

# Wastewater-fed Aquaculture in Temperate Climates - Nutrient Recycling via Daphnia and Fish



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## Introduction

- The present work was done as a **diploma thesis** at the Swiss Federal Institute of Technology
- Experiments were carried out at the **aquaculture pilot plant Otelfingen** near Zurich <sup>1</sup>

## Scope

- Can **products from aquaculture** be used as fish food?
- Which **fish species** result in best growth?
- Do the species perform differently in **mono- or polyculture**?

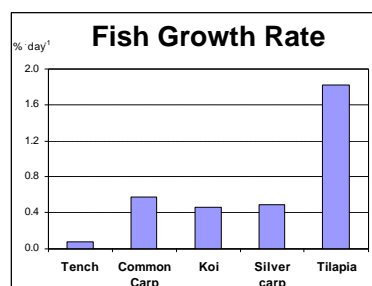
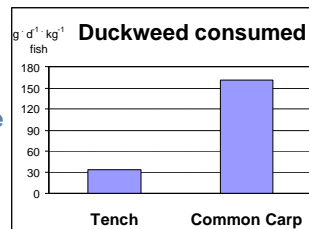
<sup>1</sup> see R. Junge-Berberovic et al. 1999 (workshop presentation at ICEE4, Ås)  
J. Staudenmann et al. 1999 (poster presentation at ICEE4, Ås)

## Results

- **Duckweed consumption:**
  - ▶ **Common carp consume 5x more than Tench**
  - ▶ rate depends on water temperature
- Food conversion:
 

	[g food · g <sup>-1</sup> fish]
Common carp and Tench were similar	2.2, 2.3
<b>Tilapia incorporated feeds the best</b>	1.6
- Growth rate:
 

	[% · d <sup>-1</sup> ]
at favorable conditions	
<b>Tilapia equalled Common carp</b>	2.3, 2.4
<b>Tench grew slower</b>	1.0
at low feeding level	13 % bwt · d <sup>-1</sup> fresh food
Tilapia showed the best growth rate	1.8
followed by Common carp and Tench	0.6, 0.1
Two year old common carp and tench lost weight	



- **Polyculture** versus monoculture:
  - ▶ **Silver carp grew faster** 1.3, 0.6
  - ▶ Common carp and Tench showed no difference 0.2, 0.1
- Decrease in water temperature from 22 to 17°C caused high Tilapia mortality 89 %
- Key numbers:
  - ▶ overall fish production: 4.36 kg fresh meat
  - ▶ feeds consumed: 63.4 kg *Daphnia*, 115 kg duckweed
- **Further research** topics:
  - ▶ alterations in plant design
  - ▶ improvement of *Daphnia* production
  - ▶ nutrient balance of the fish module

## Material

- Fish were kept outdoors in 5 m<sup>3</sup> concrete tanks
- Water was aerated and renewed ( $\tau$  =60 days)
- Fish species used (initial size 40 g):
  - ▶ **Common carp** (*Cyprinus carpio*)
  - ▶ **Koi Japanese carp** (*Cyprinus carpio*)
  - ▶ **Tilapia** (*Oreochromis niloticus*)
  - ▶ **Silver carp** (*Hypophthalmichthys molitrix*)
  - ▶ **Tench** (*Tinca tinca*)
- Fish food was exclusively produced at aquaculture:
  - ▶ **water fleas** (*Daphnia magna*)
  - ▶ **duckweed** (*Lemna ssp.*)



## Methods

- Fish were fed:
  - ▶ once per day with *Daphnia*
  - ▶ ad libitum with duckweed
- Fish were weighed every 4 weeks to calculate:
  - ▶ **condition index**
  - ▶ **growth rate**
  - ▶ **food conversion**
- The Experimental period lasted 115 days



Aquatic food chain: Algae are filtered by Silver carp and *Daphnia* which are in turn consumed by Tilapia

## Conclusions

- **Tilapia culture** (at latitude 47° N):
  - ▶ is restricted to summer months (June - Sept)
  - ▶ **can replace Common carp and Tench** in pond culture if water temperature is higher than 20 °C
- Matching initial fish biomass to expected *Daphnia* production improves individual fish growth
- **Inorganic nutrients from wastewater can be converted into valuable fish biomass**