An Evaluation of the 2011 Flushing Influence to Recruitment of Hatchery Rainbow Trout in Holter Lake

MOTAC Projects 751-11, 751-12

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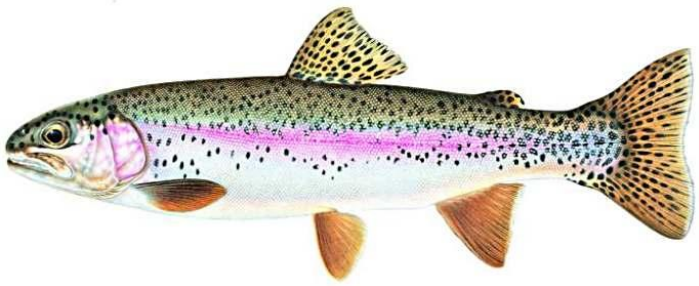

Prepared for

PPL-Montana
FERC Project 2188
336 Rainbow Dam Road
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Montana Fish, Wildlife & Parks

December 2012

Introduction

In 2011, peak flow in the Missouri River below Holter Dam was 23,000 cfs which was the highest flow measured in 14 years (Appendix A,B). This flow event led to excessive flushing of hatchery stocked rainbow trout from Holter Lake downstream into the Missouri River. Flushing of hatchery trout from Holter Lake has long been documented (see Skaar and Humphrey 1997); however, in 2011 hatchery production issues coupled with high summer flows further increased flushing rates to the point where hatchery rainbow trout made up a measurable part of the fish community below Holter Dam. The high rate of flushing negatively influenced recruitment of reservoir rainbow trout, but it also impacted the trout population in the Missouri River downstream. Although the 2011 flushing event was uncommon, hatchery fish in the river have persisted for two years afterwards and could negatively affect fish management strategies in the reservoir and the river.

Additional evaluations of this event, observations made during the high flow period, and evaluations of other flow events in recent years led us to hypothesize that Holter Dam spill gates may be operated in a way to decrease entrainment of stocked rainbow trout and perhaps other fish species. We propose that if flows were spread across more spill gates at Holter Dam the depth of the water column at each gate would be reduced and could minimize fish entrainment.

Article 416 of FERC license 2188 provides a number of criteria for monitoring dam operations and the affects of dam operations on fish populations in Holter Lake and the Holter Dam tailwater area. The purpose of this report is to describe the results of recent monitoring efforts on these fisheries and make recommendations to reduce impacts from dam operations.

Holter Lake monitoring

Since 2006, the Holter Lake rainbow trout fishery has been maintained by stocking approximately 125,000 yearling Eagle Lake strain rainbow trout (EL) in the summer following spring runoff, and another 125,000 Arlee strain (AR) in the fall. Recruitment of these fish is monitored through spring and fall standardized gillnetting series. Recruitment rates between strains are quantified by a return index (RI, number of fish recaptured in nets, divided by the number of fish stocked, then multiplied by 100,000). A higher RI indicates good recruitment for each group of fish stocked. For this evaluation, only years 2006 – 2011 were used as previously different stocking regimes were being tested to offset the influence of increased walleye abundance and shortfalls in the FWP hatchery program.

Due to reconstruction at the Big Spring State Trout Hatchery in 2011, approximately 131,000 EL were stocked at the Gates of the Mountains from June 22-30, when flows ranged between 17,900 and 22,500 cfs (Figure 1). Peak flow at the Holter gage was 23,000 which occurred on July 3. Shortly after stocking (July 10) hatchery rainbow trout were reported in the Missouri River near the Dearborn confluence (approximately 13 river miles downstream). Under normal conditions, these fish would have been held at the hatchery until flows subsided; however, the fish had to be stocked during high flows in order to facilitate hatchery reconstruction.

Not surprisingly, recruitment of this stocking was low in Holter Lake and strongly influenced the rainbow trout populations in the Missouri River below Holter Dam. Extrapolating abundance

from annual population estimates from the Craig section, an estimated 12,840 2011 Holter EL could be found in the Missouri River from Holter Dam to Craig. This number would account for 9.8% of the Holter summer EL plant residing in the Missouri River (not including the fish that likely flush even further downstream).

Although not statistically significant, there is a strong relationship between recruitment (RI) and summer flows (Figure 2). Comparing RI among years, recruitment was substantially better in 2006 and 2009 when total flow was lower compared to higher flow years like 2008, 2010, and 2011 (Table 1). Timing of stocking relative to the stage of the hydrograph (increasing or decreasing) also plays a role in recruitment. For example, a relatively low RI of 10.1 in 2008 is likely a function of a secondary increase in the hydrograph shortly after stocking (Figure 1). Another example is AR stocked approximately 1 month after EL in 2011. Even though flows were still relatively high during late-July stocking (Figure 1), RI for the AR was 19.6 while EL RI was 6.9 (Table 1).

Similar to this evaluation, Skaar and Humphrey (1997) also found negative correlations between discharge and recruitment as measured by fall netting. Skaar and Humphrey (1997) also found covariance between spill quantity and turbine quantity suggesting that both spill and turbine discharge contribute to fish flushing. Spinelli (2010) observed that most entrainment on Hauser Lake occurred after spill ended and likely related to dispersal of stocked fish rather than high discharge. Even though stocked fish likely flush through the turbines, modifying releases over the spill gates might reduce overall entrainment, thus improving recruitment to the Holter rainbow fishery.

Skaar and Humphrey (1997) also found that hatchery rainbow trout primarily occupied water less than 12 feet deep in May and less than 22 feet in June. As water temperatures increased, hatchery trout occupied deeper water seeking cooler temperatures. Spill withdrawal on the Holter spill gates ranges from 6 to 16 feet, so high densities of hatchery rainbow trout occupy depths that are vulnerable to flushing, especially during periods when flows are highest (Figure 1).

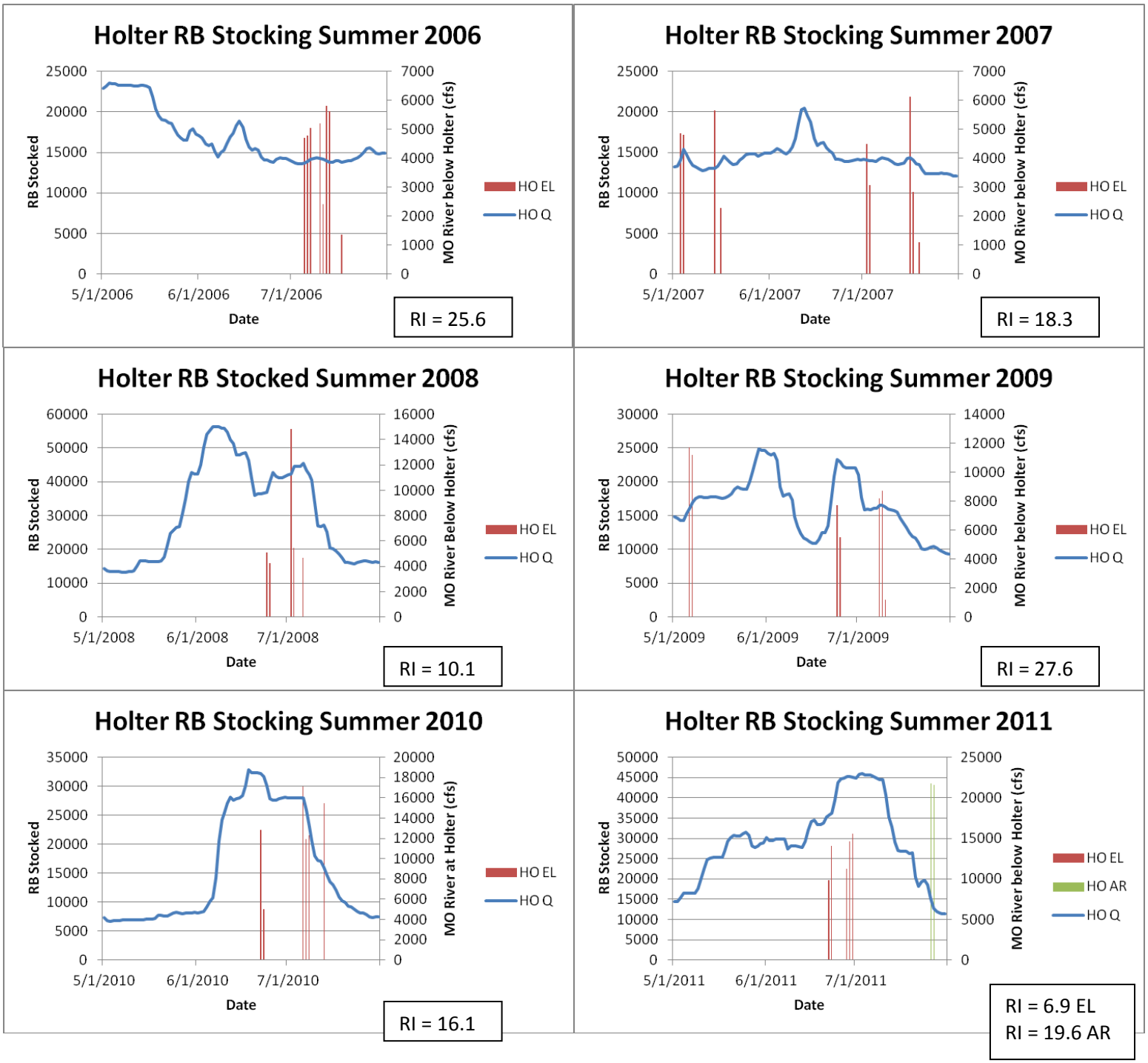

Figure 1: Date and number of rainbow trout stocked in summer (May 1-July 31) and average daily flow (cfs) at Holter Dam, 2006-2011. Arlee were stocked in summer 2011 (HO AR) rather than the fall due to hatchery reconstruction. RI = Return Index: relative index of stocked fish that recruit to fall gillnets.

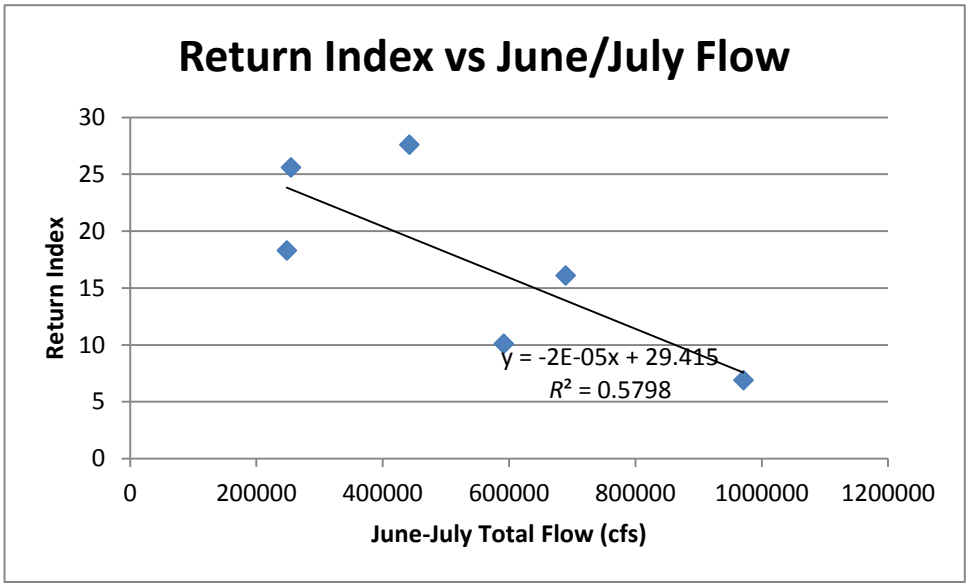

Figure 2: Relationship between EL recruitment (return index) and total June and July flows at Holter Dam. The correlation coefficient for RI and total discharge is not statistically significant (R^2 = -0.76, P = 0.08).

Table 1: Total June and July flow at Holter Dam (Q Jun-Jul) and return index for Eagle Lake (RI EL) and Arlee (RI AR) strains stocked in Holter Reservoir, 2006-2011. Summer stocking of AR occurred only in 2011.

Year	Q Jun-Jul	RI EL	RI AR
2006	254,590	25.6	--
2007	248,090	18.3	--
2008	591,460	10.1	--
2009	441,970	27.6	--
2010	689,470	16.1	--
2011	971,000	6.9	19.6

Missouri River monitoring

In 2011 and 2012 Montana Fish, Wildlife & Parks estimated the highest rainbow trout populations on record in the Craig section of the Missouri River. The estimate of rainbow trout ≥10 inches long in 2011 was 6,034 (SD 194) per mile and in 2012 it increased to 7,312 (SD 201) per mile (Figure 3). The 30-31 year mean is approximately 3,100 fish per mile.

In 2011 fishery crews observed a very high number of 10-12.9 inch long hatchery fish in the Craig section. This was attributed to high water flows during the spring that flushed fish from Holter Lake. Hatchery fish made up 20.2% of the fish that were sampled (1,130/5,583). We calculated an estimate of 1,605 (SD 240) hatchery trout per mile. The estimate of wild trout was 4,429 fish per mile which would be the second highest on record. In 2012, hatchery fish were also prevalent and made up 12% of the fish we sampled (836/6,922). The estimate of hatchery fish in 2012 was 700 (SD 184) per mile. The estimate of wild fish was 6,612 per mile, which is the highest on record.

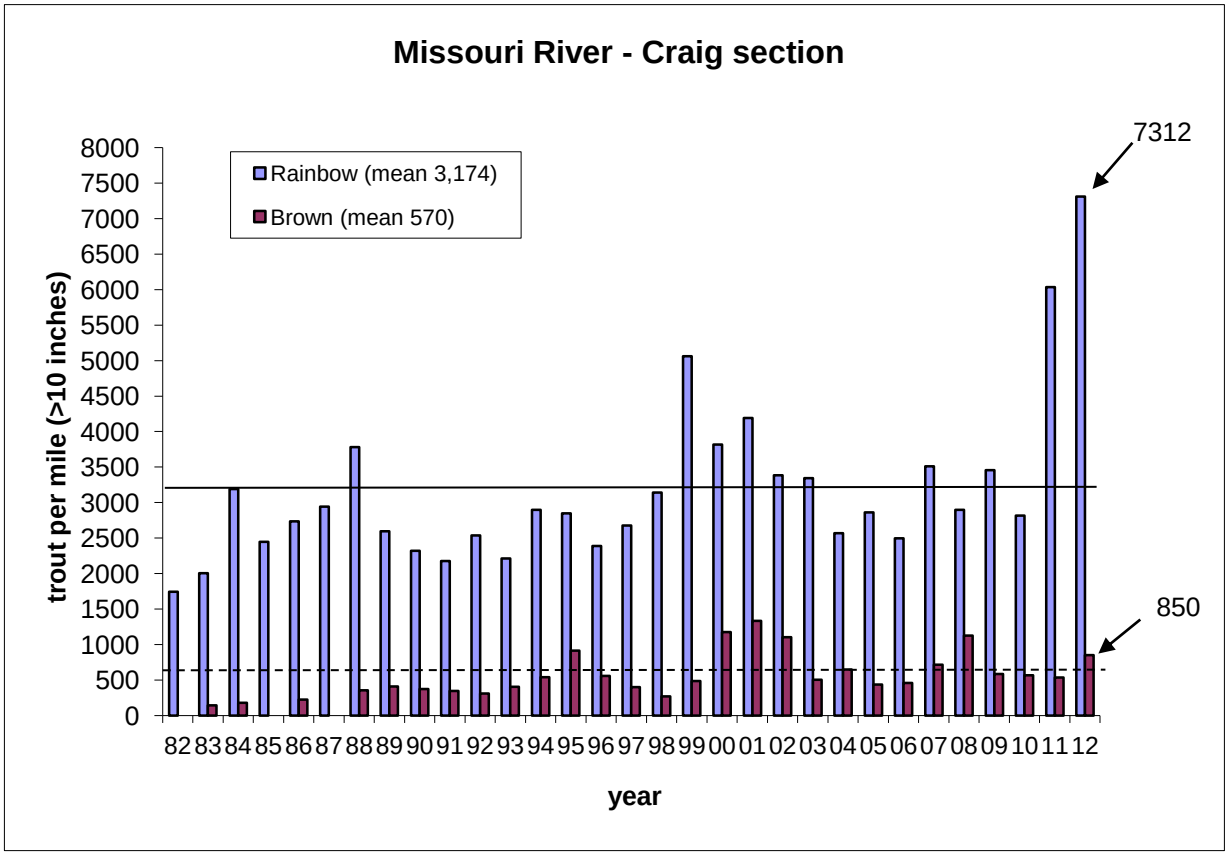

Figure 3. Estimates of rainbow trout and brown trout 10 inches long and greater in the Craig section of the Missouri River, Montana, 1982-2012.

The metrics we used to evaluate the origin of rainbow trout included visual observations of fin quality. Wild fish typically have fully developed fins. Wild fish commonly experience superficial

fin damage during spawning caused by traveling long distances in shallow water, digging redds, defending territories and the act of spawning. This damage is typically limited to erosion of caudal fin ray tips and split membranes and is commonly observed in wild Missouri River rainbow trout during the May sampling period. Fin rays and membranes regenerate within 2-3 weeks as water temperature increases and caloric intake increases. Fin damage on hatchery fish can be manifested in all fins and is caused by high density crowding and prolonged abrasion in concrete hatchery raceways. Rainbow trout stocked in the Missouri River reservoirs are typically 1-2 years old and display obvious signs of fin damage. This type of damage generally does not regenerate because it is sustained over a longer period of time and the damage extends to a deeper portion of the fin ray. Visual signs of hatchery fish can include a "nub" appearance of the pelvic and pectoral fins, splitting of the caudal fin that reaches to the peduncle and a "stub" appearance of the dorsal fin. None of these conditions are common in wild rainbow trout during the October sampling period.

Another metric we used to evaluate hatchery fish in 2011 was the dominance of the 10-13 inch length groups. These groups are typically underrepresented in Missouri River population estimates because this is the demarcation between age 1 and age 2 fish. Evaluation of data showed estimates of 10-13 inch fish were 3.9 to 9 times (mean 6.7) more abundant in 2011 than in the previous 5 years, with 11 inch fish representing 36% of the total hatchery fish catch (not estimate) in 2011.

Determining the total number of hatchery fish that spilled from Holter Lake into the Missouri River in 2011 was not possible. However, reasonable interpretations can be made with the known information. The estimate of 1,605 (SD 240) hatchery fish per mile in the 5.6 mile-long Craig section yields a total number of 8,988 in this section. Empirical information from numerous anglers indicates in July 2011 hatchery fish were being caught by anglers as far downstream as the mouth of the Dearborn River (river mile 13.5). Fishery crews working in the Pelican Point trout population estimate section in October 2011 observed (but did not record or differentiate) an inordinately higher number of hatchery fish, but numbers far below those recorded in the Craig section. These observations indicate that hatchery rainbow trout were prevalent in the Missouri River as far downstream as Pelican Point and the number progressively diminished moving downstream. The per mile estimate of hatchery fish in the Craig section in 2012 translated to 3,955 total hatchery fish in the Craig section. Fishery workers in the Pelican Point section observed only a small number (<100) of hatchery fish, which indicates the fish from the upper reaches did not disburse throughout the reach. Information from anglers and game wardens working in the area indicates from September 2011 through October 2012, angers were catching and harvesting a high number of hatchery rainbow trout from the upper reaches of the Missouri River.

From 1982-2010 mean length at age for 2 year old wild rainbow trout in the Craig section was 13.4 inches and for age 3 rainbow trout mean length was 16.7 inches (difference of 3.3 inches). Comparing the length frequency histogram of hatchery fish sampled in the Craig section in 2011 and 2012, showed a shift of dominate fish by approximately 3 inches, which is consistent with growth of wild rainbow trout in this section (Figure 4). This indicates that hatchery fish sampled in 2012 were likely fish that spilled over Holter Dam in 2011.

There is compelling information that indicates fish spilled from Holter Lake reside in the 2 mile reach immediately below the dam (Skaar and Humphrey 1997). This information is the basis for the monitoring program for Hauser Dam and Holter Dam operations under FERC license 2188.

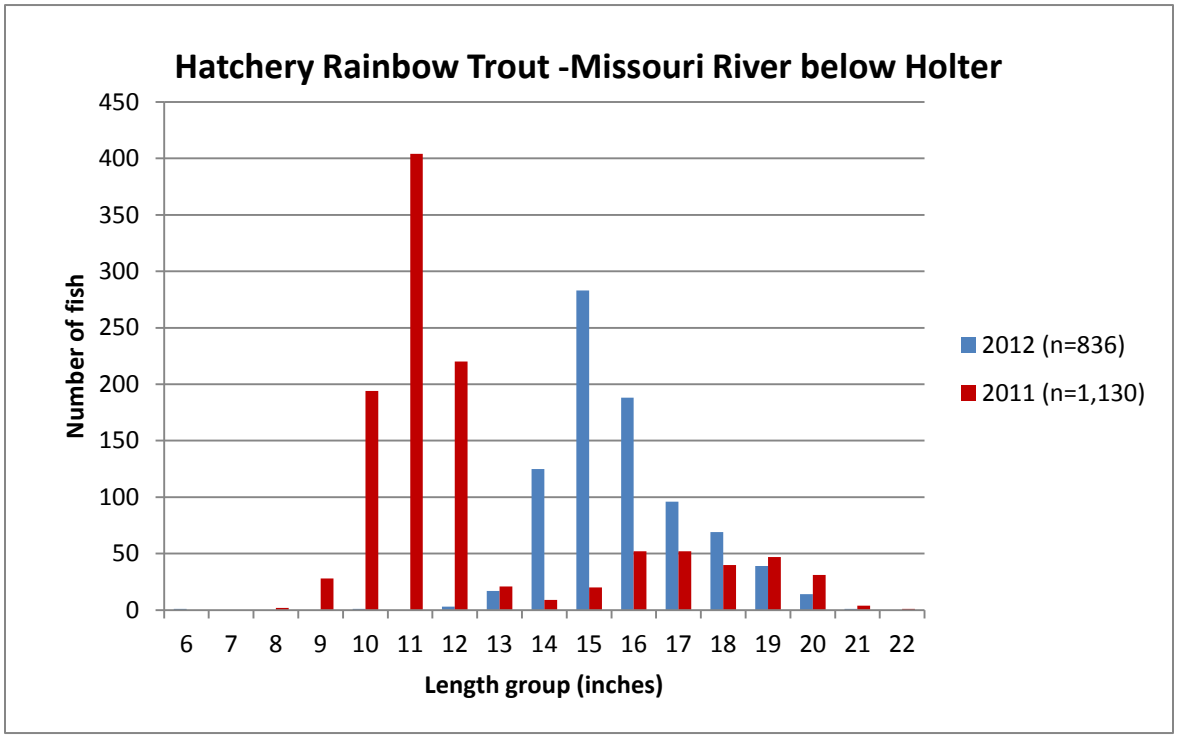

Figure 4. Hatchery rainbow trout sampled by night electrofishing in the Craig section in 2011-12. Missouri River, Montana.

The impacts of spilling Holter Lake rainbow trout into the Missouri River are difficult to quantify, but surely include economical, biological and social aspects. The Missouri River was stocked with rainbow trout from 1933-1973 with undesignated strains and has since been influenced by at least 12 different strains stocked in the upstream reservoirs, including Holter Lake (Grisak et al. 2012). Hatchery fish are highly catchable by anglers and will likely assimilate into the population, get harvested by anglers and disburse throughout this reach of river.

The economic and social impacts are more quantifiable and attributed more as a loss to the Holter Lake fishery than a gain to the Missouri River fishery. Assuming the average density estimate in 2011 was 1,605 hatchery fish per mile, the first 10 miles of river would contain approximately 16,050 hatchery fish. MFWP staff from both the Big Springs Trout Hatchery and Giant Springs Trout Hatchery determined that the cost of raising and transporting these yearling rainbow trout to Holter Lake was $0.84 per fish (Jim Drissell, MFWP, personal communication, Ryan Derr, MFWP, personal communication). The total estimated economic loss of these fish was $13,482 in the first 10 miles alone.

The social loss is quantified by stocking yearling hatchery fish in Holter Lake where they are highly valuable to anglers, only to have these fish flushed into the Missouri River, where they were not intended, are not needed, and confounds the wild fish management policy for streams and rivers that MFWP has instituted in the Missouri River since 1973. Fewer fish in Holter Lake undoubtedly results in lower catch rates and diminished angler experience. During the 2006-09 license years anglers spent an average 52,312 days fishing Holter Lake for an average annual revenue of $3.6 million per year. The estimated harvest of Holter Lake rainbow trout is 46,478 fish per year. Combining these data shows each rainbow trout harvested in Holter Lake generates $77 in revenue to the state. The initial cost of raising and stocking yearling fish is $0.84 per fish. The cost to economic benefit dollar ratio of a Holter Lake rainbow trout is 77:0.84; or a return rate of roughly $92 for every $1 spent stocking rainbow trout into Holter Lake. The estimated revenue loss to the state from flushing 16,050 rainbow trout from the lake in 2011 is approximately $1.0 million.

Recommendations

In 2011 and 2012 fishery crews observed the operation of spill gates on Holter Dam and noticed gates 7, 9 and 10 (from the east) are typically operated to spill several feet of reservoir head before dam operators open more gates. During the spill the amount of reservoir head drafted from these gates appears to be substantial, up to several feet deep. Perhaps fish losses could be reduced by opening more gates that would have less open head to entrain fish. Reducing the depth of withdrawal over the spill gates by opening additional gates might diminish entrainment by decreasing water depth influenced by spill.

Even though fish stocking is typically timed to avoid excessive flushing during high flows, circumstances occasionally warrant stocking at inopportune times (i.e. 2011 during high flows) or with unpredictable fluctuations in the hydrograph (i.e. secondary increase to the hydrograph following stocking in 2008). FWP would like to begin a dialog with PPL Montana to discuss spill gate operations and options for reducing entrainment of stocked trout over the spill gates. Clearly there will be circumstances where high rates of entrainment will be largely unmanageable (e.g. 2011) but perhaps with a few adjustments to water management stocked rainbow recruitment might be improved in years with moderately higher flows (e.g. 2008, 2010).

References

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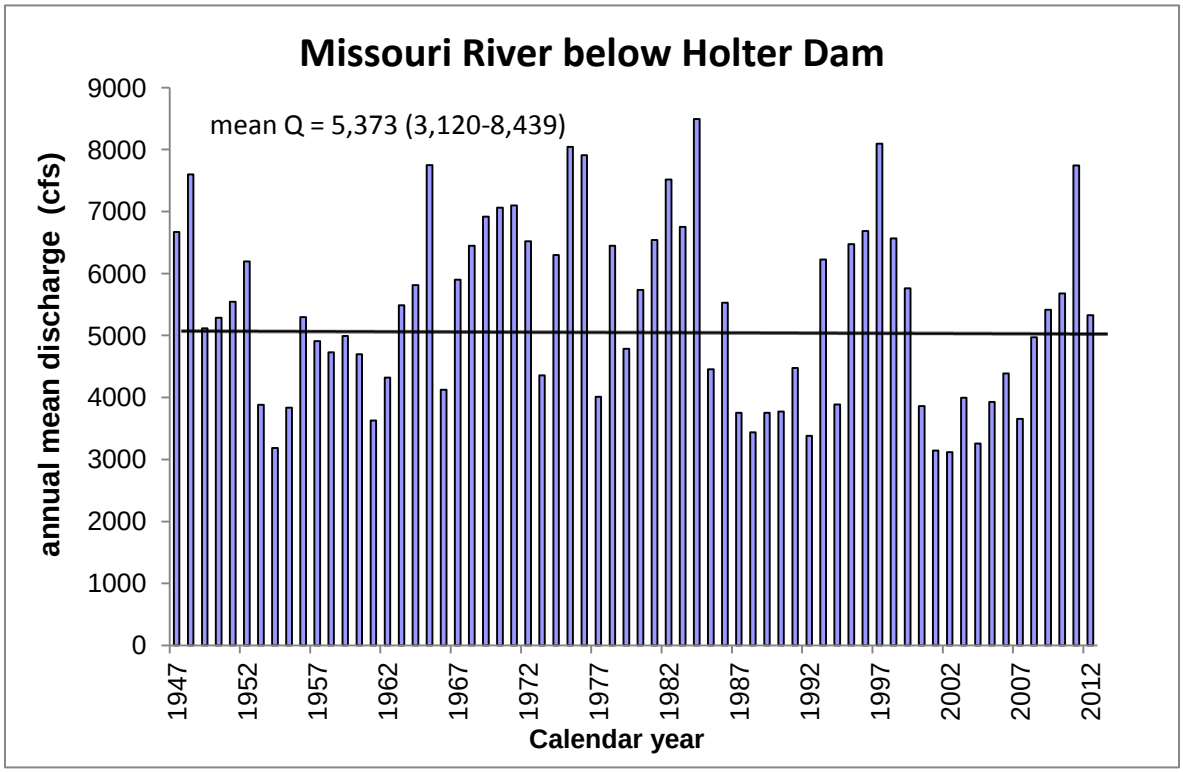
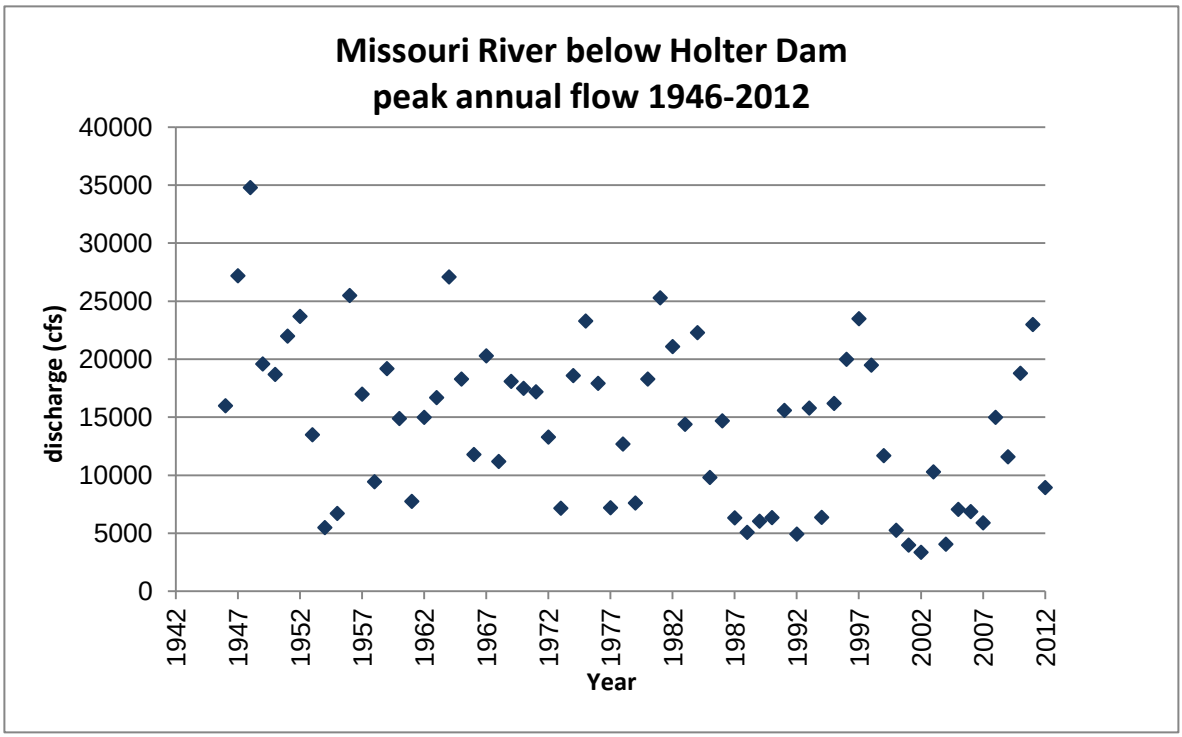


Appendix A. Mean annual flow of the Missouri River below Holter Dam, Montana, 1948-2012.



Appendix B. Mean annual flow of the Missouri River below Holter Dam, Montana, 1946-2012.