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Short Communication

Commercial fish composition in the Anzali Wetland

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Introduction

The Anzali Wetland is one of the most important wetlands in the southwestern Caspian Sea. It is connected to the Caspian Sea, which plays a crucial role in supporting anadromous fish by providing spawning grounds and nursery areas (Kimbal and Kimbal, 1974; Holčík and Oláh, 1992). Additionally, the Caspian Sea's water level significantly influences the wetland's water volume and fish catch. Historical data from the Soviet-Iranian fishing company shows that the total fish catches in the Anzali Wetland between 1932 and 1940 ranged from 4.0 to 7.5 thousand tons. As far back as 1939-40 the wetland contributed 98% of Iran's total kutum, 90% bream and 73 percent pike-perch catch. Between years 1951 and 1952, the fish catch in the Anzali Wetland dropped to 2,000 tons and by 1962-1963 it had declined to a minimum of just 63 tons - a decrease of more than 90 times. The primary cause for this drastic decline was the decreasing water level of the Caspian Sea and reduced river discharge into the wetland (Hydroproject, 1965).

Iranian Fisheries Organization released a total of 120,000 juvenile grass carp into the Anzali Wetland between 1965 and 1978 following the advice of former Soviet experts. This effort was done to control the overgrowth of aquatic plants and boost fish catches. With the rise in the Caspian Sea's water level, fish catches increased to 314 tons in 1992. The catch nearly doubled following year, reaching 598 tons in 1993 (Nezami, 1994). In the subsequent years, the catch was estimated at 630 tons in 1994, 425.5 tons in 1995, and 320 tons in 1996 (Khodaparast *et al*., 1998).

Over the past three decades, the composition of fish caught in the Anzali lagoon has undergone significant changes; the populations of endemic fish such as wels (*Silurus glanis*), bream (*Abramis*

brama), roach (*Rutilus lacustris*), great barb (*Luciobarbus capito*), asp (*Aspius aspius*) have declined substantially. Meanwhile, the population of the non-native Prussian carp (*Carassius gibelio*) has increased significantly (Haghighi and Valipour, 1997; Khodaparast, 2003).

Over the past two decades, the degradation of the Anzali Wetland has accelerated due to several factors, including the decline in the Caspian Sea's water level (Prange *et al*., 2020), urban expansion, increased pollution (Mirzajani, 2009), high sedimentation, dense aquatic vegetation and the invasion of exotic fauna and flora (Mirzajani *et al*., 2021). These factors have significantly contributed to the decline in the wetland's fisheries values. During this period, fisheries statistics have been unclear, with annual catches estimated between 500 and 1000 tons, often without detailed field studies. The primary objective of this study is to analyze the fish community structure and estimate fish catches in the Anzali Wetland during 2023-2024. The findings will aid in planning fisheries activities and developing strategies for the rehabilitation of fish stocks.

Materials and methods

The general framework for estimating fish catch was based on two approaches - landings and market- described by Bazigos (1974). The evaluation of commercial fish catches from the Anzali Wetland was conducted by collecting data from local markets. The survey followed a simple random sampling approach along with a complete census of fishes (NRC, 1998; Conquest *et al*., 2023). Anzali and Abkanar, the two main trading markets of the Anzali Wetland were randomly visited on 125 days between February 2023 and January 2024. All fish traded in these markets were identified and completely counted. The length of each species caught was measured to the nearest 1cm and total weight to the nearest 1g. The number of involved fishermen was sought through the individuals bringing the daily catch to the markets. This data was used to estimate of catch per unit effort (CPUE). Seasonal variations in the fish catch and fishing activity were also investigated.

Results and discussion

A total of 22 fish species were traded in the markets. The estimated annual fish catch from the Anzali Wetland was 93.1 tons. The average daily catch was approximately 256.2 kg, while the CPUE was estimated at 5.7 kg per fisherman per day. The occurrence frequency of fish (percentage of observed days) indicated that Prussian carp and Northern pike were traded in the markets every day. They were followed by Common carp (*Cyprinus carpio)*, Tench (*Tinca tinca)*, and Rudd (*Scardinius erythrophthalmus)*. Four species including Northern pike, common carp, Prussian carp and tench accounted for the highest proportions of the total catch weight, contributing 42.6%, 24.8%, 22.1% and 5.9%, respectively. Their respective frequencies in the total number of fish caught were 37.6%, 9.5%, 18.1% and 23.9%. Non-native species, particularly Chinese carps including grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), and bighead (*Hypophthalmichthys nobilis*),

made up only a small percentage of the total catch weight. Among native species, wels catfish (*Silurus glanis*) and European perch *(Perca fluviatilis*) contributed just 0.3% and 0.01% of total weight, respectively. The anadromous Caspian fishes, including Caspian vimba (*Vimba persa*), Caspian shemaya (*Alburnus chalcoides*), kutum (*Rutilus frisii*), and roach (*Rutilus rutilus*), were also present in small amounts, comprising about 1.2% of the total catch weight (Table 1).

Table 1: Species composition, observation percentage, and fish caught estimation from the local markets for Anzali Wetland from February 2023 to January 2024.

Fish species	Occurrence percentage in fish Market	Total Weight (kg)	Number of fish
Northern pike (*Esox lucius*)	100	39617.9	102445
Common carp (*Cyprinus carpio*)	98.4	23108.6	25960
Prussian carp (*Carassius gibelio*)	100	20603.9	49317
Tench (*Tinca tinca*)	81.6	5486.2	65092
Grass carp (*Ctenopharyngodon idella*)	71.2	1244.4	578
Rudd (*Scardinius erythrophthalmus*)	71.2	923.7	18235
Kutum (*Rutilus frisii*)	28.0	575.3	453
Silver carp (*Hypophthalmichthys molitrix*)	34.4	368.5	1458
Silver bream (*Blicca bjoerkna*)	20.8	253.0	2558
Wels catfish (*Silurus glanis*)	8.8	252.8	181
Great barb (*Luciobarbus capito*)	35.2	242.2	406
Caspian vimba (*Vimba persa*)	31.2	124.5	3135
Big head carp (*Hypophthalmichthys nobilis*)	8.8	78.4	38
Caspian shemaya (*Alburnus chalcoides*)	17.6	69.8	1390
Mullet (*Chelon* spp.)	10.4	42.0	310
Bream (*Abramis brama)*	20.8	40.3	292
Roach *(Rutilus lacustris*)	14.4	38.0	435
Sharpbelly (*Hemiculter leucisculus*)	12	15.0	342
European perch (*Perca fluviatilis*)	10.4	11.2	111
Razii barb (*Capoeta razii*)	2.4	7.4	41
European pikeperch (*Sander lucioperca*)	3.2	3.3	38
Transcaucasian chub (*Squalius turcicus*)	0.8	0.3	3
Total		**93106.6**	**272818**

The seasonal trend in fish catch showed that the highest and lowest daily catch amounts occurred in spring (279 kg/day) and summer (168 kg/day), respectively. The number of fishermen was the lowest in winter (24 individuals) and the highest in autumn (57 individuals) (Table 2).

The average weight of Northern pike was 572±427 g with 50% of the individuals weighing less than 400 g. For common carp the average weight was 1037±993 g with half of the fish weighing below 745 g. The average weight of Prussian carp and tench was 412±212 g and 95±50 g, respectively. Half of the Prussian carp weighed less than 397 g, while 50% of the trench weighed below 85 g (Fig. 1).

The fish catch and species composition in the Anzali wetland have significantly declined over the past decades. Between 1932 and 1940, more than 50% of the catch consisted of Caspian Sea species, including pike perch, roach, common carp, kutum and bream (Hydroproject, 1965).

Table 2: The number of fishermen, daily catch and catch per unit effort (CPUA) for different seasons from the local markets for Anzali Wetland.

Season	Visited days	Min and Max of fishermen	Daily catch (kg) (Mean±SD)	CPUA (kg/day, fisherman)
Spring	38	11-79	279 ± 133	8.3
Summer	28	10-85	168 ± 79	4.0
Autumn	25	18-94	213 ± 82	3.8
Winter	34	4-45	175 ± 132	7.4

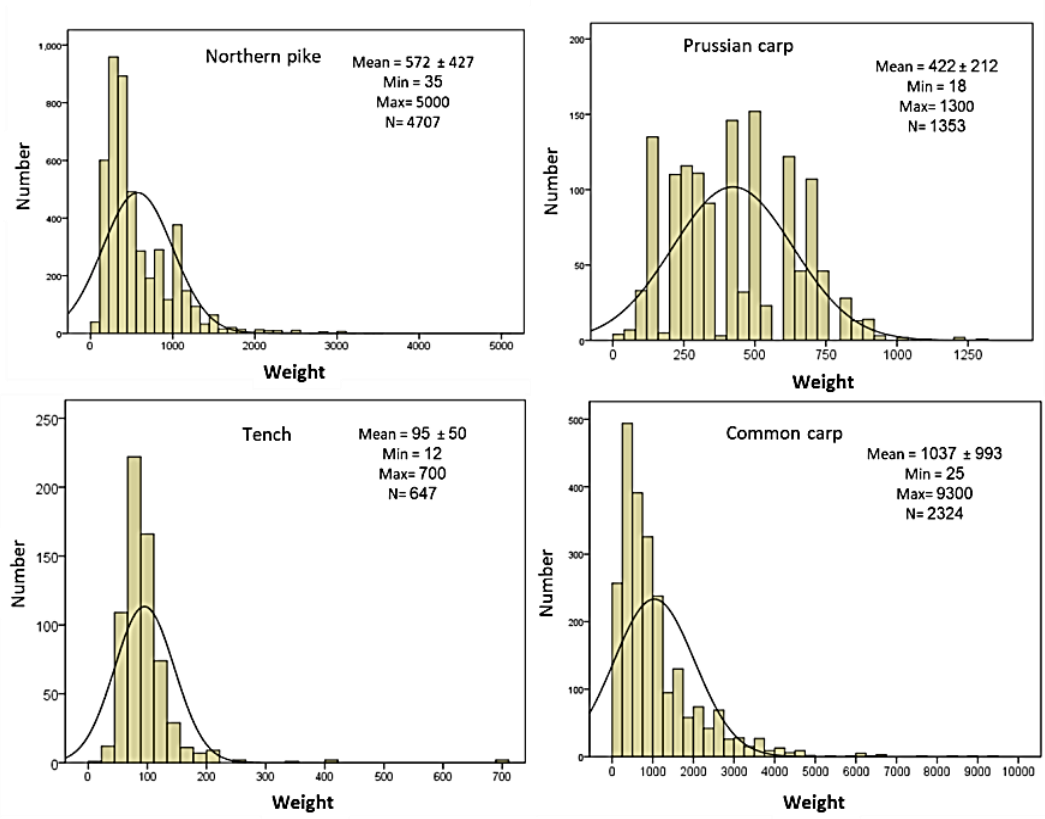

Figure 1: Weight class frequency distribution of dominant species from the local markets in the Anzali Wetland; for each species, the average, minimum and maximum weight (g) of fish in the market and the number of fish caught on the inspection days.

However, the commercial fish composition has been shifted entirely to Northern pike, common carp and Prussian carp nowadays. The current fish composition resembles that of the late 1980s; however, during that period, in addition to pike and common carp, native species such as wels and European perch were also caught in significant numbers. From 1992 to 1996, 25 species of fish were recorded in the Anzali Wetland with the non-native Prussian carp being dominant averaging 188.7 tons annually. It was followed by Northern pike (82.3 tons), common carp (70.2 tons), European perch (27.2 tons), and wels catfish (17.7 tons), collectively comprising 82.3% of the total fish caught (Haghighi and Valipour, 1997). The most significant factor contributing to the decline of fish caught is the reduction of water quantity both in depth and extent. This decline is primarily driven by rising air temperatures, reduced precipitation and inflow, excessive sediment deposition, and the decreasing

Caspian Sea level (Mahdian *et al.,* 2024). In 1931, the wetland covered approximately 400 km^2 with a depth of 8 meters (Kimbal and Kimbal, 1974). Today its area has shrunk to less than 37 km^2 with a maximum depth of just 1.5 meters (Mirzajani, 2024). Since 1996, the Caspian Sea level has been decreasing by 8 cm y^{-1} 1996 (Chen *et al*., 2017; Lahijani *et al*., 2023), leading to the shrinkage and desiccation of most of the Anzali Wetland. Currently, the only remaining water body is in the western Abkenar region, covering approximately 3620 hectares with a depth of less than one meter. This area is densely covered with aquatic vegetation, creating poor biological conditions for fish and other aquatic organisms. These unfavorable conditions have resulted in a record of low fish catches. Future projections indicate that fish catch levels will likely continue to decline due to the high density of two invasive aquatic plants; Indian lotus, *Nelumbo nucifera* and the water hyacinth, *Pontederia crassipes,* which severely reduce primary production and oxygen levels in the wetland (Mirzajani, 2024). In the present study, non-native species, particularly Chinese carps such as grass carp, silver carp, and bighead carp, accounted for only a small percentage of the total catch weight (Table 1).

These species have been released into the wetland in limited numbers by the Fisheries Organization as part of restoration efforts. Several endangered native species including tench, European perch and common carp are also included in the Iranian Fisheries Organization's restoration programs. These initiatives, which involve artificial reproduction and release, require significant financial resources. However, the economic challenges of fishing have led fishermen to catch even small-sized fish as evidenced by tench ranking second in abundance with 50% of the population weighing less than 85 g (Fig. 1).

Globally, 64% of the wetlands have disappeared in the last century (Vasumthi *et al.,* 2023) and between 2010 and 2020, Iran experienced an estimated 14% loss of its wetlands, a trend that is expected to continue (Mahdian *et al.,* 2024).

Anzali Wetland is undergoing rapid degradation, and predictive estimation models suggest that under non-conservative scenarios, it will experience seasonal desiccation between 2058 and 2062. Even under optimistic scenarios, assuming no changes in the Caspian Sea level, the wetland is projected to gradually diminish by 2100 (Mahdian *et al.,* 2024).

Currently, as in many other regions, fisheries in Anzali Wetland are in decline, facing challenges such as illegal fishing activities, and the spread of invasive species (Bakiu *et al*., 2022). Increasing awareness and educating of the fishing community on substantial practices such as preventing the trade of undersized fish, using larger mesh size in fishing nets, protecting spawning grounds (especially during spawning seasons), dredging to create water bodies, and managing aquatic vegetation, particularly invasive species, will be essential for restoring native and migratory fish stocks.

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