GREAT LAKES FISHERY COMMISSION

2000 Project Completion Report[1]

IMSL Systems Support

by:

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April 2000

[1]Project completion reports of Commission-sponsored research are made available to the Commission's Cooperators in the interest of rapid dissemination of information that may be useful in Great Lakes fishery management, research, or administration. The reader should be aware that project completion reports have not been through a peer review process and that sponsorship of the project by the Commission does not necessarily imply that the findings or conclusions are endorsed by the Commission.

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The suggested project start date is April 3, 2000 and completion is January 31, 2001. Intermediate task completion dates discussed are listed in the *Schedule* section below.

We have discussed the following payment schedule:

Payment 1 (half): $27,450.00 + $1,921.50 (GST) = $29,371.50
Payable upon signing of the contract

Payment 2 (quarter): $13, 725.00 + $960.75 (GST) = $14,685.75
Payable upon completion of 75% of the contract work

Payment 3 (quarter): $13,725.00 + $960.75 (GST) = $14,685.75
Payable upon completion of 100% of the contract work

ESTR Tasks:

We have discussed the following tasks for ESTR categorized by their priority in the overall project.

High Priority:

- Get and load US 1995 data and handle any outstanding issues for 95-99 data
  The loading of the 1995 US data will complete the ESTR database. If possible we will use the 1995 US data load as a test for procedures for ESTR data loading and maintenance. As the result we will have a complete and up to date ESTR database for years 1995 through 1999.
- Uncertainty Analysis (coding bootstrapping and Monte-Carlo analysis)
  The approach currently examined is to use bootstrapping for variables where data is available (proportions of type 1 and 2 habitat, stream width, probability of capture, etc) or externally determined distributions for variables where direct measurements are not available (average daily growth, transformation, etc).
- Sensitivity Analysis
  The uncertainty and the sensitivity analyses will have 2 impacts. They are a key for SLIS II papers and will have an impact on future selection of streams for treatment. The content of the tasks has not been well defined yet. We will deliver code and data needed to produce key aspects of the analyses. The preliminary results of the analyses will be discussed in a meeting in mid-May.
- Calculating defaults by the system
  We need to finalize the algorithm for calculating various default values within the QASSampleUnitID and implement it. We have identified 2 alternatives (a) average of existing values; or (b) most recent value measured. The outcome of the task is the chosen algorithm implemented in ESTR and accessible from one of the menus.

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Medium Priority:

- ESTR System Improvements and Modifications:
  - 2-year Forecast, Back-cast, stream treatments

    We will have to finalize and implement the algorithms for the 2-year forecasts, the back-casts, and the stream treatments to be used within ESTR. The expected result is implemented and documented algorithms within ESTR.
- Flexible QASSampleUnit mapping and reach structure

  For QASSampleUnit mapping we will identify and implement the method required for automatic mapping of the Zone/Branch-lentic/Station coordinates to the QASSampleUnits within ESTR. We will discuss the impact of the new structure on the ESTR-LCSS data load. We recognize that small differences may not really be very important for LCSS since it is looking at the basin wide, long term forecasts, but they are important for ESTR where estimates for individual streams are critical.
- ESTR documentation
  - User's Guide

    Diana Abraham of ESSA Technologies Ltd. is currently putting together the basics of the manual and the on-line help. I will be adding more technical sections to it. The expected outcome is a completed manual with all of the necessary information for understanding and use of ESTR and on-line help integrated with the ESTR system.
  - Algorithm documentation (for interrogation by users and for SLIS II)

    Much of the algorithm documentation is imbedded in the code. The core of this task will be to extract the existing documentation along with equations, fill in the gaps and format them into a coherent document.
- Load protocols, QA/QC, integrity tests

  We have identified a number of tests for integrity of the ESTR data. Some of them were implemented in the project phase currently coming to an end as procedures in the ESTR database. This made performing of the tests easier, more complete and more consistent. One of the outcomes of this task is to finish implementing the key of the tests.

  We will also generate a plan to allow the agents load the year 2000 data with minimum of outside assistance. Implementation of such a plan will likely be iterative with refinements implemented the following years.
- Load algorithms, DB queries and links (station-to-QASSampleUnitID match) (Core items only)

  As part of the year 2000 data load we will put together a set of queries which will automate the extraction of the data from the agent databases to be readied for the load within the ESTR database. The ideal is to create a set of queries that would allow the agents to load the data directly into the ESTR database.
- Training (Core items only)

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As part of the mid-May meeting we will go over the features of the current implementation of ESTR to allow the GLFC personnel to use the system independent of any outside help.

- Version Control (who does what when) (Core items only)
  With the greater control of the system and the database by the Agents there will be a need to identify procedures for keeping the integrity and completeness of the data intact. Through a series of discussions we will identify the persons responsible and procedures needed to maintain the system and the database.
- Web/FTP distribution (Core items only)
  Web or FTP distribution has been identified as the most efficient way to distribute the central and "official" versions of the system and the database. The distribution package will be kept on a central server with a password-protected access. The distribution will be set up by GLFC personnel on the GLFC server. My will be to ensure that the site meets the needs of the distribution of the software and maintaining the software on the site until this function can be transferred to someone at GLFC.

Low Priority:

- ESTR Documentation
  - Database Documentation
- ESTR System Improvements and Modifications:
  - Different ways of sorting (e.g. SampleID – click on a column and sort by it)
  - Alternate ranking criteria (e.g. total larval population) – modify the cumulative calculations to whatever the subset or ordering is currently used.
  - Exporting different tables
  - Scheduling module and interface
  - Graph and map output
  - Age-Frequency graphs for population distribution
  - Ignore unranked streams in the L vs. C curve
  - Force stream treatments (put them on the list regardless of the rank)
  - Rank streams without assessment data

LCSS related tasks

We have discussed the following tasks for LCSS categorized by their priority in the overall project.

High Priority:

- ESTR-to-LCSS load update
  ESSA Technologies Ltd. is currently under contract to identify the procedure and load the ESTR data into LCSS. There will also be a need to identify the procedure for keeping the data within LCSS current with the updates of the ESTR data. Such procedure should minimize the manual aspect of the load. My

responsibility is to assist ESSA Technologies Ltd. in loading the ESTR data into LCSS.

- Data analysis and fill (missing data – streams without habitat data)
  Some habitat and other data are not collected regularly especially for the non-producing streams or for areas that are not infested by lamprey (e.g. above barriers). The data is necessary for full simulation within LCSS. The outcome of the task is to create a procedure and generate the missing data.
- Parameterization/Calibration
  - Initial Conditions
    The full LCSS runs begin in 1958, which will require the estimation of the lamprey levels based on our best understanding of the conditions at that time. The current system is set to use the lamprey levels calculated by running it for 50 years without treatment and averaging the last 10 years of the simulation. The setup of the initial conditions may have to be repeated to allow for adjustment in various parameters (such as growth or survival). The first outcome of this task will be an automated procedure for re-generating the initial pre-treatment conditions.
    Another aspect of the initial condition estimation is using the estimates of ammocetes within the streams in 1998 and 1999 to initialize the current year 2000 conditions within the individual streams. A challenge with initializing of the stream conditions within LCSS is that there is very little empirical data collected on the age structure of the population within streams. We will identify and implement most appropriate way to use the assessment data to initialize the year specific stream conditions. This will allow for the most accurate predictions of the production on the short term. These values will be less useful in long term runs.
    Year 1958 initial conditions are necessary for preparation of the year 2000 initial conditions since the assessment data will not be available for all of the streams.
  - End Points (e.g. get parasitic phase lamprey estimates in the right zone)
    We can use the estimates of the ammocete and the parasitic phase lamprey levels to adjust the parameters within LCSS. We will identify the appropriate indicators for the system. The outcomes of this task are the necessary queries or code to adjust parameters within LCSS based on the empirical data.
- Document parameter estimation
  Most parameters within LCSS will be estimated from the measurements. The documentation for parameter estimation will increase the system integrity and allow for more complete interrogation of the simulation results. The expected outcome of the task is the complete documentation for how all of the parameters used in the simulation model were arrived at.
- LCSS Runs
  - EIL runs/long-term

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The greatest strength of the LCSS is in its ability to produce long-term runs into the future. A series of these runs will produce estimates for the level of larval and parasitic populations of lamprey at various budget levels. When put together these will form a lamprey levels vs. cost graphs for various lakes and the overall Great Lakes basin (L vs. C curves). From this data we will also be able to infer the Economic Injury Level (EIL), a point at which the cost of non-treatment (e.g. damage to fishers) equals the cost of treatment. The outcome of this task is to produce the data necessary for the L vs. C curves and the EILs for each of the Great Lakes and overall for the Great Lakes basin.

- Baseline basin structure vs. sub-basin

  As part of this task we will also examine the influence on the lamprey levels of the subdivisions of the Great Lakes basin into various combinations of sub-basins. As well we will examine the influence of limiting the cost allocation of the treatment program to individual lakes. The outcome of this task is a series of data allowing comparison of the various combinations of sub-basins and the data comparing the effectiveness of the control program with various restrictions on distribution of the resources.

- Analysis/Output Evaluation (Deterministic Model)

  As part of preparation for the SLIS II conference we will produce analysis of influence of barriers and SMRT on the overall program cost and effectiveness. We will also examine the influence of the assumptions of the source of the current parasitic phase populations on the overall LCSS system behaviour.
  - Barriers
  - SMRT
  - Source of parasitic population (residual population vs. untreated and lentic populations)
- Assessment DB refinements and update (Core items only)

  LCSS database contains some the data collected through the assessment program. We will fill in the gaps in the current data (e.g. most recent 1998 and 1999 parasitic phase estimates) and we will examine the need for additional assessment information within the LCSS database and how best to use it.
- Sensitivity analysis (Core items only)

  We will examine the model within LCSS and its sensitivity to the various parameters.
- Stochastic calculations and error propagation (Core items only)

  We will implement stochastic calculations and error estimates within or outside of the LCSS system to examine its influence on the behaviour of the system and the various aspects of the system.
  - Treatment effectiveness and failure
  - Spawner allocation
  - Growth and transformation
  - Barriers

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- Effect on Lake Trout population size (average behaviour vs. catastrophic failure)
- Error characteristics of the L vs. C graphs
- Error characteristics for population size vs. time for various levels of suppression

Medium Priority:

- Analysis/Output Evaluation (Deterministic Model)
  Some aspects of the analysis for SLIS II are of lower priority and will be examined as time allows.
  - Density Dependence
  - Spawner Allocation
  - Chemical Efficiency
  - Growth rate vs. transformation rate
  - Lower TFM concentration (Sturgeon Protocol) – higher risk of mistreatment (not lethal throughout the whole river or lower treatment effectiveness)
  - Migration to the lentic areas

Low Priority:

- Analysis/Output Evaluation (Deterministic Model)
  - First year colonizing suppresses following year's (density dependence)
  - Baseline basin structure vs. sub-basins
- Graphic and map output
- Distribution and version control

Within the items identified by "Core items only" and we will implement the elements comprising the most important part of the task.

Schedule

We have identified the following milestones for the work listed above. All of the work will be completed by January 31, 2001.

Late April 2000: Meeting with Agents

1) Load protocols for 2000 assessment data
   - Data integrity test list, QA/QC
   - Package of data load spreadsheets or load database
   - Think through lessons learned from previous loads
   - Prepare SLIMS and other queries

2) System review, training, modification design
   - Documentation (iterative approach – documentation in draft form; ask for direction where need to elaborate more)
   - List of the ESTR system modifications suggested so far

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- Review of the scale of modifications (effort, scheduling, priority)
- Training material (handouts, presentations, overheads, etc.)

3) 95-99 database completion
   - Finish 95-99 data load
   - List of outstanding data issues
   - Combine the data sets for 95-99

4) Change of QASSampleUnits over years
   - Barriers
   - How many streams get redefined
   - Write up the description of the problem and possible solutions
   - Effort in implementation

5) LCSS parameter and estimates and fill
   - Non-producing reaches and streams (mostly habitat info, growth rates – nearest neighbour)

Late May 2000: Meeting

1) Review ESTR data 95-99
   - Finish loading all of the 95-99 data (including the "new" US 1995 data)

2) Results of ESTR 95-99 runs and analysis
   - Sensitivity analysis
   - Treatment level among years
   - Treatment effort by lake
   - Rank criteria larval vs. transformer
   - Error analysis
   - Implications of error analysis on rank order

3) LCSS parameterization and calibration
   - Habitat for streams without assessment
   - Spawner allocation and production in non-producing streams
   - Parameters for lentic areas and lentic production
   - Treatment effectiveness
   - Spawner allocation rules

4) Assessment DB review and completion update
   - Spawner run data
   - Parasitic phase lamprey
   - LCSS model calibration data (do we have the right data to calibrate the model)

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Mid-June 2000: Meeting

1) L vs. C curves
   - Finish preliminary L vs. C runs and do the preliminary analysis
   - Effects of barriers
   - Effects of spawner allocation

Mid-August 2000: SLIS II Conference

October 2000: Year 2001 rank list.

I hope that the above agrees with your understanding of the work ahead if there are any discrepancies please do not hesitate to contact me.

I'm looking forward to continuing to work with you. I'm confident that we can complete the work outlined above to your satisfaction.

Sincerely,

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Tuesday, May 16, 2000

Gavin Christie
IMSL Specialist
Great Lakes Fishery Commission
Suite 209 – 2100 Commonwealth Blvd.
Ann Arbor, Michigan
48105-1563

Dear Gavin,

As per our discussion I'm sending you this letter with a few amendments to the proposal dated April 3, 2000.

Task Revisions

In the course of work to date we have come up with additional tasks of high priority which will necessitate reassignment of time within the project. We have decided to reduce the scope and duration of the tasks listed below to accommodate new tasks and increase the scope of others. The overall cost and duration of the project has not changed.

Tasks reduced in scope:

- *Back-casting*: the algorithm for back-casting is proving elusive, we will continue to refine the algorithm, but we will differ the implementation till later.
- *Load algorithm, DB queries and links*: the agents may not require as much assistance as originally thought.
- *Training*: part of this task is already complete, the rest will be differed till later.

Tasks increased in scope:

- *System Improvements and Modifications*: we have identified additional system improvements, which will enhance the function of ESTR. The high priority items, listed below are in the process of implementation.
- *Users' Guide*: the documentation is taking longer to complete than originally through, due in part to additional System Improvements and Modifications.

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New tasks:

- *Transect Data*: Bootstrapping was identified as the preferred method for the uncertainty analysis and will require transect data for habitat variability. The task includes identifying the data structure, which will accommodate the Canadian and US data, implementing the user interface, gathering the data, and implementing the integrity tests to insure that the data loaded is complete.
- *Depth and Conductivity based Electrofishing Algorithm*: this is a new algorithm, which will be used with the 2000 assessment data. Implementing it will require database modifications to accommodate the depth and conductivity with samples, implementing and integrating the algorithm into the overall structure of the system.

New System Improvements and Modifications:

- treatments; add TreatmentList.Date
- sorting by QASSampleUnit column on the PopByLen screen
- separate ranking by transformer production (chemical efficiency is always = 1) and potential kill (chemical efficiency is as specified)
- transformers by reach (include list by QAS Sample Unit in the Ranking screen or transformer estimates with StreamPop)
- add ChemOptID fields (ExtraCrew, ExtraDays, etc.)
- add ChemOptID.LakeID and StreamID (redundant but useful for verification)
- add TreatmentList.LakeID and StreamID (redundant but useful for verification)
- Exporting different tables as CSV files

Most of these system modifications have already been started, some of them have already been completed.

Attached is a revised budget including the changes listed above.

Interim Deliverables

We have identified September 30, 2000 as the date when the project will be 75% complete. At that time we should have the following tasks completed:

- ESTR: US 1995 data load and other outstanding 95-99 data questions
- ESTR: Calculating defaults for streams
- ESTR: 2-year forecast
- ESTR: Stream treatments
- ESTR: Other Improvements and Modifications
- ESTR: Flexible QASSampleUnit mapping and reach structure
- ESTR: User's Guide
- ESTR: algorithm documentation

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- LCSS: ESTR-to-LCSS update
- LCSS: Data analysis and fill
- LCSS: Parameterization and Calibration
- LCSS: Initial Conditions
- LCSS: 1958 Initial Conditions
- LCSS: 2000 Initial Conditions
- LCSS: End Points
- LCSS: Documenting parameter estimation
- LCSS: LCSS Runs
- LCSS: EIL Runs
- LCSS: Baseline basin structure vs. sub-basins

The following tasks will be partially completed:

- ESTR: Uncertainty analysis
- ESTR: Sensitivity analysis
- ESTR: Back-cast
- ESTR: Depth and Conductivity based BPEF algorithm
- ESTR: Load protocol, QA/QC, integrity tests
- ESTR: Load algorithms, DB queries and links
- ESTR: Training
- ESTR: Version control
- ESTR: Web/FTP distribution

- LCSS: Analysis/Output Evaluation
- LCSS: Barriers
- LCSS: SMRT
- LCSS: Source of parasitic population
- LCSS: Assessment DB refinements and update
- LCSS: Sensitivity analysis
- LCSS: Stochastic calculations and error propagation
- LCSS: Treatment effectiveness and failure
- LCSS: Spawner allocation
- LCSS: Growth and transformation
- LCSS: Barriers
- LCSS: Effect on Lake Trout population
- LCSS: Error characteristics of the L vs. C curve
- LCSS: Error characteristics for population size vs. time at various
- LCSS: levels of suppression
- LCSS: Aalysis/Output Evaluation

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- LCSS: Density dependence
- LCSS: Spawner allocation
- LCSS: Chemical efficiency
- LCSS: Growth rate vs. transformation rate
- LCSS: Lower TFM concentration (Sturgeon protocol)
- Project Management

If any of the above does not agree with your understanding please feel free to contact me at my number (416)922-3674.

I'm looking forward to continuing to work on the tasks we have started on. I'm confident that we'll be able to bring them to a satisfactory completion.

Sincerely,

Miroslaw Kuc

Budget

May 16, 2000

	Rate:	$60.00 / hr	7.5 hrs/day	$450 / day
ESTR High Priority Task:			Time (days):	Cost (CDN$):
US 1995 data load and other outstanding 95-99 data questions			8.0	$3,600.00
Uncertainty analysis			10.0	$4,500.00
Sensitivity analysis			6.0	$2,700.00
Transect Data load and integration			4.0	$1,800.00
Calculating defaults for streams			1.0	$450.00
ESTR Medium Priority Tasks:				
System Improvements and Modifications				
2-year forecast			2.0	$900.00
Back-cast			0.5	$225.00
Stream treatments			1.0	$450.00
Other Improvements and Modifications			2.0	$900.00
Flexible QASSampleUnit mapping and reach structure			4.0	$1,800.00
Depth and Conductivity based BPEF algorithm			2.0	$900.00
ESTR User's Guide			5.5	$2,475.00
ESTR algorithm documentation			4.0	$1,800.00
Load protocol, QA/QC, integrity tests			7.0	$3,150.00
Load algorithms, DB queries and links			0.5	$225.00
Training			1.0	$450.00
Version control			1.0	$450.00
Web/FTP distribution			0.5	$225.00
		ESTR Total:	60.0	$27,000.00
LCSS High Priority Tasks:				
ESTR-to-LCSS update			2.0	$900.00
Data analysis and fill			4.0	$1,800.00
Parameterization and Calibration				
Initial Conditions				
1958 Initial Conditions			3.0	$1,350.00
2000 Initial Conditions			2.0	$900.00
End Points			3.0	$1,350.00
Documenting parameter estimation			2.5	$1,125.00
LCSS Runs				
EIL Runs			5.0	$2,250.00
Baseline basin structure vs. sub-basins			2.0	$900.00
Analysis/Output Evaluation				
Barriers			4.0	$1,800.00
SMRT			2.0	$900.00
Source of parasitic population			2.0	$900.00
Assessment DB refinements and update			1.5	$675.00
Sensitivity analysis			10.0	$4,500.00
Stochastic calculations and error propagation			10.0	$4,500.00
Treatment effectiveness and failure				
Spawner allocation				
Growth and transformation				
Barriers				
Effect on Lake Trout population				
Error characteristics of the L vs. C curve				
Error characteristics for population size vs. time at various levels of suppression				
LCSS Medium Priority Tasks:				
Analysis/Output Evaluation			5.0	$2,250.00
Density dependence				
Spawner allocation				
Chemical efficiency				
Growth rate vs. transformation rate				
Lower TFM concentration (Sturgeon protocol)				
		LCSS Total:	58.0	$26,100.00
Project Management			4.0	$1,800.00
		Project Total:	122.0	$54,900.00
		GST (7%):		$3,843.00
		Grand Total:		$58,743.00