Date: August 14, 2002
Project Name: Lake Washington Ship Canal, Hiram M. Chittenden Smolt Passage Restoration
Non-Federal Sponsor: King County, City of Seattle, Washington, and Muckleshoot Indian Tribe
Location: Seattle, Washington
Congressional District: 7
Project Completion: May, 2000
Project Cost: $2,500,000
Authority: Section 1135 of WRDA 1986, PL 99-662
Project Manager: Corey Loveland, 206 764-3488
Coordinated With:
Lake Washington Forum
Lake Sammamish Forum
City of Seattle Public Works

Project Location:
The Lake Washington Ship Canal Project, constructed in 1916, provides navigation access between Puget Sound and the interior waters of Lake Washington and Lake Union near Seattle, Washington. The Sammamish and Cedar River systems support large anadromous salmon runs, particularly sockeye, which feed in Lake Washington. Puget Sound Chinook, an endangered species, also reside in the Lake Washington basin. A fish ladder at the Hiram M. Chittenden Locks provides for upstream migration of returning salmon adults. However, there were significant mortalities for salmon smolt when they migrate from the lake system and pass through the lock chambers to salt water.

Project Description:
The Lake Washington Ship Canal Section 1135 smolt passage improvement project began feasibility in 1999 and completed construction of primary project features by May 15, 2000. The project was designed collaboratively with fish passage engineers and biologists from the Washington Department of Fish and Wildlife and National Marine Fisheries Service. Up to 7 million salmon smolts pass through the Corps owned and operated Hiram M. Chittenden Locks. Prior to the Section 1135 project, many or most of these smolts used passage routes (up to 12 possible routes) through the project that were non-fish friendly (10 unfriendly routes). The majority of smolts were entrained in the large lock culverts with up to 70% descaled and possibly 10-15% directly killed after entrainment. The smolt passage improvement project features had three objectives: 1) reduction of smolt entrainment into the large lock filling culverts through use of strobe lights and slower fill of the large lock; 2) reduction of smolt injury once smolts are in the conduits by removing barnacles lining the conduits and possibly by slowing velocities; and 3) addition of four, low-flow surface collectors (smolt slides) in two spillway bays. The smolt passage project consists of two new structural features and two operational modifications to the large lock. On the spillway dam, two spillbays are seasonally removed from service to accommodate four new surface bypass collectors (smolt slides or smolt passage flumes). In the large lock chamber, a strobe light array will be installed around both filling culvert intakes (18 lights per intake), operated from April 1 to July 31 each year: after three years of equipment problems the strobe lights were fully tested in spring 2002. Operationally, the existing motors operating the Stoney gate

valves used to fill the lock chamber will be replaced with variable speed motors (VSM) to allow slow fill of the chamber: replacement is scheduled to occur in 2003. Besides replacement of the valve motors, the marine barnacles that line the filling conduits and culverts in the large lock are scraped each year.

Project Results/Monitoring Status: Monitoring of juvenile salmon (smolt) passage at the Locks has been ongoing since 1994. We will report on results for 2000 and 2001. Description of monitoring methods are available in separate reports, see http://www.nws.usace.army.mil/ers/Monitoring.cfm. Juvenile salmon may pass through the Locks through one of 12 different routes or pathways. We monitored four of these pathways during 2000 and 2001. Results are broken into the following areas: 1) entrainment into the large lock filling culverts; 2) observer counts of smolts passing over flumes; 3) fish guidance efficiency (FGE) – percent of smolts using one of two pathways – the flumes or large lock culverts; and 4) monitoring of other pathways – the saltwater drain and spillway bay number 2.

Entrainment Reduction by Slow Fill

- Purse seine catch suggests a trend with lower entrainment rates with slower fill rates.

Barnacle Removal

- The injury rate for heavily descaled smolts is 75% lower since barnacle removal (removal first occurred in November 1999) and 65% lower for lightly descaled fish.

Strobe Lights

- The first testing of the strobe light array was completed in spring 2002. Initial data analysis suggests there is an 80% reduction in smolt entrainment during fill events when the lights are turned on. Reporting of results will occur in winter 2003.

Smolt Passage Flumes

- In a single day up to 45,000 smolts can be passed over the flumes vs. a peak entrainment of 1,000 fish through the large lock culverts – or 98% using the flumes v 2% through culvert (98% fish guidance efficiency). PIT-tagging results show a peak in juvenile chinook passage in mid to late June for 2000 and 2001. In 2001, the peak passage period for wild Bear Creek and Cedar River chinook coincided with the decline in available water for spill. Observer counts likely underestimate the actual number of smolts passing through the larger flumes.

Fish Guidance Efficiency

- Adequate flow volume through the flumes is largely responsible for the reduced entrainment rate through the large lock culverts. Over the range of flume volume discharges (50-405 cfs) we have observed 1) over 97% of counted smolts pass over the flumes when flow volumes are greater than 260 cfs; 2) between 131 to 260 cfs approximately 92% of smolts pass over the flumes; and 3) at flows less than 130 cfs there is an almost even passage rate with 50% of smolts using the flumes and 50% entrained in the large lock culverts.

Saltwater Drain

- Few smolts are entrained during periods of spill or smolt passage flume operation. Estuarine fish are the most entrained fish with the highest entrainment rates in late August and September. Adult chinook enter the area of the drain intake and may hold for short periods but are able to swim-out during normal summer conditions.

Spillway Gate

- The estimates of fish passage through spillway gate number 2 suggest increased passage at a 12-inch gate height vs. 6 inch.

Estimates were 100 to 150% higher for the 12-inch gate opening, requires conversion to fish/cfs. The minimum gate opening previously used at the locks was 6 inches (this opening did not incorporate an objective to pass juvenile salmon).