

Dr. Rick Routledge

CURRICULUM VITAE

Rick Routledge

Statistics and Actuarial Science
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EDUCATION

Ph.D.	Mathematical and Statistical Ecology, Dalhousie University, Canada	1975
M.Sc.	Mathematical Statistics, University of Alberta, Canada	1972
B.Sc. (Hon)	Mathematics and Physics, Queen's University, Canada	1970

CURRENT RESEARCH INTERESTS

The development and use of stochastic models and statistical inference techniques with emphasis on applications to population ecology and renewable resource management.

Sample surveys of juvenile sockeye salmon in Rivers and Smith inlets to gain general information on the early marine phase of these severely depressed fish stocks.

Assessing the role of salmon farms on the dynamics of sea lice infestations on wild Pacific salmon during their juvenile migration past the farms.

PROFESSIONAL EMPLOYMENT HISTORY

Department Chair (2004 - 2007), Statistics and Actuarial Science, Simon Fraser University

Professor (1994 - present), Mathematics and Statistics, Simon Fraser University
(Statistics and Actuarial Science since 2004)

Director (July 1999 - August 2004), Environmental Science Undergraduate Program, Simon Fraser University

Founding Member of Pacific Fisheries Resource Conservation Council, Government of Canada (September 1998 - December 2000). (Council appointed by Honorable David Anderson, Minister of Fisheries and Oceans, to report on the health of Canada's Pacific salmon stocks).

Member of Fraser River Sockeye Public Review Board (October 1994 - March 1995). (Government of Canada. Board appointed by Honorable Brian Tobin, Minister of Fisheries and Oceans, to investigate “missing fish” in the 1994 Fraser River sockeye run.)

Associate Professor (1983 - 1994), Mathematics and Statistics, Simon Fraser University

Assistant Professor (1980 - 1983), Mathematics and Statistics, Simon Fraser University

Assistant Professor (1975 - 1980), Mathematics, University of Alberta

Killam Post-doctoral Fellow (1975 - 1977), Mathematics, University of Alberta

AWARDS, HONORS AND SCHOLARSHIPS

Award for Impact in Applied and Collaborative Work. Statistical Society of Canada. (2009)

Murray A. Newman Award for Excellence in Aquatic Science, Vancouver Aquarium Marine Science Centre. Details: Awarded jointly to Anthony Farrell, Patricia Gallagher, and Rick Routledge for significant achievement in aquatic conservation and research stemming from experiments on reducing coho by-catch mortality. (2002)

Faculty of Science Teaching Award, Simon Fraser University. (1995)

Membership in the International Statistical Institute. (Membership by nomination and election, 1992)

Killam Postdoctoral Fellowship, Killam Trust. (1975 – 1977)

Killam Scholarship, Killam Trust. (1972 – 1975)

Day Prize in Physics, Scholarship, Queen’s University. (1967)

McDowall Entrance Scholarship, Queen’s University. (1966)

MOST SIGNIFICANT CONTRIBUTIONS

1. Ainsworth, L.M., Routledge, R., and Cao, J. 2009. Functional Data Analysis in Ecosystem Research: the Decline of Oweekeno Lake Sockeye Salmon and Wannock River Flow. Accepted by The Journal of Agricultural, Biological, and Ecological Statistics. November, 2010.

This paper identifies an important application for functional regression analysis in ecosystem research – with the dependent variable being some infrequently estimated measure of biological performance and the independent variable being a virtually continuously monitored physical parameter. In this context, it develops new methodology for constructing simultaneous confidence bands for the regression function and applies it to gain insight on a potential contributing factor to the demise of a major sockeye salmon population.

2. Brahney, J., Bos, D., Pellatt, M., Edwards, T.W.D., and Routledge, R. 2006. Delta-15N and C:N as indicators of nitrogen limitation in sockeye salmon nursery lakes, British Columbia, Canada. *Limnology and Oceanography*, **51**(5): 233-2340.

This paper reassesses the way that researchers have been interpreting nitrogen-15 isotope concentrations in lake sediments. This heavy isotope is more prevalent in marine vs. freshwater environments, and its concentration in lake sediments has been used as a proxy for the number of sockeye salmon that returned from the sea to spawn in the lake watershed. The paper develops

methodology for adjusting raw estimates to account for preferential uptake of nitrogen-14 when nitrogen is not a severely limiting nutrient. Dr. Routledge and the co-authors have now begun to analyze sediments from specific sockeye salmon rearing lakes on the British Columbia coast in more detail, and are generating evidence that recent declines in adult sockeye returns to these lakes are unprecedented, and that they are associated with substantial changes to lake ecology.

3. Chiu, G., Lockhart, R., and Routledge, R. 2005. Bent-cable regression theory and applications. *Journal of the American Statistical Association*, **101**: 542-553.

This paper provides statistical methodology for addressing a central question in research on threshold phenomena: Is there really a threshold at which an effect begins to develop, and if so, how abrupt is it? Dr. Routledge and the co-authors demonstrate that in many applications where researchers have been tempted to draw definitive conclusions, there is insufficient evidence in the data to justify their claims. Richard Lockhart and Dr. Routledge were Grace Chiu's Ph. D. supervisors, and this paper was developed from part of her dissertation. A version of this paper won first prize in the 2002 Student Paper Competition conducted by the Western North American Region of the International Biometric Society, and Grace's Ph. D. thesis won the 2002 Pierre Robillard Award for the best Ph. D. thesis in statistics in Canada.

4. Morton, A. and Routledge, R. 2005. Fulton's condition factor: Is it a valid measure of sea lice impact on juvenile salmon? *North American Journal of Fisheries Management*, **26**: 56-62.

This paper is one of a series of articles assessing the interactions among farmed salmon, sea lice, and juvenile Pacific salmon. Of these, it received the most media attention, including front-page coverage in the Vancouver Sun, Vancouver's premier daily newspaper. In the paper, Dr. Routledge and his team informally adapted methodology for case-control studies on humans to show that sea lice are potentially lethal to juvenile pink salmon.

5. Routledge, R. D., and Tsao, M. 1997. On the relationship between two asymptotic expansions for the distribution of the sample mean and its applications. *Annals of Statistics*, **25**: 2200-2209.

This paper establishes the mathematical relationship between Daniels' saddlepoint expansion for the probability density function for the sample mean and Lugannani and Rice's similar expansion for the cumulative distribution function. Both approximations had been heavily developed and used in recent years. However, the connection between them, though discussed informally and assessed numerically, was first firmly established by the proofs reported in this paper. Dr. Routledge was Min Tsao's Ph. D. supervisor and this paper was developed from part of his dissertation.

6. Routledge, R. D. 1993. Practicing safe statistics with the mid- p . *Canadian Journal of Statistics*, **22**: 103-110.

On basis of this and a former paper, Dr. Routledge was asked to write an article for the *Encyclopedia of Biostatistics*. The paper develops formal justification from both a frequentist and Bayesian perspective for the mid- p -value that has been progressively promoted over the past half century for use with discrete test statistics.

LEADERSHIP

Simon Fraser University

- Piloted proposal for precursor of autonomous statistics department through formal Faculty of Science approval.

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- Coordinated the development of formal statistics undergraduate programs.
- Chaired formative curriculum deliberations for Environmental Science program.
- Served as Director of the Environmental Science Program.
- Served as Chair of the Department of Statistics and Actuarial Science during key expansion era.

Research Community

- Member of Board of Directors of the Statistical Society of Canada.
- Program Secretary for the Statistical Society of Canada (coordinating the scheduling and organizing of annual meetings).
- Member of NSERC Grant Review Panel for Collaborative Project Grant Program.
- External reviewer in appeal of a negative NSERC decision.

Impact on Public Policy

- In response to the 1992 Pearse-Larkin Inquiry, led a team of three who revised the methodology used by the Pacific Salmon Commission for estimating numbers of sockeye and pink salmon migrating up the Fraser River past Mission.
- Appointed by Hon. Brian Tobin to the 1994-1995 Fraser River Sockeye Public Review Board, investigating management of the 1994 salmon fisheries in British Columbia.
- Appointed by Hon. David Anderson as a founding member of the Pacific Fisheries Resource Conservation Council (1998-2000).
- By invitation of the British Columbia Special Legislative Committee on Sustainable Aquaculture, participated in a 5-hour debate in front of the committee on the scientific evidence on impacts of fish farms on coastal ecosystems (2006).

ACTIVE SERVICE TO THE ACADEMIC COMMUNITY

Government Review Panels and Boards

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| 1998 - 2000 | <i>Founding Member</i> , Pacific Fisheries Resource Conservation Council. |
| 1997 - 1998 | <i>Member</i> , Science Council of B.C. Forest Renewal BC Research Grant. Review Panel on Inventory Methodology. |
| 1994 - 1995 | <i>Member</i> of Review Panel A, NSERC Collaborative Project Grants Program. |
| 1994 - 1995 | <i>Member</i> , Fraser River Sockeye Public Review Board. |

Other Government Review Work

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| 1995 | <i>External Advisor</i> (confidential review of individual case), NSERC. |
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- 1995 *Reviewer* of proposed experiment for assessing impact of logging practices on species and structural diversity.
- 1995 - 1995 *External Advisor*, providing recommendations on hydroacoustic programs for Fraser River salmon enumeration, Department of Fisheries and Oceans.

Reviewing Activity

- **Journal Refereeing:** Reviewed numerous papers for research journals in statistics, ecology, forestry and fisheries research.
- **Grant Application Refereeing:** Reviewed grant applications for NSERC and several provincial granting agency programs.
- **Referee for Tenure and Promotion:** Provided several such referee reports.
- **External Reviews:** Served on two-person review panel for the statistics graduate programs at the University of Toronto.

Work for Professional Societies

- 2003 – 2005 *Member*, Snedecor Award Committee (Western North American Region (WNAR) Representative).
- 1993 – 1995 *Regional Representative*, Board of Directors of the Statistical Society of Canada.
- 1991 – 1995 Appointed as *Program Secretary* (Re-appointed for 1994-95), Statistical Society of Canada.
- 1991 – 1993 *Regional Representative*, Board of Directors of the Statistical Society of Canada.

Consulting

- 1996 - 1996 A writing project, preparing a chapter on a procedures manual for adaptive management, with \$4,400 contract, B.C. Ministry of Forests.
- 1996 - 1996 A coordination and writing project to reconvene personnel from the Fraser River Sockeye Public Review Board to prepare a more detailed proposal for a Pacific Fisheries Conservation Council, with a \$30,000 grant, B.C. Ministry of Agriculture, Fisheries and Food.
- 1994 - 1994 With C. Dean and C. J. Schwarz, a consulting on urchin surveys in the Queen Charlotte Islands, Haida Nation.
- 1992 - 1993 With François Bellavance and Sarath Banneheka, consulting project on estimating salmon escapement on the Fraser River, with two \$,1000 contracts, Pacific Salmon Commission.
- 1992 - 1993 With François Bellavance and Carolyn Taylor, a consulting project on ecological impacts of logging activities, with \$3,600 and \$3,000 contracts, B.C. Ministry of the Environment.

Administrative Responsibilities at University of Alberta

- 1977 - 1980 *Member*, Honours Committee, Mathematics Department, University of Alberta.
1977 - 1978 *Biology Liaison*, Math. Department, University of Alberta.

SERVICE TO THE COMMUNITY AT LARGE

- 2003 - current *Member*, Pacific Salmon Commission's technical panel for resolution of international disputes.
- 2000 - current *Member*, Technical Advisory Committee to the Rivers and Smith Salmon Ecosystem Planning Society.
- 1998 *Presenter* for a brief at public hearings into the terms of reference for the proposed Pacific Fisheries Resource Conservation Council, Federal Department of Fisheries and Oceans and B.C. Ministry of Agriculture, Fisheries, and Food.
- 1995 *Presenter* for a brief to the British Columbia Heritage Rivers Board presenting a case for heritage status for the Quesnel-Horsefly River. (First submitted, June, 1995, resubmitted December, 1995, status conferred.), BC Heritage Rivers Board.
- 1995 - 1997 *Guest Lecturer* on fish management and associated statistical issues, Advanced undergraduate and graduate classes in Geography and Statistics at SFU.
- 1995 - 1995 *Presenter* for a brief to the British Columbia Heritage Rivers Board presenting a case for heritage status for the Quesnel-Horsefly River. (First submitted, June, 1995, resubmitted December, 1995, decision pending), BC Heritage Rivers Board.
- 1995 *Invited Participant* for two workshops on in-season run size estimation, Pacific Salmon Commission.
- 1995 *Advocate*, wrote letters to numerous MP's, provincial MLA's, and the Vancouver Sun on issues related to fish conservation, spring and summer of 1995.
- 1995 *Advisor* for two meetings with the Honorable David Zirnhelt, B.C. Minister of Agriculture, Food, and Fish, to provide advice on the creation of a Pacific Fisheries Conservation Council.
- 1995 With John Fraser, Iona Campagnolo and Bob Brown of SFU, met with the Honorable Brian Tobin, Minister of Fisheries and Oceans to argue for the immediate creation of a Pacific Fisheries Conservation Council.
- 1995 *Invited Lecturer* for students in Fish and Wildlife Program at BCIT.
- 1995 *Organizer and Speaker* at the fish forum, "Getting the Missing Fish Story Straight", SFU Continuing Studies at Harbour Centre Campus.
- 1993 - 1993 *Lecturer*, for the Mathematics High School Conference, Simon Fraser University.
- 1989 - 1989 *Workshop Organizer*, for the Women Do Math Conference (with T. Swartz).
- 1988 - 1988 *Workshop Organizer*, for the Women Do Math Conference (with T. Swartz).
- 1989 *Invited judge* of the science fair, Lochdale Community School, Burnaby, B.C.
- 1986 *Invited judge* of the science fair, Lochdale Community School, Burnaby, B.C.

Dr. Rick Routledge

- 1985 Prepared a brief report on a disjunct occurrence of plants (normally found on the Atlantic Coastal Plain) in a proposed park in Ontario. Report was presented to the Ontario Ministry of Natural Resources, Parry Sound District.
- 1984 - 1984 **Resource Person** at problem session at High School Enrichment Conference.
- 1983 - 1983 **Presenter** for two lectures to Mathematics High School Enrichment Conf, SFU.
- 1983 - 1983 **Resource Person** at problem session at High School Enrichment Conference.
- 1982 - 1982 **Invited Lecturer**, Langley Secondary School.
- 1978 - 1978 **Invited Lecturer**, High School Mathematics Teachers in Edmonton, Alberta.

ACTIVE SERVICE TO SIMON FRASER UNIVERSITY

Numerous Departmental and Faculty Committees

Member of University Senate, 1984

PUBLICATIONS

Refereed Journals

1. Tanasichuk, R., and Routledge, R. 2011. An investigation of the biological basis of return variability for sockeye salmon (*Oncorhynchus nerka*) from Great Central and Sproat lakes, Vancouver Island. Accepted by Fisheries Oceanography (January, 2011).
2. Ainsworth, L.M., Routledge, R., and Cao, J. 2011. Functional Data Analysis in Ecosystem Research: the Decline of Oweekeno Lake Sockeye Salmon and Wannock River Flow. Submitted to The Journal of Agricultural, Biological, and Ecological Statistics. Accepted December 2010.
3. McConnell, A., Routledge, R., and Connors, B.M. 2011. The effect of artificial light on marine invertebrate and fish abundance in an area of active salmon farming. Submitted to Marine Ecology Progress Series. Accepted September 8, 2010.
4. Price M.H.H., Proboszcz S.L., Routledge R.D., Gottesfeld A.S., Orr C., and Reynolds, J. 2011. Sea Louse Infection of Juvenile Sockeye Salmon in Relation to Marine Salmon Farms on Canada's West Coast. PLoS ONE 6(2): e16851. doi:10.1371/journal.pone.0016851
5. Morton, A., Routledge, R., McConnell, A., and Krkosek, M. 2011. Sea lice dispersion and salmon survival in relation to salmon farm activity in the Broughton Archipelago. – ICES Journal of Marine Science, 68: 144–156.
6. Brahney, J., Bos, D., Routledge, R., and Pellatt, M. 2010. Changes to the productivity and trophic structure of a sockeye salmon rearing lake in British Columbia. The North American Journal of Fisheries Management, 30:433-444. (Lead author, Janice Brahney, was presented with the 2010 Mercer Patriarch Award for the best paper in the journal for that year.)
7. DeLury, N.C., Thistlewood, H., and Routledge, R. 2008. Phytotoxicity of GF-120[®] NF Naturalyte[®] fruit fly bait carrier on sweet cherry (*Prunus avium* L.) foliage. *Pest Management Science*, 65: 52-59.

8. Morton, A., Routledge, R., and Krkosek, M. 2008. Occurrence of sea lice (*Lepeophtheirus salmonis*) and (*Caligus clemensi*) on juvenile salmon (*Oncorhynchus* sp.) and herring (*Clupea pallasii*) off the east central coast of Vancouver Island April -June 2005. *North American Journal of Fisheries Management*, 28:523-532.
9. Morton, A., and Routledge, R. 2008. Comment on Butterworth et al. *Fisheries Research*, 92, 345-6.
10. Chiu, G., Lockhart, R., and Routledge, R.D. 2006. Bent-cable regression theory and applications. *Journal of the American Statistical Association*, 101: 542-553.
11. Brahney, J., Bos. D., Pellatt, M., Edwards, T.W.D., and Routledge, R.D. 2006. Delta-15N and C:N as indicators of nitrogen limitation in sockeye salmon nursery lakes, British Columbia, Canada. *Limnology and Oceanography*, 51(5): 2333-2340.
12. Morton, A., and Routledge, R.D. 2006. Mortality rates for juvenile pink and chum salmon (*Oncorhynchus gorbuscha* and *keta*) infested with sea lice (*Lepeophtheirus salmonis*) in the Broughton Archipelago. *Alaskan Fisheries Research Bulletin*, 11(2): 146-152.
13. Hadwin, A.K.M., Del Rio, L.F., Pinto, L.J., Painter, M., Routledge, R.D., and Moore, M.M. 2006. Microbial communities in wetlands of the Athabasca oil sands: genetic and metabolic characterization. *Microbial Ecology*, 55: 68-78.
14. Morton, A., and Routledge, R.D. 2006. Fulton's Condition Factor: Is it a valid measure of sea lice impact on juvenile salmon? *North American Journal of Fisheries Management*, 26: 56-62.
15. Morton, A., Routledge, R.D., and Williams, R. 2005. Temporal patterns of sea lice infestation on wild Pacific salmon in relation to the fallowing of Atlantic salmon farms. *North American Journal of Fisheries Management*, 25: 811-821. (Listed in November 2005 by the American Fisheries Society as ***one of top 20 downloaded articles from the Society's six journals in previous month.***)
16. Chiu, G., Lockhart, R., and Routledge, R.D. 2005. Asymptotic theory for bent-cable regression - the basic case. *Journal of Statistical Planning and Inference*, 127; 143-156.
17. Morton, A., Routledge, R.D., Peet, C., and Ladwig, A. 2004. Sea lice (*Lepeophtheirus salmonis*) infection rates on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*Oncorhynchus keta*) salmon in the nearshore marine environment of British Columbia, Canada. *Canadian Journal of Fisheries and Aquatic Sciences*, 61: 147-157.
18. Buchanan, S., Farrell, A.P., Fraser, J., Gallagher, P., Joy, R., and Routledge, R.D. 2002. Reducing gillnet mortality of incidentally caught coho salmon. *North American Journal of Fisheries Management* 22: 1270-1275.
19. Chiu, G., Lockhart, R., and Routledge, R.D. 2002. Bent-cable asymptotics when the bend is missing. *Statistics and Probability Letters*, 59: 9-16.
20. Routledge, R.D. 2001. Mixed-stock vs. terminal fisheries: a bio-economic model. *Natural Resource Modeling*, 14: 523-540.
21. Farrell, A.P., Gallagher, P.E., and Routledge, R.D. 2001. Rapid recovery of exhausted adult coho salmon after commercial capture by troll fishing. *Canadian Journal of Fisheries and Aquatic Sciences*, 58: 2319-2324.
22. Farrell, A.P., Gallagher, P.E., Fraser, J., Pike, D., Bowering, P., Hadwin, A.K.M., Parkhouse, W., and Routledge, R.D. 2001. Successful recovery of the physiological status of coho salmon on board a commercial gillnet vessel by means of a newly designed revival box. *Canadian Journal of Fisheries and Aquatic Sciences*, 58: 1932-1946.

23. Farrell, A.P., Gallagher, P., Clarke, C., DeLury, N., Kreiberg, H., Parkhouse, W., and Routledge, R.D.. 2000. Physiological status of coho salmon (*Oncorhynchus kisutch*) captured in commercial non-retention fisheries. *Canadian Journal of Fisheries and Aquatic Sciences*, 57: 1668-1678.
24. Routledge, R.D., and Irvine, J. 1999. Chance fluctuations and the survival of small salmon stocks. *Canadian Journal of Fisheries and Aquatic Sciences*, 56: 1512-1519.
25. Routledge, R.D., Smith, J.G., Dawe, N.K., and Nygren, E. 1999. Estimating the size of a transient population. *Biometrics*, 55: 224-230.
26. Routledge, R.D., and Tsao, M. 1997. On the relationship between two asymptotic expansions for the distribution of the sample mean and its applications. *Annals of Statistics*, 25: 2200-2209.
27. Routledge, R.D., and Tsao, M. 1997. Quadrature methods for computing distributions. *Computational Statistics and Data Analysis*. 26: 149-161.
28. Routledge, R.D. 1997. P-values from randomization and F-tests. *Computational statistics and data Analysis*, 379-386.
29. Banneheka, S., Routledge, R.D., and Schwarz, C.J. 1997. Stratified Two-Sample Tag-Recovery Census of Closed Populations. *Biometrics*, 53: 1212-1224.
30. Zhan, M., Dean, C.B., Routledge, R.D., Gallagher, P., Farrell, A.P., and Thorarensen, H. Inference on segmented polynomial models. *Biometrics*, 52, 321-327 (March 1996.)
31. Banneheka, S., Routledge, R.D., and Guthrie, I., 1995 Estimation of in-river fish passage using a combination of transect and stationary hydroacoustic sampling. *Canadian Journal of Fisheries and Aquatic Sciences*, 52: 335-343 (1995).
32. Routledge, R.D., and Tsao, M. 1995. Uniform validity of saddlepoint expansions on compact sets. *Canadian Journal of Statistics*, Vol. 23, No. 4, 425-431.
33. Routledge, R.D. 1994. Practicing safe statistics with the mid-p, *Canadian Journal of Statistics*, Vol. 22, No. 1, 103-110.
34. Routledge, R.D. 1990. When stepwise regression fails: correlated variables some of which are redundant. *International Journal of Mathematical Education in Science and Technology*, 21, 403-410.
35. Routledge, R.D. 1992. Resolving the conflict over Fisher's Exact Test, *Canadian Journal of Statistics*, Vol. 20, No. 2, 201-209.
36. Routledge, R.D. and Fyfe, D.A. 1992. Confidence limits for line transect estimates based on shape restrictions, *Journal of Wildlife Management*, 56: 402-407.
37. Routledge, R.D. and Fyfe, D.A. 1992. TRANSAN: Line transect estimates based on shape restrictions. (4 typed pages) *Wildlife Society Bulletin at the request of the editors of the Bulletin and Journal of Wildlife Management*, 20:455-456.
38. Routledge, R.D. and Swartz, T.B. 1992. Rejoinder to "Fitting Taylor's power law," by J.N. Perry and I.P. Woiwod. *Oikos* 65: 3, 543-544.
39. Routledge, R.D. 1991. Using time lags in estimating anaerobic threshold, *Can. J. Stat.*, 19, 233-236.
40. Routledge, R.D. and Swartz, T.B. 1991. Taylor's power law re-examined, *Oikos* 60:1, 107-112. (published in FORUM section containing discussion on important issues in ecology).
41. Routledge, R. 1990. Spatial patterns arising from plant dispersal as modelled by a correlated random walk. *Journal of Applied Probability*, 27, 1-13.

42. Rossmo, K. and Routledge, R.D. 1990. Estimating the size of criminal populations. *Journal of Quantitative Criminology*, 6, 293-314
43. Routledge, R.D. 1989. The removal method for estimating the size of natural populations: incorporating auxiliary information. *Biometrics*, 45, 111-122 .
44. Routledge, R.D. 1988. Assessing long-term costs of soil degradation. Proceedings of the Tenth B.C. Soil Science Workshop, Land Management Report No. 56, B.C. Ministry of Forests, 223-226.
45. Routledge, R.D. 1987. Rhizome architecture for dispersal in the spike rush, *Eleocharis palustris*. *Canadian Journal of Botany*, 65, 1218-1223.
46. Routledge, R.D. 1987. The impact of soil degradation on the expected present net worth of future timber harvests. *Forest Science*, 33, 823-834.
47. Routledge, R.D. 1985. The line transect method: a new estimator based on shape restrictions. *Biometrics*, 41, 669-679.
48. Routledge, R.D. 1984. Estimating ecological components of diversity. *Oikos* 42, 23-29.
49. Routledge, R.D. 1983. Evenness indices: Are any admissible? *Oikos* 40, 149-151. (published in FORUM section containing discussion on important issues in ecology).
50. Peterman, R.M., and Routledge, R.D. 1983. Experimental management of Oregon coho salmon (*Oncorhynchus kisutch*): designing for yield of information. *The Canadian Journal of Fisheries and Aquatic Sciences* 40, 1212-1223.
51. Routledge, R.D. 1982. The method of bounded counts: When does it work? *The Journal of Wildlife Management* 46, 757-761.
52. Routledge, R.D. 1981. The unreliability of population estimates from repeated, incomplete aerial surveys. *The Journal of Wildlife Management* 45, 997-1000.
53. Routledge, R.D. 1980. Bias in estimating the diversity of large, uncensused communities. *Ecology* 61, 276-281.
54. Routledge, R.D. 1980. The form of species-abundance distributions. *The Journal of Theoretical Biology* 82, 547-558.
55. Routledge, R.D. 1980. The effect of potential catastrophic mortality and other unpredictable events on optimal forest rotation policy. *Forest Science* 26, 389-399.
56. Routledge, R.D. 1979. Diversity indices: Which ones are admissible? *The Journal of Theoretical Biology* 76, 503-515.
57. Routledge, R.D. 1979. Niche metrics and diversity components. *Oecologia* 43, 121-124.
58. Pielou, E.C., and Routledge, R.D. 1976. Salt marsh vegetation: latitudinal gradients in the zonation patterns. *Oecologia* 24, 311-321.
59. Routledge, R. 1976. On Whittaker's components of diversity. *Ecology* 58, 1120-1127.

Other Publications (e.g. technical reports, books)

1. Routledge, R., 2008. Update on Rivers Inlet Ecosystem Study. Published in Wuikinuxv First Nation Newsletter.

2. Routledge, R. D. 2008. Fisher's exact test. Encyclopedia of clinical trials, R. B. D'Agostino, L. Sullivan, and J. Massaro, eds. Wiley-Interscience, NY (Reprinted from Encyclopedia of Biostatistics).
3. Joy, R., and Routledge, R.D. 2001. Can thinning and burning increase ponderosa cone production? Report submitted to B.C. Ministry of Forests, Penticton Office. October, 2001.
4. Seven articles on probability published in the on-line version of the Encyclopaedia Britannica.
5. Letter to the Editor of the Globe and Mail on sea lice and aquaculture.
6. Boitnott, A., Desautels, E., Hanson, L., MacQueen, J., Mau, P., Mellott, C., Riddell, E., Romanczuk, N., and Tsai, P. (with revisions to Executive Summary by Joy, R. and Routledge, R.D.) 2001.
7. Routledge, R., Joy, R., and EVSC 491 Students. Effectiveness of a silvicultural operation in restoring a native ponderosa pine / antelope bitterbrush ecosystem based on eight significant indicators. Report to the B.C. Ministry of Forests for EVSC 491 - Advanced Field Studies in Environmental Science
8. Chiu, G., Lockhart, R., and Routledge, R.D. Using the bent cable to assess an abrupt change in species abundance and other phenomena.
9. Orr, C., and Routledge, R.D. Co-Chairs' report of Salmon Hatchery Workshop, June, 2001.
10. Routledge, R.D. Fisher's exact test: When can you do what comes naturally? Simon Fraser University Technical Report.
11. Dill, L., and Routledge, R.D. Co-chairs' Report in Speaking for the Salmon Workshop Proceedings: Aquaculture and the Protections of Wild Salmon.
12. Fraser, J.A., M. Angelo, M.-S. Atkinson, M. Chatwin, T. Glavin, P. LeBlond, R.D. Routledge, B.D. Ryan, and C. Walters. Pacific Fisheries Resource Conservation Council 1999-2000 Annual Report.
13. Routledge, R.D. 2000. Fisheries and Oceans' "Wild Salmon Policy": A view from the perspective of science. Consensus statement from a meeting of scientists, forwarded to Fisheries and Oceans Canada.
14. Routledge, R.D., and Wilson, K. Fraser River Sockeye, pp. 135-154 in Pacific Fisheries Resource Conservation Council Background Papers. Paper No. 1999/1c.
15. Routledge, R.D. and Wilson, K. 1999. Coast-wide Coho, pp. 155-180 in Pacific Fisheries Resource Conservation Council Background Papers. Paper No. 1999/1d.
16. Remis, R.S., LeClerc, P., Routledge, R.D., Taylor, C., Bruneau, J., Beauchemin, J., Millson, P., Palmer, R., Degani, N., Strathdee, S., and Hogg, R. Consortium to characterize injection drug users in Canada Final Report.
17. Fraser, J.A., Angelo, M., Atkinson, M.-S., Chatwin, M., Glavin, T., LeBlond, P., Routledge, R.D., Ryan, D., and Walters, C. Pacific Fisheries Resource Conservation Council 1998-1999 Annual Report.
18. Routledge, R.D., Fisher's exact test. Invited contribution to the Encyclopedia of Biostatistics, Wiley, NY.

19. Jamieson, G.S., Cripps, K., Gijssen, M., Greba, L., Jones, R., Martel, G., Sandoval, W., Schwarz, C.J., Taylor, C., and Routledge, R.D. Reanalyses of 1993 red sea urchin surveys conducted in Haida, Heiltsuk, Kitsoo and Tsimshian traditional territory, pp. 57-68 in Invertebrate working papers reviewed by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms (B.J. Waddell, G.E. Gillespie, and L.C. Walthers eds.). Canadian Technical Report of Fisheries and Aquatic Sciences 2215. Fisheries and Oceans Canada.
20. Routledge, R.D. Measurements and estimates, pp. 55-68 in Statistical methods for adaptive management studies (V. Sit and B. Taylor, eds.). B.C. Ministry of Forests.
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30. Routledge, R.D., Fishing for answers: Is the Pacific sockeye fishery headed for another tumultuous season? Simon Fraser News, July 6, 1995, and reprinted in edited form on the Opinion pages of the Vancouver Sun and the Globe and Mail, July, 1995.
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33. Routledge, R.D. 1989. The Removal Method: The Need for Auxiliary Information. Mathematical Models of Renewable Resources, Proceedings of the Third Pacific Coast Conference on Mathematical Modelling of Renewable Resources, 179-184.
34. Routledge, R.D. 1981. Appendix to "The unreliability of population estimates from repeated, incomplete aerial surveys." National Auxiliary Publication Service Document 03830, 8 pp.
35. Routledge, R.D. 1979. Ecological components of diversity. (A limited-circulation appendix to "Diversity indices: Which ones are admissible?") 9 pp.

CONFERENCES, WORKSHOPS AND PRESENTATIONS (last 15 years)

Invited Presentations

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| October 2010 | Why Are So Many Sockeye Salmon Populations Declining? Invited seminar at University of the Fraser Valley, Abbotsford, BC |
| June 2010 | Preserving Pacific Wild Salmon. Invited Plenary Address in Honour of the SSC Impact Award. Laval University, PQ |
| January 2010 | Closing Panel Presentation at a Public Forum on Fraser Rivers Sockeye Salmon, Wosk Centre, Vancouver, BC |
| December 2008 | Speaking for the Salmon Workshop on Salmon Nutrients Science and Policy. One of four invited panelists. |
| May 2008 | Banff International Research Station workshop on Climate Change Impacts on Ecology and the Environment. Why are many coastal sockeye salmon populations declining? |
| January 2008 | NSERC Site Visit for NICDS Application. Value of National Institute for Complex Data Structures (NICDS) to Rivers Inlet Ecosystem Study. |
| July 2007 | Fields Institute Summer Workshop on Environmetrics. Impediments to Environmental Research. |
| July 2007 | Fields Institute Summer Workshop on Environmetrics. Rivers Inlet Ecosystem Study: A Case Study in Ecosystem Research. |
| December 2006 | Science Consultation Hearings of the British Columbia Special Legislative Committee on Sustainable Aquaculture. A six-hour session in which a panel of scientists presented their views on five contentious questions with questions from the MLAs on the committee. |

Dr. Rick Routledge

- May 2006 Statistics in Forestry workshop at the Banff International Research Station. Fire history: evidence from natural recorders.
- November 2005 Townhall Meeting on Getting the Missing Fish Story Straight: Part II. A Ten-Year Retrospective on Fraser Sockeye Salmon Centre for Dialogue, SFU, Vancouver, BC. Panelist on Stock Assessment and Catch Monitoring.
- November 2004 Rivers and Smith Salmon Ecosystem Partnership Society Meeting. Rivers Inlet Ecosystem Study.
- June 2004 Statistical Society of Canada Annual Meeting, Montreal, PQ. Ecosystem research in an unstable environment.
- June 2004 Western North American Regional Joint Meeting of the International Biometric Society and the Institute of Mathematical Statistics, Albuquerque, NM. Hydrodynamic modelling of Rivers Inlet, BC.
- December 2003 December meeting of the Central Coast Advisory Board (a group that advises Fisheries and Oceans Canada with respect to fisheries management on the Central Coast of British Columbia). Ecosystem research on Rivers and Smith Inlet sockeye salmon.
- October 2003 October meeting of the Rivers and Smith Sockeye Ecosystem Renewal Society. Early marine survival of Rivers Inlet sockeye.
- June 2003 "Common Vision" Workshop hosted by the Pacific Salmon Foundation. Opening address at evening reception for Dr. Routledge's research on Rivers and Smith Inlets Sockeye Salmon.
- April 2002 Murray A. Newman Award Ceremony, Vancouver Aquarium Marine Science Centre. Evolutionary History of Thompson Coho Salmon.
- November 2001 Workshop for Rivers and Smith Inlets Partnership Group. Invited presentation on research needs for Rivers and Smith Inlet sockeye salmon.
- November 2001 Leggatt Inquiry into Pacific Salmon Aquaculture. Salmon aquaculture: Views of an independent scientist.
- November 2000 Fisheries Renewal B.C. Workshop on Rivers Inlet Sockeye. Opening address entitled, Rivers Inlet Sockeye: Views of an Independent Scientist/
- November 1999 SFU Continuing Studies in Science Public Lecture Series. When can fishing get back to normal?
- June 1999 Pacific Salmon: Status of Stocks and Habitat. Status salmon stocks in British Columbia: coastwide overview of stock status, highlighting concerns for coho.
- January 1998 Speaking for the Salmon. The importance of biodiversity.
- February 1998 Wood Forum '98. Biodiversity Measurement.
- August 1997 Indian Pow-wow at Horsefly River, Horsefly B.C. Short invited address on the significance of the Horsefly River sockeye run.
- August 1996 Joint Statistical Meetings, Chicago, Illinois.
- July 1996 Be a Good Ancestor, SFU Faculty of Science Symposium. Where have all the fish gone?

Dr. Rick Routledge

- October 1995 30th Anniversary Public Lecture Series, Faculty of Science, Simon Fraser University.
- June 1991 The 1991 Annual Meeting of the Statistical Society of Canada, Toronto. How many prostitutes work the streets of Vancouver?

Speaker

- November 2009 Biennial Meeting of the Coastal Ecology Research Foundation. Oweekeno Lake sockeye salmon: evidence of critical habitat in the downstream fjord.
- November 2006 Public hearings for the British Columbia Special Legislative Committee on Sustainable Aquaculture. Salmon farms and sea lice: perspective of an independent scientist.
- November 2004 Roundtable Discussion on Aquaculture and Sea Lice in the Broughton Archipelago. Summary of results from a holding study on sea-lice induced mortality.
- November 2002 Speaking for the Salmon Seminar on Nutrients and Salmon Production. Rivers and Smith Inlets: Possible Influence of Lake Conditions.
- June 1999 Pacific Salmon: Status of Stocks and Habitat. Status salmon stocks in British Columbia: coast-wide overview of stock status, highlighting concerns for coho.
- January 1998 Speaking for the Salmon. The importance of biodiversity.
- July 1996 Be a Good Ancestor, SFU Faculty Science Symposium. Where have all the fish gone?

Contributed Talks

- November 2009 Biennial Meeting of the Coastal Ecology Research Foundation, Portland, Oregon. Oweekeno Lake sockeye salmon: evidence of critical habitat in the downstream fjord.
- October 2005 Climate and Fisheries: Impacts, Uncertainty and Responses of Ecosystems and Communities. Possible climate change contribution to the decline of Oweekeno Lake sockeye salmon ecosystems.
- May 2002 Annual Meeting of the Canadian Society of Environmental Biologists. Measuring Biodiversity Value.

Chair of Invited Paper Session

- August 2010 Joint Statistical Meeting, Vancouver, BC. Session on the British Columbia Forest Resource in a Changing Climate.
- August 2006 Joint Statistical Meeting, Seattle, Washington. Session on generating insight on past ecological conditions from natural recorders.
- June 2001 Statistical Society of Canada Annual Meeting, June 2001, Simon Fraser University, Burnaby, B.C. Fisheries Statistics.

Dr. Rick Routledge

- June 1999 Statistical Society of Canada Annual General Meeting. Statistical Issues in Fisheries Management.
- June 1996 Annual Meeting of the Statistical Society of Canada, Waterloo, Ontario. Statistics in Resource Management Controversies (Chair and Speaker).

Chair

- November 2006 Workshop on integrated ecosystem research in Rivers Inlet, BC. Organized at the request of the Tula Foundation to develop plans for a major research initiative.
- June 2001 Speaking for the Salmon Workshop on Hatcheries. Chair and Moderator of closing session for developing overview statement.
- July 2000 Aquaculture and the Protection of Wild Salmon. Co-Chair with L. Dill of closing plenary session whose purpose was to extract as much consensus as possible for inclusion in a summary report.
- May 2000 Speaking for the Salmon Workshop on Draft Wild Salmon Policy. Chair of meeting with responsibility for building a consensus statement from the assembled scientists to be forwarded to Fisheries and Oceans Canada.
- August 1999 Joint Statistical Meetings, Baltimore, MD. Luncheon Roundtable Discussion on Fisheries Management Issues.
- January 1998 Speaking for the Salmon. Co-organizer with Bob Brown (SFU), P. Gallagher (SFU), A. Narcisse (NicolaBand), and C. Orr (private consultant). Workshop to maintain pressure for a Pacific Fisheries Conservation Council.

Invited Lecturer

- April 2005 BISC 204 Introduction to Ecology. Guest lecture on ecological interactions between salmon farms, sea lice, and wild salmon.
- October 1995 30th Anniversary Public Lecture Series, Faculty of Science, Simon Fraser University.

Organizing Panel

- December 2009 Think Tank on Fraser Sockeye, Simon Fraser University, Burnaby, B.C.

Media Interviews

- January 2006 Front page report in the Vancouver Sun on research article co-authored with Alexandra Morton. "Dying fish had twice the sea lice," by Jonathan Fowlie. Published: Monday, January 16, 2006 in The Vancouver Sun and the Victoria Times-Colonist and the Campbell River Courier-Islander, with follow-up reports on CKNW, Radio Canada International and Rock 101.
- January 2006 Night Line (evening talk radio show). Half-hour interview with Michael Smith on CKNW (980 AM) and on the Corus Network on sea lice and fish farms. From 8:30 to 9:00 pm, on January 17, 2006.

Dr. Rick Routledge

- January 2006 Report in the Globe and Mail on research article co-authored with Alexandra Morton. “Impact of sea-lice infestation underestimated, report says,” by Mark Hume. Published: Tuesday, January 17, 2006, Globe and Mail, p. S3.
- January 2005 Quoted in article by Paul Rudan, Campbell River Mirror on January 4, 2005. Interview on sea lice and aquaculture.
- January 2005 Interview with Terry Moore from 4:10 to 4:30 on CFX Radio, Victoria. Discussion of recent scientific workshop on aquaculture and sea lice.
- March 2004 Interview with Terry Moore from 5:10 to 5:30 on CFX, an all-news radio station in Victoria. Discussion of a recent article co-authored by me on sea lice and fish farms.
- October 2003 Interviewed for article in Salmon Watch. “Restoring Rivers Inlet Sockeye”, pp. 10-11 in Salmon Watch, Fall 2003 edition, published by the T. Buck Suzuki Environmental Foundation.
- September 2003 Quoted in article on sea lice and salmon farming in The New York Times.
- June 2003 CBC Radio News. Interviewed by CBC Radio News on Dr. Routledge’s research project on Rivers and Smith Inlets Sockeye Salmon.
- September 2002 Interviewed by CBC radio news on lifting of moratorium on salmon aquaculture expansion in British Columbia.

Other Media Exposure

- July 2007 24 Hours Newspaper. Quoted in a series of two “At Issue” articles by reporter, Robyn Stubbs, on July 3 and 4, 2007.
- May 2007 Quoted in The Vancouver Sun in report on the B.C. Special Legislative Committee on Sustainable Aquaculture. Also, interviewed by producer of CBC Early Edition for background briefing for Rick Cluff in interviews with Committee Chair, Robin Austin and aquaculture industry representative, Mary Ellen Walling.
- March 2006 The Province Newspaper. March 15, 2006, p. A31, the Money Section. Report by Ashley Ford. Study links lice to wild salmon fishery: Researcher calls for more stringent regulation.
- October 2005 Boston Legal. Research on ecological impacts of salmon aquaculture used in script for episode of Boston Legal first airing on October 10, 2005. (Not my idea!)

RESEARCH FUNDING RECEIVED (last 15 years)

Project Title	Period	Agency	Total Funding
Hakai Network	2010-18	Tula Foundation	\$8,000,000
Tula Foundation Professorship	2010-11	Tula Foundation	\$236,000
Discovery Grant	2009-14	NSERC	\$80,000
Rivers Inlet Ecosystem Study	2007-10	Tula Foundation	\$1,233,460
Discovery Grant	2004-09	NSERC	\$115,000
Rivers Inlet Ecosystem Study	2007	Tula Foundation	\$114,000
Rivers Inlet Ecosystem Study	2006	Tula Foundation	\$70,000

Dr. Rick Routledge

Okanagan Valley Fire History	2006-07	GEOIDE	\$10,000
Rivers Inlet Ecosystem Study	2005	NPCDS	\$28,700
Rivers Inlet Sockeye Salmon	2003-04	Pacific Salmon Foundation	\$100,000
Rivers Inlet Sockeye Salmon	2003-04	DFO Science Subvention	\$15,000
Discovery Grant	2000-04	NSERC	\$92,000
Rivers Inlet Sockeye Salmon	2002-03	Pacific Salmon Foundation	\$25,000
Rivers Inlet Sockeye Salmon	2002	Mr. Rudy North	\$10,000
Computing Network Upgrade	2002	NSERC	\$34,346
Rivers Inlet Sockeye Salmon	2002	RSPG (local stewardship group)	\$40,100
Seven Encyclopdia Articles	2001-02	Encyclopedia Britannica	\$1,000
Selective Fishing Experiments	2001-02	DFO	\$50,000
Computing Network Upgrade	2001	NSERC	\$53,290
Selective Fishing Experiments	2000-01	DFO	\$50,000
Computing Network Upgrade	2000	NSERC	\$51,616
Selective Fishing Experiments	1999-2000	DFO	\$50,000
Discovery Grant	1996-2000	NSERC	\$63,200
Computing Network Upgrade	1999	NSERC	\$35,277
Selective Fishing Experiments	1998-99	DFO	\$100,000
Intravenous Drug User Study	1997-98	Health Canada	\$110,000
Manual on Adaptive Mgmt.	1996-8	BC Forest Ministry	\$4,300
Computing Network Upgrade	1995	NSERC	\$32,645
Estimating Salmon Abundance	1994-5	NSERC/DFO Science	\$7,500

STUDENT SUPERVISION

Student Supervision

Dr. Routledge has supervised 18 M.Sc. (2 current) and 3 Ph.D. students. All of the latter currently hold academic or research positions:

- Grace Chiu (Ph.D. 2002) is Senior Research Scientist, CSIRO, Australia.
- Sarath Banneheka (Ph.D. 1995) returned to an academic position in Sri Lanka.
- Min Tsao (Ph.D. 1995) is Full Professor, Department of Mathematics and Statistics, University of Victoria, BC.

The M.Sc. graduates are employed in a variety of positions including Camosun College, Thompson Rivers University, and the Centre for Excellence in HIV/AIDS at St. Paul's Hospital.

In addition, Dr. Routledge has supervised approximately 25 undergraduate student Research Assistant appointments. Most of these students have subsequently enrolled in graduate programs.

Dr. Routledge has also served as External Examiner for two Ph.D. students at other universities, and on the supervisory committees for approximately 50 other graduate students. He is currently supervising 3 M. Sc. students, 1 Ph. D. candidate, 1 postdoctoral fellow, and 1 research associate.

TEACHING AT SIMON FRASER UNIVERSITY

- Taught numerous courses in probability and statistics from introductory to advanced graduate level, and several undergraduate environmental science courses.
- Developed separate undergraduate major and honours programs in statistics.
- Restructured undergraduate course structure for new degree programs.
- Developed graduate statistics course for students in biology and resource and environmental management.
- Helped develop curriculum for environmental science major and honours programs, including the field course, EVSC 491, which he ran for the first four years of its operation.
- Developed a graduate statistics course for students in biology and resource management, STAT 650 (1980's).
- Developed a new course in statistical quality control (1980's).
- Oversaw revisions to the calculus sequence (1982-1984).
- Devised several demonstrations, activities, and experiments for use in statistics classes, including a set of irregular dice for introducing the basic concepts of logistic regression.