

# Dr. Carl Schwarz

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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:

- 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.
- 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.

- 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 (in the past 5 years)

Chavarie, L., Dempson, J.B., Schwarz, C.J., Reist, J.D., Power, G., and Power, M. (2010). Latitudinal variation in growth among Arctic charr in eastern North America: evidence for countergradient variation? *Hydrobiologia*, \*\*, \*\*\*\*-\*\*\*\*. DOI: 10.1007/s10750-009-0043-z

Letink, M., Norbury, G., Cree, A., Seddon, P.J., Duncan, R., and Schwarz, C. J. (2010). Removal of introduced predators, but not artificial refuge supplementation, increases skink (*Oligosomma maccanni*) survival in coastal duneland, New Zealand. *Biological Conservation* 143, 72-77.

Sutherland, J. M., Castelluccio, P., and Schwarz, C. J. (2009). A multi-level model for continuous time population. *Biometrics* 65, 841-849. DOI: 10.1111/j.1541-0420.2008.01129.x

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. *Canadian Journal of Fisheries and Aquatic Sciences*, 66, 1245-1255. DOI:10.1139/F09-082

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.

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.

### **Computer Software and On-line WWW Materials (in the past 5 years)**

Bonner, S.J. and Schwarz, C. J. (2009) BTSPAS - Bayesian Time Stratified Petersen Analysis System. An R package submitted to the CRAN with software using the Trinity River Restoration Program (TRRP) project.

### **Contract and Consulting Reports (in the past 3 years)**

Schwarz, C. J. (2010). Analysis of preliminary creel survey and recommendations for a creel survey of Kootenay Lay, British Columbia. Prepared for Fish & Wildlife Compensation Program – Columbia Basin. 46pp.

Schwarz, C. J. (2010). A review of the use of safety factors in environmental toxicology. Prepared for B.C. Ministry of Environment. 10 pp.

Moore, D. L., Schwarz, C. J., and Bercovitz, I. (2010). A proposed survey to estimate the vehicle kilometers driven in BC for use in estimating carbon dioxide emissions. Prepared for the B.C. Ministry of Environment. 2010-05-20. 38 pp.

Schwarz, C. J. (2010). Review of “Effects of Selenium on American Dippers and Spotted Sandpipers in the Elk River Valley, British Columbia” and “Accumulation of Selenium and Lack of Severe Effects on Productivity of American Dippers (*Cinclus mexicanus*) and Spotted Sandpipers (*Actitis macularia*)”. Prepared for the B.C. Ministry of Environment. 5pp. 2010-05-07.

Schwarz, C. J. (2010). Review of “Uptake of selenium and productivity in waterfowl in the Elk River Valley, British Columbia”. Prepared for the B.C. Ministry of Environment. 4pp. 2010-05-06.

Schwarz, C. J. (2010). Review of “Evaluation of Selenium Related deformities among Columbia Spotted Frog tadpoles in wetlands downstream of coal mines in the Elk Valley, BC”. Prepared for the B.C. Ministry of Environment. 2pp. 2010-05-11.

Bercovitz, I. and Schwarz, C. J. (2010). Proposed methods for auditing returned beverage containers in British Columbia. Prepared for Encorp BC. April 2010. 10 pp.

Schwarz, C. J. (2010). A simulation study to examine the performance of a proposed tagging program on MilleLacs, MN. Produced for the Minnesota Department of Natural Resources. February 2010. 10pp.

Schwarz, C. J. (2010). Review of “Canadian Water Quality Guidelines for Cadmium: Scientific Criteria Document dated 2010-02-02”. Performed for the B.C. Ministry of Environment. February 2010. 10 pp.

Jones, R., Jeffery, S., DeFrootas, B. and Schwarz, C. J. (2009). Estimation of reference points and a precautionary harvest strategy for the razor clam (*Siliqua patula*) fishery at Haida Gwaii. Submission to the Pacific Stock Assessment Review Committee, December 2009.

Schwarz, C.J., D. Pickard, K. Marine and S.J. Bonner. 2009. Juvenile Salmonid Outmigrant Monitoring Evaluation, Phase II– December 2009. Final Technical Memorandum for the Trinity River Restoration Program, Weaverville, CA. 155 pp. + appendices.

- Schwarz, C. J. (2009). Review of Development of Site-Specific BAFs for Se in the Elk Valley: Summary of Statistical Analyses. Contract report for the B.C. Ministry of Environment, 6 pp.
- Schwarz, C.J. (2009). A review of the "California Coastal Salmonid Population Monitoring Plan: Overall strategy, design and methods". Report produced for the California Department of Fish and Game, 5pp.
- 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.
- Marine, K., Pickard, D., and Schwarz, C. J. (2008). Trinity River Restoration Program: Juvenile salmonid outmigrant monitoring evaluation. Final Technical Memorandum. Prepared for Trinity River Restoration Program. 82pp.
- Schwarz, C. J. (2008). Analysis of Moyie Burbot data -2008 report. Prepared for BC 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 B.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.

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## Works Submitted for Refereed Publications

- Huston, C. and Schwarz, C. J. (2010). Hierarchical Bayesian strategy for modelling correlated compositional data with observed zero counts. Submitted to Biometrics, June 2010.
- Bonner, S.J., Schwarz, C. J., Pickard, D., Marine, K. (2010). A Bayesian hierarchical model with splines for Time-Stratified Petersen experiments. Canadian Journal of Fisheries and Aquatic Sciences. Submitted 2010-03-01.
- Bonner, S.J. and Schwarz, C.J. (2010). Smoothed estimates for time-stratified mark-recapture experiments using Bayesian P-splines. Biometrics. Submitted 2010-03-10.

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## Conferences, Workshops and Presentations (in the past 10 years)

### Invited Talks (in the past 5 years)

- 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.
- 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 Stratified 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 Stratified 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.

### Presentations (in the past 5 years)

- March 2010 Automobile Fuel Cell Corporation. Burnaby, B.C. Schwarz, C. J. (2010). Beyond simple regression.
- January 2010 Trinity River Science Symposium. Weaverville, CA, 13-14 January 2010. Schwarz, C. J., Pickard, D., Marine, K., and Bonner, S. J. (2010). Trinity River Restoration Program Juvenile Salmonid Outmigrant Monitoring Program Evaluation.

- 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.
- 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: a power analysis. **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
- 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. 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.