STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-4

Study No.: 721

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

Period Covered: October 1, 2002 to September 30, 2003

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: In December of 2002, the Resource Inventory Planning Committee was disbanded, and as such, my role has shifted to focus more on development and documentation of analytical techniques. Several publications and a training module have been developed that document and explain methods used in the Division's aquatic resource inventory. Work continues on statistical issues associated with the inclusion of fixed sites in lake surveys. Preliminary results indicate that the statistical model used influences the perception of which design is "best".

Findings: Jobs 1 through 6 were scheduled for 2002-03, and progress is reported below.

Job 1. Title: Chair the Resource Inventory Planning Committee.–In December 2002, the Fisheries Division Management Team evaluated the progress achieved by the Resource Inventory Planning Committee. The Management Team concluded that the Committee had achieved the majority of its charge, and the Committee should be disbanded, and a new administrative structure should be developed to oversee the implementation and continued functioning of the inventory process.

Job 2. Title: Develop and present training modules.–In April 2003, I participated in a workshop hosted by Bob Day (Michigan Department of Environmental Quality) on statistical designs for contaminant monitoring in fish. I presented a two-day continuing education course (29-30 Sept, 2003) on the theoretical basis and application of statistical sampling.

Job 3. Title: Analyze the performance of fixed sampling sites.–A stochastic model was developed to simulate various sampling designs, included varying proportions of fixed sampling sites. Preliminary results to date have focused on the interaction between the sampling design and statistical analysis model (Table 1). These results suggest that the statistical model used has important implications for the factors that can be estimated from a given design. Additional research is needed to determine the "best" or most appropriate analysis model and to determine the best design for the questions that the resource inventory is designed to answer.

Job 4. Title: Assist in the development of analysis and reporting tools.–I have written a draft of a chapter, for inclusion in an AFS-sponsored book, covering statistical aspects of population estimation. This chapter has undergone peer review, and is in the process of revision. A copy of this chapter is available at: http://www.msu.edu/user/hayesdan/chapter.htm

I have also been asked to help in the revision of a chapter in the same book, covering statistical aspects of sampling. Both of these chapters will provide useful tools and guidance for the analysis and reporting of data collected in the inventory process.

Job 5. Title: Assist in the production of a publication for the general public reporting the results of state-wide sampling.–No work has been done on this job this year.

Job 6. Title: Prepare annual report and communicate program results.–An article providing an overview of the resource inventory program was published in Fisheries (reprint attached).

Hayes, D., E. Baker, R. Bednarz, D. Borgeson, Jr., J. Braunscheidel, et al. 2003. Developing a standardized sampling program: the Michigan experience. Fisheries 28(7):18-25.

Prepared by: Daniel Hayes
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Table 1.–Estimability of factors for different sampling designs and analysis models. Simulations included a sample frame of 100 lakes, with a sample size of 7 each year, and a 25 year time horizon. Columns under the "Fix" subheading indicate model applications where the "lake" effects are treated as fixed effects. Columns under the "Mix" subheading indicate model applications where the "lake" effects are treated as random effects. A "Y" indicates effects are estimable, an "N" indicates they are not, and a "P" indicates partial estimability.

Design	Model 1	Model 2	Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
			Fix	Mix	Fix	Mix	Fix	Mix	Fix	Mix	Fix	Mix	Fix	Mix
Simple Random Sampling	Y	N	Y	Y	N	N	P	N	N	N	N	N	N	N
Random Rotational	Y	N	Y	Y	N	N	P	N	N	N	N	N	N	N
1 fixed, random rotational	Y	N	Y	Y	N	N	P	N	N	N	N	N	N	N
2 fixed, random rotational	Y	N	Y	Y	P	N	P	N	N	N	N	N	N	N
3 fixed, random rotational	Y	N	Y	Y	P	N	P	Y	N	N	N	N	N	N
Staggered panel 4 years on	Y	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N
4 fixed lakes	Y	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N
100 fixed lakes	Y	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N

Note: In all models including year_index (i.e., treating year as a categorical variable), year_index **must** be treated as a random effect if a trend is being estimated. Thus, models 2, 4, 6, 7, and 8 must be estimated as a mixed model

Note: Models 3 through 8 can treat lake and lake interactions as fixed or random effects

1. $Y = \beta_0 + \beta_1 Year$
2. $Y = \beta_0 + \beta_1 Year + \beta_{2i} Year\_index$
3. $Y = \beta_0 + \beta_1 Year + \beta_{3j} Lake$
4. $Y = \beta_0 + \beta_1 Year + \beta_{2i} Year\_index + \beta_{3j} Lake$
5. $Y = \beta_0 + \beta_1 Year + \beta_{3j} Lake + \beta_{4j} Lake * Year$
6. $Y = \beta_0 + \beta_1 Year + \beta_{2i} Year\_index + \beta_{3j} Lake + \beta_{5ij} Lake * Year\_index$
7. $Y = \beta_0 + \beta_1 Year + \beta_{2i} Year\_index + \beta_{3j} Lake + \beta_{4i} Lake * Year$
8. $Y = \beta_0 + \beta_1 Year + \beta_{2i} Year\_index + \beta_{3j} Lake + \beta_{4i} Lake * Year + \beta_{5ij} Lake * Year\_index$