

**TCDS 8902**

**July 26, 1989**

**PACIFIC SALMON COMMISSION  
JOINT TECHNICAL COMMITTEE ON DATA SHARING**

**REPORT TCDS (89) - 2**

**ACTIVITIES OF THE WORKING GROUP  
ON MARK-RECOVERY STATISTICS  
1986-1988**

**July 26, 1989**

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## HISTORY OF THE WORK GROUP

The original terms of reference (2/4/86) (Appendix 1) state that the work group should: a) summarize different methods presently used to estimate recovery rates, total survival of tagged fish, and contribution to catches of untagged fish and then come up with consensus on standard procedures; b) develop confidence intervals for estimates and identify efforts needed to achieve desired confidence levels; c) determine data requirements, method assumptions, and sensitivity to assumptions and variation in input data; d) develop sampling procedures to improve precision and cost efficiency; e) write up a report by April 1, 1987 to the Data Sharing Committee; and f) identify factors which presently limit value of coded-wire-tag (cwt) data for stock assessment.

A chronological history of the Work Group is given in Appendix 2. The Work Group met once in 1986, four times in 1987, and three times in 1988. Most of the effort in the first four meetings was put into discussing the terms of reference and determining the mode of operation for the group. The Work Group itself decided that the best approach was on emphasizing case-studies and providing consulting services to the technical committees of the Pacific Salmon Commission (PSC). Each member of the Work Group would work on some specific project dealing with the PSC and then the Work Group would convene to discuss the various works in a peer review type of situation. It was decided that methods of collecting cwt data are too diverse for there to be agreement on a coast wide estimation technique. An alternate version of the terms of reference was drafted and presented to the Data Sharing Committee at their November 15, 1987, meeting.

The Data Sharing Committee rejected the revised draft of the terms of reference in favor of the original draft. The Data Sharing Committee did agree to a case study approach by the Work Group, stating that this approach should eventually produce a standard statistical methodology for mark-recapture data.

A summary progress report from the Statistics Work Group was written and presented to the Commission in June 1987 (Appendix 3). That report discussed the operational plans of the Work Group and summarized statistical work in progress. The statistical work included:

- a) development of a common data set to be shared by members of the Work Group and used to compare various analytical methods;
- b) review of the precision of estimates based on cwt recovery rates; and
- c) discussion of evidence of bias in cwt estimates of hatchery returns.

A progress report was submitted to the Data Sharing Committee at their January 20, 1988, meeting (a copy may be found in Attachment 2 of the minutes to that meeting). This report consisted of minutes of the last Work Group meeting, an unofficial roster of contributing members (dated 12/18/87), and abstracts from six on-going projects dealing with mark-recovery databases and statistics. The roster of members submitted by the Work Group differed from the official PSC roster at that time (dated 01/17/88) due to the PSC office not having received written conformation on membership of some of the people. Both of these rosters plus a current one (dated 07/06/89) are presented in Appendix 4.

The Work Group participated in and attended a Workshop on Coded-Wire-Tag Statistics held in Seattle, Washington, in the spring of 1988. Stephen Mathews and Ray Hilborn from the Work Group were on the steering committee (see Mathews et al. 1987).

## REVIEW OF PROJECTS

### Benchmark Data Sets

Three benchmark data sets were assembled in order for the Work Group to have a common database to work from, facilitating the comparison of the types of cwt data collected and the techniques and statistics used for analysis. Most of the release data included were from experimental rather than production tagging projects. One sample data set was put together by the Canadian Department of Fisheries and Oceans (CDFO) using Canadian cwt data from selected tag codes, i.e. from selected tagged stocks of chinook and coho salmon. This data set is completed and available on diskettes to members of the Work Group. The data set is documented in a 32 page report and is available from Kuhn, CDFO. Extended documentation has been prepared (Kuhn 1988a, 1988b) to: 1) discuss the collection process of the Canadian Mark-Recovery Program (MRP) data and the significance of all recorded data and 2) explain the use of software built to extract data from the Canadian MRP database and to prepare reports from the database. The Canadian benchmark data set is a subset of their MRP database.

Alaska provided another data set which included some tagging data of chinook salmon in Alaska and recovery data of tags included in the Canadian benchmark data set. The format of the data set was summarized in a memo to the Work Group and sampling and tagging methods have been documented in several Alaska Department of Fish and Game (ADF&G) technical reports (available from J.E. Clark, ADF&G).

A third data set was provided by Frank de Libero (Washington Department of Fisheries, WDF) and Ken Newman (Northwest Indian Fisheries Commission) from a subset of Washington tag studies. This data set is available from the Work Group on request.

A report was tabled (Palermo, a 1987 meeting) which compares the three benchmark data sets. There were major differences in the amount and kinds of information included in each data set. Problems encountered in preparing these benchmark data sets were discussed in meetings of the Work Group and difficulties expected in the international exchange of mark-recovery data were highlighted. These differences have since been resolved by the Work Group on Mark-Recovery Databases through the formation of a common database format for coastwide mark-recovery data.

### Bias in CWT Returns to Hatcheries

Mulligan and Schnute have conducted a study on bias in cwt estimates of total return to selected Canadian hatcheries. They looked at six hatcheries from 1973 to 1988. In a comparison of counted returns and cwt-estimated returns, in which both estimates are assumed to have error, the cwt-estimates consistently reported only 80% of the return estimated by counts. This was for both chinook and coho salmon at all hatcheries, except for chinook salmon at Robertson Creek hatchery where the bias is greater, and over all years. The study has been presented and discussed at several meetings of the Work Group and has been submitted for publication.

The results of the above study prompted Mulligan and Lapi to design some multiple marking experiments in order to determine causes of the bias. The multiple marks will be used to differentiate various error sources including, possibly, those causing the bias.

Jon Schnute is using an errors-in-variables model to study bias in estimates based on tag data of hatchery returns. Since both the cwt-estimate and the observed return are measured with error, the variance for each must be

represented in the analysis. Behavior of the variance of the estimated relative bias is under investigation.

#### Study of "Replicate" CWT Information

Embedded replicate coded-wire-tagging, e.g. giving a single batch of hatchery fish more than one cwt code and using the various codes as replicate samples, has been used in an attempt to obtain empirical information on the variance of cwt-based estimators. Ken Newman and Rich Comstock presented results of some simulation studies that indicated these "replicates" were not providing the desired information. This prompted further research by Jon Schnute. Using a nonparametric comparison of expected values of replicate and theoretical estimators, he demonstrated that no additional information is obtained by using replicate tagged releases. Schnute's work is still in progress and is expected to be published shortly.

#### Variance Estimates for Compound Distributions

Most cwt-based estimates of the contribution of tagged fish to a fishery are the result of several stages of estimation. The resulting estimate has a compound or contagious distribution and the calculation of a variance is not a trivial matter. Although the theoretical procedure exists, the resulting estimation technique will vary between programs depending on sampling procedures, actual data collected, and assumptions made. However, the theoretical approach can provide general guidelines to allocation of resources within and between sampling and tagging programs. One interesting generalization is that monies allocated to cwt programs should be divided equally between the tagging and sampling activities in order to maximize the precision of the resulting estimates. Ken Newman (1988), J.E. Clark (Clark and Bernard 1987 and in press), and J. Schnute have all presented some ideas from specific applications they have worked on. The Clark and Bernard papers have been distributed to the Work Group for review. At present, a coastwide technique is not feasible due to the variations in sampling design between agencies and Parties.

#### Marking Release and Recovery Rates

At a regular meeting of the Work Group (June 1987), the comparison of marked proportions at release and then again at recovery at the hatchery was discussed. In order to make such comparisons, it is necessary to have an estimate of the age composition of the unmarked return that is independent of the cwt data.

#### Model for Analysis of CWT Data.

Ray Hilborn and John Skalski are working on developing a computer simulation model to study the behavior of standard log-linear parameter estimation techniques, assuming a binomial selection process. The model was tested, using the Canadian benchmark database, for reliability using Monte-Carlo techniques and appeared to behave normally and without bias. They would like to test it next on a larger, more complex database.

#### Hatchery Addon and the Risk Adjustment Calculation

Paul Starr, CDFO, and John Clark, ADF&G, compared risk adjustment calculations using the method in use by ADF&G on marking and sampling rates in Canadian and Alaskan hatcheries and fisheries. There seems to be some differences in how

lost tags are incorporated into the estimation process and it was agreed this should be looked at in more detail.

#### CO-OPERATION WITH OTHER PSC GROUPS

##### Mark-Recovery Database Work Group

The MR Database Work Group asked for advice on whether variances on the proportion of released tags should go into the database. The recommendation made by the Statistics Work Group was to include a field indicating how the estimate was made.

##### Chinook Technical Committee

Some members of the Work Group are also members of the Chinook Technical Committee and provide guidance in cwt-related estimates in the chinook model. No references are available.

##### Coho Technical Committee

Gary Morishima asked for help on evaluating the potential use of simultaneous linear equations to estimate coho stock compositions. J.E. Clark together with Leon Shaul worked out a solution and produced a paper "Use of coded-wire tag data to estimate aggregate stock composition of salmon catches in multiple mixed stock fisheries (Shaul and Clark 1988)."

The Coho Technical Committee has established a Stock Composition Work Group which is working on preparing analytical models. One model utilizes linear programming techniques for cwt data sets similar to that presented by Shaul and Clark (1988).

#### REFERENCES

- Clark, J.E. & D.R. Bernard 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in southeastern Alaska. ADF&G, Informational Leaflet No. 261.
- Clark, J.E. & D.R. Bernard in press. Optimal allocation of funding between and within coded-wire tagging and sampling programs by evaluation of a compound probability density function. Biometrics.
- Kuhn, B. 1988a. An introduction to the Canadian database on Marked Pacific Salmonids. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1649.
- Kuhn, B. 1988b. The MRP-Reporter program: a data extraction and reporting tool for the mark recovery program database. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1625.
- Mathews, S.B., J. Skalski, & R. Cormack. 1987. Coded Wire Tag Workshop Final Report, 1987. Report to Columbia River Intertribal Fishery Commission.
- Newman, K. 1988. Variance estimation of contribution rate estimates based on sample recoveries of coded wire tagged fish. Presented at the Workshop on Coded-Wire-Tag Statistics, Seattle, WA, 1988.
- Shaul, L.D. & J.E. Clark 1988. Use of coded-wire tag data to estimate aggregate stock composition of salmon catches in multiple mixed stock fisheries. Presented at the Workshop on Coded-Wire-Tag Statistics, Seattle, WA, 1988.

APPENDIX 1. TERMS OF REFERENCE

Feb  
~~20~~/04/86 Draft 1  
(Riddell)

TERMS OF REFERENCE FOR THE WORKING GROUP  
ON MARK-RECOVERY STATISTICS

The Data Sharing section of the Memorandum of Understanding in the Pacific Salmon Treaty commits the parties to maintaining and reviewing the coastwide coded-wire tagging program. The objective of this review is to ensure that this program is designed to provide statistically reliable data for stock assessments and fishery evaluations. Specifically, the Working Group will:

- a) specify mathematical models used coastwide to estimate recovery rates in fisheries and total survival of tagged groups, and contribution to catches of untagged fish associated with tagged groups; and attempt to develop a consensus recommendation on one model;
- b) develop a theoretical framework for statistically evaluating the confidence about the estimates, and estimating marking and recovery efforts required to achieve desired confidence levels;
- c) specify data requirements for these models and analyses, the assumptions involved, and evaluate the sensitivity of the parameters estimated to these assumptions or error in the input data;
- d) recommend procedures in sampling methodologies for improving the precision about estimated parameters and cost efficiencies of the program;
- e) submit a written report on these deliberations and any software developed, which will have general utility in designing coded-wire tagging programs, to the Data Sharing Committee by April 1, 1987;
- f) identify factors which presently limit the value of coded-wire tag data for stock assessment and/or fishery evaluations, and recommend improvements to data systems and/or new research need to improve the program.

Publication Policy?



## APPENDIX 2. A HISTORY OF THE STATISTICAL WORK GROUP

Original Memorandum of Understanding, January 28, 1985

Section B. Data Sharing: "the Parties consider it necessary to develop a coast-wide stock assessment and management data system, including catch, effort, escapement, and coded-wire tag data that will yield reliable management information in a timely manner and to develop analytical models along with standardized methods for monitoring fishing effort."

More specifically "The Parties agree to maintain a coded-wire tagging and recapture program designed to provide statistically reliable data for stock assessments and fishery evaluations. The Parties agree to establish a working group prior to April 1, 1985 to review the program..."

Data Committee Task Force (US Section), June 26, 1985 (Sand Point)

U.S. members have been chosen for what becomes the Data Sharing Committee (Bevan, Marasco, Henry, Morishima, Marshall, Seibel); ask Commissioners to expedite appointment of Canadian members.

Pacific Salmon Treaty CWT-Indicator Stock Workshop, January 15, 1986

Gary Morishima acted as chair, 35 people attended from both Canada and the U.S. The workshop was convened by the joint Chinook and Coho Technical Committees to discuss and develop interim recommendations on issues of importance to the Pacific Salmon Treaty tagging requirements for fish being released that spring. Replication and variance estimation were discussed. Indicator stocks for chinook salmon were identified as most important to be tagged and studied. Recovery strata were developed. Information goals included determining migratory patterns, estimating harvest rates within certain fisheries, determining production rates of various hatcheries.

First Meeting of the Data Sharing Technical Committee, February 18, 1986

Participants Riddell (chair), Lapi, Schutz, Bjerring  
Bevan, Marshall, Seibel, Henry

Terms of Reference for the Work Group on Statistics in the coded-wire-tag program was deferred to a later meeting and clarification of the status of this group was requested from the Commissioners by letter from the chair of the Data Sharing Committee.

First Draft of Terms of Reference for Work Group, February 4, 1986

To: develop standard coastwide methods for estimating recovery rates in fisheries and total survival of tagged groups; develop theoretical framework for confidence about estimates; specific data requirements; recommend procedures in sampling design; and identify current limitations in data or methods.

First Meeting of the Statistical Work Group, September 16, 1986

Focused on terms of reference. Development of benchmark data sets was identified as being helpful in order to provide a common data set for testing estimation techniques. Conducted review of on going research in field by members of Work Group.

Second Meeting of the Statistical Work Group, February 24, 1987

In attendance: Clark, de Libero, Newman, Comstock, Mulligan, Palermo, Schnute.

Focused on terms of reference which were considered too broad and general. Decided that case-study approach might be the best in determining estimation techniques. Concern expressed over quality of cwt data. A standard, shareable information system is essential. Canadian benchmark data set was presented.

Roster, March 13, 1987

Canadians: Schnute, Palermo, Hoyt, Lapi, Mulligan.

U.S.: Clark, Newman, Henry, de Libero, Mathews.

Third Meeting of the Statistical Work Group, March 31, 1987

In attendance: de Libero(co-c), Clark, Newman, Comstock,  
Schnute(co-c), Hoyt, Lapi, Mulligan, Palermo, Riddell.

Discussion of terms of reference and using a case-study approach to carry out terms of reference. Each member is to bring a case study to next meeting. Have received one from Coho Technical Committee to look at Qualicom cwt data analyses.

1. J. Schnute: cwt variance estimation: compound distribution to estimate variance associated with cwt survival rates. Differed from K. Newman approach presented at an earlier meeting. Also, an approach given by J. Clark. Group will continue with comparison of the theoretical approaches.
2. K. Newman gave presentation of computer interactive program to determine appropriate tagging levels given specified precision goals for contribution rate estimates.
3. Measures of error: standard deviation versus standard error
4. Tagged to Untagged ratios at the rack: apparent bias related to tagged hatchery returns. Tag recoveries at rack were 15% less than that expected.
5. J. Clark: survey questionnaire to explore for bias.

**\*\*Data Sharing Committee, Fourth Meeting, May 27, 1987, Vancouver**

Statistics Work Group report, Lapi reviewed work of this group from minutes. Group is currently helping the Coho Technical Committee look at Qualicom cwt coho data analyses.

Fourth Meeting of the Statistical Work Group, June 3, 1987, Sand Point

Prepared report for Commissioners June meeting.

New draft of terms of reference by Work Group stating consulting nature of Work Group and presenting the case study approach.

No minutes from meeting available.

Progress Report of PSC Working Group on M/R Statistics, June 8, 1987

Terms of Reference. Four meetings to date, over half of time spent on clarifying terms of reference. The original terms of reference assigned this group to develop a complete standard statistical methodology for the cwt data. Important overall goal but unattainable at this point. Recommend changes in terms of reference that make the Work Group a consulting group for PSC Technical Committees. "Emphasis on case studies is not meant to preclude ancillary theoretical work". Suggested that members present progress reports at quarterly meetings of the Work Group and that minutes of these meetings with reports attached be forwarded to the Data Sharing Committee and other interested parties.

Work in Progress. Case studies are being solicited from the Technical Committees. Benchmark data sets have been completed to allow for a common data set in testing various methods. Discussion of precision of cwt recovery rate estimates under discussion. Marked-to-unmarked ratio of fish at hatchery racks have been explored and suggest some bias in estimation techniques. This is being followed up with further work. Tendencies for tagged fish to clump and the effect on estimations based on recoveries is being investigated.

Terms of Reference, November, 1987.

A November draft by the Work Group was rejected by Data Sharing Committee at their November 15, 1987 meeting. See notes from December meeting of the Work Group below.

Fifth Meeting of the Statistical Work Group, December 9, 1987, Nanaimo

In attendance: de Libero(co-c), Clark, Hilborn, Lawson, Mathews, Newman, Schnute(co-c), Hoyt, Lapi, Mulligan, Palermo.

Terms of Reference: instructions from Data Sharing Committee regarding these were discussed. Data Sharing instructed the Work Group to continue to use the existing terms of reference and to respond on a case-by-case study to problems identified by the Technical Committees and produce a progress report in December detailing their accomplishments.

June CWT Workshop: Work Group would participate in planning and attending a 2-day workshop which is coordinated by U. of Wash. Mathews and Hilborn will be on steering committee.

Error Estimates in CWT Database: Two task teams to be formed, first being de Libero and Palermo to prepare report specifying variables in the cwt database that could have associated errors included in reports. Second, (Clark, Comstock, de Libero, Lapi, and Lawson) will document how their jurisdiction calculates the point estimates which are identified for inclusion of associated errors.

Progress Reports: **Clark:** discussed model to estimate abundances of stock aggregates of coho salmon (Lynn Canal), testing probability distributions with simulation.

**Hilborn:** presented plans to develop methods of using cwt data to estimate distributions patterns, harvest rates and maturation schedules using cohort analysis simultaneously with spatial analysis.

**Mathews:** For estimating overall survival of hatchery production, current methods of analysis are adequate but better planning and coordinated effort is needed. Experimental effort in time and space not sufficiently represented.

**Mulligan:** Estimating bias in cwt estimates. Draft reports out on testing accuracy and precision of MR estimators and comparing expanded tag recoveries and observed hatchery escapements.

**Newman:** gave results of a test statistic for comparing catch distributions and also some simulation work to suggest that replicate tag data may give biased variance estimates.

Lawson: demonstrated that the smaller of encounter rate or mortality rate will be the more important in determining total mortality due to incidental gear encounters.

Roster, December 18, 1987

Canadians: Schnute (co-chair), Palermo, Hoyt, Lapi, Mulligan. (unchanged)  
U.S.: de Libero (co-chair), Clark, Newman, Henry, Mathews,  
new: Hilborn, Lawson, Skalski, Comstock(observer).

Report of the Work Group to the Data Sharing Committee, January 20, 1988

This report consisted of minutes of the Work Group's December 1987 meeting; the unofficial roster of December 18, 1987, of those working on the Work Group; and six individual progress reports or abstracts of cwt-research by various members of the Work Group. The six reports include:

1. CWT Bias Estimation Progress Report by Lapi, Mulligan, and Schnute.
2. MR Planning and Experimental Design (abstract).
3. Description of Problem to Test Accuracy and Precision of MRP Estimators by Canadian members.
4. A Model to Compare Expanded Tag Recoveries and Observed Hatchery Escapements by Mulligan.
5. Positive Bias in the Replicate Based Estimate of Variance? by Newman.
6. A Test Statistic for comparing Catch Distributions by Newman.

Copies of these reports/abstracts may be found in Attachment 2 to the January 20, 1988, minutes of the Data Sharing Committee.

Sixth Meeting of the Statistical Work Group, March 17, 1988, Nanaimo

In attendance: de Libero(co-c), Clark, Lawson, Mathews, Newman, Comstock(obs)  
Schnute(co-c), Mulligan, Palermo.

Inclusion of Statistical Errors in PSC CWT Database: draft recommendation tabled, would like to include error measures in database, but whether recommendation should be made now was undecided.

Work in Progress: Mulligan and Schnute discussed apparent biases in cwt data. An underestimate of total returns to most hatcheries apparent. Clark reviewed his work and concluded that greatest component of variation in estimating stock compositions of catches was associated with tagging. Newman reviewed his work on compound binomial distribution to estimate cwt variances and compared with variances derived from replicate groups. Work indicates a bias in replicate derived estimates, due perhaps to sampling without replacement.

Seventh Meeting of the Statistical Work Group, June 30, 1988, Seattle

Meeting held in conjunction with the Coded-wire-tag Statistical Workshop held in Seattle, WA.

Minutes of the meeting are missing.

Eighth Meeting of the Statistical Work Group, December 8, 1988, Vancouver, B.C.

In attendance: Clark, Hilborn, Lawson, Pascual, Sands, Skalski, Comstock  
Schnute(co-c), Lapi, Mulligan, Palermo, Starr.

First, Louis Lapi gave a report from the Coho Technical Committee. They are using a best fit approach rather than a linear model approach and are looking to the statistical work group for approval. Norma Jean Sands distributed a draft copy of a progress report of the Statistical Work Group for comment. Progress reports by the various members were given. Jon Schnute reported on his work on the analysis of bias from salmon tagging data using an errors-in-variables model. He is developing a new approach of using likelihood to estimate confidence limits. Ray Hilborn, John Skalski and Miguel Pascual presented a simulation model for the general linear model of estimating hatchery returns using cwt. They warn that by pooling data one tends to introduce interactions that do not exist in the original data. John Clark and Paul Starr discussed the hatchery add-on concept and the role of risk adjustment in determining the add-on. There was some ambiguity about how each agency determined the number of tags in the catch. Pete Lawson requested input from others who have already standardized their cwt reporting procedures, since Oregon has just started this procedure. Variance: a general discussion of variance estimation developed and it was reiterated that one should be careful in comparing variances that are derived based on different levels of time or space or on different basic assumptions. Meeting procedures were discussed. While it was generally agreed that it would be good to exchange papers before the meetings in order to give members a chance to digest material and ask intelligent questions, it was decided that this couldn't be requested since the members don't have time to write the papers before hand and are often discussing work and ideas that are on going and developing right up until the moment of the meeting.

June 8, 1987

## PROGRESS REPORT OF PSC WORKING GROUP ON M/R STATISTICS

### Terms of Reference

Our working group has met four times to date. Well over half of this total meeting time has pertained to clarifying our terms of reference. We propose a revised (draft) terms of reference which we hope the Data Sharing Committee will agree with.

The original terms of reference (see attachment) essentially assign this W/G to develop a complete standard statistical methodology for the CWT. This is clearly an important overall goal. It is the group's opinion, however, that no universal methodology to achieve this goal can be identified at the present. To discover practical analytical solutions to the Commission's statistical needs, we recommend that our terms of reference be changed to accommodate the following:

That we help resolve some of the meaningful special issues faced by the Technical Teams, and at the same time contribute to the broad goals noted above, by emphasizing a case-study approach. A case study will be defined as any statistical mark/recovery problem germane to the Pacific Salmon Treaty, and will meet the following criteria:

1. The statistical problems are identified by members of the various PSC committees.
2. Resolution of the problems will include the active collaboration of a concerned user of the results.
3. Data used in the analysis must be shareable, ideally coming from the agreed-upon international database.

The emphasis on case studies is not meant to preclude ancillary theoretical work or data quality issues as broadly stated in the original terms of reference (e.g., estimates of precision, testing methodologies for comparing stock distributions, procedures for assessing and controlling bias).

We suggest that this W/G serve as a general M/R-related statistical consulting group to the Technical Committees. Given this and the emphasis on case studies to accumulate a body of scientific knowledge, our recommendation is that the group be considered as a standing W/G of the Pacific Salmon Commission.

Our plan is for members of the group to present progress and results of their work at quarterly meetings. Minutes of these meetings with attached reports will be forwarded to the Data Sharing Committee and other interested parties.

## Progress Report of PSC W/G on M/R Statistics

### Work in Progress

Progress to date is given in some detail in the minutes of our meetings 2/24, 3/31 and, forthcoming, 6/3. An overview of the major items follows:

The most important is the case study approach to fulfill our terms of reference. Cases are currently being identified in conjunction with Technical Committee members and are expected to give us a full agenda for our next planned meeting (August 25 in Nanaimo).

Additionally, benchmark data sets have been largely completed and shared among the W/G members - the idea here being to isolate some of the data problems from the analyses.

A number of theoretical estimates of precision of CWT recovery rates are under discussion. These are preliminary but show promise.

The marked-to-unmarked ratios at the racks have been explored, both empirically and theoretically. This has reinforced the need for experiments to test the hypothesis of tag return bias.

Preliminary investigations have been presented which suggest that CWT recoveries, at least under the circumstances considered, tend to clump. This is important with regard to determining accurate probability models for CWT estimation processes.

APPENDIX 4. MEMBERSHIP ROSTERS FOR THE WORK GROUP.  
A. STATISTICS WORK GROUP LIST OF ACTIVE MEMBERS (12/18/87).

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