Fishponds in the Czech Republic - and their Sustainable (?) Management

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All in the Czech Republic

OUTLINE:

1. Introduction – the Czech Republic
2. Fishponds and fish rearing in them
3. Ecological functions determining the ecosystem services of fishponds
4. Hyper(eu)trophy of fishponds and the way out of it (restoration of fishponds)
5. Conclusions

PRESENTATION:

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The Czech Republic (78,867 km^2, 10.5x10^6 inhabitants) is situated in the basins of 3 seas: (a) North Sea (Labe/Elbe + Vltava – 433 km), (b) Black Sea (Morava/March + Dyje – 306 km), (c) Baltic Sea (Odra/Oder – 135 km).

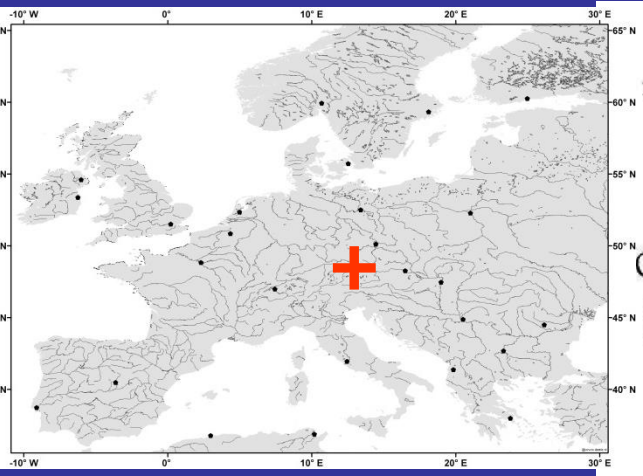

Fig. 1.

PRESENTATION:

1. Introduction – The Czech Republic and its standing waters
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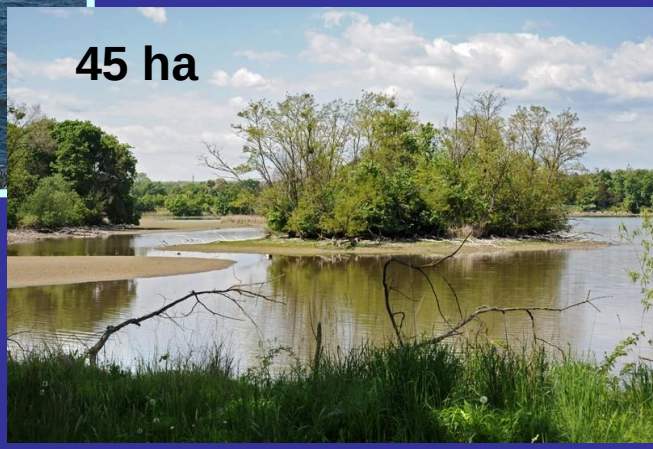
WHAT ARE FISHPONDS?

Artificial water reservoirs used for fish rearing, subjected to periodical complete drawdowns. Apart from fish rearing, they also fulfill other ecological functions (= ecosystem services).



FISHPONDS: total area: 520 km^2 ; size: <1ha to 500ha (=5 km^2) each; average depth 1.6 m.

Main fishpond regions in the Czech Republic:

CLASSIFICATION OF FISHPONDS

from the viewpoint of fish rearing

Basic classification since mid-16th century. Manual „*De piscinis*“ (1547) by the bishop of Olomouc (Moravia) Jan Dubravius (1486–1553):

- **Spawning ponds**
- **Nursery ponds**
- **Fingerling ponds**
- **Rearing (main) ponds**
- **Hibernation ponds**

Importance of summer and winter drawdown (several months) for a “healthy state“ of fishponds!

USUAL TECHNICAL EQUIPMENT

Dam – usually earth with stone rip-rap, stabilized by trees

Outlet – originally wooden (fir), now concrete or steel

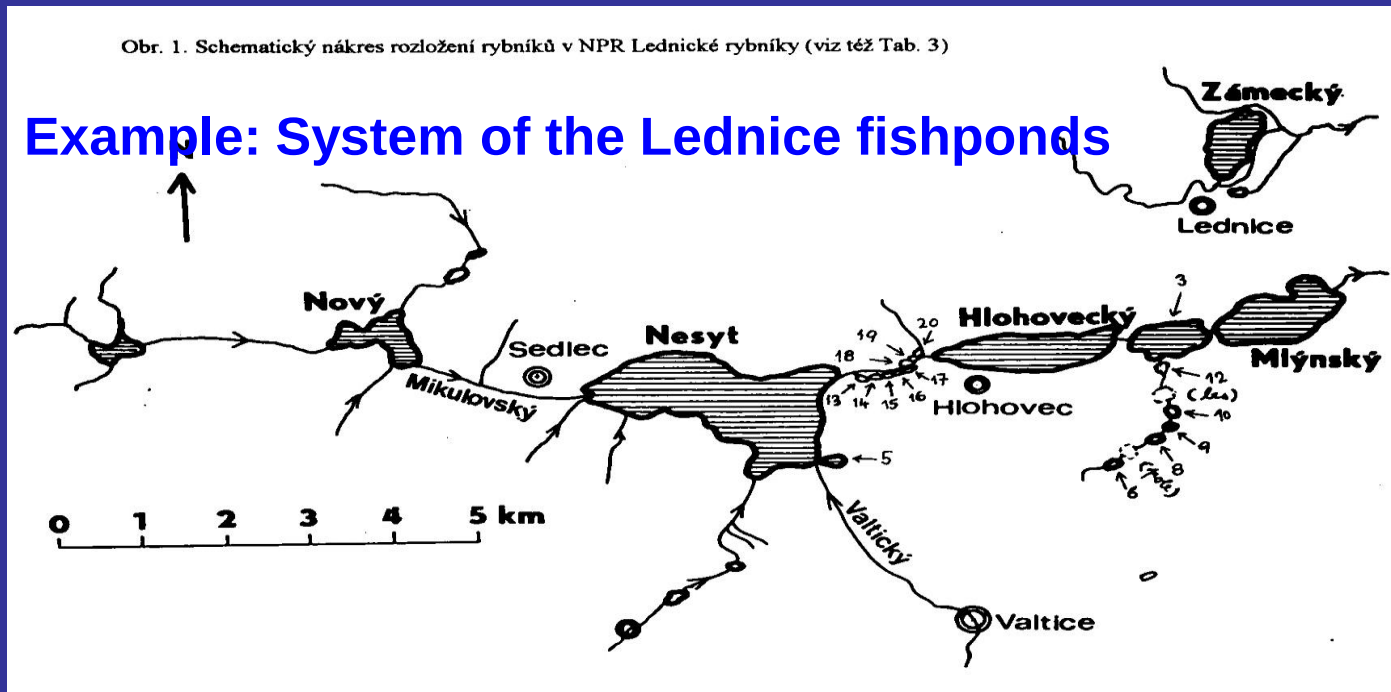
Spillway – controls normal water level

Fish collection – with nets after fishpond drawdown

Period of fishing – 2 or 3 years (summer seasons)

Size of ponds – from several to hundreds of hectares

Fishponds usually form cascade-like fishpond systems. Purpose: Economic water use.



FISHPONDS - MANAGED ECOSYSTEMS:

- Water level
- Fish stock
- Basic water chemistry
- Nutrient input

All four under control by fishery managers, but not as completely as in intense aquacultures

- Natural production procesess - of basic impofance for fish rearing in fishponds
- *QUESTION:* Main present challenge to fishery management and research?
- *ANSWER:* Introduce sustainable ecosystem functioning to the presently prevailing hyper(eu)trophic fishponds!

PRINCIPAL FISH SPECIES REARED::

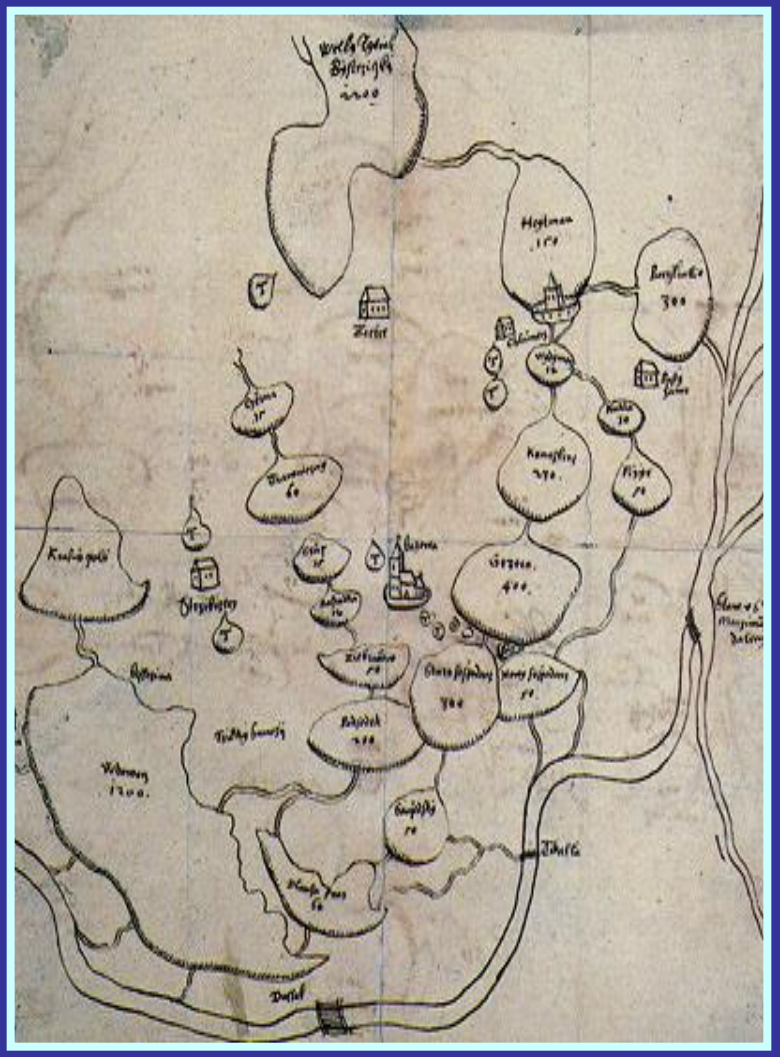
Common Carp (*Cyprinus carpio*) 88 %
(cca 17 000 metric tons per year in Czech Rep.)
Grass Carp (*Ctenopharyngodon idella*) plus
Silver Carp (*Hypophthalmichthys molitrix*) 4 %
Tench (*Tinca tinca*) 1 %
Pike (*Esox lucius*)
Pikeperch (*Stizostedion lucioperca*)
Catfish *(Silurus glanis)*

Market-size carp – average length ca 40 cm, weight ca 2.8 kg

FISH HARVEST: with nets from a pool at the pond outlet after pond drawdown

Density of marketable fish stock: 5 to 10.10^{3} ind.ha^{-1}

HISTORY OF CENTRAL EUROPEAN FISHPONDS



- First fishponds in the Roman period
- First reservoirs in 3rd centrury (Celts)
- Start of pond construction in Bohemia in 10th century
- Construction of most fishpond systems in present Czech Rep. – 16th century

- Fishponds neglected or destroyed:
17th century – 30 years´ war
19th century – drainage, mainly for sugar beet culture

DEVELOPMENT OF FISHPOND MANAGEMENT in the Czech Republic

Period	Area *thous. ha*	Production *kg.ha^{-1}*
12th cent.	unknown	?
14th cent.	75	40
16th cent.	180	40
18th cent.	79	30
1850	35	25
1924	44	81
1956	50	137
1965	50	210
1975	51	328
1985	52	393
1995	52	423

Highest present yields: up to ca 1200 kg.ha^{-1} of fish 2.5 - 3.5 years old. Total commercial fish production: ca 24 t.year^{-1}

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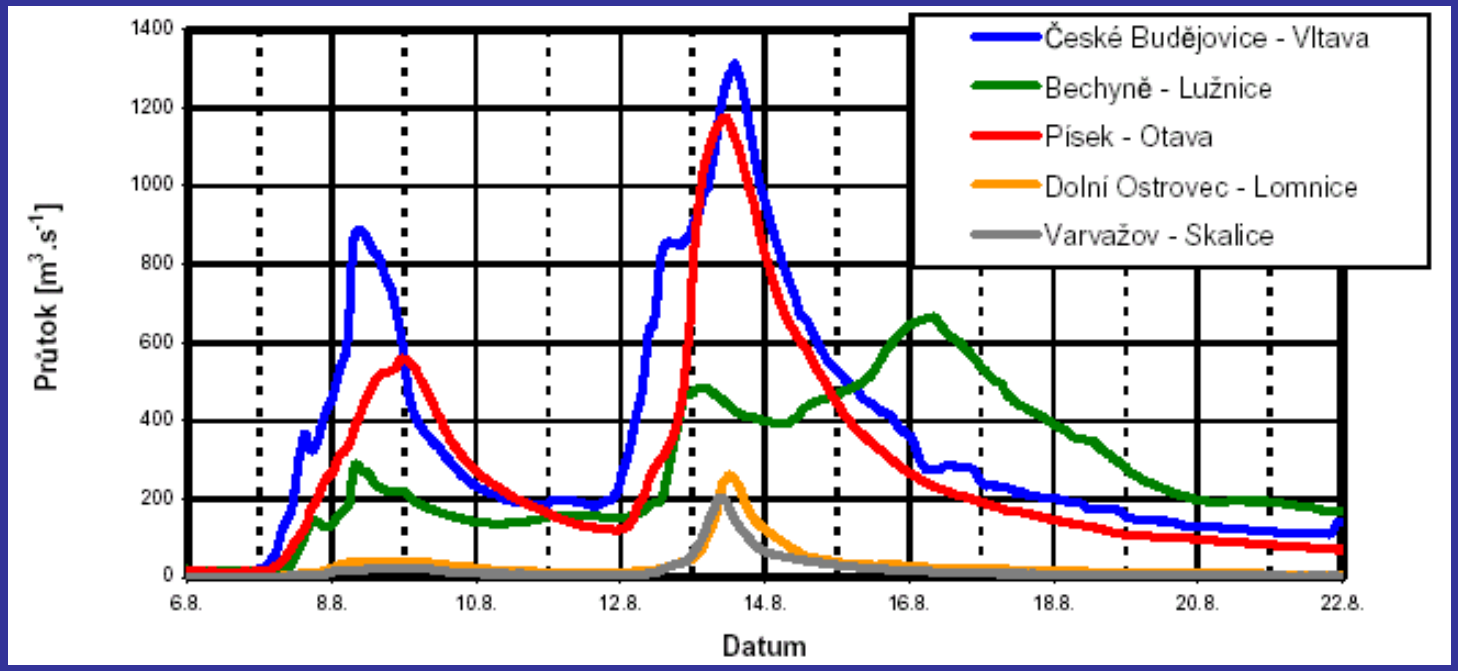
TRADITIONAL FUNCTIONS (= ecosystem sevices) OF FISHPONDS

- **Water resource** – land drainage and water capture
- **Water storage** – mainly for streaming of ores
- **Fish culture** – Rome, France, Germany, Bohemia
- **Fortification** – castle and town fortification
- **Energy gaining** – mills, mine pumps
- **Retention of excessive water** – flood control

Example: Třeboň fishponds before and during culminating flood, August 2002

FLOOD WAVE CULMINATION ON MAIN RIVERS DURING SUMMER 2002



68 hrs delay

CONTEMPORARY NON-PRODUCTION FUNCTIONS (= additional ecosystem services) OF FISHPONDS

- **Erosion control:** periodical dredging of fishponds
- **Water strorage** for irrigation or water supply
- **Energy yielding** for small hydroelectric plants
- **Stabilization** of water discharge
- **Recreation:** bathing, angling, sailing, rowing,etc.
- **Landscape formation:** important landscape elements (Czech law on nature and landscape conservation)
- **Nature conervation:** Nature reserves, Ramsar sites, Biosphere reserves, Natura 2000 sites, etc.
- **Climate modification** through direct water evaporation and transpiration of emergent littoral vegetation

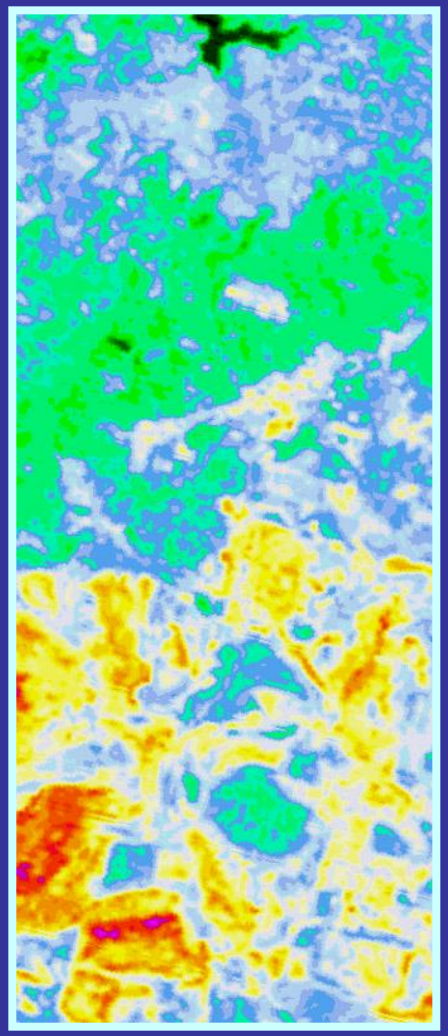
FISHPONDS AND HEAT DISSIPATION

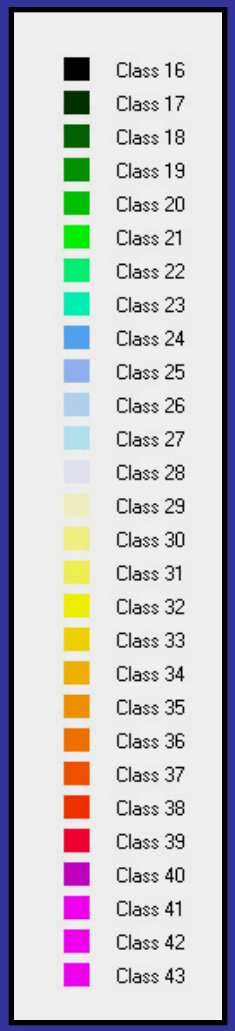
MOST BASIN (N. Bohemia)

TŘEBOŇ BASIN (S. Bohemia)

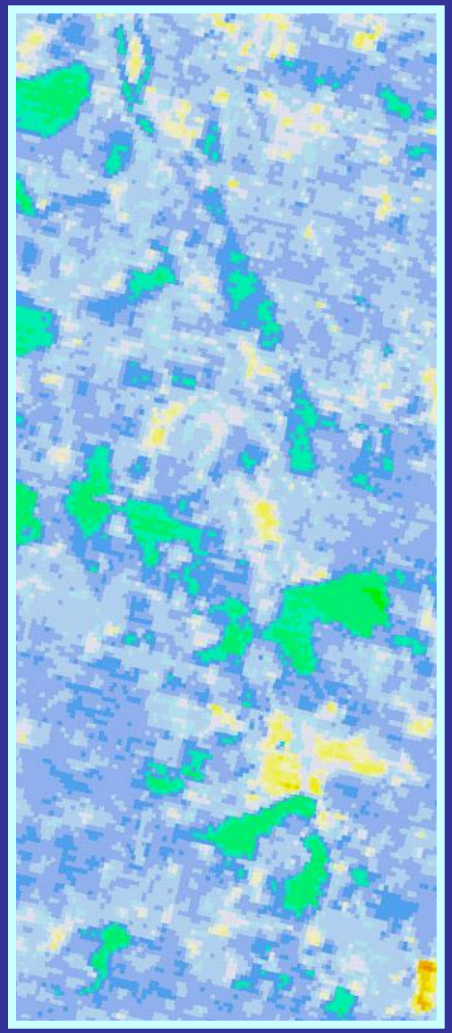
CLIMATE MODIFICATION: FISHPONDS AND HEAT DISSIPATION

MOST BASIN (N. Bohemia)





TŘEBOŇ BASIN (S. Bohemia)



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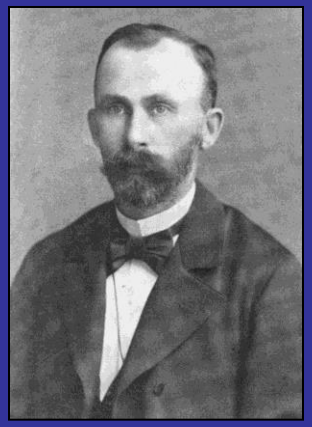
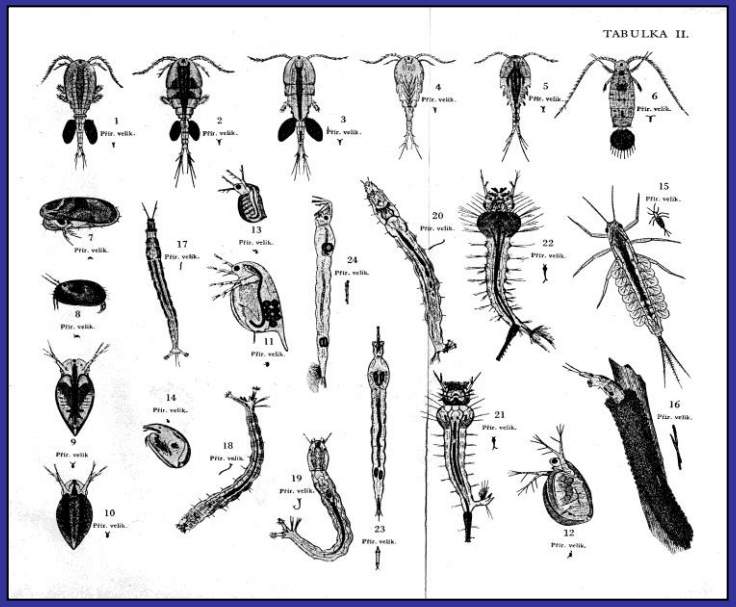
5. Conclusions – Principles of sustainable fishpond management

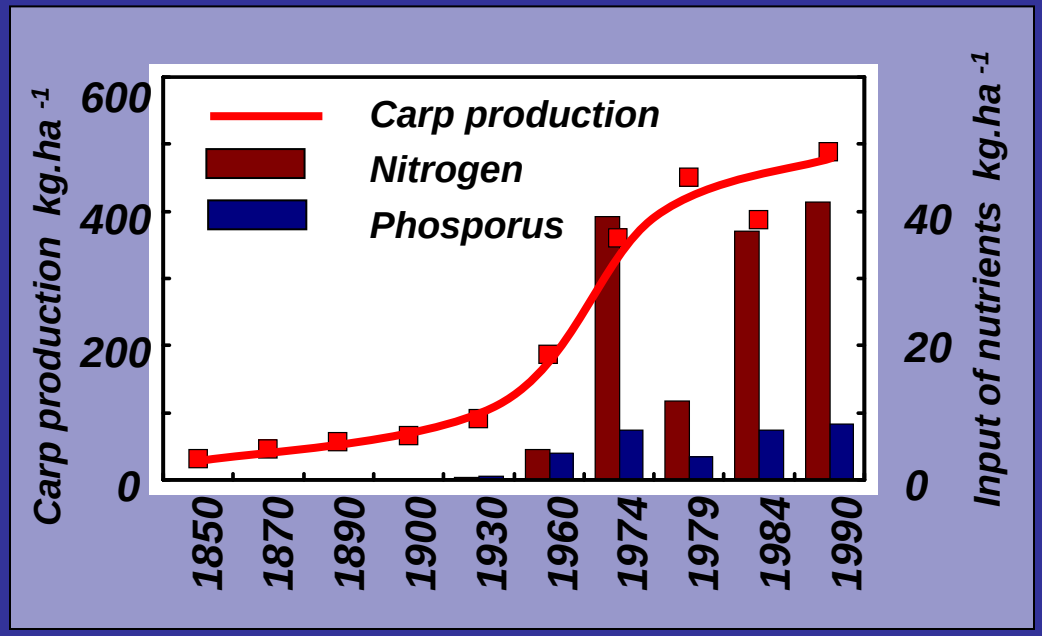


Josef Šusta (1835 – 1914)

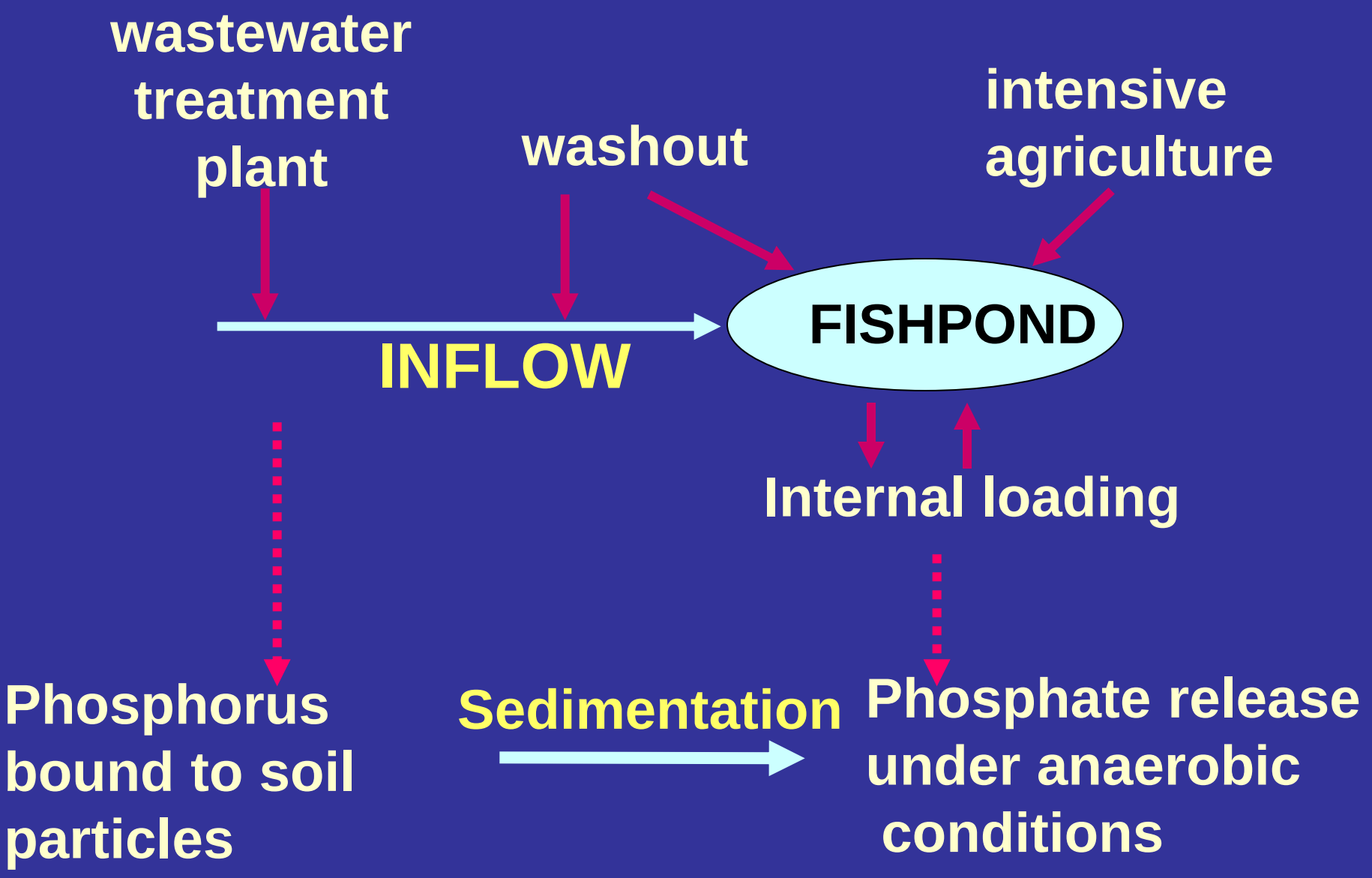
MODERN FISHPOND MANAGEMENT (since the 1880ies)

Josef Šusta developed modern scientific methods based on understanding of the role of the natural food chains in fish production. He introduced liming and fertilization to enhance the productivity of fishponds.



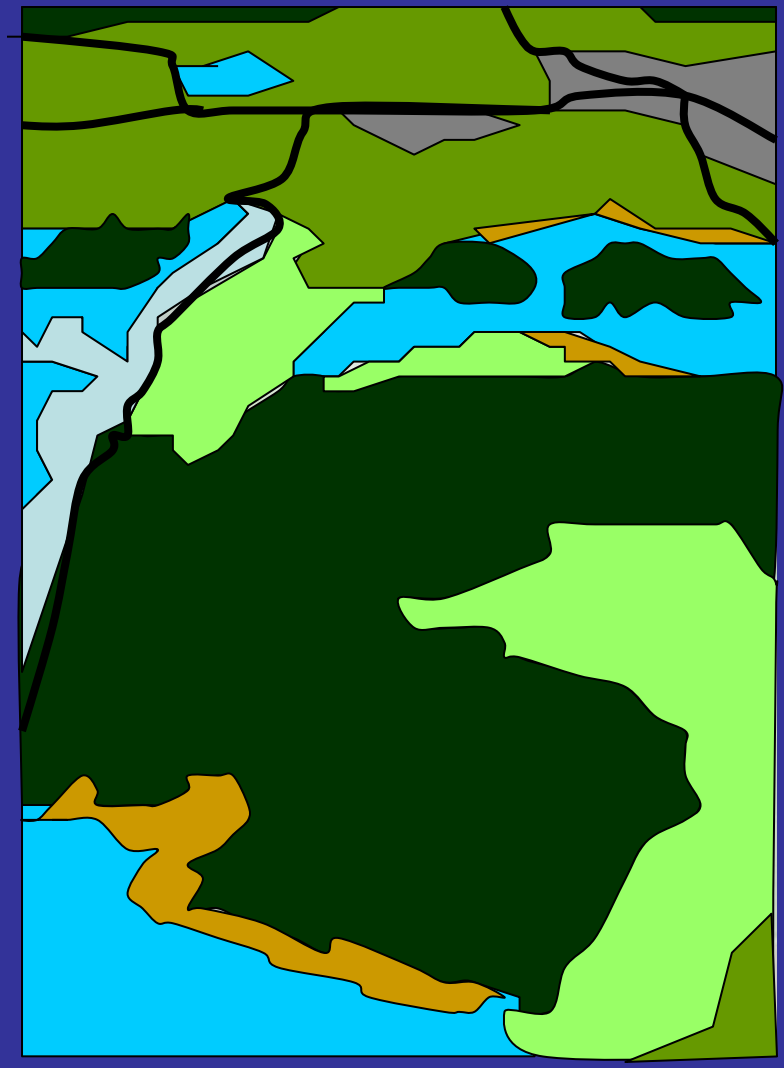


HYPERTROPHY OF FISHPONDS – REASONS:

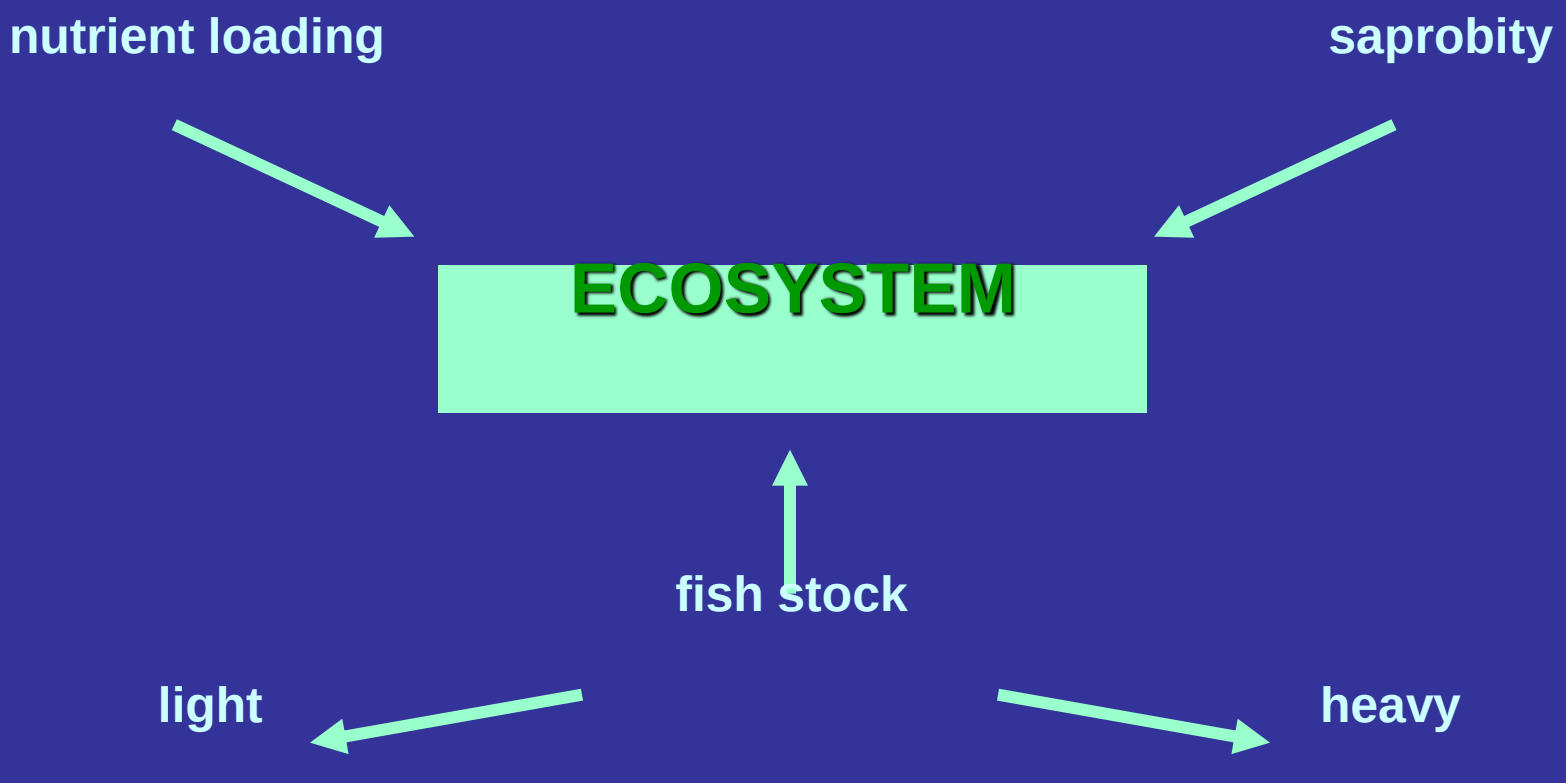


FISHPOND AS AN ECOSYSTEM

water
littoral
meadow
field
forest
settlement
roads



FISHPOND ECOSYSTEM



BIODIVERSITY DECLINE IN FISHPONDS

Increased intensity of fish farming brings about a decline of biodiversity

Plants of clean water → Ruderal plants

High fish feeding pressure → Benthos decline

Decline of bird species variety

KEY TO SUCCESS

To define a SUITABLE fish stock
(*not only a light one!*)
facilitating an effective
transfer of energy and matter
from primary producers
to zooplankton
and then to the fish

HYPERTROPHIC FISHPONDS

Examples:

Heavy fish stock, N:P balanced; dense Phytoplankton, no macrophytes

Low N:P ratio; cyanobacterial water bloom

Light or no fish stock; filamentous algae

REMEDY:
SUSTAINABLE FISHPOND MANAGEMENT

1. **Management is a CRUCIAL condition for sustainable existence of fishponds**

2. **Lack of management = terrestrialization and eventual extinction of a fishpond**

3. **Fishpond management affects the water quality**

Nutrient removal from hypertrophic fishponds

(a) Fish harvest :

P stripping in fish catch: ca 8 $kg.ha^{-1}.year^{-1}$

N stripping in fish catch: ca 100 $kg.ha^{-1}.year^{-1}$

(b) Emergent macrophyte harvest (dry biomass ca 10 $t.ha^{-1}$ of vegetated area):

P stripping: ca 35 $kg.ha^{-1}.year^{-1}$

N stripping: ca 300 $kg.ha^{-1}.year^{-1}$

Comment: *Anoxic bottom conditions in shallow water → N deficiency and low N:P ratio (ca 10:1) in hypertrophic fishponds*

OLIGOTROPHICATION

Phosphate fertilizer application ended in the 1970s.

Since 1980s, organic manuring has prevailed, being accompanied by the accumulation of a fertile sediment.

Available phosporus is released back to the water.

EXAMPLE: A FISHPOND BEFORE ITS SUCCESSFUL RESTORATION

Řežabinec Fishpond National Nature Reserve, 90 ha

Heavy fish stock

(1300 kg.ha^{-1})

Excessive manuring

High water level

No renewal of reed stands

Decline of submerged macrophytes

Severe decline of water birds

EXAMPLE: THE SAME FISHPOND AFTER ITS SUCCESSFUL RESTORATION

Řežabinec Fishpond National Nature Reserve

Foto: J. Hlásek

Black-necked grebe
(*Podiceps nigricollis*)

Stop to manuring

Adjustment of water discharge

Gradual reduction of fish stock

Lowered water level

Regeneration of reeds

Return of water birds

Attempt at wise use (= sustainable management) of CZECH FISHPOND RAMSAR SITES (RS)

(4 sites out of 14 Czech RS in total)

Břehyňský and Novozámecký Fishp. RS

FED. REP. GERMANY

POLAND

Poodří RS

PRAHA

Třeboň Fishp. RS

Lednice Fishp. RS

FED. REP. GERMANY

SLOVAK REPUBLIC

AUSTRIA

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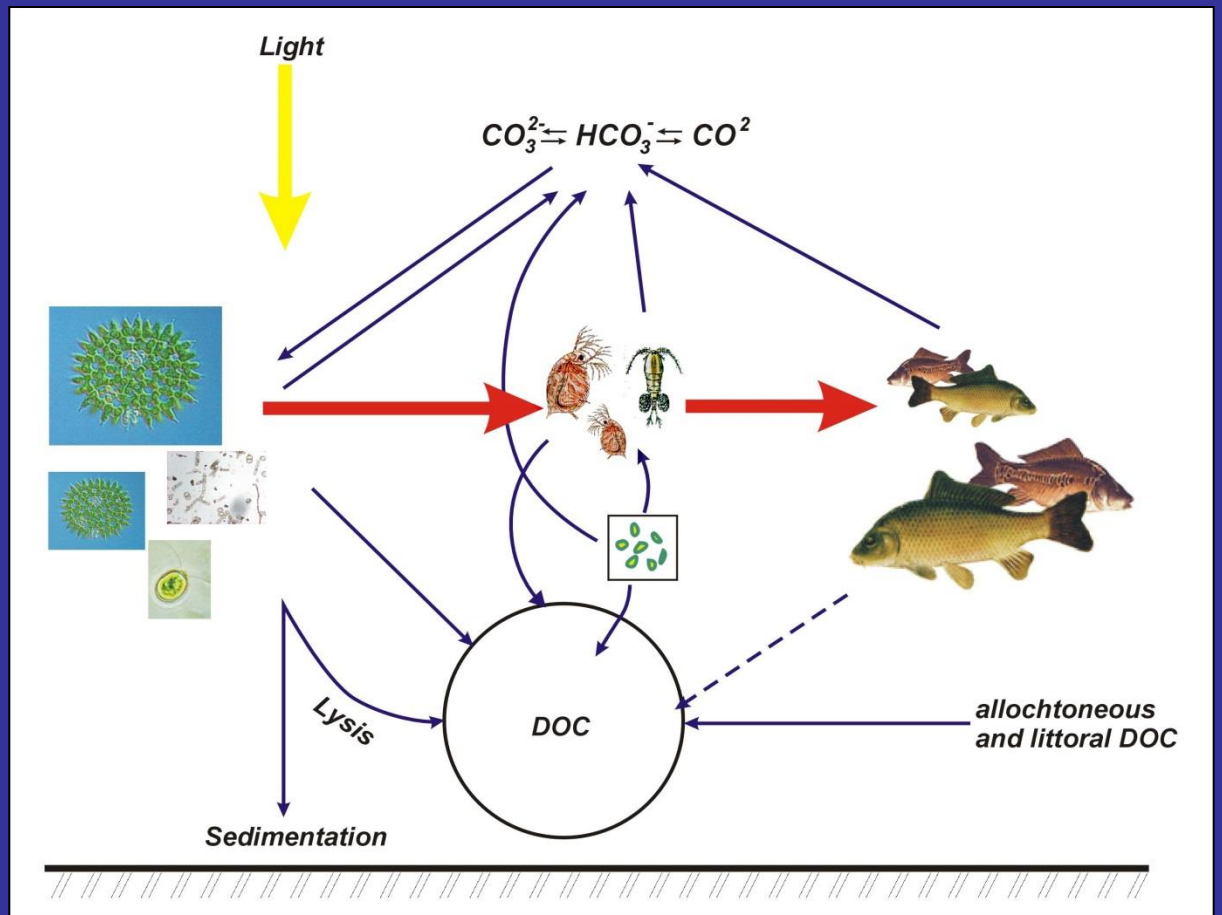
MAIN CONCLUSION - KEY TO SUCCESS:

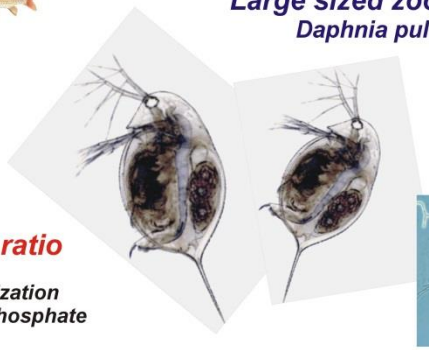
To define a SUITABLE fish stock (*not only a light one!*), facilitating effective transfer of energy and matter from primary producers to zooplankton or zoobenthos, and then to the fish.



High transparency
excess of inorganic nutrients

Small biomass of fish

Large sized zooplankton
Daphnia pulicaria



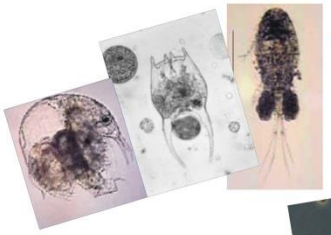
Low N:P ratio

Due to fertilization with superphosphate

Bloom of Aphanizomenon flos- aquae var. flos-aquae

High biomass of fish

Small to very small sized zooplankton



Less than 29:1 N:P ratio

High to very high amounts of manure
High pH and low carbondioxid
dense phytoplankton blooms

Dominance of Planktothrix agardhii and Anabaena spp.

Excessive bloom, very low transparency,
overloading of organic matter

ACKNOWLEDGEMENTS:

Our sincere thanks for photographs or ideas belong to:

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THANK YOU FOR YOUR ATTENTION!

STANDING WATERS IN THE CZECH REP.:

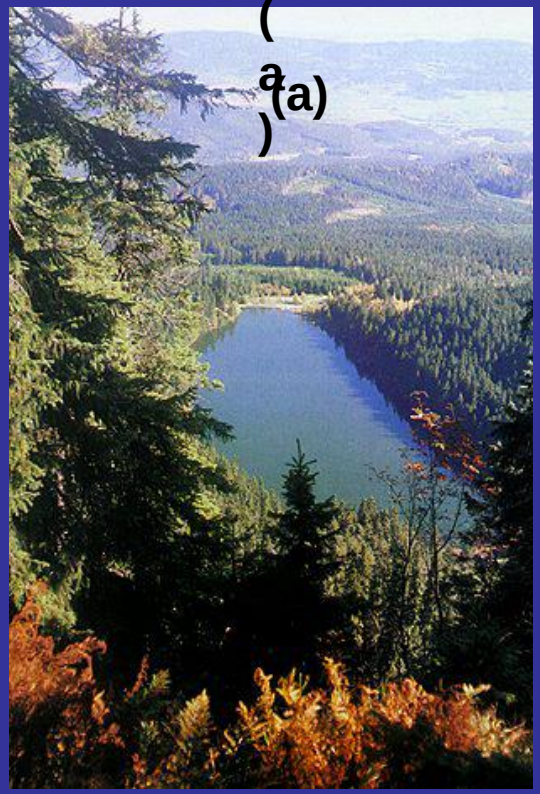
(a) Scarce and small natural mountain lakes (total area 14.2 ha; volume 3.517×10^6 m^3);

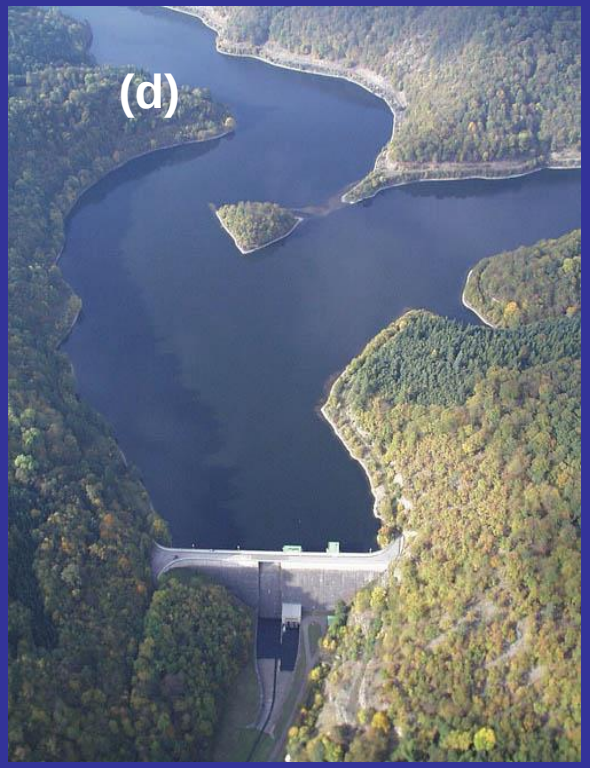
(b) Alluvial pools, oxbow lakes, backwaters;

(c) Flooded sand pits, coal pits, quarries, etc.;

(d) 118 reservoirs of various sizes and water volumes.

(e) Fishponds – see further slides





FISHPOND ECOSYSTEM
Conceptual model (H.T.Odum´s symbols)