Implementation of a Simulated Perennial Side Channel Flow Regime in the Wapatox Diversion (Naches River) to Protect High Densities of Larval/Juvenile Lampreys

[Cover photo: Downstream view of the Wapatox Diversion irrigation canal (Naches River), immediately downstream of the headgates].

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Highlights

- Many thousands of larval/juvenile lampreys reside in the Wapatox Diversion between the headgates and regulating gates 210 m downstream. Many of these lampreys become stranded when the diversion is dewatered in the irrigation off season (fall).
- As a result of partnership between the Yakama Nation Fisheries and Bureau of Reclamation, this area between the headgates and regulating gates were managed to permit perennial flow year round in 2018.
- Some challenges remain, such as the need 1) to reduce the temporary dewatering period and 2) to provide efficient measures for rescuing lampreys during the years when dredging is required.

Abstract

Wapatox Diversion is located in the lower reach of Naches River (headgates at river km 29.0). Wapatox Diversion has a long canal (266 m) between the fish screens and the headgates. There are a set of regulating gates 210 m downstream of the headgates, which during the irrigation season regulate the flow further downstream. Immediately upstream of these regulating gates is a flow return channel, which returns excess flow (and trapped fishes) back to the river. Further downstream (56 m) of the regulating gates are the fish screens and the main fish bypass channel. Annually after dewatering, a high density of lampreys (up to ~50 lamprey/m^2) and a large area of dewatered larval lamprey habitat (up to ~550 m^2) are found between the headgates and regulating gates. In November 2018, the Yakama Nation Fisheries and the Bureau of Reclamation coordinated and managed to maintain sufficient flow year-round in the section upstream of the regulating gates. The availability of regulating gates and the flow return channel at Wapatox Diversion provides the option for water and fishes to return immediately to the river (prior to approaching the fish screens). The canal section downstream of the regulating gates is then left dry, and no water infiltrates the area upstream of the fish screens (preventing damage to the fish screens related to freezing and icing). The operations at Wapatox Diversion to create a perennial side channel has the potential to provide a safe year-round rearing habitat as long as the initial extended dewatering period could be shortened. After a period of dewatering lasting 2-3.5 hours, water was restored into the canal and lampreys stranded in the dried fine sediment regained access to water. However, lampreys can certainly desiccate in even 1-2 hours and either a shorter dewatering period or a break in between the dewatering to allow staff to rescue stranded lampreys is highly recommended to reduce the risk of desiccation. Additionally, accumulated sediment in the canal area downstream of the headgates will need to be dredged using heavy equipment ever few years. This will require more intensive lamprey rescue efforts during those years. In addition to rescue efforts using electrofishing, a lamprey sifting device (to efficiently remove lampreys from the dredged material) will likely improve the overall lamprey rescue efficiency when the time comes to dredge this high density larval lamprey area.

Introduction

One of the myriad of threats larval and juvenile life stages of lampreys face is entrainment within irrigation diversions as they migrate downstream. Water is drained from these diversions typically in the fall in October/November (or the summer in June/July), and lampreys that have burrowed in the fine sediment during the irrigation season are often left to perish in these locations unless rescue efforts take place to save them. Many hundreds of irrigation diversions are scattered throughout the Columbia Basin, so it is imperative that simple, adaptive, and innovative techniques to preserve the life of larval/juvenile life stage lampreys are developed, using our best understanding of the lamprey entrainment mechanisms.

Many of the large-scale irrigation diversions have a long canal upstream of the fish screens (between the fish screens and the headgates). Large volumes of fine sediments (and large numbers of associated lampreys) can accumulate in this section of the canal. Due to this expansive area, it is very labor intensive and time consuming to rescue lampreys in this section after dewatering; and it is simply impossible to rescue all of the lampreys (typically only 50% is rescued with single pass electrofising). One potential solution to help lampreys rearing in this section of the canals is to turn the upper canal area into a simulated perennial side channel, where water is let in through the headgates (at a reduced amount) and allowed to flow through the flow return channel during the irrigation off season. This design is difficult to implement in most diversions, unless some type of a water holding structure (weir, regulating gate, etc.) and a flow return channel upstream is structurally available. At Wapatox Diversion (Naches River), an opportunity was available to implement a simulated perennial side channel flow regime during the 2018-2019 irrigation off season, providing year-round rearing habitat for larval lamprey upstream of the fish screens.

Methods

With close coordination between the Bureau of Reclamation (BOR) and Yakama Nation Fisheries (YNF), a simulated perennial side channel flow regime was implemented during the 2018-2019 irrigation off season at Wapatox Diversion (Naches River) starting on November 1, 2018. While observing for stranded larval lampreys to rescue, we recorded the time of all gate operations, took photos, and documented various observations during this new flow regime.

Wapatox Diversion is located in the lower reach of Naches River (headgates at river km 29.0). Wapatox Diversion has a long canal (266 m) between the fish screens and the headgates (Fig. 1). There are a set of regulating gates 210 m downstream of the headgates, which during the irrigation season regulate the flow further downstream (Photo 1 and 2). Immediately upstream of these regulating gates is a flow return channel, which returns excess flow (and trapped fishes) back to the river. Further downstream (56 m) of the regulating gates are the fish screens and the main fish bypass channel.

Since 2015, larval lamprey surveys have rescued many thousands of larval lampreys from a large area of fine sediment that deposits between the headgates and the regulating gates (Fig. 1 and Photo 3 and 4). Annually after dewatering, a high density of lampreys (up to ~50 lamprey/m^2), and a large area of larval lamprey habitat (up to ~550 m^2 of fine sediment and organic matter) are found between the headgates and regulating gates. Past surveys have shown that the majority of lampreys that enter Wapatox Diversion reside between the headgates and regulating gates with a significantly lesser number found downstream of the regulating gates. When Wapatox Diversion is dewatered in the fall (generally in early November), the headgates and the regulating gates are shut, cutting water supply from the diversion. In November 2018, the BOR and YNF coordinated and managed to maintain sufficient flow year-round in the section upstream of the regulating gates. The availability of regulating gates and the flow return channel at Wapatox Diversion provides the option for water and fishes to return immediately to the river (prior to approaching the fish screens). The canal section downstream of the regulating gates is then left dry, and no water infiltrates the area upstream of the fish screens (preventing damage to the fish screens related to freezing and icing). The results section highlights our observations during this operation in November, 2018.

Figure 1. An overview of Wapatox Diversion, Naches River (water flow from left to right). The area with 'high' densities of larval lampreys is outlined in red. Larval lampreys are found downstream of the regulating gates (near the fish screens, green outlined area), but in significantly lower densities. On November 1, 2018, immediately after irrigation shutdown, the headgates were left open slightly, and flow was provided between the headgates and regulating gates; in previous years this area was left mostly dewatered during the winter months. The regulating gates were kept shut, to prevent water from going further down the canal. All winter flow re-entered the river via the return flow channel.

Photo 1. An overview of the canal between the headgates and the regulating gate looking upstream on November 1, 2018 at 12:05 p.m. (left photo). The area upstream of the regulating gates looking downstream (right photo). The blue arrow in both photos show the location of the return flow channel.

Photo 2. The regulating gates after dewatering looking downstream (left photo). The regulating gates after dewatering looking upstream (right photo). In 2018, the gates were fully shut after the reopening of the headgates for the winter months. Water level is generally low after irrigation shutdown, limiting potential damages caused by freezing water coming into contact with the gates.

Photo 3. Overview of the canal and dewatered lamprey habitat between the headgates and the regulating gates. The photo is looking downstream from the headgate area. High densities of larval lampreys have been observed annually in this area after fall season dewatering. Many staff hours are required to rescue lampreys from the dry banks (by hand) and from wetted areas (using electrofishing). As much as 550 m^2 of fine sediment has been exposed and dried after each yearly dewatering event.

Photo 4. Larval lampreys collected from dewatered banks at Wapato Diversion in 2015; stranded larval lampreys on dry banks shortly after dewatering (left photo) and a collection of many hundreds of larval lampreys from the canal section between the headgates and the regulating gates during electrofishing and bank collection (right photo).

Results

A summary of the operations on November 1, 2018, is described below in chronological order:

8:00 a.m. – 10:35 a.m. – Headgates and regulating gates were sealed completely around 8:00 a.m., while the flow bypass channel remained open. Both gates needed to undergo a safety inspection by the BOR staff. The initial time when fine sediment was first exposed was not observed directly, but our best estimate is between 8:30 and 8:45 a.m. based on the sediment elevation and dewatering rate. Due to safety concerns, YNF staff were not allowed to enter the upper canal area.

10:35 a.m. – 12:05 p.m. – After safety inspections of the gates, the BOR staff opened one of the three head gates at 10:35 am (gate opened approximately 12" from closed position). The regulating gates were left closed, and dam boards were placed into the flow bypass channel (immediately upstream of the regulating gates) to hold water upstream of the gates. Right around this period, YNF staff observed a large area of exposed fine sediment immediately downstream of the headgates (Photo 5). Larval lampreys were visible on top of the dewatered sediment at 10:40 a.m.; however, YNF staff were not able to enter the area to rescue them. The same area upstream of the regulating gates was observed again at 12:05 pm. By this time (1.5 hours after the headgates were re-opened), all exposed fine sediment was covered by water. Larval lampreys trapped on the dewatered sediment were exposed for up to 3.5 hours, before flow was restored.

Photo 5. An overview of the canal between the headgates and the regulating gates on November 1, 2018 at 10:40 a.m, approximately five minutes after the headgates were reopened, looking downstream from the headgates (left photo). An overview of the canal at 12:40 p.m., approximately two hours after the headgate was reopened; all exposed larval lamprey habitat was covered again (right photo). Both photos were taken in the same location.

Discussion

The operations at Wapatox Diversion to create a perennial side channel has the potential to provide a safe year-round rearing habitat as long as the initial extended dewatering period could be shortened. After a period of dewatering lasting 2-3.5 hours, water was restored into the canal and lampreys residing in dried fine sediment regained access to water. However, lampreys can certainly desiccate in even 1-2 hours (especially the smaller lampreys, <50 mm, are known to be most susceptible to dewatering operations) and either a shorter overall dewatering period or a break in between the dewatering period to allow staff to rescue stranded lampreys is highly recommended to reduce the risk of desiccation. It may also be beneficial to electrofish for a short period in high density areas along the edge of exposed sediments.

Additionally, accumulated sediment in the canal area downstream of the headgates will need to be dredged using heavy equipment ever few years; this means that during those years, the upper canal area will need to be dewatered for a much longer period. This will require more intensive lamprey rescue efforts during those years. In addition to rescue efforts using electrofishing, the use of a lamprey sifting device (to efficiently remove lampreys from the dredged material) will likely improve the overall lamprey rescue efficiency when the time comes to dredge this high density larval lamprey area. A conceptual drawing is provided below for a portable lamprey sifter that uses a combination of an electrofisher and a small scale venturi pump (Fig. 2), which will aid the rescue of lampreys in very turbid, low-visibility water conditions.

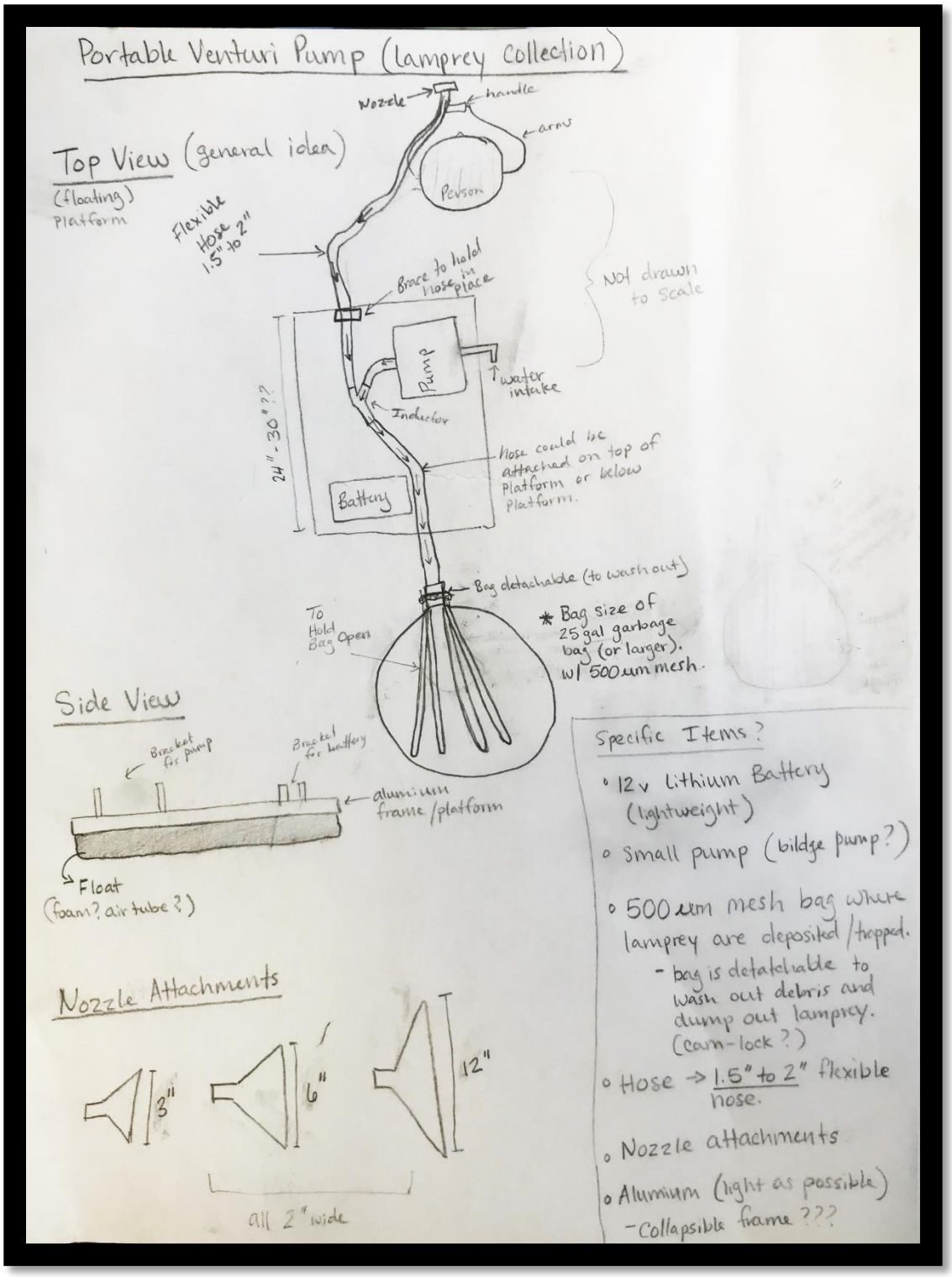

Figure 2. A conceptual design for a portable lamprey sifter that uses a small scale venturi pump in combination with an electrofisher. After the electrofishing forces larval lamprey to emerge, the lamprey sifter will siphon the lamprey into an expandable mesh bag (500-750 micron), which can be sifted in water if any fine sediment is also collected. A few nozzle attachments will be available to allow for the most efficient lamprey collection based on canal water height.