2016 Mountain Whitefish Kill on the Yellowstone River

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Montana Fish, Wildlife & Parks

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Background

In August 2016, Montana Fish, Wildlife & Parks (FWP) began to receive reports from anglers of large numbers of dead and dying Mountain Whitefish (MWF). The fish were initially reported to be dying in the area between the Grey Owl and Mallard's Rest fishing access sites (FAS). On August 12, surveys were initiated on the upper portion of the river to determine a cause of the mortality and evaluate the level of mortality occurring.

From August 12 – 18, 2016, samples of moribund MWF were collected from the Yellowstone River for analysis at the U.S. Fish and Wildlife Service (USFWS) Bozeman Fish Health Center (BFHC). The BFHC performed histology and PCR testing to identify the cause of the MWF mortality.

On, August 18, 2016, the Fish Health Center determined the MWF were infected with a parasite, *Tetracapsuloides bryosalmonea* (PKX), the causative agent of Proliferative Kidney Disease (PKD).

The PKX parasite has a two-host life cycle that includes salmonids and bryozoans, with bryozoans being the definitive host. Bryozoans can only infect salmonids and salmonids can only infect bryozoans (Ferguson and Ball 1979; D'Silva et al. 1984; Tops et al. 2004). Development and release of spores from bryozoans does not assure the loss of infection in the bryozoan (Okamura et al., 2011).

Initial histological examination of MWF indicated that the fish were heavily infected with the PKX parasite, the parasite was found in most tissues within the fish, as well as the kidneys. The MWF's naive reaction to the parasite infection suggested a recently introduction of PKX into the Yellowstone River.

River Closure

Based on the presence of the PKX parasite, high mortality of MWF, low stream flows, and high-water temperatures the FWP commission issued a closure of the Yellowstone River, 183 miles, from the northern boundary of Yellowstone National Park to Laurel, MT (Figure 1). The closure included tributaries through this reach to provide refuge, access lower water temperatures and no human disturbance, for fish. The closure included all recreational water based use, not just angling. The intent of the closure was to reduce as much stress as possible on fish to allow recovery from the parasite infection and prevent spread of the parasite to other waters. Particularly, waters in southwest Montana that had similar environmental conditions of low flow and high-water temperatures.

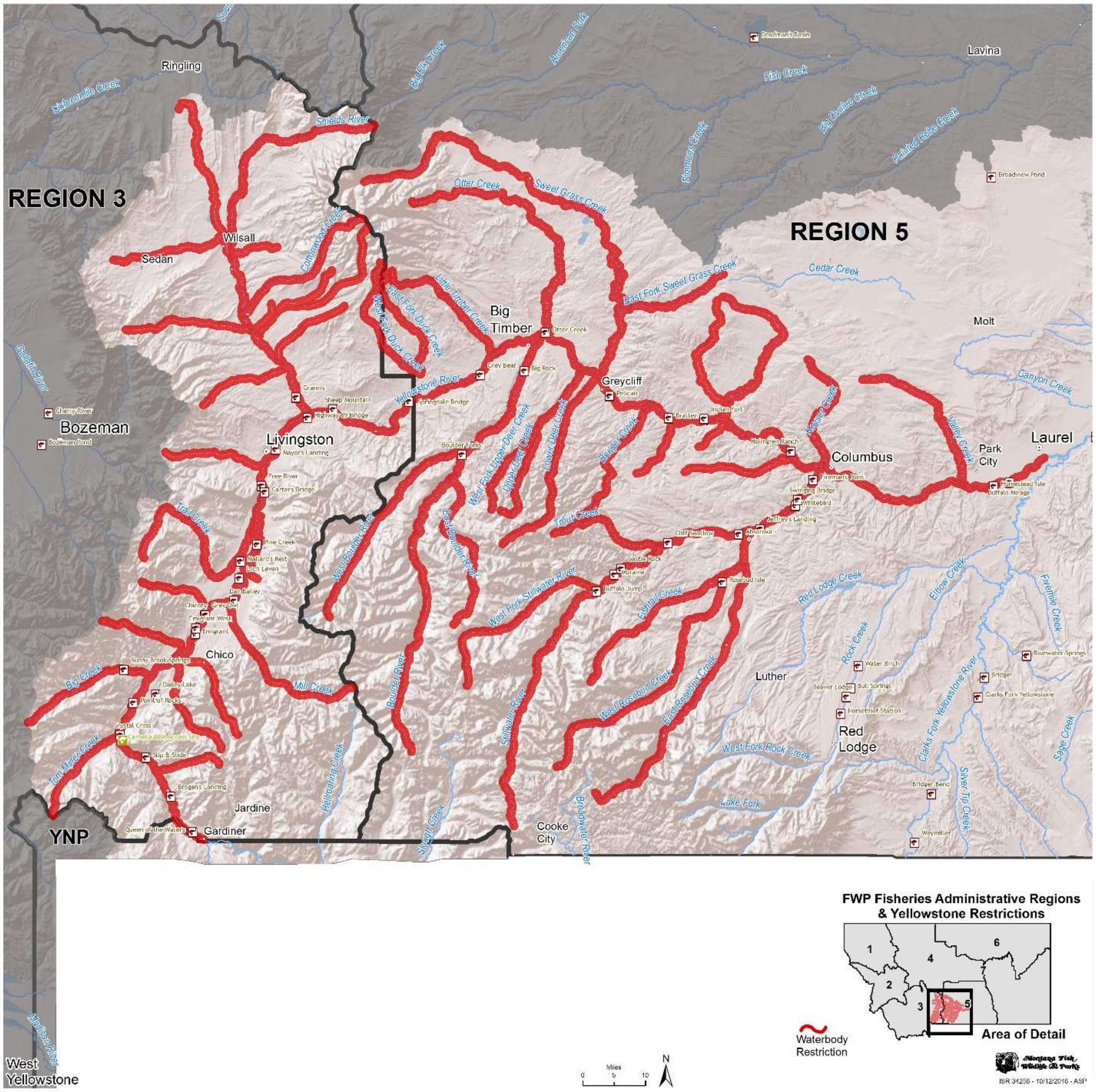

Figure 1: Map of Yellowstone River closure that was implemented on August 19, 2016. Red lines indicate closed waters.

Cleaning Stations

Mandatory Aquatic Invasive Species (AIS) cleaning stations were established on August 19, 2016 to prevent the spread of the parasite to other waters in Montana and surrounding states. The stations were located just to the west of Livingston and the east of Columbus, MT. All boats were required to stop for an inspection and those that had been on the Yellowstone River received a hot water, 140 °F, decontamination. The stations were operated from August 19 and 20, 2016.

Mortality Monitoring

Monitoring of fish mortality was conducted from August 15 through September 28, 2016 on four sections of the Yellowstone River. Monitoring was generally done weekly, but not all sections were sampled for the same duration depending on mortality levels observed. The four sections were: McConnell FAS to Cinnabar FAS, Grey Owl FAS to Loch Leven FAS, Mayor's Landing FAS to Highway 89 Bridge FAS, and Pig Farm FAS to Springdale Bridge FAS (Figure 2). The McConnell to Cinnabar reach was 4.5-miles long and river left bank (i.e., looking downstream) was sampled. The Grey Owl to Loch Leven reach was 8.4-miles long and river right bank was sampled. The Mayor's Landing to Highway 89 Bridge Section was 6-miles long and river left bank was sampled. The Pig Farm to Springdale Bridge Section was 8.6-miles long and river right bank was sampled.

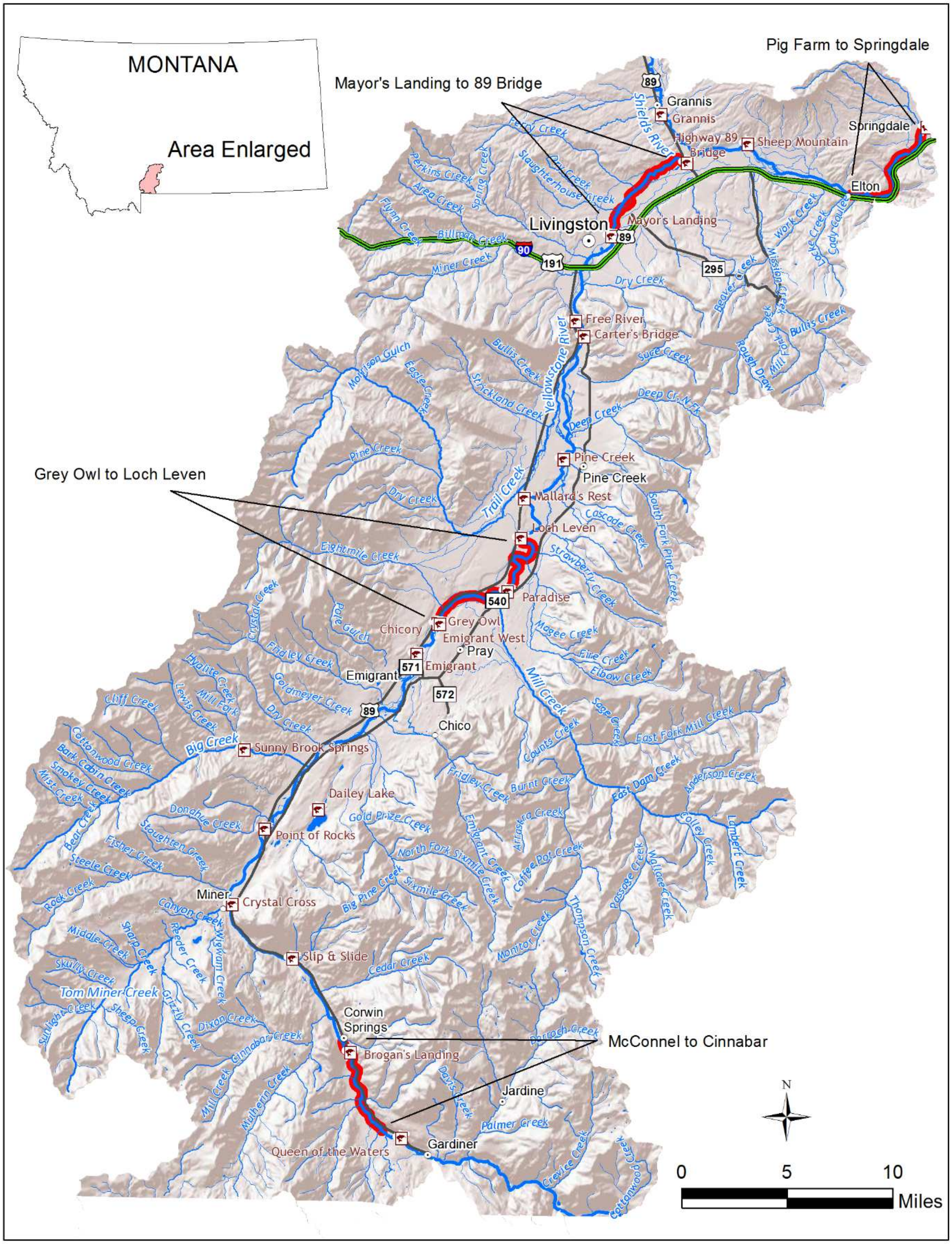

Figure 2: Map of PKD mortality monitoring sections in the Yellowstone River.

Fish that were observed were identified by species, counted, and assigned to a temporal mortality category (i.e., moribund, fish that were in process of dying; Recent, fish that had died within the last 12 hours; and Old, fish that had been dead longer than 12 hours). These categories helped determine if mortality was increasing, decreasing, or remaining stable among weekly sampling events.

McConnell to Cinnabar

The McConnell to Cinnabar Section was the most upstream section that was monitored for fish mortality (Figure 2). Monitoring occurred weekly from August 23 through September 13, 2016. Mortality in this reach was low and decreased to zero by September 6, 2016 (Table 1).

Table 1: Corwin Springs to Cinnabar mortality survey data.

Date	Total MWF	Moribund	Recent	Old
8/23/16	20	0	4	16
8/30/16	2	0	2	0
9/6/16	0	0	0	0
9/13/16	0	0	0	0

In this section of the river two dead Longnose Suckers were observed. It is unknown if these mortalities were the result of PKD or some other cause. Literature indicates that PKD has not been documented in these species.

Grey Owl to Loch Leven

The Grey Owl to Loch Leven section was monitored weekly for fish mortality from August 19 through September 28, 2016 (Figure 2). This section of the river had the highest level of mortality for MWF (Table 2). On September 2, there was an increase in the number of moribund fish observed indicating an increase in the mortality. The following week, the total number of MWF counted increased presumably because of the increased mortality during the week of September 2. From September 15 through September 28 mortality for MWF decreased.

Table 2: Grey Owl to Loch Leven mortality survey data.

Date	Total MWF	Moribund	Recent	Old
8/19/16	1,895	-	-	-
8/26/16	943	0	37	906
9/2/16	738	10	182	546
9/8/16	961	0	117	844
9/15/16	610	0	24	586
9/21/16	325	0	65	260
9/28/16	37	0	28	9

Several mortalities were observed in species other than MWF (Table 3). These included Rainbow Trout, Brown Trout, Yellowstone Cutthroat Trout (YCT), Longnose Sucker, and Longnose Dace. Testing of fish indicated that the trout mortalities were like the result of PKD, while the cause of the Longnose Sucker and Longnose Dace mortality is unknown.

Table 3: Other species mortality observed in the Grey owl to Loch Leven Section.

Species	Number of Mortalities
Rainbow Trout	1
Brown Trout	1
Yellowstone Cutthroat Trout	1
Longnose Sucker	13
Longnose Dace	1

Mayor's Landing to 89 Bridge

The Mayor's Landing to 89 Bridge Section was monitored from August 23 to September 14, 2017 (Figure 2). This section had higher mortality than McConnell to Cinnabar and lower mortality than Grey Owl to Loch Leven. Mortality in this section dropped rapidly and had stopped by mid-September (Table 4).

Table 4: Mayor's Landing to 89 Bridge mortality survey data

Date	Total MWF	Moribund	Recent	Old
8/23/17	100	0	44	56
8/30/16	15	0	5	10
9/6/16	4	0	2	2
9/14/16	0	0	0	3

No mortality of species other than MWF were observed in this section of the river.

Pig Farm to Springdale

The Pig Farm to Springdale Section was monitored weekly from August 15 through September 14, 2016 (Figure 2). This section had the second highest level of mortality among all four sections (Table 5). The mortality dropped of rapidly between August 15 and 25. Mortality had stopped by September 14, 2016.

Table 5: Pig Farm to Springdale mortality survey data

Date	Total MWF	Moribund	Recent	Old
8/15/16	318	-	-	-
8/25/16	35	0	20	15
9/7/16	46	0	1	45
9/14/17	46	0	0	46

In this section of the river mortality was observed in three Longnose Suckers. Again, FWP does not know if the mortality is the result of PKD or some other cause.

Lifting the River Closure

Sections of the river were reopened based on results of the mortality counts from the monitoring sections. On September 1, 2016, two reaches of the closure were opened (Figure 3). The reach from the northern boundary of Yellowstone National Park to Carbella FAS was opened to all recreational use except angling. This was done to protect native YCT populations in this area and try to determine if recreational use other than angling affected mortality. The reach from the 89 Bridge FAS to Laurel was opened to all recreational use. All the tributaries, except the Shields River, within the reach that remained closed were reopened. The Shields River remained closed to protect a conservation population of native YCT.

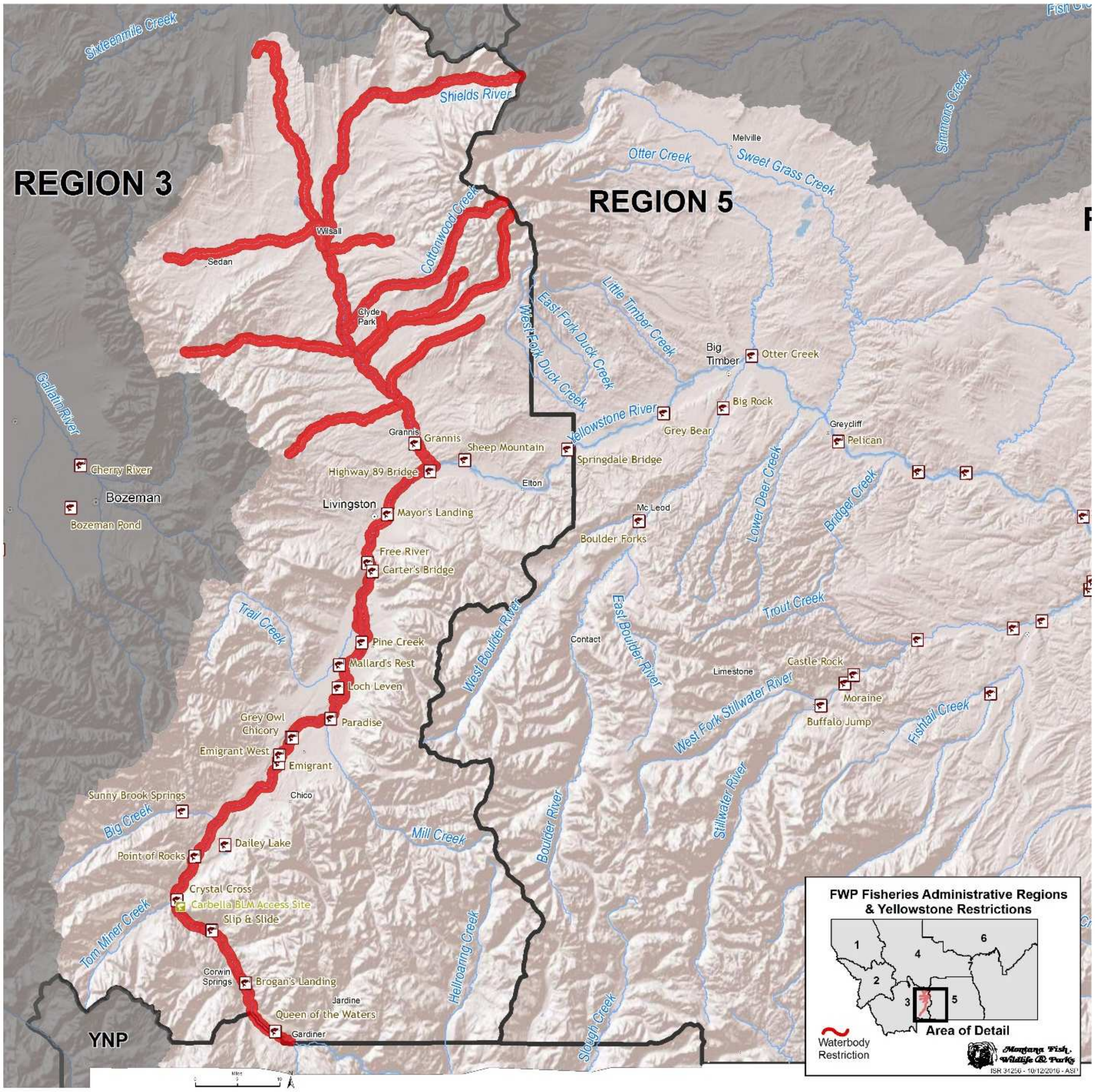

Figure 3: September 1, 2016 river closure map. Red line indicates waters that remained closed to all water based activity.

On September 6, 2016, the reach from the northern boundary of Yellowstone National Park to Carbella FAS was opened to angling (Figure 4).

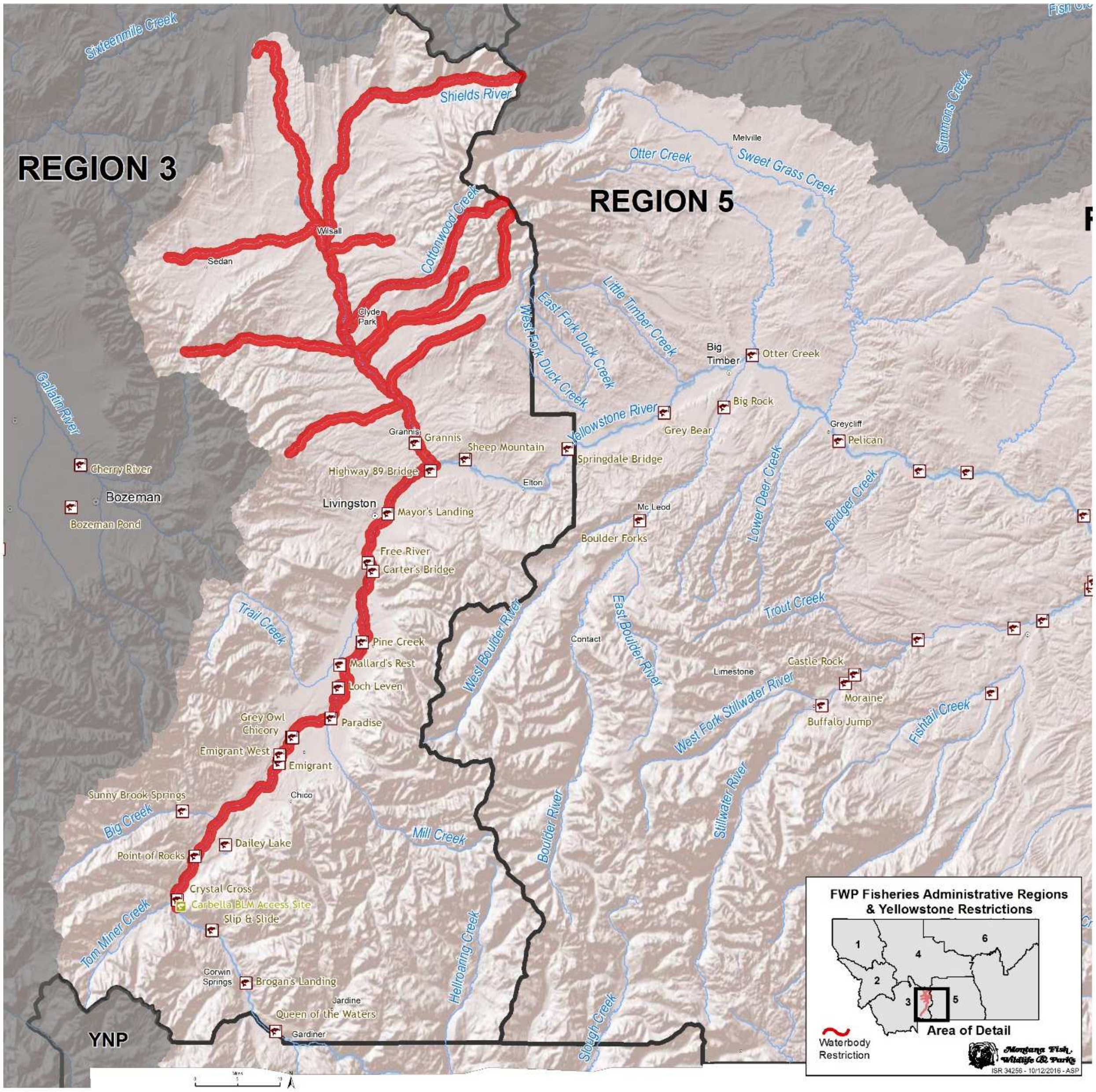

Figure 4: September 6, 2016 river closure map. Red line indicates waters that remained closed to all water based activity.

The reach from Carbella FAS to Point of Rocks FAS was opened on September 9, 2016 (Figure 5).

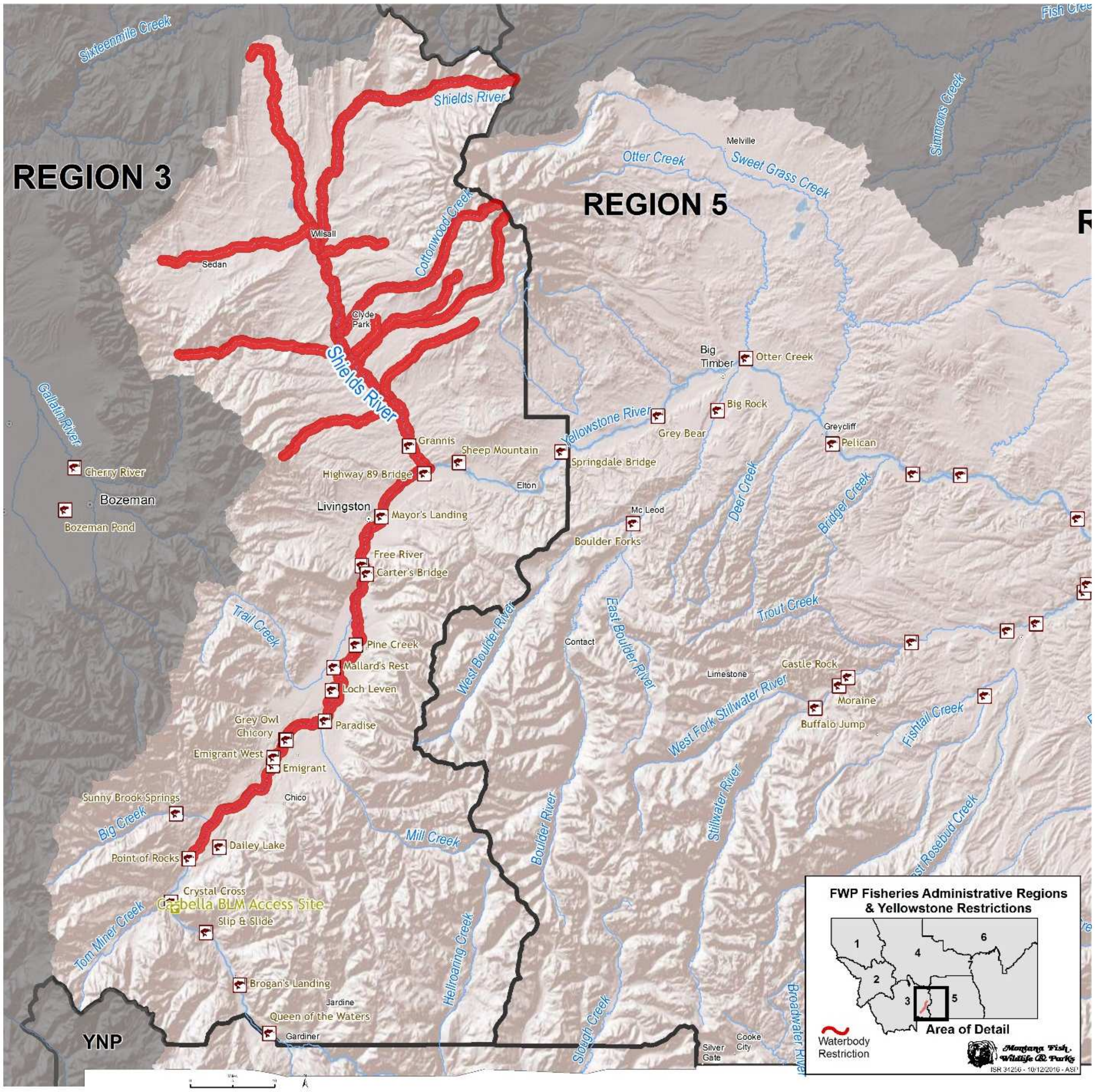

Figure 5: September 9, 2016 river closure map. Red line indicates waters that remained closed to all water based activity.

Three reaches of the river closure were opened on September 16, 2016 (Figure 6). They were Point of Rocks FAS to Emigrant FAS, Pine Creek FAS to 89 Bridge FAS, and the Shields River.

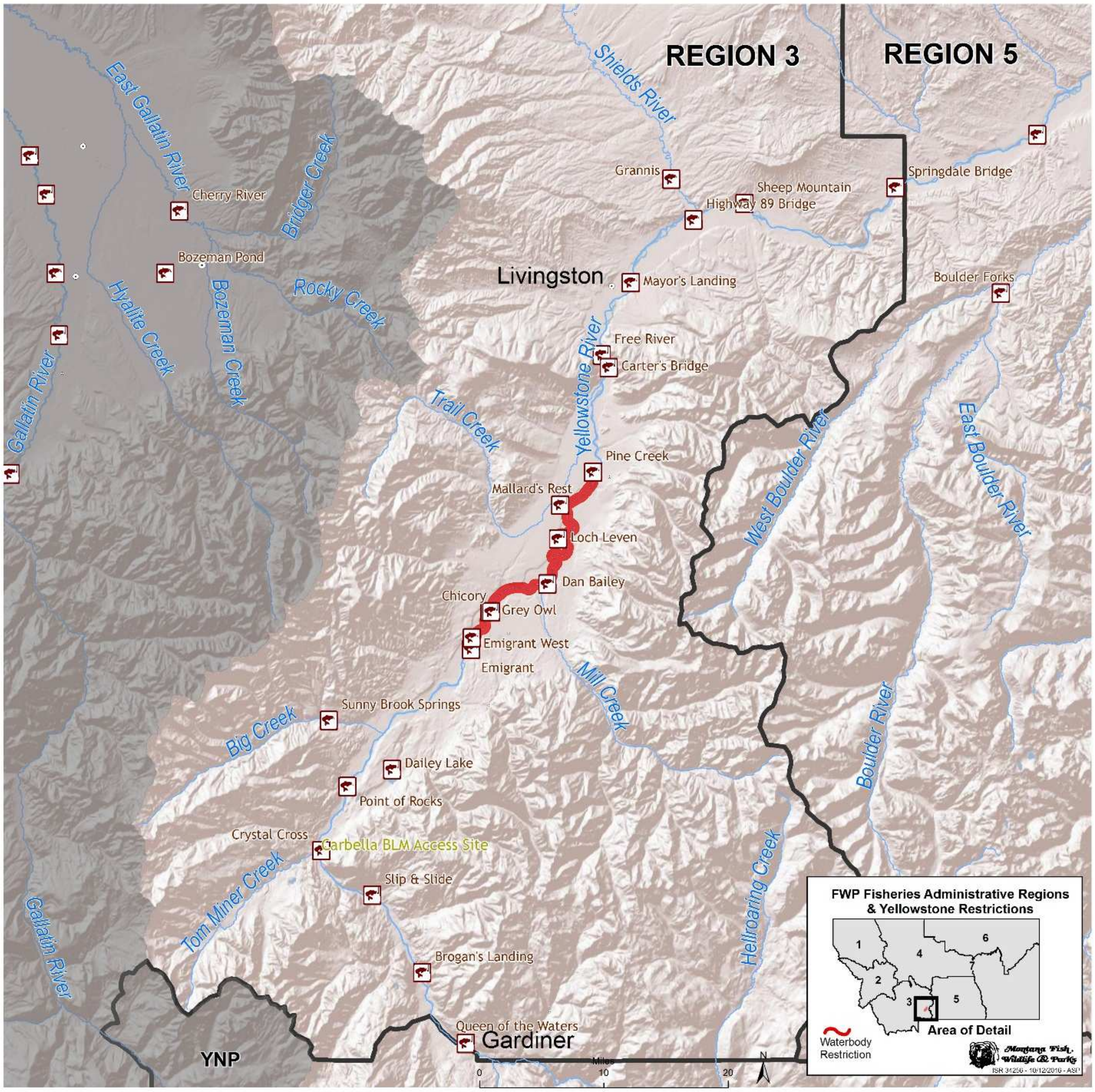

Figure 6: September 16, 2016 river closure. Red line indicates waters that remained closed to all water based activity.

The remaining 17.2 miles of the river closure was opened on September 23, 2016. Monitoring for mortality continued through September 28, 2016 to confirm there was not a rise in mortality related to the removal of the river closure.

PKX Testing

In late August and early September, fish were collected from waters in southwest Montana to look for presence of the PKX parasite. The fish were sent to the USFWS Fish Health Center in Bozeman, MT for PCR analysis. Results showed the parasite present in many locations in southwest Montana (Table 6 and Figure 7).

Table 6: PCR test results for the presence of PKX in fish collected in waters across southwest Montana (# of PKX positive/# of fish tested). MWF= Mountain Whitefish RB=Rainbow Trout LL=Brown Trout YCT= Yellowstone Cutthroat Trout HYB= YCTxRB hybrid LNSU=Longnose Sucker EBT=Eastern Brook Trout WHSU= White Sucker

		Species							
Location	**Collection Date**	**MWF**	**RB**	**LL**	**YCT**	**HYB**	**LNSU**	**EBT**	**WHSU**
Pine Creek to Carter's Bridge	8/13/16	2/2							
Yellowstone Near Livingston	8/15/16	5/5					0/1		
Yellowstone Near Livingston	8/16/16	1/5	0/1	0/1					
Dugout Cr., Shields	8/17/16				0/25			0/30	
Holmgren, Yellowstone River	8/23/16		2/2						
Armstrong Spring Creek	8/23/16		0/3	0/7					
DePuy Spring Creek	8/23/16		0/5	0/5					
Nelson Spring Creek	8/23/16		0/8	2/5					
Boulder Mouth	8/23/16		1/1						
Laurel, Yellowstone River	8/23/16	4/9							
Big Creek	8/25/16	0/4	0/6						
Jefferson River	8/25/16	1/7	2/2						0/1
Shields River	8/25/16	1/5	3/4				0/6		
Stillwater River	8/25/16	1/4	1/1						
Boulder River	8/26/16	3/5	1/4	1/1					
Mulherin Creek	8/29/16		0/5	0/2	0/3				
Eight Mile Creek	8/29/16		4/7	0/3					
Fleshman Creek	8/29/16		2/4	2/6	0/3				
Bighorn River	8/29/16	7/14							
Wood Bine, Stillwater	8/30/16	2/5	0/5						
Natural Bridge, Boulder	8/30/16		0/10						
Locke Creek	8/31/16			1/5	0/5				
Cedar Creek	8/31/16		0/4	2/4	1/2				
Tom Miner Creek	8/31/16		0/7	0/2		0/1			
Springhill Bridge, East Gallatin	9/7/16	6/10	8/11	5/10					
Logan, Gallatin	9/7/16	5/10	8/10	6/10					
Norris, Madison	9/8/16	9/10	9/10	8/11					
Varney, Madison	9/15/16	0/10	0/10	1/10					
Eastbank, Big Hole River	10/25/16	3/10	5/10						
Maidenrock, Big Hole River	10/31/16	1/10	4/10						

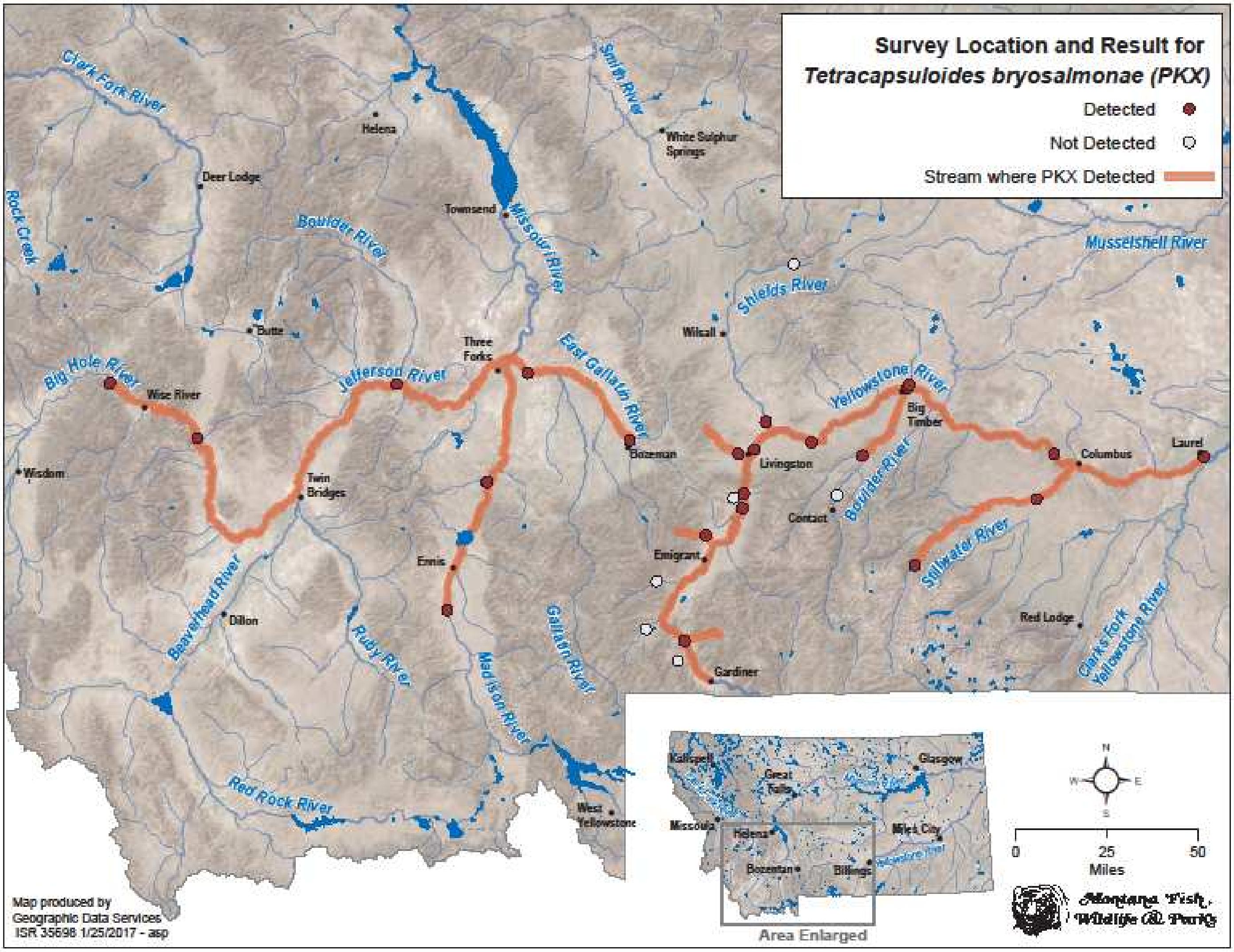

Figure 7: Map of PKX detection in fish across southwest Montana through PCR analysis.

Population Monitoring in 2017

In spring 2017, a survey effort on sections of the Yellowstone River from Corwin Springs to Laurel, MT was conducted to determine if PKD had a population-level effect on MWF and trout (Figure 8). Sampling protocols included mark-Recapture, catch-per-unit-effort (CPUE), and presence/absence.

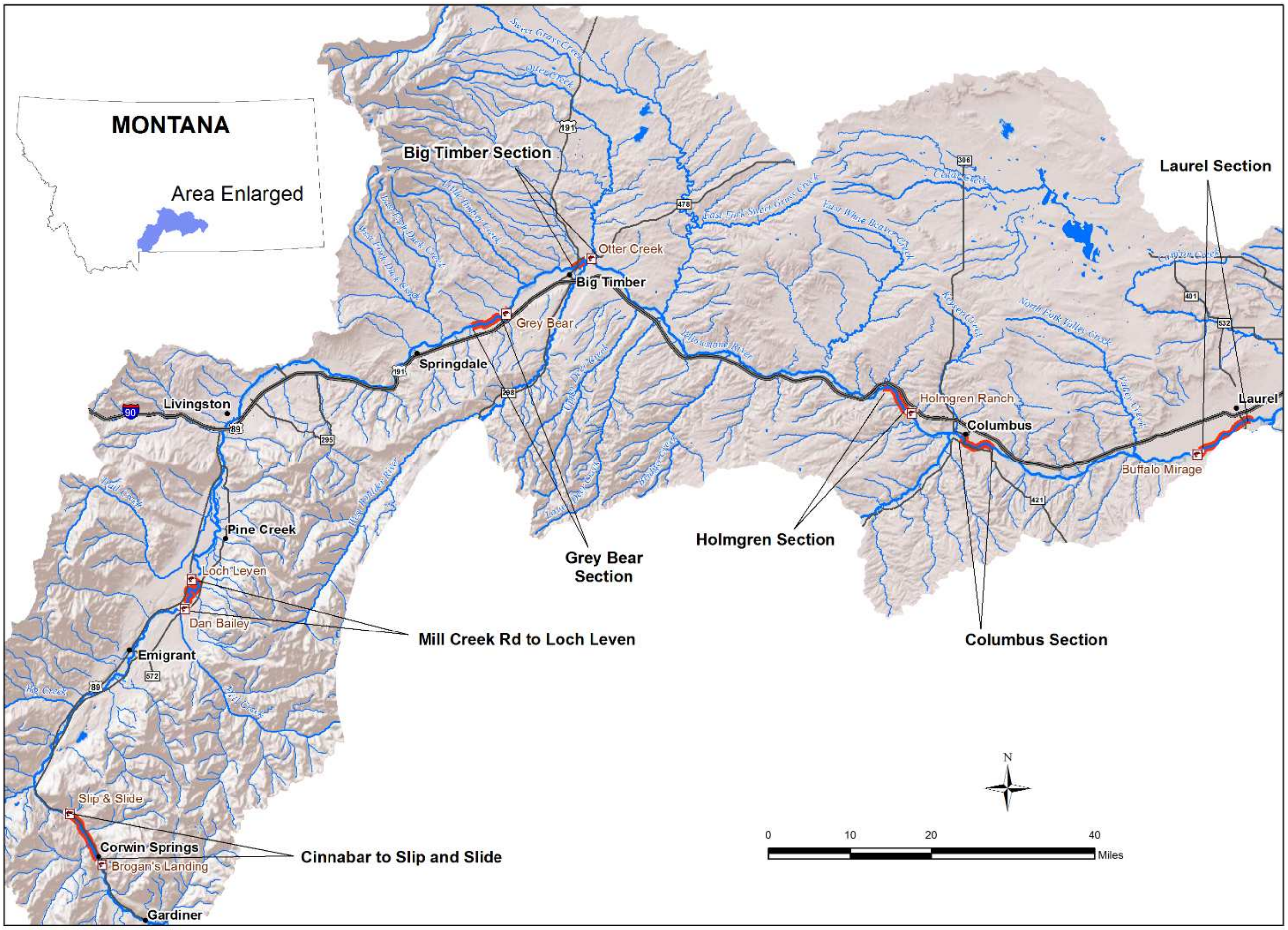

Figure 8: Sections of the Yellowstone River that were surveyed in spring 2017.

Corwin Springs Section

The Corwin Springs Section is a long-term monitoring section that has been sampled since 1978 (Figure 8). In May 2017, FWP sampled the section using the mark-recapture method and generated an abundance estimate for Rainbow, Brown, and YCT as well as Mountain Whitefish.

Rainbow Trout

The Rainbow Trout population estimate was 261 fish/mile (≥ 7in). This was lower than the two previous years, 296 and 275 fish/mile (≥ 7in), and below the long-term mean of 353 fish/mile (≥ 7in) (Figure 9). The decrease in abundance is small enough to be the result of annual fluctuation and may not be directly related PKD.

Distribution of Rainbow Trout across length groups in 2017 showed an increase of 16.1% in the 14.5 to 20.0-inch range over 2016 (Figure 10). The largest increase in an individual length group was 3.5% in the 16.0 inch-group. The percentage of fish in the 10.0 to 12.0-inch range was 11.1 % lower than 2016. The largest decrease in an individual length group, 6.2%, was in the 12.0 inch-group. As stated earlier, there does not appear to be a population-level effect due to PKD.

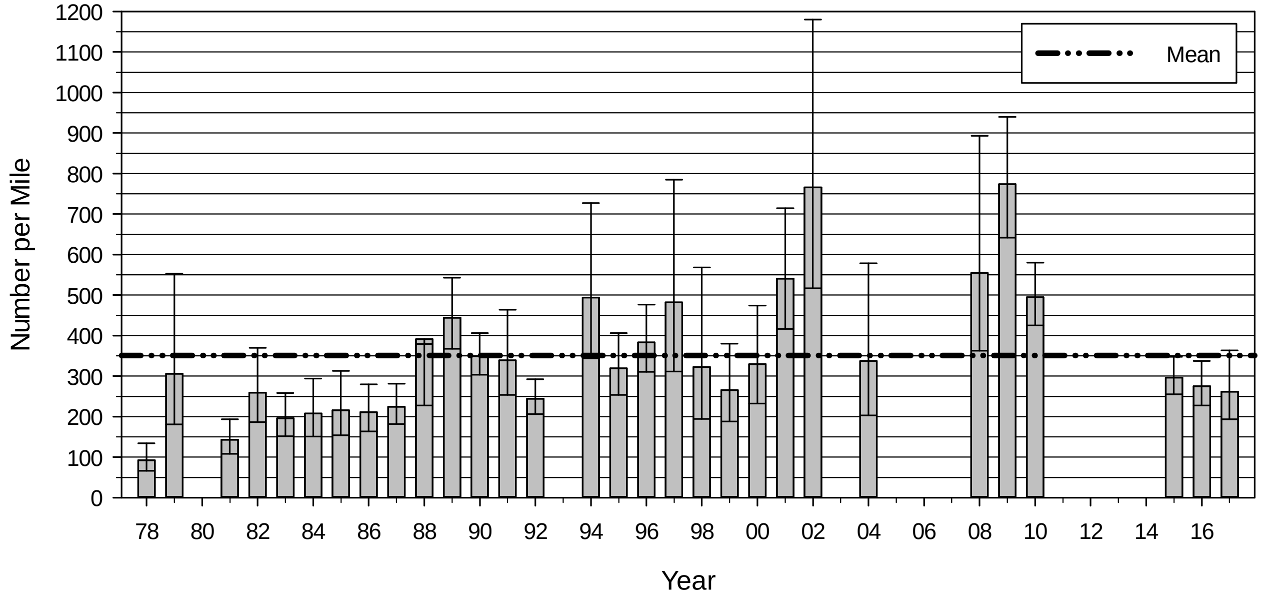

Figure 9: Corwin Springs Rainbow Trout population estimates for fish 7 inches and greater from 1978 to 2017. The error bars represent the upper and lower 95% confidence intervals.

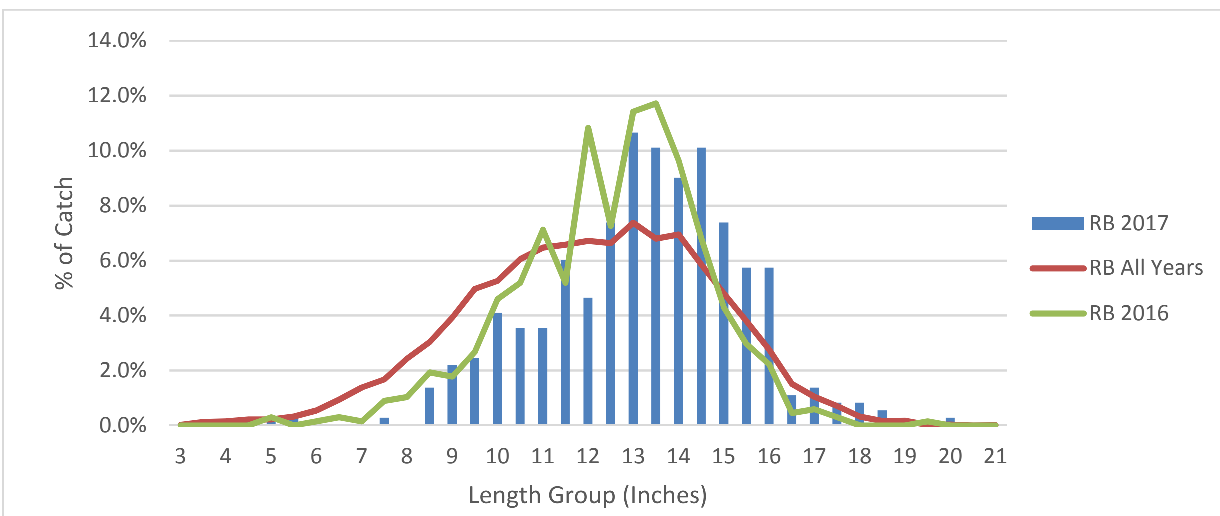

Figure 10: Percent of catch for Rainbow Trout in the Corwin Springs Section by half-inch group.

Brown Trout

Like Rainbow Trout, the Brown Trout population estimate was lower than the two prior years and remained below the long-term mean. The 2017 Brown Trout population estimate was 202 fish/mile (≥ 7in) down from 323 and 206 fish/mile (≥ 7in) in 2015 and 2016, respectively (Figure 11). There does not appear to be a population-level effect on Brown Trout in the Corwin Springs Section due to PKD.

The distribution of Brown Trout across length groups in 2017 indicated some changes compared to 2016 and the long-term average. There was an increase of 15.6% from 2016 to 2017 in the 10.0 to 12.0-inch range. The largest increase in an individual length group, 4.8%, was in the 10.0 inch-group. (Figure 12). There was a 20.9% decrease of fish in the 12.5 to 16.5-inch range from 2016 to 2017. The largest decrease in an individual length group was 4.9% in the 15.5-inch group.

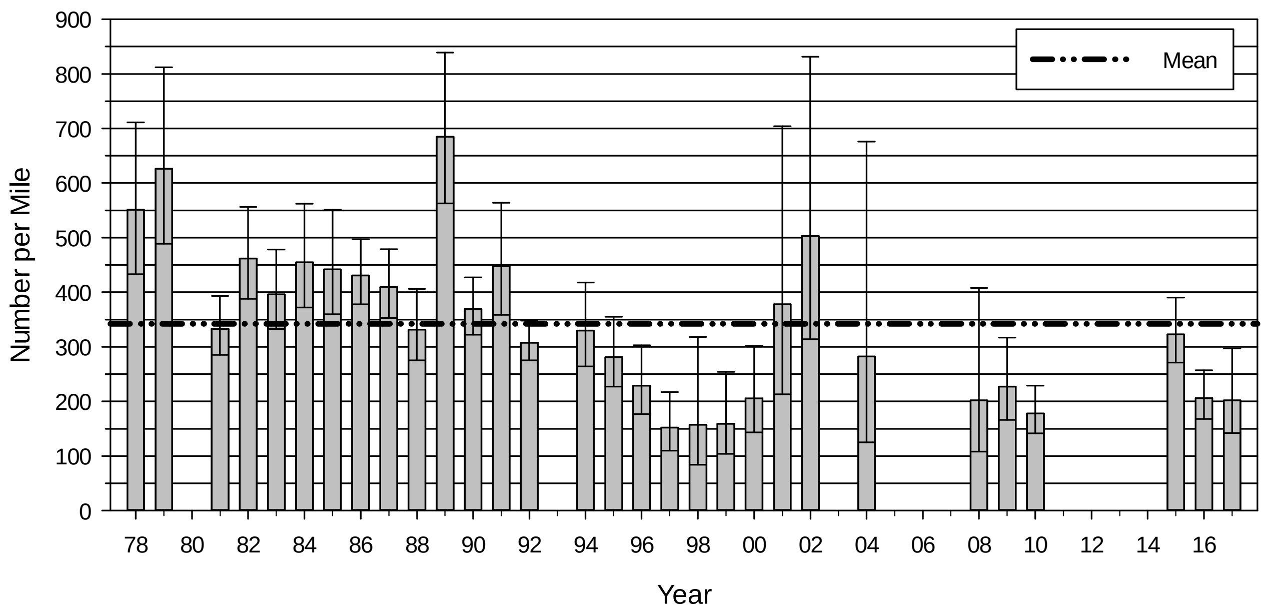

Figure 11: Corwin Springs Brown Trout population estimates for fish 7 inches and greater from 1978 to 2017. The error bars represent the upper and lower 95% confidence intervals.

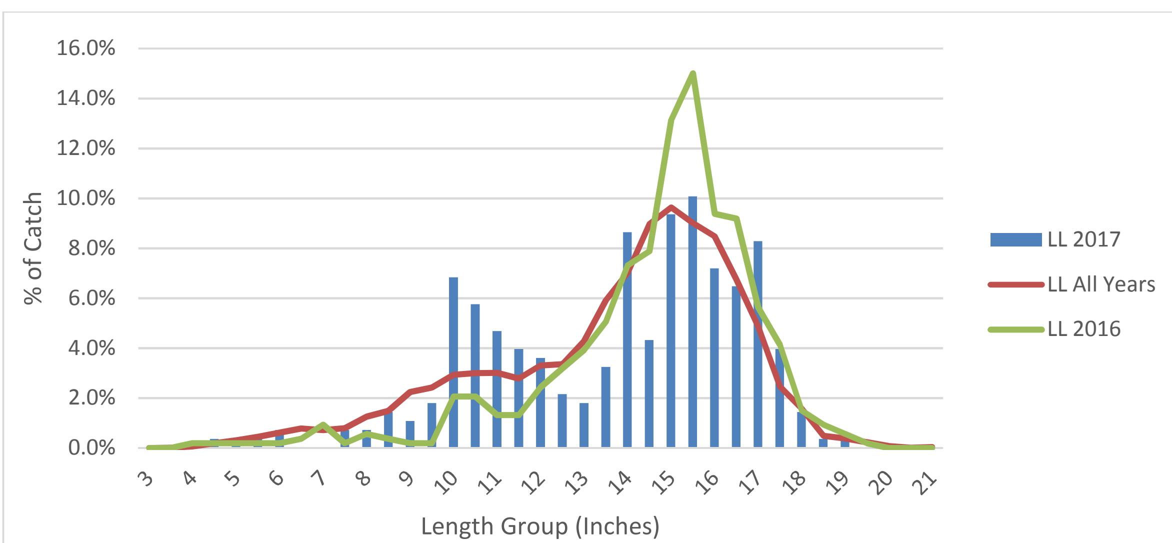

Figure 12: Percent of catch for Brown Trout in the Corwin Springs Section by half-inch group.

Yellowstone Cutthroat Trout

The 2017 population estimate for YCT decreased from the prior two years like the Rainbow and Brown Trout estimates for this section. The 2017 estimate was 210 fish/mile (≥ 7in) compared to 287 and 289 fish/mile (≥ 7in) in 2015 and 2016, respectively (Figure 13). This was also below the long-term mean of 314 fish/mile (≥ 7in). The decline in abundance was small enough that it may be the result of annual fluctuation and not PKD.

The distribution of fish across length groups in 2017 varied little from 2016 and both years were similar when compared to the long-term mean (Figure 14).

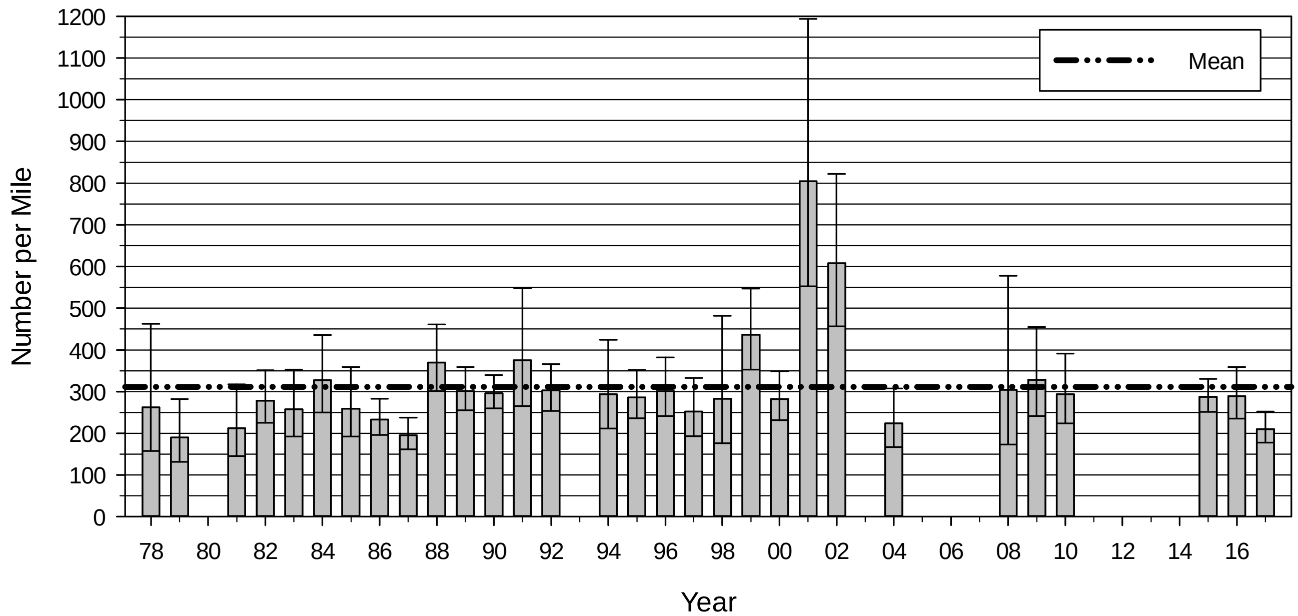

Figure 13: Corwin Springs YCT population estimates for fish 7 inches and greater from 1978 to 2017. The error bars represent the upper and lower 95% confidence intervals.

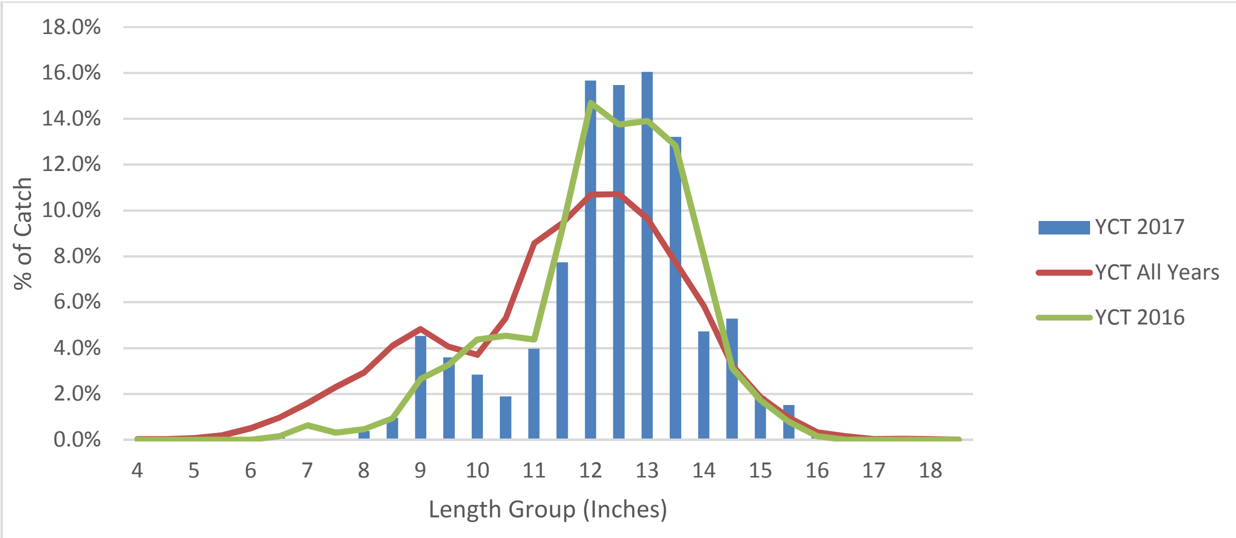

Figure 14: Percent of catch for YCT in the Corwin Springs Section by half inch group.

Mountain Whitefish

The 2017 Mountain Whitefish population estimate for Corwin Springs was lower than the estimate from 1999 at 6,902 fish/mile (≥ 7in) compared to 8,331 fish/mile (≥ 7in) (Figure 15). The 18-year time span between estimates and the lack of more estimates makes it difficult to determine if significant changes have occurred. The decrease is likely natural variability in the population rather than PKD given the sparse numbers of dead fish detected in this portion of the river in 2016.

The distribution of fish across length groups in 2017 varied from 1999. There was an increase of 40.2% in the 8.0 to 12.0-inch range with the largest individual length group increase in the 11.5 inch-group, 15.4% (Figure 16). There were decreases of 10.0% in the 5.0 to 6.5- inch range and 29.7% in the 12.5 to 14.0-inch range. The largest individual length group decrease was 20.2% in the 12.5-inch group. As mentioned earlier, it is difficult to determine how significant these changes are based on limited data.

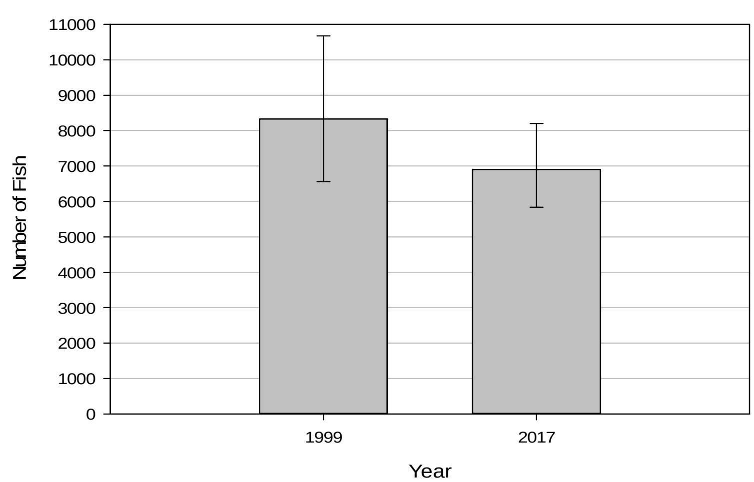

Figure 15: Corwin Springs MWF population estimates for fish 7 inches and greater from 1999 and 2017. The error bars represent the upper and lower 95% confidence intervals.

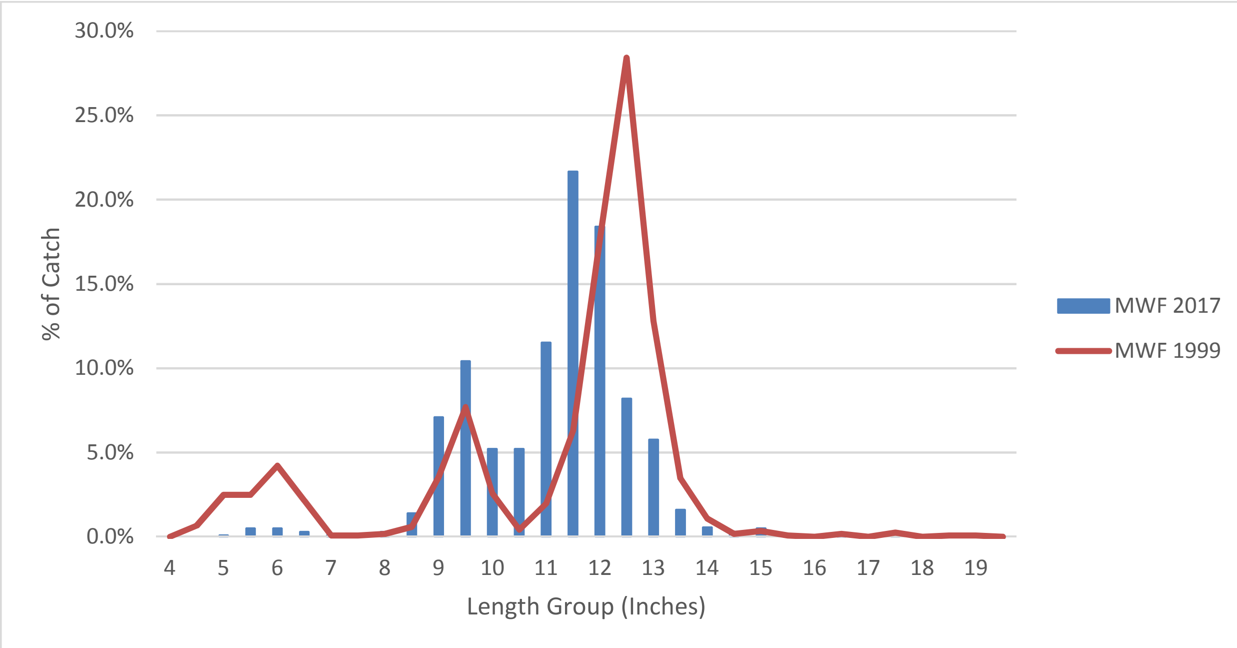

Figure 16: Percent of catch for MWF in the Corwin Springs Section by half-inch group.

Mill Creek Bridge Section

The Mill Creek Bridge Section is a long-term monitoring section that had been sampled since 1981(Figure 8). FWP sampled the section in May 2017 using the mark-recapture method and generated a population estimate for Rainbow and Brown trout along with YCT.

Rainbow Trout

The 2017 Rainbow Trout population estimate was 261 fish/mile (≥ 7in). This was the lowest estimate since 2001 and was below the long-term mean of 353 fish/mile (≥ 7in) (Figure 17). The decrease in abundance is large enough when compared to previous estimates that PKD may have had a population-level effect on Rainbow trout in the Mill Creek Bridge Section. It should be noted that factors other than PKD may have contributed to the decline in abundance (e.g., drought conditions, spring runoff, etc.).

Distribution of Rainbow trout across length groups in 2017 showed an increase of 9.9% in the 7.5 to 10.0-inch range when compared to 2016 (Figure 18). The largest increase in an individual length group was 2.7% in both the 8.5 and 9.0-inch groups. The percentage of catch in the 10.5 to 16.0-inch range was 13.5 % lower than 2016. The largest individual length group decrease, 2.8%, occurred in both the 13.5 and 14.5-inch groups. These results further indicate there was a small population-level effect as the result of PKD, other biotic or environmental factors, or a combination of factors.

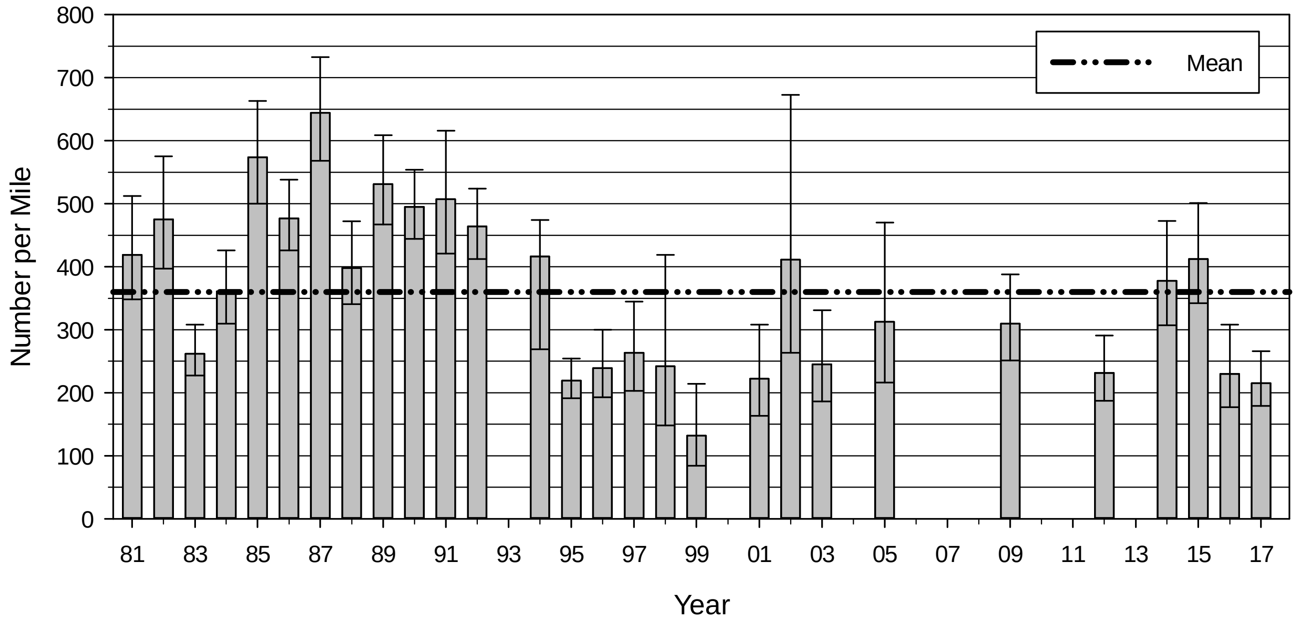

Figure 17: Mill Creek Bridge Rainbow Trout population estimates for fish 7 inches and greater from 1981 to 2017. The error bars represent the upper and lower 95% confidence intervals.

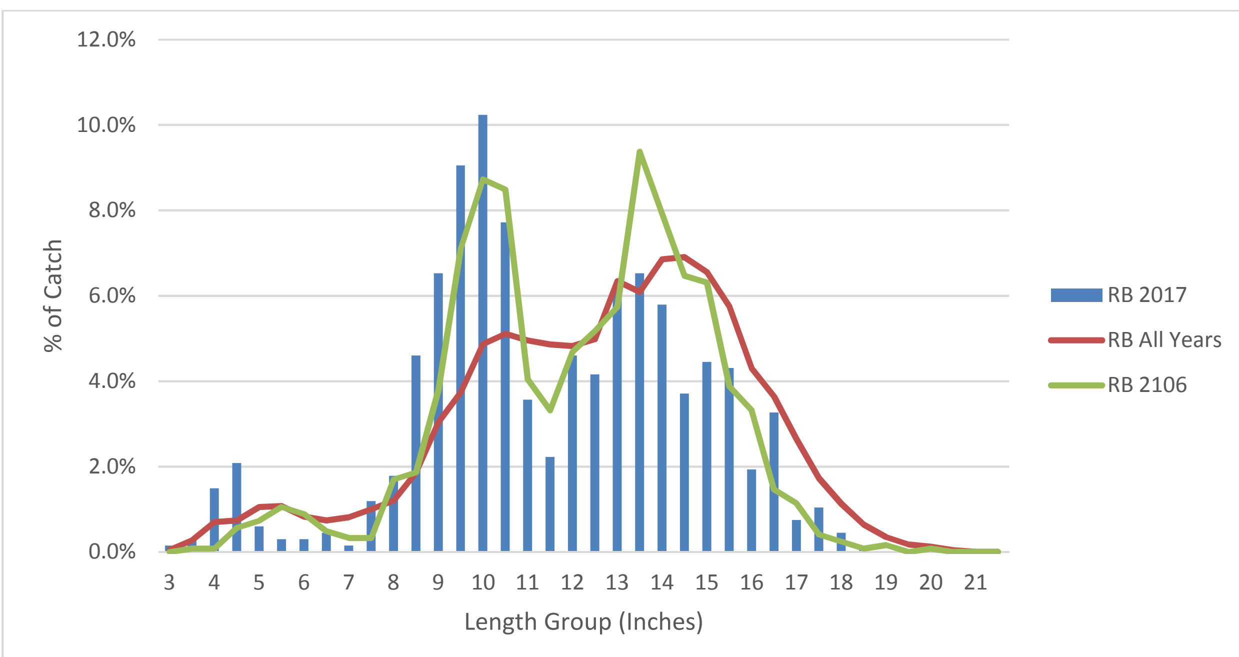

Figure 18: Percent of catch for Rainbow Trout in the Mill Creek Section by half-inch group.

Brown Trout

The Mill Creek Bridge Section Brown Trout population estimate for 2017 was 215 fish/mile (≥ 7in) (Figure 19). This was down from 230 and 412 fish/mile (≥ 7in) in 2016 and 2015, respectively. The 2017 populations estimate remains below the long-term average of 365 fish/mile (≥ 7in).

In 2017, there was an obvious change in the distribution of fish across length groups when compare to 2016. There was an increase in the 7.5 to 13.0-inch range of 59.6% from 2016 to 2017 (Figure 20). The largest increase in an individual length group, 11.0%, was in the 10.5-inch group. There was a decrease of 58.4% from 2016 to 2017 of fish in the 13.5 to 21.0-inch range. The largest individual length group decrease, 8.3%, occurred in the 16.5-inch group.

These results indicate there was a population-level effect as the result of PKD, other biotic or environmental factors, or a combination of factors. The decrease in larger fish could have been the result of multiple factors including PKD, fall spawning, and/or ice jamming on the Yellowstone River in winter of 2016/2017.

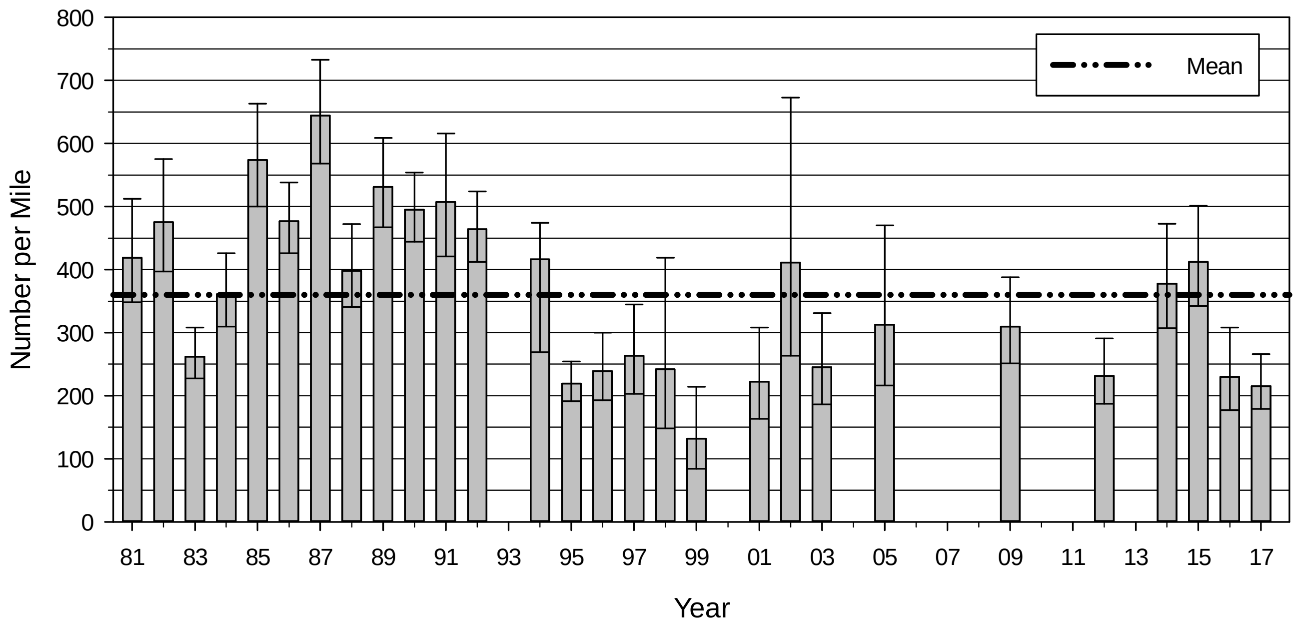

Figure 19: Mill Creek Bridge Brown Trout population estimates for fish 7 inches and greater from 1981 to 2017. The error bars represent the upper and lower 95% confidence intervals.

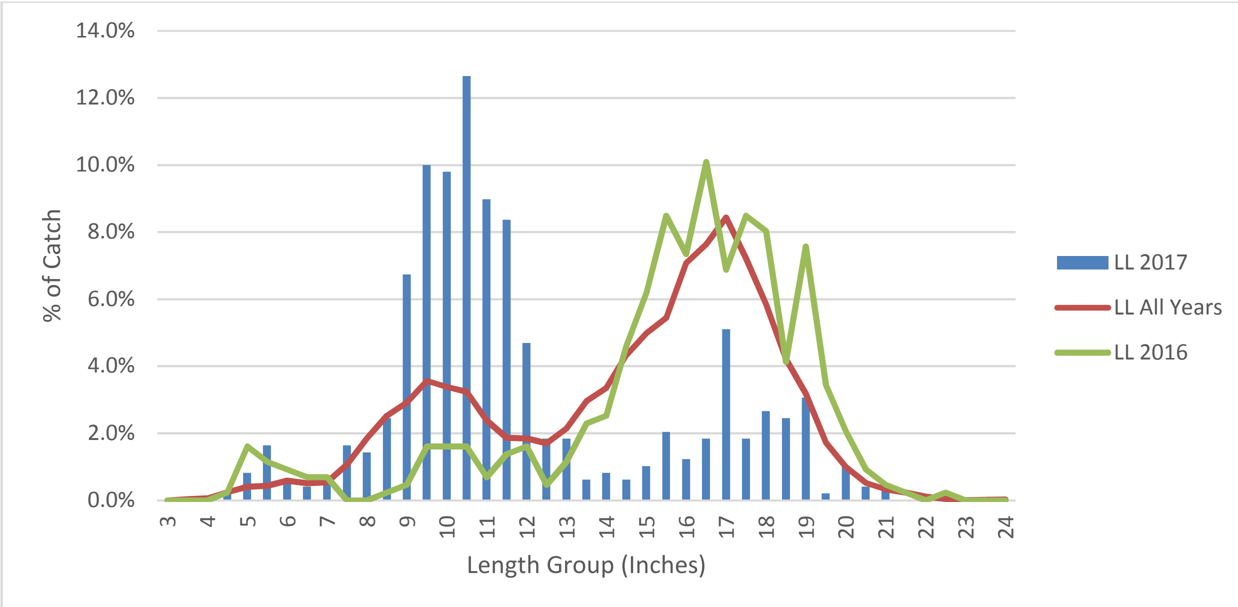

Figure 20: Percent of catch for Brown Trout in the Mill Creek Section by half-inch group.

Yellowstone Cutthroat Trout

The population estimate for YCT in the Mill Creek Bridge Section in 2017 was lower than the previous three years and the long-term average for this section. In 2017, the population estimate was 62 fish/mile (≥ 7in) compared to 152, 75, and 96 fish/mile (≥ 7in) in 2014, 2015, and 2016, respectively (Figure 21).

Distribution of YCT across length groups in 2017 was comparable to 2016 with a few exceptions. There was a 4.5%, 5.5% and 4.6% decrease in the 8.5, 12.0, and 12.5-inch lengths, respectively (Figure 22). There was a 14.6% decrease in the 13.0 to 15.5-inch range. The largest decrease in an individual length group, 5.8%, occurred in the 14.0-inch length group.

There may have been a population-level effect on YCT in the Mill Creek Bridge Section as the result of PKD, other biotic or environmental factors, or a combination of factors.

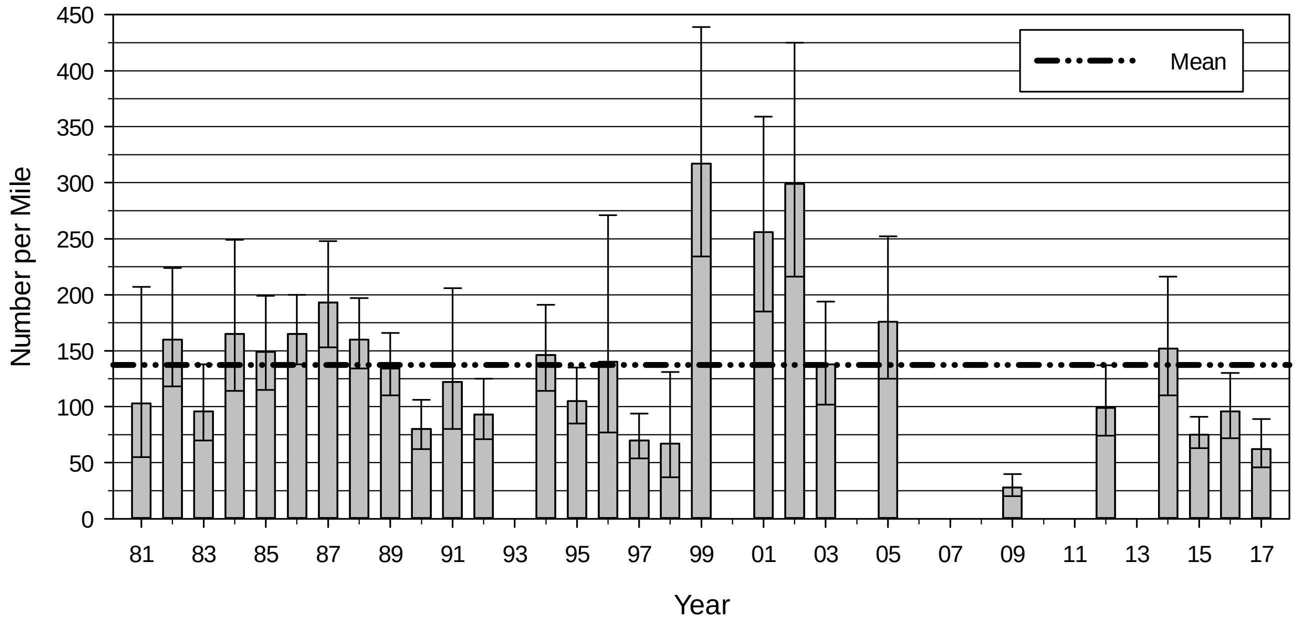

Figure 21: Mill Creek Bridge YCT population estimates for fish 7 inches and greater from 1981 to 2017. The error bars represent the upper and lower 95% confidence intervals.

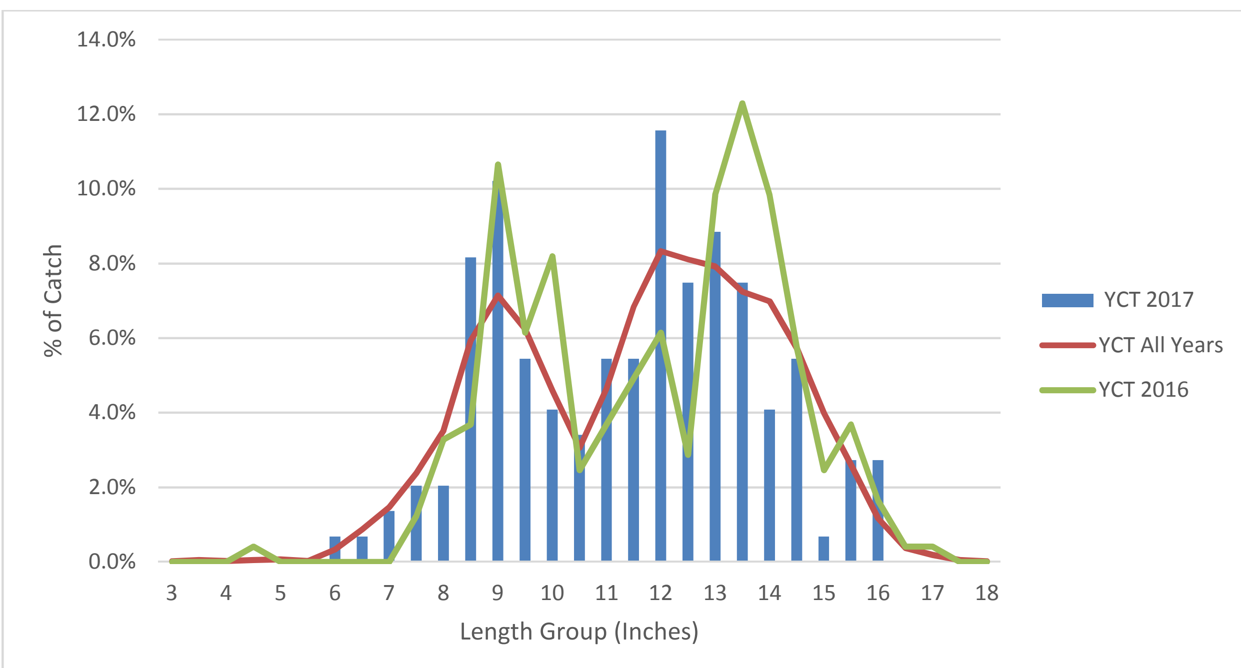

Figure 22: Percent of catch for YCT in the Mill Creek Section by half-inch group.

Mallard's Rest Section

A CPUE was completed in the Mallard's Rest Section in 2017 (Figure 8). This was compared to the CPUE of the marking effort in previous mark-recapture efforts in the section. The 2017 CPUE was much lower than previous years indicating notable change in abundance of MWF (Figure 23). The 18-year time span between sampling makes it difficult to determine if Whitefish have been declining over time or just after the 2016 fish kill.

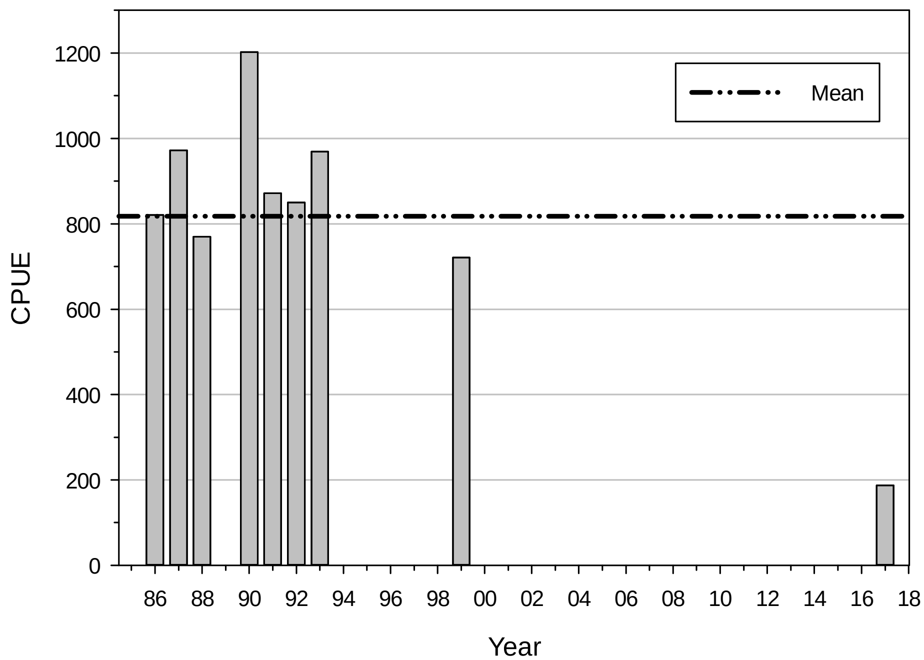

Figure 23: Mountain Whitefish CPUE in the Mallard's Rest Section from 1986 to 2017. The CPUE value is Mountain Whitefish (≥ 7in) per mile.

The Mallard's Rest Section length-frequency distribution of MWF in 2017 differed from 1999 in several length groups but was similar to the long-term average for the section (Figure 24). In 2017, there were decreases of 11.0% and 25.1% in the 8.0 to 9.5-inch range and the 13.0 to 15.0-inch range, respectively. The largest decrease in an individual length group was 7.7% in the 14.0-inch length group. There was an increase of 1.8% in the 5.0 to 7.5-inch range and 33% in the 10.0 to 12.5-inch range. Although a decline has been noted in total number of MWF sampled, it appears that the reduction affected all size classes similarly. As mentioned earlier, given the long span of time between sampling efforts makes it difficult to determine if the noted changes occurred recently or not.

In 2017, there appears to have been a population-level effect on MWF in the Mallards Rest Section as the result of PKD, other biotic or environmental factors, or a combination of factors.

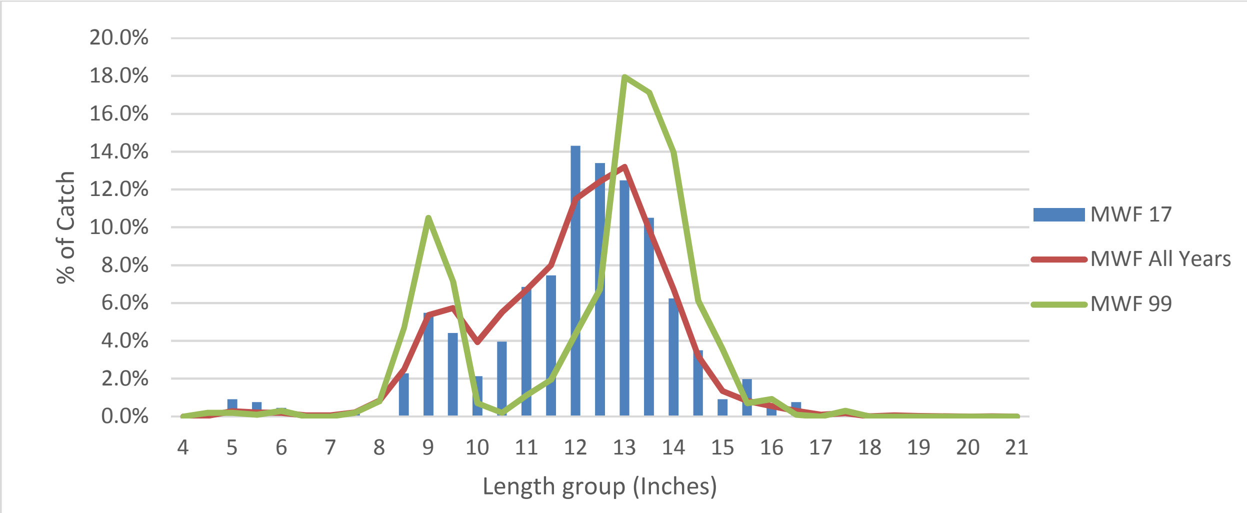

Figure 24: Percent of catch for MWF in the Mallard's Rest Section by half-inch group.

Grey Bear All Species Trend Section

Grey Bear All Species Trend Section was established in 2017 to monitor the presence and abundance of species other than trout that inhabit this section of the Yellowstone River (Figure 8). Trout were avoided and not netted to focus effort on MWF, Smallmouth Bass and non-game fishes. Grey Bear All Species Trend is 3.7 miles long and located upstream of the city of Big Timber. The section begins at the Grey Bear FAS. Seven species were sampled and CPUE was calculated to allow comparison in following years. MWF were the most common followed by Longnose Sucker, White Sucker, and Shorthead Redhorse (Figure 25). Mountain sucker, Common Carp, and Longnose Dace were also sampled in low abundance.

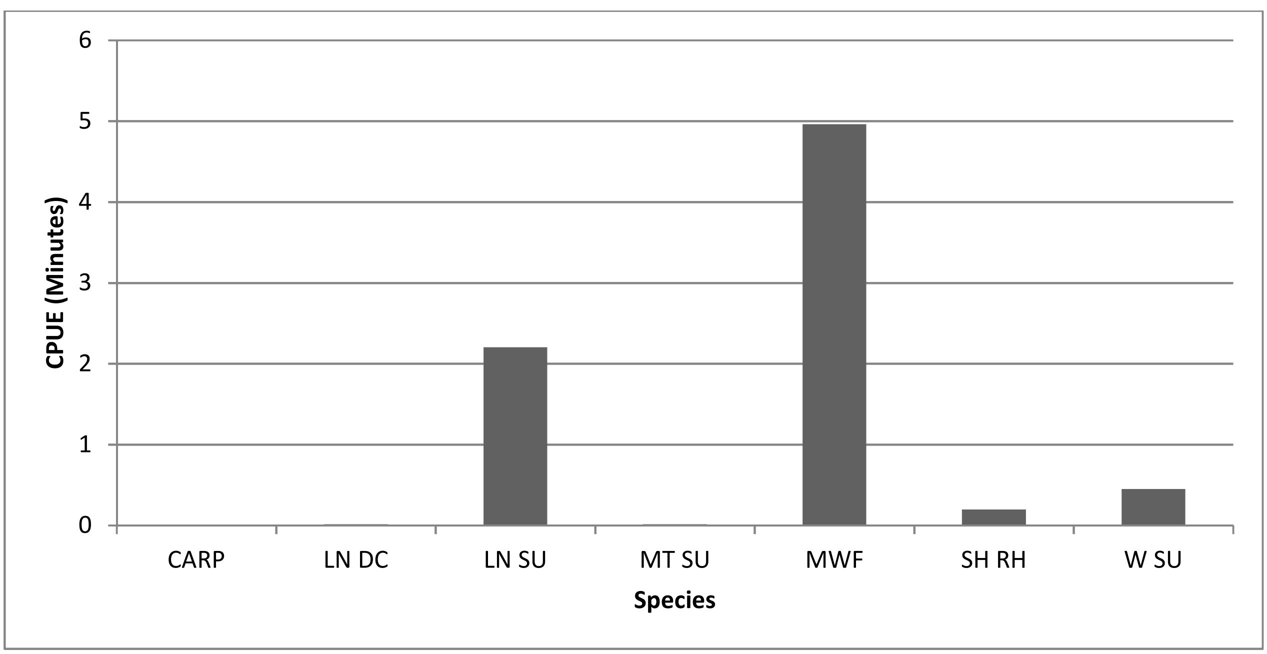

Figure 25: Grey Bear All Species Trend CPUE of Mountain whitefish (MWF), Longnose Sucker (LN SU), White Sucker (W SU), Shorthead Redhorse (SHRH), Common Carp (CARP), and Longnose Dace (LN DC).

Big Timber Section

The Big Timber Section is a long-term monitoring section that has been sampled since 1986 (Figure 8). In March 2017, FWP sampled the section using the mark-recapture method and generated a population estimate for Rainbow Trout and Brown Trout, the primary game fish in the section.

Rainbow Trout

The Rainbow Trout population for the Big Timber Section was estimated at 856 fish/mile (≥ 7in). This was lower than the previous two spring samplings from 2014 and 2013 that were 1068 fish/mile and 959 fish/mile (≥ 7in) respectively. However, the estimate of 856 fish/mile is greater than the long-term mean of 686 fish/mile (≥ 7in) (Figure 26).

Distribution of Rainbow Trout across length groups in 2017 showed above average distribution of the percentage of catch of rainbow trout from 12.0 to 15.0-inch groups (Figure 27). For the Big Timber Section there does not appear to be a population-level effect on Rainbow Trout as the result of PKD.

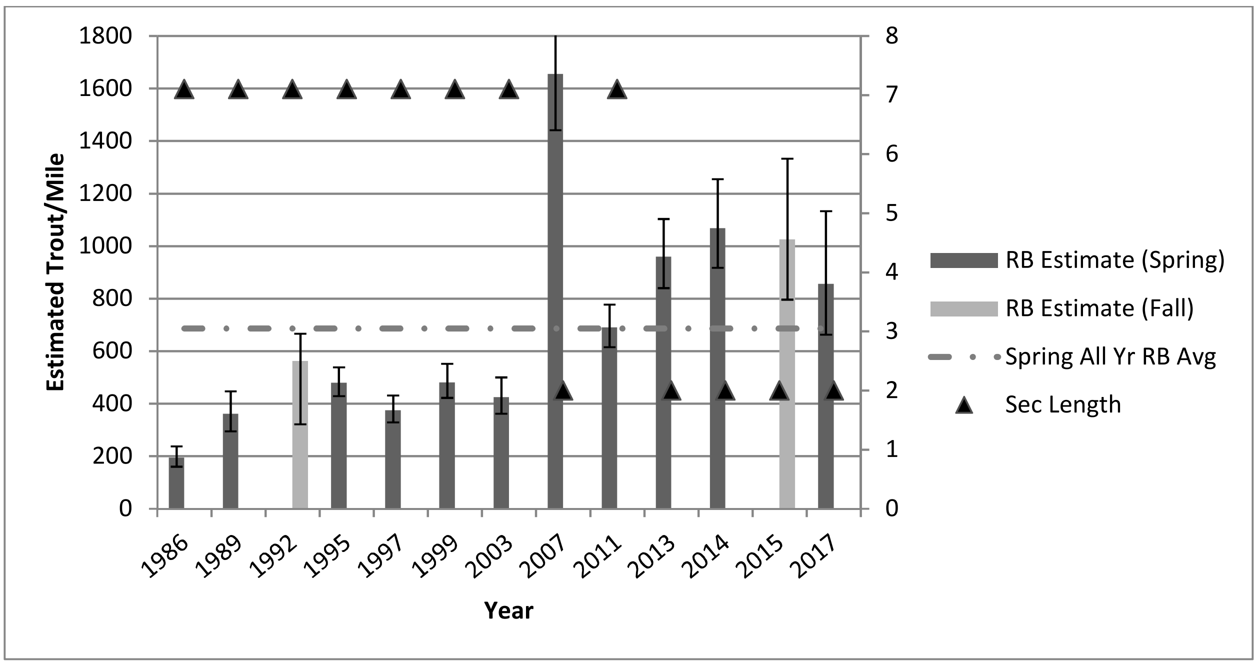

Figure 26: Big Timber Rainbow Trout population estimates for fish 7 inches and greater from 1986 to 2017. The error bars represent the upper and lower 95% confidence intervals.

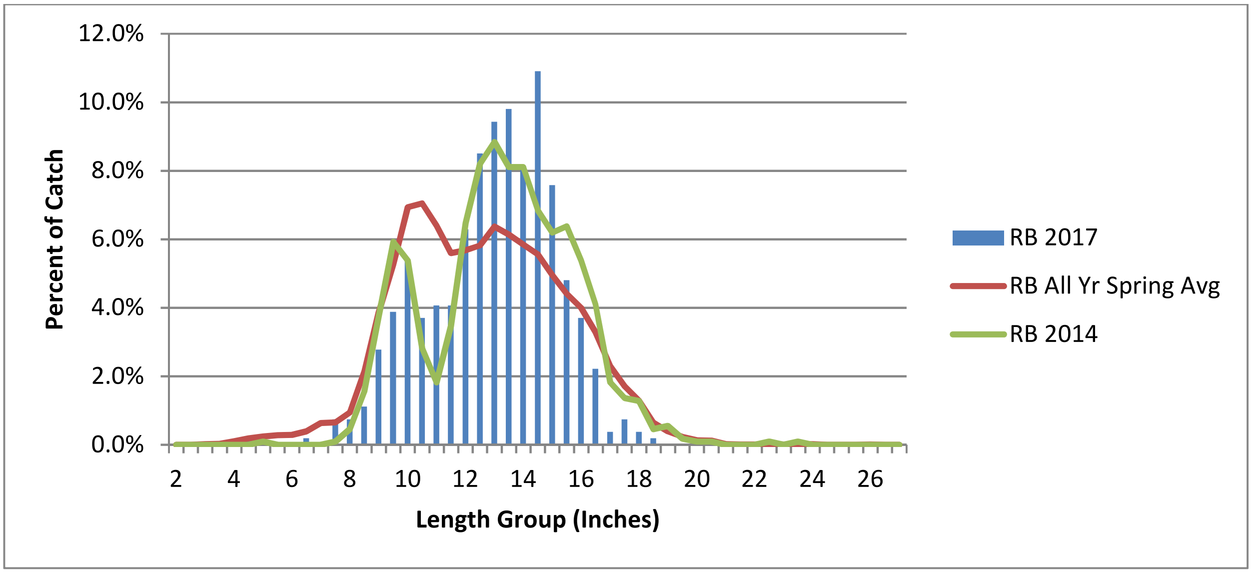

Figure 27: Percent of catch for Rainbow Trout in the Big Timber Section by half-inch group.

Brown Trout

The Brown Trout population for the Big Timber Section was estimated at 316 fish/mile (≥ 7in), which was lower than the 2014 and 2013 efforts that were 527 fish/mile and 534 fish/mile (≥ 7in), respectively. However, like the Big Timber Rainbow Trout estimate, the 2017 Brown Trout estimate of 316 fish/mile (≥ 7in) is greater than the long-term mean of 291 fish/mile (≥ 7in) (Figure 28).

Distribution of Brown Trout across length groups in 2017 was similar to the long-term average but was slightly above average for fish in the 15.0 to 18.0-inch length groups (Figure 29). For the Big Timber Section there does not appear to be a population-level effect on Brown Trout as the result of PKD.

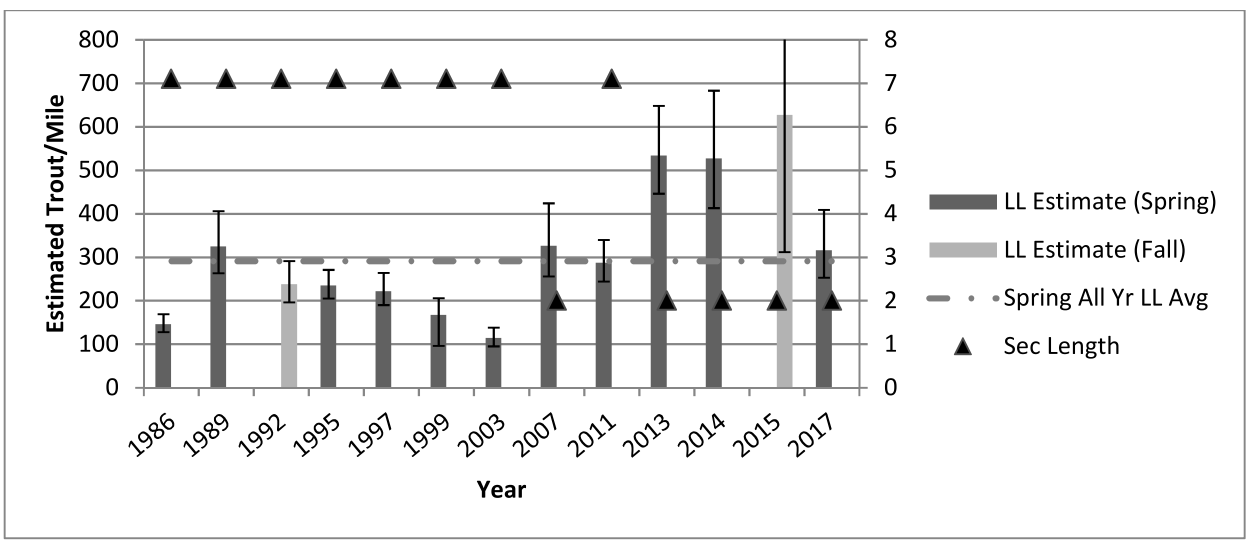

Figure 28: Big Timber Brown Trout population estimates for fish 7 inches and greater from 1986 to 2017. The error bars represent the upper and lower 95% confidence intervals.

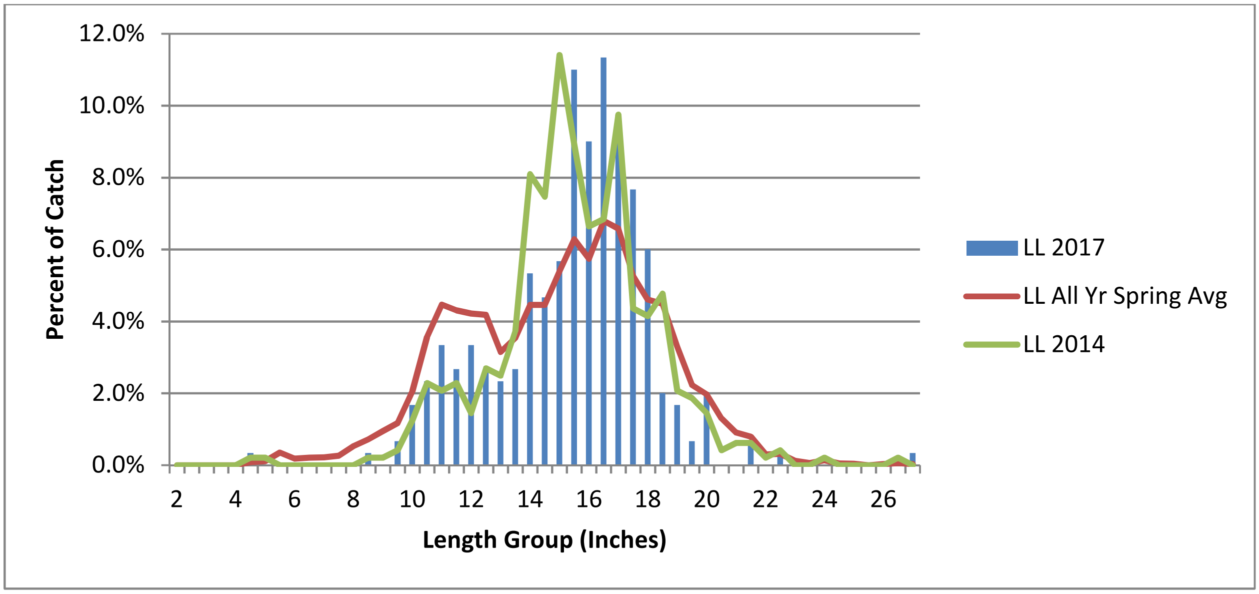

Figure 29: Percent of catch for Brown Trout in the Big Timber Section by half-inch group.

Holmgren All Species Trend Section

The all species trend section at Holmgren was established in 2017 to monitor the presence and abundance of species other than trout that inhabit this section of the Yellowstone River (Figure 8). Trout were avoided and not netted to focus effort on MWF, Smallmouth Bass and non-game fishes. Holmgren All Species Trend Section is 3.5-miles long and located upstream of the city of Columbus. The section begins at the Holmgren FAS. Eleven distinct species were sampled and CPUE was calculated to allow comparison in following years. MWF were the most common observed species followed by Longnose Sucker, White Sucker, Shorthead Redhorse, and Smallmouth Bass (Figure 30). Mountain sucker, Common Carp, Lake Chub, Burbot, Gold Eye and Rocky Mountain Sculpin were also sampled in low abundance.

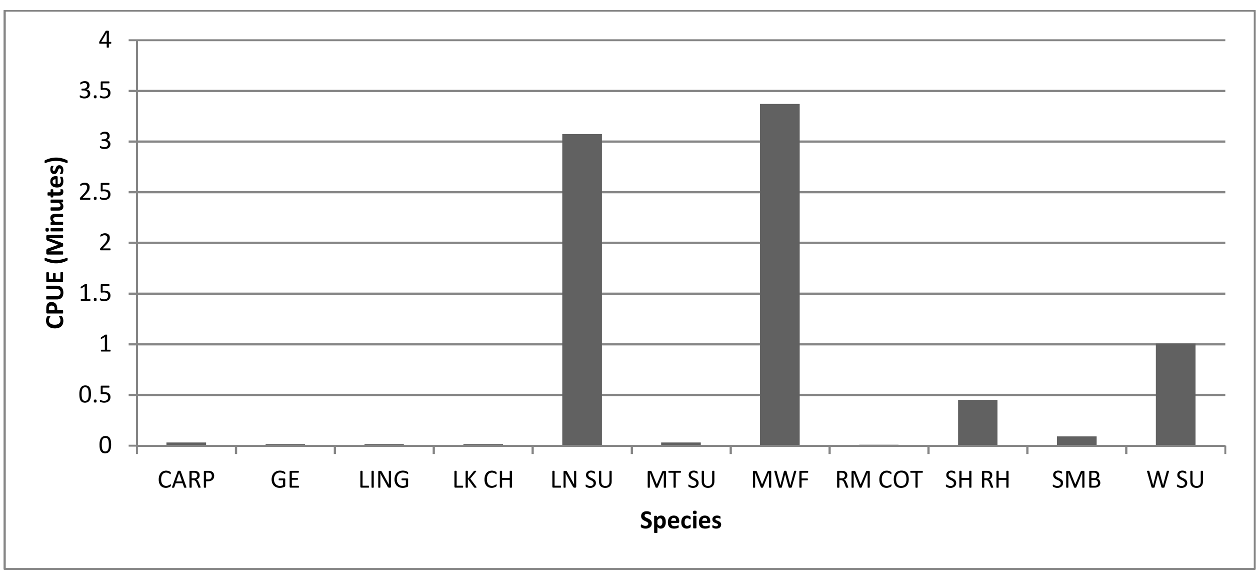

Figure 30: Holmgren All Species Trend CPUE of Mountain Whitefish (MWF), Smallmouth Bass (SMB), Longnose Sucker (LN SU), White Sucker (W SU), Shorthead Redhorse (SHRH), Mountain Sucker (MT SU), Common Carp (CARP), Lake Chub (LK CH), Burbot (LING), Gold Eye (GE) and Rocky Mountain Sculpin (RM COT).

Columbus Section

The Columbus Section is a monitoring section that has been sampled prior to 2006 (Figure 8). However, limited data prior to 2006 limits historical trend comparison. Only sampling from 2006 on are included in the analyses. In April 2017, FWP sampled the section using the mark-recapture method and generated a population estimate for Rainbow Trout and Brown Trout, the primary game fish in the section.

Rainbow Trout

The Rainbow Trout population for the Columbus Section was estimated at 314 fish/mile (≥ 7in). This was the lowest estimate since 2006 and below the long-term average (Figure 31).

Distribution of Rainbow Trout across length groups in 2017 closely mirrored the long-term average except for below average distribution in the 7.0 to 9.0-inch length groups (Figure 32). Rainbow Trout between 7.0 and 9.0 inches make up a significant portion of the catch in most years. This cohort had a reduced presence in 2017 and would decrease the population estimate. The cause for the depressed cohort is unknown and this trend will be monitored into the future but, the fluctuation may be normal population fluctuations.

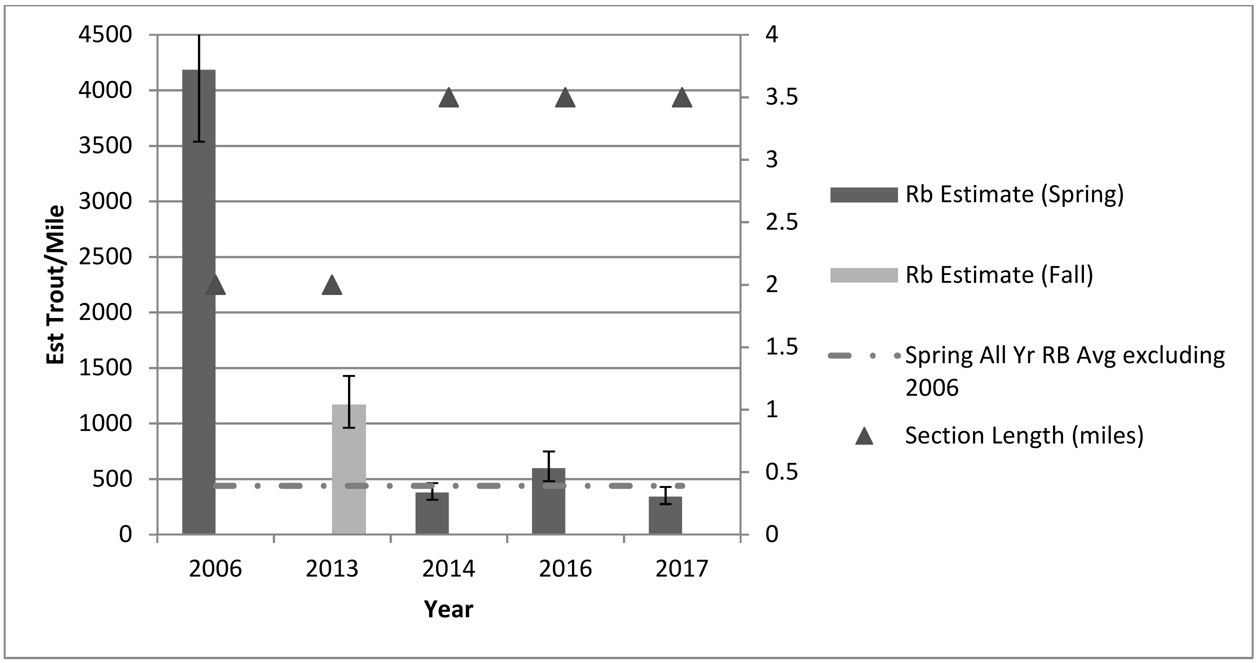

Figure 31: Columbus Rainbow Trout population estimates for fish 7 inches and greater from 2006 to 2017. The error bars represent the upper and lower 95% confidence intervals.

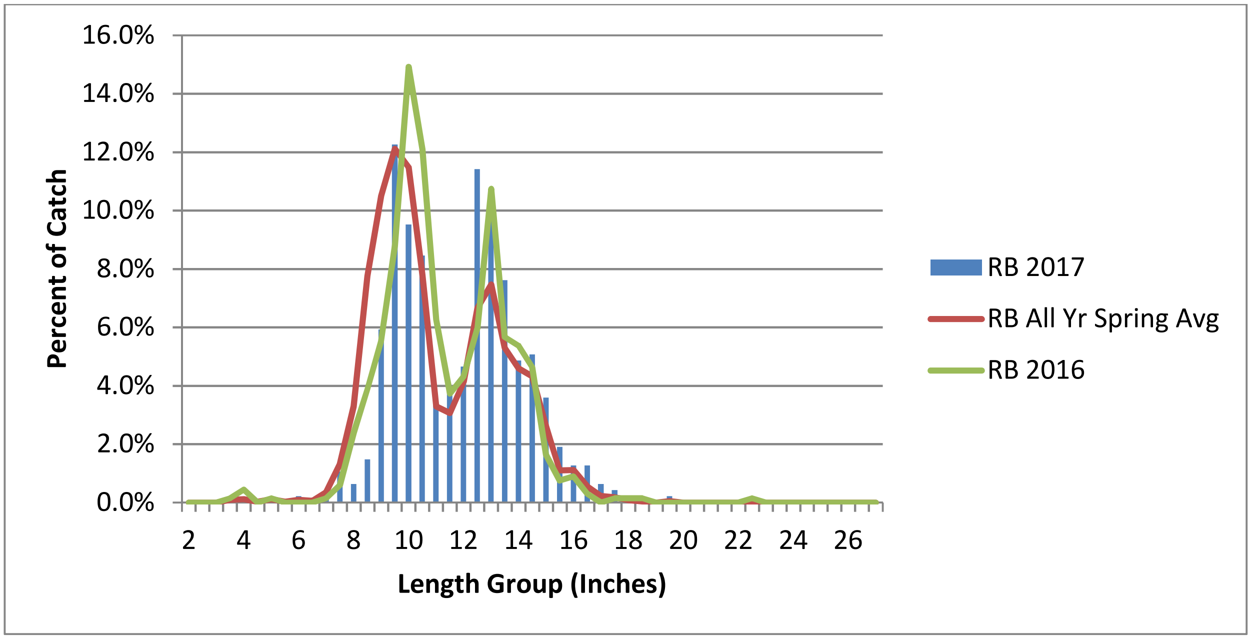

Figure 32: Percent of catch for Rainbow Trout in the Columbus Section by half-inch group.

Brown Trout

The 2017 Brown Trout population for the Columbus section was estimated at 206 fish/mile (≥ 7in), the lowest estimate since 2006 (Figure 33). Distribution of Brown Trout across length groups in 2017 was similar to the long-term average but was slightly lower from 9.0 to 10.0 inches (Figure 34).

The cause of the below average Columbus Brown Trout estimate is unknown and will be monitored into the future, but the fluctuation may be normal population fluctuations.

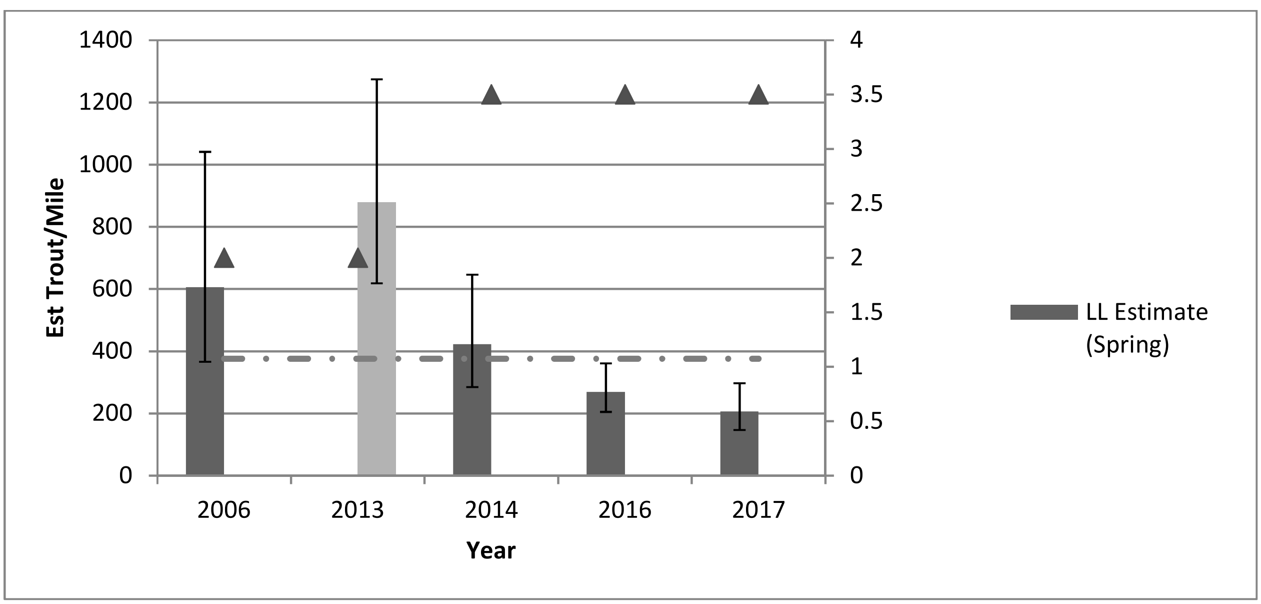

Figure 33: Columbus Brown Trout population estimates for fish 7 inches and greater from 2006 to 2017. The error bars represent the upper and lower 95% confidence intervals.

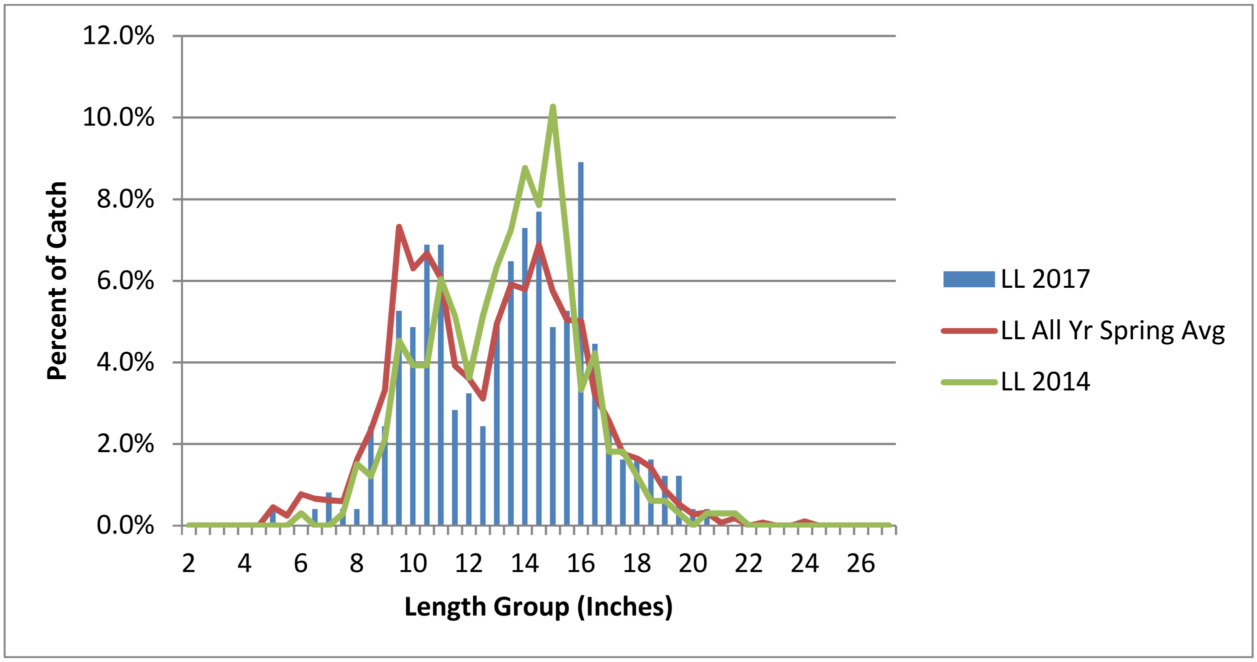

Figure 34: Percent of catch for Brown Trout in the Columbus Section by half-inch group.

Laurel Section

The Laurel Section is a monitoring section that has been sampled prior to 2013; however, like the Columbus section, historical trend comparison is limited by incomplete data (Figure 8). Only data from 2013 and newer are included in the analyses. In April 2017, FWP sampled the section using the mark-recapture method and generated a population estimate for Rainbow Trout and Brown Trout, the primary game fish in the section. Currently there are only two spring samplings for comparison in the Laurel section.

Rainbow Trout

The Rainbow Trout population for the Laurel Section was estimated at 133 fish/mile (≥ 7in). This was the lowest estimate in recent times and below the long-term average (Figure 35). Distribution of Rainbow Trout across length groups in 2017 closely resembled the long-term average (Figure 36). The similar distribution is to be expected because this is one of the two years used to generate the average. Limited historical data limit interpretation of the low Rainbow Trout population estimate in 2017. However, it is suspected warm water temperatures in the lower reaches of Yellowstone River trout habitat may have been responsible for this low population estimate.

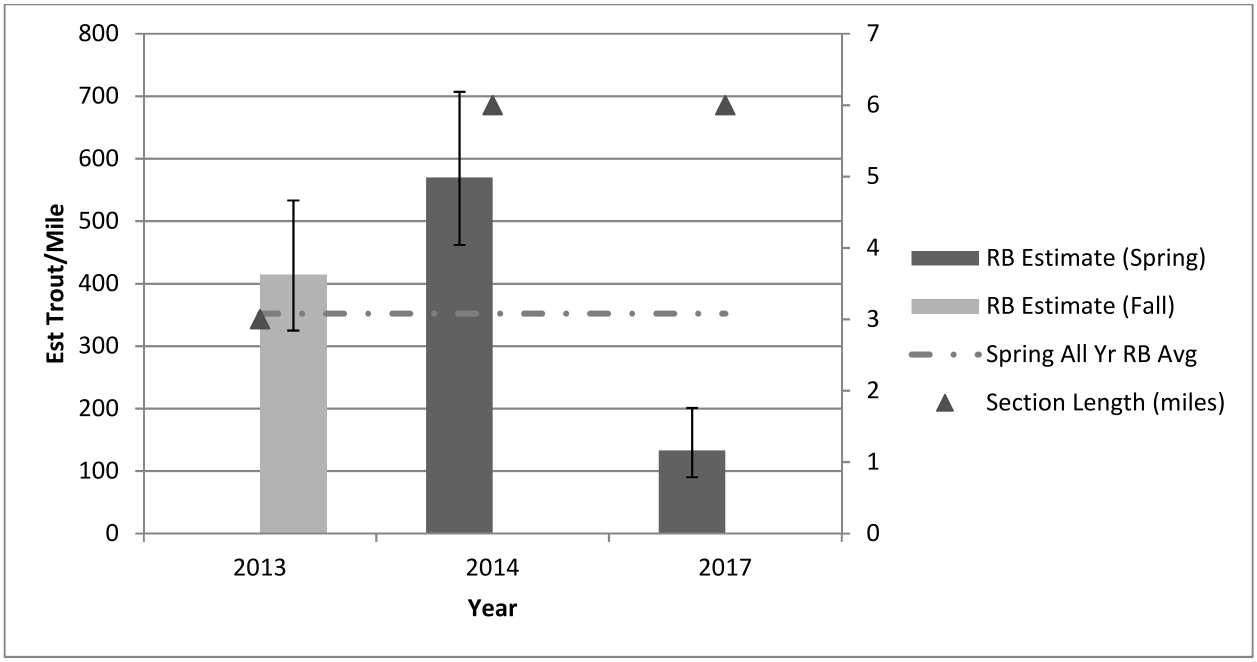

Figure 35: Laurel Rainbow Trout population estimates for fish 7 inches and greater from 2013 to 2017. The error bars represent the upper and lower 95% confidence intervals.

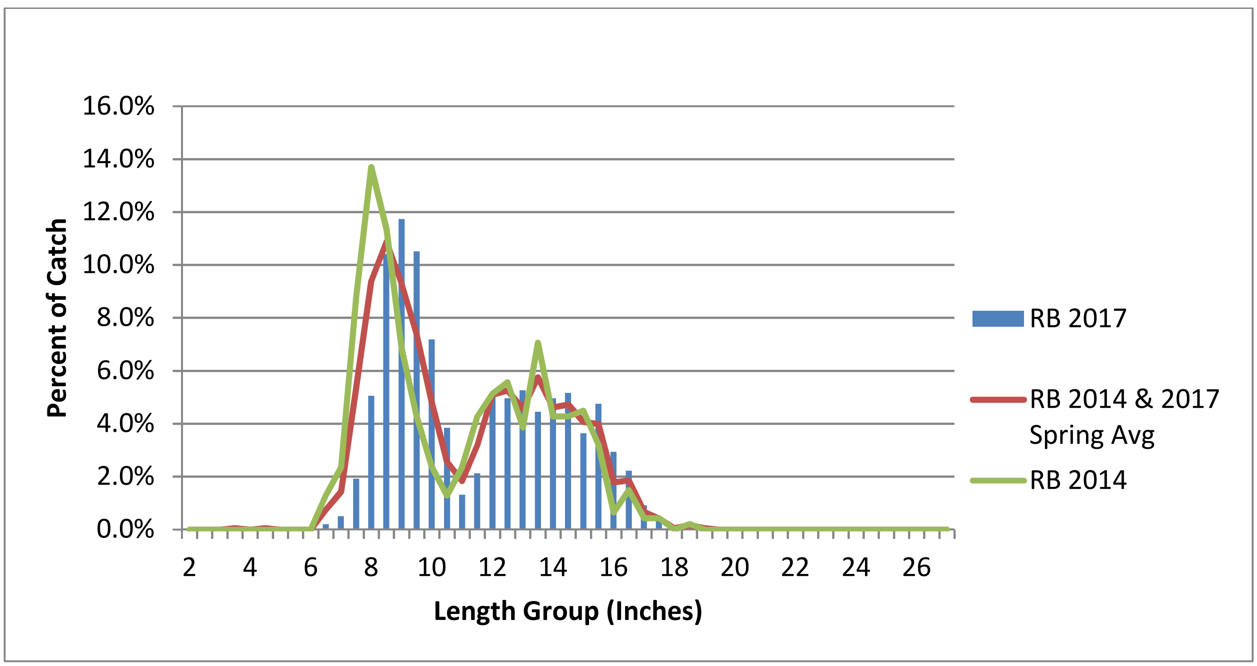

Figure 36: Percent of catch for rainbow trout in the Laurel Section by half-inch group.

Brown Trout

The Brown Trout population for the Laurel Section in 2017 was estimated at 222 fish/mile (≥ 7in). This was the lowest estimate in recent times and below the long-term average (Figure 37). Like the Laurel Section

Rainbow Trout distribution of catch, the distribution of brown across length groups in 2017 closely resembled the long-term average because it was one of the two years used to generate the average (Figure 38). Again, limited historical population estimates limit interpretation of the low population estimate in 2017. However, it is suspected warm water temperatures in the lower reaches of Yellowstone River trout habitat may have been responsible for this low population estimate.

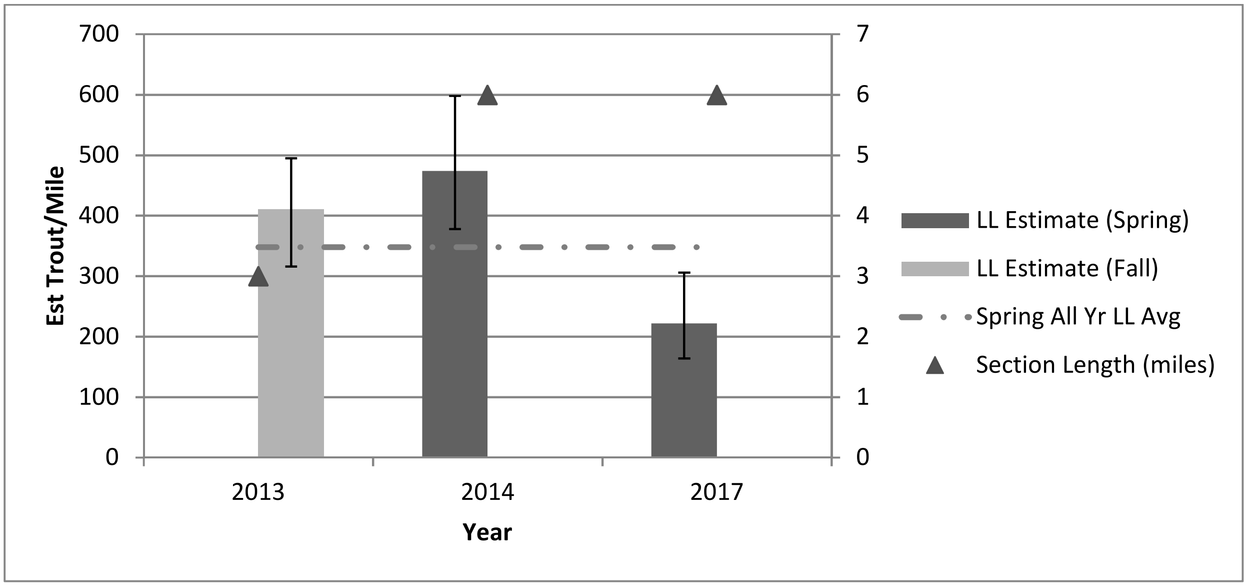

Figure 37: Laurel Brown Trout population estimates for fish 7 inches and greater from 2013 to 2017. The error bars represent the upper and lower 95% confidence intervals.

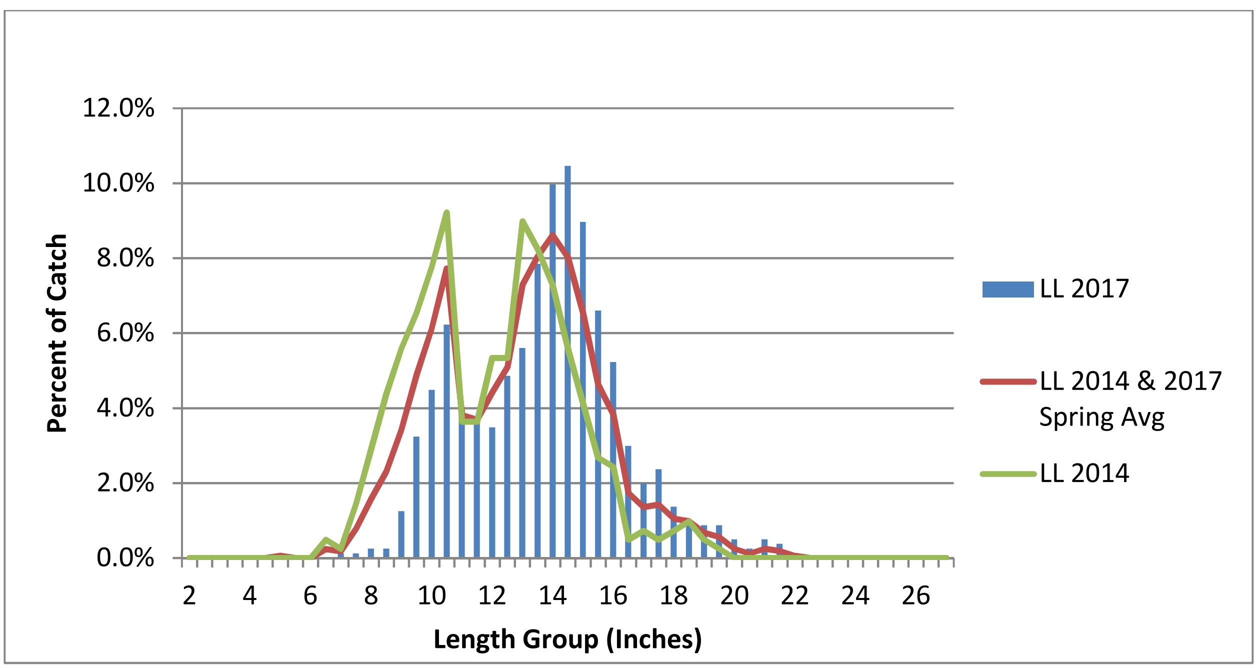

Figure 38: Percent of catch for rainbow trout in the Laurel Section by half inch group.

Summary

PKD was determined to be the cause of the fish mortality noted in the Yellowstone River in late summer 2016. The disease caused high direct mortality in the MWF population, while direct mortality in trout was limited. A 183-mile river closure was implemented to remove added stress to fish during the disease outbreak and was reduced in size as MWF mortality subsided. The river closure was completely removed by the end of September 2016. PKD testing in several waters in southwest Montana indicated that the parasite was present and more widespread than originally assumed.

Population sampling in 2017 indicated that PKD reduced the abundance of MWF in the Corwin Springs and Mallard's Rest Sections. Brown Trout in the Mill Creek Bridge Section experienced a decline of 58.4% in fish 13.5 inches and larger and a 59.6% increase in fish 13 inches and smaller. Rainbow Trout in the Mill Creek Bridge Section had a 13.5% decrease in fish 10.5 inches and larger and a 9.9% increase in fish 10 inches and smaller. These results indicate there was a population-level effect as the result of PKD, other biotic or environmental factors, or a combination of factors. The decrease in larger fish could have been the result of multiple factors including PKD, fall spawning, and/or ice jamming on the Yellowstone River in winter of 2016/2017. Similar trends were seen in the Corwin Springs Section with both Brown and Rainbow trout, but were not large enough to clearly indicate that PKD had a population-level effect on trout in this section.

Population sampling results down river from the Springdale Section indicate no potential impact to fish populations from PKD.

Monitoring of both MWF and trout populations will continue in the future to track the impacts of PKD and changes in the populations.

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