STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-5

Study No.: 230721

Title: Design, analysis, and implementation of aquatic resource inventory in Michigan.

Period Covered: October 1, 2003 to September 30, 2004

Study Objectives: (1) Assist in the continued design, analysis and reporting of a sampling plan for a statewide inventory of aquatic resources that Fisheries Division is responsible for.

Summary: Two book chapters and two training modules were developed in support of the analysis and reporting needs for the resource inventory program. A stochastic model was developed to simulate the statistical dynamics of lakes, and continues to be refined as better information regarding the variance components becomes available. I have also worked with Todd Wills and Kevin Wehrly to identify additional analysis tools needed, and to develop a general strategy for reporting results from the statewide resource inventory.

Findings: Jobs 1 through 6 were scheduled for 2003-04, and progress is reported below.

Job 1. Title: <u>Chair the Resource Inventory Planning Committee.</u>–Project amended to drop this job because committee was disbanded in December 2002.

Job 2. Title: <u>Develop and present training modules.</u>– Following the presentation of a two-day continuing education course (29-30 Sept, 2003) on the theoretical basis and application of statistical sampling, I refined the course and will present it again in December 2004. I have also submitted a course approval request to the American Fisheries Society on population estimation (Attachment A). If approved, this course will be presented in February 2005. Associated with each of these courses, I have co-authored a chapter for an upcoming book entitled "Analysis and interpretation of freshwater fisheries data" sponsored by the American Fisheries Society. Citations for these chapters are as follows.

Hansen, M., D. Beard, and D. B.Hayes In revision. Sampling and experimental design. Chapter in Guy, C., and M. Brown (eds.) Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, MD.

Hayes, D. B., J. Bence, T. Kwak, and B. Thompson. In press. Abundance, biomass and production. Chapter in Guy, C., and M. Brown (eds.) Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, MD.

Job 3. Title: <u>Analyze the performance of fixed sampling sites.</u>–A stochastic model was developed to simulate various sampling designs, included varying proportions of fixed sampling sites. Attachment B contains the SAS program used to generate simulated catches of lakes. These data are then used with previously developed SAS programs to sub-sample and analyze the data using candidate statistical models. Additional research is needed to determine the most appropriate values for the variance components incorporated into the simulation. I have contacted Kevin Wehrly, and it appears that data should be available to empirically determine reasonable values for each of the variance components.

Job 4. Title: Assist in the development of analysis and reporting tools.–The book chapters cited above contain material useful in the analysis and reporting of resource inventory data. I have met with Todd Wills and Kevin Wehrly of the Fisheries Division, Michigan Department of Natural Resources to discuss tools needed for the analysis and reporting of resource inventory data.

Job 5. Title: Assist in the production of a publication for the general public reporting the results of state-wide sampling.–I have met with Todd Wills and Kevin Wehrly to develop general strategies for producing reports. They will be taking the lead on the production of publication(s), and their schedule will determine the timing of writing, review and publication.

Job 6. Title: Prepare annual report and communicate program results.–No work was done on this job during the current year except for preparing this report.

Prepared by: Daniel Hayes
Dated: September 30, 2004

Attachment A.–Course request form for population estimation course.

I. TITLE OF PROGRAM

FISH POPULATION ESTIMATION

I. PROGRAM CODES

A. COURSE INSTRUCTION CATEGORY

- ☐ *1. Classroom Instruction*
- √ *2. Lecture/Lecture with lab*
- ☐ *3. Workshop/Institute/Conference Seminar*
- ☐ *3. Field Instruction*

B. COURSE TYPE

- ☐ *1. 1000 Bioengineering*
- ☐ *2. 1100 Early Life History*
- ☐ *3. 1200 Introduced Fishes*
- ☐ *4. 1300 Fish Health/Culture*
- ☐ *5. 1400 Leadership/Communications*
- ☐ *6. 1500 Socioeconomics*
- ☐ *7. 1600 Education*
- √ *8 . 1700 Population Management/Techniques*
- ☐ *9. 1800 Marine Fisheries*
- ☐ *10. 1900 Water Quality*
- ☐ *11. 2000 Computer Science in Fisheries*
- ☐ *12. 2100 Fish Habitat Management/Techniques*
- ☐ *13. 2200 Policy/Administration*
- ☐ *14. 2300 Environmental Law*
- *15. 2400 Other—Specify* ______________

II. PROGRAM PROVIDER(S) *(i.e. Chapter, Section, Division, Agency, University)*

Michigan Chapter AFS

III. COURSE CONTACT

Name: Daniel Hayes
Address: 334C Natural Resources Building, Dept. Fisheries and Wildlife, Michigan State University
City, State, Zip, Country: East Lansing, MI 48824-1222, USA
Phone: 517-432-3781 Fax: 517-432-1699
E-mail: hayesdan@msu.edu

Attachment A.–Continued.

IV. DATES & LOCATION

Beginning Date: In conjunction with Chapter meeting, Feb 2004
Meeting Place: Ralph McMullan Center,
City, State or Province: Roscommon, MI

V. REQUESTING CONTINUING EDUCATION UNIT CREDIT?

YES

If not requesting CEU credit, complete items VII, VIII, IX (you are encouraged to complete all remaining items). If requesting CEU credit, complete all remaining items.

VI. NEEDS IDENTIFICATION: Clearly identify the needs for the planned program/activity for participants, their supervisors, their organization and/or profession. Discuss what changes or advancements in technology that have occurred and the relevancy of the planned program/activity to address the changes to participants. Take into consideration other complementary and competitive courses. Clearly identify the target audience (example: new employees, journey level professionals, administrators, etc).

Needs for this course were identified from discussions with Todd Wills, chair of the Michigan Chapter AFS continuing education committee, as well as discussion with supervisors with the Michigan DNR Fisheries Division. The target audience is fishery managers and fishery researchers who need a refresher in statistical methods for fish population estimation. Although courses in population estimation are available at Michigan State University (as well as at other universities), these are generally taught over the course of an entire semester, which is inconvenient for working professionals. Further, these courses tend to be more general, whereas this course will emphasize methods commonly used in the state of Michigan, and will explore the topic in greater depth than would be covered in university courses.

Attachment A.–Continued.

OBJECTIVES OR LEARNING OUTCOMES: State what new knowledge or skill the participant will be able to utilize or perform upon completion of the course. List the learning objectives and action items associated with each objective. Learning objectives should be measurable.

At the end of the course, participants will be able to:
1) apply appropriate statistical estimators for mark-recapture and depletion population estimation methods, taking into account study design;
2) understand the consequences of violating assumptions, and identify appropriate field methodology or statistical approaches to minimize problems violating assumptions would entail;
3) design mark-recapture and depletion field sampling protocols.

VII. CONTENT & METHODOLOGY: Briefly describe the topic(s) to be covered and the instructional methods that will be employed during the activity/program. Active instructional methods are strongly encouraged and should be identified. (Example: participants will learn to manipulate data in the program to complete the exercises; active discussions will incorporate problem solving techniques that participants will be able to apply upon returning to the home station.)

Instruction will be accomplished with a mix of lecture and computer laboratory exercises, as well as group discussions. Lectures will be used to cover the conceptual and statistical foundations of the methods, computer exercises will be used to develop students' proficiency in applying appropriate analytical methods, and class discussion will be used to engage students in real-life situations and problems they have encountered, and possible remedies.

The principle topics to be covered will include 1) closed population mark-recapture estimation methods; 2) closed population depletion estimation methods; 3) open population methods; 4) case studies and applications of each design.

Attachment A.–Continued.

VIII. REQUIREMENTS FOR SATISFACTORY COMPLETION:

Briefly state the requirements for satisfactory completion of the activity/program.

Attendance for the full program is required for satisfactory completion. Active participation in computer laboratory exercises and group discussion is also required.

IX. ASSESSMENT OF LEARNING OUTCOMES: Briefly state how individual performances in relation to the intended learning outcomes will be assessed.

Assessment will be primarily based on completion of computer laboratory exercises. Qualitative assessments of participation will also be used to gauge learning outcomes.

X. PROGRAM EVALUATION:

Briefly describe how major aspects of the continuing education experience, i.e. organizational input, participant input, the design, content, content level, and operation will be evaluated. Participant evaluations, which may include self-assessments, are strongly encouraged. Evaluation examples are attached at the end of this application

The program will be assessed using the standard evaluation form provided with this form.

XI. INSTRUCTION:

List the instructional personnel involved in planning and conducting the program/activity and indicate the approximate proportion of instruction time for each. A resume of up to two pages must be submitted for major instructors. *Standard: Qualified instructional personnel are directly involved in determining the program purpose, developing intended learning outcomes, and planning and conducting each learning experience.*

Daniel Hayes will be the instructor for this course. See attached resume.

XII. DETERMINING NUMBER OF CEUs TO BE AWARDED:

One CEU is awarded for each 10 contact hours of instruction. The 60-minute clock hour is used as the contact hour. Coffee breaks, lunches, etc. are not included. Field trips (minus travel and other administrative time) may be awarded CEUs, but usually on a basis of at least two hours of field trip equivalent to one contact hour of classroom instruction. Fractions of CEU's are awarded for one day or half day workshops based upon contact hours.

Attachment A.–Continued.

The following and similar activities are not included when calculating the number of contact hours:

- ***Time for study, assigned reading, and other related activities, outside the classroom or meeting schedule.***
- ***Meeting time devoted to business of committee activities.***
- ***Meeting time devoted to announcements, welcoming speeches, or organizational reports.***
- ***Time allocated to social activities, refreshment breaks, luncheons, receptions, dinner and so forth. Note: time devoted to a luncheon or dinner presentation integral to the continuing education experience may be included in calculating instructional contact hours.***

A. Please include a syllabus or topical outline with time allocations

Day 1

9:00 – 10:00 a.m.	Course introduction, basic statistical concepts
10:15 – 12:00 p.m.	Closed Populations: Mark-Recapture
1:00 – 3:00 p.m.	Computer exercises: Mark-Recapture
3:15 – 5:00 p.m.	Closed Populations: Depletion methods

Day 2

8:00 – 10:00 a.m.	Computer exercises: Depletion
10:15 – 12:00 p.m.	Open population estimation
1:00 – 3:00 p.m.	Computer exercises: Open populations
3:15 – 5:00 p.m.	Group discussions of case studies

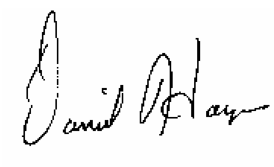
B. Total Number of Contact Hours: 14

Attachment A.–Continued.

XIII. NUMBER OF PARTICIPANTS EXPECTED TO REQUEST CEUs: 15

XVI. ADDITIONAL INFORMATION:

Submitted by:



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(NAME-PLEASE SIGN)

Daniel Hayes, Ph. D. Associate Professor

(NAME & TITLE-PLEASE PRINT)

10 September 2004______________

(DATE)

Approved by:

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(NAME-PLEASE SIGN)

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(NAME & TITLE-PLEASE PRINT)

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(DATE)

Attachment B.–SAS program used to simulate statistical properties of lake sampling programs.

```
* Program:      Data generation.sas                                                                    ;
*                                                                               ;
* Purpose:      Generate data to test sampling designs                                    ;
*                             Data on individual lakes are generated so that each lake           ;
*                             has it's own initial mean cpe and its own trend over time          ;
*
               ;
* Revisions:   Jan - Mar 2000  Initial coding                                                   ;
*                             May 2000              Augment internal commenting                        ;
*                             Jan 2002              Add log-scale variables and re-name variables       ;
*                             Sept 2004             Add in macro variables                             ;
                                                                                                       ;
*
               ;
* Critical decision points in program                                                                  ;
*                     1) Number of repetitions                                                                ;
*                     2) Number of lakes per repetition                                                ;
*                     3) Specification of overall trend and its variability                 ;
*                     4) Degree of common time effects                                                 ;
*                     5) Individual net catches - assumed number of nets and variance           ;
*
               ;
* Characteristics of data generation                                                            ;
*                     1) Initial means for each lake come from lognormal distribution           ;
*                     2) Trends among lakes are normally distributed                            ;
*                     3) Common year effects are lognormally distributed                    ;
*                     4) Lake by year effects are normally distributed                      ;
*                     5) Assume cv of net catches is 100% (i.e., mean catch = std of catch;
*                        Net catches lognormally distributed                                           ;
*================================================================================;
* Define macro variables representing critical decision points;
%let n_reps=3;        * Defines number of repetitions;
%let n_lakes=5;               * Defines number of lakes per repetition;
%let n_nets=150;      * Defines number of nets per lake;

%let initial_mean=10; * Defines mean of all lakes at starting time of simulation;
%let initial_var=100; * Defines variance of all lakes at starting time of simulation;
%let trend=1.00;        * Define trend (slope) over time.  1.0 means no change;
%let trend_std=0.1;     * Define standard deviation of trend (slope) over time.  0.0 means no variance in slopes among lakes;
%let year_effect_mean=1.00; * Define year-specific multiplier mean (should be 1.0);
%let year_effect_var=0.1;   * Define year-specific multiplier variance;

%let start_year=2000; * Define starting year for simulation;
%let end_year=2024;     * Define ending year for simulation;

%let lakexyear_mean=1.00; * Define mean for lake by year deviations from normal distribution;
%let lakexyear_std=0.05;  * Define standard deviation for lake by year deviations from normal distribution;

* Set page size options and no date and no center options;
options ps=499 nocenter nodate;
* Define library name for computer being used;
```

Attachment B.–Continued.

```
libname rip 'c:\data\dnr\invent~1\sampli~2';
*================================================================================;
* Compute lake-specific mean catch and lake-specific trend over time;
* The number of "experiments" is defined by n_reps in the first do loop;
* The number of lakes is defined by n_lakes;
* Note:  the mean and variance of this component of the data generation (and other components);
*               process was checked by generating lakes and using proc;
*               univariate to compute descriptive statistics;
data lake;
do rep=1 to &n_reps;
 do lake=1 to &n_lakes;
     * Lake specific mean (initial year) coming from lognormal distribution with mean and variance by macro variables;
     * Formula looks complicated because program allows us to enter desired mean and variance of lognormal directly;
    lakemean= exp((rannor(0) * (log((&initial_var + &initial_mean**2)/(&initial_mean**2)))**0.5 ) +
(log((&initial_mean**2)/(&initial_var + &initial_mean**2)**0.5)));
         * Lake specific trend - normally distributed with mean=1.00 and std=0.10;
    trend = (rannor(0)* &trend_std) + &trend;
   output;
 end;
end;
run;
*---------------------------------------------------------------------------------;
* Generate common time effect.  Basically this is a multiplier that;
* makes a particular year "good" or "bad" using a lognormal distribution;
data time;
* Common year effect - lognormally distributed with mean and variance specified in macro variables;
do rep=1 to &n_reps;
   do year=&start_year to &end_year;
      y_effect= exp((rannor(0) * (log((&year_effect_var + &year_effect_mean**2)/(&year_effect_mean**2)))**0.5 ) +
                   (log((&year_effect_mean**2)/(&year_effect_var + &year_effect_mean**2)**0.5)));
      output;
   end;
end;
run;
*---------------------------------------------------------------------------------;
* Generate data matrix for year*time effects.  These are lake-specific;
* deviations from general year effects and from lake-specific trend;
data L_by_Y;
do rep=1 to &n_reps;
 do year=&start_year to &end_year;
   do lake=1 to &n_lakes;
    * generate random variate;
     L_by_Y=(rannor(0)* &lakexyear_std) + &lakexyear_mean;
        * generate a random uniform variate for use as an additional lake identifier;
        * in other programs;
     index=ranuni(0);
     output;
   end;
 end;
end;
```

Attachment B.–Continued.

```
run;
*------------------------------------------------------------------------------;
* Merge lake-specific and year-specific effects with data matrix;
proc sort data=L_by_Y;by rep lake;run;proc sort data=lake;by rep lake;run;
data m1;
merge L_by_Y lake;
by rep lake;
run;

proc sort data=m1;by rep year;run;proc sort data=time;by rep year;run;
data m2;
merge m1 time;
by rep year;
run;
*------------------------------------------------------------------------------;
* Produce individual net catches with lognormal distribution;
* and mean determined by design matrix, and with a cv of 100%;
data m3;
set m2;
* This statement defines the "true" underlying cpe for a particular;
* lake in a particular year;
truecat = lakemean * y_effect * L_by_Y * (trend**(year-&start_year));
log_true=log(truecat);
* Variance of net catches is assumed to result in cv=100%;
do i=1 to &n_nets;
  catch=exp((rannor(0) * (log((truecat**2 + truecat**2)/(truecat**2)))**0.5 ) +
           (log((truecat**2)/(truecat**2+ truecat**2)**0.5)));
  log_cat1=log(catch);
output;
end;
run;

proc sort;by rep lake year;run;

* Compute underlying true catches, and  observed mean catches for all lakes;
proc summary;
by rep lake year;
id  index;
var catch log_cat1 truecat log_true;
output out=l mean=mean_cat mean_log truecat mean_lt;
run;

proc print;
run;
```