HISTORICAL SYNOPSIS

In 1966, the Montana Fish and Game Department hired Dick Vincent to develop electrofishing sampling gear and formulate uniform statistical methods for fish population estimates. Electrofishing sampling gear originally consisted of an aluminum boat, a generator and electrodes. A rectifying unit was not part of this original system, with the electrical current being controlled by changing the size of the electrodes. In contrast with present techniques associated with mobile electrofishing, the electrofishing crew did not stand in the boat to conduct fish shocking. All of the crew, including the netter, sat in the boat to collect fish. Imagine trying to net fish while seated! In addition, the person controlling the positive electrode did not throw the electrode but simply waved it in the water along the side of the boat to stun fish.

Fortunately, equipment and techniques evolved rapidly following these early attempts at electrofishing, with the first rectifying unit being constructed for the Department in 1967 by Jim Fisher, a television repairman and uncle to Dick Vincent. Techniques were also developed to allow netters to stand in the boat and crew members to throw the positive electrode into suspect waters holding trout.

First attempts at obtaining trout population estimates in Montana occurred on the Manley section of the East Gallatin River and the Hildreth section of the Beaverhead River. These attempts were made at the same time as electrofishing gear was being developed. Original population estimates were conducted by making single marking runs, waiting three to four days, and then making single recapture runs. The basic Peterson's formula was used to simply calculate a total estimate.

Numerous experiments were conducted during the Department's early days of population estimates to evaluate, among other things, appropriate section length to insure a closed population, appropriate time intervals between mark and recapture to insure proper redistribution of marked fish and the use of the multiple mark and recapture method to insure appropriate sample size to meet Robson-Regier criteria. One outcome of this research was a paper entitled <u>River Electrofishing and Fish Population Estimates</u> written by Vincent and published in The Progressive Fish Culturist in 1971.

By the mid 1970's, size groups were being estimated based on similar capture efficiencies and minimum Robson-Regier criteria, although the concept of a capture efficiency curve in relation to the size of a fish had yet to be developed. The acquisition of personal computers and associated statistical software in the mid 1980's enabled Vincent to refine the concept of heterogeneous capture efficiencies among differing sizes of fish that eventually led to the conceptual capture efficiency curves now being used in the Department's MR4 and MR5 (beta version) mark-recapture programs.

During the late 1960's and early 1970's, mark-recapture data were either calculated by hand or sent to Helena to be run on a main frame computer. Burwell Gooch, an employee with the Department of Administration, was contracted by the Department in about 1972 to oversee population estimates through the main frame computer in Helena. In 1975, due to concerns over estimate quality and to Gooch's frustrations over improperly coded data, the Department made the decision to centralize fish population estimates through Vincent to insure that valid population estimates were being produced by area biologists. This individual review was effective in insuring estimate quality but acted as a bottleneck in completing the data analysis.

Department population estimates became decentralized in the mid 1980's, primarily due to the Department's acquisition of personal computers. Area biologists began to keypunch their own mark-recapture data and use Department developed programs to calculate fish population estimates. As a result, quality control of estimates became the responsibility of the individual biologist.

The first personal computer estimate program developed by the Department, called MRSYS, was a computer program that used the modified Peterson's formula. MRSYS relied on the biologist to appropriately segregate length groups into capture efficiencies that approximated a conceptualized efficiency curve. The MR4 program, developed by the Department's Information Services Unit, improved upon MRSYS by providing the option of using a log-likelihood methodology to estimate capture efficiencies that provide a "best fit" on a conceptualized curve. A beta version of MR5, the newest Department program, is a Windows version of MR4 with improvements that make the program more user friendly and, more importantly, encourage the user to become more aware of the quality of data that is being run through the program.

NEED FOR A MARK-RECAPTURE WORKSHOP

The need for a Mark-Recapture workshop was three-fold. First, there was a need to introduce the MR5 program to biologists from around the state involved with population estimates. Secondly, there was a need to gather ideas for possible future needs and improvements associated with the Mark-Recapture computer program. Thirdly, there appeared to be a need to re-evaluate the concept of quality control for Department population estimates. The need for quality control has been recently magnified as a result of greater public access to estimate data, both through electronic means (MRIS and the possibility of Network access) and through the ever increasing trend for information requests by the general public. This need for quality control is also highlighted by the ease of producing a population estimate as a result of our Department's computer programs. These programs do not consider any of the assumptions and criteria associated with producing valid population estimates. The programs will just as easily calculate estimates from poor quality data and violated assumptions as they will from good quality data and honored assumptions.

The workshop was held in Bozeman on June 19 and 20, 1997. The agenda for the workshop and a list of attendees are presented in Appendix A. Workshop presenters included Stuart Brittain and Bob McFarland from the Fisheries Division and Dr. Jay Rotella from Montana State University. Rob Brooks, MFWP's Bio-economist, facilitated the group discussion concerning the need for over-all quality control for fish population estimates obtained by the Department.

The desired results from the workshop were to :

1). Introduce the MR5 (beta version) program;
2). Review the assumptions and criteria associated with mark-recapture population estimates;
3). Generate a set of draft guidelines to determine M/R estimate quality;
4). Develop recommendations on distribution and the quality rating of estimates; and
5). Develop a prioritized list of features for a future Program Estimate package.

WORKSHOP RESULTS

MR5 Program

This new version converts MR4 to run under a windows environment as well as adding new features and variance formulas. Metric data can now be used and reports produced with metric numbers. Unbiased estimators are now used to give confidence intervals and variance estimate for size and biomass groups. The editor (MREDIT) is now included in MR5. The ability to exclude entire length groups from the log-likelihood process is now provided. A partial log-likelihood estimator is used.

In general, population estimates obtained from a Log-likelihood estimator are similar to estimates obtained using the Modified Peterson's estimator (if length groups are broken into appropriate capture efficiencies when using the Peterson's estimator). Typically, the Modified Peterson's estimator tends to under-estimate the smaller size groups (yearlings) when compared to the Log-likelihood estimator. Although untested, the Log-likelihood estimator probably produces a more accurate estimate for these smaller size groups than does the Modified Peterson's estimator.

Comparisons of Madison River population estimates by age class obtained from the Modified Peterson's estimator with those obtained from the Log-likelihood estimator using the same raw data are presented in Appendix B. The Log-likelihood estimates were used for standards as the basis for comparison. Although not statistically analyzed, these comparisons indicate that the Modified Peterson's estimator tends to underestimate the yearling populations (graph skewed towards the negative) when compared to the Log-likelihood estimator. Despite this difference, however, approximately 80% of all the yearling estimates were within 20% difference between the two estimators. The amount of skewness shown in the graphs tended to decrease when comparing the estimators among the older age groups. In addition, the two estimators produced more similar population estimates among the older age groups. For total population estimates, approximately 65% of all estimates were within 10% difference between the two estimators, while 95% of the estimates were within 20% difference between the two estimators.

Assumptions and Criteria Associated With M/R Estimates

Dr. Jay Rotella presented a lecture on the assumptions that must be met for any capture/recapture type estimate. His lecture notes are included in Appendix C. The basic four assumptions that must be met for any m/r estimate are:

Fish population is closed

This means that there can be no immigration or emigration from the study area. This can be accomplished by netting off the stream on small streams or by making the study section long enough to effectively make it a closed population. Care must be taken not to estimate populations that are migrating (i.e. spawning runs).

Fish don't lose their marks

Fish must be marked in such a way that no marks are lost.

All marks are noted and recorded correctly

Marks must be made in such a manner that they can easily be recognized and correctly recorded. Fin clips must be made so that you can distinguish this years clips from previous years.

Constant and equal probability of capture

Fish that are marked must have the ability to be caught at the same rate as unmarked fish. This means you need random redistribution of fish after your marking run. This is usually accomplished by making several stops when electrofishing so fish displacement is not great and by waiting a set time period. This is usually 7 days on small streams and 10-14 days on larger river systems. The longer you wait the better for random distribution. However, you have to be careful not to wait too long because of the growth of fish could interfere with providing for equal probability of capture for an individual size group.

Guidelines to Determine M/R Estimate Quality

1 - Robson-Regier criteria will apply to all length groups when using a Modified Peterson Estimator and will apply to 75% of the length groups when using a Log-likelihood Estimator. This criteria states: $M*C>=4N$

Where M=number of fish marked
C=number of fish in recap run
N= estimated population number

Number of recaps per size group >= 3

2 - In order to meet the assumption that there is a relationship between length and capture efficiency, size intervals will be between 1 and 3 inches for both the Modified Peterson and Log-likelihood Estimators. Using length groups less than 1 inch is impractical because of the error associated with length measurements taken in the field, while length groups greater than 3 inches among the smaller and intermediate size classes violates the assumption and produces erroneous biomass and age group estimates. The use of a size

interval larger than 3 inches is acceptable for the last and largest length group for both the Modified Peterson and Log-likelihood methodologies due to the shape of the efficiency curve. Theoretically, capture efficiencies become more similar for the larger size groups.

3 - For a low bias estimate you should mark at least 10% of the fish population. To provide an estimate with minimal bias you need to mark 20% of the fish population. The number of fish collected on the capture run should meet the same criteria as the number of fish collected on the marking run. The number of marked fish in the recapture run should be greater than or equal to 10% of the number of fish marked.

4 - To conduct age estimates, scale data should be collected every time population estimates are attempted. Scales from a minimum of 10 fish for each length group should be collected to reduce bias of your age estimates. Scale collections should be taken based on your analysis interval.

5 - For all Log-likelihood Estimations the following criteria must be met:
  - Coefficients of Variation (CV) should be
    <0.3 to produce length group estimates with low variability
    >0.3 produces an unacceptable high length group variance
  - In general the pooled chi-squared p-value should be $>.05$ for acceptable model fit, however the p-value does not determine estimate quality.

M/R Estimate Distribution and Quality Rating Recommendations

1 - All fish population estimates will be labeled as provisional until submitted in a written report (grey literature/DJ report, peer reviewed publications).

2 - When reporting mark/recapture estimates always include:
  - confidence intervals for all estimates (length groups, age classes, biomass)
  - sample size
  - quality rating (to be developed by committee)
  - a standard disclaimer (to be developed by committee)

3 - Data should not go into MRIS until it is published in a report (see #1).

Prioritized List of Desired Features for Next M/R Release

1- Complete bootstrapping computation of confidence intervals.

2 - Develop a comprehensive database of population estimates for use by individual biologists. This data base should be able to manipulate the estimates and confidence intervals.

3 - Develop alternate estimate routines for removal, multiple pass, and catch-per-unit effort.

4 - Enhance the editor by adding carry and freeze features.

Recommendations for Future Actions

1 - Form a revolving committee of at least three people to review all department estimates. This committee will also set up a quality rating system and label all estimates with the appropriate rating. This committee will also review all estimates before they are entered into MRIS.

2 - Look into getting a group together to discuss the fish aging process.

3 - Form a group to set guidelines for depletion estimates.

4 - Maintain collection code assignment from Bozeman and develop a system to archive all final raw data from M/R estimates.

5 - Hold this workshop more often in the future, at least once every two years.

Review

A draft of this report was sent to every participant for their input. These comments were incorporated into a final draft that was sent to every regional fisheries manager for comments (see memo in Appendix D). All comments received are given in Appendix D.

Appendix A

Mark/Recapture Workshop Attendees

Wayne Black
Pat Clancy
George Liknes
Pat Byorth
Clint Folden
Les Everts
Anne Tews
Eric Reiland
Mark Lere
Mike Vaughn
Ken Frazier
Mike Poore
Chris Downs
Steve Dalbey
Tom Ostrowski
Scott Snelson
Wayne Hadley
Joel Tohtz
Javier Urbanski
Rick Hunt
Gordon Pierson
Tim Swanberg
David Schmetterling
Brad Shepard
Jim Brammer

AGENDA
MARK/RECAPTURE TRAINING SESSION

WHEN: JUNE 19, 20, 1997
WHERE: Room 302, REED HALL, MSU, Bozeman
HOSTS: Stuart Brittain, Bob McFarland (ISU)
Mark Lere, (FWP Fisheries)
GUEST SPEAKER: Jay Rottella, MSU

Thursday, June 19:

- 9:00 a.m. Introduction to Mark/Recapture for Windows
  - A demo and hands-on training using MR4 for Windows
  - Demo the new software.
  - Attendees use software on sample data sets.
  - Discussion of methods and ramifications.
- 1:00 p.m. Population Estimate Overview
  - Jay Rotella, Professor Wildlife Biology, MSU
  - Definition of an estimate.
  - Various methods and their assumptions.
    - Mark/Recapture Methods
      - Peterson style estimates
      - Log-likelihood estimates
    - Depletion Estimates
      - Two-pass
      - Multi-pass
- 2:00 p.m. Guidelines to Quality
  - Interactive session discussing various examples.
  - Guidelines for identifying poor data and estimates.
  - Analyze attendee supplied examples.

Friday, June 20:

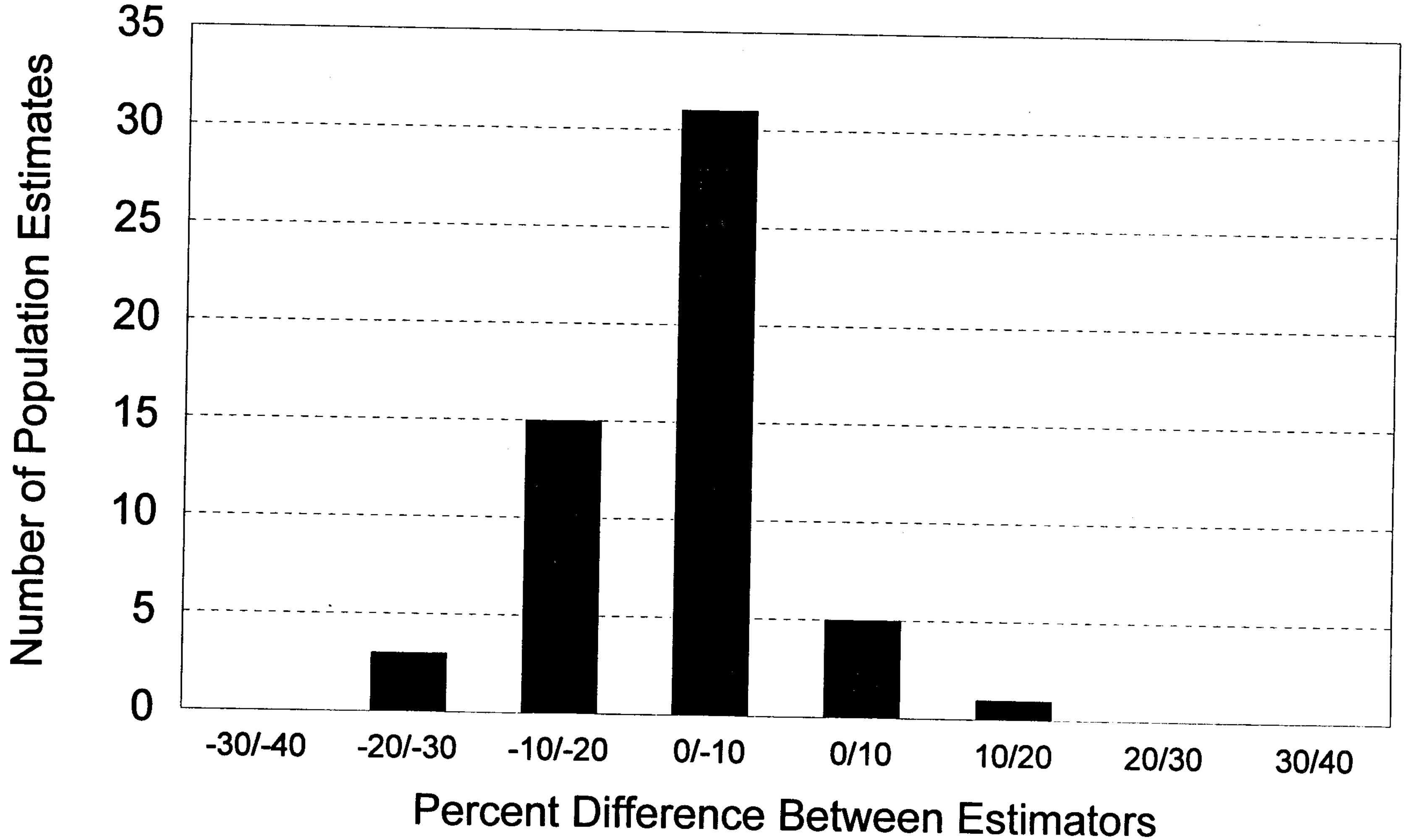
- 9:00 a.m. Quality Control - A Philosophical Discussion
  - Facilitator: Rob Brooks, FWP
  - A discussion revolving around QC procedures for FWP Fisheries population estimates
  - Should we have an estimate Czar? Population Estimate Committee?
  - Should we publish a list of recommendations?
  - Recommended reading list. (Bibliography supplied by ISU)
  - Distribution of estimates
    - Who gets them?
    - Estimate quality index or rating system?
- 11:00 a.m. MR5 Wish List
  - Facilitator: Rob Brooks, FWP
  - How can software increase a biologists confidence in quality of an estimate?
  - Desired functionality and features of next population estimate system produced by ISU.
- 12:00 p.m. Adjourn

Appendix B

Madison River - Rb/LL Estimates

Comparison of Peterson's to Log-Likelihood

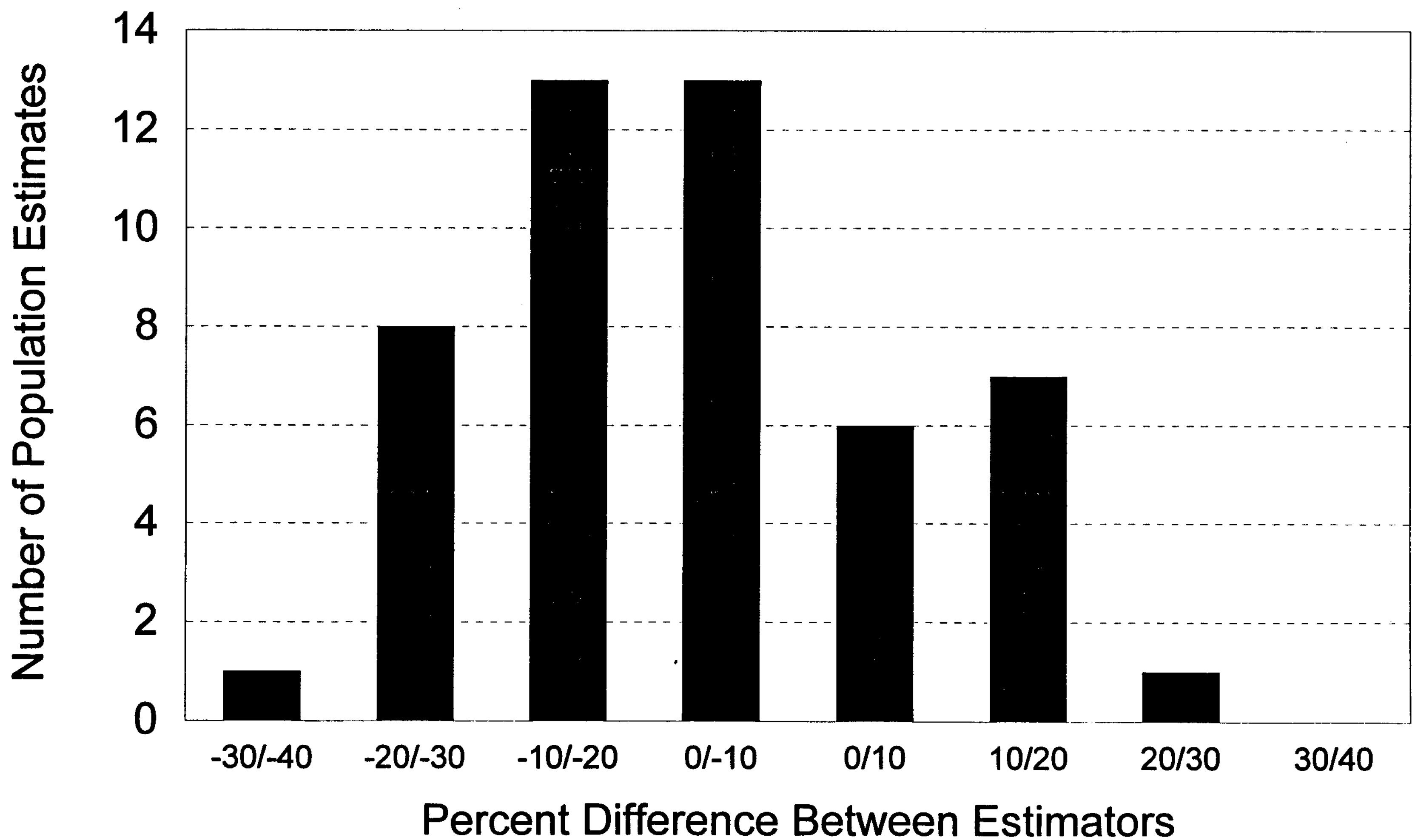
Total Estimate - Number of Population Estimates=55



Madison River - Rb/LL Estimates

Comparison of Peterson's to Log-Likelihood

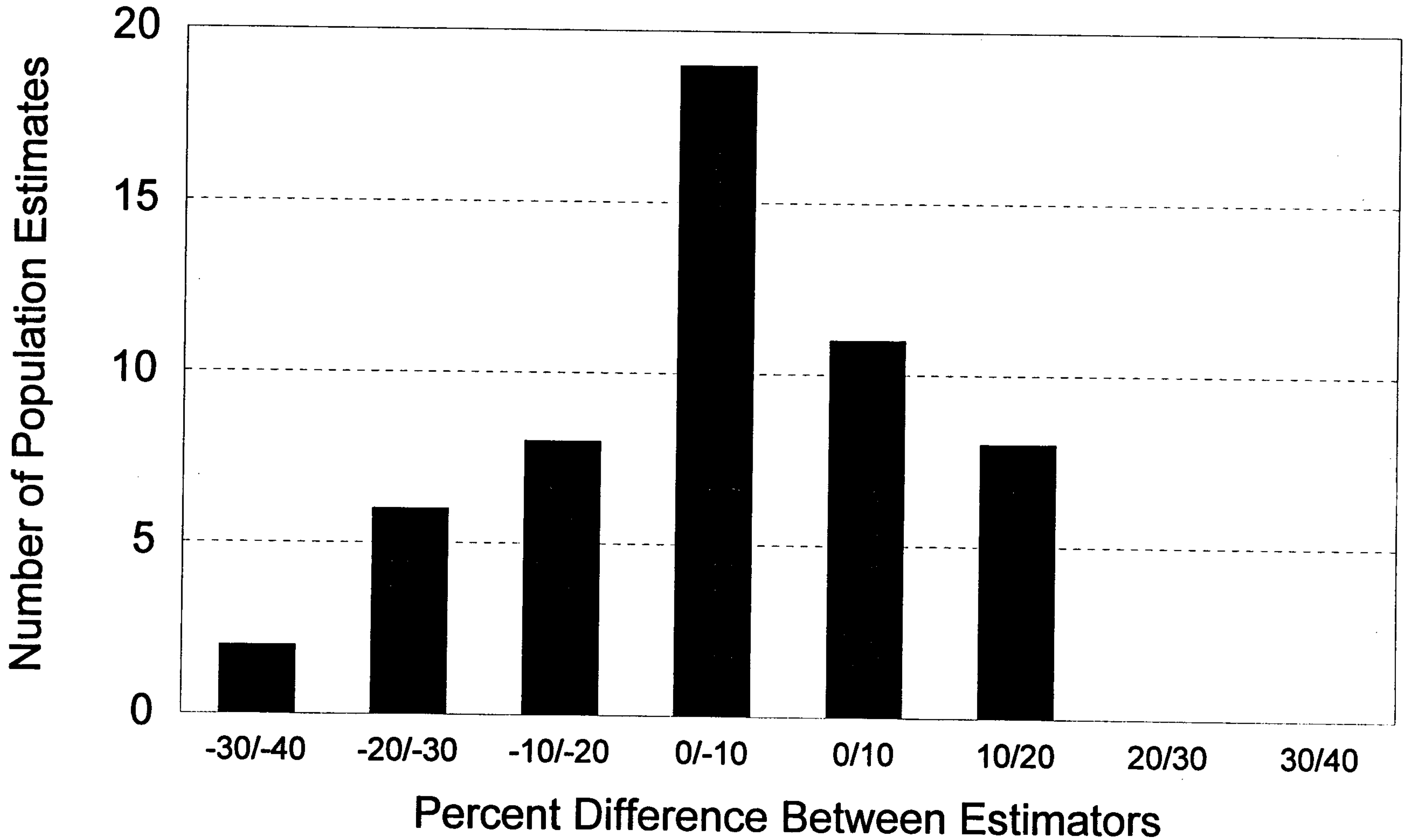
Age I - Number of Population Estimates=49



Madison River - Rb/LL Estimates

Comparison of Peterson's to Log-Likelihood

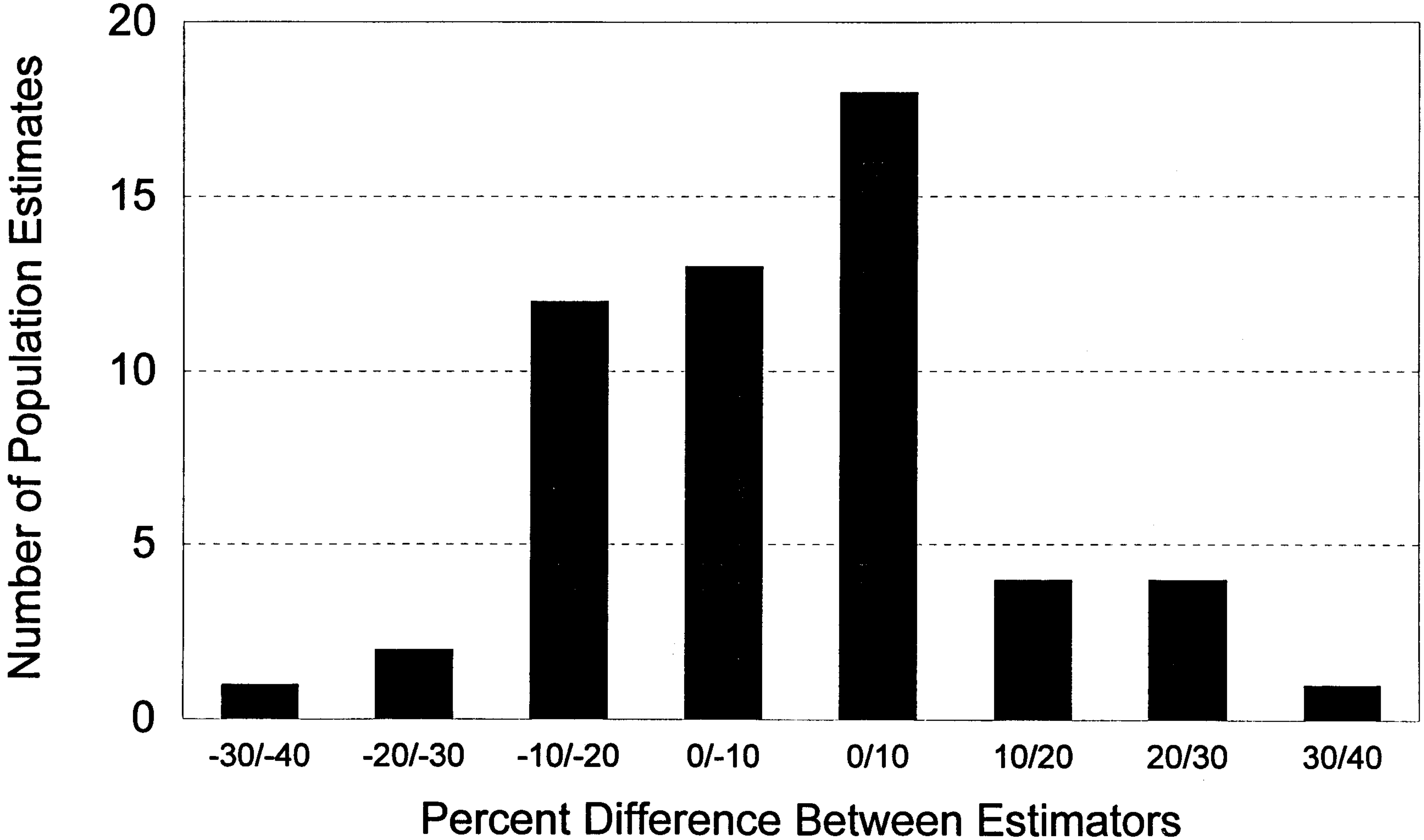
Age II - Number of Population Estimates=54



Madison River - Rb/LL Estimates

Comparison of Peterson's to Log-Likelihood

Age III - Number of Population Estimates=55



Appendix C

Mark-Recapture methods for estimating population size in streams using multiple-pass electrofishing

Goal of sampling is to estimate population size. Thus, we develop an estimate of the parameter N, which is represented by N-hat

When we capture c fish, $N = c / p$, where p = the probability of capturing a fish. This equation is a model (albeit a very simple model) that allows us to use our data to develop an estimate. The model has a set of assumptions that go with it.

1. the population is closed
2. animals do not lose their marks during the experiment
3. all marks are noted and recorded correctly
4. constant and equal probability of capture for all

If we meet the assumptions, then our model gives us reliable estimates of N, and measures of precision about N (variance). That is, we can develop unbiased estimates of N. If we obtain adequate samples, our estimates will also have good precision (overhead of precision, accuracy, and bias).

An example shows how we can use our model to estimate N. If we catch 100 fish on a single pass and know that there is a 50% chance of catching each fish on each pass, then we can calculate that there are 200 fish in the given stretch of river.

Since we don't know p, we estimate it by marking fish, doing a second pass, and counting how many of the marked fish are caught again.

Example:
Catch 30 fish on pass 1 and mark them.
Catch 36 fish on the second pass, 10 of which are marked.
Estimate p as 10/30, which is 0.3333.
Estimate N as 36/0.3333, which is 108.

This concept is used in many instances in fish & wildlife studies. Consider it any time you are counting animals! Ask yourself: is the probability of capture, sighting, etc. = 1.0. If it's not then you need to estimate p and consider factors that might influence p (e.g., habitat, weather, observer, equipment, etc.).

The example above is from Lincoln-Petersen and has been around for 45 years. Unfortunately, the model is very simplistic and does not likely hold in all instances. The problem is that capture probability (p) must be constant from the first pass to the second - this is a critical assumption.

Capture probabilities can vary by:
1. time - weather, effort, personnel, equipment
2. an animal's capture history - behavioral response to trapping
3. individual animal - size, dominance, habitat occupied, sex

Thus, we would like to test assumption #4 from our list of assumptions. If we violate the assumption, we would also like to have other models that we can use to estimate N in the face of assumption violations. These other models are called competing models and deal with modeling capture probabilities. Many studies have clearly indicated that capture probability is rarely constant among all animals or all capture events.

Competing models:

1. M_0 - capture probabilities are constant. This is the simplest model (handles the fewest situations) and is used as a baseline for comparison unless good solid work has shown that *p* is constant.
2. M_t - capture probabilities vary with trapping occasion or by time. This situation can be common even when equipment and personnel are constant through time.
3. M_b - capture probabilities vary as a function of capture history. Animals that have previously been caught are either more or less likely to be caught again than those animals that have not been caught previously. If animals are injured during trapping, this model may apply because injured animals are less likely (or more likely) to be caught again. The data can look a lot like data from M_t except that one usually sees a steady increase or decrease in daily captures.
4. M_h - capture probabilities vary by individual.
5. M_{tb} - *p* varies as a function of time and capture history.
6. M_{th} - *p* varies as a function of time and characteristics of individuals.
7. M_{bh} - *p* varies as a function of capture history and characteristics of individuals - equals a generalized removal estimator even if not removing animals (generalized means it will work in more removal experiments than the simpler removal model - M_b)
8. M_{tbh} - *p* varies as a function of time, capture history, and characteristics of individuals. This is the most general model because it fits the most situations. Unfortunately, N cannot be estimated with this model as we will see below.

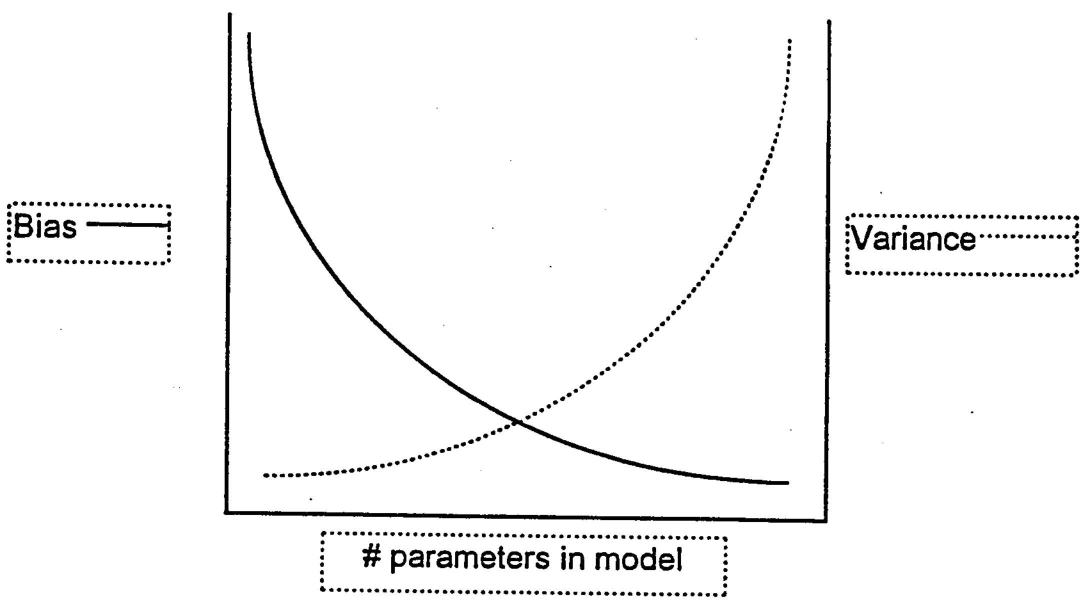
We would like to use the simplest model that fits our data, i.e., the simplest model that is appropriate.

Characteristics of models:

1. M_0 - estimate N and $p = 2$ parameters (easily have enough data - need at least 1 more data point than the number of parameters to be estimated = degrees of freedom).
1. M_t - estimate N and $p_1, p_2, p_3, \ldots p_t = t+1$ parameters
2. M_b - estimate N, *p*, and *c* (recapture probability) = 3 parameters. When this occurs, you analyze only new captures and treat it as a removal study - but better to use M_{bh}
3. M_h - estimate N and *p* for each individual - actually broken into a small number of probabilities so that can work with the situation - otherwise potentially have to estimate N + 1 parameters, which is never possible
4. M_{tb} - estimate N, *p* for each trapping occasion, and *c* for the second occasion onward, which can be up to 2 x t parameters that must be estimated.
5. M_{th} - N plus a unique *p* for each animal on each occasion

6. M_{bh} - ignore recapture data (turn the study into an analysis of removal data) so that behavioral effects can be ignored and deal with M_h. Basically dealing with a set of M_b studies: have groups of animals and within each group animals have similar *p* but among groups, *p* varies; all groups have behavioral response to trapping. Can often do quite well by modeling 2 groups - easily caught and difficult to catch. Sometimes will need to model 3 *ps*.
7. M_{tbh} - can't be dealt with - too many parameters to estimate - have to use one of the other model.

Why are we using the simplest model that fits the data? Why not just use the simplest model all the time or use the most general?



The concept of choosing the simplest model that fits the data is referred to as parsimony.

How do we choose the simplest model?
Program CAPTURE - free on the internet from CSU

The software evaluates the models and chooses the best model for the given data set.

The software also provides confidence intervals, point estimates of population size, and results of comparison tests among the different models.

An important note: due to the way in which confidence intervals are constructed, they are often not symmetrical about the point estimate of population size. Thus, it is good to provide both the point estimate of N, which is your best estimate of N, and the CI bounds, which indicate how precisely you have estimated N.

Thoughts on data collection:

1. Consider whether **closure** can be maintained. Note: no test of this assumption is possible as open populations appear to the software to be closed populations with *p* varying by time or capture history. A test is only possible if assume M_0 or M_h.
    - a) Since you can relax assumption #4, this is the key assumption to attaining reliable estimates.
    - b) keep the experiment as short a duration as possible
    - c) incorporate telemetry when possible to test for closure (also can test for marker loss)
    - d) consider open-population models if necessary
2. Review the 4 major assumptions and attempt to reduce time effects as they are somewhat in your control - you don't want to end up with M_{tbh}.
    - a) time effects are difficult to deal with in the presence of other factors that affect *p*.
    - b) expend equal effort on each trapping occasion.
    - c) if possible, avoid behavioral responses to trapping by appropriate choices of methods.
    - d) heterogeneity can be handled by conducting a stratified analysis, e.g., perhaps stratify by size class.
    - e) if stratification is to be useful, you will need adequate samples in each stratum.
    - f) use $t > 2$ so that can test assumption regarding constancy of *p* and choose appropriate model if *p* is not constant
3. Capture the maximum number of animals possible including recaptures.
    - a) need sufficient numbers of captures and recaptures
        - i) low bias if mark $\geq$10% of the population and recapture $\geq$10% of the marked animals
        - ii) good CI coverage and reasonable CI width if capture and recapture $\geq$20% of the population
    - b) want at least 30-60 different animals as a minimum to be caught
        - i) this means that if *p* is 0.5 can work with a population of 60 and get reliable estimates if do a careful job
        - ii) if *p* is only 0.2, then need to have a larger population (area) to work with so that can work with 200 or so animals.
        - iii) when *t* (# of occasions) is <10, then generally need capture probabilities >0.3
    - c) technique is not reliable for $N < 20$.
    - d) if trap deaths are <5% of the total captures, then these data can be removed for analysis and added to the estimate of N
    - e) if trap deaths are >5%, consider using M_b or M_{bh}.
4. Simulations are possible.

Appendix D

Memo

Montana Fish, Wildlife & Parks

To: Regional Fisheries Managers, Dick Vincent

From: Larry Peterman LP

Subject: Mark recapture Guidelines

Date: August 8, 1997

Please review the attached draft copy of guidelines for use in making mark/recapture estimates. These guidelines were compiled by attendees from a workshop that was held in June in Bozeman.

I would like you to review the guidelines and have your comments to Bob McFarland in Bozeman by September 30, 1997. I would like to have the guidelines adopted as a standard for the Fisheries Division following this review. I would like to present the final guidelines at the winter Fisheries Division meeting.

If you have any questions regarding the guidelines you can contact Bob, Mark Lere or Stuart Brittain.

Thanks for giving this matter your attention.

Comments on guidelines:

Comment 1

Bob,

I am sorry for getting these comments back to you so late; I just received this route to my desk last week. I am wondering in the future could you send a copy of these types of review documents directly to me? They seem to get lost for long periods of time up here.

My comments include:

Under draft guidelines M/R Estimate Distribution and Quality Rating Recommendations:

1 - I think it is a good idea to have estimates provisional until "published" but would like to see an electronic publishing as well. We keep going around about this issue but it seems silly for MRIS staff or evén the biologists to have to get hard copies of estimates to reenter into centralized databases. I would like to see a mechanism used and encouraged that would download into a file area even on the harddrive. When MRIS staff goes out to the regions they could copy this directory to a floppy and take it back with them. It seems like it would be fairly easy.

This problem becomes compounded when biologists don't even use their biomass estimates in their published reports or even in their files. Biomass still is part of the rating program and while we will not be doing this for quite some time again, there has got to be an easier way. So we are back to pre computers digging through files for the hard copy of the estimate to get biomass.

2- Great ideas; make biomass mandatory.

3- Issue addressed in #1; digital format would be much more exceptable rather than the reentry of data and the searching for data.

Prioritized List of Desired Features

Great ideas; #2 and #3 would be my first priorities.

Recommendations for Future Actions

Good ideas; the committee to review every estimate may get somewhat cumbersome; I think the fisheries manager in each region could serve as the reviewer. Our use of estimates has been for the rating program; we have removed it from the distributed program that is outside the department. I envision future reporting of population estimates in MRIS as trends in the form of graphs.

Thanks Bob for the opportunity to comment.

Comment 2
We need the program to automatically test for Robson-Reiger criteria.

Is the number of recaps >=3 per size group for both Peterson and Log-likelihood?

I don't believe that "groups greater than 3 inches among intermediate size classes violates the assumption" is always true. The slope of the actual efficiency curve is what matters.

Is "the number of marked fish in a recap run >= 10% of the marked population" for individual groups or the population as a whole?

Confidence intervals for all estimates need to be added to the program.

I thought it was 20 fish per length group instead of 10 fish.

Memo

To: Mark/Recapture Users

From: Larry Peterman LP

Subject: Mark/recapture guidelines

Date: May 5, 1998

Attached are the Mark/recapture guidelines that were developed from a workshop held in Bozeman in June, 1997. The guidelines have been adopted by the division and should be used when making estimates with the mark/recapture system.

Some of the highlights are as follows:

* A revolving committee will be formed within the Fisheries Division to establish a quality rating system for mark recapture estimates and a standard disclaimer will be developed for all FWP generated estimates.

* This revolving committee will review all FWP generated mark-recapture estimates and will label all estimates with an appropriate quality rating.

* All FWP generated mark-recapture estimates will be labeled as provisional until review by committee and submitted in a report (grey lit or peer reviewed).

* All FWP generated mark-recapture estimates shall not be input into MRIS until reviewed by the revolving committee and published in a report (grey lit or peer reviewed)

If you have any concerns or questions regarding these guidelines, please contact Bob McFarland at (406) 994-6355 in Bozeman.