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Overview of fish disease agents in cultivated and wild salmonid populations in the Maritimes

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Abstract

The majority of fish health diagnostic testing in the Maritimes is performed on cultivated salmonid populations due to extensive salmonid aquaculture; economic consequences of a disease outbreak; and live trade of cultivated fish stocks. There are a number of laboratories available for diagnostic testing and as a result of the lack of mandatory reporting of infectious disease agents of concern, the Department of Fisheries and Oceans (DFO) is not always privy to pertinent fish health information. The demand for diagnostic inspections under the Fish Health Protection Regulations (FHPR) has dramatically increased since their promulgation in 1977. The Government of Canada assumes the cost of performing FHPR inspections within Canada and the provision of these diagnostic examinations exhausts the majority of resources available for DFO's Maritime Region Fish Health Unit. Limited testing of wild finfish populations has been performed through: collection and submission of samples by other agencies and groups within DFO; the necessity for regulatory diagnostics on wild broodfish populations; and investigations of wild fish mortalities. This paper will provide a review of available fish health information collected for wild and cultivated salmonid populations in recent years.

Résumé

La plus grande partie des diagnostics de maladies du poisson réalisés dans les Maritimes porte sur des populations de salmonidés d'élevage étant donné l'envergure importante de la pisciculture des salmonidés, les conséquences économiques d'une épidémie et le commerce de poissons d'élevage à l'état vivant. Il existe plusieurs laboratoires de diagnostic et comme la déclaration des agents pathogènes importants n'est pas obligatoire, le ministère des Pêches et des Océans (MPO) ne dispose pas toujours de renseignements pertinents sur la santé des poissons. La demande de diagnostics qui découle de l'application du Règlement sur la protection de la santé des poissons (RPSP) s'est accrue de façon extrêmement importante depuis l'entrée en vigueur du règlement en 1977. Le gouvernement du Canada assume les coûts des inspections faites au Canada en vertu du Règlement et les coûts des diagnostics s'accaparent la majorité des ressources de l'unité de la santé des poissons de la Région des Maritimes du MPO. Certains tests diagnostiques ont cependant pu être réalisés sur des poissons de populations sauvages : il y a eu collecte et présentation d'échantillons par d'autres organismes ou services du MPO, l'obligation réglementaire de procéder à des diagnostics de populations de géniteurs sauvages et les enquêtes portant sur des cas de mortalité de poissons à l'état sauvage. Le présent document donne un aperçu des renseignements obtenus au cours des dernières années sur la santé des poissons des populations de salmonidés sauvages et d'élevage.

Introduction

The Fish Health Protection Regulations (FHPR) were promulgated in 1977 under the Fisheries Act of Canada to protect and conserve wild and cultured finfish populations from the spread of infectious disease agents resulting from international and interprovincial exchange of cultivated salmonids. Transfer of salmonids within a Maritime province (intraprovincially) must satisfy the Maritimes Region Fish Health Policy (RFHP). The requirement for additional diagnostic testing of salmonids prior to transfer, over and above the FHPR and the RFHP (as well as the testing of non-salmonid species), can be required to satisfy section 56 (b) of the Fishery (General) Regulations (F(G)R) which states that " *The minister may issue a licence if the release or transfer of the fish do not have any disease or disease agent that may be harmful to the protection and conservation of fish.*" The Government of Canada assumes the cost of RFHP and FHPR inspections through the provision of these diagnostic services.

As a result of the growth of the aquaculture industry since its inception in the late 70's, the demand for regulatory diagnostics has dramatically increased and represents approximately 87% of the current diagnostic workload performed by the DFO Maritimes Region Fish Health Unit. Examinations of wild salmonid finfish through regulatory inspections of wild broodfish, wild fish mortalities and field surveys comprise 7% of diagnostic samples. The limited diagnostic testing of wild finfish is unfortunate. Under the existing FHPR fish can be imported interprovincially between facilities with like disease profiles, providing the health status of facilities and/or drainage basins is available to support these transfers. Proper sampling of wild finfish populations would provide required information to support and formulate fish health regulations/policies, as well as insight into the disease interactions of wild and cultured finfish populations.

Diagnostic examination of losses or moribund fish are more likely to result in the identification of an infectious agent than regulatory examinations of randomly sampled fish. Presently less than 2% of the samples examined by DFO are mortalities of cultivated salmonids. The majority of these diagnostic investigations are provided by private and provincial diagnostic laboratories. Presently there is no requirement for mandatory reporting of disease agent identifications to federal authorities. Although fish health information is obtained through voluntary notification by industry and provincial agencies, our knowledge of the health status of cultivated stocks is incomplete. This paper will review the salmonid fish health information collected by the DFO Maritimes Region Fish Health Unit since 1993 for cultivated populations, and over the past 10 years for wild populations.

Cultured Fish

During FHPR inspections fish are examined for: filterable replicating agents, including but not limited to, the viruses causing infectious pancreatic necrosis (IPN), infectious hematopoietic necrosis (IHN) and viral haemorrhagic septicaemia (VHS); bacterial agents causing furunculosis (*Aeromonas salmonicida*), enteric redmouth (ERM) (*Yersinia ruckerii*) and bacterial kidney disease (BKD) (*Renibacterium salmoninarum*); and the parasites responsible for causing whirling disease (*Myxobolus cerebralis*) and Ceratomyxiasis shasta (*Ceratomyxa shasta*).

Salmonids held in facilities that only transfer live fish intraprovincially under the RFHP are examined for agents causing furunculosis, ERM as well as for the presence of BKD lesions. Since the identification of the infectious salmon anaemia (ISA) virus in 1997, salmonids from several freshwater hatcheries in NB, as well as those in NS which receive(d) eggs/fry of Bay of Fundy, NB origin, are, or have been, screened for ISA virus. With the exception of required testing for two parasitic agents under the FHPR, routine screening of finfish for the presence of parasites prior to transfer is not required under current federal fish health legislation in the Maritimes.

New Brunswick (NB)

Prior to 1993 microbial fish pathogens impacting aquaculture facilities primarily included *A. salmonicida* (Olivier, 1992), *R. salmoninarum* and *Vibrio anguillarum* type I and type II (causative agents of vibriosis). Although IPN virus has been detected in both marine and freshwater environments in most years, there are very few reported epizootics attributed to infection with this virus. The few epizootics documented in DFO's database are of brook trout fry in freshwater hatcheries. Since 1993, the disease agents that have significantly impacted the marine cage culture industry include: the first isolations of *Vibrio salmonicida*, causative agent of hitra disease in 1993 and 1994; infections with sea lice (*Caligus sp.* and *Lepeoptheirus sp.*) in 1994 and 1995; and the virus causing ISA in 1996 and 1997 (Table 1). As a result of enhanced screening, depopulation and site fallowing, the number of ISA virus positive sites has been drastically reduced in 1998. To date ISA virus has not been identified in freshwater hatcheries. Although microbial agents responsible for causing furunculosis, IPN, ERM and BKD are still detected, due to the advances in farm husbandry/management practices, losses from these infections are not always severe.

Nova Scotia (NS)

Microbial fish pathogens identified prior to 1993 include: *V. anguillarum* type I and II, IPN virus, *Y. ruckerii* and *R. salmoninarum*. *Vibrio salmonicida* was first detected in the Maritimes at one marine farm in NS in 1990, however losses were not as severe as those caused by this pathogen in later years in the NB Bay of Fundy industry. Parasitic infections of sea lice (*Caligus sp.* and *Lepeophtheirus sp.*) have been detected and continue to be monitored and treated in marine/brackish culture.

ISA virus was detected at one marine farm in 1998, however no evidence of the disease caused by this agent has been reported. Other notable identifications in recent years include: the first identifications of *A. salmonicida* typical strain in a marine farm in 1994 and at a freshwater site in 1995; *Piscirickettsia salmonis* at a marine farm in 1996; proliferative kidney disease (PKD) agent at one freshwater hatchery in 1995 and 1996; and *Enterocytozoon sp.* at a freshwater hatchery in 1996 (Table 2). According to DFO's records these agents have not been identified in any other year.

Prince Edward Island (PEI)

With the exception of identifications of *Vibrio anguillarum* isolated from rainbow trout reared in marine cages in 1979 through to 1981, DFO has no official records of any pathogen responsible for significant losses in cultivated populations. IPN virus has been detected in 1977, 1982 and 1990 and identifications of BKD agent (by slide examinations only) in 1976 through to 1980 and in 1995. Although 13,873 salmonids from 11 facilities have been examined by DFO for disease agents since 1993, DFO has not made or is aware of, any significant identifications of finfish pathogens within this time.

Wild Fish

Historically (prior to 1987) microbial pathogens identified from wild salmonid fish include: *A. salmonicida* (typical strain) in the Saint John and Restigouche drainages, NB (Olivier, 1992); *A. salmonicida* (atypical strain) in the Medway River, NS and in the Saint John River, NB; clinical BKD in the Margaree River system in Cape Breton, NS (Paterson, 1979); identifications of IPN virus in a variety of drainages in NS and NB and *Y. ruckerii* in the Miramichi and Saint John river systems. Sea lice parasites have been identified on Atlantic salmon returning to the Restigouche, Big Salmon and Apple (head of the Bay of Fundy) (White, 1940) rivers in New Brunswick and to the Margaree and Moser rivers in Nova Scotia (White, 1940).

Since 1987, 5651 wild salmonids have been examined for disease agents; 60% of the samples are from NB sources, 36 % from NS and 4% from PEI. The most noteworthy identification in recent years is the first identification of *A. salmonicida* in the Miramichi drainage in 1997 and again in 1998 (Table 3). Most of the wild salmonid fish health information is obtained through opportunistic sampling since there are no resources dedicated to performing these surveys. Due to the concern regarding the potential impact of ISA virus on wild salmonid populations, 650 wild salmonids, as well as 335 non salmonids, have been screened for ISA virus using culture techniques on the salmon head kidney (SHK) cell line in 1998 (Table 4). To date ISA virus has not been detected in wild finfish tested using culture techniques.

Conclusions

The DFO Maritimes Region Fish Health Unit primarily screens salmonid populations from freshwater facilities for FHPR and RFHP microbial agents. Due to the resources required to provide these regulatory diagnostics there are limited resources available to perform wild finfish surveys and additional diagnostics on cultivated populations. The majority of these additional diagnostics are provided by private and provincial diagnostic laboratories. Without mandatory reporting of disease identifications by these agencies to DFO, our records may not accurately reflect the distribution of disease agents or the presence of disease agents within the aquaculture industry. This information is crucial for the formulation of fish health policies/regulations that adequately protect and conserve both wild and cultivated finfish populations without being unjustly restrictive for aquaculturists. The existing FHPR allows interprovincial transfer between facilities/drainage basins with the same disease profiles. In the absence of knowledge of

the identity and distribution of disease agents in both wild and cultivated finfish populations, importations that do not pose a significant risk to salmonid populations may be unnecessarily denied. These concerns are among many that are currently being addressed during the major revision of the FHPR. Planned revisions include: the creation of a list of disease agents of concern for each province; mandatory reporting of disease agents; inclusion of non-salmonid finfish species; the designation of zones as positive or negative for disease agents supported by a disease surveillance program of both wild and cultivated finfish populations; and inclusion of a quality assurance program. These changes should result in enhanced knowledge of the health status of wild and cultivated finfish populations for relevant disease agents and confidence that the information available is accurate.

Unfortunately the data available does not permit us to make any meaningful assessment of the potential fish health implications of wild fish/cultured fish interactions. In order to assess this potential a dedicated program of wild fish sampling would have to be established; one that is adequately funded and based on statistically valid sample sizes.

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Table 1: Diseases/Disease Agents Identified in Cultured Salmonid Populations (Freshwater and Marine sites) in the Province of New Brunswick: 1993 - 1998

	YEAR					
	1993	1994	1995	1996	1997	1998
Number of Samples (DFO)[2]	4268	4662	2892	3606	2369	2713
Number of Sites (DFO)[2]	21f; 41m	14f; 43m	21f; 23m	17f; 19m	18f; 9m	13f; 12m
ISAv				?m [a]	***21m[a]	6m[a]
Clinical BKD	3f; 24m	3f; 9m	7f; 12m	2f; present in marine sites	present in marine sites	2f present in marine sites
IPNv	2f; 1m	3m	1f; 2m	1f	2f; 1m	1f
Vibrio anguillarum; Type I & II and	32m; type I 5m; type II	22m; type I 4m; type II	8m; type I 5m; type II		1m; type I	2m; type I
Vibrio salmonicida	*32m	31m	1m			
Aeromonas salmonicida; typical	4f; 2m	4f; 6m;	6f; 4m	4f	6f	5f
Sea Lice - *Caligus sp.* - *Lepeophtheirus sp.*	present	20m [a]	70m [a]	present	present	present

[2].... number of sites/samples examined by DFO
* first identification in New Brunswick
*** first identification in Canada
[a] report from provincial agency

f = freshwater site
m = marine site

Table 2: Diseases/Disease Agents Identified in Cultured Salmonid Populations (Freshwater and Marine sites) in the Province of Nova Scotia: 1993 - 1998

	YEAR					
	1993	1994	1995	1996	1997	1998
Number of Samples (DFO) [2]	5196	4323	3731	2901	3532	3355
Number of Sites (DFO) [2]	19f	19f; 1m	15f; 1m	15f; 1m	15f	15f
ISAv						1m[a]
IPNv		2f		1f; 1m	2f	2f
Clinical BKD	1f		1f	2f	1f	
Yersinia ruckerii	1f	1m				
PKD			**1f [a]	1f		
Piscirickettsia salmonis				**1m [a]		
Enterocytozoon sp.				**1f [a]		
Vibrio anguillarum; Type I & II				1m; type I		
Vibrio salmonicida				2m [a]		
Aeromonas salmonicida; typical / atypical		*1m; typical 1f; atypical	1f; typical			
Sea Lice a - *Caligus sp.* - *Lepeophtheirus sp*	present [a]	present [a]	present [a] treated	present [a] treated	present [a]	present [a]

[2] number of sites/samples examined by DFO
* first identification in Nova Scotia
** first identification in Maritimes
[a] report from provincial agency

f = freshwater site
m = marine site

Table 3: Diseases/Disease Agents Identified in Wild Salmonid Populations in the Maritimes by DFO: 1987 - 1998

Year	Number of Samples	Clinical BKD	*Aeromonas salmonicida* typical/atypical	IPNv	*Vibrio anguillarum*; Type I & II	*Edwardsiella tarda*
1987	925		Medway River, NS - atypical	Glace Bay, NS Baker Brook, NB	St. Mary's River, NS Morell River, PEI	
1988	403		Tobique River, NB - typical	Big Salmon River, NB	Grand River, NS	
1989	601	Margaree River system, NS	Tobique River, NB - typical	Passamaquoddy Bay, NB St. John River, NB	Nepisiguit River, NB	
1990	539		St. John River, NB - typical	Nepisiguit River, NB Oromocto Lake, NB		
1991	503				East River Pictou, NS - type I	Harvey Lake, NB
1992	245				Nepisiguit River, NB - type II	
1993	440					
1994	463	N.E. Margaree River, NS		St. John River, NB Indian Brook, NS		
1995	341			Little Elm Tree Brook, NB Muniac Stream, NB Grand Reed Brook NB		
1996	179			Muniac Stream, NB Grand Reed Brook NB		
1997	228		Miramichi River, NB; - typical Nashwaak River, NB - typical		N.W. Miramichi River, NB - type I	
1998[1]	784	Magaguadavic River, NB[2]	St. John River, NB - typical Miramichi River, NB - typical Restigouche River NB - typical	Magaguadavic River, NB[2]		

[2] fish labeled as an escaped aquaculture fish

Table 4: Wild finfish tested in 1998 by the DFO Fish Health Unit (Maritimes Region) for the presence of the infectious salmon anaemia (ISA) virus using the salmon head kidney (SHK) cell line.

Species	Number of Fish Tested	Province of Origin	Results
Non Salmonids			
herring	300	New Brunswick	Negative for ISAv
lumpfish	6	New Brunswick	Negative for ISAv
Atlantic cod	1	New Brunswick	Negative for ISAv
pollock	20	New Brunswick	Negative for ISAv
flounder	2	New Brunswick	Negative for ISAv
mackerel	1	New Brunswick	Negative for ISAv
pickerel	1	New Brunswick	Negative for ISAv
yellow perch	4	Nova Scotia	Negative for ISAv
Salmonids			
brook trout	29	New Brunswick	Negative for ISAv
rainbow trout	4	New Brunswick	Negative for ISAv
landlocked salmon	16	New Brumswick	Negative for ISAv
brown trout(+)	1	Nova Scotia	Negative for ISAv
Atlantic salmon (parr)	332	New Brunswick	Negative for ISAv
	95	Nova Scotia	Negative for ISAv
Atlantic salmon (adult)			
Gaspereau River	1	Nova Scotia	Negative for ISAv
Tusket River	3	Nova Scotia	Negative for ISAv
River Philip	3	Nova Scotia	Negative for ISAv
Musquodoboit River	2	Nova Scotia	Negative for ISAv
LaHave River	4	Nova Scotia	Negative for ISAv
Stewiacke River(+)	1	Nova Scotia	Negative for ISAv
St. John River	60	New Brunswick	Negative for ISAv
- Restigouche River	6	New Brunswick	Negative for ISAv
- Hammond River	1	New Brunswick	Negative for ISAv
St. Croix River	2	New Brunswick	Negative for ISAv
Buctouche River	2	New Brunswick	Negative for ISAv
Kennebacasis	1	New Brunswick	Negative for ISAv
Dennis River(+)	2	New Brunswick	Negative for ISAv
- Magaguadavic River			
(aquaculture escapees)	74	New Brunswick	Negative for ISAv
(wild (+))	11	New Brunswick	Negative for ISAv

(+) received blood samples instead of tissue pools containing kidney, spleen pyloric caeca and gill tissues).