Fish Population Monitoring Results for Reservoirs on the Missouri River in the Great Falls Area, 1990-2009

Prepared By:

Stephen A. Leathe
PPL Montana

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ABSTRACT

Fish populations in the five reservoirs (Black Eagle, Rainbow, Cochrane, Ryan, and Morony) owned and operated by PPL Montana on the Missouri River near Great Falls were monitored using standard experimental floating and sinking gill nets during the 20-year period 1990-2009. Fourteen fish species were captured during these surveys, but several species (flathead chub, pumpkinseed sunfish, burbot, brook trout) were very rare and were caught only once or on very few occasions. Black Eagle Reservoir (the furthest upstream reservoir) was surveyed only in 1990 and netting was discontinued thereafter due to clogging of nets by drifting algae. Rainbow Reservoir was only netted in 2008 and 2009 and had substantially higher numbers of suckers and black bullheads than the three downstream reservoirs. Cochrane, Ryan and Morony reservoirs had similar fish communities and net catches were dominated by suckers, walleye and yellow perch. The density, size, and relative weight of walleye in Cochrane, Ryan and Morony reservoirs in recent years was comparable to other popular walleye fishing reservoirs in northcentral Montana. Walleye stocking in Cochrane Reservoir during 1977-1986 had poor success but appeared to enhance walleye numbers in the two downstream reservoirs (Ryan and Morony). The walleye population in Cochrane Reservoir increased dramatically in 1997 and the increase was linked to the establishment and subsequent flushing of walleye from Canyon Ferry Reservoir, which is located approximately 130 miles upstream from Great Falls. The establishment of walleye in Canyon Ferry appears to have greatly altered walleye abundance in downstream waters, including Hauser Reservoir, the Missouri River downstream from Holter Dam, Cochrane Reservoir, and possibly the Missouri River downstream from Great Falls. The density of suckers in Cochrane, Ryan and Morony decreased substantially during the 20-year period and average length of suckers increased markedly. These trends were similar to observations made in Canyon Ferry and Hauser reservoirs and were attributed to increased walleye predation in the Great Falls reservoirs. Walleye populations were probably very low in Ryan and Morony reservoirs prior to stocking by MDFWP and it is postulated that elevated walleye populations in the Great Falls reservoirs in recent years are maintained primarily by drift from upstream sources. Sauger were stocked by MDFWP in Cochrane, Ryan and Morony during 1999-2005, but failed to establish a significant naturally-recruiting population in any of the reservoirs. The temporary establishment of sauger populations appeared to cause a decline in walleye relative weight, indicating competition for limited food resources. Catchable-sized rainbow trout were stocked by MDFWP annually in Rainbow Reservoir during 2000-2009 but the hatchery rainbows contributed little to the fish population there or in downstream reservoirs. Gill net catches of rainbow trout in Cochrane, Ryan and Morony reservoirs were higher in years when rainbows were not stocked immediately upstream. Seventy-five percent of rainbow trout netted in Cochrane, Ryan and Morony reservoirs in 2008-2010 were wild fish that probably drifted in from upstream sources. Rainbow trout density in the Great Falls reservoirs was low in comparison to other popular trout fishing reservoirs in the area. Short retention times (average flushing time less than 24 hours) of these reservoirs probably limits fish population levels via flushing of juvenile fish and depression of zooplankton production. Angling use on these reservoirs is very low, a probable result of low fish populations and somewhat limited boat and shore access. Due to the low catch rates in floating nets and the shallowness of the Great Falls reservoirs, effective fish population monitoring can probably be achieved by discontinuing the use of floating nets and instead setting 3-4 sinking nets in each reservoir.

Introduction

PPL Montana owns and operates five hydroelectric projects on the Missouri River in the Great Falls area. A new 40-year federal operating license for these and other dams on the Missouri River was issued to PPL by the Federal Energy Regulatory Commission in September, 2000 (FERC Project No. 2188). Article 417 of the license requires the Company to monitor the relative abundance of the most abundant fish species in the reservoirs created by the Great Falls dams. This report summarizes results of gill net surveys conducted on the reservoirs during the 20-year period 1990-2009.

Study Area

Five hydroelectric dams were built during the years 1891-1930 on the Missouri River in the Great Falls area (Figure 1). The dams were built on or near several natural waterfalls on the river that ranged from 7-90 feet in height. These waterfalls were natural barriers that blocked upstream colonization by a number of native fish species that inhabit the river downstream from Great Falls. Fish species whose upstream distribution was blocked include: goldeye, shorthead redhorse sucker, blue sucker, freshwater drum, river carpsucker, bigmouth buffalo, smallmouth buffalo, pallid sturgeon, shovelnose sturgeon, channel catfish, sauger, and several minnow species.

The five dams on the Missouri in the Great Falls area created small reservoirs, ranging between 126 to 402 surface acres (Table 1). The reservoirs are relatively shallow, with average depths ranging from 5 to 46 feet deep. The reservoirs have extremely short retention times (the theoretical amount of time required for the inflowing river to completely replace water stored in the reservoir), because of their small size relative to the large volume of inflow from the Missouri River. The river delivers an average of approximately 5 million acre-feet of water per year at Great Falls. As a result, the retention time of the Great Falls reservoirs ranges between 3 and 24 hours (Table 1). Retention times range from 1-13 hours during the highest flow month (June) and from 3-34 hours in the lowest flow month (September). The reservoirs do not thermally stratify because of their short retention times and resultant high rates of water exchange.

Table 1. Physical characteristics of hydroelectric reservoirs on the Missouri River in the Great Falls area. Data from FERC project 2188 license issued in 2000.

Reservoir	Year built	Surface area (acres)	Storage (ac-ft)	Ave depth (ft)	Average retention time (hrs)	Powerplant capacity (megawatts)
Black Eagle	1894	402	1,820	5	3	18
Rainbow	1910	126	1,237	10	2	35
Cochrane	1958	249	8,464	34	15	54
Ryan	1915	168	3,653	22	6	60
Morony	1930	304	13,889	46	24	48

Figure 1. Map of the Missouri River and reservoirs in the vicinity of Great Falls, MT.

Fish Stocking

The history of fish stocking in the Great Falls reservoirs was determined from searching the MT Department of Fish, Wildlife & Parks (FWP) fish stocking database and consultation with FWP fisheries biologists. The database shows only one stocking event for Black Eagle Reservoir, when approximately 17,000 2-inch long bullheads (probably black bullheads) were stocked in 1933. This is unusual, since black bullheads are commonly considered a nuisance species in modern times.

Rainbow Reservoir, including the approximate 1.7-mile river tailwater section that extends from Black Eagle Dam to the headwaters of Rainbow Reservoir near Giant Springs, has by far received the most hatchery fish of all the five Great Falls reservoirs. The earliest stockings in this area were rainbow trout in 1937 and brown trout in 1938. Rainbow trout were stocked almost every year between 1946 and 1985 while brown trout were only stocked on four occasions between 1938 and 2000. The only other species stocked in this area were walleye fry in 1977 and goldfish in 1981. The goldfish stocking is perplexing and perhaps they were stocked into the Giant Springs pool for viewing pleasure.

According to FWP records, no fish were stocked in Rainbow Reservoir and the Black Eagle tailwater during the 14-year period 1986-1999. Annual stocking resumed in 2000, and consisted mostly of 'catchable'-sized rainbow trout (typically 7-10 inches long) and a few brown trout (Table 2).

Table 2. Stocking summary for Rainbow Reservoir and the Black Eagle tailwater for the years 2000-2009. (Rb= rainbow trout; Br Tr= brown trout).

Year stocked	Species	Size (inches)	Number stocked
2000	Rb	11.8	800
"	Br Tr	4.1	25,020
2001	Rb	4.3-10.0	21,061
"	Br Tr	4.3	7,476
2002	Rb	7.3-9.9	20,347
2003	Rb	8.1-9.7	19,000
2004	Rb	7.6-11.1	16,908
2005	Rb	2.6-10.4	19,383
2006	Rb	6.6-8.9	22,310
2007	Rb	8.2-9.9	21,000
2008	Rb	9.1-10.5	17,428
2009	Rb	8.2-9.9	19,901

Table 3. Stocking summary for Cochrane, Ryan and Morony reservoirs.

Reservoir	Year	Species	Size (inches)	# Stocked
Cochrane	1977	Walleye	fry	200,000
	1985	Walleye	fry	100,000
	1986	Walleye	fry	100,000
	2001	Sauger	1-3	8,000*****
	2002	Sauger	1-3	10,000*****
	2005	Sauger	fry	436,850
	"	Sauger	1.8	4,917
Ryan	2005	Sauger	1.8	4,917
Morony	1985	Walleye	2.0	4,000
	1986	Walleye	fry	100,000
	"	Walleye	4.0	650
	1987	Walleye	3.0	14,080
	1990	Walleye	4.6	9,985
	1991	Walleye	3.6	10,000
	1992	Walleye	4.3	4,893
	1993	Walleye	4.5	10,000
	1994	Walleye	3.9	10,000
	1995	Walleye	4.1	10,000
	1996	Walleye	3.6	5,628
	1999	Sauger	2.5	5,024
	2001	Sauger	1.5	9,550*
	2002	Sauger	1-3	13,823*
	2003	Sauger	1.2-1.5	69,957*
	2005	Sauger	1.8	9,834

***** *According to records of Bill Gardner, FWP biologist, Lewistown*

Relatively few fish have been stocked in the lower-most three reservoirs (Cochrane, Ryan and Morony) and no species other than walleye and sauger have been stocked in these waters, according to FWP records (Table 3). Sauger were stocked experimentally in the lower three reservoirs during 2001-2005 in an attempt to establish a naturally reproducing population that would trickle juvenile recruits downstream to the river below Morony where the sauger population had declined. There is some discrepancy between the records in the FWP fish stocking database and the records of the FWP biologist (Bill Gardner) who supervised the sauger stocking effort. Where differences existed, the biologist's information was used in Table 3.

Methods

Fish population monitoring was conducted by use of standard experimental floating and sinking gillnets. Nets were typically set in late afternoon, allowed to fish overnight, and were retrieved in the morning of the next day. Nets were the same as used for standard lake and reservoir surveys by Montana Department of Fish, Wildlife and Parks in northcentral Montana and were 125 feet long by 6 feet tall. They were constructed of multifilament white nylon with 25-foot sections of ¾", 1", 1 ¼", 1 ½", and 2" square mesh. The total length of captured fish was measured to the nearest 0.1 inch and fish were weighed to the nearest .01 pound. Nets were typically set in the upper, middle and lower sections of each reservoir in late summer to mid-fall. All data were analyzed using FA+ software developed by Montana Department of Fish, Wildlife and Parks.

Results

River Flow

Average runoff during the high spring flow period (April through July) in the Missouri River at the USGS gage located approximately 20 miles upstream from Great Falls is shown in Figure 2. The Missouri River typically supplies 80-90% of the inflow to the Great Falls reservoirs. The remainder is contributed by small tributaries in the immediate Great Falls area, and the Sun River, which flows directly into Black Eagle Reservoir.

Annual fisheries monitoring surveys using gill nets on the Great Falls reservoirs was initiated in 1990, which immediately followed several years of substantially below-average runoff in the Missouri River (Figure 2). Spring runoff was well above average for four consecutive years (1995-1998), followed by a period of several years of below-average runoff during 2000-2007.

Flushing rate of the Great Falls reservoirs is an important biological issue because of their relatively small size relative to the large amount of river inflow. The largest of the Great Falls reservoirs (Morony) only holds 13,889 acre-feet, and the other four hold substantially less water (Table 1). During low water years like 1987 and 1988, when spring runoff totaled around one million acre-feet (Figure 1), the average retention time for Morony would be around 1.7 days and Rainbow Reservoir would flush once every 3.6 hours. In exceptionally high water years like 1995-1997, Morony retention time would only be around 14 hours during the spring high water period, and Rainbow Reservoir would flush every 1.2 hours.

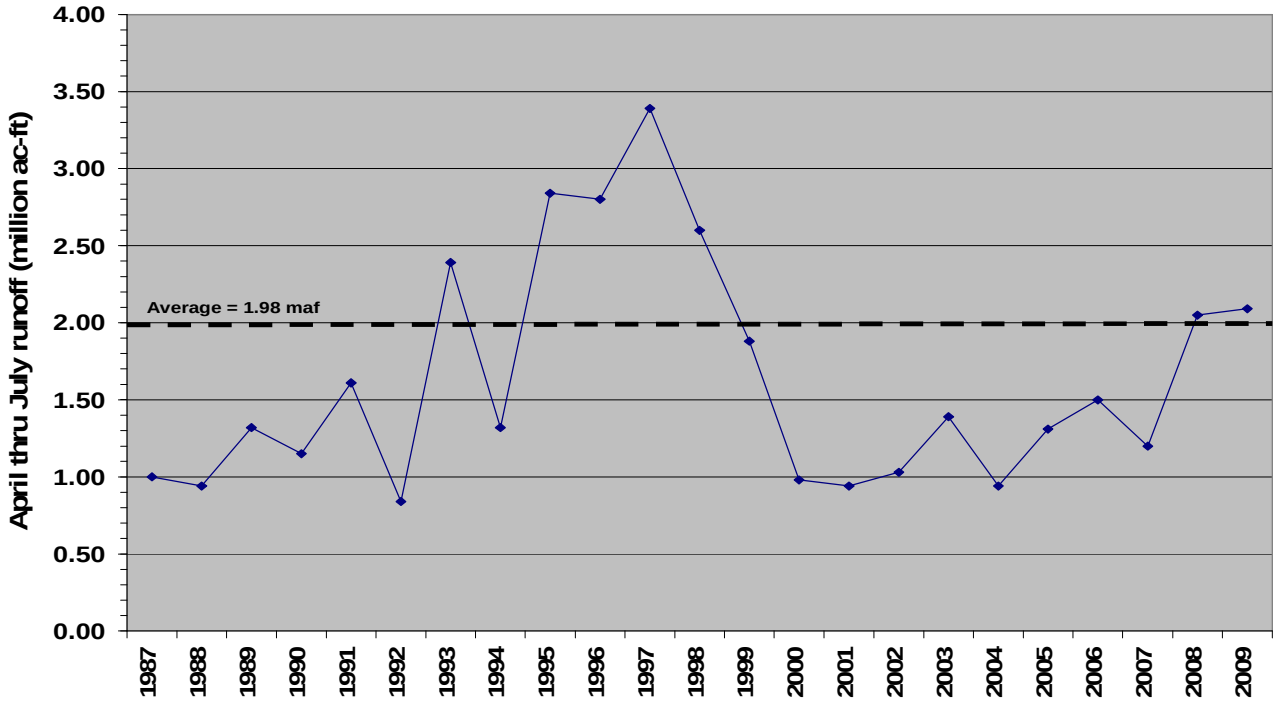

Figure 2. Annual discharge (millions of acre-feet) during the April through July high water period at the USGS gage site located 9.1 miles downstream from the Smith River, near Ulm, MT. Long term average for the years 1957-2009 is 1.98 million acre-feet, as shown on graph.

Angling Use

Angling use on the Great Falls reservoirs was determined using results from the MT Department of Fish, Wildlife & Parks Statewide Angling Pressure Survey. This mail survey is run on alternate years to estimate fishing use on all waters in MT. Fishing pressure is expressed as 'angler-days', which equates to one person's typical fishing day on a water. A typical fishing day lasts approximately four hours.

Results from the statewide survey indicate angling use on the Great Falls reservoirs was very low during 1991-2009 (Table 4). Survey results indicate no fishing use on Black Eagle, Cochrane and Ryan reservoirs in the ten surveys conducted during the 20-year period.

Table 4. Average annual fishing pressure (angler-days) for the five Great Falls reservoirs for the period 1991-2009 as determined by the biennial MDFWP Statewide Fishing Pressure Survey. Number of survey years with reported fishing use and max/min fishing use for all survey years are also shown.

Reservoir	Ave annual fishing pressure (angler-days)	# Survey years with pressure >0	Max/min annual fishing pressure
Black Eagle	0	0	0/0
Rainbow	30	3	128/0
Cochrane	0	0	0/0
Ryan	0	0	0/0
Morony	673	10	1,667/217

Statewide survey results indicated Rainbow Reservoir supported an average of only 30 angler-days per year, which is probably less than the actual amount of fishing use that occurs there. Giant Springs

State Park and State Fish Hatchery are located at the headwaters of Rainbow Reservoir in the transition zone between river and reservoir habitat. The State Park has a handicap-accessible fishing pier and it is common to observe several people fishing there at any given time during the spring, summer and fall months. It is likely that several hundred angler-days of fishing use occur there annually and this use is probably incorrectly classified in the survey as occurring in the Missouri River between Great Falls and Cascade.

The survey indicated a consistent and significant amount of fishing use on Morony Reservoir. This is probably an over-estimate because there are no public access facilities on Morony and no boats are allowed on the reservoir. The reservoir shoreline is relatively steep and inaccessible. However, there is a popular and heavily used fishing access site on the river immediately downstream from Morony Dam. It is likely that a significant portion of the fishing pressure assigned to Morony Reservoir by the survey actually occurs on the river immediately below Morony Dam.

Overall, fishing use on the Great Falls reservoirs is very low. For comparison, annual fishing pressure on Hauser or Holter reservoirs ranges from 50,000-80,000 angler-days per year and pressure on the 35-mile 'blue-ribbon' stretch of the Missouri River between Holter Dam and Cascade sometimes exceeds 100,000 angler-days per year. Annual angling use on popular local walleye reservoirs like Tiber and Lake Frances typically ranges from 10,000-20,000 angler-days per year.

Black Eagle Reservoir Netting Results

Gillnets were set in Black Eagle Reservoir only once, in the fall of 1990. The nets clogged very badly with algal mats that drifted into the reservoir from the Missouri River, hence netting surveys were discontinued thereafter. White suckers were the most abundant species in the floating gillnets, while yellow perch were most abundant in the sinking nets (Table 5). Average length of perch (6.7") and white suckers (10.9") was relatively small (Table 6).

Table 5. Number of fish caught per net in standard floating and sinking experimental gill nets set in Black Eagle Reservoir on 27 September 1990.

Net type	# Nets	Rb	YP	WSu	LnSu
Floating	2	1.0	0	9.0	0.5
Sinking	2	0	8.5	4.0	0

Table 6. Average length, weight, and relative weight of fish caught in standard experimental floating and sinking gill nets in Black Eagle Reservoir on 27September1990.

Species	N	Ave length (in)	Ave weight (lb)	Ave Relative Weight
Rb	2	9.8	0.30	80.1
YP	17	6.7	0.16	100.8
WSu	26	10.9	0.86	95.2
LnSu	1	15.9	2.29	-

Rainbow Reservoir Netting Results

Gillnet surveys were conducted on Rainbow Reservoir only in 2008 and 2009. Three sinking nets were set overnight on each occasion. White suckers and longnose suckers were the most abundant species caught in 2008, while white suckers and black bullheads were the most numerous species in

2009 (Table 7). White suckers were fairly large (average length 14-15") and were very plump, with average relative weight ranging between 111-113 (Table 8). Black bullheads averaged around 9 inches long. No rainbow trout were captured in either year, which was somewhat surprising because the reservoir is stocked with around 20,000 catchable rainbow trout annually (Table 2). Rainbow Reservoir is relatively shallow and the sinking nets were set in water only 8-10 feet deep. The nets are 6 feet tall, hence they fished very close to the surface, where rainbow trout typically reside.

Table 7. Number of fish caught per net in standard sinking experimental gill nets set in Rainbow Reservoir in 2008 and 2009.

Date	# Nets	We	YP	WSu	LnSu	BlBh
8/26/2008	3	1.3	0.7	37.7	10.3	3.7
8/31/2009	3	0	1.3	19.0	2.0	8.0

Table 8. Average length, weight, and relative weight of fish caught in standard experimental sinking gill nets in Rainbow Reservoir in 2008 and 2009.

Species	Year	*N*	Ave length (in)	Ave weight (lb)	Ave Relative Wt
We	2008	*4*	16.0	1.89	99.2
	2009	*0*	-	-	-
YP	2008	*2*	9.5	0.52	-
	2009	*4*	7.6	0.34	148.9
WSu	2008	*113*	14.1	1.48	110.7
	2009	*57*	14.8	1.75	113.3
LnSu	2008	*31*	13.9	1.16	-
	2009	*6*	13.8	1.18	-
BlBh	2008	*11*	8.9	0.29	69.0
	2009	*24*	9.3	0.35	70.2

Cochrane Reservoir Netting Results

Netting surveys were conducted on Cochrane Reservoir sporadically in 1990-1996 and nearly every year during 1997-2009. On average, white suckers were the most common species caught in floating nets, followed by walleye and rainbow trout in order of abundance (Table 9). With the exception of rainbow and brown trout, catches for most fish species were higher in sinking gill nets than in floating nets (Tables 9 & 10). White suckers were the most abundant fish in sinking nets set in Cochrane, followed by walleye, yellow perch, and longnose suckers in the earlier years.

Sauger were stocked in Cochrane Reservoir during 2001, 2002 and 2005 (Table 3). Sauger were caught in floating gillnets set in Cochrane during 2001-2003, but not thereafter. Sauger were caught in sinking gillnets every year between 2001 and 2006, but none were captured in 2007, 2008, or 2009. It appears sauger did not successfully reproduce in significant numbers in Cochrane.

A number of minor, and even rare, species have been captured in gill nets set in Cochrane Reservoir. Flathead chubs were caught in floating nets in 1990 and 1997, but have not been caught since. Carp, mountain whitefish, brown trout, and black bullheads were sporadically caught in small numbers in floating nets. Black bullheads were fairly commonly caught in sinking nets, but their overall abundance was low. A single burbot was captured in a sinking net in 1999 and this is the only burbot ever caught in nets set in the Great Falls reservoirs. Likewise, single individual pumpkinseed sunfish

were caught in sinking nets in 2006 and 2007, and these are the only occurrences of this species in the Great Falls reservoirs during the report period.

Abundance of the most common species in sinking gillnets was used as the best indicator for population trends because sinking net catches were higher than floating net catches for all the most common species except rainbow trout. Walleye were caught in small numbers in 1990, 1992, and 1995 (Figure 3) despite being stocked as fry in 1977, 1985, and 1986 (Table 3). Walleye numbers increased in 1997 and they have been a significant member of the fish community ever since. This population increase occurred approximately 10 years after the cessation of stocking, indicating factors other than stocking were most likely responsible for the population increase. Yellow perch numbers were quite high in 1990 and were also fairly high in 2000 and 2003. Perch numbers declined to very low levels in 2008 and 2009. White sucker and longnose sucker populations both appear to have declined dramatically over the 20-year period in Cochrane Reservoir.

Average length and relative weight of walleye in Cochrane were variable and somewhat cyclic (Figure 4). Average walleye length increased to 15.3" in 1999, declined steadily to 12.4" in 2003, then increased steadily to 16.5" in 2008 only to decline precipitously to 10.8" the following year (Appendix A1). There was an overall downward trend in walleye relative weight during the study period (Figure 4). Walleye relative weight was generally high (95-100) during 1997-2001, declined noticeably to 75-85 during the middle years (2002-2006) and returned to reasonably good levels (90-95) during 2007-2009. Relative weight of walleye in specific length groups is shown in Appendix A2.

The noticeable decline in walleye relative weight during 2002-2006 did not appear to be caused by any substantial change in walleye abundance (Figure 3), or reservoir inflow/flushing rate (Figure 2). The walleye relative weight decline coincided very closely with the appearance of significant numbers of sauger in sinking gillnets (Table 10). The decline in walleye condition during 2002-2006 was likely caused by competition with recently stocked sauger for the limited prey base.

There was a dramatic and steady increase in the average size of white suckers netted in Cochrane Reservoir during 1990-2009 (Figure 4). This trend corresponded very closely with the substantial decline in white sucker numbers over the same period (Figure 3). Average length of white suckers increased from around 9-11" in 1990-1995 to around 15" in 2002-2009. Average length of longnose suckers showed the same general trend (Appendix A4), but long term data for this species are more limited because the population declined to very low levels after 1999 (Figure 3). There was a steady increase in relative weight of white suckers (Figure 4) which paralleled the decline in population size and the increase in average length of this species during the study period. There is some evidence that relative weight of individual size classes of white suckers also increased over time, but data for large fish are limited in the early years and data for small fish are likewise limited in the later years (Appendix A3). Average total length of other species caught in Cochrane Reservoir gill nets is shown in Appendix A4.

*Table 9. Number of fish caught per net in standard experimental **floating** gill nets set in Cochrane Reservoir during 1990-2009.*

Year	# nets	We	Sgr	YP	Rb	LL	WSu	LnSu	Other 1		Other 2	
									Sp	#/net	Sp	#/net
1990	2	0	0	1.5	2.0	1.0	11.5	0	FhCh	0.5	Carp	0.5
1992	3	0.3	0	0	2.3	0.7	5.7	0				
1995	2	0	0	1.5	2.0	0	19.5	0.5				
1997	3	0.7	0	1.3	0	0.3	9.3	0	BlBh	1.3	FhCh	0.3
1998	1	0	0	7.0	0	0	36.0	0	Carp	2.0		
1999	3	2.3	0	1.7	2.7	0	11.7	2.3	MWf	1.0	Carp	0.3
2000	3	2.7	0	0.7	0.7	0.3	4.0	0.7	MWf	0.7		
2001	3	2.3	0.3	0.3	0	0	3.3	0	MWf	1.7		
2002	3	0.3	0.3	0	0.3	0	1.7	0				
2003	3	1.3	2.3	0	0	0.3	1.0	0	MWf	0.3		
2005	3	1.0	0	0	1.0	0.3	2.0	0.7				
2006	3	0.7	0	0	0	0.7	1.0	0.3				
2007	3	2.3	0	0	0.7	0	0.3	0.3			Carp	0.3
2008	3	0.3	0	0.3	0.7	0	0.7	0.3				
2009	3	1.7	0	0.3	2.0	0	1.0	0.7				
Weighted ave catch/net	*41 nets*	*1.2*	*0.2*	*0.7*	*1.0*	*0.2*	*5.4*	*0.4*	*Carp*	*0.1*	*BlBh*	*0.1*
									MWf	*0.3*	*FhCh*	*0.1*

*Table 10. Number of fish caught per net in standard experimental **sinking** gill nets set in Cochrane Reservoir during 1990-2009.*

Year	# nets	We	Sgr	YP	Rb	LL	WSu	LnSu	BlBh	Other 1		Other 2	
										Sp	#/net	Sp	#/net
1990	2	0	0	12.5	0.5	0	124.0	5.0	6.0			Carp	3.5
1992	3	0.7	0	1.0	1.0	0.3	58.0	4.3	0.3				
1995	2	0.5	0	2.5	0.5	0.5	70.0	6.0	1.0				
1997	3	6.3	0	0.3	0	0	35.3	1.3	3.0	MWf	1.0	Carp	0.3
1998	3	2.3	0	2.7	0.7	0	36.7	2.3	0.3	MWf	0.7		
1999	3	3.0	0	2.3	0	0.3	38.3	1.3	0	MWF	0.3	Ling	0.3
2000	3	4.7	0	7.3	0	1.0	41.0	0	0.3	MWf	0.7	Carp	0.3
2001	3	4.0	0.3	4.0	0	0.3	17.7	0.3	0.7	MWf	0.3	Carp	0.3
2002	3	5.0	1.0	3.3	0	0	15.6	0	0.3			Carp	0.3
2003	3	3.4	2.7	7.7	0	0.3	15.0	0	0.3	MWf	0.3		
2005	3	6.7	0.3	2.3	0	0	15.3	0.3	0.3				
2006	3	3.3	1.3	3.3	0.7	0	7.7	0	0.3	Pump	0.3	Carp	0.3
2007	3	5.3	0	4.3	0	0	12.0	0.3	0.3	Pump	0.3		
2008	5	1.6	0	0.6	0	0	4.2	0.2	0			Carp	0.4
2009	3	3.3	0	0.3	1.0	0	5.3	0	0.7			Carp	0.7
Weighted ave catch/net	*45 nets*	*3.4*	*0.4*	*3.3*	*0.3*	*0.2*	*29.0*	*1.2*	*0.8*	*Carp*	*0.3*	*Pump*	*< .1*
										MWf	*0.2*	*Ling*	*< .1*

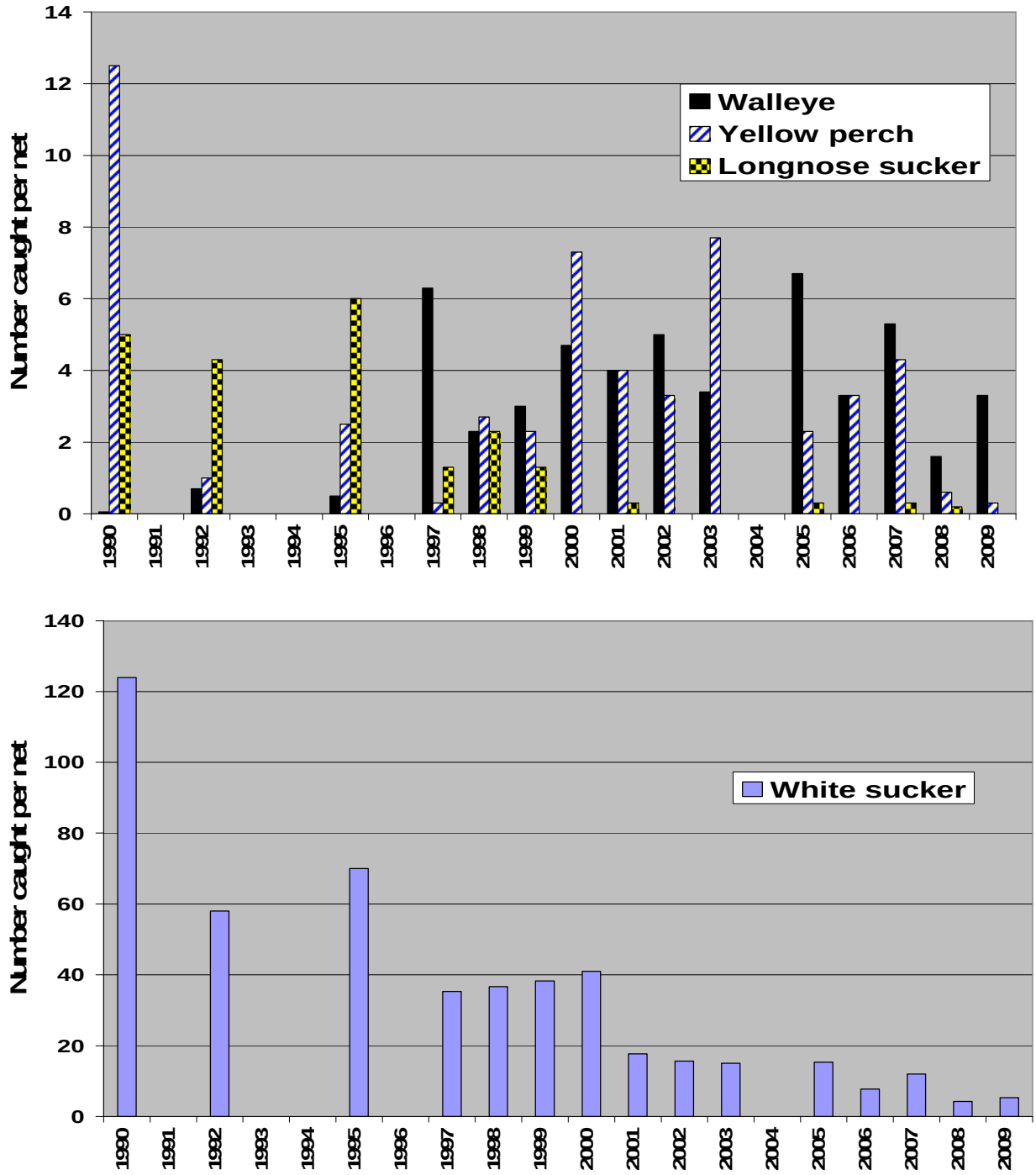

Figure 3. Average annual catch per net for walleye, yellow perch and longnose sucker (top panel) and white sucker (lower panel) in sinking gill nets set in Cochrane Reservoir during 1990-2009.

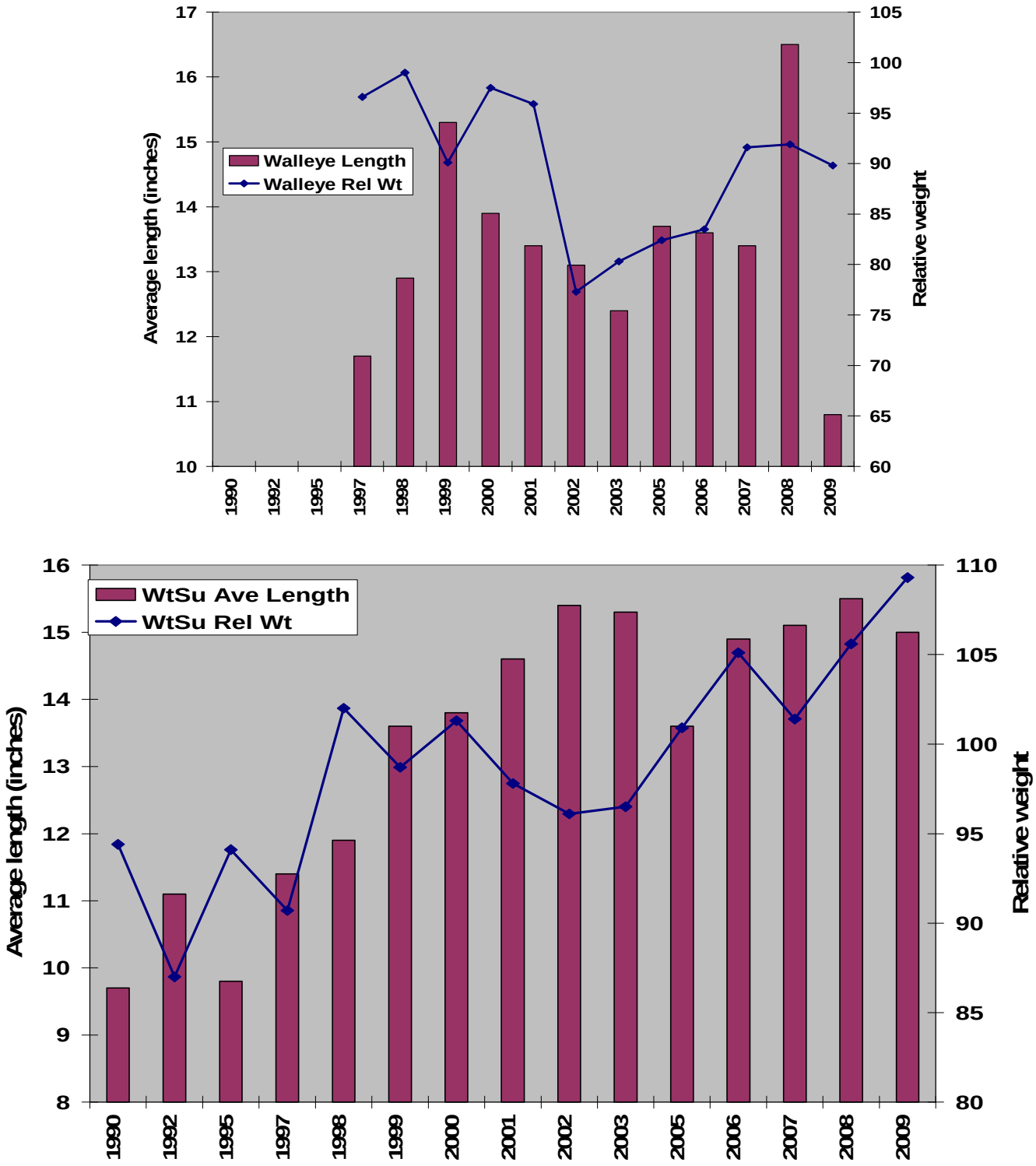

Figure 4. Annual trends in average length (inches) and relative weight of walleye (top panel) and white suckers (bottom panel) caught in floating and sinking gill nets set in Cochrane Reservoir during 1990-2009. Only data from years when at least five individuals were measured and weighed are included.

Ryan Reservoir Netting Results

Netting surveys were conducted on Ryan Reservoir in 15 of 20 years during the period 1990-2009. White suckers were typically the most common species captured in floating nets, followed by longnose suckers and walleye in order of abundance (Table 11). White suckers were also the most abundant species caught in sinking nets, followed by walleye, longnose suckers and yellow perch (Table 12). Average catch of most species were higher in sinking nets or similar in both types of nets. Carp and black bullheads were occasionally caught in both types of nets and flathead chubs were captured only once, in 1999. The only brook trout ever captured in nets set in the Great Falls reservoirs was caught in a floating net on Ryan Reservoir in 2002.

According to FWP stocking records, sauger were stocked in Ryan Reservoir on only one occasion, in 2005. However, records show that sauger were stocked immediately upstream in Cochrane Reservoir in 2001, 2002, and 2005 (Table 3). Sauger were caught in both floating and sinking nets in Ryan in 2003 and these fish must have flushed out of Cochrane Reservoir because sauger were not stocked in Ryan until two years later. Sauger numbers peaked in both floating and sinking gill nets set in Ryan in 2005 (Tables 11 & 12). All of the sauger netted in Ryan in 2005 were 10" or longer (all but one were >11") and they probably also flushed downstream from Cochrane. Sauger were only 1.8" long at their first and only stocking in Ryan at the end of June in 2005 and very few would have been large enough to catch in gill nets set two months later on 25Aug. For comparison, sauger were first stocked in Cochrane Reservoir in 2001 as 1-3" fingerlings, and only two small sauger (7.4 & 7.7 inches long) were caught in gill nets set in Cochrane on 12Sept of that year, indicating that stocked fingerling sauger are generally less than eight inches long by September of their first year in these waters. Sauger numbers dwindled to very low levels in Ryan in 2008 and 2009, indicating a near-total lack of natural reproduction. In contrast, walleye numbers were approximately 10 times higher in those same years, despite no records of walleye stocking in Ryan.

Changes in sinking gillnet catches were used as the best indicator of fish population trends in Ryan Reservoir because catches of most species in sinking nets was equivalent to, or higher than, catches in floating nets (Tables 11 & 12). White suckers were the most abundant species in sinking nets in the 1990's, but their numbers declined dramatically after 2000 (Figure 5), as they did in Cochrane. Walleye numbers were fairly high in the early 1990's and seemed to decline somewhat in recent years. Longnose suckers declined substantially in recent years from their peak in the mid-1990's, similar to white suckers, while yellow perch numbers showed no noticeable trend.

Average length and relative weight of walleye in Ryan Reservoir tended to decrease over the 20-year study period (Figure 6). Average walleye length was 13-15 inches in 1990-1995 and decreased to 11-12 inches in 2006-2009 (Appendix A5). As was observed in Cochrane Reservoir, the average length of white suckers increased dramatically and steadily from 10-11" in 1990 to around 16" in 2009 (Figure 6). Average relative weight of white suckers also increased during the study period, though this may be related mostly to the fact that larger suckers tend to be more plump. There was no clear change in relative weight within various size groups of white suckers (Appendix A6) though analysis was clouded by low sample sizes of large suckers in the early years and low numbers of smaller suckers in the latter years.

Though sample sizes are smaller, the average length of longnose suckers also appeared to increase during the study period. Average length of longnose was 13-14" in 1990-1997, increasing to 15-16" in 2007-2009 (Appendix A8). There were no obvious trends in average size of rainbow trout, brown trout, sauger, or black bullheads in Ryan Reservoir (Appendix A8).

*Table 11. Number of fish caught per net in standard experimental **floating** gill nets set in Ryan Reservoir during 1990-2009.*

Year	# nets	We	Sgr	YP	Rb	LL	WSu	LnSu	MWf	Other 1		Other 2	
										Sp	#/net	Sp	#/net
1990	2	1.0	0	0	0	0	1.0	0	0				
1992	3	5.0	0	1.0	0	0	6.7	1.3	0				
1995	3	3.0	0	0	2.3	0.7	2.7	0.7	0.7	Carp	0.3		
1997	3	2.3	0	0	0	0.3	5.0	0.3	0	BlBh	0.3		
1998	2	1.5	0	0	1.5	0	9.0	3.5	0				
1999	3	2.0	0	0	2.0	0.7	3.7	2.3	0				
2000	3	1.7	0	0	0.7	0	6.3	3.3	0.3				
2001	3	2.7	0	0	0.7	0	3.3	5.7	0.3				
2002	3	0.7	0	1.0	0	0	0.7	5.3	0	EBT	0.3		
2003	3	1.7	0.7	0	0	0	3.0	1.0	0				
2005	3	0.7	2.7	0.7	0.3	0	1.7	2.0	0				
2006	3	1.3	1.7	1.7	0	0	3.7	1.7	0				
2007	3	1.7	0.3	0	0.3	0	2.0	2.3	0				
2008	3	0	0.3	0	2.7	0.7	3.0	1.3	0.7				
2009	3	1.7	0.3	0	1.3	0	1.7	1.3	0.3				
Weighted ave catch/net	*43 nets*	*1.8*	*0.4*	*0.3*	*0.8*	*0.2*	*3.5*	*2.2*	*0.2*	*Carp*	*> .1*	*EBT*	*< .1*
										BlBh	*< .1*		

*Table 12. Number of fish caught per net in standard experimental **sinking** gill nets set in Ryan Reservoir during 1990-2009.*

Year	# nets	We	Sgr	YP	Rb	LL	WSu	LnSu	MWf	Other 1		Other 2	
										Sp	#/net	Sp	#/net
1990	2	6.0	0	1.0	0	0	4.0	1.5	0				
1992	3	8.3	0	1.3	2.7	0.3	20.0	4.3	0				
1995	3	5.7	0	1.7	2.0	0	34.0	9.7	0	Carp	0.7	BlBh	0.3
1997	3	3.0	0	1.0	1.0	0	10.0	6.3	0.7	Carp	0.3	BlBh	2.0
1998	2	1.0	0	1.5	0	0.5	36.5	0	0	Carp	0.5	BlBh	1.0
1999	3	2.7	0	2.3	0	0	19.0	4.3	0	Carp	0.7	FhCh	0.7
												BlBh	1.0
2000	3	6.0	0	0.7	0	0.3	23.7	0.7	0.7	Carp	0.7	BlBh	1.0
2001	3	3.7	0	1.7	0.3	0.3	9.7	1.7	0.7	Carp	0.3		
2002	3	2.3	0	1.3	0	0	6.0	0.3	0				
2003	3	5.0	0.3	2.3	0	0	2.0	0	0	Carp	0.3		
2005	3	5.3	2.0	0.3	0	0	7.7	0	0.3				
2006	3	1.7	0.3	1.0	0	0	4.0	0.7	0				
2007	3	3.7	1.0	2.7	0	0	1.3	0	0	Carp	0.3		
2008	4	3.3	0.3	1.8	0.3	0	2.0	1.3	0.5				
2009	3	2.7	0.3	1.0	0.3	0	0.3	0	0.3				
Weighted ave catch/net	*44 nets*	*4.0*	*0.3*	*1.5*	*0.5*	*0.1*	*11.4*	*2.1*	*0.2*	*Carp*	*0.3*	*FhCh*	*0.1*
										BlBh	*0.3*		

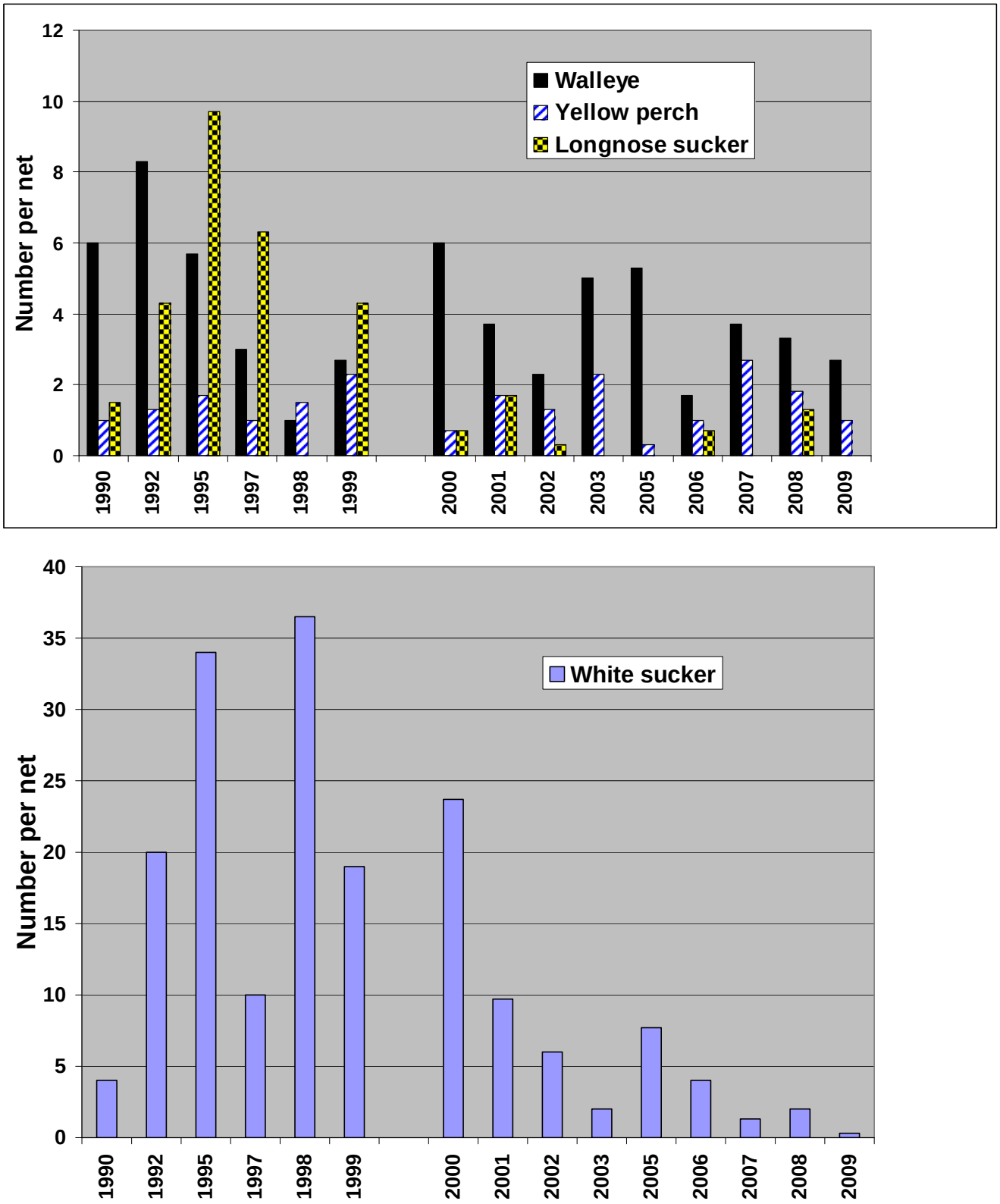

Figure 5. Average annual catch per net for walleye, yellow perch and longnose sucker (top panel) and white sucker (lower panel) in sinking gill nets set in Ryan Reservoir during 1990-2009.

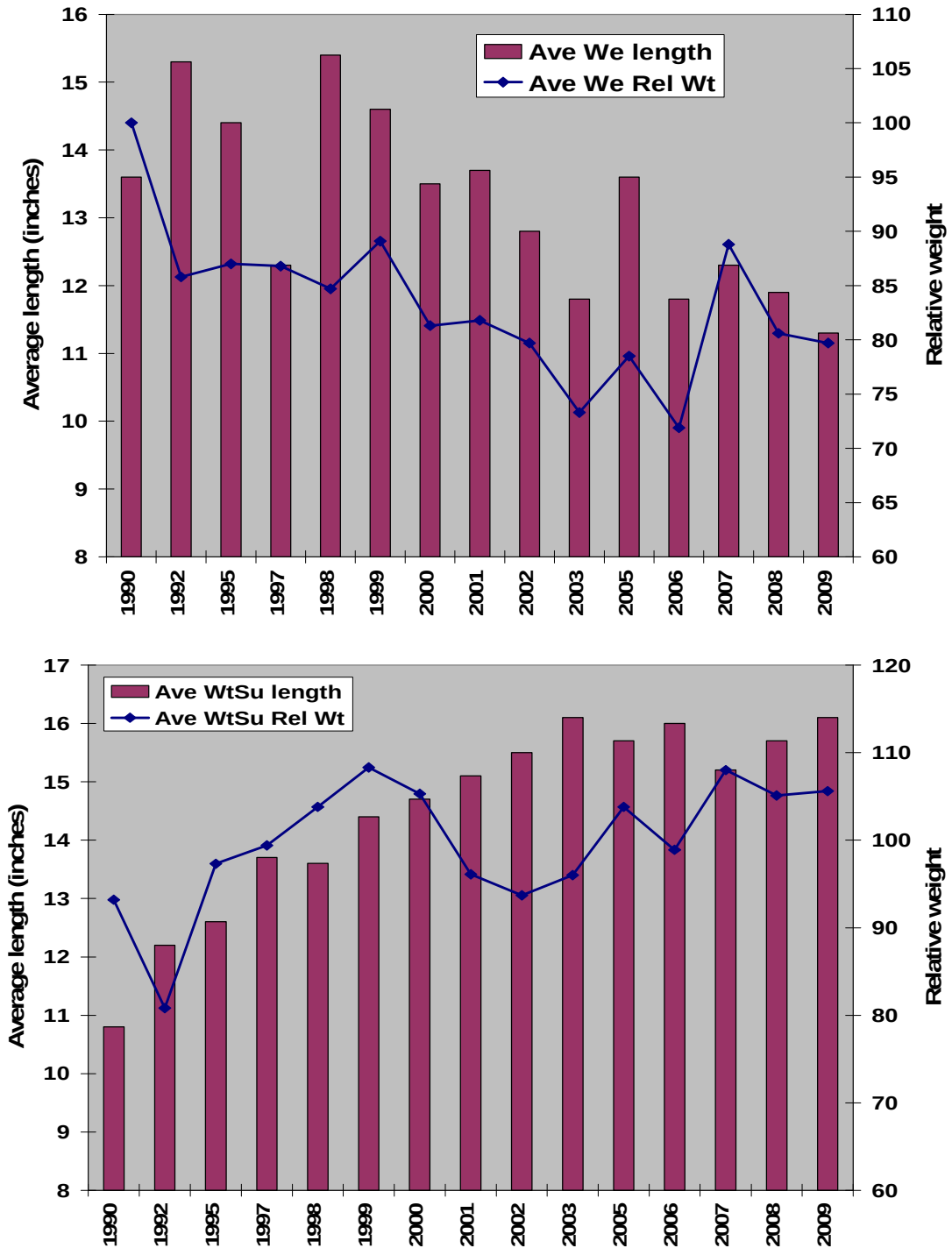

Figure 6. Annual trends in average length (inches) and relative weight of walleye (top panel) and white suckers (bottom panel) caught in floating and sinking gill nets set in Ryan Reservoir during 1990-2009. Only data from years when at least five individuals were measured and weighed are included.

Morony Reservoir Netting Results

White suckers and walleye were the most common species caught in floating nets set in Morony Reservoir during 1990-2009 and the same species, along with yellow perch, predominated in sinking nets (Tables 13 & 14). Average catch for most species was higher in sinking nets than in floating nets. Carp and black bullheads were occasionally captured, while flathead chubs were caught in floating nets in 1990 and 1995, but were not captured in subsequent years. Longnose suckers and mountain whitefish were fairly commonly caught in Cochrane and Ryan reservoirs, located immediately upstream, but were almost non-existent in Morony.

Sauger were stocked by MDFWP in five of seven years during 1999-2005 (Table 3) in an attempt to establish a naturally reproducing population in Morony Reservoir that would augment sauger populations in the river downstream via occasional flushing from the reservoir. The goal of establishing a naturally reproducing sauger population in Morony does not appear to have been achieved. Sauger were caught in low numbers in nets set in 2000 and 2005-2008, but none were caught in 2009 (Tables 13 & 14). In contrast, walleye were not stocked after 1996 (Table 3), yet walleye were far more numerous than sauger in sinking gill net catches during 2005-2009 (Table 14).

Changes in sinking gillnet catches were used as the best indicator of fish population trends in Morony Reservoir because catches of most species were higher in sinking nets than in floating nets. As was found for upstream reservoirs, white suckers were very abundant in the 1990's (30/net or higher), but declined dramatically to relatively low levels after around 2003 (Figure 7). Walleye numbers generally increased over time, while yellow perch displayed no particular trend. Average length of walleye also showed no discernable trend, but walleye relative weight generally declined from high levels (100-110) in 1990 & 1997 to levels generally ranging 70-90 in later years (Figure 8; Appendix A9). Walleye relative weight fell to historic low levels in 2002-2005, which corresponds closely with sauger stocking (Table 3). This same general trend was observed in Cochrane and Ryan reservoirs and suggests sauger and walleye competed for the limited prey base (mostly suckers and yellow perch) during those years. The average length of white suckers increased steadily and substantially, as was seen in upstream reservoirs as well (Figure 8). There were no obvious trends in average size of minor species caught in Morony Reservoir, and sample sizes were low (Appendix A12).

*Table 13. Number of fish caught per net in standard experimental **floating** gill nets set in Morony Reservoir during 1990-2009.*

Year	# nets	We	Sgr	YP	Rb	LL	WSu	LnSu	MWf	Other 1		Other 2	
										Sp	#/net	Sp	#/net
1990	2	3.0	0	0.5	0	0.5	11.5	0	0			FhCh	0.5
1995	4	0.3	0	0	0.3	0.5	10.8	0	0			FhCh	0.3
1997	3	0.3	0	0	0	0	20.7	0	0	Carp	0.3	BlBh	0.3
1998	2	0.5	0	0	0	0	14.0	0	0				
1999	3	0.7	0	1.0	1.0	0	1.3	0	0				
2000	3	1.3	0.3	0	0.3	0	9.3	0	0				
2001	3	0	0	1.3	0.3	0	1.7	0	0				
2002	3	1.7	0	0	0.3	0	1.3	0	0	Carp	0.3		
2003	3	0.3	0	0	0.7	0	10.0	0	0				
2005	3	0	0	0	0.3	0	0.7	0	0				
2006	3	0.3	0	0	0	0	0.3	0	0				
2007	3	0	0	0	0	0.3	2.3	0	0				
2008	2	0	0	0	0	0	0.5	0	0				
2009	3	0.3	0	0	0	0	0.3	0	0				
Weighted ave catch/net	*40 nets*	*0.6*	*< .1*	*0.2*	*0.3*	*0.1*	*6.0*	*0*	*0*	*Carp*	*0.1*	*BlBh*	*< .1*
										FhCh	*0.1*		

*Table 14. Number of fish caught per net in standard experimental **sinking** gill nets set in Morony Reservoir during 1990-2009.*

Year	# nets	We	Sgr	YP	Rb	LL	WSu	LnSu	MWf	Other 1		Other 2	
										Sp	#/net	Sp	#/net
1990	2	1.5	0	2.0	0	0	34.0	0	0	Carp	0.5		
1995	2	0.5	0	3.5	0	0	59.0	1.5	0	Carp	0.5	BlBh	2.5
1997	3	1.0	0	0.3	0	0.3	71.0	0	0	Carp	0.3		
1998	2	0.5	0	4.5	0	0	71.0	0	0				
1999	3	2.3	0	5.7	0	0	51.7	0	0				
2000	3	3.3	0.3	3.0	0	0	41.0	0	0			BlBh	1.3
2001	3	3.7	0	6.7	0	0	37.0	0	0				
2002	3	1.3	0	0.7	0	0	26.0	0	0				
2003	3	2.0	0	2.0	0	0	25.7	0	0				
2005	3	3.7	0.7	1.3	0	0	13.3	0	0			BlBh	0.3
2006	3	1.3	0.7	2.3	0	0	9.7	0	0			BlBh	0.3
2007	3	5.3	0.7	3.7	0	0.3	12.3	0	0				
2008	6	3.3	0.2	7.3	0	0	10.5	0	0	Carp	0.5	BlBh	0.2
2009	3	5.7	0	2.3	0	0	9.7	0	0	Carp	0.3	BlBh	0.7
Weighted ave catch/net	*42 nets*	*2.7*	*0.2*	*3.5*	*0*	*< .1*	*30.6*	*0.1*	*0*	*Carp*	*0.2*		
										BlBh	*0.3*		

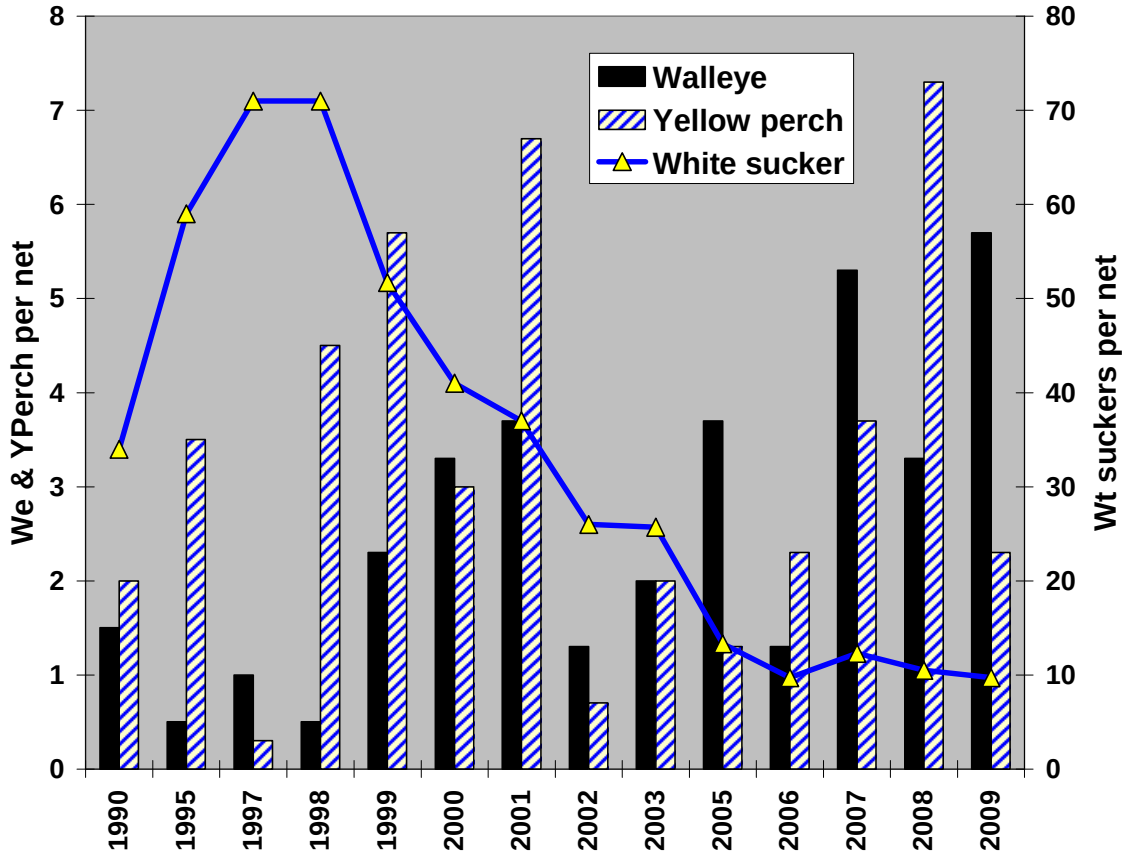

Figure 7. Average annual catch per net for walleye, yellow perch and white suckers in sinking gill nets set in Morony Reservoir during 1990-2009.

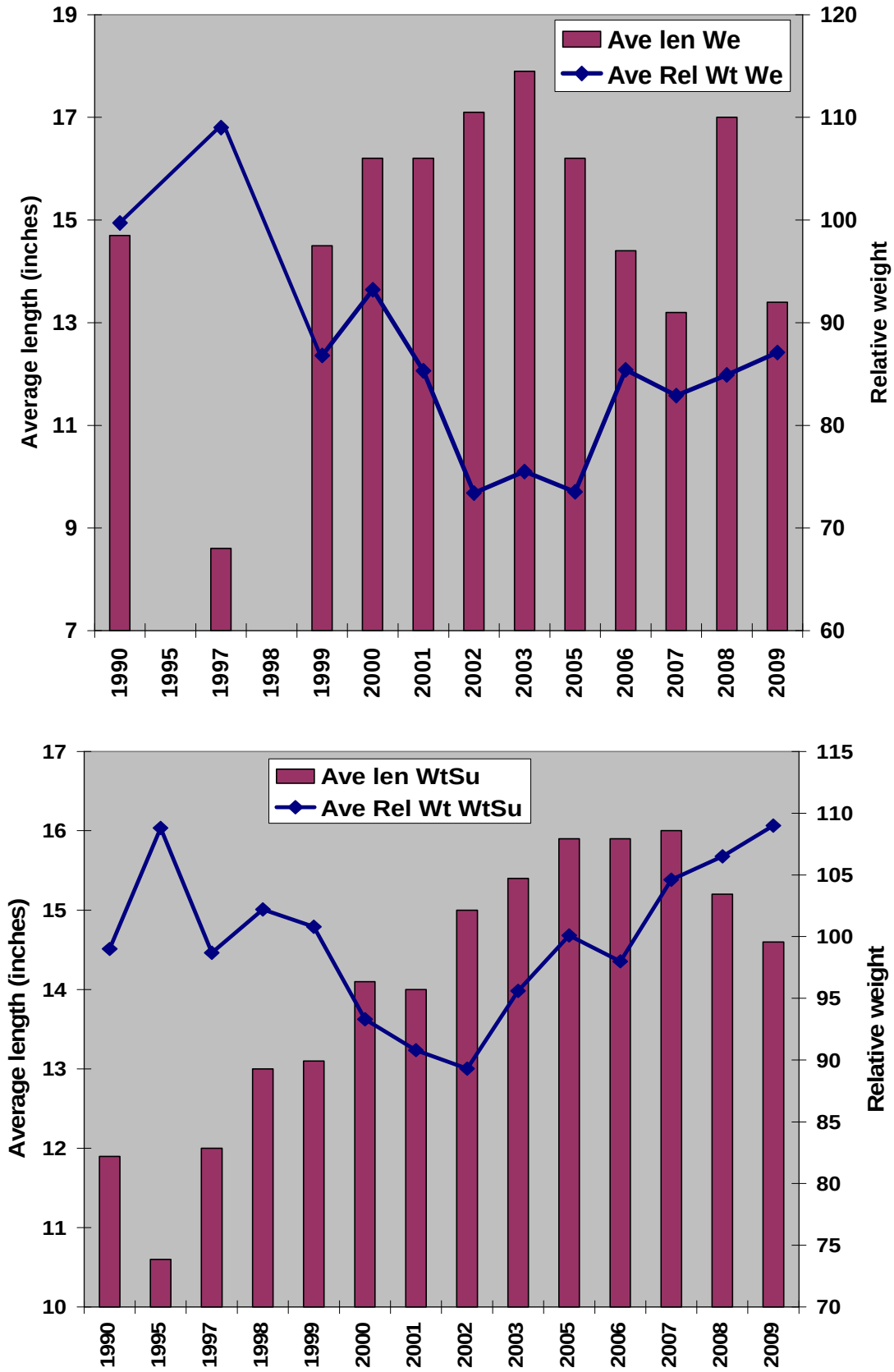

Figure 8. Annual trends in average length (inches) and relative weight of walleye (top panel) and white suckers (bottom panel) caught in floating and sinking gill nets set in Morony Reservoir during 1990-2009. Only data from years when at least four individuals were measured and weighed are included.

Discussion

Comparison of Reservoirs and Net Types

Netting surveys were conducted on Rainbow Reservoir only in 2008 and 2009, and results indicated substantial differences between Rainbow and the three downstream reservoirs. Comparison of average sinking net catch only for the 2008-2009 period indicated densities of white suckers, longnose suckers and black bullheads were substantially higher in Rainbow than in downstream waters (Figure 9). The relatively high abundance of suckers in Rainbow Reservoir is probably due to two factors. Walleye abundance in Rainbow was substantially lower than in the other waters, hence the predation impact on sucker populations was probably lower. Also, Rainbow Reservoir has far more riverine habitat in its headwaters than the other three reservoirs. An approximate 2-mile stretch of free-flowing river exists between the headwaters of Rainbow Reservoir (near Giant Springs) and Black Eagle Dam, located upstream. The three downstream reservoirs (Cochrane, Ryan, Morony) essentially impound water to the base of the next upstream dam, with little or no riverine habitat. The river section immediately upstream from Rainbow Reservoir could provide spawning and rearing habitat for suckers, as well as provide a relatively high-velocity refuge from predatory walleye.

The relatively high population of black bullheads in Rainbow Reservoir could be explained by the reduced walleye population (fewer predators), the presence of a significant amount of 'weedy' habitat in the reservoir immediately downstream from Giant Springs, and proximity to known sources of black bullheads in the Missouri and lower Sun rivers.

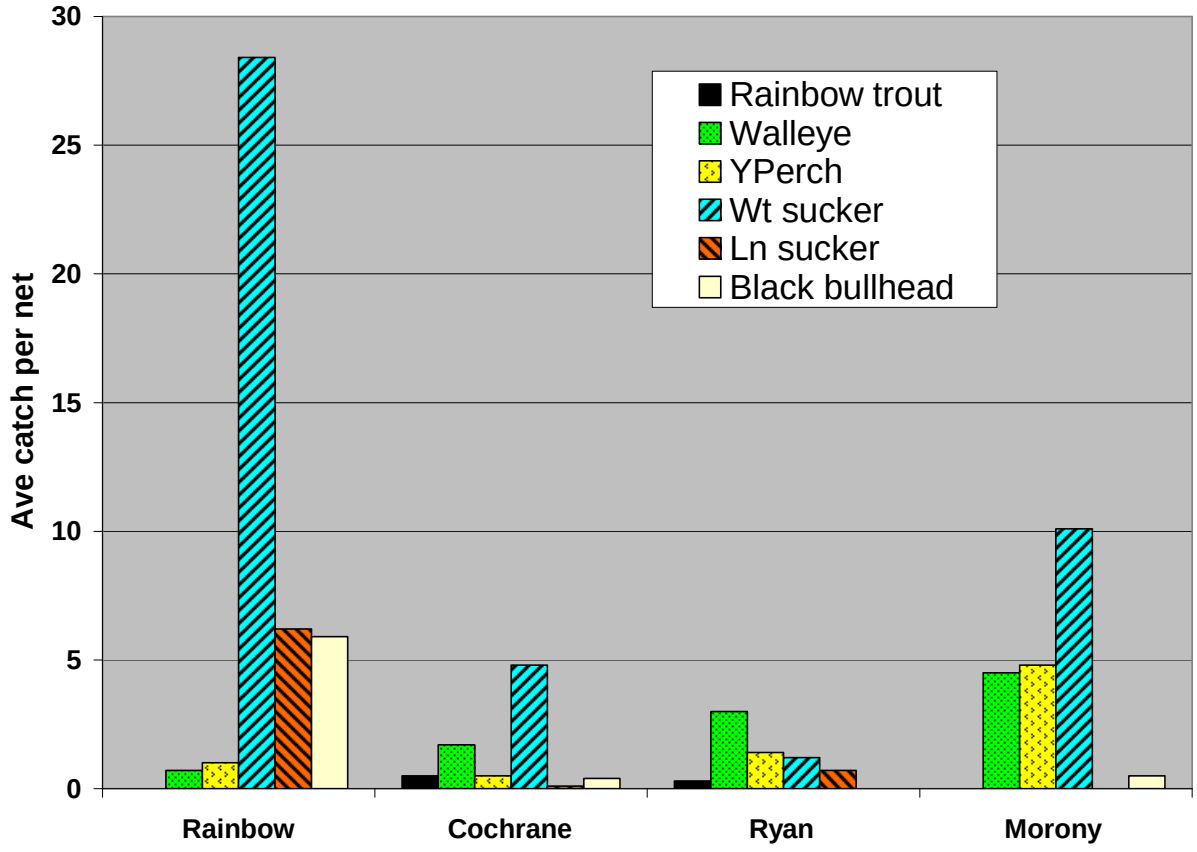

Figure 9. Comparison of average catch, by species, in sinking gill nets set in four Great Falls reservoirs during 2008 and 2009.

On average, sinking gill nets captured 2-5 times as many fish as floating nets in Cochrane, Ryan and Morony Reservoirs (Table 15). Floating net catches were slightly higher in Cochrane and Ryan than in Morony, while sinking net catches were lower in Ryan than in the other two reservoirs. Of the five most common fish species (We, YP, Rb, WtSu, LnSu), only rainbow trout were caught in higher numbers in floating nets than in sinking nets. Average rainbow trout catch in floating nets decreased progressively in a downstream direction (Table 15). Due to the low catch rates in floating nets and the shallowness of the Great Falls reservoirs, effective fish population monitoring can probably be achieved by setting 3-4 sinking nets in each reservoir and discontinuing use of floating nets.

Table 15. Comparison of average catch (fish/net) in standard experimental floating and sinking gill nets set in Cochrane, Ryan and Morony Reservoirs during 1990-2009.

Species	Cochrane		Ryan		Morony	
	Floating	**Sinking**	**Floating**	**Sinking**	**Floating**	**Sinking**
We	1.2	3.4	1.8	4.0	0.6	2.7
Sgr	0.2	0.4	0.4	0.3	< .1	0.2
YP	0.7	3.3	0.3	1.5	0.2	3.5
Rb	1.0	0.3	0.8	0.5	0.3	0
LL	0.2	0.2	0.2	0.1	0.1	< .1
WtSu	5.4	29.0	3.5	11.4	6.0	30.6
LnSu	0.4	1.2	2.2	2.1	0	0.1
MWf	0.3	0.2	0.2	0.2	0	0
Carp	0.1	0.3	< .1	0.3	0.1	0.2
BlBh	0.1	0.8	< .1	0.3	< .1	0.3
FhCh	0.1	0	0	0.1	0.1	0
Pump	0	< .1	0	0	0	0
Ling	0	< .1	0	0	0	0
EBT	0	0	< .1	0	0	0
TOTAL	***9.7***	***39.1***	***9.4***	***20.8***	***7.4***	***37.6***
# Nets	41	45	43	44	40	42

Rainbow Trout Populations & Influence of Stocking

Rainbow trout catches in the Great Falls reservoirs were very low in comparison to other waters in northcentral Montana that support popular sport fisheries for this species (Table 16). Even though catchable-sized rainbows were stocked annually into Rainbow Reservoir (or in the river immediately upstream), no rainbows were captured in nets set there in 2008 and 2009. Rainbow trout stocked into Rainbow Reservoir may concentrate in the plume of cold, clear water emanating from Giant Springs and may also move into the 2-mile section of river immediately upstream, where they would not be detected by these netting surveys.

Rainbow trout have been the most common fish stocked in the Great Falls reservoirs over the years. Rainbows were stocked annually in the Giant Springs area (Rainbow Reservoir and headwaters) during 1946-1985 and again during 2000-2009. Rainbows were not stocked in the system during 1986-1999. Given the short retention times of these reservoirs, one might expect significant flushing losses of hatchery rainbows to downstream reservoirs (Cochrane, Ryan and Morony). However, comparison of

periods when rainbows were stocked versus periods when they were not stocked indicates rainbow trout density was somewhat higher in the downstream reservoirs during the non-stocking period (Table 17).

Catchable-sized hatchery rainbow trout are easily recognized in the wild after stocking because their fins are typically heavily worn and deformed as a result of nipping and abrasion that occurs in the hatchery raceways. All rainbow trout captured during 2008-2010 were examined closely for fin erosion. Sample size is low because of low abundance of rainbows in these reservoirs, but only 25% of the 28 rainbows examined from Cochrane, Ryan and Morony during this 3-year period were identified as hatchery fish. There is essentially no spawning habitat available to rainbows living in these three reservoirs, hence it is nearly certain that most of the rainbows in these waters are wild fish that drift in from upstream areas.

The failure of the Great Falls reservoirs to support healthy populations of rainbow trout is probably related to their short retention times, limited food supply, limited spawning habitat, and high water temperatures coupled with a lack of thermal stratification. Zooplankton, primarily *Daphnia*, provide the bulk of the rainbow trout diet in the extremely productive reservoirs (Canyon Ferry, Hauser, Holter) located upstream on the Missouri River near Helena, MT (MDFWP 2010). Zooplankton have not been quantified in the Great Falls reservoirs, but it is likely that densities are low, due to short retention times and the long distance from the nearest upstream reservoir (Holter, located approximately 100 miles upstream). Cowell (1970) concluded that the retention time in Lewis and Clark Reservoir on the Missouri River in Nebraska was too short (average annual retention time 10 days) for the development of zooplankton populations. Johnson (1964) observed a dramatic negative effect on zooplankton standing crop when mean retention time was less than 15 days and summarized other authors suggesting the minimum flushing time for significant zooplankton production was 10-18 days. Average annual retention time of the Great Falls reservoirs is less than one day.

Table16 . Rainbow and cutthroat trout catches in standard 6x125' floating experimental gill nets set in the fall in Great Falls reservoirs compared to catches in identical nets set in other popular trout fishing reservoirs in northcentral Montana during fall 2005-2009.

Reservoir	Surface acres @ full pool	# Years surveyed during 2005-2009	Total # experimental floating nets set in fall	Ave catch per net	
				Rb	Ct
Cochrane Res.	249	5	15	0.9	-
Ryan Res.	168	5	15	0.9	-
Morony Res.	304	5	14	0.1	-
Ackley Res.[1]	226	5	5	24.4	-
Bair Res.[1]	221	5	5	17.6	1.2
Canyon Ferry Res.[2]	35,200	5	90	3.7	-
Hauser Res.[2]	3,800	5	55	2.8	-
Holter Res.[2]	4,800	5	45	4.3	-
Newlan Cr. Res.[3]	275	4	5	4.6	0.6
Nilan Res.[4]	520	5	10	5.7	-
Willow Cr. Res.[4]	1,314	5	20	3.7	-

[1]*Data from Anne Tews (FWP, Lewistown)* [3]*Data from Paul Hamlin (FWP, Great Falls)*
[2]*Data from Eric Roberts (FWP, Helena)* [4]*Data from Dave Yerk (FWP, Choteau)*

Table17. Comparison of rainbow trout catches in floating gill nets set in Cochrane, Ryan and Morony reservoirs during 1990-1999 (years when rainbow were not stocked in the system) versus 2000-2009 (years when rainbow trout were stocked). Standard deviation in parenthesis.

	Ave # rainbow caught per net	
Reservoir	**Non-stocked years (1990-1999)**	**Stocked years (2000-2009)**
Cochrane	1.5 (± 1.2)	0.6 (± 0.6)
Ryan	1.0 (± 1.1)	0.7 (± 0.9)
Morony	0.3 (± 0.4)	0.2 (± 0.2)

Evaluation of Sauger Stocking Program

The effort to create a naturally reproducing sauger population in the Great Falls reservoirs appears to have been unsuccessful. Eggs were collected by MDFWP personnel from wild sauger in the Missouri River in the Woodhawk area (between the mouth of the Judith River and Fred Robinson Bridge) and were hatched and raised at the Miles City state fish hatchery. Progeny were stocked in Cochrane in 2001, 2002, and 2005; in Ryan in 2005; and in Morony between 1999 and 2005. Sauger were not caught in gill nets set in Cochrane after 2006. Very low numbers of sauger were netted in Ryan in 2009, but none were captured in nets on Morony in 2009. Though not covered in this report, three floating and three sinking nets were set in each reservoir in 2010 and not a single sauger was captured. Temporary establishment of sauger in the three reservoirs apparently created competition with walleye for prey fish. Walleye relative weight declined noticeably in all three reservoirs during years when sauger were regularly caught in gill nets.

Walleye & Sucker Population Trends

Walleye were typically one of the 2-3 most abundant species captured by netting in the Great Falls reservoirs and have been the most common gamefish caught in gill nets in recent years. Comparison with other popular walleye fishing reservoirs in the local area indicates that walleye density and average length in the Great Falls reservoirs are similar to other local waters (Table 16). Relative weight of walleye in the Great Falls reservoirs tends to be a bit lower than on the other local reservoirs, indicating forage limitations. In general, walleye tend to be less plump in northcentral Montana reservoirs than in other areas, probably as a result of a lack of native prey fish species diversity in local waters. The average relative weight value for 114 walleye populations in North America was approximately 93 (Murphy et al. 1990), while the average walleye relative weight in northcentral Montana reservoirs typically ranges from 85-90.

Walleye numbers in Cochrane Reservoir were very low and were substantially lower than in the two downstream reservoirs (Ryan and Morony) during 1990-1995. This suggests that stocking a total of 400,000 walleye fry into Cochrane during 1977-1986 was largely unsuccessful. However, walleye were fairly abundant in Ryan Reservoir (immediately downstream from Cochrane) during 1990-1995, perhaps as a result of stocking and subsequent flushing losses from Cochrane. Walleye were fairly common in Morony during 1990-1998, though densities were much lower than in Ryan during the same period for unknown reasons. The apparent higher density of walleye in Ryan versus Cochrane or Morony during 1990-2005 is puzzling. Ryan Reservoir is much smaller and shallower than the other two reservoirs and has an average retention time of only 6 hours. Personal communication with PPL

reservoir operation staff indicated water level fluctuations in Ryan Reservoir were not much different than on Cochrane or Morony. Coincidentally, Ryan supported sauger longer than the other two reservoirs, suggesting it is indeed a more favorable environment for the closely-related predatory percids. The aquatic habitat in all three reservoirs is very similar, but Ryan may be more turbid than the other two reservoirs, which could favor walleye and sauger. Morony Reservoir had the most walleye stocked and was regularly stocked with walleye fingerlings between 1985 and 1996. Much of this stocking did not appear to be effective, as the Morony walleye population did not increase significantly until 1999, three years after walleye fingerling stocking ceased.

Table16. Catch and size statistics for walleye caught in standard 6x125-foot sinking experimental gill nets set in the fall in Great Falls reservoirs compared to catches in other popular walleye fishing reservoirs in northcentral Montana during 2005-2009.

Reservoir	Surface acres @ full pool	# Years surveyed in 2005-2009	Total # sinking nets set in 5 yrs	Ave # We per net	Ave We length (in)	Ave We relative weight
Cochrane Res.	249	5	17	3.8	13.4	87.5
Ryan Res.	168	5	16	3.3	12.3	80.6
Morony Res.	304	5	18	3.8	14.9	83.2
Canyon Ferry Res[1]	35,200	5	75	5.0	14.9	91.5
Hauser Res.[1]	3,800	5	35	4.6	10.9	86.8
Holter Res.[1]	4,800	5	30	5.2	13.7	89.3
Lake Frances[2]	3,618	5	50	6.7	15.5	90.7
Tiber Res.[2]	14,842	5	150	2.4	14.5	88.3

[1]*Data from Eric Roberts (FWP, Helena)*

[2]*Data from Dave Yerk (FWP, Choteau)*

The presence of a significant walleye population in the Great Falls reservoirs is somewhat surprising, given the short retention times of the reservoirs. Willis and Stephen (1987) observed that walleye populations and stocking success were very low in Kansas reservoirs when storage ratio was less than 1.0 (equivalent to a retention time of 1 year, or 365 days). Maceina and Stimpert (1998) observed very poor recruitment of white crappie in southeastern US reservoirs when retention time was less than 6-10 days. The Great Falls reservoirs have average retention times of less than one day, raising the question of whether the walleye populations in these reservoirs sustain themselves by natural reproduction within the reservoirs or are supported by the influx of walleye from upstream areas.

The overall abundance of walleye in the Missouri River/reservoir complex upstream from Great Falls has changed dramatically in the past 15 years. Walleye were first introduced in 1951 into Lake Helena, which is connected to Hauser Reservoir, near Helena (MDFWP 2010). Walleye existed in very low numbers in Hauser (115 miles upstream from Great Falls) for more than 40 years following this introduction, but they apparently drifted downstream into Holter Reservoir (90 miles upstream from Great Falls) shortly after being stocked in Lake Helena. Walleye eventually established a stable, naturally reproducing population that has persisted in Holter for many years.

The abundance of walleye in the upper Missouri River complex changed dramatically following the establishment of walleye in Canyon Ferry Reservoir in the mid- to late 1990's. Canyon Ferry is the first significant reservoir on the mainstem Missouri River and is located approximately 130 miles

upstream from Great Falls. It is very large (35,200 surface acres) compared to Hauser Reservoir (3800 acres), which is located immediately downstream, and Holter Reservoir (4800 acres), located immediately downstream from Hauser. Walleye were never stocked into Canyon Ferry or in upstream areas by MDFWP and were not captured in extensive netting surveys on the reservoir from 1955-1988. The first capture of walleye in gill nets on Canyon Ferry occurred in 1989 (MDFWP 2010). Though never conclusively proven, the evidence strongly suggests walleye were illegally stocked in Canyon Ferry.

Following their first appearance in 1989, the Canyon Ferry walleye population reached detectable numbers by 1994 and the population expanded dramatically in subsequent years (Figure 10). Walleye were rarely caught in Hauser gill nets until 1996-1998, and the Hauser walleye population expansion mirrored the Canyon Ferry expansion very closely. The striking similarity of the two population trends indicates the Hauser walleye population expansion was initiated, if not maintained, by fish drifting in from Canyon Ferry (Figure 10).

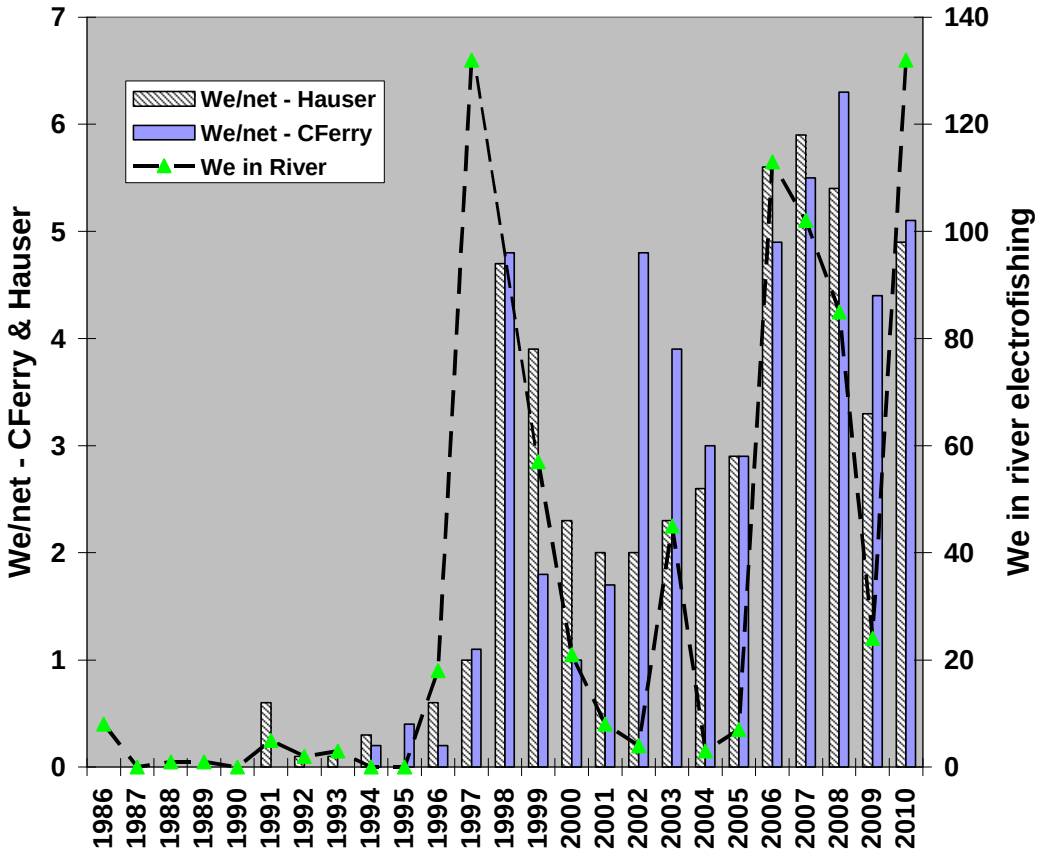

Figure 10. Walleye population trends in sinking gill nets set in Canyon Ferry Reservoir and Hauser Reservoir and the total number of walleye captured in fall electrofishing sections (Craig and Pelican Point Sections combined) on the Missouri River downstream from Holter Dam. Data provided by Eric Roberts and Grant Grisak, MT Department of Fish, Wildlife & Parks.

The establishment of a high-density walleye population in Canyon Ferry appears to have influenced walleye population levels in the Missouri River between Holter Dam and Great Falls as well. MDFWP has monitored fish populations by electrofishing in two sections of the Missouri River (Craig section – 6 miles below Holter Dam; Pelican Point section – 26 miles below Holter Dam) periodically since 1980. Walleye numbers were very low in the river sections during 1980-1995, and no more than

a total of five walleye were captured during fall electrofishing in either section in a given year during that period. The pattern of low walleye abundance in the river changed dramatically beginning in 1996 and record numbers of walleye were captured in the river sections in 1997 (Figure 10). Walleye numbers have varied substantially since 1997, but on average there has been a more than 20-fold increase in annual walleye catch in the river between the periods 1986-1995 (pre-Canyon Ferry walleye expansion) and 1996-2009 (post-expansion). Although walleye numbers appear to have increased noticeably in the river downstream from Holter Dam, trout still outnumber walleye there by a factor of 100:1 or more.

The dramatic increase in the walleye population that occurred in 1997 in the river below Holter Dam and also in Cochrane Reservoir appears to be closely related to expanding walleye numbers in Canyon Ferry and Hauser reservoirs at the same time (Figure 10) coupled coincidentally with unusually high flushing flows during 1995-1998 (Figure 2). Tagging and entrainment studies have shown that walleye frequently flush out of the Helena area Missouri River reservoirs (Canyon Ferry, Hauser, Holter) into downstream waters. Rainbow trout and walleye were the two most abundant species flushed from Hauser in 2007 and 2008, when an estimated 8,000-19,000 walleye flushed through and over the dam each year (Spinelli 2010). River flow during Spinelli's two-year study period was average to below-average, and was well below levels observed in 1995-1997 when walleye populations expanded throughout the system. Hence it is quite possible that even higher numbers of walleye flushed from the reservoirs above Holter Dam during the high water years of 1995-1998. Humphrey and Skaar (1997) reported that higher numbers of rainbow trout were flushed (entrained) from the Helena-area reservoirs during high water years.

Fish flushing rates have not been quantified at Holter Dam, but a substantial number of walleye tagged in Holter Reservoir have been recovered in the river downstream from Holter (personal communication with Eric Roberts and Troy Humphrey, MT Dept Fish, Wildlife & Parks, Helena) and walleye tagged in Canyon Ferry Reservoir have also been recovered in the river below Holter (personal communication with Adam Strainer, Montana Dept FW&P, Helena). In addition, Humphrey and Skaar (1997) reported substantial numbers of hatchery rainbow trout stocked in Holter Reservoir were later recaptured by anglers and electrofishing in the river immediately below the dam.

Interpretation of walleye population trends on Ryan and Morony reservoirs and the possible influence of walleye flushing in from upstream sources is complicated by periodic stocking of walleye by MDFWP in the Great Falls reservoirs during 1977-1996. However, as mentioned previously, walleye stocking in Cochrane during 1977-1986 did not appear to be very successful, based on consistently low catches of walleye observed in 1990, 1992 and 1995 netting surveys. Walleye numbers in Cochrane increased dramatically in 1997 and this increase corresponded precisely with the dramatic increase in walleye numbers in the Craig and Pelican Point electrofishing sections, located approximately 80 and 60 miles upstream respectively of Cochrane (Figure 11). However, with the exception of the close correspondence in 1997, there was no correlation between the number of walleye netted in Cochrane and the number of walleye captured in upstream river electrofishing sections the same year ($R^2 = 0.11$) or in the previous year ($R^2 = 0.02$).

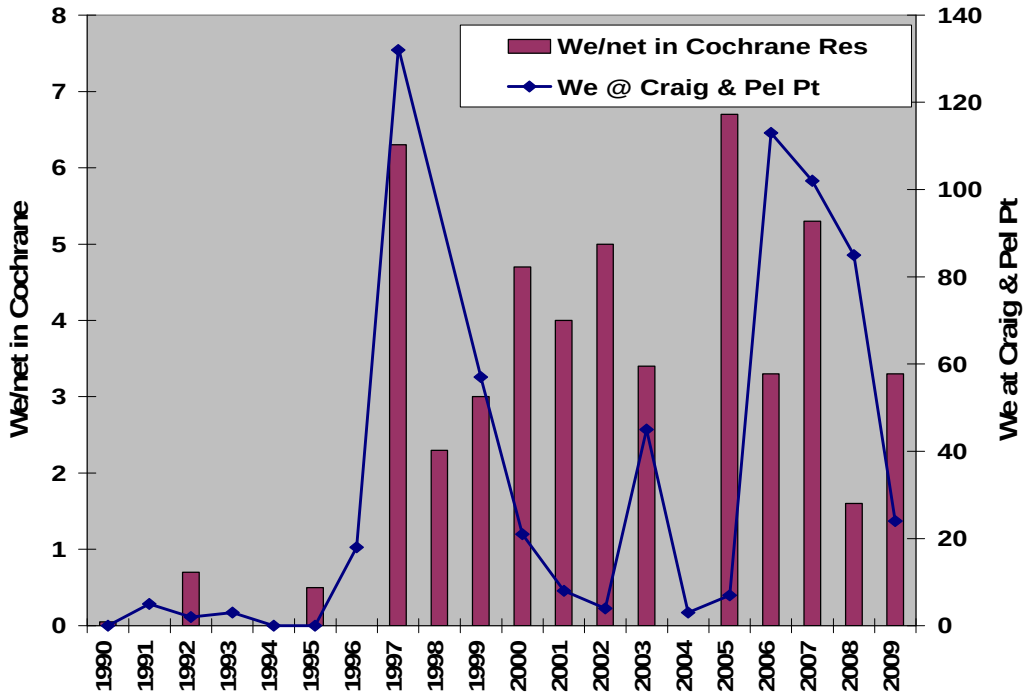

Figure 11. Average number of walleye caught in fall sinking gill nets in Cochrane Reservoir compared to the total number of walleye captured in fall electrofishing sections on the Missouri River downstream from Holter Dam, 1990-2009. Electrofishing data provided by Grant Grisak, MDFW&P.

Walleye net catches showed no clear temporal trend in Ryan Reservoir, but walleye numbers in Morony did appear to increase and remain high after 1998, perhaps also in response to an overall increase in walleye numbers in the Missouri River system upstream from Great Falls. Coincidentally, there appeared to be a decline in average size of walleye in Ryan and Morony in 1997 (Appendix A5 & A9). This might suggest an influx of juvenile fish from upstream sources, but sample sizes were somewhat low and there was no dramatic increase in number of walleye caught in Ryan and Morony in 1997 as was noted on Cochrane. There was also a general increase in walleye numbers and a decrease in walleye size during 1995-1999 in the Morony electrofishing section on the Missouri River, located about five miles downstream from Morony Dam (Appendix A13), suggesting that the river downstream from Great Falls may also have been affected by walleye expansion in Canyon Ferry. Coincidentally, the four highest river runoff years observed in the 23-year period (1987-2009) occurred consecutively during 1995-1998.

Trends in sucker populations can also be used to provide some insight into the sources and effects of expanding walleye populations in the study area. Perhaps the most obvious fish population trend in the Great Falls reservoirs during 1990-2009 was the overall decline of white sucker numbers and the substantial and steady increase in the average length of white suckers (Figure 12). Though sample sizes are more limited, longnose suckers showed the same trends in Cochrane and Ryan reservoirs. The abundance of longnose suckers in sinking gillnets declined noticeably after 1999 in these two reservoirs (Tables 10 &12). The most likely explanation for these trends is that walleye were controlling the abundance and size composition of sucker populations by selectively preying on juvenile fish. This exact same trend was observed in Canyon Ferry Reservoir, where sucker numbers began declining and average size began increasing noticeably after walleye became abundant in 1997 (Appendix A14). The same phenomenon was also observed in Hauser reservoir when the walleye population expanded (personal communication with Eric Roberts, MDFWP, Helena).

The effect of walleye on sucker populations seemed most pronounced on Cochrane Reservoir, which had the highest number and smallest average size of white suckers in the early 1990's and also had the lowest walleye population (Figure 12). Trends in sucker populations (especially average length), suggest the relatively high walleye populations in Ryan and Morony is a relatively recent phenomenon, probably resulting from walleye stocking in the 1970's and 1980's. Using sucker population trends as a guide, it is likely that pre-stocking walleye populations in Ryan and Morony were low, as they were in Cochrane prior to the postulated major influx of walleye from upstream sources in 1997. Natural reproduction and recruitment of walleye within the Great Falls reservoirs is probably very low due to short reservoir retention times and resulting high flushing of juvenile fish. This conclusion is supported by the observed lack of natural reproduction by sauger (a closely related species) in recent years.

The newly-founded walleye population in Canyon Ferry Reservoir expanded rapidly during 1994-1998, which happened to coincide with four consecutive years of exceptionally high runoff. Evidence strongly suggests a substantial number of walleye were flushed out of Canyon Ferry during those years, which increased walleye populations in Hauser Reservoir, the Missouri River downstream from Holter Dam, Cochrane Reservoir, and possibly the Missouri River downstream from Morony Dam.

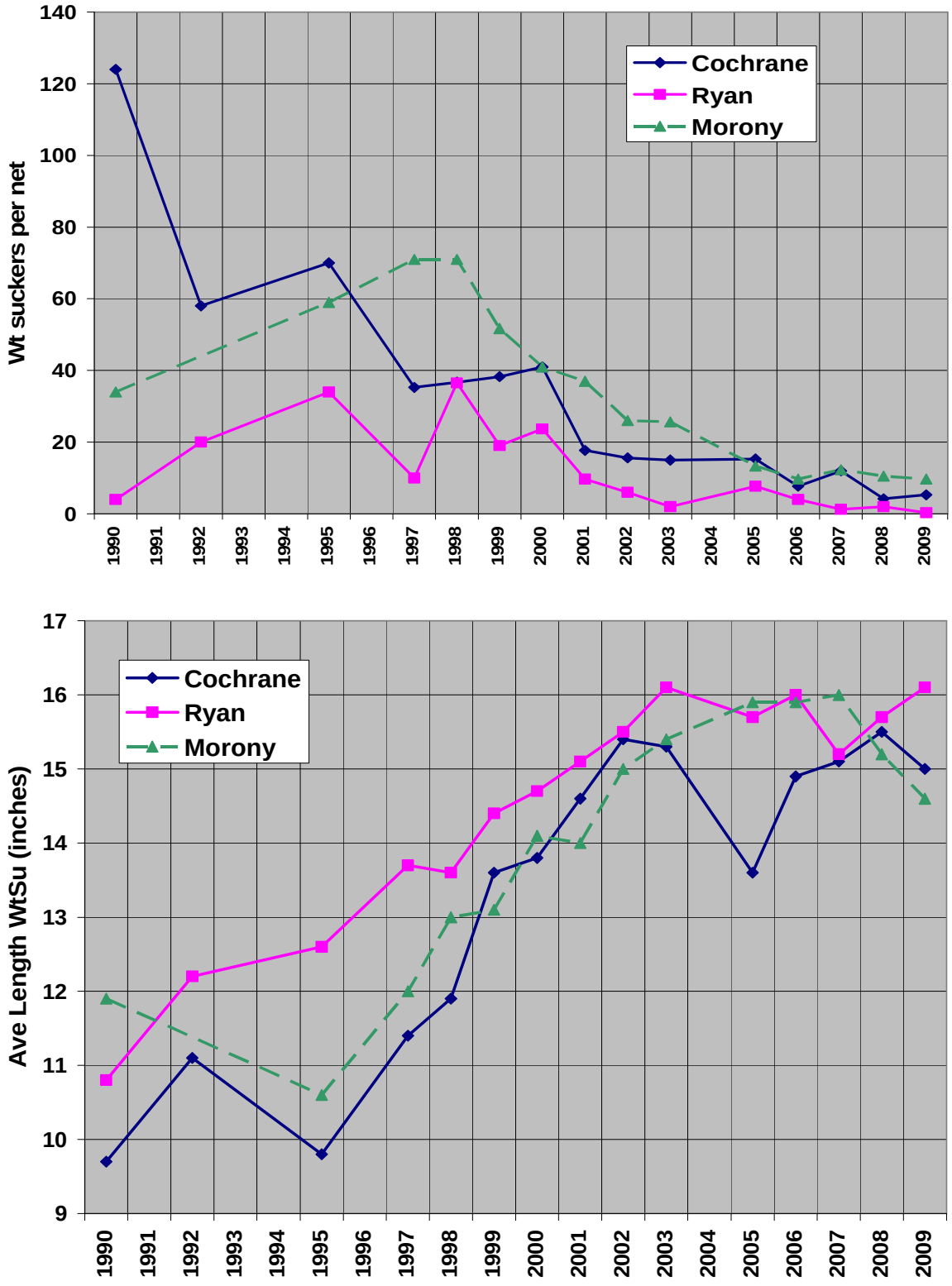

Figure 12. Average number of white suckers captured per sinking gill net (top panel) and average length of white suckers (lower panel) caught in Cochrane, Ryan and Morony Reservoirs 1990-2009.

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Brent Mabbott, Tim Schultz, Frank Pickett and others at PPL Montana collected much of the field data presented in this report. Eric Roberts, Grant Grisak, and Randy Rodencal from MT Department of Fish, Wildlife and Parks kindly provided data from the Missouri River and reservoirs. Paul Hamlin, Anne Tews, and Dave Yerk from MDFWP provided information from other waters in northcentral Montana.

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SPECIES ABBREVIATIONS USED IN THIS REPORT:

BlBh – Black bullhead
Carp – Carp
EBT – Eastern brook trout
FhCh – Flathead chub
Ling – Burbot
LL – Brown Trout (Loch Leven)
LnSu – Longnose sucker
MWf – Mountain whitefish
Pump – Pumpkinseed sunfish
Rb – Rainbow trout
Sgr - Sauger
We - Walleye
WtSu or WSu – White sucker
YP – Yellow perch

APPENDIX

Appendix A1. Size statistics for walleye, perch, and white suckers caught in floating and sinking experimental gill nets in Cochrane Reservoir during 1990-2009.

Year	Walleye								Yellow perch								White sucker							
	N	Length (in)			Weight (lb)		Relative weight		*N*	Length (in)			Weight (lb)		Relative weight		*N*	Length (in)			Weight (lb)		Relative weight	
		Ave	SD	95% CI	Ave	SD	Ave	SD		Ave	SD	95% CI	Ave	SD	Ave	SD		Ave	SD	95% CI	Ave	SD	Ave	SD
1990	***0***								***28***	6.6	0.51	1.00	0.15	0.06	97.5	18.2	***271***	9.7	0.72	1.42	0.55	0.26	94.4	25.4
1992	***3***	12.4	-	0.14	0.86	-	106.3	-	***3***	8.5	-	-	0.31	-	89.3	-	***191***	11.1	0.90	1.77	0.64	0.33	87.0	25.6
1995	***1***	13.5			0.81		90.4		***8***	8.7	0.58	1.13	0.33	-	107.2	13.8	***179***	9.8	0.90	1.77	0.68	0.36	94.1	28.4
1997	***21***	11.7	0.52	1.01	0.64	0.11	96.6	15.9	***5***	6.9	0.23	0.45	0.18	0.03	88.3	7.6	***134***	11.4	0.92	1.80	0.77	0.29	90.7	40.9
1998	***7***	12.9	0.12	0.23	0.85	0.04	99.0	5.7	***15***	6.1	0.31	0.61	0.14	0.04	127.9	39.3	***146***	11.9	0.76	1.48	0.89	0.29	102.0	28.7
1999	***16***	15.3	0.52	1.02	1.27	0.17	90.1	12.4	***12***	6.9	0.41	0.80	0.17	0.05	99.9	56.9	***150***	13.6	0.79	1.56	1.19	0.32	98.7	53.0
2000	***22***	13.9	0.53	1.03	1.14	0.37	97.5	27.3	***24***	8.2	0.49	0.96	0.31	0.09	107.8	23.6	***135***	13.8	0.69	1.35	1.21	0.30	101.3	22.8
2001	***19***	13.4	0.44	0.86	0.89	0.14	95.9	13.7	***13***	8.7	0.38	0.74	0.35	0.06	101.7	17.1	***63***	14.6	0.63	1.23	1.39	0.35	97.8	19.9
2002	***16***	13.1	0.55	1.07	0.68	0.18	77.3	17.4	***10***	8.5	0.33	0.65	0.33	0.08	87.7	33.2	***52***	15.4	0.60	1.17	1.57	0.32	96.1	17.7
2003	***15***	12.4	0.64	1.25	0.63	0.05	80.3	12.3	***23***	8.2	0.32	0.63	0.30	0.04	100.1	18.5	***48***	15.3	0.52	1.02	1.57	0.28	96.5	15.3
2005	***23***	13.7	0.57	1.11	0.91	0.39	82.4	33.0	***7***	7.4	0.46	0.91	0.23	0.06	87.5	6.8	***52***	13.6	0.71	1.39	1.25	0.36	100.9	28.8
2006	***12***	13.6	0.24	0.47	0.96	0.05	83.5	5.1	***10***	8.5	0.52	1.02	0.35	0.08	107.1	4.9	***26***	14.9	0.40	0.79	1.64	0.30	105.1	14.7
2007	***23***	13.4	0.77	1.50	0.86	0.16	91.6	16.1	***13***	7.3	0.23	0.44	0.19	0.05	88.9	28.0	***37***	15.1	0.90	1.75	1.67	0.26	101.4	14.7
2008	***9***	16.5	0.67	1.31	2.12	0.05	91.9	12.4	***4***	7.8	0.35	0.68	0.23	0.03	92.0	4.5	***23***	15.5	0.50	0.97	1.85	0.27	105.6	11.7
2009	***15***	10.8	0.53	1.03	0.44	0.05	89.8	11.0	***2***	9.9	-	-	0.56	-	106.5	-	***19***	15.0	0.58	1.14	1.69	0.43	109.3	19.2

Appendix A2. Trends in relative weight by length group for walleye caught in standard floating and sinking experimental gill nets in Cochrane Reservoir during 1990-2009.

Year	8-11.9”			12-15.9”			16.0-19.9”		
	N	Ave rel wt	SD	*N*	Ave rel wt	SD	*N*	Ave rel wt	SD
1990	*0*			*0*			*0*		
1992				*2*	96.4	1.4			
1995				*1*	90.4				
1997	*4*	95.3	8.6	*12*	96.9	11.5	*1*	95.3	
1998	*2*	108.7	6.6	*4*	94.6	6.3	*1*	97.1	
1999	*3*	96.3	9.0	*8*	87.2	5.6	*5*	91.0	4.5
2000	*7*	96.6	13.5	*6*	97.0	9.2	*6*	90.2	11.9
2001	*4*	89.8	3.8	*12*	96.3	4.6	*2*	90.2	5.9
2002	*3*	82.6	11.9	*11*	75.3	6.9	*1*	79.2	
2003	*10*	80.6	7.4	*4*	78.5	6.3	*1*	84.1	
2005	*7*	83.3	6.9	*12*	83.8	19.7	*3*	75.8	5.9
2006	*6*	82.3	4.4	*2*	82.8	2.8	*3*	88.8	2.7
2007	*8*	85.9	5.7	*9*	87.5	7.2	*5*	82.3	4.1
2008	*2*	85.1	1.0	*3*	92.8	17.7	*1*	101.6	
2009	*11*	89.5	3.6	*4*	90.6	8.2			

Appendix A3. Trends in relative weight by length group for white suckers caught in standard floating and sinking experimental gill nets in Cochrane Reservoir during 1990-2009.

Year	8-11.9”			12-15.9”			16.0-19.9”		
	N	Ave rel wt	SD	*N*	Ave rel wt	SD	*N*	Ave rel wt	SD
1990	*22*	97.0	7.7	*14*	100.0	7.8	*3*	101.5	3.8
1992	*100*	84.7	6.4	*64*	89.4	7.3	*8*	90.9	7.7
1995	*87*	93.6	8.4	*38*	95.5	8.7	*4*	88.2	4.8
1997	*34*	85.5	10.3	*71*	99.0	7.0	*3*	96.0	5.4
1998	*37*	96.7	8.1	*85*	104.0	9.0	*2*	98.8	1.6
1999	*25*	91.5	10.9	*108*	100.3	8.7	*13*	102.4	5.1
2000	*10*	100.1	10.0	*118*	102.0	9.0	*6*	89.2	9.1
2001	*1*	97.6		*53*	97.8	8.9	*8*	97.0	8.9
2002	*1*	90.0		*34*	98.9	7.4	*17*	90.9	10.8
2003	*1*	85.0		*34*	97.2	7.0	*12*	96.4	7.1
2005	*17*	98.6	6.2	*20*	103.1	13.3	*14*	101.8	8.8
2006	*2*	96.9	7.8	*15*	108.7	7.7	*9*	100.8	7.5
2007	*6*	88.5	11.1	*11*	102.8	7.0	*20*	104.6	5.9
2008	*0*			*11*	108.1	6.9	*11*	105.1	4.5
2009	*1*	94.5		*13*	110.8	8.4	*5*	108.3	7.7

Appendix A4. Average length (inches) and weight (pounds) of less abundant fish species caught in floating and sinking experimental gill nets set in Cochrane Reservoir during 1990-2009.

Year	Rainbow trout			Brown trout			Sauger			Longnose sucker			Black bullhead		
	N	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**
1990	***5***	14.1	1.24	***2***	18.9	2.91				***10***	8.5	0.30	***12***	8.0	0.25
1992	***10***	16.6	2.17	***3***	16.2	1.67				***13***	9.2	0.41	***1***	8.7	0.24
1995	***5***	18.1	2.60	***1***	11.5					***13***	9.3	0.57	***2***	8.8	0.44
1997				***1***	14.4					***4***	12.0	0.61	***13***	8.9	0.31
1998	***2***	12.5	0.75							***7***	12.8	0.98	***1***	7.8	0.25
1999	***8***	13.5	1.11	***1***	10.3	0.38				***11***	12.9	1.04			
2000	***2***	15.2	1.35	***4***	14.1	0.94				***2***	14.1	1.25	***1***	8.0	0.19
2001				***1***	20.3	2.95	***2***	7.6	0.14	***1***	14.3	1.24	***2***	10.2	0.40
2002	***1***	14.5	1.25				***4***	10.6	0.31				***1***	10.4	0.40
2003				***2***	17.1	2.36	***15***	11.0	0.37				***1***	9.3	0.29
2005	***3***	13.8	1.04	***1***	10.0	0.35	***1***	17.5	1.37	***3***	12.2	0.82	***1***	9.2	0.34
2006	***2***	12.2	0.79	***2***	13.7	1.05	***4***	12.5	0.69	***1***	16.2	1.62	***1***	8.5	0.24
2007	***2***	14.1	0.92							***2***	11.2	0.94	***1***	9.9	0.36
2008	***2***	13.2	0.92							***2***	15.0	1.75			
2009	***9***	14.5	1.27							***2***	16.4	2.00	***2***	7.2	0.20

Appendix A5. Size statistics for walleye, perch, and white suckers caught in floating and sinking experimental gill nets in Ryan Reservoir during 1990-2009.

Year	Walleye								Yellow perch								White sucker							
	N	Length (in)			Weight (lb)		Relative weight		*N*	Length (in)			Weight (lb)		Relative weight		*N*	Length (in)			Weight (lb)		Relative weight	
		Ave	SD	95% CI	Ave	SD	Ave	SD		Ave	SD	95% CI	Ave	SD	Ave	SD		Ave	SD	95% CI	Ave	SD	Ave	SD
1990	***14***	13.6	0.39	0.76	1.03	0.06	100.0	3.9	***2***	7.7	-	-	0.29	-	103.9	-	***10***	10.8	0.50	0.99	0.68	0.11	93.2	5.2
1992	***40***	15.3	0.80	1.57	1.29	0.32	85.8	17.1	***7***	8.1	0.21	0.42	0.22	0.05	96.4	15.7	***80***	12.2	0.79	1.54	0.77	0.32	80.8	26.0
1995	***26***	14.4	0.66	1.29	1.11	0.22	87.0	13.5	***5***	7.6	0.28	0.54	0.19	0.03	87.4	10.3	***110***	12.6	0.82	1.61	1.10	0.43	97.3	47.7
1997	***16***	12.3	0.62	1.22	0.61	0.12	86.8	16.4	***3***	6.0	0.14	0.28	0.10	-	88.9	6.0	***45***	13.7	0.70	1.37	1.19	0.37	99.4	35.6
1998	***5***	15.4	0.49	0.97	1.23	0.04	84.7	4.7	***3***	6.1	0.28	0.55	0.16	0.02	145.3	3.5	***91***	13.6	0.76	1.48	1.20	0.31	103.8	26.1
1999	***14***	14.6	0.67	1.32	1.24	0.34	89.1	19.8	***7***	7.2	0.25	0.49	0.21	0.03	111.8	3.1	***68***	14.4	0.86	1.68	1.47	0.38	108.3	29.1
2000	***23***	13.5	0.50	0.99	0.84	0.20	81.3	14.1	***2***	7.9	-	-	0.28	-	115.1	-	***90***	14.7	0.61	1.20	1.58	0.31	105.3	16.6
2001	***19***	13.7	0.73	1.43	0.92	0.22	81.8	26.5	***5***	8.4	0.38	0.74	0.32	0.08	99.6	12.4	***39***	15.1	0.59	1.15	1.49	0.44	96.1	45.1
2002	***9***	12.8	0.62	1.22	0.69	0.59	79.7	32.8	***7***	6.9	0.25	0.49	0.18	0.02	99.8	14.3	***20***	15.5	0.48	0.94	1.56	0.23	93.7	10.7
2003	***20***	11.8	0.67	1.31	0.37	0.09	73.3	9.27	***7***	8.0	0.10	0.20	0.28	0.02	99.1	7.1	***15***	16.1	0.57	1.12	1.74	0.25	96.0	12.8
2005	***18***	13.6	0.50	0.98	0.97	0.12	78.5	15.0	***3***	9.3	-	-	0.43	-	100.2	-	***28***	15.7	0.65	1.28	1.81	0.26	103.8	16.3
2006	***9***	11.8	0.45	0.88	0.53	0.04	71.9	10.9	***8***	8.5	0.34	0.66	0.34	0.09	93.6	16.5	***23***	16.0	0.46	0.91	1.80	0.33	98.9	19.3
2007	***16***	12.3	0.72	1.41	0.76	0.11	88.8	19.8	***8***	7.0	0.06	0.12	0.21	0.01	126.5	3.5	***10***	15.2	0.37	0.72	1.75	0.24	108.0	9.7
2008	***13***	11.9	0.68	1.33	0.55	0.08	80.6	14.2	***7***	8.8	0.15	0.29	0.31	0.05	87.5	10.2	***17***	15.7	0.27	0.53	1.86	0.21	105.1	10.7
2009	***13***	11.3	0.58	1.13	0.59	0.06	79.7	10.6	***3***	10.8	-	-	0.63	-	90.4	-	***6***	16.1	0.62	1.22	1.92	0.20	105.6	18.4

Appendix A6. Trends in relative weight by length group for white suckers caught in standard floating and sinking experimental gill nets in Ryan Reservoir during 1990-2009.

Year	8-11.9”			12-15.9”			16.0-19.9”		
	N	Ave rel wt	SD	*N*	Ave rel wt	SD	*N*	Ave rel wt	SD
1990	*2*	86.9	3.6	*4*	91.6	2.8	*1*	108.2	-
1992	*37*	72.9	11.5	*36*	87.0	7.8	*6*	95.6	8.1
1995	*29*	85.9	12.1	*71*	102.0	13.8	*4*	98.2	8.7
1997	*6*	89.1	12.1	*37*	101.6	16.6	*2*	91.0	0.9
1998	*14*	100.7	10.8	*73*	104.9	8.9	*4*	94.5	7.2
1999	*6*	112.1	16.1	*55*	108.0	9.4	*7*	107.0	11.3
2000	*5*	99.2	0	*74*	106.1	8.3	*11*	101.9	8.0
2001	*1*	90.7	-	*27*	97.0	12.2	*11*	94.3	4.8
2002				*12*	94.4	7.1	*8*	92.6	6.2
2003				*7*	102.1	7.7	*8*	90.6	10.5
2005	*1*	104.9	-	*9*	110.4	9.8	*18*	100.5	5.9
2006				*10*	104.1	9.4	*13*	94.9	6.7
2007	*1*	107.7	-	*4*	113.2	5.6	*5*	104.2	6.6
2008	*1*	91.9	-	*9*	105.8	5.5	*7*	106.1	7.4
2009				*4*	114.9	9.7	*2*	87.2	15.5

Appendix A7. Trends in relative weight by length group for walleye caught in standard floating and sinking experimental gill nets in Ryan Reservoir during 1990-2009.

Year	8-11.9”			12-15.9”			16.0-19.9”		
	N	Ave rel wt	SD	*N*	Ave rel wt	SD	*N*	Ave rel wt	SD
1990	*1*	97.4	-	*9*	100.6	4.2	*2*	100.1	7.4
1992				*26*	85.0	7.4	*10*	90.5	6.5
1995	*6*	86.8	9.2	*12*	86.3	7.0	*7*	89.0	4.3
1997	*9*	92.0	11.3	*7*	80.0	5.0			
1998				*4*	85.8	12.1			
1999	*2*	95.0	7.4	*8*	88.2	7.5	*2*	84.9	10.7
2000	*9*	86.8	9.2	*8*	83.9	5.8	*5*	67.2	5.8
2001	*7*	76.7	7.5	*8*	82.9	10.2	*3*	92.7	31.3
2002	*5*	76.5	3.7	*2*	76.3	7.3	*2*	91.2	32.5
2003	*13*	73.9	4.7	*6*	72.0	2.1	*1*		
2005	*8*	78.5	7.0	*7*	76.5	5.2	*1*	92.6	-
2006	*5*	73.8	5.5	*2*	66.0	15.1	*2*	73.3	5.5
2007	*8*	88.4	7.7	*5*	83.9	10.6	*1*	81.8	-
2008	*8*	83.6	8.0	*4*	75.7	2.6	*1*	76.8	-
2009	*9*	78.9	5.2	*3*	78.7	5.3			

Appendix A8. Average length (inches) and weight (pounds) of less abundant fish species caught in floating and sinking experimental gill nets set in Ryan Reservoir during 1990-2009.

Year	Rainbow trout			Brown trout			Sauger			Longnose sucker			Black bullhead		
	N	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**
1990										***3***	12.9	0.88			
1992	***8***	16.3	1.56	***1***	15.5	1.14				***17***	13.5	1.03			
1995	***13***	14.5	1.15	***2***	13.8	0.94				***31***	14.0	1.20	***1***	9.7	0.44
1997	***3***	14.3	0.96	***1***	16.3	1.38				***20***	13.8	1.12	***7***	9.3	0.36
1998	***3***	16.7	1.56	***1***	20.8	2.81				***7***	14.8	1.40	***2***	8.8	0.28
1999	***6***	13.7	0.89	***2***	14.8	1.16				***20***	13.9	1.22	***3***	8.5	0.28
2000	***2***	15.0	1.10	***1***	9.2	0.25				***12***	16.0	1.81	***3***	9.4	0.36
2001	***3***	16.7	1.33	***1***	12.2	0.48				***22***	15.5	1.59			
2002										***17***	16.3	1.68			
2003							***3***	8.9	0.17	***3***	13.1	0.93			
2005	***1***	15.3	0.92				***14***	11.9	0.42	***6***	13.2	0.99			
2006							***6***	11.1	0.33	***7***	14.6	1.33			
2007	***1***	12.3	0.55				***4***	12.5	0.48	***7***	16.0	1.81			
2008	***9***	15.8	1.36	***2***	12.4	0.73	***2***	11.1	0.35	***9***	14.9	1.51			
2009	***5***	14.0	1.09				***2***	14.3	0.78	***4***	15.3	1.61			

Appendix A9. Size statistics for walleye, perch, and white suckers caught in floating and sinking experimental gill nets in Morony Reservoir during 1990-2009.

Year	Walleye								Yellow perch								White sucker							
	N	Length (in)			Weight (lb)		Relative weight		*N*	Length (in)			Weight (lb)		Relative weight		*N*	Length (in)			Weight (lb)		Relative weight	
		Ave	SD	95% CI	Ave	SD	Ave	SD		Ave	SD	95% CI	Ave	SD	Ave	SD		Ave	SD	95% CI	Ave	SD	Ave	SD
1990	***9***	14.7	0.32	0.62	1.28	0.06	99.7	8.7	***5***	6.6	0.10	0.19	0.18	0.01	131.1	8.6	***91***	11.9	0.74	1.45	0.80	0.21	99.0	26.0
1995	***2***	18.2	-	-	2.41	-	101.3	-	***7***	7.6	0.10	0.20	0.24	0.04	-	-	***153***	10.6	0.75	1.47	1.48	0.33	108.8	19.3
1997	***4***	8.6	0.28	0.55	0.24	0.05	109.0	5.1	***1***	10.6	-	-	0.69	-	107.9	-	***275***	12.0	0.93	1.83	0.88	0.45	98.7	65.1
1998	***2***	15.6	-	-	1.56	-	91.6	-	***9***	7.4	0.59	1.17	0.24	0.07	102.7	19.1	***170***	13.0	0.78	1.52	1.10	0.34	102.2	31.1
1999	***9***	14.5	0.35	0.69	1.17	0.08	86.8	13.1	***20***	7.0	0.38	0.75	0.20	0.09	105.1	54.6	***159***	13.1	0.91	1.78	1.19	0.37	100.8	44.8
2000	***14***	16.2	0.37	0.72	1.63	0.24	93.2	7.8	***9***	8.7	0.39	0.76	0.44	0.11	111.3	19.0	***151***	14.1	0.77	1.51	1.17	0.29	93.3	26.6
2001	***11***	16.2	0.29	0.56	1.57	0.10	85.3	6.2	***24***	6.8	0.54	1.06	0.18	0.14	88.3	23.8	***116***	14.0	0.73	1.44	1.15	0.36	90.8	22.4
2002	***9***	17.1	0.14	0.28	1.46	0.27	73.4	10.5	***2***	6.8	-	-	0.23	-	-	-	***82***	15.0	0.54	1.07	1.35	0.24	89.3	13.6
2003	***7***	17.9	0.43	0.84	1.71	0.13	75.5	4.3	***6***	8.6	0.17	0.34	0.42	0.05	90.5	9.4	***107***	15.4	0.52	1.03	1.54	0.32	95.6	18.1
2005	***11***	16.2	0.07	0.14	1.38	0.04	73.5	1.5	***4***	9.0	0.64	1.25	0.36	-	91.0	20.0	***42***	15.9	0.47	0.93	1.78	0.42	100.1	25.3
2006	***5***	14.4	-	-	1.10	-	85.4	-	***7***	9.0	0.32	0.62	0.49	0.05	108.5	8.1	***30***	15.9	0.43	0.84	1.75	0.28	98.0	13.6
2007	***16***	13.2	0.19	0.37	0.81	0.16	82.9	15.8	***11***	9.6	0.39	0.75	0.62	0.16	113.1	24.1	***44***	16.0	0.49	0.97	1.90	0.30	104.6	16.6
2008	***20***	17.0	0.43	0.85	2.00	0.84	84.9	16.3	***44***	9.1	0.60	1.18	0.50	0.21	107.5	28.0	***64***	15.2	0.86	1.69	1.80	0.36	106.5	27.8
2009	***18***	13.4	0.75	1.47	0.83	0.16	87.1	20.2	***7***	11.1	0.64	1.25	0.88	0.13	111.7	6.1	***30***	14.6	0.65	1.27	1.77	0.39	109.0	21.6

Appendix A10. Trends in relative weight by length group for white suckers caught in standard floating and sinking experimental gill nets in Morony Reservoir during 1990-2009.

Year	8-11.9”			12-15.9”			16.0-19.9”		
	N	Ave rel wt	SD	*N*	Ave rel wt	SD	*N*	Ave rel wt	SD
1990	*29*	100.9	7.5	*56*	96.6	6.1			
1995	*12*	100.1	12.6	*63*	109.2	8.7	*8*	106.6	10.6
1997	*115*	92.0	26.0	*137*	103.2	9.9	*19*	111.0	7.2
1998	*15*	101.3	11.0	*134*	102.2	9.1	*10*	111.8	7.6
1999	*15*	99.9	15.4	*113*	101.3	8.4	*14*	99.9	7.6
2000	*3*	91.1	14.5	*139*	94.8	9.6	*8*	88.9	7.6
2001	*7*	84.8	10.6	*103*	91.5	9.7	*5*	89.5	10.6
2002				*71*	90.2	7.2	*11*	83.6	6.4
2003				*81*	96.1	7.9	*26*	94.1	6.7
2005				*21*	102.5	11.0	*21*	97.7	7.8
2006				*12*	102.2	11.3	*17*	94.3	4.9
2007				*18*	108.0	8.2	*26*	102.1	9.6
2008	*8*	112.9	13.8	*19*	110.7	9.8	*35*	105.6	9.3
2009	*3*	98.4	6.8	*12*	119.0	13.4	*12*	110.0	5.6

Appendix A11. Trends in relative weight by length group for walleye caught in standard floating and sinking experimental gill nets in Morony Reservoir during 1990-2009.

Year	8-11.9”			12-15.9”			16.0-19.9”		
	N	Ave rel wt	SD	*N*	Ave rel wt	SD	*N*	Ave rel wt	SD
1990	*1*	96.7	-	*5*	99.9	8.5	*3*	100.4	3.7
1995							*1*	98.8	-
1997	*2*	87.9	5.1						
1998	*1*	90.7	-				*1*	92.4	-
1999	*3*	88.3	6.3	*3*	87.2	10.9	*2*	84.5	2.6
2000	*1*	88.9	-	*5*	98.1	7.8	*6*	89.7	4.1
2001	*1*	83.7	-	*3*	79.5	4.0	*6*	85.5	5.9
2002				*2*	75.9	0.5	*7*	72.6	4.5
2003				*1*	77.4	-	*5*	75.3	3.5
2005	*2*	71.5	4.9	*4*	76.1	2.4	*2*	77.4	0.8
2006	*2*	95.4	9.3	*1*	75.1	-	*2*	80.5	0.5
2007	*9*	87.5	6.2	*4*	78.8	7.5	*2*	74.5	0.2
2008	*3*	92.8	9.9	*5*	85.9	7.2	*7*	82.4	6.9
2009	*5*	86.5	9.6	*12*	87.5	6.6	*1*	84.8	-

Appendix A12. Average length (inches) and weight (pounds) of less abundant fish species caught in floating and sinking experimental gill nets set in Morony Reservoir during 1990-2009.

Year	Rainbow trout			Brown trout			Sauger			Black bullhead		
	N	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**	***N***	**Ave len**	**Ave wt**
1990				***1***	24.0	4.36						
1995	***1***	8.2	0.25	***2***	12.6	0.75				***5***	10.0	0.53
1997				***1***	18.1	2.19				***1***	10.4	0.50
1998												
1999	***3***	14.6	1.15									
2000	***1***	17.2	2.13				***2***	11.1	0.41	***4***	10.4	0.58
2001	***1***	15.7	1.10									
2002	***1***	13.4	0.75									
2003	***2***	18.2	1.64									
2005	***1***	9.6	0.25				***2***	13.2	0.58	***1***	7.8	0.25
2006							***2***	11.9	0.54	***1***	8.3	0.25
2007				***2***	12.8	0.88	***2***	14.4	0.84			
2008							***1***	15.2	0.90	***1***	7.7	0.14
2009										***2***	8.6	0.25

Appendix A13. Walleye catch rate and average length in fall electrofishing on the Morony section of the Missouri River. Sample size in parenthesis. Data from Montana Dept FWP.

Year	#We caught/hr	Ave length (inches) & sample size
1988	2.1	15.2 (14)
1989	0.2	17.1 (1)
1991	0.1	17.3 (1)
1993	2.3	19.3 (6)
1994	0.4	18.3 (3)
1995	3.5	19.3 (19)
1996	3.5	14.8 (24)
1997	3.9	15.2 (32)
1998	1.1	14.1 (6)
1999	4.2	14.2 (27)
2000		
2001	0.9	18.0 (15)
2002	0.2	21.3 (3)
2003	0.2	20.8 (2)
2004	0.3	16.9 (3)
2005	0.4	15.2 (4)
2006	0.7	18.4 (8)
2007	0.9	17.1 (9)
2008	0.5	16.9 (4)
2009	3.1	16.8 (26)
2010	3.7	14.4 (32)

Appendix A14. Average catch per net and length of white suckers captured in gill nets set in Canyon Ferry Reservoir 1984-2010. Data from Eric Roberts, Montana Dept FWP – Helena.