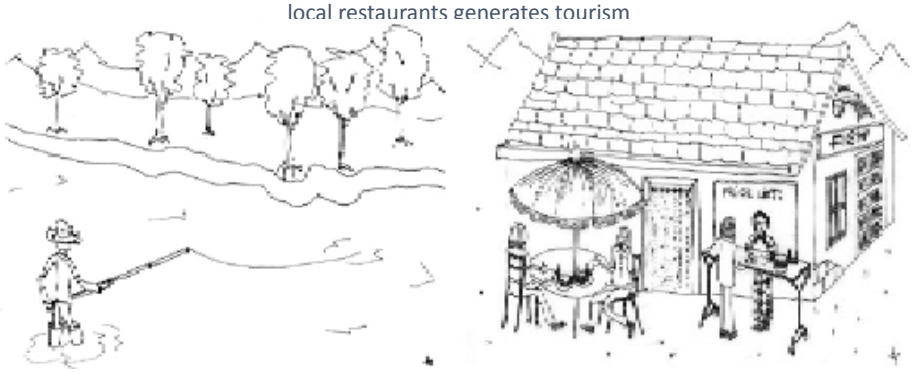

Figure 3. Brown, lake and sea trout

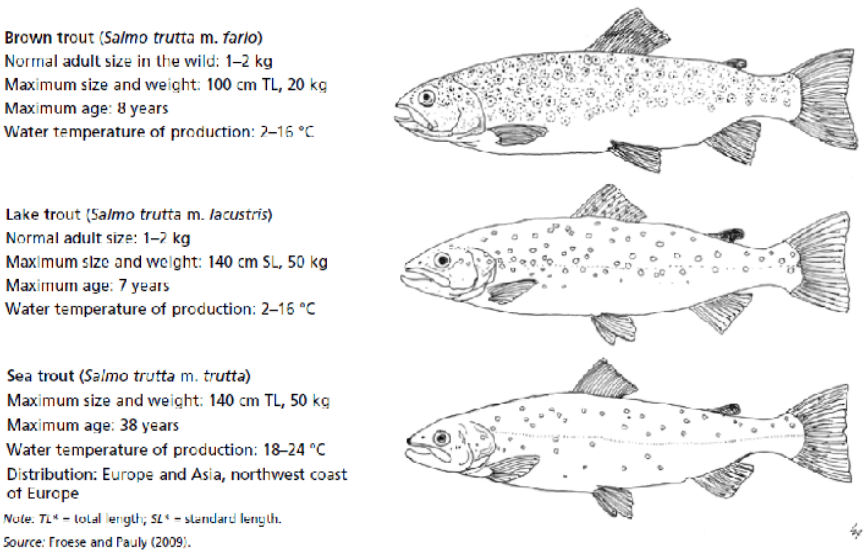

Figure 4. Brook trout (Salvelinus fontinalis)

Normal adult size in the wild: 1–2 kg
Maximum size and weight: 86 cm TL, 9.39 kg
Maximum age: 24 years

Note: TL = total length.
Source: Froese and Pauly (2009).

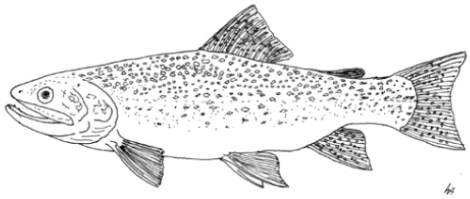

Figure 5. Rainbow trout

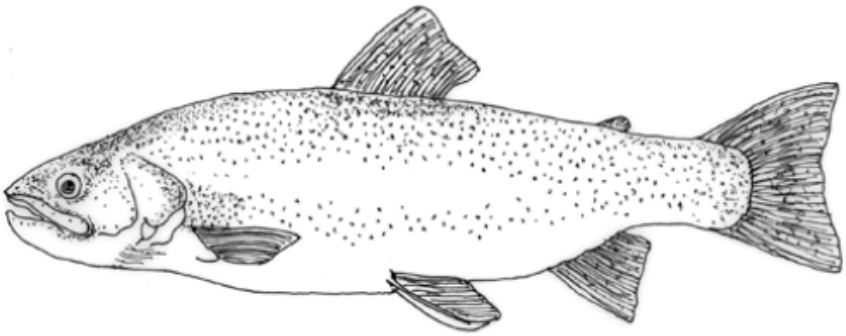

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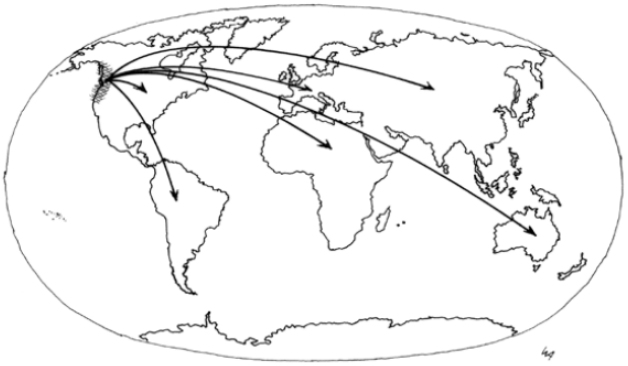
Figure 6. Native range and international introductions of rainbow trout



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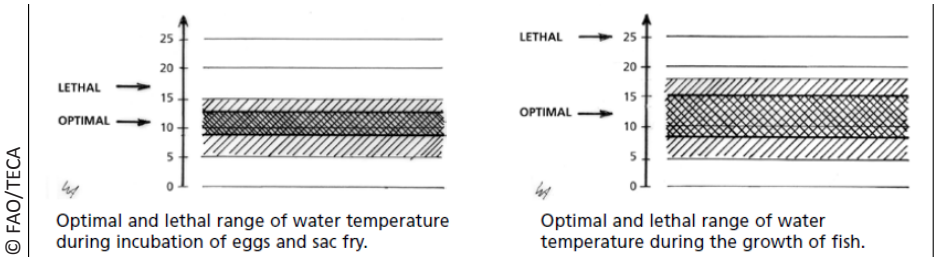
sections of rivers and seas. As in the case of other trout, the habitat and food of rainbow trout determine both their actual colour and shape.

The rainbow trout has many local strains, which have developed in the different river systems. Out of these, numerous improved commercial strains have been bred. The widely cultured commercial strains have been improved from those original rainbow trout populations that possessed advantageous qualities, such as hardiness, fast growth, resistance to diseases and reliable reproduction under farm conditions.

In the wild, there are rainbow trout populations that spawn in autumn and there are other populations that spawn in spring. From these populations, two different commercial strains have been bred. Their qualities are similar, only their spawning seasons differ from each other.

Figure 7. Temperature ranges for rainbow trout at various stages



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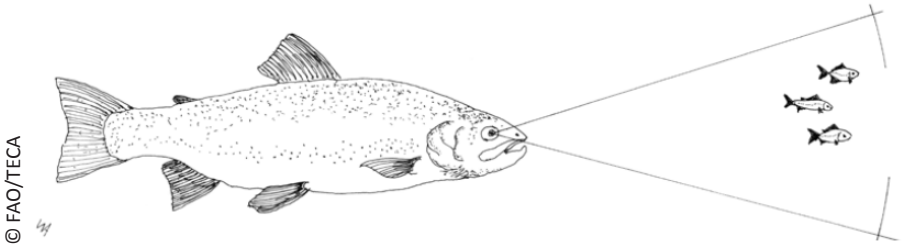
Optimal and lethal range of water temperature during incubation of eggs and sac fry.

Optimal and lethal range of water temperature during the growth of fish.

Figure 8. Clear water enables efficient feeding



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This enables the production capacities of a rainbow trout farm to be increased. In many countries, the albino form of rainbow trout is cultured and is often, but mistakenly, called golden trout. This form is a popular ornamental and "put-and- take" fish, even if it is very sensitive to unfavourable environmental and production conditions.

1.1.1 Native range and international introductions

Rainbow trout is native to the cold water rivers and lakes of the Pacific coasts of North America and Asia. It has been introduced to about 82 countries (Figure 6), practically everywhere the conditions are favourable for its culture, because rainbow trout tolerates a wide range of environmental and production conditions better than other trout species.

1.1.2 Habit factors

There are four vital habitat factors that basically influence the growth of rainbow trout:

- Cold water: rainbow trout is a typical cold water fish (Figure 7).
- Clear water: keen eyesight is crucial for the efficient feeding of trout (Figure 8).
- Clean water: saturated with dissolved oxygen (DO) in high concentrations (Figure 9) and free from harmful gases and harmful solid materials produced during metabolism and respiration (Figure 10).
- Rich water: water that contains enough natural food (Figure 11).

1.1.3 Natural food

The actual natural food of rainbow trout depends on the age and size of fish, on the size of food item and on the habitat occupied. Rainbow trout are aggressive and greedy in feeding. They are opportunistic feeders that grab and eat almost anything. Figure 12 summarizes the most frequent natural food items of rainbow trout.

Terrestrial insects are also consumed when they fall into the water. These insects are adult beetles (*Coleoptera*), flies (*Diptera*), ants (*Formicidae*) and larvae of Lepidoptera (moths and butterflies).

Figure 9. High concentrations of dissolved oxygen enable smooth respiration

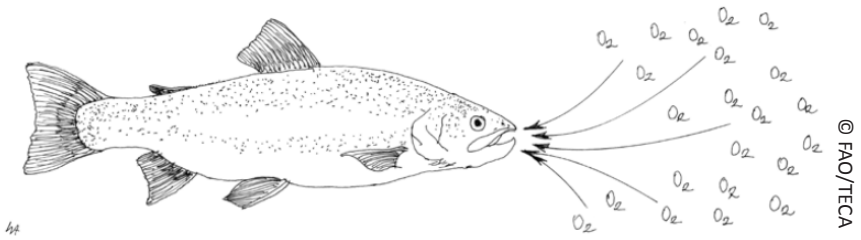

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Figure 10. Trout need water that is free of harmful solid or gaseous waste materials

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Figure 11. Most frequent natural food items of rainbow trout

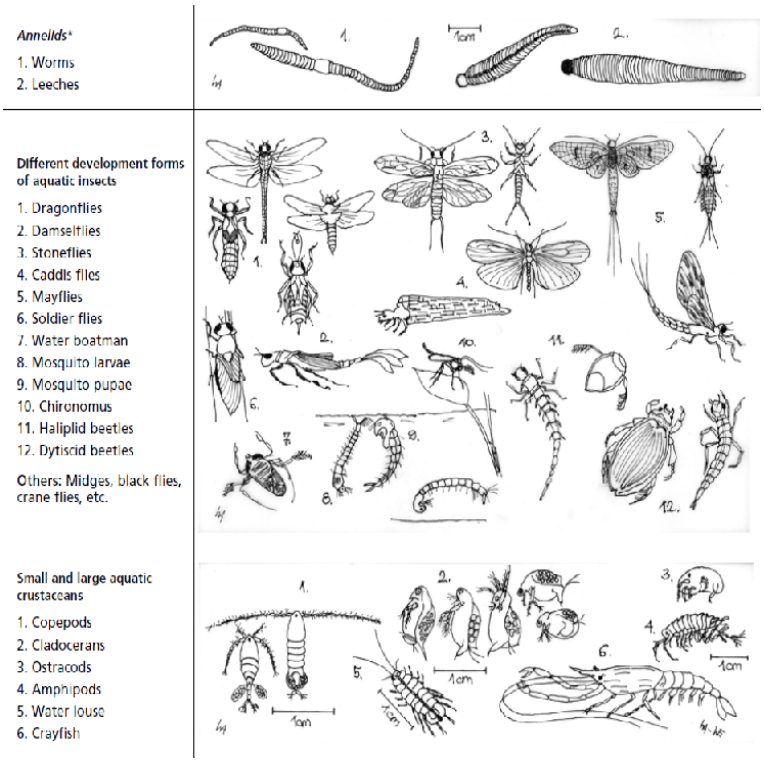

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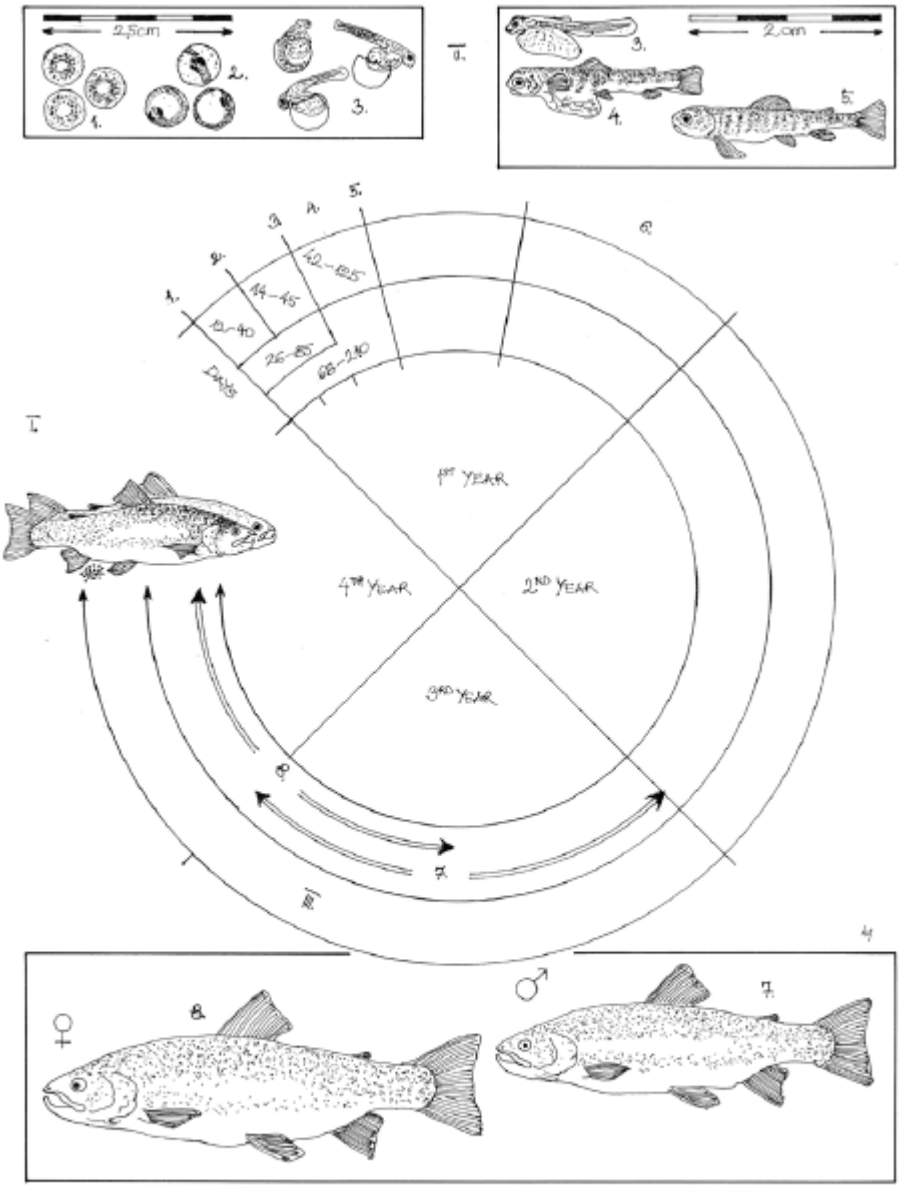
Figure 12 The life cycle and development stages for rainbow trout in the wild

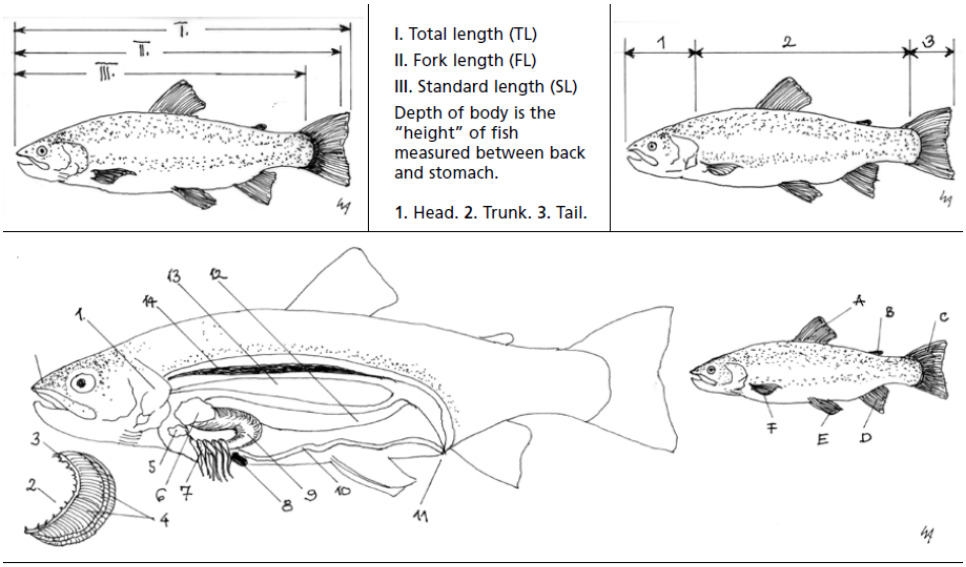


Development stages: **1.** *Fertilized eggs**. **2.** *Eyed egg**. **3.** Hatched *sac fry**. **4.** *Swim-up fry**. **5.** *Fry**. **6.** One-summer fish. **7.** Sexually mature males (*symbol**: ♂) and **8.** females (*symbol**: ♀) are ready to spawn (after Huet, 1970).

Development phases: **I.** Spawning. **II.** Development of fertilized eggs and sac fry. **III.** Development and sexual maturation of fish.

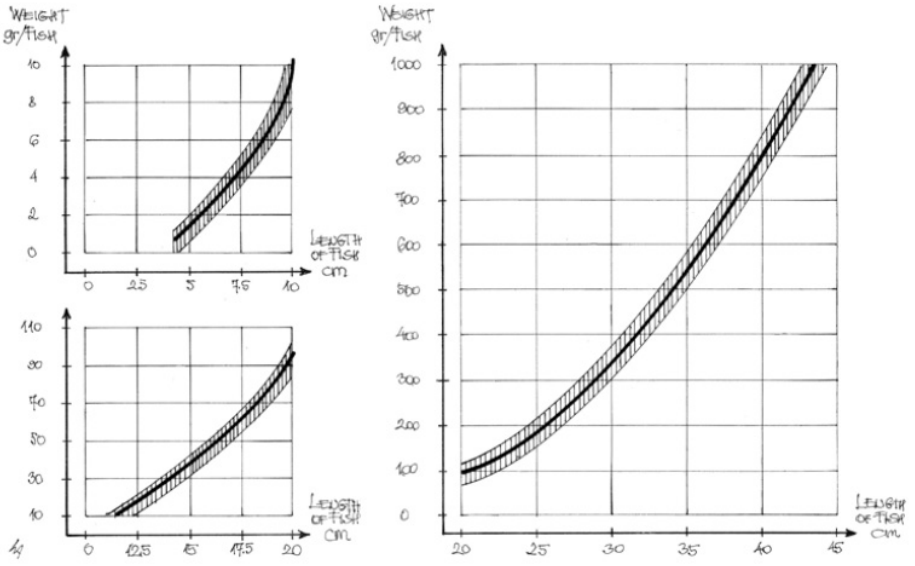
The actual start and duration of the different development phases depend on the water temperature, the genotype as well as the quantity and quality of available natural fish food.

Figure 13. Standard measurements and body parts of rainbow trout



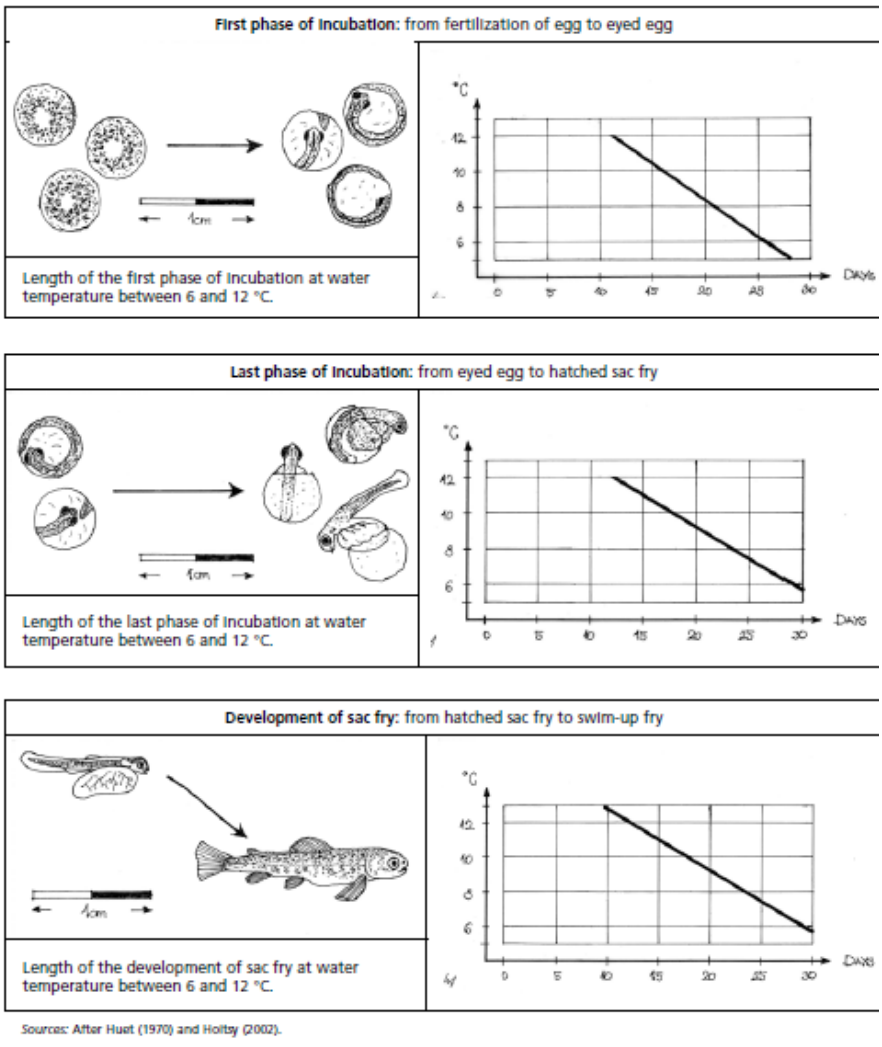
1. Opercula (gill cover). 2. Gill raker. 3. Gill arch. 4. Gill filaments. 5. Heart. 6. Liver. 7. Pyloric caecae and pancreas. 8. Spleen. 9. Stomach. 10. Intestine. 11. Anus and urogenital papilla. 12. Gonad. 13. Swimming bladder. 14. Kidney.
A. Dorsal fin. B. Adipose fin. C. Caudal fin. D. Anal fin. E. Pelvic fin. F. Pectoral fin.

Figure 14. Correlation between the total length and the weight of rainbow trout



Sources: After Klontz (1991); Mills (2001); Hoitsy (2002).

Figure 15. Duration of the development stages of rainbow trout



1.1.3 Life cycle and development stages in wild

Figure 12 shows the life cycle and development stages for rainbow trout in the wild.

1.1.4 Measurements, body parts, organs and correlations between length band weight

Figure 13 shows the standard measurements of body parts of a rainbow trout, while figure 14 shows the correlation between its total length and weight.

1.1.5 Duration of the development stages

Water temperature is a determining factor of fish production. This is because the body temperature of embryos, fry and developing fish equalize their temperature to that of the water they are in.

Along with the body temperature, the intensity of the metabolism also changes. The developing embryos and fry feed from the yolk sac and receive oxygen through the entire body surface. When the water temperature is higher, the embryos and fry develop more rapidly, while at lower water

temperatures the speed of development reduces (Figure 15). Outside of a certain range of water temperature development stops.

The total length of the development of embryo and fry from fertilization to swim-up is about 37 - 83 days at water temperatures between 6 and 12°C.

After starting external feeding, the actual length of the development of the different age groups depends not only on the temperature and oxygen content of water but also on the quality and quantity of consumed feed.

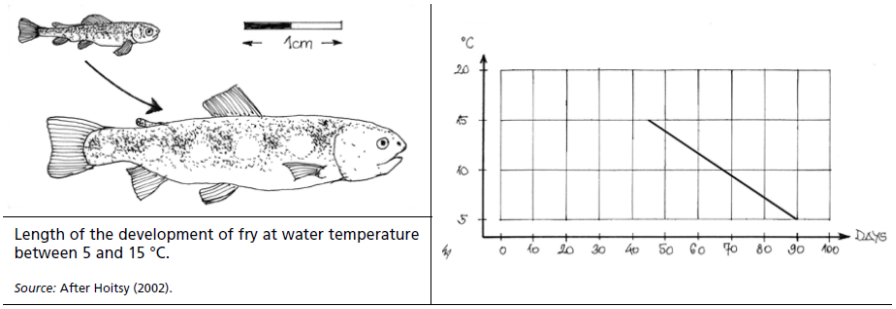
In determining the following figures, it has been assumed that trout is adequately fed with commercial feeds, which are readily and widely available in the countries of Central and Eastern Europe (CEE) and the Caucasus and Central Asia (CCA).

Development of fry from swim-up fry takes 1.5 to 3 months (Figure 16). For the sake of clear understanding and simple calculations, “fry” in this technical paper refers to a total length of 5 cm and to an average body weight of 2 g.

Development of fingerlings from fry takes 3 to 4.5 months (Figure 17).For the sake of clear understanding and simple calculations, “fingerling” in this technical paper refers to a total length of 12.5 cm and to an average body weight of 25 g.

Development of table fish from fingerling takes 4 to 6.5 months (Figure 18). For the sake of clear understanding and simple calculations, “table fish” in this technical

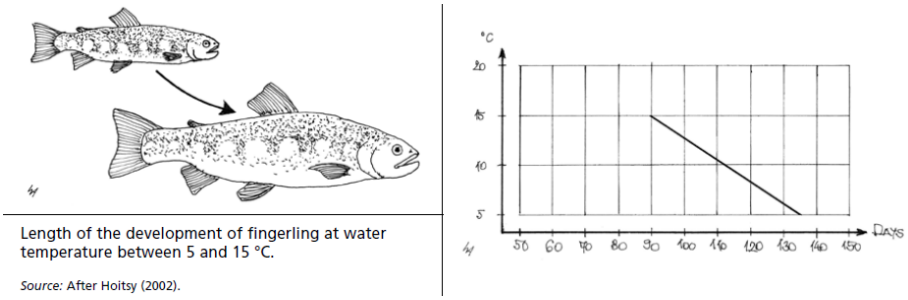
Figure 16. Development of fry



Length of the development of fry at water temperature between 5 and 15 °C.

Source: After Hoitsy (2002).

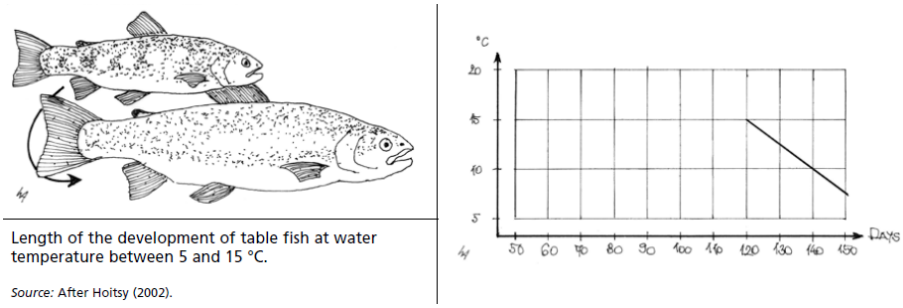
Figure 17. Development of fingerlings



Length of the development of fingerling at water temperature between 5 and 15 °C.

Source: After Hoitsy (2002).

Figure 18. Development of table fish



Length of the development of table fish at water temperature between 5 and 15 °C.

Source: After Hoitsy (2002).

paper refers to the desired minimum body weight of 250 g.

Growth of large table fish from 250 g to 500 g takes a further 2.5 to 4.5 months (75 to 135 days) when the water temperature is between 5 and 15 °C.