Monitoring Sockeye Salmon Health in the Cedar River and Lake Washington

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The Cedar River sockeye salmon enhancement program began in 1991, with the goals of increasing the number of *Oncorhynchus nerka* returning to the Cedar River and providing biologists with an opportunity to study factors affecting sockeye salmon survival throughout their life history. Washington Department of Fish and Wildlife (WDFW) operates the hatchery with funding provided by Seattle Public Utilities (SPU) through the Cedar River Habitat Conservation Plan. Since its inception WDFW has provided fish health monitoring for the Cedar River Hatchery located at the Landsburg diversion dam. In July of 2005 SPU also began contributing funding to support the Fish Health component.

Since the origin of this project the majority of the pathogen monitoring at the facility has been screening for the viral pathogen infectious hematopoietic necrosis virus (IHNV). This virus is present in the Lake Washington basin and caused substantial mortalities in sockeye salmon during a previous incubation project on the Cedar River. Stringent disinfection and isolation procedures are in place at the current hatchery to avoid infection of the juveniles with this virus. Each fall adults are tested for IHNV throughout the spawning season to ascertain the prevalence of the virus. Each release of fry is also tested for IHNV to assess the condition of the group at release. If the fish in any incubator show unusual behavior, or have above normal mortality prior to release, these fish are examined and tested for viral pathogens. Many years the naturally produced sockeye salmon fry are also tested for viral pathogens throughout the outmigration to monitor the prevalence of IHNV.

Periodically since the enhancement project originated juvenile fish that have been collected for various analyses have also been sampled for pathogens. In the spring of 2007 smolts were collected from Lake Union for otolith analysis and the Fish Health lab was able to obtain a number of these fish for pathogen monitoring.

During the summer of 2005, returning adults were also screened for specific pathogens to determine whether disease plays a role in the survival of adults returning to the spawning grounds. No pathogens were detected during that screening to indicate that disease played a role in the poor adult survival. Otolith sampling occurred again on returning adults at Ballard Locks in the summer of 2006 but the only pathogen sample was a virology sample was taken late in the migration. This was primarily because no pathogens were detected the previous summer, no mortalities were seen during this sample period, and no abnormalities were evident in the fish collected at the locks.

METHODS

Adults

On August 23, 2006 WDFW staff collected samples for virology testing from 20 sockeye salmon adults captured from the fish ladder at the Ballard Locks by Muckleshoot Indian Tribe biologists. Each year during spawning at the hatchery ovarian fluid (OF) from approximately 24 adults is sampled weekly and on one spawn day, 63 kidney and spleen samples were also taken. These samples were tested for IHNV and other regulated viral pathogens. OF is generally a more sensitive specimen to test for IHNV so it is emphasized during the hatchery sampling. The following describes the testing methodology. Kidney and spleen tissues were individually harvested from each fish sampled at the locks for testing for viral pathogens. Kidney and spleen tissues collected from adults at the hatchery were combined in 3-5 fish pools to screen for a viral pathogen that is not detected in the OF. All OF samples were tested individually. These tissues and all juvenile samples were processed fresh using standard virological cell culture procedures. The diluted sample is inoculated onto CHSE 214 and EPC cell lines for a minimum of 14 days at 15°C to monitor for the cytopathic effect from viruses. Confirmation of any viral isolates is done using specific antibody tests. Methodology is used that will detect IHNV, infectious pancreatic necrosis virus (IPNV) or viral hemorrhagic septicemia virus (VHSV).

Juveniles

Each year approximately 30 fry are collected from each incubator or rearing unit at release to test for IHNV. This monitoring assesses the health of the fish at release and is used to evaluate the effectiveness of the IHNV control strategies. Most weeks some of the fry were held in the incubators and only one shipment was made to the lab each week in order to minimize shipping. The fry were transferred to the Fish Health Lab live, euthanized upon receipt and processed whole in five fish pools. If fish in any of the incubators or rearing containers showed abnormal behavior or excessive mortality, a representative sample was sent to the lab at that time to evaluate the cause and test for virus. In addition to virology, a small number of fish from all of the fed groups and many of the unfed groups were also examined microscopically to monitor for bacteria, parasites, gill condition, and other abnormalities. Rearing space is limited at this hatchery, but 4.8 million of the fry were fed for a one to two week period prior to release. This practice has been shown to improve the survival of the fry after release. However, the intensive feeding has the potential cause gill disease so the gill condition was evaluated.

Many years the WDFW Fish Health Lab has also taken weekly samples of 100 sockeye salmon fry from the floating inclined-plane screen trap that is maintained on the lower river to monitor outmigration. These fish are also processed whole in five fish pools and tested for virus. Although there is no way to separate the naturally produced fry from the hatchery fry, sampling has been done on nights that were at least two nights after any hatchery releases above the fry trap to minimize the likelihood of including hatchery produced fry. Although 2006 had been a good return year, high flows in November destroyed a large percentage of the redds. This dramatically reduced the number of outmigrating fry and only two samples were collected from early in the outmigration. Fish from one of these samples were also examined microscopically.

A portion of the smolts that were captured in Lake Union for otolith analysis in the spring of 2007 were also sampled for regulated viral pathogens. A total of 74 fish were brought to the Fish Health

Lab over a period of three weeks in May, examined, and kidney and spleen tissues were harvested from each fish. These tissues were combined in two fish pools and tested for viruses as described above.

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RESULTS AND DISCUSSION

Adults

During the summer of 2006 the adult return was estimated to be 458,000 sockeye salmon through the Ballard Locks. The fish examined at the locks had light infestations of copepods and occasional wounds, but no external signs of disease. Returns to the river were lower than anticipated but there were no reports of moribund or dying adults this year. No viral pathogens were detected in any of the immature adults collected at Ballard Locks or mature adults spawned at the hatchery (Table 1.). Mortality levels were normal in the adults that were held at the hatchery for spawning. No signs of disease were evident in these fish, but no testing was done other than the viral testing. This is the first year of monitoring that IHNV has not been detected in spawning adults. This is extremely unusual and indicated a low incidence of the virus in the system in 2007. However, high flows in the river in early November damaged the adult collection weir and only a limited number of adults were collected after that, with the last eggtake on November 14th. Often IHNV is not detected in the early eggtakes and prevalence increases throughout the spawning period. It is likely that virus would have been detected if later spawning adults had been sampled.

Table 1. Results for adult sockeye salmon virus testing

Sample date	**Viral results**
08/23/06	0/20 from K/S VD*
09/27/06	0/24 from OF VD
10/03/06	0/24 from OF VD
10/11/06	0/24 from OF VD
10/17/06	0/24 from OF VD
10/24/06	0/24 from OF VD 0/14 pools from K/S (63 fish total in 3-5 fish pools) VD
10/31/06	0/24 from OF VD
11/09/06	0/24 from OF VD
11/14/06	0/22 from OF VD

* virus detected

Juveniles

The health of the fry was very good at release (Table 2.). There were only minor impacts on gill condition in some of the fed groups and the majority of the fry were showing some deposition of fat. Mortality was only seen in one incubator and the loss was not due to IHN. No virus was detected in the naturally produced sockeye salmon fry (Table 3.) but due to a poor outmigration of these fry and limited staffing in the lab, only two samples were collected. They were collected during the time of outmigration when virus has been detected in the years that it was present. No virus was detected in the smolts collected in Lake Union (Table 4.). No other pathogen screening

was performed on these fish, but by visual exam the fish were normal externally and internally with no overt signs of disease.

Overall, this was considered a very successful year with the fry released in good condition. The fish accepted feed well and had good growth, even with the short rearing period. Ewos feed was used this year, and although there were some palatability issues with other species, no problems were seen with the sockeye. As seen in the past, there was some yolk retention on a small portion of the fish, but this is normal for fry that can't emerge volitionally. Strict adherence to disinfection procedures, low prevalence of virus in the adults and improvements to protect the spring water supply at the hatchery all helped prevent losses due to IHN this year.

Table 2. Results for hatchery produced sockeye salmon fry

Sample date	**Vessel**	**Rearing**	**Sample type**	**Virus results**	**Visual exam**
01/29/07	A-7	unfed	routine	0/6 pools (30 fish) VD	early swim up of some fry, no virus detected and gills normal, fish released
01/29/07	A-8	unfed	routine	0/6 pools (30 fish) VD	no exam
01/29/07	A-9	unfed	routine	0/6 pools (30 fish) VD	no exam
01/29/07	A-10	unfed	routine	0/6 pools (30 fish) VD	no exam
01/31/07	A-1, S-1	fed	routine	0/6 pools (30 fish) VD	normal
01/31/07	A-3	fed	routine	0/6 pools (30 fish) VD	normal
01/31/07	A-4	fed	routine	0/6 pools (30 fish) VD	normal
02/07/07	S-2, A-5, A-6, S-3	fed	routine	0/6 pools (28 fish) VD	normal
02/07/07	A-15	unfed	routine	0/6 pools (30 fish) VD	normal
02/07/07	A-16	unfed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-13	fed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-14	fed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-11	fed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-12	fed	routine	0/6 pools (30 fish) VD	normal
02/12/07	B-15	unfed	diagnostic	0/7 pools (35 fish) VD	early swim up of some fry, no virus detected and gills slightly swollen, probably a problem with flow, fish released
02/12/07	A-17	unfed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-18	unfed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-19	unfed	routine	0/6 pools (30 fish) VD	normal
02/12/07	A-20	unfed	routine	0/6 pools (30 fish) VD	normal
02/20/07	A-21, A-22	fed	routine	0/6 pools (30 fish) VD	normal
02/20/07	A-23	fed	routine	0/10 pools (30 fish) VD	normal
02/20/07	A-24	fed	routine	0/10 pools (30 fish) VD	gills slightly swollen
02/20/07	A-25	fed	routine	0/6 pools (30 fish) VD	normal
02/20/07	A-26	fed	routine	0/6 pools (30 fish) VD	normal

Table 2. Viral results from hatchery produced sockeye salmon fry (continued)

Sample date	Vessel	Rearing	Sample type	Virus results	Visual exam
02/20/07	A-27	fed	routine	0/6 pools (30 fish) VD	normal
	A-28			no test – fish lost to suffocation	
02/21/07	B-1	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	B-2	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	B-3	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	B-7	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	B-8	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	B-9	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	B-10	unfed	routine	0/6 pools (30 fish) VD	no exam
02/21/07	S-4	unfed	routine	0/6 pools (30 fish) VD	no exam
02/28/07	B-11	unfed	routine	0/6 pools (30 fish) VD	no exam
02/28/07	B-12	unfed	routine	0/6 pools (30 fish) VD	no exam
02/28/07	B-13	unfed	routine	0/6 pools (30 fish) VD	no exam
02/28/07	B-14	unfed	routine	0/6 pools (30 fish) VD	no exam
03/07/07	B-4	fed	routine	0/6 pools (30 fish) VD	normal
03/07/07	B-5	fed	routine	0/6 pools (30 fish) VD	slight gill swelling
03/07/07	B-6	fed	routine	0/6 pools (30 fish) VD	normal
03/07/07	B-15	unfed	routine	0/6 pools (30 fish) VD	normal
03/07/07	B-16	unfed	routine	0/6 pools (30 fish) VD	normal
03/07/07	B-17	unfed	routine	0/6 pools (30 fish) VD	normal
03/07/07	S-5	unfed	routine	0/6 pools (30 fish) VD	normal
03/14/07	B-18	unfed	routine	0/6 pools (30 fish) VD	no exam
03/14/07	B-19	unfed	routine	0/6 pools (29 fish) VD	no exam
03/14/07	B-20	unfed	routine	0/6 pools (30 fish) VD	no exam
03/19/07	S-6	unfed	routine	0/6 pools (30 fish) VD	no exam

Table 3. Viral results from naturally produced sockeye salmon fry

Sample date	Virus results	Visual exam
01/29/07	0/21 pools (104 fish) VD	no exam
02/12/17	0/20 pools (100 fish) VD	normal, more variation in yolk adsorption

Table 4. Viral results from sockeye salmon smolts captured in Lake Union

Sample date	Virus results
05/08/07	0/18 pools (36 fish) VD
05/15/07	0/5 pools (5 fish) VD
05/22/07	0/10 pools (20 fish) VD
05/29/07	0/4 pools (8 fish) VD