



Issues of ecological and economical sustainability of fish culture in the southern hydrological basin of lake Balaton

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ABSTRACT

Lake Balaton - as the biggest natural lake in Central Europe - has an extended drainage basin (5180 km²). In the southern part of this basin 235 water bodies can be found, most of them (220) are used as fish ponds while the remaining serve for angling (15) and for water storage (1). The aim of this study was surveying this vulnerable area from the main viewpoints of sustainability. GIS based survey of the area revealed that update of the official database is highly recommended, moreover a significant part of ponds is already covered by macrovegetation. Generally applied semi-intensive pond fish culture is based on use of large quantities of organic matter input (cereal grains and manure) which does not cause environmental pollution during the growing season. Moderate water pollution may occur only in the autumn harvesting time however the almost total use of water sources may negatively influence the water balance of the Lake Balaton. Feeding 2 – 3 t/ha cereals per growing season makes possible to obtain net yields around 600 kg/ha in fish ponds. This form of production is not sustainable for long neither from economic nor from environmental point of views. However one part of fish production serves restocking purposes (common carp and carnivorous species) which is indispensable for the management of Lake Balaton the presence of grass carp, silver carp and bighead carp in the production structure may be interpreted as constant hazard for the ichthyofauna of the lake.

(Keywords: Lake Balaton, fish culture, sustainability, semi-intensive technology)

INTRODUCTION

The concept of sustainable development is an attempt to combine growing concerns about a wide range of environmental issues with socio-economic issues (Hopwood *et al.*, 2005). In other words sustainable development is a process for meeting human development goals while sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depend (IAP, 2000). Sustainability has become one of the most frequent keywords of the last decade in the literature related to aquaculture and with sound reason (Costa-Pierce *et al.*, 2010). Criteria of sustainability and their implementation in European freshwater aquaculture are summarized and thoroughly discussed in SUSTAINAQUA Handbook (Anon., 2009).

During the 20th century plenty of fish ponds have been built on the southern influent streams of Lake Balaton, therefore South-Transdanubia became one of the traditional fish farming centers of Hungary. Fishponds and reservoirs built on the southern influent

streams of Lake Balaton have a complex impact on the environment. Fish production realized on these water bodies possibly influence the water quality of the Lake Balaton but certainly affects directly its fish fauna (*Hancz and Varga, 2014*).

Ruling production system is the so-called semi-intensive technology which is based on additional feeding of cereals and enhancing of natural productivity by fertilization. From the sixties of the last century East-Asian cyprinids (bighead, silver and grass carp) make part of the species structure. This kind of Chinese type of polyculture enabled to duplicate net yields of ponds in Hungary. However introduction of bighead and silver carp to the Lake Balaton proved to be a great mistake because they can't be harvested neither by angling nor by traditional fishing methods.

Heavy organic matter input to ponds raise the question of water pollution. However this is not a real hazard since during the production season (April – September) practically there is no effluent water from fish ponds. On the other hand ponds are “trapping” all influent water that may influence the water balance of the lake. Effluent pond water at autumn harvesting time is rich in nutrients but causes no significant harm considering the relatively small ratio of it (*Körmendi, 2013*).

The main goal of this study was to evaluate the structure and intensity of fish production, surveying ponds and water reservoirs built in the southern basin of Lake Balaton and to evaluate the sustainability of their long-term functioning.

MATERIAL AND METHODS

Firstly creation of a database and GIS based survey of the ponds and other reservoirs have been carried out. Collected data were the number of ponds, type of use, surface and volume of lakes. Identification of ponds (*ddvir.ddvizig.hu*) and the measurements of water surfaces was carried out (*Google Earth Pro 7.0*). Comparison of official (DDVIZIG) and own-made database was also done and evaluated statistically by paired samples t-probe.

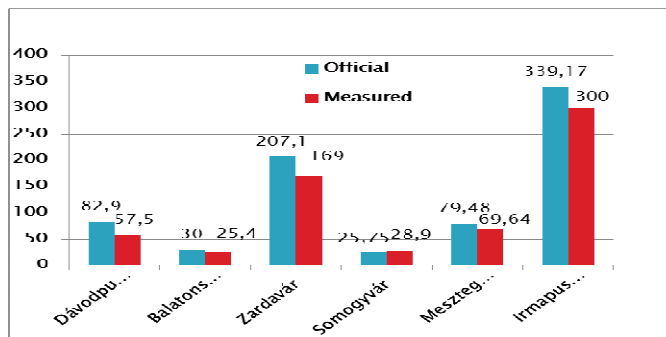
Two large production units were selected for data collection and evaluation of pond managing technology applied: Balaton Fish Management Non-Profit Ltd. (445 ha of fish pond area in 3 units of different size) and Tógazda Ltd. using Marcali reservoir (538 ha). Data of years 2011–2013 were provided by the companies. Both companies apply the above described semi-intensive technology and are situated at close vicinity of the lake.

RESULTS AND DISCUSSION

Geographic surveying of the southern basin of the Lake Balaton revealed that official database of water bodies is far from to be complete. Ponds' areas in the official database are mirroring a decades-old state. According to our measurements carried out on satellite maps open water areas have diminished by 5–20% owing to the increasing reed areas as it can be seen on *Figure 1*. The difference between means of the old and the new data set proved to be significant at $P < 0.05$ level.

Figure 1

Differences in pond areas (ha) between official and newly obtained data in different farm units



This situation can also be observed on a satellite photo (*Figure 2*) showing a typical situation of fish ponds older than 10 years. This discrepancy of officially registered and real pond area may lead to severe problems in planning production operations and also in calculation of subsidies. Stocking herbivorous fish species (grass carp) is a cost-effective way to control macro vegetation, but the presence of alien species in Balaton water system can be considered as a risk factor from ecological point of view.

Figure 2

Satellite photo of fishponds of Irmapuszta, where darker areas mark areas covered by macro-vegetation (Google Earth Pro)



Both companies investigated produced somewhat higher net yields (524–706 kg/ha) in the analyzed two years (2011–2012) than the Hungarian average of 480 kg/ha (*Horváth et al.*, 2011). Balaton Fish Management Non-Profit Ltd. plays an important role in the production of fish (common carp and carnivorous species) for restocking of the Lake Balaton however its practice of pond management aims also maximizing net yields. 1.4

t/ha feed (mainly cereal grains) is used to attain net yields around 600 kg/ha. Pond fertilization is not applied since all fish ponds have already a thick layer of decomposing organic matter which provides more than enough nutrients for the production of natural food along the green and brown food chains (Körmendi, 2013). It is important to mention that the state owned company does not produce silver and bighead carps, only a small amount of grass carp.

Marcali reservoir (538 ha) is managed as a fish pond in the last years, about the intensity of which production data in *Table 1* give an idea.

Table 1

Production data of Marcali reservoir in 2011

<i>Species, Age group Feeding</i>	<i>Stocking (kg)</i>	<i>Harvesting (kg)</i>	<i>Net yield (kg)</i>
C. carp 2 summer old	40 000		
C. carp 3 summer old		112 000	72 000
Grass carp 2 summer old	4 000		
Grass carp 3 summer old		14 000	10 000
Silver carp 2 summer old	60 000		
		210 000	150 000
E. catfish 2 summer old	6 000		
Trash fish		34 000	34 000
Total	110 000	370 000	260 000 (483 kg/ha)
Cereals fed	1 274 000 kg (2.4 t/ha)		
FCR	4.9 kg/kg		

It is clearly seen that this big reservoir is managed like a common fish pond and the relatively high yield is achieved by a typical polyculture and intense feeding. Food conversion ratio (FCR) is not extremely high but 2.4 t/ha/season cereal input means a heavy load of organic matter. Presence of a large quantity of silver carp at the border of Lake Balaton line can certainly be evaluated as risk factor in many respects.

CONCLUSIONS

Based on our findings it can be concluded that:

- Revision of official database of water bodies, especially fishponds and reservoirs in the South-Balaton basin is an urgent task.
- Traditional semi-intensive pond technology targeting high net yields and applying high amount of organic matter inputs seems to be unsustainable for long for both economic and ecological reasons.
- Ecologically important regions like Lake Balaton need special regulation of fish production methods including list of permitted species and intensity of production.

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