Booth Diversion Fish Entrainment Study




Final report

By James DeRito and Nick Walrath, Trout Unlimited

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Front Cover Photo Captions

Booth Canal fish trap on June 9, 2015.	Utah Sucker captured in the Booth Canal. Utah suckers (n=20) had the greatest mean weight of any fish species entrained in the canal.
Whitefish captured in Booth Canal. Whitefish had the greatest number of fish entrained (n=93) of any salmonid.	Electrofishing the Booth Canal on July 14, 2015.

Authors' Contact Information

James DeRito
44 West Spring Creek Parkway
Providence, UT 84332
Email: jderito@tu.org
Phone: 208-360-6165

Nick Walrath
520 Wilkes Dr. Suite 4B
Green River, WY 82935
Email: nwalrath@tu.org
Phone: 307-532-0753

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Common Acronyms Used

cfs = cubic feet per second
g = grams
km = kilometers
m = meters
mm = millimeters
NRCS = Natural Resources Conservation Service
TU = Trout Unlimited
UBRTU = Upper Bear River Trout Unlimited Chapter
WGFD = Wyoming Game and Fish Department
WSEO = Wyoming State Engineers Office

Acknowledgements

Robb Keith and John Walrath of the Wyoming Game and Fish Department (WGFD) provided assistance with the study design, collection permit application, data summary, and review of a preliminary presentation and report. All picket weir and trap materials were provided by the WGFD. In addition, the WFGD provided an electrofishing unit for the last three canal sampling events. The water user provided permission for this study to occur in his canal. Fisheries technician field work was completed by Olivia Tesoro and Eli Tesoro. Mark Tesoro took photos of the electrofishing sampling on July 14 that were later used for a newspaper article about the study in the September 2015 Southwest Wyoming Outdoors insert (a publication of the Wyoming Newspapers Incorporated). Funding for this study was provided by the Upper Bear River Trout Unlimited chapter and the Natural Resources Conservation Service's Regional Conservation Partnership Program through their support of the Upper Bear River Stream Restoration and Irrigation Efficiency Project

Introduction

The Booth Canal is located on the Bear River at about 1.4 river kilometers upstream from the highway 150 bridge crossing of the Bear River south of Evanston (Figure 1). An earthen push-up dam is annually constructed across the river by the water user to divert water into the canal. The water user is working with Trout Unlimited (TU) and several partner organizations to replace the push-up dam with a permanent rock cross-vane diversion structure. This will eliminate a large annual sediment source, restore instream fish habitat and riparian areas, and improve upstream fish passage. In addition, the organizations involved desired to assess fish loss, termed entrainment, into the Booth Canal to determine if installation of a fish screen would be a cost effective benefit for the project.

The entrainment of fishes into irrigation canals can have detrimental effects to fish populations (Walters et al. 2012, Roberts and Rahel 2008, Post et al. 2006, Der Hovanisian 1995). In the Upper Bear River, 32 percent (8 of 25) of radio-tagged Bonneville Cutthroat Trout *Oncorhynchus clarkii utah* (aka, Bear River Cutthroat Trout, hereafter Cutthroat Trout) that migrated more than 5 km to spawn were entrained into irrigation canals (Walrath 2016). On the Thomas Fork of the Bear River, 23% of radio-tagged post-spawning Cutthroat Trout were entrained into an irrigation diversion and subsequently died there (Shrank and Rahel 2004). Preventing entrainment, however, with fish screens can be expensive. For example, in one Idaho watershed, fish screen costs ranged from $3,600 to $4,600 per cubic foot second (cfs) of irrigation water screened (Walters et al. 2012). Over 30 fish screens have been installed by TU in the Bear River watershed, but all have been on tributary streams to improve fish passage for the migratory life history of Cutthroat Trout. A fish screen has yet to be installed on a mainstem Bear River irrigation canal, because the effects of these canals on fish passage is typically more difficult to assess than on tributary streams and consequently has been given lower restoration priority.

Fish entrainment into the Booth Canal was initially assessed by the Wyoming Game and Fish Department (WGFD) and TU during a one-day survey in 2014 that demonstrated that while species diversity was high in the Booth Canal, total numbers of individuals was low (WGFD 2015). However, fish sampled in a canal at the end of an irrigation season may not be indicative of the total number of fishes entrained in a canal throughout the season (Post et al. 2006). Therefore, we determined that further research was necessary to assess fish entrainment throughout the irrigation season for the Booth Canal. Our objectives for this study were to: 1) assess the total entrainment of fishes; 2) evaluate variables such as the amount and timing of water diversions that may affect fish entrainment; and 3) provide river-wide context for the number and diversity of fishes entrained.

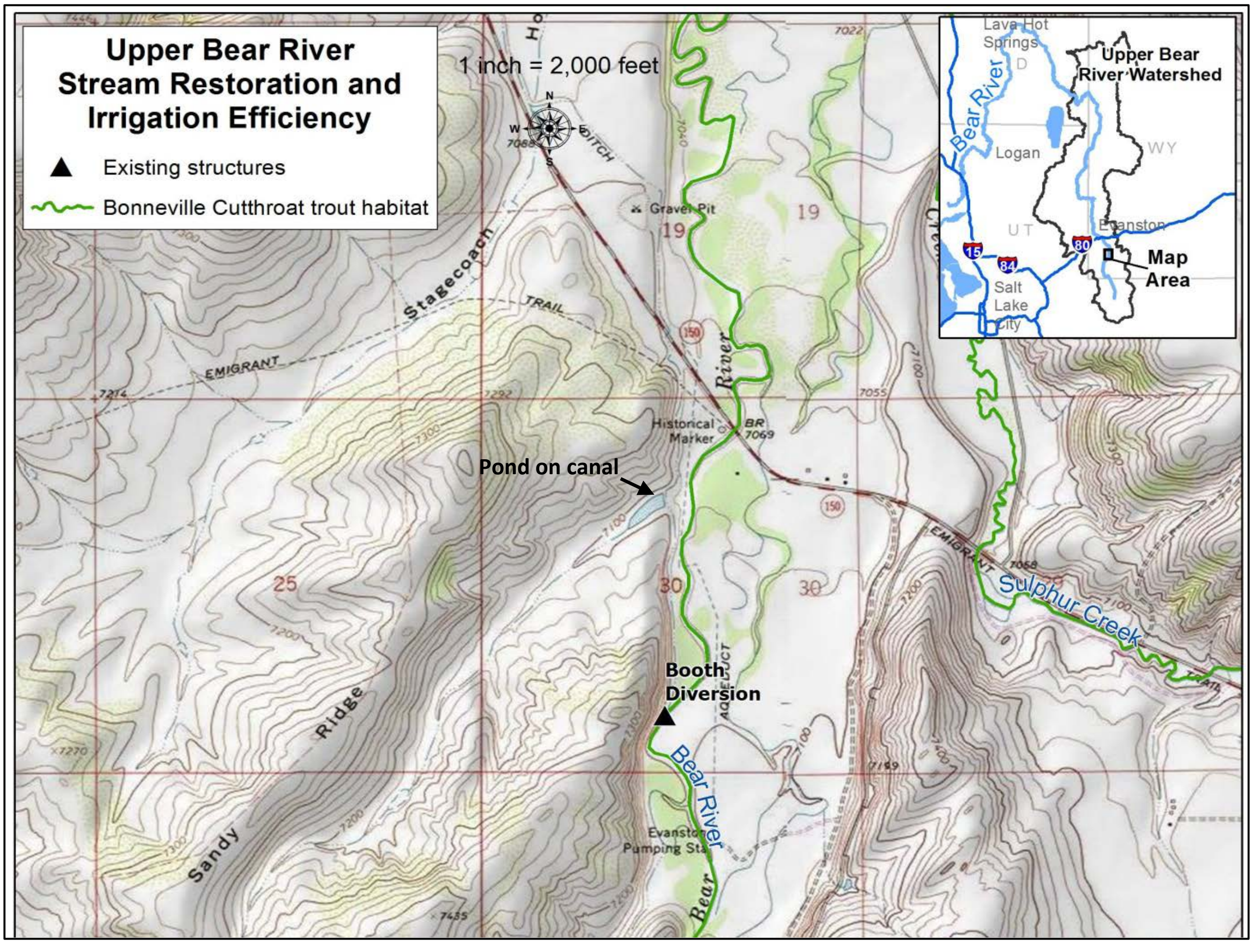

Figure 1. Location of the Booth Canal diversion on the Bear River in Wyoming. The Wyoming State Engineers Office monitoring flume for the canal flows is located immediately downstream of the pond noted on canal. Electrofishing was completed in the canal in 2014 in two sections: 1) downstream of the headgate to the pond; and 2) adjacent the gravel pits north of the highway 150 crossing.

Study Area

The Booth Canal headgate is located at Universal Transverse Mercator Zone 12, 0509924 East, 4556286 North (North American Datum 1983). The canal headgate is on river left (looking downstream) and the push-up dam extends completely across the river. When the push-up is fully constructed, water passing downstream seeps through the dam and no water flows over or around the dam (Figure 2).

Figure 2. Photograph of the Booth Canal push-up dam taken from near the headgate looking across the river after dam construction on June 26, 2015.

The Booth Canal has only one water user. The canal is used to divert a 12.18 cfs cumulative water right with an October 23, 1889 priority date and 823 acre feet of storage water from Sulphur Creek Reservoir by exchange (Wyoming Water Development Office 2011). An additional 1 cfs per decreed right can be administered to this canal when water is available, because the water right has a pre-1945 date. Irrigation water usage in Wyoming also allows users to divert more than their appropriation during high river flows, when the river is considered "not in regulation". Entrainment could be high in the Booth Canal given the early priority date and total allowable flow that can be diverted from the river is coupled with a push-up dam that is typically a complete fish barrier.

The Bear River provides habitat for four native fishes that are Species of Greatest Conservation Concern in Wyoming's Wildlife Action Plan: Cutthroat Trout, Mountain Whitefish *Prosopium williamsoni*, Bluehead Sucker *Catostomus discobolus*, and Northern Leatherside Chub *Lepidomeda copei* (Wyoming Wildlife Action Plan 2010). Other native fishes in the Bear River include Utah Sucker *Catostomus ardens*, Mountain Sucker *Catostomus platyrhynchus*, Utah Chub *Gila atraria*, Speckled Dace *Rhinichthys osculus*, Longnose Dace *Rhinichthys cataractae*, Redside Shiner *Richardsonius balteatus*, and Mottled Sculpin *Cottus bairdii* (Baxter and Stone 1995). Non-native fishes in the Bear River include Brown Trout *Salmo trutta*, Rainbow Trout *Oncorhynchus mykiss*, Brook Trout *Salvelinus fontinalis*, and Fathead Minnow *Pimephales promelas*. All of these fishes may be susceptible to entrainment into irrigation canals along the Bear River.

The initial assessment of fish entrainment by the WGFD and TU occurred on September 22, 2014 in two sections of the Booth Canal: 1) three 100-meter reaches from the canal headgate to a pond; and 2) 781 meters adjacent the gravel pit (WGFD 2015; Figure 1). A single electrofishing pass of both sections was completed with two backpack electrofishing units. Fishes captured included Mountain Sucker (n =13), Brown Trout (n = 12), Cutthroat Trout (n = 6), Rainbow Trout (n = 1), Mountain Whitefish (n = 1), Bluehead Sucker (n = 1), and presence, but no numbers recorded for Utah Sucker, Speckled Dace, Redside Shiner, and Fathead Minnow. Eighteen trout were captured in section one and one Brown Trout was captured in section two. A Utah Sucker was the only fish sampled from the pond on the canal in a 6-hour gill net set (WGFD 2015).

Crayfish are among other aquatic organisms in the Bear River that may be entrained in the Booth Canal. The nonnative Virile crayfish *Orconectes virilis* appears to have completely replaced the native Pilose crayfish *Pacifasticus gambelii* in the Bear River in Wyoming since the mid 1980s (Hubert 2010).

Methods

We used a combination of fish trapping and electrofishing to assess fish entrainment into the Booth Canal. Fish trapping began in the canal 70 m downstream of the headgate culvert on May 25. The fish trap consisted of picket-weir wing walls angled downstream to a trap box (see front cover photo). Pickets were about 12 mm in diameter with a spacing of 12 mm and lengths of 0.63 m or 0.94 m. Some pickets were initially fully set below the water level to allow debris to flow over. The fish trap box consisted of a metal frame with a wooden bottom and plastic mesh sides. The plastic mesh had openings of 10 mm by 22 mm. The opening to the trap box had plastic mesh sides slanted inwards to a metal picket weir opening framework. The 0.94 m length pickets were spaced in the opening frame to create a fish entrance opening of 62 mm at the top to 85 mm at the bottom.

The fish trap was checked for fish and cleaned of debris every weekday. A wooden board was placed in front of the trap box on Friday afternoon to prevent debris and fish movement into the trap on weekends when the trap wasn’t checked. After about two weeks of capturing no fish, the trap was left open on weekends and no water was allowed to flow over the pickets.

Large suckers and smaller trout were visually observed in the canal below the headgate culvert, but no fish were being caught in the fish trap in early June. Therefore, we moved the fish trap upstream in the canal to a distance of 17 m below the headgate culvert on June 9. The fish trap was operated at this location until it was removed on November 19, when surface ice in the canal was consistently present.

We began electrofishing between the headgate culvert and the fish trap on June 16, because no fish had been captured in the fish trap at this point. A backpack electrofishing unit was used to complete two to three pass fish removals. Two people completed the electrofishing, except three people completed the work on August 5. Electrofishing was completed every two to three weeks through October 20.

All captured fish were identified using a fish key that was developed for this project. The dichotomous key was developed with input from fisheries professionals at the Wyoming Game and Fish Department, the Utah Division of Wildlife Resources, and Idaho State University. Total length (mm) and weight (g) were collected on all fish. Any unusual marks, characteristics, or mortalities of individual fish were noted. All fish were returned to the Bear River downstream of the Booth Diversion push-up dam.

Water levels were measured at an existing staff plate in the Booth Canal about 7 m downstream from the headgate culvert. Canal flows were measured by the Wyoming State Engineers Office (WSEO) at their flume that is located about 970 meters downstream from the headgate culvert and immediately below the canal pond. The 15-minute measured canal flows for the irrigation season (May 1 to September 30) of 2015 were obtained from the WSEO website (WSEO 2016). The staff plate water levels recorded were correlated to the flume flows about 45 minutes later (assuming an average 0.33 m flow velocity between the staff plate and flume). This exponential relationship (r^2= 0.25) was then used with the staff plate water levels to estimate canal flows outside of the irrigation season from October 1 to November 9 (time of last staff plate reading). The WSEO website was also used to obtain Booth Canal mean daily diverted water flows for the 1985 to 2015 irrigation seasons.

Results

A total of 82 fish encompassing eight different species were captured with the fish trap in the Booth Canal in 2015 (Figure 3). Mountain Suckers (n = 35) were the most captured species followed by Mountain Whitefish (n = 20) and Cutthroat Trout (n = 7). Fewer than six fish of all other species were captured.

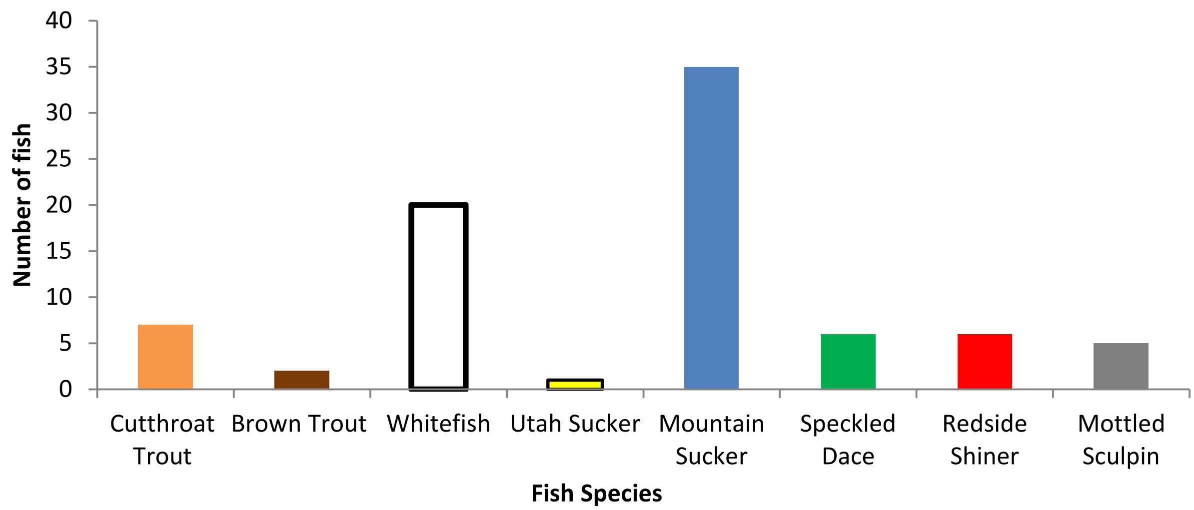

Figure 3. Total number of fish captured (n = 82) by species with the fish trap in the Booth Canal during 2015.

The first fishes captured with the fish trap were on Monday, June 29 after the push-up dam was completed by the water user on Friday, June 26 (Figure 4). The majority (66%; n = 54) of fish captured with the fish trap were in the two week period (June 26 to July 10) after the push-up dam was completed, including 83% of Mountain Suckers, 75% of Mountain Whitefish, and 71% of Cutthroat Trout. Mortalities of fish included 10 Mountain Suckers, 8 Mountain Whitefish, and 1 Utah Sucker, along with wounds on the tails of a Cutthroat Trout and a Mountain Whitefish during this same period. No salmonids were captured between July 21 and September 4 (Figure 4). The last fishes captured with the fish trap were on October 7, despite the trap being operational until November 19. A total of 87 crayfish were captured with the fish trap from June 30 to September 11. These crayfish were likely Virile Crayfish, but the identification hasn't been confirmed based on photos.

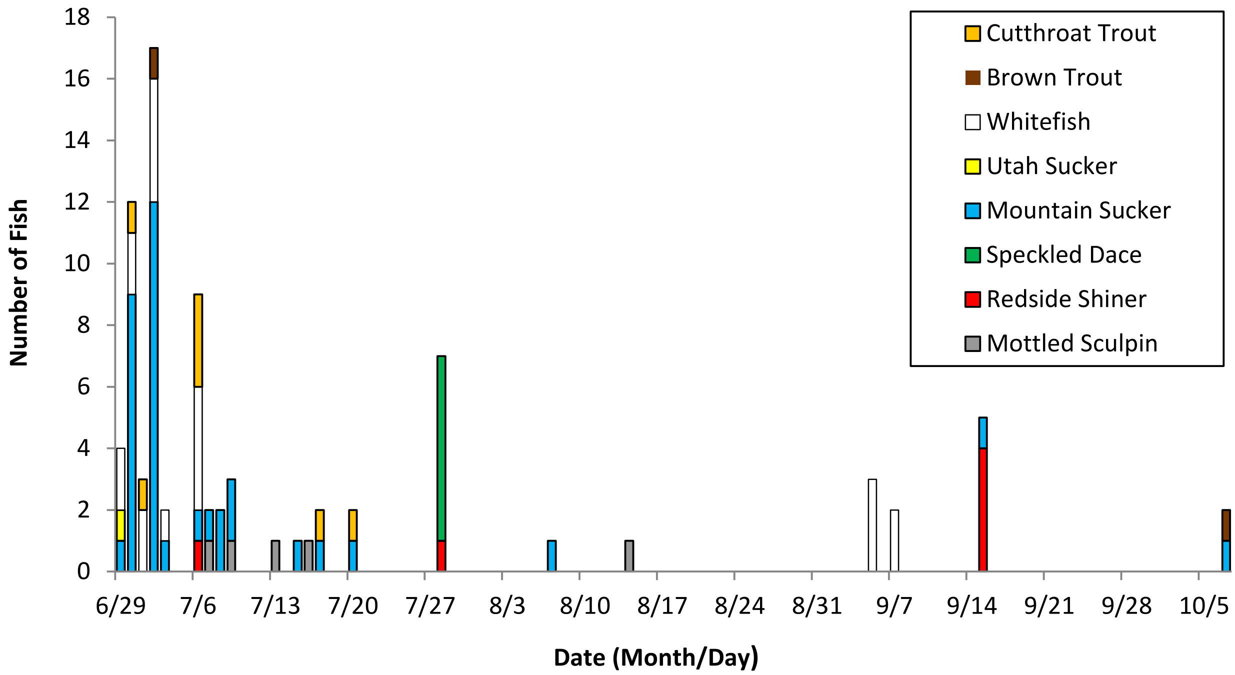

Figure 4. Fish species by date captured with the fish trap in the Booth Canal during 2015. No fish were captured before June 29 or after October 7.

A total of 709 fish encompassing ten different species was captured during the eight electrofishing events in the canal (Table 1). Cyprinids (Speckled Dace, Longnose Dace, and Redside Shiner) comprised 73% of all fish captured by electrofishing; followed by 17% Salmonids (Cutthroat Trout, Rainbow Trout, Brown Trout, and Mountain Whitefish), 8% Catostomids (Mountain Suckers and Utah suckers); and 3% Cottids (Mottled Sculpin). The largest total capture of fish by event occurred on June 30, with the largest number captured by date of four species: Mountain Whitefish, Mountain Suckers, Utah Suckers, and Redside Shiners. The greatest number of captured trout per event was 13 trout (11 Brown and 2 Cutthroat) on October 1 (Table 1).

Table 1. Fish species, event dates (month/day), number of electrofishing passes (in parentheses below date), total number captured, and percent total composition from backpack electrofishing between the Booth Canal headgate culvert and the picket weir from mid-June to mid-October, 2015.

Fish species	6/16 (2)	6/30 (3)	7/14 (3)	8/5 (2)	8/27 (2)	9/11 (2)	10/1 (2)	10/20 (2)	Total # captured	Percent of total
Cutthroat Trout	1	1	0	4	0	3	2	0	11	2
Rainbow Trout	0	1	0	0	0	0	0	0	1	0
Brown Trout	1	1	2	4	1	2	11	12	34	5
Mountain Whitefish	1	7	33	4	0	23	1	4	73	10
Utah Sucker	4	2	11	1	0	1	0	0	19	3
Mountain Sucker	1	3	18	2	1	2	2	3	32	5
Speckled Dace	6	13	52	35	55	62	75	34	332	47
Longnose Dace	0	0	0	0	0	14	30	14	58	8
Redside Shiner	8	23	45	7	7	14	24	0	128	18
Mottled Sculpin	0	0	4	1	1	5	2	8	21	3
Total	22	51	165	58	65	126	147	75	709	100

Utah Suckers had the greatest mean length (258 mm), mean weight (358 g), and maximum weight (1180 g) of all fish species entrained in the canal. Brown Trout had the greatest mean length (584 mm) and Longnose Dace had the lowest mean length (48 mm) and mean weight (1.2 g). A total of 23,338 g of fish were captured in the Booth Canal, with the six adult Utah Suckers comprising 26% (6,024 g).

Table 2. Minimum, mean, and maximum lengths and weights of all fish captured by species in the Booth Canal in 2015. The weights of a total of nine fish were not collected because of problems with the scale.

	Length (mm)				Weight (g)			
Species	N	Minimum	Mean	Maximum	N	Minimum	Mean	Maximum
Cutthroat Trout	18	169	223	352	18	29	118	408
Rainbow Trout	1		56		1		2.1	
Brown Trout	36	63	157	584	36	3.0	118	1129
Whitefish	93	95	191	330	90	15	81	434
Utah Sucker	20	96	258	485	20	24	358	1180
Mountain Sucker	67	69	114	251	66	3.0	18	128
Speckled Dace	338	23	57	90	338	0.1	2.3	11
Longnose Dace	58	25	48	85	58	0.1	1.2	4.5
Redside Shiner	134	32	64	98	129	0.4	3.0	10
Mottled Sculpin	26	37	65	92	26	0.4	5.1	13
Total	791				782			

The 2015 Booth Canal diverted flows were similar to the average flows of past years. The 2015 mean daily diverted flows had a median of 9.75 cfs (range 3.44 to 15.3 cfs; Figure 5). The 2015 flows predominantly fell within the interquartile range of the prior thirty years. The 2015 flows exceeded the 75th percentile for most of May and were below the 25th percentile twice, one of which was when the canal flows were decreased to 4.38 cfs on June 25 when the push-up was being installed.

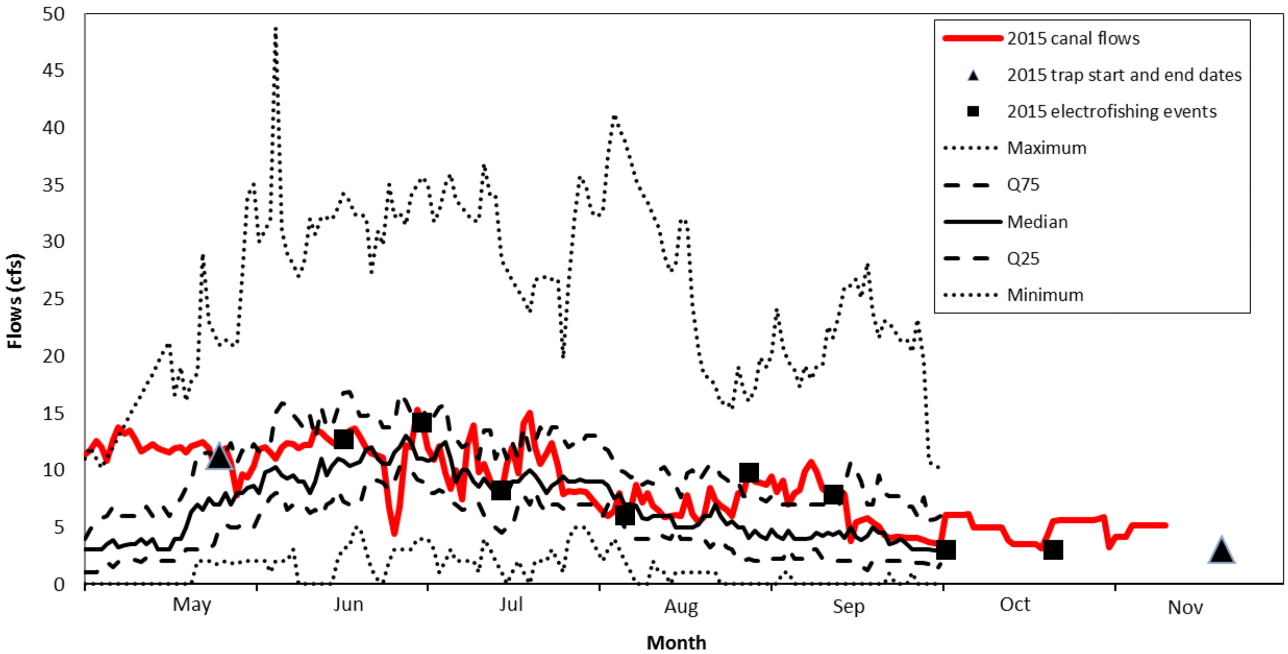

Figure 5. Booth Canal mean daily diverted flows (red line) and fish trapping and electrofishing dates for 2015. The black lines are the mean daily minimum, 25th percentile, median, 75th percentile, and maximum flows for the canal (1985 to 2014).

Project Budget

The total project cost for the fish entrainment study was estimated to be $16,261. The Upper Bear River TU chapter (UBRTU) funded $5,000 of the study cost, including most of the salary and travel for the fisheries technicians. Materials purchased for the study included wading gear for a fisheries technician, a temperature logger, printing and lamination of the fish key, and tools for installing and maintaining the fish weir. The Natural Resources Conservation Service (NRCS) funded the remainder of the fisheries technicians' salaries and travel. The NRCS funded James DeRito's salary and travel for the study, which included project planning and budgeting, fisheries technician hiring and oversight, coordinating with partners, fish trap install and checking, electrofishing, data quality control and assurance, data analysis, preparation of and project presentation to the UBRTU chapter on November 10, 2016, and the drafting of this report. Nick Walrath's salary and travel include project coordination, fish trap install/checking/removal, and review and editing of this report that were paid by other funding sources.

Table 3. Project budget for the Booth Canal fish entrainment study.

	Funding Sources and Amounts ($)			
Item	UBRTU	NRCS	Other	Total
Fisheries Technician (salary)	3,789.20	2,250.00		6,039.20
Fisheries Technician (travel)	866.27	638.98		1,505.25
Materials	344.53	29.35	148.79	522.67
Trout Unlimited staff (salary)		5,478.00	1,036.00	6,514.00
Trout Unlimited staff (travel)		1,478.40	201.60	1,680.00
Totals	5,000.00	9,874.73	1,386.39	16,261.12

Discussion

The number of sport fish entrained in the Booth Canal was low, but relatively high compared to the densities of sport fishes in the Bear River. In 2015, 55 trout and 93 whitefish were captured in the canal. The Bear River downstream of the Booth Canal in Bear River State Park had a density of 122 trout/km, based upon a three-pass electrofishing mark and recapture estimate (WGFD 2009). In Bear River State Park there were also 28 whitefish/km in 2005 (one-pass; WGFD 2006) and 54 whitefish/km captured in 2008 (three-pass; WGFD 2009). The number of trout and whitefish entrained in the Booth Canal could then be a large percentage of the salmonid densities in the Bear River.

Cutthroat Trout comprised most of the trout catch (86% to 89%) in the Bear River in 2005 and 2008 (WGFD 2006, WGFD 2009), whereas only (33%) of the trout entrained in the Booth Canal were Cutthroat Trout in 2015. The greater number of Cutthroat Trout in the Bear River as compared to that entrained in the Booth Canal is likely because of the stocking of Cutthroat Trout in Bear River State Park by the WGFD.

Non-game fishes comprised most of the catch of fishes in the Booth Canal in 2015. Similarly, fish entrained in the Covey Canal on the Smith's Fork of the Bear River in 2003 were primarily non-game fish (Roberts and Rahel 2008). Bluehead Suckers are present in the Bear River downstream in Bear River State Park (WGFD 2006, WGFD 2009). However, no Bluehead Suckers were identified among the suckers with a scraping plate, but we identified 67 Mountain Suckers (69mm to 251mm) that were entrained in the Booth Canal during 2015. Mountain Suckers do not typically exceed 250 mm, whereas Bluehead

Suckers can reach lengths of over 450 mm (Baxter and Stone 1995). Therefore, based on sucker lengths, then the Mountain Suckers identified fell within the accepted species size range and it's obvious that no adult Bluehead Suckers were captured. However, the primary diagnostic characteristic of a juvenile Bluehead Sucker is the presence of pigmentation of the interradial membranes of the caudal fin as compared to the lack of this pigmentation for a Mountain Sucker. This can be a difficult characteristic to discern on smaller fish and it's possible that some juvenile Bluehead Suckers could have been misidentified as Mountain Suckers. Similarly, no Northern Leatherside Chubs were identified in the canal, but these fish can be difficult to discern from the Redside Shiners that were prevalent (n = 134) in the canal. Lastly, we identified all dace as Speckled for the first five electrofishing events and it wasn't until the last three events that Longnose Dace were identified. It's likely that Longnose Dace were present in the earlier electrofishing events, but misidentified as Speckled Dace.

It appears that the construction of the Booth Canal push-up dam results in the mortality and injury of fishes. We captured dead (n = 19) and injured fish (n = 2) during the two weeks after the push-up dam was completed on June 26. The process of constructing the push-up dam may directly impact fishes when the river bed and banks are disturbed. Bottom-oriented whitefish and suckers comprised most of the fishes that were killed or injured. These dead and injured fish contributed to the highest capture rate with the fish trap.

There appears to be little relationship between the canal flows and fish entrainment. Record high canal flows began the irrigation season and stayed high for most of May as compared to previous years irrigation seasons (Figure 5). It would be expected that more water would bring in more fish. However, no fish were captured in the fish trap (though not operational until May 25) even when the trap was moved upstream and relatively few fish were captured during the first electrofishing event on June 30. It is possible that some of the fish entrained in the canal early in the irrigation season were preyed upon by pelicans. A pelican were observed at the canal headgate and three were also seen on the pond on the Booth Canal in June. The greatest numbers of Brown Trout (n = 24) were captured in October after irrigation ended when canal flows were low. The longest Brown Trout (i.e., 584 mm) captured was in the fish trap on October 7 and this fish was an obvious adult that may have been migrating to spawn. All other Brown Trout captured in October were subadults with a median length of 98 mm and all less than 225 mm length.

Downstream fish passage will be improved and the mortality of fishes decreased after the installation of a permanent diversion structure for the Booth Canal. The river will continually flow through and over the large-boulder cross vane, providing a means of downstream fish passage that is completely or minimally present as compared to when a push-up dam is in place for most of the year. Fewer fish should then be entrained in the canal with the rebuild of the diversion. In addition, the direct mortality of fishes from the construction of the push-up dam will also be eliminated once a permanent diversion structure is in place.

Fish entrainment of radio-tagged Cutthroat Trout in Bear River irrigation canals was greatest in canals just below the Utah state line (n = 4), as compared to downstream canals (n = 2, Walrath 2016). Also, radio-tagged cutthroat trout entering Mill Creek (n = 5) were entrained at a high rate (n = 2) in two different irrigation canals. If a primary goal of fish screens for irrigation canals on the Upper Bear River is the reduction of the entrainment of migratory Cutthroat Trout, then initial fish screening priorities should be directed towards these upper canals on the Bear River and on Mill Creek.

A fish screen is not planned during the rebuild of the Booth Canal diversion for 2017 and 2018, because downstream fish passage will be improved and there are other potentially higher priority canals to screen. However, a fish screen may be beneficial to install in the Booth Canal after other higher priority canals are screened and/or fish entrainment is reevaluated after the rebuild of the Booth Canal.

If a fish screen is installed in the Booth Diversion in the future, then it should provide fish protection at all diverted canal flows. For this study, we compiled mean daily canal flow records for the past thirty-one years of the Booth Canal (1985 to 2015; Figure 5). Most of the maximum mean daily flows during this period occurred when a large snowpack produced consistently high river flows during the 2011. It's likely that the 48.7 cfs maximum on June 6, 2011 was an anomaly, because the mean daily canal flows the day prior (June 5) was 6 cfs and the day after (June 7) was 12 cfs. The canal may have diverted more than needed on June 6 when the Bear River at Evanston increased from 1,740 cfs early that morning to 2,750 cfs later that day (USGS 2016). The next highest mean daily flow outside of 2011 for all years since 1985 has been 35 cfs. Accounting for canal flow fluctuations within a given day, the Booth Canal should be adequately served by a fish screen with a maximum design capacity of about 40 cfs.

The total number of fish captured during the eight electrofishing events was eight times as many fish as were captured during the 179-day period (May 25 to November 19) of fish trapping. More fish were captured with electrofishing for all fish species, except Mountain Suckers which were captured in greater numbers with the fish trap (n = 35) versus electrofishing (n = 32). Electrofishing captured many more cyprinids (n = 518) versus fish trapping (n = 12). The smaller-bodied Cyprinds (length range of 23 mm to 98 mm; Table 2) were likely able to pass through the spacing of both the pickets and the fish trap mesh, if they attempted to pass downstream. Larger individuals of Utah Suckers and Brown Trout were also lacking in the fish trap. These fish may have avoided the fish trap because of the opening size of the fish trap, though large enough (65 to 85 mm width) to allow the movement of these fishes into the trap, they may have behaviorally avoided it. Furthermore, habitat in the canal in the form of a deep plunge pool below the headgate culvert and large wood pile on the side of the canal may have provided holding cover for fish and limited downstream fish movement to the trap.

If the fish entrainment study were to be repeated after the rebuild of the Booth Canal diversion, then it may be more efficient and cost effective to solely use electrofishing as the method to catch fish. A picket weir could be installed in the canal similar to this study, but without a fish trap box. The weir would prevent the downstream movement of larger bodied fishes and could be cleaned and attended by a fisheries technician less frequently than if a fish trap were used. Electrofishing every two to three weeks, similar to this study, should then capture the vast majority of fish that enter the canal. However, the canal will be realigned as part of the diversion rebuild and the plunge pool and woody debris jam will be eliminated post construction. Fish holding habitat may then be limited compared to the current situation and this may increase the tendency of entrained fishes to move downstream in the canal and make fish trapping a more efficient fish capture method.

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