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# Investigation of the volume of fish production and catch in Serbia from 2012 to 2021

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ABSTRACT

In the Serbian market, fish is available from aquaculture (such as carp and trout) and from fishing (commercial and recreational catch). In the past ten years, from 2012 to 2021, there has been a decrease in the production of carp due to reduced farming areas, but trout production has increased. On average, during this period, aquaculture production yielded approximately 5,491 tons of carp and 2,977 tons of trout, while the fish catch averaged around 2,979 tons. The yield per hectare in carp ponds was 800 kg, while in trout ponds, it was 20 kg per square meter. As the demand for fish exceeds the domestic supply, the market is supplemented with imported fish.

## 1. Introduction

The world's fish for human consumption comes from two sources. One source is the capture of fish from open waters (oceans, seas, rivers, lakes), while the other source is farmed fish, i.e., fish from aquaculture. Fish in aquaculture can be farmed in marine, brackish, and mostly freshwater (artificial and natural lakes) environments. Aquaculture has been known for over 2,000 years, but its full significance was recognized in the early 1990s when the demand for fish increased due to population growth worldwide and because the capture of fish from open waters was between 90 and 100 million tons. Since then, the capture volume has not been increased as it was observed that it would disrupt the biological balance in marine ecosystems. Fish production in aquaculture was the only solution to meet the demand for fish in the global market (*Baltić & Teodorović*, 1997; *Ivanović et al*., 2015). In the 2020s, fish production in aquaculture exceeded the capture of fish from natural resources (*Boyd et al.*, 2022). Thanks to this, there were 178 million tons of fish on the global market in 2020, and it is expected to reach 196 million tons by 2025 (*Pedro & Nunes*, 2019). Some opinions suggest that in a few decades, the amount of food derived from water (fish and algae) will be equal to the amount of meat from land animals (*Baltić et al*., 2022). The Serbian market is supplied with fish from aquaculture and from capture (rivers, lakes), with

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the majority of fish being imported. The aim of this study is to examine the volume of fish production and capture in Serbia from 2012 to 2021.

## 2. Materials and methods

Data on the fish market supply in Serbia from aquaculture and capture were collected from the Statistical Yearbooks of Serbia from 2012 to 2021 (https://www.stat.gov.rs/). The Statistical Yearbooks provide information on the surface area of carp ponds expressed in hectares and the production of consumable carp expressed in tons. Data on the surface area of trout ponds (expressed in square meters) and the production of consumable trout (expressed in tons) are also presented. Separate data are provided for the total fish catch in lakes, rivers, and canals (expressed in tons) for commercial and recreational fishing separately. The Statistical Yearbooks also include data on the catch of the four most commonly caught fish species (carp, white bighead, bream, goldfish) from both commercial and recreational fishing. The results obtained were compared by statistical analysis using Microsoft Excel 2010 and GraphPad Prism software, version 8.00 for Windows (GraphPad Software, San Diego, California USA, www.graphpad.com). The mean values and measures of variation of fish production and catch were calculated. Trends in fishery areas and catches were computed. All results are presented graphically.

## 3. Results

Carp ponds in Serbia are located in Vojvodina. During the observed period (2012–2021), the average surface area of carp ponds was 7,439.4 ± 1,055.07 ha (the largest being 8,724 ha in 2014, and the small-

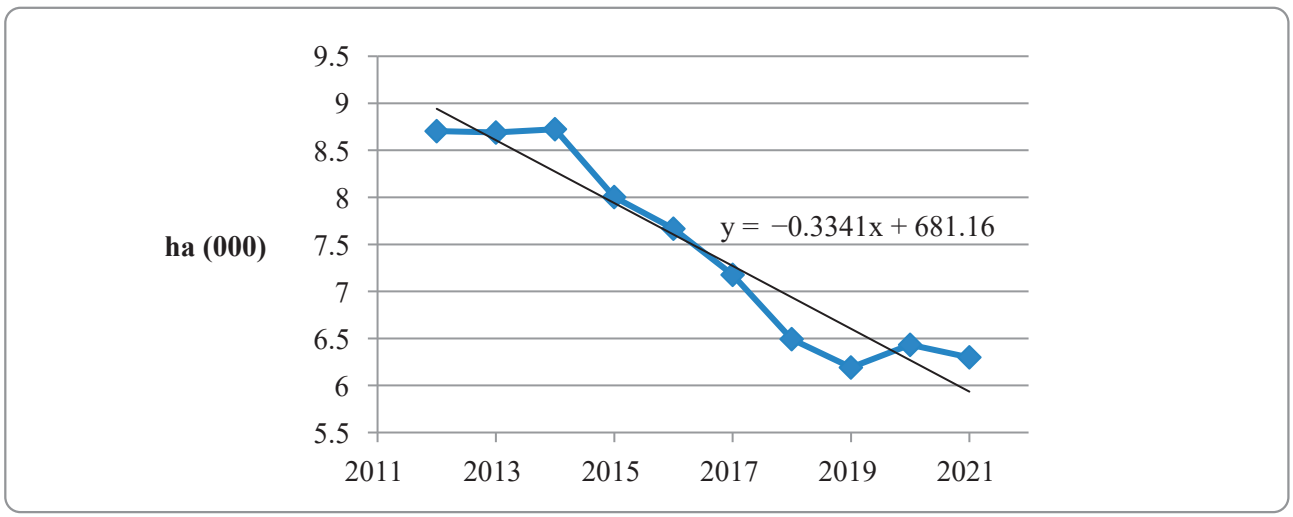


**Figure 1.** The trend of changes in the surface area of carp ponds from 2012 to 2021.

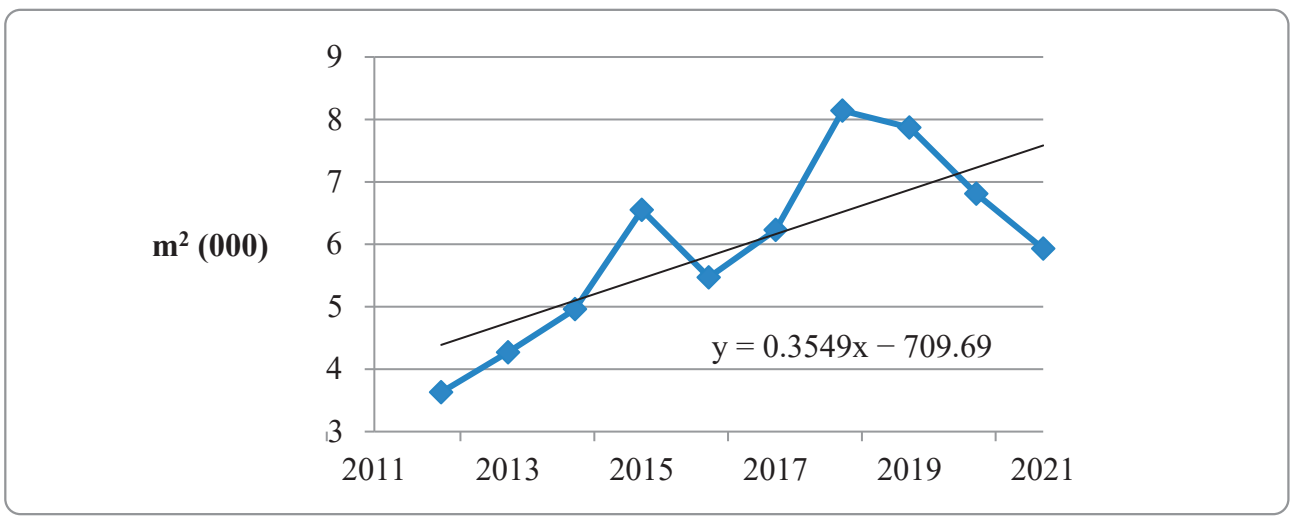


**Figure 2.** The trend of changes in the surface area of trout ponds from 2012 to 2021.

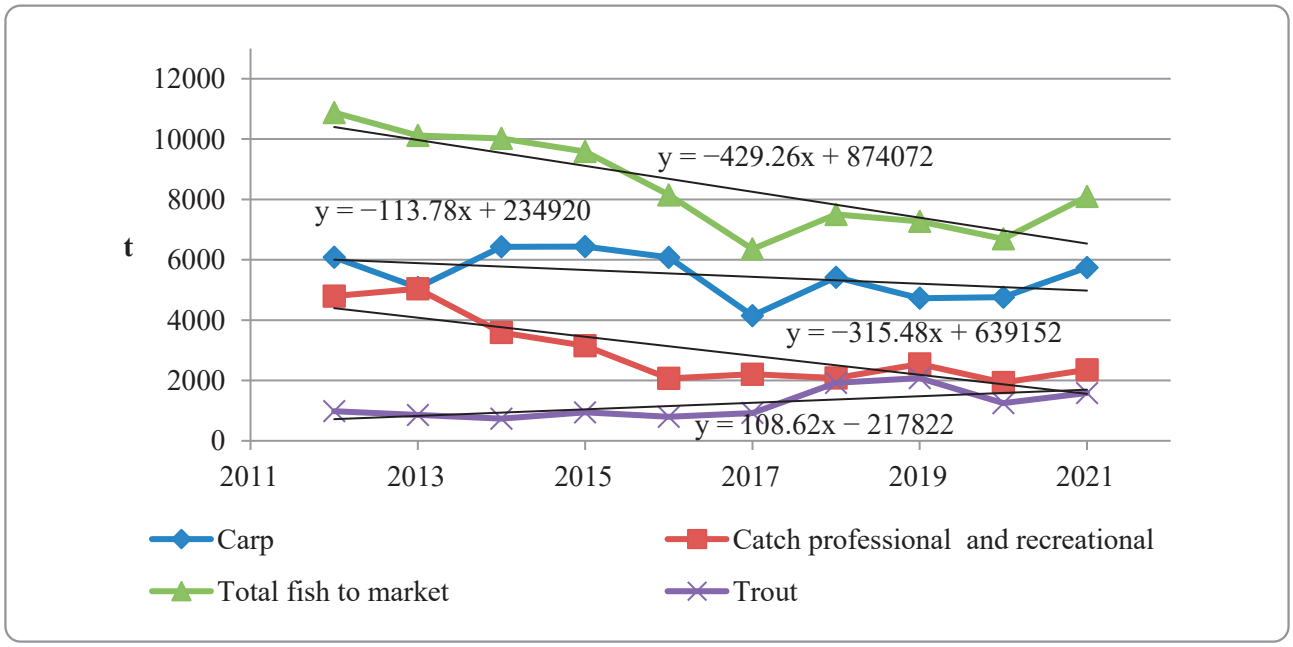


**Figure 3.** Trends in fish production, fish catch, and total fish supply in the Serbian market from 2012 to 2021.

est being 6,192 ha in 2019). The change in the surface area of carp ponds from 2012 to 2021 is shown in Figure 1 and can be represented by the equation y = –0.3341x + 681.16.

The surface area of trout ponds has varied to a much greater extent compared to the changes in the surface area of carp ponds. From 2012 to 2018, the surface area of trout ponds increased, but then sharply decreased by 2021. Overall, during this period, the surface area of trout ponds increased (y = 0.3459x + 709.69). The surface area of trout ponds was the smallest in 2012 (36,302 m$^2$), and the largest in 2018 (81,411 m$^2$), with an average of 59,864.6 ± 1,455.38 m$^2$ over the ten-year period (Figure 2).

The average catch of carp from 2012 to 2021 was 5,491.5 ± 0.791 t, and for trout it was 1,206.6 ± 0.486 t, making a total of 6,698.1 t. The highest production of consumable carp was 6,438 t in 2015, while the lowest was 4,728 t in 2020. The highest catch of consumable trout was in 2019 (2,079 t), and the lowest was in 2014 (736 t). In the total pro-

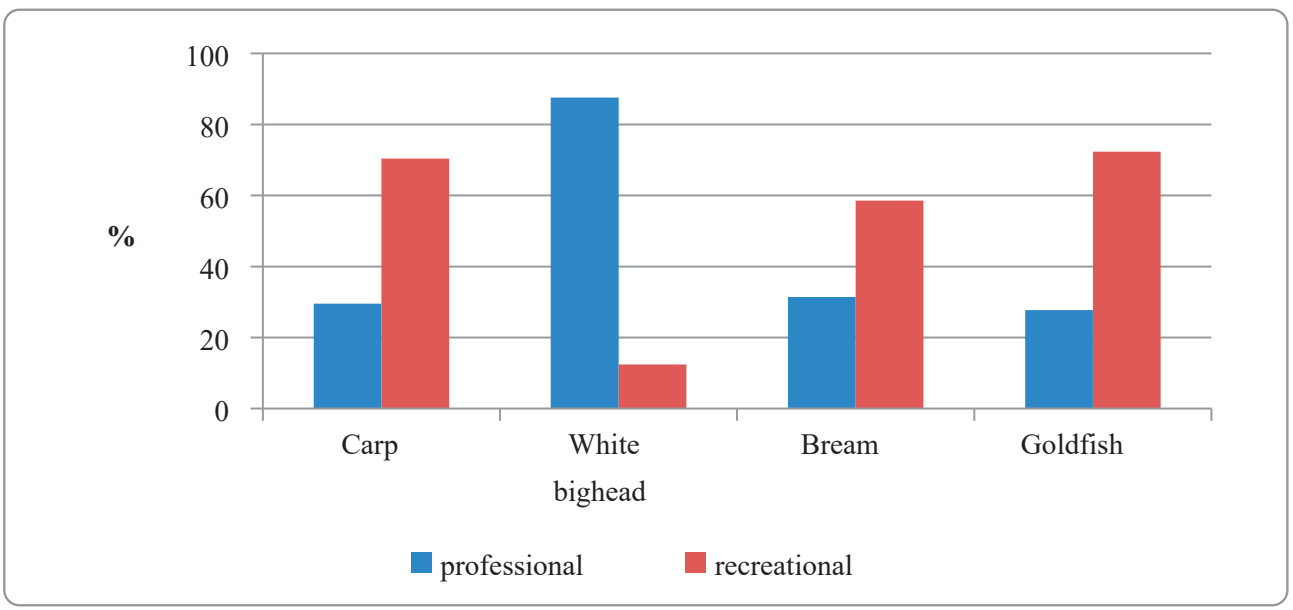


**Figure 4.** The percentage (%) contribution of carp, white bighead, bream, and goldfish catch from commercial and recreational fishing

duction of consumable fish in aquaculture, the proportion of carp over a ten-year period was 81.98%, while trout accounted for 9.02%. Based on the average areas of carp and trout ponds from 2012 to 2021, it was determined that the yield of carp per ha was 800 kg, and for trout per $m^2$ was 20 kg. The fish catch (commercial and recreational) was highest in 2013 (5,048 t) and lowest in 2000 (1,931 t). The data on fish catch refer only to the four most commonly caught fish species (carp, white bighead, bream, goldfish). The average ten-year total catch of these fish species was as follows: carp 257.6±133.30 t, white bighead 185.7±41.56 t, bream 229.0±126.00 t, and goldfish 511.7±186.50 t. The commercial catch of carp over the ten years was 76.1 t (29.54% of the total catch), while the recreational catch was 181.5 t (70.40%). In contrast to carp, the commercial catch of white bighead accounted for 87.56% (162.6 t), while the recreational catch was 12.44% (23.1 t). The recreational catch of bream was higher (58.56%; 134.1 t) compared to the commercial catch (31.44%; 94.9 t). This difference is even more pronounced for goldfish, since 72.31% (370.0 t) of the total catch of this fish was from recreational fishing, while 27.69% (141.7 t) was from commercial fishing. The data represent the average ten-year catch of these fish species. Figure 3. shows the trends in fish production, fish catch, and total fish supply in the Serbian market from 2012 to 2021.

The percentage (%) contribution of carp, white bighead, bream, and goldfish catch from commercial and recreational fishing is shown in Figure 4.

## 4. Discussion

The average annual production of consumable carp from 2006 to 2012 was 6,103±1,008 t, and trout production was 923.1±208.0 t (*Ivanović et al.,* 2015). Other fish species in carp aquaculture (white bighead, grass carp, occasionally catfish and pike) are produced in much smaller amounts than carp. Carp is the most commonly farmed fish species in aquaculture worldwide, especially in China and other Asian countries (Vietnam, India). In Serbia, as well as in most countries around the world, carp is farmed in a semi-intensive system. In this system, the majority of the feed comes from the natural ecosystem, with a smaller portion consisting of added nutrients. The semi-intensive nature of carp production in Serbia is evident from the data on the yield of harvested consumable carp per unit area (ha), which has been less than 1 t from 2012 to 2021. Carp production per ha can be increased by using grain (corn or pelleted feed) in the diet. By choosing high-quality feeds and implementing agrotechnical measures (such as water aeration), carp yields per hectare can exceed 3 t, and even reach 5 t or more in optimal conditions, such as cage culture systems (*Marković*, 2010). The lowest catch volume of fish from open waters (carp, grass carp, bream, and goldfish) in the observed period was in 2020, which can be attributed to it being the first year of the COVID-19 pandemic. Decreased fish catch and production in 2020 were observed globally in the fishing industry as a whole (*Boyd et al.,* 2022). Trout yield is highly dependent on feed, as well as other factors such as aeration and water temperature, and can range from 5 to 50 kg (*Aganović*, 1979). In addition to farmed fish in aquaculture, a portion of the fish in the Serbian market comes from commercial and recreational fishing. The contribution of fish from recreational fishing is greater than that from commercial fishing in the total fish catch. Within specific fish species, commercial fishing makes a higher contribution only in the case of common carp, while recreational fishing has a higher catch of carp, bream and goldfish.

In the Serbian market, in addition to fish farmed in aquaculture and fish from local catch, imported fish (mostly marine fish) also play a role. The volume of fish imports from 2012 to 2021 ranged from 30,000 to 40,000 tons, significantly impacting fish consumption in Serbia (*https://www.stat.gov.rs*). With fish from domestic sources alone, the average annual fish consumption per capita in Serbia would be 1.5 kg, while with imported fish, it reaches around 7 kg. The average global fish consumption in 2021 was 20.2 kg, which is double the amount in 1960 when it was 9.9 kg. Iceland has the highest consumption of fish per inhabitant per year (91 kg), followed by the Maldives, Portugal, and South Korea, and Afghanistan has the smallest (0.24 kg) (*Ali et al.*, 2022; *FAO*, 2022).

## 5. Conclusion

Fisheries in Serbia are sharing the fate of agricultural production, especially livestock farming, as fish production in aquaculture is decreasing. Serbia has the potential to increase fish production in existing fishponds, especially carp ponds, by revitalizing neglected fishponds and also by constructing new ones. The implementation of adequate agrotechnical measures and improved feeding practices would

contribute to higher fish production. Changes in the fish supply chain would also contribute to increased fish consumption. Currently, fish produced in Serbia is mostly sold live in the market, which is the least favorable method of fish supply, especially for urban populations.

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