

University of Idaho

College of Natural Resources
Department of Fish and Wildlife Resources
P.O. Box 443141
Moscow, Idaho 83844-3141
Phone: 208-885-6400
Fax: 208-885-9080

To: Dave Clugston – U.S. Army, Corps of Engineers, Portland District

From: Tami Clabough, Eric Johnson, Dan Joosten, and Chris Peery

RE: Evaluating adult Pacific lamprey dam passage counting methodology at Bonneville and The Dalles dams – 2007 – A preliminary letter report for Bradford Island Fishway.

Date: 28 February 08

The following is a preliminary summary of nighttime lamprey counts in the Bradford Island fish ladder at Bonneville Dam.

Introduction

The Pacific lamprey (*Lampetra tridentata*) is one of six anadromous lamprey species in the Northern Hemisphere. Their distribution extends from northern Mexico (Baja, California) north along the west coast of the U.S. to Canada and west along the Pacific Rim to Japan (Renaud 1997). Ecologically, Pacific lampreys are an important prey source for mammals (e.g. sea lions), fish (e.g. sturgeon), and birds (Close et al. 2002). Culturally, Pacific lampreys are an important food source for Northwest tribes and are used medicinally and in ceremonies. Pacific lamprey abundance in the Columbia and Snake River basin has dramatically declined (Renaud 1997; Kostow 2002; Moser and Close 2003). Habitat degradation, flow regulation (hydroelectric projects and irrigation), and pollution have all contributed to the decline in lamprey populations (Close et al. 1995; Renaud 1997). Existing information on population estimates of lamprey have been based primarily on counts of fish passing dams during the day (0500-2100 hrs). However, lampreys are nocturnal and mainly migrate at night (2100-0500 h; Moser et al. 2002; Daigle et al. 2005). In order to estimate total lamprey escapement past dams, nighttime passage of lamprey in fishways need to be enumerated.

The objectives of this study were to 1) estimate numbers of Pacific lamprey passing Bonneville and The Dalles dams at night and 2) estimate total escapement past these dams for Pacific lamprey by summing the day count (count window), night count (video window count), and lamprey passage structure (LPS) count (Bonneville Dam only) at each dam.

Methods

Data collection

Digital cameras (Sanyo color CCDs) were set up on tripods in front of the count windows at both fish ladders at Bonneville and The Dalles dams (Figures 1-2). Video images were recorded with digital video recorders (Everfocus EDSR100H and EDR410H) and stored on hot swappable hard drives (Maxtor 250-300 GB). Video from the hard drives was downloaded using an HD Reader drive (Everfocus) to a computer and then burned to DVD (.edr or .wmv files). Video cameras were operated at the Bradford Island count window from 17 May through 26 August for 8 h each night.

Video evaluation

Individuals reviewed video and recorded hourly counts of lamprey passing both upstream and downstream past each count window. Two video outages (16 h total) occurred at the Bradford Island fish ladder in May (22-23 May; 28-29 May).

Lamprey counts

Lamprey counts were summarized based on a calendar day. Counts from 2400 to 0500 h and from 2100 to 2400 h were considered night counts for the particular calendar day. Day time lamprey passage included counts from 0500 to 2100 h. Lamprey counts at Bonneville Dam from the Lamprey Passage Structure (LPS) were provided by Mary Moser (NOAA) and summarized for each calendar day. The LPS is a flume structure designed to improve lamprey passage that was installed in the auxiliary water channel in the Bradford Island fish ladder at Bonneville Dam in 2006.

Total dam passage escapement was estimated by summing the night count (8 h), the day count (16 h), and the LPS count (24 h). The escapement estimate is missing 80 h of LPS counts since LPS data collection did not occur until May 20 (3 days after video count) and an outage occurred on the night of July 10 (8 h). The percent of lamprey passing by hour was estimated by summing the counts for each hour within a month and dividing by the total count for each month. Percent of lamprey moving downstream was estimated for each night by summing the number of fish moving downstream each night divided by the total number of lamprey passing upstream and downstream each night.

Results

Lamprey counts

A total of 18,352 lampreys were counted at night (8 h) from May through August at the Bradford Island count window at Bonneville Dam (Figure 3). The day count (16 h) total at the Bradford Island count window was 8,430 and the total Lamprey Passage System (LPS) was 6,817 during the same time period. Therefore, a total escapement estimate of lamprey passing the Bradford Island fish ladder was 33,599 for May-August in 2007 (Table 1).

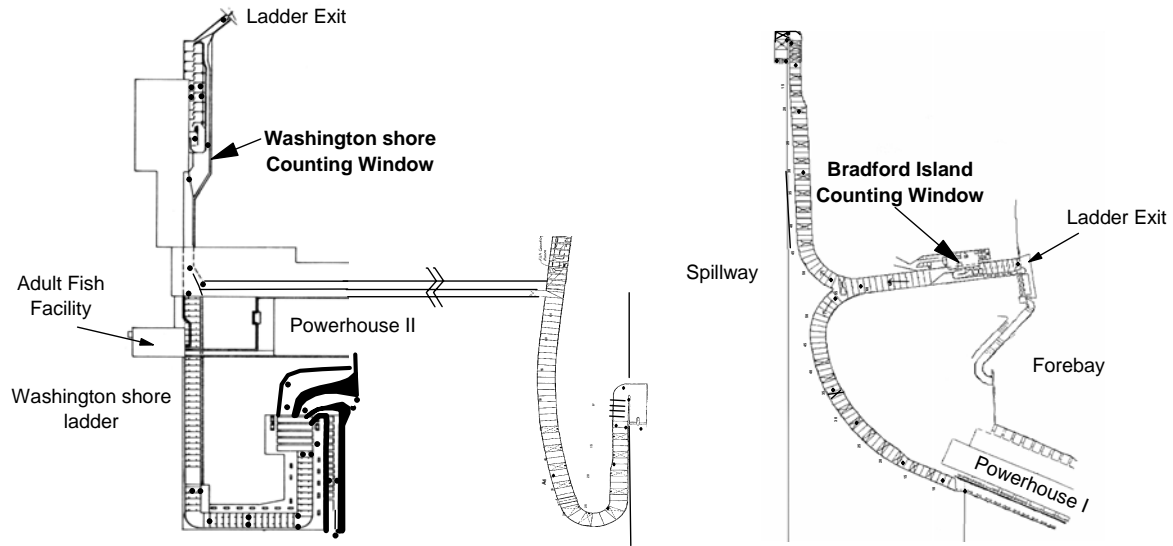


Figure 1. Location of count windows in the Washington shore and Bradford Island fish ladders at Bonneville Dam.

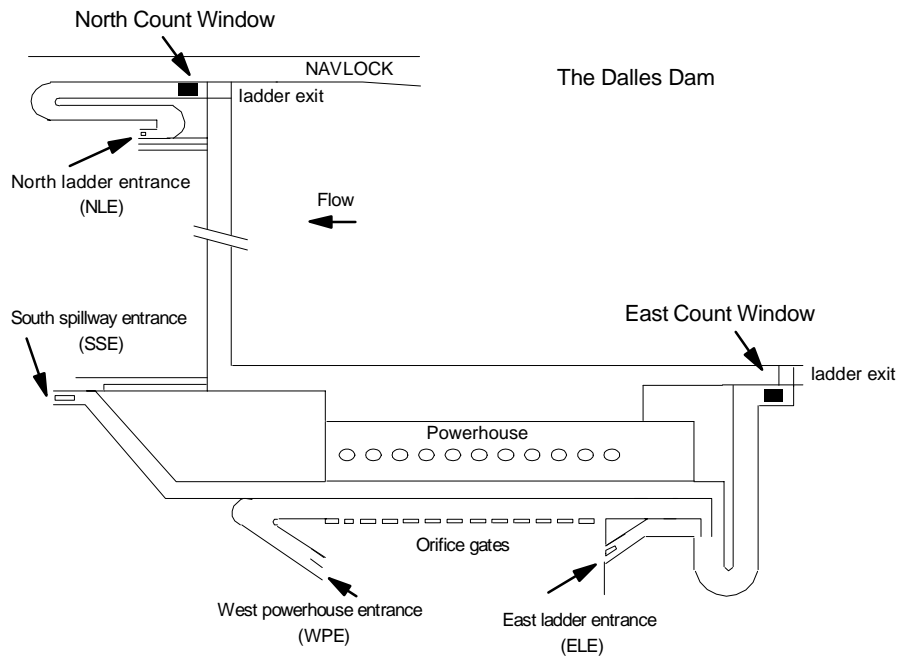


Figure 2. Location of count windows in the north and east fish ladders at The Dalles Dam.

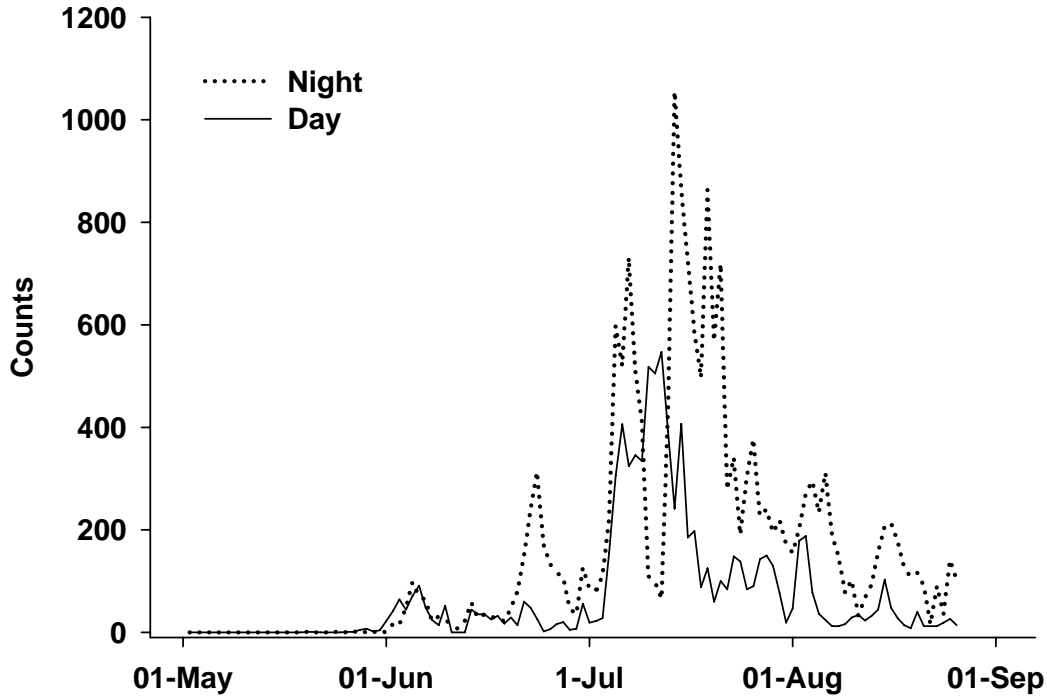


Figure 3. Night and day time lamprey passage counts in the Bradford Island fish ladder at Bonneville Dam during May through August in 2007.

Table 1. Lamprey passage counts in the Bradford Island fish ladder during the night, day, and total counts through the LPS (day and night) during May-August in 2007.

Month	Night count	Day count	LPS count	Total
May	8	44	16	68
June	2,189	926	1,203	4,318
July	12,398	6,370	4,263	23,031
August	3,757	1,090	1,335	6,182
Total	18,352	8,430	6,817	33,599

In May, during the beginning of the lamprey run only eight lampreys were counted at night compared to a total day count of 44 (Figure 4). In both June and July, lamprey counts at night were approximately two times higher than the day count while in August, nighttime counts were three times greater than the day count (Figure 5).

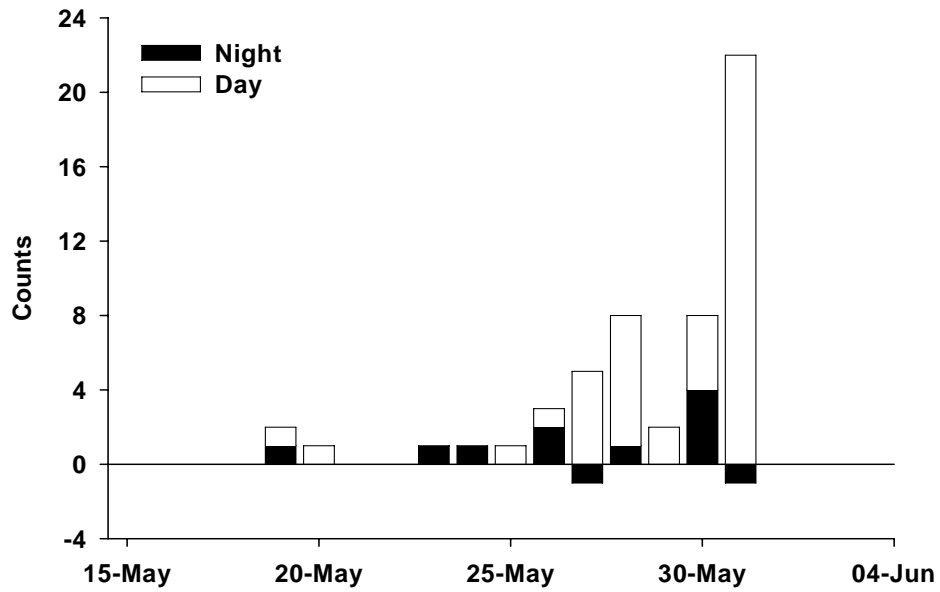


Figure 4. Daily night and day time lamprey passage in the Bradford Island fish ladder at Bonneville Dam during May 2007.

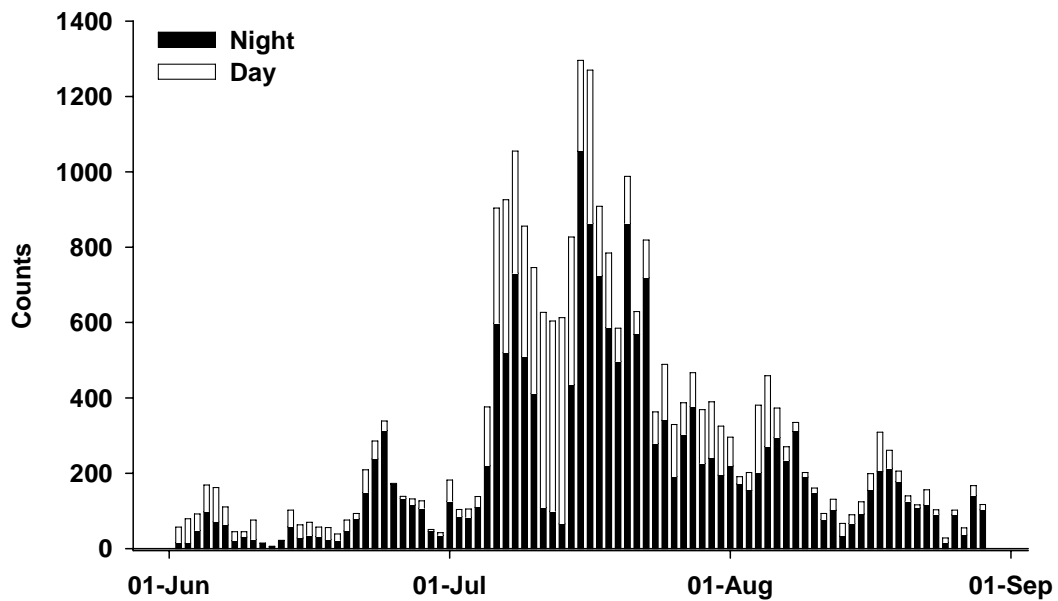


Figure 5. Daily night and day time lamprey passage in the Bradford Island fish ladder at Bonneville Dam during June, July, and August 2007.

Lamprey passage behavior

The temporal distribution of lamprey passage within the 8 hour nighttime period ranged from 6.5 (2100 to 2200 h) to 18.8 (2400-0100 h) percent per hour during June through August (Table 2). Percentages of lamprey passing the Bradford Island count window at night decreased from 0400 to 0500 in the early morning hours and from 2100-2200 h in the early evening hours.

Table 2. Percent of lamprey passing the Bradford Island count window by hour and month in 2007.

Month	N	2400-0100 h	0100-0200 h	0200-0300 h	0300-0400 h	0400-0500 h	2100-2200 h	2200-2300 h	2300-2400 h
May	8	12.5	12.5	25.0	0.0	25.0	0.0	25.0	0.0
June	2,189	18.8	16.0	14.0	9.8	8.2	5.7	13.6	13.9
July	2,398	15.7	13.2	12.3	9.8	8.2	8.4	14.8	17.7
August	3,757	14.2	13.5	14.2	15.5	12.5	6.5	11.4	12.2

We observed lamprey swimming both upstream and downstream past the count window (Figures 6-7). Overall, the average percentage of lamprey moving downstream of the total counted per night was 32% (June-August). Downstream movement of lamprey was highest in August (35%) followed by June at 28% and July at 22%.

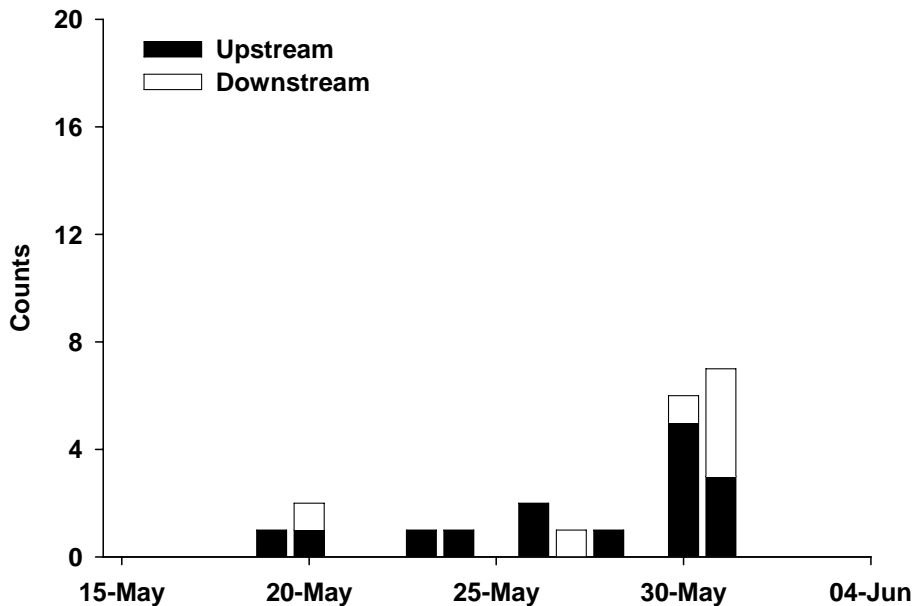


Figure 6. Nightly upstream and downstream lamprey counts in the Bradford Island fish ladder at Bonneville Dam during May 2007.

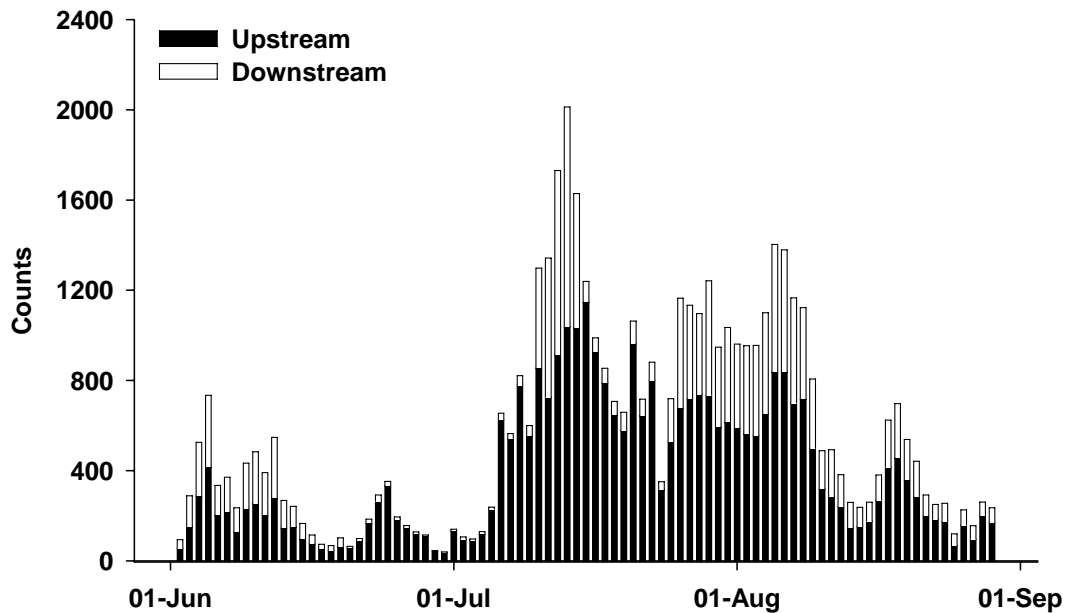


Figure 7. Nightly upstream and downstream lamprey counts in the Bradford Island fish ladder at Bonneville Dam during June, July, and August 2007.

Discussion

Nighttime lamprey counts in the Bradford Island fish ladder were approximately twice as high as day counts during our study. The nighttime video counts indicate passage of lamprey at night may account for a high proportion of the total dam escapement. Within nights, the majority of lamprey did not pass the count window at any particular hour. However, we did observe a decrease in the percentage of lamprey passing in the last hour of the early morning and in the first hour of the evening. We also observed lamprey swimming upstream as well as downstream during all nighttime hours, with approximately two-thirds of fish moving upstream and one-third, on average, moving downstream during the nighttime video.

Several technical issues made it difficult to obtain accurate lamprey counts. These issues include, power outage, equipment failures, poor lighting, video capture rates, and visibility in the counting window. Moreover, counts may be biased because lamprey may pass undetected between the main fishway channel and the auxiliary water channel. For example, a lamprey could be counted twice by swimming past the count window in the Bradford Island fish ladder, then downstream through the auxiliary water channel then through the LPS. We are currently analyzing telemetry data that was collected concurrently during this study to better estimate these types of behaviors and how they may affect count information.

For future studies we recommend improved lighting conditions by shining lights directly down between the crowder and count window glass from above, mounting cameras on the ceiling, and increased frequencies of algae removal from the count window. We also suggest continuing

nighttime video counts due to the difficulty of counting lamprey in real time.

References

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