EXECUTIVE SUMMARY:

Project 1A - Hatchery Disease Impact Assessment

The objectives of this report were; (1) to review disease data and reports from salmon enhancement facilities operated under the authority of Fisheries and Oceans Canada (DFO) and the Freshwater Fisheries Society of British Columbia (FFSBC) and evaluate the potential for a qualitative and/or quantitative assessment of the potential effect of diseases present in enhancement facilities on the production of Fraser River sockeye salmon (*Oncorhynchus nerka*) and, (2) if possible evaluate the disease risks posed by the operation of salmonid enhancement facilities on the production of Fraser River sockeye salmon.

The role of enhancement hatcheries in sustaining wild salmon populations is controversial. Salmonid enhancement is intended to improve the freshwater productivity of native salmonids. Concerns about negative effects from interbreeding of enhanced and wild salmon, ecological competition, and the impacts of mixed fisheries have been the subject of other reviews and remain unresolved. This report only considers the potential infectious disease risks of salmonid enhancement facilities in the Fraser River watershed and Strait of Georgia for approximately the past decade.

Two methods were used to assess the burden of evidence available for risk assessment and to attempt to evaluate the risks. First, a scoping literature review sought direct and indirect evidence of a causal relationship between salmonid enhancement related infectious diseases and Fraser River sockeye salmon production. Second, data provided by the Cohen Commission including, salmonid enhancement disease diagnostic data; hatchery-level health records and; production data were examined using a risk assessment framework.

The disease impacts of salmon enhancement facilities on Fraser River sockeye salmon are largely unexplored in the literature. The published literature failed to provide sufficient direct or indirect evidence to fulfill standard criteria for causation. Infectious diseases and disease causing microorganisms have been reported in the literature in both Fraser River sockeye salmon and other species of enhanced salmonids in British Columbia. These pathogens are capable of causing clinical and sub-clinical impacts on individual fish but the effects on population productivity remain speculative.

The literature was unable to provide sufficient information to determine the likelihood of salmonid enhancement-associated diseases impacting Fraser River sockeye salmon, the magnitude of the hypothetical impacts, or the ability of enhancement facilities to prevent or mitigate the risks. A small number of historic cases have associated the presence of pathogens in Fraser River sockeye salmon with acute and sometimes large scale mortality, but the hypothesized association between crowding at spawning channels and increased risk of disease have not been definitively proven.

The goal of determining the impact of a specific disease on wild fish productivity is largely unachievable due to the high variability in exposure settings, environmental conditions and biological responses; high level of uncertainty due to infrequent or inaccurate measurements; and large number of unknown interacting factors. Past reviews of the impacts of enhancement hatcheries have suggested a negative effect on wild salmon, but supporting evidence is lacking.

Limitations in research designs and the challenges of studying fish disease under natural settings are significant obstacles to understanding the impacts of disease and to establishing with sufficient precision that free-ranging fish are exposed to pathogens of enhancement facility origin. There is biological and epidemiological plausibility that diseases, under certain environmental conditions, could affect wild fish population dynamics and there is experimental evidence that certain pathogens can cause death, disease and impaired physiological function in individual fish. However, there is insufficient information and understanding in the published literature to establish the proportional contribution of infectious diseases alone or in combinations with other host and environmental stressors to Fraser River sockeye salmon production.

We could not find an evidence-based, non-zero standard to define an acceptable frequency or amount of transfer of pathogens from enhanced fish to wild fish that could be used in a risk assessment.

We know of no legal fish health standard that establishes an acceptable level of fish pathogen risk for enhancement operations except for legislation dealing with the exclusion of foreign or exotic disease from Canada. A single standard for acceptable exposure cannot currently be defined as the capacity for individuals and populations to cope with a disease is context specific and would be affected by things such as the pathogen, host species, life stage, habitat quality, water temperature and many other factors.

A health standard of no infectious or parasitic microorganisms or diseases in Fraser River sockeye salmon is unattainable because; infection and disease are normal in wild fish populations and a variety of infectious agents are ubiquitous in aquatic environments or common in cultivated or wild fishes.

Disease data from enhanced salmon in British Columbia did not allow for the construction of a complete hazards list for use in a risk assessment or for estimating the frequency and abundance of infection in enhanced fish populations. The nature of the diagnostic systems restricted our knowledge to the more common infections that are capable of causing overt clinical signs in a sub-set of the population as well as to a small number of pathogens in returning broodstock. The data did reveal that a variety of pathogenic hazards exist in enhanced salmon in British Columbia; none of which were unexpected or exclusive to enhanced salmonids. Enhanced salmon in the province do harbour viruses, bacteria and parasites capable of causing severe clinical disease in infected fish under experimental or culture conditions. We were able to document cases where fish with known or suspected infections

were released from salmonid enhancement operations into fish bearing waters. In no case were we provided evidence that post-release monitoring of surrounding wild fish was undertaken. There was no evidence found to assess if these releases did or did not result in exposure or impacts on other fish.

For a risk to exist, an individual or population must be exposed to a hazard. Generally, there are three variables that affect the probability of exposure to an infectious hazard; (1) the geographic distribution of the escaped pathogen; (2) the abundance of the pathogen in the receiving environment and; (3) the frequency with which the fish are involved in an exposure that results in transmission of the pathogen. As there are no data for these 3 variables, exposure assessment was not possible. Fraser River sockeye salmon reared in enhancement hatcheries or spawning channels have the most plausible route of exposure to diseases present in hatcheries or spawning channels. Exposure of Fraser River sockeye salmon outside of enhancement facilities to infectious enhanced salmonids has not been monitored. Biologically plausible routes of exposure exist, but none have been measured.

Federal and provincial salmonid enhancement programs do many things to reduce the risk of disease to wild fish by managing disease abundance in their facilities. Diagnostic services provided to salmonid enhancement facilities allow for identification and treatment of infections; movement restrictions limit the translocation of pathogens; and broodstock screening allows for the reduction of certain vertically transmitted diseases. The operating procedures for risk reduction at the enhancement hatcheries and spawning channels focus on two elements; reducing the prevalence of disease within groups of fish to be released from salmonid enhancement operations; and pre-release assessments of groups of fish with previous disease or infection histories. There is no routine assessment of the infection status of groups that are either not showing clinical signs and/or are not progeny of fish with vertically transmitted infections or at risk of having known vertically transmitted infections. A population-wide fish disease surveillance program does not exist.

All major DFO and FFSBC hatcheries have Fish Health Management Plans that are intended to support the goal of not releasing fish with known infections. The Plans have not been audited. There are inadequate resources to allow fish health professionals to visit enhancement facilities to help adapt Fish Health Management Plans to local conditions, audit their practices and develop ongoing disease prevention programs. The Plans vary in detail and in their adaptation to local conditions. There is little opportunity to apply Fish Health Management Plans to spawning channels and it did not appear that the Community Economic Development Program or Public Involvement Project hatcheries have comprehensive fish health management plans. The amount of risk reduction to Fraser River sockeye salmon realized by these efforts has not been investigated but it is reasonable to assume that reduction of infection in salmonid enhancement facilities will reduce the level of exposure for wild salmonids from this potential source.

The current system for reporting and recording fish health in salmonid enhancement facilities or for documenting the suitability of fish for release, lack consistency, quality and accessibility thus limiting external review and public assurance.

A risk assessment could currently only conclude that the risk of transfer of infectious agents is biologically and epidemiologically plausible. There is a suite of pathogenic hazards present in fish in enhancement facilities and evidence that pathogens have viable means to escape spawning channels and hatcheries via fish or water releases; thus entering fish bearing waters potentially occupied by Fraser River sockeye salmon. The probability and consequence of an exposure to released infectious agents on Fraser River sockeye salmon cannot be specified using the current scope of scientific knowledge.

We could not determine if diseases present in salmon enhancement facilities (hatcheries or spawning channels) present potential for serious or irreversible harms to Fraser River sockeye salmon. Limitations in scientific understanding, lack of ongoing surveillance of wild and cultured fishes, and deficits in data provided to us were the primary reasons for our inability to make specific cause-effect conclusions and to qualitatively or quantitatively assess risk.

We provide management and research recommendations that may improve the effectiveness of fish health programs in risk management as well as increase oversight of fish diseases to provide public assurances that undue disease risks are not arising from salmonid enhancement facilities. Management recommendations fall into 3 themes: (1) shifting the emphasis and organization of fish programs from diagnostic services for disease treatment to comprehensive health management for health promotion and disease prevention; (2) promoting a systems perspective that allows for fish disease and population data to be integrated and (3) improving auditing and oversight. Research recommendations are intended to support these management objectives by developing evidence for strategic management decisions and to create new understandings to better characterize and monitor disease interactions between cultured and free-ranging fish.