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MEMORANDUM

To:	Chris Pinney (U.S. Army Corps of Engineers)	**Date:**	October 4, 2016
From:	Dalton Hance (Anchor QEA, LLC)	**Project:**	151163-01.01
Cc:	Joe Miller, Josh Murauskas, Sam Haffey, Mark Weiland, Pradeep Mugunthan, and Larissa Rohrbach (Anchor QEA) Peter Johnson (LGL) Geoff McMichael (Mainstem Fish Research) Rich Townsend (University of Washington)		
Re:	Lower Granite Dam Adult Passage and Post-passage Temperature Evaluation Weekly Report		

OVERVIEW

This is the weekly summary report for the Sound and Vibration Passage Study for Week 39, 2016.[1] This is the final weekly report for the study. The data reported here include construction activities, underwater sound and vibration measured in the LGR adult fish ladder, and fish passage through the LGR adult fish ladder. These data are preliminary and may be subject to change.

Sound Levels in the Fish Ladder

Sound-measuring instruments are deployed at four locations to measure sound-induced ground and structure motion. Three of these locations are within the adult fishway and are equipped with sensors that measure sound-induced pressure waves within the water. Each location has instruments that measure vibrations in the ladder walls and sound pressure in the water. Sound moving through the ladder walls causes the walls to vibrate, and these vibrations are measured by triaxial accelerometers. Sound vibrating the ladder walls could potentially enter the water. Sound transmitted into the water in this way consists of both water particle movements and sound pressure. The pressure component of the sound field is

[1] Week 39 is the period from midnight (00:00:00) Monday, September 26, 2016, to immediately prior to midnight (23:59:59) Sunday, October 2. As of August 22, fish passage statistics encompass the same time period as other metrics.

measured by a series of three hydrophones deployed in the water at each of the fish ladder sound-monitoring locations.

Sound data generated by this monitoring program are intended to assess if sound and vibration enter the fish ladder and whether these are intense enough to be detected by fish transiting the ladder. Salmon hearing is not sensitive to the pressure component of sound but rather the particle motion component of sound. For this reason, data from the three triaxial accelerometers in the fish ladder are shown to depict vibrations traveling through the walls of the ladder and potentially transferring to the water as particle motion. Figure 1 shows the peak acceleration levels of the vibrations, which is a measure of the maximum sound amplitude per measurement interval. Figure 2 shows the frequency components of the vibrations.

Upstream Fish Passage Events

Total numbers of fish that passed through the fish ladder during the reporting week are shown in Table 1. Cumulative counts to date for 2016 are also shown in Table 1.

Table 2 summarizes the number of unique passive integrated transponder (PIT)-tagged fish detected anywhere within the ladder, number of unique PIT-tagged fish detected at the ladder entrance, proportion of successful passages, dropback rate, and re-ascension rate for each species during trapping and non-trapping periods. Table 3 summarizes median passage time for each species during trapping and non-trapping periods. The statistics shown in Tables 2 and 3 include all PIT-tagged fish released at or upstream of LGR as juveniles that were detected during the reporting week.

Beginning on approximately July 28, 2016, radio frequency interference has reduced detection efficiency of PIT antennas located near the ladder exit, affecting the calculation of statistics summarizing passage success. This reduced detection efficiency will be addressed further in the annual report.

A running summary of weekly estimates of passage success, dropback probability, and passage time is depicted in Figure 4. From Week 16 to Week 33, passage monitoring based on PIT data includes PIT monitoring arrays at the fishway entrance and exit in conjunction

with a reduced trapping schedule, allowing volitional passage between approximately 14:00 Friday and 14:00 Sunday each week. The estimates in Figure 4 are based on a pooling of trapping and non-trapping periods for these weeks. The exact time of fish trapping is being recorded by the National Marine Fisheries Service and will be included in the annual report.

ARIS

The ARIS system was installed on June 20 and deployed 60 feet below the water surface from the trolley pipe on the north side of the fishway exit. The ARIS is attached to a rotator programmed to aim the ARIS in five unique positions each hour to allow for data collection throughout a sample volume that extends 80 feet upstream of the dam. The system has been collecting data continuously since 11:00 on June 21.

ARIS data processing involves reviewing imagery files and marking fish that pass through the fields-of-view. Criteria used to select fish to be marked include estimated total length, body shape, and swimming behaviors (e.g., occurrence of schooling is used to exclude American shad from the data set). A subset of 5 hours of data per day are processed between the hours of 06:00 to 21:00 to capture the bulk of historically observed adult salmonid movements. For the final report, fish observation data will be presented using vector and distribution plots. For the in-season weekly reports, plots will present the counts of marked fish per hour on a daily basis, as shown in Figure 3.

Turbine Operations

Turbine operations are summarized as generation flow (cubic feet per second) for the entire project and by individual turbine unit recorded in 5-minute intervals. Operation data are expected to be available for the prior week of reporting for each weekly report. Figure 5 depicts peak acceleration levels of vibrations in the upper ladder aligned to a time series of generation flow for the previous week (Week 38) to assess the potential impact of turbine operation on measured vibration levels.

Construction Activities

Construction activities at LGR occur during both day and night shifts. Activities related to the Juvenile Fish Facility Upgrade Project occur in the vicinity of the adult ladder and can include channel mining, concrete drilling, concrete forming and pouring, and earthwork (excavation and backfilling). Other general construction activities in support of the fish facility upgrade can also occur. Construction activity data shown herein were obtained from daily construction logs submitted to USACE by the construction contractor. At the time of this report, daily construction logs were available from the beginning of this study (July 13, 2015) through September 23, 2016.

Table 1
Fish Counts

Species	Fish Window Count	
	This Week	2016 to Date
Chinook	3,807	12,1790
Coho	614	1,275
Sockeye	0	815
Steelhead	12,809	48,885

Table 2
Passage Success

Species	Unique Fish in Ladder	Unique Fish at Entrance	P Success	SE of P Success	P Dropback	SE of P Dropback	P Re-ascent	SE of P Re-ascent
Chinook	24	22	0.55	0.11	0	0	0	0
Coho	8	6	0.50	0.20	0	0	0	0
Sockeye	0	0	NA	NA	NA	NA	NA	NA
Steelhead	229	164	0.85	0.03	0	0	0	0

Table 3
Median Passage Time

Species	Unique Fish	Median Travel Time (days)
Chinook	22	0.21
Coho	6	0.19
Sockeye	0	NA
Steelhead	164	0.17

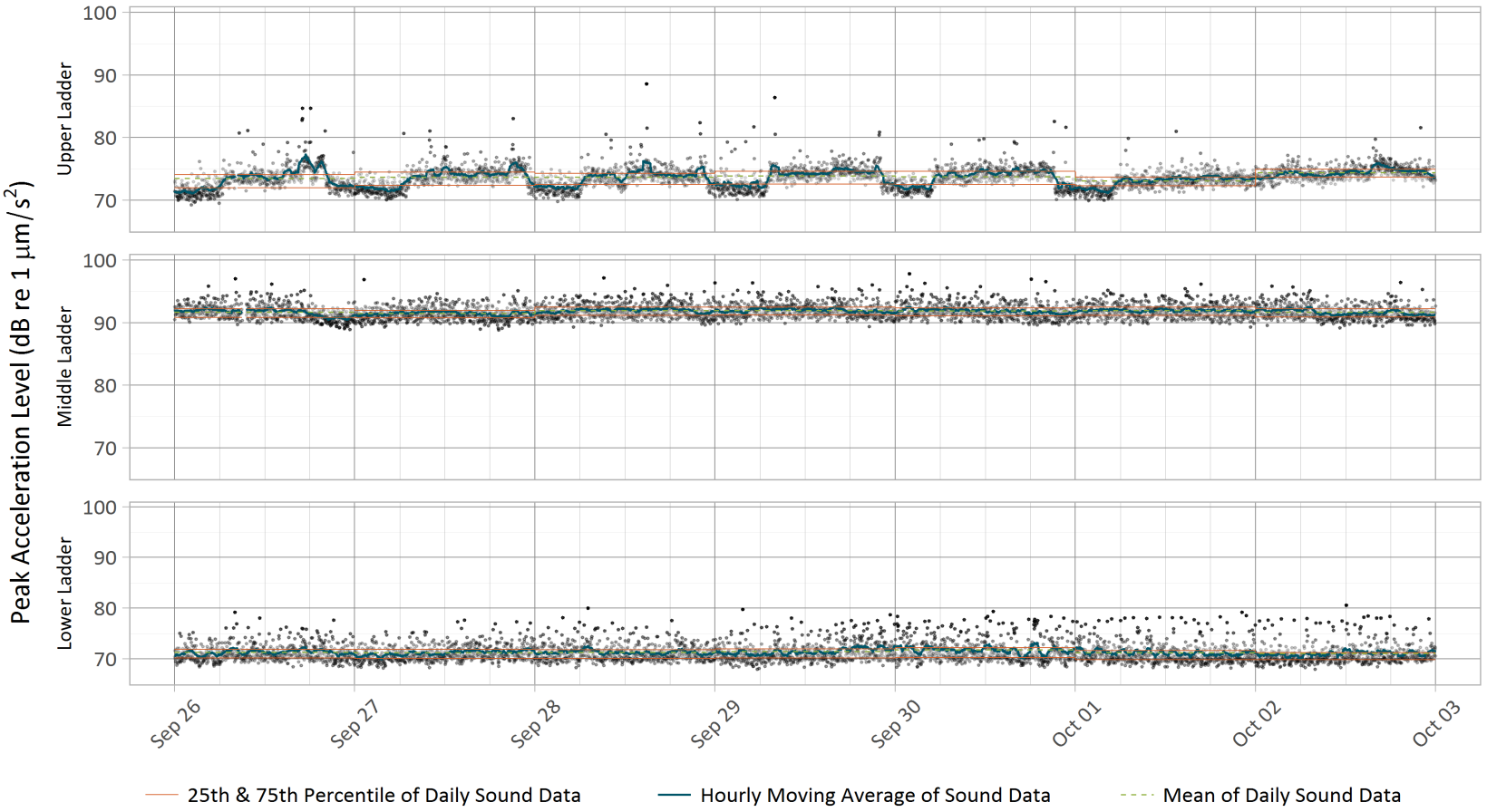

Figure 1

Peak Acceleration Levels Measured by Triaxial Accelerometers for Week 39

X-axis major tick marks are shown at midnight, and minor tick marks are shown at 6-hour intervals. Peak acceleration levels depict the maximum sound amplitude recorded per a 1-minute time interval. The sampling rate was 2 kilohertz (kHz), with a sampling duration of 60 seconds, 50% duty cycle, and band-pass filtered with cutoff frequencies of 10 and 30 hertz (Hz). Darker-colored dots show larger deviations of a single sound recording from mean sound levels.

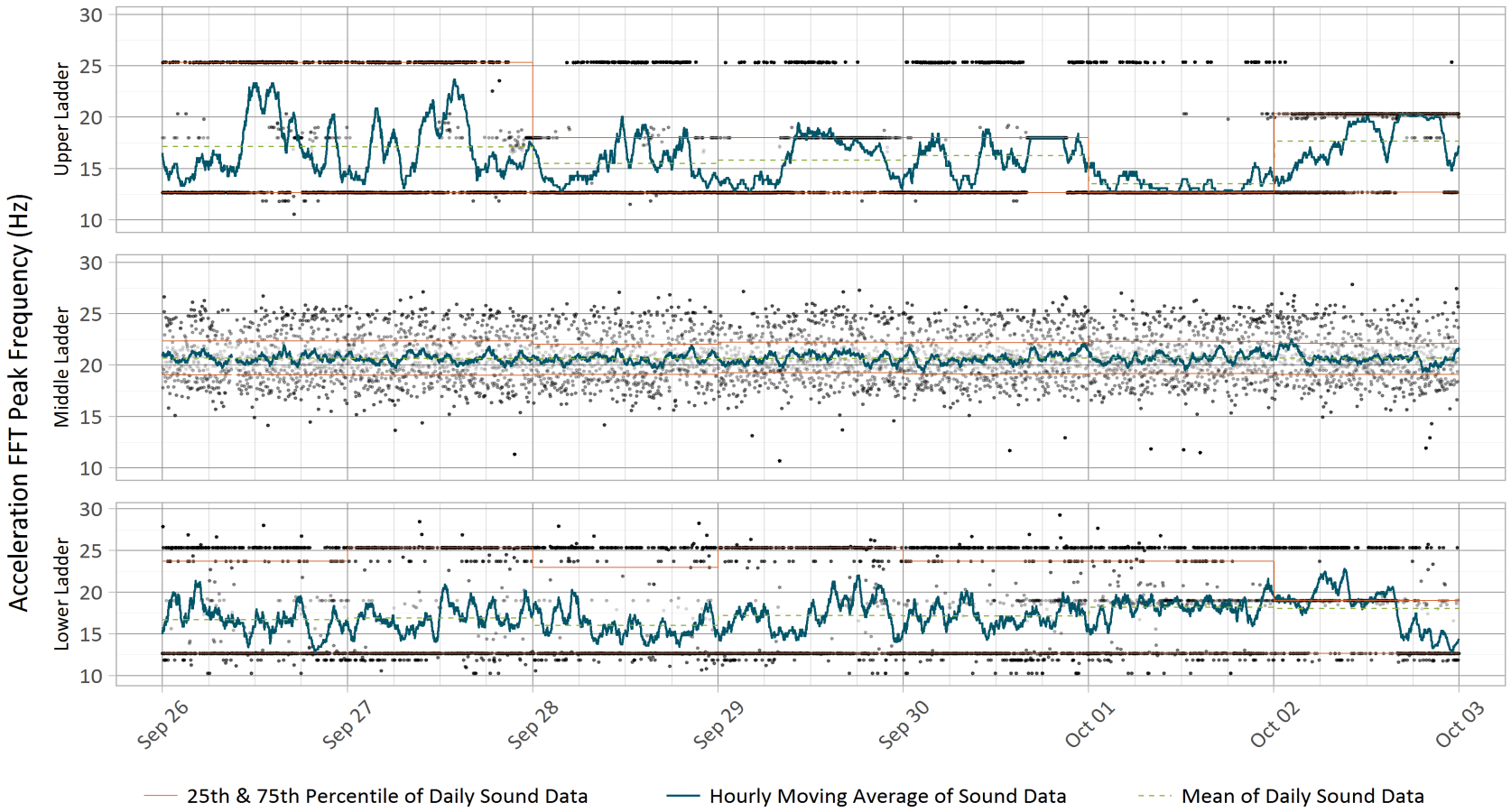

Figure 2

Acceleration Peak Frequencies Measured by Triaxial Accelerometers for Week 39

X-axis major tick marks are shown at midnight, and minor tick marks are shown at 6-hour intervals. Acceleration Fast-Fourier (FFT) transformed peak frequency depicts the largest peak in the frequency spectrum per a 1-minute time interval. The sampling rate was 2 kHz, with a sampling duration of 60 seconds, 50% duty cycle, and band-pass filtered with cutoff frequencies of 10 and 30 Hz. Darker-colored dots show larger deviations of a single sound recording from mean sound levels.

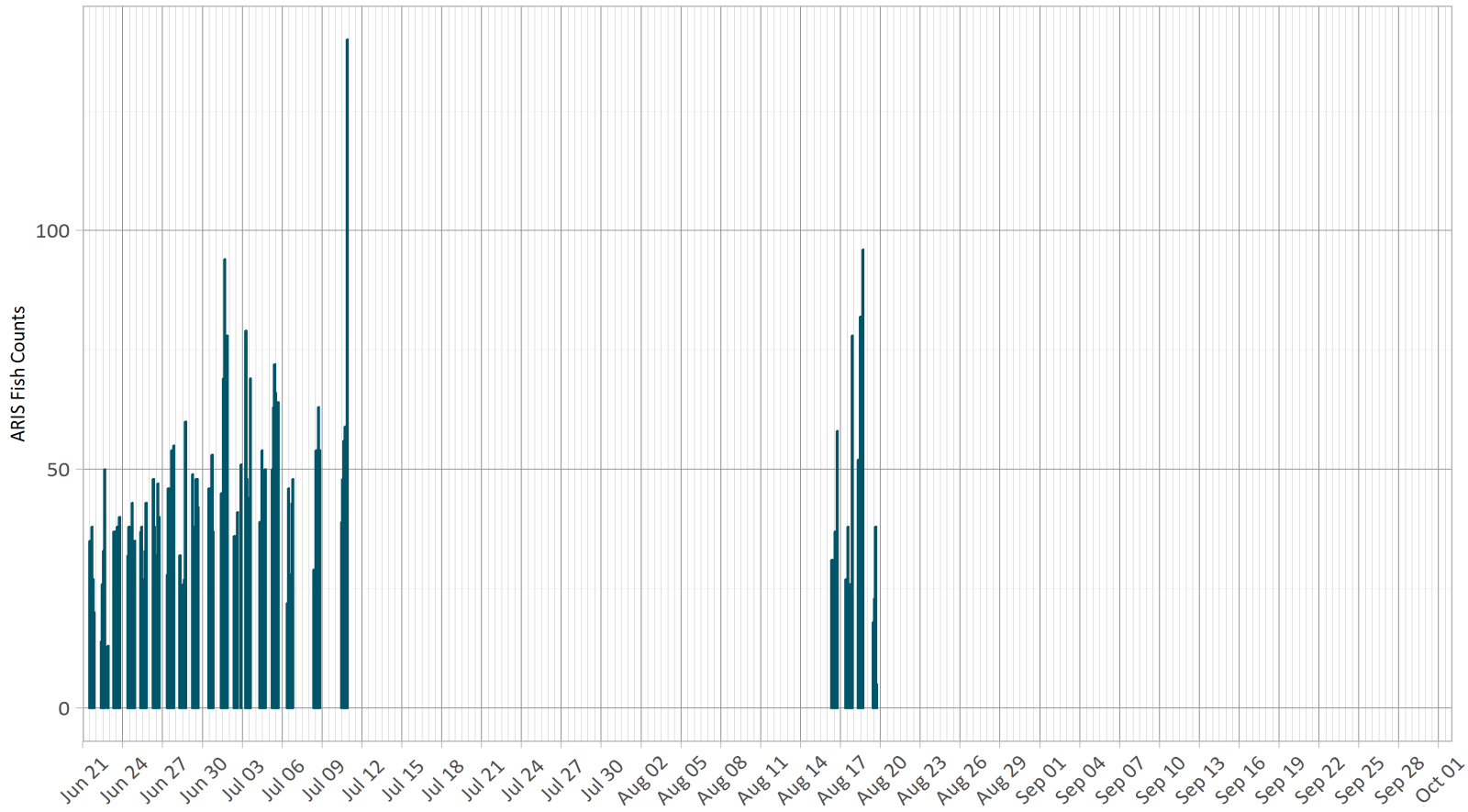

Figure 3

ARIS Fish Counts

The counts of marked fish by hour and day are shown for all days in which data processing has been completed. For each hour the counts reflect the sum total of fish marked within each of the five ARIS aiming positions.

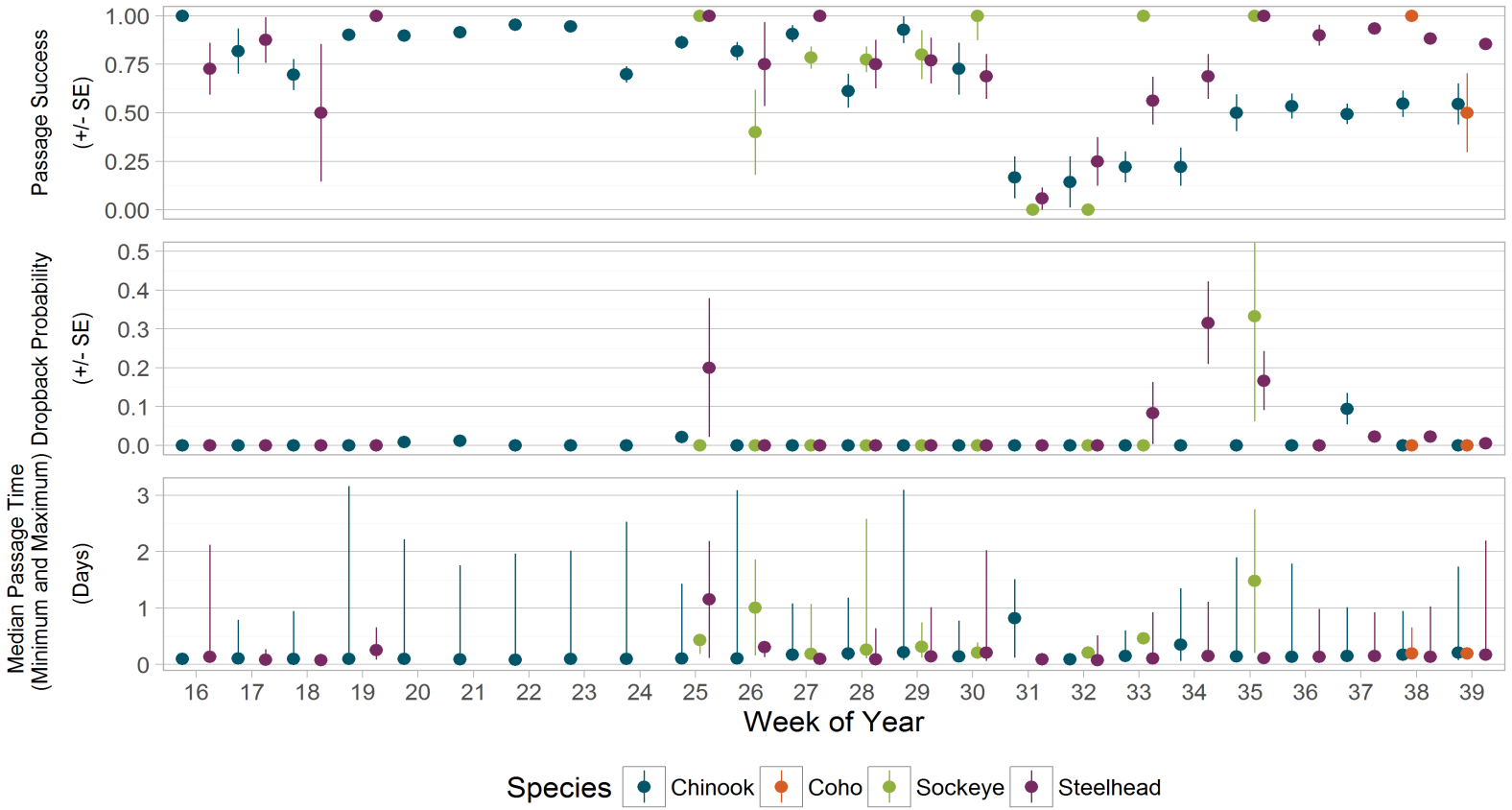

Figure 4

Running Summary of Fish Passage Metrics

Passage success and dropback probability and median passage time for each species in each week are based on pooling trapping and non-trapping periods. Error bars around the proportion of passage success and dropback probability represent plus or minus one standard error, for passage time they represent the minimum and maximum passage time for that week. For weeks with larger numbers of fish the standard error may be so small as to not be apparent. The numbers used to plot passage success and travel time are broken out by trapping and non-trapping periods for this week in Tables 2 and 3.

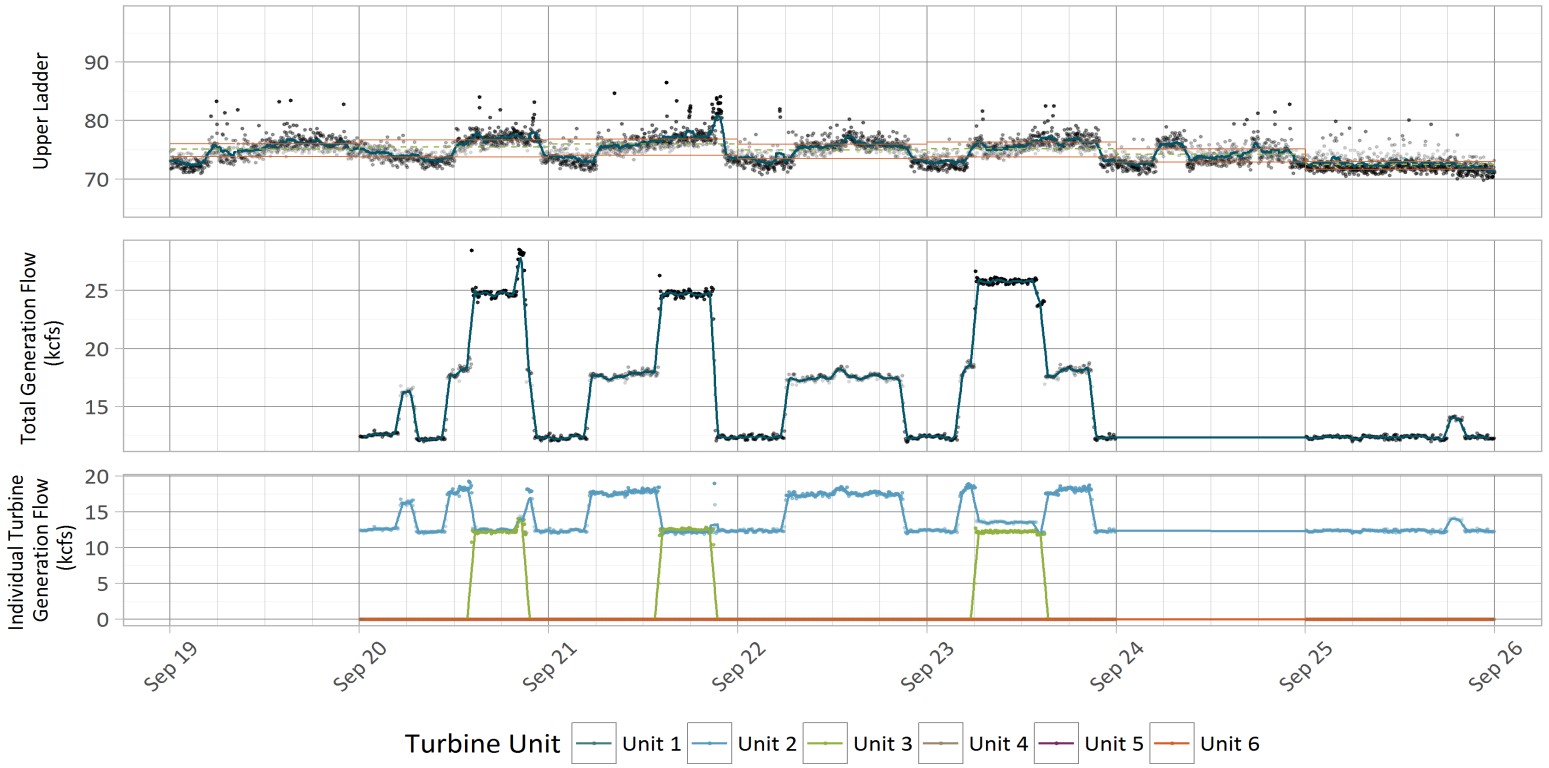

Figure 5

Peak Acceleration Levels Measured by Triaxial Accelerometers in the Upper Ladder with Turbine Operations for Week 38

X-axis major tick marks are shown at midnight, and minor tick marks are shown at 6-hour intervals. Peak acceleration levels depict the maximum sound amplitude recorded per a 1-minute time interval in the upper ladder. The sampling rate was 2 kHz, with a sampling duration of 60 seconds, 50% duty cycle, and band-pass filtered with cutoff frequencies of 10 and 30 Hz. Darker-colored dots show larger deviations of a single sound recording from mean sound levels. Individual turbine unit and overall generation flow are recorded in 5-minute time intervals and summarized with an hourly moving average line.

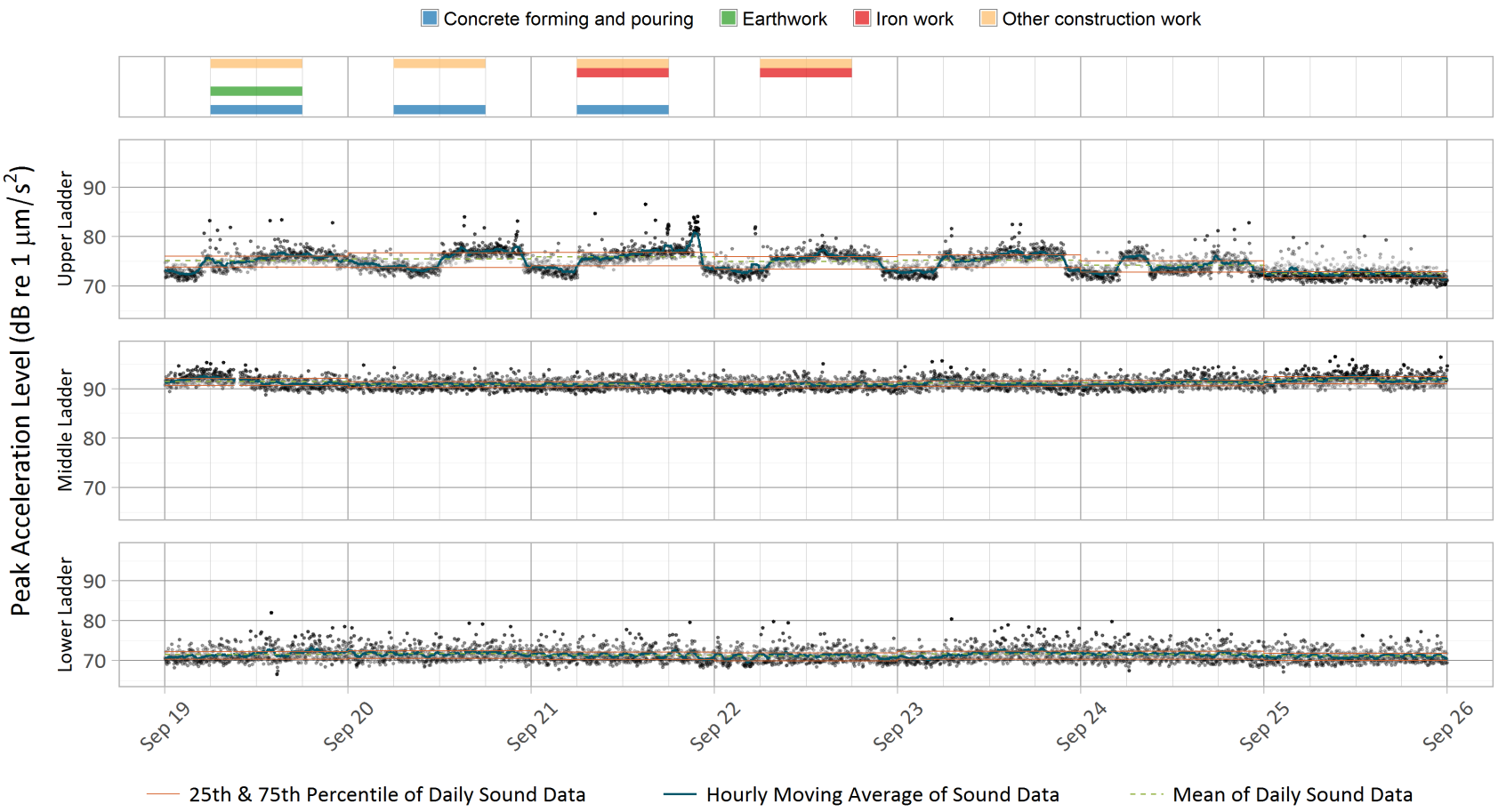

Figure 6

Peak Acceleration Levels Measured by Triaxial Accelerometers with Construction Information for Week 38

X-axis major tick marks are shown at midnight, and minor tick marks are shown at 6-hour intervals. Peak acceleration levels depict the maximum sound amplitude recorded per a 1-minute time interval. The sampling rate was 2 kHz, with a sampling duration of 60 seconds, 50% duty cycle, and band-pass filtered with cutoff frequencies of 10 and 30 Hz. Darker-colored dots show larger deviations of a single sound recording from mean sound levels.

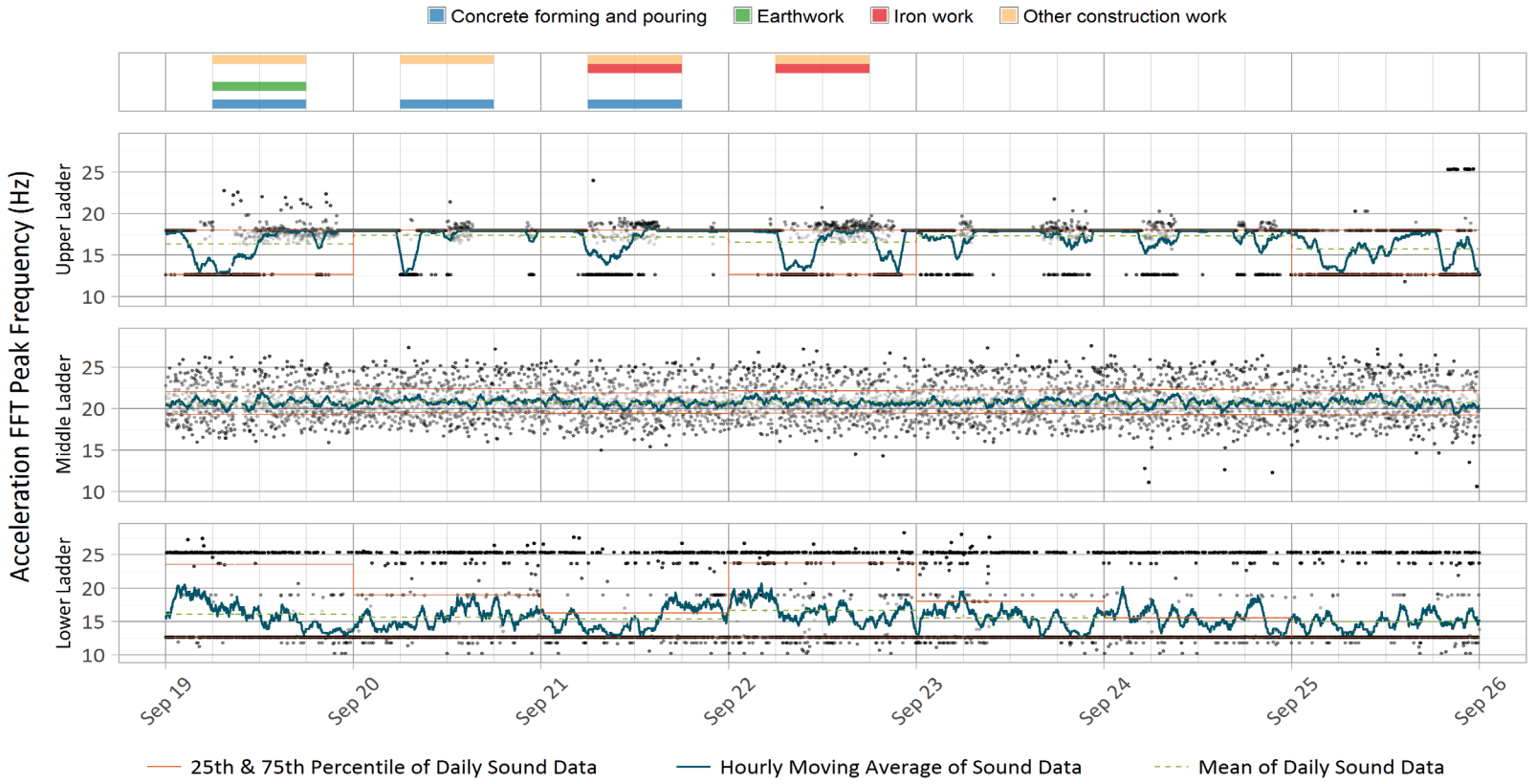

Figure 7

Acceleration Peak Frequencies Measured by Triaxial Accelerometers with Construction Information for Week 38

X-axis major tick marks are shown at midnight, and minor tick marks are shown at 6-hour intervals. Acceleration FFT transformed peak frequency depicts the largest peak in the frequency spectrum per a 1-minute time interval. The sampling rate was 2 kHz, with a sampling duration of 60 seconds, 50% duty cycle, and band-pass filtered with cutoff frequencies of 10 and 30 Hz. Darker-colored dots show larger deviations of a single sound recording from mean sound levels.