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CHARACTERISTICS OF BURBOT AND STONECAT POPULATIONS IN THE MISSOURI RIVER, MONTANA

Final Report

by

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ABSTRACT

Although burbot *Lota lota* and stonecats *Noturus flavus* are native to Montana, little is known about the distribution, life history or ecology of either species. The objectives of this study were to determine the distribution and population characteristics of burbot and adult stonecats in the Upper Missouri River Basin in Northcentral Montana. Hoop nets and cod traps were fished in the Missouri River during March 2005 and 2006. Slat traps were fished during March 2006. In 2006, hoop nets and slat traps were fished in the Sun River. In total, hoop nets were fished for nearly 300 two-night periods, and cod traps and slat traps were fished for nearly 50 two-night periods. Hoop nets sampled 82%, cod traps sampled 13%, and slat traps sampled 5% of the 303 burbot sampled during the study. Catch rates of hoop nets and cod traps were higher in 2005 than in 2006, and catch rates of all gear types were higher in the upper half of the study area. The size of burbot sampled varied among gear types, and burbot sampled in hoop nets were longer and weighed more than those sampled in either cod traps or slat traps. Slat traps were effective in sampling juvenile burbot. Although most (80%) burbot were recaptured in the general area where they were tagged, some burbot moved more than 32 km. Anglers reported harvesting 11 burbot with tags, resulting in an estimated exploitation of 10 to 15%. Based on these data and anecdotal observations we hypothesize that burbot may be over harvested at highly fished areas and anglers may be having an effect on the population size structure by harvesting the largest burbot in the population. Stonecats were only sampled in the most downstream 18 km section of the Missouri River. No stonecats were sampled in cod traps. Mean hoop net catch rates were 2.8 stonecats per two-night period in 2005, and no stonecats were sampled in 2006 hoop nets. The slat trap catch rate was 0.2 stonecats per two-night period in 2006. Stonecat catch rates were higher in the Sun River. Mean hoop net and slat trap catch rates were 4.8 and 6.5 stonecats per two-night period, respectively. Our results indicate that stonecats are presently limited to the lower 18 km section of the Missouri River. We hypothesize that burbot and stonecat distributions have changed due to the cumulative effect of upstream reservoirs (Canyon Ferry, Hauser, and Holter) on downstream water temperature regimes.

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INTRODUCTION

Burbot *Lota lota*, the only freshwater cod species, has a circumpolar distribution in northern latitudes (McPhail and Paragamian 2000). In Montana, burbot are native to the three major river drainages (Columbia, Missouri, and Saskatchewan; Brown 1971). In response to a petition to list burbot in the Kootenai River as an endangered species Montana Fish, Wildlife & Parks (FWP) initiated a status assessment of Montana burbot populations (see Jones-Wuellner and Guy 2004). Jones-Wuellner and Guy (2004) concluded that insufficient data existed to evaluate the status of burbot in many of Montana's waters. In addition, the authors recommended implementation of studies (using standard burbot sampling gear) to better understand the status of burbot populations in Montana.

In the Upper Missouri River drainage, burbot have been sampled with boat-mounted electrofishing systems since the early 1980s (FWP unpublished data); however, during these sampling events burbot were incidentally sampled (trout were being targeted), sample sizes of burbot were typically low and the relationship between electrofishing catch per unit effort and population abundance is unknown. A paucity of information exists regarding life history, distribution, and movement of Missouri River burbot. In 2005, this study was initiated to provide a better understanding of burbot populations in the Upper Missouri River, between Holter Dam and Great Falls, Montana. Initially, study objectives included determining the distribution, population and life history characteristics, and angler exploitation of burbot in this 142-km reach of the Missouri River; however, study objectives were broadened after stonecats *Noturus flavus* were captured in hoop nets, during 2005.

The native distribution of stonecats—a small yellowish-brown catfish—in North America extends from southern Canada to the Prairie Region on the Midwestern United States, and from the Rocky Mountains to the Hudson, Allegheny, and Mohawk basins in New York (Scott and Crossman 1973; Pflieger 1997). The Upper Missouri River in Montana represents the western edge of the stonecats distribution. In 1892, stonecats were documented in the Missouri River near Craig, Montana (Brown 1971). General distribution data exist for stonecats throughout the Missouri River Basin, but these records are generally the result of incidental samples (FWP unpublished data). Other than general distribution throughout the Missouri River Basin, little is known about specific populations (density, life history, size structure, etc.) of stonecats in Montana. In 2005, adult stonecats were sampled in the most downstream section of the 142-km long study area. Therefore, the study objectives were expanded to determine stonecat distributions and population characteristics within the study area.

STUDY AREA

The study area was located in the Upper Missouri River Basin in Northcentral Montana. Sampling was conducted on a 142-km reach of the Missouri River beginning at Holter Dam near Helena, Montana and proceeding downstream to Black Eagle Dam in Great Falls, Montana (Figure 1). Sampling was also conducted on the lowermost 10.5 km of the Sun River—a major tributary to the Upper Missouri River that enters the Missouri River from the west near Great Falls, Montana. Three reservoirs (Canyon Ferry, Hauser and Holter) impound the Missouri River immediately upstream from the study area. A variety of habitat changes occur along the 142-km reach. The influence of the upstream dams on discharge and water temperature regimes diminishes progressively downstream. Geological features laterally control much of the upper river channel, and stream gradient is highest in the upper river. As the river leaves the mountains it transitions to a highly sinuous channel with fine substrates, higher turbidity, and deeper water.

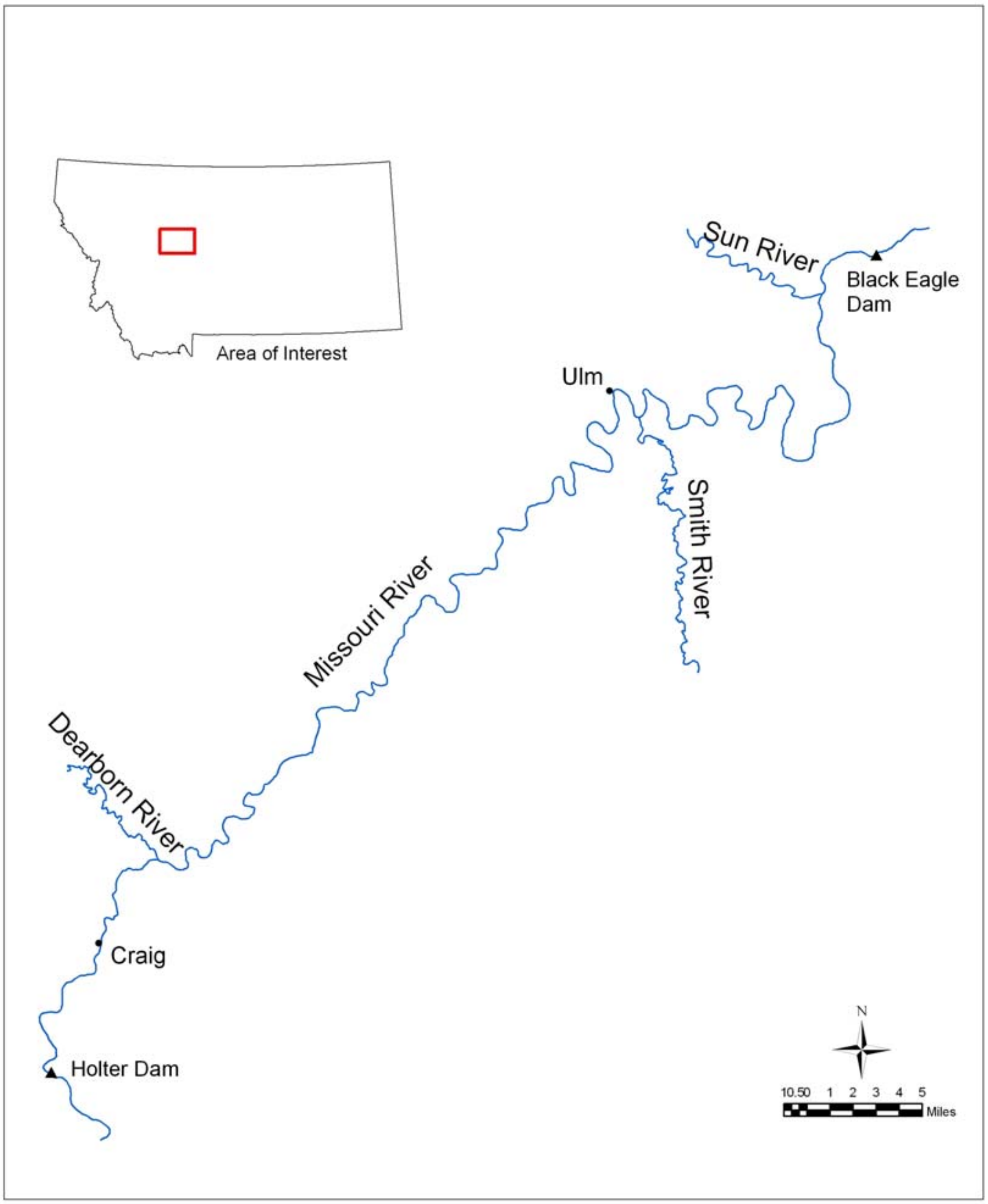

Figure 1. Map delineating the study area on the Missouri and Smith rivers in north central Montana.

METHODS

Three gear types (hoop nets, cod traps, and slat traps) were fished throughout the study area; all gear types were baited using longnose suckers *Catostomus catostomus* and white suckers *C. commersoni*. Hoop nets measured 3.05-m long, maximum hoop diameter was 61 cm, and mesh size was 2.5 cm (bar measure; Paragamian 2000). Cod trap frames were constructed from 1.3 cm rebar (Spence 2000). The bottom hoop diameter was 1.0-m, the top hoop diameter was 69 cm, and the trap height was 64 cm tall. Nylon mesh (1.3 cm bar measure) covered the structure, and a 25 cm wide oval-shaped throat entered the trap from the side. Wooden slat traps measured 61 cm long, 30 cm wide, and 30 cm tall. The slat trap opening was constructed from a sheet of plastic mesh (6 mm bar measure) that was formed into a funnel. The throat of the funnel measured 5.7 cm. The maximum distance between wooden slats was 1.6 cm.

The 142 km Missouri River study area was divided into eight 18 km sections. All sampling occurred during March, and the section sampling order was randomly determined each year. Hoop nets were systematically fished on both sides of the river at approximately 2 km intervals (total of 18 sets in each section). The systematical procedure was to fish six hoop nets along the right bank in the upper two-thirds of the section during the first two-night period. Then, six hoop nets were fished along the left bank in the upper two-thirds of the section during the second two-night period. During the final two-night period, six hoop nets were simultaneously fished along both banks (3 on each bank) in the lower third of the section. Since hoop nets were systematically placed in discrete locations throughout each section, specific habitats were not targeted. Instead, nets were set to avoid extremes for depth and velocity. As a general rule, hoop nets were set in 1-3 m of water with low to moderate velocities. One cod trap was fished for three two-night periods in each section on the Missouri River. Cod traps were fished in backwater and eddy areas; therefore, cod trap placement was not systematic, it was dictated by habitat availability. In 2006, two slat traps were fished for three two-night periods in each section. During each two-night period slat traps were fished in the same area (i.e., upper third, middle third, and lower third of the section on the first, second, and third two-night period, respectively) on opposite sides of the river. Spacing between successive slat trap sets averaged approximately 5.9 km. The 10.5 km reach of the Sun River was only sampled with hoop nets and slat traps during March 2006. Net spacing was similar to the Missouri River, but due to the narrower river width only one net was fished at each location. Length and weight was recorded on all sampled fish. In 2005, all burbot sampled during netting operations were tagged with Floy ™ tags to obtain an estimate of angler exploitation. Burbot were also Floy ™ tagged by FWP employees during standard electrofishing surveys conducted in the Craig (river km 4 through 12.9) and the Pelican Point (river km 38.4 through 45.5) long-term trout monitoring sections during the fall of 2004 and the spring and fall of 2005. Overall, 136 burbot sampled by electrofishing operations were tagged in these two areas. Passive Integrated Transponder (PIT ™) tags were implanted into the left cheek of sampled burbot to identify Floy ™ tag loss and to facilitate long-term individual identification of burbot.

Exploitation estimates require information on tag loss, angler reporting rate, and tagging mortality rates (Miranda et al. 2002). In this study, estimates of tag loss will be obtained through subsequent recaptures of burbot, but estimates of tagging mortality (e.g., fish that die from the tagging process) and angler tag-reporting rate were derived from the primary literature. Tagging mortality rates using Floy ™ tags varied from 11% for crappies *Pomoxis spp.* (Miranda et al. 2002) to 32% in rainbow trout *Oncorhynchus mykiss* (Mouring et al. 1994). Miranda et al. (2002) concluded that the greatest source of uncertainty in exploitation estimates is due to angler tag-reporting rates. Many studies have estimated angler tag-reporting rates through a variety of methods (e.g., postcard surveys, surreptitiously implanting tags on harvested fish, and by using reward tags). Using postcards (as a tag surrogate) that offered a ball cap as a reward, Zale and Bain (1994) reported angler-reporting rates varying from 33% to 37% in two different states. Green et al. (1983) estimated angler tag-reporting rates at 29% by surreptitiously implanting tags during creel examinations of harvested fish. Finally, Miranda et al. (2002) estimated the angler tag-reporting rate at 24% with a limited edition ball cap offered as a reward. To calculate an exploitation estimate, we will use a conservative mortality rate of 10%, and we will vary angler tag-reporting rates from 24% to 37%.

RESULTS

During the two-year study period, hoop nets were fished for nearly 300 two-night periods. Cod traps and slat traps were fished for nearly 50 two-night periods. Hoop nets sampled 9 species of fish including: rainbow trout, brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, burbot, stonecats, white suckers, longnose suckers, yellow perch *Perca flavescens*, and black bullheads *Ameiurus melas*. Cod traps sampled 6 species of fish including rainbow trout, brown trout, white suckers, longnose suckers, yellow perch and common carp *Cyprinus carpio*. Finally, slat traps sampled stonecats, burbot, and white suckers. Crawfish *Orconectes spp.* were also sampled in hoop nets and slat traps.

<u>Burbot</u>

During the two-year study period, 303 burbot were sampled by netting. Hoop nets sampled the most burbot (n = 249, 82% of total), followed by cod traps (n = 39, 13% of total), and slat traps (n = 15, 5% of total). Mean overall hoop net catch rates were higher in 2005 than in 2006 (1.09 and 0.65 burbot per two-night period respectively). Similarly, mean cod trap catch rates were higher in 2005 than in 2006 (0.92 and 0.71 burbot per two-night period respectively). The 2006 average catch rate in slat traps was 0.32 burbot per two-night period.

A spatial pattern of catch rates existed where more burbot were sampled in the upper half of the study area in both years and with all gear types (Table 1). For example in 2005, the mean hoop net catch rate of burbot in the upper half of the study area was 1.72 per two-night period, compared to 0.47 in the lower half of the study area. Moreover, a significant (P = 0.001) negative relationship existed between section-wide mean hoop net catch rates (both years combined) and river kilometer at the section midpoint (Figure 2). Although cod trap and slat trap catch rates were higher in upstream sections and lower in downstream sections, the correlation between catch rates and river km was not significant at a p-value of 0.05 (Figure 3 & 4). No burbot were sampled in the Sun River section during 2006.

Table 1. Sampling effort (number of two-night periods; Effort) and mean, standard error (SE), minimum (Min), maximum (Max) burbot catch rates by year, gear type (Gear), and section on the Missouri River in north central Montana.

Year	Gear	Section	Effort	Mean	SE	Min	Max
2005	Cod trap	1	3	2.00	1.15	0	4
		2	2	0.00	0.00	0	0
		3	3	1.67	0.67	1	3
		4	3	3.33	1.86	1	7
		5	3	0.00	0.00	0	0
		6	3	0.00	0.00	0	0
		7	3	0.00	0.00	0	0
		8	3	0.33	0.33	0	1
	Hoop net	1	18	2.94	0.69	0	10
		2	18	1.33	0.49	0	8
		3	17	1.65	0.41	0	5
		4	18	0.94	0.29	0	4
		5	18	0.50	0.17	0	2
		6	18	0.94	0.24	0	3
		7	18	0.28	0.18	0	3
		8	18	0.17	0.09	0	1
2006	Cod trap	1	3	0.00	0.00	0	0
		2	3	2.00	0.58	1	3
		3	3	0.67	0.33	0	1
		4	3	2.33	1.33	1	5
		5	3	0.33	0.33	0	1
		6	3	0.00	0.00	0	0
		7	3	0.33	0.33	0	1
		8	3	0.00	0.00	0	0
	Hoop net	1	18	0.83	0.52	0	9
		2	18	1.56	0.43	0	6
		3	18	0.83	0.29	0	5
		4	18	0.44	0.15	0	2
		5	18	0.44	0.15	0	2
		6	17	0.94	0.50	0	8
		7	18	0.11	0.08	0	1
		8	18	0.06	0.06	0	1

Table 1. (continued)

Year	Gear	Section	Effort	Mean	SE	Min	Max
2006	Slat trap	1	6	0.17	0.17	0	1
		2	6	0.83	0.48	0	3
		3	6	0.33	0.33	0	2
		4	4	0.25	0.25	0	1
		5	6	0.17	0.17	0	1
		6	6	0.83	0.78	0	3
		7	6	0.00	0.00	0	0
		8	6	0.00	0.00	0	0

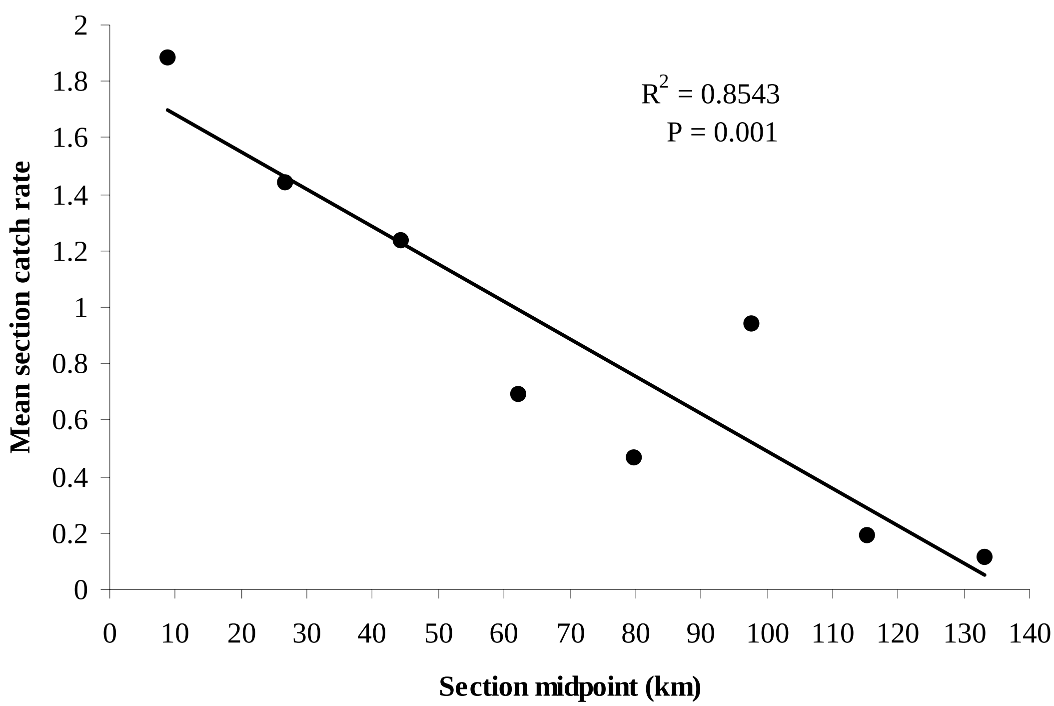

Figure 2. Relationship between burbot hoop net catch rate (mean of section, 2005 and 2006 combined), and section midpoint (river km) on the Missouri River.

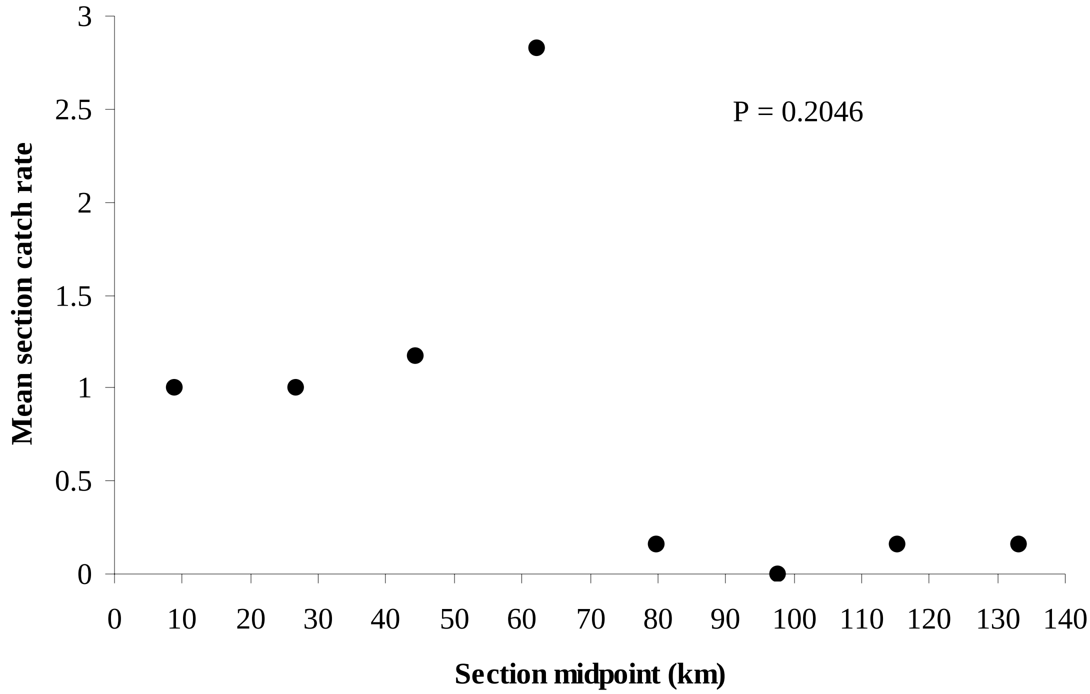

Figure 3. Relationship between burbot cod trap catch rate (mean of section, 2005 and 2006 combined), and section midpoint (river km) on the Missouri.

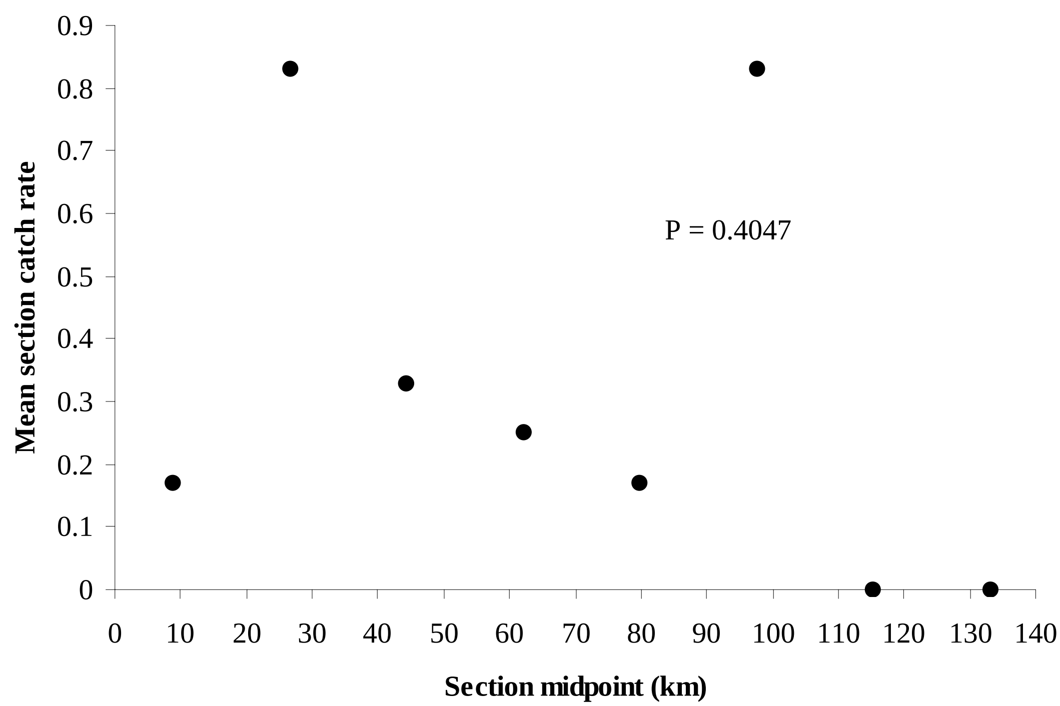

Figure 4. Relationship between burbot slat trap catch rate (mean of section), and section midpoint (river km) on the Missouri River.

The size of burbot sampled varied considerably among gear types (Table 2). For example, burbot sampled in hoop nets were longer on average (overall mean length = 497 mm SE 4.9), than burbot sampled in cod traps (overall mean length = 448 mm SE 18.2) or slat traps (overall mean length 341 mm SE 18.6). Slat traps were effective for sampling juvenile burbot throughout the study area. Over two-thirds of the burbot sampled in slat traps were between 240 and 360 mm. Mean relative weight of burbot sampled in hoop nets was similar to cod traps, but relative weight of burbot sampled in slat traps was lower than either hoop nets or cod traps (Table 2).

Table 2. Number of burbot sampled, mean, standard error (SE), minimum (Min) and maximum (Max) for length, weight and relative weight (Wr) of burbot sampled by gear type (Gear) and year, in the Missouri River, Montana in 2005 and 2006.

			Length				Weight				Wr			
Gear	**Year**	**n**	**Mean**	**SE**	**Min**	**Max**	**Mean**	**SE**	**Min**	**Max**	**Mean**	**SE**	**Min**	**Max**
Cod traps														
	2005	22	439	27.2	147	643	532	82.2	36	1,380	70	1.6	60	86
	2006	15	461	21.3	338	579	551	85.4	150	1,398	70	3.3	52	103
Hoop nets														
	2005	156	503	5.6	300	709	669	23.4	127	1,789	70	0.6	51	87
	2006	94	485	8.8	290	709	628	35.0	114	1,898	70	1.0	46	117
Slat traps														
	2006	15	341	18.6	246	505	213	41.2	59	672	62	2.1	44	73

As on March 2007, twenty-six tagged burbot had been recaptured during sampling or by anglers. These data provide some basic information regarding movement of burbot. Most of the recaptured burbot (80%) were recaptured in the same general area in which they were tagged. Of the burbot exhibiting measurable movement, 33% made upstream movements, and the remaining fish made downstream movements. Three burbot moved more than 32 km (33.3, 41.2, and 47.0 km), and all were in a downstream direction.

Up until February 2007, anglers returned tags from 11 harvested burbot to FWP employees. Ten of these fish had Floy ™ tag, and one fish had a PIT ™ tag. The angler who identified the PIT tagged burbot had been informed about the tagging procedures. Therefore, he knew where to look for the tag. Otherwise, most anglers would likely not discover a PIT tag. Over the entire burbot project, 292 burbot were tagged with Floy ™ tags. Overall, 11 burbot that had been tagged with both a Floy ™ tag and a PIT ™ tag, were recaptured by FWP personel. Of these fish, only two burbot had lost their Floy ™ tags at the time of recapture. The corresponding tag retention rate was 82% for Floy ™ tagged burbot, over a period of approximately 1.5 years. Due to the low number of recaptured burbot and the required reporting period, we were not able to provide estimates of tag retention relative to the time since tagging. Exploitation estimates varied from 10% (using an angler tag-reporting rate of 37%) to 15% (using an angler tag-reporting rate of 24%).

Stonecats

In the Missouri River, stonecats were only sampled in the most downstream 18 km of the study area (herein referred to as the Great Falls section). In addition, stonecats were only sampled in the Missouri River study area with hoop nets during 2005. Overall (Sun and Missouri rivers study areas combined), 93 stonecats were sampled during the study. Seventy-nine stonecats were sampled in hoop nets, 14 in slat traps, and no stonecats were sampled in cod traps. Hoop net catch rates varied from 0 to 33 per two-night period. In 2005, the mean hoop net catch rate was 2.8 stonecats per two-night period, in the Great Falls section. In the Missouri River the mean slat trap catch rate was 0.17 (SE 0.17) stonecats per two-night period, since only one stonecat was sampled in one of 46 sets. In the Sun River, the mean hoop net catch rate was 4.8 (SE 2.9; catch varied from 0 to 19) stonecats per two-night period. The mean slat trap catch rate was 6.5 (SE 2.5; catch varied from 4 to 9) stonecats per two-night period. Size of stonecats sampled (all gears and years combined) was similar between the two rivers. Mean length of all stonecats sampled in the Missouri River was 220 mm (SE 2.4; length varied from 180 to 251 mm) compared to 227 mm (3.5 SE; length varied from 178 to 290) in the Sun River. Size selectivity of stonecats by hoop nets and slat traps was similar.

DISCUSSION

The results of this study provide the first quantitative data relative to burbot distributions in the Missouri River between Holter Dam and Great Falls, Montana. In addition, we presented some comprehensive data on size structure and condition of burbot throughout the study area. We also obtained data on movement of tagged fish and estimated angler exploitation of burbot. Although the data in this report are useful to fish managers, more detailed data are needed to effectively manage this fish population. Further studies should focus on long-term trends in relative abundance and identifying factors influencing these trends. Better data are needed to identify seasonal movement patterns of burbot. Researching burbot movement patterns will help identify habitat requirements throughout the different seasons. In addition, better movement data will help identify time of spawning and spawning areas.

The angler exploitation estimate of burbot in this study was low (10 to 15%), but some anecdotal evidence exists suggesting that angler exploitation may be high locally and may be influencing the size structure of the population. In 2005, 10 burbot were tagged in the Missouri River near Ulm, Montana. Within one month of being tagged, anglers returned two of the tagged burbot. This suggests that in some areas, angler harvest may be higher; however, more detailed angler harvest data are required prior to making any conclusions. Many anglers indicated that they used to catch (10+ years ago) larger burbot in the study area. This anecdotal information identifies the possibility that anglers are having an impact on larger burbot in the population. Better harvest data (e.g., through a detailed creel survey) are required prior to making conclusions.

In 2005, fifty stonecats were sampled in the Missouri River; however, only one stonecat was sampled during the 2006 season. Differences in sampling-period water temperature between years may have reduced the catch in 2006. For example in 2005, mean water temperature was 3.1 ºC (SE 0.04), compared to 2.0 ºC (SE 0.08) in 2006. For comparison, 42 stonecats were sampled in the Sun River where the mean water temperature was 5.9 ºC, in 2006. Based on the historic distribution of stonecats in North America, it is apparent that stonecats prefer warm water temperatures (Trautman 1981; Jenkins and Burkhead 1993). In fact, stonecat spawning occurs when water temperature exceeds 27 ºC in some areas (Scott and Crossman 1973; Walsh and Burr 1985). Given that we deployed passive capture gears, stonecat catch rates in our study would likely have been higher if sampling had been conducted in a warmer season (i.e., stonecats were likely less active in March, that in warmer periods).

We are unaware of literature that describes sampling stonecat populations in large-river systems with passive capture gears. In our study, baited hoop nets and slat traps proved effective for sampling stonecats in the Missouri and Sun rivers. However, the stonecats sampled in this study were large individuals. Total length (TL) of stonecats sampled in our project varied from 178 to 290 mm [overall mean length was 223 mm (SE 2.1)]. These lengths are generally longer than lengths reported in the literature. For example, Brown (1971) reported sizes from 76 to 177 mm, with some specimens reaching 305-mm TL. Other published length ranges rarely reached the length of our smallest stonecats (Trautman 1981; Etnier and Starnes 1993; Jenkins and Burkhead 1993). Sampling stonecats in other parts of their range—where growth rates and population size structure may be different—may require gear with smaller mesh (or gaps) than those used in our study. In this study, the length frequency of stonecats sampled by hoop nets and slat traps were similar, despite the differences in mesh and gap openings.

Although slat traps proved effective for sampling juvenile burbot, sample sizes were low, primarily due to the limited number of sets throughout the project. The mean length of burbot sampled in slat traps was over 150 mm shorter than the mean length of burbot sampled in hoop nets. Spatial patterns of burbot catch rates in slat traps were similar to hoop nets, where more were sampled in the upper river compared to the lower river. A notable deviation from this pattern occurred in the sections of the river with major river tributaries. The Dearborn River joins the Missouri River 21.7 km downstream from Holter Dam, and the Smith River joins the Missouri River 93.5 km downstream from Holter Dam. Catch rates of burbot were higher in the sections associated with these confluences. We hypothesize that the tributaries are burbot spawning and rearing locations.

The effect of large water-storage impoundments on downstream physical habitat and biological communities (i.e., the Serial Discontinuity Concept) has been well developed in the primary literature (Ward and Stanford 1983, Ward and Stanford 1995). Based on the results of this project, we hypothesize that burbot and stonecat distribution have changed since the late 1800s do to the thermal influence of the three large reservoirs (Canyon Ferry, Hauser, and Holter Reservoirs) immediately upstream from our study area. The three reservoirs upstream from our study area have reduced (relative to historic) summer water temperatures downstream from the dams. For example, July and August average daily (2004 and 2005) water temperatures in the Missouri River upstream of Canyon Ferry Reservoir were 2.8 ºC and 3.7 ºC warmer than downstream from Holter Dam in 2004 and 2005, respectively (United State Geological Survey (USGS) 06054500 station and USGS 06066500 station, unpublished data). Furthermore in the river upstream from Canyon Ferry Reservoir, maximum daily water temperature was 5.0 ºC and 5.5 ºC higher than the maximum daily water temperatures downstream of Holter Dam during 2004 and 2005, respectively. Scott and Crossman (1973) indicate that stonecats may disappear from streams that are impounded. In our study area, pre-impoundment records documented stonecats in the Missouri River near Craig, Montana, located in the upper part of the 142-km long study area (Brown 1971); however, during this study stonecats were only caught in the most downstream 18 km of the Missouri River study area. More than 110 km separates these two areas. FWP has conducted biannual electrofishing surveys since the early 1980s in the areas near Craig and Cascade (approximately 9 km and 43 km downstream from Holter Dam, respectively), Montana, but no stonecats have been documented during these efforts (FWP unpublished data). We hypothesize that water temperature changes caused by the upstream reservoirs are preventing stonecats from completing their life cycle in all but the lower 18 km of the study area. Although no historical data exist to document distributions of burbot in this section of the Missouri River, it is likely (based on historical thermal and flow regimes and burbot biology) that burbot densities were historically lower—due to higher river temperatures prior to building dams—and distributions within the river may have been different. Based on this logic, we hypothesize that the thermal influence of the upstream reservoirs has had a positive effect on burbot populations in the river.

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