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Technical Paper No. 6620
Oregon Agricultural Experiment Station

Sea Grant College Program
Oregon State University
AdS A418
Corvallis, Oregon 97331

Publication No.: ORESU-T-83-002

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Acknowledgements

This work is a result of research sponsored (in part) by the Oregon State University Sea Grant College Program supported by NOAA Office of Sea Grant, U. S. Department of Commerce, under Grant No. NA79AA-D-00106 (Project No. R/FSD-5). The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

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Abstract

From 1980 through 1982 a significant increase in isolations of infectious hematopoietic necrosis virus (IHNV) from hatchery salmonids in the Columbia River basin was documented. Losses of cultured salmonids to the disease increased more than twentyfold from 1980 to 1981, and mortality-related losses were almost forty times that of 1980 levels during 1982. Extreme modifications of conventional hatchery practices have been adopted at certain locations where viral-infected stocks of fish must be used as a source for eggs. Because the virus is now widespread in the basin, personnel at locations with no previous history of IHNV must be especially alert to prevent its introduction.

Introduction

The viral etiology of infectious hematopoietic necrosis (IHN) disease of salmonid fish was established in 1958 (Wingfield et al., 1969). The virus, infectious hematopoietic necrosis virus (IHNV), was isolated and identified in tissue homogenates prepared from juvenile sockeye salmon undergoing an epizootic at Oakridge Salmon Hatchery located on Salmon Creek, a tributary of the Willamette River in Oregon. Previous evidence for the viral nature of what is believed to have been the same disease was reported as early as 1953 (Rucker et al., 1953). This also involved juvenile sockeye salmon at a Columbia River basin (CRb) hatchery (Leavenworth National Fish Hatchery in the state of Washington). Since those early observations the presence of the virus has been confirmed in fish at certain locations in the CRb and in other areas of the western United States, western Canada, Alaska and Japan. Amend et al. (1969) proposed the disease be named infectious hematopoietic necrosis, and this designation has gained wide acceptance. The impact of the virus in the CRb appeared to have declined coincidentally with the decrease in sockeye salmon production during the 1960s. During the decade of the 1970s, the virus was isolated sporadically at only a few CRb hatcheries. An exception was Round Butte Hatchery in central Oregon, where IHNV is enzootic (Mulcahy et al., 1980).

Epidemiology

From 1980 (Table 1) to 1981 (Tables 2 and 3) an alarming increase in the incidence of IHNV in fish at CRb hatcheries was observed. The data concerning isolations of IHNV in the CRb during 1982 (Tables 4 and 5) confirm that the virus has become more widely disseminated. The increase was apparent by the number of locations where the virus was detected in adult (carrier) fish (Tables 2 and 4) and by the occurrence of epizootics amoung juveniles (Tables 3 and 5). Most important was that from 1980 to 1982 thirteen hatcheries reported IHNV among stocks of fish for the first time. The trend during 1982 continued with observations of the virus at stations first reporting it during 1980 and 1981. This indicated the establishment of the agent in fish stocks at these locations.

Estimated losses of fish to the viral disease increased more than twentyfold from 1980 to 1981, and losses increased

almost fortyfold from 1980, during 1982 (Table 6). The magnitude of these losses were such that fish production quotas were not met at certain facilities. These were primarily rainbow and steelhead trout hatcheries where mortality among this species was devastating. The widespread dissemination and increased occurrence of the virus in the CRb (Figure 1) pose a serious threat to susceptible species reared throughout the system.

Speculation concerning the mechanisms that lead to the rapid spread of IHNV in the CRb was the subject of a recent report (Groberg, 1983). A precise determination of the event(s) that caused this situation would require intensive laboratory and epidemiological investigations. It is important that the reader realize a serious, nontreatable, infectious disease problem now confronts fish culturists throughout the CRb.

Life History

Fish culturists should be alert for the rapid onset of excessive mortality, associated with signs of IHN disease among alevins and young fish (Pilcher and Fryer, 1980). Acute mortality in young fish has been the most common form of the disease. Unpublished reports of IHNV isolations from yearlings and smolts have become more frequent, however, and these isolations are typically associated with an insidious, chronic type of loss. This chronic form is probably not the result of recent virus infection but more likely involves fish infected when they were young. In addition, where IHNV was recovered from larger fish, other infectious agents and/or severe stress factors were present. Under these conditions, it is difficult to determine if IHNV was the direct or sole cause of the chronic loss.

As indicated (Tables 1-5), IHNV isolation was most often made from asymptomatic, adult carriers or from juveniles with IHN disease. Between the time infected fish grow to about one gram in weight and reach sexual maturity as adults, the virus apparently resides in the tissues of carrier fish in a latent or eclipse phase (Amend, 1975). Present methods for virus recovery do not allow detection during the eclipse phase in carrier fish. When virus is detected in adult fish at spawning, a management decision must be made concerning the disposition of eggs derived from the carrier brood. Because there is circumstantial evidence for vertical transmission of virus from one or both parents (Carlisle, Schat and Elston, 1979; Pilcher and Fryer, 1980), destruction of potentially infected eggs is recommended by many pathologists. However, other factors may be involved in these decisions; infectious disease may not always be the primary consideration. Similar decisions are required when

the disease occurs in young fish. Destruction of infected lots is a biologically sound practice because a portion of survivors become lifelong carriers and release infectious virus only as they approach sexual maturity (Amend, 1975). Therefore, transmission of virus from carrier fish can be prevented only by the elimination of carrier fish and eggs derived from them. While this approach seems drastic, avoidance represents the only known method of control for IHN.

Methods for Control

The prevalence of IHNV in the CRb has profoundly affected fish cultural practices at certain hatcheries where infected or carrier stocks must be used. All current procedures available for control of IHN are avoidance measures designed to prevent transmission of virus from infected or carrier fish to eggs or uninfected fish. It must be emphasized, however, that many of these control methods for IHNV are unproven. Examples of avoidance measures or modifications of conventional spawning and egg incubation methods are (1) fertilization of eggs from a single female with sperm from a single male (mating pair), (2) iodophor disinfection of eggs (Wood, 1974) from individual mating pairs during or after water hardening, (3) incubation of eggs from each mating pair using a separate, fish pathogen-free water source and (4) viral examinations of each fish spawned and only progeny from mating pairs in which virus cannot be detected are maintained and reared. Early rearing of fish, when they are highly susceptible to IHNV, in small groups affords an additional precaution. This concept is based on the fact that the disease may occur in some groups but will not occur in all, leaving these fish for production. Infected lots are destroyed to eliminate potential carriers. It is obvious that an excess of eggs must be taken to accommodate the anticipated loss and thus insure the amount required for production.

Several other avoidance considerations are required to prevent epizootics or introduction of IHNV into hatcheries with no history of the virus. Infectious hematopoietic necrosis is a contagious disease and therefore, carrier fish in a hatchery water supply serve as a reservoir of virus for hatchery fish. Carrier fish must be eliminated from the water source or the water must be freed of infectious virus (disinfected) to prevent waterborne transmission of the virus to fish in the hatchery. Transfers of eggs or fish into a virus-free facility should be made only if the parent stock has a documented history (viral inspections over a 3-5 year period) indicating with high probability that the brood stock are not infected or carrying the virus. The watershed from

which transferred fish come should be evaluated as part of this disease history. Any egg transfers from facilities in the CRb to areas where IHNV does not occur must now be regarded as a high-risk practice. When transfers are made, they should involve only eggs from adults which have been inspected and incubated in pathogen-free water. Fish culturists should insist upon prior sanitation of any fish transport equipment and trucks, tagging equipment, grading devices and other paraphernalia brought into their facility. Sanitary practices (Amend and Conte, 1982) within the hatchery should also be strictly followed to limit the spread of disease if outbreaks occur amoung fish in a limited number of ponds.

Indications are that IHN will continue to pose a severe threat to fish in the CRb. Personnel at hatcheries with no previous history of IHN will have to be particularly alert to prevent introduction of the virus into their facilities. Spawning stocks and water supplies must be kept free of infected or carrier fish, and sanitation of equipment coming into a hatchery should be insisted upon. Fish culture by conventional methods is probably impractical at stations where infected stocks are present and must now be used for production. Extreme measures such as those identified in this report may be the only means now available to successfully rear fish at these locations.

Acknowledgements

The authors wish to acknowledge that the data presented in this report was made available in part through the efforts of the following fisheries professionals: Mr. Kevin Amos (WDF), Mr. Ray Brunson (USFWS), Mr. Wayne Brunson (WDG), Mr. Steve Leek (USFWS), Mr. Joseph Lientz (USFWS), Dr. Daniel Mulcahy (USFWS), Mr. Harold Ramsey (IDFG), Mr. Steve Roberts (WDG) and Mr. Gib Taylor (USFWS). This paper was presented in part at the Northwest Fish Culture Conference, Gleneden Beach, Oregon, Nov. 30-Dec. 2, 1982 as Oregon State University Agricultural Experiment Station Technical Paper No. 6620 and was published in the proceedings of that conference.

This research was supported by the Oregon Department of Fish and Wildlife under the Columbia River Fishery Development Program funded by the National Marine Fisheries Service, Contract No. 82-ABH-29 and the Oregon State University Sea Grant College Program supported by NOAA Office of Sea Grant, Department of Commerce under Grant No. NA79 AA-D-00106.

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List of Abbreviations

The following abbreviations are used in Figure 1 and Tables 1-5.

A. Abbreviations for management agencies responsible for facilities listed.

IDFG	Idaho Department of Fish and Game
ODFW	Oregon Department of Fish and Wildlife
USFWS	United States Fish and Wildlife Service
WDF	Washington Department of Fisheries
WDG	Washington Department of Game

B. Abbrevations for species of fish.

ChF	fall chinook salmon	Rb	rainbow trout
ChS	spring chinook salmon	StS	summer steelhead trout
Ct	cutthroat trout	StW	winter steelhead trout
K	kokanee salmon		

C. Abbreviations for age of fish.

Juv	juvenile
Yl	yearling
Ad	adult

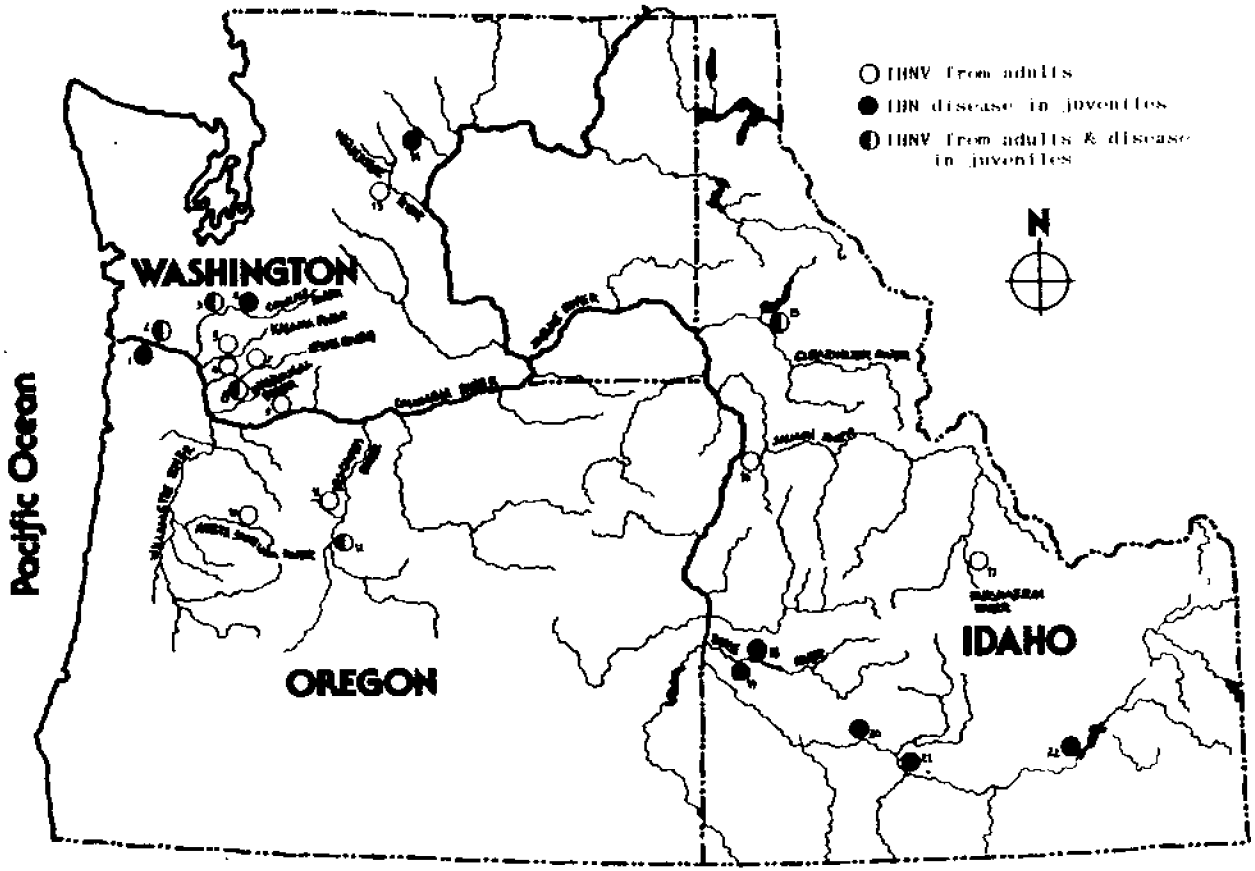

FIGURE 1. IHNV ISOLATIONS (1980-1982)

1. Gnat Creek Hatchery (ODFW)
2. Beaver Creek Hatchery (WDG)
3. Cowlitz Hatchery (WDG)
4. Mossyrock Hatchery (WDG)
5. Kalama Trap (WDG)
6. Lewis River Hatchery (WDF)
7. Speelyai Hatchery (WDF)
8. Skamania Hatchery (WDG)
9. Little White Salmon Hatchery (USFWS)
10. Minto Pond (ODFW)
11. Warm Springs Hatchery (USFWS)
12. Round Butte Hatchery (ODFW)
13. Leavenworth Hatchery (USFWS)
14. Entiat Hatchery (USFWS)
15. Dworshak Hatchery (USFWS)
16. Rapid River Hatchery (IDFG)
17. Pahsimeroi Hatchery (IDFG)
18. Eagle Hatchery (IDFG)
19. Nampa Hatchery (IDFG)
20. Hagerman Hatchery (IDFG)
21. Niagra Springs Hatchery (IDFG)
22. American Falls Hatchery (IDFG)

Table 1. Isolations of infectious hematopoietic necrosis virus from salmonid fish at Columbia River basin hatcheries during 1980.

Hatchery	Major river drainage	Species	Age	First known occurrence IHNV this location
Round Butte (ODFW)	Deschutes	StS	Ad	8-73
Warm Springs (USFWS)	Deschutes	StS	Ad	4-79
Round Butte (ODFW)	Deschutes	StS	Juv	8-73
Pahsimeroi (IDFG)	Salmon	StS	Ad	5-80
Speelyai (WDF)	Lewis	ChS	Ad	4-73
Dworshak (USFWS)	Clearwater	ChS	Ad	9-80

Table 2. Isolations of infectious hematopoietic necrosis virus from adult salmonid fish at Columbia River basin hatcheries during 1981.

Hatchery	Major river drainage	Species	First known occurrence IHNV this location
Round Butte (ODFW)	Deschutes	StS	8-73
Cowlitz (WDG)	Cowlitz	StW StS Ct	2-81
Warm Springs (USFWS)	Deschutes	StS	4-79
Little White Salmon (USFWS)	Columbia	ChS	8-81
Round Butte (ODFW)	Deschutes	ChS	8-73
Minto Pond (ODFW)[a]	North Santiam	ChS	9-81
Speelyai (WDF)	Lewis	ChF K	4-73
Cowlitz (WDG)	Cowlitz	Ct StS StW	2-81
Beaver Creek (WDG)	Columbia	Ct	12-81

[a] Adult trapping and spawning site.

Table 3. Isolations of infectious hematopoietic necrosis virus from yearling and juvenile salmonid fish at Columbia River basin hatcheries during 1981.

Hatchery	Major river drainage	Species	Age	First known occurrence IHNV this location
Entiat (USFWS)	Columbia	ChS	Yl	6-74
Eagle (IDFG)	Boise	Rb K	Juv Juv	4-81
Gnat Creek (ODFW)	Columbia	StW StS	Juv Juv	4-81
American Falls (IDFG)	Snake	Rb	Juv	1-80
Skamania (WDG)	Washougal	StS	Juv	5-81
Mossyrock (WDG)	Cowlitz	StW Rb Ct	Juv Juv Juv	5-81
Cowlitz (WDG)	Cowlitz	Rb Ct	Yl Juv	2-81
Niagra Springs (IDFG)	Snake	StS	Juv	7-78
Dworshak (USFWS)	Clearwater	Rb	Yl	9-80
Hagerman (IDFG)[a]	Snake	Rb	Juv	11-81

[a] IHNV diagnosed coincident with a proliferative kidney disease epizootic.

Table 4. Isolations of infectious hematopoietic necrosis virus from adult salmonid fish at Columbia River basin hatcheries during 1982.

Hatchery	Major river drainage	Species	First known occurrence IHNV this location
Pahsimeroi (IDFG)	Salmon	StS	5-80
Dworshak (USFWS)	Clearwater	StS ChS	9-80
Cowlitz (WDG)	Cowlitz	Ct StS StW	2-81
Beaver Creek (WDG)	Columbia	StS StW	12-81
Skamania (WDG)	Washougal	StS	5-81
Kalama Trap (WDG)[a]	Kalama	StS	3-82
Rapid River (IDFG)	Salmon	ChS	1979
Leavenworth (USFWS)	Wenatchee	ChS	3-51[b]
Speelyai (WDF)	Lewis	ChS	4-73
Lewis River (WDF)	Lewis	ChF	4-73

[a] Adult trapping site.

[b] Loss attributed to a filterable agent (Rucker et al., 1953).

Table 5. Isolations of infectious hematopoietic necrosis virus from juvenile salmonid fish at Columbia River basin hatcheries during 1982.

Hatchery	Major river drainage	Species	First known occurrence IHNV this location
Niagra Springs (IDFG)	Snake	StS	7-78
Dworshak (USFWS)	Clearwater	ChS StS	9-80
Round Butte (ODFW)	Deschutes	StS	8-73
Cowlitz (WDG)	Cowlitz	Ct StW StS	2-81
Hagerman (IDFG)[a]	Snake	Ct Rb	11-81
Beaver Creek (WDG)	Columbia	Ct StW StS	12-81
Skamania (WDG)	Washougal	StS	5-81
Nampa (IDFG)	Snake	Rb	9-82

[a] IHNV diagnosed coincident with a proliferative kidney disease epizootic.

Table 6. Estimated losses of trout and salmon eggs and juvenile fish to infectious hematopoietic necrosis virus at Columbia River basin hatcheries[a] since 1980.

Year	Eggs destroyed[b] (X 1,000)	Juvenile mortality[c] (X 1,000)	Combined loss (X 1,000)
1980	149	150	299
1981	4,805	2,938	7,743
1982	1,125	5,659	6,784

[a] Does not include data for private trout hatcheries in Idaho.

[b] Eggs destroyed because IHNV recovered from brood fish.

[c] Mortality to IHN including fish destroyed because they were in infected lots.