

**Dr. Carl Schwarz**  
Dept of Statistics and Actuarial Science  
Simon Fraser University, Burnaby, BC, CANADA V5A 1S6  
Selected Publications and Research Interests

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## Educational Background

- 2004 P.Stat.     Statistics, Statistical Society of Canada, Canada  
The P.Stat. designation represents accreditation as a Professional Statistician by the Statistical Society of Canada.
- 1988 Ph.D.     Statistics, University of Manitoba, Canada  
Post-release stratification and migration models in band-recovery and capture-recapture models
- 1981 M. Math    Statistics, University of Waterloo, Canada
- 1980 M.Sc.     Computer Science Simulation and modeling, University of Manitoba, Canada
- 1978 B.Sc.     Computer Science, University of Manitoba, Canada
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## Employment History at Academic Institutions

- September 2001 - Current     Professor, Statistics and Actuarial Science, Simon Fraser University
- September 2001 - August 2004   Chair, Department of Statistics and Actuarial Science, Simon Fraser University
- January 1994 - August 2001     Associate Professor, Department of Statistics and Mathematics, Simon Fraser University
- July 1988 - December 1993     Assistant Professor, Department of Statistics, University of Manitoba
- September 1987 - July 1988    Lecturer, Department of Statistics, University of Manitoba
- September 1984 - July 1988    Consultant, Statistical Advisory Service, University of Manitoba
- September 1984 - August 1987   Sessional Lecturer, Department of Statistics, University of Manitoba
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## Current Research Interests

Statistics - experimental design ANOVA STATISTICAL CONSULTING

My research program is in three areas: capture-recapture modeling of animal population dynamics; statistical consulting; and linear and generalized linear models. The research in capture-recapture models requires the development of new stochastic models, the development of model fitting and testing procedures, and the development of computer software. In large part, it is motivated by real problems encountered by ecologists. My interest in statistical consulting involves assistance in experimental design and analysis in complex experimental situations where the "standard textbook" results are not appropriate. Both of these areas give rise to my interest in linear and generalized linear models.

My current research projects are:

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- the development of capture-recapture methodology to estimate population parameters of temporally stratified populations. This has applications in estimating salmon escapement; in estimating salmon smolt runs; and in estimating sable fish populations.
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- the development of capture-recapture methodology to estimate population parameters of long-lived animal populations that have temporary absences from the sampling areas. This will be applied to estimate the population size and survival rates of the seal herd on Sable Island, Nova Scotia. This population consists of long-lived animals with year-to-year temporary absences from the breeding colony, and within-year temporary absences from the beaches during multiple within-year surveys. the development of tag-recovery methodology to study migration among geographically-stratified populations. This has been used to study the movement of herring among spawning areas in B.C. and the movement of mallards among wintering areas in the southern United States. A new study is underway to examine the movement of hatchery released salmon from the coded-wire returns obtained from the fishery.
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- the provision of statistical advice (through the Statistical Advisory Service) to graduate students and faculty at the University and to researchers off campus. For example, we are currently involved in a project to investigate the relationship between forest inventory data stored in a GIS and habitat data obtained by ground crews.

the development of statistical methodology to study the effects of restrictions on randomization upon analysis of variance models. This is being done by a Ph. D. student under my supervision.

Dissemination of the research findings is through publications in refereed journals. However, because of the time lag between completion of a research project and the eventual publication in a journal, I also regularly give presentations at conferences where the users of the research are most likely to attend and have given workshops to transfer the results to ecologists. My work in statistical consulting is important for similar reasons - to ensure that modern methods in statistics are effectively used in other disciplines.

[capture-recapture, statistical ecology, experimental design, statistical consulting]

Statistics - experimental design COMPLEX EXP DESIGN

Statistics - statistical ecology MARK-RECAPTURE

Statistics - statistical ecology TAGGING

Statistics - statistical ecology BAND RECOVERY

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## Completed Works

### Refereed Publications

Sutherland, J. M., Castelluccio, P., and Schwarz, C. J. (2009). A multi-level model for continuous time population. Published Online: Jan 23 2009. DOI: 10.1111/j.1541-0420.2008.01129.x

Schwarz, C. J. (2009). Migration and movement -- the next stage. Pages 325-350 in Modeling Demographic Processes in Marked Populations Series: Environmental and Ecological Statistics , Vol. 3. Thomson, David L.; Cooch, Evan G.; Conroy, Michael J. (Eds.). Springer, New York.

Challenger, W.O. and Schwarz, C. J. (2009). Mark-recapture Jolly-Seber abundance estimation with classification uncertainty. Pages 829-846 in Modeling Demographic Processes in Marked Populations Series: Environmental and Ecological Statistics , Vol. 3. Thomson, David L.; Cooch, Evan G.; Conroy, Michael J. (Eds.). Springer, New York.

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Selected Publications and Research Interests

- Bonner, S. J., Thomson, D., and Schwarz, C. J. (2009). Time-varying covariates and semi-parametric regression in capture-recapture: an adaptive spline approach. Pages 659-678 in *Modeling Demographic Processes in Marked Populations: Environmental and Ecological Statistics*, Vol. 3. Thomson, David L.; Cooch, Evan G.; Conroy, Michael J. (Eds.). Springer, New York.
- Skibo, K. M., Schwarz, C. J. and Peterman, R. M. (2008). Evaluation of sampling designs for red sea urchins (*Strongylocentrotus franciscanus*) in British Columbia, Canada. *North American Journal of Fisheries Management* 28, 219-230. DOI: 10.1577/M06-293.1
- Muthukumarana, S., Schwarz, C. J., and Swartz, T. B. (2008). Bayesian analysis of mark-recapture data with travel-time-dependent survival probabilities. *Canadian Journal of Statistics* 36, 5-28.
- Dupuis, J.A. and Schwarz, C.J. (2007). A bayesian approach to the multi-state Jolly-Seber capture-recapture model. *Biometrics* 63, 1015-1022. DOI: 10.1111/j.1541-0420.2007.00815.x.
- Schwarz, C. J. (2007). Computer-aided statistical instruction - multi-mediocre techno-trash? *International Statistical Review* 75, 348-354. DOI:10.1111/j.1751-5823.2007.00035.x
- Sutherland, J. M., Schwarz, C. J., and Rivest, L. P. (2007). Multi-List Population Estimation with Incomplete and Partial Stratification. *Biometrics* 63, 910-916. DOI: 10.1111/j.1541-0420.2007.00767.x.
- Cowen, L. L. and Schwarz, C. J. (2006). The Jolly-Seber model with tag loss. *Biometrics* 62, 699-705. Cowen was awarded first prize for an oral presentation on this topic at the 2005 summer WNAR meeting in Fairbanks, Alaska.
- Anthony, R.G., Forsman, E.D., Franklin, A.B., Anderson, D.R., Burnham, K.P., White, G.C., Schwarz, C.J., Nichols, J.D., Hines, J.E., Olson, G.S., Ackers, S.H., Andrews, L.S., Biswell, B.L., Carlson, P.C., Diller, L.V., Dugger, K.M., Fehring, K.E., Fleming, T.L., Gerhardt, R.P., Gremel, S.A., Gutiérrez, R.J., Happe, P.J., Herter, D.R., Higley, J.M., Horn, R.B., Irwin, L.L., Loschl, P.J., Reid, J.A., and Sovern, S.G. (2006). Status and trends in demography of northern spotted owls, 1985-2003. *Wildlife Monographs* 163, 1-47.
- Bonner, S. J. and Schwarz, C. J. (2005). An Extension of the Cormack-Jolly-Seber model for continuous covariates with application to *Microtus pennsylvanicus*. *Biometrics* 62, 142-149. DOI: 10.1111/j.1541-0420.2005.00399.x
- Schwarz, C. J. (2006). Multi-state models. In *Handbook of Capture-recapture analysis*. Amstrup, S.C., McDonald, T. L. and Manly, B. F. J. (editors). Princeton University Press: Princeton.
- Cowen, L. L. and Schwarz, C. J. (2005). Capture-recapture studies using radio telemetry with premature radio-tag failure. *Biometrics* 61, 657-664.
- Power, M., Dempson, J. B., Reist, J. D., Schwarz, C. J. and Power, G. (2005) Latitudinal variation in fecundity among Arctic char populations in eastern North America. *Journal of Fish Biology* 67, 255-273.
- Schwarz, C. J. and Bairlein, F. (2004). Dispersal and migration. *Animal Biodiversity and Conservation* 27, 297-298.
- Bonner, S. J. and Schwarz, C. J. (2004). Continuous time-dependent individual covariates and the Cormack-Jolly-Seber Model. *Animal Biodiversity and Conservation* 27, 149-155.
- Sutherland, J. and Schwarz, C. J. (2005). Multi-List Methods Using Incomplete Lists in Closed Populations. *Biometrics* 61, 134-140.
- Demson, J. B., O'Connell, M. F., and Schwarz, C. J. (2004). Spatial and temporal variation in abundance of Atlantic salmon, *Salmo salar*, with emphasis on impacts of the closure of the Newfoundland commercial fishery. *Fisheries Management and Ecology* 11, 387-402.
- Dempson, J. B., Schwarz, C. J., Shears, M., and Furey, G. (2004). proximate body composition of Atlantic salmon with emphasis on parr from fluvial and lacustrine habitats. *Journal of Fish Biology* 64, 1257-1271.
- McPherson, R. J., Arnold, T. W., Armstrong, L. M., and Schwarz, C. J. (2003). Estimation of the nest survival rate and the number of nests initiated per breeding pair. *Journal of Wildlife Management* 67, 843-851. McPherson was a summer NSERC student.

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## Selected Publications and Research Interests

- Manske, M., Stobo, W.T. and Schwarz, C.J. (2002). Estimation of age-specific probabilities of first return to the breeding colony and annual survival rates for the male Grey Seal (*Halichoerus grypus*) on Sable Island from capture-recapture data. *Marine Mammal Science* 18, 145-155. <http://dx.doi.org/10.1111/j.1748-7692.2002.tb01024.x>
- Seber, G. A. F. and Schwarz, C. J. (2002). Capture-recapture: before and after EURING 2000. *Journal of Applied Statistics*, 29, 459-474. In: Morgan, B.J.T. and Thomson, D.L. (Eds.)(2002) 'Statistical Analysis of Data from Marked Bird Populations' *Journal of Applied Statistics* 29, nos -4.
- Schwarz, CJ (2002). Discussion comments on 'Prior distributions for stratified capture-recapture models' *Journal of Applied Statistics* 29, 239-240. In: Morgan, B.J.T. and Thomson, D.L. (Eds.)(2002) 'Statistical Analysis of Data from Marked Bird Populations' *Journal of Applied Statistics* 29, nos -4.
- Barker, R., Cooch, E., Schwarz, C (2002). Discussion comments on: 'Approaches for the direct estimation of Lambda and demographic contributions to Lambda, using capture-recapture data' *Journal of Applied Statistics*, 29, 569-572. In: Morgan, B.J.T. and Thomson, D.L. (Eds.)(2002) 'Statistical Analysis of Data from Marked Bird Populations' *Journal of Applied Statistics* 29, nos -4.
- Pledger, S. and Schwarz, C.J. (2002). Modelling heterogeneity as a random effect using mixture models. *Journal of Applied Statistics*, 39, 315-328. In: Morgan, B.J.T. and Thomson, D.L. (Eds.)(2002) 'Statistical Analysis of Data from Marked Bird Populations' *Journal of Applied Statistics* 29, nos -4.
- Schwarz, C. J. (2002). Real and quasi-experiments in capture-recapture. *Journal of Applied Statistics*, 29, 459-474. In: Morgan, B.J.T. and Thomson, D.L. (Eds.)(2002) 'Statistical Analysis of Data from Marked Bird Populations' *Journal of Applied Statistics* 29, nos 1-4.
- Arnason, A. N. and Schwarz, C. J. (2002). POPAN-6: Exploring convergence and estimate properties with SIMULATE. *Journal of Applied Statistics* 29, 649-688. In: Morgan, B.J.T. and Thomson, D.L. (Eds.)(2002) 'Statistical Analysis of Data from Marked Bird Populations' *Journal of Applied Statistics* 29, nos 1-4.
- Dempson, J. B., Schwarz, C. J., Reddin, D. G., O'Connell, M. F., Mullins, C. C., and Bourgeois, C. E. (2001). Estimation of marine exploitation rates on Atlantic salmon (*Salmo salar L.*) stocks in Newfoundland, Canada. *ICES Journal of Marine Science* 58, 331-341.
- Schwarz, C. J. (2001). The Jolly-Seber model: more than just abundance. *Journal of Agricultural, Biological, and Environmental Statistics* 6, 195-205.
- Dauk, P.C. and Schwarz, C. J. (2001). Catch estimation with restricted randomization in the effort survey. *Biometrics* 57, 461-468.
- Dauk, P. C. and Schwarz, C. J. (2001). Catch estimation in the presence of declining catch rate due to gear saturation. *Biometrics* 57, 287-293.
- Schwarz, C. J. and Arnason, A. N. (2000). The estimation of age-specific breeding probabilities from capture-recapture data. *Biometrics* 56, 59-64. <http://dx.doi.org/10.1111/j.0006-341X.2000.00059.x>
- Schwarz, C. J. and Stobo, W. T. (2000). The estimation of age-specific pupping probabilities for the grey seal (*Halichoerus grypus*) on Sable Island from capture-recapture data. *Canadian Journal of Fisheries and Aquatic Sciences* 57, 247-253. <http://dx.doi.org/10.1139/cjfas-57-1-247>
- Manske, M. and Schwarz, C. J. (2000). Estimates of stream residence time and escapement based on capture-recapture data. *Canadian Journal of Fisheries and Aquatic Sciences* 57, 241-246.
- Chen, S., Dauk, P., Ghahramani, M. Kalbfleisch, H., Sutherland, J., Taylor, C., Thompson, D., Wu, C., Xu, X. and Schwarz, C.J. (1999). Everyone complains about textbook prices but no-one .... *Stats* 24, 10-13.
- Schwarz, C. J. and Seber, G. A. F. (1999). A review of estimating animal abundance III. *Statistical Science* 14, 427-456.

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## Selected Publications and Research Interests

- Schwarz, C. J. and Stobo, W. T. (1999). Estimation and effects of tag-misread rates in capture-recapture studies. *Canadian Journal of Fisheries and Aquatic Sciences* 56, 551-559.
- Arnason, A. N. and Schwarz, C. J. (1999). Using POPAN-5 to analyze banding data. *Bird Study* 46 (suppl.), s157-s168.
- Schwarz, C. J., Andrews, M., Link, M. R. (1999). The Stratified-Petersen with a known number of unread tags. *Biometrics* 55, 1014-1021. This work was cited in the *Biometric Bulletin* as an example of diversity of biometry.
- Schwarz, C. J. (1998). Studies of uncontrolled events. In *Statistical Methods for Adaptive Management Studies*, p. 19-40, Sit, V. and Taylor, B. (editors). BC Ministry of Forests.
- Schwarz, C. J. and Taylor, C. G. (1998). The use of the stratified-Petersen estimator in fisheries management: estimating the number of pink salmon (*Oncorhynchus gorboscha*) that spawn in the Fraser River. *Canadian Journal of Fisheries and Aquatic Sciences* 55, 281-297. <http://dx.doi.org/10.1139/cjfas-55-2-281>
- Schwarz, C. J. and Stobo, W. T. (1997). Estimating temporary migration using the robust design. *Biometrics* 53, 253-269.
- Schwarz, C. J. and Sutherland, J. (1997). An on-line workshop using a simple capture-recapture experiment to illustrate the concepts of a sampling distribution. *Journal of Statistical Education* 5(1) - an online journal -.
- Rajwani, K. N. and Schwarz, C. J. (1997). Adjusting for missing tags in salmon escapement surveys. *Canadian Journal of Fisheries and Aquatic Sciences* 54, 800-808.
- Banneheka, S. G., Routlege, R. D. and Schwarz, C. J. (1997). Stratified two-sample tag recovery census of closed populations. *Biometrics* 53, 1212-1224.
- Schwarz, C. J. (1997). StatVillage: An online, WWW-accessible, hypothetical city based on real data for use in an introductory class in survey sampling. *Journal of Statistical Education* 5(2) - an online journal -.
- Schwarz, C. J. and Arnason, A. N. (1996). A general methodology for the analysis of capture-recapture experiments in open populations. *Biometrics* 52, 860-873.
- Schwarz, C. J. and Reid, N. (1995). Comment on the analyses. In "Effects of growth-regulators on silver-maple trees: a case study", Reid, N. editor. *Canadian Journal of Statistics*, 23, 311-332.
- Sloan, J. A., Schwarz, C. J., and Neden, L. R. (1995). Dataset on silver-maple-tree growth regulators. In "Effects of growth-regulators on silver-maple trees: a case study", Reid, N. editor. *Canadian Journal of Statistics* 23, 311-332.
- Schwarz, C. J. and Ganter, B. (1995). Estimating the movement among staging areas of the Barnacle Goose (*Branta leucopsis*). *Journal of Applied Statistics* 22, 711-724.
- Arnason, A. N. and Schwarz, C. J. (1995). POPAN-4: Enhancements to a system for the analysis of mark-recapture data from open populations. *Journal of Applied Statistics* 22, 785-800.
- Schwarz, C.J., and Dempson, B.D. (1994). Mark-recapture estimation of a salmon smolt population. *Biometrics* 50: 98-108.
- Schwarz, C.J. (1993). The mixed model ANOVA: The truth, the computer packages, the books. Part I: Balanced Data. *The American Statistician* 47:48-59.
- Schwarz, C.J., Bailey, R.J., Irvine, J., and Dalziel, F.C. (1993). Estimating salmon escapement using capture-recapture methods. *Canadian Journal of Fisheries and Aquatic Sciences* 50: 1181-1197.
- Schweigert, J.F. and Schwarz, C.J. (1993). Estimating migration rates for Pacific herring (*Clupea harengus pallasii*) using tag-recovery data. *Canadian Journal of Fisheries and Aquatic Sciences* 50: 1530-1540.
- Schwarz, C.J., Schweigert, J., and Arnason, A.N. (1993). Using tag-recovery data to estimate migration rates. *Biometrics* 49: 177-194.
- Schwarz, C.J., Sloan, J.A., Neden, L.R., and Brewster, J.F. (1992). Multiple sclerosis dataset. *Canadian Journal of Statistics* 20:102-108.

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## Selected Publications and Research Interests

- Smando, R.F. and Schwarz, C.J. (1991). Comparative replicate analyses of a variety of inoculated fishery products and rehydrated potato flakes of *Echerichia coli* using the rapid membrane overlay method and the classical most probable number method. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1768.
- Schwarz, C.J. and Samanta, M. (1991). An inductive proof of the sampling distribution for the MLEs of the parameters in an Inverse Gaussian Distribution. *The American Statistician* 45: 223-225.
- Arnason, A.N., Schwarz, C.J., Gerrard, J. (1991). Estimating closed population size and number of marked animals from sighting data. *Journal of Wildlife Management* 55:716-730.
- Schwarz, C.J. and Samanta, M. (1989). Minimum variance unbiased estimation in a multivariate linear regression model. *South African Statistical Journal* 23:143-155.
- Krebs, E., Hurlburt, G., and Schwarz, C.J. (1988). Vocational self-estimates and perceived competencies of Native high-school students: Implication for vocational guidance counselling. *Canadian Journal of Counselling* 22:212-225.
- Samanta, M. and Schwarz, C.J. (1988). On the Shapiro-Wilk test for exponentiality based upon censored data. *Journal of the American Statistical Association* 83:528-531.
- Schwarz, C.J., Burnham, K.P., and Arnason, A.N. (1988). Post-stratification in band recovery models. *Biometrics* 44: 765-785.
- Dunstall, T.G. and Schwarz, C.J. (1983). Effects of temperature elevation and entrainment on heterotrophic uptake of glutamic acid. *Water Research*, 17:1847-1853.

## Refereed Conference Proceedings

- Godwin-Sheppard, C. and Schwarz, C.J. (2006) Assessing the impact of base camps upon wolverine distributions by examining patterns of tracks in snow. Paper at the Wildlife and Environmental Impact Assessment, held in Yellowknife, NWT, 10-12 March 2006.
- LeMay, V. and Schwarz, C. J. (1997). Use of spatial information in analyzing experiments. In *Proceedings of the IUFRO Interdisciplinary uneven-aged management symposium*. Corvallis, Oregon, September, 1997. pp. 583- 589. Volume issued in late 1999.
- Jones, R. R., Schwarz, C. J., and Lee, L. (1998). Intertidal population estimates of razor-clams (*Siliqua patula*) at beaches near Haida Gwaii/Queen Charlotte Islands and applications to fishery management. *In: Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management*. Edited by G. S. Jamieson and A. Campbell. Canadian Special Publication in Fisheries and Aquatic Sciences 125, 199-211.
- Schwarz, C. J. (1995). Statistical prerequisites of a valid capture-recapture estimate. *In Proceedings of the 1994 salmon escapement workshop plus an annotated bibliography on escapement estimation*. Irvine, J.R. and Nelson, T.C. (editors). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2305, 8-9.
- Schwarz, C.J. (1993). Estimating migration rates using tag-recoveries. *In Marked Individuals in the Study of Bird Populations* (Proceedings of EURING'92). Lebreton, J.-D. and North, P.M. (editors). Birkhauser Verlag Basel. p. 255-264.
- Fortier, P.A. and Schwarz, C.J. (1991). Procrustean Analysis of Thematic Structures in Andre' Gide's *L'Immoraliste*. Presented at the ACH/ALLC 1991 Conference, Tempe, Arizona, 20 March 1991.
- Schwarz, C.J. and Arnason, A.N. (1990). The use of tag-recovery information in migration and movement studies. *American Fisheries Society Symposium* 7: 588-603.
- Hughes, E. and Schwarz, C.J. (1983). Dollar-unit sampling as applied to large inventories. 1983 Proceedings of the Business and Economic Statistics Section. Sponsored by the American Statistical Association, Toronto, August 1983, pp. 125-130.
- Arnason, A.N., Schwarz, C.J., Scuse, D.H. (1981). An on-line simulator and data-base system for the management of a commercial fish farm. 1981 Proceedings of the Winter Simulation Conference. Sponsored by the Association for Computing Machinery, the Institute of Management Sciences, *et al.*, Atlanta, December 1981, pp. 141-152.

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## Refereed Letters and Other Publications

Schwarz, C. J. (2008). Review of "Advanced distance sampling". *Biometrics* 64, 997-997. DOI: 10.1111/j.1541-0420.2008.01082\_12.x

Schwarz, C. J. (2008). Review of "Analyzing Ecological Data". *Biometrics* 64, 310-311.

Schwarz, C. J. (2007). Review of "Data Analysis and Graphics using R, 2nd edition". *Biometrics* 63, 974-975. DOI: 10.1111/j.1541-0420.2007.00787.x

Schwarz, C. J. (2005). Estimation of movement from tagging data. Pages 591-606 In *Stock Identification Methods*, (Cadran et al eds). Academic Press, New York.

Anthony, R. G., Forsman, E. D., Franklin, A. B., Anderson, D. R., Burnham, K. P., White, G. C., Schwarz, C. J., Nichols, J., Hines, J., Olsen, G. S., Ackers, S. H., Andrews, S., Biswell, B. L., Carlson, P. C., Diller, L. V., Dugger, K. M., Fehring, K. E., Fleming, T. L., Gerhardt, R. P., Gremel, S. A., Gutierrez, R. J., Happe, P., Herter, D. R., Higley, J. M., Horn, R. B., Irwin, L. L., Loschl, P. J., Reid, J. A., and Sovern, S. G. (2004). Status and trends in demography of Northern Spotted Owls, 1985-2003. Report prepared for the Interagency Regional Monitoring Program, USDA Forest Service, 130 pp.

Jamieson, G.S., Jones, R., Martel, G., Schwarz, C.J., Taylor, C.G., and Routledge, R. (1998). Analyses of 1994 Red Sea Urchin Survey located in Haida Gwaii, Pacific Management Area 1. In: Waddell, B. J., Gillespie, G.E. and Walthers, L.C. [eds]. *Invertebrate Working Papers reviews by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms. Canadian Technical Report of Fisheries and Aquatic Sciences 2215: 3-18.*

Jamieson, G.S., Sandoval, W., Schwarz, C.J., Taylor, C.G., and Routledge, R. (1998). Analyses of the 1994 red sea urchin survey conducted in Heiltsuk traditional territory, Pacific Management Area 7, subareas 18 and 25. In: Waddell, B. J., Gillespie, G.E. and Walthers, L.C. [eds]. *Invertebrate Working Papers reviews by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms. Canadian Technical Report of Fisheries and Aquatic Sciences 2215: 19-32.*

Jamieson, G.S., Scarf, G., Schwarz, C.J., Taylor, C.G., and Routledge, R. (1998). Analyses of 1994 red sea urchin surveys conducted in Awenna K'Ola traditional territory, subareas of Pacific Management Area 12. In: Waddell, B. J., Gillespie, G.E. and Walthers, L.C. [eds]. *Invertebrate Working Papers reviews by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms. Canadian Technical Report of Fisheries and Aquatic Sciences 2215: 33-56.*

Jamieson, G.S. and Schwarz, C. J. (1998). Survey protocol considerations for 1995 sea urchin surveys. In: Waddell, B. J., Gillespie, G.E. and Walthers, L.C. [eds]. *Invertebrate Working Papers reviews by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms. Canadian Technical Report of Fisheries and Aquatic Sciences 2215: 69-82.*

Jamieson, G.S., Cripps, K., Gijssen, M. Greba, L., Jones, R., Martel, G., Sandoval, W., Schwarz, C.J., Taylor, C.G., and Routledge, R. (1998). Reanalysis of the 1993 Red Sea Urchin Surveys conducted in Haida, Heiltsuk, Kitasoo, and Tsimshian traditional territory. . In: Waddell, B. J., Gillespie, G.E. and Walthers, L.C. [eds]. *Invertebrate Working Papers reviews by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms. Canadian Technical Report of Fisheries and Aquatic Sciences 2215: 57-68.*

Schwarz, C. J. (1999). STAT-VILLAGE: An online, virtual village using real life census microdata. *American Statistical Association 1999 Proceedings of the Section on Statistical Education*, 42-47.

Campbell, A., Hand, C.M., Paltiel, C., Rajwani, K.N. and Schwarz, C.J. (1996). Evaluation of survey methods for geoducks. *PSARC working paper 196-03*, 31p.

Arnason, A.N., Kirby, C.W., Schwarz, C.J., and Irvine, J. (1996). Computer analysis of marking data from stratified populations for estimation of salmonid escapements and the size of other populations. *Canadian Technical Report of Fisheries and Aquatic Sciences 2106: 37p.*

Schwarz, C.J. (1995). The Mixed-Model ANOVA. Reply to comment by Stanek and Buonaccorsi. *The American Statistician* 49: 323-324.

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Selected Publications and Research Interests

## Computer Software and On-line WWW Materials

<http://www.stat.sfu.ca/>

This consists of web pages for the stats group, plus the material developed for the Innovation Fund and other teaching materials.

<http://www.cs.umanitoba.ca/~popan/System>

, A.N., Schwarz, C.J., and Boyer, G. (1998). POPAN-5: A data maintenance and analysis for mark-recapture data. Scientific Report, Department of Computer Science, University of Manitoba, Winnipeg, viii+318p.

Schwarz, C.J. and Sutherland, J. (1997). An on-line workshop using a simple capture-recapture experiment to illustrate the concepts of a sampling distribution. *Journal of Statistical Education*, 5(1) - an online journal -.

StatVillage: An On-Line WWW-Accessible hypothetical city based on real data for use in an introductory class in survey sampling.

<http://www.math.sfu.ca/stats/Innovation/StatVillage>

This is a teaching aid to help students plan and execute survey samples based on the 1991 public use microdata files from Statistics Canada.

Schwarz, C.J. (1997) StatVillage: An online, WWW-accessible, hypothetical city based on real data for use in an introductory class in survey sampling. *Journal of Statistical Education*, 5(2) - an online journal -.

<http://www.cs.umanitoba.ca/~popan/>

SPAS - Stratified Population Analysis System

Arnason, A.N., Kirby, C.W., Schwarz, C.J. and Irvine, J. (1996). Computer analysis of marking data from stratified populations for estimation of salmonid escapements and the size of other populations. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2106: 37p.

<http://www.cs.umanitoba.ca/~popan/>

POPAN System

Arnason, A.N., Schwarz, C.J., and Boyer, G. (1995). POPAN-4: A data maintenance and analysis system for mark-recapture data. Scientific Report, Department of Computer Science, University of Manitoba, Winnipeg, viii+267p.

## Contract and Consulting Reports

Schwarz, C. J. (2009). Review of "Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir – Draft Technical Report (Version 2) – 2008" performed for B.C. Hydro. 2009-05-19. 9 pp.

Schwarz, C. J. (2009). Review of Coggins and Walters (2009) "Abundance trends and status of the Little Colorado River population of Humpback Chub: An update considering data from 1989-2008". Conducted for the U.S. Geological Survey, Grand Canyon Monitoring and Research Center. 10pp.

Schwarz, C. J. (2009). Analysis of the Petitot River Walleye telemetry study. Prepared for the B.C. Ministry of the Environments. Dated 2009-03-20. 34 pp.

Schwarz, C. J. (2009). Considerations in design a long-term tagging program to monitor the Walleye population in Mille Lacs, Minnesota. Prepared for the Minnesota Department of Natural Resources dated 2009-01-20. 6 pp.

Schwarz, C. J. (2009). Analysis of the mark-recapture studies for walleye in Mille Lacs, Minnesota: 2008 report. Prepared for the Minnesota Department of Natural Resources dated 2009-01-20, 33 pp.

Schwarz, C. J. (2008). A Sensitivity Analysis of various scenarios on the estimation of the HC5 in Species Sensitivity Distributions (SSD). Prepared for the B.C. Ministry of Environment. 2008-12-08. 17pp.

Schwarz, C.J. (2008). Review of book proposal on use of Bayesian methods for ecologists using WinBugs for Elsevier, Science and Technology Books. 10 pp.

Schwarz, C. J. (2008). A review of the protocol for the derivation of water quality guidelines, especially through the use of Species Sensitivity Distributions (SSD). Prepared for B.C. Ministry of Environment. 19 pp.

Schwarz, C. J. (2008). Review of "Potential Bias of Spawning Adult Walleye Mark-Recapture Population Estimates". Prepared for the Great Lakes Indian Fish and Wildlife Commission (GLIFWIC). 2008-09-24. 4 pp.

# **Dr. Carl Schwarz**

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## **Selected Publications and Research Interests**

- Marine, K., Pickard, D., and Schwarz, C. J. (2008). Trinity River Restoration Program: Juvenile salmonid outmigrant monitoring evaluation. Final Technical Memorandum. 2008-08-27. Prepared for the Trinity River Restoration Program. 82pp.
- Schwarz, C. J. (2008). Analysis of Moyie Burbot data - 2008 report. Prepared for B.C. Ministry of Environment. 6 pp.
- Schwarz, C. J. (2008). A template for the analysis of vegetation monitoring studies. Prepared for FORREX. 50pp.
- Schwarz, C. J. (2008). Review of "Protocol for a line-transect evaluation of the availability of terrestrial lichen forage for Norther Caribou". Prepared for the B.C. Ministry of Environment. 6pp + Detailed comments on actual review protocol.
- Schwarz, C. J. (2008). Survey Selection for Camping Satisfaction Survey of B.C. Parks. Prepared for .C. Ministry of Parks. 5 pp + computer code.
- Bonner, S. J. and Schwarz, C. J. (2008). Analysis of Variability in Water Quality, Sediment Quality, and Abundance of Benthic Organisms in Two Lakes of the Koala Watershed. Report for Rescan Environmental Services Ltd. 71pp.
- Schwarz, C. J. (2007). Estimating survival and exploitation rates from a tagging study on juvenile Atlantic halibut (*Hippoglossus hippoglossus*) in 3NOPs4VWX conducted between 1995 and 2007. Prepared for the Department of Fisheries and Oceans. 23 pp.
- Schwarz, C. J. (2007). Estimating the number of burbot in Maxan Lake. Prepared for B.C. Ministry of Environment. 34 pp.
- Schwarz, C. J. (2007). Design of a minnow monitoring program for an in-stream hydroelectric project. Prepared for Pottinger Gaherty Environmental Consultants Ltd. (PGL). 17 pp.
- Loughin, M., Bercovitz, I., Schwarz, C. J. (2007). Ecological risk assessment of sediment contamination from the a pulp mill based on the benthic community. Prepared for Keystone Environmental Consulting. 43 pp.
- Schwarz, C. J. (2007). An examination of the predictive ability of a habitat model for the Black Throated Green Warbler (BTNW) and the Connecticut Warbler (COWA) in the South Peace, British Columbia. Prepared for the B.C. Ministry of Environment. 13pp.
- Schwarz, C. J. (2007). Data validation for the Small Lakes Assessment data base. Prepared for the B.C. Ministry of Enviroment. 12 pp + attachments.
- Schwarz, C. J. (2007). Habitat as a predictor of Warbler usage. Prepared for the B.C. Ministry of Environment. 9 pp.
- Schwarz, C. J. (2007). Estimates of the Moyie Lake burbot population based on mark-recapture data. Prepared for the B.C. Ministry of the Environment. 18pp.
- Schwarz, C. J. (2006). Analysis of the mark-recapture studies for northern pike in Mille Lacs, Minnesota. 2006 report. Contract for the Minnesota Department of Natural Resources, 65 pp.
- Schwarz, C. J. (2006). A review of the AEMP. Prepared for Rescan Environmental Consulting. 48 pp.
- Schwarz, C. J. (2006). A power-sample size analysis of the TEEM project on Base Saturation. Prepared for the Terrestrial Environment and Ecological Monitoring subcommittee of the Wood Buffalo Environmental Association. 34 pp.
- Schwarz, C. J. (2006). Review of "Evaluation for temporal and spatial associations amongst levels of sea lice on farmed Atlantic salmon and wild juvenile salmon..." Prepared for Pacific Salmon Forum, 5 pp.
- Schwarz, C. J. (2006). An issues analysis for the SLAM system. Prepared for the B.C. Ministry of the Environment. 21 pp.
- Schwarz, C. J. (2006). Expert witness for Dispute Resolution Panel between two parties dealing with extra cost charges for conditions on job site different from that presented in tender. 12-14 September 2006.

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## **Selected Publications and Research Interests**

- Schwarz, C.J. and Bercovitz, I. (2006). Seymour-Capilano Twin Tunnel Project. Relationship of rock quality and productivity. Prepared for Bilfinger Berger, 17 pp.
- Schwarz, C. J. and Bercovitz, I. J. (2006). A review of response to a change order request. Prepared for Bilfinger Berger (Canada). 8 pp.
- Schwarz, C. J. (2006). A planning tool for designing monitoring studies for in-river hydroelectric facilities. Prepared for the B.C. Ministry of Environment. Includes a web-based interface to assist in power analysis of potential studies.
- Schwarz, C. J. (2005). Analysis of the mark-recapture studies for and northern pike in Mille Lacs, Minnesota. 2005 report. Contract for the Minnesota Department of Natural Resources, 98 pp.
- Hankin, D. G. (Chair), Clark, J. H., Deriso, R. B., Garza, J. C., Morishima, G. S., Riddell, B. E., Schwarz, C. J., Scott, J. B. (2005). Report of the Expert Panel on the Future of the Coded Wire Tag Recovery Program for Pacific Salmon. Prepared for the Pacific Salmon Commission, 227 pp.
- Cowen, L. L. and Schwarz, C. J. (2005). Power analysis for a rotating power design. Prepared for the Canadian Wildlife Service. 18 pp.
- Schwarz, C. J. (2005). Estimating the increased cost from extra boulders in excavations at the Seymour-Capilano Twin Tunnel. Prepared for Bilfinger Berger, 8 pp.
- Schwarz, C. J. (2005). Review of "An assessment of white sturgeon stock status and trends in the lower Fraser River" by Walters et al. Prepared for the Pacific Stock Assessment Review Committee and presented at the review on 21 June 2005 in Nanaimo. 6 pp.
- Schwarz, C. J. (2005). A power-sample size analysis of the TEEM project. Prepared for the TEEM monitoring project in the Alberta Oil Sands. 18pp.
- Schwarz, C. J. (2005). Survey guidelines for assessing candidate protected areas in the Northwest Territories, Prepared for AMEC, Calgary. 20pp.
- Cowen, L. L. and Schwarz, C. J. (2005). A migration model with tag loss. Prepared for Department of Fisheries and Ocean, St. Johns. 21 pp.
- Schwarz, C. J. (2004). Review of proposed Data Selection Methodology for the Consumers Association of Canada 2004 Automobile Insurance Study. 4pp.
- Challenger, W. and Schwarz, C. J. (2004). An Examination Of The Impact of Fishfarms Upon Bottom Flora and Fauna. Prepared for /Xaixais First Nations. 102 pp.
- Bercovitz, I. B. and Schwarz, C. J. (2004). Estimating the rate of change of TEQ and predicting when the mean TEQ falls below critical values using data from the Dioxin/Furan Monitoring Program of Environment Canada. Prepared for Environment Canada. 35pp.
- Schwarz, C. J. (2004). Estimating the number of walleye Mille Lacs, Minnesota – 2003 season. Work performed for the Department of Natural Resources State of Minnesota. 66 pp.
- Schwarz, C. J. (2003). Review of "Population Assessment of the Northern Spotted Owl in British Columbia 1992-2001" and other related documents. Conducted for the B.C. Ministry of Water, Land and Air Protection. 8 pp.
- Kitchell, J. F., Grimes, G., Lindley, S., Otis, D, Schwarz, C. J. (2003). An Independent Review of Ongoing and Proposed Scientific Methods to Assess the Status & Trends of the Grand Canyon Population of the Humpback Chub (*Gila cypha*). A Report of a Workshop Conducted at the National Center for Ecological Analysis and Synthesis 6-7 November 2003. Report for the Adaptive Management Work Group of the Grand Canyon Monitoring and Research Center. 20 pp.
- Schwarz, C. J. (2003). Review of the Lichen Indicator Pilot Program Report" conducted for the Wood Buffalo Environmental Association (WEBA). 10pp.
- Schwarz, C. J. (2003). Review of proposed creel survey design - Columbia River Hugh Keenleyside Dam to US Border. Prepared for Canadian Columbia River Inter-Tribal Fisheries Commission. 8 pp.

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## **Selected Publications and Research Interests**

Schwarz, C. J. (2003). Biostatistics Review of Oil Sands Regional Aquatics Monitoring Program (RAMP) Year Report. Prepared for the RAMP Technical Committee. 42 pp.

Schwarz, C. J. (2003). A review of "Response of Sphagnum fuscum to Nitrogen Deposition" by Vitt et al. Prepared for the TEEM project of the Wood Buffalo Environmental Assessment project. 10 pp.

He, L., Zhang, W. C., Schwarz, C. J. (2003). The 2003 geoduck inventory for FanSea Foods. Prepared for Fan SeaFoods, 10 pp. [He and Zang were NSERC Undergraduate Research Students.]

He, L., Zhang, W. C., and Schwarz, C. J. (2003). An analysis of a fish farm impact assessment. Prepared for the Kitasoo/Xaixais First Nations under the NSERC Undergraduate Student Research Programme.

Schwarz, C. J. (2003). A review of a book proposal "Statistics are not difficult" for Cambridge University Press. 6 pp.

Schwarz, C. J. and Bercovitz, I. B. (2003). A comparison of the Most Probable Number (MPN) and Direct Plating (DP) assays in determining the concentrations of *Vibrio parahaemolyticus* in seafood samples. Prepared for the Canadian Food Inspection Agency.

Schwarz, C. J. (2003). A review of "The Harrison Bar Gravel Removal Experiment: Final Report". Review conducted for BC Ministry of Water, Land, and Air Protection (WLAP). 9 pp.

Schwarz, C. J. (2003). Estimating the Precision of the Creel Surveys on Arrow Lake. Prepared for BC Hydro. 10pp + excel spreadsheet + SAS program.

Schwarz, C. J. (2003). Estimating the number of walleye in Mille Lacs Lake, Minnesota. Prepared for the Minnesota Department of Natural Resources. 88pp.

Schwarz, C. J., and Bercovitz, I. B. (2003). An investigation into changes in the lake levels at Lake Athabasca. Prepared for B.C. Hydro.

Jamieson, G. S., Scrosati, R., Schwarz, C. J., Levings, C. and Smiley, B. (2002). Review of Shorekeepers Guide: Data Quality and Sampling Protocols. Canadian Science Advisory Secretariat Research Document 2002/121. Available at: [http://www.dfo-mpo.gc.ca/csas/Csas/English/Research\\_Years/2002/2002\\_121e.htm](http://www.dfo-mpo.gc.ca/csas/Csas/English/Research_Years/2002/2002_121e.htm)

Parker, S. J., Schwarz, C. J. and Skalski, J. R. (2002). Technical review of the proposed IPHC PIT Marking Experiment. Prepared for the International Pacific Halibut Commission. 17pp.

Jones, R., Schwarz, C. J., DeFreitas, B. and Lee, L. (2002). Results of surveys of intertidal razor clams (*Siliqua patula*) on beaches near Massett, Haida Gwaii and recommendations on fishery management. DFO Canadian Science Advisory Secretariat Research Document 2001/152.

Schwarz, C. J. (2002). A review of a SAS-program for Collection Management. Prepared for Gabor Consulting Services. 8 pp.

Schwarz, C. J. (2002). A simulation study of three statistical adjustment methodologies for VRI. Prepared for the B.C. Ministry of Forests. 32 pp.

Schwarz, C. J. (2002). Review of "Trace metal in traditional foods within the Athabasca oil sands area". Prepared for the Wood Buffalo Environmental Association. 17 pp.

Schwarz, C. J. (2002). Review of "Monitoring the long term effects of acid emissions on soil and vegetation in Jack Pine and Aspen forest of northeast Alberta. 1998 Report". Prepared for the Wood Buffalo Environmental Association. 27pp.

Schwarz, C. J. (2002). A review of the StreamKeepers Sampling Protocol and data collection. Prepared for the Department of Fisheries and Oceans. 13 pp. + 18pp appendices.

Starr, P.J. and Schwarz, C.J. (2001). Feasibility of a bottom trawl survey for three slope groundfish species in Canadian waters. Canadian Stock Assessment Secretariat Research Document 2000/156. Available at: [www.dfo-mpo.gc.ca/csas](http://www.dfo-mpo.gc.ca/csas).

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## **Selected Publications and Research Interests**

- Schwarz, C. J. and Cowen, L. L. (2001). A reanalysis of the 1999 PIT-tag and radiotelemetry study conducted by Chelan PUD. Prepared for Chelan PUD (a hydroelectric utility). 75pp.
- Joy, R. and Schwarz, C.J. (2001). Error analysis of VRI plots. Report prepared for the Ministry of Forests, Government of British Columbia. 5 pp.
- Schwarz, C.J. (2001). The Statistical Estimation and Adjustment Process using a PPSWR sampling design in the Vegetation Resource Inventory- Summary. Prepared for the Ministry of Forests, Government of British Columbia. 18 pp.
- Schwarz, C.J. (2000). Review of "Development of a Fishery for Tanner Crab (*Chionoecetes tanneri*) off the Coast of British Columbia". Prepared for the West Coast Sustainability Association. Also a presentation of this review to PSARC in June 2000
- Schwarz, C.J. (2000). The Statistical Estimation and Adjustment Process using a PPSWR sampling design in the Vegetation Resource Inventory. Prepared for the B.C. Ministry of Forests, 82pp.
- Schwarz, C.J. (2000). Followup on "Regression analysis of the Albion Chum Test fishery". Prepared for the Department of Fisheries and Oceans, 4 pp.
- Schwarz, C.J. (1999). Estimating the size of the Aboriginal Population in Vancouver/Richmond based on mark-recapture methods using multi-list studies for the Vancouver/Richmond Board of Health.
- Schwarz, C.J. (1999). A review of "Regression analysis of the Albion Chum Test Fishery in relation to interior Fraser River steelhead escapements". Prepared for the Department of Fisheries and Oceans, 3 pp.
- Conser, R, Gararis, S., Murawski, S., Rose, G., Schwarz, C. J. (1999). Peer Review Of Some Analyses Of The Status Of Northern Cod Conducted By Dr. G. Winters. Prepared for the Department of Fisheries and Oceans, Ottawa in response to a disagreement between the DFO estimate and Dr. Winters estimate for the size of the northern cod stocks. 40 pp.
- Schwarz, C. J. (1999). Analysis of the 1998 Catch Monitoring Program in the South-coast and Fraser River regions. Prepared for the South Coast Salmon Stock Assessment Division, Department of Fisheries and Oceans. 28 pp.
- Franklin, A. B., Burnham, K.P., White, G.C, Anthony, R.J., Forsman, E.D, Schwarz, C.J., Nichols, J.D., and Hines, J.E. (1999). Range-wide status and trends in northern spotted owl populations. Prepared for Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Forest Service, 71pp.
- Schwarz, C.J. (1998). The effect of ploidy type, marking status, and year class upon subsequent survival of rainbow trout - update to include the 1997 field results. Prepared for the Alberta Ministry of Environment. 16 pp.
- Schwarz, C. J. (1998). Analysis of the 1997 Johnstone Strait Study experiment comparing selectivity between Multi-strand 60 mesh gill nets and Alaska twist 90 mesh gill nets. Prepared for the South Coast Salmon Stock Assessment Division, Department of Fisheries and Oceans. 30 pp.
- Schwarz, C.J. (1997). Proposed sampling design for monitoring a gill net fishery in Johnstone Strait and a proposed experimental design for comparing catch efficiencies of two types of net. Prepared for the South Coast Salmon Stock Assessment Division, Department of Fisheries and Oceans. 45 pp.
- Schwarz, C.J. (1997). The effect of ploidy type, marking status, and year class upon subsequent survival of rainbow trout. Prepared for the Alberta Ministry of Environment. 11 pp
- Schwarz, C.J. (1997). A Review of the Fish Lake rainbow trout capture-recapture study. Prepared for Triton Environmental Consulting, 30 pp. (Numerous drafts of the report were reviewed - page count is total of all reviews).
- Schwarz, C.J. (1996). Analysis of the 1995 Upper Fraser River Catch Monitoring Program of First Nations Fisheries. Prepared for DFO. 35 pp.
- Schwarz, C.J. (1996). Studies of uncontrolled events. Prepared for the B.C. Ministry of Forestries. 44p.
- Rajwani, K.N. and Schwarz, C.J. (1995). Density and Biomass estimates for five clam areas in squirrel cove. Prepared for the Klahoose Fisheries Program. 14 pp.

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Selected Publications and Research Interests

Frith, H.R., Nelson, T.C. and Schwarz, C.J. (1995). Comparison of rotary trap mark-recapture outmigration estimates with fence counts for coho and steelhead smolts in the Keogh River, 1995. Prepared for the Ministry of Environment, Lands, and Parks - Watershed Restoration Program by LGL Limited Environmental Research Associates. 34+50 pp.

Frith, H.R., Nelson, T.C. and Schwarz, C.J. (1995). Mark-recapture estimates of coho and steelhead smolt outmigration derived from rotary trap recaptures of marked fish for the Waukwass River in 1995. Prepared for the Ministry of Environment, Lands, and Parks - Watershed Restoration Program by LGL Limited Environmental Research Associates. 23+49 pp.

Schwarz, C.J. (1994). A review of the "Estimation of Vital Rates of the Northern Spotted Owl". Conducted for the United States Department of Agriculture Forestry Service. 10 pp.

Schwarz, C.J. (1994). Estimating waterfowl populations in the Manitoba NAWMP areas based upon data from the Waterfowl Breeding Population Survey. Produced for the Canadian Wildlife Service. 16 pp, plus about 2000 lines of SAS source code.

Schwarz, C.J. (1993). A mathematical model for the Brand Resighting Data on Sable Island. Report as part of contract FB 245-2-0400/01 OSC prepared for the Department of Fisheries and Oceans (Bedford Institute). 23 pp.

Schwarz, C.J. (1993). An analysis of the data collected for the Habitat Evaluation Survey of the Manitoba Forestry and Wildlife Project. Reports as part of contract MG.70.04.062/7024 prepared for the Manitoba Habitat Heritage Corporation. 96pp.

Schwarz, C.J. and Armstrong, L.M. (1993). A secondary analysis of the shrub data collected for the Habitat Evaluation Survey of the Manitoba Forestry and Wildlife Project. Report as part of contract MG.70.04.062/7024 prepared for the Manitoba Habitat Heritage Corporation. 28 pp.

Schwarz, C.J. and Yeung, A.S.K. (1993). An analysis of Random Number Generator 1 - Phase 1. Report produced for the Western Canada Lottery Foundation. 13 pp.

Schwarz, C.J. and Yeung, A.S.K. (1993). An examination of the pseudo-random number generator source code proposed for a lottery game. Report produced for the Western Canada Lottery Foundation. 5 pp.

Schwarz, C.J. (1992). Analysis of Sable Island Grey Seal Recovery Database. Report as part of contract FP 245-1-0580/01-OFC prepared for the Department of Fisheries and Oceans (Bedford Institute). 24 pp.

Schwarz, C.J. (1988) A comparative review of five books under consideration for the course 5.221. Prepared for Collier MacMillan Canada.

## Other Publications

Schwarz, C. J. (2009). JMP Supplement (Problems and Solutions) for the Basic Practice in Statistics, 5e. Contract with W.H. Freeman. 243 pp.

Wu, H., Schwarz, C. J., and Loughin, T. (2008). Statistical Inference for MIC Data. Prepared for British Columbia Ministry of Agriculture and Lands. Poster presented at the SSC Annual Meeting, Ottawa, Canada, May 2008.

Wu, H., Schwarz, C. J., and Loughin, T. (2008). Statistical Inference for MIC Data. Prepared for British Columbia Ministry of Agriculture and Lands. 2008-03-31. 82 pp.

Bonner, S. J. and Schwarz, C. J. (2007), Sampling plans and analysis strategies for environmental assessment of diamond mine impacts in northern Canada. Report for a MITACS internship from Bonner at ResCan Environmental Consulting. This internship was awarded the Award of Excellence (Natural Resources) from MITACS in the November 2007 awards ceremony.

Schwarz, C. J. and Bercovitz, I. J. (2006). JMP across the border to Canada. JMPer Cable. 2006 Fall Issue. 2 p.

Cowen, L., Walsh, S., and Schwarz, C. J. (2006). A migration model with tag loss. Prepared for the NAFO Science Meeting, June 2006.

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## Selected Publications and Research Interests

- Dupuis, J. A. and Schwarz, C. J. (2006). The stratified Jolly-Seber capture-recapture model: a Bayesian approach. Technical report available from: <http://www.lsp.ups-tlse.fr/Fp/Dupuis/rapportabundance.pdf>.
- Schwarz, C. J. and Arnason, A. N. (2006). Jolly-Seber models in MARK. Chapter 17 of a Gentle Introduction to MARK, Cooch, E.C. and White, G. (eds). 62 pp. The Gentle Introduction to Mark manual is THE documentation on using the MARK computer package for the analysis of capture-recapture data.
- Brethewitz, R., Drake, M. T., Jone, T., Reeves, K., Schwarz, C. J. (2006). 1937 Ceded Territory Fisheries Committee Meeting - Minnesota Department of Natural Resources Division of Fish and Wildlife Report. 203 pp.
- Hamm, J., Schwarz, C. J., and Williamson, I. (2004). Estimating the Rate of Concussions in British Columbia Minor Hockey Using Community Volunteer Collected Data. Poster at the Statistical Society of Canada 2004 Annual Meeting, June 2004, Montreal, Quebec.
- Sutherland, J. and Schwarz, C. J. (2003). Multi-list methods using incomplete lists in closed populations. Proceedings of the Survey Methods Section, SSC Annual Meeting, June 2003, Available on CD ROM.
- Bonner, S. J. and Schwarz, C. J. (2003). Poster entitled "Continuous time-dependent individual covariates and the Cormack-Jolly-Seber model".
- Schwarz, C. J. (2003). An Online System for Teaching the Design (and Analysis) of Experiments. 2003 Proceedings of the American Statistical Association, Statistical Education Section [CD-ROM], Alexandria, VA: American Statistical Association: 3732-3738.
- He, L., Zhang, W., and Schwarz, C. J. (2003). Poster entitled "An analysis of a fish farm impact survey". Prepared as part of the NSERC Undergraduate Student Research program.
- Cowen, L. L. and Schwarz, C. J. (2003). Poster entitled "Comparing survival estimates from a radio-tag mark-recapture study" presented at the Annual Meeting of the Statistical Society of Canada in June 2003.
- Schwarz, C. J. (2003). Review of *Estimating animal abundance: closed populations* by Borchers, D. L., Buckland, S. T. and Zucchini, W. Quarterly Review of Biology, 78, 243.
- Schwarz, C.J. (2002) Rare events may not be rare after all. PI in the sky - student magazine from PIMS. Sept 2002 issue.
- Paltiel, C., Nikleva, D., Morrell, M., and Schwarz, C. J. (2002). Poster entitled "An analysis of the 1994-1996 northern Strait of Georgia Oyster Survey" summarizing his M.Sc. thesis.
- Cowen, L. L. and Schwarz, C. J. (2001). Poster entitled "Adjusting radio-telemetry detection data for premature tag-failure" presented at the Annual Meeting of the Statistical Society of Canada in June 2001.
- Schwarz, C. J. (2001). How to ask sensitive questions - the randomized response survey. PI in the sky, June 2001, 15-16.
- McPherson, R. and Schwarz, C.J. (2001). Poster entitled "Estimation of the number of nests initiated by mallard ducks (*Anas platyrhynchos*)". Part of undergraduate summer NSERC research project.
- Schwarz, C.J., and Arnason, A.N. (2000). Poster entitled "Estimation of age-specific breeding probabilities from capture-recapture data using the Jolly-Seber method". Presented at EURING 2000 at the Point Reyes Bird Observatory, October 2000.
- Schwarz, C.J. (2000). Poster entitled "Use of the Jolly-Seber model to estimate lambda (population growth) and related parameters". Presented at EURING 2000 at the Point Reyes Bird Observatory, October 2000.
- Schwarz, C. J. (2000). Poster entitled "The Siren call of the Schaefer Estimator in Fisheries Management." presented at the Annual Meeting of the Statistical Society of Canada in Ottawa.
- Babineau, D. and Schwarz, C.J. (2000). Poster entitled "Estimating the population size of Razor Clams using a mode assisted sampling design and analysis". Presented at the Annual Meeting of the SSC in Ottawa in June 2000.
- Manske, M. and Schwarz, C.J. (1999). Poster entitled "Estimating stream residence times for salmon" summarizing her paper submitted to the Canadian Journal of Fisheries and Aquatic Sciences.

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## **Selected Publications and Research Interests**

Paltiel, C. and Schwarz, C.J. (1999). Poster entitled "Anatomy of a bad graph" illustrating how a graph that appeared in the Vancouver Sun was misleading.

Manske, M., Schwarz, C.J., and Stobo, W. (1999). Poster entitled "Estimation of birthing rates for Grey Seals." summarizing her paper submitted to Canadian Journal of Fisheries and Aquatic Sciences.

Taylor, C. G. and Schwarz, C. J. (1999). A review of the BC Vegetation Resources Inventory sampling design and proposed estimator. Technical report, Department of Statistics and Actuarial Science, Simon Fraser University.

Arnason, A.N., Schwarz, C.J., and Boyer, G. (1998). POPAN-5: A data maintenance and analysis for mark-recapture data. Scientific Report, Department of Computer Science, University of Manitoba, Winnipeg, viii+318p.

Johnston, R.S. and Schwarz, C.J. (1998). A general, unified method to model the effects of restrictions on randomization. Technical Report, Department of Statistics and Actuarial Science, Simon Fraser University.

Macleod, C., Paltiel, C., and Schwarz, C.J. (1998). Results of a survey of textbook prices at the SFU Bookstore vs. Amazon.com. Prepared for the bookstore. 6p.

Sutherland, J. and Schwarz, C.J. (1996). Estimating the number of fish that return to spawn using capture-recapture method. *Vector*, 37, 55-58.

[*Vector* is the magazine for BC High School Math Teachers.]

Arnason, A.N., Schwarz, C.J. and Boyer, G. (1995) POPAN-4: A data maintenance and analysis system for mark-recapture data. Scientific Report, Department of Computer Science, University of Manitoba, Winnipeg. viii+267 pp.

Schwarz, C.J., Jones, R., Lee, L., Nguyen, M. (1995). Estimating the number of clams in an intertidal zone using a three-stage sampling technique. Report 95-001. Statistical Consulting Service, Department of Mathematics and Statistics, SFU. 30 pp.

Schwarz, C.J., Bailey, R.J. and Irvine, J., Dalziel, F.C. (1993). Estimating salmon escapement using capture-recapture methods. Pages 70-83 in L. Berg and P.W. Delaney, editors. *Proceedings of the Coho Workshop*, Nanaimo, B.C. May 26-28, 1992.

Choudhury, S. and Schwarz, C.J. (1991). A simple example of a boot-strap in testing a rank-correlation with measurements subject to error. *The Statistical Consultant*, 8(2):11-12.

Schwarz, C.J. (1989) Sampling Grade 6 and 9 Students in French Immersion to assess language competencies. Statistical Advisory Service, University of Manitoba, Technical Report dated 22 March 1989. 20 pp.

Sloan, J.A., Schwarz, C.J., and Neden, L.R. (1989). Silver Maple Tree Growth Regulators Dataset. A submission for Case Studies in Data Analysis for the 1988 Annual Meeting of the Statistical Society of Canada. Department of Statistics, Technical Report 194. 17pp.

Schwarz, C.J., Sloan, J.A., and Neden, L.R. (1989). Multiple Sclerosis Dataset. A submission for Case Studies in Data Analysis for the 1988 Annual Meeting of the Statistical Society of Canada. Department of Statistics, Technical Report 195, 41 pp.

Schwarz, C.J. (1989). The effects of incubation temperature and moisture on the survival of snapping turtle embryos. A submission for Case Studies in Data Analysis for the 1989 Annual Meeting of the Statistical Society of Canada. Department of Statistics, Technical Report 196. 25 pp.

Schwarz, C.J. (1989). Analysis of microbial counts reported by three different assays and two laboratories. A report prepared for the Inspection Services Branch, Department of Fisheries and Oceans. Statistical Advisory Service, Department of Statistics, University of Manitoba. Technical Report dated 26 October 1989. 14 pp.

Balshaw, R. Brewster, J., Neden, L., Schwarz, C.J. (1988). Statistical Analysis of Moose Survey Results; Wood Buffalo National Park; 1987-1988. Statistical Advisory Service, University of Manitoba, Technical Report 3, ii+21 pp.

Schwarz, C.J. (1988) Post-stratification in band-recovery and capture-recapture Models. Ph.D. Thesis, University of Manitoba.

# **Dr. Carl Schwarz**

**Dept of Statistics and Actuarial Science**

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## **Selected Publications and Research Interests**

- Arnason, A.N., and Schwarz, C.J. (1987). POPAN-3: extended analysis and testing features for POPAN-2. Charles Babbage Research Centre, St. Pierre, Manitoba. ii+83 pp.
- Samanta, M. and Schwarz, C.J. (1986). On testing of the equality of  $k$  exponential distributions. Department of Statistics Technical Report 157, University of Manitoba.
- Neden, L.R. and Schwarz, C.J. (1986). Development of the PAYQUAL system at Manitoba Hydro. Statistical Advisory Service, University of Manitoba, Technical Report 1. ii+30pp.
- Schwarz, C.J. and Sloan, J.A. (1985). Using the IBM Quietwriter 7with WP on the IBM PC. Department of Statistics Technical Report 159, University of Manitoba.
- Sloan, J.A. and Schwarz, C.J. (1985). Using PC-Tal III with the AMDAHL. Department of Statistics Technical Report 158, University of Manitoba.
- Schwarz, C.J. (1984). Modified Dollar-Unit Sampling user manual. Ontario Hydro Research Report 83-541-K.
- Schwarz, C.J. (1984). A linear programming solution to minimizing the work required to reposition the Bruce NGS garter springs. Ontario Hydro Research Report 84-231-H (confidential Series).
- Schwarz, C.J. (1983). A statistical examination of the effect of weld parameters upon weld quality. Ontario Hydro Research Report 83-128-K.
- Schwarz, C.J. (1983). Validation of the 1981 Acid Rain Data-base. Ontario Hydro Research Report 83-192-K.
- Schwarz, C.J. (1983). Single and double sampling plans for project material certification in the Generation Projects Division. Ontario Hydro Research Report 83-308-K.
- Schwarz, C.J. (1983). Estimating the number of latent defects in pressure tube joints of Bruce Unit-2. Ontario Hydro Research Report 83-319-K.
- Schwarz, C.J. (1982) Evaluation of herbicides for vegetation control along Hydro right-of-ways. Ontario Hydro Research Report 81-49-K.
- Schwarz, C.J. (1982). A statistical procedure for multiple comparisons of time-of-use period designs. Ontario Hydro Research Report 82-54-K.
- Schwarz, C.J. (1982). Estimating tritium oxidation in soils at the Bruce Nuclear Power Development, Ontario Hydro Research Report 82-50-K.
- Schwarz, C.J. (1982). Effect of temperature elevation and entertainment on heterotrophic assimilation of glutamate. Ontario Hydro Research Report 82-278-K.
- Schwarz, C.J. (1982). Examination of the customer sample in the Time-of-Use experiment for sampling biases. Ontario Hydro Research Report 82-300-K.
- Schwarz, C.J. (1982). Using the Fracture Appearance Transition Temperature (FATT) in assessing turbine disc lifetimes. Ontario Hydro Research Report 82-414-K.
- Arnason, A.N., Schwarz, C.J., and Meszaros, G.M. (1981). FISHDAMS User Manual: A database management system and growth simulator for optimal management planning of a commercial-type fish rearing facility. iii+72 pp.

## Works Accepted for Publication / Production / or Presentation

### Refereed Publications

Cowen, L., Walsh, S., Schwarz, C. J., Cadigan, N., and Morgan, J. (2009). Estimating exploitation rates of a migrating population of yellowtail flounders using multi-state mark-recapture methods incorporating tag-loss and variable reporting rates. Accepted by the Canadian Journal of Fisheries and Aquatic Sciences. 2009-03-03.

### Refereed Letters and Other Publications

Schwarz, C. J. (2009). Review of "ZUUR, A. F., IENO, E. N., WALKER, N. J., SAVELIEV, A. A., and SMITH, G. M. Mixed Effects Models and Extensions in Ecology with R. Springer, New York, 2009. xxii+574 pp. ISBN: 9780387874579." Biometrics xx:xxx-xxx.

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## Works In Progress

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## Works Submitted for Publication

### Refereed Publications

Chavarie, L., Dempson, J.B., Schwarz, C.J., Reist, J.D., Power, G., and Power, M. (2009). Latitudinal variation in growth among Arctic charr in eastern North America: evidence for countergradient variation? Submitted to Hydrobiologia, 2009-06-11.

Lettink, M., Norbury, G., Cree, A., Seddon, P.J., Duncan, R., and Schwarz, C. J. (2008). Removal of introduced predators, but not artificial refuge supplementation, increases skink (*Oligosoma maccanni*) survival in coastal duneland, New Zealand. Submitted to Journal of Animal Ecology.

Lavers, J. L., Schwarz, C. J., Pradel, R., Jones, I. L. (2008). Adjusting estimated apparent survival rates for biases caused by tag-read errors in capture-recapture studies. Submitted to The Condor, 2008-06-20.

Wu, H., Schwarz, C. J., and de With, N. (2008). The analysis of minimum inhibitory concentration (MIC) data for anti-microbial agents from complex experiments. Submitted to Journal of Applied Statistics, 2008-04-02.

Schwarz, C. J. (2003). An online system for teaching the design (and analysis) of experiments. Journal of Statistical Education, \*, \*\*\*,\*\*\*.

Schwarz, C. J., Arnason, A. N., and Kirby, C. W. (2002). The Siren Song of the Schaefer Estimator - no better than a pooled Petersen. Submitted to the Canadian Journal of Fisheries and Aquatic Science 22 May 2002.

## Significant Contributions to your Field

- 2008 Muthukumarana, S., Schwarz, C. J., and Swartz, T. B. (2008). Bayesian analysis of mark-recapture data with travel-time-dependent survival probabilities. *Canadian Journal of Statistics*, 36, 5-28.  
A key assumption of Cormack-Jolly-Seber models applied to spatial movement models is that survival rates are independent of the length of time spent in segments of the path. This model relaxes this assumption and allows survival to depend on travel times. The interesting feature is that some travel times are not observed (e.g. if an animal is not detected at a check-point) and so the survival rate depends on a latent variable. Bayesian methods are a natural way to deal with this type of data.
- 2007 Dupuis, J.A. and Schwarz, C.J. (2007). A bayesian approach to the multi-state Jolly-Seber capture-recapture model. *Biometrics* 63, 1015-1022. DOI: 10.1111/j.1541-0420.2007.00815.x.  
A key assumption of the Jolly-Seber model is that all animals have the same probability of capture, survival, and recruitment rates are same for all segments of the population. A common way to deal with violations of this assumption is via stratification or multi-state models. In this paper, we developed an extension of the stratified-Petersen model and the multi-state Cormack-Jolly-Seber models to the Jolly-Seber model where abundance is a primary concern.
- 2005 Bonner, S. J. and Schwarz, C. J. (2004). Continuous time-dependent individual covariates and the Cormack-Jolly-Seber Model. *Animal Biodiversity and Conservation* 27, 149-155. Bonner, S. J. and Schwarz, C. J. (2005). An Extension of the Cormack-Jolly-Seber model for continuous covariates with application to *Microtus pennsylvanicus*. *Biometrics* 62, 142-149. DOI: 10.1111/j.1541-0420.2005.00399.x  
It is well known that survival rates and capture probabilities often depend upon attributes of animals such a body mass. However, unless an animal is captured, its body mass is unknown. In these papers, we developed the first solution to a very difficult problem – how to model the effect of individual time-varying covariates (such a body mass) upon subsequent survival when such covariates cannot be measured at all occasions. These models are very important to understanding the role of such individual based covariates upon survival processes which is a fundamental tenet of biology. These papers can be viewed as an alternative to extremely fine stratification, e.g. rather than classifying animals by body mass into small, medium or large, the actual body mass is used.
- 2005 Cowen, L. L. and Schwarz, C. J. (2005). Capture-recapture studies using radio telemetry with premature radio-tag failure. *Biometrics* 61, 657-664. Cowen, L. L. and Schwarz, C. J. (2005). The Jolly-Seber model with tag loss. *Biometrics* 62, 699-705.  
It is well known that tag loss causes bias in estimates of survival and abundance. These papers look at methods for adjusting mark-recapture methods for tag loss. In the first paper, premature failure of radio tags was accounted for by using information on the failure times of a batch of radios kept aside. In the second paper, a general methodology to use information from double-tagged fish to estimate tag loss and adjust abundance estimates was developed.
- 2004 Sutherland, J. and Schwarz, C. J. (2004). Multi-List Methods Using Incomplete Lists in Closed Populations. *Biometrics* 61, 134-140.  
A key assumption of capture-recapture multi-list studies is that all animals have the same probability of capture on each list. If this assumption is false, then severe biases can be introduced into estimates. It is well known that stratification can improve the estimates by removing sources of heterogeneity in catchability. However, what if a complete stratification is impossible – for example in a multi-list study of human populations, you may decided to stratify by age. But what happens if not all lists cover all age strata, e.g. some lists may not collect information on members over age 65. In this paper, we develop methodology to deal with such incomplete stratification.

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## Selected Publications and Research Interests

- 2003 McPherson, R. J., Arnold, T. W., Armstrong, L. M., and Schwarz, C. J. (2003). Estimation of the nest survival rate and the number of nests initiated per breeding pair. *Journal of Wildlife Management* 67, 843-851. It is relatively easy to measure nest survival rates once nests are located. However, in order to estimate the total productivity of a waterfowl population, it is also necessary to estimate how nests are initiated per breeding pair to adjust for nests initiated but failed (e.g. due to predation). In this paper, we applied a variation of a capture-recapture model to estimate the total number of nest initiations per breeding pair so that total productivity could be estimated.
- 2002 Manske, M., Stobo, W.T. and Schwarz, C.J. (2002). Estimation of age-specific probabilities of first return to the breeding colony and annual survival rates for the male Grey Seal (*Halichoerus grypus*) on Sable Island from capture-recapture data. *Marine Mammal Science* 18, 145-155. Schwarz, C. J. and Arnason, A. N. (2000). The estimation of age-specific breeding probabilities from capture-recapture data. *Biometrics* 56, 59-64. Many animal species have a staggered start to breeding, i.e. not every animal starts to breed at the same age. In this paper, we show how to use capture-recapture methods to estimate the distribution of ages of first breeding in a grey-seal population. While using a specific species as an example, the methodology is applicable to any species that can be tagged while young and have a staggered breeding start.
- 2001 Schwarz, C. J. (2001). The Jolly-Seber model: more than just abundance. *Journal of Agricultural, Biological, and Environmental Statistics* 6, 195-205. This paper shows how the standard Jolly-Seber method for estimating animal abundance can be used in a variety of other settings such as (1) estimation of age-specific breeding proportions (2) estimation of the pattern of recruitment (3) estimation of population growth.
- 2000 Schwarz, C. J. and Arnason, A. N. (2000). The estimation of age-specific breeding probabilities from capture-recapture data. *Biometrics* 56, 59-64. Schwarz, C. J. and Stobo, W. T. (2000). The estimation of age-specific pupping probabilities for the grey seal (*Halichoerus grypus*) on Sable Island from capture-recapture data. *Canadian Journal of Fisheries and Aquatic Sciences*, 57, 247-253. These papers develop a method to estimate age-specific breeding probabilities (the probability that an animal will breed for the first time at a given age) from capture-recapture data using the Jolly-Seber method. This is an advance over previous methods in that the parameter of interest can be estimated directly (rather than being a function of other parameters not of interest in previous models) which allows direct model fitting and selection to be done in a much more straight forward fashion.
- 1999 Schwarz, C. J. and Seber, G. A. F. (1999). A review of estimating animal abundance III. *Statistical Science*, 14, 427-456. In this review, we examined the advances in capture-recapture methodology for the last 10 years and outlined new research areas.
- 1998 Schwarz, C.J. and Taylor, C.G. (1998). The use of the stratified-Petersen estimator in fisheries management: estimating the number of pink salmon (*Oncorhynchus gorbuscha*) that spawn in the Fraser River. *Canadian Journal of Fisheries and Aquatic Sciences*, 55, 281-297. In this paper, we wrote an extensive "how to" guide on using the Stratified-Petersen estimator in population estimation. Prior to this publication, there was little practical experience with this estimator and no readily accessible publication exploring the many issues in applying this estimator correctly.
- 1997 Schwarz, C.J. and Stobo, W.T. (1997) Estimating temporary migration using the robust design. *Biometrics* 53: 253-269. In this paper, we generalized one of the results of Kendall, Pollock, and Brownie (1995, *Biometrics*, 51:293-308) and showed that the robust design could be used to estimate the temporary migration rate. This has been applied to the Grey Seal colony on Sable Island which is undergoing a population explosion. Detailed information on the life history of this animal is needed in order to manage its impact on nearby fish populations.

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Selected Publications and Research Interests

- 1997 Schwarz, C.J. and Sutherland, J. (1997). An on-line workshop using a simple capture-recapture experiment to illustrate the concepts of a sampling distribution. *Journal of Statistical Education*, 5(1) - an online journal -  
, C.J. (1997) StatVillage: An online, WWW-accessible, hypothetical city based on real data for use in an introductory class in survey sampling. *Journal of Statistical Education*, 5(20) - an online journal -  
In these paper, we created two web-based instruction modules for an introductory statistics class. The latter has been used when I teach Stat-301, while the former has been used in workshops for biologists that teach capture-recapture methods.
- 1996 Schwarz, C.J. and Arnason, A. N. (1996). A general methodology for the analysis of capture-recapture experiments in open populations. *Biometrics* 52, 860-873  
In this paper, we generalized the Jolly-Seber model to allow for arbitrary constraints to be placed on the estimates, to allow for covariates when estimating abundance, and to allow for multiple groups where parameters can vary across time and across groups. This generalization permits sequential model fitting within a comprehensive model framework much like that available for survival models. The results have been fully implemented in a comprehensive computer-software (POPAN; Arnason, Schwarz, and Boyer, 1995). For the first time, biologists can now fit biologically interesting models to capture-recapture data.
- 1995 Schwarz, C.J. and Ganter, B. (1995). Estimating the movement among staging areas of the Barnacle Goose (*Branta leucopsis*). *Journal of Applied Statistics* 22:711-724.
- Schwarz, C.J., Schweigert, J., and Arnason, A.N. (1993). Using tag-recovery data to estimate migration rates. *Biometrics* 49:177-194.  
In these two papers, we developed the methodology to estimate movement rates for capture-recapture models. This series of models is now referred to as the Arnason-Schwarz formulation and is the basis of most modelling efforts in the capture-recapture literature that focus on estimating movement rates.
- 1994 Schwarz, C.J., and Dempson, B. D. (1994). Mark-recapture estimation of a salmon smolt population. *Biometrics* 50: 98-108.  
In this paper, a method for estimating the size of smolts leaving a river based on a temporal stratification was developed. This method is now the standard for smolt estimation in Newfoundland, and has been used extensively on the West Coast in coho streams (Frith, Nelson, and Schwarz (1995) Comparison of rotary trap mark-recapture outmigration estimates with fence counts for coho and steelhead smolts in the Keogh River, 1995. Prepared for the Ministry of Environment, Lands, and Parks - Watershed Restoration Program by LGL Limited Environmental Research Associates. 34+50 pp.; Frith, Nelson, and Schwarz (1995). Mark-recapture estimates of coho and steelhead smolt outmigration derived from rotary trap recaptures of marked fish for the Waukwass River in 1995. Prepared for the Ministry of Environment, Lands, and Parks -Watershed Restoration Program by LGL Limited Environmental Research Associates. 23+49 pp.).

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## Conferences, Workshops and Presentations

### Invited Talk

- July 2009                      Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Schwarz, C. J. (2009). Discussant of "Misspecifying a random effects distribution: Why getting it wrong probability doesn't matter.
- March 2009                      Resource and Environmental Management Graduate Student Colloquium. Schwarz, C. J. (2009). Bayesian analysis of mark-recapture data with travel- and spatial-dependent survival probabilities.

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## Selected Publications and Research Interests

- July 2008 International Statistical Ecology Conference, St.Andrews, Scotland, 9-11 July 2008. Schwarz, C. J. (2008). Designed experiments in capture-recapture studies.
- July 2008 Canadian Integrated Program for Antimicrobial Resistance (CIPARS) meeting July 2008, Guelph, Ontario. We were invited to the CIPARS meeting after CIPARS received the M.Sc. thesis of Wu. Wu. H. and Schwarz, C. J. (2008). The analysis of Minimum Inhibitor Concentration (MIC) data from CIPARS.
- July 2008 International Biometrics Conference, Dublin, Ireland, 13-18 July 2008. Sutherland, J. M. and Schwarz, C. J. (2008). Multi-List Methods Using Incomplete Lists in Closed Populations.
- June 2008 The International Environmetrics Conference, Kelowna, BC. 8-13 June, 2008. Schwarz, C. J. (2008). The analysis of designed experiments in capture-recapture studies.
- June 2008 B.C. Centre for Disease Control. Schwarz, C. J. (2008). Multi-list methods: methodological problems and advances.
- September 2007 Pacific Salmon Commission Workshop on Genetic Stock Identification and its used for Pacific salmon management. 11-13 September 2007. Vancouver, B.C. Schwarz, C. J. (2007). The use of small area estimation with Genetic Stock Identification.
- March 2007 Institut Fédératif de Recherche, Faqulte des Medecine, Toulouse, France. 23 March 2007. Schwarz, C. J. (2007). Estimating population sizes using multi-list methods.
- March 2007 Centre d'Ecologie Fonctionnelle et Evolutive, Montpellier, France 28 March 2007. Schwarz, C. J. and Muthukumarana, S. (2007). Estimation of travel times and related parameters using capture-recapture methods.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Schwarz, C. J. (2007). Formal experimental design and capture-recapture studies.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Schwarz, C. J. (2007). Migration and movement - the next stage.
- December 2006 A Taste of Pi. Schwarz, C. J. (2006). One fish, two fish, ... How to estimate the size of animal and human populations using mark-recapture methods.
- June 2006 PRIMES workshop on Bayesian methods in Ecology. Schwarz, C. J. and Dupuis, J. A. (2006). A Bayesian approach to the Stratfied Jolly-Seber Model.
- May 2006 Capture 2006 - A conference on capture-recapture methods. Universite Laval, Quebec City, 2006-05-01. Schwarz, C. J. and Dupuis, J. A. (2006). The Stratfied Jolly-Seber Model.
- May 2006 Capture 2006 - A conference on capture-recapture methods. Universite Laval, Quebec City, 2006-05-01. Schwarz, C. J. (2006). Multi-state capture-recapture models. Past, present, and future.
- April 2006 Western Enviro-Agricultural Laboratory Association. Edmonton, Alberta, 2006-04-19. Schwarz, C. J. (2006). Statistical Considerations for Designing Monitoring Studies.
- March 2006 Science Subcommittee of the Wood Buffalo Environmental Association. Calgary, AB. 2006-03-01. Schwarz, C. J. (2006). Statistical Considerations for Designing Monitoring Studies.
- January 2006 UBC/SFU Graduate Student Workshop. 2006-01-16. Vancouver, BC. Schwarz, C. J. (2006). A (very) short tour of mark-recapture.
- June 2005 Statistical Society of Canada, Annual Meeting in Saskatoon, 12-15 June 2005. Schwarz, C. J. (2005). An on-line system for the design (and analysis) of experiments.
- May 2005 UBC/SFU Graduate Student Workshop. 13 May 2005. Vancouver, BC. Schwarz, C. J. (2005). A directed random walk from graduate student to faculty member.

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## Selected Publications and Research Interests

- February 2005 Environmental Quality Biologists Workshop. Putting monitoring information into action. 9-10 February 2005. Vancouver, BC. Schwarz, C. J. (2005). Highly variable data and other data challenges in water quality measurements.
- November 2004 Queensland and New Zealand Industrial and Applied Mathematics Conference, 27-28 November 2004, Townsville, Australia. Schwarz, C. J. (2004). A tour of mark-recapture.
- July 2004 International Biometrics Society, Cairns, Australia, 10-17 July 2004. Invited Discussant for session on New Developments in Wildlife Population Assessment.
- June 2004 Statistical Society of Canada 2004 Annual Meeting, 31 May- 3 June 2004, Montreal, Quebec. Schwarz, C. J. (2004). Stratification in Capture-recapture Modeling,
- March 2004 PRIMES (PRogram for Interdisciplinary Mathematics, Ecology, and Statistics) at Colorado State University, Fort Collins, CO. 11-12 March 2004. Schwarz, C. J. (2004). Estimating Abundance - harder than you think.
- March 2004 PRIMES (PRogram for Interdisciplinary Mathematics, Ecology, and Statistics) at Colorado State University, Fort Collins, CO. 11-12 March 2004. Schwarz, C. J. (2004). The use of stratification in capture-recapture studies.
- November 2002 Institut National de la Recherche Agronomique (IRNRA), Toulouse, France. Schwarz, C. J. (2002). The Multi-state model in capture-recapture studies.
- August 2001 The Application of Ecological Research to Conservation: East meets West. A conference in honor of the retirement of Dr. Fred Cooke, Chair of Wildlife Ecology, Simon Fraser University. Schwarz, C. J. (2001). Mark recapture-methodology - present and future.
- June 2001 2001 Annual Meeting of the Statistical Society of Canada in June, 2001 held at SFU. Assessing fish populations with capture-recapture: a tour of the "simple" Petersen and related methods.
- October 2000 EURING 2000. Real and quasi-experiments in capture-recapture studies.
- October 2000 EURING 2000. Capture-recapture. Where we've come from and where are we going? Summary address of EURING 2000.
- August 2000 American Statistical Association 2000 Annual Meeting, Indianapolis, Indiana. Journal of Statistics Education Invited Paper. Interactive Web Pages - Applets for the Teacher, Perls of Wisdom, or a Cup of Java?
- December 1999 Statistics in Ecology and Environmental Monitoring (SEEM3) in honor of George Seber held in Dunedin, New Zealand in December 1999. The Jolly-Seber model: more than just abundance.
- August 1999 Annual Meeting of the American Statistical Association, Section on Statistical Education, held in Baltimore, August 1999. STAT-VILLAGE: An on-line virtual village using real life census micro-data.
- June 1999 WNAR Region Meeting of the International Biometric Society in Seattle, 27-30 June 1999. The Stratified-Petersen estimator with a known number of unread tags.
- June 1998 Invited talk to the Institute of Statistics and Operations Research at Victoria University, Wellington, New Zealand. Recent Advances in Capture-Recapture Research.
- June 1998 14th Australian Statistical Conference, Brisbane, Australia. Estimating temporary migration using the robust design.
- April 1998 A celebration in honor of George Seber on his retirement held at the Department of Statistics, University of Auckland. The Estimation of Animal Abundance - a selected review of the contributions of G. A. F. Seber.
- December 1997 Australasia Biometrics Regional Meeting, Adelaide, Australia. The effect of and estimating tag-misread rates.

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## Selected Publications and Research Interests

- November 1997 Department of Statistics, Massey University, New Zealand. Recent advances in capture-recapture modelling.
- October 1997 Landcare Research, Christchurch, New Zealand. Recent advances in capture-recapture modelling.
- April 1997 EURING'97. Held in University of East Anglia in Norfolk, England. Arnason, A.N., and Schwarz, C.J. (1997). Using POPAN-5 to analyze banding data.
- January 1997 International Arena of Science, Simon Fraser University. The Earth is Flat ( $p > 0.05$ ): Just what can Statistics tell us?
- October 1995 B.C. Association of Mathematics Teachers meeting on 20 October 1995 at Burnaby South Secondary School, Burnaby, B.C. The case of the missing salmon - how to count fish with high school students.
- March 1995 North Pacific Symposium on Invertebrate Stock Assessment and Management, Nanaimo. Schwarz, C.J., Jones, R.R., and Lee, L. Intertidal population estimate of razor clams (*Siliqua patula*) at North Beach, Haida Gwaii/Queen Charlotte Islands and applications to fishery management.
- February 1995 SFU/UBC/UVic Mathematics and Statistics meeting, SFU, Burnaby, B.C. One fish, two fish...How to count salmon.
- November 1994 Pacific Northwest Statistics Meeting, Simon Fraser University. One fish, two fish: how to count fish.
- September 1994 EURING'94 Patuxent Wildlife Research Centre, Laurel MD. Schwarz C.J. and Ganter, B. (1994). Estimating movement among staging areas of the Barnacle Goose.
- September 1994 EURING'94 Patuxent Wildlife Research Centre, Laurel MD. Arnason, A.N., and Schwarz, C.J. (1994). POPAN-4: Enhancements to a system for the analysis of mark-recapture data from open populations.
- August 1994 Environmetrics, Burlington, Ontario. Assessing forest industry composition from aerial surveys.
- August 1994 American Statistical Association Annual Meeting, Toronto, Ontario. A generalized unified theory for the analysis of capture-recapture experiments.
- August 1994 American Statistical Association Annual Meeting held in Toronto. Arnason, A.N., Kirby, C. and Schwarz, C.J. (1994). Stratified estimators of abundance.
- June 1994 Pacific Northwest SAS User's Group held in Vancouver (17 June 1994). Glum about GLM; try marvelous Mixed.
- May 1994 Salmon Escapement Workshop of the Department of Fisheries and Oceans in Sidney, B.C. Statistical prerequisites for valid mark-recapture estimates of escapement.
- May 1992 Coho workshop of the Association of Professional Biologists and the North Pacific Chapter of the American Fisheries Society, Nanaimo. Estimation salmon escapement using capture-recapture estimates of escapement.
- April 1992 EURING 92, Montpellier, France. Estimation of migration patterns, intensity, or direction using ring recoveries.
- January 1992 Canadian Conference for Fisheries Research, Halifax. Estimation of fish migration patterns.
- June 1991 Annual Meeting of the Statistical Society of Canada, Toronto. Estimation of the super-population size in open populations using capture-recapture methods.

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**Selected Publications and Research Interests**

**Workshop Leader**

- January 2006 Minnesota Department of Natural Resources. Held in Minneapolis, MN. 23-25 January 2006. Schwarz, C. J (2005). An introduction to mark-recapture methods used in fisheries management.
- January 2005 American Fisheries Society Regional Meeting, Duluth, Minnesota. 30 participants. One day workshop on 17 January 2005. Schwarz, C. J. (2005). An introduction to the use of mark-recapture methods in fisheries management.
- January 2004 Analysis of Demographic Rates of Northern Spotted Owls. Held at Oregon State University, 4-11 January 2004. Leader for the analysis of the fecundity data. Reviewer of final report.
- October 2000 EURING 2000. Schwarz, C.J. and Arnason, A.N. (2000). Estimation of recruitment and population growth rates using the Jolly-Seber model.
- October 2000 EURING 2000. Arnason, A.N. and Schwarz, C.J. (2000). An introduction to POPAN for the analysis of capture-recapture data.
- February 2000 Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo. Review of the Georgia Strait Creel Survey and related creel surveys.
- February 2000 Klahoose First Nation Wild Oyster Stock Assessment and Monitoring Project, Cortes Island. Sampling designs in the Wild Oyster Stock Assessment and Monitoring Project.
- June 1999 Annual Meeting of the Statistical Society of Canada, Regina Saskatchewan, 6 June 1999. Hines, J., Nichols, J. and Schwarz, C. J. (1999). Estimation of Animal Abundance and rates of survival, reproduction, and movement.
- May 1999 Statistical Association of Manitoba Annual Meeting. Schwarz, C. J. (1999). Missing data in designed experiments. Held at the Annual Meeting of Statistical Association of Manitoba, Winnipeg, Manitoba. 28 May 1999.
- March 1999 Department of Fisheries and Oceans, Newfoundland. Schwarz, C. J. and Arnason, A. N. (1999). Mark-recapture methods in fisheries management with applications to Newfoundland. Held at Department of Fisheries and Oceans, Newfoundland, on 23-28 March 1999.
- January 1999 Pacific Biological Station, Nanaimo, BC. Schwarz, C. J. and Dauk, P. C. (1999). "Recent advances in capture-recapture modelling" held at the Pacific Biological Station (Nanaimo) on 21-22 January 1999.
- December 1998 Analysis of Demographic Rates of Northern Spotted Owls. Held at Oregon State University, 7-16 December 1998. Leader for the analysis of the fecundity data. of final report.
- April 1997 Exploring co-operative management in Fisheries. Held at SFU Harbour Center. Dealing with data: ownership, confidence, and incorporating local knowledge.
- January 1996 North Vancouver School Board. Teaching statistics in grades K-7.
- May 1995 DFO/First Nations/PUHA Working Group, Prince Rupert, B.C. Counting sea-urchins.
- August 1994 "High Performance Fish," American Fish Physiology Association, Vancouver. Advanced Experimental Design.
- June 1993 Department of Fisheries and Oceans, Nanaimo. Schwarz, C.J. and Arnason, A.N. Use of capture-recapture methods in salmon escapement estimation.
- June 1992 Department of Fisheries and Oceans, Nanaimo. Schwarz, C.J. and Arnason, A.N. Use of capture-recapture methods in salmon escapement estimation.
- June 1990 Annual Meeting of the Statistical Society of Canada, St. John's. Arnason, A.N., and Schwarz, C.J. Use of capture-recapture and band-recovery methods.

# Dr. Carl Schwarz

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Selected Publications and Research Interests

## Presentation

- June 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Bonner, S. and Schwarz, C. J. (2009). Capture-recapture, Jolly-Seber, and the Horvitz-Thompson Estimator: ML Estimates of Abundance for populations with variable capture probabilities.
- June 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Challenger, W. and Schwarz, C. J. (2009). Occupancy modelling with multiple states and multiple seasons. Challenger won a student paper award for his paper and presentation.
- June 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Huston, C. and Schwarz, C. J. (2009). Spatial CAR models and compositional data. Huston won a student paper award for her paper and presentation.
- April 2009 Graduate student seminar series. Dean, C.D., Lockhart, R.A., Schwarz, C. J. (2009). "Peer-Reviewed Publishing: the writing, submission and review process". Presentation to graduate students. 2009-04-17.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Wu, H., Schwarz, C. J., and de With, N. (2008). Linear Models for Minimum Inhibitory Concentration (MIC) Data on Anti-microbial Resistance. Prepared and presented by Schwarz based on M.Sc. thesis by Wu.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Challenger, W. and Schwarz, C. J. (2008). Mark-recapture Jolly-Seber Abundance estimation with classification uncertainty. Poster.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Huston, C. and Schwarz, C. J. (2008). Interpretation of Acoustic Tag Signals of Transplanted Black Rockfish. Poster.
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland. 9-11 July 2008. Challenger, W. and Schwarz, C. J. (2008). Optimal designs for the multinomial mixture model: aanalysis. This presentation won a Student Best Presentation Award at the conference.
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland. 9-11 July 2008. Huston, C. and Schwarz, C. J. (2008). Estimating stock proportions in Fraser River salmon runs using a multivariate CAR model.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Cowen, L. and Schwarz, C. J. (2008). Estimating Exploitation Rates of a Migrating Population of Yellowtail Flounders using Multi-state Mark-recapture Methods incorporating Tag Loss and Variable Reporting Rates. Poster.
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland, 9-11 July 2008. Cowen, L. C. and Schwarz, C. J. Estimating exploitation rates using multi-state mark-recapture methods incorporating tag loss.
- May 2008 Institut Mediterrani d'Estudis Avançats (IMEDEA), Mallorca, Spain. Schwarz, C. J. (2008). The analysis of designed experiments in capture-recapture studies.
- May 2008 Statistical Society of Canada Annual Meeting, 25-29 May 2009. Ottawa, Canada. Wu, H., de With, N., Schwarz, C. J., and Loughin, T. (2008). Statistical inference for Minimum Inhibitory Concentration (MIC) data. Poster presented at the SSC meeting.
- May 2008 Statistical Society of Canada Annual Meeting, 25-29 May 2009. Ottawa, Canada. Bonner, S. J. and Schwarz, C. J. (2008). Hierarchical Bayesian Modelling of Two-Stage Capture-Recapture Experiments. This presentation won the Student Presentation Award at this meeting.
- January 2008 Review panel for the Trinity River Restoration Project. Redding, California, 2008-01-22. Schwarz, C. J. (2008). Review of estimation methodology for the Trinity River Restoration Project

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## Selected Publications and Research Interests

- August 2007 American Statistical Association Annual Meeting, Salt Lake City, Utah, 2 August 2007. Sutherland, J.M., Schwarz, C.J., Rivest, L.-P. (2007). Multi-list Population Estimation with Incomplete and Partial Stratification.
- June 2007 Statistical Society of Canada Annual Meeting. St. John's, NL. 11-13 June 2007. Huston, C. and Schwarz, C. J. (2007). Finding the fish: Straying trends between B.C. Pacific herring (*Clupea pallasii*) populations.
- June 2007 WNAR/IMS Annual Meeting, University of California, Irvine. June 26 2007. Bonner, S.J. and Schwarz, C.J. (2007). Bayesian Smoothing of the Stratified-Petersen Model.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Challenger, W. O. and Schwarz, C. J. (2007). Dealing with classification uncertainty in abundance estimation.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Bonner, S.J., Thomson, D., and Schwarz, C. J. (2007). Time-varying covariates and semi-parametric regression in capture-recapture studies.
- January 2006 UNBC Department of Statistics, Mathematics, and Physics. 31 January 2006. Schwarz, C. J. (2006). A (very) short tour of mark-recapture.
- September 2005 Bayesian Methods for Population Ecology Workshop held in Cambridge, England 4-8, September, 2005. Schwarz, C. J. and Dupuis, J. A. (2005). A Bayesian approach to the Jolly-Seber Capture-Recapture Model.
- June 2005 Western North American Regional meeting of the International Biometric Society in Fairbanks, Alaska. 20 June 2005. Cowen, L. C. and Schwarz, C. J. (2005). The Jolly-Seber model with tag loss. This presentation won first prize in the WNAR student paper oral competition.
- April 2005 St. Pauls HIV Network of Statisticians. Schwarz, C. J. (2005). Accreditation of Statisticians - an overview of what is to come.
- January 2005 Mayo Clinic. Department of Statistics. Rochester, Minnesota. 25 January 2005. Schwarz, C. J. (2005). Estimating population sizes with multi-list methods under non-standard conditions.
- January 2005 Minnesota 1837 Ceded Territory Fishery Committee Meeting. 19-20 January 2005, Duluth, Minnesota. Schwarz, C. J. (2005). Estimating the number of walleye in MilleLac, Minnesota using mark-recapture.
- August 2004 Departmental Seminar; Mathematic, Physics, and Statistics; James Cook University. Townsville Australia. Schwarz, C. J. (2004). Estimating Abundance - harder than you think.
- July 2004 International Biometrics Society, Cairns, Australia, 10-17 July 2004. Schwarz, C. J. (2004). Estimating the nest success rate and the number of nests initiated by radiomarked mallards.
- July 2004 International Biometrics Society, Cairns, Australia, 10-17 July 2004. Cowen, L. C. and Schwarz, C. J. (2004). Capture-recapture studies using ratio telemetry with premature radio-tag failure.
- June 2004 Statistical Society of Canada 2004 Annual Meeting, 31 May-4 June 2004, Montreal, Quebec. Hamm, J., Schwarz, C. J., and Williamson, I. (2004). Estimating the Rate of Concussions in British Columbia Minor Hockey Using Community Volunteer Collected Data. Poster.
- August 2003 American Statistical Association Annual meeting, San Francisco, 4-11 August 2003. Sutherland, J. and Schwarz, C. J. (2003). Multi-list methods using incomplete lists in closed populations.
- August 2003 American Statistical Association Annual meeting, San Francisco, 2-7 August 2003. Schwarz, C. J. (2003). An online system for teaching the design (and analysis) of experiments.

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## Selected Publications and Research Interests

- June 2003 Statistical Society of Canada Annual Meeting. Cowen, L. and Schwarz, C. J. (2003). Comparing survival estimates from a radio-tag mark-recapture study. Poster presented at SSC 2003 in Halifax.
- June 2003 Statistical Society of Canada Annual Meeting. Sutherland, J. and Schwarz, C. J. (2003). Multi-list methods using incomplete lists in closed populations. Presentation at the 2003 SSC in Halifax.
- August 2001 Institute for Wetlands and Waterfowl Research, Ducks Unlimited, Oak Hammock Marsh, Manitoba. Schwarz, C. J. (2001). Using Mark-recapture methodology to model and monitor populations - present and future.
- August 2001 American Fisheries Society (AFS) meeting Aug in Phoenix, AZ. Dempson, B. J. and Schwarz, C. J. (2001). Estimation of marine exploitation rates on salmon stocks in Newfoundland, Canada.
- October 2000 UBC Department of Statistics. How do I love thee: let me count the ways. Counting elusive populations using capture-recapture methods.
- September 1999 Department of Zoology, UBC. Schwarz, C. J. (1999). Recent Advances in Capture-recapture modelling.
- August 1999 Annual Meeting of the American Statistical Association in Baltimore. Dauk, P.C. and Schwarz, C. J. (1999). Catch Estimation In The Presence Of Declining Catch Rate Due To Gear Saturation
- August 1999 Annual meeting of the American Statistical Association in Baltimore. MacLeod, C.A. and Schwarz, C.J. (1999). Estimation of Age Specific Breeding Probabilities from Cross Sectional Studies.
- August 1999 Annual meeting of the American Statistical Association in Baltimore. Babineau, D. and Schwarz, C. J. (1999). Determination of Power and Sample Size for Aquaculture Experiments.
- June 1998 Department of Statistics, University of Auckland. The Stratified-Petersen with a known number of unread tags.
- May 1998 Department of Statistics and Mathematics, University of Otago, Dunedin, New Zealand. Using the robust design to estimate temporary emigration.
- September 1997 Department of Statistics, University of Auckland. The effect of and estimating tag misread rates in capture-recapture studies.
- September 1997 IUFRO 1.14.00 Interdisciplinary, Uneven-aged Silviculture symposium in Corvallis, Oregon. Lemay, V. and Schwarz, C.J. (1997). Use of Spatial information in Analyzing Experiments.
- May 1997 SFU Department of Mathematics and Statistics Journal Club. The "Simple" Petersen Estimator.
- April 1997 Discover the Possibilities Conference. How to count salmon
- February 1996 Department of Mathematics and Statistics, Simon Fraser University. One sea urchin, two sea urchins, red sea urchin, purple sea urchin. How to count sea urchins.
- January 1996 North Vancouver Elementary Schools Math Workshop on 15 January 1996 at the North Vancouver Curriculum Center, North Vancouver. An introduction to the Probability and Statistics Curriculum in Grades 4-7.
- June 1995 World of Math workshops for high school students at Simon Fraser University (28 June 1995). One fish, two fish, red fish, blue fish: counting salmon.
- May 1995 Parent Information Forum for early admission students and parents at Simon Fraser University (25 May 1995) - two presentations. Where have all the salmon gone?

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Selected Publications and Research Interests**

- April 1995 Evening on Mathematics and Applied Science for high school students (6 April 1995).  
Statistical Salmon
- April 1995 Discover the Possibilities for junior high school students (21 April 1995). One fish, two fish,  
red fish, blue fish: counting salmon.
- March 1995 Board of Governors at Simon Fraser University (23 March 1995). An overview of how to count  
fish
- April 1993 Department of Mathematics and Statistics, Simon Fraser University. Estimating salmon  
escapement using capture-recapture methods.
- May 1992 Association of Professional Biologists and the North Pacific Chapter of the American Fisheries  
Society, Nanaimo, B.C. Estimating salmon escapement using capture-recapture methods.
- February 1992 Pacific Biological Station, Nanaimo, B.C. Estimating the interchange among spawning  
grounds.
- February 1992 Department of Mathematics and Statistics, University of Victoria. Estimating migration using  
tag recoveries.
- February 1992 Department of Mathematics and Statistics, Simon Fraser University. Estimating migration  
using tag recoveries.
- January 1992 Northwest Atlantic Fisheries Research Station, St. John's. Estimating the super-population size  
using capture-recapture.
- January 1992 Northwest Atlantic Fisheries Research Station, St. John's, Newfoundland. Estimating migration  
using tag recoveries.
- May 1991 Joint Meeting of the Statistical Association of Manitoba and the Red River Valley Chapter of  
the American Statistical Association, Grand Forks, N.D. One fish, two fish...or How to count  
salmon.
- November 1990 Department of Fisheries and Oceans, Nanaimo, B.C. A mark-recapture method used to estimate  
salmon smolt numbers leaving the Conne River, Newfoundland.
- June 1990 Annual Meeting of the Statistical Society of Canada, St. John's. The use of tag-recovery data to  
estimate migration rates.
- April 1989 Annual Meeting of the Statistical Association of Manitoba, Winnipeg. Expert systems in the  
design and analysis of experiments.
- June 1988 Statistical Association of Manitoba, Winnipeg. An introduction to bird-banding models.
- June 1988 International Symposium and Educational Workshop on Fish Marketing Techniques, Seattle.  
The use of tag-recovery information in migration and movement studies.
- May 1988 Department of Statistics, University of Manitoba. Post-release stratification in band-recovery  
and capture-recapture model.
- February 1988 Department of Statistics, University of Manitoba. The Shapiro-Wilk test of exponentiality bases  
upon censored data.
- August 1984 Annual Meeting of the American Statistical Association. Log-linear models in the analysis of  
mark-recapture data.
- August 1983 Annual Meeting of the American Statistical Association. Dollar-Unit sampling applied to large  
inventories.
- December 1981 Winter Simulation Conference, Atlanta. An on-line simulator and database system for the  
management of a commercial fish farm.