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Analysis of catch data for record-sized (15 kg+) common carps (*Cyprinus carpio* L.) in the Ráckeve Danube

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Abstract. Angling is a very popular leisure activity nowadays. Common carp (*Cyprinus carpio* L.) is one of the most popular target species in Europe and Asia. The in-situ conservation of large fish (15 kg+) is therefore a priority for many natural water fishery organizations. In this article, we provide guidance on how to manage fish stocks for this purpose. Our study analyzed 2515 catch records of 1394 common carp individuals caught in a slow-flowing, heavily modified water body, a Hungarian River Danube section, Ráckeve Danube Arm (RSD), covering an area of 1963 ha. We examined fish body weight and condition, spatial and temporal distribution of catches, with particular attention to data related to recaptures. In several cases, our analysis has shed new light on previous views on common carp and their learning. Furthermore, the results obtained may be useful not only for the management of the water area under study, but also for other stakeholders managing for similar objectives.

Keywords: common carp, catch & release, tagging, recapture, migration.

Introduction

Angling is one of the most popular leisure activities. Nearly 220-700 million people worldwide are anglers (Arlinghaus et al. 2015); therefore, the impact of angling on nature is significant (Embke et al. 2022). The amount of fish caught by anglers is estimated to be as high as 12% of the total fish caught (Cooke & Cowx 2004), and in some cases and some waters, angling is the most important source of mortality (Shertzer et al. 2019). To mitigate this, the so-called catch and release (C&R) fishing method was introduced in the mid-20th century, and consequently, anglers fish primarily for the experience rather than the fish meat (Ferter et al. 2013). This angling method is mainly voluntary in some areas and has been made mandatory by lawmakers in others. This method also has effects on fish stocks (Kerns et al. 2012), which can be lethal or sublethal (Sass et al. 2018). There is a large literature on what can influence the effectiveness of the C&R method. For example, we know that fish species, angling method, hook type, or even water temperature can affect fish survival by using C&R (Cooke et al. 2003, Alós et al. 2008, Thompson et al. 2008, Czarkowski & Kapusta 2019, Skov et al. 2022, 2023). However, it is also worth bearing in mind that the effect of C&R is not clearly positive, and in many cases, the results may not meet the expectations and preconceptions of anglers (Sass & Shaw 2020). Employing ‘best angling practices’ is critical for sustainable recreational fisheries, including recovery tactics that can improve survival (Brownscombe et al. 2017). Despite its potential drawbacks, angling can also play a role in the conservation of endangered fish species (Cooke et al. 2016).

The common carp (*Cyprinus carpio* L.) is one of the most abundant fish species in the world's aquaculture production (FAO 2024). It is also the most important fish for angling in many countries (Specziár & Turcsányi 2014). In other continents, it is considered an invasive alien species (Koehn 2004, Souza et al. 2022). Carp fisheries in particular can be shaped by stocking, and it is well known that carp can be damaging to the environment (Hickley 2009). Input-output balances for total phosphorus revealed that, if ground- and pre-baiting is excessively used and harvest rates are low, then carp angling may contribute substantially to anthropogenic eutrophication (Arlinghaus & Mehner 2003). Excessive use of groundbait when a high amount of it remains unconsumed can enhance eutrophication in P-limited ecosystems (Fazekas et al. 2023).

Numerous studies have been conducted on the habitat use of this species. These have confirmed that it prefers primarily slow-flowing and stagnant waters, but it is found in a wide range of habitats from the barbel zone to brackish waters (Froese & Pauly 2024). Studies show that the home range is highly variable in size, and it is also common for its spring-summer and autumn-winter habitats to differ significantly in lake environments (Taylor et al. 2012). They have also found that in riverine environments, 66% of fish were recaptured within 1 km and just under 20% were recaptured beyond 5 km (Stuart & Jones 2006). A similar distribution is reported by Vitál et al. (2022) in a study of the recapture of newly stocked common carp in a Hungarian water habitat. As expected from the above, common carp catches are not homogeneous: Žák’s (2021) study showed that the peak of catches is not always between sunset and sunrise, and that the catches are increasing substantially on multi-day angling trips; therefore the learning and recognition of new feeding grounds by the fish play an important role in catching fish. Further difficulties in our understanding of catchability arise from the fact that the social relationships and interactions of common carp significantly influence their daily and annual territorial/habitat use (Monk et al. 2023).

Several studies have also been carried out on C&R fishing for common carp. Some of these studies have investigated technical devices such as fishing keepnets (Rapp et al. 2012) or hooks (Rapp et al. 2008), or minimum angling size (Roman 2020); others have focused on socio-economic aspects (Arlinghaus 2007). However, the results of the present study should be compared with studies that have mainly analysed fish tagging and recapture. Notable among these is the study by Raat (1985), who investigated the recapture of stocked common carp by anglers in two replicates in closed, small ponds and found that mortality was low (5% and 3% respectively) over the 3-month and 4-month study periods, and fish grew despite repeated captures. Still, their condition deteriorated (although this was compounded by the scarcity of natural food and high population density in the pond under study). The fact is that in both replicates, fish caught twice, or several times increased in weight more than fish caught once or not at all. An interesting addendum is the study by Lovén Wallerius et al. (2020), who demonstrated that catch and release induces bait avoidance not only in common carp caught but also in those individuals who see this process; however, this effect is only valid over shorter time scales (4-7 days). Further fact, clouding the issue, is the re-examination of the same fish, which has shown that hook avoidance in captured common carp is confirmed for about 7 months (Czapla et al. 2023). Finally, it has also been shown that angling catches can be influenced by domestication (Klefoth et al. 2013). In the present study, we aim to shed new light on these results by analysing angling catches in a partially closed but relatively large water system.

Materials and methods

Our studies were carried out on the Ráckeve-Soroksár Danube Arm (hereafter, RSD) and its tributaries and canals. This water system is the second-longest tributary of the Hungarian Danube section, connected by small oxbow lakes and canals. The water area is partially enclosed: a sluice can be found at both the lower (Tass) and upper (Budapest) ends, which are only open at certain water levels. The length of the RSD is 57.3 km. The surveyed area of the branch system (i.e., this River Danube section, oxbow lakes, outbranching canals) is 1962.7 ha of total area, of which the main arm and the smaller branches directly connected to it cover 1766.4 ha and the outbranching channels and oxbow lakes 196.3 ha. Since 1945, the water system has been managed by a non-governmental organisation (Ráckeve Danube Arm Fishing Association, abbreviated in Hungarian, and hereafter, RDHSZ), which is an association of local sportfishing clubs and also a regional member of the Hungarian National Angling Federation. The RDHSZ also has among its members the oldest angling association in Hungary, the Budapest Sports Anglers' Club, founded in 1908. The water area is used for a variety of purposes (water management, irrigation, inland water protection, drought management, recreation, etc.), but fishing is a particular focus of attention. To achieve this goal, there is continuous fish monitoring, fishing inspection, and a significant stocking of native fish species. The most economically important fish species in the area is common carp, which plays a major role in both anglers' catches and fish stocking. Details of these are presented in the "Results" chapter. For common carp, it is not only the quantity of catches but also their quality that is of major importance. According to the annual fisheries management plan approved by the fisheries management authority, RDHSZ will stock at least 180,000 kg 2-3-summer-carp (C2 & C3) per year in the RSD and its tributaries, making it one of the most intensively stocked natural waters in Hungary. From the outset, the aim is to achieve an increase in the proportion of older (and bigger) fish classes and the protection of larger fish by appropriate stocking structure and fish protection measures. To achieve this goal, a Large-Carp Protection Programme was launched by local angling regulations, and other means were used to motivate anglers to report large (record-sized) specimens voluntarily or compulsorily (depending on size range), and a record list was introduced in 2009, initially for common carp over 10 kg and from 2021 for carp over 15 kg. From 2021, the release after catch of common carp over 7 kilograms has been mandatory, and from 2024, the maximum size of carp has been reduced to 6 kilograms. In this study, these catch data were analysed between August 2020 and December 2024.

Only verified data can be added to the RDHSZ record database. Carp on the record list must always be released back into the water. Fish hooked to the outside of the body surface, not in the mouth, i.e., fish not hooked due to feeding behaviour, cannot be validated. A further condition for entry on the record list is that the angler must be able to take full care of the fish until it is certified. The fish must be kept in a carp sack of suitable size and material; otherwise, it must be returned. The data are validated by professional fishing inspectors employed by RDHSZ, in the presence of the angler who has been caught the fish, and no later than 12 hours after the fish has been reported. The validation shall be carried out by completing a certification report; in addition, photographs of both sides of the fish and the release shall be required. Changes in body weight due to physiological mechanisms (e.g., retention or evacuation from the intestinal tract) during the 0-12 h periods between catching and validation of the respective record fish, which varied from individual to individual, were not considered.

The date and place of catch, standard body length and weight of the fish, the name of the angler who caught the fish, and the bait used were recorded. In addition, the fish was tagged with a chip – after checking with a chip reader to ensure that the fish did not carry a previous chip – so that the fish could be tracked later. A fold-out wooden measuring stick and tape measure to measure the standard body length of fish, and a Prologic Avenger digital fishing scale certified up to 50 kg for body weight, were used. Fish tagging microchips (transponder conforming to ISO 11784:2024 using FDX-B technology) was inserted under the anterior half of the dorsal fin, into the dorsal region, lifting the scale with the sterile needle of the chip applicator, piercing the skin into the dorsal area, and disinfecting the wound with disinfectant (Animedazon spray 2.45 w/w %). The dorsal region of each captured fish was checked with a transponder-compatible chip reader (Datamars F12, ISO 11785:1996). In case of recapture, the new catch data were matched with the history data of the individual. The tools described above are shown in Figure 1, and the chipping process in Figure 2. During the data collection process, the protection of fish and animal welfare was a priority. (This study was carried out in strict accordance with the recommendations of the Institutional Animal Welfare Committee of the Hungarian University of Agricultural and Life Sciences, Szent István Campus.)

Figure 1. The equipment used to measure and mark record fish (Photo: Zs. Udvari).

Figure 2. Implantation of the micro transponder and disinfection in one step (Photo: B. Szendőfi).

In this way, the location of any recapture and the change in body weight, length, etc., could be examined separately for each fish. Recapture data were analyzed for fish caught at least three times, as chance may have played a particularly important role for fish caught twice. The standard body length and weight data were used to calculate the condition of the fish and its variation. The following formula was used to evaluate condition (Froese 2006):

$$K=100*\frac{W}{L^3}$$

where W is body weight (g), L is total body length (TL, cm). Since the available catch data were in standard body length (SL, cm), they were converted to total body length as described in Treer et al. (2003):

$$TL=3.524+1.117*SL$$

To explore the relationship between individual changes in body weight and condition and the time elapsed between catches, a correlation analysis was performed at the 95% significance level. At the same time, a two-sample t-test was used to compare conditions at the first and last catch.

Results

Our database contains data on 2,515 catches of 1,394 common carp from the start of the Large-Carp Protection Programme until 31 December 2024. There were two specimens caught 9 times, one specimen caught 8 times, seven specimens caught 7 times, 22 fish caught 6 times, 29 fish caught 5 times, 84 fish caught 4 times, 148 fish caught 3 times, 282 fish caught 2 times, and 819 specimens caught only once (Table 1).

Considering the spatial dimensions, or distance "limits", of the 57.3 km long RSD, Table 2 shows the extreme long-distance values of large carp migration for the ten carp individuals that moved the greatest distance with active translocation. The longest upstream migration, along the RSD length section, was 49 km, and the corresponding time between two detections was 369 days. The longest downstream migration along the length section of the RSD was 45 km, and the associated time between two detections was only 66 days. Table 3 shows the data for the 10 individuals with the fastest movements, calculated as the different periods between their two consecutive captures. The fastest change of position, with an average speed of 5 km/day, was observed for an individual swimming downstream, given the 3 days between its two captures and the total distance of 15 km. Plotting the distance travelled by the carp as a function of flow direction shows a symmetric normal Gaussian distribution (Figure 3).

Table 1. Distribution of marking-recapture individuals.

Number of times an individual was caught	Number of individuals	Ratio
1 time	819	0.58752
2 times	282	0.20230
3 times	148	0.10617
4 times	84	0.06026
5 times	29	0.02080
6 times	22	0.01578
7 times	7	0.00502
8 times	1	0.00072
9 times	2	0.00143
Total individuals	1394	1,00000

Table 2. The 10 furthest migrations along the RSD length section.

Distance travelled (RSD along length section, km)	Direction of migration relative to the direction of flow	Number of days
49	upstream	369
48	upstream	189
45	downstream	66
45	downstream	119
43	downstream	361
42	upstream	338
40	downstream	161
40	downstream	361
38	upstream	74
38	upstream	745

Table 3. The 10 fastest changes of position along the RSD length section.

Chip identifier	Distance travelled (RSD along length section, km)	Direction of migration relative to the direction of flow	Number of days elapsed between catches	Average distance travelled per day (km/day)
2239	15	downstream	3	5.00
2680	29	downstream	6	4.83
2596	10	downstream	3	3.33
2920	8	upstream	3	2.67
2804	29	downstream	11	2.64
1753	35	downstream	14	2.50
3869	5	upstream	2	2.50
3643	11	upstream	7	1.57
3896	14	downstream	9	1.56
3836	33	upstream	22	1.50

We have examined the percentage of first captures (occurrences) – and also of tagging with a chip – for a given individual, between 2020 and 2024, considering the total number of captures detected in a given year as 100-100%. We obtained the following data for each year: in 2020, total catches are 99 individuals, of which the proportion of new catches is 100% as a starting year; in 2021, total detections are 202, of which the proportion of new catches is 93%; in 2022, total detections are 334, of which the proportion of new catches is 85%; in 2023, total detections are 917, of which the proportion of new catches is 74%; in 2024, total detections are 963, of which the proportion of new catches is 52% (Figure 4).

Figure 5 shows the monthly distributions of catches between 2020 and 2024. By analysing the bar charts for the five years under study, it is possible to see peaks in spring (May) and autumn (October), when most catches were taken. Figure 6 shows the distribution of catches by time of day, with the periods of day and night being separated, in addition to the periods of day and night, to show the periods of morning and evening twilight (light change), which generally have a positive effect on the fish's appetite for catching. It can be seen that during the winter months (from November to January), catches are mostly during the daytime, which can be explained by the fact that the local fishing regulations allow fishing on the RSD and its tributaries from 1 January to 28 February and from 1 December to 31 December only from 06:00 to 20:00. In the summer-autumn period (from July to November), the majority of the catches were taken during the night period. Figure 7 illustrates the breakdown of catches by four-hour blocks for all data for the period 2020-2024. It can be clearly seen that the largest part of the catches (641 catches) fell between 04:00 and 08:00, followed by the period 00:00 to 04:00 with 609 catches, the period 20:00 to 24:00 with 443 catches, the period 08:00 to 12:00 with 363 catches, the period 12:00 to 16:00 with 232 catches and finally the period 16:00 to 20:00 with 227 catches.

If we look at the variation in body weight of the individuals, the main data for the 20 individuals with the highest body weight gain between two consecutive catches (or recaptures, as the case may be) are shown in Table 4. One individual stands out with a body weight gain of 9.8 kg in only 105 days. Table 5 summarises the 20 individuals with the highest weight loss. The most extreme weight loss, 10.26 kg, was recorded in an individual with 409 days between captures. Table 6 and Figure 8 show the distribution of carp catches by location, taking into account the administrative boundaries of the RSD coastal municipalities concerned. It is striking that the largest share of record catches of carp is associated with the 5 southernmost municipalities (Ráckeve 638, Szigetbecse 363, Dömsöd 602, Makád 352, and Tass 221 catches) when looking at the capital (4 affected districts) and 16 other RSD coastal municipalities, representing a total of 86.5% of the total RSD large carp catches in the period under study – 2020 to 2024.

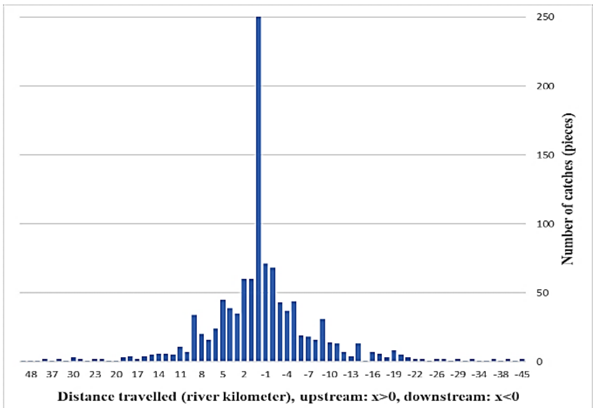

Figure 3. The distance travelled by carp as a function of flow direction.

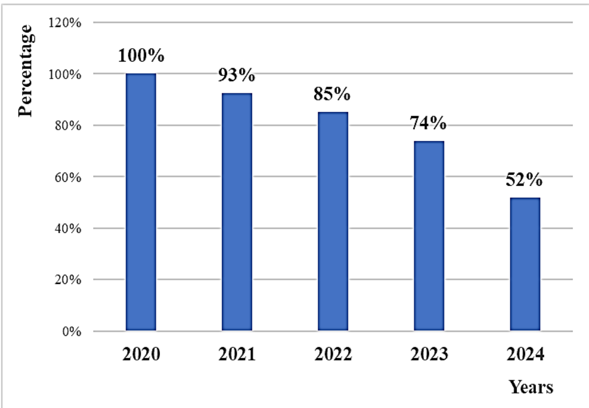

Figure 4. First "catches" as a percentage of total catches detected in a given year (100%).

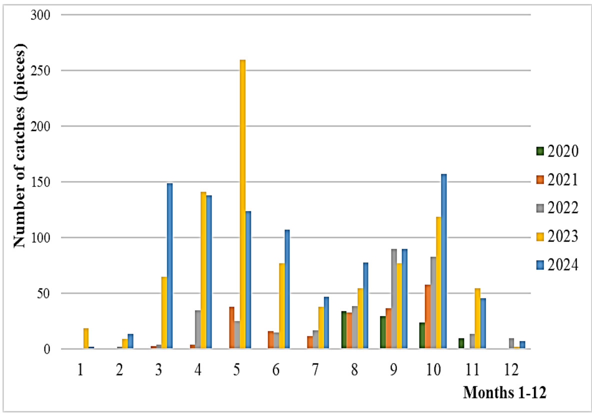

Figure 5. Number of monthly catches in the period under review (years 2020-2024).

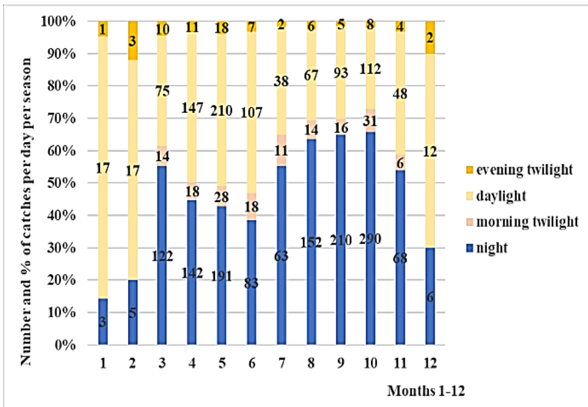

Figure 6. Share of day and night catches in monthly blocks (year 2020-2024).

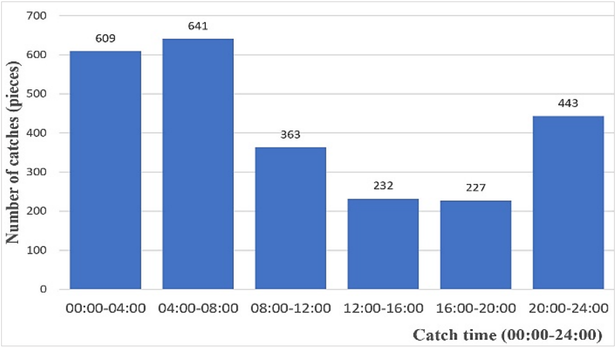

Figure 7. Number of catches per time of day – divided into 4-hour intervals.

Table 4. Data for the 20 individuals with the highest weight gain.

Body weight gain (kg)	Number of days between two catches	Change per day
9.80	105	0.0933
8.99	788	0.0114
8.48	1364	0.0062
8.37	906	0.0092
7.84	948	0.0083
7.78	993	0.0078
7.41	686	0.0108
7.21	748	0.0096
6.98	555	0.0126
6.91	69	0.1001
6.70	1341	0.0050
5.25	805	0.0146
4.41	818	0.0973
4.02	367	0.0255
3.71	745	0.0184
3.35	568	0.0238
2.50	715	0.0139
2.40	382	0.0276
1.95	715	0.0478
1.86	443	0.0873

Table 5. Data for the 20 individuals with the greatest weight loss.

Weight loss (kg)	Number of days between two catches	Change per day
−10.26	409	−0.0251
−5.85	41	−0.1427
−5.81	310	−0.0187
−5.30	28	−0.1893
−4.97	333	−0.0149
−4.95	174	−0.0284
−4.71	66	−0.0713
−4.60	14	−0.3286
−4.51	311	−0.0145
−4.45	87	−0.0511
−4.34	35	−0.1240
−4.32	43	−0.1005
−4.27	44	−0.0970
−4.20	43	−0.0977
−3.80	240	−0.0595
−3.36	429	−0.0214
−3.07	434	−0.0387
−2.68	348	−0.0181
−2.28	247	−0.0648
−2.09	313	−0.0137

Table 6. Distribution of catches according to the administrative boundaries of the municipalities.

Municipality (place of catch)	Catch number	Total weight (kg)	Average calculated weight per individual (kg)
01 - Budapest	25	446.46	17.86
02 - Szigetszentmiklós	7	140.04	20.01
03 - Dunaharaszti	21	367.58	17.50
04 - Taksony	3	51.41	17.14
05 - Szigethalom	7	135.79	19.40
06 - Dunavarsány	19	337.95	17.79
07 - Tököl	10	178.48	17.85
08 - Majosháza	11	218.88	19.90
09 - Szigetcsép	34	596.06	17.53
10 - Áporka	66	1 162.15	17.61
11 - Szigetszentmárton	54	1 013.40	18.77
12 - Kiskunlacháza	63	1 158.19	18.38
13 - Ráckeve	638	11 955.43	18.74
14 - Szigetbecse	363	6 482.31	17.86
15 - Dömsöd	602	11 180.48	18.57
16 - Makád	352	6 583.25	18.70
17 - Tass	221	4 045.52	18.31
Total	2496	46 053.36	18.45

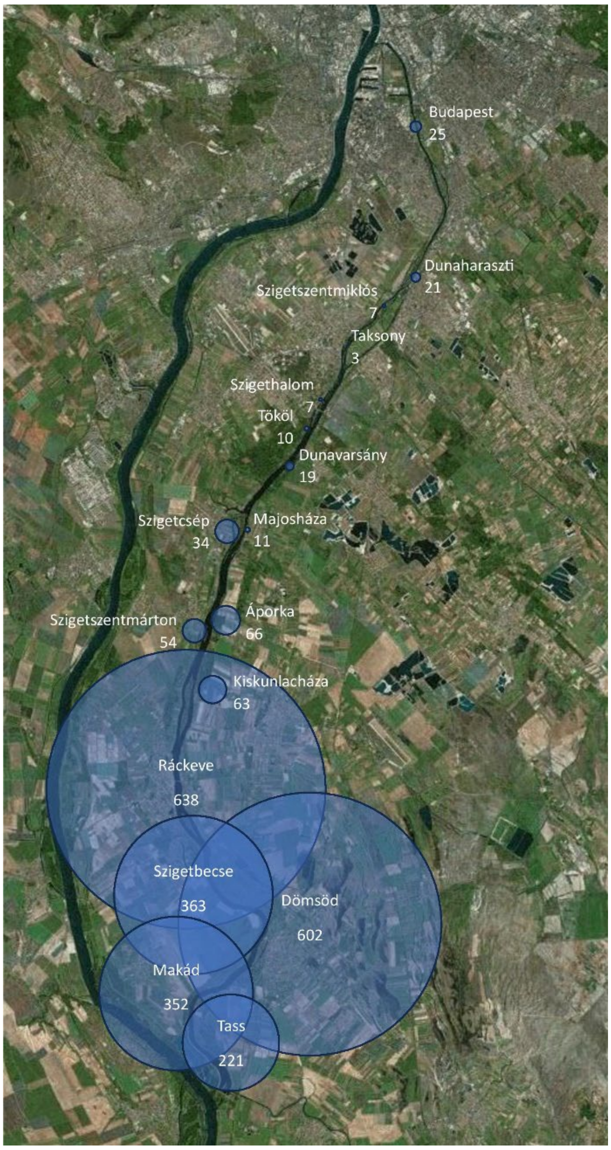

Figure 8. Quantitative distribution of large carp caught in the RSD section of the administrative territory of each municipality.

It is worth noting that 90% of the fish (2199 catches) were caught with a single bait type, so-called boilie (boiled paste balls), with all other baits sharing the remaining 10% (corn - 100, pellets - 67, tiger nuts - 59, rubber corn - 13, and other baits in 13 catches) (Figure 9).

The catches of large (record-sized) fish may be an interesting figure in itself, but it is also worth comparing with the common carp stocking data (Table 7), as this is an important modifier for a regularly stocked inland water body.

Correlation analysis showed that there is a significant correlation between the two factors (r=0.8348), indicating that there is a probable relationship between common carp stocking and the probability of catching record-sized carp.

It is also interesting to look at another aspect of the spatial distribution: the distance at which individuals caught at least three times were recaptured. The average distance between the two furthest catch points for a given fish was 4.97 km (less than a tenth of the length of the arm), but there were individuals caught three times within a kilometer. The histogram of the data is shown in Figure 10. It can be observed that more than 70% of the fish moved a maximum of 5 km, but 93% did not swim more than 16 km, indicating that the fish only use a small part of the river and its tributary regularly.

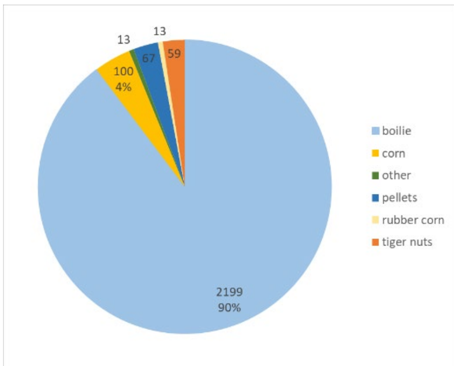

Figure 9. Distribution of bait types in % and number of catches.

Table 7. Carp stockings in the RSD and its tributaries (kg).

RSD section (river kilometer)	Years								Total
	2017	2018	2019	2020	2021	2022	2023	2024	
0.5-14.32 rkm	57 059	67 087	56 224	46 148	62 413	37 075	71 393	64 130	461 529
14.32-28.64 rkm	41 547	85 885	46 660	51 047	76 362	43 355	87 427	31 158	463 441
28.64-42.96 rkm	55 384	27 423	43 411	36 147	26 900	14 756	4 916	14 231	223 168
42.96-57.2 rkm	33 577	50 696	37 243	54 950	51 684	18 896	28 537	41 784	317 367
Tributaries	12 864	8 470	13 610	15 642	23 243	13 147	9 929	16 030	112 935

Looking at the size of the fish, the following conclusions can be drawn: the smallest fish weighed 10060 grams and the largest 32930 grams between 2020 and 2023. Three individuals weighed more than 30 kg. The average was 18438 ±3012 grams. If we look at the variation of fish body weight during recaptures, we can see that the fish body weight increased by an average of 721±2253 grams between the first and the last recapture. This wide variation was because there were fish that gained 6550 grams, but also fish that lost 4380 grams between the catch and the next catch. The elapsed time between recaptures may also be an interesting aspect. The average time between the first and the last recapture was 534±300 days (minimum 73 days, maximum 1160 days), but the interval between each recapture was also very wide: some fish were recaptured within 3 days, while in other cases more than 988 days elapsed between two recaptures. The average was 210±87 days (Figure 11). It’s also worth looking at how the body weight has changed with recaptured individuals. Correlation analysis between the two catches and the change in body weight showed that there is a correlation between the time between the two catches and the increase in fish body weight (r=0.3036), which, similar to the change in body weight, indicates that fish weight increases over time despite the catches. If we compare the condition of fish caught 3, 4, and 5 times at the first and last catch (in these cases we have sufficient data for a valid statistical analysis), we find that in two cases the average condition at the last catch is slightly poorer than at the first catch, and in one case the condition at the last catch was slightly better. No statistically justified difference was found in either case (Table 8).

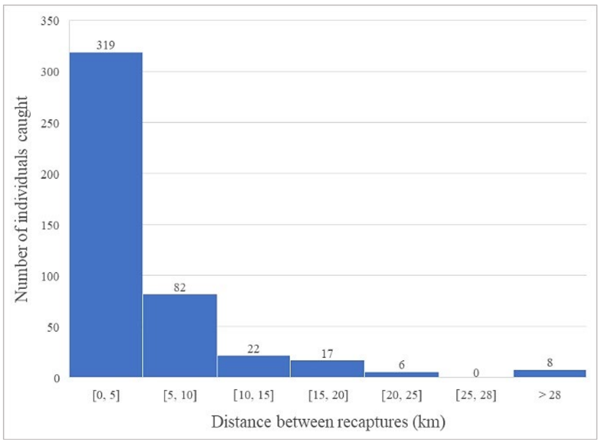

Figure 10. Distribution of the distance of recaptures.

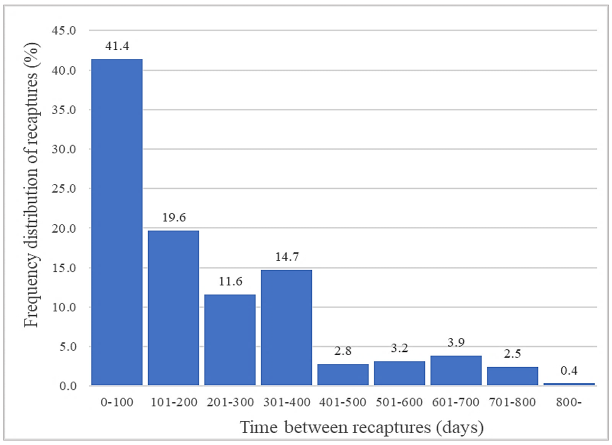

Figure 11. Distribution of time (days) between recaptures (%).

Table 8. Comparing the condition of fish caught more than once at the first and last catch.

How many times was the fish caught?	Average condition at first catch	Average condition at last catch	P value	Element number
3	2.127±0.3335	2.110±0.2510	0.7427	69
4	2.159±0.2386	2.043±0.2871	0.1066	28
5	2.041±0.2652	1.961±0.2905	0.5295	10

Discussion

Analysis of the years 2020-2024 of large carp tagging studies showed that of the 1394 carp individuals over 15 kg caught and tagged, there were 2 carps that had been caught 9 times in the years. However, in 2024, 359 of the 693 individuals caught were first-time records, indicating that the percentage of individuals (51.8%) from the RSD watershed that have not been detected to date remains respectable, and the watershed has a significant resource reserve of individuals not yet carrying a chip. However, it is also worth noting that the percentage of individuals not yet tagged with a chip is statistically verifiably decreasing (Figure 4). If the tagging scheme can be maintained for a sufficiently long period, the proportion of chip-tagged large carp in the total population will eventually follow the characteristics of a "saturation curve", while there will always be new individuals reaching the certification/tagging size (15 kg). Our studies have shown statistically verifiable evidence that the largest part of the RSD carp population is concentrated in the section of the RSD below Ráckeve (86.5%), which may be explained by the ideal habitat conditions for the carp species (e.g. good water quality, better watercourse conditions compared to the upper RSD and the high biomass of natural food organisms, especially molluscs), but also by the higher volume of stocking.

The data we examined confirmed the results of previous studies in several aspects, but also provided some nuanced insights. The results of this study, which covered more than 4 years and 1963 ha, showed a very similar pattern to the results of Raat's (1985) study of just over 3 months in two replicates on a 0.4 ha pond. The proportions of fish caught once were 50% and 73% in Raat's (1985) studies and 58.75% in ours, respectively, and the proportions of fish caught twice were 29% and 23%, while in the present study they were 20.23%. Finally, the rates for common carp caught 3 times were 15%, 4%, and 10.61% in ours, respectively. The above results raise the possibility that there is some conservative pattern among common carp, whereby the populations contain equal proportions of shy and less shy individuals, or perhaps learning (bait avoidance) occurs in a very similar way.

The data on the spatial distribution of catches partly support the findings of Stuart & Jones (2006), Specziár & Turcsányi (2014), and Vitál et al. (2022) that common carp typically move only over a small area. In Stuart & Jones' (2006) two-year study, nearly 80% of the fish moved within 5 km, with an average distance of 19 km, whereas in our case, the average displacement was smaller (4.97 km). However, this distance is significantly shorter than the results of a survey of younger age class carp in the same water area, which showed an average distance of 12 km (Vitál et al. 2022). This fact may be a plausible explanation for the close correlation between the distribution of the stocked fish and the catch of record-sized fish. On the other hand, the possibility that anglers discovered already in the first half of the 20th century (when the large-scale stocking that is typical today was virtually non-existent) that this Danube arm was an excellent habitat for common carp cannot be dismissed. This is why the number of anglers in this area was so high, and why, when stocking began, the practice of angling association was and is still aimed at maintaining catches and therefore stocking more fish in this closed section of the Danube. In this case, however, the increase in record-size fish is not due to stocking, but to the excellent fish habitat and abundant natural fish food, and the overall excellent fish-keeping capacity of this water body.

Looking at the body weight of fish, it can be seen that even at this very old age class, there is still growth (most fish can be assumed to be between 6+ and 28+ years old based on Winker et al. 2011). An interesting aspect is that the average time between two catches is 210 days, a very similar value to the seven months reported in Czapla et al. (2023), which is the average time for which bait/hook avoidance after earlier catches has been confirmed for common carp. This implies that the hypothesis proven in laboratory conditions is confirmed under natural conditions. The variation in body weight of fish and whether this variation correlates with time raises two possibilities. In the first case, fish growth is continuous and primarily depends on time, while in the second case, it may be proportional because the stress of catches is more easily eliminated over a longer period. When looking at how the condition of the fish changed between the first catch and the last catch, the results show that the catch did not significantly change the condition of the fish. This, in turn, means that the first hypothesis may be true. This finding is consistent with the observations of other researchers on largemouth bass (*Micropterus salmoides*) (Sass et al. 2018), where the condition of the fish did not change after capture, and puts in a different light the results of Raat (1985), where the condition of the fish deteriorated under poor natural food supply.

Based on the results of the study, several general conclusions can be drawn that are important for the management of freshwater carp populations. The first is that the protection of larger fish can be highly effective, as a significant proportion of the caught fish were recaptured multiple times, indicating the efficacy of the catch and release (C&R) methodology. Another key finding is that despite being captured regularly, the fish were still able to grow, and their condition did not deteriorate significantly, suggesting that fishing did not cause serious harm. Finally, it can be concluded that the protection of older age groups of common carp requires general, ecosystem-wide measures. The reason for this is that if specific areas (refuge zones) are protected, only the individuals residing in those areas will benefit, as individuals from other habitat areas, due to their limited movement range, will not utilize these zones.

In conclusion, microtransponder tagging of older age classes of common carp is a non-invasive method that is sustainable, provides active protection against fish theft, is suitable for monitoring growth and migration patterns of stocks, and can be used as a basis for fish management planning (stocking, fishing inspection) based on long-time series data.

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