Final Report

Shields River Yellowstone Cutthroat Trout Conservation – II (Montana)

NFWF Grant # 45393

Illustration courtesy of J. Tomellari

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Executive Summary

We installed three temporary fish barriers and they appeared to be effective, but we found one fish above one barrier. We are uncertain how this fish passed the barrier. We removed 1,820 brook trout from the study area from 2014 to 2015 using electrofishing and another 18 using fyke nets. We did not catch any brook trout above barriers in Turkey Creek and the unnamed tributary near Dugout Creek during sampling in late 2015 and believe we have eradicated brook trout from these areas, something eDNA sampling confirmed because no brook trout DNA was detected above these barriers. In Scofield Creek we did not capture any brook trout in late 2015 above the temporary fish barrier, but eDNA sampling found some brook trout DNA that likely originated from a few brook trout inhabiting the very upper portion of this stream. Late fall electrofishing was extremely effective for capturing brook trout that had congregated in large deep pools. Monitoring suggests that Yellowstone cutthroat trout abundances have generally increased in all areas where brook trout were suppressed or eradicated, except in the smallest streams, which may be too small to support fish in all seasons.

Introduction

This final report summarizes technical information for grant # 45393 between the Park County Conservation District (on behalf of the Shields Valley Watershed Group; SVWG) with the National Fish and Wildlife Foundation's Bring Back the Natives program to conserve native Yellowstone cutthroat trout (YCT) in the upper Shields River basin of Montana. Montana Department of Fish, Wildlife & Parks (MFWP), SVWG, USGS Northern Rocky Mountain Science Center and Montana Cooperative Fishery Research Unit, Custer Gallatin National Forest, and others have been working collaboratively over the past decade to conserve YCT in the Shields River basin under the leadership of MFWP. Initial work focused on identifying threats to extant populations of YCT. The current work is evaluating short-term and long-term strategies for conserving YCT in about 32 miles of connected habitats within the upper Shields River basin (Figure 1).

Specifically, this report provides information on: 1) installation of three temporary barriers to prevent the upstream movement of fish; 2) the effectiveness of these temporary barriers; 3) physical removals of brook trout from the project area; 4) effectiveness of physical removals of brook trout; 5) installation of a long-term barrier to upstream fish movement; and 6) monitoring of YCT within the project area.

Installation of Three Temporary Fish Barriers

Temporary fish barriers were installed in an unnamed tributary near Dugout Creek, in Turkey Creek, and in Scofield Creek by the Custer Gallatin National Forest (Figure 1). These barriers were created by installing perched culverts with hardened shallow outfall pools to prevent fish from being able to jump up into the culverts (Photo 1). All temporary barriers were installed by the fall of 2014.

Effectiveness of Temporary Fish Barriers

The effectiveness of temporary fish barriers was evaluated by monitoring movements of fish tagged with 12 and 23 mm long passive integrated transponder (PIT) tags. We concentrated our efforts in Turkey Creek and the unnamed tributary near Dugout Creek. Fish were captured by electrofishing and 12 mm PIT tags were inserted into captured fish 80 mm (TL) to 130 mm and 23 mm tags were inserted into fish 130 mm and longer after they were anesthetized, measured, and weighed. Recaptures of previously PIT-tagged fish were made by electrofishing above and below fish barriers, using mobile PIT-tag receivers in the unnamed tributary by Dugout Creek, and using a fixed-station PIT tag receiver placed at the temporary barrier on Turkey Creek. Two PIT receiver antennas were placed below and one was placed above the fish barrier on Turkey Creek to continuously monitored movements of PIT-tagged fish near this barrier during the summer and fall of 2014 and 2015. The direction of each fish's movement could be assessed by the timing of fish movement across each of these antennas.

Figure 1. Map of upper Shields River basin showing locations of long-term fish monitoring sections, temporary and long-term fish barriers, and passive integrated tag (PIT) fixed-location receiver stations.

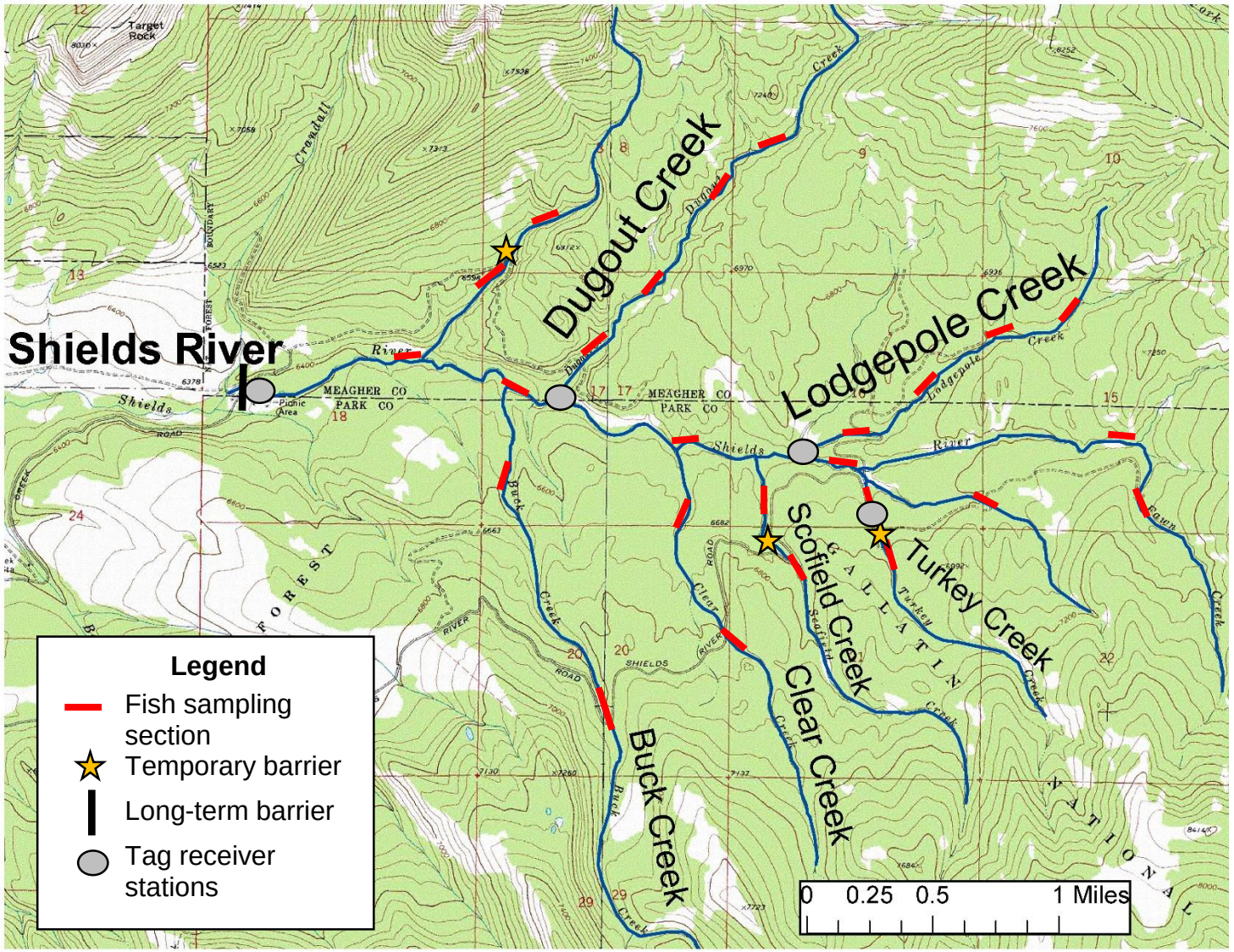

Photo 1. Photos of temporary fish barrier located on Turkey Creek.

We tagged a total of 413 brook trout and 2,638 YCT from 2011 to 2015 in the Shields basin (Table 1). Sixty-four of these brook trout and 1,412 of these YCT were tagged during 2014 and 2015. We recorded 57 tag recapture events in Turkey Creek and 14 in the unnamed tributary by Dugout Creek during electrofishing sampling after the temporary barriers were installed. We had 53 recapture events in Turkey Creek and six in the unnamed tributary by Dugout Creek above the temporary barriers during that time. We did not find any fish that had been previously PIT-tagged below any of the temporary barriers during this electrofishing sampling above the barriers.

Table 1. Number of passive integrated transponder tags (PIT) put into fish within the upper Shields River basin by fish species, stream, and year.

Species	Year					
Stream	2011	2012	2013	2014	2015	Total
Brook Trout						
Dugout Cr	44	67	53			164
Lodgepole Cr	2	4				6
Mill Cr			33	5		38
Shields R	20	107	3	24		154
trib near Dugout Cr	5	8	3	25		41
Turkey Cr				10		10
TOTAL	**71**	**186**	**92**	**64**	**0**	**413**
Yellowstone cutthroat trout						
Dugout Cr	133	101	84	86	240	644
Fawn Cr			6			6
Lodgepole Cr	97	94	34	116	252	593
Lodgepole Cr - trib		1			14	15
Mill Cr			19	11		30
Scofield Cr				43		43
Shields R	133	274	221	96	377	1101
trib near Dugout Cr	14	5	10	40	26	95
Turkey Cr				101	10	111
TOTAL	**377**	**475**	**374**	**493**	**919**	**2638**

We recorded 48 PIT-tag recapture events during three separate mobile surveys of the unnamed tributary by Dugout Creek in 2014, but only ten of these were above the temporary barrier. Of these ten, all but one was either originally tagged prior to the

barrier being installed or in the reach of stream above the temporary barrier. One brook trout was tagged on July 10, 2014 immediately below the fish barrier and was detected on September 10, 2014 about 180 m above the barrier. We are unsure how this fish moved past the barrier. It is likely this brook trout was subsequently removed during electrofishing removals (see below).

The fixed-station PIT tag receiver at the temporary barrier in Turkey Creek did not record any fish that moved up above the temporary barrier. We recorded 189 different movements (a fish moving during a day) near the temporary barrier during 2014 and 2015. Twelve of these movements were down through the culvert barrier and the rest were fish that moved up to the barrier but were not recorded moving above the barrier.

Physical Removal of Brook Trout

We used two primary methods for physically removing brook trout from waters in the project area. We used electrofishing removals in much of the habitats above the proposed long-term fish barrier that will be located just above Crandall Creek (Figure 1). We also periodically set small fyke nets located in the Shields River just below Dugout Creek and in Dugout Creek near its mouth in the fall to see if these nets would successfully capture mature adult brook trout moving upstream to spawn.

Electrofishing Removals

We initially focused our efforts to remove brook trout using electrofishing in Turkey Creek and the unnamed tributary near Dugout Creek above the temporary fish barriers. We also made several efforts within Dugout Creek and in the Shields River from the long-term barrier site up to the upper crossing of the river by the Forest Service's Shields Loop Road (Figure 1). Most of these removal efforts consisted on a single electrofishing pass through the entire portion of these streams that supported brook trout.

We conducted 28 removal efforts during 2014 and 2015 and two other efforts in 2013 when we relocated captured brook trout (Table 2). During these removal efforts we removed a total of 1,820 brook trout (Table 2, including footnotes). These removal efforts reduced the number of brook trout in those segments of streams where they occurred, especially above temporary barriers. We found that we captured more brook trout in fall efforts, probably because flows were low, brook trout had moved up into the upper Shields and its tributaries to spawn, and water temperatures were cold – cuing fish to congregate in pool habitats. We believe we were successful in eradicating brook trout from the areas above the temporary barriers in the unnamed tributary (Trib near Dugout Creek) and Turkey Creek during this project (Table 2; and see below in Monitoring). We believe the reasons we were successful in eradicating brook trout from these areas were because 1) brook trout had recently invaded and were present in low densities; and 2) these streams were small allowing our electrofishing efforts to be efficient.

Table 2. Number of brook trout removed during 2014 and 2015 and treatment reach lengths (km) for streams of the upper Shields River basin by stream, treatment reach, and year.

Stream	Dates	Section treated	Km treated	Year	
				2014	2015
Buck Cr	Late-August	Mouth up to FS Loop Road	1.61		14
Clear Cr	Late-August	Mouth up to FS Loop Road	1.34		0
Dugout Cr	Early-July	Near FS Loop Road up 1.15 km	1.15	39	51
	Mid-July	FS Loop Road up 1.35 km	1.35		147
	Late-July	Mouth up to FS Loop Road	0.25		13
	Late-September	Near FS Loop Road crossing	0.20		34
	Late-September	Below zigzag up to log road	0.70		69
	Mid-October	Mouth up to near top end of fish	3.00	185	
Fawn Cr	Early-August	Mouth up 0.85 km	0.85		15
Lodgepole Cr	Early-July	Long-term monitoring sections	0.61	3	
	Mid-October	Mouth up to FS Loop Road and monitoring sections	1.24	16	
	August to September	Mouth up to end of fish	2.20		3
	Early-October	Middle portion of creek and trib	1.65		0
Shields R	Mid-August	FS Campground to Buck Cr	2.60		
	Mid to Late - October	FS Campground to Buck Cr	2.60		886
	Late-July	Buck Creek up to FS Loop Road	2.60		88
	Late-July	FS Loop Road up to end of fish	3.77		52
Scofield Cr	Early-September	Just above FS Loop Road	0.28	0	1
	Mid-July	FS Loop Road up 1.06 km	1.06		14
Trib near Dugout Cr	Mid-August	Mouth up to below FS Loop Road	0.77		34
	Late-July	Below FS Loop Road	0.30		25
	Early-September	FS Loop Road upstream	0.88	4	
	Mid-October	FS Loop Road upstream	0.75	0	
	Early-July	FS Loop Road upstream	0.89		0
Turkey Cr	Late-July	Below temporary barrier	0.10		4
	Early-September	Above temporary barrier	0.46	1	
	Mid-October	Above temporary barrier	0.90	0	
	Early-July	Above temporary barrier	0.90		0
TOTALS				248	1450

[a/] A total of 119 Brook Trout were moved out of this section in 2013.

[b/] Three Brook Trout were moved from this section below the temporary barrier in 2013.

Fyke Net Removals

Fyke nets were tried as an additional tool to remove brook trout from waters in the upper Shields basin. One 38-cm diameter fyke net was placed in the Shields River just below the confluence with Dugout Creek and another was placed in Dugout Creek approximately 10 meters upstream of the mouth. The nets were placed in the thalweg with the openings facing in a downstream direction. Net leads attached to each side of the downstream fyke net opening were stretched diagonally downstream of these nets. These leads were rocked down and additional rocks were placed from the ends of these leads to the shoreline to direct upstream moving fish into the nets. These two locations were chosen because of known fall upstream movement of brook trout and ease of human access to monitor the nets. We recorded dates and time of deployment (24-hour military time), and catch of fish and date and time for each time we checked the nets and when nets were removed. Catch per effort was computed as the number of fish by species caught per hour each net was deployed.

In the Shields River, the fyke net was placed at 11:15 on September 23, 2015 and checked on September 24, 2015 at 14:00. A total of 8 brook trout were in the net. Seven were ripe males and one was a gravid female (Table 3). The males ranged in total length from 170 to 225 mm and the female was 233 mm. The net was checked again and then removed at 9:30 on September 25, 2015. No fish were present. The net was re-set on September 27, 2015 at 9:30. On September 30 at 17:00 the net was checked and no fish were present. The trap was left running and was checked again on October 1, 2015 at 10:15. There were two brook trout and one YCT in the net. The brook trout were both ripe males and were 199 and 204 mm in total length. The YCT was not sexed or measured. On October 2, 2015 there was one 70 mm long brook in the net. The trap was pulled for the season at 10:00 on October 2, 2015.

In Dugout Creek, the fyke net was placed at 11:30 on September 23, 2015 and was checked on September 24, 2015 at 14:11. One small, 68 mm, brook trout was present (Table 3). The net was checked again and then removed at 9:30 on September 25, 2015 and no fish were present. The fyke net was re-set on September 27, 2015 at 9:30 and checked on October 1, 2015. Three small brook trout and one YCT were present. The brook trout ranged in total length from 78 to 80 mm. The YCT was not measured. The net was checked on October 2, 2015 and one YCT was present. The net was pulled for the season on October 2, 2015 at 10:00.

Fyke nets appear to be a viable option to capture brook trout that are moving in the fall. Based on initial results the nets will need to be set earlier in the fall in order to cover more of the spawning migration season for brook trout. The nets will provide an inexpensive capture method that requires little manual labor. These nets catch pre-spawning adults and could be an important technique for reducing recruitment of brook trout. We plan to use more nets and see if leaving gravid females in the net will attract more fish next fall.

Table 3. Catches of fish (by species) in fyke nets by location (stream) and date.

Water Date	Brook Trout	YCT
Shields River		
9/24/15	8	0
9/25/15	0	0
9/30/15	0	0
10/1/15	2	1
10/2/15	1	0
10/8/15	2	2
Dugout Cr		
9/24/15	1	0
9/25/15	0	0
9/30/15	0	0
10/1/15	3	1
10/2/15	0	1
10/8/15	1	0
Total	**18**	**5**

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Effectiveness of Physical Removal Efforts

The effectiveness of our physical efforts to remove brook trout was evaluated using two primary methods. First, we evaluated relative catch rates of brook trout during electrofishing surveys (catch per unit effort - CPUE; number of brook trout captured in the first electrofishing pass standardized as the number per 100 m of stream length sampled) over time from the beginning of removal efforts to the end of 2015. We used sampling of longer-term monitoring sections that have been established since 2011 and sampling during brook trout removal treatments in 2014 and 2015 to compute CPUE estimates. A total of 22 sampling sections have been sampled through time in the nine streams and the Shields River above Crandall Creek prior to and during this project (Figure 1). All or a sub-set of these established sample sections could be used to monitor this project over time. Montana FWP will determine how many of these sections will be sampled and the frequency of sampling. It is likely that future monitoring will be a collaborative effort. Secondly, we took water samples above temporary fish barriers to conduct eDNA analyses that looked for the presence of brook trout (Carim et al. 2015; Wilcox et al. 2015; Wilcox et al. 2016).

Relative Catches of Brook Trout Over Time

Relative catches of brook trout were monitored in long-term monitoring sections and a total of 147 capture events were completed (Table 4). Brook trout catch rates went up from 2011 to 2013, before we began removing brook trout, in many streams, but especially in Dugout Creek. Catch rates went down from 2014 to 2015 in all areas where we removed brook trout except in the Shields River (Table 5). However, catch rates in the Shields River did go down from 2013 to 2014, probably because we removed some brook trout from the Shields River in the fall of 2014. The CPUE of brook trout captured during removal treatments showed a similar trend, but since we only sampled and removed brook trout in the area of the Shields River from the Forest Service campground up to Buck Creek in 2013 and 2015 catches increased between these time periods (Table 6). Brook trout likely move into this area of the Shields River both from down-river areas and from tributaries. Highlighting the need to install the long-term barrier near the Forest Service campground.

Table 4. Number of capture events in long-term sample sections by stream and year in waters of the upper Shields River basin from 2011 to 2015. Removals of brook trout began in the late fall of 2013. Sample sizes are shown for the areas above and below temporary barrier locations in the unnamed tributary by Dugout Creek (Trib) and in Turkey Creek.

Stream (reach)	2011	2012	2013	2014	2015	Totals
Dugout Cr	8	15	7	8	12	50
Lodgepole Cr	5	7	6	11	11	40
Shields R	7	6	10	6	5	34
Trib (above barrier)		1	2	1		4
Trib (below barrier)	2	1	1	1	1	6
Turkey Cr (above barrier)	2		1	6	2	11
Turkey Cr (below barrier)				1	1	2
Totals	24	30	27	34	32	147

Table 5. Average annual catches (number of 75+mm fish per 100 m of stream length) of brook trout captured in long-term monitoring sections within streams of the upper Shields River basin from 2011 through 2015. Removals of brook trout began in the late fall of 2013. Catches for areas above and below the temporary fish barriers are shown for the unnamed tributary near Dugout Creek (Trib) and Turkey Creek.

Stream (reach)	2011	2012	2013	2014	2015
Dugout Cr	3.9	8.8	15.7	7.3	4.9
Lodgepole Cr		1.1	0.0	2.1	0.0
Shields R	2.1	0.8	4.1	1.7	1.9
Trib (above barrier)		4.9	5.8	4.0	
Trib (below barrier)	3.0	7.7	14.3	12.7	2.0
Turkey Cr (above barrier)			0.9	0.7	0.0
Turkey Cr (below barrier)				10.4	4.2

Table 6. Average annual catches (number of 75+ mm fish per 100 m of stream length) of brook trout captured during brook trout removal treatments in streams within the upper Shields River basin from 2013 through 2015. Catches for areas above the temporary fish barriers are shown for the unnamed tributary near Dugout Creek (Trib) and Turkey Creek.

Stream (reach)	2013	2014	2015
Dugout Cr		6.2	9.5
Lodgepole Cr		0.9	0.1
Shields R	4.6		12.9
Trib (above barrier)		0.2	0.0
Turkey Cr (above barrier)		0.1	0.0

eDNA Sampling

Water samples were taken at eight locations in four streams to test for the presence of brook trout DNA within the water. Water samples were collected using methods of Carrim et al. (2015) and analyzed according to methods presented by Wilcox et al. (2013; 2016) by the U.S. Forest Service Rocky Mountain Laboratory, Missoula, Montana. No evidence of brook trout DNA was found in any samples, except for a sample collected about 500 m above the temporary fish barrier located in Scofield

Creek (Table 7). These results suggest brook trout have been successfully eradicated from Turkey Creek and the unnamed tributary near Dugout Creek above temporary fish barriers constructed on these streams. It appears that brook trout may not inhabit Clear Creek above the Forest Service road, but more testing is needed to confirm this result. A small amount of brook trout DNA was found in the upper water sample site in Scofield Creek, suggesting that some brook trout may still be present in the upper reaches of this stream.

Table 7. Locations where water samples were taken on October 13, 2015 above temporary fish barriers in streams within the upper Shields River basin for eDNA analyses and results of analysis to detect brook trout (N=no brook trout DNA detected; Y=brook trout DNA was detected).

Stream	Date	Site	Latitude	Longitude	Brook Trout eDNA detected
Scofield Creek	10/13/2015	Just above FS Road	46.17494	110.36022	N
Scofield Creek	10/13/2015	About 320 m above FS Road	46.17191	110.35904	Y
Clear Creek	10/13/2015	Just above FS Road	46.17038	110.36571	N
Turkey Creek	10/13/2015	Just above lower FS Road crossing	46.17971	110.35465	N
Turkey Creek	10/13/2015	Just above upper FS Road crossing	46.17579	110.35263	N
Turkey Creek	10/13/2015	About 300 m above upper FS Road crossing	46.17359	110.35251	N
Unnamed Tributary	10/13/2015	Just above FS Road	46.19267	110.38366	N
Unnamed Tributary	10/13/2015	About 300 m above FS Road	46.19448	110.38114	N

Installation of Long-Term Barrier Above Crandall Creek

The Custer Gallatin National Forest commissioned DJ&A, P.C. to design a concrete fish barrier on the Shields River, to prevent upstream movement of nonnative brook, brown, and rainbow trout. Interagency partners provided input into the design. This design was completed in 2015 and was used by project collaborators to secure $405,000.00 for project implementation from partners including BBN (Table 8).

Table 8. Shields River fish barrier funding summary.

Funding Source	Granted
Forest Service	$219,950
Future Fisheries	$119,775
Jackson One Fly	$30,000
NFWF BBN	$27,000
Joe Brooks TU	$5,000
MT AFS (RAF)	$3,500
Total	$405,225

Monitoring Yellowstone Cutthroat Trout Conservation

Catches of YCT were some of the highest in recent years during 2015 in most streams (Table 9). It is difficult to attribute the recent increases in abundance of YCT to brook trout removal efforts, but the increases from 2013 to 2015 are an encouraging sign. However, YCT did not increase above the temporary barrier in Turkey Creek from 2014 to 2015 nor in the unnamed tributary near Dugout Creek. We speculate that these streams may either be too small to support all seasonal habitat needs of YCT, or that repeated electrofishing to remove brook trout may have resulted in lower YCT numbers, or both.

Table 9. Average annual catches (number of 75+ mm fish per 100 m of stream length) of Yellowstone cutthroat trout captured in long-term monitoring sections within streams of the upper Shields River basin from 2011 through 2015. Removals of brook trout began in the late fall of 2013. Catches for areas above the temporary fish barriers are shown for the unnamed tributary near Dugout Creek (Trib) and Turkey Creek.

Stream (reach)	2011	2012	2013	2014	2015
Dugout Cr	8.8	7.4	8.6	6.1	17.2
Lodgepole Cr	8.3	11.1	20.3	10.5	16.6
Shields R	9.3	10.5	15.3	12.4	18.9
Trib (above barrier)		7.8	4.4	14.0	
Trib (below barrier)	8.5	6.8	9.8	10.9	29.0
Turkey Cr (above barrier)	2.4		17.7	10.9	6.0
Turkey Cr (below barrier)				6.3	1.0

Conclusions and Recommendations

Conclusions

1. Temporary fish barriers were effective, but we documented that one fish moved above one barrier. We are unsure how it passed the barrier. It may have been moved by a member of the public that captured it below the barrier and moved it above, it may have been moved by an animal, or it may have passed the barrier somehow on its own.
2. Using electrofishing to suppress or eradicate brook trout can be effective, especially in smaller streams where brook trout have recently invaded.
3. Fish barriers at the lower boundary of treatment areas are necessary to prevent additional invasion.
4. Conducting electrofishing removals during the fall after water temperatures and flows have declined appears most effective.
5. Fyke nets can be used to capture pre-spawning adult brook trout.
6. A barrier on the Shields River near the Forest Service campground will make future brook trout removal efforts more effective by preventing additional brook trout from moving up into treated areas.

Recommendations

1. A long-term barrier in the Shields River at the Forest Service campground needs to be installed. This installation is slated for 2016.
2. Temporary fish barriers should be maintained until brook trout are eradicated from areas below these barriers.
3. Electrofishing removal efforts should be continued and expanded to test whether this method can eradicate brook trout in all streams and the Shields River in this area. We suspect electrofishing eradication will be possible in most of the medium to smaller tributaries if enough effort is expended, but we are uncertain if eradication can be achieved in larger tributaries or the Shields River.
4. Use of fyke nets should be expanded both in time and across space. We suggest that fyke netting should begin in mid-September and end in mid- to late October. Fyke nets should be deployed throughout the treatment area in sites that have relatively easy human access to capture more brook trout.
5. Monitoring of a sub-set of existing monitoring sections plus some additional sections in a few different streams should be done annually or semi-annually.
    a. The collaborators will determine which existing monitoring sections will be continued after 2016.
    b. The collaborators will decide which new sections should be added to the monitoring program. We will probably add sections near the FS Loop Road for all streams plus a few additional sections for some of the longer streams.

Acknowledgements

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