PROCEEDINGS

OF THE

FORTY-SECOND ANNUAL

NORTHWEST FISH

CULTURE CONFERENCE

DECEMBER 3-5, 1991

REDDING, CALIFORNIA

THE NORTHWEST FISH CULTURE CONFERENCE

The Northwest Fish Culture Conference is an annual informal meeting by and between fish culturists for the exchange of information and ideas about all aspects of fish culture.

The PROCEEDINGS contain abstracts and or talks presented at the conference. They are unedited, contain progress reports of uncompleted programs, and, as such, SHOULD NOT BE CONSIDERED A FORMAL, PEER-REVIEWED PUBLICATION.

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ACKNOWLEDGMENTS

The 42nd Northwest Fish Culture Conference was held at the Red Lion Inn in Redding, California from noon December 3 through noon December 5, 1991. This was the first time the California Department of Fish and Game was provided the opportunity to host the Conference.

There were a total of 376 attendees from California (146), Washington (79), Oregon (87),Idaho (22), British Columbia (20), Alaska (10), Utah (8), Montana (4), Nevada (2), and Wyoming, Illinois, North Dakota, and Colorado (each with 1).

As General Coordinator of the conference, I would like to thank the California Department of Fish and Game for their contributions of time for the organizing committee to plan the conference and for absorbing the cost of phone calls and preliminary mailings. The Committee Chairs are also due thanks for their efforts, as well as all those assisting them with committee activities.

This year 27 exhibitors displayed their products at the trade show/product display. Their contribution and participation was appreciated. Silver Cup, Rangens, and Moore-Clark, not only displayed their feeds, but hosted two social hours, which facilitated the exchange of ideas and information.

Many, many companies and individuals donated raffle prizes. They have been acknowledged with individual letters but their contributions were an important part of the overall meeting and much appreciated.

The speakers are acknowledged for their efforts in preparing their papers and traveling to Redding to present them. Thanks!

An lastly, but not last in importance, my thanks to Jean Anglin, who retyped portions of the Proceedings and readied it for the printer.

Ken Hashagen
General Coordinator
Northwest Fish Culture Conference

WELCOME

I would like to welcome you all to the 42nd Northwest Fish Culture Conference. As many of you know, this is the first time California has hosted the conference an we thank you for the opportunity.

In California, the sale of fishing licenses, many of them for the pursuit of hatchery reared fish, supports not only our hatchery system but many other functions in the Department as well. I'm sure that it is true for many of the states, provinces, and agencies represented here today. Hatcheries and their production are obviously important to those of us in the recreation business.

If hatcheries are important, then it makes sense to spend time and money to train the personnel operating them. The Northwest Fish Culture Conference is an excellent forum for training. My Department is sending everyone who wanted to attend. I understand several other agencies also use the conference for the same purpose.

Ron Ducey has put together an excellent program. I hope all of you will enjoy the program, as well as your stay in Redding.

Banky Curtis
Regional Manager, Redding
Department of Fish and Game

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SURVIVAL OF COHO SALMON SMOLTS IN SALT WATER FOLLOWING EXPOSURE TO CERCARIA OF THE SALMON POISONING FLUKE, NANOPHYETUS SALMINCOLA

TIMOTHY W. NEWCOMB, GLEN A. SNELL, and F. WILLIAM WAKNITZ

National Marine Fisheries Service
Northwest Fisheries Center
2725 Montlake Boulevard East
Seattle, WA 98112

ABSTRACT

Coho salmon, *Oncorhynchus kisutch*, smolts were held in live boxes in six different sites in Grays Harbor, WA, where the salmon poisoning fluke, *Nanophyetus salmincola*, is endemic. The fish were transferred to seawater (29 ppt) after 5, 9, or 14 days exposure. Salmonid mortality was directly related to the number of metacerceria found in the posterior third of the kidney. Metacercerial load was positively correlated with live box placement and holding time in the live box.

INTRODUCTION

Two major river systems empty into Grays Harbor in Southwestern Washington. The Humptulips has a 245-square mile watershed and discharges into the north side of Greys Harbor in an undeveloped area, while the Chehalis has a 2,200-square mile watershed and discharges into the narrow east end of Greys Harbor. Unlike the area around the mouth of the Humptulips River, the highly developed area around the mouth of the Chehalis River contains two pulp mills which discharge 48 to 50 million gallons of pulp mill effluent per day, along with several landfills, log storage areas, and sewage treatment plants which contribute pollutants to the east end of Greys Harbor. In addition, the navigation channel in the inner harbor is regularly dredged, which adds suspended sediments to the water column (Fig. 1).

Since the late 1950's, biologists with Washington Department Fisheries (WDF) have observed that a higher percentage of coho, *Oncorhynchus kisutch*, and chinook salmon, *O. tshawytscha*, released in the Humptulips River have been harvested from the ocean than coho and chinook salmon released from the Simpson Hatchery on a tributary of the Chehalis River. In 1973, WDF placed coded-wire tags (CWTs) into two groups of 100,000 fall chinook that were being reared at the Simpson Hatchery northeast of Aberdeen. One of these groups was trucked and released into the Humptulips River, while the other was released near the

Hatchery into the Chehalis River system. The release into the Humptulips contributed 18 times as many fish to the ocean fisheries as those released in the Chehalis River basin (Seiler 1989).

In 1980, WDF began a long-term research effort to evaluate the production and survival of wild and hatchery coho salmon in the Grays Harbor area. In each brood year between 1980 and 1985, both wild and hatchery coho salmon survived and were caught in the ocean fisheries in significantly higher numbers from the Humptulips River when compared to those from the Chehalis River (Seiler 1989; Seiler, Pers. commun.) (Figs. 2 and 3).

Over the last several years, a multi-agency effort (including EPA, NMFS, WDF, and various other state and local agencies) has been mounted to determine the reasons for the fish loss from the Chehalis River. As part of this research, NMFS personnel placed coho salmon smolts in live boxes at numerous locations throughout Greys Harbor and, after exposure for up to 2 weeks, surviving fish were taken to Manchester to evaluate their long term survival in salt water. One portion of this work examined the relationship between infestation of the cercaria of the salmon poisoning fluke, Nanophyetus salmincola, and the long term survival of coho salmon smolts.

The life cycle of the salmon poisoning fluke involves a definative host and two intermediate hosts. The cycle starts when eggs in the feces of the definitive mammal host are shed into the water of a stream. The eggs soon hatch as free-swimming miracidia. These miracidia search out and enter a specific snail, Juga plicifera, where they multiply. They then leave the snail as cercaria, which move about until a chance encounter with a small fish. They burrow into the fish, where they encyst as metacercaria. The fish must then be eaten by a mammal to complete the cycle. The metacercarial cysts are carried through the digestive system where they develop and attach themselves to the walls of the intestine. The mature flukes shed eggs into the feces of the definative host. The principal mammalian hosts are the raccoon and the spotted skunk, but a wide variety of predators, both wild and domestic, have been found to shelter this parasite including the dog and cat (Schlegel et al. 1968). Nanophyetus is itself a carrier of another pathogen, Neorickettsia helminthoaeca, which can cause death in dogs (Wood 1978; Booth et al. 1984). Important intermediate fish hosts include the chars, trout, and salmon (Bennington and Pratt 1960).

Nanophyetus is found west of the Sierra Nevada and Cascade mountains from the Sacramento River in northern California to the southern end of the Olympic mountains in southwestern Washington.

Its occurrence is limited to waters which are the habitat of the graceful keeled horn snail, J. plicifera, (Booth et al. 1984). This snail prefers muddy-sand bottoms of small and medium-sized lakes and slow-flowing streams which contain large rocks, pilings, bridges, old planks, and other debris (Bennington and Pratt 1960; and Clarke 1981).

While Nanophyetus metacercaria are found encysted in almost every tissue of juvenile salmon, most metacercaria are found in the kidney, muscles, and fins (Wood 1980; Unpublished). Counts of over 450 cysts have been reported in the posterior one-third of the kidney of juvenile coho salmon (Harrell and Deardorff 1990). Following penetration of the fins, the cercaria have been observed entering the blood vessels between the fin rays and migrating down these vessels to the base of the fin. Passage to the kidney is thought to be by way of the renal portal system (Baldwin et al. 1967; Bennington and Pratt 1960).

METHODS AND MATERIALS

Six sites were established in Grays Harbor, the mouth of the Chehalis River, to expose coho salmon smolts to various suspected pollutants and pathogens. Four sites were in estuarine areas subject to industrial and urban discharges, one site was in a non-industrial estuarine area, and one site was in a non-industrial freshwater area (Montesano, WA) (Fig. 1). Each site had two nylon-mesh net-pens, each 2.4 x 2.1 x 1.8 m deep, suspended from a well anchored floating frame.

Unvaccinated, unmedicated coho salmon smolts from the WDF Humptulips Hatchery were used to stock all live-boxes. Fish were subsampled from each site on day 5, 9, and 14 of the test. Approximately 300 fish were placed in one of the nets, from which fish were removed on Day 5 and Day 9 post-exposure, and 200 fish in the second net, from which fish were removed only on Day 14. Initial density in the net containing 300 fish was below 1.75 kg/m^3. On Days 5, 9, and 14, approximately 100 fish were removed from each live-box and transported to seawater net-pens at the NMFS Field Station at Manchester, WA, near Seattle. Tanks containing approximately 150 gallons of water collected from each live-box site were used to transport the coho salmon smolts. Water in the tanks was aerated with oxygen for the duration of transport, usually 3 hours. On arrival at Manchester, each group was acclimated to seawater for 30 minutes by gradually replacing the hauling water with ambient seawater (29 ppt salinity). Each test group was then transfered in seawater to a 1.2 x 2.1 x 1.5 m deep nylon-mesh net-pen.

Fish were fed Oregon Moist Pellet three times daily after transfer to seawater. Dead fish were removed daily and examined for bacterial pathogens. In addition, counts were made of the number of metacercarial cysts of N. salmincola in the posterior third of the kidney of all mortalities.

Two separate live-box trials were conducted: Series 1 beginning April 22, and Series 2 beginning May 12, 1989. Each series of trials was followed in saltwater for at least 16 weeks.

RESULTS AND DISCUSSION

At the end of 10 weeks in seawater, all three groups from Montesano site had suffered over 75% mortality, while all groups from the five estuarine sites had suffered less than 25% mortality (Fig. 4). Cumulative saltwater mortality ranged from a high of 95% after 14 days exposure at Montesano, Washington, to a low of 75% after only 5 days exposure at the same site. After 10 weeks in seawater, mortality increased in all test groups from the five estuarine sites due to an outbreak of vibriosis.

A significant increase in the average number of cysts found in the posterior third of the kidney was found in all groups exposed at Montesano, Washington, while groups from the five estuarine sites consistently showed fewer cysts (P> 0.01). In the first series, estuarine groups averaged less than 30 cysts per fish, while the Montesano groups averaged from 40 to 72 cysts per fish. In the second series, the estuarine groups averaged less than 50 cysts per fish, while the Montesano groups averaged from 74 to 136 cysts per fish. In both series of tests, the average number of cysts in the posterior third of the kidney in all estuarine groups was similar to the average number of cysts found in fish at Humptulips Hatchery at the start of a particular series of tests.

Salmon mortality was directly related to the number of metacercaria found in the posterior third of the kidney. When the average numbers of metacercaria in mortalities from each group were plotted against percent group mortality, a sigmoidal relationship was seen (Fig. 5).

Subsequent examination of the Montesano site revealed high concentrations of J. plicifera, which would explain the large numbers of metacercaria found in the posterior third of the kidney of coho salmon smolts placed in that live-box. Since all other sites were in seawater, the fish placed in those live-boxes were protected from additional "strikes" of N. salmincola metacercaria, which require freshwater.

These results suggest a reason why the coho salmon from the Chehalis River contribute to the fishery at a lower rate than those from the Humptulips River. It could be that many coho salmon from the Chehalis River enter the inner harbor with heavy parasitism from N. salmincola and encounter the additional stress of industrial and urban pollution which compromises their transition to seawater.

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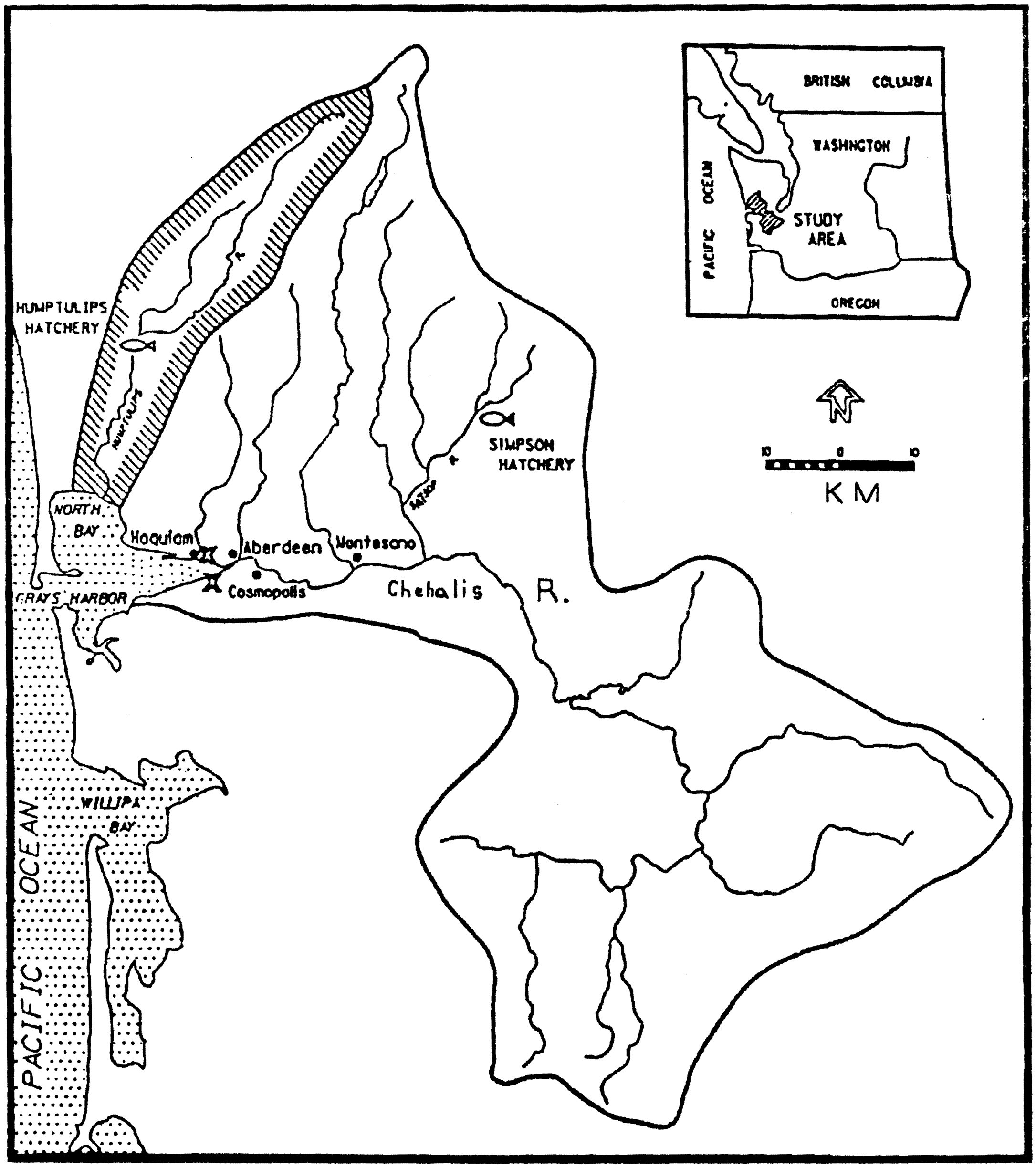

Figure 1. Chehalis River Basin, site of Nanophyetus research.

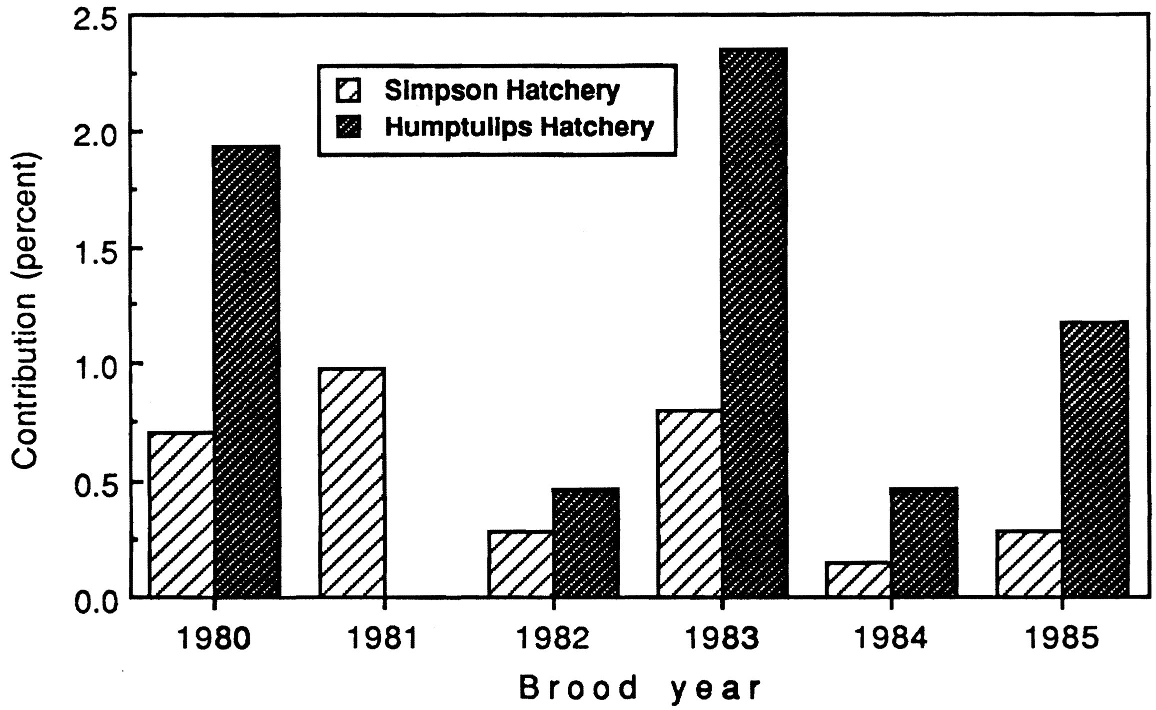

Figure 2. A comparison of the contribution rates of Simpson (Chehalis watershed) and Humptulips hatchery coho salmon to ocean fisheries. In 1981, no Humptulips fish were tagged because of a disease outbreak at the hatchery (Seiler, 1989).

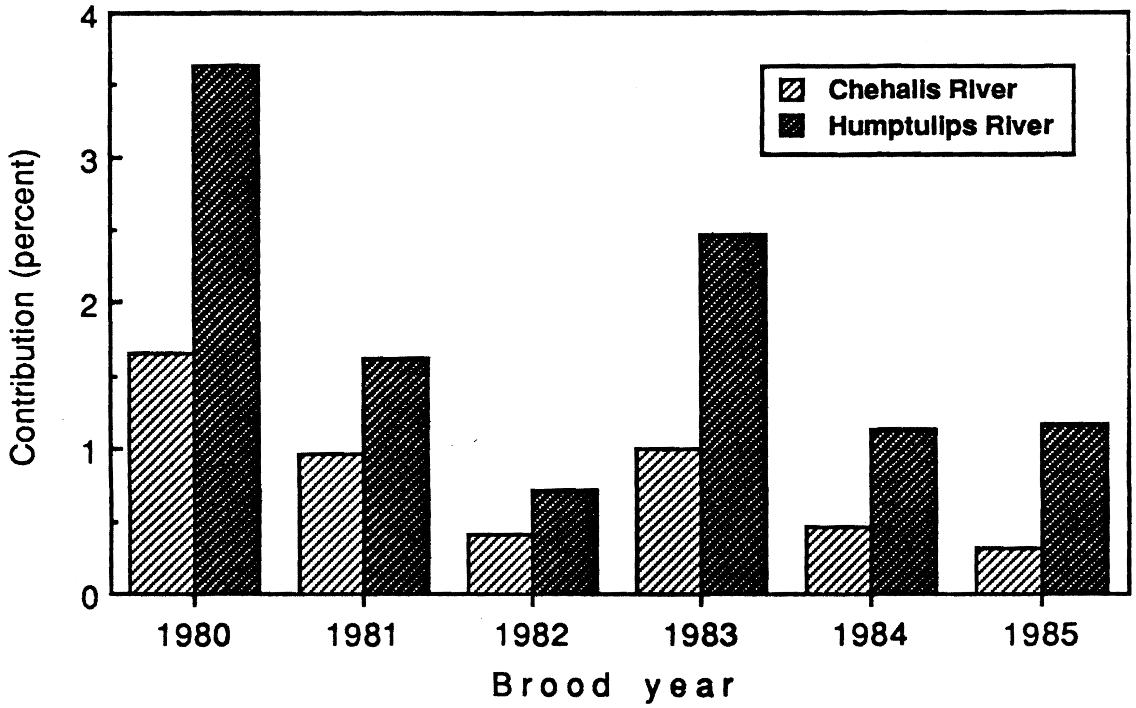

Figure 3. A comparison of the contribution rates of Chehalis and Humptulips wild coho salmon to ocean fisheries (Seiler, 1989).

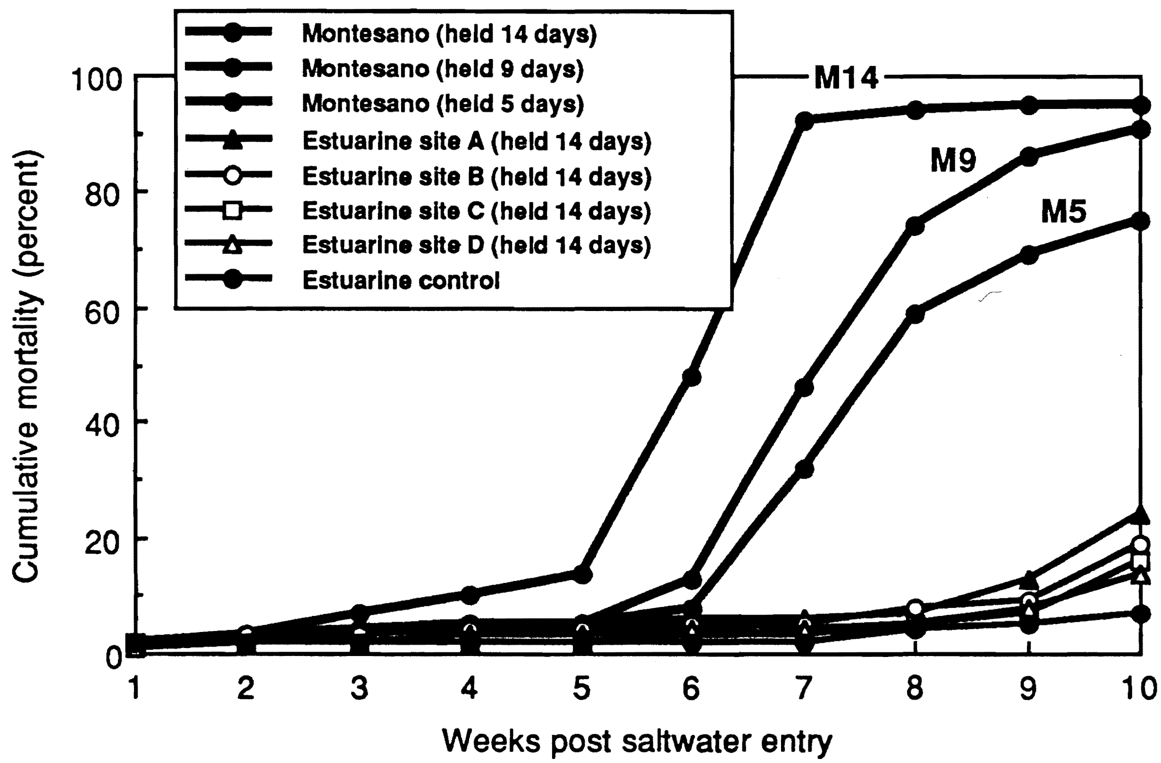

Figure 4. Cumulative saltwater mortality of coho salmon smolts held at Montesano, Washington, on the Chehalis River compared to similar groups of coho salmon held at various estuarine sites in Grays Harbor groups experienced an outbreak of vibriosis at week ten.

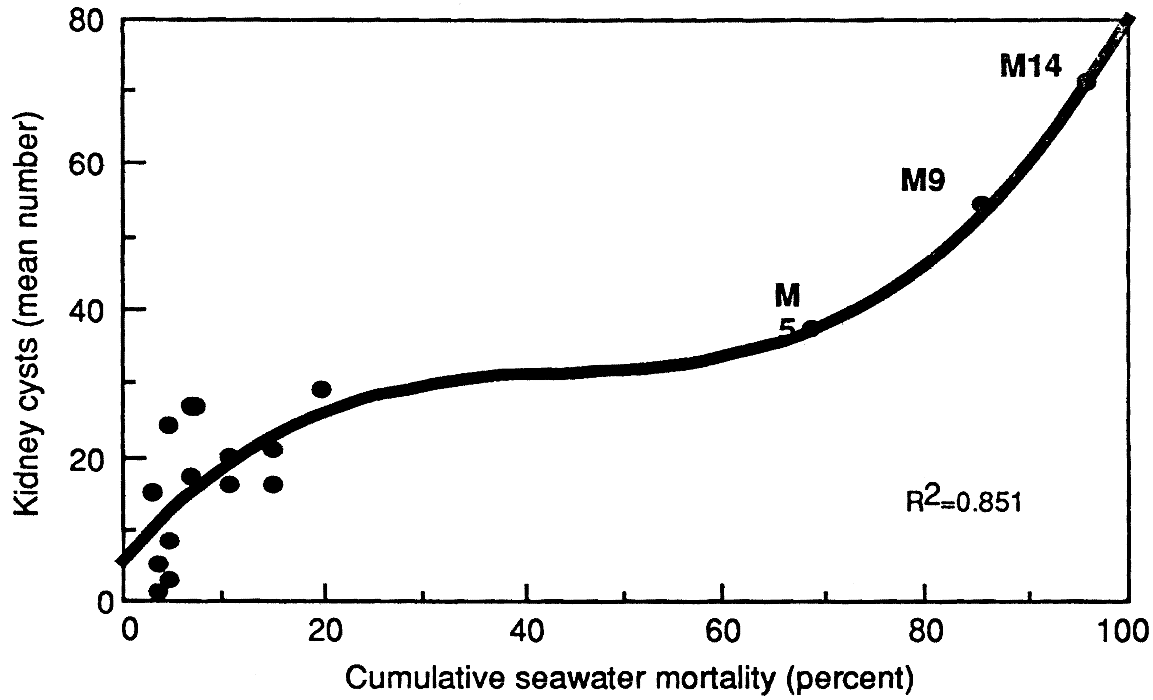

Figure 5. The relationship between the number of <u>Nanophyetus</u> cysts in the posterior third of the kidney and the survival of juvenile coho salmon smolts after 10 weeks in seawater.