

Infectious Hematopoietic Necrosis

Oregon Sockeye Salmon Disease,
Columbia River Sockeye Disease,
Sacramento River Chinook Disease

Last Updated: July 2007



the Center for
Food Security
& Public Health

IOWA STATE UNIVERSITY®

College of Veterinary Medicine
Iowa State University
Ames, Iowa 50011
Phone: 515.294.7189
Fax: 515.294.8259
cfsph@iastate.edu
www.cfsph.iastate.edu



INSTITUTE FOR
INTERNATIONAL
COOPERATION IN
ANIMAL BIOLOGICS

Iowa State University
College of Veterinary Medicine
www.cfsph.iastate.edu/IICAB/

Importance

Infectious hematopoietic necrosis (IHN) is a serious viral disease of salmonid fish. This disease was first reported at fish hatcheries in Oregon and Washington in the 1950s. The causative virus now exists in many wild and farmed salmonid stocks in the Pacific Northwest region of North America. It has also spread to Europe and some Asian countries. Clinical infections are most common in young fish, particularly fry and juveniles. Infectious hematopoietic necrosis can have a major economic impact on farms that rear young rainbow trout or salmon; the cumulative mortality rates on these farms can reach 90-95%. Occasional epizootics have also been reported in wild salmon.

Etiology

Infectious hematopoietic necrosis is caused by infectious hematopoietic necrosis virus (IHNV), a member of the genus *Novirhabdovirus* and family Rhabdoviridae. Virus strains vary in their pathogenicity.

IHNV isolates can be grouped into three genetic types, which are correlated mainly with geographic regions. The U genogroup includes isolates from Alaska, British Columbia, coastal Washington watersheds and the Columbia River basin, as well as a few isolates from Oregon, California and Japan. The L genogroup contains most of the viruses from California and the Oregon coast. The M genogroup contains isolates from Idaho, the Columbia River basin and Europe, as well as a virus from the Washington coast. The M genogroup has significantly higher genetic diversity than the L or U groups.

Species Affected

Infectious hematopoietic necrosis affects rainbow/ steelhead trout (*Oncorhynchus mykiss*), cutthroat trout (*Salmo clarki*), brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), and Pacific salmon including chinook (*O. tshawytscha*), sockeye/ kokanee (*O. nerka*), chum (*O. keta*), masou/ yamame (*O. masou*), amago (*O. rhodurus*), and coho (*O. kisutch*). Experimental infections have been reported in species other than salmonids including pike fry, sea bream and turbot.

Geographic Distribution

Infectious hematopoietic necrosis is endemic in fish hatcheries and wild fish in the Pacific Northwest region of North America. Affected provinces and states include British Columbia, Alaska, Washington, Oregon, Idaho and California. Outbreaks have been reported in Minnesota, West Virginia, South Dakota and Colorado. IHN is also endemic in continental Europe and Japan. In addition, outbreaks have been reported in Korea, Iran and parts of China.

Transmission

IHNV is transmitted by clinically ill fish and asymptomatic carriers. This virus is shed in the feces, urine, sexual fluids and external mucus. Transmission is mainly from fish to fish, primarily by direct contact, but also through the water. IHNV can survive in water for at least one month, particularly if the water contains organic material. This virus can also be spread in contaminated feed. The gills or the digestive tract have been suggested as the major sites of virus entry, but recent evidence suggests that IHNV may enter at the base of the fins. "Egg-associated" (vertical) transmission also occurs; whether IHNV can be present inside the egg as well as on the surface is controversial. Invertebrate vectors may exist.

Incubation Period

The incubation period is 5 to 45 days.

Clinical Signs

The clinical signs include abdominal distension, exophthalmia, darkened skin and pale gills. Long, semi-transparent fecal casts often trail from the anus. Affected fish are typically lethargic, with bouts of hyperexcitability and frenzied, abnormal activity. Petechial hemorrhages commonly occur at the base of the pectoral fins, the mouth,

Infectious Hematopoietic Necrosis

the skin posterior to the skull above the lateral line, the muscles near the anus, and the yolk sac in sac fry. In sac fry, the yolk sac often swells with fluid. In fry less than two months old, there may be few clinical signs despite a high mortality rate. Surviving fish often have scoliosis.

Post Mortem Lesions

The abdomen, stomach, and intestines often contain white to yellowish fluid, but food is usually absent from the digestive tract. The kidney, liver, spleen and heart are typically very pale. Necrosis is common in the kidney and spleen, and focal necrosis may be noted in the liver. Petechiae are often found in the internal organs including the pyloric caeca, spleen, peritoneum, intestines, and the membranes surrounding the heart and brain. Hemorrhages may occur in the kidney, peritoneum and swim bladder.

Morbidity and Mortality

Clinical disease usually occurs when the water temperature is between 8°C (46°F) and 15°C (59°F), but outbreaks have occasionally been reported at temperatures warmer than 15°C (59°F). Disease outbreaks are generally seen between spring and early summer.

Young fish are most susceptible to disease, particularly during the first two months of life. The cumulative mortality in young animals can reach 90-95%. Resistance to infection increases in older fish, and disease is uncommon. The mortality rate varies with concurrent diseases or infections, management factors, genetic resistance and general fish health. In a series of outbreaks in farmed Atlantic salmon in British Columbia, the cumulative mortality rate varied between farms, with an average rate of 47%. Fish that survive usually develop good immunity to disease, but some may become asymptomatic carriers. Asymptomatic infections can become clinical after co-infection with other pathogens, handling or other stress, and at sexual maturation.

Diagnosis

Clinical

Infectious hematopoietic necrosis should be suspected in salmonid fish with typical clinical symptoms and necropsy lesions. In some cases, the major symptom is a significant rise in mortality in young fish, with few clinical signs. Most outbreaks occur in the spring and early summer.

Differential diagnosis

The differential diagnosis includes infectious pancreatic necrosis, viral hemorrhagic septicemia and whirling disease.

Laboratory tests

Infectious hematopoietic necrosis can be diagnosed by virus isolation in cell cultures; appropriate cell lines include EPC (*Epithelioma papulosum cyprini*) and BF-2 (bluegill

fry) cells. Virus identity is confirmed by virus neutralization, immunofluorescence, enzyme-linked immunosorbent assay (ELISA), DNA probes or polymerase chain reaction (PCR) tests. Nucleic acids can also be identified directly in tissues by PCR. Antibody-based techniques can identify viral antigens in tissues, but these methods are not in routine use. Rapid serologic tests have been developed and are becoming more readily available. Serologic tests have not been validated yet for international trade.

Samples to collect

The samples to collect from symptomatic animals vary with the size of the fish. Small fish (less than or equal to 4 cm) should be sent whole. The viscera including the kidney should be collected from fish that are 4 to 6 cm long. The kidney, spleen, and encephalon should be sent from larger fish. If the fish are asymptomatic, the samples should include the kidney, spleen, and encephalon, and the ovarian fluid at spawning. A new test has been reported to diagnose infections in live fish by virus isolation from mucus.

Samples should be taken from ten diseased fish and combined to form pools with approximately 1.5 g of material (no more than five fish per pool). The pools of organs or ovarian fluids should be placed in sterile vials. The samples may also be sent in cell culture medium or Hanks' balanced salt solution with antibiotics. They should be kept cold [4°C (39°F)] but not frozen. If the shipping time is expected to be longer than 12 hours, serum or albumen (5-10%) may be added to stabilize the virus. Ideally, virus isolation should be done within 24 hours after fish sampling.

Recommended actions if infectious hematopoietic necrosis is suspected

Notification of authorities

Infectious hematopoietic necrosis is endemic in the U.S. State guidelines should be consulted for reporting requirements.

Federal: Area Veterinarians in Charge (AVIC):

http://www.aphis.usda.gov/animal_health/area_offices/

State Veterinarians:

<http://www.usaha.org/Portals/6/StateAnimalHealthOfficials.pdf>

Control

Most epizootics have been linked to the importation of infected eggs or fry, but IHNV can also be introduced in asymptomatic carriers. In areas where this disease is not endemic, outbreaks are controlled by culling, disinfection, quarantines and other measures. Where IHNV is endemic, good biosecurity and sanitation decrease the risk of introducing the virus to a farm. Eggs should be disinfected with an iodophor solution, and virus-free water should be used to incubate eggs and raise animals. Feed should be sterilized for at least 30 minutes at 60°C (140°F) IHNV is

Infectious Hematopoietic Necrosis

readily inactivated by most common disinfectants including iodophors. It is also acid and ether labile, but is resistant to ethanol. In addition, this virus can be inactivated by drying, or by heating to 60°C (140°F) for 15 minutes. Promising vaccines have been tested in field trials, but no vaccines are commercially available as of July 2007.

If an outbreak occurs, it may be possible to limit losses by raising the water temperature. Simultaneous fallowing of infected sites can control virus spread in saltwater net pens. Autogenous vaccines have been used during outbreaks in some areas. After an outbreak, it may be helpful to harvest all remaining fish, as recurrences have been reported in surviving fish on some farms.

Public Health

There is no indication that infectious hematopoietic necrosis is a threat to humans.

Internet Resources

USDA APHIS Aquaculture Disease Information

http://www.aphis.usda.gov/animal_health/animal_dis_s pec/aquaculture/

World Organization for Animal Health (OIE)

<http://www.oie.int>

OIE Manual of Diagnostic Tests for Aquatic Animals

<http://www.oie.int/international-standard-setting/aquatic-manual/access-online/>

OIE Aquatic Animal Health Code

<http://www.oie.int/international-standard-setting/aquatic-code/access-online/>

References

- Basurco B, Yun S, Hedrick RP. Comparison of selected strains of infectious hematopoietic necrosis virus (IHNV) using neutralizing trout antisera. *Dis Aquat Org.* 1993; 15: 229-233.
- Brudeseth BE, Castric J, Evensen O. Studies on pathogenesis following single and double infection with viral hemorrhagic septicemia virus and infectious hematopoietic necrosis virus in rainbow trout (*Oncorhynchus mykiss*). *Vet Pathol.* 2002;39:180-9.
- Egusa S, editor. *Infectious diseases of fish*. New Delhi, India: Amerind Pub Co; 1992. Infectious hematopoietic necrosis; p. 20-35.
- Fernanda Rodriguez M, LaPatra S, Williams S, Famula T, May B. Genetic markers associated with resistance to infectious hematopoietic necrosis in rainbow and steelhead trout (*Oncorhynchus mykiss*) backcrosses. *Aquaculture.* 2004; 241:93-115.
- Fisheries Research and Development Organization. Department of Agriculture, Fisheries and Forestry. Commonwealth of Australia. *Aquatic animal diseases significant to Australia: Identification field guide*. 2nd edition [online]. Commonwealth of Australia; 2004. Differential diagnostic table. Available at: <http://www.diseases-watch.com/documents/CD/index/index.htm>. Accessed 31 Jul 2007.
- Harmache A, LeBerre M, Droineau S, Giovannini M, Brémont M. Bioluminescence imaging of live infected salmonids reveals that the fin bases are the major portal of entry for *Novirhabdovirus*. *J Virol.* 2006;80:3655-9.
- International Committee on Taxonomy of Viruses [ICTV]. Universal virus database, version 4. 00.061.1. 01.062.0.06.001. Infectious hematopoietic necrosis virus [online]. ICTV; 2006. Available at: <http://www.ncbi.nlm.nih.gov/ICTVdb/ICTVdB>. Accessed 13 Jul 2007.
- Kahn CM, Line S, editors. *The Merck veterinary manual* [online]. Whitehouse Station, NJ: Merck and Co; 2003. Fish health management: Viral diseases. Available at: <http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/170416.htm>. Accessed 6 Jul 2007.
- Kurath G, Garver KA, Troyer RM, Emmenegger EJ, Einer-Jensen K, Anderson ED. Phylogeography of infectious haematopoietic necrosis virus in North America. *J Gen Virol.* 2003;84:803-14.
- LaPatra SE, Fryer JL, Rohovec JS. Virulence comparison of different electropherotypes of infectious hematopoietic necrosis virus. *Dis Aquat Org.* 1993;16:115-120.
- Schäperclaus W, Kulow H, Schreckenbach K, editors. *Fish diseases*, 5th ed. Rotterdam: A.A. Balkema; 1992. Infectious hematopoietic necrosis (IHN); p. 345-9.
- St-Hilaire S, Ribble CS, Stephen C, Anderson E, Kurath G, Kent ML. Epidemiological investigation of infectious hematopoietic necrosis virus in salt water net-pen reared Atlantic salmon in British Columbia, Canada. *Aquaculture.* 2002;212:49-67.
- Troyer RM, Kurath G. Molecular epidemiology of infectious hematopoietic necrosis virus reveals complex virus traffic and evolution within southern Idaho aquaculture. *Dis Aquat Organ.* 2003;55:175-85.
- World Organization for Animal Health [OIE] Handistatus II [database online]. OIE; 2004. Available at: <http://www.oie.int/hs2/report.asp?lang=en>. Accessed 17 Jul 2007.
- World Organization for Animal Health [OIE]. *Manual of diagnostic tests for aquatic animals* [online]. Paris: OIE; 2006. General information. Available at: http://www.oie.int/eng/normes/fmanual/A_00017.htm. Accessed 6 Jul 2007.
- World Organization for Animal Health [OIE]. *Manual of diagnostic tests for aquatic animals* [online]. Paris: OIE; 2006. Infectious hematopoietic necrosis. Available at: http://www.oie.int/eng/normes/fmanual/A_00019.htm. Accessed 13 Jul 2007.
- World Organization for Animal Health [OIE] Regional Representation for Asia and the Pacific. *Regional aquatic animal disease report*. Available at: <http://www.oie-jp.org/>. Accessed 19 Jul 2007.