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May 1, 2003

Mackenzie Valley Environmental Impact Review Board
5105 - 50th Avenue
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Yellowknife, Northwest Territories
X1A 2N7

Attention: Alan Ehrlich, Acting Manager of Environmental Impact Assessment

RE: WesternGeco Mackenzie and Liard Rivers Seismic Program 2003
MVEIRB Information Request No. 1

Dear Alan:

Attached are responses to the MVEIRB Information Request No. 1 dated 7 April, 2003.

We trust that the attached responses address the comments and recommendations noted in the Information Request.

Yours very truly,

WesternGeco Canada Ltd.

A handwritten signature in black ink, appearing to read 'Keith Rosindell'.

Keith Rosindell

cc. T. M. Baker, National Energy Board
J. Allen, Inuvialuit Environmental Impact Review Board

1.1.2 Request

Please provide detailed information about the pathology studies performed to permit the evaluation of the methods and results. In each case, provide data that enables the reviewer to compare animals at each of the distances from the source, as well as from the controls.

- a) Provide detailed methods on how the tissues were preserved and prepared for analysis. Were fish opened to allow fixative to penetrate into the internal tissues (Appendix III, p.18)?
- b) Provide information on the methods used to analyze the material beyond the statement that light microscopy was used. How much of the tissue from each animal was studied, and what was the expertise of the individual(s) examining the tissue? Were the examinations done "blind" or did the observer know the treatment group from which the fish came?
- c) Justify the use of light microscopy as a method to analyze any potential damage to sensory hair cells, when this is generally only visible at the electron microscopy level.
- d) Why was electron microscopy not performed?
- e) Provide the justification for the statements that there was no damage to the sensory cells of the lateral line and ear based upon light level histology of formalin preserved tissue (Appendix III, p.35-36). Provide the data used to determine that there was no damage to sensory cells of the ear and the lateral line. Data should be provided for each fish evaluated, including controls, and should include high quality photographs or other images of the tissue that was evaluated. Any information about quantification used should also be provided.
- f) Were observations made on possible damage to the lateral line, and, if so, what were the results? Please provide detailed results including sufficient micrographs to support the conclusions reached.

- g) Where there any observations made on the cristae of the semicircular canals to determine if these vestibular organs were intact? If so, what were the results? If not, why were these not analyzed?
- h) Specify what is meant in Table VIA (Appendix III) "hairs/cilia visible and intact".
- i) Provide data on the results from each organ examined (as listed in Appendix III, p.18) including images of exposed and control tissues.
- j) Was every animal examined for each tissue listed in Appendix III, p. 18? Provide data on each animal analyzed, including micrographs to support the conclusions. This should provide information on each organ mentioned in Appendix III, p.18.
- k) What were the effects, if any, on the swim bladder? Describe how the swim bladder was evaluated and the results from the evaluation.
- l) In addition to the pathology described which involve sectioning of tissue, were there gross examinations of the swim bladder to determine whether there were gross impacts on this organ?

Response

General Comments:

- The caged fish test evaluated short term (48 h) mortality of endemic common species found in the Mackenzie River.
- Any fish that died from exposure in the caged fish test (0 mortalities attributable to exposure to airguns) were examined for visible damage to vulnerable organs (swim bladder, gills, internal organs).
- Tissues and organs from fish exposed to airguns were preserved for later histopathological analysis. A variety of tissues and organs were examined.
- The 2002 Test Program was not privy to the results of experiments by McCauley et al. 2003 for obvious chronological reasons.

Specific Responses:

- a) Fish that survived exposure to the airguns but that were sacrificed for examination of organ status and for later histopathological analysis were euthanized using a clove oil and water mixture and preserved in 10% buffered formalin.
 - Small fish were opened by making a ventral incision along the length of the abdominal cavity (pectoral to anal fin).
 - Large bodied fish were sectioned for preservation.
- b) Laboratory procedures:
 - i. Fish sent in 10% buffered formalin were sectioned for light microscopy. Standard techniques were used and tissues were sectioned at 5 micro m and stained with hematoxylin and eosin. The following tissues were examined for most fish: skin, gills, brain and spinal cord, cranial calvarium and macula, nasal pit, lateral line, eye, thymus, thyroid, oral and branchial cavities, pseudobranch, heart (ventricle, atrium and bulbous where possible), liver, pancreas, spleen, swim bladder, kidney (anterior and posterior) and inter-renal gland, ureter, pancreas (exocrine and endocrine), gonads, esophagus, stomach, intestine, skeletal muscle and bones. For many fish, the smaller organs (thyroid, inter-renal, etc.) were not always included in the sections examined.
 - ii. See curriculum vitae of Dr. John Lumsden, University of Guelph, for expertise of the individual who examined the tissue (see attached pdf file).
 - iii. The examinations were done blind, i.e. the treatment was unknown to the examiner. Samples provided to the University of Guelph were numbered, but the examiner did not have access to the key (i.e. which exposure the fish came from).
- c) The histopathological examination was not just to examine hair cells, but to perform an assessment of fish health that included an assessment of most, if not all, vulnerable structures.

- d) As stated on page 36 of Appendix III, fish samples were preserved adequately for general histopathology and further examination of tissues by electron microscopy was not recommended by the histopathologist.
- e) The above statement that "there was no damage to the sensory cells of the lateral line and ear based upon light level histology" is not made in Appendix III. What is stated is that none of the 18 fish examined had abnormalities attributable to exposure from airgun insonification (p. 35, Appendix III). In terms of the hearing structures (maculae, cristae and otolith organs), this statement is supported by the observation, under light microscopy, that hairs and cilia were visible and intact on all fish except for one; the latter fish could not be examined due to extensive autolysis of the tissues, attributed to inadequate preservation (see Table VIA, Appendix VI, which gives histopathology results for each fish examined). Histopathology methods outlined in section 3.3.4.3 listed the tissues that were examined for most fish, when possible. Although the lateral line was included in this list, it was not in fact one of the tissues examined. Photographic records were not taken as part of the histopathology examination.
- f) The lateral line was not examined.
- g) Please see page 35-36 for information relating to cristae.
- h) 'Hair/cilia visible and intact' indicates that these structures were visible and they appeared 'normal' to the examiner.
- i) This data was provided to us in a summarized format. Please see the tables in appendix vi of Appendix III for this information.
- j) Each animal was not examined for every tissue listed in Appendix III, p. 18. Each fish was sectioned as described on p. 18 of Appendix III. All organs and tissues that appeared in sections were examined. As stated in i), the results of the examinations were provided in a summarized format and each organ/tissue that was examined for each specimen cannot be extrapolated from this.

- k) Swim bladders were examined prior to preservation of the specimens, after euthanization following the 48 hours post-exposure holding period. All fish that were sacrificed for histopathological examination were grossly examined externally and internally prior to preservation. Swim bladders were visually examined to determine if they were inflated or if hemorrhage had occurred (Falk and Lawrence 1973).
- l) Please see k).

1.1.3 Request

- a) Describe the basis for suggesting that there is no long-term impact on fish from air gun exposure.
- b) What differences might one expect in fishes that can swim away from the approaching source and fishes whose normal fright behaviour is to stay in the area? What is the evidence, and how strong is it (regarding effects on both groups of fishes)?
- c) It is unclear how the comment that for marine species the lethal radius for eggs and larvae is under 3 m with sounds at 230 dB (page 5, 2nd paragraph from bottom) is related to the data, at least as discussed in the reference used, Gausland 2000. This is a review that makes a statement to this effect, but there are no data in this paper and no references are given for this statement. Provide scientific justification for this determination.
- d) Kostyuchenko (1973) worked with marine fishes, none of which are related to the species in the Mackenzie. However, it is notable that these investigators found damage to eggs at up to 20 m from the source. This study is cited as supporting little or no damage to fish eggs. However, review of the paper shows that there were minimal observations since eggs were not allowed to survive and develop. It is very possible that damage would not be manifest in the first day after stimulation, or that the initial damage would be sub-cellular and only show up in later development. It would be of value to understand how this paper (and that of Gausland, 2000) can be used to justify an argument that there is likely to be no impact on eggs.

- e) The issue of development discussed on page 8 needs some clarification. Even if the ear is fully developed late in the life stages of some fishes, the younger fish still have ears (and would have trouble orienting without them) and they also have lateral lines. It is potentially possible that there would be impact on the developing ear and lateral line. Please provide clarification.
- f) Can your interpretation of behavioural and physiological effects be extrapolated to whitefish?

Response

General Comments:

- The objectives for the fish studies in the 2002 Test Program, as specified in a) Acoustic and Biological Test for the Mackenzie River/Delta and b) Appendix III: Behavioural and Physical Response of Riverine Fish to Airguns, are directed at acute effects and behavioural responses
- Methods specified for the Caged Fish Test and ensuing histopathological examination in the study outline and results in Appendix III relate to acute effects only.
- The effects from "damage to sensory cells of the ear" are inferred by McCauley et al. (2003).
- The statement that whitefish '...were not considered in the caged fish tests', which occurs in the last paragraph of the Preamble is incorrect. Please see Tables IIIa and IIIb in appendix iii of Appendix III. It should be noted that approximately 100 juvenile coregonids were captured but released prior to the caged fish test. The captured coregonids were held until the day of the test but it was apparent that the test coregonids were 'stressed', had lost scales and so they were released. The rationale for the approach should be obvious; when conducting an 'exposure' experiment, healthy animals must be used to minimize results from extraneous (i.e. handling) and other uncontrolled stressors.

- A DFO Hay River staff member was in consensus with us that coregonids are particularly sensitive to handling stress in summer, and commented back to the DFO Inuvik office to this effect.

Specific Responses:

- a) Very high intensity pure tones (e.g. over 180dB re 1 uPa) presented for several hours may cause damage to sensory hair cells of several fish species (Enger 1981; Hastings et al. 1996). McCauley et al. (2003) showed that damage to sensory epithelia was apparent as ablated hair cells and that no evidence of repair or replacement was apparent up to 58 days after the repeated exposures (7 approaches by an airgun over 1.4 h, fish at 5-15 m from airgun, repetition rate 2x that of WesternGeco's proposed array). McCauley et al. (2003) objectively provided caveats for interpreting effects from the observed "damage" and indicated that additional studies were required to determine the population and biological effects from the observed "damage". Reviews of airgun effects made available by Chamberlain (1991), Turnpenny and Nedwell (1994) and Davis et al. (1998) indicate that effects are primarily behavioural and short term in nature.
- b) Travel routes, habitat selection, species specific differences in hearing ability and individual fright responses by fish provide a myriad of combinations of responses and possible effects. We are reluctant to speculate about probable exposure levels for individual fish or for species and its effects upon individual fish in the Mackenzie River. Our 2002 Test Program results, however, indicate that individual responses did not result in statistically significant effects at the population level.
- c) Went on the summary provided in the review.
- d) The Kostyuchenko (1973) paper was not used to *justify* the argument that there is likely to be no impact on fish eggs, it was provided as one of the few research papers that have examined the effects of seismic sources on fish eggs. If one refers back to Table 4 of the Kostyuchenko (1973) paper, it will be noted that survival rate of marine fish eggs was very near that of the control at 10 m, not 20 m as stated in the 1.1.3 Request. The

important issue here is that fish eggs and larvae must be near the airgun source and exposed for an extended but unknown period of time for mortality to occur, that most eggs and larvae will be in tributaries at the time of the 2003 program, that only a small proportion of the river volume will be at potentially harmful levels, and that the development of fish eggs and larvae post airgun exposure is presently unknown. Gausland (2000) stated that "Several studies (we do not know if these are unpublished or in the literature) of direct physical damage by airguns on fish eggs and larvae confirm that signals exceeding 230-240 dB re 1uPa are necessary for harm to occur." Available data, reviews and summaries all seem to indicate that no significant effects on fish eggs are likely to occur.

- e) Page 8 of the EA is blank and 1.1.3 is referenced to p. 108-114 of the EA.
- f) Our 2002 Test program was designed to address specific objectives and we are reluctant to "stretch" the results by developing a species specific interpretation of effects. Whitefish were almost certainly among those fish that were counted and their position in the water column determined by hydroacoustics; there was no indication that a species specific response by whitefish overwhelmed the (lack of) response by the community that we assessed.

1.1.4. Request

Please provide detailed data on the behavioural observations made in the cages of the fish that were insonified and of the control fish.

- a) How were the behavioural observations made at the reference area (Appendix III, p. 17)? For how long were the observation periods? How many individuals made the observations? How easy was it to see into the water and could all fish be observed?
- b) How were these data quantified to demonstrate the presence or lack of behavioural impact? Include all information about the behavioural observations on the controls. If quantitative data were gathered, provide a sample of the data and discuss how it was analyzed.

- c) Was there any evidence of vestibular disturbance in the form of fish swimming in tilted positions or any other position than the normal upright posture?
- d) Were behavioural observations made during the insonification and, if so, how were these done? In cases where water was turbid (e.g., Appendix III, p. 33), were attempts made to determine the behaviour of these larger fish in the presence of, and just after, insonification? If not, why not? If observations were made, please describe the methods and detailed results.
- e) In Appendix III, p. 38, it is stated that fish in the cages with highest exposure levels were "briefly stunned". Explain the basis for this statement, and provide specific data to indicate how often this occurred, and the nature of the stunning (e.g. the behaviour of the stunned fish). What was the duration of the period indicated as "briefly"?

Response

General Comments:

- The Caged Fish Test was a test for short term mortality of fishes endemic to the Mackenzie River and exposed to airgun operation. The extended airgun exposure history of these fish is provided in Appendix III: Behavioural and Physical Response of Riverine Fish to Airguns.
- No behavioural observations were intended.
- The observation that fish were stunned came from the assessment of mortality (or absence of mortality) within exposure cages immediately after exposure and prior to transport to the holding (reference) area.

Specific Responses:

- a) On page 17 of Appendix III, we did not state that *behavioural* observations were made. However, on p. 33 of Appendix III, it states that behavioural observations were not made due to the high turbidity of the Mackenzie River at the time the tests were conducted.

- b) No behavioural observations were made during the caged fish test. See a) and the general comments.
- c) No behavioural observations were made during the caged fish test. See a). However, as noted in Appendix III and the above general comments, a proportion of the fish were momentarily stunned after exposure at 2 m from the airgun array and apparently had recovered by the time the transfer to the holding area was complete, i.e. < 30 minutes (time for retrieval of all exposure cages plus transit time to the reference area took approximately 30 minutes). Swimming ability was not observed, due to the need to move the caged animals to the reference area and the turbidity of the reference area.
- d) No behavioural observations were made during the caged fish test. See a).
- e) As stated in Appendix III and the above general comments, a proportion of the fish were observed to be momentarily stunned after being exposed at 2 m from the airgun array. When the fish cages were lifted from the 2 m exposure location, after insonification, a small proportion of the fish were quiescent and appeared 'stunned'. This is the basis for the statement that the fish were stunned. The duration of the condition was not recorded; however, by the time the cages were lifted from the live wells on board our transfer vessel, all fish in the 2 m exposure cages were active and did not show any evidence of abnormal or confused behaviour, and no 'stunned' fish could be observed at the reference location (time for retrieval of all exposure cages plus transit time to the reference area took approximately 30 minutes).

1.1.5 Request

Please respond to the following questions.

- a) Please provide details about those contacted during the 2002 Test Program and detailed minutes of these discussions. If possible, submit a complete list of individuals consulted.
- b) Please provide detailed minutes of meetings between community-based monitors and community residents after the passage of the Test Program, cited on p. 47 of the EARR.

- c) How will shore-based community monitoring be improved for the proposed WG Mackenzie and Liard Rivers 2D Seismic Program 2003?
- d) How was the confidence measure determined for potential impacts to fish and harvesting success?
- e) How would concerns regarding monitoring methods (e.g., woody debris, scavengers, lack of standardized approach) affect the confidence measures?

Response

- a) The community monitors were instructed to brief everyone they met traveling on the river and at fish camps, of the test program, and to report on anything unusual as observed by themselves and local residents. Each of the community monitors daily reports is part of the EA appendices (V), and there were few comments from community residents, outlying fish camps, or local boaters.
- b) The following reports were submitted by community monitors, where people were talked to on the river.

NORMAN WELLS COMMUNITY MONITOR (JOHN MACDONALD)

July 19 ... sat and talked to him at his camp (Wilfred MacDonald) for about an hour.

July 20 ... people living on the bank (at Norman Wells) could feel vibrations and heard a steady thumping noise from the anchored boats. Met some people who were paddling down the river (Mackenzie River).

July 22 ... towards Ogilvie Island and Oscar Creek. Talked with the person who owns the cabin and traps there. I stayed for about an hour talking about different things.

July 23 ... asked the boys looking after the cable if they saw anything but they said they didn't, so all is well so far.

Aug 01 ... the north side of the river, all the way to my brother's cabin. He told me I would never find any dead fish after 3 days because the ravens and seagulls would eat them up. There is a lot of drift, so seeing anything floating wouldn't be easy. My brother said as much.

Aug 03 ... talked to a paddler who was camped at Canyon Creek. He said he hadn't noticed any thing in his travels.

SAHTU COMMUNITY LIAISON (RON DOCTOR)

Jul 17 to Jul 23 ... spoke with Tulita Chief Frank Andrew, Tulita Land & Financial Corporation President Gordon Yakeleya, Métis President Rocky Norwegian, also a number of elders, some youth, office staff, and people on the street:

- Some people didn't know about the operation, and some people heard something of the operation
- Some knew what was going to happen
- Some people are interested what will happen after the barge do the test run
- People I spoke with didn't oppose the operation, they were more interested.
-

Concern from (Norman Wells') resident: noise from test barges, could feel (vibrations?) in town.

TSIIGEHTCHIC COMMUNITY MONITOR (DAN ANDRE)

Jul 31 ... Stopped at Rosa Andre's fish camp about 4 km from Tsiigehtchic. She had one net in the water.

- c) WesternGeco and IMG-Golder will produce a standard Community Monitor reporting form. The form and training in its use, will ensure:
 - A complete list of those talked to is recorded.
 - Detailed minutes are made of those discussions.
 - Place and time of conversations or observations are always logged.
 - Reports are provided from community monitors to regional liaison staff and from the regional liaison staff to WesternGeco on the seismic vessel and to RRCs or other designated community organisations.
- d) The confidence measure was determined according to the impact assessment criteria provided in Appendix VIII. The level of confidence attributed to the residual effects identified is based on an assessment of all of the attributes of the particular residual effect. The significance of the potential residual effect identified for fish harvesting (Section 9.2.9 and Table 9-4) is predicted to be low, with medium confidence. In this case, the assessment of medium confidence was based on a limited understanding of cause-effect relationships using data pertinent to the study area.
- e) Concerns regarding monitoring methods were part of the basis for assigning the medium confidence measure.

1.1.6 Request

Please respond to the following questions.

- a) Can WG predict which species of fish will be in the Liard and Mackenzie River at the proposed time of the operation?

Response

Please see Tables 8-1 and 8-2 in the EA for species that are potentially present in the Mackenzie and Liard Rivers. This information was summarized from the historical and technical references listed in the EA. Table 8-3 provides a summary of habitat requirements for adults and juvenile fish listed in Tables 8-1 & 8-2, where information was available. Table 8-3 also provides information on migration timing for the various migratory species. The two statements of the MVEIRB preamble provided seem contradictory. If additional information, i.e. not in references provided in the EA, exist as implied by MVEIRB preamble statement 1, we would appreciate those references. Our literature summary was conducted in part because "Few studies document" i.e. statement 2 of the Preamble.

1.1.7 Request

Please provide information, based upon what is known, of fish hearing that would indicate hearing abilities of Mackenzie River fishes, *at all life stages*.

Response

We could find no information on the hearing abilities for those fish species endemic to the Mackenzie River, although information is available for most of the taxonomic orders of freshwater fishes that are resident. If additional information exists for freshwater fish as implied in the Preamble to this information request, we would appreciate those references. We agree that there is no evidence of substantive hearing differences between freshwater and marine fishes. We assumed that hearing abilities within families of fishes were similar and provided those attributes, when available, for families of fishes that we expected to exist in the Mackenzie River.

1.1.8 Request

Please respond to the following questions.

- a) Can WG identify *all* river seismic programs implemented?
- b) Can WG describe the seismic technologies used in the river seismic programs identified in *question (a)* and explain the extent to which these programs are relevant to this EAR?
- c) Can WG provide the fish monitoring protocol and any results obtained from previous river seismic programs?

Response

WesternGeco has operated similar seismic programs in the river systems mentioned below, but as noted in the EA very little observational environmental data exists from them.

It was because of the unprecedented scope and nature of this proposed river seismic program in the NWT, and paucity of studies on the physiological and behavioural effects of airguns on fish in rivers, that WesternGeco decided to undertake the extensive 2002 fish study program. WesternGeco would consider the 2002 Mackenzie River Test Program data sufficient to show low potential for physical and behavioural impact on fish species found in the Mackenzie River.

- a) River and freshwater lake systems surveyed by similar seismic projects are:

Job	Place	Type of Resource Use	Date	Client
Atchafalaya River,	Louisiana	Commercial Fishing	1997	WesternGeco
Amazon River	Brazil	Commercial Fishing	1975-83	Various
Mahakam Delta	Indonesia	Shrimp	1995-96	Total
Lake Salvador	Louisiana	Fishing and Crabs	1996	WesternGeco
Barataria Water Way	Louisiana	Fishing	1996	WesternGeco
Lake Bourne	Louisiana	Fishing	2001	WesternGeco
Lake Blanc	Louisiana	Recreational Fishing	1996	WesternGeco
Wyth Farm	Poole Harbour U.K.	Commercial Fishing & Shell Fish	1998	BP
Mackenzie Delta	NWT	Fishing	1970	Exxon

Job	Place	Type of Resource Use	Date	Client
Cerros Colorados	Argentina	Fresh water reservoir	1996-97	YPF
Mobile Bay	Alabama	Fishing	1982-83	Mobil

- b) All the above programs used air gun arrays. There is no environmental monitoring data recorded from these surveys, and had it been available it would have been included in this EA. WesternGeco recognizes the value in anecdotal reports and would say that had there been a negative impact from these surveys it would not be long before the industry gets a bad name. History has not shown an adverse effect on fish from air gun arrays used in these areas.
- c) WesternGeco does not have any fish monitoring protocol prior to the 2002 Mackenzie River Test Program and associated monitoring. State Fish and Wildlife staff at various times monitored the US programs and we were told that any problems would be brought to our attention. We have no corporate recollection of specific problems being raised and we have not found records indicating that any problems were reported. The 2002 NWT Test Program was unprecedented in its monitoring protocol and documentation.

CURRICULUM VITAE

John Sanderson Lumsden

Born July 3, 1962, Oshawa, Ontario, Canadian citizen.

CONTACT ADDRESS

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EDUCATION AND QUALIFICATIONS

Secondary School Diploma	1980
Bachelor of Science (general biology)	1983
Doctor of Veterinary Medicine	1987
Master of Science	1989
Doctor of Philosophy	1994
MACVSc (Pathology)	1998

RELEVANT EMPLOYMENT EXPERIENCE

May 1984-September 1984, May 1985-Sept. 1985, May 1986-Sept. 1986: Department of Pathology, University of Guelph. Student research assistant.

June 1987-September 1989: Ontario Veterinary College, Department of Veterinary Microbiology and Immunology. M.Sc. Thesis: Immune response to an aromatic mutant of *Salmonella typhimurium* in SLA-defined miniature and Yorkshire pigs. Supervisor Dr. B. N. Wilkie.

May 1990-December 1994: Ontario Veterinary College, Fish Pathology Laboratory, Department of Pathology. Ph.D. Thesis: Gill-associated antibody of trout and the response to *Flavobacterium branchiophilum*. Supervisor Dr. H. W. Ferguson.

January 1995-Dec. 1995: Department of Pathology. Research Associate, fish diagnostics and terrestrial post mortem.

January 1996-April 2002: Pathobiology Group, IVABS, Massey University, Senior Lecturer.

January 2000-April 2002: Fish health consultant for New Zealand King Salmon.

April 2002-present: Associate Professor, Dept. Pathobiology, OVC, University of Guelph.

AWARDS

Ontario Scholar	1980
Young Researchers Stipend	1984-1986
Laforet Research Assistantship	1988-1989
Medical Research Council Fellowship	1990-1994

COURSES Molecular Genetics for Veterinary Researchers, Aug. 5-16, 1991
Teaching methods, Massey University, Nov. 12-13, 1997
PhD Supervision, Massey University, Feb. 22, 1998
Descriptive Pathology, AFIP, July 6-10, 1999

TEACHING

University of Guelph, 1991-1995; Four lectures on fish immunology and fish disease given annually to biology undergraduates and veterinary students.

Massey University, 350+ scheduled undergraduate contact hours/year;

i) Veterinary students;

16.303. Pathology I - General pathology; 26 lectures and 10 labs on description techniques, and general disease mechanisms.

16.303. Pathology I - Cardiopathology; Five lectures and two labs.

95.501. Clinical Studies - Exotic diseases of fish; One lecture.

16.404. Non-domestic Pathology - Fish health and handling; Five lectures and one lab. Supervision of final year post mortem rosters, including case presentations, weekly rounds and gross pathology tests.

Final year aquaculture elective and field trip – 30 hours contact.

The fish health lectures, exotic diseases lecture and the aquaculture elective were new additions to the curriculum.

ii) Biology students;

62.282 - Course Coordinator for Medical Laboratory Practice, Bachelor of Medical Laboratory Technology - 16 lectures and four labs on general disease mechanisms.

62.389. Immunology, (B.Sc.) - Six lectures and three labs. Topics include hypersensitivity, autoimmunity, immunosuppression and comparative immunology.

University of Guelph, 2002-present;

i) Veterinary students; Comparative Medicine 4480, 2 modules on fish health.

Post mortem supervision, 10% of roster.

ii) Veterinary, biology and Aquaculture M.Sc. students, Aquatic Animal Disease, 24 lectures, 12 labs.

REFEREED PUBLICATIONS

36. Roe WD, Maloney C, Allan F, Lumsden JS. Pulmonary alveolar proteinosis (phospholipidosis) in a West Highland white terrier. New Zealand Veterinary Journal, Accepted for publication.
35. Clark P, Norman RJ, Lentle R, Lumsden JS. (2002). Haematological changes in the Tamar Wallaby (*Macrops eugenii*) following intraperitoneal administration of lipopolysaccharide. Comparative Clinical Pathology, 11:238-45.
34. Lumsden JS, Marshall S. Sporadic tumors of chinook salmon (*Oncorhynchus tshawytscha*) in New Zealand. Journal of Fish Diseases, In Press.

PUBLICATIONS (continued)

33. **Lumsden JS**, Minamikawa M, Wybourne B, Gillard M, Marshall S. Experimental reproduction of gastric dilation in chinook salmon (*Oncorhynchus tshawytscha*) and its association with osmoregulation. *Journal of Fish Diseases*, Accepted for publication.
32. Hussein HM, Fenwick SG, **Lumsden JS**. Competitive exclusion of *Yersinia enterocolitica* biotype 4 serotype O:3 by biotype 1A in tissue culture and in pigs. *New Zealand Veterinary Journal*, Accepted for publication.
31. Forester NT, **Lumsden JS**, Parton K, Cowan PE, O'Toole PW. Isolation of *Helicobacter mustelae* from stoats in New Zealand. *New Zealand Veterinary Journal*, Accepted for publication.
30. Kakrada M, **Lumsden JS**, Lee EA, Collett MG. (2002). Cilia-associated respiratory bacillus infection in New Zealand rats. *New Zealand Veterinary Journal*, 50:81-2.
29. **Lumsden JS**, Clark P, Hawthorn S, Minamikawa M, Fenwick S.G, Haycock M, Wybourne, B. (2002). Gastric dilation and air sacculitis in chinook salmon (*Oncorhynchus tshawytscha*). *Journal of Fish Diseases*, 25:155-163.
28. Hussein HM, Fenwick SG, **Lumsden JS**. (2001). A rapid and sensitive method for the detection of *Yersinia enterocolitica* from clinical samples. *Letters in Applied Microbiology*, 33: 1-5.
27. Forester NT, **Lumsden JS**, O'Toole PW. (2001). Antigenic variation in the A-surface protein of *Helicobacter mustelae*. *Infection and Immunity* 69: 3447-50.
26. Forester NT, **Lumsden JS**, Parton K, O'Toole PW. (2000). Isolation of *Helicobacter mustelae* from ferrets in New Zealand. *New Zealand Veterinary Journal* 48: 65-69.
25. Fenwick SG, West DM, Hunter JE, Sargison ND, Ahmed F, **Lumsden JS**, Collett MG. (2000). *Campylobacter fetus fetus* abortions in vaccinated ewes. *New Zealand Veterinary Journal* 48:155-157.
24. Ostland VE, Byrne PJ, **Lumsden JS**, MacPhee DD, Derksen JA, Haulena M, Skar K, Ferguson HW. (1999). Atypical bacterial gill disease: A new form of bacterial gill disease affecting intensively reared salmonids. *Journal of Fish Diseases* 22:5:351-358.
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GRADUATE STUDENTS

Currently primary supervisor for two PhD students and committee member for three M.Sc. students

Completed secondary supervision of three PhD, and one MVSc students.

OTHER ACTIVITIES

Member, Ontario Aquaculture Association, Canadian Rift Lake Cichlid Association, American Fisheries Society, International Association of Aquatic Animal Health, Massey University Veterinary student mentor – 1997.

Active participant with Veterinary Student association and have been involved with organizing staff-student cricket, golf, billiard games, etc.

Served on the Deans advisory council (1998) and the Masterate committees (1997-1998) for the Massey Veterinary College.

Serve on the Department of Pathobiology Promotions and Tenure Committee, 2002-4, and OVC curriculum committee.

Provide professional advice to private veterinarians, hobbyists and fish farmers on management, treatment, etc. on a case basis.