STUDY PERFORMANCE REPORT

State: Michigan   **Project No.:** F-81-R-6

Study No.: 230721   **Title:** Design, analysis, and implementation of aquatic resource inventory in Michigan.

Period Covered: October 1, 2004 to September 30, 2005

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 analysis tools needed, and to develop a general strategy for reporting results from the statewide resource inventory.

Findings: Jobs 2 through 6 were scheduled for 2004-05, and progress is reported below.

Job 2. Title: <u>Develop and present training modules.</u>–I refined the two-day continuing education course on the theoretical basis and application of statistical sampling I had developed in 2003, and presented it to 22 participants in December 2004. The course on population estimation I had submitted to the American Fisheries Society, Continuing Education Committee was approved, and was presented in February 2005 to approximately 25 participants. Associated with each of these courses, I have co-authored two chapters for an upcoming book entitled "Analysis and interpretation of freshwater fisheries data" sponsored by the American Fisheries Society. Extensive revisions to the Hansen et al. chapter were undertaken in 2004-2005, and user-friendly, Excel-based spreadsheets were developed for both chapters. Citations for these chapters are as follows.

> Hansen, M., D. Beard, and Hayes, D. B. In press. 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>–I have worked with Ty Wagner (Ph.D. student at Michigan State University) in refining stochastic simulations of sampling designs. These efforts have led to a draft manuscript that is in preparation for submission to Transactions of the American Fisheries Society. We have also drafted a paper (submitted to Fisheries) discussing statistical issues associated with mixed-effects general linear models, and their appropriate application to fishery data.

Job 4. Title: <u>Assist in the development of analysis and reporting tools.</u>–The book chapters cited above contain material useful in the analysis and reporting of resource inventory data. Further, the Excel-based spreadsheets provide useful tools and examples for the analysis and interpretation of fish

1

habitat and population data. In conjunction with Todd Wills and Kevin Wehrly of the Fisheries Division, Michigan Department of Natural Resources, I have developed several SAS-based analysis programs for the appropriate analysis of resource inventory data. Copies of these draft programs are in Attachment A.

Job 5. Title: <u>Assist in the production of a publication for the general public reporting the results of state-wide sampling.</u>–I have met with Todd Wills and Kevin Wehrly to initiate the analysis and summary of data into a format suitable for reports. There remains substantial work to be done in refining the database into a form that is suitable for final analysis. In particular, summaries of sampling effort are needed for each lake sampled to allow for the calculation of appropriate measures of CPUE by net type.

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

Prepared by: <u>Daniel Hayes</u>
Dated: <u>September 30, 2005</u>

Attachment A. Draft SAS programs for the analysis of resource inventory data.

Program to rectify gear naming conventions, and to produce an effort summary by gear type.

```
libname RIP "C:\Data\dnr\Resource Inventory Lake Reporting Template Aug 2005";

options ps=200 ls=120 nocenter nodate;

data fish2003;
set rip.fish;
run;

proc sort;
by gear_type1;
run;

proc summary;
by gear_type1;
var number;
output out=dum1 n=n;
run;

/* Printout used to get list of gear_type1 for cleanup below
proc print noobs;
var gear_type1;
run;
*/

data fish2003a;
set fish2003;
 if gear_type1="1/8 inch bar maxi-fyke net"        then gear1="Small-mesh fyke";
 if gear_type1="125 ft experimental"               then gear1="Inland gillnet";
 if gear_type1="25 x 5 foot minnow seine"          then gear1="Seine";
 if gear_type1="3/4 inch bar fyke net"                 then gear1="Small-mesh fyke";
if gear_type1="4 x 25 minnow seine"                   then gear1="Seine";
if gear_type1="5x 25 x .19"                                then gear1="Seine";
if gear_type1="Boom Shocker"                          then gear1="Boom Shocker";
if gear_type1="Boomshocker"                                then gear1="Boom Shocker";
if gear_type1="DC boom"                                   then gear1="Boom Shocker";
if gear_type1="Exp Multifila Gill Net 125 ft"      then gear1="Inland gillnet";
if gear_type1="Experimental"                          then gear1="Inland gillnet";
if gear_type1="Experimental Gill Net"              then gear1="Inland gillnet";
if gear_type1="Fyke LM HAR-01"                            then gear1="Large-mesh fyke";
if gear_type1="Fyke LM HAR-08"                            then gear1="Large-mesh fyke";
if gear_type1="Fyke SM HAR 17"                            then gear1="Small-mesh fyke";
if gear_type1="Fyke net - 3/4 inch mesh"          then gear1="Small-mesh fyke";
if gear_type1="GAY Inland Trap - Large mesh"      then gear1="Large-mesh fyke";
if gear_type1="GLGN HAR 03"                                   then gear1="Great Lakes
gillnet";
if gear_type1="GLGN HAR 05"                                   then gear1="Great Lakes
gillnet";
if gear_type1="GLGN HAR 06"                                   then gear1="Great Lakes
gillnet";
if gear_type1="GRY 1 S & T 3/16 Delta Seine"      then gear1="Seine";
if gear_type1="GRY#05monofilamentEXP 125 ft"      then gear1="Inland gillnet";
if gear_type1="GRY#06 fine mesh 125ft leader"     then gear1="Small-mesh fyke";
if gear_type1="GRY#06 large mesh 100ft leader"    then gear1="Large-mesh fyke";
if gear_type1="GRY#06monofilamentEXP 125 ft"      then gear1="Inland gillnet";
if gear_type1="GRY#08 fine mesh 125ft leader"     then gear1="Small-mesh fyke";
if gear_type1="GRY#08 large mesh 100ft leader"    then gear1="Large-mesh fyke";
if gear_type1="GRY#49Smallmesh 75 ft leader"      then gear1="Small-mesh fyke";
if gear_type1="GRY#51Smallmesh 75 ft leader"      then gear1="Small-mesh fyke";
if gear_type1="GRY#53Largemesh 75ft leader"       then gear1="Large-mesh fyke";
if gear_type1="GRY#57Largemesh 100 ft leader"     then gear1="Large-mesh fyke";
if gear_type1="GRY#59 Largemesh 100 ft leader"    then gear1="Large-mesh fyke";
if gear_type1="GRY#60 Largemesh 100 ft leader"    then gear1="Large-mesh fyke";
```

```
if gear_type1="Gill Net, Experimental Mesh"        then gear1="Inland gillnet";
if gear_type1="Inland Gill Net (IGN)"              then gear1="Inland gillnet";
if gear_type1="Inland Trap Net"                          then gear1="Large-mesh trap";
if gear_type1="JAC 02"                                   then gear1="Large-mesh trap";
if gear_type1="JAC 04"                                   then gear1="Large-mesh trap";
if gear_type1="JAC 05"                                   then gear1="Large-mesh trap";
if gear_type1="Large Mesh Fyke Net (LMF)"          then gear1="Large-mesh trap";
if gear_type1="Large-mesh Fyke"                          then gear1="Large-mesh trap";
if gear_type1="Mini-Fyke"                                then gear1="Small-mesh fyke";
if gear_type1="Minnow Seine"                          then gear1="Seine";
if gear_type1="Minnow Seine 25 feet long"          then gear1="Seine";
if gear_type1="NBY Exp. Gill Net 01"               then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 02"               then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 04"               then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 05"               then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 06"               then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 07"               then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 09"               then gear1="Inland gillnet";
if gear_type1="NBY Fyke Net 02"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 03"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 07"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 09"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 11"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 13"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 16"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 18"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 21"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 22"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 23"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 24"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 25"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 29"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 33"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 43"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 45"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 52"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 61"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 63"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 64"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 65"                          then gear1="Small-mesh fyke";
if gear_type1="NBY Seine 01"                          then gear1="Seine";
if gear_type1="NBY Seine 03"                          then gear1="Seine";
if gear_type1="NBY Trap Net 03"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 04"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 06"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 07"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 08"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 09"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 10"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 11"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 12"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 13"                          then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 14"                          then gear1="Large-mesh trap";
if gear_type1="Regional Boom shocker"              then gear1="Boom Shocker";
if gear_type1="Seine (3/16 inch)"                     then gear1="Seine";
if gear_type1="Small Mesh Fyke Net (SMF)"          then gear1="Small-mesh fyke";
if gear_type1="Smith Root"                               then gear1="Boom Shocker";
if gear_type1="Smith-Root 16 S boat DNR 1999"      then gear1="Boom Shocker";
if gear_type1="Smith-Root 18 ft boat"              then gear1="Boom Shocker";
if gear_type1="Standard 6 by 3"                          then gear1="Large-mesh trap";
if gear_type1="Trap Net"                                 then gear1="Large-mesh trap";
if gear_type1="walleye harvest mini-fyke"          then gear1="Small-mesh fyke";
run;


proc sort;
by lake gear1 effort_id;
run;
```

4

```
proc summary;
by lake gear1 effort_id;
var number;
output out=sum1 n=n;
run;

proc tabulate noseps formchar="                " format=10.0;
class lake gear1;
var effort_id;
table lake ,gear1*(effort_id*n)/  misstext="0" ;
run;
```

Program to determine number of lakes sampled within each stratum

```
libname RIP "C:\Data\dnr\Resource Inventory Lake Reporting Template Aug 2005";

options ps=200 ls=120 nocenter nodate;

data fish2003;
set rip.fish;
run;

proc sort;
by event_id;
run;

proc summary;
by event_id;
id lake;
var number;
output out=event n=dummy;
run;

proc sort;
by event_id;
run;


data keys;
input new_key $ basin $ mgt_unit $ acres max_depth size_stratum $ event_id year;
cards;
71-53      H      LHN      189.24 20     M      4326     2003
26-2       H      LHS      249.36 19     M      4169     2003
71-27      H      LHN      30.33  33     S      4082     2003
44-287     H      LHS      15            17     S      4042     2003
25-11      H      LHS      545.87 78     M      4039     2003
28-56      M      LMC      1994.53       102    L   3895      2003
8-141      M      LMS      644.2  48     M      4031     2003
41-516     M      LMS      134.72 47     M      4129     2003
2-104      M      LMN      61.16  7      S      4581     2003
49-280     M      LMN      4132.92       29     L      4086     2003
36-456     M      LMN      595.97 68     M      4448     2003
38-568     E      LMS      151.5  30     M      4033     2003
2-627      S      LSE      121.71 32     M      4053     2003
48-485     S      LSE      6.65   0      T      4040     2003
48-480     S      LSE      286.25 30     M      4084     2003
17-469     S      LSE      489.73 0      M      4163     2003
48-622     S      LSE      6.04   0      T      4137     2003
66-31      S      LSW      2126.98       80     L      4544     2003
36-1936    S      LSW      120.39 40     M      4134     2003
36-1488    S      LSW      51.93  20     S      4449     2003
36-2067    M      LMN      240.06 15     M      4037     2003
71-52      H      LHN      197.03 14     M      4299     2003
48-621     S      LSE      6.64   43     T      4136     2003
35-104     H      LHS      179.17 14     M      4198     2003
81-7       E      LE       194.18 24     M      4026     2003
47-73      E      LE       29.14  0      S      4030     2003
63-673     E      LE       95.16  41     S      4023     2003
46-80      E      LE       546.44 53     M      4024     2003
1-4        H      LHN      975.48 43     M      4079     2003
69-78      H      LHN      64.91  87     S      4292     2003
69-66      H      LHN      72.85  74     S      4266     2003
71-127     H      LHN      318.65 29     M      4089     2003
27-108     S      LSW      612.26 25     M      4713     2003
60-71      H      LHN      111.72 50     M      4081     2003
69-316     H      LHN      12.34  0      S      4090     2003
60-167     H      LHN      118.52 51     M      4156     2003
65-151     H      LHS      186.22 95     M      4261     2003
15-15      M      LMC      462.9  22     M      3496     2003
48-49      M      LMN      1709.09       50     L      4087     2003
```

```
48-53        M       LMN     10346.07     25     L      4085    2003
22-383       M       LMN     345.7  0             M      4135    2003
75-294       M       LMN     13.85  40            S      4580    2003
5-89         M       LMC     368.72 31            M      3494    2003
5-27         M       LMC     172.16 13            M      3493    2003
83-3         M       LMC     1172.39      28     L      4080    2003
36-417       M       LMN     531.58 90            M      4469    2003
28-187       M       LMC     317.23 64            M      3491    2003
35-9         H       LHS     244.63 25            M      4181    2003
26-20        H       LHS     188.07 28            M      4165    2003
59-404       H       LHS     19.27  0             S      4259    2003
35-96        H       LHS     486.32 62            M      4210    2003
;
run;


proc sort;
by event_id;
run;

data all (drop=_type_ _freq_ dummy);
merge event keys;
by event_id;
if dummy=. then delete;



if size_stratum="L" and max_depth>34 then depth_stratum="Deep   ";
if size_stratum="L" and max_depth<35 then depth_stratum="Shallow";
if size_stratum="L" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="M" and max_depth>24 then depth_stratum="Deep   ";
if size_stratum="M" and max_depth<25 then depth_stratum="Shallow";
if size_stratum="M" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="S" and max_depth>14 then depth_stratum="Deep   ";
if size_stratum="S" and max_depth<15 then depth_stratum="Shallow";
if size_stratum="S" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="T" and max_depth>14 then depth_stratum="Deep   ";
if size_stratum="T" and max_depth<15 then depth_stratum="Shallow";
if size_stratum="T" and max_depth=0 or max_depth=. then depth_stratum="Unknown";

run;

data all1;
set all;
if size_stratum="L" then size_stratum="Large";
if size_stratum="M" then size_stratum="Medium";
if size_stratum="S" then size_stratum="Small";
if size_stratum="T" then size_stratum="Tiny";

if basin="E" then basin="Erie";
if basin="S" then basin="Superior";
if basin="H" then basin="Huron";
if basin="M" then basin="Michigan";
proc print;
run;

proc tabulate format=8.0;
class size_stratum depth_stratum basin;
var max_depth;
tables size_stratum*depth_stratum all, basin*(max_depth*n)all/misstext="0" printmiss;
run;

proc tabulate format=8.0 formchar="             " noseps;
class size_stratum depth_stratum basin;
var max_depth;
tables size_stratum*depth_stratum all, basin*(max_depth*n)all/misstext="0" printmiss;
run;
```

Program to determine preliminary CPUE of largemouth bass within each stratum


```
libname RIP "C:\Data\dnr\Resource Inventory Lake Reporting Template Aug 2005";

options ps=200 ls=120 nocenter nodate;

data fish2003;
set rip.fish;
run;

proc sort;
by event_id;
run;

proc summary;
by event_id;
id lake;
var number;
output out=event n=dummy;
run;

proc sort;
by event_id;
run;


data keys;
input new_key $ basin $ mgt_unit $ acres max_depth size_stratum $ event_id year;
cards;
71-53      H      LHN     189.24 20     M      4326    2003
26-2       H      LHS     249.36 19     M      4169    2003
71-27      H      LHN     30.33  33     S      4082    2003
44-287     H      LHS     15            17     S      4042    2003
25-11      H      LHS     545.87 78     M      4039    2003
28-56      M      LMC     1994.53       102    L   3895     2003
8-141      M      LMS     644.2  48     M      4031    2003
41-516     M      LMS     134.72 47     M      4129    2003
2-104      M      LMN     61.16  7      S      4581    2003
49-280     M      LMN     4132.92       29     L      4086    2003
36-456     M      LMN     595.97 68     M      4448    2003
38-568     E      LMS     151.5  30     M      4033    2003
2-627      S      LSE     121.71 32     M      4053    2003
48-485     S      LSE     6.65   0      T      4040    2003
48-480     S      LSE     286.25 30     M      4084    2003
17-469     S      LSE     489.73 0      M      4163    2003
48-622     S      LSE     6.04   0      T      4137    2003
66-31      S      LSW     2126.98       80     L      4544    2003
36-1936    S      LSW     120.39 40     M      4134    2003
36-1488    S      LSW     51.93  20     S      4449    2003
36-2067    M      LMN     240.06 15     M      4037    2003
71-52      H      LHN     197.03 14     M      4299    2003
48-621     S      LSE     6.64   43     T      4136    2003
35-104     H      LHS     179.17 14     M      4198    2003
81-7       E      LE      194.18 24     M      4026    2003
47-73      E      LE      29.14  0      S      4030    2003
63-673     E      LE      95.16  41     S      4023    2003
46-80      E      LE      546.44 53     M      4024    2003
1-4        H      LHN     975.48 43     M      4079    2003
69-78      H      LHN     64.91  87     S      4292    2003
69-66      H      LHN     72.85  74     S      4266    2003
71-127     H      LHN     318.65 29     M      4089    2003
27-108     S      LSW     612.26 25     M      4713    2003
60-71      H      LHN     111.72 50     M      4081    2003
69-316     H      LHN     12.34  0      S      4090    2003
60-167     H      LHN     118.52 51     M      4156    2003
65-151     H      LHS     186.22 95     M      4261    2003
15-15      M      LMC     462.9  22     M      3496    2003
48-49      M      LMN     1709.09       50     L      4087    2003
```

```
48-53      M     LMN    10346.07   25    L     4085   2003
22-383     M     LMN    345.7  0   M     4135   2003
75-294     M     LMN    13.85  40  S     4580   2003
5-89       M     LMC    368.72 31  M     3494   2003
5-27       M     LMC    172.16 13  M     3493   2003
83-3       M     LMC    1172.39    28    L     4080   2003
36-417     M     LMN    531.58 90  M     4469   2003
28-187     M     LMC    317.23 64  M     3491   2003
35-9       H     LHS    244.63 25  M     4181   2003
26-20      H     LHS    188.07 28  M     4165   2003
59-404     H     LHS    19.27  0   S     4259   2003
35-96      H     LHS    486.32 62  M     4210   2003
;
run;


proc sort;
by event_id;
run;

data all (drop=_type_ _freq_ dummy);
merge event keys;
by event_id;
if dummy=. then delete;



if size_stratum="L" and max_depth>34 then depth_stratum="Deep    ";
if size_stratum="L" and max_depth<35 then depth_stratum="Shallow";
if size_stratum="L" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="M" and max_depth>24 then depth_stratum="Deep    ";
if size_stratum="M" and max_depth<25 then depth_stratum="Shallow";
if size_stratum="M" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="S" and max_depth>14 then depth_stratum="Deep    ";
if size_stratum="S" and max_depth<15 then depth_stratum="Shallow";
if size_stratum="S" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="T" and max_depth>14 then depth_stratum="Deep    ";
if size_stratum="T" and max_depth<15 then depth_stratum="Shallow";
if size_stratum="T" and max_depth=0 or max_depth=. then depth_stratum="Unknown";


run;

data all1;
set all;
if size_stratum="L" then size_stratum="Large";
if size_stratum="M" then size_stratum="Medium";
if size_stratum="S" then size_stratum="Small";
if size_stratum="T" then size_stratum="Tiny";

if basin="E" then basin="Erie";
if basin="S" then basin="Superior";
if basin="H" then basin="Huron";
if basin="M" then basin="Michigan";

* Do gear re-coding;
data gear;
set fish2003;
 if gear_type1="1/8 inch bar maxi-fyke net"      then gear1="Small-mesh fyke";
 if gear_type1="125 ft experimental"             then gear1="Inland gillnet";
 if gear_type1="25 x 5 foot minnow seine"        then gear1="Seine";
 if gear_type1="3/4 inch bar fyke net"           then gear1="Small-mesh fyke";
if gear_type1="4 x 25 minnow seine"              then gear1="Seine";
if gear_type1="5x 25 x .19"                      then gear1="Seine";
if gear_type1="Boom Shocker"                     then gear1="Boom Shocker";
if gear_type1="Boomshocker"                      then gear1="Boom Shocker";
if gear_type1="DC boom"                          then gear1="Boom Shocker";
if gear_type1="Exp Multifila Gill Net 125 ft"    then gear1="Inland gillnet";
if gear_type1="Experimental"                     then gear1="Inland gillnet";
if gear_type1="Experimental Gill Net"            then gear1="Inland gillnet";
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9

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if gear_type1="Fyke LM HAR-01"                          then gear1="Large-mesh fyke";
if gear_type1="Fyke LM HAR-08"                          then gear1="Large-mesh fyke";
if gear_type1="Fyke SM HAR 17"                          then gear1="Small-mesh fyke";
if gear_type1="Fyke net - 3/4 inch mesh"        then gear1="Small-mesh fyke";
if gear_type1="GAY Inland Trap - Large mesh"    then gear1="Large-mesh fyke";
if gear_type1="GLGN HAR 03"                             then gear1="Great Lakes
gillnet";
if gear_type1="GLGN HAR 05"                             then gear1="Great Lakes
gillnet";
if gear_type1="GLGN HAR 06"                             then gear1="Great Lakes
gillnet";
if gear_type1="GRY 1 S & T 3/16 Delta Seine"    then gear1="Seine";
if gear_type1="GRY#05monofilamentEXP 125 ft"    then gear1="Inland gillnet";

if gear_type1="GRY#06 fine mesh 125ft leader"   then gear1="Small-mesh fyke";
if gear_type1="GRY#06 large mesh 100ft leader"  then gear1="Large-mesh fyke";
if gear_type1="GRY#06monofilamentEXP 125 ft"    then gear1="Inland gillnet";
if gear_type1="GRY#08 fine mesh 125ft leader"   then gear1="Small-mesh fyke";
if gear_type1="GRY#08 large mesh 100ft leader"  then gear1="Large-mesh fyke";
if gear_type1="GRY#49Smallmesh 75 ft leader"    then gear1="Small-mesh fyke";
if gear_type1="GRY#51Smallmesh 75 ft leader"    then gear1="Small-mesh fyke";
if gear_type1="GRY#53Largemesh 75ft leader"     then gear1="Large-mesh fyke";
if gear_type1="GRY#57Largemesh 100 ft leader"   then gear1="Large-mesh fyke";
if gear_type1="GRY#59 Largemesh 100 ft leader"  then gear1="Large-mesh fyke";

if gear_type1="GRY#60 Largemesh 100 ft leader"  then gear1="Large-mesh fyke";
if gear_type1="Gill Net, Experimental Mesh"     then gear1="Inland gillnet";
if gear_type1="Inland Gill Net (IGN)"           then gear1="Inland gillnet";
if gear_type1="Inland Trap Net"                         then gear1="Large-mesh trap";
if gear_type1="JAC 02"                                  then gear1="Large-mesh trap";
if gear_type1="JAC 04"                                  then gear1="Large-mesh trap";
if gear_type1="JAC 05"                                  then gear1="Large-mesh trap";
if gear_type1="Large Mesh Fyke Net (LMF)"       then gear1="Large-mesh trap";
if gear_type1="Large-mesh Fyke"                         then gear1="Large-mesh trap";
if gear_type1="Mini-Fyke"                               then gear1="Small-mesh fyke";
if gear_type1="Minnow Seine"                      then gear1="Seine";
if gear_type1="Minnow Seine 25 feet long"       then gear1="Seine";
if gear_type1="NBY Exp. Gill Net 01"            then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 02"            then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 04"            then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 05"            then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 06"            then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 07"            then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 09"            then gear1="Inland gillnet";
if gear_type1="NBY Fyke Net 02"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 03"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 07"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 09"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 11"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 13"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 16"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 18"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 21"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 22"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 23"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 24"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 25"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 29"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 33"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 43"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 45"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 52"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 61"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 63"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 64"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 65"                         then gear1="Small-mesh fyke";
if gear_type1="NBY Seine 01"                        then gear1="Seine";
if gear_type1="NBY Seine 03"                        then gear1="Seine";
if gear_type1="NBY Trap Net 03"                         then gear1="Large-mesh trap";
```

10

```
if gear_type1="NBY Trap Net 04"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 06"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 07"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 08"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 09"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 10"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 11"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 12"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 13"                                 then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 14"                                 then gear1="Large-mesh trap";
if gear_type1="Regional Boom shocker"          then gear1="Boom Shocker";
if gear_type1="Seine (3/16 inch)"                  then gear1="Seine";
if gear_type1="Small Mesh Fyke Net (SMF)"      then gear1="Small-mesh fyke";
if gear_type1="Smith Root"                                  then gear1="Boom Shocker";
if gear_type1="Smith-Root 16 S boat DNR 1999"    then gear1="Boom Shocker";
if gear_type1="Smith-Root 18 ft boat"          then gear1="Boom Shocker";
if gear_type1="Standard 6 by 3"                            then gear1="Large-mesh trap";
if gear_type1="Trap Net"                                   then gear1="Large-mesh trap";
if gear_type1="walleye harvest mini-fyke"      then gear1="Small-mesh fyke";
run;

*==========================================================================================
=======;
* Select out shocking catches;
data lmb_shock;
set gear;
*Select shocking gear;
if gear1="Boom Shocker";
* Select LMB as species;
if species="LMB";
run;

* Calculate total catch for each event, all sizes combined;
proc sort;by event_id effort_id;run;
proc summary;
by event_id ;
var number;
output out=shock sum=shock_catch;
run;

* Select out largemesh trap data;
data lmb_trap;
set gear;
*Select gear;
if gear1="Large-mesh trap";
* Select LMB as species;
if species="LMB";
run;
* Calculate total catch for each event, all sizes combined;
proc sort;by event_id effort_id;run;
proc summary;
by event_id ;
var number;
output out=trap sum=trap_catch;
run;

*=================================================================;
*Calculate total effort for each gear type;
* Calculate total boom shocking effort for each event;
data all_shock;
set gear;
if gear1="Boom Shocker";
```

```
run;

proc sort;by event_id effort_id;run;

proc summary;
by event_id effort_id;
var number;
output out=effort_sum1 n=n;
run;

proc summary;
by event_id;
var n;
output out=shock_effort n=shock_effort;
run;

*Large-mesh trapnet effort;
data all_shock;
set gear;
if gear1="Large-mesh trap";
run;

proc sort;by event_id effort_id;run;

proc summary;
by event_id effort_id;
var number;
output out=effort_sum1 n=n;
run;

proc summary;
by event_id;
var n;
output out=trap_effort n=trap_effort;
run;




data effort;
merge shock_effort trap_effort;
by event_id;
run;

proc print;
run;


data catch;
merge shock trap;
by event_id;
run;




data m2;
merge effort catch;
by event_id;
run;

data catch_summary;
merge m2 all1
by event_id;
```

```
if shock_catch=. then shock_catch=0;
if trap_catch=. then trap_catch=0;
Shock_CPUE=Shock_catch/shock_effort;
Trap_CPUE=trap_catch/trap_effort;
run;

proc sort;by shock_cpue;run;
proc print;
var event_id lake basin size_stratum depth_stratum shock_CPUE trap_CPUE;
run;

proc gplot;
plot shock_cpue * trap_cpue;
run;

proc gplot;
plot shock_cpue * acres;
run;

proc corr;
var  shock_cpue  trap_cpue;
run;


/*
proc sort;by CPUE;run;
title "Boom Shocking Statistics";
proc print;
var lake basin size_stratum depth_stratum CPUE;
run;

proc univariate;
var cpue;
run;
*==============================================================================================
=======;


*/
```

Program to determine species richness by gear type within each stratum

```
libname RIP "C:\Data\dnr\Resource Inventory Lake Reporting Template Aug 2005";

options ps=200 ls=120 nocenter nodate;

data fish2003;
set rip.fish;
run;

proc sort;
by event_id;
run;

proc summary;
by event_id;
id lake;
var number;
output out=event n=dummy;
run;

proc sort;
by event_id;
run;


data keys;
```

13

```
input new_key $ basin $ mgt_unit $ acres max_depth size_stratum $ event_id year;
cards;
71-53      H     LHN     189.24 20      M       4326    2003
26-2       H     LHS     249.36 19      M       4169    2003
71-27      H     LHN     30.33  33      S       4082    2003
44-287     H     LHS     15             17      S       4042    2003
25-11      H     LHS     545.87 78      M       4039    2003
28-56      M     LMC     1994.53        102     L    3895    2003
8-141      M     LMS     644.2  48      M       4031    2003
41-516     M     LMS     134.72 47      M       4129    2003
2-104      M     LMN     61.16  7       S       4581    2003
49-280     M     LMN     4132.92        29      L       4086    2003
36-456     M     LMN     595.97 68      M       4448    2003
38-568     E     LMS     151.5  30      M       4033    2003
2-627      S     LSE     121.71 32      M       4053    2003
48-485     S     LSE     6.65   0       T       4040    2003
48-480     S     LSE     286.25 30      M       4084    2003
17-469     S     LSE     489.73 0       M       4163    2003
48-622     S     LSE     6.04   0       T       4137    2003
66-31      S     LSW     2126.98        80      L       4544    2003
36-1936    S     LSW     120.39 40      M       4134    2003
36-1488    S     LSW     51.93  20      S       4449    2003
36-2067    M     LMN     240.06 15      M       4037    2003
71-52      H     LHN     197.03 14      M       4299    2003
48-621     S     LSE     6.64   43      T       4136    2003
35-104     H     LHS     179.17 14      M       4198    2003
81-7       E     LE      194.18 24      M       4026    2003
47-73      E     LE      29.14  0       S       4030    2003
63-673     E     LE      95.16  41      S       4023    2003
46-80      E     LE      546.44 53      M       4024    2003
1-4        H     LHN     975.48 43      M       4079    2003
69-78      H     LHN     64.91  87      S       4292    2003
69-66      H     LHN     72.85  74      S       4266    2003
71-127     H     LHN     318.65 29      M       4089    2003
27-108     S     LSW     612.26 25      M       4713    2003
60-71      H     LHN     111.72 50      M       4081    2003
69-316     H     LHN     12.34  0       S       4090    2003
60-167     H     LHN     118.52 51      M       4156    2003
65-151     H     LHS     186.22 95      M       4261    2003
15-15      M     LMC     462.9  22      M       3496    2003
48-49      M     LMN     1709.09        50      L       4087    2003
48-53      M     LMN     10346.07       25      L       4085    2003
22-383     M     LMN     345.7  0       M       4135    2003
75-294     M     LMN     13.85  40      S       4580    2003
5-89       M     LMC     368.72 31      M       3494    2003
5-27       M     LMC     172.16 13      M       3493    2003
83-3       M     LMC     1172.39        28      L       4080    2003
36-417     M     LMN     531.58 90      M       4469    2003
28-187     M     LMC     317.23 64      M       3491    2003
35-9       H     LHS     244.63 25      M       4181    2003
26-20      H     LHS     188.07 28      M       4165    2003
59-404     H     LHS     19.27  0       S       4259    2003
35-96      H     LHS     486.32 62      M       4210    2003
;
run;


proc sort;
by event_id;
run;

data all (drop=_type_ _freq_ dummy);
merge event keys;
by event_id;
if dummy=. then delete;


if size_stratum="L" and max_depth>34 then depth_stratum="Deep   ";
```

14

```
if size_stratum="L" and max_depth<35 then depth_stratum="Shallow";
if size_stratum="L" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="M" and max_depth>24 then depth_stratum="Deep   ";
if size_stratum="M" and max_depth<25 then depth_stratum="Shallow";
if size_stratum="M" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="S" and max_depth>14 then depth_stratum="Deep   ";
if size_stratum="S" and max_depth<15 then depth_stratum="Shallow";
if size_stratum="S" and max_depth=0 or max_depth=. then depth_stratum="Unknown";
if size_stratum="T" and max_depth>14 then depth_stratum="Deep   ";
if size_stratum="T" and max_depth<15 then depth_stratum="Shallow";
if size_stratum="T" and max_depth=0 or max_depth=. then depth_stratum="Unknown";


run;


data all1;
set all;
if size_stratum="L" then size_stratum="Large";
if size_stratum="M" then size_stratum="Medium";
if size_stratum="S" then size_stratum="Small";
if size_stratum="T" then size_stratum="Tiny";


if basin="E" then basin="Erie";
if basin="S" then basin="Superior";
if basin="H" then basin="Huron";
if basin="M" then basin="Michigan";
* Do gear re-coding;
data gear;
set fish2003;
 if gear_type1="1/8 inch bar maxi-fyke net"      then gear1="Small-mesh fyke";
 if gear_type1="125 ft experimental"             then gear1="Inland gillnet";
 if gear_type1="25 x 5 foot minnow seine"        then gear1="Seine";
 if gear_type1="3/4 inch bar fyke net"             then gear1="Small-mesh fyke";
if gear_type1="4 x 25 minnow seine"               then gear1="Seine";
if gear_type1="5x 25 x .19"                          then gear1="Seine";
if gear_type1="Boom Shocker"                     then gear1="Boom Shocker";
if gear_type1="Boomshocker"                          then gear1="Boom Shocker";
if gear_type1="DC boom"                              then gear1="Boom Shocker";
if gear_type1="Exp Multifila Gill Net 125 ft"    then gear1="Inland gillnet";
if gear_type1="Experimental"                         then gear1="Inland gillnet";
if gear_type1="Experimental Gill Net"            then gear1="Inland gillnet";
if gear_type1="Fyke LM HAR-01"                       then gear1="Large-mesh fyke";
if gear_type1="Fyke LM HAR-08"                       then gear1="Large-mesh fyke";
if gear_type1="Fyke SM HAR 17"                       then gear1="Small-mesh fyke";
if gear_type1="Fyke net - 3/4 inch mesh"         then gear1="Small-mesh fyke";
if gear_type1="GAY Inland Trap - Large mesh"     then gear1="Large-mesh fyke";
if gear_type1="GLGN HAR 03"                              then gear1="Great Lakes
gillnet";
if gear_type1="GLGN HAR 05"                              then gear1="Great Lakes
gillnet";
if gear_type1="GLGN HAR 06"                              then gear1="Great Lakes
gillnet";
if gear_type1="GRY 1 S & T 3/16 Delta Seine"     then gear1="Seine";
if gear_type1="GRY#05monofilamentEXP 125 ft"     then gear1="Inland gillnet";
if gear_type1="GRY#06 fine mesh 125ft leader"    then gear1="Small-mesh fyke";
if gear_type1="GRY#06 large mesh 100ft leader"   then gear1="Large-mesh fyke";
if gear_type1="GRY#06monofilamentEXP 125 ft"     then gear1="Inland gillnet";
if gear_type1="GRY#08 fine mesh 125ft leader"    then gear1="Small-mesh fyke";
if gear_type1="GRY#08 large mesh 100ft leader"   then gear1="Large-mesh fyke";
if gear_type1="GRY#49Smallmesh 75 ft leader"     then gear1="Small-mesh fyke";
if gear_type1="GRY#51Smallmesh 75 ft leader"     then gear1="Small-mesh fyke";
if gear_type1="GRY#53Largemesh 75ft leader"      then gear1="Large-mesh fyke";
if gear_type1="GRY#57Largemesh 100 ft leader"    then gear1="Large-mesh fyke";
if gear_type1="GRY#59 Largemesh 100 ft leader"   then gear1="Large-mesh fyke";
if gear_type1="GRY#60 Largemesh 100 ft leader"   then gear1="Large-mesh fyke";
if gear_type1="Gill Net, Experimental Mesh"      then gear1="Inland gillnet";
if gear_type1="Inland Gill Net (IGN)"            then gear1="Inland gillnet";
if gear_type1="Inland Trap Net"                        then gear1="Large-mesh trap";
if gear_type1="JAC 02"                                 then gear1="Large-mesh trap";
if gear_type1="JAC 04"                                 then gear1="Large-mesh trap";
```

15

```
if gear_type1="JAC 05"                                                           then gear1="Large-mesh trap";
if gear_type1="Large Mesh Fyke Net (LMF)"              then gear1="Large-mesh trap";
if gear_type1="Large-mesh Fyke"                                   then gear1="Large-mesh trap";
if gear_type1="Mini-Fyke"                                        then gear1="Small-mesh fyke";
if gear_type1="Minnow Seine"                               then gear1="Seine";
if gear_type1="Minnow Seine 25 feet long"             then gear1="Seine";
if gear_type1="NBY Exp. Gill Net 01"                  then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 02"                  then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 04"                  then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 05"                  then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 06"                  then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 07"                  then gear1="Inland gillnet";
if gear_type1="NBY Exp. Gill Net 09"                  then gear1="Inland gillnet";
if gear_type1="NBY Fyke Net 02"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 03"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 07"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 09"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 11"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 13"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 16"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 18"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 21"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 22"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 23"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 24"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 25"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 29"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 33"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 43"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 45"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 52"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 61"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 63"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 64"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Fyke Net 65"                                  then gear1="Small-mesh fyke";
if gear_type1="NBY Seine 01"                               then gear1="Seine";
if gear_type1="NBY Seine 03"                               then gear1="Seine";
if gear_type1="NBY Trap Net 03"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 04"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 06"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 07"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 08"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 09"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 10"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 11"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 12"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 13"                                  then gear1="Large-mesh trap";
if gear_type1="NBY Trap Net 14"                                  then gear1="Large-mesh trap";
if gear_type1="Regional Boom shocker"             then gear1="Boom Shocker";
if gear_type1="Seine (3/16 inch)"                      then gear1="Seine";
if gear_type1="Small Mesh Fyke Net (SMF)"         then gear1="Small-mesh fyke";
if gear_type1="Smith Root"                                       then gear1="Boom Shocker";
if gear_type1="Smith-Root 16 S boat DNR 1999"     then gear1="Boom Shocker";
if gear_type1="Smith-Root 18 ft boat"             then gear1="Boom Shocker";
if gear_type1="Standard 6 by 3"                                  then gear1="Large-mesh trap";
if gear_type1="Trap Net"                                         then gear1="Large-mesh trap";
if gear_type1="walleye harvest mini-fyke"         then gear1="Small-mesh fyke";
run;


*=========================================================================================
=======;
* Select out shocking catches;
data lmb_shock;
set gear;
*Select shocking gear;
if gear1="Boom Shocker";
* Select LMB as species;
if species="LMB";
run;
```

16

```
proc tabulate format=3.0 noseps formchar="                    ";
class lake inch_group;
var number;
tables lake all, inch_group*(number*sum) all*sum*number;
run;
libname RIP "C:\Data\dnr\Resource Inventory Lake Reporting Template Aug 2005";

options ps=200 ls=120 nocenter nodate;

data fish2003;
set rip.fish;
run;

proc sort;
by event_id lake species;
run;

proc summary;
by event_id lake species;
var number;
output out=sum1 sum=total_catch;
run;

proc print;
run;

proc summary;
by event_id lake;
var total_catch;
output out=richness n=species_richness;
run;

proc print;
run;

proc sort;
by species_richness;
run;

proc print;
var event_id lake species_richness;
run;
```