Impact Monitoring for Aquatic Organisms During Pile Driving for Bridge Construction in Western Washington

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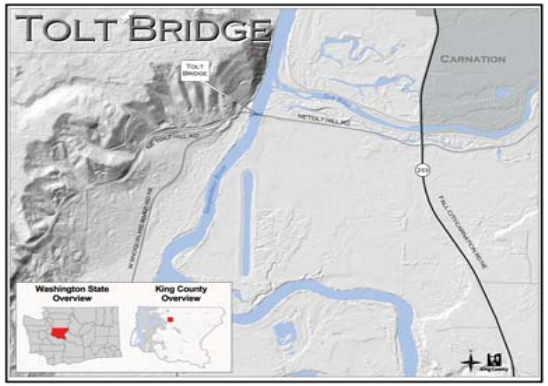
Abstract

Pile installation with hydraulic impact hammers (pile driving) for construction in and around water bodies has generated concerns about the types and level of impacts these activities have on aquatic organisms. Knowledge and studies of these impacts are particularly limited in riverine systems. In an effort to further understanding of these impacts, King County DOT monitored pile driving activities during a bridge replacement in Western Washington in the summers of 2006 and 2007. Biologists monitored the behavior of fish and amphibians during periods with and without pile driving and also tested the effectiveness of sound attenuation techniques to reduce the decibel level of underwater sound. Hydroacoustic monitoring occurred on ten percent of the piles installed to determine performance of bubble curtains and to assist in the assessment of the level of impact to fish and amphibians. The hydroacoustic monitoring indicated that attenuation devices can be effective in reducing underwater sound levels below 180 dBpeak (180 dB is the threshold for injury to salmon and trout currently used by the Services). Snorkel, sonar, and visual surveys were conducted to assess occurrence of instantaneous mortality or behavioral modification of species present. Fish species were observed to startle at the onset of pile driving, but then returned to pre-impact behaviors. No instantaneous mortality was detected. Results indicate that fish may be initially disturbed by sounds levels generated during pile installation, but return to normal behaviors relatively quickly in freshwater riverine and adjacent wetland habitats even as sound levels continue to be elevated.

Study Area



Snoqualmie River:

The project area is located in the Snoqualmie River at RM 25.15, approximately 700 feet upstream of its confluence with the Tolt River. In the vicinity of the project area, the Snoqualmie River is a low-gradient river that meanders through a broad floodplain with a mean annual flow of 3,704 cfs. The Snoqualmie River in the project area serves as migration and rearing Waters for a variety of anadromous salmonids including steelhead, Chinook, coho, chum, and pink salmon.

Wetland:

Within the study area is a 3.42 acre Category I wetland with an open water component that provides habitat for waterfowl, amphibians and fish. The surface connection to the Snoqualmie River also provides rearing habitat for salmonids under some flow conditions.

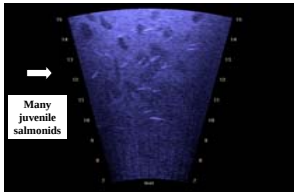
Methods

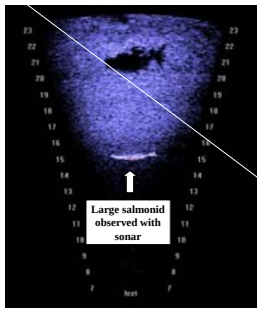
Hydroacoustic Monitoring:

Three Reson Type 4013 hydrophones were deployed at a depth of 5 ft from the water surface. Spacing always provided one channel of measurement at a distance of 33 ft from the pile being driven, with the other two measurement locations at approximately 90 and 190 ft from the pile. Signals from the hydrophones were recorded using a Dactron Photon 4-channel signal analyzer connected to a Fugitsu tablet computer. Data measured in Pascals and converted to Sound Pressure Level (SPL_{peak}).

Fish Monitoring (pre, during, and post pile driving):

- Visual surveys- conducted by boat and on river banks
- Snorkel surveys
- Sonar surveys- conducted with a DIDSON, dual frequency identification sonar fitted with a remote Ocean Systems pan/tilt system





Amphibian Monitoring:

- Visual behavioral observations of caged northwestern salamander larvae and bullfrog tadpoles
- Developmental measurements (length and weight) of caged northwestern salamander larvae and Pacific tree frog and red-legged frog tadpoles

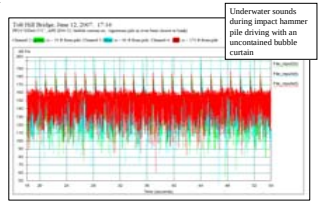
Uncontained bubble curtain with bubbles drifting downstream

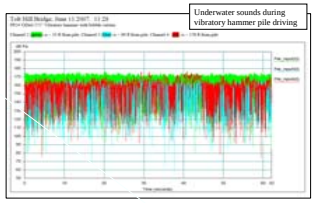
Contained bubble curtain (sleeve) placed around steel pile

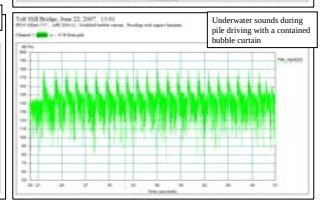
Results

Noise measurements:

- Landward impact pile driving resulted in peak underwater noise levels of 187dB [pile was 37 ft from river, hydrophone was 50 ft from shore (a total of 87 ft from pile)]
- In-water impact pile driving resulted in peak underwater noise levels between 188 and 204 dB
- In-water impact pile driving with uncontained bubble curtains in flowing water were not effective in attenuating pile driving sounds
- In-water impact pile driving with contained bubble curtains were effective in attenuating pile driving sounds by 8-24 dB







Fish observations:

- No instantaneous mortality observed (no assessment of internal injuries conducted)
- Behavior modifications did occur
  - Fish generally did not leave the area, even when within 15 ft of pile
  - Salmonids would stop feeding during pile driving
  - Initial startle response observed

Amphibian Monitoring:

- Data collected show no statistical difference between treatment (pile driving) and control (non-pile driving) in behavior of 5 month old bullfrog tadpoles and 7 month old Northwestern salamander larvae under the experimental conditions used and pile-driving values recorded
- Developmental data is currently being analyzed and no conclusions available

Acknowledgments

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