Seasonal Movements and Angler Exploitation of an Adfluvial Walleye Population in The Missouri River, Montana

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Abstract

An unauthorized introduction of walleye in Canyon Ferry Reservoir (CFR) challenges fisheries managers as the population pioneers new habitat upstream in the Missouri River. Montana Fish, Wildlife & Parks (MFWP) confirmed walleye in the river upstream of CFR in 2007. Angler tag returns suggested walleye were abundant in the river. It was unknown if these were adfluvial walleye originating in CFR, or a discrete fluvial population. Understanding seasonal movements and ecology of walleye in the river will allow managers to effectively monitor and manage these fish. The objectives of this study were to monitor radio and anchor-tagged walleye movements to quantify movements and determine if two distinct populations exist, establish spatial and temporal densities within the river, and calculate exploitation rates of walleye by anglers in the river. Overall, most radio-tagged walleye relocated in the river, 88 percent river and 100 percent CFR implanted fish, exhibited seasonal adfluvial movements suggesting, similar to other studies, that two distinct walleye populations are not present. Adfluvial walleye were concentrated in the lower 6.4 km of the river during the annual ascending hydrograph, maintained maximum upstream extent throughout the summer, and out-migrated into CFR by late fall. Radio-tagged walleye only used the river between 17 March and 27 November. We estimated walleye exploitation rates were 21 percent for CFR-tagged walleye and 13 percent for river-tagged walleye. Exploitation rates for anchor-tagged walleye in this study reflect CFR exploitation rates (18% from 2010-2014) just prior to this study. These results suggest that adfluvial Missouri River walleye are seasonally abundant and exploited at similar rates as lacustrine CFR walleye, but no changes to current river walleye management strategies are recommended. In addition, routine walleye population monitoring surveys and a creel survey are warranted as the adfluvial CFR walleye population continues to adapt, expand, and establish.

Key Words: walleye, adfluvial, Missouri River, exploitation, radio telemetry, radio tag, anchor tag, reservoir fisheries Montana

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Introduction

In 1989, a novel population of walleye (*Sander vitreus*) was discovered in Canyon Ferry Reservoir (CFR) in central Montana (MFWP 1991). Based on back-calculated length at age, walleye were likely introduced into CFR in the early 1980's (Yerk 2000). Given abundant spawning habitat (McMahon 1992), this population was expected to prosper. Concern over this new population, and its effects on one of the most popular recreational fisheries in Montana (Colby and Hunter 1989) prompted an investigation of the basic biology of the species in the upper Missouri River system to understand the potential trophic level and community changes that could occur as the fish community approached an equilibrium. In addition, an upstream range extension into the Missouri River was possible since reservoir walleye populations routinely migrate to tributary river spawning locations, typically in early spring (Forney 1963, Scott and Crossman 1973, Olsen et. al 1978), and a sizeable proportion may persist in deep pools throughout the river during the summer and out-migrate to the reservoir each fall (McMillan 1984).

Indeed, in 2003, Montana Fish, Wildlife & Parks (MFWP) confirmed the use of the Missouri River by walleye, when an angler harvested a 381 mm walleye in the river 3.9 km upstream from CFR. In 2007 MFWP captured a walleye in the lower 3.9 river km (rkm) during a semi-annual spring survey. Anglers reported catching 32 additional walleye, anchor-tagged in CFR, from 2004 through 2015 within the river, but no additional walleye were sampled in the river by MFWP biologists during that period (MFWP, *unpublished data*).

Canyon Ferry Reservoir is one the most popular recreational fisheries in Montana. Historically nearly 100,000 anglers annually targeted yellow perch (*Perca flavescens*) and rainbow trout (*Oncorhynchus mykiss*). However, with the introduction of walleye, the management goal shifted in 2000 to include walleye as part of quality multi-species fishery (MFWP 2010). The management goals for the river section between Toston and CFR have been to manage the walleye population to minimize predation impacts on existing rainbow trout, brown trout (*Salmo trutta*), and forage species and to provide a low-level sport fishery (MFWP 2010). Angler caught Walleye tag returns steadily increased from the river section from 2007-2015 and raised questions about whether walleye density was increasing in the river or if greater catch was a function of more anglers using the river. Furthermore, increasing walleye use of the river has implications for the management and monitoring of CFR.

The objectives of this study were to: 1) describe walleye movements between CFR and Missouri River, 2) determine if two distinct walleye populations existed in the area (i.e., fluvial or adfluvial river walleye), 3) determine the seasonal density of walleye in the Missouri River, and 4) determine angler exploitation rates of walleye in the Missouri River. Results from this study could be used to evaluate management strategies for the Missouri River to achieve management goals for CFR (MFWP 2010).

Study area

Canyon Ferry is a 35,000-surface acre reservoir on the mainstem Missouri River, in central Montana. Canyon Ferry Dam construction was completed in 1954 and the reservoir is operated by the US Bureau of Reclamation (BOR) as a flood storage facility (Pick-Sloan Flood Control Act 1944). In order of intended purpose, CFR is managed by the BOR for flood control, hydroelectric power generation, irrigation, and recreation. Reservoir elevations are typically held stable through 1 March where the target elevation is 1154.3 (m) to ensure there is storage space suitable to buffer spring runoff. The recreation pool elevation is 1157.3 (m) and the target date is 1 July. The average annual reservoir elevation fluctuation from 2000-2015 was 4.6 m (range 3.4-6.4 m).

Yellow perch abundance in CFR is primarily limited by walleye predation in conjunction with limited spawning habitat (i.e., aquatic vegetation) due to seasonal fluctuations in reservoir elevation from reservoir operations (MFWP 2010). Yellow perch in CFR are currently protected by the most conservative species specific harvest regulation in Montana (10 daily and in possession) (MFWP 2010). Rainbow trout are managed by stocking hatchery raised fish, and size at stocking has increased (i.e., CFR was historically planted with fingerlings) to catchable sized fish (greater than 203 mm) over the years to maximize survival from walleye predation. Canyon Ferry Reservoir is one of the top three most fished waters in Montana and creel surveys found that anglers increasingly preferred pursuing walleye (Table 1).

The Missouri River section of the study area was 37.3 rkm from the inlet of CFR upstream to Toston Dam (Fig. 1). Water flow in the upper Missouri River basin are controlled primarily by Hebgen Dam on the Madison River and two minor storage reservoirs on the Jefferson (Clark Canyon Reservoir) and Ruby (Ruby Reservoir) rivers. Mean annual discharge at the U.S. Geological Survey (USGS) Toston gage,

Table 1. Biennial statewide pressure survey rankings (Rank) by study area section and percentages of CFR creel surveyed anglers targeting Walleye (%), 1991-2015.

Year / Study Area Section	1991		1993		1995		1997		1999		2001		2003	
	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%
Canyon Ferry Res.	6	--	1	--	1	--	2	3.6	1	16.8	3	33	3	41.1
Missouri River	61	n/a	105	n/a	102	n/a	147	n/a	133	n/a	81	n/a	79	n/a
Year	**2005**		**2007**		**2009**		**2011**		**2013**		**2015**		**Mean**	
	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%
Canyon Ferry Res.	3	(68)	3	(49)	1	(34)	3	24	5	59.8	5	32	3	40
Missouri River	158	n/a	96	n/a	92	n/a	106	n/a	119	n/a	69	n/a	104	n/a

just downstream from Toston Dam, from 1989-2015 was 127 m^3/s and the mean annual water temp was 9°C. The river has been managed by MFWP exclusively as a wild trout fishery (i.e., reproduction is natural except periodic brown trout plants through 1998). Walleye were included as a management priority in the river in 2010 and identified as a "low-level" angling opportunity (MFWP 2010). This section of the Missouri River historically has 10 times less annual angling pressure as CFR and ranks, on average, as the 104th fishery in the Montana since 1991 (Table 1).

Methods and materials

To evaluate fish behavior, location, and movement from the reservoir and river we used both active and passive methods. We used radio telemetry to track movements of fish year-round, but sample size was limited by funding. To increase the sample size, and to be able to compare angler return rates for exploitation, we tagged additional walleye to confirm radio telemetry results during this study. We adjusted for tag loss by utilizing tag loss rates established during a 2007-08 CFR walleye tagging evaluation (MFWP, *unpublished data*). We compared tag reporting rates established during anchor tagging efforts on CFR from 2010-2015 (MFWP 2016).

In the reservoir, we captured fish at the same locations in April and May in 2015 and April in 2016 using non-baited "Merwin" floating traps with shore leads similar to those described by Hamilton et. al (1970). Each trap net measured 2.5 m tall, 2.5 m wide, and 2.5 m long "spiller" and "pot" capture chambers with 3 m tall leads varying in length from 14 m to 38 m (adjusted throughout annual surveys for reservoir elevation changes) and all netting panels were 25 mm mesh

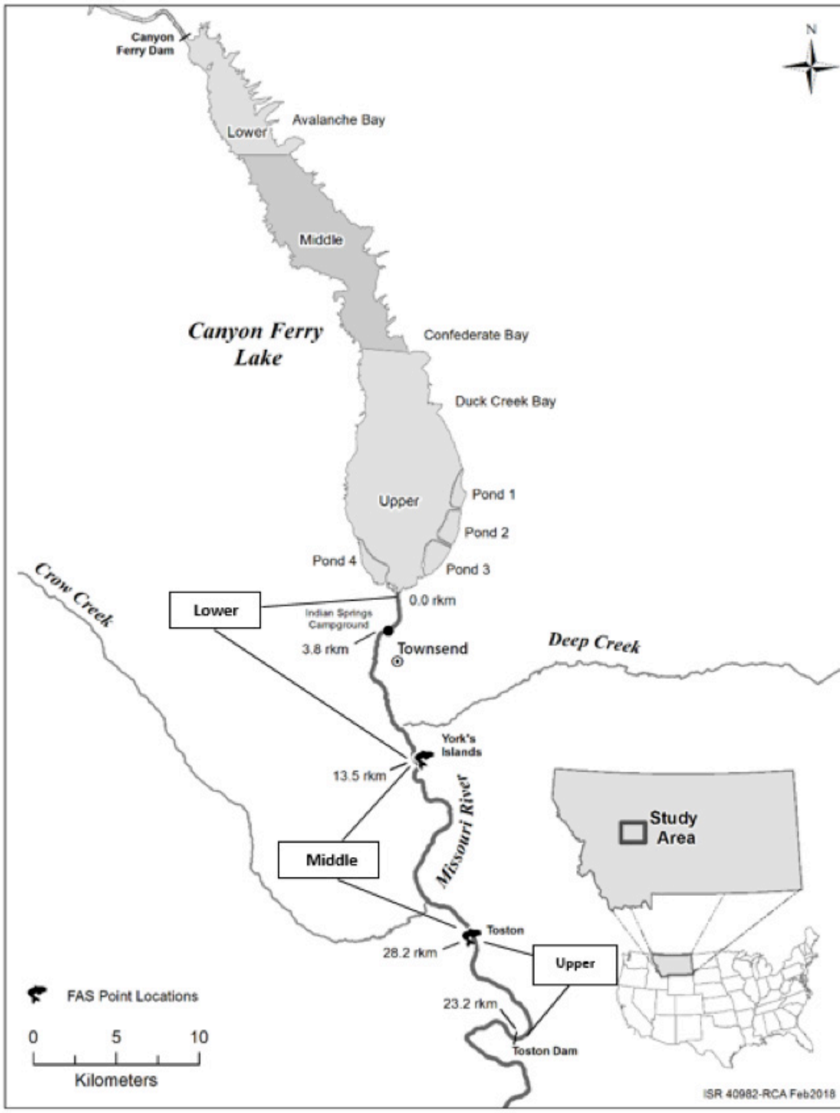

Figure 1. Study area map of the Upper Missouri River from Canyon Ferry Reservoir to Toston Dam.

(bar measure). We set traps on the south end of CFR near the Silos recreation area (west) and the Dust Abatement Pond #1(east; Fig. 1). We fished Merwin traps 24 hrs/day, for 116 days at both trapping locations during both years. Trapping effort between the two CFR sites was 41 percent on the east and 58 percent on the west, with differential sampling between the two caused by high wind fouling trap sets on the east shore, a common occurrence during spring sampling.

Walleye were captured in the Missouri river upstream of CFR from late March to early June in 2015, 2016 and 2017 (Table 2) by electrofishing the river margins using a 6 m aluminum jet boat mounted electrofishing system with two boom mounted anodes. AC power from a 5,000-watt generator was routed through a *Coffelt VVP*-15 rectifying unit to produce approximately 200 V and 7.25 Amps of smooth DC.

Once captured, all Fish were weighed to the nearest gram (g), measured for total length (mm), and inspected for sex using

Table 2. Shocking effort (minutes shocked (min)) and total number of captured walleye, rainbow trout, brown trout, mountain whitefish (*Prosopium williamsoni*), common carp (*Cyprinus carpio*), and burbot (*Lota lota*) in the Missouri River, by river reach (rkm), during spring-time surveys.

			No. of Fish Captured						
Date	Shocking Time (min)	River Reach (rkm)	Walleye[1]	Rainbow Trout	Brown Trout	Suckers[2]	Mountain Whitefish	Common Carp	Burbot
3/20/15	136	13.5-0.08	--	99	31	215	55	--	--
3/27/15	121	37.0-17.9	--	99	28	295	135	--	--
4/6/15	21	4.0-0.8	--	12	6	25	5	--	--
4/14/15	97	35.4-24.8	--	35	15	50	75	9	--
4/20/15	109	24.1-16.3	--	60	16	35	49	35	--
4/27/15	66	4.0-0.8	11	46	7	46	5	43	2
4/30/15	153	13.5-0.8	11	44	21	213	42	183	--
5/1/15	101	17.7-13.2	5	81	16	165	98	28	--
5/4/15	58	37.0-28.2	5	31	25	115	32	23	--
5/7/15	114	6.4-1.5	31	30	26	222	10	99	--
5/20/15	69	13.5-6.4	10	21	22	150	40	59	--
5/29/15	29	13.8-10.5	5	8	8	100	25	50	--
4/6/16	46	3.9-0.8	10	29	3	28	5	30	--
4/19/16	42	3.9-0.8	26	10	2	40	--	50	--
4/26/16	136	13.5-0.8	27	42	8	147	18	92	--
5/3/16	60	3.9-0.8	20	52	7	115	8	150	3
5/17/16	47	3.9-0.8	18	29	3	62	--	53	3
5/25/16	114	13.5-0.8	16	18	34	190	25	105	--
6/2/16	81	6.4-0.8	90	13	10	124	5	171	4
4/11/17	61	4.2-0.8	39	39	3	60	6	32	--
4/20/17	68	13.5-6.4	7	35	5	83	25	38	--
4/24/17	64	6.4-0.8	67	16	13	50	1	69	--
4/25/17	32	37.0-34.4	--	19	1	133	8	--	--
5/1/17	73	6.4-0.8	40	11	1	100	2	64	--
5/8/17	74	6.4-0.8	42	31	5	184	1	147	1
5/15/17	35	3.9-1.5	7	10	7	50	1	22	--
6/5/17	51	3.4-1.8	10	2	14	65	--	82	--
Total	2058		497	922	337	3062	676	1634	13

[1]Includes recaptured Walleye
[2]Combined count for White Suckers and Longnose suckers

methods described by Beard et. al (1997). We tagged all walleye with Floy brand FD-94 T-bar anchor tags on the left front spinous dorsal fin (Grisak et. al 2012). A subset of walleye greater than 406 mm were surgically implanted with Lotek model SR-11-25 and MCFT-3FM transmitters (in 2015) or MCFT-3FM transmitters (in 2016) using the external antennae method (Bunt and Cooke 2001). These transmitters had 876 and 584-day life expectancies respectively.

We actively relocated fish by using truck, boat, and airplane and maintained a stationary data logging receiver located near the mouth of the river (reservoir/river interface) to determine movement to and from CFR (Fig. 1). A Lotek model SRX_800 BCV4.1 receiver was used for mobile tracking. We actively searched for radio-tagged walleye, throughout the entire river section and CFR, primarily focused on the shallow (depths < 10 m) upper sub-section and shallow shoreline habitat throughout the middle and lower reservoir sub-sections, approximately weekly from Spring to Fall (truck or boat) and monthly (truck or airplane) during the winter. A Lotek model SRX_400 W32CT receiver was used as the stationary data logging receiver annually from Spring to early Winter. We removed the stationary receiver in the winter to avoid significant annual river ice jams.

We divided the reservoir into three historically standardized fisheries survey sections (lower, middle, and upper) (MFWP 2016) and locations of radio-tagged and angler reported or MFWP surveyed anchor-tagged fish were recorded according to these sections (Fig.1).

We classified the river in three sub-sections (lower, middle and upper), based on boat launch access, that measured 13.5 km, 14.6 km, and 9.2 km, respectively (Fig. 1) and a total of 2,015 minutes of shock time was expended. Sample time by section was 72 percent lower, 16 percent middle, 10 percent upper. Differential sampling by section was caused by fish density as we determined that walleye densities were concentrated downstream of rkm 6.4 during annual sampling timeframes (Table 2). We recorded locations of telemetered fish to the nearest 0.2 rkm and angler reported or MFWP captured anchor-tagged fish were recorded to the nearest 0.2 rkm, landmark or river sub-section (Fig. 1). We monitored mean daily river discharge using the USGS gaging station on the Missouri River at Toston, MT (USGS gage 06054500) during this study.

We hypothesized that fish in the reservoir and river would be discrete localized populations. Radio-tagged fish movement data was analyzed using Chi square goodness of fit tests. We used two sample ANOVA to determine if walleye movements into the river were significantly different between tag type, section implanted, and sex. We used anchor-tagged walleye to verify seasonal radio telemetry movements and evaluate whether exploitation rates from angler captured anchor-tagged fish were similar to rates established in CFR just prior to this study. We related tagged walleye river movements and river discharge, using a correlation coefficient, to determine how annual discharge influenced walleye movement. The significance level for all tests was $\alpha=0.05$.

Results

Fish Movement

Reservoir tagged walleye – In CFR we implanted radio transmitters in six male and three female walleye. Lengths averaged 466 mm (range 409-533 mm) and weights averaged 945 g (range 544-1588 g). We anchor-tagged 175 walleye. Walleye lengths averaged 356 mm (range 254-818 mm) and weights averaged 457 g (range 95-5987 g) and included 95 males, 16 females and 64 unidentified.

All reservoir implanted walleye were relocated in 2015 and 2016, 30 percent were relocated in 2017, and each fish was relocated an average of six times (range 2-11). Relocations in the river occurred in 2015 from April 16 to November 19, in 2016 from March 17 to November 27, and in 2017 from May 22 to July 11. Overall, 39 percent (*n*=20) of reservoir radio-tagged walleye observations were made in the river section, exclusively within the lower river section (range 1.1-12.6 km), and 61 percent (*n*=31) were within the reservoir. One female was relocated at rkm 12.6 and one male was relocated at rkm 3.9, which represented the upstream extent of CFR tagged walleye by sex. Ninety percent of walleye relocation were in the upper reservoir (*n*=28), with 10% of relocations within the middle reservoir (*n*=3), and no relocations in the lower reservoir.

Anchor-tagged walleye in 2015 were reported by anglers within the river between 28 April and 14 September and the reservoir between July 10 and 15. In 2016, anchor-tagged walleye were only reported by anglers within the reservoir from 9 April to 26 September. Anchor-tagged walleye in 2017 were reported by anglers within the river on 24 April and in the reservoir between 29 March and 17 June.

River tagged walleye – In the Missouri river upstream from CFR, we implanted radio transmitters in 8 male and 10 female walleye with an average length of 513 mm (range 419-724 mm) and an average weight of 1389 g (range 526-3856 g). We anchor-tagged 457 walleye including 266 males, 46 females and 109 unidentified sex. Missouri River anchor-tagged walleye lengths averaged 399 mm (range 178-724 mm) and weights averaged 629 g (range 45-3856 g).

Ninety-two percent of fish radio-tagged in the river were relocated in 2015, 88 percent in 2016, and 42 percent in 2017. Mean relocations per fish was 12 (range 3-37). Radio-tagged walleye were relocated in the river in 2015 from 27 April to 24 October, in 2016 from 6 April to 5 October, and in 2017 from 11 April to 13 August. We relocated walleye throughout the entire river (range 0.0-37.3 rkm). Distribution in the reservoir was likely under represented due to deep water detection limitations throughout middle and lower reservoir sub-sections. We located a single female radio-tagged walleye approximately 24.1 linear km from the river inlet (within the lower reservoir section), and a male was located approximately 16.1 linear km from the inlet (within the middle reservoir section).

In 2015 anglers caught river anchor-tagged fish within the river between 15 July and 12 October and within the reservoir on 24 August in 2015. Walleye anchor-tagged in the river in 2016 were caught by anglers within the river from 3 May to 1 October in 2016 and on 12 July in 2017. In 2016, river anchor-tagged walleye were caught by anglers in the river from 15 May to 19 September in 2016 and 10 May to 20 August in 2017. River anchor-tagged walleye from 2017 were caught by anglers within the river between 1 May and 7 September and the reservoir between 5 May and 25 July.

Population Definition

Radio-tagged walleye movement was not localized to CFR or the river (χ^2=0.62, df=3, *P*= 0.43) as 88 percent of river and 57 percent of CFR implanted fish moved into an adjacent study section and 96% of walleye relocated in the river exhibited seasonal adfluvial movements. Angler caught anchor-tagged walleye were localized to their section (χ^2=30.11, df=3, *P*= <0.01), and relocation sites were similar to the seasonal locations displayed by radio-tagged walleye in the river.

Average upstream movement in the river was significantly different between reservoir and river radio-tagged fish (F=1.68; df=48; *P*=<0.01). Both sexes from each section migrated into the river similarly. No significant difference in upstream river movement was observed between males and females implanted within the same section from either the reservoir (F=1.77; df=13; *P*=0.14) or river (F=1.69; df=32; *P*=0.18).

Mean upstream migrations of radio-tagged walleye from each section into the river were significantly different (F=1.68; df=37; *P*=<0.01). Overall, radio-tagged river walleye moved further upstream (mean 17.1 rkm, SE: 2.1) than radio-tagged reservoir tagged walleye (2.4 rkm, SE: 0.9) within the river. Mean upstream capture locations for anchor-tagged walleye from each section into the river were not significantly different ($F=1.70$; $df=27$; $P=0.13$). Overall, walleye anchor-tagged in the reservoir were captured further upstream (mean 15.4 rkm, SE: 11.0) than walleye anchor-tagged in the river (8.9 rkm, SE: 1.6).

Radio-tagged male walleye were significantly longer than anchor-tagged male walleye and lengths in the reservoir ($F=1.66$; $df=95$; $P=<0.01$) and river ($F=1.65$; $df=287$; $P=0.01$). However, radio-tagged male walleye lengths were not significantly different between the river and reservoir ($F=1.81$; $df=10$; $P=0.17$), but anchor-tagged male walleye lengths were significantly different between the river and reservoir ($F=1.65$; $df=372$; $P=<0.01$) as larger fish were sampled and tagged in the river (average 405 mm, SE: 4.5) than in the reservoir (average 358 mm, SE: 4.5).

Female walleye lengths were not significantly different between tag types in the reservoir ($F=1.73$; $df=17$; $P=0.09$) or river ($F=1.68$; $df=44$; $P=0.28$) Radio-tagged female walleye lengths were not significantly different between sections ($F=1.79$; $df=11$; $P=0.65$) but walleye anchor-tagged in the river were significantly longer (average 556 mm, SE: 13.4) than those tagged in CFR (average 469 mm, SE: 46.8).

Seasonal use by tagged fish

Overall, 96 percent of river walleye captured for this study were found in the lower river sub-section, specifically from rkm 1.1 to 6.4. Despite an overall decrease in sampling effort in the river section between 2015 and 2017 (1,074, 526, and 458 minutes shocked), the number of walleye captured and tagged each year (75, 195, and 197 fish tagged) increased.

For radio-tagged river walleye, 63 percent of relocations came from the lower river sub-section, 15 percent in the middle, 15 percent in the upper and 7 percent in CFR. Overall, 66 percent of river telemetered walleye migrated into the river multiple years, 22 percent one year, and 12 percent were never relocated in the river. Six multi-year migrants returned to within a mean of 0.4 rkm (range 0-1.6 rkm) from their maximum upstream relocation the previous year.

Walleye radio-tagged in CFR were only located in the lower river sub-section. Overall, 29 percent of CFR telemetered walleye migrated into the river multiple years, 29 percent only one year, and 42 percent were never observed in the river. Two multi-year migrants returned to within a mean of 7.5 rkm (range 0-11.5 rkm) maximum upstream location the previous year.

Increasing springtime river discharge and movement into the river were related for river ($R^2= 0.15$) and reservoir ($R^2 = 0.07$) telemetered walleye. River migrants, especially those located within the upper river sub-section, did not reach maximum upstream extent in the river until after peak river discharge occurred in early summer each year. These movements were confirmed by anchor-tagged walleye as none were reported by anglers earlier than 15 July from the upper sub-section despite anecdotal evidence of walleye angling effort throughout the entire river from spring to fall.

Exploitation

Thirty-One walleye anchor-tagged in CFR were caught by anglers or MFWP personnel for an overall reporting rate of 18 percent. Of those, 90 percent were caught or captured in CFR and 10 percent were in the river. Fifty-Three walleye anchor-tagged in the river were caught and reported by anglers or MFWP personnel for an overall reporting rate of 12 percent. Of those, 28 percent were caught or captured in CFR and 72 percent in the river. Estimated exploitation, corrected for tag loss, was 21 percent (range 19.9-21.5%) for CFR and 13 percent (range 7-20%) for river anchor-tagged Walleye.

Discussion

Walleye tagged and relocated in the Missouri River upstream from CFR were observed throughout all sub-sections in the river, and all relocated telemetered fish out-migrated to CFR. Walleye found in the river that were initially radio-tagged in CFR migrated only into the lower sub-section of the river and then out-migrated. No radio-tagged fish (regardless of capture location) over wintered in the river. No anchor-tagged fish were caught or captured in the river outside the timeframe observed by radio-tagged fish. Thus, this study suggests that two distinct resident populations are not present, but that a proportion of CFR walleye exhibit adfluvial movement.

We strived to capture and tag fish uniformly across all sections, however, this does not reflect seasonal walleye distribution throughout the river. Our results suggest that walleye, during the spring (April to early June), were primarily in the lower sub-section of the river, reach maximum upstream extent throughout the summer, and out-migrate to CFR in the fall. Also, multi-year radio-tagged river migrants showed signs of site fidelity. These movements could be related to deep pool riverine (McMillian 1984, Hanson 2006) habitat availability throughout the summer, although this remains mostly unknown.

Although walleye with radio tags were slightly longer than anchor-tagged fish, there was no difference in how far they moved upstream, and seasonal adfluvial behavior was observed by fish from both tag types. Size differences, albeit slight, between lacustrine and adfluvial sampled CFR walleye suggest that seasonal river inhabitants may grow larger than lacustrine CFR walleye. This could be explained by sampling selectivity or capture method, but we hypothesize that adfluvial walleye may be slightly larger in the river compared to CFR due, potentially, to differences seasonal thermal conditions (i.e., max water temperature near 26°C in 2015; USGS gage 06054500), forage availability (i.e., relatively large quantities of yellow perch, white suckers (*Catostomus commersonii*), and longnose dace (*Rhinichthys cataractae*) may be available in the river compared to reservoir; Traxler 2017) or other unknown variables.

Average estimated CFR anchor tag exploitation reported by other studies in this area was 18 percent (range 17-20 percent; MFWP *unpublished data*). The overall anchor tag reporting rate from this study (13 percent) was similar to the average reporting rate of 11.8 percent (range 8-14; MFWP 2016) percent during CFR anchor tag studies from 2011-2016. One major study, which compared nearly 50 walleye populations across North America (Baccante and Colby 1996) found that most exploitation rates varied from 3-30 percent. Data from this study suggest that exploitation is currently similar between reservoir and river caught walleye. Overall, anchor tagged fish exploitation in this study was likely underrepresented as only fish tagged in 2015 were at-large for 3 years. Moreover, river tagged fish exploitation was 38 percent less than reservoir tagged fish and could be explained by river walleye migration timing with a combination of lower reservoir angling effort in early spring/late fall, specifically for walleye, and overall angling pressure differences (approximately 10-times more reservoir pressure on average) between sections over time.

Anchor tag returns may have been biased by angler timing. Based on MFWP creel data from 2015-2017 (MFWP 2016, MFWP 2017, MFWP *unpublished data*), few anglers sought walleye in April (averaged 24 per year or 1.4% of annual anglers surveyed) and October (averaged 18 anglers or 1.2% of annual anglers surveyed). Even fewer anglers historically sought walleye during the winter fishing months (MFWP 2010). Therefore, it is not surprising that no anchor-tagged fish, especially river captured walleye, were reported by anglers within the reservoir from late fall to early spring each year.

Though not the intent of this study, we found that electrofishing was more efficient than Merwin traps for capturing walleye in this study. Walleye CPUE for electrofishing the river section averaged 0.23 fish per minute (SE 0.18) and trap nets in the reservoir averaged <0.01 fish per minute (SE 0.0). An active capture method, like electrofishing, may be a more efficient survey tool for future walleye surveys in the reservoir.

Lastly, though not the intent of this study, female walleye were observed in the river during electrofishing and one appeared reproductively ready and was expressing eggs. Other studies in Montana have shown walleye, or sauger (*Sander canadensis*), from the same genus, spawn in rivers (Jaeger et. al 2005, Bellgraph 2006, Grisak et al. 2012) and the timing of movements of walleye from CFR into the Missouri River are similar to other studies (Paragamian 1989, DePhilip et. al 2005, Hanson 2006). In a separate 2017 survey we confirmed young-of-the year walleye in the river during beach seine surveys, indicating that natural reproduction may be occurring. Downstream early life history drift of age-0 walleye has been documented for river spawning walleye populations (Corbett and Powles 1986, Mitro and Parrish 1997) and could explain our survey results. Results from this study, in conjunction with results from other walleye surveys in the study area, have helped develop a better understanding of walleye life history in the upper Missouri River drainage from Canyon Ferry Dam to Toston Dam.

Conclusion and Management Implications

The timing and movements of walleye into the Missouri River upstream of Canyon Ferry Reservoir were poorly understood prior to this study. Future walleye management strategy assessments within the study area should consider seasonal adfluvial walleye movement throughout the study area and we recommend that walleye be designated as seasonally abundant and well-distributed throughout the river. Based on tag returns and radio telemetry relocations, walleye in this study were observed throughout all river sub-sections from spring to fall. Size differences between CFR and river tagged walleye were observed and necessitate a better understanding of basic walleye biology differences such as growth, diet, spawning success between the river and reservoir. In order to fully monitor and manage the CFR walleye population, we recommend a standardized walleye electrofishing survey within the river section.

Angling pressure estimates in the river indicate a steady increase in angling pressure over time since 1991 with a high of 10,635 angler days in 2015 (MFWP 2017). Anecdotal evidence indicates that river section anglers, specifically boat anglers, are pursuing walleye at an increasing rate in recent years. Angling pressure estimates in the reservoir also indicate a steady increase in angling pressure over the same period and a record high of over 133,220 angler days in 2009. Anglers pursuing walleye in the reservoir, based on summer creel evaluations from 1996-2016, increased from zero percent in 1996 to 33 percent by 2001 and the mean thereafter observed was 45 percent (range 24-77%). Thus, we assume that more anglers are pursuing walleye in the river as the population expands into the river. Angling dynamics in this unique sport fishery have likely changed, since walleye expansion into the river in the mid-2000's, and we recommend a creel survey be considered to better understand angler trends in the river upstream of CFR.

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