FRED Reports

EFFECT OF INFECTIOUS HEMATOPOIETIC NECROSIS ON SOCKEYE SALMON CULTURE IN ALASKA

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Alaska Department of Fish & Game
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ABSTRACT

Sockeye salmon, *Oncorhynchus nerka*, is a very important commercial species. In 1984 the sockeye fishery was the single-most important one in Alaska; the 38.2 million fish harvested had an ex-vessel value of $214 million ($5.60 per fish). Of this total, Alaskan hatcheries produced 368,000 fish (less than 1%) having an estimated ex-vessel value of slightly over $2 million.

The role of hatcheries in sockeye salmon rehabilitation and enhancement has been small because of concern about the adverse impact of infectious hematopoietic necrosis (IHN); mortalities approaching 100% have occurred in Alaskan hatcheries. During the report period (1973 through 1984), over 23 million hatchery sockeye salmon, representing 13% of nearly 185 million fry of this species produced, died because of IHN. This loss is equivalent to 186,000 adults, which represents a 1984 value of over $1 million.

Starting in 1981, sockeye salmon were propagated using culture guidelines developed by the Fisheries Rehabilitation, Enhancement, and Development Division (FRED). These guidelines were designed to reduce mortalities from IHN virus. From 1981 to 1984, almost 118 million sockeye fry were produced; of these only 1.6 million were lost to IHN, or about 1%. Compared with the period before the guidelines were instituted (1973-1980) and when total production was over 65 million fry, a loss of almost 22 million, or about 33%, was attributed to IHN. This 25-fold reduction in mortality (1.3% vs. 33.2%) is convincing evidence that it is now possible to accelerate sockeye salmon production to a scale similar to that of other commercial salmon species.

KEY WORDS: *Oncorhynchus nerka*, infectious hematopoietic necrosis, disease control.

INTRODUCTION

Importance of Sockeye Salmon in the Commercial Catch

Sockeye salmon, *Oncorhynchus nerka*, comprises a major portion of the Alaska annual commercial catch; from 1973 to 1983, it varied from 4.5 to 52.8 million fish and had an ex-vessel value of approximately $18.9 to $221.9 million (ADF&G 1985). In 1984 38.2 million sockeye were caught. The ex-vessel value of these fish was $214 million ($5.60/fish: $2.05/kg or $.93/lb), making it the most valuable fishery in Alaska (ADF&G 1984).

Importance of Artificial Production of Sockeye Salmon

Despite the current preponderance of natural production in Bristol Bay, a major impact in artificial sockeye salmon production has been important to southcentral and interior Alaska. In 1984 adult returns were increased by an estimated 368,000 fish (Hansen 1985), resulting in 2,208,000 lb (a value of about $2 million). In 1984 during the highest commercial catch levels since 1882, the ex-vessel value of $1.54/kg ($.70/lb) for sockeye salmon was achieved (ADF&G 1985) and, as such, was a low per-pound figure.

During the first part of the 1985 season, Commercial Fisheries Division fish-ticket reports from the mouth of the Copper River (Prince William Sound) indicated the ex-vessel value of this species reached $3.96/kg ($1.80/lb), which was equal to that of chinook salmon, *Oncorhynchus tshawytscha*, caught in the same area. At $3.96/kg value, the production of 368,000 adults there would mean revenue of $4 million. With the addition of a commercial multiplier and estimates of dollar flows through the economy, larger values could be calculated from these returns.

During 1973 through 1984, almost 162 million sockeye salmon were released from state facilities. These releases resulted in an estimated 1.3 million adult returns (7.8 million pounds) that, in turn, had an estimated ex-vessel value ranging from $5.4 to $14.0 million, at $1.54 to $3.96 per kilogram, respectively.

Infectious Hematopoietic Necrosis Virus in Alaska

The IHN disease has prevented sustained artificial propagation of sockeye salmon in Alaska. The IHN virus has caused the disease in both wild and hatchery eggs and juvenile fish. The disease (also called Oregon Sockeye Disease and Sacramento River Chinook Disease), is found in North America and Japan. Susceptible species include sockeye salmon, chinook salmon, chum salmon, *Oncorhynchus keta*, rainbow and steelhead trout, *Salmo gairdneri*, and Atlantic salmon, *Salmo salar* (Yasutake et al. 1965; Amend et al. 1969; Wingfield et al. 1969; Wingfield and Chan 1970; Sano 1976; Wolf 1976; Sano et al. 1977; Carlisle et al. 1979; Mulcahy et al. 1980; Grischkowsky 1981).

Mortalities in Alaskan hatcheries due to IHN virus have taken place during the propagation of sockeye and chum salmon. Virus transmission probably occurs both vertically (from adults to offspring through the eggs) and horizontally (from an infected fish to another fish via the water). In this disease, kidney, spleen, brain, and gills are heavily involved organs (Mulcahy 1982). Death is known to be associated with a severe electrolyte and fluid imbalance due to kidney failure, but it is probably caused by a combination of factors within these organs (Amend and Smith 1975).

Sockeye salmon mortality occurs during incubation and rearing, and once fish have been exposed to the virus in fresh water, death can occur in fresh water or salt water. IHN disease can occur in newly hatched salmon alevins. Prior to disease onset, the period of exposure can be as short as 4 days (Yasutake and Amend 1972). The disease first appears in juvenile salmonids as behavioral abnormalities. Some of the early signs are not specific for this disease but may be those seen with other possible health problems. This makes early diagnosis difficult.

The carrier status of IHN virus in sockeye salmon in Alaska was established by Grischkowsky and Amend (1976), who reported the occurrence of epizootics of the disease in that species. From early 1973 through 1984, IHN disease was responsible (both directly from the condition and indirectly as part of attempts to stem the infection) for the death of nearly 23.5 million hatchery sockeye salmon juveniles. Epizootics are not uncommon in artificially produced fish, but only rarely have they been documented in nature such as those occurring at Hidden Lake, Alaska, in 1980-1982 (Burke and Grischkowsky 1984) and Chilko Lake, British Columbia, in 1975 (Williams and Amend 1976). In 1980 an additional natural mortality in Alaska occurred in wild sockeye salmon fingerlings at Upper Russian Lake on the Kenai Peninsula. This does not mean, however, that mortalities in nature due to the virus are uncommon; it merely reflects the amount of energy spent looking.

Mortalities of juvenile sockeye salmon have occurred at Kitoi Bay Hatchery, near Kodiak Island (1973, 1974, 1975 and 1980); in fingerlings and smolts taken from Auke Creek near Juneau and held in estuarine net pens in Starrigavan Bay near Sitka (1975); at Big Lake Hatchery near Wasilla (1979, 1980, and 1984); East Creek Hatchery at Lake Nunavaugaluk in North Bristol Bay (1980); and at Gulkana Hatchery in the Upper Copper River basin of Prince William Sound (1983 and 1984). Mortalities directly attributable to IHN have ranged from 10% to 99%; the higher levels have been most commonly encountered and frequently have involved millions of fish. The virus is distributed throughout all 63 sockeye salmon populations that have been tested sufficiently to detect a level of incidence less than 2% (Saft et al., in press). It is detectable only in carrier adult salmon at or near spawning condition and in juvenile fishes dying from the disease.

MATERIALS AND METHODS

IHN Detection

The association of IHN with sockeye salmon mortality of juvenile fish was made by observations of signs associated with the disease, traditional viral assay and viral plaque assay, histopathological examination, and serum neutralization. At least three of these methods were concurrently used for every epizootic. Abnormal signs and behavior were viewed firsthand by hatchery or laboratory personnel for initial indications of IHN involvement. Fresh tissue or whole-fish samples were sent (on ice) to the FRED Division laboratory for viral analysis. These samples were either processed within three days or were frozen and held at -20°C for less than two months prior to thawing and processing. Tissue or whole-fish samples were homogenized; all samples were then centrifuged and antibiotics added to counter microbial contamination. Samples were diluted and *epithelioma papulosum cyprini* (EPC) cell monolayers were inoculated. Using a microscope at 40X, cells in culture wells were checked for cytopathic effect in 3-14 days. Cells exhibiting this cell-killing effect were subcultured to rule out possible toxic effects of the samples and contamination from bacteria and fungus.

The plaque assay, a newer technique for enumerating the amount of virus present in a sample, was used frequently. It allowed the completion of testing in 7 days, instead of the 15-30 days typically required for virus culture. The paraffin histo-technique, the examination of thin sections of organs and tissues of fish showing signs of IHN virus, was the fastest method of diagnosis used. By direct microscopic observation, this method allowed the destructive effects of IHN virus within the fish to be determined by subsequent comparison with normal organs and tissues.

Mortality Estimate Determination

Mortality estimates of sockeye salmon juveniles directly attributable to an IHN epizootic were determined from weekly FRED Division life-stage survival reports. These reports were compiled from information from hatchery managers, personal interviews with hatchery personnel, and fish-disease diagnosis documents.

Fish-Release Figures

Information on fish-release numbers and locations came from FRED Division's fish-stocking records and life-stage survival reports and from reports by Flagg et al. (1984); McMullen et al. (1983); McMullen and Hansen (1984); Hansen (1985); Rowse and Kaill (1983); Roberson and Holder (1984); and Moberly (1983).

Sockeye Salmon Cultural Guidelines

Following the 1980 IHN epizootics of sockeye salmon in three hatcheries located at Kitoi Bay, East Creek, and Big Lake, the most logical disease-control concepts and techniques applicable to sockeye salmon culture were assembled into the Sockeye Salmon Culture Policy Statement (Appendix A). The guidelines set out in this policy statement can be summarized as one of "farming around" the disease without having solved all of the major research questions concerning IHN; they were first applied in the 1980 spawning operations. The guidelines provided for more stringent culture procedures that would allow the highest possible success level.

Salient points of the guidelines include (a) a limit on the number of fish species reared in a hatchery with a history of (or strong potential for) IHN epizootics, (b) a limit on the movement of equipment and personnel between hatcheries working with sockeye salmon, (c) elimination of movement of supplies, (d) prohibition of the planting or passage of sockeye salmon into the water supply of the hatchery without depuration (in use at Kitoi Bay Hatchery), (e) promotion of improved environmental sanitation, and (f) a requirement for the use of foot baths in and out of the hatcheries.

Eggs from each female were collected and fertilized separately. Eggs from as few females as possible were combined into incubators. Separate incurrent and efferent water flows were necessary for each combination of incubator and rearing container. Separation was a requirement for different incubator and rearing-tank combinations within the same sockeye salmon stock, and complete isolation was required between sockeye salmon stocks. Fish or eggs in any container showing signs of IHN or in which IHN was diagnosed were destroyed, and affected containers and related equipment were appropriately sanitized.

Culture of chinook and chum salmon as well as steelhead and rainbow trout was not allowed in a sockeye salmon facility, even when sockeye salmon were not physically present at the time. Movement of equipment from a sockeye salmon hatchery to other hatcheries was only permitted after adequate sanitization. Supplies, such as fish food and equipment that could not readily be sanitized, were not allowed out of sockeye salmon hatcheries. Personnel entering or leaving a hatchery that cultured sockeye salmon passed through a disinfectant foot bath containing iodophor or chlorine (200 ppm). Protective clothing, including rain gear and spawning gloves, were also sanitized with iodophor or chlorine.

Special procedures were incorporated into all sockeye salmon spawning operations. Eggs had to be fertilized, water hardened, and rinsed (if necessary) in virus-free water such as well water, depurated water, or surface water that had not been exposed to sockeye salmon at any time during the year. Prior to removal of eggs or sperm, the ventral surfaces of all fish were sanitized with iodophor. Although a weak solution of iodophor was prescribed for use on the ventral surface of fish immediately prior to egg and seminal-fluid removal, actual use by hatchery managers of iodophor (100 ppm applied with sponges or by immersion of the whole fish) were found to be nondetrimental to the fertilization process. Dry paper towels applied to the area surrounding the vent were used to remove iodophor prior to fertilization. Utensils, spawning gloves, knives, and other items coming in contact with fish were sanitized and rinsed between fish. Eggs were evenly divided into all available incubators, instead of just filling a few to maximal capacity. In an attempt to reduce vertical transmission, iodophor sanitization of fertilized eggs (at 100 ppm for 15 minutes) was required.

Cleansing and sanitization of hands and utensils were required before and after exposure to incubation, holding, or rearing receptacles. Daily floor cleaning with steam or disinfectant was necessary. Fish receptacles, pumps, hoses, and other devices coming in contact with or containing salmon were sanitized after egg or fish removal. Since it is imperative that hatcheries be disinfected after an IHN mortality, portions of a facility that could be physically and operationally separated were considered as functionally separate hatcheries.

Sockeye salmon could not be planted in the watershed upstream of a hatchery water intake nor allowed to enter there naturally, if sockeye, chinook, or chum salmon or rainbow or steelhead trout were cultured in that hatchery. Exceptions were to have been allowed if the water was depurated by ultraviolet radiation or ozone generation prior to exposure to fish within a hatchery. Stocks of sockeye salmon experiencing IHN mortality were not to have been released from a hatchery.

The guidelines are aimed at greatly reducing the viral load to which the eggs and fish are exposed. Eggs from a single fish containing large amounts of virus may distribute the virus throughout a common incubator to uninfected eggs. Compartmentalization and good environmental sanitation can limit the extent of the mortality when the disease occurs in the affected incubator; however, the higher the viral incidence and titer, the less value would potentially result from these methods.

Effects of IHN on Sockeye Salmon Culture

From 1972 through 1984, sockeye salmon juvenile mortality due to IHN (including fish and eggs destroyed after its diagnosis) was evaluated by comparing disease occurrences before and after the application of the guidelines, by considering all hatcheries, and by considering just those facilities and years in which there was an IHN occurrence. The production of emergent fry was tabulated for the release years 1973-1984 and examined, relative to the implementation of the guidelines (Figure 1).[1]

RESULTS

Working Within the Guidelines

Fish-culture personnel actively applied the guidelines to hatcheries that were culturing sockeye salmon. Using resourcefulness and imagination within the guidelines, they soon

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[1]The production figures, however, do not include the Karluk Lake Facility where eyed eggs were the only stage planted.

Figure 1. Sockeye salmon produced from all state facilities, expressed as percent of initial emergent fry for release years 1973-1984.

developed procedures that did not materially reduce their production or efficiency. Initially, spawning operations proceeded very slowly, but after the first season, the rates nearly equaled those previously attained.

Effects of IHN on Sockeye Salmon Culture

The deaths of almost 23.5 million sockeye salmon juveniles represent a major loss of adult returns. Historically achieved survivals of 80% within the hatchery, 10% within the nursery lake, and 10% during the ocean phase translate into an estimated loss of 235,000 adult fish. The mean weight of an adult sockeye salmon is about 2.7 kg/fish, or 6 lb/fish (ADF&G 1984); therefore, the estimated loss represents 630,000 kg (1.4 million pounds) of fish. Using the 1983 statewide mean ex-vessel value of $1.54/kg, or $0.70/lb (ADF&G 1984), these fish would have had an ex-vessel value of about $1 million. From 1981 to 1985, the 80% survival rate within the hatchery has been consistently reached or exceeded by Alaskan sockeye hatcheries (even those with IHN-caused mortality). A 20-million-egg sockeye salmon facility would, therefore, produce 160,000 adults, or 960,000 lb, that would have an ex-vessel value of $670,000 to $1.7 million.

IHN disease has reoccurred most often in locations where it was originally found: Kitoi Bay, Big Lake, and Gulkana hatcheries (Tables 1 & 2). Kasilof Hatchery, on the Kenai Peninsula, has been operating for over ten years without an IHN occurrence; for that reason, the hatchery staff was not required to follow the sockeye salmon culture guidelines.

TABLE 1. Itemization of mortality from IHN in sockeye salmon statewide, 1973 through 1984*.

Site	Year mortality occurred	Mortality percent	Mortality number	Total juveniles including mortality
		Without guidelines		
Kitoi Bay	1973	100	(20,000)	20,000
	1974	100	(951,000)	951,000
	1975	6	(4,999)	87,244
	1980	70	(3,086,061)	4,408,659
East Creek	1980	83	(4,774,355)	5,752,235
Big Lake	1979	100	(10,381,913)	10,381,913
	1980	65	(2,487,273)	3,886,364
Starrigavan	1975	67	(739)	1,103
Sub Total		85.2	(21,706,340)	25,488,518
		With guidelines		
Big Lake	1984	12	(1,045,873)	8,407,873
Alaska Field Station	1984	20	(2,055)	10,165**
Gulkana	1983	1	(107,000)	9,887,000
	1984	4	(400,000)	11,300,000
Sub Total		5.3	(1,554,928)	29,594,873
GRAND TOTAL	1973 to 1984	42.2	(23,261,268)	55,083,391

*Auke Creek Hatchery, a facility operated by the National Marine Fisheries Service and the Territorial Sportsman's Association had a mortality in 1975 of 150,000 sockeye salmon juveniles out of 200,000 (75%) from IHN. Those figures are excluded from these analyses.

**These fish had previously survived in Big Lake Hatchery and were counted in that number.

Table 2. Sockeye salmon fry released from state facilities, fish mortalities due to IHN, and total fry (millions) for release years 1973-1984.

NUMBERS IN MILLIONS

RELEASE YEAR	RELEASE	IHN DEAD	TOTAL FRY	PERCENT RELEASED
1973	0.13	0.01	0.14	87
1974	0.00	0.95	0.95	0
1975	0.00	0.01	0.01	0
1976	0.01	0.00	0.01	100
1977	12.45	0.00	12.45	100
1978	10.43	0.00	10.43	100
1979	11.42	10.38	21.80	52
1980	9.16	10.35	19.50	47
1981	19.22	0.00	19.22	100
1982	30.41	0.00	30.41	100
1983	29.67	0.11	29.77	100
1984	38.66	1.45	40.11	96
TOTAL	161.56	23.25	184.81	87

In the examination of the IHN mortality figures for sockeye salmon juveniles (Table 1), a distinct pattern of losses relative to the implementation of the sockeye salmon culture guidelines became apparent. In state facilities operating without the guidelines (1973-1980), 85.2% of the 25.5 million sockeye salmon fry produced died prior to release; however, during 1981-1984 when guidelines were in use, mortality prior to release was only about 1.5 million fry, or 5.3% of 29.6 million fry that had been produced.

Mortality resulting from IHN typically occurred in very young fry and continued to occur until fish were fingerling size. On one occasion immediately after the fall spawning operation, mortality occurred coincidently in newly hatched fry and in yearling pre-smolts: Kitoi Bay Hatchery during the December 1973 to January 1974 epizootic.

From 1973 through 1984, epizootics occurred in 7 out of the 12 years, the total IHN-related mortality of sockeye salmon juveniles was 23.3 million, and hatcheries released 184.9 million emergent fry (87.4% in-hatchery survival rate). Big Lake Hatchery was the facility with the greatest mortality; 10.4 million sockeye salmon died in 1979, and nearly 12.9 million died in the 1979-1980 biennium. The largest production of sockeye salmon was by Gulkana Hatchery; despite IHN epizootics during both of those years, 21.2 million sockeye salmon were successfully released during 1983 and 1984. From 1980 through 1984, Gulkana Hatchery has met or exceeded the in-hatchery survival rates of 80% for each year (Roberson and Holder 1984).

The number of sockeye salmon fry released exceeded mortality from IHN in every year except 1974, 1975, and 1980 (Table 2); the mortality was not substantial after 1980. Because of IHN disease, more fish were lost than produced within the facilities where the disease occurred in 1974, 1975, 1979, and 1980. The sockeye salmon culture guidelines were implemented after the hatchery epizootics in 1980 at Big Lake, Kitoi Bay, and East Creek hatcheries, and a reversal of the previous trend of high IHN mortality exceeding the numbers of fish released was seen in 1981 with the implementation (Figures 2 and 3). The epizootics occurring in 1973-1976 affected a total of less than one million fish each year; these epizootics were of a much lower magnitude than those of 1979 and 1980.

Prior to the introduction of the sockeye salmon culture guidelines, 85.2% of the eyed eggs that were placed in hatcheries and later affected by IHN did not survive to be released. From 1973 through 1980, 21.7 million sockeye salmon juveniles died of IHN (Figure 4). Such mortality was catastrophic, and it precluded successful production of sockeye salmon in the affected facilities.

When data from all state sockeye salmon hatcheries (*see* Table 1) were considered, the 21.7 million juvenile sockeye mortality occurring prior to guideline implementation comprised 33.2% of emergent sockeye salmon fry, and the total number of released sockeye salmon juveniles exceeded 65 million. With the sockeye salmon culture guidelines in place, the magnitude of IHN mortalities was much reduced: 1.6 million (5%) of 29.6 million emergent fry in affected facilities.

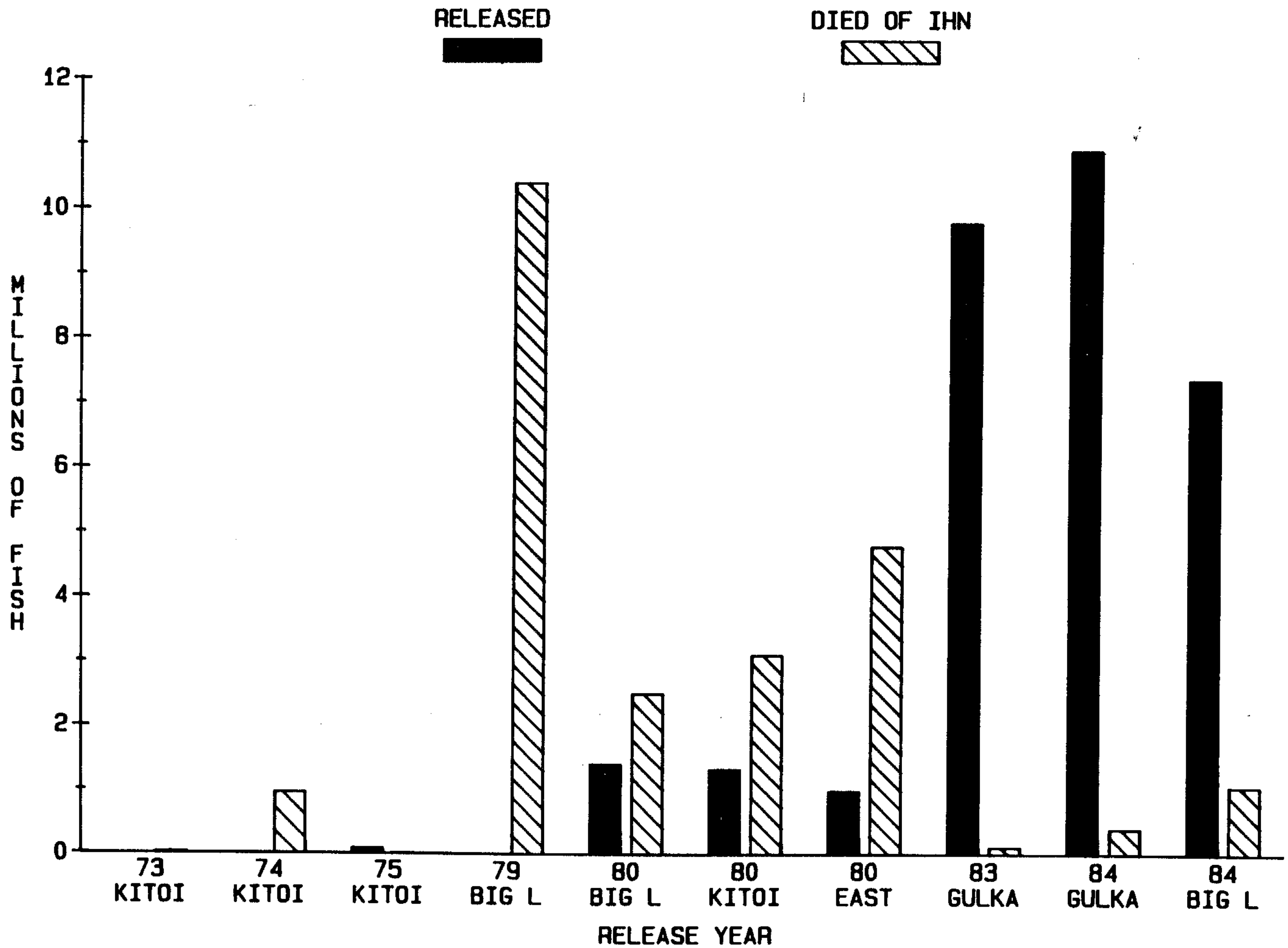

Figure 2. Sockeye salmon juvenile fish produced at state facilities with IHN occurrences for release years 1973-1984.*

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* Abbreviation key: KITOI, Kitoi Bay Hatchery; BIG L, Big Lake Hatchery; EAST, East Creek Hatchery; and GULKANA, Gulkana Hatchery.

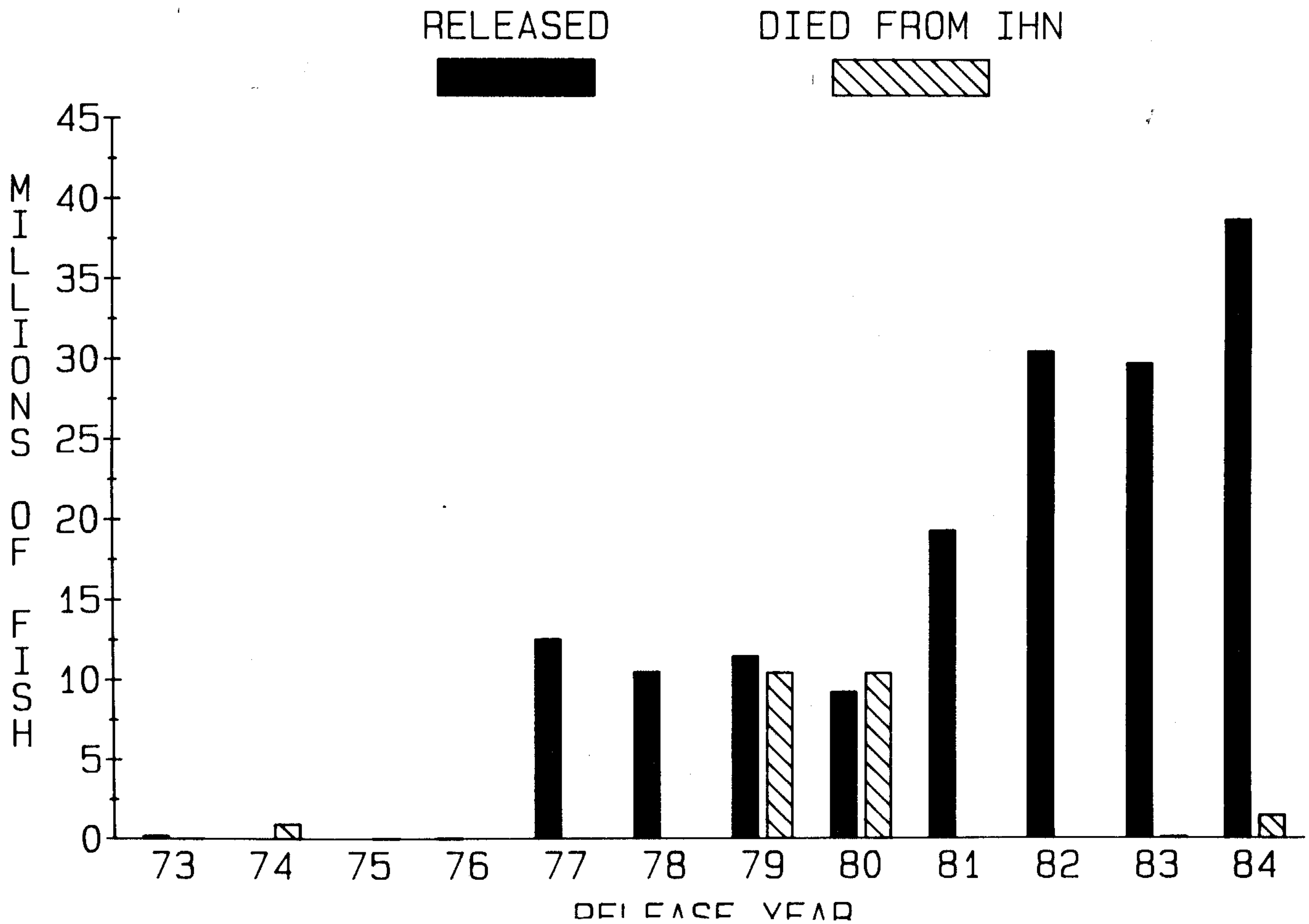

Figure 3. Juvenile sockeye salmon produced from all state facilities for release years 1973-1984.

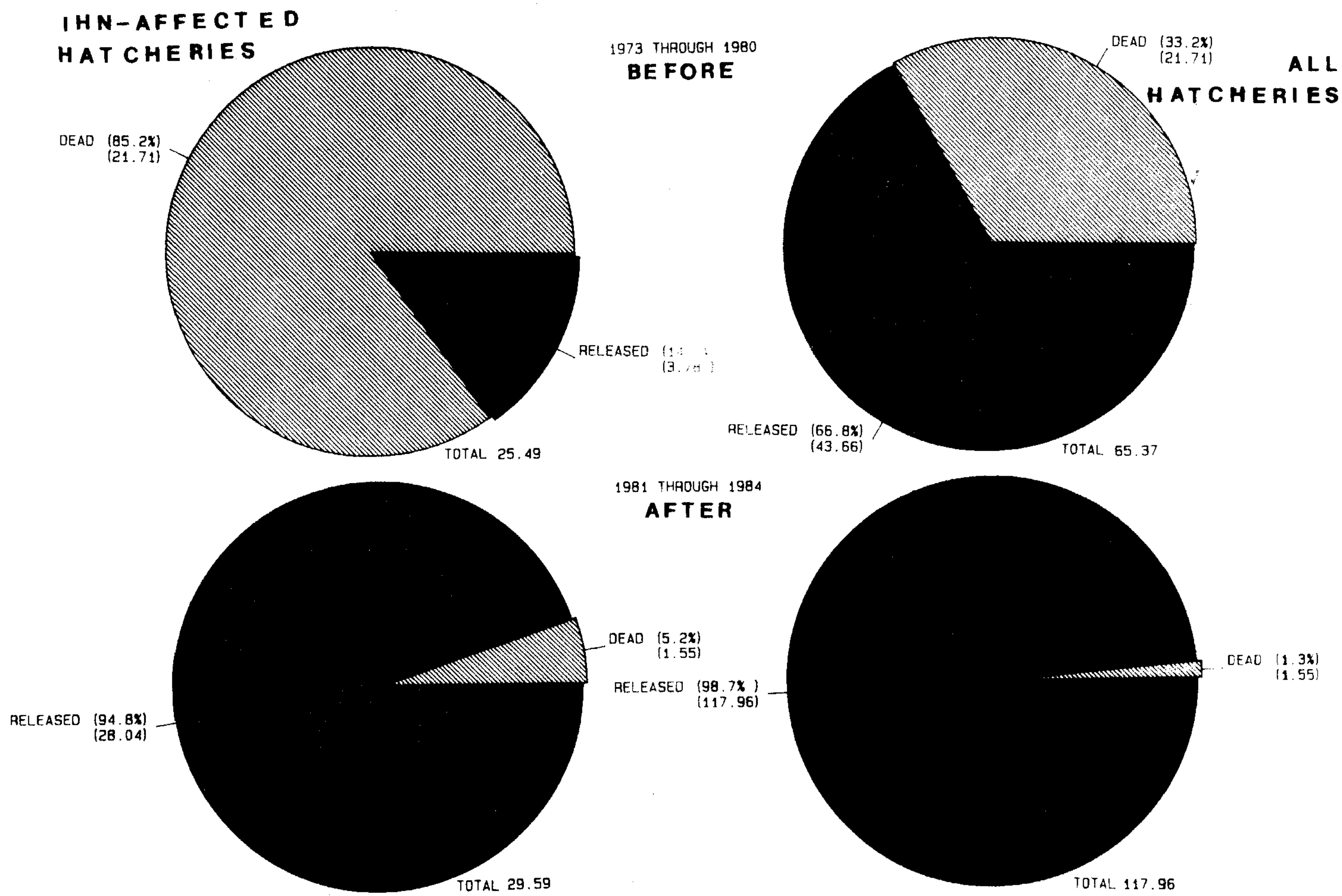

Figure 4. Sockeye salmon fry releases (in millions) compared to mortalities due to IHN in IHN-affected hatcheries and in all hatcheries for the periods before and after the implementation of disease control guidelines, 1973-1980 and 1981-1984, respectively.

From 1973 through 1984, the IHN hatchery mortality was 42.2% of 55.1 million emergent fry. When all years and all facilities are considered without regard to the use of the guidelines, the mortality for 185 million emergent fry is 12.6%.

DISCUSSION

When considering all facilities since the implementation of the cultural guidelines, IHN mortality was reduced to 1.3% of 118 million emergent sockeye salmon fry, compared to 33.2% mortality prior to guideline implementation. This amounts to a 25-fold reduction of IHN-caused mortality, which is convincing evidence that it is now possible to accelerate sockeye salmon production to a scale similar to other commercial species.

At only a little more than 1% mortality since guideline implementation, IHN is no longer the limiting factor for sockeye salmon culture in the state. When the provisions of the guidelines (including isolation) were used, the mortality became no more of a problem than any number of things that concern fish-culture operations.

IHN is no longer an insurmountable barrier to successful artificial propagation of sockeye salmon, and it is now possible to gain the economic and social benefits of enhancing this valuable resource. The ex-vessel value of all IHN mortalities of sockeye salmon documented in this study are estimated at $1.0 to $2.5 million; this is comparable to the revenues gained from the production and subsequent projected adult returns of a 20-million-egg facility, or $670,000 to $1.7 million. More loss of revenue appears to be occurring from the lack of a more aggressive artificial propagation approach than from the dreaded IHN disease.

The application of disease-control measures for countering IHN should minimize the mortality that would otherwise be expected if artificial culture of sockeye were to expand. By utilizing guidelines that primarily involve common sense and good fish-cultural practices, the highly successful production of this species will provide many opportunities that previously had not been considered because of IHN disease, poor survival rates, and other associated risks. One such opportunity may be the planting of juveniles back into lakes that have become barren because of the uplifting associated with the 1964 earthquake.

Since they would not have been exposed to the virus during incubation and natural rearing, the juveniles produced in hatcheries utilizing these guidelines would be expected to have less risk of IHN occurrence. Naturally produced juveniles that are exposed to IHNV in surface waters may have higher IHN risks than hatchery-produced juveniles. The planting of hatchery-produced juvenile sockeye salmon in barrier lakes (where no adults can enter) might be an appropriate use of fish produced under these guidelines.

Possible favorable areas for the increased production of sockeye salmon are as follows: (1) Cook Inlet because of shorter transport lines for fish delivery, processing, and product routing, (2) Prince William Sound and southeast Alaska because of high ex-vessel values and demand, and (3) Bristol Bay because it would provide a higher base-production level to counter the periodic years of exceedingly low natural production.

It should be cautioned, however, that the guidelines are a coping mechanism, not a cure. Fish successfully kept alive using this approach are still potential carriers of IHNV. Little is known about this virus, and while these guidelines are of great value as a management tool, they do not alter its occurrence and distribution. Although the currently discussed avoidance techniques have been successful, they may not be the whole solution. The success presented here should not reduce the research efforts that may help solve the problem: (1) virus contribution of adult carcasses into the lacustrine environment, (2) parameters that precipitate the disease state within an enhanced system, (3) reduced virus levels, and (4) development of a rapid diagnostic technique for screening of adult fish.

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APPENDIX

PROVISIONS OF SOCKEYE SALMON CULTURE POLICY STATEMENT

May 26, 1981

Species Mix Within a Hatchery

Combinations of chinook and chum salmon, steelhead, and rainbow trout are allowed within a facility; however, when sockeye salmon are present, none of these susceptible species will be allowed. This provision is to prevent possible viral adaptation, mortality of other species within the hatchery, and risk to local populations in the vicinity.

Equipment, Supplies, and Movement of Personnel

Equipment:

Hatcheries containing sockeye salmon will have essentially no exchange of equipment to or from other hatcheries. Only items that can be adequately sanitized will be moved from a sockeye hatchery; further, using at least a 200-ppm chlorine or iodophor solution, these items will be treated at the shipping hatchery and similarly at the receiving hatchery. Equipment that can not be effectively sanitized, such as those items containing wood, or egg-sorting and picking machines, will not be moved from hatcheries that culture sockeye salmon.

Supplies:

Most supplies and materials can not be readily sanitized and will not be removed from facilities that culture sockeye salmon.

Movement of Personnel:

Personnel entering or leaving a hatchery that cultures sockeye salmon will go through a foot bath (200-ppm chlorine or iodophor solution), and they will brush with or dip protective clothing (e.g., rain gear or spawning gloves) in that solution. This procedure will be routinely used by local hatchery and maintenance personnel, workers from other areas and visitors.

Sockeye Salmon Egg Take Procedures

Eggs and Sperm Collection:

Eggs and sperm will be collected in separate sanitized containers or disposable bags or combined immediately in the same container in the desired fertilization ratio.

Fertilization of Eggs:

Eggs will be fertilized, water hardened, and rinsed (if necessary) in virus-free water, such as well water, depurated water (ultraviolet irradiated or ozone treated) or surface waters that has not been exposed to sockeye salmon at any time during the year. This will require either a separate collection and transportation of gametes from remote egg-take sites to a suitable processing site or the use of virus-free water transported to (or available at) the site.

Holding Adult Salmon:

Adult sockeye salmon will not be severely crowded in any holding structure. Crowding facilitates the spread of IHNV to all of the contained fish. Prior to egg or sperm stripping the ventral surface of all fish will be sanitized with a weak solution of iodophor (10-20 ppm). This may be applied with a sponge or paper towel. Disinfectant must be wiped from these surfaces with a clean paper towel immediately prior to spawning.

Spawning Utensils:

During spawning operations, utensils, spawning gloves, knives, and other items that come into contact with fish or water containing fish will be sanitized (200-ppm chlorine or iodophor) between each fish; each item should then be rinsed in water before use.

Seeding of Fertilized Eggs:

Eggs will be seeded into incubators in such a manner as to provide optimal use of all incubators provided for that species.

<u>Isolation of Stocks</u>

Separation:

Physical separation of sockeye salmon stocks will be provided to the maximal extent possible by the use of dividers, curtains, and isolated rooms or by spacing between containers.

Water Manifolds:

Individual incurrent and efferent water connections will be provided to all incubators and rearing containers.

Incubator Connection to Rearing Container:

A pod of discrete incubators will provide fish for one rearing container.

Hands and Culture Utensils:

Sanitization of hands, utensils, gloves, and dip nets will occur between all incubation, holding, or rearing containers.

Incubator Size:

Emphasis will be on fish quality produced and not solely on production numbers. To this end, small incubators, which maximize compartmentalization of paired specimens, will be used.

Floor Sanitization:

Daily floor wash-downs with steam or disinfectant (200-ppm chlorine or iodophor solution) will be used to help maintain high levels of environmental sanitation.

Container Sanitization:

Containers, pumps, hoses, and other devices used with sockeye salmon will be sanitized after fish or egg removal.

Hatchery Interior:

The entire hatchery interior will be sanitized after any virus-induced mortality has occurred.