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Infectious Salmon Anemia Virus

The occurrence of infectious salmon anemia virus in Atlantic salmon populations in the Northeast may threaten interagency recovery efforts for this endangered species.

Atlantic salmon (*Salmo salar*) once thrived in the northeastern part of the United States and ranged from the rivers and streams of Maine to as far south as the Housatonic River in Connecticut. Although populations once thrived in the Connecticut, Merrimack and Penobscot Rivers, Atlantic salmon essentially disappeared from the New England area by the mid-1880's. Their decline was principally attributed to construction of dams, pollution and overfishing - problems associated with an unfettered industrialization of the northeast. It was not until the later half of the 20th century, however, that conservation efforts began in earnest to restore Atlantic salmon within their historic range.

Atlantic Salmon restoration is a joint Federal-State Initiative

The U.S. Anadromous Fish Conservation Act of 1965 provided stability for a long-range restoration program involving cooperation of numerous federal agencies, state departments of fish and wildlife, industry, and private conservation groups. The current restoration program depends upon development of river-specific broodstock to maintain and maximize the genetic diversity of fishes in the Connecticut, Merrimack, Penobscot and several other smaller rivers on the downeast coast of Maine.

Following a 2-3 year tenure at sea off the coast of Greenland, mature Atlantic salmon return to their natal rivers to spawn. These fish are captured at dams and weirs and maintained as non-feeding captive broodstock from the time that they return to the rivers in May until they are spawned in September/November. At this point, holding and production facilities become the cornerstone of the restoration program.

Gametes, taken from captive brood salmon are used to produce fry, parr and smolts that are stocked to enhance restoration of populations in their respective rivers. Juvenile fish will remain in their natal rivers for their first two years of life before they migrate to the ocean.

There are several diseases of Atlantic salmon that must be carefully managed and controlled for the restoration program to be successful. One such disease is Infectious Salmon Anemia. ISA is a highly infectious disease of Atlantic salmon that was first reported within Norwegian aquaculture facilities. The disease has since been described among cultured Atlantic salmon in New Brunswick, Canada and Scotland. Canadian biologists have confirmed the presence of the disease in the Bay of Fundy and the first case of the disease in aquaculture fish in US waters in Maine was reported in 2001.

In the marine environment, ISA is most often transmitted by cohabitation or contact with infected live salmon or infected biological materials such as animal wastes or discharges from normal culture operations, slaughter facilities and contaminated well boats. The virus spreads from fish

Current and Planned Research Activities

- **Assess the use of enzyme-linked immunosorbent assays (ELISA) as a diagnostic tool for detecting antibodies for the virus in Atlantic salmon.**
- **Investigate the route of infection among feral Atlantic salmon and assess the effects of environment on disease development.**
- **Investigate correlations between diagnostic assays that detect infection (PCR) with those that provide indirect evidence of exposure based on antibody production (ELISA).**

to fish when an infected individual sheds viral particles from its blood, gut contents, urine, and epidermal mucus. Fish that survive epizootics may become carriers and can continue to shed virus for more than one month into the surrounding water. The effective management of the New England restoration program requires that ISAV-positive fish do not enter pre-spawning facilities.

Scientists at the Leetown Science Center have been providing technical and research support to the US Fish and Wildlife Service to describe the etiology of this emerging disease and to help develop management options. In 2003, scientists evaluated the use of an enzyme-linked immunosorbent assay (ELISA) that detects antibodies to ISAV in Atlantic salmon serum. This non-lethal assay could be performed using a small amount of blood taken from fish as they return to spawn and before they are used as brood fish in the restoration program.

Microbiologists used archived blood samples taken from returning salmon from 1995 to 2002 on the Penobscot, Merrimack, and Connecticut Rivers for the ELISA assay. Samples taken before 1996 pre-dated detection of ISAV in North American Atlantic salmon. Prior to completing the ELISA assays, scientists confirmed that antibodies in sera were not degraded during almost 10-years in freezer storage.

Results of these assays suggested that the virus was present in feral Atlantic salmon from the earliest samples archived. Fish with antibodies for the virus were detected in Penobscot River salmon from returning fish in 1995, 1998 and 1999. In the Merrimack River detection of ISAV antibodies was recorded from returning fish in 1996, 1997, and 2002. No antibodies for the virus were detected in Connecticut River salmon.

While the presence of the antibody does not necessarily correlate with active infection or overt disease, these results do suggest that the virus has been in feral Atlantic salmon populations for some time and within production lots of the fish used in the restoration program since at least 1995.

In other studies, 4-year-old retired domestic salmon broodstock were segregated by gender for challenge as control and infectious salmon anemia virus (ISAv) challenge cohorts. Fish that tested free of ISAv by polymerase chain reaction (PCR) assay were exposed to the ISA virus by injection. Mortality in the exposed fish began 3 weeks after injection and continued with acute mortality for 3 weeks and with chronic mortality for an additional 2 months. The few fish that survived this challenge were then spawned. The gametes recovered from ISAv-infected fish were of lesser quality and quantity than those from control fish and no progeny resulted from the matings. At 4 weeks post-spawning, the remaining control and virus-exposed fish were cohabitated. Survivors of cohabitation were stressed by injection of immunosuppressant to enhance the probability of expression of clandestine ISAv infection. Results of the cohabitation studies suggested that freshwater transmission of the virus occurred.

Scientists at the Leetown Science Center are working with management biologists with the US Fish and Wildlife Service to develop biosecurity and monitoring plans in response to these finding. New studies will be devised to investigate the route of infection among feral Atlantic salmon, to identify reservoirs of infection, and to assess the effects of environment on disease development. Scientists will also work with the US Fish and Wildlife Service's Northeast Fishery Center in Lamar, PA to investigate correlations between the various diagnostic assays used to detect the presence of ISAv in Atlantic salmon .

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