Fish Health Risk Assessment of Adult Anadromous Fish in Marion Creek on Fish Stocks Reared at Marion Forks Hatchery

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EXECUTIVE SUMMARY

Studies to examine the potential for reintroduction of winter steelhead and spring Chinook salmon above Detroit Dam on the North Santiam River are underway. The plan is to eventually pass returning anadromous fish above the dams to provide access to historical spawning grounds. This report outlines the substantial fish health risks that these adult fish pose to the spring Chinook, steelhead and other trout species reared at Marion Forks Hatchery. Marion Forks Hatchery utilizes both Horn and Marion creeks to supply water to the hatch house, raceways and ponds. A finger weir is in place on Marion Creek to block returning anadromous fish from entering waters supplying the hatchery. Horn Creek has a cement dam blocking fish passage. Even with the weir in place on Marion Creek, adult spring Chinook escaped above the weir in 2013, 2014, and 2015. Since the arrival of adult spring Chinook in Marion Creek above the hatchery intake, juvenile spring Chinook at the hatchery have had increasing prevalence and severity of Bacterial Kidney Disease (BKD). In 2016, there was a BKD epizootic in spring Chinook at the hatchery, killing 45% of the BY2014 smolts. Returning winter steelhead adults pose additional risk through the introduction of Infectious Hematopoetic Necrosis Virus (IHNV). Consequences of IHNV infection depend on the fish species. Rainbow trout and steelhead typically have higher losses from the virus than Chinook, but Chinook can become infected as well. Besides fish mortality, IHNV incidence at the hatchery will also affect where that year class of fish and those in subsequent years can be stocked. Unlike some other hatcheries that have anadromous passage above the hatchery intake, there are just four miles of habitat above the hatchery on Marion Creek. This limits the dilution of pathogens prior to reaching the hatchery intake. It is the conclusion of this risk assessment that anadromous fish pose a high risk of pathogen transmission to fish in the hatchery and that the best course of action is to install a water disinfection system. A well-designed water treatment system can provide pathogen-free water to the hatchery without blocking habitat for anadromous and resident fish species. A system capable of applying 150 mWs of UV irradiation should inactivate the causative agents of BKD, IHNV and bacterial coldwater disease.

INTRODUCTION

In 2017, ODFW biologists expect the first returns of adult winter steelhead *Oncorhychus mykiss* to the North Santiam River that were part of a paired release study that started in 2014. The purpose of the study was to describe the generalized effects of dam and reservoir passage and inform future reintroduction efforts.

Historic spawning habitat is currently inaccessible because of multiple dams (Detroit and Big Cliff) that prevent upstream migration.

Marion Forks Hatchery is located near river mile 86 in the Cascade mountain range upstream of Detroit Dam on the North Santiam River. The facility utilizes both Marion Creek and Horn Creek as water supplies. Both creeks have methods of blocking adult anadromous fish passage above the hatchery water intake, but they vary in their efficacy. Marion Creek utilizes a seasonal finger weir, but topography and weather conditions make the weir prone to clogging during storms, and the flashy nature of the stream makes it unsafe for maintenance or removal at certain times in the winter and spring. Horn Creek has a cement dam that blocks upstream fish passage. In 2013, adult spring Chinook salmon *O. tshawytscha* that were passed above Detroit Dam returned to Marion Creek and escaped above the weir. An increase in the prevalence of *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD) in juvenile spring Chinook at the hatchery coincided with this event. In 2015, loss of spring Chinook smolts in the hatchery reached epizootic levels (>0.1% mortality per day) with the disease first detected in the summer and mortality continuing into spring 2016. In addition to lethal infections, *R. salmoninarum* may persist in the fish at a low chronic level, leading to compromised health status. Poor smolt health, the loss of large juvenile fish (14-17 fish per pound), the use of expensive antibiotics, and release schedule changes were all consequences of adult Chinook escaping above the weir.

Expansion of adult passage above the dams with continued migration above the hatchery intakes is expected to exacerbate fish health problems in fish at the hatchery. Marion Forks Hatchery primarily rears spring Chinook salmon but also produces winter steelhead for release on the North Santiam (currently, for research only). Brook trout *Salvelinus fontinalis*, cutthroat trout *O. clarkii* and rainbow trout are also reared for high lake stocking. Several hundred thousand spring Chinook are reared for the SAFE program and are transferred to net pens in the Columbia River. Besides fish health and economic issues, changes in the pathogens enzootic to the hatchery water supply could also change the ability to transfer fish reared at this facility to other locations. Oregon's fish health policy prohibits the stocking of fish infected with certain pathogens into non-enzootic areas.

Fish passage above Detroit Dam is expected to expand in the future, and without suitable weirs blocking adult anadromous fish from going above the hatchery intake or water treatment to disinfect incoming water to the hatchery, fish health impacts are predicted to persist and worsen with time. This report provides an assessment of the health risks to Marion Forks Hatchery production if anadromous fish (both spring Chinook and winter steelhead) continue to be permitted to enter the area above the hatchery water intake on Marion Creek.

This report is organized as follows:

1. Background- pertinent information including fish stocks and number of fish reared at the facility, a summary of the disease history at the

hatchery, disease history of returning adult anadromous fish and our current knowledge of pathogens endemic to resident fish currently residing in the hatchery water supply

2. Statement of the Problem- returning adult anadromous fish passed above the dams migrate into waters supplying the hatchery
3. Evaluation of Risks- returning adult anadromous fish in the hatchery water supply pose health risks to the fish stocks at Marion Forks Hatchery
4. Conclusions and Recommendations- ODFW Fish Health recommendations

BACKGROUND

Marion Forks Hatchery is located near river mile 86 in the Cascade mountain range, and utilizes both Marion Creek and Horn Creek as water supplies. The facility can choose between water sources based on water temperature or flow availability. The facility can also provide a mix of the two water sources. The hatch-house uses vertical incubators as well as Canadian troughs. Eggs are transferred into Marion Forks Hatchery from Minto Fish Facility, where adult anadromous fish are trapped and spawned. Eggs from other trout species are shipped in from other facilities. Fish moved out of the early rearing building are transferred outside where there are 48 cement circular ponds and eight raceways.

Hatchery Production

The following species are reared onsite: spring Chinook (2,079,000 eggs, 1,554,000 smolts), winter steelhead (25,000; for the paired release study), brook trout (4,200), cutthroat trout (7,000) and rainbow trout (15,000). Spring Chinook are reared to smolts, then transferred to Minto for acclimation and released below the dams or transferred to net pens on the Columbia River as part of the SAFE program. The trout species are stocked into high mountain lakes during the summer.

Water Supplies/Barriers

Hatchery water sources- the hatchery has two water sources:

a) Marion Creek- can be supplied to the hatchery and all of the ponds
b) Horn Creek – can be supplied to the hatchery and all of the ponds

Passage barriers- barriers to fish passage are:

a) A temporary picket weir is in place on Marion Creek from July to October depending on rainfall and flows.
b) Horn Creek has a cement dam that forms the intake for the hatchery and prevents fish passage. Downstream, there is also a picket weir that prevents fish from migrating into the discharge of the raceways and jumping into the ponds.

Resident and migrating fish

Fish below the hatchery
Brook, cutthroat and rainbow trout, mountain whitefish *Prosopium williamsoni*, winter steelhead and spring Chinook are present in the North Santiam River. In 2015, coho salmon *O. kisutch* were also trapped at the Minto collection facility and released downstream. With passage above Detroit Dam planned for both winter steelhead and spring Chinook, these are the species of concern if they escape above the hatchery intake on Marion Creek. The construction of the dams in the 1950s prevented all adult anadromous fish from migrating back to Marion Creek. Starting in fall 2013, adult spring Chinook were trucked to Detroit Lake; these fish then migrated to Marion Creek and (except for 2016) bypassed the weir. The seasonal picket weir (in place July to October depending on weather and flows) is effective at low flows but fish have bypassed it most years during high flow events since outplanting above the dams began. Besides being compromised by fish passing above it, weir placement, removal, and maintenance is a safety concern for staff during certain weather conditions and stream flows.

Resident fish above the hatchery
Several miles of creek and high mountain lakes located above the hatchery support resident fish species. Gooch Falls, a natural barrier to anadromous fish passage, is four miles above the hatchery on Marion Creek. Pathogen prevalence and fish health status of fish above the weir is unknown,[1] as no surveys have been performed for resident salmonids or other species. This is a current data gap.

Fish Health at Marion Forks Hatchery and the North Santiam

Adults in the North Santiam- Adult Chinook held at Minto Fish Facility for broodstock return to the trap infected with the following bacterial infections: Columnaris, furunculosis, opportunistic *Aeromonads-Pseudomonads* and BKD. Broodstock are injected with antibiotics to improve survival to spawning and prevent further disease transmission. Adults also have copepod infestations.

Renibacterium salmoninarum and BKD[2] have a long history in North Santiam spring Chinook on the N. Santiam. This bacterium can be transmitted horizontally from fish to fish as well as vertically from an infected female into the eggs. Based on fish health testing using ELISA, prevalence in spawned adults over the last 30 years was

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[1] Although pathogen surveys have not been conducted, current data indicates that *Renibacterium salmoninarum* has become established in resident fish upstream of the hatchery. This is explained in the: “Statement of the problem” section of this report.

[2] For clarification, there is a difference between prevalence of bacterial detection in diagnostic tests such as an ELISA or fluorescent antibody test (FAT) and incidence of BKD, in which the fish’s tissues show pathological changes associated with disease.

generally low (< 10%), but there were three periods (1987-1989, 1994-1997, and 2001-2004) when prevalence ranged from 11% to as high as 47%. Most of these were low infection intensity (indicated by low optical density ELISA values) but there were still a large number of fish with medium and high results. Returning adults have several potential sources of infection: they could be carriers since hatch (via vertical transmission), they could encounter the bacteria during outmigration in fresh water, or could contract the infection during saltwater residence.

Knowledge of winter steelhead health issues is more limited. *Renibacterium salmoninarum* prevalence was considerably lower in the winter steelhead, which were only tested from 1988-1990. For these three years, *R. salmoninarum* prevalence ranged from 2.0%-4.5% and all detections were low positives (low intensity). Historical fish health records do not report bacterial culture data from these fish. Virus testing from several species in the North Santiam system is summarized in Table 1.

Table1. Virus sampling and prevalence in salmonids in the North Santiam River.

Species	**Timeframe tested**	**Life stage**	**Locations**
KOKANEE	1981-2015	Aduts (746)	Green Peter
			Foster Reservoir and Trap
			Detroit Reservoir
	Results: No evidence of virus (NEV)		
SPRING CHINOOK	1983-2015	Juvenile (536)	Detroit Reservoir, Dexter
			Marion Forks Hatchery
	Results: No evidence of virus (NEV)		
	1980-2016	Adults (5046)	Minto, N. Santiam River
	Results:		
	IHNV +	2% of 190 fish in 1989	
		6% of 69 fish in 1989	
		15% of 60 fish in 2004	
SUMMER STEELHEAD	1980, 1984-1985, 1990	Adults (250)	Foster Trap, Green Peter
			Minto
	Results:		
	IHNV +	33% of 24 fish in 1984	
WINTER STEELHEAD	1980-1998, 2002		Marion Forks Hatchery
	2005-2010, 2013, 2015		Minto
		Juveniles (651)	
	Results: No evidence of virus (NEV)		
		Adults (2864)	
	Results:		
	IHNV +	4% of 100 fish in 1986	
		7% of 102 fish in 1986	
		29% of 70 fish in 1986	
		10% of 68 fish in 1987	
		45% of 64 fish in 1987	
		15% of 13 fish in 1987	
		32% of 73 fish in 1987	
		46% of 68 fish in 1987	
		21% of 190 fish in 1988	
		10% of 195 fish in 1988	
		12% of 60 fish in 1988	
		9% of 68 fish in 1989	
		40% of 24 fish in 1989	
		30% of 35 fish in 1989	
		35% of 57 fish in 1989	
		6% of 61 fish in 1990	
		82% of 43 fish in 1990	
		100% of 12 fish in 1996	
		100% of 7 fish in 1996	
		100% of 3 fish in 1996	
		* 82% of 49 **wild fish** in 2002	
		* 25% of 8 **wild fish** in 2002	
		21% of 24 fish in 2005	
		* 71% of 20 **wild fish** in 2006	

Fingerlings/smolts- Pathogens and parasites found in juvenile fish at Marion Forks Hatchery are listed in Table 2. Prior to the implementation of the ELISA[3] culling program in 1998, BKD occurred regularly in fry and smolts and erythromycin medicated feed was used routinely. Once the ELISA culling program was fully implemented, the *R. salmoninarum* prevalence in fry dropped precipitously. There were no clinical infections, signs of BKD or BKD epizootics from 1998 to 2013. In those 15 years, juvenile spring Chinook sampled at liberation from Marion Forks were mostly negative by ELISA and the few years that did have positive detections (1998, 2001, 2005, and 2012) were limited to low prevalence and low intensity. Since its detection in kidney lesions in smolts in 2013, clinical BKD has occurred each year. In 2013 and 2014, detections did not occur until fall in smolts, after the adults had bypassed the weir. In summer 2015, BKD was detected in juvenile spring Chinook at the hatchery prior to adult migration. In spring 2016, these BY2014 smolts had epizootic loss (>0.1% per day) and nearly 100% prevalence in mortalities. Erythromycin medicated feed was used to treat the ponds experiencing the highest mortality with little effect. A sub-group of these same 21.14 stock smolts sent to Clatsop County Fisheries had 58% prevalence. In contrast, historical records report that prevalence of BKD in the juvenile winter steelhead (tested 1988 to 1991) never exceeded 3.6% and all detections were low intensity.

Coldwater disease (CWD, *Flavobacterium psychrophilum*) causes occasional infections in juvenile salmon at the hatchery, requiring treatment of both winter steelhead and spring Chinook. Both species have been successfully treated with florfenicol. External parasites such as *Chilodonella*, *Ichthyobodo,* or Trichodinids require formalin treatment usually at least once a year depending on the species. In the past (1995 and 2000) cutthroat have needed treatment for bacterial gill disease (BGD), but this is not a routine problem. *Saprolegnia* (fungus) is detected occasionally and does not usually require treatment. No viruses have been detected at the hatchery. *Myxobolus cerebralis* is tested for annually and has never been detected.

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[3] *Renibacterium salmoninarum*, the causative agent of BKD, is a bacterial pathogen that can be passed vertically from the female into the eggs or horizontally from fish to fish. In the ELISA culling program, each female is screened and assigned a pathogen detection level. During spawning, the kidney is visually inspected and if lesions are seen in the kidney, eggs from this female are discarded immediately. A sample of kidney tissue collected from each remaining female is submitted for ELISA testing. The ELISA test quantifies the amount of *R. salmoninarum* antigen present and the results are assigned to 4 categories based on the optical density: not detected, low, medium or high. ELISA testing gives an estimate of infection prevalence (number of positive detections) and intensity (increasing optical density corresponds to increasing infection intensity). Eggs from females with high ELISA values (categorized as having a high risk of passing *R. salmoninarum* into the offspring) are destroyed in an effort to eliminate vertical transmission of the bacteria.

Table 2. Pathogens and parasites found in juvenile fish at Marion Forks Hatchery.

Parasites	Bacteria	Viruses	Fungi
Ichthyobodo (Costia)	*Flavobacterium psychrophilum* (CWD)	None	*Saprolegnia* (External and internal fungi)
Trichodinids	*Renibacterium salmoninarum* (BKD)		
Gyrodactylus	*Flavobacterium branchophilum* (BGD)		
Chilodonella	Opportunists (Aeromonads-Pseudomonads)		
Gill Amoeba			

STATEMENT OF THE PROBLEM: ANADROMOUS FISH MIGRATION INTO MARION CREEK AND ABOVE HATCHERY INTAKE

Spring Chinook: Some adult spring Chinook are already passed above Detroit Dam and winter steelhead are expected to be outplanted in the future. Each year passage has occurred, adult spring Chinook have migrated to Marion Creek. During low flows, the weir blocks these fish from entering the hatchery water supply, but at high flows, adult spring Chinook have bypassed the weir several years in a row. The diseases carried by these returning fish have already had a substantial impact on juvenile spring Chinook at the hatchery.

In December 2013, BKD was detected by the observation of clinical lesions in BY2012 spring Chinook smolts at the hatchery for the first time since the implementation of the ELISA culling program[4]. This event followed adult spring Chinook bypassing the weir for the first time that fall. Prior to 2013, the use of ELISA based culling in combination with a clean water supply reduced BKD incidence in the hatchery population to nearly 0%. In this time, positive detections of the bacterium were at low prevalence and infection intensity and other signs of disease were absent. In contrast, clinical lesions and overt bacterial kidney disease have been detected in the fall or winter in smolts each year at the hatchery since implementation of adult Chinook passage above Detroit Dam in 2013. Concern over the presence and establishment of *R. salmoninarum* in the water supply increased at the end of the summer in 2015. In August 2015, a routine fish health exam detected BKD in spring Chinook juveniles at the hatchery prior to adult migration. This suggests that the bacteria are established in resident fish above the hatchery. The

[4] The ELISA culling program was implemented for the N. Santiam (21) stock in the mid-1990s.

destructive nature of these bacteria to spring Chinook was made apparent at the hatchery when the BY2014 spring Chinook experienced a BKD epizootic, and resulted in 45% cumulative loss. Although *R. salmoninarum* infection can be treated with Erythromycin medicated feed, the treatment poses significant problems. First, the treatment is expensive. The larger the fish, the larger the amount of medicated feed needed. In 2015, it would have cost over $70,000 to treat the entire spring Chinook smolt population affected by BKD at the hatchery. Second, water temperatures, age of the fish, and palatability of the antibiotic make it difficult to administer the full four-week treatment to smolts[5]. Rather than consume the full ration, smolts will often leave much of the erythromycin-medicated feed on the bottom of the pond uneaten. This leads to potentially wasting very expensive medicated feed without resolving the disease.

Winter steelhead: Specifically, Infectious Hematopoetic Necrosis Virus (IHNV) is of concern. Detection of this virus is sporadic (Table 1), there is no way to predict if returning fish will have a high prevalence of the virus, and accurate sampling of the virus requires lethal sampling. The 2016 epizootic of IHNV in summer steelhead at South Santiam Hatchery is a recent example of an isolated outbreak of the virus. Adult winter steelhead have been passed above South Santiam Hatchery for over 40 years, yet this was the first epizootic of the virus at the hatchery. Approximately 47% of the summer steelhead at the hatchery died as a result. Virus detections in mortalities continued up to five months after the onset of the outbreak. Fry and young fish are most susceptible to the virus. Hatching and fry rearing have only occurred at the hatchery over the last five years. Therefore, the incidence of an epizootic may have surfaced only more recently due to the presence of younger, more susceptible fish than had resided at the hatchery over the last 30 years. Gnat Creek Hatchery had a similar problem in 1981 when adult winter steelhead were passed above the hatchery and subsequently summer and winter steelhead at the facility suffered 70% mortality from IHNV. Although IHNV causes acute mortality of steelhead and rainbow trout, spring Chinook can be infected and suffer epizootics as well. Lookingglass Hatchery in eastern Oregon passes adult fish above the facility and routinely has outbreaks of IHNV in spring Chinook.

If an IHNV epizootic occurred at Marion Forks Hatchery, the consequences would affect more than just the immediate population at the hatchery. The severity of the epizootic and loss of fish cannot be predicted. The hatchery rears relatively small numbers of steelhead and trout, which are both highly susceptible to the virus. A 47% infection prevalence and mortality (like that which occurred at South Santiam Hatchery) could impact the small research and tagging studies that frequently occur at Marion Forks (which had previously been selected for its relatively pathogen-free

[5]Treatment of smolts with Aquamycin (Erythromycin medicated feed) should not be confused with the treatment of fingerlings. Several ODFW hatcheries growing spring Chinook salmon routinely treat fingerlings (250-275 fish per pound). Although the medicated feed is not palatable, the smaller size, quick metabolism and high feeding and growth rate of smaller fish result in successful completion of the antibiotic course.

fish health history). Chinook can succumb to infection, but generally mortality is not as high as in trout and steelhead. The second consequence of an IHNV outbreak would affect where the fish could be released and stocked. It is Oregon's fish health policy that a fish population with an IHNV outbreak history not be stocked in naïve waters. This would potentially eliminate the high lakes stocking of trout and could impact where Chinook are transferred. Additionally, once IHNV has occurred at a facility, stocking from that facility may be restricted to IHNV enzootic waters only, for up to five years. Again, this would impact high lakes stocking for several years after an outbreak but may also affect other stocks on site.

Additionally, adult winter steelhead could carry *Flavobacterium psychrophilum*, the cause of bacterial coldwater disease. This pathogen has already been a sporadic cause of loss in Chinook at Marion Forks and higher inputs from adults shedding the bacteria can increase both infection prevalence and intensity.

Although steelhead and trout do not regularly succumb to BKD, they can be carriers of the *R. salmoninarum* bacterium. See "Adults in the North Santiam- winter steelhead" in the above section for prevalence. As stated above for CWD, this can increase both infection prevalence and intensity for fish in the hatchery; especially spring Chinook that are highly susceptible to BKD.

EVALUATION OF FISH HEALTH RISKS AND PROBLEMS

Infected resident or anadromous fish in the water supply of a fish hatchery are a direct source of pathogens for fish in the hatchery. The greater the number of adult fish entering a hatchery water supply, the greater the likelihood and abundance of pathogens entering the hatchery intake and increased risk of transmission to hatchery fish. Besides direct disease effects and mortality of hatchery fish, more disease in the hatchery leads to the increased use of therapeutants, which have both a financial and environmental cost. In a time of decreasing budgets, increased limitations on the use of antibiotics and concerns regarding residual chemicals in hatchery effluent, the benefit of disease prevention arguably outweighs the cost of disease treatment. For some pathogens such as IHNV, there are no treatments or ways to control fatal infections. Prevention by avoidance is the only method to manage such pathogens. Hatchery practices have long been in place to prevent vertical transmission of pathogens such as *R. salmoninarum,* but for horizontal (fish to fish) transmission of pathogens, avoidance remains the best strategy. In Marion Creek the means of preventing infection are either to block anadromous fish from the hatchery water supply or to disinfect incoming water to the hatchery to neutralize pathogens (such as with a UV system).

In the Willamette Basin, there are several facilities where adult anadromous fish are passed into their water supplies. Although the principles of increased disease risk apply to each of those facilities, the scale and dispersal of the fish and pathogens are unique to each system. As an example, McKenzie Hatchery rears spring Chinook and utilizes the ELISA culling program to address vertical transmission, but *R. salmoninarum* is still present in the water supply. Erythromycin-medicated feed is routinely used to treat fingerlings, yet clinical BKD lesions are regularly detected in Chinook smolts at McKenzie Hatchery. Although BKD is present, it is at a very low level and far below epizootic loss. In this case, adult steelhead and spring Chinook are passed above the facility into waters that supply the hatchery but medicated feed and presumably low bacterial inputs keep the disease incidence and severity acceptably low. The biggest difference between McKenzie Hatchery and Marion Forks Hatchery (both raise spring Chinook) is the potential dilution of pathogens from the adult fish in relation to fish at the hatchery. On the McKenzie River, adults can migrate into over 40 miles of river habitat upstream of the hatchery intake as compared to just 4 miles on Marion Creek. Additionally, the volume of flow in the McKenzie River is exponentially greater than that of Marion Creek above the hatchery. Hence the scale of volume and distance create two totally different risk factors for pathogen transmission: low for McKenzie but high for Marion Forks. South Santiam Fish Hatchery is similar to the McKenzie Hatchery in both its rearing of spring Chinook, passing fish above the facility as well as the scale and volume into which those fish can migrate in waters supplying the facility. However, even at this scale, the low apparent risk at South Santiam was realized in a devastating IHNV outbreak in 2016.

CONCLUSIONS AND RECOMMENDATION

The conclusion of the risk assessment is that adult anadromous fish in Marion Creek above the hatchery intake will be a direct source of pathogens to the hatchery, as has been demonstrated with BKD. The greater number of fish, the greater the abundance of pathogens expected. The return of adult winter steelhead is expected to exacerbate the pathogen load in the water supply, such as *Flavobacterium psychrophilum* the cause of coldwater disease and it may even introduce new pathogens such as IHNV and other parasites. The relatively small volume of Marion Creek and limited (4 miles) habitat upstream of the facility create a high risk for pathogen transmission from adults to juvenile fish at the hatchery. It is for these reasons that we recommend to either place an effective weir during all times of adult anadromous fish migration (both Chinook and steelhead), or install a water treatment system to disinfect water coming into the hatchery. A water treatment system is the preferred long-term solution. Disinfection of incoming water would avoid problems associated with a weir. A system capable of applying 150 mWs of UV irradiation should inactivate the causative agents of BKD, IHNV and bacterial coldwater disease. Although 30 mWs is often referenced as effective for eliminating 99.99% of vegetative bacteria, physiological characteristics of some bacteria such as *Flavobacterium psychrophilum* and *Renibacterium salmoninarum* (the causes of coldwater disease and BKD, respectively) require higher UV doses to adequately kill bacterial cells. A well-designed filtration and UV disinfection system would provide the hatchery with pathogen-free water without impacting resident fish or blocking migration when unmarked Chinook and steelhead are re-introduced to the system.