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Full Research Article

CYPRINID FISH FARMS IN VOJVODINA (NORTH SERBIA): TWO DECADES OF CHANGES

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Abstract

Fish farming in Serbia takes place in cyprinid (carp) and salmonid (trout) fish farms that together account for over 95% of the total fish produced. Cyprinids are grown in warm water fish farms, and cold water farms are designed for trout. The great majority (97%) of cyprinid fish farms are located in Vojvodina, Serbia's northern province. This paper examines how the traditional carp sector was developed during the recent 20-year period in Vojvodina, paying particular attention to the comparison of the number and condition of cyprinid fish farms in that interval according to the available sources. The comparison was made by comparing maps with data on fishponds from 1999 and 2021, and according to the data from the Statistical Office of Serbia. After the analysis of many data from other authors and our study, it is evident that there is a lot of room for improving the production of cyprinid fish in Vojvodina. This is especially because we noticed decreasing trends for two major parameters: the area of fishpond water surfaces in Serbia (from 7,190 ha to 6,299 ha), and the number of ponds in Vojvodina (from 72 to 60), from 1999 to 2021, respectively. On the contrary, the amount of

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fish produced has increased from 2,409 t in 2002 to 4,761 t in 2021. According to government planning documents, Serbia lacks a national strategy for development of aquaculture production in general, and especially of cyprinid fish species.

Key Words: common carp, production, fishponds, Vojvodina, Serbia

INTRODUCTION

Fish farming in Serbia takes place in cyprinid (carp) and salmonid (trout) fish farms, together accounting for over 95% of the total fish produced. Cyprinids are grown in warm water fish farms, while cold water farms are designed for trout. Production of fish in cages and enclosed or partitioned natural or man-made waters is at a much lesser scale (Marković and Mitrović-Tutundžić, 2003). Based on official data from the Statistical Office of the Republic of Serbia (2021), the total production of all fish species for human consumption in cyprinid fish farms in Serbia was 4,761 t in 2021, when there were 60 cyprinid farms. In Serbia, marketable common carp (*Cyprinus carpio*) is often grown with other cyprinids (grass carp *Ctenopharyngodon idella*, silver carp *Hypophthalmichthys molitrix*, and bighead carp *Aristichthys nobilis*), but carp fry are mostly grown in monoculture, often fed with supplemental diets. Cyprinid farms constitute 99.9 % of the total water surface area in Serbian fishponds, and salmonid farms account for only 0.1% (Marković et al., 2009a). Of the gross amount of warm water fish, 70-75% are market-sized fish (Marković et al., 2009a).

To the authors' best knowledge, there is a lack of available data about fish farming in Vojvodina. This was the motivation to conduct a short analysis on the state of cyprinid fish farms in Vojvodina in relation to previous research available in other authors' studies.

Ćirković et al. (2002) stated that annual fish consumption per capita in Serbia, according to estimates of production and imports, is about 4.50-5 kg. Also, those authors stated that fish is consumed mostly during traditional holidays and fasting days, so 39.55% of the population consumes fish only during fasting. Then, Marković et al. (2009b) claimed the average consumption of fish per capita was 6.39 kg in Serbia in 2001. For comparison, the average consumption of fish in Europe in 2019 was 21.10 kg, and it was 20.50 kg worldwide (FAO, 2022). Most of the fish consumed in Serbia is brought to the market as fresh fish (90%), then as frozen, canned, smoked or dried fish. The estimate of the Statistical Office of the Republic of Serbia (Statistical Yearbook, 2021) is that local consumption is around 5 kg, while some authors estimate the consumption at around 7 kg (Baltić et al., 2009).

MATERIALS AND METHODS

The paper examines how the traditional carp sector was developed during the recent 20-year period in Vojvodina, paying particular attention to the comparison of the

number and condition of cyprinid fish farms in that interval according to the available sources. Monitoring the flow and functioning of several different fish farms is also described by examples. This was done by comparing the maps with data on fishponds from 1999 and 2021, as well as data from the Statistical Office of Serbia (Statistical Yearbook, 2021).

RESULTS

The history of fish farms in Vojvodina

As we have already mentioned, it is difficult to find relevant literature sources with data on aquaculture in Vojvodina. The one exception is the publication of Bugarčić (2006). He reported that most of the lakes and fishponds in Vojvodina were constructed after World War II. It is important to note that in the year of his report, he collected data from 1999. That year, there was a total of 72 fishponds in Vojvodina, as shown in Figure 1. Bugarčić emphasized that the number of fish farms was increasing. According to a previous study (Ćirkovic, 2002), the total number of cyprinid fish farms was 75, while the areas varied from several hectares to several thousand hectares. Bugarčić reported that fish farms that are smaller than 10 ha have one or more ponds, whereas those bigger than 10 ha have whole pond complexes that consist of spawning places, young fish breeding places, livestock places, and winter feed places. At that time, the biggest fishpond in Vojvodina and one of the biggest in Europe was Ečka. The greatest number of cyprinid fish farms was located in the microregion of Banat, followed by Bačka, whereas the smallest number was found in Srem. Smaller fish farms usually produced young fish while bigger ones produced both categories, juvenile and adult fish.

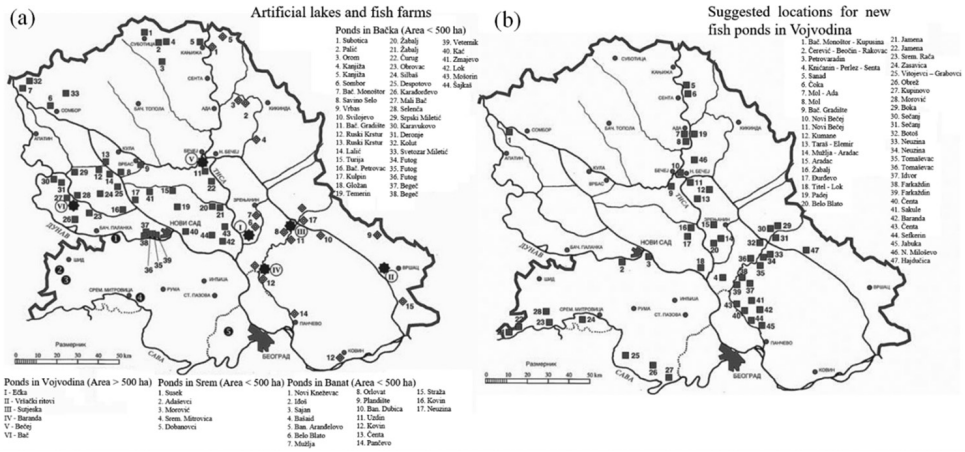

Figure 1. Cyprinid fish farms in Vojvodina **(a)** and proposed locations for new fish ponds **(b)** (Bugarčić, 2006).

Most of the smaller fish farms were located in southern Bačka, mainly next to the second order canals from which they were supplied with water (Bugarčić, 2006). If this

is compared to the current situation, the difference is that they now try to use greater quantities of well water, but this depends primary on water quality, because well waters can contain iron (Fe) and manganese (Mn) in concentrations above the proposed limits. Only a few fish farms are supplied with water from the Danube and the main Danube-Tisa-Danube (DTD) canal. A few smaller fish farms are located in the north, near Subotica. Banat contains even more fish farms than southern Bačka. Most of them are next to the rivers Begej and Tamiš. There are no fish farms in the area of Deliblato Sands due to the unfavorable geological composition of the substrate soils. There are only five fish farms in Srem, and they are located exclusively in the peripheral parts of the subregion. Some smaller lakes, such as Kać and Veternik, were built mainly for sport fishing. They were built next to the largest city in Vojvodina, but the formation of similar farms should be expected next to other larger cities in the province.

Fish markets are usually found in rural areas. Until the 1990s, farmed fish were exported to European countries (Italy, Austria, Germany, the Netherlands, etc.).

The production system in cyprinid fish farms

Fish farming is conducted in semi-intensive and intensive farming systems. Fishponds are supplied with water from different sources: canals, open waterways, rivers, and wells. The small fishponds engaged in cyprinid production are supplied with water mainly from wells and canals, while the water supply for large fishponds is from rivers and the DTD canal system. Smaller-sized fishponds were mainly constructed during 20 years (1982-2002), and production in them was, to some extent, carried out according to intensive farming systems. In contrast to such practice, almost all large cyprinid ponds were constructed prior to that, and in these ponds, production was conducted according to semi-intensive farming systems. Thus, in the intensive systems, common carp was farmed in monoculture, while in the semi-intensive fishponds, common carp was reared as a polyculture with other fish species. Therefore, the yield per hectare in the semi-intensive, large cyprinid pond systems was between 1,000 kg/ha and 2,000 kg/ha, depending on whether and to what extent extruded carp feed was used, and whether agro-technical measures were implemented. Similar information can be found in the work of other authors (Horvath et al., 1992).

Carp fish production can be increased to over 3,000 kg/ha if extruded feed is used. This is the case with intensive fish farming, where this amount of fish can be produced on average for several years (Čanak, 2014). However, under ideal and intensive carp fish farming conditions (aeration of water, for example), production can be increased up to 5,000-10,000 kg/ha (Marković et al., 2009b).

Fishponds for intensive carp production in Serbia are simple structures built as shallow depressions to prepare the ponds that are filled with water. Refilling during the summer is done using pumps, while emptying of the pond is usually gravitational. The most common source of water is well water. Fishponds are equipped with aerators to enrich the water with oxygen during the summer months (Rajić et al., 2016).

According to Marković et al. (2009b), most (97%) cyprinid fish farms in Serbia are located in Vojvodina. In this province, the possibilities for building new fish farms are considerable. Estimations for the Banat area are that there are over 100,000 ha of unfertile or low-fertility land in the vicinity of rivers and canals that are not used, or are only occasionally used for cattle grazing. These areas are suitable for the construction of cyprinid fishponds. Perspectives for the development of this type of production in Serbia are obvious, especially because the semi-intensive system of warm water fish rearing is compatible with the modern concept of sustainable agriculture and economical production (Markovic et al., 2005).

The state of fish farms in Vojvodina in 2021

As was explained earlier, there are no official sources of data on the production of carp species in Vojvodina only, but the quantities produced in the whole of Serbia are known. As we know that 97% of cyprinid ponds are located in Vojvodina, it is only possible to calculate proportionally how many fish are produced. The average annual production of fish in cyprinid ponds in Serbia from 2002 to 2021 was 5,152.65±1,712.84 t (Statistical Office of Serbia, 2021). Based on these data, the amount produced in Vojvodina would be 4,998.07±1,661.45 t. Cyprinid fish production in fishponds in Serbia was 2,409 t in 2002, with the lowest amount reported in 2003 (1,218 t) and the highest in 2010 (7,322 t). Based on our investigation, there was a total of 60 fish farms in Vojvodina in 2021, which are shown in Figure 3. These are divided in three groups based on differences in water surface area.

Figure 2. The surface water area (ha) of cyprinid fish farms in Serbia, 2002-2021 (Statistical yearbook, 2021)

According to our unofficial discussion with many fish producers, we assume that the total area under cyprinid ponds is significantly larger than that shown in official statistics (Figure 2). Although the surface area of the ponds has not changed much, there is still a visible decrease in the last seven years. On this topic, we agree with Marković et al. (2011). They emphasized that the reasons for these disagreements should be sought primarily in the inadequate collection of data on fishponds. Due to the change in the ownership structure and the fact that a proportion of the ponds (about 20%) is out of function, the data showing fishpond areas change from year to year. Official statistics on fish production are always significantly lower than the real figures, which is attributed to the facts that fishpond owners do not report the true state of fish production, and part of the fish trade is being conducted illegally (Marković et al., 2009b).

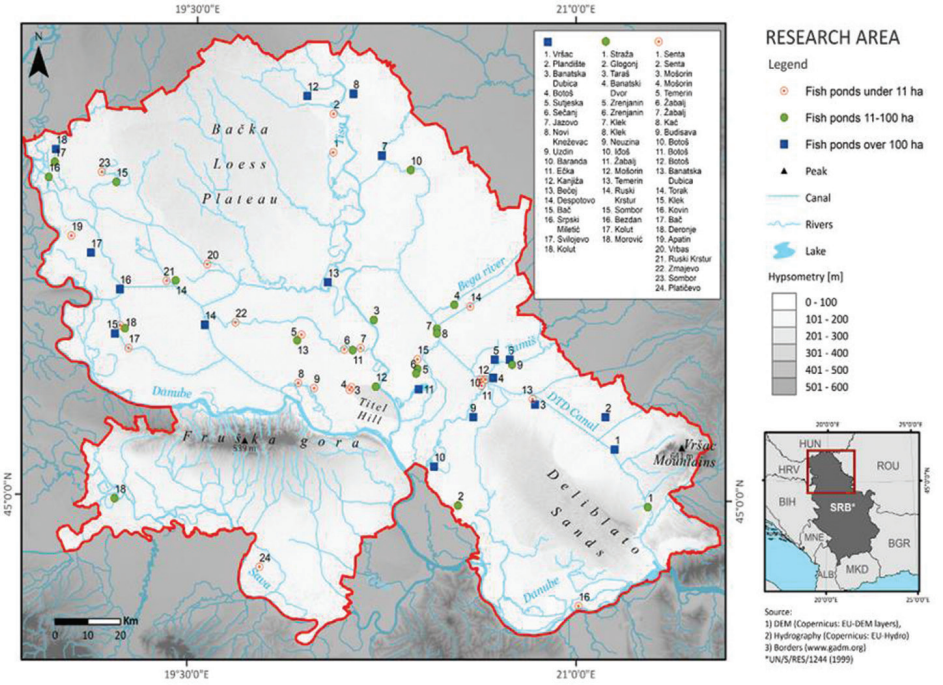

Figure 3. The location of cyprinid fish farms in Vojvodina, 2021. (CLMS, 2021; GADM, 2012)

DISCUSSION

When we compare the trend of cyprinid area farmed in the last 20 years with amounts of market-sized fish produced, a decreasing trend of cyprinid fish production in Serbia is obvious. The areas under cyprinid ponds did not change significantly (Figure 2), while a significant increase in production was recorded. However, there was also an

obvious 20% decrease in the number of fish farms. Today, all fishponds (100%) are privately owned.

It is interesting to compare some data in the research of Bugarčić (2006) with present data (2022), as shown in Figure 3. Bugarčić (2006) stated that more efficient production could be organized using smaller fishponds (less than 10 ha of water surface), but most farms do not have the necessary personnel and equipment. In the meantime, the situation has now partially changed, so according to available data, some of the small ponds with intensive production have developed better than the bigger ponds.

The change to some fish farms over time. Bugarčić (2006) reported that the medium-sized fishponds, Despotovo and Novi Kneževac, were the most cost-effective, each with annual production of about 1,600 kg/ha of market-sized fish. Today, the situation is different. According to available data, Despotovo now has ponds of 100 ha (of the available 200 ha) and producing 1,300 kg/ha. Unfortunately, seven years ago (2015), the Novi Kneževac fish farm was closed and in the meantime has been completely overgrown by willow forest (*Salix* spp.). Among the small fishponds with a production of 8,000 kg/ha, the most cost-effective were owned by Veljko Simin in Čonoplja and Željko Đanić in Svetozar Miletić (Bugarcic, 2006). Interestingly, based on our investigation in 2021, the situation for these two ponds has not much changed, because they now produce 4,000 kg/ha in Čonoplja and 8,000 kg/ha in Svetozar Miletić.

As for the locations of fishponds near settlements (Uzdin, Čenta), this was justified by the fact that fish markets in nearby places dictated the range of production and the age structure of fish. Now, we observe that this is no longer the case, due to fact that although the only fish farm in Uzdin remains active (220 ha), the fish farm in Čenta stopped production and closed several years ago.

Fish hatcheries then and now. Twenty years earlier, the equivalent prices used to be 1 kg of juvenile fingerlings corresponding to 5 kg of fish for consumption. Today, due to the large number of newly built hatcheries and ponds for breeding juveniles, this ratio has been reduced to 1 kg corresponding to 2.8 kg of fish. However, the assortment of fish raised in the ponds remains uniform. Mostly, grass carp, common carp, and silver carp are raised. In many ponds, there is a significant percentage of so-called "fish weed" and "white fish", and the species are: topmouth gudgeon (*Pseudorasbora parva*); gudgeon (*Gobio gobio*); Prussian carp (*Carasus gibelio*); common rudd (*Scardinius erythrophthalmus*); roach (*Rutilus rutilus*); ruffe (*Gymnocephalus cernua*) and; pumpkinseed (*Lepomis gibbosus*).

The development of aquaculture. Bugarčić (2006) claimed that one of the significant disadvantages of the freshwater fish trade in Serbia was that the majority of fishponds sold only live fish as a final product, and not fish products, which are added-value and much more expensive to purchase. The fish was sold exclusively on the Serbian market. The sales network was not well organized, and marketing activities were weak. Fish was marketed by several private traders.

Finally, in his study, Bugarčić (2006) suggested some locations for the construction of new ponds in Vojvodina (Figure 1b). The author explained that Vojvodina has great physical and geographical predispositions and economic needs for the construction of new fishponds. These ponds were suggested in areas that are not suitable for intensive agricultural production, and often not even for forestry. In Vojvodina, there are significant areas with salinized land (over 100,000 ha), largely unsuitable for crop production. It is justifiable to build fishponds in such areas from the social and economic aspects. Bugarčić concluded that the largest potential areas, as much as 18,300 ha, for the construction of ponds were in Banat. This statement is understandable because Banat has the most swampy and salinized land. In the Bačka area, Bugarčić (2006) stated it would be possible to build new ponds on 2,630 ha, and in Srem on 3,630 ha. If we compare these data with the present situation, we come to the devastating fact that in the meantime, only approximately 10 fishponds have been built or registered on an area of only 200 ha. This represents only 0.81% of the total 24,560 ha proposed for Serbia by Bugarčić (2006).

We agree with previous report of Martinovska-Stoycheska et al. (2017) that overall, fish production in Serbia is still underdeveloped, considering that most of the production takes place in semi-intensive ponds with outdated supporting infrastructure, while there are only a small number of modern fish farms. Other reasons for enhancing economies of scale are related to increased benefits for large-scale producers in discounts when procuring inputs, i.e., getting lower input charges when purchasing higher quantities of input. Finally, producing larger output volumes boosts the negotiating powers and market positioning of the producer. As freshwater fish consumption levels are low in Serbia, there is the realistic growth potential for changing consumer food patterns and increasing fish consumption on the domestic market. Nevertheless, to achieve that, it is necessary to emphasize the need for an adequate fisheries development strategy and stimulating support from the state, i.e., national policies for the production, processing, and marketing of fish.

CONCLUSION

After analyzing many data from other authors and our study, it is obvious that there is a large space for improvement of cyprinid fish production in Vojvodina (Serbia). This is especially because we have found decreasing trends in two major parameters: area of water surface (7,190 ha to 6,299 ha, in 1999 and 2021, respectively) on fish farms in Serbia and number of fish farms in Vojvodina: from 72 in 1999 to 60 nowadays. On the contrary, the amount of market-sized fish produced has positively changed: from 2,409 t in 2002 to 4,761 t in 2021. However, these data are questionable because the fish producers lack motivation to submit real data to the Statistical Office of Serbia. According to planning documents in Serbia, there is a lack of national strategy for development of aquaculture production in general, and in particular for the cyprinid

fish species. Additionally, after the design of strategy, there is a need to create appropriate and realistic action plans for implementation of future strategy.

This requires an effort to look for the possibilities for increasing fish production by fish farms, and generally developing this branch of agriculture. Given that carp is the most commonly consumed freshwater fish on the local market, the most logical directions for development are to increase production on existing fish farms and to construct new fish farms. Further research is clearly required to ensure that we maintain consistent, long-term and actual data on production of cyprinid fish species in Vojvodina and Serbia.

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Authors' contributions

Although this work is the result of a common effort, M.U. was responsible for the supervision and conceptualization of the work and took the lead in organizing the structure of the manuscript. J.G. and M.K. contributed to the data collection and analysis, the result interpretation. I.P. and M.I. designed all figures and helped in corrections of English language. M.I. made additional corrections after reviewers' remarks. All the authors have contributed to critically reviewing and editing the manuscript. All the authors read and approved the final version.

Competing interests

The authors declare that they have no competing interests.

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ŠARANSKI RIBNJACI U VOJVODINI (SEVERNA SRBIJA): DVE DECENIJE PROMENA

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Kratak sadržaj

Uzgoj ribe u Srbiji se odvija na šaranskim i pastrmskim ribnjacima (preko 95% ukupne proizvedene ribe), gde se u toplovodnim ribnjacima drže šaranske vrste, a hladnovodni ribnjaci služe za pastrmke. Najveći broj šaranskih ribnjaka se nalazi u Vojvodini (97%). U radu je analiziran razvoj sektora tradicionalne šaranske proizvodnje u Vojvodini u novijem periodu, pri čemu je posebna pažnja posvećena poređenju broja i stanja ribnjaka u intervalu od 20 godina, prema dostupnim izvorima podataka. Istraživanje je urađeno poređenjem mapa sa obeleženim ribnjacima iz 1999. i 2021. godine, kao i korišćenjem podataka Zavoda za statistiku Srbije. Nakon analize brojnih podataka drugih autora i našeg istraživanja, očigledno je da postoji veliki prostor za unapređenje proizvodnje šaranskih vrsta riba u Vojvodini (Srbija). Tim pre što smo zaključili da postoji trend smanjenja dva glavna parametra: veličine vodene površine (7190 ha na 6299 ha) na ribnjacima u Srbiji i broja ribnjaka u Vojvodini: sa 72 do 60 danas. Sa druge

strane, količina proizvedene konzumne ribe je imala pozitivan trend: sa 2.409 t u 2002. na 4.761 t u 2021. godini. U odnosu na planska dokumenta u Srbiji uopšte, nedostaje državna strategija razvoja proizvodnje ribe, a posebno šaranskih vrsta riba.

Ključne reči: šaran, proizvodnja, ribnjaci, Vojvodina–Srbija