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Underwater Video Monitoring of Adult Fish Ladder Modifications to Improve Pacific Lamprey Passage at McNary, Ice Harbor, Little Goose, and Lower Granite Dams, 2013

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I. EXECUTIVE SUMMARY

In 2010–2013, The U.S. Army Corps of Engineers (USACE) took several actions to promote passage of adult Pacific lampreys (*Lampetra tridentata/Entosphenus tridentatus*) through fish ladders at McNary, Ice Harbor, Lower Monumental, Little Goose and Lower Granite Dams. Among these actions were elevating the picketed leads at the count window section of the ladders, installing lamprey orifices at the upper ladder sections of McNary Oregon shore (2010), Ice Harbor and Lower Monumental (2012), and Little Goose and Lower Granite Dams in 2013, and creating a high-velocity deep attraction plume at the south fishway entrance (SFE2) of McNary Dam in 2012. Passive video monitoring was used again in 2013 to assess lamprey escapement and behavior at the picketed leads, and also to observe salmonid and lamprey behavior at new lamprey orifices at Little Goose and Lower Granite Dams. Finally, a graphical user interface (GUI) was completed for a software system (CBVision) used to automatically process underwater video.

Picketed lead monitoring in 2013 largely mirrored findings from 2011 at McNary and Ice Harbor, and picketed lead video counts, in conjunction with window counts, were again used to determine lamprey escapement at each monitored ladder. The McNary south ladder again had the highest proportion of lampreys passing the picketed leads (44.8%), with a total lamprey escapement at the count window section of 4,522. Lamprey escapement increased from 1,719 in 2011 (the first year of picketed lead monitoring), from 2,331 in 2012, and was greater than the 10-year average of 3,360 lampreys. Window and picketed lead video counts were significantly statistically correlated across all hours of the day for the years 2011–2013, with a combined correlation for these 3 years $R^2 = 0.77$, with similar proportions of lampreys passing the count window and pickets by hour. Similar trends in counts at the window and in picketed lead video across years indicate that count window estimates provide a reasonable index of the passage rate at this site. The linear regression equation may be used to estimate picketed lead video counts given window count numbers on an hourly basis following the cessation of lamprey passage at season's end.

Lampreys exhibited similar behavior at the picketed leads at McNary south ladder across 2011–2013, with 73.7% observed swimming under the picketed lead gap, 16.2% moving downstream under the picketed lead gap, 9.0% moving "across" behind the pickets, and 1.1% swimming upstream through the vertical bars of the picketed leads. Overall, the behavioral observations spanning 2011–2013 revealed that the raised picketed lead slot provided an important passage route for adults and that very few passed directly through the picket screen.

At the McNary north and Ice Harbor ladders, lampreys' use of picketed leads was similar to 2011–2012, and remained relatively low compared to McNary South. At McNary North, while lamprey ladder escapement increased 75% from the previous year, only 1.7% of lampreys were observed in picketed lead video (15 lampreys). At Ice Harbor South, lamprey ladder escapement was 627, similar to 2012 but well above the 10-year average of 396 and also above the 345 lampreys of 2011, when picketed lead monitoring began. Sixteen lampreys were counted in picketed lead video, despite the addition of another camera (as in 2012) behind the pickets to increase coverage. The large increase in lamprey numbers over 2011–2013 was due to more lampreys passing through the count window during night hours. Lamprey escapement at the north ladder decreased from 568 lampreys in 2012 to 295 lampreys in 2013. Picketed lead use by

lampreys increased slightly from 2012 (4.6%) with 6.4% of lampreys counted in picketed lead video, but remained a relatively small fraction of total escapement at Ice Harbor.

The varying rates of picketed lead use by lampreys at different locations may be due to variations in the size and flow of the ladder channels, as well as structural differences in the count slot entrance. The shape of the count slot entrances at the McNary north and Ice Harbor ladders may present less of an obstacle for lampreys. If so, this could account for the paucity of lampreys counted in picketed lead video at these locations, relative to other ladder locations. Distinguishing between these two potential mechanisms (encounter rate vs. count window entrance) would be helpful for improving passage conditions through the count window at McNary South.

Video monitoring of newly constructed lamprey orifices at the upper portions of the ladders at Little Goose and Lower Granite Dams was used to assess possible risk to migrating adult salmonids (spring, summer, and fall Chinook, steelhead, and sockeye), either through delay or interactions, and to determine lamprey use of and behavior at the orifices. With the exception of sockeye salmon, roughly a quarter of each run was monitored, corresponding to the early and middle portion of the run. Monitoring for these runs occurred from 07:00 to 13:00 Sunday through Thursday throughout their respective seasons. The sockeye runs at both locations were monitored on a 24/7 basis throughout the early and peak season; thus 87.7% and 80.0% of the run was monitored at Little Goose and Lower Granite, respectively. The relatively small size of the sockeye run and higher nocturnal activity in this species warranted increasing the monitoring period to establish significant trends in fish behavior at orifices.

Salmonid observations at lamprey orifices were focused on two important elements, delay and interaction. To assess delay, behavior was categorized into "approach," defined as the fish turning head first into the flow of the orifice without touching the orifice. An "interaction" was defined as the fish nosing into or trying to pass the orifice. Jack Chinook (all runs) were most likely to approach and interact with the lamprey orifices at Little Goose ladder, with the summer run scoring the highest rates of approach (21.7%) and interaction (4.7%). Interactions were brief, lasting on average 9.1 seconds, and did not cause remarkable delay. It is unclear why jack Chinook approached and interacted with the orifices in such relatively high numbers, but the large size of the run in 2013, coupled with smaller size of jacks may put them at increased risk for taking the small orifice opening to be a possible means of passage through the ladder. Additionally, of the two monitored Little Goose lamprey orifices, the orifice at the uppermost end of the ladder had by far the most salmon approaches and interactions. Subtle differences between the two monitored weirs, including variations in flow and lighting conditions, may account for these differences. Though diel behavioral differences were not noted for any species, local conditions at the orifices may play an important role in determining the ideal location of some lamprey orifices. In contrast to previous years (2011–2012), relatively few sockeye salmon or steelheads interacted with the orifices, with 0.2% of each run interacting with the openings. For sockeye salmon this low value is noteworthy, as over 87% of the run was monitored at Little Goose. At the Lower Granite ladder, few approaches and interactions by Chinook were observed, and only 1 jack during the monitoring period interacted with the lamprey orifice (summer Chinook). For steelheads, no fish were observed displaying either behavior during the entire run, and for the sockeye run, 4 fish, or 0.6% approached the orifices. No sockeye interactions were recorded.

Lampreys' use of orifices was assessed across day and night hours. At Little Goose, 100% of the run was monitored and at Lower Granite 77% was monitored. At Little Goose, night counts at the window ceased August 7, so the actual total lamprey run may have been higher, resulting in a lower proportion of the run monitored. Three key metrics were calculated for lampreys observed in orifice video, indicating lamprey use of the orifice and expressing this as a fraction of the total observed passing the window (the orifice use rate [window]) and the total observed in orifice video (the orifice use rate [video]). The orifice use rate (video) was higher at Little Goose, with 34.7% passing the orifices, compared to the Lower Granite ladder, with 16.2% thus passing. The orifice observation rate (percentage of lampreys observed in video compared to the total counted in the window) was 109.1% for Little Goose and 22.6% for Lower Granite. The higher percentage at Little Goose resulted from cessation of night counts August 7. The orifice use rate (window), or the percent of lampreys passing the orifices in relation to the window count, was very low at Lower Granite with 3.7% of lampreys passing through the orifice.

Behavior of lampreys at the orifices was characterized by various modes of orifice passage. At Little Goose, 72% of all lampreys passing the orifice did so by attaching to the substrate downstream of the orifice for a period before swimming through, and 8% swam directly though the orifices. At Lower Granite, more than 16% passed in this manner, while over 83% swam directly through the orifices without attachment.

Finally, in order to improve utility of CBVision software, a GUI was developed to run on Windows OS, and offers a five tab visual interface enabling the user to change all parameters previously invoked by command line. The interface enables queuing of video processing jobs, and job prioritization. The GUI was designed for ease of use and ideal for repetitive processing jobs.

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1.0 INTRODUCTION

Declining counts of pre-spawning adult Pacific lampreys (*Lampetra tridentata*) to the Columbia River have underscored the need to document juvenile and adult passage at dams (Close et al. 1995; Jackson et al. 1996) and identify other factors that may be limiting lamprey productivity in the system. Pacific lampreys are anadromous and must pass up to eight or nine dams and reservoirs, 4 each in the lower Columbia and Snake Rivers and 5 in the mid-Columbia River, above the confluence of the Snake, to reach upstream spawning areas historically used by the species. Impeding passage of lampreys below dams may subject them to increased predation pressure and other sources of loss. Difficult passage conditions may also decrease recruitment to upstream populations. In a broader sense, this project was initiated to build on information previously learned about adult lamprey behavior when navigating hydropower fish passage systems; specifically in 2013 to assess variability across years in lamprey picketed lead passage and to evaluate the effectiveness of lamprey passage improvements in fish ladders using underwater video technology.

Central to determining escapement at a hydropower system is the accurately enumeration of passing fish, typically as they pass through a count window. One route of lamprey passage around the count station is through the picketed leads and behind the count station, despite the apparent impediment of passing through the picketed lead grating (vertical spacing is typically ≤ 1"). Historically, adult lamprey counts at Bradford Island (Bonneville Dam) have indicated that a large portion (20–30%) of adult lampreys pass through the picketed lead grating and exit via the Lamprey Passage Structure (LPS) rather than through the count window slot and fishway exit (Clabough et al. 2009; Moser et al. 2011). In 2010, the University of Idaho and the National Oceanic and Atmospheric Administration Fisheries Service compared counts of adult lampreys at the Bonneville Washington Shore Fishway count slot to counts of lampreys passing via the picketed leads and the LPS after the picketed leads had been raised by 1" to increase passage rates through the grating. The results suggest the proportion of all adult lampreys passing via the picketed leads and LPS approximately doubled, from 23% in 2009 to 46.7% in 2010 (Moser et al. 2011). Consequently, in 2011 USACE raised the picketed leads 1.5" off the fishway floors at other projects.

In 2011–2012, video monitoring at picketed lead sections revealed differences in the proportion of lampreys passing behind pickets at McNary and Ice Harbor dams. The McNary south ladder had the highest picketed lead use, with 41.7% (2011) and 46.2% (2012) of all lampreys at this location using the picketed leads as a means of passage (Thompson et al. 2011). Use at other locations was substantially lower: McNary North, 5.4% (2011) and 1.9% (2012); Ice Harbor North, 13.2% (2012) and 4.6% (2012); and Ice Harbor South, 2.9% (2011) and 0.2% (2012), with structural differences in the ramp leading into the count window the major reason cited for differential use (Thompson et al. 2011). If more adults pass behind count windows, as observed at the McNary Oregon shore ladder, then lamprey counts at the window will be biased low in comparison to estimates from previous years. Coupling counts at the window to counts observed in picketed lead video established an accurate estimate of total escapement at the count window section of the ladders, and for McNary/Oregon shore in 2011, the count was 1,709 lampreys versus 1,076 in 2010 (Thompson et al. 2011). Counts with picketed lead monitoring again jumped in 2012 to 2,331 (Thompson, et al. 2012). As long as picketed leads remain elevated at these locations, continued monitoring of lampreys will improve understanding of behavior and

factors affecting their movement through fishways, and provide a basis for comparing trends across years.

Additionally, the Walla Walla District, Army Corps of Engineers modified the upper fish ladder weir sections at McNary/Oregon shore (2010), Ice Harbor and Lower Monumental (2012), and Little Goose and Lower Granite (2013) to reduce delays and improve lamprey passage through ladder structures. To this end, several "lamprey orifices" were cut into the weirs, flush to the fishway floor and measuring 2.5" tall by 16" wide. Video monitoring was used at orifices to assess lamprey passage and behavior and to monitor migrating salmon and steelhead stocks for potential negative impacts, as evidenced by delay or by attempting to pass lamprey orifices (Loge et al. 2012; Thompson et al. 2012).

During video monitoring in 2010 at the McNary Oregon shore ladder, runs of spring, summer, and fall Chinook and steelhead were largely unaffected by the presence of the orifices, with only 1 Chinook attempting orifice passage, while sockeye interactions were higher, with 0.02% of the run interacting with the orifices (Eder et al. 2011). Due to the relatively large 2010 runs, the video monitoring period (Sunday–Thursday; 07:00–13:00) was sufficient to capture at least a quarter of the total number passing the ladder and thus reflect a representative sample size monitored of each run. Lamprey behavior and passage at McNary orifices were recorded both day and night, owing to lampreys' nocturnal behavior. On average, roughly half the lampreys seen in cameras passed successfully through the orifices by:

- Attaching to the substrate near the downstream side of the orifice with subsequent burst swimming through the orifice;
- Burst swimming through the orifice with subsequent attachment near the upstream side of the orifice;
- Attaching to the substrate near the downstream side of the orifice, burst swimming through the orifice, and subsequently reattaching on the upstream side of the orifice; or
- Burst swimming through the orifice with no attachment (Eder et al. 2011).

The total number of lampreys observed during video monitoring (260) was considerably higher than the number counted at the fish counting window over the same time period (90), indicating that lampreys likely pass through the picketed leads and therefore are not counted at the count window (Eder et al. 2011). It should be noted that in 2010, video was not monitored behind the picketed leads at McNary Dam; hence, the degree to which lampreys bypassed the count window is unknown. However, as mentioned above, monitoring the picketed leads in 2011 and 2012 revealed a substantial portion of lampreys using the picketed leads to bypass the count station (Thompson et al. 2011).

Orifice monitoring in 2012 at Ice Harbor and Lower Monumental revealed that stocks of adult Chinook, steelhead, and sockeye were not appreciably delayed or otherwise harmed by the presence of lamprey orifices (Thompson et al. 2012). Of all monitored species, sockeye salmon were once again most likely to approach and interact with orifice passages. Due to the propensity for sockeye salmon to interact with lamprey orifices, the video monitoring period was extended for this species in 2013 to capture a majority of the run at Little Goose and Lower Monumental dams.

Regardless of location (picketed leads, lamprey orifice, or entrance) using optical video to study behavior and generate passage metrics necessarily entails capturing large amounts of video, often from multiple cameras per location. Depending on various factors (such as camera location, fish

traffic, and water turbidity) these videos can show very little activity, with review by human annotators time-intensive per fish event, making the non-invasive video approach burdensome and costly. For example, Spampinato et al. (2010) estimate that reviewing 6 years of video from ten cameras would take 900 human years. To facilitate analysis of large amounts of video data, an automated video event and detection classification software (AVEDac) used in marine studies was adapted for fish monitoring at various hydropower projects (Eder et al. 2011; Loge et al. 2011; Loge et al. 2012; Thompson et al. 2011) and is currently referred to as Cyborg Vision (CBVision). This USACE-funded research has successfully reduced the person-hours needed to review monitoring video (Eder et al. 2011; Thompson et al. 2011) by removing portions of video with no movement and by tracking moving objects. Further work on a graphical user interface (GUI) for CBVision was carried out in 2013.

2.0 METHODOLOGY

Approach and sample design

Optical video cameras were deployed upstream of picketed leads at McNary and Ice Harbor Dams and downstream of lamprey orifices at Little Goose and Lower Granite dams. Two orifices were monitored at each ladder at Little Goose and Lower Granite.

Video cameras at McNary and Ice Harbor picketed leads and count windows

Lengths of 3" aluminum I-beam were attached to the walkway framework and to the bottom of the channel upstream of each picketed lead section at the north and south ladders of McNary and Ice Harbor Dams for monitoring picketed lead passage. I-beams were situated 3 feet from picketed leads and equally spaced along the width of the picketed lead section (Figure 1).

Camera trolleys, each measuring 18" x 6" x 2", were raised and lowered along these I-beams. Each trolley contained a 5-pound metal plate to keep it stable on the bottom (Figure 1, inset image). External infrared lights and video cameras were mounted directly to the trolleys. Camera trolleys were lowered all the way to the ladder floor and the camera and lights aimed directly at the 1.5" picketed lead gap. Trolleys were hand-retracted during the season for routine maintenance, cleaning, and to reposition cameras and lights.

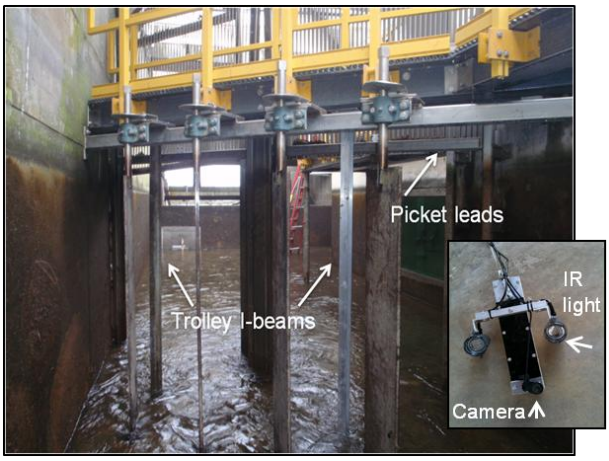

Figure 1. Left: McNary North fish ladder picketed lead section, looking downstream. Picketed leads are shown in the raised position typical during winter maintenance. Inset: video camera trolley system with stabilization weight (black), armored cable, adjustable lights and video camera.

As in 2010–2012 video work (Eder et al. 2011; Thompson et al. 2012; Thompson et al. 2011), SPECO CVC 320 underwater infrared cameras were used for picketed lead and count window monitoring (Figure 2). Each underwater camera was paired with two external infrared lights (Model 42, Seaviewer Inc., Tampa FL) to provide sufficient illumination during nighttime observations at the picketed leads. Cameras at the count station of the south and north ladders of Ice Harbor were mounted to a portable camera tripod (Figure 2). Cameras were situated towards the upstream side of the count window to keep the equipment from obstructing the view of the fish-counting technician. Video cables were routed to an electrical enclosure as described below.

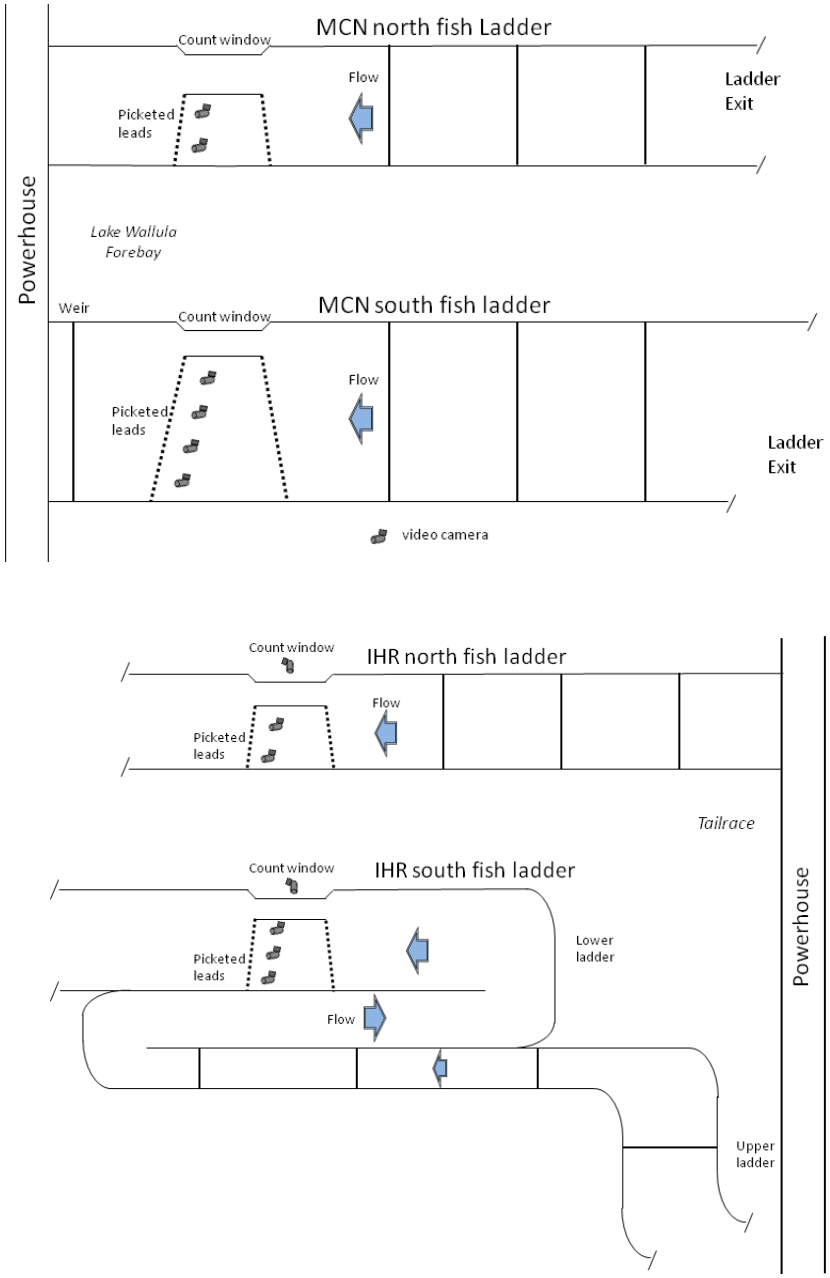

Figure 2. Location and numbers of video cameras deployed at the picketed leads of McNary (top) and Ice Harbor (bottom) fish ladders. Location of cameras at Ice Harbor Dam count windows shown as well.

Lamprey orifices. Three-inch aluminum I-beam sections were attached (using expansion anchors) to the lateral aspect of the fish ladder channel immediately downstream of lamprey orifices at both Little Goose and Lower Granite dam fish ladders; an exemplary installation from a previous study is shown in . All I-beam tracks were located approximately 2 feet from the orifice openings (Figure 3). Identical camera trolleys to those used for picketed lead monitoring were used at these locations.

Figure 3. Dewatered McNary south ladder, facing upstream, 2010. A lamprey orifice is visible at lower left, and a fish passage orifice is visible at upper right. A camera placement I-beam is shown against the left ladder wall. Although this orifice and camera rail were not part of the 2013 study, the relationship of the camera-mount I-beam to the lamprey orifice is illustrative of other orifice locations monitored in 2013.

At Little Goose, two orifices on successive weirs were monitored at the very top of the fish ladder (Figure 4) and an additional camera was mounted inside the count window station on the ceiling at Little Goose (not shown). At Lower Granite, lamprey orifices on the uppermost weir (737) and weir 734 were monitored (Figure 4).

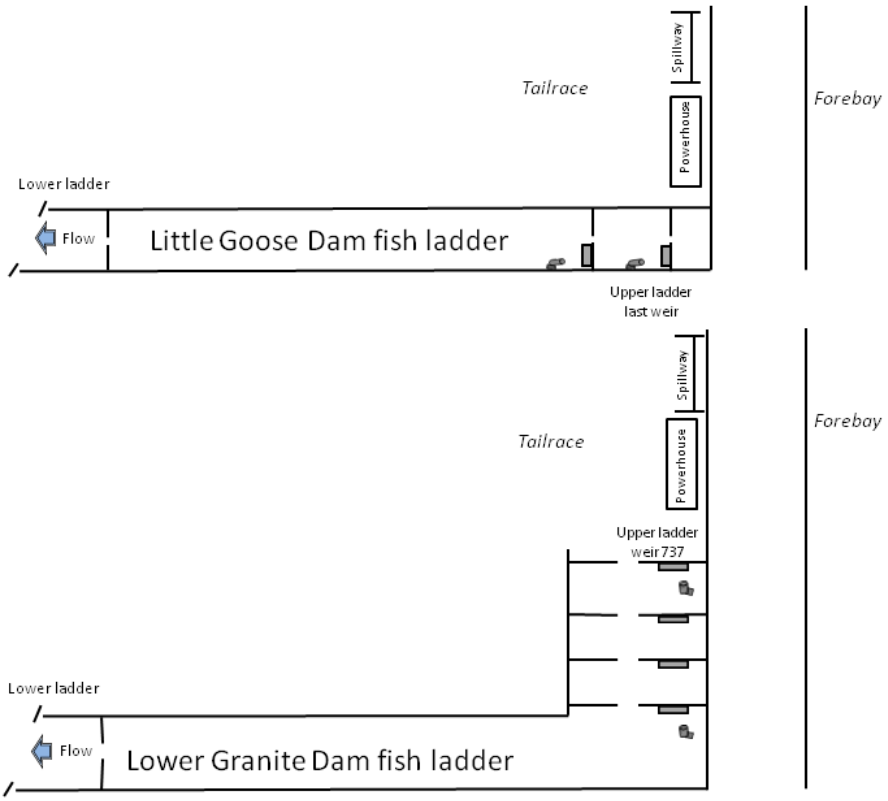

Figure 4. Location of video camera deployments at lamprey orifices for Little Goose (top) and Lower Granite (bottom) fish ladders.

Camera recording and video data collection

McNary and Ice Harbor: All video cameras were set to record with the following parameters: 704 x 480 resolution; normal record (video quality 250 KB/sec; 15 frames per second (fps); grayscale color scheme, and no audio. BNC cable ends from video cameras were routed to ventilated, NEMA-4-rated electrical enclosures. Each dam had two enclosures, one for each ladder. The enclosures housed a personal computer-based digital video recorder (DVR; Intel dual-core processor, 2 GB RAM, PCI slot, 2 SATA hard drive ports, Windows 7 OS), using 8- or 16-channel Hikvision video capture cards (Model DS-4008HCI and DS-4016HCI; Hikvision USA, City of Industry, CA) and 2 TB of hard drive space dedicated to video recording. Additionally, for power protection an uninterrupted power supply (UPS-Tripplite OMNI900LCD, Chicago IL) was added to each enclosure.

At the McNary South and Ice Harbor North ladders, enclosures held a Hughes Satellite modem (model HN9000; Hughes Network Systems, LLC., Germantown, MD), a Linksys router (model E1200; Cisco Consumer Products, Irvine, CA) and a signal repeater for the other ladder. Enclosures at McNary North and Ice Harbor South held a DVR and a signal repeater receiver.

Remote connectivity from the UC Davis facilities to the PC-based DVR units was achieved using a 2-watt, 1-meter satellite dish (Hughes Satellite, Germantown, MD), with upload speeds

of 512–1024 KB/sec and a static IP address. Data received by the Hughes Satellite dish were encoded by the Hughes modem and transmitted to the Linksys router. The Linksys router enabled the two DVR units at each dam to share the connection. The connection from the Linksys router to the DVR unit held in the same housing was made through a Cat 5e Ethernet cable, while the other was made over a wireless repeater, with a Cat 5e Ethernet cable from the repeater to the DVR unit.

Little Goose and Lower Granite orifice video: Hardware, recording and collection of data was similar to McNary South and Ice Harbor North, without the Linksys router and signal repeater. Remote connectivity to UC Davis was achieved using the Hughes satellite dish described above (one dish per location), with similar upload speeds and via a static IP address.

Little Goose count window: BNC cable end from the camera was routed to an 8-channel (Pelco model DX4500) DVR which was programmed on site to record video (normal record setting used) for the duration specified in Table 1. Video data was periodically retrieved from the DVR hard drive by swapping out with a newly formatted 1.5-TB drive.

Network video data transfer

Except for the Little Goose count window DVR, programming of recording settings and other DVR control commands described above was performed remotely from UC Davis using the remote administration tools native to Windows 7 (Microsoft, Inc., Redmond, WA). These commands enable modifying camera settings (e.g., image-collection time, frame rate, resolution, and bit rate), updating DVR software, and checking camera status, water quality, etc. The DVRs were programmed to send email alerts about malfunctions to maintenance personnel at UC Davis. A cell phone application (Google Android OS) provided by Hikvision was also used by personnel to check camera status from any location with cellular data or WiFi service. Video recordings were downloaded using the CBVision video acquisition module, which used an FTP connection and saved video files in the native MPEG-4 format (.mp4), using standard H.264/MPEG-4 video compression codecs (Thompson et al. 2012).

Table 1. Summary of video recording dates and daily recording hours for all locations. Numbers in parentheses are number of cameras used at a given location.

Project/site	Location	Dates	Hour/Notes
McNary south ladder	Picketed leads (4)	June 10–Oct. 15	24/7
McNary north ladder	Picketed leads (2)	June 14–Oct. 15	24/7
Ice Harbor south ladder	Picketed leads (3)	June 12–Oct. 15	24/7
	Count window (1)	June 13–Oct. 15	21:00–05:00
Ice Harbor north ladder	Picketed leads (2)	June 14–Oct. 15	24/7
	Count window (1)	June 14–Oct. 15	21:00–05:00
Little Goose ladder	Count window (1)	June 25–Aug. 9	21:00–05:00
	Lamprey orifices (2)[a]	May 15–Sept. 26	07:00–13:00
			21:00–05:00
		June 30–Aug. 7	24/7 (sockeye)
Lower Granite ladder	Lamprey orifices (2)[a]	May 12–Sept. 26	07:00–13:00
			21:00–05:00
		June 30–Aug. 8	24/7 (sockeye)

[a] Except for sockeye salmon, orifice monitoring Sunday through Thursday for the indicated times.

Video analysis: methods

Picketed lead video

Daily video files of the picketed lead gap were manually reviewed using the open-source VLC Media Player, version 1.1.11 (www.videolan.org). Files were reviewed at a playback speed of 2–4x. The following data were collected for each daily video file:

- Length of video file
- Location of camera, date, and time of day (from time-stamped video)
- Number of lampreys observed
    - For lampreys moving upstream: those coming through the picketed leads, those coming under the picketed lead gap, and those moving laterally or across field of view of camera.
    - For lampreys moving downstream: those passing completely under picketed lead gap.

During the video file review process, several assumptions were made regarding whether a lamprey was counted and whether this count was scored as positive or negative. First, when a lamprey was observed in one camera, adjacent cameras were checked for the appearance of lampreys within 10 minutes of the first sighting. Lampreys appearing to move laterally in adjacent cameras in this period were not counted unless they were observed to come directly under the picketed lead gap. Second, when a lamprey was observed to move downstream under the picketed lead gap, it was counted as negative. Lamprey counts from all cameras at one location were summed hourly and daily and behaviors (lampreys moving under, through, across, or downstream through picketed leads) quantified.

Count window video

Daily video files were manually reviewed using the VLC media player at 2x playback speed. Lampreys observed moving upstream were counted as positive, while those moving downstream were counted as negative. Also included for each lamprey was the time of day (from 21:00 to 05:00) the observation occurred. Counts were summed hourly and daily and recorded, along with the length of the video file.

Lamprey orifice and conduit video

Video files of lamprey orifices and lamprey conduit openings were manually reviewed using VLC media player, Version 1.1.11. Files were reviewed at 2–4x playback speed.

Video analysis: assessment

Escapement estimation

To determine total lamprey ladder escapement, hourly lamprey counts at the count window were obtained from USACE fish count technicians over the course of the study (www.nwp.usace.army.mil/environment/fishdata.asp). These hourly window counts were added to the hourly counts obtained from the picketed lead video to provide total escapement numbers for this ladder. Hereafter, the hours from 05:00 to 21:00 are referred to as “day,” and 21:00 to 05:00 as “night.” The difference in length of day (hours of light) between July 1 and October 15 is slightly less than 5 hours.

Orifice interactions: spring, summer, and fall Chinook; steelhead; and sockeye

Fish observed in the field of view were scored for whether they approached or interacted with the orifice or conduit. An approach was defined as headfirst swimming towards the orifice opening without the head contacting or entering the opening. These fish were observed either swimming directly towards the orifice from off camera, or turning towards orifice while in the camera's field of view. In either case, the approach was scored and its duration recorded. An interaction was defined as a fish nosing into or touching its head to the orifice opening. Interactions were observed frame by frame (1 frame = 1/15 second) to observe if any bodily damage or scale loss resulted from these behaviors. The duration of the event was recorded along with pertinent observations (species, time of day, water clarity).

For each monitored day, total approach and interaction counts along with the duration of the observed behaviors were summed. Daily window counts (USACE) restricted to the time of monitoring were used to determine the proportion of run monitored, as well as the proportion of the run either approaching or interacting with the orifices. For sockeye counts at Little Goose, total daily window counts were summed using day counts (USACE) and night counts (this study). Average time spent by fish approaching or interacting at orifices was obtained by dividing the total time observed in the camera's field of view by the total number of fish displaying a given behavior.

Orifice interactions: Pacific lamprey

Lampreys were scored as "pass" or "no pass" at the orifice and conduit. For those lampreys not passing the orifice, the time spent in the field of view was recorded. For lampreys passing the orifice, their behaviors were categorized according to the following criteria and the duration of these behaviors recorded:

a. Through: direct passage without attachment to substrate;
b. Position 1: attachment in front or directly in the orifice, followed by burst swimming through the orifice;
c. Position 2: orifice passage and attachment upstream of the orifice with tail/caudal fin still visible in the orifice;
d. Both position 1 and 2.

Additional metrics describing the proportion of lampreys using (passing) the orifices and conduit with respect to the number passing the fish ladder at the count window include the following:

$$\text{Orifice use rate (window)} = \frac{\text{number passing orifice}}{\text{number counted at window}} \quad (1)$$

$$\text{Orifice use rate (video)} = \frac{\text{number passing orifice}}{\text{total number observed in video}} \quad (2)$$

$$\text{Orifice observation rate} = \frac{\text{number passing+no pass}}{\text{number counted at window}} \quad (3)$$

In each case, the number counted in the window is restricted to the number counted during the monitoring period, with day counts expanded by a factor of 1.2 where appropriate, per USACE protocol.

CBVision video monitoring application

A graphical user interface (GUI) has been developed for the CBVision lamprey event detection and tracking software. Running on Windows OS and developed in C#, this interface uses a client-server distributed architecture to achieve scalability and optimize resource utilization. The application structure consists of three components:

1. CBVision Server: A central server software program
2. CBVision Admin GUI: An administrative graphical user interface
3. CBVision Client: A worker program that can be scaled to run in multiple parallel instances

The CBVision Server maintains a processing job queue and distributes the workload between all worker programs, which are registered as clients. Users of the system attach external hard drives or copy over the raw video data to the computer hosting the server, and the server will distribute the data over the network to the processing clients.

The CBVision Admin GUI connects to the server, enabling system administrators to add new jobs to the job queue, manage priorities, modify processing parameters, and visualize the distribution of processing jobs across clients.

The video processing component of the CBVision software suite, the CBVision Client connects to the server and receives new processing tasks whenever it is idle. It can be located on the same computer as the server, on a different computer on the same network or even over the Internet. This allows for great flexibility in scaling the processing power of the system, simply by adding new computers that run the client. The CBVision Client can also take advantage of multi-core computers by accepting as many tasks as there are cores allocated to it.

The CBVision system has undergone limited laboratory testing and will be used in full production for the 2014 monitoring year.

Correlation analysis

The linear correlation between lamprey observation numbers at count window stations and picketed leads was computed using Pearson's correlation coefficient for three consecutive years starting from 2011. A combined 3-year correlation coefficient was also computed. The correlation was tested using Student's T-distribution with $p < 0.05$ and the zero-correlation null hypothesis. If the null hypothesis is rejected, scatter plots are produced. Each year is then fitted with a linear regression line and the goodness of fit is estimated using the coefficient of determination R^2. If the regression lines have similar parameters, the combined regression line can be used as estimation for the linear relationship between counts at the two locations.

3.0 RESULTS

McNary south ladder picketed lead video

Lamprey behavior

Lamprey run size and timing. The 2013 lamprey migration at McNary South Ladder arrived on a similar temporal scale to the 10-year average (Figure 5). The 2013 run arrived approximately a week earlier than the 2012 run, and was nearly double in size. Peak passage occurred the last week of July, again about a week before the 10-year average and the 2012 migration season. Counts from 2011 to 2013 include lampreys counted in picketed lead video and these numbers were added to count window numbers to arrive at total escapement (Thompson et al. 2011). Additionally, counts from 2013 to 2009 include both day and night counts; night counts began at McNary Dam in 2009 and therefore years previous to this were not included except for determining the 10-year average.

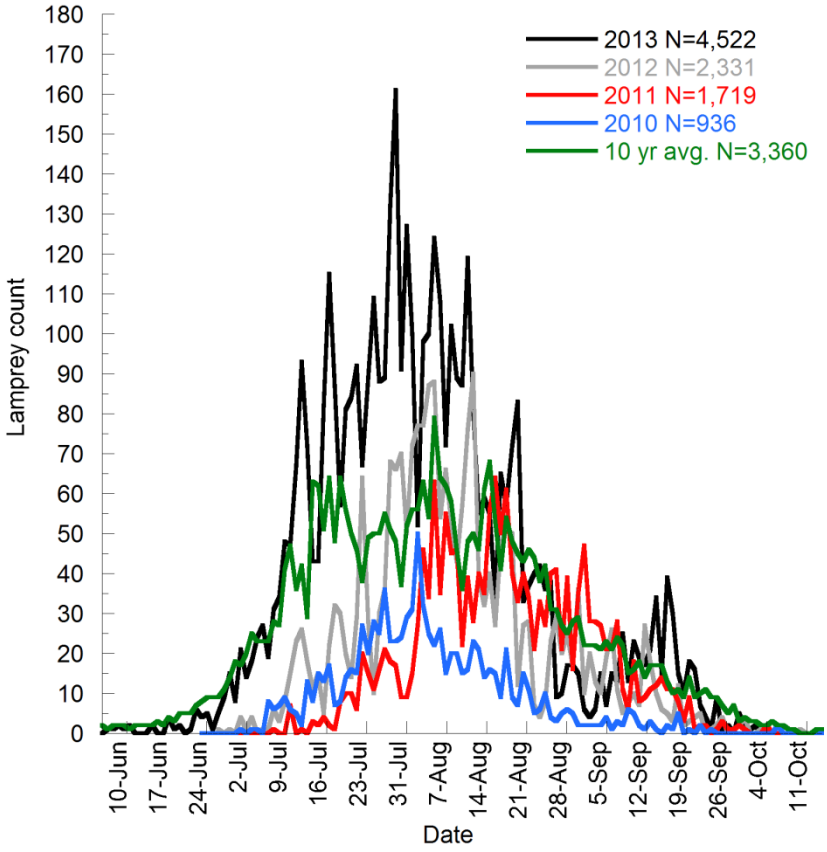

Figure 5. Annual lamprey passage numbers at McNary south fishway ladder for 2010–2013, with the 10-year average. All day counts at the window were expanded by a factor of 1.2 to account for the 50-minute per hour counting period used by observers at the count stations.

Picketed lead video observations. Similar to 2011 and 2012, lampreys counted in video cameras at McNary South ladder pickets exhibited one of four distinct behaviors during the study period. The greatest number of lampreys (2,211, or 73.7%) was observed to swim directly under the picketed leads by means of the gap at the bottom (Figure 6). Invariably, these lampreys swam without hesitation through this gap and continued past the video camera and out of sight. The

next highest percentage of behavior was exhibited by 16.2% of lampreys (485), which were observed to move downstream through the picketed lead gap. These lampreys were commonly seen suddenly moving from behind and away from the video camera. The next most common behavior was "across," exhibited by 9.0% or 269 lampreys, and consisted of lampreys moving laterally across the field of view of the cameras or situations where only part of the body was visible in the camera's field of view. Finally, a relatively small number of lampreys (33, or 1.1% of the total) were observed to come upstream through and between the picketed lead slats. These lampreys usually appeared 1–2 feet above the ladder floor in the picket slats, and after easily moving through the slats swam to the bottom and quickly moved past the camera.

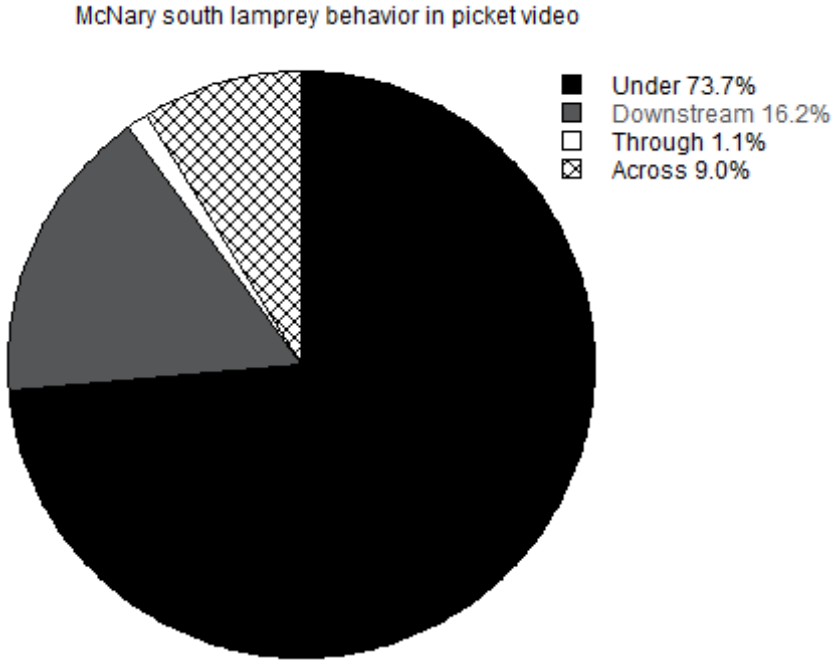

Figure 6. Observed lamprey behaviors in picketed lead video at McNary south ladder as lampreys swam past picketed leads. Percentages are based on all lampreys counted (upstream plus downstream).[1]

As in 2011–2012, the lateral distribution of lampreys across the picketed lead gap was examined by comparing count frequencies in the four cameras (Figure 7). Coverage of the gap was approximately 94%. In keeping with past years, the greatest number of lampreys (708) was seen at the camera nearest the count window slot (Camera 1). The next highest lamprey count (667) was for Camera 4, the camera farthest from the count window and nearest to the south channel wall.

[1] Note that these numbers do not correspond exactly with lamprey escapement numbers, which represent *net* upstream passage (upstream minus downstream).

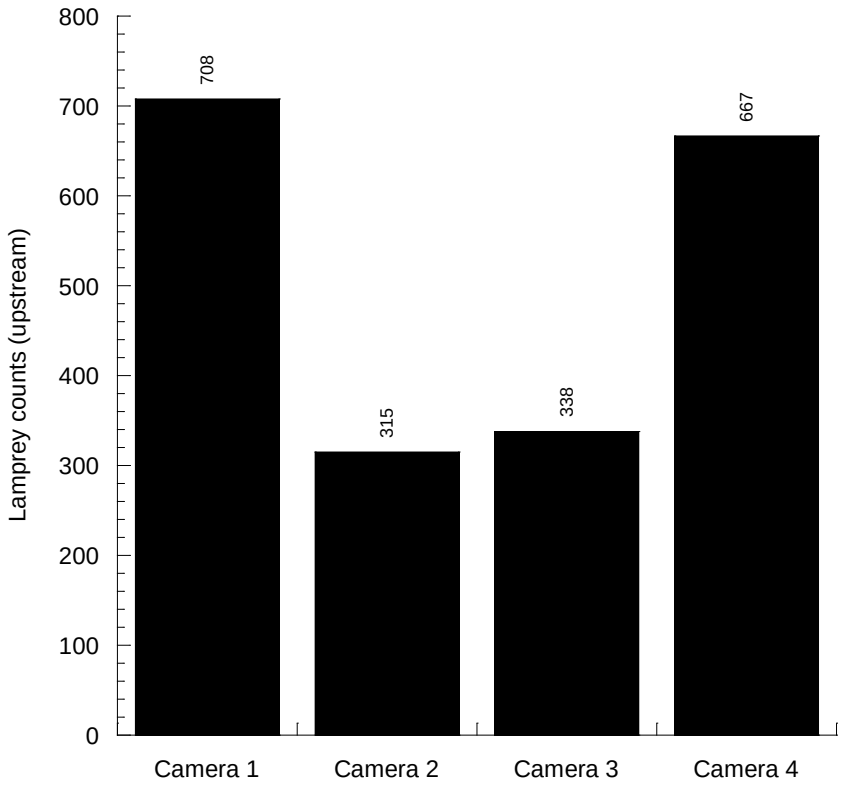

Figure 7. Frequency of lampreys seen in picketed lead video at McNary south ladder. Camera 1 was situated in the ladder channel nearest the count window, followed by cameras 2 and 3. Camera 4 was located near the ladder south channel wall opposite the count window.

The percent of lampreys counted at the window and in picketed lead video is shown in Figure 8. For window counts the highest percentage of lampreys were counted during the hour of 04:00 to 05:00 (14.5%) while for picketed lead video the hour of peak counts was a few hours later from 06:00 to 07:00 (19.0%, Figure 8). For both window counts and picketed lead video, fewest lampreys were counted from noon to midnight.

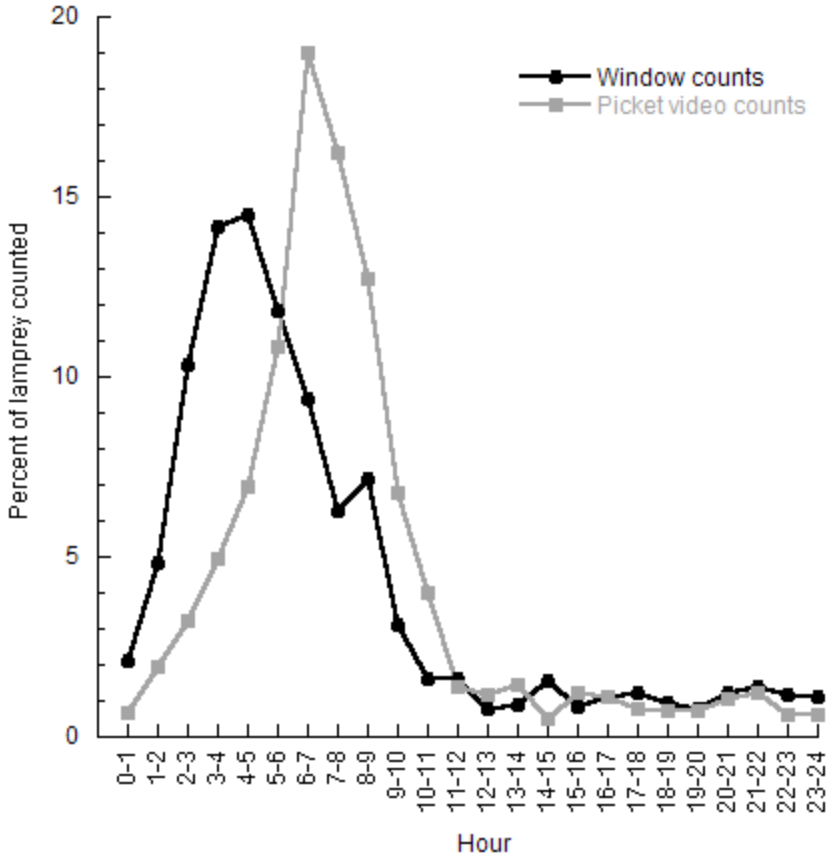

Figure 8. Percentage of lamprey counts by hour at McNary south ladder for the count window and picketed lead video for the 2013 migration season. Daily counts at the window expanded by a factor of 1.2 per USACE protocol.

Lamprey escapement

As in previous years, a primary goal of the study was to estimate lamprey escapement using the information collected at the picketed leads from underwater video combined with counts from count station windows. Prior video work (Thompson et al. 2011), indicated that this combination results in the best possible image quality and coverage of potential lamprey passage routes. Video monitoring at the picketed leads began on June 10 and ended on October 15, 2013. Cameras were operated 24 hours per day, 7 days per week using the DVR's normal record feature. The DVR failed to record August 27 to September 2 due to a local power failure and simultaneous failure of the uninterruptible power supply (UPS).

For the south ladder of McNary Dam for June 10 to October 15, 2013, total escapement (upstream events minus downstream events) estimated from window and picketed lead counts was 4,522 lampreys (Table **2**). The first lamprey was counted at the window on July 1 for night hours, and June 3 for day hours. The first lampreys were counted in picketed lead video on June 11 (day) and June 30 during the night. The last lamprey was observed at the count window on October 2 (day) and September 23 (night), and September 27 in picketed lead video (day and night).

Table 2. McNary south ladder 2013 lamprey count summary

	June	July	August[c]	September[c]	October 1–15	Total
Window[a,b]	44	1,186	1,049	211	4	2,494 (55.2%)
Picketed lead video	29	964	857	178	0	2,028 (44.8%)
						4,522

[a] 16-hour total daily count, expanded by a factor of 1.2.
[b] Night counts began July 1 and ended Sept. .30.
[c] Picketed lead video counts unavailable Aug. 27–Sept. 2.

This year during the day hours, more lampreys passed the picketed leads than the count window (Table 3), with 56.2% of all lampreys counted passing the picketed leads during these hours. The proportion of lampreys passing the picketed leads was substantially lower at night, with only 24.9% of all lampreys counted during these hours passing the picketed leads. Lamprey's use of the count window was very similar across day and night hours, with 1,256 counted during day hours and 1,238 lampreys counted at the window at night.

Table 3. Net upstream day and night counts of lampreys at count window and behind picketed leads at McNary south ladder, 2013. Counts to October 15.

	05:00–21:00	21:00–05:00
Window[a,b]	1,256	1,238
Picketed lead video	1,617	411
Sub total	2,873	1,649
% lampreys counted in picketed lead video	56.2	24.9

[a] 16-hour total daily count, expanded by a factor of 1.2
[b] Night counts began July 1 and ended Sept. 30.

A secondary goal of the study was to determine whether counts at a single location, such as the count window, provide an accurate index of lamprey escapement when picketed leads are elevated. Hourly lamprey counts for both window and picketed lead video were summed across the 2011–2013 migration seasons and plotted against each other; the regression lines for each year and the combined regression for 2011–13 are shown in Figure 9. The results of the linear regression analyses for each year are presented in Table 4. For each year and the combined years 2011–2013, the hourly correlation was significant, with p-values < 0.05 (zero correlation null hypothesis rejected with $p < 0.05$). The best fit regression was for 2012 with $r^2 = 0.84$ (Table 4). When counts from the window and picketed leads were summed across 2011–2013, $r^2 = 0.77$.

Table 4. Summary of results for the correlation analysis between lamprey counts at the count window station and picketed leads for McNary south ladder

	Migration year			
Parameter	**2013**	**2012**	**2011**	**Combined**
N	22	22	22	22
r	0.61	0.92	0.70	0.88
r^2	0.37	0.84	0.49	0.77
p	0.0015	<0.001	<0.001	<0.001
Linear regression	$y = 0.5773x + 24.501$	$y = 0.9993x - 7.34$	$y = 0.5234x + 7.9504$	$y = 0.8308x + 5.2682$

Where:
N = number of days
r = computed correlation coefficient
r^2 = coefficient of determination
p = computed probability of the null hypothesis
y = picketed lead lamprey count
x = count window lamprey count

Figure 9 shows the overlapped scatter plots of the three years of data and the linear regression for each year. The combined linear regression line is also shown.

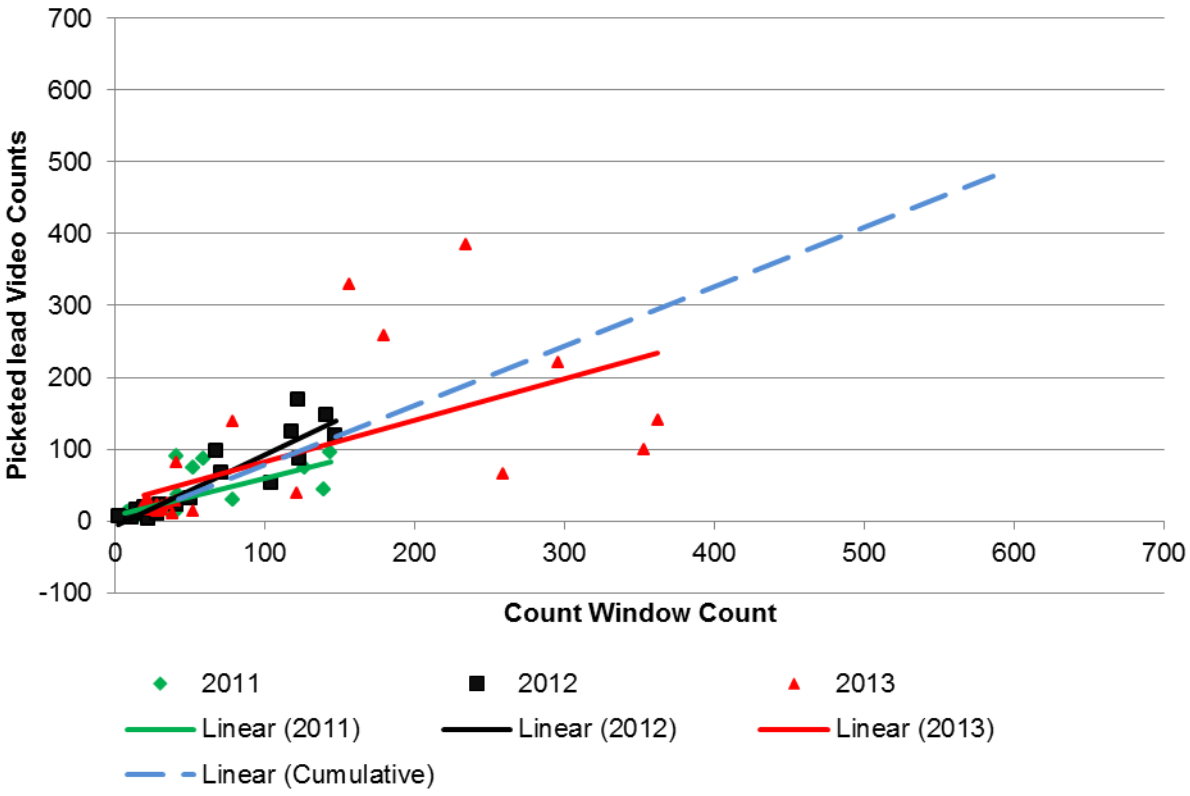

Figure 9. Correlation of 24-hour lamprey counts at the window and in picketed lead video for the 2011–2013 migration seasons.

A summary of total window counts and picketed lead video counts for day and night hours for the 2011–2013 migration seasons is shown in Figure 10. For the 2013 season, both window

counts and picketed lead counts for both day and night hours increased compared to previous years (Figure 10). Noteworthy in this increase is a relatively large increase in daytime picketed lead counts compared to 2011–2012 counts at both the window and picketed leads during day and night hours. Day picketed lead video counts in 2013 corresponded to 35.8% of the total counts, 32.0% in 2012, and in 2011 21.1% of the total lampreys counted.

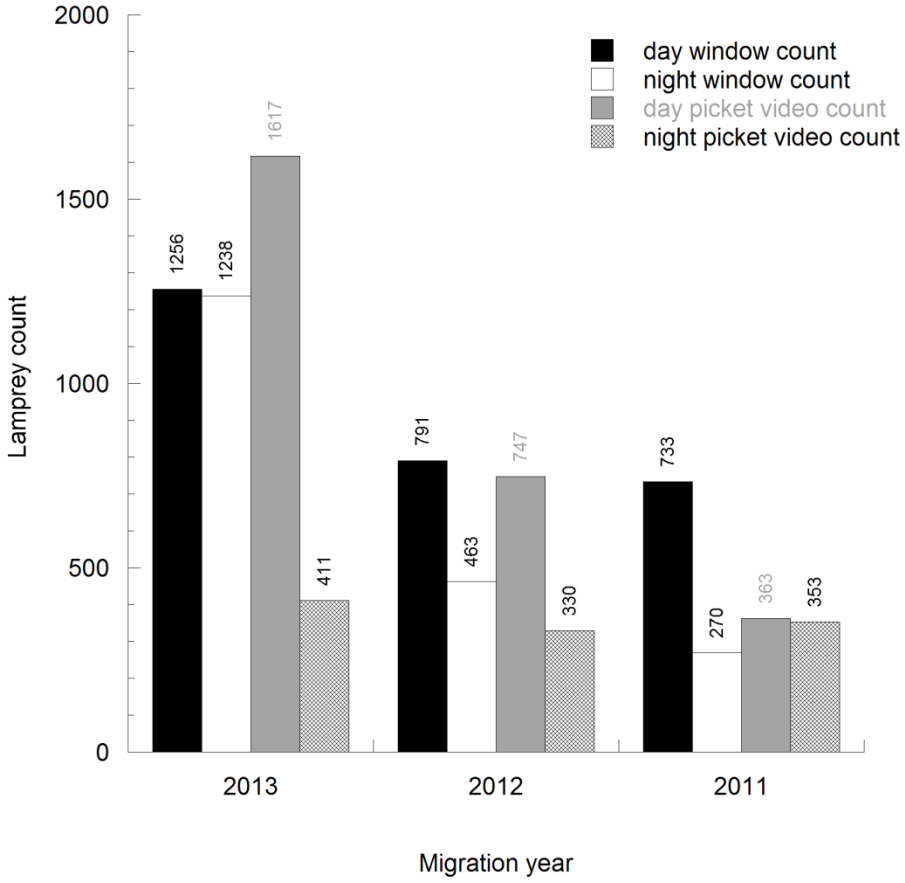

Figure 10. Summary of day and night lamprey totals for window counts and picketed lead video for the 2011–2013 migration seasons at McNary South.

McNary north ladder picketed lead video

Lamprey behavior

Lamprey run size and timing. In keeping with historical annual counting data (Columbia River DART)[2] lamprey counts at the McNary north ladder were a fraction of counts at the south ladder. In contrast to the south ladder, the lamprey run at McNary North was smaller and arrived much later than the 10-year average (Figure 11). Most passage (84%) in 2013 occurred from the last week in July to the first 3 weeks in September. The early-September resurgence in counts is likely due to a cessation of dam spill that occurred September 1. For this ladder, the run size in

[2] http://www.cbr.washington.edu/dart/dart.html

2013 increased by 386 fish over 2012 (a 75% increase) and by 492 (121% increase) over 2011. Counts for 2009–2013 include both day and night counts. Night counts began at McNary Dam in 2009; therefore, years previous to this were not included, except to determine the 10-year average.

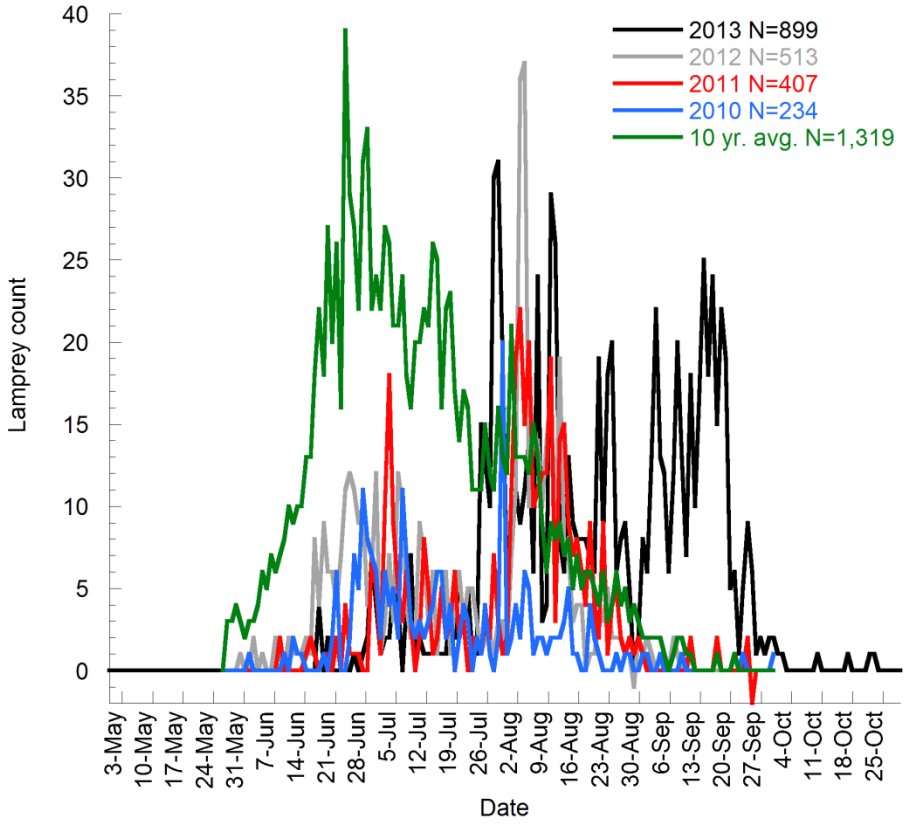

Figure 11. Daily lamprey passage numbers at McNary north fishway ladder for 2010–2013, with the 10-year average. Numbers for 2009–2013 include day and night counts. For 2008 and previous years, day counts alone were kept. These are included to calculate the 10-year average.

Picketed lead video observations. Two video cameras were placed upstream of the picketed lead section at McNary north ladder and aimed at the gap along the bottom of the picketed leads. Coverage of the gap was approximately 80%. Video recording, 24 hours per day, 7 days per week, began at this location on June 14 and ended on October 15, 2013. Counts at the window were obtained in the same manner as at the McNary south ladder.

In keeping with 2011–2012, a small sample size was observed in the picketed lead video at the McNary north ladder in 2013 ($N = 15$). Lampreys exhibited each of the four common behaviors described above at the south ladder. Thirteen lampreys were observed moving upstream under the picketed lead gap; 3 moved laterally (across), 3 moved through the vertical picketed leads slats, while 4 swam downstream under the picketed lead gap.

Lamprey escapement

In total, for the 2013 migration season, a total of 899 lampreys were counted at the north ladder of McNary Dam (Table 5). The first lamprey was counted in day at the window on April 22 and on June 30 for night counts. For picketed lead video, the first lamprey was counted during the

day on June 26 and during the night on August 27. The last lamprey counted during the day at the count window arrived on October 30 and in picketed lead video on September 23. The last lampreys counted at night were at the window on September 29 and in video at the picketed leads on September 14. In contrast to the south fishway, the vast majority of lampreys in the north fishway were observed at the count window. Of the 899 lampreys counted, only 15 (1.7%) were counted in picketed lead video over the entire season.

Table 5. McNary north ladder 2013 lamprey count summary

	April-May	June	July	August	September	October	Total
Window[a,b]	23	18	185	319	332	8	884 (98.3%)
Picketed lead video	–	2	3	3	7	0	15 (1.7%)
Subtotal	23	10	188	321	339	8	
							899

[a] 16-hour total daily count, expanded by a factor of 1.2
[b] Night counts began July 1 and ended Sept. 30.

Overall lamprey escapement was lower at the north ladder than at the south ladder. More lampreys (574) were counted during night hours than during day hours (325) (Table 6). The proportion of lampreys counted in picketed lead video was 3.4% of the total lamprey count by day, and 0.7% of the total lamprey count by night.

Table 6. Net upstream day and night counts of lampreys at count window and behind picketed leads at McNary north ladder for 2013. Picketed lead video counts to October 15.

	05:00–21:00	21:00–05:00
Window[a,b]	314	570
Picketed lead video	11	4
Sub total	325	574
% counted in picketed lead video	3.4	0.7

[a] 16-hour total daily count, expanded by a factor of 1.2.
[b] Night counts began July 1 and ended Sept. 30.

A summary of total window counts and picketed lead video counts for the day and night hours of the 2011–2013 migration seasons is shown in Figure 12. For the 2013 season, window counts for day and night hours increased over 2011–2012, while picketed lead video counts in 2013 were lower than in 2011.

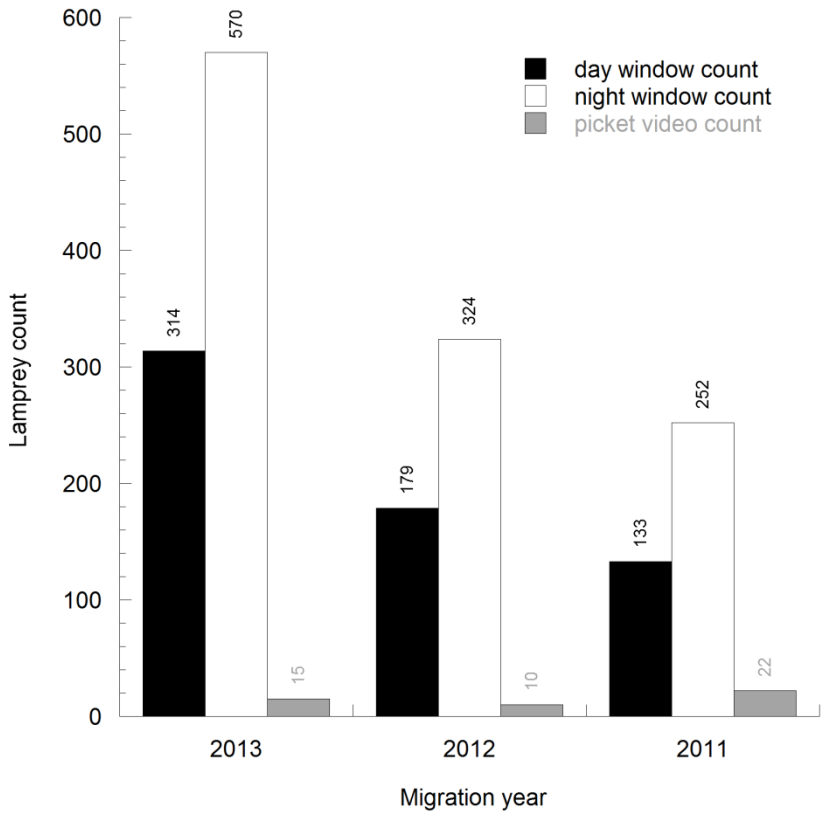

Figure 12. Day and night lamprey totals for window and picketed lead video for the 2011–2013 migration seasons at McNary North.

In summary, in 2013 for both north and south ladders, 37.7% of all lampreys (2,043 of 5,421) were counted in picketed lead video at McNary Dam.

Ice Harbor south ladder picketed lead video

Lamprey behavior

Lamprey run size and timing. The overall 2013 run of 627 lampreys, at the Ice Harbor south ladder was greater than the 10-year average (Figure 13). For this ladder, the run size in 2013 decreased by 17 lampreys from 2012, but increased over the 2011 and 2010 runs by 282 (81.7% increase) and 557 (795.7% increase) lampreys, respectively. 2011 was the first year of night window counts at Ice Harbor Dam; all annual counts prior to this year were determined from day window counts.

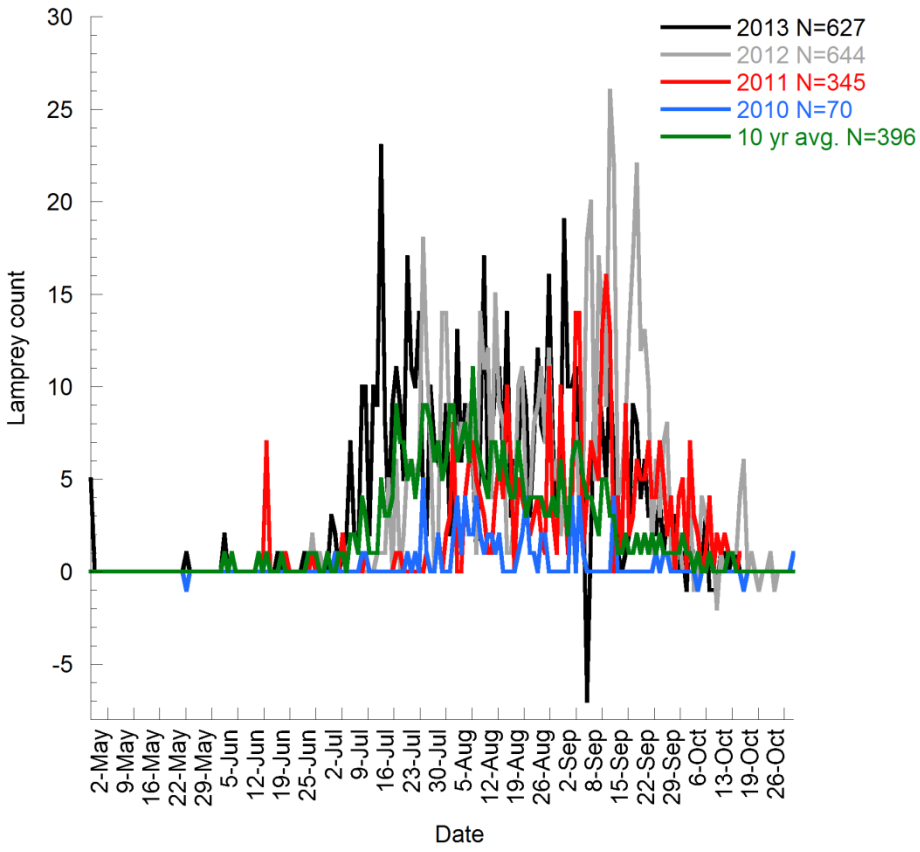

Figure 13. Daily lamprey passage numbers at Ice Harbor south fishway for 2010–2013, with the 10-year average. Counts for 2011–2013 include night window counts; all other years use day window counts only.

Picketed lead video observations. As in 2012, three video cameras were placed upstream of the picketed lead section at the Ice Harbor south ladder, aimed at the gap along the bottom of the picketed leads. Coverage of the gap was 100%. In 2011, two cameras were used at this location: the additional camera was used to increase coverage. At this location, video recording began on June 12 and ended on October 15, 2013 for 24 hours per day, 7 days per week. At the count window, video recording began on June 13 and ended October 15 (21:00–05:00 daily).

For the entire 2013 migration season, 16 lampreys were observed in picketed lead video. The most common behavior observed was upstream swimming under the picketed lead gap, exhibited by 15 lampreys, followed by 6 lampreys moving across the field of view behind the picketed leads. Six lampreys were counted moving downstream through the picketed lead gap. No lampreys were observed swimming upstream through the picketed lead slats.

Lamprey escapement

From April 12 to October 30, a total of 627 lampreys were counted at the south ladder of Ice Harbor Dam (Table 7). The first lamprey was counted in daylight at the window on April 12, with the first night-counted lamprey following on June 13. The first lamprey was counted in picketed lead video during day hours on August 9 and June 22 for night hours. The last were counted in picketed lead video on September 11 (day) and Sepember 22 (night). The last lampreys were counted at the window on October 14 (day) and October 11 (night). Overall, very

few of (2.6%) of the 627 counted lampreys were counted in picketed lead video during the entire season at this ladder. More lampreys (254) passed the ladder in August than in any other month.

Table 7. Ice Harbor south ladder lamprey count summary for 2013

	April–May	June	July	August	September	October	Total
Window[a,b]	6	10	216	250	124	5	611 (97.4%)
Picketed lead video	–	1	5	4	6		16 (2.6%)
Sub total	6	11	221	254	130	5	
							627

[a] 16-hour total daily count, expanded by a factor of 1.2
[b] Night counts began June 13 and ended Oct. 15.

Substantially more lampreys were counted at the window during night hours than during the day (484 versus 127, Table 8). A higher percentage of lampreys were counted in picketed lead video during the day (5.2%) than during the night hours (1.8%).

Table 8. Lampreys counted at the window and behind the picketed leads at the Ice Harbor south ladder during 2013. Counts to October 30.

	05:00–21:00	21:00–05:00
Window[a,b]	127	484
Picketed lead video	7	9
Sub total	134	493
% counted in picketed lead video	5.2	1.8

[a] 16-hour total daily count, expanded by a factor of 1.2.
[b] Night counts began June 13 and ended Oct. 15.

A summary of total window counts and picketed lead video counts for day and night hours for the 2011–2013 migration seasons is shown in Figure 14. For the 2013 season, the day window count (127) was lower than the 2011–2012 day window counts, while night window counts have increased across the years from 2011–2013. Picketed lead video counts remain a relatively small percentage of lamprey counts at this ladder, with most counted in picketed lead video during the 2013 season (16 lampreys).

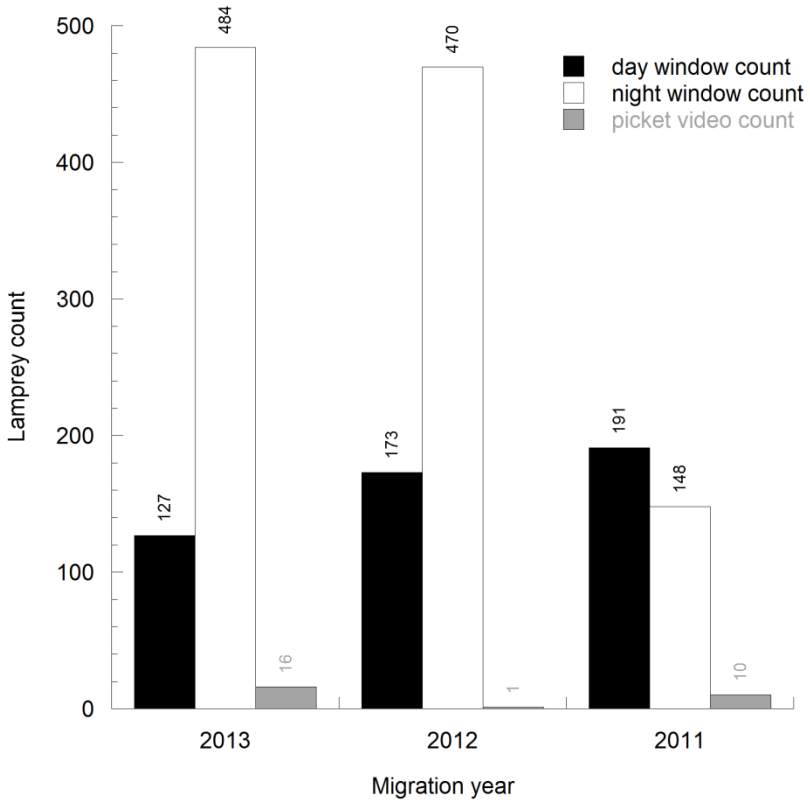

Figure 14. Day and night lamprey totals for window and picketed lead video for the 2011–2013 migration seasons at Ice Harbor South.

Ice Harbor north ladder picketed lead video

Lamprey behavior

Lamprey run size and timing. The overall run at the Ice Harbor north ladder (295 lampreys) was considerably lower than the 2012 seasonal run, but still surpassed the 10-year average of 157 lampreys (Figure 15). The 2013 run arrived at the ladder in a similar timeframe to the 10-year average, but was characterized by sporadic days with relatively high lamprey counts. 2011 marked the first year of night window counts at Ice Harbor Dam, and all annual counts prior to this year to 1999 were determined from day window counts.

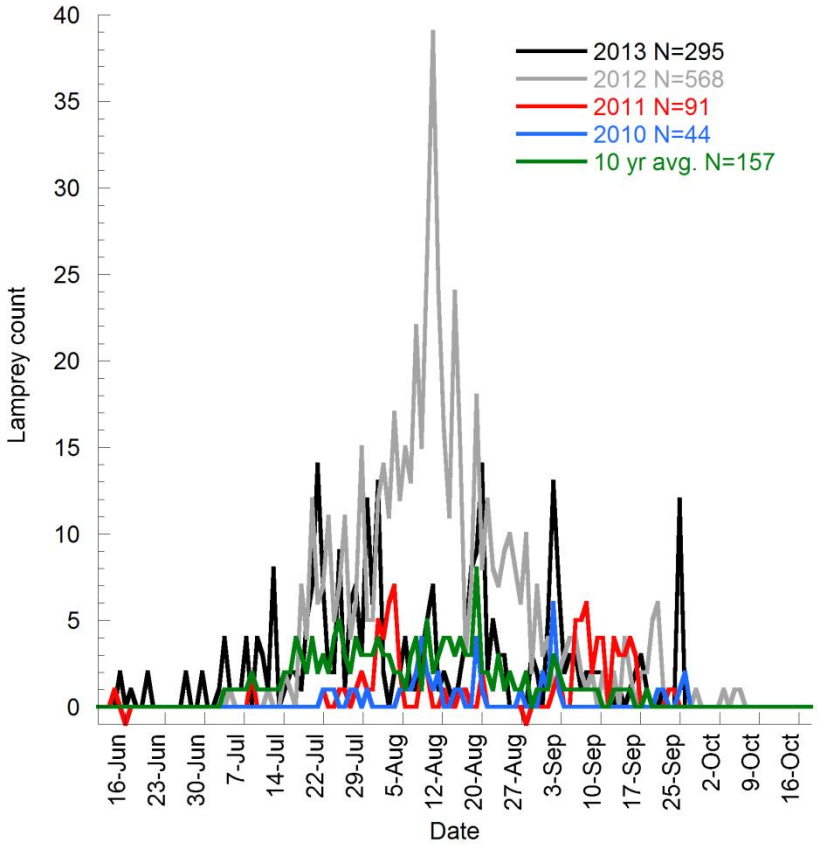

Figure 15. Daily lamprey passage numbers at the Ice Harbor north fishway for 2010–2013, along with the 10-year average. Counts for 2011–2013 include night window counts; all other years, day window counts only.

Picketed lead video observations. Two video cameras were placed upstream of the picketed lead section at the Ice Harbor north ladder, aimed at the gap along the bottom of the picketed leads. Coverage of the gap was 100%. Video recording began on June 14 and ended on October 15, 2011 for 24 hours per day, 7 days per week. At the count window, video recording from 21:00 to 05:00 began daily on June 14 and ended October 15.

A total of 19 lampreys were observed in picketed lead video from Ice Harbor North. Lampreys exhibited the same three behaviors as described for the south ladder. Most lampreys swam across behind the picketed lead gap (12 lampreys), while 9 lampreys swam upstream under the gap, and 2 lampreys swam downstream through the gap in picketed lead video.

Lamprey escapement

In total, 295 lampreys were counted at the North ladder of Ice Harbor Dam from April 4 to October 15 (Table 9). The first lamprey was counted in daytime at the window on April 4 and on June 15 for night counts. For picketed lead video, the first lamprey was counted during the day on June 27 and at night on July 30. Of the 295 lampreys counted, 19 were counted in picketed lead video during the entire season, corresponding to 6.4% of the total count.

Table 9. Ice Harbor North ladder lamprey count summary for 2013

	April–May	June	July	August	September	October 1–15	Total
Window[a,b]	2	8	115	94	55	2	276 (93.6%)
Picketed lead video	–	1	3	5	9	1	19 (6.4%)
Sub total	2	9	118	99	64	3	
							295

[a] 16-hour total daily count, expanded by a factor of 1.2.
[b] Night counts began June 14 and ended Oct. 15.

In sum, more lampreys were counted during day hours (216) than during night hours (79; Table 10). The proportions of lampreys counted in picketed lead video at the Ice Harbor north ladder were 6.9% and 5.1% of the total day and night lamprey counts, respectively. Two hundred and one lampreys were counted at the window during day hours, compared to 75 lampreys counted at night.

Table 10. Lampreys counted at window and behind picketed leads at Ice Harbor north ladder in 2013. Counts to October 15.

	05:00–21:00	21:00–05:00
Window[a,b]	201	75
Picketed lead video	15	4
Sub total	216	79
% counted in picketed lead video	6.9	5.1

[a] 16-hour total daily count, expanded by a factor of 1.2.
[b] Night counts began June 14 and ended Oct. 15.

A summary of total window and picketed lead video counts for day and night hours for the 2011–2013 migration seasons is shown in Figure 16. For 2013, counts at the window and in picketed lead video were lower than in 2012, but substantially higher than in 2011. Picketed lead video counts remained relatively low for this location, but were proportionally higher than in 2012.

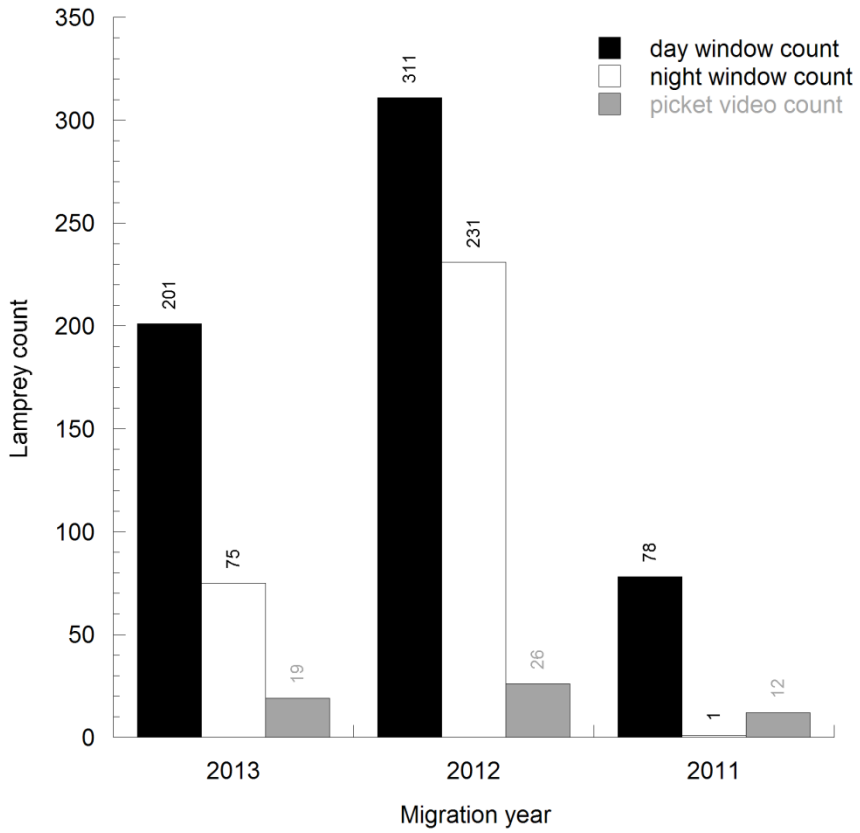

Figure 16. Day and night lamprey totals for window and picketed lead video for the 2011–2013 migration season at Ice Harbor North.

Overall for both ladders, of the 922 lampreys counted at Ice Harbor Dam, 3.8% (35 lampreys) were observed in picketed lead video.

Lamprey orifice video monitoring

General adult and jack spring Chinook run and monitoring details

The adult spring Chinook run at Little Goose Dam spans April 15 to June 15, and during this time in 2013 a total of 35,041 fish were counted, representing 66% of the 10-year average (DART, 2003–2012). The spring run of jack Chinook run totaled 19,443, far greater than the ten year average of 44,913 fish. For Little Goose, adult spring Chinook counts during orifice monitoring were 6,001 fish, corresponding to 17.1% of the run monitored (Table 11). For the jack run, 25.9% of the run was monitored at the two orifices. In sum, 20.3% of the entire spring Chinook run was monitored.

At Lower Granite Dam, total adult spring Chinook counts during orifice monitoring were 35,031, corresponding to 65% of the 10-year average. Spring run of jacks was 19,940, corresponding to 203% of the 10-year average. For orifice monitoring, 26.1% of the adult run and 29.6% of the jack run was monitored (Table 11). In sum, 27.4% of the entire spring Chinook run was monitored at this location.

Table 11. Orifice monitoring details for adult and jack spring Chinook at all locations

Location/Run	Monitoring dates	Monitoring time	Run total	Window counts during monitoring	Percent of run monitored
Little Goose	May 15–June 15	07:00–13:00			
Adult run			35,041	6,001	17.1
Jack run			19,443	5,031	25.9
Total			**54,484**	**11,040**	**20.3**
Lower Granite	May 12–June 17	07:00–13:00			
Adult run			35,031	9,144	26.1
Jack run			19,940	5,902	29.6
Total			**54,971**	**15,046**	**27.4**

General summer Chinook run and monitoring details

The adult summer Chinook run at Little Goose Dam spans June 16 to August 18. During this time in 2013 a total of 10,120 fish were counted, representing 56% of the 10-year average (DART, 2003–2012). The summer jack Chinook run totaled 7,632, 152% of the 10-year average. For Little Goose, adult summer Chinook counts during orifice monitoring were 3,074 fish, corresponding to 30.4% of the run monitored (Table 12). For the jack run, 35.1% of the run was monitored at the two orifices. In sum, 32.4% of the entire summer Chinook run was monitored.

At Lower Granite Dam, total adult summer Chinook counts during orifice monitoring were 8,423, corresponding to 51% of the 10-year average. The summer run of jacks was 7,572, corresponding to 133% of the 10-year average. For orifice monitoring, 30.7% of the adult run and 27.8% of the jack run was monitored (Table 12). In sum, 28.8% of the entire summer Chinook run was monitored at this location.

Table 12. Orifice monitoring details for adult and jack summer Chinook at all locations.

Location/Run	Monitoring dates	Monitoring time	Run total	Window counts during monitoring	Percent of run monitored
Little Goose	June 16–July 25	07:00–13:00			
Adult run			10,120	3,074	30.4
Jack run			7,632	2,679	35.1
Total			**17,752**	**5,753**	**32.4**
Lower Granite	June 18–July 25	07:00–13:00			
Adult run			8,423	2,588	30.7
Jack run			7,572	2,107	27.8
Total			**15,995**	**4,607**	**28.8**

General fall Chinook run and monitoring details

The adult fall Chinook run at Little Goose Dam spans August 16 to October 31, and during this time in 2013 a total of 10,120 fish were counted, representing 261% of the 10-year average (DART, 2003–2012). The fall jack Chinook run totaled 21,985, or 195% of the 10-year average. For Little Goose, adult fall Chinook counts during orifice monitoring were 22,991 fish, corresponding to 41.7% of the run monitored (Table 13). For the jack run, 35.7% of the run was monitored at the two orifices. In sum, 39.9% of the entire fall Chinook run was monitored.

At Lower Granite Dam, total adult fall Chinook counts during orifice monitoring were 56,565, corresponding to 298% of the 10-year average. The fall run of jacks was 22,395, 157% of the 10-year average. For orifice monitoring, 42.2% of the adult run and 34.3% of the jack run was monitored (Table 13). In sum, 40.0% of the entire fall Chinook run was monitored at this location.

Table 13. Orifice monitoring details for adult and jack fall Chinook salmon at all locations

Location/Run	Monitoring dates	Monitoring time	Run total	Window counts during monitoring	Percent of run monitored
Little Goose	Aug. 16–Sept. 26	07:00–13:00			
Adults			55,190	22,991	41.7
Jacks			21,985	7,844	35.7
Total			**77,175**	**30,835**	**39.9**
Lower Granite	Aug. 18–Sept. 26	07:00–13:00			
Adults			56,565	23,873	42.2
Jacks			22,395	7,679	34.3
Total			**78,960**	**31,552**	**40.0**

General steelhead run and monitoring details

The steelhead run at Little Goose Dam from April 1 to October 31 totaled 95,871 in 2013, representing 58% of the 10-year average (DART, 2003–2012). During the monitoring period, 18,776 fish passed the ladder, resulting in 19.6% of the run monitored (Table 14).

At Lower Granite, the steelhead run total was 107,805, or 60% of the 10-year average. During the monitoring period 23,479 fish were counted, resulting in 21.8% of the run monitored. For both locations, during the peak passage dates of September 20 and 21 the monitoring period was extended to 05:00–21:00 daily (Table 14) to increase the proportion of run monitored.

Table 14. Orifice monitoring details for steelhead at all locations

Location	Monitoring dates	Monitoring time	Run total	Window counts during monitoring	Percent of run monitored
Little Goose	June 30–Sept. 26	07:00–13:00*	95,871	18,776	19.6
Lower Granite	June 30–Sept. 26	07:00–13:00*	107,805	23,479	21.8

*Sept. 20 and 21 monitored 05:00-21:00 (peak passage)

General sockeye run and monitoring details

The sockeye run at Little Goose spanned June 5 to October 26, 2013, with 1,013 fish counted (including night counts from this study), corresponding to 185% of the 10-year average. To capture as much of the run as possible, the orifice was monitored on a 24/7 basis from June 30 to August 7 (Table 15). During the monitoring period, 888 fish were counted at the window, corresponding to 87.7% of the run monitored.

The sockeye run at Lower Granite was from June 6 to October 5, 2013, with 850 fish counted (including night counts), equating to 116% of the 10-year average. As with Little Goose, the video monitoring period was 24/7 for the dates listed in Table 15. Approximately 80% of the sockeye run was monitored at this location.

Table 15. Orifice monitoring details for sockeye salmon at all locations

Location	Monitoring dates	Monitoring time	Run total	Window counts during monitoring	Percent of run monitored
Little Goose	June 30– Aug. 7	00:00–24:00	1,013	888	87.7
Lower Granite	June 30–Aug. 8	00:00–24:00	850	680	80.0

Little Goose and Lower Granite dam lamprey orifices: salmonid observations

The results of lamprey orifice monitoring (two orifices) for Chinook salmon are presented in Table 16. Jack Chinook were more likely to approach and interact with the orifices, with 2.7% of the spring run approaching and 0.6% interacting with the orifices. Adult spring Chinook approached at a lower rate (2.1%), while 0.2% of the spring adult run interacted with the orifices. Average time of interactions was longer than approaches, with all interactions averaging 6.7 seconds and 1.5 seconds for approaches for the spring run (Table 16). For the total spring Chinook run, 2.4% and 0.4% of the total run interacted and approached the orifices at this location.

A similar pattern of increased jack activity relative to adults held for the summer and fall runs. The summer run was marked by the largest percentage of jack Chinook approaching (21.7%) and interacting (4.7%) with the two lamprey orifices (Table 16). For the total summer run, the approach rate was 17.3% and the interaction rate was 3.0%. Times observed for each behavior type were similar to those observed in the spring run. For the fall run, jacks again had the highest approach rate with 3.0% and an interaction rate of 0.7%. The number of adults approaching and interacting was significantly lower at this location, with only 1 adult interacting for the fall run. For the entire fall Chinook run, the approach rate was 1.1% with an interaction rate of 0.004%.

Table 16. Results of orifice monitoring at Little Goose fish ladder for Chinook salmon

Species	No. approaches	Orifice approach (%)	Avg. approach time, in seconds (SD)	No. orifice interactions	Orifice interaction (%)	Avg. interaction time, in seconds (SD)
Spring Chinook						
Jacks	137	2.7	1.5 (0.7)	30	0.6	8.6 (5.8)
Adults	129	2.1	1.5 (0.6)	14	0.2	5.5 (5.2)
Spring run total		*2.4*	*1.5 (0.7)*		*0.4*	*6.7 (5.1)*
Summer Chinook						
Jacks	581	21.7	1.3 (0.8)	127	4.7	9.1 (5.2)
Adults	416	13.5	1.5 (0.5)	48	1.6	7.6 (7.7)
Summer run total		*17.3*	*1.4 (0.7)*		*3.0*	*8.7 (4.6)*
Fall Chinook						
Jacks	235	3.0	1.4 (0.9)	52	0.7	3.1 (2.1)
Adults	87	0.4	1.6 (0.5)	1	0.004	17.0
Fall run total		*1.1*	*1.4 (0.8)*		*0.2*	*3.8 (2.2)*

For Lower Granite Dam, relatively few Chinook approached or interacted with the lamprey orifices, and only 1 jack Chinook interacted with the orifices (Table 17). For the spring run, 0.08%, or 12 fish, approached the orifices with an average time of 1.2 seconds per fish. Only 1

summer Chinook, or 0.02% of the total run, approached the orifices, while 1 jack Chinook interacted (0.02% of the summer run). No fall run Chinook were observed to approach or interact with the lamprey orifices (Table 17).

Table 17. Results of orifice monitoring at Lower Granite fish ladder for Chinook salmon

Species	No. approaches	Orifice approach (%)	Avg. approach time, in seconds (SD)	No. orifice interactions	Orifice interaction (%)	Avg. interaction time, in seconds (SD)
Spring Chinook						
Jacks	0	–	–	0	–	–
Adults	12	0.1	1.2 (0.5)	0	–	–
Spring run total		*0.08*	*1.2 (0.5)*		–	–
Summer Chinook						
Jacks	0	–	–	1	0.05	4
Adults	1	0.04	1	0	–	–
Summer run total		*0.02*	*1*		*0.02*	*4*
Fall Chinook						
Jacks	0	–	–	0	–	–
Adults	0	–	–	0	–	–
Fall run total		*0*	–		*0*	–

For the steelhead run at Little Goose, 302 steelheads approached the orifices for an approach rate of 1.6% for the run (Table 18). A smaller number of steelheads interacted with the orifices, with 31 fish interacting (0.2% of the entire run). More sockeye salmon approached the orifices than interacted, with 2.6% of the run approaching the orifices and 0.2% of the run interacting with the orifices (Table 18).

Table 18. Results of orifice monitoring at Little Goose for steelhead trout and sockeye salmon

Species	No. of approaches	Orifice approach (%)	Avg. approach time, in seconds (SD)	No. of orifice interactions	Orifice interaction (%)	Avg. interaction time, in seconds (SD)
Steelhead	302	1.6	1.4 (1.5)	31	0.2	2.5
Sockeye	23	2.6	1.1	2	0.2	3.5

At Lower Granite, no steelheads were observed to either approach or interact with the lamprey orifices. Only 4 sockeye salmon approached the orifices (0.6% of the sockeye run). No sockeye salmon were observed in video interacting with the orifices during the monitoring period.

Table 19. Results of orifice monitoring at Lower Granite for steelhead trout and sockeye salmon

Species	No. of approaches	Orifice approach (%)	Avg. approach time, in seconds (SD)	No. of orifice interactions	Orifice interaction (%)	Avg. interaction time, in seconds (SD)
Steelhead	0	–	–	0	–	–
Sockeye	4	0.6	1.8 (0.6)	0	–	–

Lamprey use of orifices at Little Goose and Lower Granite dams

At the Little Goose ladder, daily counts at the window during the monitoring period and counts of lampreys observed in orifice video were compared. A total of 66 lampreys were counted at the window (day counts USACE, night counts this study), compared to 72 lampreys observed in orifice video during the same period (Figure 17).

Counts for both increased the first week of August and were sporadic following this period. Few lampreys were observed at the orifices August 7–August 18 or from September 3 to the end of monitoring (Figure 17).

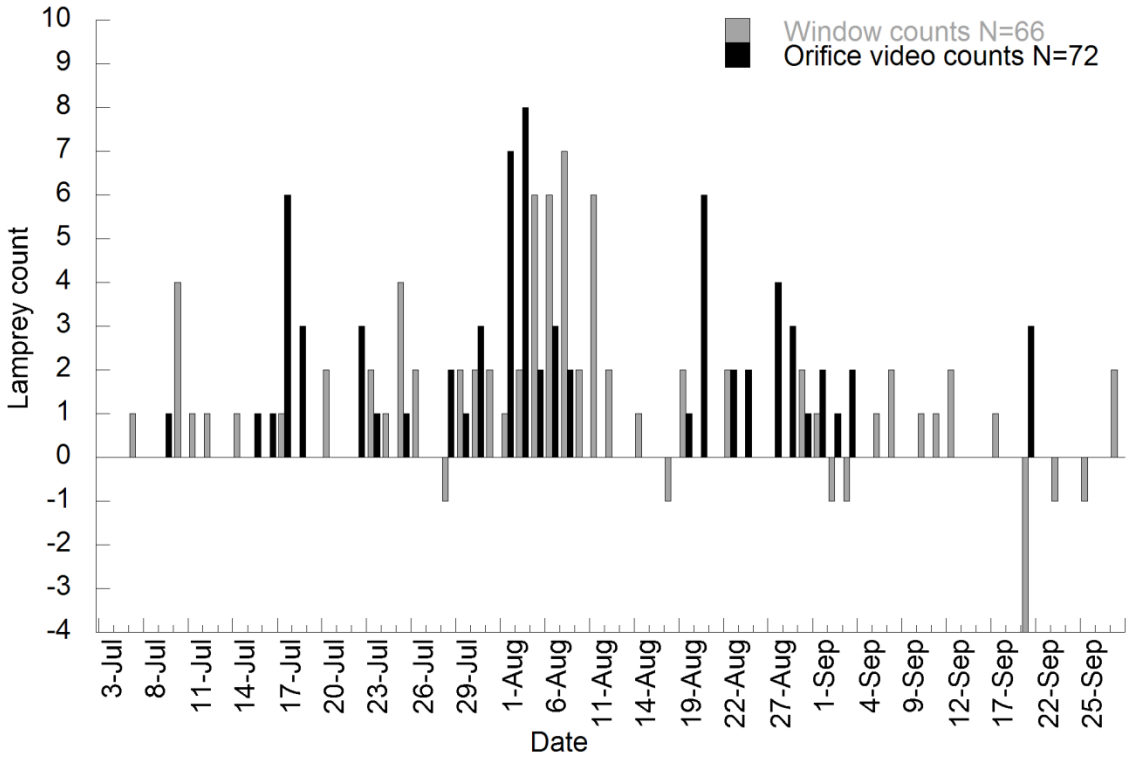

Figure 17. Daily lamprey counts at Little Goose count window during monitoring, with observed lamprey counts in orifice video. Orifice video counts are total observed at the orifice, whether passing or not passing.

At Lower Granite ladder, substantially more lampreys were counted at the window than were observed in orifice video (Figure 18). A total of 164 lampreys were counted at the window (day and night counts USACE), compared to 37 lampreys observed in orifice video during the same period (Figure 18).

Most lampreys passed the Lower Granite ladder window from July 25 to the second week in August, while lampreys observed in orifice video appeared sporadically throughout the study period, with the first two weeks in September the longest period where lampreys were not observed in orifice video at Lower Granite (Figure 18).

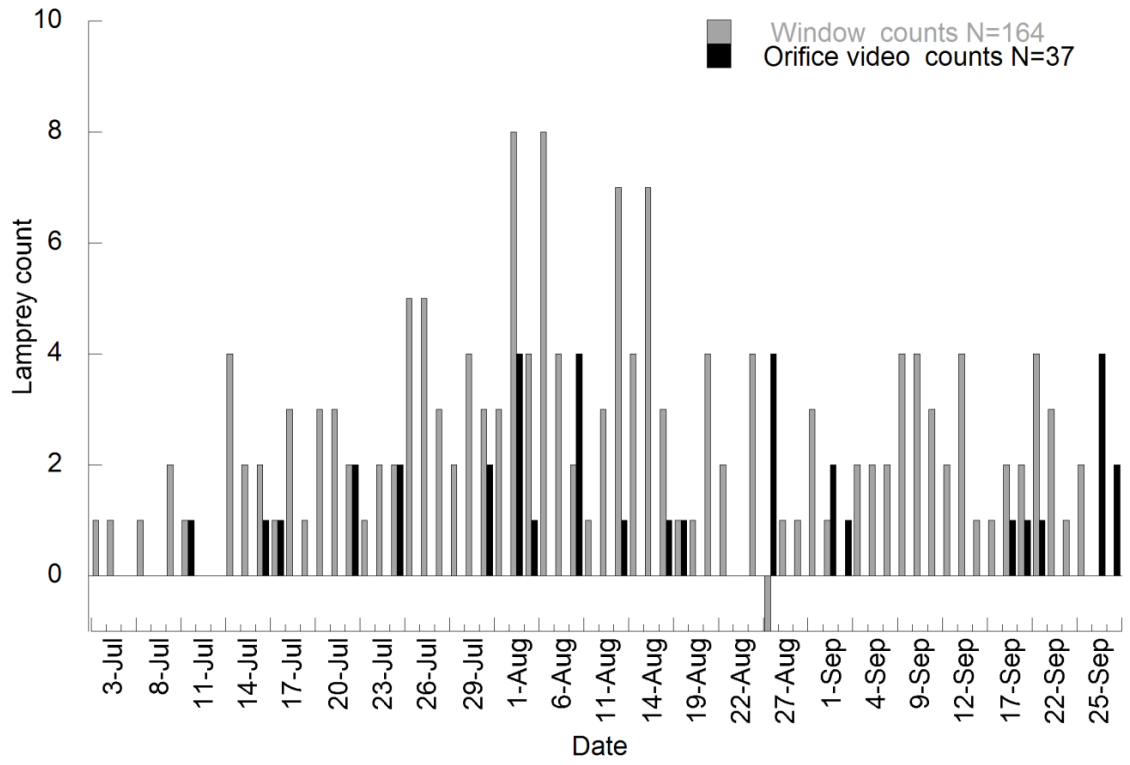

Figure 18. Daily lamprey counts at Lower Granite fish ladder during the monitoring period for the count window and observed counts in orifice video. Orifice video counts are the total observed, passing or not passing the orifice.

The proportion of lampreys counted at the orifices and lamprey use rates are presented in Table 20. At Little Goose ladder, lamprey counts were similar across the window and in orifice video, with more lampreys observed in orifice counts than in the window (a 109.1% orifice observation rate). Of the 72 lampreys observed at the orifices, 25 lampreys passed through the orifices for an orifice use rate of 34.7% (Table 20). When compared to window counts, the use rate (window) was 37.9%.

At Lower Granite, substantially more lampreys were counted in the window than observed in orifice video (orifice observation rate = 22.6%, Table 20). Only 6 lampreys passed through the orifices, for an orifice use rate of 16.2% and when compared to the count window this rate was just 3.7%.

Table 20. Lamprey orifice use details for all locations. Counts for the window are only during the period of orifice monitoring.

Location	Window count	Count at orifice	Count passing through orifice	Orifice use rate (window)	Orifice use rate (video)	Orifice observation rate
Little Goose	66	72	25	37.9%	34.7%	109.1%
Lower Granite	164	37	6	3.7%	16.2%	22.6%

Lamprey behavior at orifices

Behavior of lampreys passing through orifices was categorized as described in the Methodology section, falling into one of four categories. At Little Goose, most lampreys, 72.0% of all passing, used “position 1”, defined as attachment to the floor downstream of the orifice, followed by burst

swimming through the orifice to pass (Table 20). Lampreys took on average 27.3 seconds (SD 31.1 sec) to pass in this manner. The next most common passage behavior was position 2, with 20.0% of lampreys passing through in this manner (average 8.0 sec), followed by 8.0% directly passing through (without attachment). No lampreys combined positions 1 and 2 to pass.

Of the 6 lampreys observed passing the orifices at Lower Granite ladder, the majority (83.3%) passed directly through without attachment in an average time of 2.2 seconds (Table 20). The only other passage behavior observed at this location was 1 lamprey (16.7%) passing using position 1, taking 66 seconds to do so.

Table 21. Behavior of lampreys successfully passing through orifices at Little Goose and Lower Granite dams. SD in parentheses.

Behavior	Little Goose (%)	Avg. time to pass (s)	Lower Granite (%)	Avg. time to pass (s)
Direct passage	8.0	6.5 (4.9)	83.3	2.2 (1.3)
Position 1	72.0	27.3 (31.1)	16.7	66
Position 2	20.0	8.0 (7.3)	0	–
Positions 1 and 2	0	–	0	–

Diel orifice passage behavior. Of the 78 lampreys observed at Little Goose and Lower Granite not passing the orifices, most were observed in video from the hours of 21:00–07:00, while for those passing the orifice, most passed from 0:00 to 11:00 (Figure 19).

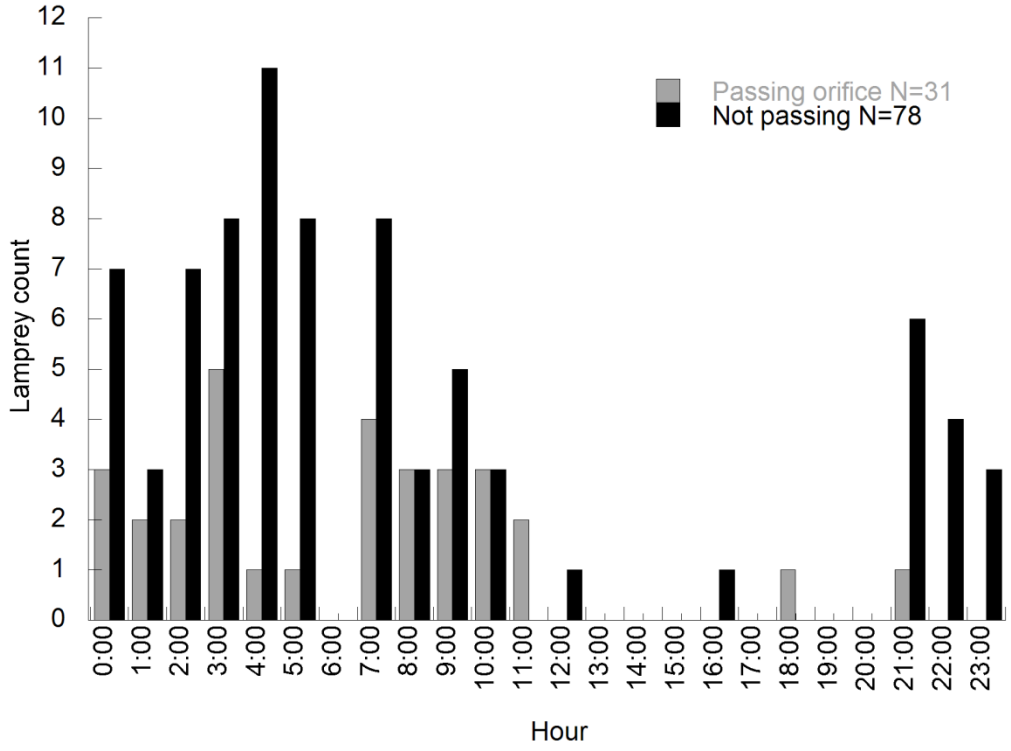

Figure 19. 24-hour passage behavior of lampreys in video at Little Goose and Lower Granite lamprey orifices

4.0 DISCUSSION

This study is an extension of research initiated in 2010 to use passive monitoring to study lamprey and salmonid behavior at various structures within fish ladders at the McNary, Ice Harbor, Little Goose and Lower Granite Dams. In 2010, modified lamprey orifices were installed at the tilting weir section of the south ladder of McNary Dam and video monitoring was successfully used to observe salmonid and lamprey behavior at these orifices. In 2011, picketed lead sections were elevated off the fishway floor at most projects on the Columbia and Snake Rivers to permit lamprey passage under the pickets, which necessitated monitoring and assessment of lamprey escapement rates at McNary and Ice Harbor Dams. Also in 2011, video monitoring in the south fishway entrance (SFE) was performed to assess the feasibility of using video cameras in a large, high-velocity environment to study lamprey behavior at the point of entry into the fish ladder—a structure past research has indicated lampreys have difficulty finding and efficiently passing. In 2012, picketed lead monitoring was continued at McNary and Ice Harbor, while the installation of new lamprey orifices at Ice Harbor and Lower Monumental Dams necessitated salmonid and lamprey monitoring. Video monitoring at the McNary Dam SFE was expanded to include sonar imaging using DIDSON cameras to study lamprey passage and behavior in response to a newly introduced 16-inch-deep slot in SFE2, and video monitoring at SFE1 was continued.

In 2013, picketed lead monitoring continued at McNary and Ice Harbor, while new lamprey orifices were installed at Little Goose and Lower Granite upper fish ladders, necessitating monitoring for salmon and lamprey behavior. Finally, from 2010 through 2013, CBVision software was developed and refined to process huge amounts of video and to classify lampreys automatically in a variety of environments. CBVision work in 2013 focused on developing a graphical user interface for this software.

Picketed leads: lamprey escapement and behavior at McNary and Ice Harbor Dams

Overall, results of picketed lead monitoring at McNary Dam in 2013 were similar to those of 2011 and 2012. Again, the south ladder had the most lampreys counted in picketed lead video, with 44.8% of all lampreys passing behind the picketed leads. Total lamprey escapement at the count window section was 4,522, and increased compared to 2011 (1,719) and 2012 (2,331) when picketed lead monitoring began. Despite the large increase in lamprey counts from year to year during this period, the proportion of lampreys counted in picketed lead video was similar across years. In 2012 and 2013, more lampreys passed the picketed leads during day hours versus 2011: in 2013 56.2% of all lampreys were counted in day hour picketed lead video as opposed to 24.9% of the total during night hours. In 2011 only 33.1% were counted during the day and 56.7% at night. Despite these differences in passage routes, comparison of the picketed lead and window counts indicates that the window counts provide a reasonable index of the passage rate. The correlation of counts by hour at the window and in picketed lead video were compared for each year (2011–2013) and for all years combined. The correlation was statistically significant ($p < 0.05$ for each year) but the degree of correlation differed from year to year, with a r^2 of 0.49 in 2011, 0.85 in 2012, and 0.37 in 2013. When all data from 2011–2013 were collapsed into a single year, the r^2 equaled 0.77, and was significant across all hours of the day, with increasing and decreasing lamprey numbers throughout the hours of the day mirrored at the count window and in picketed lead video. For the third year, similar trends in counts by hour at McNary south shore ladder indicate that lampreys counted in picketed lead video are a valid

measure of the total lampreys passing the ladder in any given hour, and that the equation $y = 0.8308x + 5.2682$ may be used *post facto* to estimate picketed lead counts (y) when only counts from the window (x) are available.

Lamprey behavior was similar from 2011 to 2013; in all years at the south ladder, most lampreys appeared under the picketed lead lead gap and swam quite quickly past the cameras (66.2%, 78.6%, and 73.7% for 2011–2013). A relatively small number of lampreys, 1.1%, swam through the vertical bars of the picketed leads in both 2013 and 2012, and in 2011, 1.3% did so. Again, as in past years lampreys classified as "across" (16.2%) were more difficult to enumerate. The assumption was made that these were unique lampreys that had not been previously counted, highlighting one of the challenges of using video to enumerate lampreys at the picketed leads. Because it would be practically infeasible to video-image the entire sample volume of the picketed lead section (i.e., the space "beyond" the count window in the channel), the fate of lampreys once they pass the camera is unknown. Some possible scenarios for lamprey behavior include:

- Continuing to swim upstream without delay.
- Attaching briefly; then continuing upstream.
- Circulating within the channel flow, moving from side to side or up and down in the water column.

Evidence supporting the first two scenarios came from analysis of lamprey behavior in adjacent cameras. When lampreys were observed coming under the picketed leads (the vast majority), few were observed in adjacent cameras within minutes to hours of this event. Typically, lampreys moved rapidly under the picketed leads with no other movement events observed for hours afterward. Any lampreys observed in adjacent cameras within 10 minutes of the first sighting were not counted, to minimize potential double-counting. Very few lampreys attached to a surface (e.g. the channel floor) or stayed in one place for more than a few seconds, an observation in agreement with previous lamprey video observations in this ladder (Eder et al. 2011; Thompson et al. 2011). Those few lampreys stayed in this attached position for minutes to several hours. Overall, the behavioral observations in 2011–2013 revealed that the raised picket slot provided an important passage route for adults and that very few passed directly through the picket screen.

For the McNary north ladder, escapement at the count window section of the ladder was higher in 2013 than in 2011–2012, with a total of 899 counted, compared to 407 lampreys in 2011 and 513 in 2012. As in 2011–2012, very few lampreys used the picketed lead section to pass, with only 15 (1.7% of total) lampreys observed in picketed lead video. More lampreys (11) were counted in picketed lead video during day hours, as compared to just 4 during the night hours. Counts at the window were higher than day window counts, in keeping with 2011–2012 trends.

At Ice Harbor, lamprey escapement for both ladders was lower in 2013 than in 2012, but much higher than in 2011, while picketed lead use remained quite low for each ladder. At the south ladder, 627 lampreys were counted in 2013, well above the 10-year average of 396 and also above 2011 (345 lampreys), but just shy of the 644 lampreys counted in 2012. Sixteen lampreys were counted in picketed lead video, compared to 1 in 2012. Examination of counts from 2011–2013 reveals the large increase in these years was due to more lampreys passing the count window at night (484, 470, and 148 from 2013, 2012, and 2011, respectively). Night counts began again in 2011, following a period of no night counting from 2003 to 2010. Despite higher

escapement, picketed lead use by lampreys remained a small fraction of lampreys counted, comprising just 2.6% of the total. At the North ladder, total lamprey escapement was 295 lampreys, lower than in 2012 (567) but significantly more than in 2011 and in the 10-year average. Again, as in 2012, most passage occurred during the day, but counts at the window for both day and night were lower than in 2012. Picketed lead use by lampreys remained relatively low, with 19 lampreys counted (6.4% of total), which was lower than 2012, when 26 lampreys passed the picketed leads.

For the third year, the relatively high proportion of adults passing under the picketed lead at McNary South compared to other sites indicates that structural differences may account for these patterns, as the McNary south fishway is wider and its picketed lead section longer than those at other sites and thus higher use may be related primarily to a higher lamprey encounter rate at the pickets. As in 2011–2012, most lampreys were observed at the camera nearest the count window and near the south channel wall. These findings support the hypothesis that lampreys prefer the edges of the channel for movement, as these areas offer surfaces for them to attach for burst swimming. Structural differences in the count slot entrances described in Thompson et al. (2012) again appear to be the main factor for lower lamprey passage past elevated picketed leads at McNary North and Ice Harbor ladders.

A review of the escapement data from 2011 to 2013 at McNary Dam indicate that picketed lead passage and lamprey behavior at this site are quite similar over the 3 years since picketed lead monitoring began. The high use of this passage route supports continued use of raised pickets. At Ice Harbor Dam, passage at both ladders approached the numbers observed in 2012, but was still much lower in picketed lead passage than McNary. 2013 was the third year of night window counts at Ice Harbor, and the high use of this route supports continued use of window counts. As more data are gathered, it becomes increasingly apparent that lamprey escapement (from day counts) at this location has been underestimated in prior years (2003–2010), perhaps by significant numbers.

Lamprey orifice monitoring for salmonids: Little Goose and Lower Granite Dams

Lamprey orifice monitoring involves two main objectives: assessing whether salmonids are delayed or injured by the presence of the orifices, and determining orifice use and related behaviors by lampreys. To address the first objective, the early and peak portions of the spring, summer, and fall Chinook, steelhead, and the majority of the sockeye runs were monitored at newly installed lamprey orifices at Little Goose and Lower Granite: for spring Chinook, 20.3 to 27.4% of the entire run was monitored at each location, for summer Chinook, the range was 28.8 to 32.4%, for fall Chinook, 39.9 to 40.0%, for steelhead, 19.6 to 21.8%, and for sockeye, 80 to 87.7%. Most monitoring occurred during peak diel activity, which occurs in the early morning hours. As such, monitoring periods for most runs was from 07:00 to 13:00, 5 days per week (except for sockeye, discussed later). Observations for salmonids were focused on two important metrics, delay and interaction. To assess delay, behavior was categorized into “approach,” which was defined as the fish turning headfirst into the flow of the orifice without touching the orifice. A fish attempting to nose into or pass the orifice was categorized as an “interaction.”

At Little Goose, jack Chinook were far more likely to approach and interact with the orifices than adults. For the spring run, 2.7% of the jack run and 2.1% of the adult run approached the two orifices, while 0.6% of the jacks and 0.2% of the adults interacted with the orifice openings. The summer Chinook run was most likely to approach and interact, with 21.7% of jacks

approaching versus 13.5% of adults, and 4.7% of jacks interacting along with 1.6% of adult Chinook. Compared to other runs, fall Chinook were least likely of the salmonids to display either behavior. It is unclear as to why the Chinook runs, in particular jacks, approached and interacted with the orifices in such relatively high numbers, but several mitigating factors are worth noting. One is that the 2013 run of jack salmon in the Snake River was far above the 10-year average; this, coupled with the smaller body size of jacks, may put them at increased risk for considering the small orifice opening as a possible means of egress through the ladder. Another observation for increased orifice investigation by salmonids at Little Goose is subtle differences between the two uppermost monitored weirs. Substantially more Chinook (jacks and adults) were observed approaching and interacting with the uppermost weir than at the next weir downstream. Slight differences in flow in these areas may play a role, as well as lighting conditions, as the uppermost weir is the first downstream of the powerhouse deck/roadway, which passes directly over the water surface. The main fish passage orifice may be shaded a greater part of each day, rendering it more difficult for fish to find or the flow at the depth of the lamprey orifice in this location may act as an attractant. Indeed, visible jets of stronger current were occasionally seen in the camera pulsing through only this orifice. No diel behavioral differences were noted for any species, but local conditions at the orifices may play an important role in determining the ideal location of lamprey orifices. Relatively few sockeye salmon or steelheads interacted with the orifices, with 0.2% of each run interacting with the openings. For sockeye salmon, this low value is noteworthy, as over 87% of the run was monitored at Little Goose.

Compared to Little Goose, few approaches and interactions by Chinook were observed at Lower Granite ladder, and 1 jack (a summer Chinook) interacted with the lamprey orifice during the monitoring period. No steelheads were observed displaying either behavior during the entire run, and for the sockeye run, 4 fish, or 0.6%, approached the orifices. No sockeye interactions were recorded. Again, the latter finding for sockeye salmon is noteworthy as 80% of the run was monitored, and previous monitoring of lamprey orifices at McNary, Ice Harbor, and Lower Monumental dams indicated that sockeye salmon were most likely to interact with orifices in these locations.

Orifice monitoring for lampreys: Little Goose and Lower Granite Dams

To address lamprey use of and behavior at the orifices, lampreys were monitored during hours for salmonid monitoring (07:00–13:00) and from 21:00 to 05:00, 5 days a week during the lamprey migration season. Compared to salmonid runs, a substantially greater proportion of the total lamprey run was monitored at each location, with 77.0% monitored at Lower Granite and 100% of the total run monitored at Little Goose. At Little Goose, night counts at the window ceased August 7, so the actual total lamprey run may have been higher, resulting in a lower proportion of the run monitored.

As in 2012, three key metrics were calculated for lampreys observed in orifice video. The purpose of each was to provide an indication of lamprey use of the orifice, and to express this fraction in terms of the total observed passing the window (the orifice use rate [window]) and the total observed in orifice video (the orifice use rate [video]). The orifice use rate (video) was higher at Little Goose, with 34.7% passing the orifices, compared to the Lower Granite ladder, with 16.2%. At the Lower Granite ladder, only 6 lampreys were observed passing through the orifices all season. These ranges are in accord with proportions reported at Lower Monumental

and Ice Harbor dams in 2012 (Thompson et al. 2012). Additionally, low lamprey use at the Lower Granite ladder lamprey orifices is in keeping with few or no observed Chinook, steelheads, or sockeye salmon, but the extent these observations are linked to structural or flow characteristics or some other feature of the weir is unknown. The orifice observation rate (percentage of lampreys observed in video compared to the total counted in the window) was 109.1% and 22.6% for Little Goose and Lower Granite, respectively. The higher percentage at Little Goose indicates that lampreys are passing the window during night hours but are not counted, which likely occurred after August 7, when night counts ceased. The orifice use rate (window), or the percent of lampreys passing the orifices in relation to the window count, was very low at Lower Granite, with only 3.7% of lampreys passing through the orifice.

Behavior of lampreys at the orifices was characterized by various modes of orifice passage. At Little Goose, 72% of all lampreys passing the orifice did so by attaching to the substrate downstream of the orifice for a period before swimming through (position 1), and 8% swam directly though the orifices. Conversely, at Lower Granite more than 16% passed in this manner, yet over 83% swam directly through the orifices without attachment. Differences in lamprey behavior passing through orifices may be due to hydraulic characteristics as lamprey orifices were not installed in the intervening weirs between the monitored orifices. The time to pass depended on the mode: position 1 took on average roughly 30 seconds to one minute across sites, while swimming through took at most 10 seconds. Across both locations, most lampreys passed orifices during the hours of midnight to 05:00, and again from 07:00 to 11:00.

Progress in CBVision

The usability of CBVision was advanced in 2013. To 2012, CBVision's core algorithms were developed to the point that the software could be used to process tremendous volumes of video, eliminating frames with no activity. While effective, the software was not user-friendly. This year's development efforts remedied these shortfalls as a graphical user interface (GUI) was developed to enable use on the Windows OS platform, using C# and other native Microsoft software tools.

The Administrator interface now offers a five-tab visual interface that enables a user to change all parameters previously invoked by command-line interface commands and flags. From this interface, the operator can choose video files from local or networked servers, create jobs to process video files, review the progress of ongoing processing operations, and prioritize and interrupt jobs as required. These settings can be retained in "job templates" for ease of repetition when multiple videos are processed from identical cameras under similar lighting conditions.

5.0 CONCLUSIONS AND RECOMMENDATIONS

- Combining net upstream counts from video cameras situated behind picketed leads with upstream window counts is a viable method to enumerate lamprey ladder escapement at McNary and Ice Harbor Dams. Lamprey counts and behavior at the picketed leads were consistent across 2011–2013, and ladder escapement at McNary Dam has increased annually since picketed lead monitoring began.
- Lamprey passage under the picketed lead gap is highly variable between locations and frequent at the McNary south ladder. Variation in lamprey passage behind picketed leads among locations suggests that variation among ladders' structural features, water velocities, and count slot configurations affect adult lampreys' choice of whether to pass via the count window or picketed leads.
- Lamprey counts in the window and in picketed lead video are significantly correlated each year from 2011–2013, and a linear regression may be used to estimate picketed lead video counts.
- Passage under the picketed section accounted for a considerable portion of the total lamprey count at McNary Dam (37.7%), with most passage occurring at the south ladder.
- Passage under the raised picketed lead section at Ice Harbor Dam accounted for a small portion (3.8%) of the total count, suggesting enumeration at the count station alone does not provide a gross underestimate of escapement past Ice Harbor Dam.
- Passage of lampreys at the count station during night hours at Ice Harbor Dam continues to contribute significantly to annual escapement estimates.
- Migrating stocks of adult Chinook and sockeye salmon and steelhead trout were not remarkably delayed by the presence of lamprey orifices.
- Of all monitored species, jack Chinook were most likely to approach and interact with orifice passages at Little Goose Dam. Few monitored species were observed approaching or interacting with lamprey orifices at Lower Granite Dam.
- Differences in salmonid approaches and interactions at Little Goose lamprey orifices suggest local weir structure, water flow, or visual cues could influence salmonids to investigate one lamprey orifice over another.
- Lamprey passage through orifices was variable across sites: 34.7% passed through at Little Goose and 16.2% at Lower Granite. Lower Granite lamprey orifices were characterized by little activity from monitored species as well.
- The majority of successful lamprey orifice passages involved substrate attachment, followed by burst swimming through the orifice or direct passage by swimming through without attachment. Lampreys using attachment moved relatively quickly through the orifices (a matter of a few minutes) and did not spend appreciable time in the vicinity of the orifices.

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8.0 APPENDICES

Appendix A Hourly counts of lampreys at McNary and Ice Harbor Dam picketed leads

Table 22. Hourly count of adult lampreys in picketed lead video at the south shore ladder of McNary Dam during the 2013 season. Hour 1 starts at 05:00 PDT and hour 16 ends at 21:00 PDT. The values reflect net upstream counts.

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
10 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Jun.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
12 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jun.	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jun.	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jun.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Jun.	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jun.	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
28 Jun.	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0
29 Jun.	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
30 Jun.	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0
01 Jul.	2	1	1	2	0	1	0	0	0	0	0	0	0	0	0	0
02 Jul.	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
03 Jul.	1	0	2	2	1	0	0	0	0	0	1	0	0	0	0	0
04 Jul.	0	3	4	1	2	1	0	0	0	0	0	0	0	0	0	0
05 Jul.	3	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Jul.	2	1	2	0	0	0	0	0	0	0	1	0	0	0	0	0
07 Jul.	3	4	0	2	6	1	0	0	1	0	0	0	0	1	0	0
08 Jul.	0	3	3	3	1	2	0	0	0	0	0	0	0	0	0	0
09 Jul.	8	3	3	4	0	1	0	0	0	0	0	0	1	0	0	0
10 Jul.	3	7	6	4	3	3	0	0	0	0	3	0	0	1	1	0
11 Jul.	11	13	1	5	3	1	1	0	0	0	0	0	0	0	0	0
12 Jul.	12	8	14	4	1	1	0	0	2	0	1	0	0	0	0	0
13 Jul.	12	6	4	4	2	2	1	0	0	0	0	0	0	0	0	0
14 Jul.	3	4	4	2	2	1	1	0	0	1	0	0	0	1	0	0
15 Jul.	4	1	3	3	1	0	1	0	0	0	0	2	0	1	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
16 Jul.	6	11	7	7	5	0	3	1	1	0	0	0	0	0	0	0
17 Jul.	11	15	9	12	3	6	0	0	0	0	0	0	0	1	1	0
18 Jul.	6	10	6	10	4	1	0	0	1	0	0	2	0	0	0	0
19 Jul.	2	5	5	4	0	2	0	0	0	0	0	0	0	0	0	0
20 Jul.	4	13	5	17	3	0	1	0	0	0	0	0	0	0	1	0
21 Jul.	7	7	12	1	2	1	1	0	0	0	0	0	0	1	2	0
22 Jul.	5	5	4	4	1	2	0	0	1	1	0	0	1	0	0	0
23 Jul.	5	12	5	6	4	1	1	0	0	0	2	0	0	0	0	0
24 Jul.	4	12	4	7	3	1	1	1	3	0	0	1	1	0	0	0
25 Jul.	2	8	9	7	1	2	0	0	0	0	0	3	1	0	0	0
26 Jul.	3	16	7	2	4	1	0	0	2	0	0	0	0	0	0	0
27 Jul.	2	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0
28 Jul.	3	4	6	3	4	0	0	1	0	1	1	0	0	0	0	1
29 Jul.	5	16	9	3	1	0	0	0	0	0	2	0	0	0	0	0
30 Jul.	2	4	7	2	0	1	0	0	1	0	0	0	0	0	0	0
31 Jul.	7	14	10	7	1	2	2	0	0	0	0	0	0	1	0	2
01 Aug.	5	12	11	8	1	0	0	0	0	0	0	2	1	1	0	1
02 Aug.	4	11	4	4	0	2	0	0	1	0	0	0	0	1	0	0
03 Aug.	1	11	9	8	3	1	0	1	0	0	1	0	0	0	1	1
04 Aug.	7	8	9	2	3	2	1	0	0	0	0	1	1	0	0	0
05 Aug.	5	6	7	2	1	0	0	1	0	0	1	1	2	2	1	2
06 Aug.	2	8	7	6	3	0	2	2	1	0	0	0	0	0	0	0
07 Aug.	5	2	1	4	4	0	0	0	1	0	1	0	0	1	2	0
08 Aug.	5	7	11	7	4	2	0	0	1	0	0	0	0	0	0	0
09 Aug.	6	5	7	7	2	1	1	2	0	1	1	0	0	0	0	0
10 Aug.	6	5	7	6	1	2	0	0	0	0	1	1	1	0	1	0
11 Aug.	3	11	18	3	3	3	1	0	1	1	0	0	2	0	0	1
12 Aug.	1	6	6	5	5	3	0	3	1	0	0	0	0	0	0	0
13 Aug.	1	0	3	4	2	1	0	1	0	0	1	0	0	1	0	0
14 Aug.	1	8	5	0	2	2	0	0	0	0	1	1	0	0	0	1
15 Aug.	1	4	3	6	2	2	0	0	1	0	1	0	0	0	1	0
16 Aug.	2	5	5	3	0	1	0	0	0	0	0	0	0	0	0	0
17 Aug.	0	11	6	5	6	0	0	1	1	1	0	1	0	0	0	0
18 Aug.	3	7	7	3	1	3	0	0	1	0	0	0	1	0	0	1
19 Aug.	2	5	4	5	6	0	0	0	3	0	2	0	1	0	1	0
20 Aug.	2	0	4	3	–1	2	0	1	0	3	2	4	0	0	0	0
21 Aug.	1	3	5	2	2	0	0	0	0	0	0	0	0	0	0	2
22 Aug.	1	4	1	2	0	2	0	0	0	0	2	0	0	0	0	1
23 Aug.	2	5	3	3	0	2	0	0	0	0	0	0	0	0	0	1
24 Aug.	0	1	2	0	3	1	0	0	1	0	0	0	0	0	0	0
25 Aug.	2	1	1	2	0	1	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
26 Aug.	0	4	2	1	0	1	0	2	0	0	0	0	0	0	0	0
27 Aug.								Power failure								
28 Aug.								Power failure								
29 Aug.								Power failure								
30 Aug.								Power failure								
31 Aug.								Power failure								
1 Sept.								Power failure								
2 Sept.								Power failure								
3 Sept.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
4 Sept.	1	1	1	2	2	0	2	0	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
6 Sept.	1	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0
7 Sept.	1	1	1	1	0	1	0	0	1	0	0	0	0	1	0	0
8 Sept.	0	3	2	0	3	0	0	0	0	0	0	0	0	0	0	0
9 Sept.	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
10 Sept.	1	1	1	1	4	2	1	1	1	0	0	0	0	0	1	2
11 Sept.	0	2	1	3	2	1	0	0	0	0	0	0	0	0	0	0
12 Sept.	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
14 Sept.	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0
15 Sept.	2	0	0	1	2	0	2	0	0	0	0	1	0	0	0	0
16 Sept.	2	4	4	3	5	3	–1	1	0	1	0	1	1	0	0	0
17 Sept.	0	1	3	3	2	1	0	0	0	0	0	0	0	0	1	2
18 Sept.	0	3	1	0	1	0	1	0	0	0	0	0	0	0	1	1
19 Sept.	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1
20 Sept.	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0
21 Sept.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Sept.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Sept.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	1
26 Sept.	0	0	–1	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Sept.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
6 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 23. Hourly count of adult lampreys in picketed lead video at the south shore ladder of McNary Dam during the 2013 season. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT. The values reflect net upstream counts.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
10 Jun.	0	0	0	0	0	0	0	0
11 Jun.	0	0	0	0	0	0	0	0
12 Jun.	0	0	0	0	0	0	0	0
13 Jun.	0	0	0	0	0	0	0	0
14 Jun.	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	1	0	0	0	0	1	0
01 Jul.	0	0	0	0	0	0	0	1
02 Jul.	0	0	0	0	0	1	0	0
03 Jul.	1	0	0	0	0	0	1	2
04 Jul.	0	0	0	0	0	0	1	0
05 Jul.	0	0	0	0	0	1	0	2
06 Jul.	0	1	0	0	0	0	1	0
07 Jul.	0	0	1	1	0	0	1	1
08 Jul.	2	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	2
10 Jul.	0	0	1	1	0	0	1	0
11 Jul.	0	0	0	0	0	1	5	4
12 Jul.	0	0	0	0	0	1	3	8
13 Jul.	0	0	0	0	1	4	4	3
14 Jul.	0	1	1	0	0	0	1	4
15 Jul.	0	1	0	0	0	0	1	1
16 Jul.	0	0	0	0	0	2	1	5
17 Jul.	0	1	0	0	2	1	1	7

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
18 Jul.	0	–1	0	0	1	1	1	4
19 Jul.	0	0	0	0	0	0	2	2
20 Jul.	0	0	0	0	0	1	4	2
21 Jul.	1	0	0	0	0	2	4	1
22 Jul.	1	0	0	0	1	3	2	3
23 Jul.	0	0	0	0	0	0	0	3
24 Jul.	0	0	0	0	1	0	0	1
25 Jul.	0	0	0	0	1	1	3	0
26 Jul.	1	1	0	0	0	0	1	1
27 Jul.	0	0	0	0	1	0	1	0
28 Jul.	1	1	0	1	0	1	1	1
29 Jul.	0	0	0	0	1	1	4	2
30 Jul.	0	0	0	0	0	1	1	0
31 Jul.	0	0	0	0	1	1	5	4
01 Aug.	0	0	0	1	0	4	4	3
02 Aug.	3	1	0	0	0	0	2	0
03 Aug.	1	0	0	0	4	1	1	5
04 Aug.	1	1	0	1	1	1	3	2
05 Aug.	0	1	1	0	1	1	3	1
06 Aug.	2	0	1	0	0	3	2	3
07 Aug.	2	0	0	1	3	1	0	4
08 Aug.	0	0	0	0	1	4	6	4
09 Aug.	0	0	1	2	1	4	6	5
10 Aug.	0	0	0	0	1	1	1	1
11 Aug.	0	0	1	0	0	1	2	8
12 Aug.	1	1	0	1	1	1	0	8
13 Aug.	1	0	1	0	2	2	1	0
14 Aug.	0	0	0	0	1	3	–3	2
15 Aug.	0	0	0	0	0	1	1	4
16 Aug.	0	0	0	0	0	2	2	0
17 Aug.	0	0	1	0	1	2	2	1
18 Aug.	1	0	0	0	0	0	–1	2
19 Aug.	1	1	2	1	1	0	1	2
20 Aug.	1	1	0	0	3	0	2	2
21 Aug.	0	0	0	0	1	1	0	1
22 Aug.	0	0	0	2	1	0	1	4
23 Aug.	0	0	0	0	0	2	1	0
24 Aug.	0	0	0	0	0	2	0	2
25 Aug.	0	0	0	0	0	0	0	5
26 Aug.	1	0	0	0	1	1	1	0
27 Aug.	Power failure							

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
28 Aug.								
29 Aug.								
30 Aug.				Power failure				
31 Aug.								
1 Sept.								
2 Sept.								
3 Sept.	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	3	1
5 Sept.	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	0	0	0	1	0
7 Sept.	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	0	0	0	0	0
9 Sept.	0	0	0	0	0	0	1	0
10 Sept.	0	–1	0	0	0	0	0	0
11 Sept.	0	0	0	0	1	0	0	1
12 Sept.	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	1	0	0	0	0
16 Sept.	0	0	0	1	0	1	3	2
17 Sept.	0	1	1	0	2	0	0	2
18 Sept.	0	1	0	0	0	0	1	0
19 Sept.	1	0	1	0	0	0	1	0
20 Sept.	0	0	0	0	1	3	0	1
21 Sept.	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	2	0	1	0
23 Sept.	0	0	0	0	0	0	0	0
24 Sept.	1	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0
26 Sept.	1	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	1
28 Sept.	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
7 Oct.	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0

Table 24. Hourly count of adult lampreys in picketed lead video at the north shore ladder of McNary Dam during the 2013 season. Hour 1 starts at 05:00 PDT and hour 16 ends at 21:00 PDT. The values reflect net upstream counts.

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
14 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jul.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
23 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jul.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Aug.	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
25 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Sept.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
2 Sept.	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Sept.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Sept.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	–1	0	0	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
13 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 25. Hourly count of adult lampreys in picketed lead video at the north shore ladder of McNary Dam during the 2013 season. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT. The values reflect net upstream counts.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
14 Jun.	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	0	0
14 Jul.	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0
17 Jul.	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0
20 Jul.	0	0	0	0	0	0	0	0
21 Jul.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
22 Jul.	0	0	0	0	0	0	0	0
23 Jul.	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0
28 Jul.	0	0	0	0	0	0	0	0
29 Jul.	0	0	0	0	0	0	0	0
30 Jul.	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0
03 Aug.	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	0	0	0
10 Aug.	0	0	0	0	0	0	0	0
11 Aug.	0	0	0	0	0	0	0	0
12 Aug.	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	0	0	0
15 Aug.	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0
18 Aug.	0	0	0	0	0	0	0	0
19 Aug.	0	0	0	0	0	0	0	0
20 Aug.	0	0	0	0	0	0	0	0
21 Aug.	0	0	0	0	0	0	0	0
22 Aug.	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	0	0	0
24 Aug.	0	0	0	0	0	0	0	0
25 Aug.	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	0	0
27 Aug.	0	0	0	0	0	0	0	1
28 Aug.	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	0	0	0	0
30 Aug.	0	0	0	0	0	0	0	0
31 Aug.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1 Sept.	0	0	0	0	0	0	0	0
2 Sept.	0	0	0	0	0	0	0	0
3 Sept.	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	0	0	0	0	0
7 Sept.	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	1	0	0	0	0
9 Sept.	0	0	0	0	0	0	0	0
10 Sept.	0	0	0	0	0	0	0	0
11 Sept.	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	1
13 Sept.	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	1	0	0
15 Sept.	0	0	0	0	0	0	0	0
16 Sept.	0	0	0	0	0	0	0	0
17 Sept.	0	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0
21 Sept.	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	0
23 Sept.	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
12 Oct.	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0

Table 26. Hourly count of adult lampreys in picketed lead video at the south shore ladder of Ice Harbor Dam during the 2013 season. Hour 1 starts at 05:00 PDT and hour 16 ends at 21:00 PDT. The values reflect net upstream counts.

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
12 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
21 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 Aug.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
31 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Sept.	0	0	3	1	0	1	0	0	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Sept.	–1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Sept.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
10 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 27. Hourly count of adult lampreys in picketed lead video at the south shore ladder of Ice Harbor Dam during the 2013 season. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT. The values reflect net upstream counts.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
12 Jun.	0	0	0	0	0	0	0	0
13 Jun.	0	0	0	0	0	0	0	0
14 Jun.	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0
22 Jun.	0	0	1	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	1	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	1	0
14 Jul.	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0
17 Jul.	0	0	1	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
20 Jul.	0	0	0	0	0	0	0	0
21 Jul.	0	0	1	0	0	0	0	0
22 Jul.	0	0	0	0	0	0	0	0
23 Jul.	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	1	0
28 Jul.	0	0	0	0	0	0	0	0
29 Jul.	0	0	0	0	0	0	0	0
30 Jul.	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0
03 Aug.	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	0	0	0
10 Aug.	0	0	0	0	0	0	0	0
11 Aug.	0	0	0	0	0	0	0	0
12 Aug.	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	0	0	0
15 Aug.	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0
18 Aug.	0	0	0	0	0	0	0	0
19 Aug.	0	0	0	0	0	0	0	0
20 Aug.	0	0	0	0	0	0	0	0
21 Aug.	0	0	0	0	0	0	0	0
22 Aug.	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	0	0	0
24 Aug.	0	0	0	0	0	0	0	0
25 Aug.	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	1	0
27 Aug.	0	0	0	1	0	0	0	0
28 Aug.	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
30 Aug.	0	0	0	0	0	0	0	0
31 Aug.	0	0	0	0	0	0	0	0
1 Sept.	0	0	0	0	0	0	0	0
2 Sept.	0	0	0	0	0	0	0	0
3 Sept.	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	0	0	0	0	0
7 Sept.	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	0	0	0	0	0
9 Sept.	0	0	0	0	0	0	0	0
10 Sept.	0	0	0	0	0	0	0	0
11 Sept.	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	0	0	0	0
16 Sept.	0	0	0	0	0	0	0	0
17 Sept.	0	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0
21 Sept.	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	1
23 Sept.	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	1	0	0
8 Oct.	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
10 Oct.	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0

Table 28. Hourly count of adult lampreys in picketed lead video at the north shore ladder of Ice Harbor Dam during the 2013 season. Hour 1 starts at 05:00 PDT and hour 16 ends at 21:00 PDT. The values reflect net upstream counts.

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
14 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
23 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Jul.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Jul.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
03 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Aug.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Aug.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
20 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
24 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Aug.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
2 Sept.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
7 Sept.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
9 Sept.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
10 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Sept.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Sept.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Hour															
Date	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
13 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 29. Hourly count of adult lampreys in picketed lead video at the north shore ladder of Ice Harbor Dam during the 2013 season. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT. The values reflect net upstream counts.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
14 Jun.	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	1	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	0	0
14 Jul.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
15 Jul.	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0
17 Jul.	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0
20 Jul.	0	0	0	0	0	0	0	0
21 Jul.	0	0	0	0	0	0	0	0
22 Jul.	0	0	0	0	0	0	0	0
23 Jul.	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	1
26 Jul.	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0
28 Jul.	0	0	0	0	0	0	0	0
29 Jul.	0	0	0	0	0	0	0	0
30 Jul.	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0
03 Aug.	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	0	0	0
10 Aug.	0	0	0	0	0	0	0	0
11 Aug.	0	0	0	0	1	0	0	0
12 Aug.	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	0	0	0
15 Aug.	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
18 Aug.	0	0	0	0	0	0	0	0
19 Aug.	0	0	0	0	0	0	0	0
20 Aug.	0	0	0	0	0	0	0	0
21 Aug.	0	0	0	0	0	0	0	0
22 Aug.	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	0	0	0
24 Aug.	0	0	0	0	0	0	0	0
25 Aug.	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	0	0
27 Aug.	0	0	0	0	0	0	0	0
28 Aug.	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	0	0	0	0
30 Aug.	0	0	0	0	0	0	0	0
31 Aug.	0	0	0	0	0	0	0	0
1 Sept.	0	0	0	0	0	0	0	0
2 Sept.	0	0	0	0	0	0	0	0
3 Sept.	0	0	0	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	0
6 Sept.	0	0	0	0	0	0	0	0
7 Sept.	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	0	0	0	0	0
9 Sept.	0	0	0	0	0	0	0	0
10 Sept.	0	0	0	0	0	0	0	0
11 Sept.	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	0	0	0	0
16 Sept.	0	0	0	0	1	0	0	0
17 Sept.	0	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
21 Sept.	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	0
23 Sept.	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0

Table 30. Hourly count of adult lampreys in count window video at the south shore ladder of Ice Harbor Dam during the 2013 season. Net upstream counts only. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
13 Jun.	0	0	0	0	0	0	0	0
14 Jun.	0	0	0	0	0	0	0	0
15 Jun.	0	0	0	0	0	0	0	0
16 Jun.	0	0	0	1	0	0	0	0
17 Jun.	0	0	0	0	0	0	0	0
18 Jun.	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0
20 Jun.	0	0	0	0	0	0	0	0
21 Jun.	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	–1	0	0
23 Jun.	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	1	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	–1	0	0	1	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	1	1	0	1
01 Jul.	0	0	0	1	1	1	–1	0
02 Jul.	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	1
05 Jul.	0	0	0	1	2	1	1	0
06 Jul.	0	0	0	0	0	0	0	1
07 Jul.	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	3	0	1	1
09 Jul.	0	0	0	2	2	1	1	0
10 Jul.	0	0	0	1	0	0	1	0
11 Jul.	0	0	0	0	1	2	2	1
12 Jul.	0	0	2	2	3	1	0	0
13 Jul.	0	0	0	6	6	2	4	2
14 Jul.	0	1	0	0	1	1	4	0
15 Jul.	0	0	0	2	0	0	1	0
16 Jul.	0	0	3	0	1	1	1	3
17 Jul.	0	1	–1	2	1	1	6	0
18 Jul.	0	1	2	2	0	1	1	1
19 Jul.	0	0	0	2	2	0	0	1
20 Jul.	0	0	2	0	3	4	1	2
21 Jul.	0	0	2	2	0	4	0	1

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
22 Jul.	0	0	3	0	2	3	1	0
23 Jul.	0	0	0	3	2	0	2	2
24 Jul.	0	1	0	1	2	0	0	0
25 Jul.	0	0	0	1	0	0	1	0
26 Jul.	0	0	0	2	2	3	0	1
27 Jul.	0	0	0	1	1	1	2	1
28 Jul.	0	0	0	2	1	1	1	1
29 Jul.	0	0	0	1	1	2	0	0
30 Jul.	0	0	1	0	1	1	4	2
31 Jul.	0	0	0	0	0	2	0	0
01 Aug.	0	1	0	3	–1	0	0	0
02 Aug.	0	0	1	2	3	2	1	2
03 Aug.	0	0	1	0	1	2	1	0
04 Aug.	0	0	1	0	1	2	1	0
05 Aug.	0	0	0	2	1	0	0	2
06 Aug.	0	0	0	0	3	1	1	1
07 Aug.	0	0	0	1	0	–2	1	1
08 Aug.	0	0	2	0	0	0	0	1
09 Aug.	0	0	0	6	1	2	3	2
10 Aug.	0	0	0	0	0	0	0	0
11 Aug.	0	0	1	1	1	3	0	0
12 Aug.	0	1	0	0	3	2	–1	1
13 Aug.	0	0	2	0	0	0	3	5
14 Aug.	0	0	0	0	1	3	1	0
15 Aug.	–1	0	3	3	0	2	1	4
16 Aug.	0	0	0	0	0	2	0	0
17 Aug.	0	0	0	0	0	0	4	1
18 Aug.	0	0	1	0	0	1	2	1
19 Aug.	0	0	0	1	2	4	3	1
20 Aug.	0	0	0	0	3	4	1	0
21 Aug.	0	0	0	0	1	1	1	0
22 Aug.	0	0	1	1	0	3	0	1
23 Aug.	0	1	0	1	2	3	1	2
24 Aug.	0	0	0	2	1	1	3	2
25 Aug.	0	0	2	0	2	0	1	1
26 Aug.	0	0	–2	7	4	3	1	1
27 Aug.	0	0	1	–3	3	2	3	0
28 Aug.	0	0	0	0	1	0	0	1
29 Aug.	0	–1	2	0	2	0	–1	2
30 Aug.	0	0	1	7	2	5	1	–1
31 Aug.	0	0	0	5	1	0	2	1

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1 Sept.	0	0	1	0	0	3	2	3
2 Sept.	1	0	0	1	0	3	4	1
3 Sept.	0	0	1	1	1	0	0	0
4 Sept.	0	0	0	1	3	0	1	0
5 Sept.	0	0	0	–11	1	2	0	0
6 Sept.	0	0	1	0	1	–2	0	1
7 Sept.	0	0	1	2	1	2	2	0
8 Sept.	0	0	0	2	3	0	4	0
9 Sept.	0	0	0	0	3	2	3	0
10 Sept.	0	0	0	0	1	1	1	0
11 Sept.	0	0	0	2	2	1	0	1
12 Sept.	0	0	0	1	0	2	2	1
13 Sept.	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	1	0	0	0
16 Sept.	0	0	2	0	0	0	0	0
17 Sept.	1	0	0	2	1	2	0	1
18 Sept.	0	1	0	0	2	2	1	0
19 Sept.	0	0	1	0	1	1	0	1
20 Sept.	0	0	0	0	1	0	0	0
21 Sept.	0	1	0	0	0	0	2	0
22 Sept.	0	0	0	0	0	1	0	1
23 Sept.	0	0	1	0	0	0	0	0
24 Sept.	0	0	1	1	0	0	1	0
25 Sept.	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	1	0	0	1	–1
27 Sept.	0	1	0	0	0	0	1	0
28 Sept.	1	0	0	0	0	1	1	0
29 Sept.	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	1	0	0
1 Oct.	0	–1	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	1	0
3 Oct.	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	–1	–1	0	0
5 Oct.	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	1	0	1	0	0
7 Oct.	0	0	0	0	0	0	0	–1
8 Oct.	0	0	0	0	0	0	–1	0
9 Oct.	0	0	0	0	0	0	0	–1
10 Oct.	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	1	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
12 Oct.	0	0	0	0	0	0	0	0
13 Oct.	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0

Table 31. Hourly count of adult lampreys in count window video at the north shore ladder of Ice Harbor Dam during the 2013 season. Net upstream counts only. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
14 Jun.	0	0	0	0	0	0	0	0
15 Jun.	0	2	0	0	0	0	0	0
16 Jun.	0	0	0	0	0	0	0	0
17 Jun.	0	0	0	0	0	1	0	0
18 Jun.	0	0	0	0	0	0	0	0
19 Jun.	0	0	0	0	0	0	0	0
20 Jun.	1	0	0	0	1	0	0	0
21 Jun.	0	0	0	0	0	0	0	0
22 Jun.	0	0	0	0	0	0	0	0
23 Jun.	0	0	0	0	0	0	0	0
24 Jun.	0	0	0	0	0	0	0	0
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	1	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	1	1	1	1	0
05 Jul.	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	0	0
10 Jul.	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	1	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	2	1
14 Jul.	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0
16 Jul.	1	0	0	0	0	1	0	0
17 Jul.	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	1	0
19 Jul.	0	0	0	0	0	1	0	0
20 Jul.	0	0	1	0	1	0	2	1
21 Jul.	0	0	0	–1	1	0	0	0
22 Jul.	1	0	0	0	0	0	0	1

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
23 Jul.	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	1	0	1	0
25 Jul.	1	0	0	0	0	0	0	1
26 Jul.	0	0	0	0	0	0	1	0
27 Jul.	0	0	0	0	1	0	3	0
28 Jul.	2	0	0	0	0	0	0	0
29 Jul.	1	0	0	0	0	0	1	0
30 Jul.	0	0	0	0	0	0	1	1
31 Jul.	0	0	0	0	0	1	0	0
01 Aug.	0	0	0	0	1	1	0	0
02 Aug.	0	1	0	0	0	0	0	0
03 Aug.	0	0	0	0	0	0	–1	0
04 Aug.	0	0	0	0	0	0	0	1
05 Aug.	1	0	0	0	0	0	0	0
06 Aug.	0	0	0	1	0	0	0	1
07 Aug.	0	0	0	0	0	0	1	0
08 Aug.	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	1	0	0
10 Aug.	0	1	0	0	0	1	0	0
11 Aug.	0	0	0	0	0	0	0	0
12 Aug.	0	0	0	0	0	0	0	0
13 Aug.	0	0	0	0	0	0	0	0
14 Aug.	0	0	0	0	0	1	0	0
15 Aug.	0	0	0	0	0	0	0	0
16 Aug.	0	0	0	0	0	0	0	0
17 Aug.	0	0	0	0	0	0	0	0
18 Aug.	1	0	1	0	0	0	0	0
19 Aug.	0	1	0	0	0	0	1	2
20 Aug.	0	0	0	0	1	1	0	0
21 Aug.	0	0	1	0	0	0	0	1
22 Aug.	0	0	0	0	0	0	0	0
23 Aug.	0	0	0	0	0	1	0	0
24 Aug.	1	0	0	0	1	0	0	0
25 Aug.	0	0	0	0	0	0	0	0
26 Aug.	0	0	0	0	0	0	0	0
27 Aug.	0	0	0	0	0	0	0	0
28 Aug.	0	0	0	0	0	0	0	0
29 Aug.	0	0	0	0	1	0	0	0
30 Aug.	0	0	0	0	0	0	0	2
31 Aug.	0	0	0	0	0	0	0	0
1 Sept.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
2 Sept.	0	0	0	0	1	0	0	1
3 Sept.	0	0	1	0	0	0	0	0
4 Sept.	0	0	0	0	0	0	0	0
5 Sept.	0	0	0	0	0	0	0	1
6 Sept.	1	0	0	0	0	0	0	0
7 Sept.	0	0	0	0	0	0	0	0
8 Sept.	0	0	0	1	0	0	0	0
9 Sept.	0	0	0	0	0	1	0	0
10 Sept.	0	0	0	0	0	0	0	0
11 Sept.	0	0	0	0	0	0	0	0
12 Sept.	0	0	0	0	0	0	0	0
13 Sept.	0	0	0	0	0	0	0	0
14 Sept.	0	0	0	0	0	0	0	0
15 Sept.	0	0	0	0	0	0	0	0
16 Sept.	0	0	0	0	0	0	0	0
17 Sept.	0	0	0	0	0	0	0	0
18 Sept.	0	0	0	0	0	0	0	0
19 Sept.	0	0	0	0	0	0	0	0
20 Sept.	0	0	0	0	0	0	0	0
21 Sept.	0	0	0	0	0	0	0	0
22 Sept.	0	0	0	0	0	0	0	0
23 Sept.	0	0	0	0	0	0	0	0
24 Sept.	0	0	0	0	0	0	0	0
25 Sept.	0	0	0	0	0	0	0	0
26 Sept.	0	0	0	0	0	0	0	0
27 Sept.	0	0	0	0	0	0	0	0
28 Sept.	0	0	0	0	0	0	0	0
29 Sept.	0	0	0	0	0	0	0	0
30 Sept.	0	0	0	0	0	0	0	0
1 Oct.	0	0	0	0	0	0	0	0
2 Oct.	0	0	0	0	0	0	0	0
3 Oct.	0	0	0	0	0	0	0	0
4 Oct.	0	0	0	0	0	0	0	0
5 Oct.	0	0	0	0	0	0	0	0
6 Oct.	0	0	0	0	0	0	0	0
7 Oct.	0	0	0	0	0	0	0	0
8 Oct.	0	0	0	0	0	0	0	0
9 Oct.	0	0	0	0	0	0	0	0
10 Oct.	0	0	0	0	0	0	0	0
11 Oct.	0	0	0	0	0	0	0	0
12 Oct.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
13 Oct.	0	0	0	0	0	0	0	0
14 Oct.	0	0	0	0	0	0	0	0
15 Oct.	0	0	0	0	0	0	0	0

Table 32. Hourly count of adult lampreys in count window video at Little Goose Dam during the 2013 season. Net upstream counts only. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0
02 Jul.	0	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0
07 Jul.	0	0	0	0	0	0	0	0
08 Jul.	0	0	0	0	0	0	0	0
09 Jul.	0	0	0	0	0	0	1	0
10 Jul.	0	0	0	0	0	0	0	0
11 Jul.	0	0	0	0	0	0	0	0
12 Jul.	0	0	0	0	0	0	0	0
13 Jul.	0	0	0	0	0	0	0	0
14 Jul.	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	0	0	0	0
17 Jul.	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	1
20 Jul.	0	0	0	0	0	0	0	0
21 Jul.	0	0	0	0	0	0	0	0
22 Jul.	0	0	0	0	0	0	1	0
23 Jul.	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	1
25 Jul.	0	1	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0
28 Jul.	0	0	0	0	0	0	1	0
29 Jul.	0	0	0	0	0	0	0	1
30 Jul.	0	0	0	0	1	0	0	0
31 Jul.	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	1	0	0
02 Aug.	0	0	0	0	1	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
03 Aug.	0	0	0	0	2	1	0	0
04 Aug.	0	0	0	1	1	0	0	0
05 Aug.	0	1	0	3	0	–1	0	0
06 Aug.	0	1	0	0	1	1	0	0
07 Aug.	0	0	0	0	0	0	0	1
08 Aug.	0	0	0	1	0	0	2	0
09 Aug.	0	0	0	1	0	0	0	1

Table 33. Hourly count of sockeye at the count window at Little Goose Dam during the 2013 season. Net upstream counts only. Hour 17 starts at 21:00 PDT and hour 24 ends at 05:00 PDT.

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
25 Jun.	0	0	0	0	0	0	0	0
26 Jun.	0	0	0	0	0	0	0	0
27 Jun.	0	0	0	0	0	0	0	0
28 Jun.	0	0	0	0	0	0	0	0
29 Jun.	0	0	0	0	0	0	0	0
30 Jun.	0	0	0	0	0	0	0	0
01 Jul.	0	0	0	0	0	0	0	0
02 Jul.	1	0	0	0	0	0	0	0
03 Jul.	0	0	0	0	0	0	0	0
04 Jul.	0	0	0	0	0	0	0	0
05 Jul.	0	0	0	0	0	0	0	0
06 Jul.	0	0	0	0	0	0	0	0
07 Jul.	1	0	0	0	0	0	0	0
08 Jul.	0	1	0	0	0	0	0	1
09 Jul.	1	1	0	1	1	1	0	0
10 Jul.	0	0	0	0	0	0	0	0
11 Jul.	1	0	0	0	0	0	0	0
12 Jul.	0	0	0	2	1	0	0	0
13 Jul.	2	0	0	0	0	0	0	1
14 Jul.	0	0	0	0	0	0	0	0
15 Jul.	0	0	0	0	0	0	0	0
16 Jul.	0	0	0	0	1	0	0	0
17 Jul.	0	0	0	0	0	0	0	0
18 Jul.	0	0	0	0	0	0	0	0
19 Jul.	0	0	0	0	0	0	0	0
20 Jul.	0	0	0	0	0	0	0	0
21 Jul.	0	0	0	0	0	0	0	0
22 Jul.	0	0	0	0	0	0	0	0
23 Jul.	0	0	0	0	0	0	0	0
24 Jul.	0	0	0	0	0	0	0	0
25 Jul.	0	0	0	0	0	0	0	0
26 Jul.	0	0	0	0	0	0	0	0
27 Jul.	0	0	0	0	0	0	0	0
28 Jul.	0	0	0	0	0	0	0	0
29 Jul.	0	0	0	0	0	0	0	0
30 Jul.	0	0	0	0	0	0	0	0
31 Jul.	0	0	0	0	0	0	0	0
01 Aug.	0	0	0	0	0	0	0	0
02 Aug.	0	0	0	0	0	0	0	0

	Hour							
Date	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
03 Aug.	0	0	0	0	0	0	0	0
04 Aug.	0	0	0	0	0	0	0	0
05 Aug.	0	0	0	0	0	0	0	0
06 Aug.	0	0	0	0	0	0	0	0
07 Aug.	0	0	0	0	0	0	0	0
08 Aug.	0	0	0	0	0	0	0	0
09 Aug.	0	0	0	0	0	0	0	0

Appendix B Video observations of fish approaches and interactions with the lamprey orifice at the Little Goose fish ladder

Table 34. Video observations of spring Chinook salmon in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
15 May	07:00–13:00	1,049	5	1.0	0	–
16 May	07:00–13:00	1,246	0	–	0	–
19 May	07:00–13:00	697	0	–	0	–
20 May	07:00–13:00	696	0	–	0	–
21 May	07:00–13:00	536	1	1.0	0	–
22 May	07:00–13:00	340	1	2.0	0	–
23 May	07:00–13:00	546	0	–	0	–
26 May	07:00–13:00	277	1	1.0	0	–
27 May	07:00–13:00	540	4	1.0	0	–
28 May	07:00–13:00	407	0	–	0	–
29 May	07:00–13:00	253	2	1.0	0	–
30 May	07:00–13:00	613	0	–	0	–
2 Jun.	07:00–13:00	226	26	1.0	2	9.5
3 Jun.	07:00–13:00	575	55	2.6	18	14.5
4 Jun.	07:00–13:00	265	46	1.2	6	16.5
5 Jun.	07:00–13:00	280	21	1.5	6	7.8
6 Jun.	07:00–13:00	186	14	1.0	3	5.7
9 Jun.	07:00–13:00	347	3	3.0	1	8.0
10 Jun.	07:00–13:00	275	11	1.0	0	–
11 Jun.	07:00–13:00	307	3	2.0	0	–
12 Jun.	07:00–13:00	485	0	–	0	–
13 Jun.	07:00–13:00	401	73	1.3	12	1.4

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 35. Video observations of summer Chinook salmon in 2013

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
16 Jun.	07:00–13:00	407	105	1.2	15	3.8
17 Jun.	07:00–13:00	379	91	2.3	15	10.9
18 Jun.	07:00–13:00	304	86	1.3	13	20.3
19 Jun.	07:00–13:00	137	16	1.6	0	–
20 Jun.	07:00–13:00	199	3	1.0	0	–
23 Jun.	07:00–13:00	421	96	1.2	12	6.9
24 Jun.	07:00–13:00	118	29	1.8	3	7.7
25 Jun.	07:00–13:00	190	37	1.6	17	15.2
26 Jun.	07:00–13:00	275	48	1.1	10	7.1
27 Jun.	07:00–13:00	608	228	1.4	35	13.8
30 Jun.	07:00–13:00	140	18	1.7	1	10.0
1 Jul.	07:00–13:00	151	17	1.0	1	15.0
2 Jul.	07:00–13:00	256	15	1.6	4	12.5
3 Jul.	07:00–13:00	420	60	1.0	16	10.5
4 Jul.	07:00–13:00	379	60	1.3	21	12.0
7 Jul.	07:00–13:00	73	3	1.0	0	–
8 Jul.	07:00–13:00	143	8	1.0	1	10.0
9 Jul.	07:00–13:00	210	20	1.4	3	7.0
10 Jul.	07:00–13:00	78	2	4.5	0	–
11 Jul.	07:00–13:00	197	11	1.2	3	7.0
14 Jul.	07:00–13:00	94	8	1.9	1	11.0
15 Jul.	07:00–13:00	70	5	1.0	0	–
16 Jul.	07:00–13:00	86	8	1.1	0	–
17 Jul.	07:00–13:00	65	6	1.0	2	5.5
18 Jul.	07:00–13:00	92	4	1.0	1	2.0
21 Jul.	07:00–13:00	95	2	2.0	0	–
22 Jul.	07:00–13:00	58	1	1.0	0	–
23 Jul.	07:00–13:00	37	5	1.0	0	–
24 Jul.	07:00–13:00	36	2	1.0	1	2.0
25 Jul.	07:00–13:00	36	3	1.0	0	–

[a] Numbers established by fish count technicians at the Oregon shore fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 36. Video observations of fall Chinook salmon in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
18 Aug.	07:00–13:00	262	41	1.3	7	9.3
19 Aug.	07:00–13:00	196	29	1.0	5	6.0
20 Aug.	07:00–13:00	139	0	–	0	–
21 Aug.	07:00–13:00	144	7	2.1	0	–
22 Aug.	07:00–13:00	97	1	2.0	0	–
25 Aug.	07:00–13:00	289	6	1.8	3	3.3
26 Aug.	07:00–13:00	342	21	1.1	2	3.0
27 Aug.	07:00–13:00	276	15	1.2	9	7.5
28 Aug.	07:00–13:00	234	22	1.1	8	6.2
29 Aug.	07:00–13:00	310	7	1.0	3	2.7
1 Sept.	07:00–13:00	444	10	1.7	1	3.0
2 Sept.	07:00–13:00	534	8	1.4	0	–
3 Sept.	07:00–13:00	391	3	5.3	1	5.0
4 Sept.	07:00–13:00	538	7	1.7	0	–
5 Sept.	07:00–13:00	295	5	2.0	0	–
8 Sept.	07:00–13:00	2422	8	1.9	1	1.0
9 Sept.	07:00–13:00	493	13	1.4	0	–
10 Sept.	07:00–13:00	1556	13	1.7	0	–
11 Sept.	07:00–13:00	870	10	2.3	3	6.0
12 Sept.	07:00–13:00	746	4	1.5	0	–
15 Sept.	07:00–13:00	1332	1	1.0	0	–
16 Sept.	07:00–13:00	1667	7	1.1	0	–
17 Sept.	07:00–13:00	4435	18	2.5	3	2.0
18 Sept.	07:00–13:00	3012	25	1.3	0	–
19 Sept.	07:00–13:00	1505	13	1.0	3	2.0
22 Sept.	07:00–13:00	1900	9	1.1	0	–
23 Sept.	07:00–13:00	1895	10	1.2	0	–
24 Sept.	07:00–13:00	1387	2	1.0	0	–
25 Sept.	07:00–13:00	1954	8	1.0	1	3.0
26 Sept.	07:00–13:00	1148	0	–	2	3.5

[a] Numbers established by fish count technicians at the Oregon shore fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 37. Video observations of steelhead trout in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
18 Aug.	07:00–13:00	130	7	1.9	0	–
19 Aug.	07:00–13:00	151	17	1.1	0	–
20 Aug.	07:00–13:00	162	0	–	0	–
21 Aug.	07:00–13:00	121	2	1.5	0	–
22 Aug.	07:00–13:00	88	0	–	0	–
25 Aug.	07:00–13:00	187	6	2.0	0	–
26 Aug.	07:00–13:00	205	4	1.0	0	–
27 Aug.	07:00–13:00	226	9	1.4	2	1.0
28 Aug.	07:00–13:00	211	8	1.1	2	1.0
29 Aug.	07:00–13:00	118	2	1.5	0	–
1 Sept.	07:00–13:00	162	4	2.8	0	–
2 Sept.	07:00–13:00	109	2	4.5	0	–
3 Sept.	07:00–13:00	74	2	7.5	0	–
4 Sept.	07:00–13:00	107	3	2.3	0	–
5 Sept.	07:00–13:00	72	0	–	0	–
8 Sept.	07:00–13:00	275	2	1.0	0	–
9 Sept.	07:00–13:00	155	2	2.0	0	–
10 Sept.	07:00–13:00	358	3	1.7	0	–
11 Sept.	07:00–13:00	316	1	3.0	0	–
12 Sept.	07:00–13:00	330	2	2.0	0	–
15 Sept.	07:00–13:00	238	3	4.0	0	–
16 Sept.	07:00–13:00	451	5	1.2	1	1.0
17 Sept.	07:00–13:00	1265	23	1.3	6	2.5
18 Sept.	07:00–13:00	2442	53	1.6	6	4.6
19 Sept.	07:00–13:00	1314	26	1.0	2	4.0
20 Sept.	05:00–21:00	2626	0	–	0	–
21 Sept.	05:00–21:00	1325	0	–	0	–
22 Sept.	07:00–13:00	853	19	1.1	3	2.0
23 Sept.	07:00–13:00	895	44	1.2	2	3.3
24 Sept.	07:00–13:00	773	37	1.1	7	7.9
25 Sept.	07:00–13:00	950	14	1.0	0	–
26 Sept.	07:00–13:00	499	2	1.0	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 38. Video observations of sockeye salmon at the lamprey orifice in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
30 Jun.	24 hr	4	0	–	0	–
1 Jul.	24 hr	13	1	1.0	0	–
2 Jul.	24 hr	24	1	1.0	0	–
3 Jul.	24 hr	23	2	1.0	0	–
4 Jul.	24 hr	40	4	1.0	0	–
5 Jul.	24 hr	50	0	–	0	–
6 Jul.	24 hr	49	0	–	0	–
7 Jul.	24 hr	36	0	–	0	–
8 Jul.	24 hr	56	0	–	0	–
9 Jul.	24 hr	54	0	–	0	–
10 Jul.	24 hr	41	0	–	0	–
11 Jul.	24 hr	78	0	–	0	–
12 Jul.	24 hr	58	0	–	0	–
13 Jul.	24 hr	73	0	–	0	–
14 Jul.	24 hr	56	2	1.0	0	–
15 Jul.	24 hr	41	0	–	0	–
16 Jul.	24 hr	23	0	–	0	–
17 Jul.	24 hr	30	0	–	0	–
18 Jul.	24 hr	24	2	1.0	0	–
19 Jul.	24 hr	23	0	–	0	–
20 Jul.	24 hr	14	0	–	0	–
21 Jul.	24 hr	17	1	1.0	0	–
22 Jul.	24 hr	7	0	–	0	–
23 Jul.	24 hr	6	0	–	0	–
24 Jul.	24 hr	6	1	1.0	0	–
25 Jul.	24 hr	2	1	1.0	0	–
26 Jul.	24 hr	1	0	–	0	–
27 Jul.	24 hr	13	0	–	0	–
28 Jul.	24 hr	1	1	3.0	0	–
29 Jul.	24 hr	5	3	1.0	0	–
30 Jul.	24 hr	1	0	–	0	–
31 Jul.	24 hr	5	3	1.0	0	–
1 Aug.	24 hr	4	1	1.0	1	2.0
2 Aug.	24 hr	0	0	–	0	–
3 Aug.	24 hr	2	0	–	0	–
4 Aug.	24 hr	0	0	–	0	–
5 Aug.	24 hr	2	0	–	0	–
6 Aug.	24 hr	2	0	–	0	–
7 Aug.	24 hr	2	0	–	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 39. Video observations of adult lampreys at the lamprey orifice in 2013.

Date	Recording time	Window counts[a]	Pass counts	Avg. pass time[c] at orifice (s)	No Pass counts	Avg. no pass time[c] at orifice (s)
1 Jul.	24 hr	0	0	–	0	–
2 Jul.	24 hr	0	0	–	0	–
3 Jul.	24 hr	0	0	–	0	–
4 Jul.	24 hr	1	0	–	0	–
5 Jul.	24 hr	0	0	–	0	–
6 Jul.	24 hr	0	0	–	0	–
7 Jul.	24 hr	0	0	–	1	19.0
8 Jul.	24 hr	0	0	–	0	–
9 Jul.	24 hr	3	0	–	0	–
10 Jul.	24 hr	1	0	–	0	–
11 Jul.	24 hr	1	0	–	0	–
12 Jul.	24 hr	0	0	–	0	–
13 Jul.	24 hr	1	0	–	0	–
14 Jul.	24 hr	0	0	–	1	1.0
15 Jul.	24 hr	0	0	–	1	8.0
16 Jul.	24 hr	1	4	13.75	2	1.5
17 Jul.	24 hr	0	3	10.67	2	7.5
18 Jul.	24 hr	0	0	–	0	–
19 Jul.	24 hr	1	0	–	0	–
20 Jul.	24 hr	0	0	–	0	–
21 Jul.	24 hr	0	1	38.0	2	16.0
22 Jul.	24 hr	1	0	–	1	1.0
23 Jul.	24 hr	1	0	–	0	–
24 Jul.	24 hr	3	0	–	1	1.0
25 Jul.	24 hr	1	0	–	0	–
26 Jul.	24 hr	0	0	–	0	–
27 Jul.	24 hr	–1	0	–	2	1.0
28 Jul.	24 hr	1	0	–	1	10.0
29 Jul.	24 hr	1	1	15.0	2	1.0
30 Jul.	24 hr	1	0	–	0	–
31 Jul.	24 hr	1	2	13.5	5	4.2
1 Aug.	24 hr	1	3	12.3	5	2.0
4 Aug. **4–5 Aug.**	07:00–13:00 21:00–05:00	2	0	–	4	1.25
5 Aug. **5–6 Aug.**	07:00–13:00 21:00–05:00	3	1	3.0	0	–
6 Aug. **6–7 Aug.**	07:00–13:00 21:00–05:00	3	0	–	1	1.0
7 Aug. **7–8 Aug.**	07:00–13:00 21:00–05:00	1	0	–	0	–
8 Aug. **8–9 Aug.**	07:00–13:00 21:00–05:00	3	0	–	0	–
11 Aug. **11–12 Aug.**	07:00–13:00 21:00–05:00	1	0	–	0	–

Date	Recording time	Window counts[a]	Pass counts	Avg. pass time[c] at orifice (s)	No Pass counts	Avg. no pass time[c] at orifice (s)
12 Aug.	07:00–13:00	0	0	–	0	–
12–13 Aug.	21:00–05:00					
13 Aug.	07:00–13:00	0	0	–	0	–
13–14 Aug.	21:00–05:00					
14 Aug.	07:00–13:00	0	0	–	0	–
14–15 Aug.	21:00–05:00					
15 Aug.	07:00–13:00	0	0	–	0	–
15–16 Aug.	21:00–05:00					
18 Aug.	07:00–13:00	0	1	56.0	0	–
18–19 Aug.	21:00–05:00					
19 Aug.	07:00–13:00	0	0	–	6	4.3
19–20 Aug.	21:00–05:00					
20 Aug.	07:00–13:00	0	0	–	2	4.0
20–21 Aug.	21:00–05:00					
21 Aug.	07:00–13:00	0	0	–	0	–
21–22 Aug.	21:00–05:00					
22 Aug.	07:00–13:00	0	0	–	2	15.5
22–23 Aug.	21:00–05:00					
25 Aug.	07:00–13:00	0	0	–	0	–
25–26 Aug.	21:00–05:00					
26 Aug.	07:00–13:00	0	5	25.4	0	–
26–27 Aug.	21:00–05:00					
27 Aug.	07:00–13:00	0	0	–	1	4.0
27–28 Aug.	21:00–05:00					
28 Aug.	07:00–13:00	0	1	11.0	0	–
28–29 Aug.	21:00–05:00					
29 Aug.	07:00–13:00	0	1	11.0	1	1.0
29–30 Aug.	21:00–05:00					
1 Sept.	07:00–13:00	0	0	–	1	359.0
1–2 Sept.	21:00–05:00					
2 Sept.	07:00–13:00	–1	1	130.0	0	–
2–3 Sept.	21:00–05:00					
3 Sept.	07:00–13:00	0	0	–	0	–
3–4 Sept.	21:00–05:00					
4 Sept.	07:00–13:00	0	0	–	0	–
4–5 Sept.	21:00–05:00					
5 Sept.	07:00–13:00	0	0	–	0	–
5–6 Sept.	21:00–05:00					
8 Sept.	07:00–13:00	0	0	–	0	–
8–9 Sept.	21:00–05:00					
9 Sept.	07:00–13:00	1	0	–	0	–
9–10 Sept.	21:00–05:00					
10 Sept.	07:00–13:00	0	0	–	0	–
10–11 Sept.	21:00–05:00					
11 Sept.	07:00–13:00	1	0	–	0	–
11–12 Sept.	21:00–05:00					
12 Sept.	07:00–13:00	0	0	–	0	–
12–13 Sept.	21:00–05:00					
15 Sept.	07:00–13:00	0	0	–	0	–
15–16 Sept.	21:00–05:00					
16 Sept.	07:00–13:00	1	0	–	0	–
16–17 Sept.	21:00–05:00					
17 Sept.	07:00–13:00	0	0	–	1	3.0
17–18 Sept.	21:00–05:00					

Date	Recording time	Window counts[a]	Pass counts	Avg. pass time[c] at orifice (s)	No Pass counts	Avg. no pass time[c] at orifice (s)
18 Sept.	07:00–13:00	–1	0	–	2	9.5
18–19 Sept.	21:00–05:00					
19 Sept.	07:00–13:00	0	0	–	0	–
19–20 Sept.	21:00–05:00					
22 Sept.	07:00–13:00	0	0	–	0	–
22–23 Sept.	21:00–05:00					
23 Sept.	07:00–13:00	0	0	–	0	–
23–24 Sept.	21:00–05:00					
24 Sept.	07:00–13:00	0	0	–	0	–
24–25 Sept.	21:00–05:00					
25 Sept.	07:00–13:00	0	0	–	0	–
25–26 Sept.	21:00–05:00					
26 Sept.	07:00–13:00	1	0	–	0	–
26 Sept.	21:00–00:00					

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.

Appendix C Video observations of fish approaches and interactions with the lamprey orifice at Lower Granite fish ladder in 2013

Table 40. Video observations of spring Chinook salmon in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
12 May	07:00–13:00	1769	4	1.25	0	–
13 May	07:00–13:00	688	0	–	0	–
14 May	07:00–13:00	1126	0	–	0	–
15 May	07:00–13:00	1706	0	–	0	–
16 May	07:00–13:00	1348	0	–	0	–
19 May	07:00–13:00	740	0	–	0	–
20 May	07:00–13:00	492	0	–	0	–
21 May	07:00–13:00	410	2	1.0	0	–
22 May	07:00–13:00	631	0	–	0	–
23 May	07:00–13:00	323	0	–	0	–
26 May	07:00–13:00	172	0	–	0	–
27 May	07:00–13:00	346	0	–	0	–
28 May	07:00–13:00	268	0	–	0	–
29 May	07:00–13:00	329	0	–	0	–
30 May	07:00–13:00	416	0	–	0	–
2 Jun.	07:00–13:00	324	0	–	0	–
3 Jun.	07:00–13:00	222	0	–	0	–
4 Jun.	07:00–13:00	403	0	–	0	–
5 Jun.	07:00–13:00	565	0	–	0	–
6 Jun.	07:00–13:00	356	0	–	0	–
9 Jun.	07:00–13:00	283	2	1.0	0	–
10 Jun.	07:00–13:00	271	0	–	0	–
11 Jun.	07:00–13:00	172	1	2.0	0	–
12 Jun.	07:00–13:00	272	0	–	0	–
13 Jun.	07:00–13:00	391	0	–	0	–
16 Jun.	07:00–13:00	668	0	–	0	–
17 Jun.	07:00–13:00	354	3	1.0	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 41. Video observations of summer Chinook salmon in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
18 Jun.	07:00–13:00	404	0	–	0	–
19 Jun.	07:00–13:00	406	0	–	0	–
20 Jun.	07:00–13:00	168	0	–	0	–
23 Jun.	07:00–13:00	774	0	–	0	–
24 Jun.	07:00–13:00	367	0	–	0	–
25 Jun.	07:00–13:00	146	0	–	0	–
26 Jun.	07:00–13:00	251	0	–	0	–
27 Jun.	07:00–13:00	274	0	–	0	–
30 Jun.	07:00–13:00	257	0	–	0	–
1 Jul.	07:00–13:00	34	0	–	0	–
2 Jul.	07:00–13:00	198	0	–	0	–
3 Jul.	07:00–13:00	101	0	–	0	–
4 Jul.	07:00–13:00	294	0	–	0	–
7 Jul.	07:00–13:00	229	0	–	0	–
8 Jul.	07:00–13:00	62	0	–	0	–
9 Jul.	07:00–13:00	101	0	–	0	–
10 Jul.	07:00–13:00	48	0	–	0	–
11 Jul.	07:00–13:00	89	0	–	0	–
14 Jul.	07:00–13:00	78	0	–	0	–
15 Jul.	07:00–13:00	30	0	–	0	–
16 Jul.	07:00–13:00	115	0	–	0	–
17 Jul.	07:00–13:00	26	0	–	0	–
18 Jul.	07:00–13:00	66	0	–	0	–
21 Jul.	07:00–13:00	16	0	–	0	–
22 Jul.	07:00–13:00	0	0	–	0	–
23 Jul.	07:00–13:00	–1	0	–	0	–
24 Jul.	07:00–13:00	17	1	1.0	0	–
25 Jul.	07:00–13:00	146	0	–	1	4.0

[a] Numbers established by fish count technicians at the Oregon shore fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 42. Video observations of fall Chinook salmon in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
18 Aug.	07:00–13:00	48	0	–	0	–
19 Aug.	07:00–13:00	31	0	–	0	–
20 Aug.	07:00–13:00	7	0	–	0	–
21 Aug.	07:00–13:00	202	0	–	0	–
22 Aug.	07:00–13:00	64	0	–	0	–
25 Aug.	07:00–13:00	74	0	–	0	–
26 Aug.	07:00–13:00	71	0	–	0	–
27 Aug.	07:00–13:00	174	0	–	0	–
28 Aug.	07:00–13:00	256	0	–	0	–
29 Aug.	07:00–13:00	107	0	–	0	–
1 Sept.	07:00–13:00	361	0	–	0	–
2 Sept.	07:00–13:00	235	0	–	0	–
3 Sept.	07:00–13:00	31	0	–	0	–
4 Sept.	07:00–13:00	116	0	–	0	–
5 Sept.	07:00–13:00	362	0	–	0	–
8 Sept.	07:00–13:00	907	0	–	0	–
9 Sept.	07:00–13:00	2833	0	–	0	–
10 Sept.	07:00–13:00	157	0	–	0	–
11 Sept.	07:00–13:00	1414	0	–	0	–
12 Sept.	07:00–13:00	2824	0	–	0	–
15 Sept.	07:00–13:00	400	0	–	0	–
16 Sept.	07:00–13:00	701	0	–	0	–
17 Sept.	07:00–13:00	4487	0	–	0	–
18 Sept.	07:00–13:00	2149	0	–	0	–
19 Sept.	07:00–13:00	3576	0	–	0	–
22 Sept.	07:00–13:00	2154	0	–	0	–
23 Sept.	07:00–13:00	2510	0	–	0	–
24 Sept.	07:00–13:00	2008	0	–	0	–
25 Sept.	07:00–13:00	1852	0	–	0	–
26 Sept.	07:00–13:00	1501	0	–	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 43. Video observations of steelhead trout in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
30 Jun.	07:00–13:00	7	0	–	0	–
1 Jul.	07:00–13:00	2	0	–	0	–
2 Jul.	07:00–13:00	2	0	–	0	–
3 Jul.	07:00–13:00	2	0	–	0	–
4 Jul.	07:00–13:00	6	0	–	0	–
7 Jul.	07:00–13:00	11	0	–	0	–
8 Jul.	07:00–13:00	4	0	–	0	–
9 Jul.	07:00–13:00	6	0	–	0	–
10 Jul.	07:00–13:00	7	0	–	0	–
11 Jul.	07:00–13:00	11	0	–	0	–
14 Jul.	07:00–13:00	17	0	–	0	–
15 Jul.	07:00–13:00	7	0	–	0	–
16 Jul.	07:00–13:00	30	0	–	0	–
17 Jul.	07:00–13:00	16	0	–	0	–
18 Jul.	07:00–13:00	12	0	–	0	–
21 Jul.	07:00–13:00	7	0	–	0	–
22 Jul.	07:00–13:00	–4	0	–	0	–
23 Jul.	07:00–13:00	18	0	–	0	–
24 Jul.	07:00–13:00	5	0	–	0	–
25 Jul.	07:00–13:00	48	0	–	0	–
28 Jul.	07:00–13:00	53	0	–	0	–
29 Jul.	07:00–13:00	28	0	–	0	–
30 Jul.	07:00–13:00	32	0	–	0	–
31 Jul.	07:00–13:00	32	0	–	0	–
1 Aug.	07:00–13:00	67	0	–	0	–
4 Aug.	07:00–13:00	55	0	–	0	–
5 Aug.	07:00–13:00	53	0	–	0	–
6 Aug.	07:00–13:00	70	0	–	0	–
7 Aug.	07:00–13:00	76	0	–	0	–
8 Aug.	07:00–13:00	50	0	–	0	–
11 Aug.	07:00–13:00	48	0	–	0	–
12 Aug.	07:00–13:00	65	0	–	0	–
13 Aug.	07:00–13:00	70	0	–	0	–
14 Aug.	07:00–13:00	59	0	–	0	–
15 Aug.	07:00–13:00	107	0	–	0	–
18 Aug.	07:00–13:00	61	0	–	0	–
19 Aug.	07:00–13:00	61	0	–	0	–
20 Aug.	07:00–13:00	42	0	–	0	–
21 Aug.	07:00–13:00	91	0	–	0	–
22 Aug.	07:00–13:00	68	0	–	0	–
25 Aug.	07:00–13:00	107	0	–	0	–

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
26 Aug.	07:00–13:00	61	0	–	0	–
27 Aug.	07:00–13:00	101	0	–	0	–
28 Aug.	07:00–13:00	72	0	–	0	–
29 Aug.	07:00–13:00	100	0	–	0	–
1 Sept.	07:00–13:00	146	0	–	0	–
2 Sept.	07:00–13:00	84	0	–	0	–
3 Sept.	07:00–13:00	19	0	–	0	–
4 Sept.	07:00–13:00	89	0	–	0	–
5 Sept.	07:00–13:00	88	0	–	0	–
8 Sept.	07:00–13:00	167	0	–	0	–
9 Sept.	07:00–13:00	202	0	–	0	–
10 Sept.	07:00–13:00	86	0	–	0	–
11 Sept.	07:00–13:00	155	0	–	0	–
12 Sept.	07:00–13:00	239	0	–	0	–
15 Sept.	07:00–13:00	76	0	–	0	–
16 Sept.	07:00–13:00	269	0	–	0	–
17 Sept.	07:00–13:00	911	0	–	0	–
18 Sept.	07:00–13:00	1340	0	–	0	–
19 Sept.	07:00–13:00	1256	0	–	0	–
20 Sept.	24 hr	6439	0	–	0	–
21 Sept.	24 hr	3620	0	–	0	–
22 Sept.	07:00–13:00	1440	0	–	0	–
23 Sept.	07:00–13:00	1621	0	–	0	–
24 Sept.	07:00–13:00	1470	0	–	0	–
25 Sept.	07:00–13:00	1230	0	–	0	–
26 Sept.	07:00–13:00	696	0	–	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring.

Table 44.Video observations of sockeye salmon in 2013.

Date	Recording time	Window counts[a]	Approach[b] counts	Avg. time[c] at orifice (s)	Interaction counts	Avg. time[c] at orifice (s)
30 Jun.	24 hr	20	0	–	0	–
1 Jul.	24 hr	8	0	–	0	–
2 Jul.	24 hr	4	0	–	0	–
3 Jul.	24 hr	12	0	–	0	–
4 Jul.	24 hr	17	0	–	0	–
5 Jul.	24 hr	23	0	–	0	–
6 Jul.	24 hr	46	0	–	0	–
7 Jul.	24 hr	46	0	–	0	–
8 Jul.	24 hr	30	0	–	0	–
9 Jul.	24 hr	13	0	–	0	–
10 Jul.	24 hr	18	0	–	0	–
11 Jul.	24 hr	46	0	–	0	–
12 Jul.	24 hr	41	0	–	0	–
13 Jul.	24 hr	13	0	–	0	–
14 Jul.	24 hr	22	0	–	0	–
15 Jul.	24 hr	36	0	–	0	–
16 Jul.	24 hr	38	2	2.0	0	–
17 Jul.	24 hr	28	0	–	0	–
18 Jul.	24 hr	25	0	–	0	–
19 Jul.	24 hr	1	0	–	0	–
20 Jul.	24 hr	1	0	–	0	–
21 Jul.	24 hr	4	0	–	0	–
22 Jul.	24 hr	6	0	–	0	–
23 Jul.	24 hr	2	0	–	0	–
24 Jul.	24 hr	2	0	–	0	–
25 Jul.	24 hr	26	0	–	0	–
26 Jul.	24 hr	–4	0	–	0	–
27 Jul.	24 hr	30	0	–	0	–
28 Jul.	24 hr	41	1	2.0	0	–
29 Jul.	24 hr	2	1	1.0	0	–
30 Jul.	24 hr	2	0	–	0	–
31 Jul.	24 hr	2	0	–	0	–
1 Aug.	24 hr	22	0	–	0	–
2 Aug.	24 hr	7	0	–	0	–
3 Aug.	24 hr	2	0	–	0	–
4 Aug.	24 hr	5	0	–	0	–
5 Aug.	24 hr	4	0	–	0	–
6 Aug.	24 hr	5	0	–	0	–
7 Aug.	24 hr	2	0	–	0	–
8 Aug.	24 hr	1	0	–	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.
[b] Fish detected on video at a lamprey orifice.
[c] Average time is calculated based on the total number of fish observed on video for a given day of monitoring

Table 45. Video observations of adult lampreys at the lamprey orifice in 2013.

Date	Recording time	Window counts[a]	Pass counts	Avg. pass time[c] at orifice (s)	No Pass counts	Avg. no pass time[c] at orifice (s)
1 Jul.	24 hr	0	0	–	0	–
2 Jul.	24 hr	1	0	–	0	–
3 Jul.	24 hr	1	0	–	0	–
4 Jul.	24 hr	0	0	–	0	–
5 Jul.	24 hr	1	0	–	0	–
6 Jul.	24 hr	0	0	–	0	–
7 Jul.	24hr	2	0	–	0	–
8 Jul.	24 hr	0	0	–	0	–
9 Jul.	24 hr	2	0	–	0	–
10 Jul.	24 hr	1	1	2.0	0	–
11 Jul.	24 hr	0	0	–	0	–
12 Jul.	24 hr	0	0	–	0	–
13 Jul.	24 hr	4	0	–	0	–
14 Jul.	24 hr	2	0	–	0	–
15 Jul.	24 hr	2	0	–	1	2.0
16 Jul.	24 hr	1	0	–	1	2.0
17 Jul.	24 hr	3	0	–	0	–
18 Jul.	24 hr	1	0	–	0	–
19 Jul.	24 hr	4	0	–	0	–
20 Jul.	24 hr	3	0	–	0	–
21 Jul.	24 hr	2	1	3.0	1	2.0
22 Jul.	24 hr	1	0	–	0	–
23 Jul.	24 hr	2	0	–	0	–
24 Jul.	24 hr	2	0	–	2	1.0
25 Jul.	24 hr	5	0	–	0	–
26 Jul.	24 hr	5	0	–	0	–
27 Jul.	24 hr	3	0	–	0	–
28 Jul.	24 hr	2	0	–	0	–
29 Jul.	24 hr	4	0	–	0	–
30 Jul.	24 hr	3	1	66.0	1	5.0
31 Jul.	24 hr	3	0	–	0	–
1 Aug.	24 hr	8	0	–	4	6.25
4 Aug. **4–5 Aug.**	07:00–13:00 21:00–05:00	4	0	–	0	–
5 Aug. **5–6 Aug.**	07:00–13:00 21:00–05:00	8	0	–	0	–
6 Aug. **6–7 Aug.**	07:00–13:00 21:00–05:00	4	0	–	1	3.0
7 Aug. **7–8 Aug.**	07:00–13:00 21:00–05:00	2	1	1.0	2	1.5
8 Aug. **8–9 Aug.**	07:00–13:00 21:00–05:00	0	0	–	0	–
11 Aug. **11–12 Aug.**	07:00–13:00 21:00–05:00	3	0	–	1	3.0

Date	Recording time	Window counts[a]	Pass counts	Avg. pass time[c] at orifice (s)	No Pass counts	Avg. no pass time[c] at orifice (s)
12 Aug.	07:00–13:00	7	0	–	0	–
12–13 Aug.	21:00–05:00					
13 Aug.	07:00–13:00	4	0	–	0	–
13–14 Aug.	21:00–05:00					
14 Aug.	07:00–13:00	7	0	–	1	3.0
14–15 Aug.	21:00–05:00					
15 Aug.	07:00–13:00	3	0	–	0	–
15–16 Aug.	21:00–05:00					
18 Aug.	07:00–13:00	1	0	–	1	3.0
18–19 Aug.	21:00–05:00					
19 Aug.	07:00–13:00	1	0	–	0	–
19–20 Aug.	21:00–05:00					
20 Aug.	07:00–13:00	4	0	–	0	–
20–21 Aug.	21:00–05:00					
21 Aug.	07:00–13:00	2	0	–	0	–
21–22 Aug.	21:00–05:00					
22 Aug.	07:00–13:00	0	0	–	0	–
22–23 Aug.	21:00–05:00					
25 Aug.	07:00–13:00	4	1	4.0	1	6.0
25–26 Aug.	21:00–05:00					
26 Aug.	07:00–13:00	–1	0	–	2	2.0
26–27 Aug.	21:00–05:00					
27 Aug.	07:00–13:00	0	0	–	0	–
27–28 Aug.	21:00–05:00					
28 Aug.	07:00–13:00	1	0	–	0	–
28–29 Aug.	21:00–05:00					
29 Aug.	07:00–13:00	3	0	–	0	–
29–30 Aug.	21:00–05:00					
1 Sept.	07:00–13:00	2	0	–	1	1.0
1–2 Sept.	21:00–05:00					
2 Sept.	07:00–13:00	0	0	–	0	–
2–3 Sept.	21:00–05:00					
3 Sept.	07:00–13:00	1	0	–	0	–
3–4 Sept.	21:00–05:00					
4 Sept.	07:00–13:00	2	0	–	0	–
4–5 Sept.	21:00–05:00					
5 Sept.	07:00–13:00	1	0	–	0	–
5–6 Sept.	21:00–05:00					
8 Sept.	07:00–13:00	4	0	–	0	–
8–9 Sept.	21:00–05:00					
9 Sept.	07:00–13:00	3	0	–	0	–
9–10 Sept.	21:00–05:00					
10 Sept.	07:00–13:00	3	0	–	0	–
10–11 Sept.	21:00–05:00					
11 Sept.	07:00–13:00	2	0	–	0	–
11–12 Sept.	21:00–05:00					
12 Sept.	07:00–13:00	4	0	–	0	–
12–13 Sept.	21:00–05:00					
15 Sept.	07:00–13:00	1	0	–	0	–
15–16 Sept.	21:00–05:00					
16 Sept.	07:00–13:00	1	0	–	1	3.0
16–17 Sept.	21:00–05:00					
17 Sept.	07:00–13:00	2	0	–	1	3.0
17–18 Sept.	21:00–05:00					

Date	Recording time	Window counts[a]	Pass counts	Avg. pass time[c] at orifice (s)	No Pass counts	Avg. no pass time[c] at orifice (s)
18 Sept. **18–19 Sept.**	07:00–13:00 21:00–05:00	3	0	–	1	3.0
19 Sept. **19–20 Sept.**	07:00–13:00 21:00–05:00	3	0	–	0	–
22 Sept. **22–23 Sept.**	07:00–13:00 21:00–05:00	3	0	–	0	–
23 Sept. **23–24 Sept.**	07:00–13:00 21:00–05:00	1	0	–	0	–
24 Sept. **24–25 Sept.**	07:00–13:00 21:00–05:00	1	1	1.0	3	3.3
25 Sept. **25–26 Sept.**	07:00–13:00 21:00–05:00	0	0	–	2	6.0
26 Sept. **26 Sept.**	07:00–13:00 21:00–00:00	0	0	–	0	–

[a] Numbers established by fish count technicians at the fish ladder during monitoring hours.