Affidavit #1 of Jack Rensel
Sworn August 17, 2011

COMMISSION OF INQUIRY INTO THE DECLINE OF SOCKEYE SALMON IN THE FRASER RIVER

In the matter of Her Excellency the Governor General in Council, on the recommendation of the Prime Minister, directing that Commission do issue under Part 1 of the *Inquiries Act* and under the Great Seal of Canada appointing the Honourable Bruce Cohen as Commissioner to conduct an inquiry into the decline of the sockeye salmon in the Fraser River

AFFIDAVIT #1 OF JACK RENSEL

I, Jack Rensel, of 4209 234th St. N.E., Arlington, Washington, USA, MAKE OATH AND SAY THAT:

1. I am an aquatic science consultant with Rensel Associates Aquatic Science Consultants, and as such, I have personal knowledge of the matters hereinafter deposed to except where stated to be based on information and belief, and where so stated I believe them to be true.

2. This affidavit is prepared in response to a request for information from commission counsel regarding harmful algal blooms generally and in the Strait of Georgia.

3. Attached as Exhibit "**A**" to my affidavit is a copy of my curriculum vitae which sets out my qualifications in the areas of:

- algal-zooplankton in marine and freshwater habitats
- harmful algal bloom dynamics, monitoring and mitigation studies
- fish physiology studies, bioassays and fish kill assessments

4. I am the primary author of "Fraser river sockeye salmon marine survival decline and harmful blooms of *Heterosigma akashiwo*", published in 2010 in the journal Harmful Algae, which article is now marked at Exhibit 1359 in this commission of inquiry.

5. Attached as Exhibit "**B**" to my affidavit is a true copy of a figure I created which updates Figure 5 as contained in the article now marked as Exhibit 1359 in this commission of inquiry. The figure has been updated to include 2008 smolts (2010 returns) to find a correlation coefficient of 0.89 between the factors for the smolt years 1997-2008.

6. In or about August 2011, I was provided with a series of questions from commission counsel with respect to which I was asked to prepare written answers. I prepared a document which sets out my written responses to the questions asked. A true copy of this document is attached to my affidavit as Exhibit "**C**".

7. The responses set out in Exhibit "**C**" are true statements as if contained within my affidavit.

SWORN before me in the City of)
Vancouver, BC, on)
August 17, 2011)
)
)
)
)
Commissioner for taking Affidavits)
in British Columbia

Wendy Baker
1000 – 840 Howe St
Vancouver, BC

JACK RENSEL

J.E. JACK RENSEL, Ph.D. Oceanography and Limnology, Plankton, Fish & Shellfish Studies

Rensel Associates Aquatic Science Consultants
4209 234th St. N.E.
Arlington, WA 98223
360 435 3285
jackrensel@att.net

Education:

Ph.D. University of Washington Ocean and Fishery Sciences, Seattle WA
Attended Stanford University, Hopkins Marine Station, Pacific Grove, CA
M.Sc. University of Washington, Seattle
B.Sc. Western Washington University, Bellingham, WA

Positions Held:

Owner - Rensel Associates Aquatic Science Consultants, 1983-present
Natural Resource Manager, Squaxin Island Indian Tribe, Southern Puget Sound, 1980-83
Fisheries Biologist, Squaxin Island Indian Tribe 1977-80
Fisheries Biologist, NOAA-NMFS, Manchester Aquaculture Laboratory 1975-77
Research Technician, Fisheries Research Institute, University of Washington, 1973-74
Marine Taxonomist: Western Washington University, Dr. Carter Broad, 1972-73

Special Skills, Training and Experience:

Dr. Rensel works in both business and academic realms, in the U.S. and overseas. His regular clients include the largest seafood company in the U.S. (Pacific Seafood Group), the largest U.S. owned and operated fish farming company (owned by Icicle Seafoods), academic organization such as Woods Hole Oceanographic Institution and private non profits environmental organizations such as Hubbs SeaWorld Research Institution and Earthjustice Hawai'i. He conducts aquatic research project contracts for NOAA, USDA and other agencies. This includes development and use of *AquaModel* 4D aquaculture effects simulation modeling with his partners at University of Southern California. See www.AquaModel.org Expertise:

- Nutrient-eutrophication and algal-zooplankton studies in marine and freshwater habitats
- Invertebrate, benthic & food web studies in lakes, rivers and marine waters
- Food web contamination and pollution studies, design and execution
- Aquaculture impact assessment including sediment and water column/nutrient studies
- Harmful algal bloom dynamics, monitoring and mitigation studies
- Invertebrate culture background including shellfish and crustacean culture
- Nutrient, sediment & pollutant studies re: industrial discharges, golf courses, urbanization
- Fish habitat, capture & population assessment skills; fish bioassay experience
- Fish physiology studies, bioassays and fish kill assessments
- Physical hydrographic studies of lakes, streams and marine waters, IFIM certified

Exhibit "A" as referred to in the Affidavit of Jack Rensel, sworn before me at Vancouver in the Province of British Columbia this 18th day of August, 2011.

A Commissioner for taking Affidavits in

Book Chapters, Journal Publications and Selected Technical Reports:

Lewitus, A.J., R.A. Horner, D.A. Caron, E. Garcia-Mendoza, B.M. Hickey, M. Hunter, D.D. Huppert, D. Kelly, R.M. Kudela, G.W. Langlois, J.L. Largier, E.J. Lessard, R. RaLonde, J.E. Rensel, P.G. Strutton, V.L. Trainer and J.F. Tweddle. In press. **Harmful algal blooms along the North America West Coast Region: history, trends, causes and impacts.** Harmful Algae.

Rensel, J.E. 2010. **Tracing of fish farm effects on sediment and food web of Rufus Wood Lake, Columbia River, 2009 Results**. Prepared by Rensel Associates Aquatic Sciences, Arlington WA for Pacific Aquaculture Inc. and the Colville Confederated Tribes, Nespelem, Washington. 38 pp.

Rensel, J.E., N. Haigh, T.J. Tynan. 2010. **Fraser River Sockeye Salmon Marine Survival Decline and Harmful Blooms of *Heterosigma akashiwo*.** Harmful Algae 10:98-115. http://www.sfu.ca/cs/science/resources/1288805500.pdf

Rensel, J.E., N. Haigh, T.J. Tynan. 2010. **Summary: Fraser River Sockeye Salmon Marine Survival Decline and Harmful Blooms of *Heterosigma akashiwo*.** *Session B: Toxic algae and pollutants. pp. 23-29 In:* Peterman R.M., D. Marmorek, B. Beckman, M. Bradford, N. Mantua, B.E. Riddell, M. Scheuerell, M. Staley, K. Wieckowski, J.R. Winton, C.C. Wood. Synthesis of evidence from a workshop on the decline of Fraser River sockeye. June 15-17, 2010. A Report to the Pacific Salmon Commission, Vancouver, B.C. http://www.psc.org/pubs/FraserSockeyeDeclineWorkshopAppCPt2.pdf

Rensel, J., J. Forster. 2009. **Biological Waste Guidance Document Development and Fish Farming in Rufus Woods Lake.** Prepared for Confederated Tribes of the Colville Reservation Nespelem, Washington. 107 p. and appendices.

Anderson, D.M., J.M. Burkholder, W.P. Cochlan, P.M. Glibert, C.J. Gobler, C.A. Heil, R. Kudela, M.L. Parsons, J.E. Jack Rensel, D. W. Townsend, V.L. Trainer and G. A. Vargo. 2008. **Harmful algal blooms and eutrophication: Examples of linkages from selected coastal regions of the United States**. Harmful Algae, 8: 39–53. http://ukpmc.ac.uk/articlerender.cgi?tool=pubmed&pubmedid=19956363

Kiefer D.A., J.E. Rensel and F.J. O'Brien. 2008. **AquaModel simulation of Water Column and Sediment Effects of Fish Mariculture at the Proposed Hubbs-SeaWorld Research Institute Offshore Aquaculture Demonstration Project.** Prepared for Hubbs SeaWorld Research Institute, San Diego, CA by Systems Science Applications, Inc. and Rensel Associates Aquatic Sciences. 68 pp. Available on request from HSWRI or SSA.

Rensel, J., Kiefer, D.A. and F. O'Brien. 2008. **AquaModel: Comprehensive Aquaculture Modeling Software.** p. 37-39 In: Open Ocean Aquaculture - Moving Forward, Cheng- Sheng Lee and Patricia J. O'Bryen (eds).

Rensel, J.E. 2007. **Fish kills from the harmful alga *Heterosigma akashiwo* in Puget Sound: Recent blooms and review**. Prepared by Rensel Associates Aquatic Sciences for the National Oceanic and Atmospheric Administration Center for Sponsored Coastal Ocean Research (CSCOR). Washington, D.C. 59 pp. http://www.whoi.edu/fileserver.do?id=39383&pt=2&p=29109

Rensel, J.E. and J.R.M. Forster. 2007. **Beneficial environmental effects of marine net pen aquaculture.** Rensel Associates Aquatic Sciences Technical Report prepared for NOAA Office of Atmospheric and Oceanic Research. 57 pp. http://www.wfga.net/documents/marine_finfish_finalreport.pdf

Rensel, J.E., D.A. Kiefer, J.R.M. Forster, D.L. Woodruff and N.R. Evans. 2007. **Offshore finfish mariculture in the Strait of Juan de Fuca.** Bull. Fish. Res. Agen. No. 19, 113-129, http://www.fra.affrc.go.jp/bulletin/bull/bull19/13.pdf

Rensel, J.E., D.A. Kiefer and F.J. O'Brien. 2006. **Modeling Water Column and Benthic Effects of Fish Mariculture of Cobia (*Rachycentron canadum*) in Puerto Rico: Cobia AquaModel.** Prepared for Ocean Harvest Aquaculture Inc., Puerto Rico and The National Oceanic and Atmospheric Administration, Washington D.C. by Systems Science Applications, Inc. Los Angeles, CA. 60 pp. http://www.lib.noaa.gov/docaqua/reports_noaaresearch/cobia_aquamodel_final_report.pdf

Rensel, J.E. 2006. **Tulalip Bay circulation and fecal coliform loading preliminary studies.** Rensel Associates and PES Environmental for Tulalip Tribes, Marysville WA. 36 pp.

Rensel, J.E., A.H. Buschmann, T. Chopin, I.K. Chung, J. Grant, C.E. Helsley, D.A. Kiefer, R. Langan, R.I.E. Newell, M. Rawson, J.W. Sowles, J.P. McVey, and C. Yarish. 2006. **Ecosystem based management: Models and mariculture**. Pages 207-210 *in* J.P. McVey, C-S. Lee, and P.J. O'Bryen, editors. The Role of Aquaculture in Integrated Coastal and Ocean Management: An Ecosystem Approach. The World Aquaculture Society, Baton Rouge, Louisiana, 70803. United States

Rensel, J.E. and R. Elston. 2006. **Review of Proposed Marine Resources Study: Sampling and Analysis Plan. Mākua Military Reservation, O'ahu, Hawai'i** for Hawai'i Earth Justice. Honolulu. 29 pp.

Elston, R., E.W. Cake Jr., K. Humphrey, W.C. Isphordring and J.E. Rensel. 2005. **Dioxin and heavy metal contamination of shellfish and sediment in St. Louis Bay, Mississippi and adjacent marine waters.** Journal of Shellfish Research. 24: 227-241.

Rensel, J.E. and D.M. Anderson. 2004. **Effects of phosphatic clay dispersal to control harmful algal blooms in Puget Sound, Washington**. Proceedings of the Xth International Conference on Harmful Algae, St. Pete's Beach, Florida. Woods Hole Oceanographic Institution contribution #10849. K.A. Steidinger, J.H. Landsberg, C.R. Tomas, and G.A. Vargo (Eds.) in Harmful Algae 2002. Florida Fish and Wildlife Conservation Commission, Florida Institute of Oceanography, and Intergovernmental Oceanographic Commission of UNESCO. Pp. 522-524.

Rensel, J.E. 2004. **Physicochemical and biological considerations: Strait of Juan de Fuca.** American Geophysical Union Proceedings, Portland Oregon. Abstract and presentation.

Rensel, J.E. and J.R.M. Forster. 2003. **Strait of Juan de Fuca, offshore marine finfish mariculture: Data report, Year two.** Prepared for U.S. National Marine Fisheries Service. Office of Oceanic and Atmospheric Research. 77 pp.

Rensel, J. E. and J.N.C. Whyte. 2003. **Finfish mariculture and Harmful Algal Blooms**. Second Edition. pp. 693-722 In: UNESCO Manual on Harmful Marine Microalgae. D. Anderson, G. Hallegaeff and A. Cembella (eds). IOC monograph on Oceanographic Methodology. http://upo.unesco.org/bookdetails.asp?id=4040

Rensel, J.E., J. Campbell and D.M. Anderson. 2003 **Effectiveness of clay flocculation for Heterosigma akashiwo bloom removal and benthic effect studies in Puget Sound, Washington**. Second Symposium on Harmful Marine Algae in the U.S., Woods Hole Oceanographic Institution, Woods Hole MA, December 9-13, 2003

Rensel, J.E. 2003. **Dungeness Bay Bathymetry, Circulation and Fecal Coliform Studies. Phase 2.** Prepared by Rensel Associates Aquatic Science Consultants, Arlington, Washington for the Jamestown S'Klallam Tribe, Sequim Washington and the U.S. Environmental Protection Agency, Seattle, Washington. 94 p.

http://www.jamestowntribe.org/jstweb_2007/programs/nrs/2-DungenessBayCircStudy.pdf

Rensel, J.E. and J.R.M. Forster. 2002. **Strait of Juan de Fuca, offshore marine finfish mariculture: Literature review and preliminary field results.** Prepared for U.S. National Marine Fisheries Service. Office of Oceanic and Atmospheric Research. 87 pp. http://www.wfga.net/SJDF/reports/2001annualrep.pdf

Anderson, D.M., P. Andersen, V.M. Bricelj, J.J. Cullen, and J.E. Rensel. 2001. **Monitoring and Management Strategies for Harmful Algal Blooms in Coastal Waters,** APEC #201-MR-01.1, Asia Pacific Economic Program, Singapore, and Intergovernmental Oceanographic Commission Technical Series No. 59, Paris. 264 p.

Rensel, J.E. 2001. **Salmon net pens in Puget Sound: Rules, performance criteria and monitoring**. Global Aqua.Adv. 4(1):66-69.

Rensel, J. 2001. **Stable isotope food web studies of mid Columbia River Reservoirs**. For Colville Confederated Tribes and CRFF Inc. Annual reports. 45 pp.

Parametrix, Rensel Associates and University of Idaho. 2001. **Water quality monitoring report. Rocky Reach Reservoir, Water Year 2000, Final Report**. Rocky Reach Hydroelectric Project FERC Project No. 2145. Public Utility District No. 1 of Chelan County. Wenatchee, Washington. http://www.chelanpud.org/rr_relicense/study/reports/2697_2.pdf

Rensel, J. 2001. **Toxic algal blooms in Laguna (Lake) Suches, Southern Peru.** For Southern Peru Copper Company, Servicios Ambientales, Ilo and Lima Peru. 44 p. & appendices.

Rensel, J., University of Idaho and Parametrix Inc. 2000. **Water column and attached benthic algal ecology of Rocky Reach Reservoir, mid Columbia River**. Prepared for Chelan County PUD. Wenatchee Washington. 132 pp. available on line at PUD website.

Rensel, J. 2000. **Biological assessment and evaluation: replacement of existing North Skagit Bay net pen structures**. For U.S. Army Corps of Engineers, Seattle and Cypress Island Inc. Anacortes WA. 56 pp. and appendices.

Rensel, J. 2000. **Chinook salmon spawning surveys, Upper Rocky Reach Reservoir and Lake Pateros, Columbia River, Washington, during 1999**. Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee Wa. 27 pp and appendices.

Rensel, J. 2000. **Biological assessment and evaluation: replacement of existing North Skagit Bay net pen structures**. For U.S. Army Corps of Engineers, Seattle and Cypress Island Inc. Anacortes WA. 56 pp. and appendices.

Rensel, J. 1999. **Lake Roosevelt Studies: (1) Fishery enhancement effects; (2) Preliminary analysis of declining nutrient loads and possible effects on aquatic productivity**. For Confederated Tribes of the Colville Reservation, Nespelem WA. 71 pp.

Beak Consultants Inc. and Rensel Associates. 1999. **Assessment of resident fish in Lake Pateros, Washington.** For Douglas County Public Utility District No. 1. East Wenatchee, WA 41 pp.

Anderson, D.M., P. Andersen, V.M. Bricelj J.J. Cullen, I. J. Hodgkiss, J. E. Rensel, J. T.Y. Wong, and R. Wu. 1999. **Proposed Red Tide (Harmful Algal Bloom) Monitoring and Management Programme for Hong Kong Aquatic Resources and Mariculture**. Technical Report No. 3, for the Agriculture and Fisheries Department, Hong Kong. China, by Woods Hole Oceanographic Institution. 284 pp. (One of several reports)

Rensel, J.E. and J.M. Lindbergh. 1998. **Aquatic Ecosystem and Fisheries Study of Laguna Suches, a High Altitude Lake in Southern Peru.** Prepared for Southern Peru Limited, Environmental Services Division. Ilo, Peru. 99 pp.

Rensel, J.E. and T.J. Smayda. 1998. **Tulalip Salmon Hatchery Waste Discharge Characterization and Related Studies.** Rensel Associates for The Tulalip Tribes, Marysville, Washington. 80 pps. and appendices.

Rensel, J.E. 1998. **Nutrients, phytoplankton and zooplankton assessment of Osoyoos Lake: Summary Report of 1994-1996**. Prepared for PUD No. 1 of Douglas County. East Wenatchee, Wa. Final Report.

Hershberger, P., J. Rensel, F. B. Taub. 1997. **Vertical migration of the harmful alga *Heterosigma carterae*: Implications for bloom development.** Canadian Journal of Fisheries and Aquatic Science. 54:2228-2234.

Hershberger, P.K., J.E. Rensel, J.R. Postel, F.B. Taub. 1997. ***Heterosigma* bloom and associated fish kill**. Harmful Algae News. 16:1, 4.

Rensel, J.E. 1997. **Third annual report: water quality of Lake Osoyoos**. Prepared for PUD No. 1 of Douglas County. East Wenatchee, Wa. 60 pp. and appendices.

Rensel, J.E. and J.M. Lindbergh. 1997. **Trout carrying capacity, risks of overstocking and recommendations for Laguna Suches, Southern Peru**. Prepared for Southern Peru Limited, Environmental Services Division. Ilo, Peru.

Rensel, J.E. 1997. **Major shift in nutrient status of the mid-Columbia River: food web implications**. Presentation to the American Fisheries Society and unpublished manuscript, North Pacific International Chapter Annual Meeting, Everett, Washington.

Rensel, J.E. 1997. **Environmental Assessment of Scan Am Fish Farms Net Pen Sites at Deepwater and Skagit Bays, Washington in 1996.** Prepared for Scan Am Group, Anacortes, Washington.

Rensel, J.E. 1996. **Salmon farming and nutrient dynamics of Rufus Wood Lake, Columbia River**. Prepared for CRFF, Inc. Omak Washington. 66 pp. and appendices.

Rensel, J.E. 1996. **Management of finfish aquaculture resources** pp. 463-474 In: UNESCO Manual on Harmful Marine Microalgae. D. Anderson, G. Hallegaeff and A. Cembella (eds). UNESCO monograph on Oceanographic Methodology.

Elston, R. and J. Rensel. 1996. **Summary Report, Fish Mortality Losses from Gas Supersaturated Columbia River Water at Columbia River Fish Farms, March-June 1996**. Loss documentation and suggestions for mitigation of excess dissolved gas in the Columbia River to the Grand Coulee Dam Working Group on gas supersaturation. Prepared for Columbia River Fish Farms, LLC.

Rensel, J. 1995. **Harmful algal blooms and finfish resources in Puget Sound**. pp. 442-429 In: Puget Sound Research Volume 1. (E. Robichaud Ed.) Puget Sound Water Quality Authority. Olympia, Washington.

Rensel, J.E. and J.M. Lindbergh. 1995. **Water quality and fisheries dynamics of Laguna Suches, Southern Peru**. Prepared for Southern Peru Copper Company, Toquepala, Cuajone and Ilo, Peru. 67 pp. and appendices.

Rensel, J. 1995. **Harmful algal blooms and finfish resources in Puget Sound.** pp. 442-429 In: Puget Sound Research Volume 1. (E. Robichaud Ed.) Puget Sound Water Quality Authority. Olympia, Wa.

Rensel, J.E. 1993. **Nutrients, algae and salmon rearing in Rufus Wood Lake of the Middle Columbia River.** Prepared for Stolt Sea Farm, Inc. Port Angeles, and Pacific Catch Inc. Brewster, WA. 94 pp. plus figures and appendix.

Rensel, J.E. 1993. **Factors controlling Paralytic Shellfish Poisoning in Puget Sound**. Journal of Shellfish Research 12:2:371-376.

White, A.W., R. G. Kvitek, S.E. Shumway and J.E. Rensel. 1993. **Fisheries and Food Webs.** pp. 17-29. In: Marine Biotoxins and Harmful Algae: A National Plan. D.M. Anderson, S.B. Galloway and J.D. Joseph (eds). Woods Hole Oceanographic Institution Technical Report 93-02.

Rensel, J.E. 1993. **Severe blood hypoxia of Atlantic salmon (*Salmo salar*) exposed to the marine diatom *Chaetoceros concavicornis*.** pp. 625-630. In: Toxic Phytoplankton Blooms in the Sea. T.J. Smayda and Y. Shimizu (eds). Elsevier Science Publishers B.V., Amsterdam

Rensel, J.E., R.P. Harris and T.T. Tynan. 1988. **Fishery contribution and spawning escapement of coho salmon reared in net-pens in southern Puget Sound, Washington**. North American Journal of Fisheries Management 3:359-366.

Rensel, J.E. 1992. **Surface water quality monitoring program at McCormick Woods**: summary report 1986-1992. Prepared for McCormick Woods, Port Orchard Wa, 47 pp.

Rensel, J.E. 1992. **North Lake: Interim Mitigation Plan.** Prepared for McCormick Woods, Port Orchard Wa, 7 pp.

Rensel Associates and PTI Environmental Services. 1991. **Nutrients and Phytoplankton in Puget Sound**. Peer reviewed monograph prepared for U.S. Environmental Protection Agency, Region 10, Seattle. Report 910/9-91-002. 130 pp.

Rensel, J.E. 1990. **Descriptive physical oceanography of marine channels near Squaxin Island, Washington**. Prepared for the Squaxin Island Tribe. 21 pp. plus figures and appendices.

Parametrix, Battelle Northwest Laboratories and Rensel Associates. 1990. **Programmatic Environmental Impact Statement: Fish culture in floating net-pens.** Prepared for the Washington Department of Fisheries. 161 pp.

Rensel, J.E. 1990. **Noxious phytoplankton and marine salmon culture.** pp. 9-11. In: F.B. Taub and T. Nosho (eds). Salmon farming and noxious phytoplankton. Washington Sea Grant WSG-WO 90-2. Seattle. WA.

Horner, R.A., J.R. Postel and J.E. Rensel. 1990. **Noxious phytoplankton blooms in western Washington: a review.** pp. 171-176. Toxic Marine Phytoplankton (Proceedings of the international meeting on toxic dinoflagellates). E. Graneli (ed)., Elsevier Science Publishing.

Rensel, J.E., R.A. Horner and J.R. Postel. 1989. **Effects of phytoplankton blooms on salmon aquaculture in Puget Sound, Washington: initial research**. Northwest Environmental Journal 5:53-69.

Rensel, J.E. 1989. **Phytoplankton and nutrient studies near salmon net-pens at Squaxin Island, Washington.** in technical appendices of the State of Washington's Programmatic Environmental Impact Statement: Fish culture in floating net-pens. Produced for the Washington Department of Fisheries. 312 pp. and appendices.

Rensel, J.E. 1989. **Review of phytoplankton and turbidity conditions in outer Grays Harbor, Washington in the vicinity of the onshore salmon farming project at Westport, Washington**. Prepared for Aquacare A/S. Bellingham, Washington. 39 pp. and appendices.

Rensel, J.E. 1989. **Analysis of proposed Sea Farm Washington, Inc. net-pen sites in Rufus Wood Lake, Columbia River, Washington and calculation of probable water quality effects.** Prepared for Sea Farm Washington, Port Angeles, Washington. 57 pp. plus.

Rensel, J.E. 1989. **Dissolved nutrients, water quality and phytoplankton studies near the Swecker Sea Farms net-pen site in Lower Case Inlet, and in southern Puget Sound, Washington.** Prepared for Swecker Sea Farms, Inc. Tumwater, Washington. 24 pp. plus.

Rensel, J.E., R. Harris, and T. Tynan. 1988. **Fishery contribution and spawning escapement of coho salmon reared in net-pens in southern Puget Sound, Washington**. North American Journal of Fisheries Management 8:359-366.

Rensel, J.E. 1987. **Circulation studies of Commencement Bay and Quartermaster Harbor**. For the Puyallup Tribe, Fisheries Division. 34 pp.

Milner-Rensel Associates. 1986. **Aquatic conditions at the Seafarm of Norway net-pen site in Port Angeles Harbor in April 1986**. Prepared for Seafarm of Norway, inc. and the City of Port Angeles Planning Department. 25 pp. and appendices.

Rensel, J. 1985. **Technical feasibility of Atlantic salmon culture for the Skagit System Cooperative.** Prepared for the Skagit System Tribal Cooperative, LaConner, WA 93 pp.

Zook, W.J. and J. Rensel. (Chairman and editor) 1984. **Recommendations for proposal and evaluation of salmonid production facilities.** Facility Design Work Group of the Enhancement Planning Team. NOAA/National Marine Fisheries Service Seattle, Wa. 76 p.

McPherson, B. and J. Rensel. (Chairman and editor) 1984. **Recommendations for planning, selecting and evaluating habitat improvement projects**. Habitat Improvement Work Group of the Enhancement Planning Team. NOAA/NMFS/SSCEA Seattle, Wa. 31 p.

Rensel, J.E. and E.F. Prentice. 1979. **Factors controlling growth and survival of cultured spot prawn, *Pandalus platyceros*, in Puget Sound, Washington**. Fisheries Bulletin 78(3):781 - 788.

Rensel, J.E. and E.F. Prentice. 1978. **Growth of juvenile spot prawn, *Pandalus platyceros*, in the laboratory and net-pens using different diets.** Fisheries Bulletin 76(4):786 - 890.

Rensel, J.E. and E.F. Prentice. 1977. **First record of a second mating and spawning of the spot prawn, *Pandalus platyceros*, in captivity**. Fisheries Bulletin 75(3):648 - 649.

Prentice, E.F. and J. E. Rensel. 1977. **Tag retention of the spot prawn, *Pandalus platyceros*, injected with coded wire tag.** Journal of the Fisheries Research Board of Canada 34(11):2199 - 2203.

Rensel, J.E. 1972. **A benthic survey of the Lummi Indian Seaponds**. University Year for Action, Western Washington University, Bellingham WA. Available at Univ. of Wash. Fish-Ocean. Library. (First benthic impact of aquaculture study in North America).

Many, many other technical reports and benthic invertebrate sampling reports for various companies and agencies, public utility districts, Washington Depts. of Ecology and Natural Resources available upon request. Over 150 presentations made at conferences including several plenary sessions.

Exhibit "B" as referred to in the Affidavit of Jack Rensel, sworn before me at Vancouver in the Province of British Columbia this 18th day of August, 2011.

A Commissioner for taking Affidavits in British Columbia

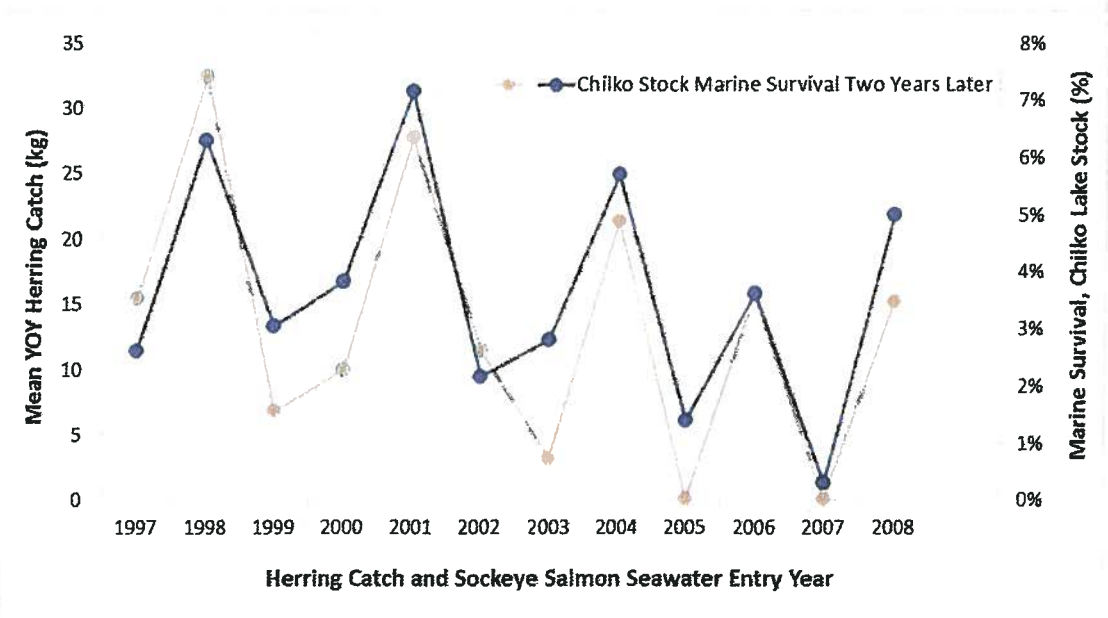

Exhibit "C" as referred to in the Affidavit of Jack Rensel, sworn before me at Vancouver in the Province of British Columbia this 18th day of August, 2011.

A Commissioner for taking Affidavits in British Columbia

1. Please describe in summary form the work that you have done and expertise you have developed relevant to the impact or potential impact of harmful algal blooms on Fraser River sockeye.

I have been involved in harmful algal bloom (HAB) research since 1974 when, as a young NOAA researcher, harmful blooms killed spot prawns and coho salmon that I was cultivating in a research laboratory and in pens in South Puget Sound. At the time, the state of the knowledge regarding HAB effects on wild species was extremely poor. As I progressed into graduate school and various appointments, I encountered fish-killing blooms of algae numerous times and developed a continued interest in the field. I also worked with fish physiology, food web ecology, benthic ecology, pollution studies and aquaculture impact assessment monitoring and research. Internationally, about 25 years ago interest in the HAB field began to grow rapidly, and I started working overseas for governments with some of the academic leaders in the field, and with affected companies and organizations. This included long-term studies in high altiplano lakes of Andes Mountains in Peru, South East Asian marine waters, the Arabian Sea and of course here in the Pacific Northwest. In our region I was often involved in fish kill response and research and was particularly interested in fish kills in marine waters that were related to phytoplankton blooms, starting in about 1989 as a consultant for USEPA. But for the most part, agencies have not been willing to commit to long term studies but instead only reacted to each bloom in a minimal fashion. Nevertheless, this led to limited-term research opportunities. Like some of my colleagues in our area, we do much of this work on a pro bono basis as blooms occur with regard to follow up, interacting with the international HAB community, presenting at conferences and publishing.

In 2010, working fully on a pro bono basis, I used a combination of government (DFO), B.C. Harmful Algal Bloom Monitoring Program data and observations in North Puget Sound to show a remarkably tight correlation between years when a fish killing alga known as *Heterosigma* bloomed and the returns of adult salmon two years later. These data also correlated with the loss of farmed fish in North Puget Sound where surface waters are those of the Strait of Georgia flowing seaward in the expected estuarine flow direction. I was greatly assisted in this work by a NOAA staff member (Tim Tynan) who is a representative to the Pacific Salmon Commission and by an independent consultant (Nicky Haigh) in B.C. who operates the B.C. Harmful Algal Bloom Monitoring Program.

We published a peer-reviewed journal paper describing this work in the leading harmful algae journal, and demonstrated with river discharge data the probable effects of larger and earlier-than-normalFraser River discharge in late spring that helps facilitate the spread of these blooms from local inlets and shallows. This paper explained how losses of sockeye could be due to acute (immediate) or chronic (delayed) toxicity of the alga as well as through adverse effects on the food web that would have caused stress and starvation to fish stocks. Entire fish farms both in the Pacific Northwest and in other regions world-wide have been wiped out by this alga and our observations suggest that wild fish are affected too, as discussed in the paper. With regard to food web effects, there is no doubt. *Heterosigma*is considered one of the most detrimental harmful algae to other phytoplankton and zooplankton known. Although present for years before, extensive blooms became more prevalent in the Salish Sea including the Strait of Georgia increased after 1989, a pivotal year in terms of changes in hydrographic conditions. These are

mega-scale events, and I have always marveled in the past at how little attention they have garnered, but that is changing.

We presented evidence in our paper that wild fish and farmed salmonids generally sink after dying in our relatively cool coastal marine waters. One should not expect to see shoals of dead fish floating about if a bloom or some other catastrophe causes a fish kill. We challenged prior speculation that wild juvenile sockeye can or would swim under or around the blooms because these blooms tend to be massive in horizontal extent, sometimes encompassing the entire Strait of Georgia. During blooms, these algal cells are common from the surface to depths of at least 10 meters, corresponding exactly with the known maximum depth that Fraser River sockeye smolts will swim. It is possible, but fish tend to react with a flight reaction when encountering environmental hypoxia (i.e., low dissolved oxygen) in a random manner, and many HABs cause gill damage that result in blood hypoxia of the fish and apparently a similar effect or in some cases lethargy.

In our recent paper we also demonstrated that since the mid-1990s, young-of-the-year herring abundance in the Strait of Georgia was strongly correlated with the marine survival rate of Chilko stock Fraser River sockeye salmon and *Heterosigma* bloom timing in the Strait. Juvenile sockeye salmon and these young herring co-occur for only six weeks in mid-May through June during initial salmon migration in the Strait. Sockeye salmon marine survival rates were therefore seen to be determined in that early period and this is the first strong evidence of this phenomenon. Only one reviewer has termed this a probable coincidence, with no explanation, all others I have dealt with are amazed at the strong relationship. I note it was maintained again in 2010 (from 2008 smolt year).

2. Have wild sockeye been observed to have been killed by *Heterosigma* blooms, or have wild fish kills been associated with *Heterosigma* blooms?

As discussed in our paper, some numbers of dead wild fish have been seen during Heterosigma blooms in both B.C. and Washington State. No one has specifically identified the fish as sockeye but juvenile salmon have been noted, particularly in North and South Puget Sound. Observations of wild fish mortality events caused by *Heterosigma* have been limited by the very large areal extent of marine areas used by sockeye for migration in the Salish Sea, the ephemeral nature of bloom events, and the paucity of hydrographic sampling by local, state, and federal resource agencies in the area.

3. Is monitoring of wild fish kills in the Salish Sea adequate to relate such kills to *Heterosigma* blooms?

No. In Washington State there is academic and fish farm interest in tracking these blooms to the extent possible, but in B.C. apparently only Nicky Haigh who conducts the B.C. Harmful Algal Bloom Monitoring Program, provides some data. Formerly DFO had a harmful algal bloom research program and researchers at University of B.C. and Simon Fraser University were involved in basic research, but DFO terminated the program about 6 years ago and the academics either retired or moved on.

4. Could exposure of juvenile Fraser River sockeye to *Heterosigma* blooms result in chronic effects leading to later mortality?

Yes, as explained in the paper, secondary bacterial or other infections via damaged gills could occur or the fish could be rendered physiologically incompetent, making them more susceptible to poor food supply conditions in the marine waters and predation.

5. Has the presence of *Heterosigma* in the Salish Sea changed over the last 30 years? If so, is this potentially related to regime shifts in the ocean environment?

There was an abrupt series of blooms that began in 1989, including two massive blooms in the 1990s in the Strait of Georgia. The extent of these blooms had not been documented before and two years later in both cases poor returns of Chilko stock Fraser River sockeye were observed. In all years when a

massive bloom was documented after 1989, two years later there were poor returns of Chilko stock of Fraser River sockeye. Fish farming in Washington State has been practiced continuously since the early 1970s and no mortality was due to *Heterosigma* was reported before 1989. Fish farms there have been severely affected by blooms since that time although there has been significant progress in mitigation techniques.

6. Is sampling in the Strait of Georgia under the BC aquaculture industry's Harmful Algae Monitoring Program, together with the sampling done in Puget Sound, adequate to understand the presence and impact of *Heterosigma* blooms which may affect Fraser River Sockeye?

No. There are no commercial fish farms in the Strait of Georgia and the sampling that does occur is done by Nicky Haigh on a volunteer basis in Departure Bay. We believe that the Heterosigma evidence justifies some sampling and experimentation on a broader area in the Strait of Georgia, including the migratory path of some of the sockeye smolts along the east side of the water body.

7. What research has been conductedto understand whether *Heterosigma* blooms can impact wild fish?

In the Salish Sea, virtually no dedicated research has occurred, only patchy monitoring by interested organizations or agencies. In Washington State the Washington Dept. of Fish and Wildlife previously sent out float planes after blooms in the 1990s to conduct "windshield surveys" and I participated in some of those surveys with them. Blooms in Washington State are much more transitory than in B.C., so being a day or two late means not seeing much in terms of the <1% of the fish that may be floating or washed up on shore. However, some other colleagues and I investigated wild fish kills in Southern Puget Sound that involved juvenile salmon and marine fish where blooms occurred in shallow inlets. We published a paper discussing how the extremely warm and shallow waters of the subject area (Case Inlet) caused the dead fish to be visible.

8. What research has been conducted to understand whether wild fish are able to navigate around and avoid the harmful algal blooms?

None. Although it may be possible using the latest versions of acoustic tags that may be fitted to smaller fish that are more representative of the average size of seaward emigrating Fraser River sockeye smolts. I do not expect that the concentration of *Heterosigma* in the Strait of Georgia will be constant everywhere during a major bloom, but the Fraser River induced vertical stratification along the periphery of the river plume in the South Strait and in all areas further north in the Strait may be relatively homogenous at times, based on the work of now retired UBC professor Max Taylor. Patchiness of bloom varies in North Puget Sound from patchy to homogeneous depending on the time of day, as often the cells are nearer the surface during the morning when it tends to be calm and the land breeze of the afternoon begins, cells tend to be mixed down giving the appearance, from an airplane, of lesser quantities of cells.

9. Are there different ecotypes of *Heterosigma akashiwo* and, if so, could they affect salmonids in different ways?

Research by two separate academic groups in Washington State is showing that there are at least six ecotypes (strains) in Puget Sound and they exhibit differences in salinity tolerance and growth rate. It is also possible that different ecotypes of *Heterosigma* have different toxin-producing capabilities that may be expressed in different locations and times.

10. Have the effects of *Heterosigma* on juvenile sockeye been researched and determined? If not, is this work which needs to be done to understand fully the potential impacts on Fraser River sockeye of exposure to *Heterosigma*?

The direct toxicity effects on juvenile sockeye will not vary greatly from that of other salmonids, but the studies have been very limited in our area. This work would not be exorbitantly expensive to conduct and could be done in the laboratory and in situ in the Strait of Georgia. The paper discusses this.

11. What is known about impacts or potential impacts of harmful algal blooms on adult sockeye? Could exposure of returning adult Fraser River sockeye to *Heterosigma* blooms result in chronic effects leading to later mortality?

Fraser River sockeye adults are at risk of acute or chronic effects from *Heterosigma* as the nearer they get to the river, the shallower they swim, often very near the surface. In late summer the entire lower Strait of Georgia remains an area where *Heterosigma* is known to occur and it is curious that since about 1995, the late run Fraser Sockeye no longer delay at the mouth of the river in most years, but move into the river despite river water that is too warm. No phytoplankton species composition sampling of the Strait of Georgia near the river mouth has been conducted. *Heterosigma* grows in a wide range of salinity. Other adult salmon have been seen dead near river mouths in B.C. during *Heterosigma* blooms.

12. Are potential impacts of harmful algal blooms on adult salmon relevant for Fraser River sockeye?

Yes, for example, in some years test fishing in Johnstone Strait has indicated a large return of Fraser River Sockeye that in some cases never materialized for the fishery or escapement. Blooms in the northern part of the Inland Passage are common at this time. Blooms in lower Georgia Strait and near the Fraser River mouth may potentially be a factor causing late-run sockeye to enter the river rather than delay migration in lower Strait of Georgia as a agonic response to Heterosigma exposure.

13. In the paper titled "Evidence of a synchronous failure in juvenile Pacific salmon and herring production in the Strait of Georgia in the spring of 2007",Commission Exhibit 1309, at pp. 19 – 20, Dr. Beamish et al state:

> Rensel et al. (2010) suggested that a toxic algae bloom was the cause of the poor survival of the juvenile sockeye salmon in the Strait of Georgia in 2007. They looked at three regions in the strait. It was only in the southern region along the western area of the Strait of Georgia where they reported large concentrations of toxic algae during the last week of May and early June in 2007 when juvenile sockeye salmon would be most abundant. The central and northern areas of the Strait of Georgia were reported to have mostly no evidence of the toxic algae Heterosigma akashiwo until late June and early July and early July. Thus, the areas where juvenile sockeye salmon would be most common did not have evidence of harmful levels of toxic algae at the time when these juveniles would be abundant.

Do you agree with this comment?

No. This was from a draft publication. I corresponded with Dr. Beamish several times about this excerpt from his draft paper and found that there was a misunderstanding about where our sampling occurred. I pointed out that the locations are actually shown in Figure 1 panel a of our publication and in fact we had no sampling locations in the central and northern areas of the Strait of Georgia. Accordingly, blooms of Heterosigma could have occurred there, as they did for the 1990 years investigated by UBC scientists. Dr. Beamish is altering his paper to account for this and is not discounting toxic algae as a possible contributing cause. I concur with him that the 2007 out-migrant juvenile sockeye met with poor food supply not only in the Strait of Georgia but also further north in Queen Charlotte Strait. He also told me that food web conditions were bad further north in the Gulf of Alaska. So the fish had a series of hurdles that year. My coauthors and I do not maintain that Heterosigma caused acute or chronic mortality is the only probable source of mortality for these fish, but that it could have been a significant, if not most significant

factor particularly in 2007 when the timing of the blooms was earlier than ever before and coincided with the peak out of river migration of Chilko sockeye smolts.

14. Have you had any discussions with Dr. Miller-Saunders about whether the possible novel viral signature she describes could have been caused by a harmful alga? If so, please describe.

Yes, I discussed this with Dr. Miller-Saunders when she cold-called me prior to our paper being published and prior to the PSC meeting in Nanaimo. At that time she suggested that exposure to *Heterosigma* may have been the cause of the genomic effects she was seeing in the fish. She had not proposed the virus theory at that time. I spoke with her briefly at the Nanaimo meeting but by then the focus was the theoretical virus. Disease effects in fish are often caused or amplified by multiple stressors, so Dr. Miller-Saunders' findings could reflect a secondary infection, related to exposure to HABs, as has been shown for bacterial diseases of fish after non-lethal HAB exposure.

15. Please explain, in summary form, the work being done by the National Oceanic and Atmospheric Administration (NOAA)harmful algal blooms team and any other researchers in Puget Sound with respect to *Heterosigma* and impacts on salmon.

The work is focused on elucidating the actual cause of fish mortality from exposure to *Heterosigma*. For example, it includes sampling blooms in a number of locations that are occurring now in 2011 and next year to extract toxin (or chemical) through the use of resin treated media bags and expose fish gill cultures to isolates. It is not focused on determining dynamics of *Heterosigma* blooms involving wild fish populations.

16. Is DFO is doing any research regarding harmful algal blooms and impacts on wild salmon?

I am not aware of any.

17. Could BC scientists contribute useful research and data to develop an understanding of the impact ofharmful algal blooms on salmonids in the Strait of Georgia, in particular impacts on Fraser River Sockeye?

Without question. Institute of Ocean Sciences and other scientists in B.C. are among the world's leaders in marine ecology studies and I have had the pleasure of interacting with several of them in preparation of our paper and through PICES (North Pacific Marine Science Organization) meetings. B.C. has some of the leading physical oceanographers in the world and many talented biological oceanographers and fisheries scientist, and relative to Washington State counterparts, more research experience in general with local waters. But as we stressed in our paper, important monitoring and research marine ecology topics in the Salish Sea are unattended.

18. Are there opportunities for DFO to contribute to the work being done on harmful algal blooms in Washington? Could Canada assist in advancing the research and understanding of these issues?

Yes. The United States and Canada share these coastal waters and the physical circulation and species dynamics have no respect for political boundaries and other types of experts in both regions do exchange information regularly. But there is little expertise with harmful algae research in British Columbia at present. Remote sensing projects, field sampling that includes phytoplankton species composition and distribution, experimental studies using live-fish cages and acoustic tagging of fish have to be done on a cross boundary basis to be valid. The U.S. NOAA has a general commitment to HAB work in our area and within the past two years there are at least three separate academic teams presently conducting studies on *Heterosigma*. Worldwide and in B.C. there is an apparent increase in the geographic extent and severity of harmful blooms with novel species creating problems for marine food webs and human consumers of seafood that should not be ignored.