Fish population monitoring in Kolob Reservoir from 2010 to 2024

WATER ID – I 789

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Introduction

Kolob Reservoir is a moderately-sized (250 acre), high elevation (7,454 ft) water storage reservoir located in Washington County, UT and is managed by the Washington County Water Conservancy District (WCWCD). The WCWCD has generally managed the reservoir with sufficient water levels to sustain a sport fishery, despite having no formal obligation to maintain a conservation pool or fishery in the reservoir. The fish species assemblage, and size structure and health within the different species present, has changed over the years, often the result of altering management approaches.

Until the late 1990s, the sport fishery at Kolob Reservoir historically consisted of Rainbow Trout *Oncorhynchus mykiss* (RBT), Brook Trout *Salvelinus fontinalis* (BRK), and several different species and strains of cutthroat trout (CTT). Management was primarily implemented through general statewide fishing regulations (e.g., daily harvest limit of eight trout, use of bait allowed) and annual stocking of larger RBT (commonly 20,000 fish > 6 in) (Ottenbacher et al. 2001).

From 1998 to 2008, a new management plan was implemented (1998 Management Plan) with general goals of improving the quality (i.e., size) of the trout and reducing stocking costs by managing for larger RBT and CTT. The 1998 Management Plan utilized special regulations that limited gear to artificial flies and lures only and reduced the daily harvest limit to two trout over 18 inches. By 2008, some anglers began expressing concerns about the 1998 Management Plan, specifically that special regulations were unnecessarily reducing angler use and opportunity to harvest fish and that Golden Shiners *Notemigonus crysoleucas* (GS) may diminish the fishery.

In response to the concerns regarding the 1998 Management Plan, a committee of anglers, angling group representatives, cabin owner, local elected official, WCWCD employee, and a member of the Southern Regional Advisory Council developed a new management plan in 2009 (2009 Management Plan). The 2009 Management Plan contained four main goals: (1) maintain/preserve a natural, self-sustaining fishery, (2) maintain long-term biological control of GS, (3) increase or improve catch and harvest rates by anglers, and (4) improve family oriented fishing opportunities (Kolob Reservoir Advisory Committee 2009). The 2009 Management Plan, in part, called for regulations to be changed to a limit of 2 trout under 15 in or over 22 in, all trout between 15 and 22 in to be immediately released, and a seasonal bait closure (January 1 through the third Saturday in May and the second Saturday in September through December 31) (Kolob

Reservoir Advisory Committee 2009). The 2009 Management Plan was fully adopted by the Utah Division of Wildlife Resources (UDWR) in 2010 and still guides sport fish management in Kolob Reservoir today. The 2009 Management Plan also included measureable objectives and "triggers" to help determine if goals are being met and if changes in management are needed (Kolob Reservoir Advisory Committee 2009).

The four major goals identified in the 2009 Management Plan had generally been achieved, or were at least close to being achieved, in the decade following implementation of the 2009 Management Plan. Results from 2010-2018 gill net surveys and a 2013 creel survey suggested that objectives had been met for maintaining/preserving a natural, self-sustaining fishery, preventing GS from negatively impacting the sport fishery, and increasing angler opportunities to catch and harvest trout and that all of the minimum trigger values had been exceeded (Braithwaite et al. 2013).

Unfortunately, Green Sunfish *Lepomis cyanellus* (GSF), Bluegill *Lepomis macrochirus* (BG), and Yellow Perch *Perca flavescens* (YP) were illegally introduced into Kolob Reservoir at some point in the mid to late-2010s, threatening the fishery. A gill net survey in the spring of 2018 found GSF and BG in very low numbers and it seemed unlikely their populations would grow to the point of disrupting the trout fishery. However, in the summer of 2018, there were several angler reports of YP, so another gill net survey was conducted at that time and YP were found to be abundant.

A rotenone treatment was completed in the fall of 2018 to remove all fish because YP seemed a much greater threat than GSF or BG and was likely necessary to maintain the trout fishery. An immediate treatment was additionally preferable to prevent whoever had illegally introduced YP from being able to utilize a YP fishery and the treatment coincided with the WCWCD's need at the time to drain the reservoir for dam repair work. Post-treatment gill net surveys in the fall of 2018 and spring of 2019 suggested a complete eradication of all fish in Kolob Reservoir had been achieved. Stocking resumed in the summer of 2019 with the intention of reestablishing a sport fishery at Kolob Reservoir that would once again meet the goals and objectives of the 2009 Management Plan.

Methods

Three traditional experimental gill nets were set perpendicular to shore and allowed to fish for a single overnight period in early to mid-May in 2010, 2011, 2012, 2013, 2014, 2016, 2018, and then each year from 2020 to 2024. Surveys included two gill nets set with the top line beginning at the top of the water column and extending down (i.e., "floating" gill nets) and one gill net with the bottom line beginning in the benthic zone and extending up into the water column (i.e., "diving" gill nets). Nets measured 6 ft x 125 ft, with five panels of increasing mesh size (0.75", 1", 1.25", 1.5", and 2"). All nets were set with the smallest mesh size near shore. Net locations have remained constant during all years of sampling (Figure 1). Species, total length (in), and weight (lbs) were recorded for each individual fish captured (data are reported in the imperial system rather than the metric system to be consistent with objectives in the 2009 Management Plan and facilitate better communication with the public). Relative abundance was calculated using catch per unit effort (CPUE; total number of fish captured/total number of nets per sampling event). Fish captured the same year as they were stocked were not included in

results. Relative weight (W_r) was used as a condition index for fish health, with a W_r of 90 to 100 generally accepted as standard for fish in good condition, and was calculated as $W_r = (W/W_s) \cdot 100$; where W is individual fish weight and W_s is a standard weight derived from species-specific weight-length regressions (Pope and Kruse 2007). W_s for RBT was estimated as $\log_{10}W_s = -4.898 + 2.990 \log_{10}$total length (Simpkins and Hubert 1996). W_s for CTT was estimated as $\log_{10}W_s = -5.189 + 3.099 \log_{10}$total length (Kruse and Hubert 1997). W_s for tiger trout (Brown Trout *Salmo trutta* x BRK) (TG) was estimated as $\log_{10}W_s = -5.422 + 3.194 \log_{10}$total length (Hyatt and Hubert 2001), which uses a weight-length regression for Brown Trout in lentic habitats because a regression for TG has not yet been developed. W_s for BKT was estimated as $\log_{10}W_s = -5.186 + 3.103 \log_{10}$total length (Hyatt and Hubert 2001b). Units used to calculate W_r are mm for total length and g for weight.

Stocking records from a UDWR database were obtained and data regarding the number, size, date, and species of fish stocked in Kolob Reservoir were reviewed and reported. Fish stocked at $\leq$ 6 in were considered "fingerling" and fish > 6 in when stocked were considered "catchable".

Results

Fish biomass in Kolob Reservoir was 100% trout in all years of gill net monitoring except in 2011 when GS were 0.1% of total biomass and 2018 when BG and GSF were 0.8% of total biomass. The trout species composition was entirely CTT and RBT from 2010 to 2018, with CTT tending to dominate, while there was a greater fluctuation of relative abundance among CTT, RBT, and TG from 2020 to 2024 (Figure 2). CPUE was relatively stable from 2010 to 2018 with a mean of 52 (SD = 9.1, N = 7), peaked in 2020 at 87, and has generally decreased since 2020 with a low of 38 in 2024 (Figure 2). BRK were also observed from 2020 to 2024, but were present at low numbers, never comprising more than 6% of total CPUE.

Trout typically ranged in size from about 12 to 14 in and 0.5 to 1.0 lbs from 2010 to 2018, were notably smaller in 2020, increased substantially in size each year since 2020, and peaked in 2024 with most trout between about 16 to 18 in and > 1.5 lbs (Figure 3). The percentage of trout captured > 15 in ranged from 6% to 30% from 2010 to 2018, decreased to < 10% each year from 2020 to 2022, and then increased to a majority of fish in both 2023 and 2024 (Figure 4). The percentage of trout captured > 20 in ranged from 0% to 2.2% from 2010 to 2018, dropped to 0% each year from 2020 to 2022, and then increased to 2.4% and 10.5% in 2023 and 2024, respectively (Figure 5). Most recently, in 2023 and 2024, RBT and TG were generally longer than CTT (Figure 6).

Overall, trout were in good condition from 2010 to 2018, then condition declined in 2020 and 2021 and improved from 2022 to 2024 (Figure 7). CTT and RBT are currently in much better condition than TG and BRK (Figure 7).

Kolob Reservoir was stocked with approximately 5,000 fingerling RBT per year from 2010 to 2018, with a few rare exceptions (e.g., no RBT stocked in 2014). A high number and variety of trout species, including fingerling and catchable-sized fish, were stocked in 2019 and then stocking rates were much lower in the years that followed, including no fish stocked in 2022 and only 1,000 fingerling TG stocked in 2023 (Table 1).

Discussion

The fish population in Kolob Reservoir appears to have largely met management goals for both the 2010 to 2018 and post 2018 periods as measured by the germane objectives from the 2009 Management Plan. (1) The GS biomass, as well as the biomass of any other undesirable fish species, has been limited to less than 10% of the total biomass in each gill net survey since 2010. (2) The Kolob Reservoir fishery has been maintained through minimal stocking (< 5,000 fingerling rainbow trout yearly), with the understandable concession of a large stocking effort in 2019 to reestablish a trout population following the 2018 rotenone treatment. (3) The trout CPUE has met or exceeded the objective of 45 in all but two years, 2013 and 2024, and even in those cases CPUE was well above the trigger of 30 and not at all unrepresentative of a quality trout fishery in southern Utah (Hepworth and Beckstrom 2004). (4) The percentage of trout > 15 in and 20 in fell short of 50% and 10% objectives, respectively, for all gill net surveys from 2010 to 2022, but has increased each year since 2020 and exceeded objective thresholds in 2023 and 2024. Nonetheless, results cannot only be viewed in the narrow, binary sense of whether or not an objective is met or a trigger is not met, rather the nuance, context, and trends must also be considered with particular attention to the current situation.

Perhaps the most important result in terms of the viability for long-term, consistent success of the sport fishery in Kolob Reservoir was the lack of a single YP, GS, or any other undesirable fish species since the rotenone treatment in 2018. A failure to eradicate YP in 2018, or a subsequent illegal introduction and establishment of any undesirable fish species, would have hindered or possibly prevented the reestablishment of a quality trout fishery, leading to years of poor angling success and possibly the need for another rotenone treatment. Management efforts can instead focus on creating and maintaining the type of trout fishery called for in the 2009 Management Plan.

The primary factor directly influencing trout density since 2020 is almost certainly stocking rate, though angler harvest and natural recruitment are also important elements to consider. The substantial stocking effort in 2019 accounts for the CPUE from 2020 to 2023 since no illegally introduced fish were discovered and natural recruitment would have been limited in the years immediately following the rotenone treatment (the majority of fish stocked in 2019 were sterile or stocked at fingerling-size). The CPUE in 2024 followed two years of greatly reduced stocking. The role of harvest in trout density in Kolob Reservoir is more ambiguous. Harvest was relatively low when last measured in 2013 (Braithwaite et al. 2013) and citations for illegal harvest are low (UDWR, unpublished data), yet anecdotal angler reports of elevated harvest, both legal and illegal, seem to have increased in recent years. From 2010 to 2018, Kolob Reservoir's trout population received a high level of natural recruitment and there is no reason to believe wild trout will not eventually comprise a meaningful portion of the fish population post-treatment.

The size and condition of trout in Kolob Reservoir is inexorably linked to trout density. It was unsurprising that trout size and condition was inversely correlated with trout density from 2020 to 2024 when considering the indeterminate growth characteristics of fish and the role of density dependent population factors. The extremely high trout densities observed from 2020 to 2022 would have reduced resources available to any individual fish, resulting in general small size and poor condition; conversely, the

lower trout density in 2024 would have increased resources available to each individual fish, resulting in general large size and good condition (e.g., Johnson et al. 1992; Marchand and Boisclair 1998; Hadley and Hepworth 2013).

Management Recommendations

Ultimately, the sport fishery at Kolob Reservoir is managed for the enjoyment of the angling public, this is the foundational concept that guided development of the 2009 Management Plan and informs the following management recommendations:

1) Annual gill net surveys should continue indefinitely to assess the fish population and determine whether objectives and triggers in the 2009 Management Plan are met (e.g., trout CPUE, percentage of catch > 15 in).

2) The species and quantity of fish stocked should continue to be adjusted as necessary to meet objectives in the 2009 Management Plan (e.g., increase stocking if CPUE falls below the trigger of 30 for two consecutive years or decrease stocking if CPUE is high and size and condition are low). In 2024, and for the foreseeable future, 5,000 fingerling RBT and 500 fingerling TG should be stocked annually. Additionally, a single stocking of 5,000 fingerling CTT and 500 fingerling BRK should occur in 2024 or as soon as excess fish are available.

3) An angler survey should be completed in 2025 (repeat of the 2013 angler survey) to assess objectives and triggers in the 2009 Management Plan related to angler experience (e.g., angler catch and harvest rates, youth participation).

4) A public committee of stakeholders (e.g., diversity of Kolob Reservoir anglers with different interests and values, Blue Ribbon Fisheries Advisory Council member, cabin owner, local elected official, WCWCD employee) should be convened in the winter of 2026 to review and update the 2009 Management Plan.

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Table 1. Record of trout stocking in Kolob Reservoir from 2019 to 2023.

Year	Species	Approximate Length (in)	Quantity	Month
2019	RBT	9	10,827	May
		3	15,436	June
		Total	26,263	
	CTT	6	2,080	June
		15	139	June
		3	5,000	November
		Total	7,219	
	TG	3	3,000	June
		5	5,040	August
		12	510	August
		Total	8,550	
	BRK	3	502	June
		Total	502	
		Year Total	**42,534**	
2020	RBT	3	5,053	June
		Total	5,053	
	BRK	3	511	June
		Total	511	
		Year Total	**5,564**	
2021	RBT	3	5,455	May
		Total	5,455	
		Year Total	**5,455**	
2023	TG	3	1,002	July
		Total	1,002	
		Year Total	**1,002**	

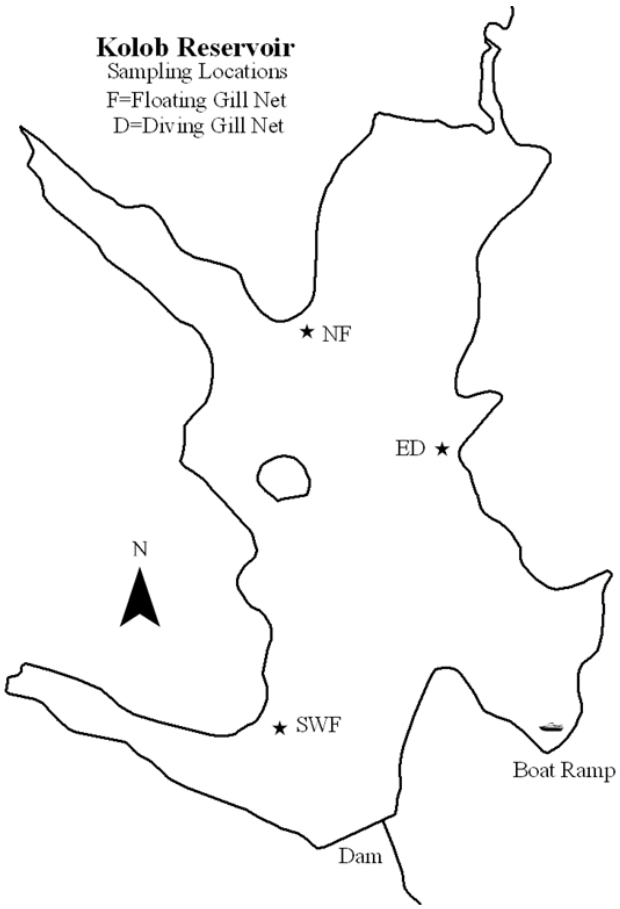

Figure 1. Gill net locations at Kolob Reservoir.

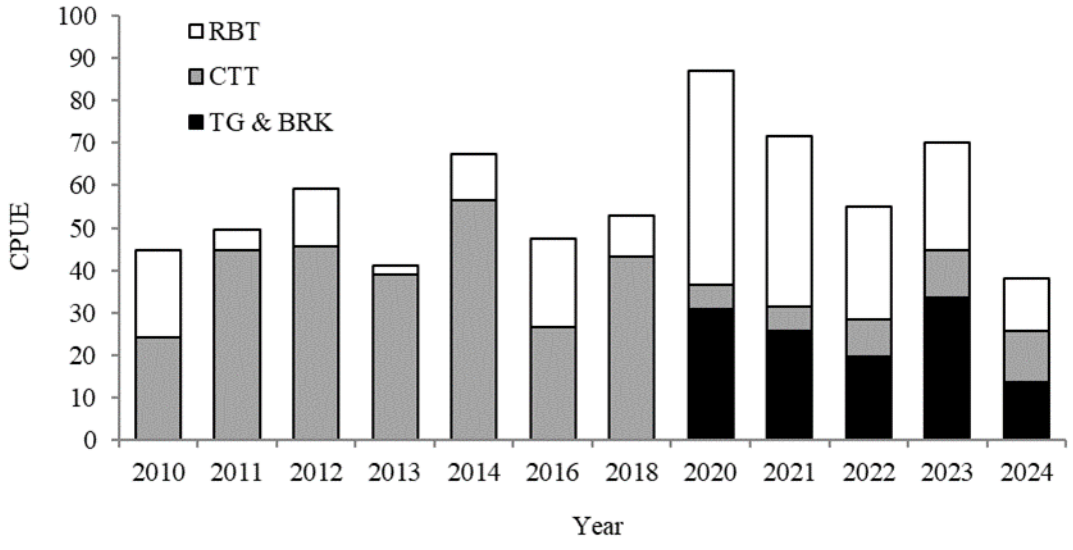

Figure 2. CPUE for RBT, CTT, and TG and BRK from 2010 to 2024.

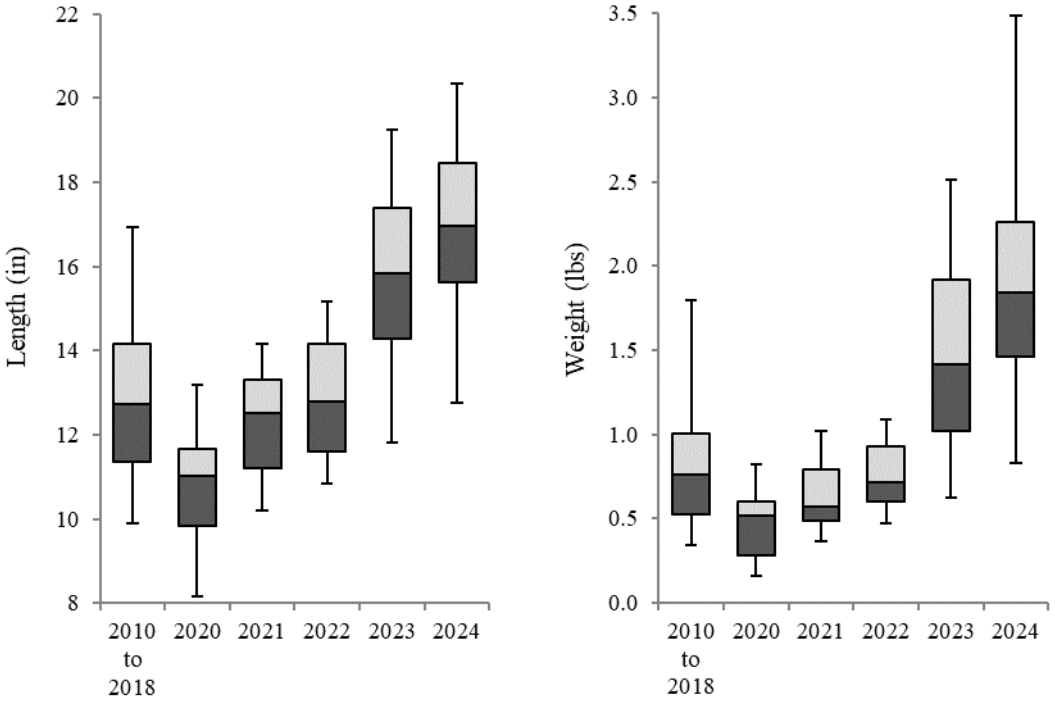

Figure 3. Box plots showing the 5th percentile, 1st quartile, median, 3rd quartile, and 95th percentile of fish length and weight.

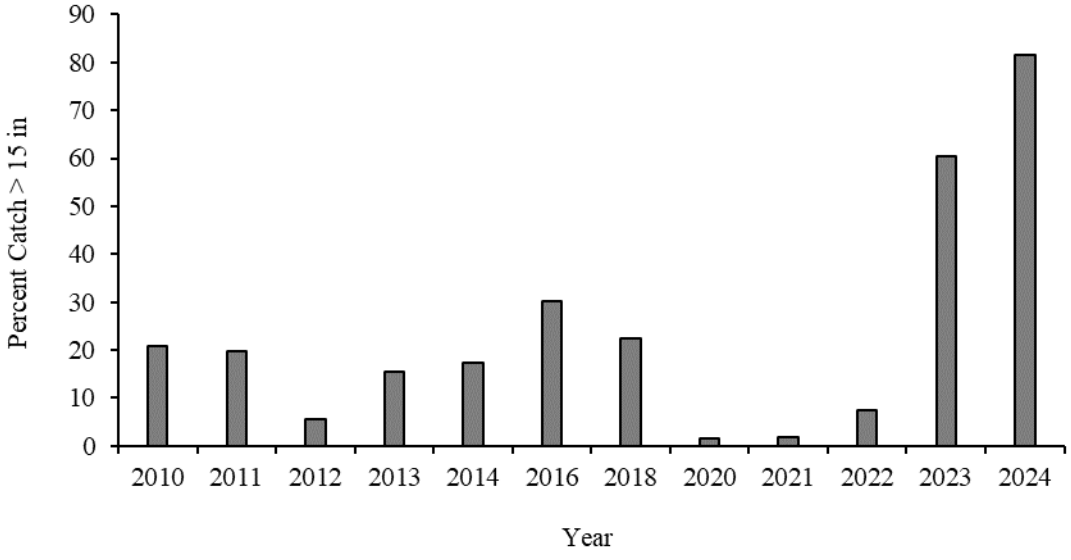

Figure 4. Percentage of total trout caught > 15 in during each gill net survey from 2010 to 2024.

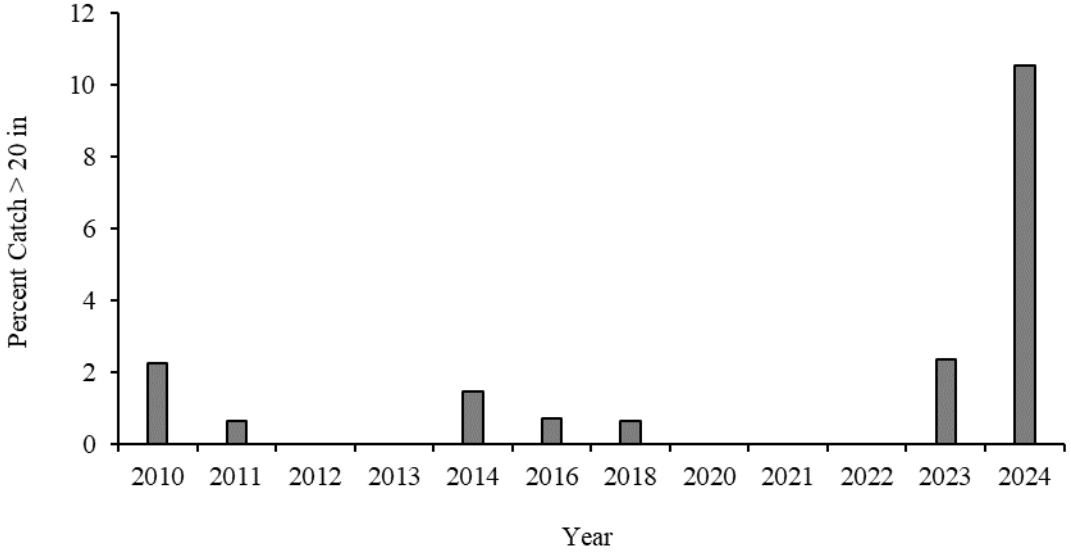

Figure 5. Percentage of total trout caught > 20 in during each gill net survey from 2010 to 2024.

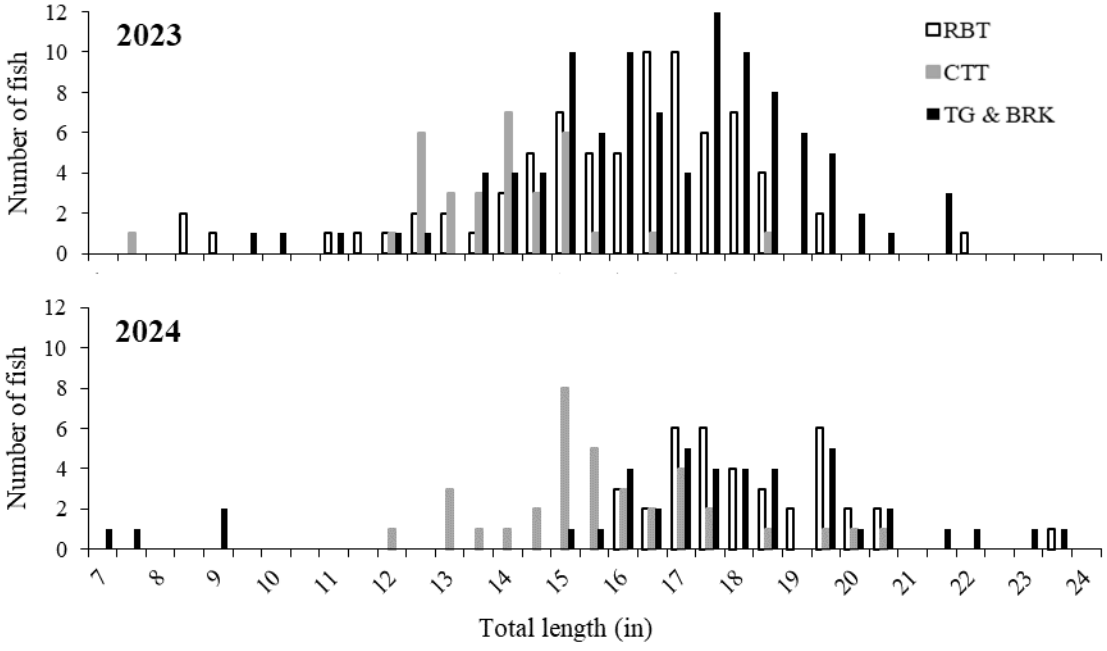

Figure 6. Length frequency distributions of CTT, RBT, TG, and BRK from 2023 and 2024 gill net surveys at Kolob Reservoir.

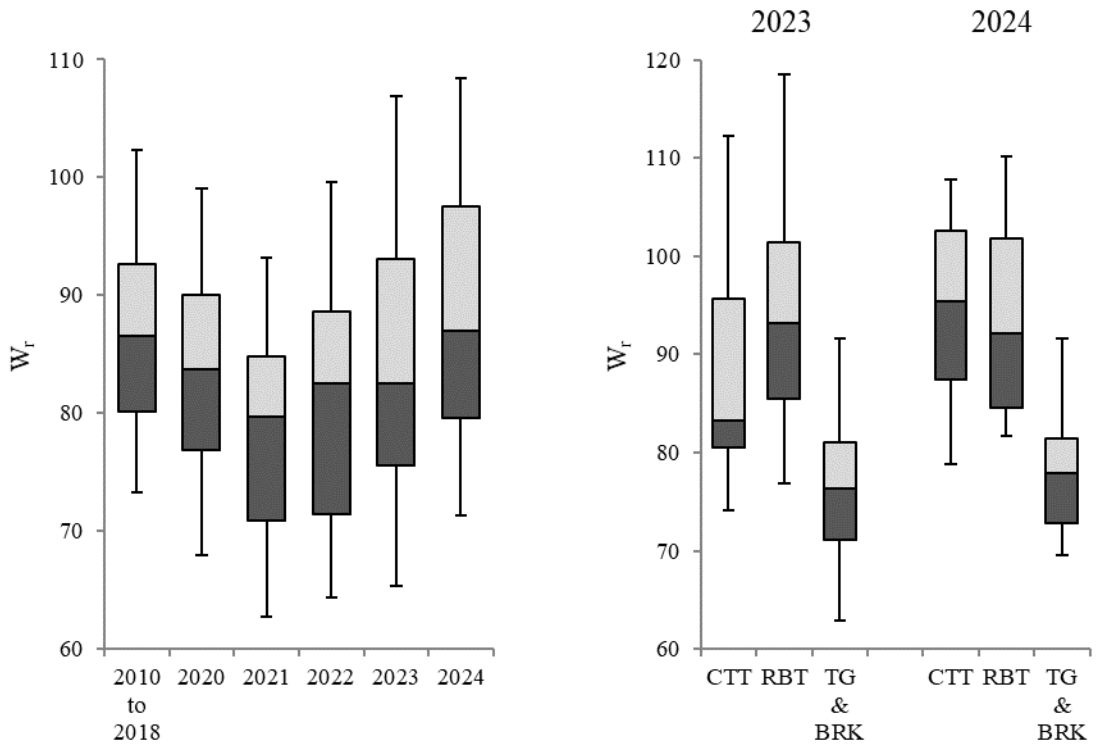

Figure 7. Box plots showing the 5th percentile, 1st quartile, median, 3rd quartile, and 95th percentile for W_r across all species in 2010 to 2018, 2020, 2021, 2022, 2023, and 2024 and by species in 2023 and 2024.