GREAT LAKES FISHERY COMMISSION

1998 Project Completion Report[1]

Integrated Management of Sea Lamprey Decision Support Tools
Users Guide Version 2.0

by:

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Integrated Management of Sea Lamprey

Decision Support Tools

User's Guide

Version 2.0

Prepared for

Great Lakes Fishery Commission
Ann Arbor, Michigan

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1.0 Introduction to LCSS

The Lamprey Control Selection System (LCSS) is a software application that has been developed to assist in long- and short-term management of sea lamprey populations in the Great Lakes.

This manual provides an overview of the concepts that form the basis of the system. This section outlines the hardware and software requirements you will need to run LCSS, and provides installation instructions. Section 2 summarizes important LCSS concepts. Section 3 outlines the various functions that you will encounter when using LCSS. Section 4 describes the user interface and contains procedures and examples of how to use the system. Section 5 outlines the user interface for ISIS, the IMSL Stream Inspection System. Section 6 contains four appendices: Appendix A describes the model that forms the foundation of LCSS; Appendix B provides an overview of the database structure; Appendix C describes database-based graphing; and Appendix D is a cross-referenced compilation of all the quick tips that appear in Sections 4 and 5. Finally, Section 7 contains a comprehensive subject index to enable users to quickly located the information they need about the LCSS user interface.

Hardware & Software Requirements

LCSS requires an IBM-compatible computer capable of running Microsoft® WINDOWS™ 95. We recommend that you run LCSS on no less than a Pentium computer with 16MB of RAM and approximately 40 MB free hard drive space.

The system requires Microsoft Access (version 2.0) to support the database and interrogative routines.

LCSS is an application that was developed using Visual Basic (version 5.0 SP3).

Installation Instructions

Diskettes:

1. Start Microsoft Windows 95.
2. Place the installation disk in drive A or B.
3. From the **Start** Menu, select *Run*.
4. Type A:\SETUP.EXE (or B:\SETUP.EXE if you insert the disk into drive B).

From CD:

1. Start Microsoft Windows 95.
2. Place the installation CD in the CD-ROM drive.
3. From the **Start** Menu, select *Run*.
4. Type D:\DISK1\SETUP.EXE (where D: identifies the CD-ROM drive on your computer).

The installation program will automatically generate a group window containing a program icons and a help file icon. Whenever you wish to run LCSS, double-click on the program icon.

2.0 General Concepts

This section describes the general concepts needed for a full understanding of the Integrated Management of Sea Lamprey (IMSL) Decision Support Tools. It is phrased from the point of the Lamprey Control Selection System (LCSS), the main element of the IMSL suite and in most respects the superset of the functionality of the suite. ISIS, the other main component, shares the model and most of the internal structure with LCSS.

LCSS is a software tool designed to support the interactive design of the sea lamprey control program in the Great Lakes. The tasks performed by LCSS include:

- assistance in the development of specific annual/tactical control program plans,
- strategic cost/benefit (economic injury level) analysis of alternative levels of lamprey control,
- exploratory analysis of the effects and benefits of the development of new barriers to lamprey migration, and
- exploratory analysis of the effects and benefits of emerging control techniques such as sterile male release.

LCSS can help to integrate control program planning and research by providing a common tool for program simulation and analysis that is accessible to both control agents and research staff. As such, the system combines several practical concepts developed by the lamprey control agents in tactical program planning with concepts of population dynamics and modelling common in research circles. This section provides an overview of some important spatial dynamics concepts that form the foundation of the LCSS model. Further information about the model is in the Appendix A.

System Overview

LCSS applies control options (including lampricide treatment, barriers, traps and sterile male release) to modelled populations of larval and spawning phase sea lamprey. The system operates on an inventory of streams that have produced lamprey that have contributed to lake populations. Figure 2.1 presents the steps in the simulation of spawning migration, recruitment, transformation, treatment ranking, selection, and scheduling. The system considers lake and basin populations of parasitic phase sea lamprey and the streams and portions of streams that produce them.

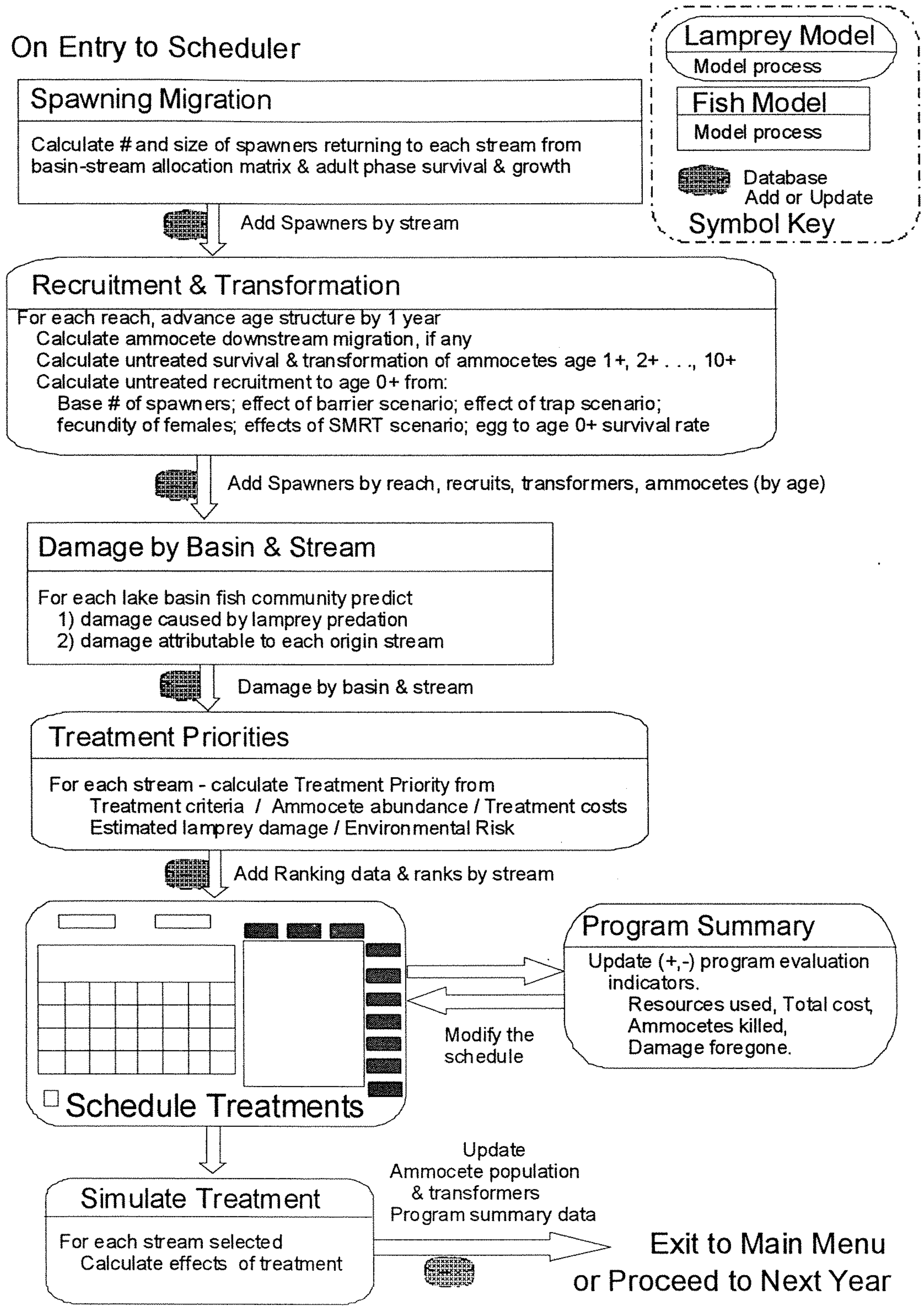


Figure 2.1: Steps in the simulation of sea lamprey populations.

Basins

The spatial structure of lakes represented in the LCSS combines the basic units in which populations of lamprey live, *Lamprey Basins*, and the spatial units in which people think about and plan control actions, *Reporting Basins*.

Lamprey Basins

A *Lamprey Basin* is defined as the area of a lake (or lakes) in which a single parasitic phase population of lamprey resides. In LCSS, a lamprey basin is defined by: I) the set of streams to which spawning phase lamprey migrate; and ii) the set of streams from which transformers migrate. The default set of lamprey basins (basin definition 1) defines each of the five Great Lakes as a basin containing a single parasitic phase population. The LCSS has the capability to define alternative sets of lamprey basins or sub-basins within a lake.

The mechanism used to assign the pattern of spawner and transformer movement allows LCSS users to specify migrations from a single stream to multiple basins (lake areas) and from multiple basins to a single stream. For example, streams located near the junction of Lakes Superior, Michigan and Huron can contribute transformers to each of these three lamprey basins and receive spawners from each basin.

Reporting Basins

A *Reporting Basin* is a collection of streams or lamprey basins for which an LCSS user wishes to summarize data.

At the level of single lake, a reporting basin and a lamprey basin define the same area. However, within a large lake such as Lake Superior, the exact number and extent of individual lamprey populations (or lamprey basins) is unknown. In addition, various management agencies have defined management areas of the lakes based on other criteria such as fishery quota management areas. The mechanisms for defining lamprey and reporting basins within the LCSS are designed to provide a high degree of flexibility in both simulating lamprey dynamics and reporting the results of alternative analyses.

Note: This function has not yet been implemented.

Reaches and Chemical Options

When planning lamprey control, chemical treatments are applied in any year over the actual extent of a stream where lamprey are abundant. The specific locations vary from year to year within a stream and consequently no single set of predefined treatment locations is in use. However, some general procedures have emerged from the program. For example, in complex streams such as the Nemadji River (illustrated below), treatments have been applied to major tributaries or portions of the stream. In some years, only the Black River or the South Fork and Net River have been treated, while in other years the entire river has been treated.

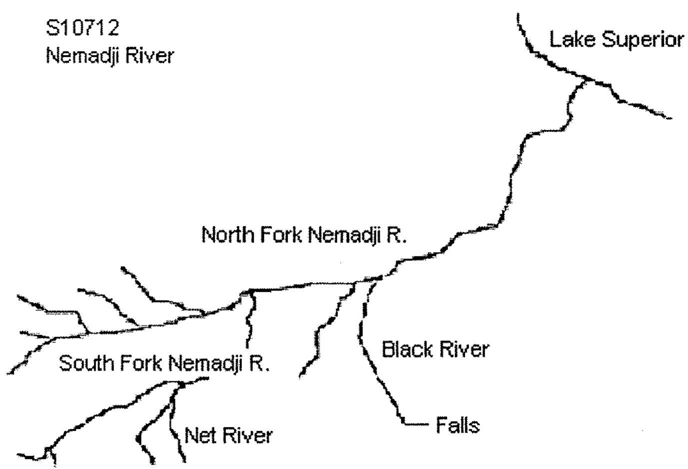
Reach

To facilitate the simulation of lamprey populations within streams treated by the LCSS, each stream that is potentially subject to lamprey control treatments has been defined as consisting of a set of one or more reaches. Each reach corresponds to a major portion of the stream that has received one or more treatments either individually or as part of a larger treatment.

Reaches are the physical portions of the stream used by larval lamprey. The sum of reach areas must total the area of the entire stream. The orientation of reaches (i.e. upstream or downstream of each other) is maintained to account for downstream movement of ammocetes and the effect of traps on upstream migrating spawners.

In the example below, the Nemadji River system has been designated as having three reaches:

- the Black River;
- the South Fork, including the Net River; and
- the main stem of the river into which the other two reaches drain.



Chemical Treatment Options

Within the LCSS database, *chemical treatment* options have been defined for each reach, and for each set of reaches which historically have been treated together.

In the example of the Nemadji system, chemical treatment options have been defined for:

- the Black River;
- the South Fork including the Net River; and for
- the entire system.

No chemical treatment options have been defined for the main stem alone, since this portion of the river is only treated in conjunction with one of the other two reaches. The simulation model within the LCSS keeps track of individual lamprey populations within each of the three reaches. When needed, the user can select a chemical treatment option which affects the desired reaches.

Barriers, Stream Configuration & Stream Barrier Activity

The concept of *Stream Configuration* provides a way to represent the change in in-stream lamprey populations when a new barrier to lamprey movement is created. If you are using the LCSS simply to schedule treatments for existing streams, with or without barriers, you should not need to worry about *stream configurations* and *stream barrier activity*. If you will be using the LCSS to explore the potential for new barrier sites, you will need to understand these concepts.

In addition to individual reaches within a stream, the LCSS keeps track of alternative stream configurations for each stream. An individual *Stream Configuration* is simply a list of reaches which together define all areas of the stream.

At least one stream configuration is defined for every stream in the LCSS database. For the vast majority of streams, the stream configuration is composed of only one reach which defines the "entire stream". For more complex streams, the stream configuration is simply a list of the various reaches that together describe the portions of the stream to which various chemical treatment options may be applied.

For any stream on which a barrier may be created, a stream configuration set has to be defined. If multiple barrier locations are to be explored, additional stream configurations may be defined as needed.

Using the example of the Nemadji River, the basic stream configuration for the river includes the Black River, the South Fork, and the main stem. If a barrier were to be placed to prevent lamprey access to a part of the system, a second stream configuration might be required, depending on the placement of the barrier. If the barrier were placed at the confluence of either the Black River or South Fork with the main stem, a new stream configuration would not need to be defined even though access to one of the reaches had been barred. Although access to a part of the river system had changed, the overall structure of the river system remains the same.

If, however, the barrier was located along the main stem of the system part way between the two major tributaries a second stream configuration would be defined for the system. Two new reaches would be described: one for the portion of the main stem of the river below the barrier and another for the portion of the main stem above the barrier. When using the new stream configuration definition for the stream, the LCSS simulation model will separately track the development of lamprey populations in these two areas. Additionally, new chemical options will need to be defined for any treatments scheduled following barrier construction. This may be done by modifying the chemical treatment options originally provided in the LCSS database. LCSS will only simulate one stream configuration for any single run. To simulate a presence or absence of barriers, we need to apply the concept of *Stream Barrier Activity*.

Stream barrier activities specify different in-stream spawner allocations. Each stream must have at least one stream barrier activity.

For streams that do have barriers, multiple stream barrier activities may be defined to specify the spawner allocation under different barrier operating conditions. At least two stream barrier activities should be defined for each barrier stream, one representing the spawner allocations to each stream reach in the "no barrier" (pre-barrier) condition and a second representing the spawner allocations when the barrier is operational. Additional stream barrier activities may be defined if needed to describe other situations (e.g., partial barrier failure, multiple barriers, etc.).

Treatment Windows

LCSS also takes into account temporal structure within the treatment season. While the underlying model functions on an annual time-step, the model can simulate effects of treating streams at different times in the season.

The flow characteristics of streams, seasonal patterns in stream biota, and the logistics of applying chemical lampricide treatments are such that for many streams, treatments are more effective at certain times of the year. For example, it may be desirable to avoid times when environmental damage to non-target species could occur, to avoid conflicts with recreational users, or to avoid periods of high water flow.

Such differences are accounted for within the LCSS by designating a specific *treatment window* to each chemical option. The date range for the treatment window is a specific attribute of each chemical option and the corresponding window is designated as being a *preferred* (P), *acceptable* (A), or *not acceptable* (N). The effectiveness of a treatment on different age classes of ammocetes can be specified for these windows. The amount of chemical required and the costs associated with each window can also be defined. Whenever possible, users should avoid scheduling treatments within negative treatment windows.

3.0 Overview of LCSS Functions

This section provides a brief overview of the major functions of LCSS and describes the general process that should be followed when using the system.

LCSS is made up of three major components:

1. *The LCSS program*. This provides an interactive interface for inputting the data that is required to define a proposed treatment schedule. Using its built-in simulation model of lamprey population dynamics, the system estimates the effect of the schedule on lamprey populations;
2. *A set of standard databases*. These contain the details of the stream inventory, standard chemical treatment options for each stream reach, definitions of the standard budget and crew resources available for carrying out the treatment program. The databases also contain the output variables from the simulation model; and
3. *A relational database management system*. This provides data management functions to LCSS, and allows users to access database review and reporting functions.

Major LCSS Functions

LCSS can be used to:

- rank streams on the basis of the potential effect of treatments on stream transformer production;
- interactively modify control schedule treatments for developing short-term control program (1 - 5 year) plans;
- simulate the effects of barriers, traps and sterile male release on lamprey populations, either separately or in concert with chemical treatments;
- run long-term (e.g. 50 year) scenarios of alternative lamprey control programs that select chemical treatment options based on user-specified stream selection criteria and logistical constraints imposed by resource availability (chemicals, people, budgetary);
- manage the retention of control program scenarios for subsequent input to Economic Injury Level (EIL) analyses, graphical inspection of relative performance, and/or numerical analysis;

- generate standard reports of control program plans, review system generated indicators of lamprey population status;
- explore the behaviour of the simulation models used by LCSS to assess the implications of alternative assumptions about lamprey population dynamics and treatment effects; and,
- manage scenarios and keep track of planning activities undertaken with the system.

The ability to explore the effects of alternative selection criteria and the implications of modifications to short-term control plans will assist in the long-term identification of preferred control plans that are consistent with maintaining lamprey populations at EIL abundance.

LCSS Scenarios

A scenario refers to the data needed to specify the conditions that will be simulated by a single simulation analysis made with LCSS. A scenario includes the following types of data:

- the starting conditions of lamprey populations (for all basins, streams, and reaches to be simulated);
- the available budget and treatment resources (e.g. crews); and
- detailed descriptions of the control treatments that are to be simulated by LCSS.

LCSS facilitates the process of defining a scenario by allowing the user to modify standard default options. Users can also maintain and carry forward variable-length scenarios of sea lamprey control programs for the Great Lakes basin. Results of scenarios can be evaluated against recent assessment data and parameter adjustments can then be made to improve the accuracy of these predictions.

LCSS simulates the following control methods for developing control plans or scenarios:

1. TFM
2. TFM bars
3. Bayer - wettable powder
4. Bayer - granular
5. Traps (normally but not necessarily limited to assessment activities)
6. Barriers - with or without traps
7. Sterile Male Release Technique (SMRT).

Alternative control techniques such as chemical treatments, traps, barriers and SMRT can be designated either individually or in combination. The databases contain default chemical treatments for any stream or part thereof. These chemical treatments can be modified to reflect the details of actual treatments as applied to meet the specific environmental conditions encountered in the field.

DEFAULT SCENARIO

When a new scenario is created, the starting data are provided by the default scenario databases. The default scenario includes the starting conditions (i.e. 1957) for lamprey in all basins, streams and reaches to be simulated; the available budget and treatment resources; and detailed descriptions of the control treatments to be simulated by LCSS. The 4 most current years population are included. The default scenario can be used to generate a complete history (use the Long-term run function and select *scheduled treatments*) or to do future simulations starting with the current year.

Modifying Scenarios

If the scenario is to simulate conditions which are not reflected in the system-standard input database, users must describe the new scenario before running the model. The following must be taken into account before developing a schedule for chemical treatments:

- any known, anticipated or hypothesized changes in barrier status (operational or not) including the planned implementation schedule for new barriers (within the calculation horizon);
- any modifications, known or anticipated, to the placement of traps in streams and operation of traps associated with barriers;
- any known, anticipated or hypothesized changes to the plans for SMRT during the time frame of the scenario; and
- the anticipated control program budget and resources available for conducting the chemical control program.

Users can describe the specific details of the new scenario using the *Scenario Description* option under the **Edit** Menu.

BARRIERS

Barrier creation and SMRT are a minor part of the current sea lamprey control program in the Great Lakes basin. Unlike lampricide control, ranking streams for the application of these methods is done outside of the current version of LCSS. However, LCSS can predict the state of larval lamprey populations in a given stream and the effect of barriers or SMRT applications. In this way, future scenarios of barrier construction and SMRT can be evaluated in terms of their effects on the ongoing chemical control program.

Barrier simulations essentially prevent sea lamprey from accessing a part or all of the stream, thus reducing the effective lamprey habitat and lowering the stream's lamprey productivity and chemical treatment priority (rank). Since some barriers may occasionally be breached, LCSS has the capability of simulating upstream populations as necessary.

Specifying the barrier placement and activity scenario requires the user to identify which streams/reaches contain barriers and the proportion of habitat accessible to lamprey when the barrier is "operational". In addition, the user may specify temporal changes in barrier activity for each year within the time-frame of the scenario.

Sterile Male Release Technique

LCSS's simulation of SMRT acts to decrease the spawning success in the stream, which may lower the stream's priority (rank) for chemical treatment. For each stream to be treated with SMRT, either the actual number of sterile males (to be/actually) released or the release rate (number released relative to natural males) must be specified. Streams that have been designated for SMRT may also be scheduled for chemical treatment.

Budgets and Resources

One of the first steps in using LCSS is to enter the available resources, the resource costs, and budgets for the current year and the years within the calculation horizon. Available resources can be presented for the overall program or its subset.

Using the resource requirements for individual stream treatments, the total resource requirements can be estimated for predicted levels of lamprey reduction.

Stream Ranking

Before scheduling streams for treatment, users must specify which criteria should be used by LCSS to estimate the relative importance of applying treatments to each stream. The criteria available for ranking streams for applying chemical treatment in any year are:

1. *maximum effect on lamprey:* the predicted number of future transformers killed by the lampricide treatment (large number killed ⇒ high rank).
2. *efficiency (benefit/cost) of lamprey reduction:* the number of future transformers killed per unit cost (large benefit/cost ⇒ high rank).
3. *reduction in economic "damage" to the fish community:* (value of lake trout * estimated lake trout mortality attributable to lamprey predation attributable to the stream): takes into account the potential damage to the lake trout stocks as a result of parasitic phase lamprey. This criterion is analogous to the maximum effect criterion of effects on lamprey (high damage/stream ⇒ high rank).
4. *efficiency (benefit/cost) of damage reduction:* equivalent to criterion (2) except measured in terms of the indirect (but primarily sought) impact on the fish community rather than the direct impact on lamprey (high damage/treatment cost ⇒ high rank).
5. *environmental risk/damage:* this incorporates those costs associated with the effect of the treatment on non-target species and the costs of remediation. These costs are added to the costs if the treatment, increasing the overall cost and lowering the rank. This option can only be used in conjunction with the "benefit" criteria (points 2 and 4 above).

You should always check the criterion setting before starting to define a treatment schedule since the selected criteria will determine the order in which streams are listed (ranked) in the treatment scheduler.

Defining the Treatment Schedule

Once users have modified the scenario according to the general procedure described above, they must develop a treatment schedule. LCSS allows users to interactively schedule treatments by displaying the list of streams to be treated in priority order (as defined by the selected ranking criteria), and a monthly calendar on which stream treatments can be scheduled.

Treatments are scheduled for individual crews and a different calendar is maintained for each treatment crew defined in the system database.

Note: in the current version, the displayed stream list includes all streams in priority order, not just those which would normally be treated by a given crew. Therefore when working with the system you may find it helpful to keep a reference list of streams which would normally be treated by the different crews.

Costing Control Program

Users can create a treatment schedule, or they can conduct an automatic scheduling. When carrying out an automatic schedule, LCSS calculates a "running" budget. The cost of the scheduled program is determined by summing the default costs for the individual stream treatments from the central database. The resource requirements and associated costs are steam-specific. Travel costs to the deployment site are considered separately from treatment costs. Depending on how the budget was structured, the cost of each treatment is subtracted from the total budget or from individual Great Lake budgets. Once all the available money is spent, no more streams will be allocated for the particular lake.

Modifying a Control Program

LCSS may be used to modify a control program, including those that are under way, as a response to unexpected logistical or climatic factors that disrupt the control schedule. Users can edit a treatment schedule to specify changes to the control program with regard to either the selection of streams for treatment or to their placement within the treatment schedule. This permits system users to explore the implications of alternative treatment selections.

Long-term Runs

In addition to using the LCSS to develop and adjust short-term lamprey control plans, it can also be used to generate long-term control scenarios. Users can compare alternative treatment selection criteria for their long-term performance and can generate the output needed to establish the form of the Lamprey Abundance (L) vs $Control_{cost}$ curve for input to EIL estimation procedures. The results from any one scenario are used to define only one point on this curve which describes the relationship between lamprey abundance and a range of control program budgets (costs). Developing the L vs $Control_{cost}$ relationship for subsequent determination of an EIL for any basin in the context of whole basin logistical and resource constraints requires simulating the effect control strategies over a series of resource (cost) levels. Scenarios must be run for a sufficiently long-term horizon so that an equilibrium level of lamprey abundance may be determined from the last few years (e.g. 5 - 10) of the simulation. The estimates of equilibrium abundance of lamprey within any basin, and the costs attributable to the basin can then be used to define L vs $Control_{cost}$.

The process of running long-term simulations is essentially the same as that described above for using the LCSS to develop short-term program plans.

Instead of using the LCSS to define or edit a detailed treatment program (including logistical constraints of crew availability and timing) you can use the *Quick Schedule* option under the **Edit** Menu to create a list of streams for treatment in each year of the scenario. This needs to be done only if you want to predefine the streams to be treated. In a longterm scheduled scenario, only the streams specified in the scheduler or *Quick Schedule* feature will be treated. The treatments applied are those selected for the streams or the defaults.

Alternately, you may use the LCSS to run a longterm *Resource Limited* scenario. When a *Resource Limited* scenario is run, the LCSS will automatically schedule streams for treatment during each year of the scenario run according to their treatment priority until resources are depleted.

4.0 LCSS User Interface

General Overview

The IMSL Decision Support System is composed of two major elements: the Lamprey Control Selection System (LCSS) and the IMSL Database Access Module. This section of the help documentation describes the user interface of LCSS and provides an overview of all menu commands and associated functions.

Throughout this documentation, certain formatting conventions have been used. These are:

Font Face	Description
italics	screen or field name (including lists, tables, and columns)
bold italics	command button
bold regular	menu or submenu option

Contents

LCSS is a software application that has been developed to assist in the long- and short-term management of sea lamprey in the Great Lakes.

From the Main Menu

File Menu

Edit Menu

LongTerm Menu

Graph Menu

Database Menu

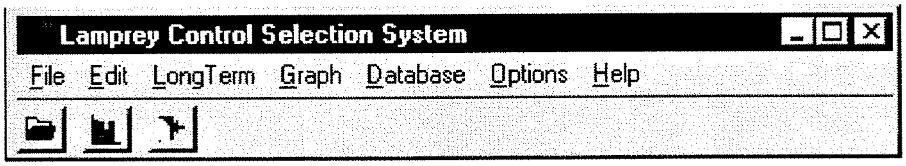
Options Menu

Help Menu

Glossary of Terms

LCSS Main Menu

The **Main** Menu gives you access to all parts of LCSS.



The three buttons on the toolbar provide quick access to:

 **File|Select Scenario DB**;

 **Graph|Run Results Setup**; and

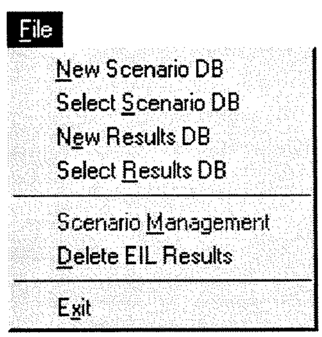
 **File|Exit**.

Each of the submenus and associated functions are described below.

File Menu

The **File** Menu *contains all of the scenario and data management options.*

The following six submenus are available from the **File** Menu. ***Exit*** closes the LCSS program.



New Scenario DB

Select Scenario DB

New Results DB

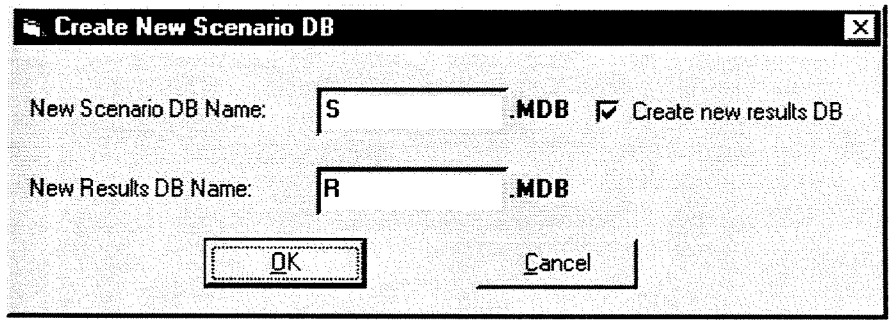
Select Results DB

Scenario Management

Delete EIL Results

NEW SCENARIO DB

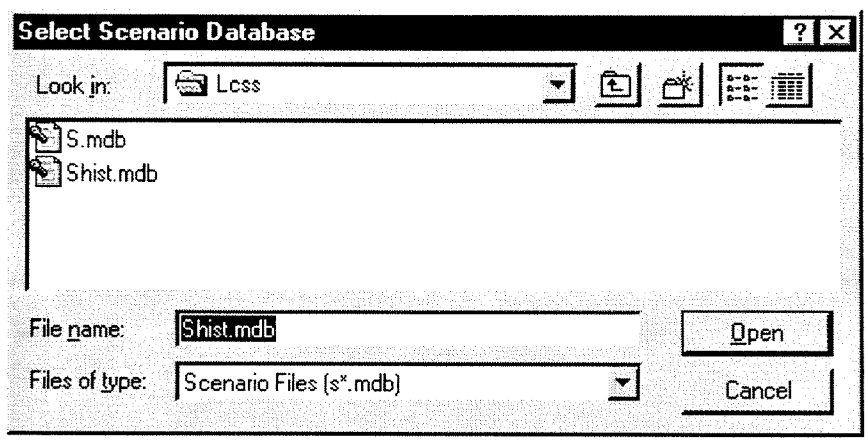
The **New Scenario Database** option is used to make a copy of the default scenario database. The copy can then modified to create a new set of conditions and parameters. The default scenario database includes the starting conditions for lamprey in all basins, streams and reaches to be simulated; the available budget and treatment resources; and detailed descriptions of the control treatments.



From the *Create New Scenario DB* screen, you are prompted to enter the name of the new scenario and results databases. Enter up to seven characters in the appropriate fields. When the "Create new results DB" box is checked, the name you entered for the new scenario database is also entered as the results database name, except for the prefix "S" or "R".

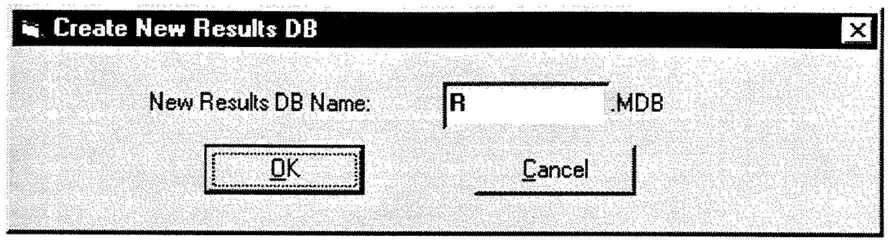
SELECT SCENARIO DB

The **Select Scenario Database** option allows you to choose a pre-defined scenario database to use for the simulation.



NEW RESULTS DB

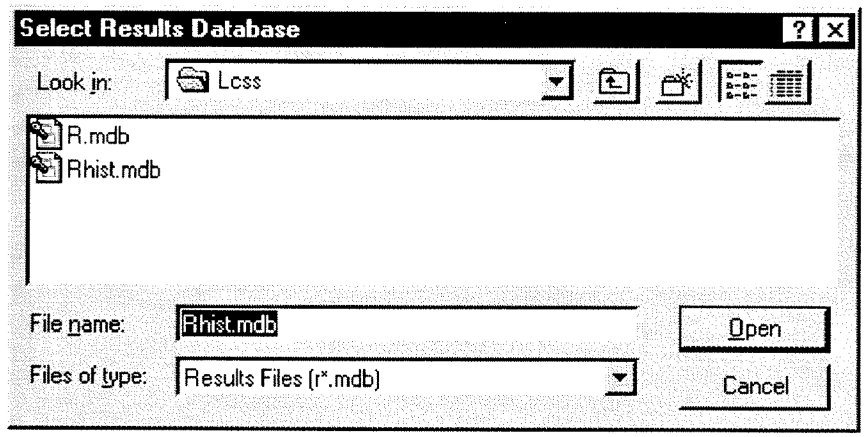
The **New Results DB** option creates a new database in which to store the results of the simulation. The results databases all begin with the prefix "R" to distinguish them from the scenario databases that begin with the prefix "S".



Enter the name of the new results database and press ***OK***.

SELECT RESULTS DB

Use the **Select Results DB** option to choose an existing results database in which to store the results of the simulation.

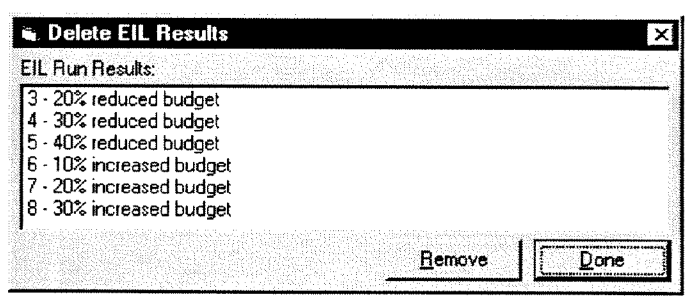


SCENARIO MANAGEMENT

When implemented, the **Scenario Management** option will be used to delete scenario and results databases.

DELETE EIL RESULTS

The **Delete EIL Results** option allows users to remove particular Environmental Injury Level (EIL) run results from the EIL Run Results list.

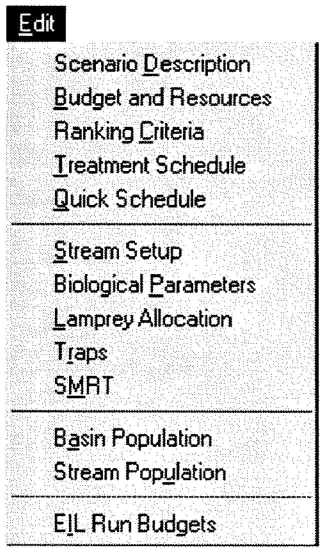


Clicking on ***Remove*** will delete the highlighted run from the list. Note that the system routinely deletes old run results before re-running a budget.

Edit Menu

The **Edit** *Menu contains all the options for modifying the parameters of a given scenario.*

The **Edit** Menu contains the submenus with which scenario parameters can be modified. You are not required to specify all values for the current scenario, as series of default values exists. However, you can modify and manipulate the default values for existing scenarios by using the following options available from this menu.



Scenario Description

Whenever a new scenario is created, you are asked to enter information about the scenario's name, operator, and provide a full description of it for future reference.

Budget and Resources

Use to enter and modify the budgets, resources, and resource costs for all of the years within the calculation horizon.

Ranking Criteria

This option lets you select which ranking criterion will be applied when streams are ranked for treatment.

Treatment Schedule

Ranks the streams and assists in the creation of treatment schedules.

Quick Schedule

This option allows you to quickly select streams for treatment and implement a treatment schedule that uses the current default options.

Stream Setup

Provides important data about each of the streams in the database, such as number, location, stream configuration, treatment and/or simulation status, and stream barrier activity.

Biological Parameters

Use this option to modify the lamprey model parameters.

Lamprey Allocation

This option is used to allocate spawners from basins to streams, and to allocate transformers from streams to basins.

Traps

Use this option to simulate the placement of traps in streams and reaches.

SMRT

Defines the release of sterile male lamprey into streams.

Basin Population

This option is used to view/enter initial lamprey population values for selected basins.

Stream Population

This option is used to view/enter initial lamprey population values for selected streams.

EIL Run Budgets

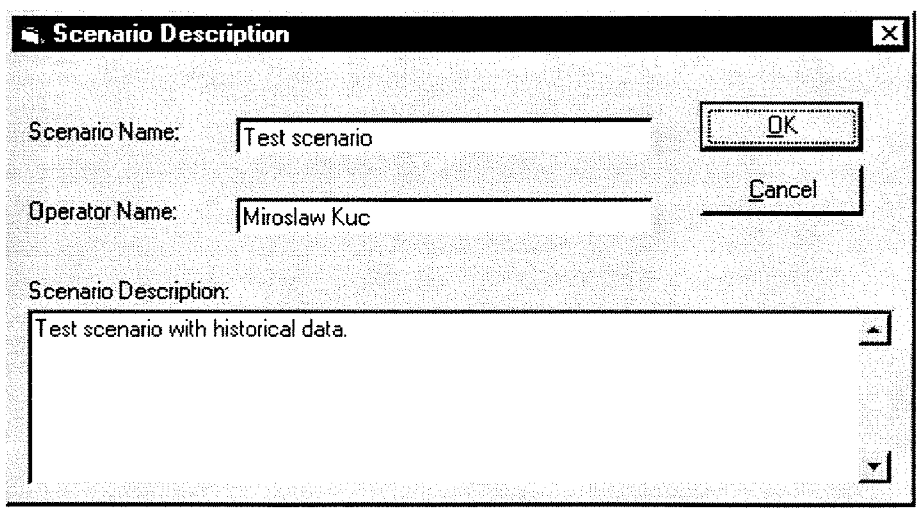
Use this option to add, remove, and view budgets associated with particular EIL runs.

SCENARIO DESCRIPTION

In addition to the explicit option under the **Edit** Menu, the *Scenario Description* screen appears whenever the nature of the current scenario is likely to have been changed.

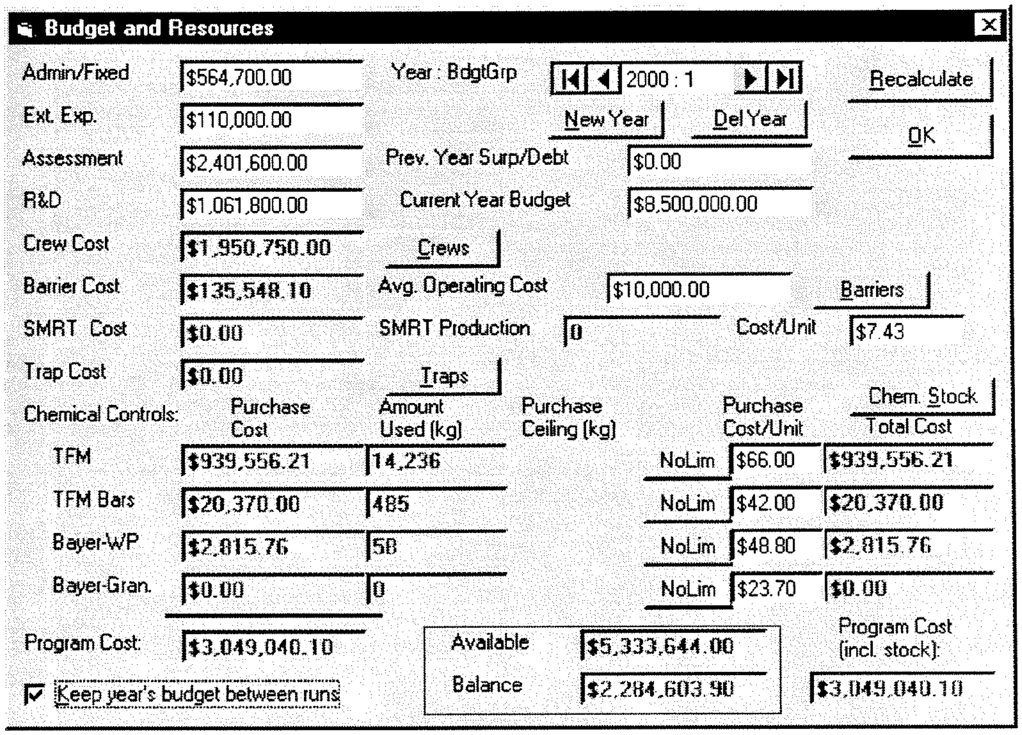
Describe the content of the current scenario using the Scenario Description *screen.*

For example, when a new scenario is created (*New Scenario*, *Save Scenario As...* options in the **File** Menu), the *Scenario Description* screen will activate.



BUDGET AND RESOURCES

The *Budget and Resources* screen, accessed from the **Edit** Menu, is used to enter and modify the budgets, resources, and resource costs for any year. Resources include funds, crews, chemicals, barriers, SMRT, and traps.



Each year of the simulation has a separate budget, which is displayed on the Budget and Resources *screen.*

Upon activation, the *Budget and Resources* screen gives the option to recalculate trap costs. This needs to be done only when trap costs have been changed by the user (for more information about traps, see page 4-46).

Generally, the fields in the top third of the screen represent known program costs plus information about the budget year and total budget. The fields in the middle third of the screen contain information on the cost of crews, barriers, sterile male release (SMRT) and traps. These costs are calculated by LCSS based on the current schedule. Details about the chemical control program are displayed in the bottom third of the screen.

The option box at the bottom of the screen, *Keep year's budget between runs* allows you to "set" user-entered budgets. As the simulation progresses, LCSS automatically creates budgets from year to year, and deletes those budgets that were not set before the run. When the *Keep* option is chosen, LCSS uses the latest *Keep* budget as a default.

In future versions of the program, different organizational units or institutional groups will be able to set new budgets, as specified by the Budget Group category (top of screen). At present, LCSS uses a single budget group to represent the Great Lakes Fishery Commission Program for all lakes.

LCSS holds detailed information only for budgets directly related to treating lamprey. However, additional fields are provided that allow users to enter other budget details. These are default administrative and fixed costs (*Admin/Fixed*), extraneous expenses (*Ext.Exp.*), assessment costs (*Assessment*), and research and development costs (*R&D*). These can be modified by simply typing in the new amounts.

☞ Barrier extraneous expenses can be specified by selecting the ***Barriers*** command button which activates the *Stream Barriers* screen (see page 4-28). From there, select extraneous expenses (***Ex. Expenses***) to access the *Extraneous Stream Barrier Costs* screen (see page 4-29).

- To enter a new budget:

1. Access the *Budget and Resources* screen from the **Edit** Menu.
2. Choose the year you wish to serve as a template.
3. Click on the ***New Year*** button and enter the new year. Modify the values in the available fields as necessary.
4. Click ***OK*** to leave the screen and return to the **Main** Menu.

- To delete an existing budget:

1. Access the *Budget and Resources* screen from the **Edit** Menu.
2. Select the year for which you wish to delete the budget.
3. Click on ***Del Year*** and specify whether you want to delete budget information only, or all information on the budget, crews and schedule that was entered for the selected year.
4. Click ***OK*** to leave the screen and return to the **Main** Menu.

If you choose to delete only budget information, crew and schedule data will be stored by the system until a new budget is entered or generated for that year.

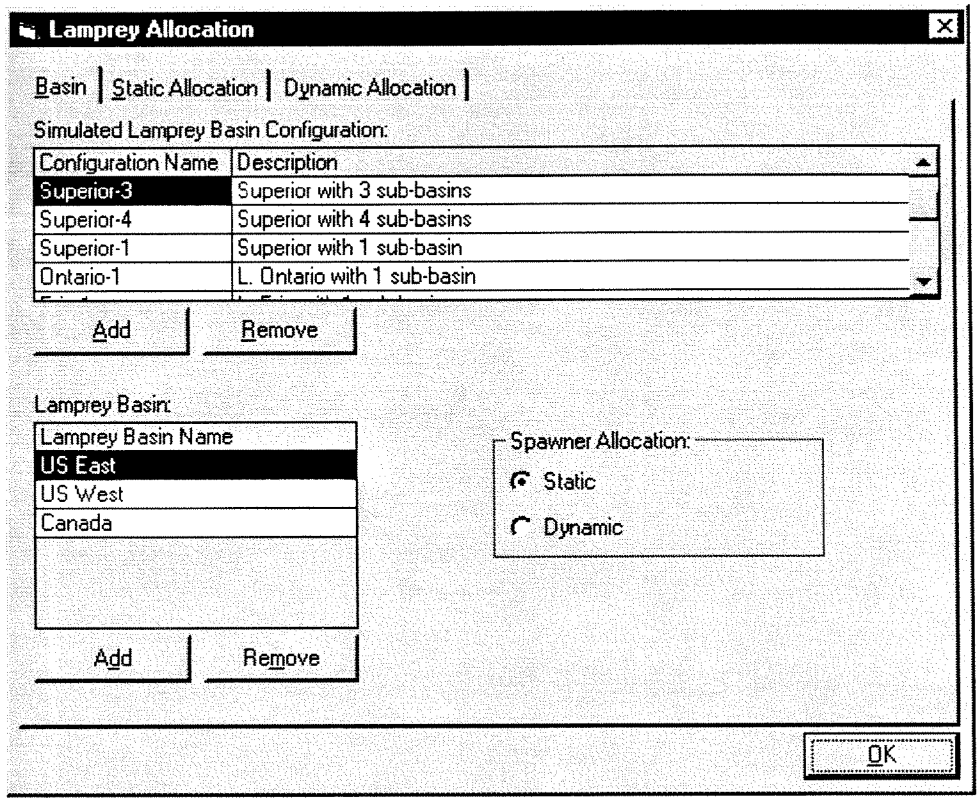
Administrative and fixed costs

The fixed cost fields on the *Budget and Resources* screen include such things as the current year's budget, the surplus or debt from the previous year, administrative costs, extraneous expenses, assessment costs, and research and development costs. In the first year of the program, you will need to enter the previous year's surplus or debt (*Prev. Year Surp. Debt* field); in subsequent years, you can choose to have this value calculated automatically by flagging an option in the *General Options* screen (select **Options** from the **Main** Menu, see page 4-64).

After you enter administrative and fixed costs for the selected year, you will need to provide the system with further information about the crews, as well as the control program for barriers, sterile male release (SMRT), traps, and chemical treatment.

Basin

The *Basin* screen allows addition, removal, modification and selection of the lamprey basin configurations. It also allows selection of the spawner allocation strategy to be used in the next simulation (static vs. dynamic). This screen is the first of three *Lamprey Allocation* screens.



The lamprey basin configurations subdivide the lake lamprey population into distinct groups. Configurations can be added and removed by pressing the ***Add*** and ***Remove*** buttons just below the list of configuration names. The name of the configuration and the configuration description can be modified directly in the table. The configuration selected upon exit from this screen will be the one used in the next simulation. The *Lamprey Basin* field, located below with its own ***Add*** and ***Remove*** buttons, lists the basins which comprise the selected configuration.

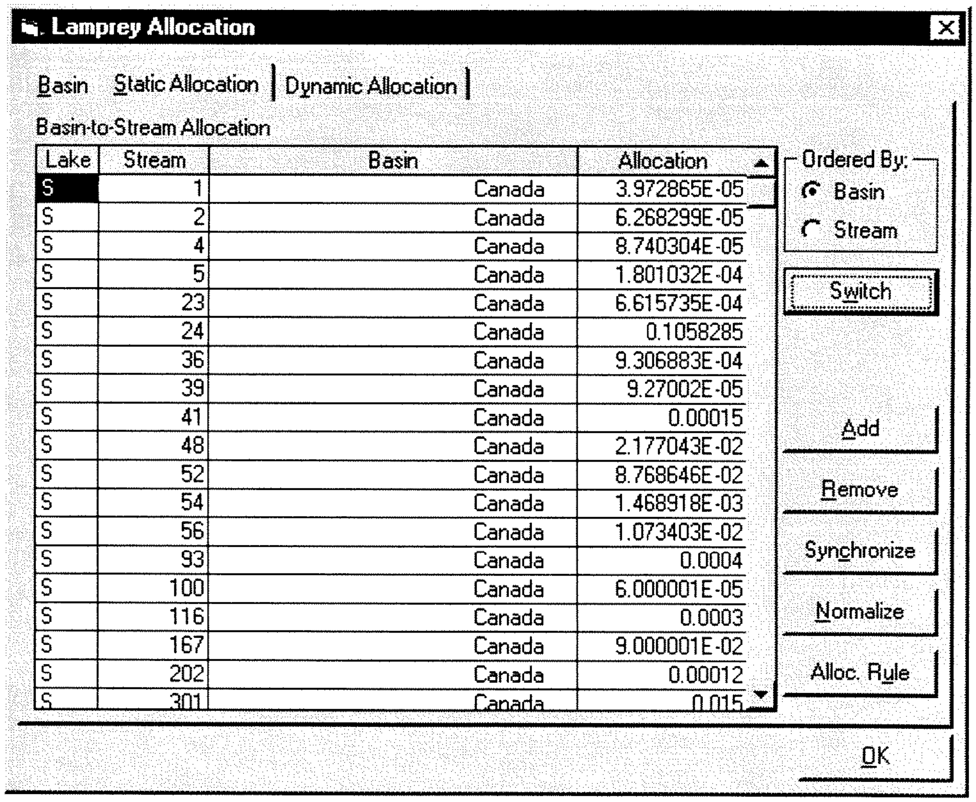
The selected basin configuration will affect the allocation of lamprey when running the model. For example, if you choose a lamprey basin configuration that contains only Lake Superior, you should not simulate streams from other lakes. The current lamprey basin configuration is always displayed on the status bar at the bottom of the screen.

Also available on this screen is the option to select the spawner allocation strategy by clicking on either the *Static Allocation* or *Dynamic Allocation* option buttons in the *Spawner Allocation* field.

Dynamic allocation incorporates dynamic criteria (e.g., ammocete count) into the allocation in addition to static criteria. This approach allows exploration of criteria for "attractiveness" of a stream to lamprey.

Static allocation

The *Static Allocation* screen contains parameters that govern the static allocation of transformers from streams to lamprey basins and from lamprey basins to streams. This screen is the second of three *Lamprey Allocation* screens. In static allocation, the proportions of lamprey allocated from streams to basin and basin to streams are fixed and are independent of changes in the streams (e.g., ammocete densities).



On the *Static Allocation* screen, the *Allocation* column of the *Basin-to-Stream Allocation* table contains the proportion of all spawners in the stream's basin that are allocated to the stream from the basin. Multiple basins can contribute spawners to one stream. The total of all proportions for a particular basin should always add to 1 (see about normalizing the allocations with the ***Normalize*** command button, below).

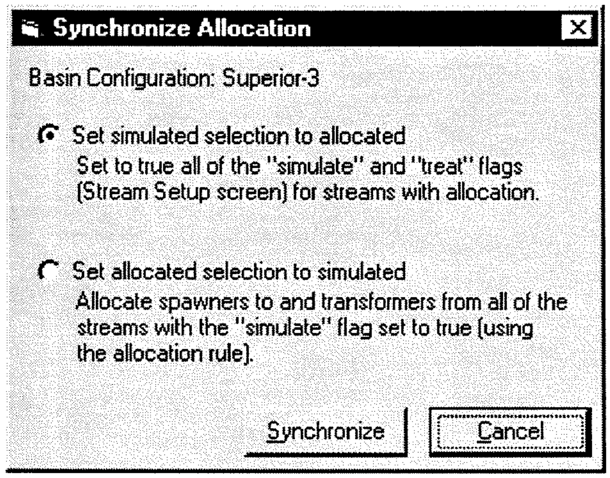
Clicking the ***Switch*** command button switches the screen between basin-to-stream allocation and stream-to-basin allocation. In the *Stream-to-Basin Allocation* table, the *Allocation* field contains the proportion of a stream's transformers migrating to a particular basin. Streams can contribute transformers to multiple basins and the total allocation for any stream should add to 1.

The allocation proportions in the *Allocation* field can be modified either manually by overtyping the values in the table or according to a static allocation rule (click the ***Stat.Alloc.*** command button on this screen to access the *Static Allocation Rule* screen; see below).

Command buttons ***Add*** and ***Remove*** allow addition and deletion of streams from the allocation list. Multiple entries in the stream-to-basin list allow splitting of the contribution from a stream among multiple basins. Multiple entries in the basin-to-stream list allow multiple basins to contribute spawners to a single stream.

Your selection of streams to be simulated can be synchronized with the stream-basin-stream allocations by clicking on the ***Synchronize*** command button, which opens the *Synchronize Allocation* screen.

SYNCHRONIZING LAMPREY ALLOCATION



From this screen, choose one of the two available options:

- set simulated selection to allocated; or
- set allocated selection to simulated.

The first of these two options modifies the list of simulated streams to match those with allocation, and the second modifies the allocation list to match the simulated streams. Click on the ***Synchronize*** command button on the *Synchronize Allocation* screen to initiate the synchronization process.

NORMALIZE

The ***Normalize*** command button on the *Static Allocation* screen invokes a function that scans all of the lamprey allocation values. It ensures that the basin-to-stream and stream-to-basin allocations add up to 1 (100%). Allocation values that have been changed by the user are preserved, and the remaining values are scaled based on their relative magnitudes.

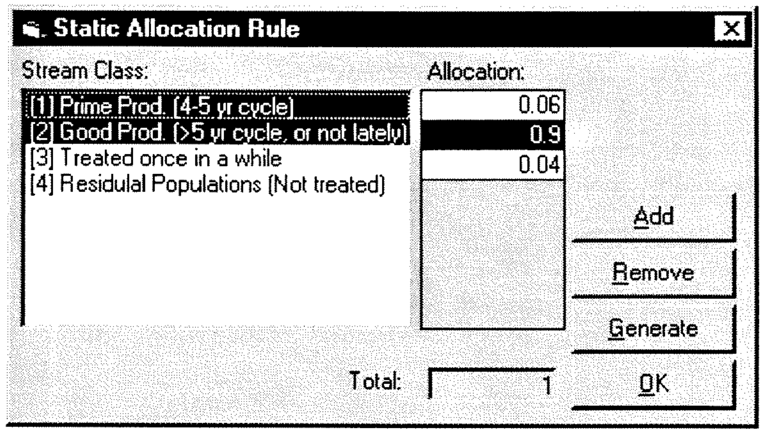
For example, in a hypothetical basin there may be three streams: A, B, and C. Suppose the original allocation was Stream A: 0.2; Stream B: 0.3; and Stream C: 0.5. If the allocation to Stream A is altered to 0.3, and you select ***Normalize,*** the allocation to Streams B and C would change to 0.2625 and 0.4375 respectively, thus adding to 1.0.

In some instances, it may be impossible to normalize the allocation. This would occur, for example, if all of the values for a particular basin in a basin-to-stream allocation were user-entered. In a case like this, an error message would be displayed when the user attempted to normalize the allocation.

The normalization routine is automatically invoked upon exiting the Static Allocation screen.

STATIC ALLOCATION RULE

The *Static Allocation Rule* screen can be accessed by clicking on the ***Alloc. Rule*** command button on the *Static Allocation* screen. It allows entry and modification of the allocation rule used to generate the static basin-to-stream allocation.



The static allocation rule is centered around stream classes (see about defining the physical layout of a stream, page 4-24). These classes represent the "attraction" of lamprey to streams. The *Stream Class* list contains all of the classes present in the simulation. The static allocation rule allows the grouping of one or more classes and the allocation of proportions (*Total* = 1) of basin spawners to these groups. Click on one of the listed *Allocation* values to view the *Stream Classes* currently associated with it. Modify the grouping by selecting or de-selecting stream classes with a click of the mouse. The ***Add*** and ***Remove*** command buttons add and remove values from the list in the *Allocation* field.

The ***Generate*** command button erases the current basin-to-stream allocation and generates a new one based on the stream-to-basin values. The allocation within the stream class groups is proportioned according to the spring discharge of the stream. The same rule is used to calculate the basin-to-stream allocations for all of the basins in the current lamprey basin configuration.

When there is more than one basin simulated, it is possible to have basins which contain only a subset of all stream classes and a subset of stream class groups. When this situation is encountered, the algorithm splits the missing group's allocation in proportion to the values of remaining stream class groups. For example, if basin 1 contains streams with classes {1,2,3}, basin 2 contains classes {1,2,3,4}, and the stream class groups are: A = {1,2}, B = {3}, and C = {4}, then for basin 1 the algorithm splits the allocation for group C between groups A and B. When a stream is contributing transformers to multiple basins, the flow is apportioned to the basins based on the stream-to-basin allocations and the stream receives spawners from each basin based on the portion assigned to the basin.

MODIFYING BASIN TO STREAM ALLOCATIONS

➤ To allocate spawners from a basin to a stream:

1. From the **Lamprey Allocation** option on the **Edit** Menu, select the *Static Allocation* tab to access the *Static Allocation* screen. Ensure that the name of the table reads *Basin-to-Stream Allocation*. If it doesn't, click on the ***Switch*** button.
2. Identify the stream basins for which you wish to edit the spawner allocation. (If you need to verify any stream numbers, go to the **Stream Setup** option on the **Edit** Menu.)
3. Enter your new values (from 0 to 1) in the *Allocation* field across from the associated lake and stream. Repeat steps 3 and 4 for all of the streams you wish to modify.
4. Click on the ***Normalize*** command button. This function ensures that the sum of all allocation values for any given basin remains equal to 1. The normalizing procedure will preserve the values you changed, and the remaining values will be scaled based on their relative magnitudes.

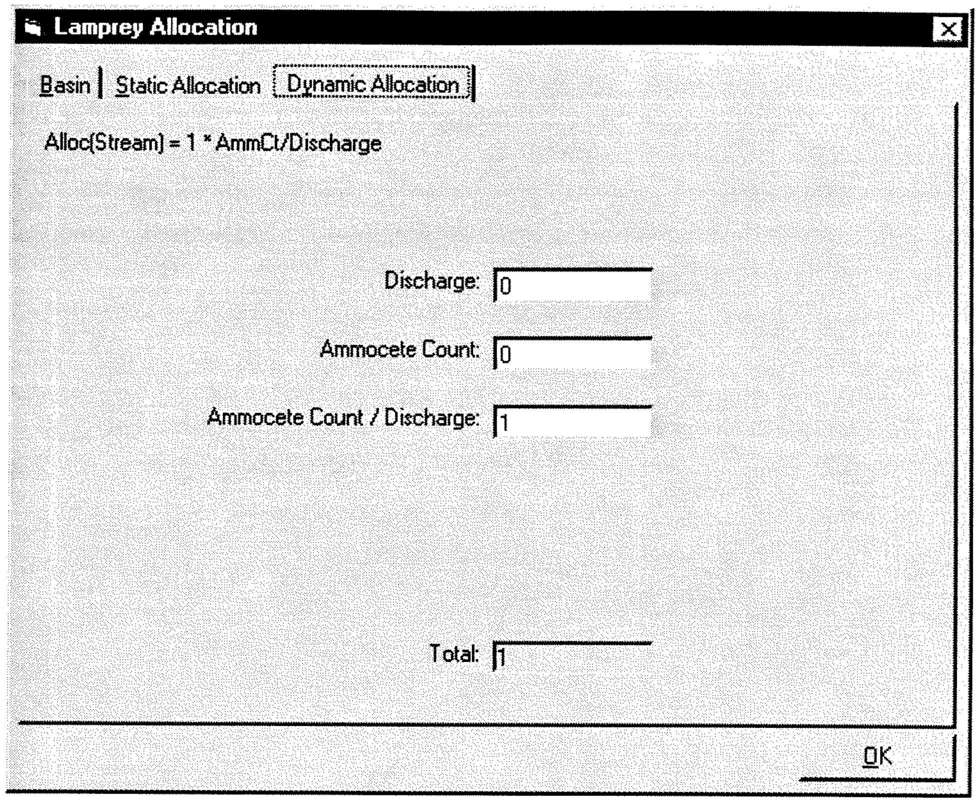
MODIFYING STREAM TO BASIN ALLOCATIONS

➤ To allocate transformers from a stream to a basin:

1. From the **Lamprey Allocation** option on the **Edit** Menu, select the *Static Allocation* tab to access the *Static Allocation* screen. Ensure that the name of the table reads *Stream-to-Basin Allocation*. If it doesn't, click on the ***Switch*** button.
2. Identify the streams for which you wish to edit transformer allocation. (If you need to verify any stream numbers, go to the **Stream Setup** option on the **Edit** Menu.)
3. Enter your new values in the *Allocation* field across from the associated lake and stream. For most streams, 100% of lamprey will be allocated to a specific basin. However, for some streams located near the junctions of two or more basins, a stream could contribute transformers to multiple basins. In these cases, enter a value that indicates the proportion of lamprey that should be allocated to the basin.
4. Click on the ***Normalize*** command button to ensure that the sum of all allocation values for each stream remains equal to 1.

Dynamic allocation

The *Dynamic Allocation* screen allows the definition of the dynamic allocation rule. It is the third of three *Lamprey Allocation* screens under the **Lamprey Allocation** option on the **Edit** Menu.



Dynamic allocation is the second of two alternative strategies for allocating spawners returning from basins to streams. It incorporates dynamic criteria (e.g., ammocete count) into the allocation in addition to static criteria. This approach allows exploration of criteria for "attractiveness" of a stream to lamprey.

Currently, there are three criteria supported:

- *Discharge* - stream spring discharge (a static criterion);
- *Ammocete Count* - total number of ammocetes within a stream; and
- *Ammocete Count/Discharge* - simulates "pheromone" concentration.

The dynamic rule can be any linear combination of these criteria. The rule is applied in a fashion similar to the static rule. The static stream-to-basin allocation is used to determine which streams will receive spawners from which basins, then the allocation factors are computed based on the value of the combined dynamic allocation criteria.

TRAPS

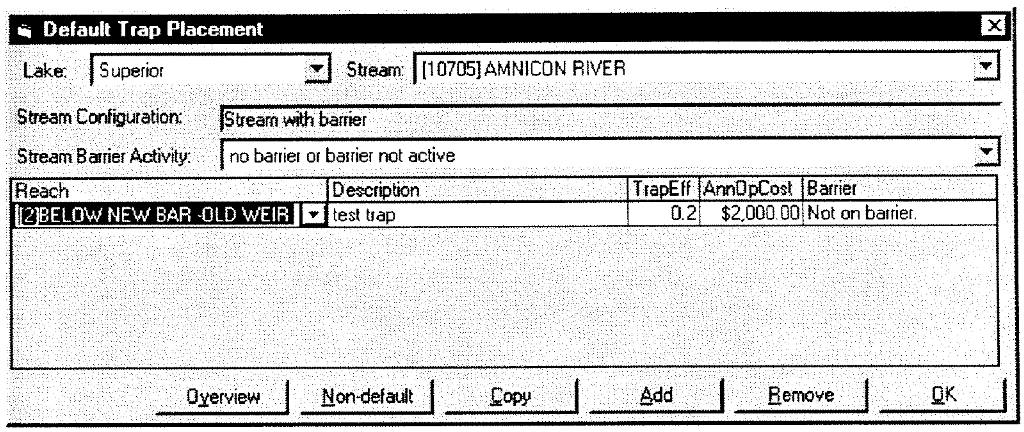
You can simulate the presence of traps in reaches by selecting the **Traps** option from the **Edit** Menu, or by clicking on the ***Traps*** command button on the *Budget and Resources* screen.

Two types of traps can be simulated: default and non-default. Default traps are always associated with a particular stream barrier activity. When that activity changes, the default trap is no longer present. For example, when the stream barrier activity on Stream A is "no barrier", the default trap placement might be a trap placed below a particular reach. If the stream barrier activity changes to "barrier active", however, the default trap is removed from the simulation.

Non-default traps are linked to a particular year in the simulation. For example, for Stream A, a non-default trap might be defined for 1980. This means that the non-default trap is present in the simulation from 1980 until the stream barrier activity changes or until a new non-default trap is placed on the reach.

Default trap placement

Simulate the presence of default traps using the *Default Trap Placement* screen.



You can set the placement, efficiency, and cost of default traps with the fields and command buttons available on this screen. They are:

Lake/Stream

These fields contain drop-down lists from which to choose the lake and stream on which you wish to place a default trap.

Stream Configuration

This field shows the currently simulated stream configuration and cannot be modified.

Stream Barrier Activity

You can select a stream barrier activity from the drop-down list in this field.

Reach

This field contains a drop-down list of reach names for the currently selected stream configuration.

Description

Enter a description of the trap in this field.

TrapEff

The value entered here (between 0 and 1) represents the efficiency of the trap. For example, a value of 0.2 indicates that 20% of all lamprey swimming by this trap (to the reach on which this trap is located and all the reaches above it) are caught.

AnnOpCost

Enter the annual operating costs associated with the trap.

Barrier

In this field you can specify the name of the barrier (if there is one) with which the trap is associated.

Overview

Activates the *Summary of Trap Activity* screen which provides an overview of the cumulative effect of default and non-default traps (see below).

Non-default

Accesses the *Non-default Trap Placement* screen (see below).

Copy

Uses a "template" trap to create a new default trap.

Add

Inserts a blank entry for a default trap.

Remove

Deletes the currently selected default trap.

Simulating default traps

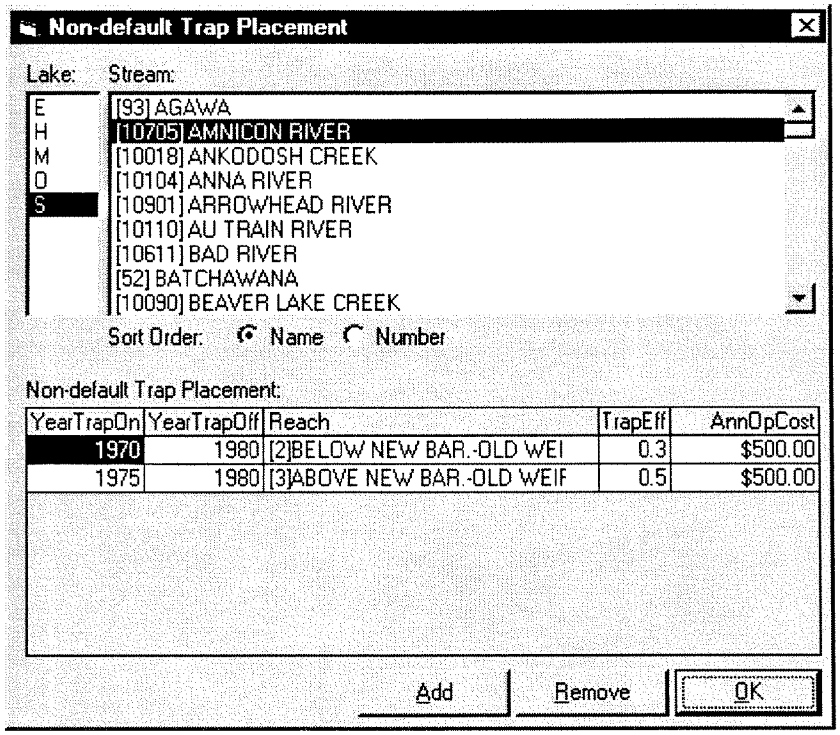
➤ To simulate the presence of default traps:

1. Select the **Traps** option on the **Edit** Menu, or clicking the ***Traps*** button on the *Budget and Resources* screen, to open the *Default Trap Placement* screen.
2. Choose the *Lake*, *Stream*, and *Stream Barrier Activity* for the stream where the trap will be placed.
3. Select the *Reach* where the trap will be placed by choosing from the drop-down list.
4. Add new traps using either the ***Add*** or the ***Copy*** button; delete selected traps using ***Remove***.
5. Enter a brief description for the trap, its efficiency (0 to 1), its annual operating cost, and choose a barrier (if there is one) with which the trap is associated from the drop-down list in the *Barrier* field.
6. Click ***OK*** to save your changes and return to the **Main** Menu.

Non-default trap placement

Whereas default traps are associated with a given stream barrier activity, non-default traps are associated with a specific year. You can simulate the presence of non-default traps by clicking the ***Non-default*** button on the *Default Trap Placement* screen which opens the *Non-default Trap Placement* screen.

Non-default trap placements act in addition to traps placed in the stream by default. However, when a stream barrier activity changes (and with it the default trap placements), all of the non-default placements are reset.



You can set the placement, timing, efficiency, and cost of non-default traps with the fields and command buttons available on this screen. They are:

Lake/Stream

Select the lake and stream on which you wish to place a non-default trap.

Sort Order

Sort the lake and stream lists either by *Name* or by *Number*.

YearTrapOn

The first year in which the trap is active.

YearTrapOff

The first year in which the trap becomes inactive.

Reach

This field contains a drop-down list of reach names for the currently selected stream configuration.

TrapEff

The value entered here (between 0 and 1) represents the efficiency of the trap. For example, a value of 0.2 indicates that 20% of all lamprey swimming by this trap (to the reach on which this trap is located and all the reaches above it) are caught.

AnnOpCost

Enter the annual operating costs associated with the trap.

Add

Adds an entry into the *Non-default Trap Placement* table.

Remove

Deletes the currently selected entry from the *Non-default Trap Placement* table.

Simulating non-default traps

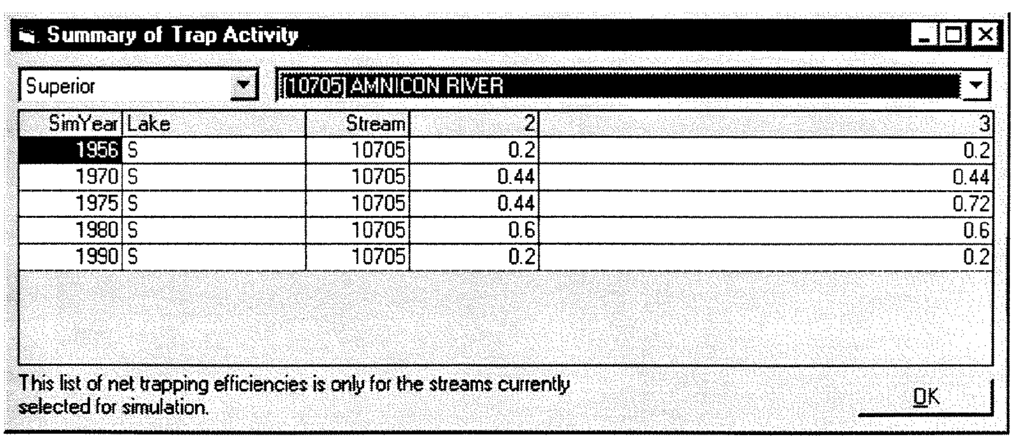
➤ To simulate the presence of non-default traps:

1. Select the **Traps** option on the **Edit** Menu (or click the ***Traps*** button on the *Budget and Resources* screen) to open the *Default Trap Placement* screen. Click ***Non-default*** to open the *Non-default Trap Placement* screen.
2. Select the *Lake* and *Stream* on which you wish to place the non-default trap.
3. Add new traps by clicking on ***Add*** (or delete selected traps using ***Remove***).
4. Enter the year in which the new trap will become active (*YearTrapOn* column), the year in which the trap will be removed from the simulation (*YearTrapOff* column), the reach, the trap efficiency (0-1), and the average annual operating cost of the non-default trap.
5. Click ***OK*** to save your changes and return to the *Default Trap Placement* screen.

Summary of trap activity

By selecting the ***Overview*** button on the *Default Trap Placement* screen, you can view summary information about the cumulative effects of all defined trap placements (default and non-default) on the reaches of a particular stream.

The fields on this screen show the simulation year, the lake, the stream number, and the reaches (identified by number) of the stream. The values displayed in the reach columns represent the cumulative effect of the default and non-default traps.

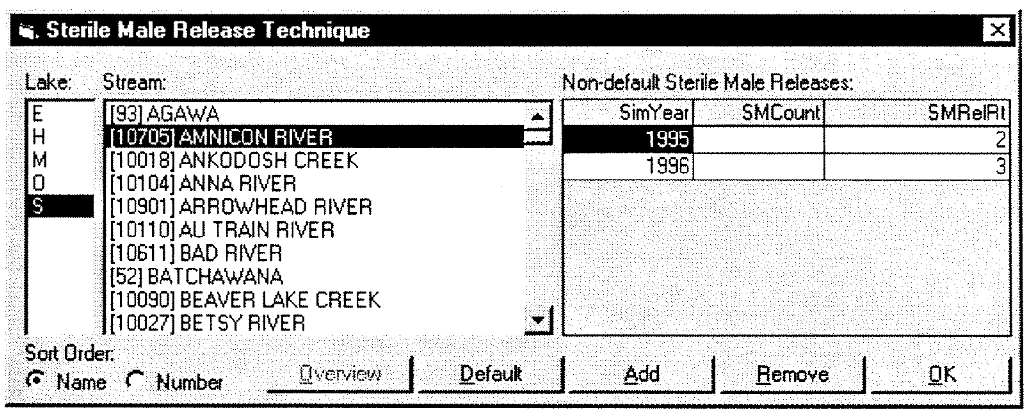


The following example explores all aspects of traps and their placement, and illustrates how cumulative trap efficiencies are calculated for each. In practice, it is unlikely that users will encounter a scenario this complex.

The Amnicon River (Lake Superior) has two reaches numbered "2" and "3". From 1956 to 1969, the default stream barrier activity is "no barrier or barrier not active", and the trap efficiency is 0.2 (80% of lamprey are not caught). (To check these values, look at the *Default Trap Placement*, *Non-default Trap Placement*, *Stream Setup*, and *Stream Barrier Activity* screens). In 1970, a non-default trap is placed on reach 2 with an efficiency of 0.3, trapping 30% of the 80% of lamprey getting through prior to the 1970 trap installation. The cumulative impact of 1956 and 1970 traps is the sum of both efficiencies, i.e., $0.2 + (0.3 \times 0.8) = 0.44$ (56% of lamprey are not caught). In 1975, a non-default trap with an efficiency of 0.5 is placed on reach 3. This trap catches 50% of the remaining 56% of lamprey getting through to reach 3. The cumulative impact of all trap efficiencies for reach 3 is therefore $0.44 + (0.5 \times 0.56) = 0.72$. Note, however, that the cumulative trap efficiency for reach 2 remains at 0.44 because the trap placed on reach 3 has no impact on reach 2 which is downstream of reach 3. In 1980, both non-default traps are disabled or removed and the stream barrier activity changes to "barrier active" (see *Stream Barrier Activity* screen) with a trap efficiency of 0.6 (see *Default Trap Placement* screen). Finally, in 1990 the stream barrier activity changes back to "no barrier or barrier not active" with a trap efficiency of 0.2.

SMRT

Choose **SMRT** from the **Edit** Menu to access the *Sterile Male Release Technique* screen. This option allows you to set the non-default release of sterile male lamprey to any stream present in the database. The default release of sterile males is specified on the *Stream Barrier Activity* screen.



The fields and buttons on the *Sterile Male Release Technique* screen are:

Lake/Stream

Select the lake and stream into which you wish to release sterile male lamprey.

Sort Order

Choose to sort lake and stream lists by *Name* or *Number* by clicking on one of these option buttons.

SimYear

The year of sterile male release.

SMCount

The actual number of sterile male lamprey released.

SMRelRt

The ratio of sterile to non-sterile male lamprey. For example, an *SMRelRt* of 2 means that 2 sterile males were released for every 1 non-sterile male. If values for both *SM Count* and *SMRelRt* are entered, the value for *SMRelRt* will be the one used by the system.

Overview

When implemented, this button will open a screen that will show a summary of the impact of the SMRT program.

Default

Activates the *Stream Barrier Activity* screen where you can enter/modify the default sterile male release counts or ratios for any of the stream barrier activities in the current stream configuration. ***Exit*** returns you to the *SMRT* screen.

Add

Adds release entries for the currently selected stream.

Remove

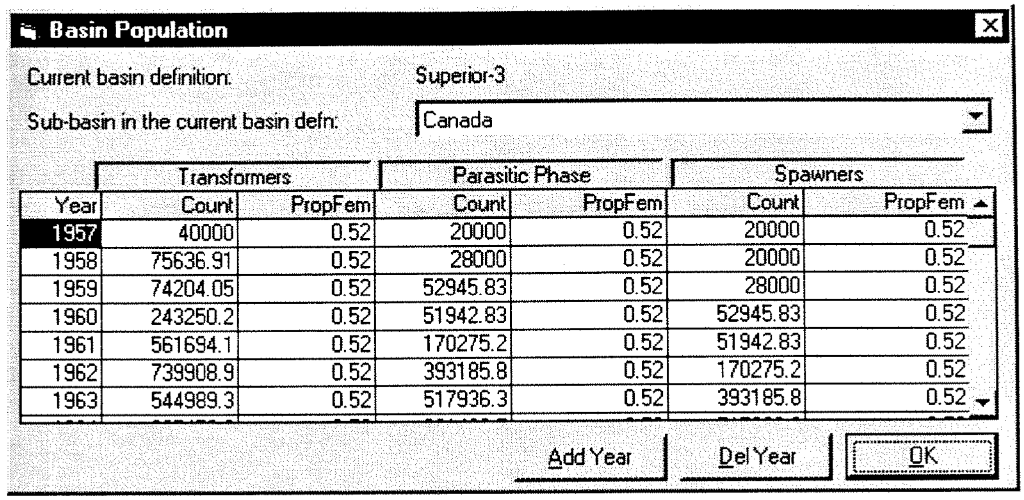
Deletes release entries for the currently selected stream.

For each stream, the following information is displayed: the simulation year, the *SMCount* (the actual number of sterile males that are released) and the *SMRelRt* (the ratio of sterile to non-sterile males).

Non-default SMRT values are associated with a particular simulation year. Values will only apply to the currently selected stream configuration. If you decide to change the stream configuration, the SMRT values will change to the default values associated with the new stream configuration (as specified on the *Stream Barrier Activity* screen) and you will have to enter a new release schedule. If you re-select the old stream configuration in a later simulation, the schedule you chose earlier will apply once more.

BASIN POPULATION

Select the **Basin Population** option from the **Edit** Menu to open the *Basin Population* screen. Use this screen to view/enter lamprey population values (e.g., number of transformers) for each of the lamprey basins in the currently selected basin definition. To make changes, simply click on the field to be modified and type in the new values.



Values entered in this screen constitute initial population conditions for a particular year and will be used by LCSS to run the simulation for the next consecutive year. For example, if you enter initial stream population data for 1987, these will form the basis for a simulation run of 1988 conditions.

The fields and buttons on this screen are:

Current basin definition

This field identifies the currently selected lamprey basin definition. This entry cannot be modified here. To change it, go to the **Lamprey Allocation** option on the **Edit** Menu (see page 4-41).

Sub-basin in current basin defn

Allows you to select the specific sub-basin for which you wish to view/enter population data.

Year

This field identifies the year to which the data apply and it cannot be modified.

Transformers Count

The number of transformers in the basin

Transformers PropFem

The proportion of the total transformer count that is female.

Parasitic Phase Count

The number of parasitic phase lamprey in the basin

Parasitic Phase PropFem

The proportion of the total parasitic phase lamprey count that is female.

Spawners Count

The number of spawners in the basin

Spawners PropFem

The proportion of the total spawner count that is female.

Add Year

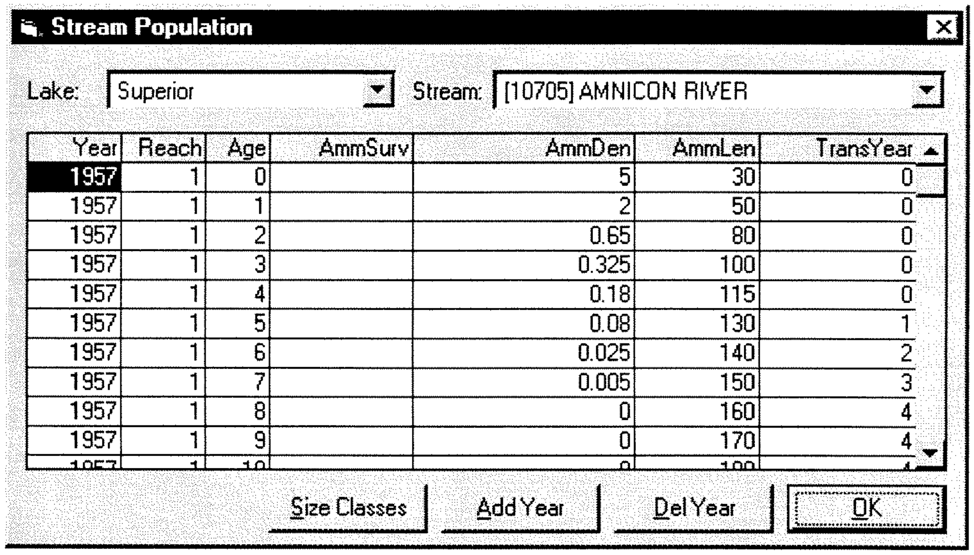
Enter data for a new year. You will be prompted to enter a specific year. A default set of population values for the new year will be automatically entered into the *Basin Population* table. Modify as appropriate.

Del Year

Deletes the selected row of data.

STREAM POPULATION

Select the **Stream Population** option from the **Edit** Menu to open the *Stream Population* screen.



The *Stream Population* screen is used to view/enter ammocete population values (i.e., ammocete density, length, and transformation year) in the currently selected stream. Data are organized by year, specific reach, and lamprey age.

Values entered in this screen constitute initial population conditions for a particular year and will be used by LCSS to run the simulation for the next consecutive year. For example, if you enter initial stream population data for 1987, these will form the basis for a simulation run of 1988 conditions.

The fields on this screen are:

Lake/Stream

Select the lake and stream for which you wish to view/enter ammocete population values from the drop-down lists in these two fields.

Year

This field identifies the year to which to the data apply. It cannot be modified.

Reach

This field shows the number of the reach to which the data will apply. It cannot be modified.

Age

Lamprey age (from 0 to 8 years) appears in this field and cannot be modified.

AmmSurv

Ammocete survival is expressed as the proportion of each age class surviving the year. ***AmmSurv*** is a calculated value dependent upon the total ammocete density and the shape of the SLP curve (see page 4-40).

AmmDen

Ammocete density is expressed as number of individuals per square meter ($\#/m^2$).

AmmLen

Ammocete length is expressed in millimeters (mm).

TransYear

This field describes the stage of transformation for lamprey in each age class (see section **Simulating Transformation to the Parasitic Phase** in Appendix A).

The actions available on this screen are:

Size Classes

Clicking on this command button activates the *Stream Ammocete Number by Size* screen (see below). Use this screen to view/edit a graph of the number of ammocetes against ammocete length for the selected year, lake, and stream.

Add Year

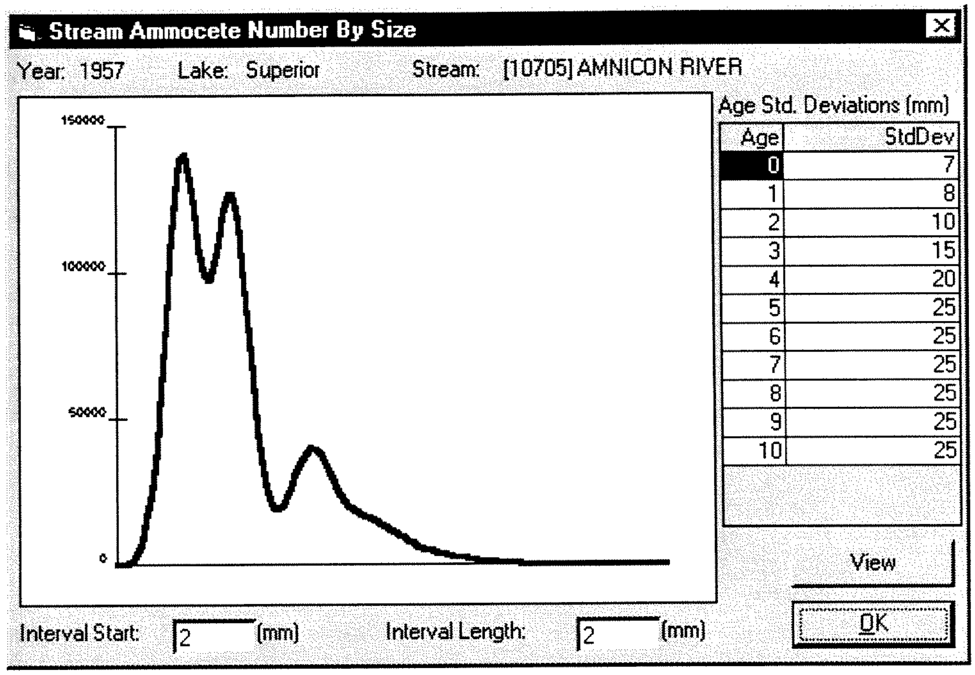
Data can be entered for new years and for specific reaches by clicking this command button, which launches the *New Population Records* screen.

Del Year

Records for a specific year and reach can be removed from the *Stream Population* screen using this command button. Highlight any row of data in the year and reach you wish to delete, and click ***Del Year***. All records for that reach in that year will be deleted.

STREAM AMMOCETE NUMBER BY SIZE

Clicking on the ***Size Classes*** button on the *Stream Population* screen activates the *Stream Ammocete Number by Size* screen.



The sizes of ammocetes (expressed as length in millimeters) are stored in the system as means for each age class.

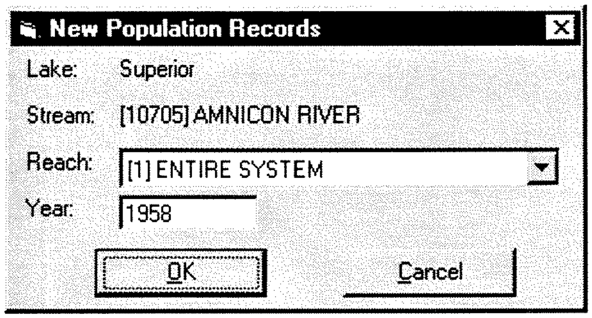
The fields across the top of the screen identify the *Year*, the *Lake* and the *Stream* for which the data are displayed. Listed on the right side of the screen is a set of standard deviation values which can be entered/modified for each age class and will directly influence the smoothness of the size distribution curve. The system stores a single set of standard deviation values for all streams in the database. Each time the user makes changes to these values in the *Stream Ammocete Number by Size* screen, the modified set will replace the previous set stored by the system. The last set of standard deviation values used is always the one displayed, no matter which stream has been selected in the *Stream Population* screen.

Graphs generated here show ammocete number on the vertical axis and ammocete size (mm) on the horizontal axis. The "granularity" of the horizontal axis can be controlled by specifying *Interval Start* and *Interval Length* values. The best results can be achieved by setting these two parameters to the same value, e.g., 2 millimeters. The upper range for size is determined automatically to include the largest lamprey in the simulation plus three standard deviations. To refresh the graph display following modifications to any of these fields, click on the ***View*** command button.

☞ Values entered in this screen are for display purposes only and will not affect the simulation.

NEW POPULATION RECORDS

The *Add Year* button on the *Stream Population* screen activates the *New Population Records* screen.

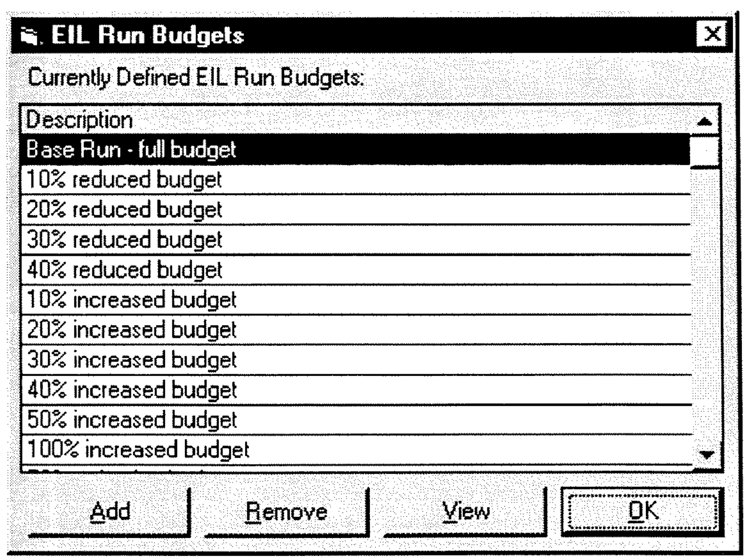


The *Lake* and *Stream* fields identify the currently selected lake and stream. Choose the year and specific reach you wish to add to the *Stream Population* table and click ***OK*** to return to the *Stream Population* screen. Modify the values for ammocete survival, density, length and transformation year by overtyping the current values with new ones. Repeat this process for each reach you wish to add.

When a new reach is created using **Edit|Stream Setup**, the system adds it to the list of reaches in the *Stream Population* screen. The reverse, however, is not true. The ***Del Year*** function in the *Stream Population* screen deletes only the lamprey population information associated with the selected reach and not the physical reach itself. To delete a reach altogether, you must use the *Physical Reach Parameters* screen in **Stream Setup**.

EIL RUN BUDGETS

Selecting the **EIL Run Budgets** option from the **Main** Menu activates the *EIL Run Budgets* screen. This screen allows the user to modify budgets for existing runs, to create new run budgets, and to delete existing run budgets.



Budgets store information for the whole (5 lake) basin. If only one lake is run at a time, e.g., current *BasinDef* set to Ontario-1 (Lake Ontario, one sub-basin), make sure that the appropriate proportion of the budget is used (e.g., one fifth). To set the proportions of each of the resources to be used in the run, go to the **LongTerm** option on the **Main** Menu. If you wish to change the basin definition for a run, go to the *General/Basin Parameters* screen in **Edit|Biological Parameters** or to the *Basins* screen in **Edit|Lamprey Allocation**.

The fields and buttons on the *EIL Run Budgets* screen are:

Currently Defined EIL Run Budgets

Contains a list of existing run budgets. You can edit the name of a budget by typing in a new *Description*.

Add/Remove

Use these command buttons to create new run budgets and to delete existing run budgets.

View

This command button activates a screen that is structurally identical to the *Budget and Resources* screen, where you can modify the values in existing run budgets, e.g., total budget amount, the cost of crews, SMRT, barriers, traps, and chemicals. When editing the values, careful consideration of the number of crews assigned to the job is important. Be aware that in lower budget scenarios, there may be insufficient money to support all crews as well as to treat streams. At higher budget levels, there may not be enough time for assigned crews to do all of the potential work. The user must define the crew details that are appropriate for the time and money allocated in the budget.

➤ To modify an existing EIL run budget:

1. Select the **EIL Run Budgets** option from the **Edit** Menu to access the *EIL Run Budgets* screen.
2. Highlight the run you wish to modify and click on the ***View*** command button. This action activates the *Budget and Resources* screen where the current values for the selected budget are displayed.
3. Modify by typing the new values into each of the fields you wish to change.
4. Click ***OK*** to save your changes and return to the ***Main*** Menu.

➤ To create a new EIL run budget:

1. Select the **EIL Run Budgets** option from the **Edit** Menu to access the *EIL Run Budgets* screen.
2. Click on the ***Add*** command button to add a new budget to the list. You will be offered the opportunity to use the currently highlighted budget as

a template for modification. Alternatively, you can choose to create a new, blank budget.

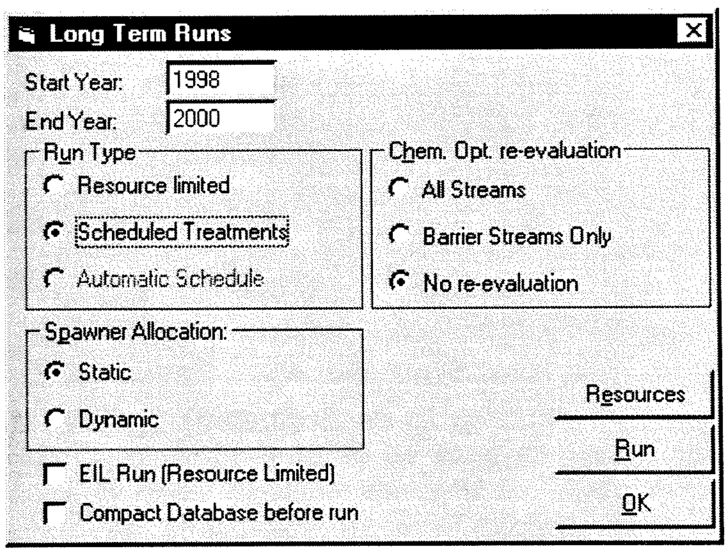
3. Provide a name for the new budget in the *Description* field.
4. Click ***View*** to activate the *Budget and Resources* screen where you can modify/enter the budget values in each of the available fields.
5. Click ***OK*** to save your changes and return to the **Main** Menu.

► To delete an existing EIL run budget:

1. Select the **EIL Run Budgets** option from the **Edit** Menu to access the *EIL Run Budgets* screen.
2. Highlight the budget you wish to delete.
3. Click on the ***Remove*** command button. You will be prompted to confirm your deletion request.
4. Click ***OK*** to save your changes and return to the **Main** Menu.

LongTerm Menu

LCSS can generate long-term control scenarios to help you evaluate the long-term performance of alternative selection criteria and budget limitations. To conduct a long-term run, select the **LongTerm** option from the **Main** Menu to access the *Long Term Runs* screen.



The fields, options, and buttons on this screen are:

Start Year/End Year

The dates entered in these fields identify the calculation horizon for the run.

Run Type

Select the type of run you wish to conduct using the option buttons in this section of the screen. There are three run types:

- *Resource Limited* runs erase the existing schedule, and select streams for treatment in priority (as determined by the ranking criteria), using the availability of chemicals, time, and money as the only limitations;
- *Scheduled Treatment* runs apply the current schedule for the range of years shown; this is done on a year-by-year basis when moving forward through the schedule; this option can be used for applying historical treatments; and
- when implemented, *Automatic Schedule* runs will erase the current schedule and use the built-in expert system to build a treatment schedule; this option will add logistic constraints to the suite of limitations examined in the *Resource Limited* runs, and will be the same as clicking the ***Gen All*** button on the *Treatment Schedule* screen.

Chem. Opt. re-evaluation

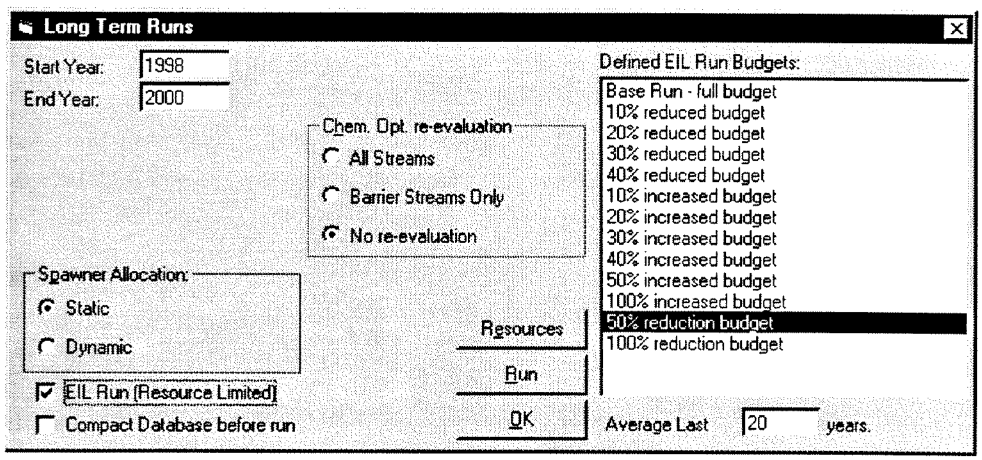
The three option buttons in this section of the screen are: *All Streams*; *Barrier Streams Only*; and *No re-evaluation*.

Spawner Allocation

Select one of two options for spawner allocation strategy: *Static* or *Dynamic*.

EIL Run (Resource Limited)

Checking this box expands the screen to include the list of *Defined EIL Run Budgets*, and *Run Type* automatically defaults to *Resource Limited*.



The *EIL Run* option also automatically turns off the *Write Simulation Details to the database* option and turns on the *Recalculate the ranking list each year* option during the run (see page 4-64). One or more EIL budgets can be included in a single run, and each will add information to the already generated data set, i.e., there is no need to run all defined EIL run budgets in a single run.

Compact Database before run

Check this box if you wish to compact the database prior to conducting a long-term run. Compacting can be disabled if a run is extended for a few years.

Resources

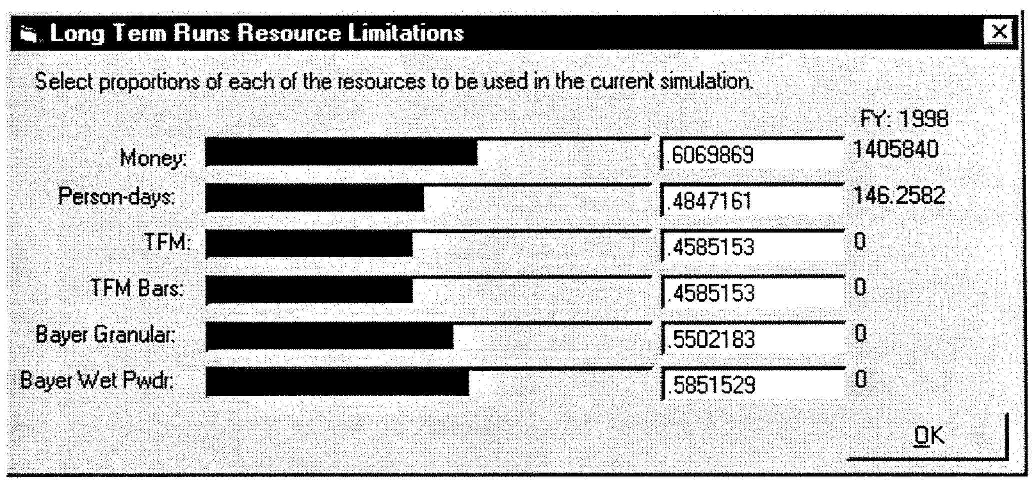
This command button activates the *Long Term Runs Resource Limitations* screen (see below). Use this screen to specify how much of each resource (e.g., money, chemical, person-days) is to be used in the simulation run.

Run/Stop Run

Click on the ***Run*** command button to initiate a long-term run; during the run, a ***Stop Run*** command button will appear. ***Stop Run*** allows you to interrupt a long-term run. If you click on this button, the system will finish the current year's calculations and then stop. The *Start Year* field will be automatically updated to one year after the last simulated year. To continue the run, click on the ***Run*** command button again. The results of a run can be viewed in Microsoft Access by choosing **Database** from the **Main** Menu.

Limiting resources in a long-term run

The ***Resources*** command button on the *Long Term Runs* screen accesses the *Long Term Runs Resource Limitations* screen.



Resources can be limited to simulate a reduction in overall resources (e.g., budget) for all of the Great Lakes or to simulate only a part of the Great Lakes system (e.g., only Lake Superior).

The screen shows a list of all resources used in the simulation. A shaded proportion of the bar next to the resource name represents the proportion of the resource available. A numerical value of the proportion follows the bar. On the far right is the amount of the resource available for the first year of the simulation. The limitations specified apply to all of the years of simulation. To limit the availability of resources you can either click on the bar at the desired resource level or enter the proportion directly.

Conducting a long-term run

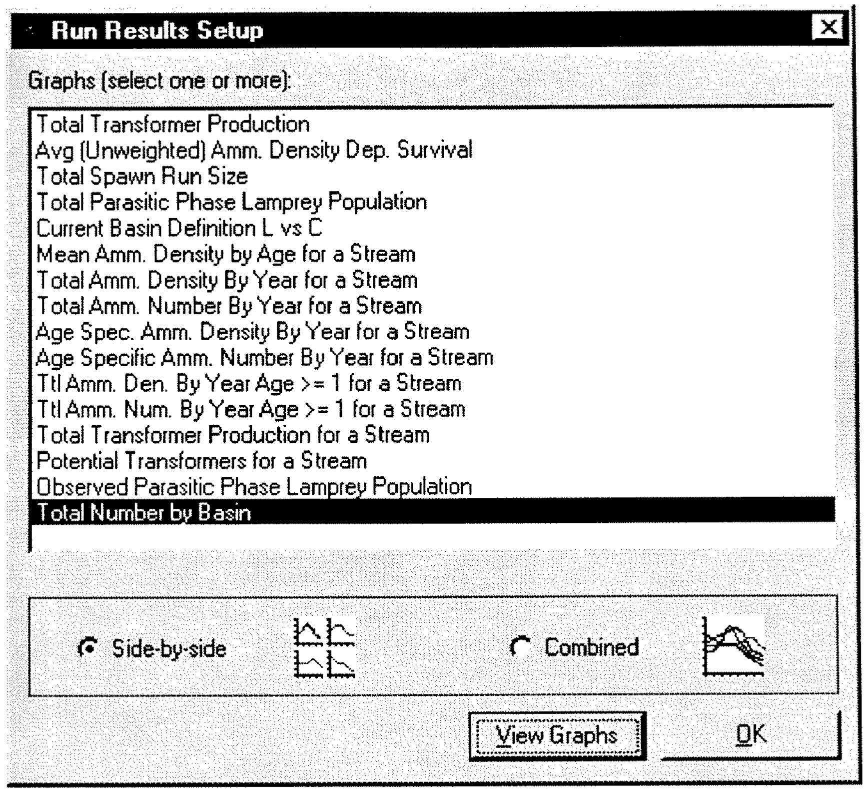
➤ To conduct a long-term run:

1. Choose **LongTerm** from the **Main** Menu to open the *Long Term Runs* screen.
2. Enter *Start Year* and *End Year* to set the calculation horizon.
3. Select the desired run type by clicking on one of the two available option buttons: resource limited or scheduled treatments.
4. Select the optional *EIL Run* and *Compact Database* if so desired.
5. Indicate which spawner allocation strategy and chemical option re-evaluation you wish to use.
6. Click on the ***Run*** command button.
7. To view the results of the run in Microsoft Access, go to the **Database** option on the **Main** Menu.

Graph Menu

The **Graph** menu provides for a visual review of many of the setup and results data for LCSS runs. There are two main components to this menu: *Run Results Setup* and *Run Results View*.

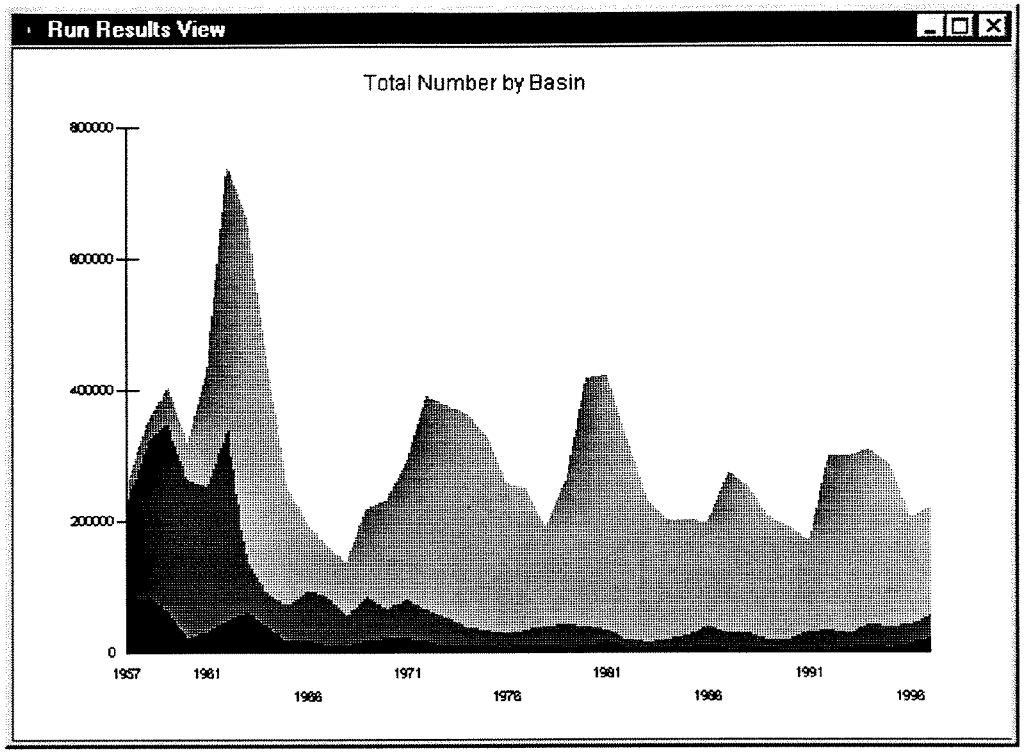
The *Run Results Setup* screen is activated by selecting **Graph** from the **Main** Menu, or by clicking the graphing icon on the toolbar.



This screen features a list of graphs available for display, and includes the option to choose display type. Select one or more graphs for display from the list in the *Graphs (select one or more)* field. Choose the type of display desired by enabling either the *Side-by-Side* or *Combined* option buttons. Graphs selected for display as overlays must all be of the same type (e.g., all bar graphs) and have the same independent variable. Graph type can be changed (e.g., from line to bar) only through the native Microsoft Access Interface (see Appendix C). Additionally, if the magnitude of the dependent variable for one graph in an overlay is substantially different (i.e., more than 10 times) from another being displayed concurrently, the data for the lower magnitude graph will be scaled automatically to the larger one (e.g., Transformer Production (in the 1000s) vs. Ammocete Survival (≤ 1)).

For all graphs involving density (e.g., Age Specific Ammocete Density), the unit of measurement is number per square metre ($\#/m^2$).

After choosing one or more graphs from the *Graphs* list, click on the ***View Graphs*** command button to initiate the graphing process.



The system will request additional information as it compiles the data for each graph. You will be prompted to identify the time period, and to identify the lake and stream (stream number is required) for which you wish to graph data. If you need to verify any stream numbers, go to **Edit|Stream Setup**.

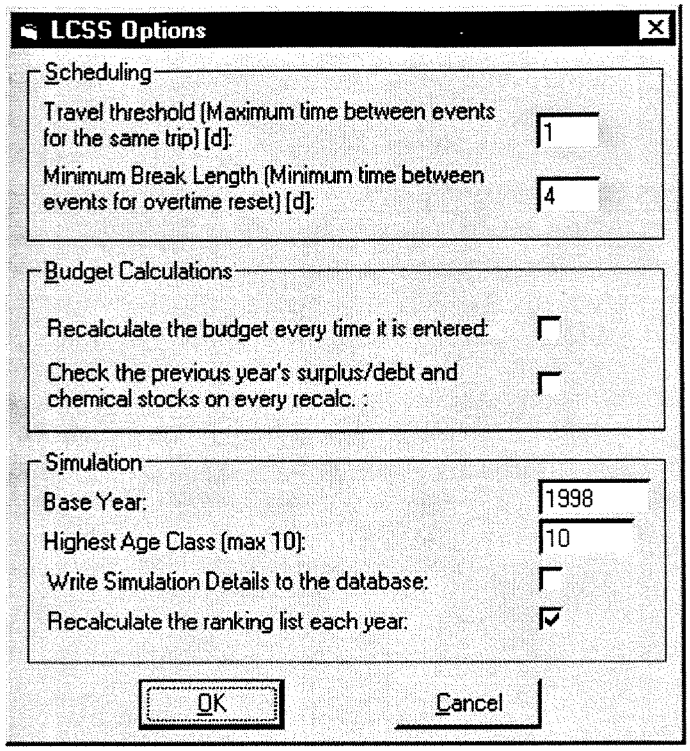
When the system has finished generating the requested graphs, the *Run Results View* screen will open to display the results. Legends for each graph can be turned on and off by right-clicking with the mouse on the graph.

Database Menu

Choosing **Database** from the **Main** Menu accesses the Microsoft Access database that contains the central files used in LCSS. From Microsoft Access you will be able to enter data and generate results from the database.

Options Menu

Selecting **Options** from the **Main** Menu activates the *LCSS Options* screen where you can set preferences for the system as a whole.



The fields and options on this screen are:

Travel threshold

The maximum time between events for the same trip is used in the scheduler to determine if a treatment or user event is a candidate for inclusion in a trip. If an event is dropped within the threshold of another event, the scheduler gives users the option of combining two events into a single trip, thus representing a single trip time to and from the site.

Min. Break Length

The minimum break length between treatments is used for overtime calculations. If this amount of time is not spent, the two events are considered "adjacent" and their time is combined for overtime calculations. If the length of such combinations exceeds 10 days, any excess time is considered as overtime.

Recalculate budget

When this option is selected, the budget is automatically recalculated whenever a budget is entered.

Check surplus/debt

This option provides continuity between years in terms of money and stock levels. Enabling this option may not be appropriate when such data are missing or incomplete.

Base year

This is the base year used in the budget, treatment scheduler, quick schedule options, and long-term runs. The value changes here whenever it is changed in the *Long Term Runs* screen and vice versa.

Highest Age Class

Set the age of the oldest lamprey to be used in the simulation (the maximum allowable is age class 10).

Write Simulation Details to the database

When this option is enabled, the system will copy the details of the current simulation (e.g., lamprey numbers, density, length, allocation to reaches) into the database. If you wish to run simulations for any years following the year you are currently running, you must turn on this option. If you plan to run the same year repeatedly to test the effects of various parameter values, leave this option disabled so the run will proceed more rapidly.

Recalculate the ranking list each year

If you enable this option, the system will re-assess the order in which the streams will appear in the *Ranked Stream List* (*Treatment Schedule* screen). Turning on this option will slow the speed of the run somewhat.

Help Menu

Help is available in two ways: through the **Main** Menu and from each screen. The help provided through the **Main** Menu is indexed for easy reference and can be best used for getting an overall view of the system, and for finding out about specifics of the program's operation.

The help available from the screens is context sensitive and is related directly to the options available from the screen. This type of help can be invoked using the <F1> key while using the system.

The information presented through both options is identical. The index presents a top-down view of the system, beginning with general topics and moving to more detailed information about LCSS. The context-sensitive help goes directly to the help topics most relevant to the current screen.

The help files follow the standard Microsoft Windows Help format.

Glossary of Terms

EIL

Environmental Injury Level.

LAMPREY BASIN

A lamprey basin is the area of a lake where a single parasitic phase population of lamprey resides. It is defined by both the set of streams to which spawning phase lamprey migrate and the set of streams from which transformers migrate.

REACH

A reach is defined as a non-overlapping section of the stream that acts as a homogenous unit. Each stream that is potentially subject to lamprey control treatments has been defined as consisting of a set of one or more reaches.

SCENARIO

A scenario represents a set of conditions that are being simulated by the model, and includes parameter values, management options and results. Scenarios include the starting conditions of lamprey populations for all basins, streams and reaches to be simulated; the budget and treatment resources that are available; and detailed descriptions of the control treatments to be simulated by the LCSS.

STREAM BARRIER ACTIVITY

The stream barrier activity defines what happens in the stream over the course of the simulation by determining the proportion of the stream's spawners allocated to each reach. For example, a stream might be divided into two reaches as a result of a potential barrier. If a simulation starts before the barrier is active (stream barrier activity = "no barrier or barrier not active"), spawners have free access to the entire stream according to the allocation associated with the stream barrier activity. When the barrier becomes active (stream barrier activity = "barrier active"), spawner access to the stream will be restricted to the lower reach only according to the spawner allocation associated with the new stream barrier activity. If a barrier gets washed out, spawners will once again have full access to the stream's reaches (stream barrier activity = "no barrier or barrier not active"). The barrier activity will determine the default values for chemical options, sterile male release, spawner allocation, and trap allocation.

STREAM CONFIGURATION

A stream configuration is a definition of the physical layout of the stream. It is composed of non-overlapping sections of the stream called "reaches", which act as homogenous units. A combination of reaches that represents the whole of the stream available for treatment is called the stream configuration. A single reach may belong to multiple stream configurations. A stream can have multiple alternate stream configurations, although only one can be used in the course of a single simulation.

TREATMENT WINDOW

Each chemical treatment option is assigned one of three treatment window types. These are: preferred, acceptable and not acceptable. Future versions of LCSS will be able to show the assigned treatment window in the calendar when you check the Show Treatment Windows box (bottom left corner of the *Treatment Schedule* screen).

5.0 ISIS User Interface

IMSL Stream Inspection System (ISIS) is a component of the IMSL suite of decision support tools. The central theme for ISIS is the stream. ISIS was designed to easily access and modify stream parameters and examine the effect of these modification on the results of simulations.

This facility, however, would not be very useful without close ties with LCSS (Lamprey Control Selection System). ISIS and LCSS share the simulation model, including the stream treatments sub-model. ISIS is also able to import and export stream parameters to and from any LCSS scenario database. This allows ISIS to become a test bed for parameter values. ISIS keeps its own copy of the parameters to allow LCSS to be used independently without fear that the parameters in LCSS will change unexpectedly.

Additionally, ISIS allows comparison of the results of stream simulations to the collected assessment data for individual years or over a period of time. This allows refinement of stream parameters which then can be used in LCSS.

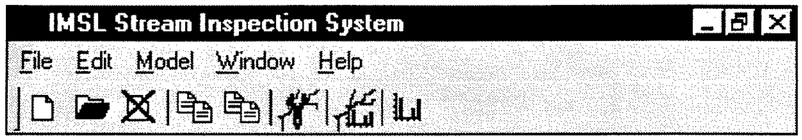
ISIS has four major components:

1. *Data maintenance and I/O* allows users to import data from LCSS, create streams, delete sets of parameters or delete results no longer needed. These options are located in the **File** Menu;
2. The *Stream construction* component allows modification of a selected stream. All stream parameters are available for review/modification in the **Edit** Menu;
3. *Model* utilizes the values of stream parameters stored in the database to run the lamprey model (see **Model Menu** section, page 5-23); and
4. *Results review* allows comparison of results of model runs using single or multiple streams to each other and to the assessment data using tables and graphs (also **Model** Menu).

Note: ISIS is still in a prototype stage and not all of its functions are fully implemented. This document describes the program's current and intended functions.

ISIS Main Menu

The **Main** Menu gives you access to all parts of the system. Menus and submenus are described below in separate sections. In addition to the main menu, there is a button bar located just below the menu which provides fast access to the most frequently used functions of ISIS.



The functions provided through the button bar are (in order):

from the **File** Menu:

- **New Stream Scenario**
- **Select Stream Scenario**
- **Delete Results Scenarios**
- **LCSS Scenario DB Import**
- **LCSS Scenario DB Export**

from the **Edit** Menu:

- **Stream Parameters**

from the **Model** Menu:

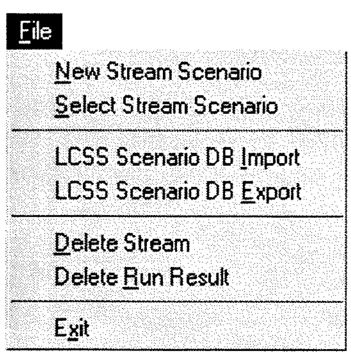
- **Run**
- **View Results**

A detailed description of the functions listed can be found under individual menu sections.

The bottom of the screen identifies the currently selected stream. This choice can be changed using menu items **New Stream Scenario**, **Select Stream Scenario** or by selecting a stream in the **Stream Parameters** set of screens.

File Menu

The **File** Menu contains the data maintenance and I/O functions. The options most often used are also present on the button bar.



New Stream Scenario creates a new stream either with default parameter values or with a copy of parameters from another stream.

Select Stream Scenario opens an existing stream for manipulation. This same function can also be performed by selecting a stream in **Edit|Stream Parameters** (see page 5-5).

LCSS Scenario DB Import and **LCSS Scenario DB Export** allow movement of parameters between the ISIS database and the LCSS Scenario database.

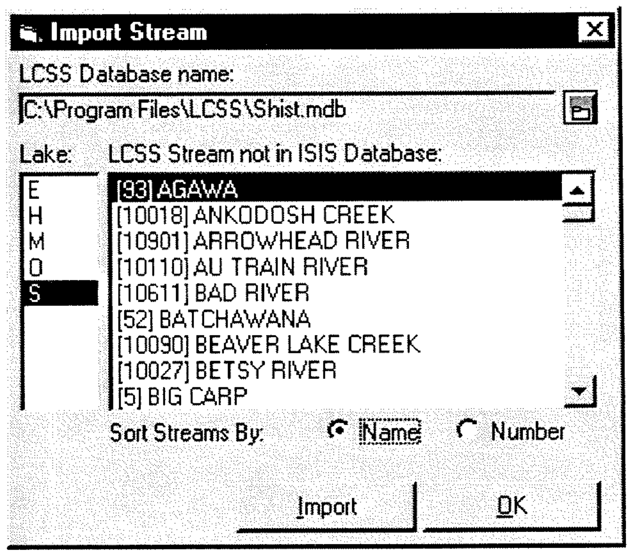
Delete Stream allows the removal of stream parameters and run results for a particular stream from the ISIS database.

Delete Run Result deletes individual run results for the current stream.

The **Exit** option shuts down the ISIS program.

LCSS SCENARIO DB IMPORT

ISIS provides a facility for importing data from the LCSS database. Selecting the **File|LCSS Scenario DB Import** option activates the *Import Stream* screen. This function can also be accessed from the button bar using the icon.



The import function copies all of the stream-related parameters from the specified **LCSS Scenario** and the associated **Options** databases to the ISIS database. These include physical parameters (i.e., stream configuration, reach and age), barriers, stream activity, spawner allocations, chemical options, treatment schedule, SMRT and trap data, and stream-basin-stream allocation data.

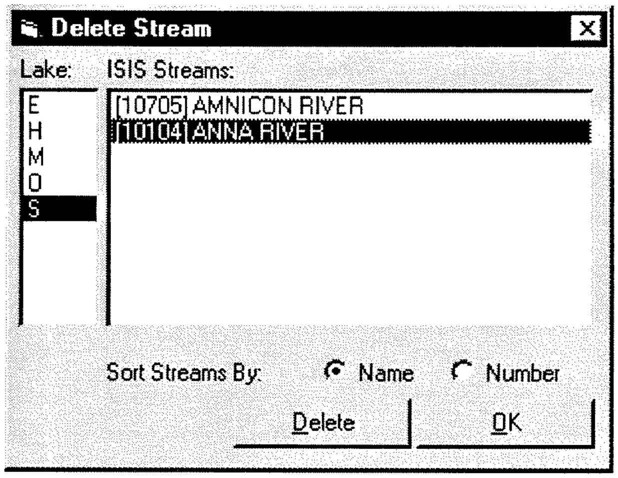
To avoid the possibility of conflicts, currently loaded stream-basin-stream allocation data are deleted prior to loading a new set of values. This may cause some streams to behave differently following the loading of an unrelated stream (due to different survival rates of parasitic phase lamprey and different proportions of returning spawners, see the Spawners tab (page 5-21) of the **Stream Parameters** set of screens.

LCSS Scenario DB Export

The **LCSS Scenario DB Export** function complements the import function described above. It allows transfer of parameter values from the ISIS database to LCSS database. The *Export Stream* screen can also be activated from the button bar using the icon.

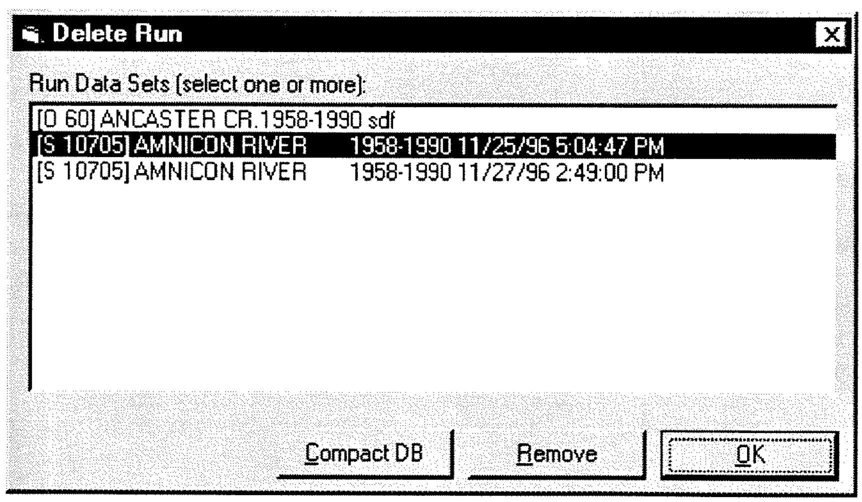
Delete Stream

Use the *Delete Stream* screen to remove the parameters and run results for selected streams from ISIS.



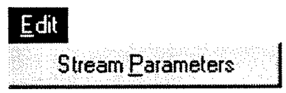
Delete Run Result

The *Delete Run* screen allows you to remove particular run results from the list of *Run Data Sets*. Select one or more runs and click on the ***Remove*** command button to delete the highlighted runs from the list.



Edit Menu

The **Edit** Menu contains the stream parameters that characterize each stream. The only option, **Stream Parameters**, invokes a set of screens containing nine tabs.



STREAM PARAMETERS

The **Stream Parameters** dialogue provides access to all stream-related parameters. These are grouped into nine tabs placed along the top of the dialogue. Most of the tabs contain layouts similar to those used in LCSS (see the **LCSS User Interface** section of this manual). This family of screens can be activated from the button bar with the icon. The nine tabs are:

Stream — Contains the general stream information. A stream selected here is later simulated in ISIS. The current selection is reflected at the bottom of the main screen.

Config — Contains parameters defining the physical structure of the stream.

BioParms — Contains biological parameters. A tabbed dialogue further subdivides the parameter set in this screen.

Barriers — Contains all of the currently defined barriers on the stream and facility for deleting or defining new barriers.

Activity — Contains the definition of the way the stream acts in response to the activation and/or failure of barriers. Here you can also access the chemical options and the default SMRT release settings.

Traps — Allows definition of default and non-default trap placements.

SMRT — Allows definition of overrides for the default SMRT releases (defined in the Activity tab).

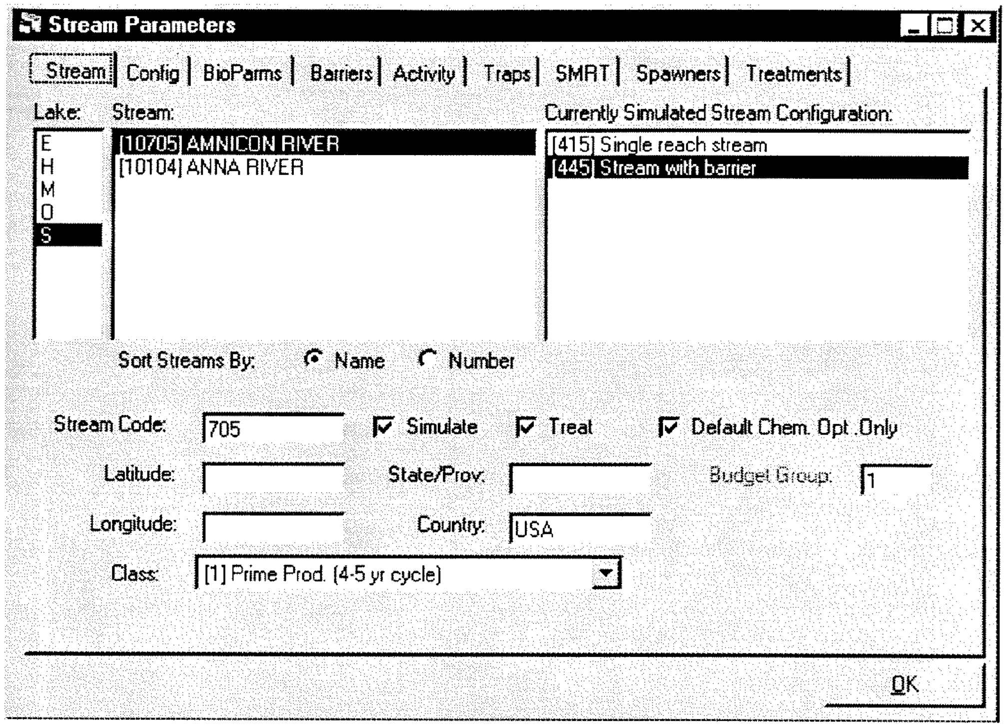
Spawners — Defines the annual allocation of spawners to the stream.

Treatments — Lists and allows modification of all of the chemical treatments selected for the current stream.

Each of these tabs is described in more detail below.

Stream

The *Stream* tab contains a screen that is very similar to the *Stream Setup* screen in LCSS (see page 4-22). It contains general information about the streams loaded in the ISIS database.



The *Lake* and *Stream* lists allow selection of a stream to be simulated, viewed or modified. The stream list contains only the streams loaded into the ISIS database. As streams are added to or removed from the database, the list will change accordingly. The *Stream* list can be sorted by either the stream *Name* or *Number*. The stream selection made here is displayed on the status bar at the bottom of the screen, and is the one that will be used for simulation runs. It will also be the currently selected stream in all of the tabs in the **Stream Parameters** family of screens.

The *Currently Simulated Stream Configuration* list displays all of the currently defined physical representations of the selected stream. The one currently highlighted is used in the simulation. For more detail on stream configurations see the **Stream Configuration** section in LCSS (page 4-24).

The *Stream* tab also allows modification of the following characteristics of streams:

Stream Code

Alternate code used in other lamprey program documentation.

Simulate

The value of this flag is set to "true" (the checkbox is marked), i.e., the stream selected here will be simulated. This field cannot be modified.

Treat

Specifies if the stream will be considered for treatment. If this flag is not set to "true" by marking the checkbox, the treatments selected on the *Treatments* tab will be ignored.

Default Chem.Opt. Only

The default value of this flag is "true", meaning that the streams will always be treated with the options selected on the *Treatments* tab. This field cannot be modified.

Latitude, Longitude, State/Province, and Country

Define the stream location.

Class

Is used in calculations of static basin-to-stream lamprey allocations (see **Lamprey Allocation** section in LCSS, page4-40).

Budget Group

Is currently unused and should always be set to 1.

Stream Configuration

The *Config* tab allows entry and modification of stream configurations for the currently selected stream. This screen is very similar to the *Stream Configuration* screen in LCSS (see page 4-24).

A stream configuration is a definition of the physical layout of the stream. It is composed of "reaches", non-overlapping sections of the stream acting as homogenous units. The reaches are connected by defining a downstream reach. The lowest single reach in a group should be defined to flow into itself. A combination of reaches, a stream configuration, represents the whole of the stream. A single reach may belong to multiple stream configurations. A stream can have multiple alternate stream configurations, although only one can be used in the course of a single simulation.

All of the stream configurations for the selected stream are listed in the *Stream Configuration* table of the *Config* tab.

The *ID* column in the table automatically generates unique identifiers for stream configurations. The *Description* column provides short descriptions of each configuration. New stream configurations can be added using the ***Add Conf*** command button. Existing stream configurations can be removed using the ***Del Conf*** button.

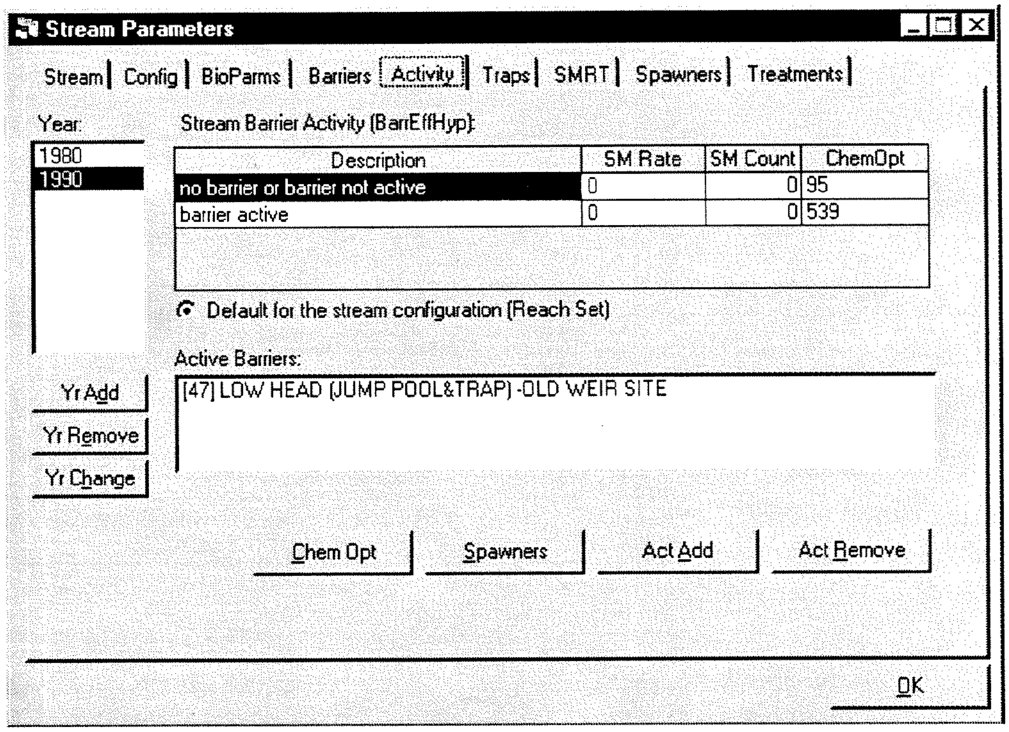
The *Reach* table lists all of the reaches defined for the stream for all of the stream's configurations. Reaches may overlap, although if they do they should not be included in the same stream configuration. The *Reach* column uniquely identifies the reach within the stream, *ReachName* provides a short description of the reach, the *In* column specifies if the reach is included in the currently selected reach configuration (true = yes), and the *DownStr* column specifies which of the other reaches within the current stream configuration is downstream of the selected reach.

Expenses are reported in the fields *Year*, *Amount* and *Description*. Existing values can be modified by clicking on a cell and simply overtyping the current contents. Expense information can be added and deleted from the table using the ***Add*** and ***Remove*** command buttons.

Values describing the cost of barrier planning, construction and maintenance are displayed in the centre of the Barriers tab. These values can be modified by overtyping currently displayed values with new ones. A choice of stream configurations and barrier locations appears at the bottom of the screen in the *Barrier Location* field.

Activity

The *Activity* tab contains a screen very similar to the *Stream Barrier Activity* screen in LCSS (see page 4-30). Stream barrier activities define what happens in the stream over the course of the simulation. Most notably, stream barrier activities affect the allocation of spawners within a stream. Activities displayed in this tab apply only to the currently simulated stream configuration.



All of the stream barrier activities for the current stream configuration are displayed in the *Stream Barrier Activity (BarrEffHyp)* table. In the example above, two different barrier activities are listed: "no barrier or barrier not active", and "barrier active". Each barrier activity has an associated default Sterile Male Release Rate (*SM Rate*) and Sterile Male Release Count (*SM Count*), and chemical options (*ChemOpt*).

➤ To define a new stream barrier activity:

Note that at least one chemical option must exist before a stream barrier activity can be defined.

1. From **Edit|Stream Parameters**, click on the *Activity* tab and click on the *Act Add* command button.
2. Enter a *Description* of the new stream barrier activity (e.g. "barrier active").
3. If this is the default activity for the stream, select the "Default for the stream configuration" option.
4. If this is not the default activity for the stream, specify the year in which this activity should take effect by pressing ***Yr Add***. You need only specify the year in which the activity changes. The barrier activity remains the same until a new value is found or the simulation ends.
5. For each active barrier, check that the appropriate spawner allocation and chemical treatment option have been defined for the activity by examining the screens accessed by clicking on the ***Spawners*** and ***Chem Opt*** buttons (see below).

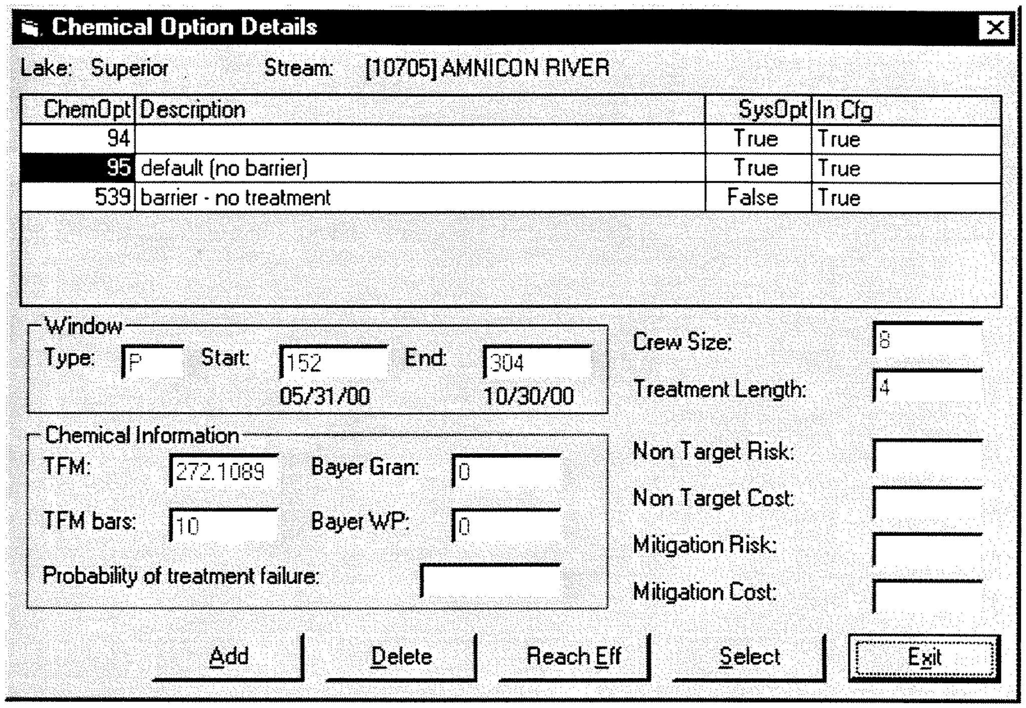
➤ To remove a stream barrier activity:

1. Select the stream barrier activity you wish to remove.
2. Press ***Act Remove***. All associated spawner allocation information will also be deleted by this action.

The *Activity* tab can also be used to enter the default *SM Rate* and *SM Count* values. *SM Count* refers to the number of sterile males released in the stream, and *SM Rate* is the ratio of sterile males to non-sterile males released (see the **SMRT** section in LCSS, page 4-51).

Once you have defined the stream barrier activity, you should examine the default chemical treatment options associated with the barrier and the allocation of spawners to the reaches of the stream. This information can be accessed by clicking on the ***Chem Opt*** and ***Spawners*** buttons on this screen. Each is discussed below.

The ***Chem Opt*** command button activates a *Chemical Option Details* screen that is identical to the one used in LCSS.



This screen allows users to view and modify the chemical treatment option for the currently selected lake and stream.

Each of the major fields on this screen is described below:

Lake/Stream

Identifies the current lake and stream.

ChemOpt

A unique identifier that references the chemical treatment option.

Description

Provides a brief description of the chemical option.

SysOpt

Choose "True" if you wish to identify the associated chemical option as a "system option" that will be protected from accidental modification.

In Cfg.

Indicates if the chemical option is relevant to the current stream configuration (true or false). This value is used to select possible chemical option alternatives when picking the best one to use for the stream.

Window

Each treatment option is assigned a window type. A window is a time period during which the treatment application occurs. Window types are indicated as "P", preferred; "A", acceptable; or "N", not acceptable. The

Window Type will be used by the automatic scheduler to select the treatment windows for each stream.

Start Date

The start and end dates for the window types are entered as Julian dates. The system automatically displays the standard month and day format below this field.

Crew Size

The crew size usually associated with this chemical treatment option.

Treatment Length

The number of days required by the selected crew to complete the treatment.

Chemical Information

These fields display the types and amounts of chemicals used in the chemical treatment option, and the probability of treatment failure.

NonTargetRisk

A value from 0 to 1 of the treatment risk on non-target species.

NonTargetCost

The probable cost incurred should the non-target species be affected by the chemical treatment option.

MitigationRisk

The likelihood of having to prevent or minimize any non-target effects (0 to 1).

MitigationCost

The cost of carrying out any necessary mitigation measures.

The actions available from the *Chemical Option Details* screen are:

Add

Create a new chemical option. The system will allow you to use the currently selected chemical option as a template for a new one. The new option is entered at the bottom of the *ChemOpt* list. Modify the values in each of the fields as necessary.

Delete

To delete a selected chemical option.

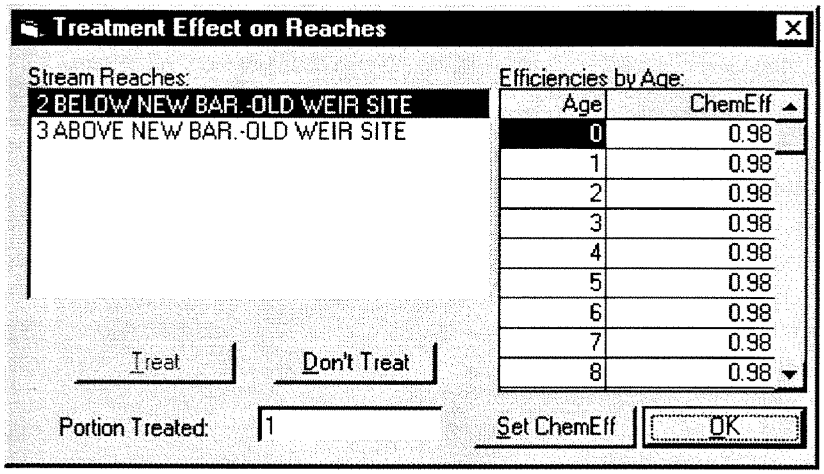
Select

Selects the current chemical option to be the new default option for the *Stream Barrier Activity* screen or to be used as the current treatment on the *Treatments* tab. This button has no affect on the *Stream Info* screen in LCSS.

ReachEff

Takes the user to the *Treatment Effect on Reaches* screen (see below).

The *Treatment Effect on Reaches* screen is accessed by pressing the ***Reach Eff*** button at the bottom of the *Chemical Options Details* screen. It identifies the proportion of ammocetes killed by the chemical treatment.



The fields and buttons available from the *Treatment Effect on Reaches* screen are:

Stream Reaches

Lists all reaches in the current stream configuration.

Portion Treated

Indicates the proportion of lamprey habitat affected by the treatment.

Efficiencies by Age

Treatment efficiencies for individual age classes. The usual settings are .99 for high, .98 for medium and .95 for low efficiency.

Treat

Specifies that the reach is to be treated.

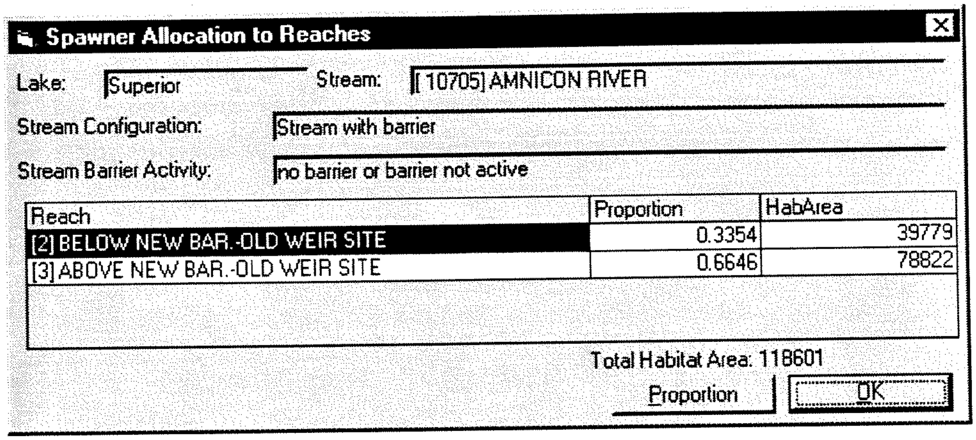
Don't Treat

Removes a reach from treatment by the current chemical option.

Set ChemEff

Allows the user to enter a new chemical efficiency value for all age classes. If you want to edit the chemical efficiency for a given age class only, click on the *ChemEff* value that you want to edit and enter the new value that reflects the portion of the age class killed.

The *Spawner Allocation to Reaches* screen in ISIS, which can be activated by clicking on the ***Spawners*** command button on the *Activity* tab, is identical to the one in LCSS. Use this option to specify what proportion of the spawners entering the stream should be allocated to each reach within the stream configuration.



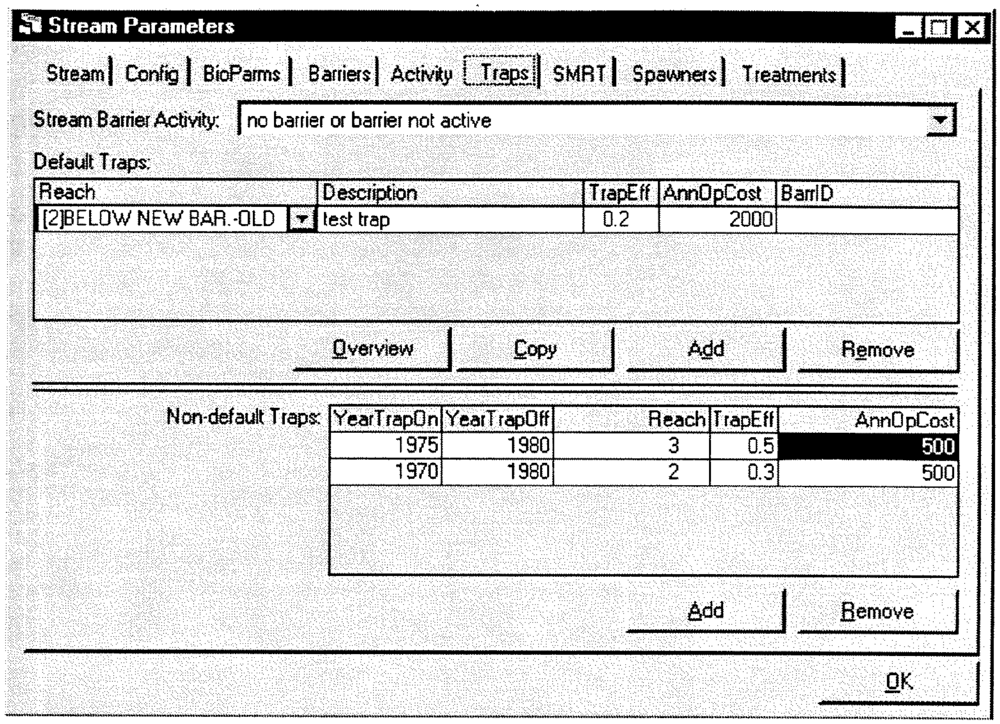
This screen allocates spawners from streams to reaches. To allocate spawners from basins to streams, go to the **Lamprey Allocation** option in LCSS (page 4-40).

As a general rule, the spawner allocation is set proportional to the habitat area in each reach (as in the example screen above). This calculation can be done automatically by clicking on the ***Proportion*** command button at the bottom of the screen. In some cases, however, an operational barrier may block the passage of lamprey upstream and the values in the *Allocation to Reach* column will be 1 (below the barrier) and 0 (above the barrier). The sum of allocation values for all reaches within a stream configuration should equal 1, otherwise the system will be inconsistent in its allocation by allowing more (or fewer) spawners to spawn than arrived in the stream.

The combination of the spawner allocation and the trapping mortality determines the number of spawners arriving in the reach. More details on how these numbers are used can be found in the model description in Appendix A.

Traps

You can simulate the placement of traps in reaches by using the *Traps* tab. The screen allows users to define the placement, efficiency, and cost of both default and non-default traps on the currently selected stream configuration.



A *default* trap placement is specific to the stream barrier activity being simulated on the stream to which the trap is added. For example, if the stream barrier activity for the Amnicon River is set to “no barrier or barrier not active”, the trap is present whenever this stream barrier activity is simulated.

Whereas default traps are linked to stream barrier activity, *non-default* traps are defined for a given year and are not dependent upon the stream barrier activity being simulated.

Fields and buttons for setting default traps with the *Traps* tab are:

Stream Barrier Activity

From the drop-down list, select one of the stream barrier activities created for the current stream configuration.

Reach

Drop-down list of reaches available for placing traps.

Description

Enter a description of the trap.

TrapEff

Enter a value between 0 and 1 to represent the efficiency of the trap. A value of 0.2, for example, specifies that 20% of all lamprey swimming by this trap (to the reach on which the trap is located and all the reaches above it) are caught.

AnnOpCost

Enter the annual cost to operate the trap.

Barrier

Barrier (if there is one) with which the trap is associated. Choose from the drop-down list provided.

Overview

Activates a summary screen which shows the cumulative effect of the default and non-default traps (see *Summary of Trap Activity* in LCSS, page 4-50).

Copy

Uses one of the "template" traps to create the new trap.

Add

Inserts a "blank" entry.

Remove

Removes the currently selected trap.

Fields and buttons for setting non-default traps with the *Traps* tab are:

YearTrapOn

First year the trap is active.

YearTrapOff

First year the trap becomes inactive.

Reach

Specify the reach on which the non-default trap is placed.

TrapEff

Proportion of lamprey the trap catches in the reach where it is placed and all the reaches above it.

AnnOpCost

Annual operating cost for the trap.

Add

Adds an entry to the Non-default Traps table.

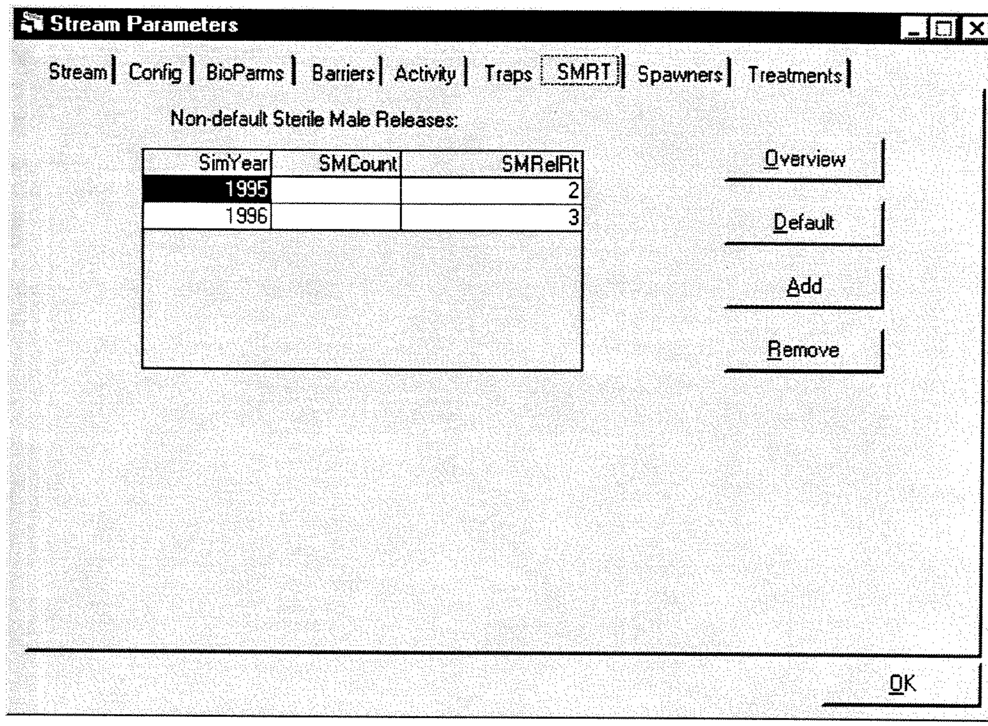
Remove

Removes the currently selected entry from the Non-default Traps table.

Non-default trap placements act in addition to traps placed in the stream by default. However, when a stream barrier activity changes (and with it the default trap placements), all of the non-default placements are reset.

SMRT

The *Sterile Male Release Technique (SMRT)* tab is used to set the non-default release of sterile males to the currently selected stream. The default SMRT releases can be set on the *Activity* tab (see the ***Default*** command button, below).



Fields and buttons on the *SMRT* tab are:

SimYear

The year of sterile male release.

SMCount

The actual number of sterile males released.

SMRelRt

The ratio of sterile to non-sterile males. For example, when the SMRelRt in 1995 is 2, then 2 sterile males are released for every 1 non-sterile male.

Overview

Activates a screen that provides a summary of the SMRT program.

Default

This command button switches you to the *Activity* tab to set default SMRT allocations.

Add

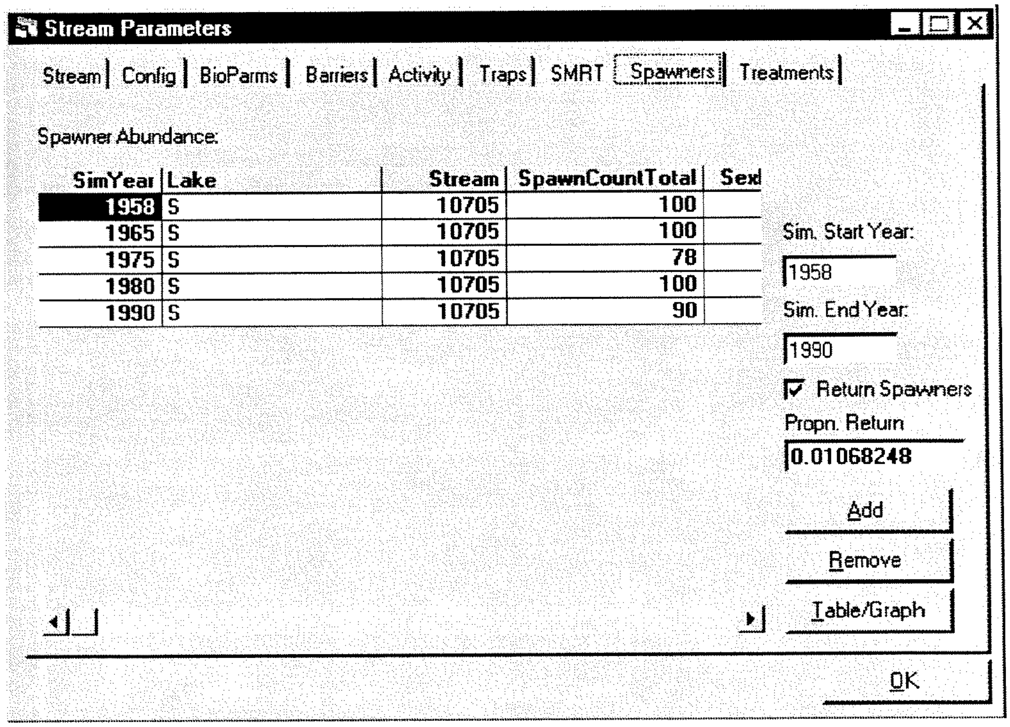
Adds release entries for the currently selected stream.

Remove

Removes release entries for the currently selected stream.

Spawners

The *Spawners* tab allows specification of the annual spawner allocation to the stream.



This screen provides both numeric and graphic representation of spawner abundance. The *Spawner Abundance* table allows entry and modification of the characteristics (e.g. number and sex ratio) of spawners entering streams from basins, and is independent of the transformer production in the selected stream (see also basin-to-stream spawner allocation in LCSS, page 4-45).

To add a feedback, with stream transformers adding to the "basin" spawners, mark the *Return Spawners* check box. ISIS will enter a value into the *Propn. Return* field that identifies the proportion of transformers from the selected stream that return to the same stream to spawn. This value comes from the basin-to-stream spawner allocation calculation in LCSS (see page 4-45). The number of returning spawners is calculated using the number of transformers produced 2 years prior to the current simulation year (which allows for their residence in a lake), and incorporates the appropriate basin mortality rate.

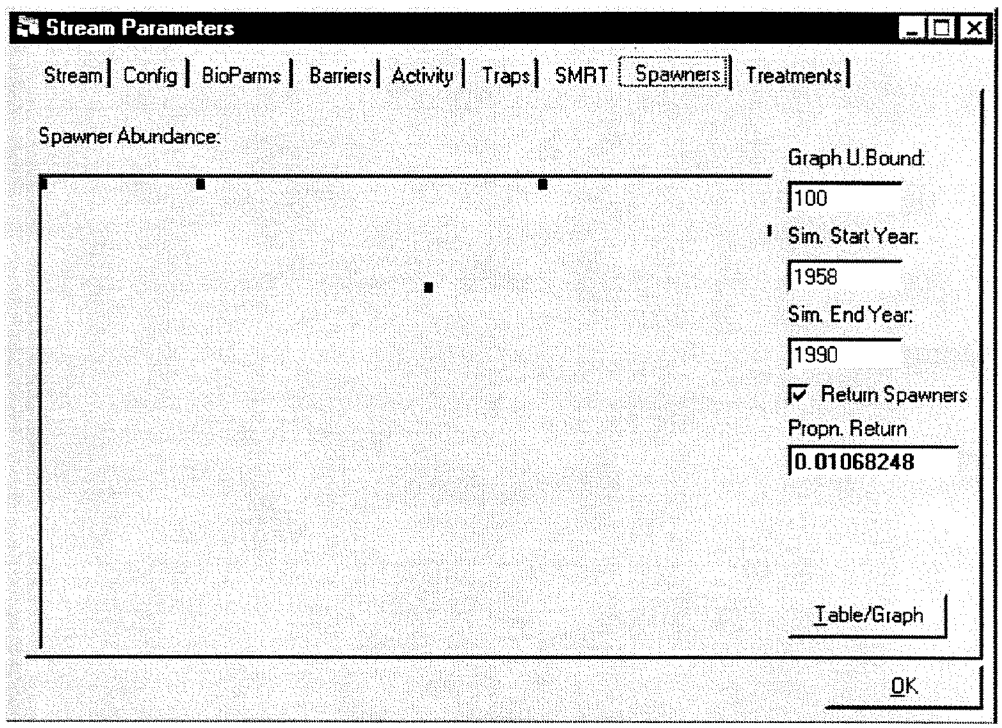
Although the *Propn. Return* value on the *Spawners* tab can be modified to simulate various hypothetical situations, the original value cannot be recovered unless you import a new stream.

CAUTION: To avoid the possibility of conflicts, currently loaded stream-basin-stream allocation data are deleted prior to loading a new set of values. This may cause some streams to behave differently following the loading of an unrelated stream (due to different survival rates of parasitic phase lamprey and different proportions of returning spawners).

The system does not require all of the years of the simulation to be entered. The spawner levels are kept constant based on the last known value (eg. if the number of spawners is set to 100 for 1965 and then to 78 for 1975, the number simulated from 1965 to 1974 will be 100 and from 1975 on will be 78). If there are no values entered for the spawner numbers prior to the currently simulated year, the lake default is used.

The yearly records can be added or removed using the ***Add*** and ***Remove*** command buttons.

The size of the spawner run can be reviewed graphically by clicking on the ***Table/Graph*** command button.

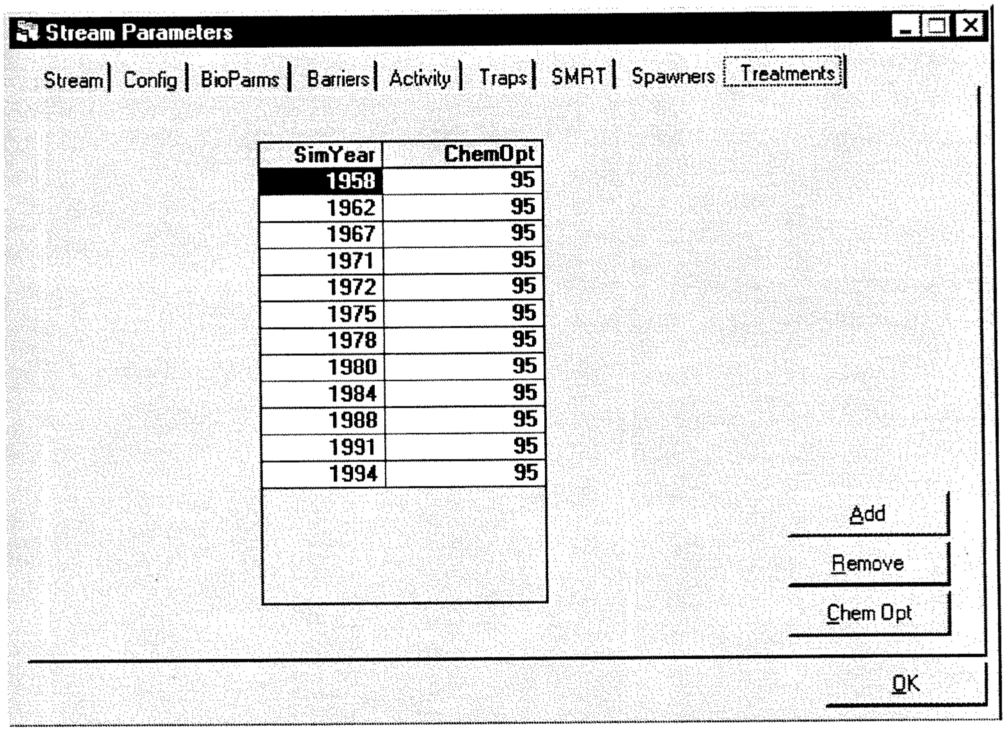


In the graph of spawner abundance, the horizontal x-axis ranges from the year entered for *Sim. Start Year* to the year entered for *Sim. End Year*. These values represent the start and end years for the simulation. The vertical y-axis depicts spawner abundance. The y-axis maximum is set to the value in the *Graph U.Bound* field. If no value is entered by the user in the *Graph U. Bound* field, the system will use the largest value found among the data displayed as a default upper bound for the y-axis. The y-axis minimum is set to 0.

Only the data for the basin-to-stream spawners (ie., data entered in the table) are displayed on the graph since the value for the returning spawners is dynamic and unknown prior to the simulation.

Treatments

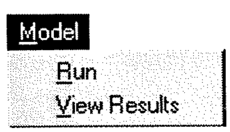
The *Treatments* tab is used to view and modify chemical options for the currently selected stream. Access to this tab will be denied if the *Treat* flag on the *Stream* tab is not set to "true" (see page 5-6).



Treatments for particular simulation years can be added and removed using the ***Add*** and ***Remove*** command buttons. Users can view and modify chemical option values by activating the *Chemical Option Details* screen (***Chem Opt*** command button) (see page 5-12).

Model Menu

The **Model** Menu contains two options.

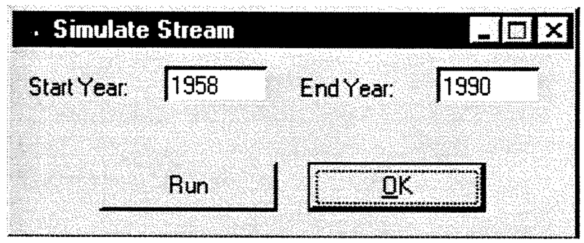


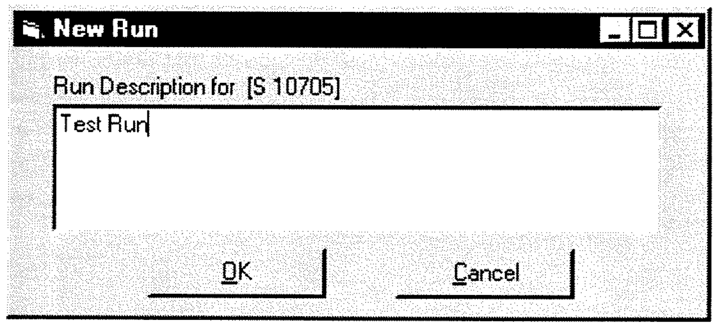
The **Run** option executes the model for the currently selected stream.

The **View Results** option allows you to view results of any of the saved runs.

RUN

The lamprey model can be run for the specified range of years. Each instance of the run is stored under a separate heading. The *Simulate Stream* screen can also be activated from the button bar using the icon.



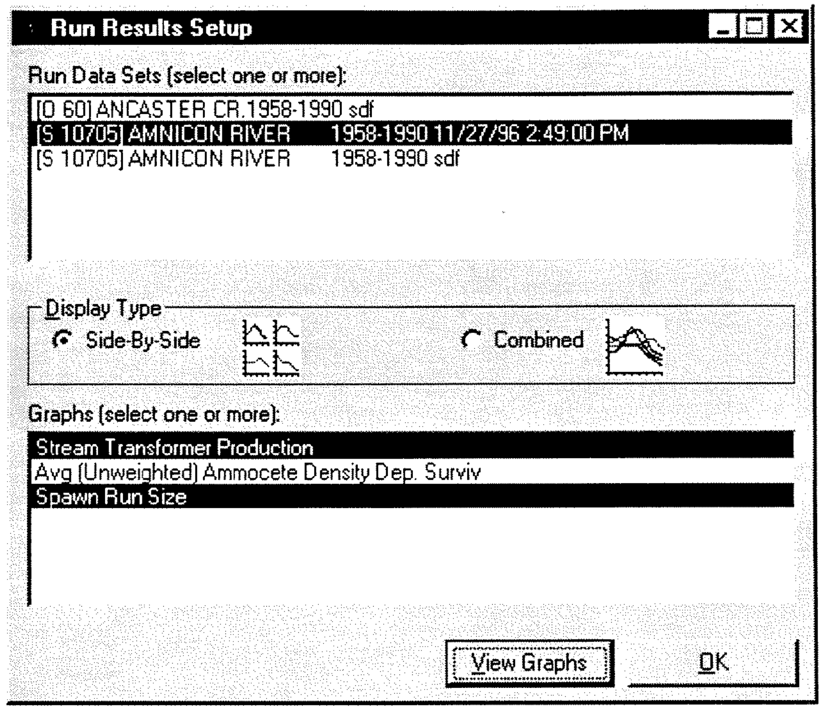


The model simulates all of the aspects of the stream including the barriers, SMRT, and Traps.

VIEW RESULTS

The last of the major components of ISIS can also be accessed from the **Model** Menu. It allows review of the results of runs stored in the database.

Here you can compare results of simulations of streams with one another or with assessment data (if available). The *Run Results Setup* screen can also be activated from the button bar using the icon.



The lists, options, and buttons on the *Run Results Setup* screen are:

Run Data Sets

Lists all of the runs available in the database. One or more runs can be selected for graphical display.

Display Type

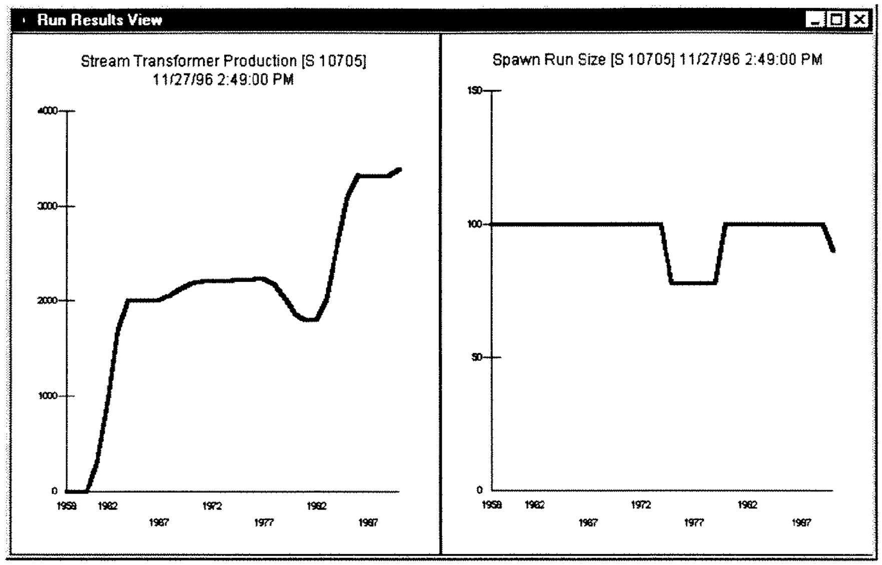
Allows you to display the results either side-by-side or as overlayed graphs.

Graphs

Lists all of the parameters available for graphing (select one or more). Each of the parameters selected will be displayed for each of the data sets selected.

View Graphs

Displays or refreshes the graph display (see below).



Help Menu

Help is available in two ways: through the **Main** Menu and from each screen. The help provided through the **Main** Menu is indexed for easy reference and can be best used for getting an overall view of the system and for finding out about specifics of the program's operation.

The help available from the screens is context-sensitive and is related directly to the options available from the screen. This type of help can be invoked using the <F1> key while using the system.

The information presented through both options is identical. The index presents a top-down view of the system, beginning with general topics and moving to more detailed information about ISIS. The context-sensitive help goes directly to the section of the **Help** Menu most applicable to the current screen.

The help files follow the standard Microsoft Windows Help format.

6.0 Appendices

Appendix A: Sea Lamprey Model

Overview of Model

The lamprey simulation model of the IMSL DSS describes both the lake and the stream phase of the life history of sea lamprey. The spatial structure of streams, reaches and lamprey basins is described in Section 2.0 of this manual. The stream reach model describes the production of ammocetes and transformers, and the effects of control options on stream phase lamprey. The lake phase model accounts for the survival and allocation of parasitic phase lamprey in the lamprey basins. The model describes the following components of lamprey dynamics:

Stream Phase:

1) allocation of spawners among stream reaches and the effects of barriers on the allocation;
2) effects of traps on the size of spawning populations;
3) lamprey fecundity and the effects of sterile male release on spawning recruitment to age 0+;
4) ammocete migration to downstream and lentic reaches;
5) survival from egg to age 0+,0+ to 1+, ...9+ to 10+ ammocetes;
6) growth of ammocetes;
7) transformer production; and
8) mortality due to chemical control treatments.

Lake Phase:

1) allocation/movement of transformers (adults) to lamprey basins[1];
2) sex ratio of adult lamprey;
3) survival from transformer to adult parasitic phase; and
4) allocation of spawners from basins to streams.

1 The term *lamprey basin* is used here to refer to the area over which a population of adult lamprey is distributed. This spatial unit may or may not correspond to geomorphic lake basins. In practice, the lake basins relevant to the spatial dynamics represented in LCSS likely correspond to the geographic range of primary prey populations.

The parameterization of these life stages in the model is based on assessment data, and on parameters in the prototype Lake Ontario lamprey model (see Greig et al. 1992 for review). Density-dependent hypotheses of ammocete survival, growth and transformation rates are described by the model. LCSS users can change the parameters of all model functions to simulate density-dependence and control the strength of each hypothesis.

INTERACTION OF MODEL WITH LCSS INTERFACE

The Lamprey Control Selection System (LCSS) allows the user to apply control options to lamprey populations that are simulated by the model that is linked to it. Users input data into the LCSS (such as treatment characteristics, population parameters, stream habitat data) that describe the dynamics of lamprey populations. The model then uses this data to simulate the annual population dynamics of lamprey in all reaches within the IMSL database. These simulations can be compared to available assessment data to further refine the input parameters. These simulations can be compared to available assessment data to further refine the input parameters. LCSS also allows for the interactive selection of controls (TFM/Bayer treatments, traps and barriers) year to year, or automatically (for TFM/Bayer treatments) for long-term runs. An overview of the sequence of calculations within the LCSS lamprey model and the model's dynamic interaction with the treatment scheduler are illustrated in Figure A.1.

LCSS saves the simulated, annual population structure (ammocete density by reach and age) of both treated and untreated streams/reaches in the database. Users can view the results of LCSS simulations in either graphical or tabular report in MS Access.

STREAM INVENTORY AND SIZE OF LARVAL HABITAT

Streams are composed of reaches of larval lamprey habitat as described in Section 2 of this manual. Reaches have been established for portions of streams that have been treated as discrete units at some time in their history. These reaches include significant stream tributaries and sections. Lamprey barriers also separate reaches within streams. Some river systems where large tributaries are always treated as single discrete units are represented as separate streams to simplify the reports and summaries (e.g. Oswego River System - Lake Ontario and the Cheboygan River System - Lake Huron).

The estimates of the quantity and quality of available habitat in each reach are used to establish the effective amount of Type I or optimal larval habitat. The total area of each reach is defined by its length and width. Reach length is defined as the average length of stream populated by ammocetes. In some streams, habitat length has been measured directly during random transect surveys. For other streams, the average length of the treated reach is used as a surrogate for habitat length. Likewise, reach width has been measured directly for some streams, while in other cases, stream widths have been estimated from a relationship between width and discharge (Leopole and Maddock 1953) and parameterized with available data:

$$Width = 9.82 \times Discharge^{0.25}$$

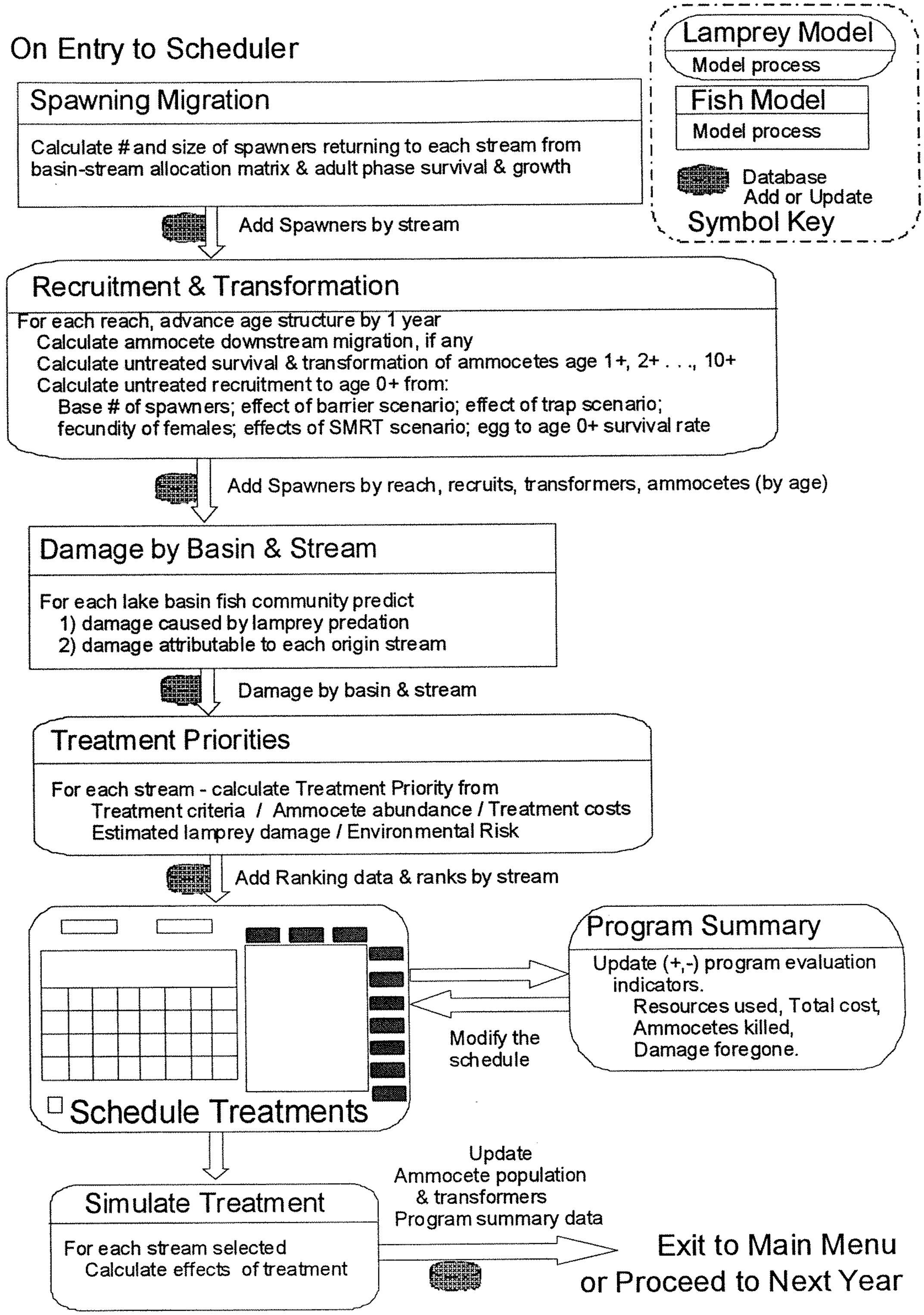


Figure A.1: LCSS interactions with the IMSL lamprey and fish community models.

Average treatment discharge is used as a surrogate for mean annual discharge where estimates of mean annual discharge are not available. Total area of the reach is estimated as the product of length and width.

$$TotArea = AvgReachLen \times ReachWidth$$

The total reach area is adjusted for the quality of larval lamprey nursery habitat available. The proportions of Type I (i.e. optimal, *PHQual*) and Type II (i.e. acceptable *PMQual*) habitats have been measured for some streams during random transect surveys. The average values for these habitat proportions have been applied to reaches where these detailed surveys were not available. The U.S. Agents have separated Type I and II habitats and density estimates in their random transect surveys. There is a significant difference in the average density of ammocetes between these habitat types. The average ratio of Type II to Type I densities (*Type II = 0.2 Type I*) has been used as a weighting factor to adjust the *TotArea* to an estimate of effective Type I or optimal habitat.

$$HabArea = TotArea \times PHQual + TotArea \times PMQual \times 0.2$$

The Canadian agents have not separated Type I and Type II habitats in their quantitative estimates. The average habitat quality proportions found in the U.S. surveys have been applied to the Canadian streams.

The estimates of habitat quality used were for whole streams, and were applied to all of the reaches within the stream (habitat quality estimates are available by reach and should be used to refine these values). The areas for lentic reaches are estimated from historic treatment and assessment data. Where available, survey and treatment data have been used to estimate the effective optimal habitat area within the lentic reach.

Spawning habitat is not explicitly defined as a model parameter. Lack of spawning habitat in lentic reaches or in some reaches below barriers is modelled by reducing the egg survival rate to zero (*EggSurvRt* = 0).

Lamprey Basin Definitions

Lamprey basins have been assigned on the basis of current understanding of parasitic- phase population patterns. Alternative basins can be selected for running historic or future simulations with the LCSS. The default basin for all the lakes is the whole lake. A total of 11 lamprey basins have been defined for the system including 4 in Lake Superior, 3 in Lake Huron, 2 in Lake Michigan, 1 each in Lakes Erie and Ontario. Streams are assigned to each basin on the basis of the proportional allocation from basin to each stream (*PropToStream*). In the current version, spawning phase lamprey are allocated to individual streams from only one basin. Likewise, the current version allocates transformers from one stream to only one basin.

Spatial Dynamics: Moving Spawners to Reaches, Transformers to Salmonid Stocks

It is important to understand the movement of lamprey populations from natal (origin) streams to lamprey basins (lake areas inhabited by salmonid stocks) and subsequently to spawning (destination) streams before using the LCSS. The system has been designed to allow flexibility when partitioning the effects of lamprey populations in lakes and allocation back to streams.

Figure A.2 illustrates a conceptual model for thinking about lamprey movement. Part A represents movement of transformers from origin streams to lamprey basins and of spawning-phase lamprey from basins to destination streams. The arrows in the figure should be thought of as representing not just the basins where transformers end up but also the proportion of transformers leaving each stream which will inhabit each basin. Some origin streams may produce transformers that will impact the salmonids in one basin only (e.g. streams 1 and n in Figure A.2_A) while others may impact more than one basin (stream 2, Figure A.2_A).

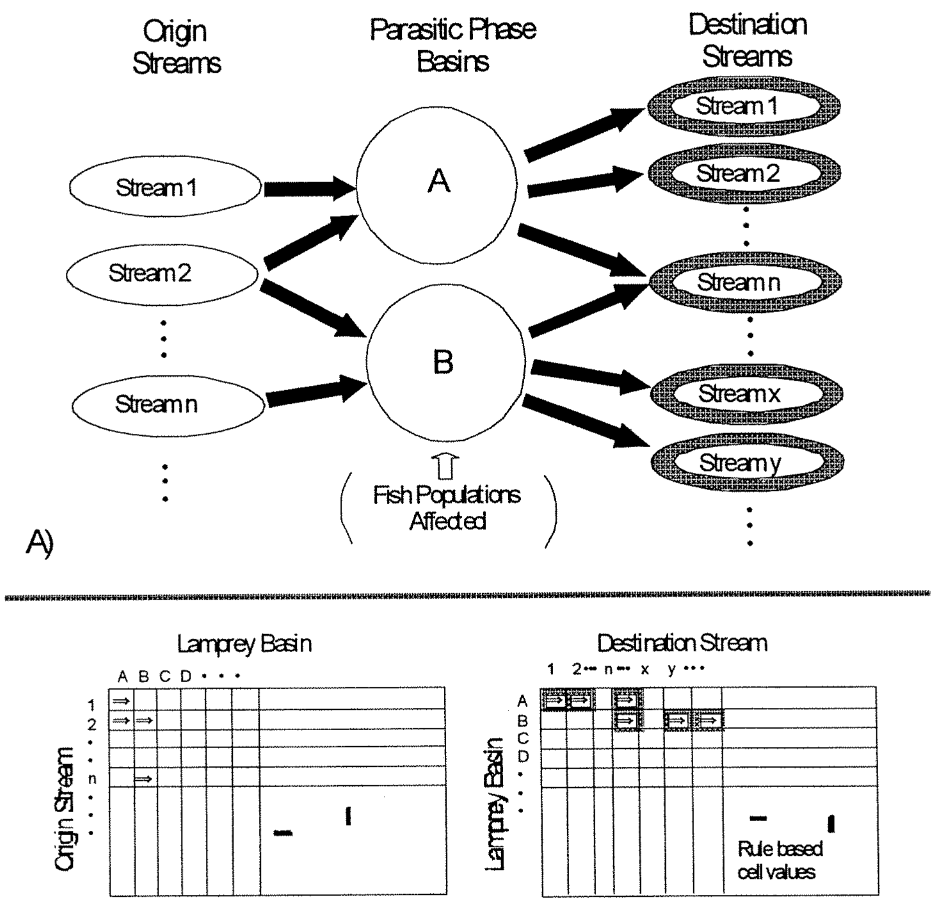


Figure A.2: Conceptual model for representing the spatial movements of transforming ammocete and spawning adults between streams and lake lamprey basins.

Spawners from any one basin are likely to enter any one of several destination streams, and some streams may attract spawners from more than one basin. The St. Mary's River is a good example of a stream which may impact on and receive spawners from multiple basins. The lamprey population in any stream that lies near the boundary between two distinct (or nearly distinct) basins may also interact with more than one basin. The arrows in the figure illustrate the linkages from origin streams to basins and from basins to destination streams. Reading across each row, the actual entries in the matrices are the proportion of lamprey moving from the origin stream to each basin (left matrix) or from a basin to destination stream (right matrix). The sum of all entries across each row must be equal to one.

This structure was designed to offer full flexibility in allocating lamprey populations and in assessing the effects of this spatial allocation on targets and control selection. However, the structure is limited in that the allocation of spawners is fixed for all years of the simulation and cannot respond to annual larval population abundance or to stream treatments as determinants of recruitment.

SIMULATING THE CHARACTERISTICS OF THE SPAWNING POPULATION WITHIN REACHES

Determination of characteristics of the spawning population within reaches is composed of two basic steps:

- determining spawner allocations to streams and to reaches within streams (including, where applicable, the effects of the barriers and traps); and
- determining the size of the individual spawning lamprey.

Lamprey Basin to Destination Stream Allocations

The number of spawners from a given basin allocated to an individual stream is defined by the parameter *PropToStream* for the selected lamprey basin structure. This proportion is calculated outside the current system based on the rank of the stream as a primary, secondary, or non-recruiting (dormant) spawning stream and the stream discharge. Primary streams receive 90% of the spawning run, secondary streams get 9.5%, and the remaining dormant streams get 0.5% of the total spawning allocation. Within each class, the allocation is based on the proportion of total discharge from an individual stream. Average treatment discharges have been used as a surrogate for spring or annual discharge values. The *PropToStream* for any individual or group of streams can be manipulated through the LCSS with the system normalizing the remaining values so that the total allocation is equal to one. The *PropToStream* selected affects all years of simulation for that scenario.

The resulting number of spawners allocated to a given stream is:

$$SpawnCountTotal_{str} = \sum\nolimits_{allbasins} PropToStream_{basin} \times SpawnCount_{basin}$$

Basic Rule for Allocating Spawners to Reaches

Most lamprey streams in the Great Lakes basin only have one lamprey-producing area that is treated on a regular basis. Some streams, however, have more than one discrete lamprey-producing area. Discrete lamprey-producing areas can be reaches along tributaries of streams, complete tributaries, or lentic areas. These production areas of streams considered by the LCSS model, and therefore subject to independent treatment simulation/scheduling, are referred to as reaches. For those streams that have discrete lamprey-producing reaches, each reach will receive a portion ($SpawnCount_{str,rea}$) of the total number of spawners ($SpawnCountTotal_{str}$) that are allocated to the stream according to a reach-specific proportionality constant ($SpawnAllocFtr_{str,rea}$). It is assumed that the reach receiving spawners will support the recruited ammocetes.

$$SpawnCount_{str,rea} = SpawnAllocFtr_{str,rea} \times SpawnCountTotal_{str}$$

The proportionality constant is determined empirically, and is stored in the database record for the reach. User-specified criteria such as streamflow, habitat area, habitat quality, or judgement (observed ammocetes) will determine the proportionality constant. The default values of $SpawnAllocFtr_{str,rea}$ in the current system are based on the proportion of total areas in each reach to the total stream. Unlike spawner allocation to streams, the allocation to individual reaches can be varied by year to simulate the effect of barriers.

Effect of Barriers and Allocation of Spawners to Reaches

The activity of barriers modifies the allocation of spawners to reaches. Each state of a barrier (e.g. active, inactive, leaky) or distinct combination of these states for multiple barriers (e.g. for two barriers, both active or the first active and the second inactive, etc.) dictates a new allocation of spawners to reaches. These are stored separately in the database and used instead of the default allocation (all barriers inactive). The $SpawnAllocFtr_{str,rea}$ for reaches above active effective barriers is 0. The spawners in the stream are reallocated to the reach(s) below the barrier. Existing barriers that do not work use the default $SpawnAllocFtr_{str,rea}$ for that stream.

Effect of Traps on Size of Spawning Populations

While barriers redirect spawners, the traps actively remove part of the spawner run. Individual traps are placed on reaches, thus affecting all of the spawners going to reaches upstream of the trap as well as the spawners of that particular reach.

The effect of traps on each reach, $TrapEff_{str,rea}$, is calculated by combining the effect of all traps downstream of that reach.

$$TrapEff_{str,rea} = 1 - \prod_{downstream,rea} (1 - TrapEff_{trap})$$

The effect of trapping on the number of returning spawners to a reach ($SpawnCount_{str,rea}$) is described by:

$$SpawnCount_{str,rea} = (1 - TrapEff_{str,rea}) \times NewSpawnAlloc_{str,rea} \times SpawnCountTotal_{str}$$

Size of Spawning Lamprey

The size of the spawning lamprey affects recruitment through fecundity. In the absence of a dynamic fish and parasitic-phase feeding model, this model assumes uniform growth of adult lamprey to an end-of-feeding season mean weight ($PreSpawnWeight_{lamprey\ basin}$) of 0.2 kg. The end-of-feeding season weight in the lamprey model is lamprey basin specific and can be adjusted to reflect differences among the basin populations. This weight is then reduced by 15 percent ($PreSpawnWLoss_{lamprey\ basin}$) prior to spawning to produce the lamprey spawning weight ($SpawnWeight_{lamprey\ basin}$). The length of spawning female lamprey ($SpawnLenFem_{lamprey\ basin}$) is predicted from $SpawnWeight_{lamprey\ basin}$.

$$SpawnWeight_{lampreybasin} = PreSpawnWeight_{lampreybasin} \times (1 - PreSpawnWLoss_{lampreybasin})$$

$$SpawnLenFem_{lampreybasin} = (SpawnWeight_{lampreybasin} \times LenWeightMult)^{LenWeightExp}$$

where:

$$LenWeightMult = 2.47E7 \text{ and}$$

$$LenWeightExp = 0.397$$

SpawnWeight, *SexRatioFem*, *SpawnLenFem*, and *EggsFem*, are all calculated for each basin. If multiple basins contribute lamprey to a single stream, they are combined using weighted averages. All are calculated in this manner because the relationship between weight and length is non-linear, so calculating length after combining the weights would produce a different result.

Estimating Ammocete Recruitment to Age 0+

Simulating the recruitment of lamprey to the stream population within a reach involves four basic calculations:

- determining, from the population sex ratio, the number of male and female spawners;
- determining, from estimates of lamprey fecundity, the expected egg deposition by a single spawning female;
- estimating the number of successful spawns as modified by a user-specified scenario of sterile male release (SMRT); and
- determining, from the expected survival rate of eggs to age 0+, the number of age 0+ ammocetes recruited to the reach ammocete population.

Sex Ratio

The sex ratio of spawning phase lamprey from a given basin is determined by the sex ratio of the transformers contributing to the population. The sex ratio of spawning lamprey in an individual stream is equal to that of the entire lamprey basin (i.e. not variable over the individual streams within a lamprey basin. The LCSS uses the coefficient $SexRatioFem_{str}$ to determine the number of female spawners within each reach to which spawners are allocated.

$$SpawnCountFem_{str,rea} = SpawnCount_{str,rea} \times SexRatioFem_{str}$$

Effects of Sterile Male Release

Two numbers specify the SMRT release: *SMCount* and *SMRelRt* (release rate). *SMRelRt* is the ratio of sterile to normal males in the stream. The number of successful spawnings are reduced in direct proportion to this ratio. *SMCount* is the number of sterile males released in the stream. *SMRelRT* is calculated for *SMCount* and the predicted number of normal males in the stream. If both numbers are present, *SMRelRt* takes precedence. If neither is specified, a default value associated with each spawner allocation criteria set ($SpawnAllocFtr_{str,rea}$) is used.

Placement of sterile males either as a fixed number or defined ratio ($SMCount_{str}$ or $SMRelRt_{str}$) in a stream will reduce the number of successful spawners. The number of successful spawning females of a stream into which sterile males are released ($SuSpawnFem_{str,rea}$) is calculated by:

$$SuSpawnFem_{str,rea} = \frac{SpawnCountFem_{str,rea}}{(1 + SMRelRt_{str})}$$

If there are no sterile males released into a reach (SMRelRtstr = 0) then

$$SuSpawnFem_{str,rea} = SpawnCountFem_{str,rea}$$

Please note that the sterile males are kept as a rate which does not change if traps are present. In effect, this simulates SMRT release to the mouth of the river during spawning runs and assumes that sterile males are affected by the traps in the same way as the rest of the lamprey.

Fecundity

Fecundity is determined with the relationship between $SpawnLenFem_{str}$ (mm) and egg production in the prototype Lake Ontario simulation model. This preserves the ability to simulate potential lake environment or prey species effects on ammocete recruitment. The total number of eggs allocated to a reach ($EggsDen_{str,rea}$) is equal to fecundity times the number of females allocated to the reach ($SpawnCountFem_{str,rea}$). As with population size in reaches, eggs are tracked as density.

$$EggsFem = FecunRegCoef \times SpawnLenFem_{lampreybasin} + FecunRegInter$$

where:

$$FecunRegCoef = 205.6$$

$$FecunRegInter = 12017$$

$$EggsDen_{str,rea} = \frac{EggsFem \times SuSpawnFem_{str,rea}}{HabArea}$$

Please note that $EggsFem$ is calculated on a basin-by-basin basis and is then combined as a weighted average to give stream values.

Age 0+ Density

Ammocete recruitment from egg to age 0+ is calculated by multiplying the total number of eggs produced in a reach by an empiric survival rate:

$$AmmDen_{str,rea,0} = EggSurvRate_{str,rea} \times EggsDen_{str,rea}$$

Growth and Survival of Ammocetes

Ammocetes can be moved downstream between reaches in order to simulate processes populating lower reaches and lentic areas. Ammocetes migrate only to a reach below the current one. The number of migrating ammocetes is calculated before mortality or transformation has been applied. Migration can be defined for all age classes, but does not affect the young of the year (YOY). The average population length at age for a reach does not change within migration; only the number (density) is altered.

The additional recruitment resulting from migration is considered in all of the density-dependent functions for survival, growth and transformation and sex ratio. Chemical options affect migrated ammocetes as they would the resident population.

In the base system, the rate of downstream migration by age has been to 0 for all reaches except those above lentic reaches. The rate of migration to lentic reaches is 0.1 for all ages.

Ammocete Density

Ammocete abundance at age in a reach is accounted for as density, that is, the number of ammocetes at age divided by the area of habitat of the reach suitable for ammocetes ($HabArea_{str,rea}$). Total density ($AmmDenTotal_{str,rea}$) is the sum across ages, but does not include the current year's age 0. The effects of ammocete migration are included in this sum.

$$HabArea_{str,rea} = HabLen_{str,rea} \times HabWidth_{str,rea}$$

$$AmmDenTotal_{str,rea} = \sum_{age} (AmmDen_{str,rea,age} + \frac{AmmMigrOut_{str,rea,age} - AmmMigrIn_{str,rea,age}}{HabArea_{str,rea}})$$

Ammocete Length

The growth of ammocoetes is modelled independently for all reaches and is dependent on density in that reach. The pattern of length at age is predicted to follow the von Bertalanffy growth model. The general form of the von Bertalanffy growth equation is:

$$AmmLen_{str,rea,age} = L_{\infty} \times (1 - e^{-K_{str,rea} \times age})$$

where:

L_{∞} = theoretical maximum asympototic length of ammocoetes (default = 200 mm), and

K = the Brody growth coefficient.

Figure A.3 presents the relationship between length and age for different values of K following the growth model. K has been estimated for individual streams based on the length at age 2 + (Figure A.4). Average values for size at age 2 have been used where data were not immediately available.

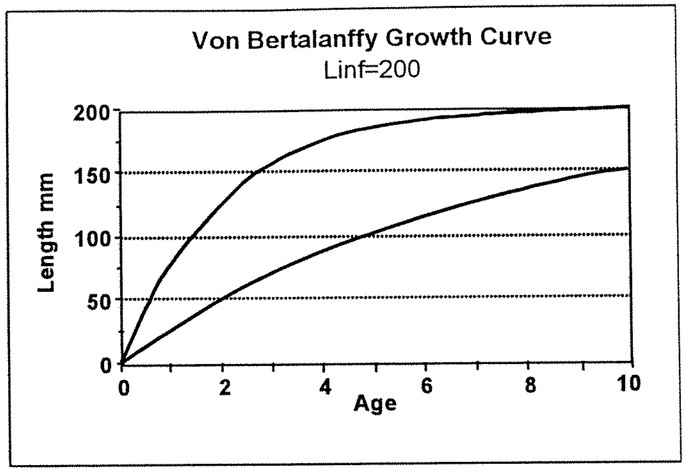


Figure A.3: Simulated ammocete growth in length for minimum and maximum observed values of K and L_∞ = 200mm.

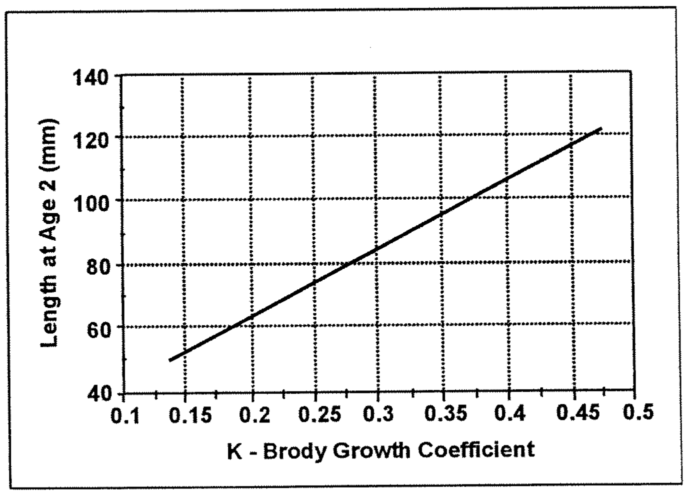


Figure A.4: Relationship between mean length at age 2 and K.

The rate of growth determines the age of first transformation by determining the age at which the size threshold is met. The size threshold for metamorphosis is estimated to be 120mm. The age at which a year class begins transformation is the age at which its mean length is equal to 120mm. This threshold parameter (*AvgLen1stTrans*) can be modified to better represent the distribution of size within a yearclass as data becomes available. Figure A.5 relates the age of first transformation to the value of K. The growth of an individual age class will be determined by its growth history, that is, the rate of growth (K) in each year of life. The value of K is dependent on density.

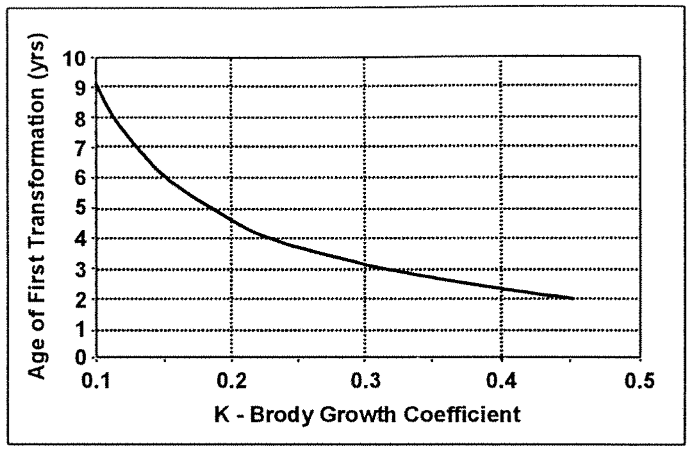


Figure A.5: Relationship between age of first transformation (mean length = 120 mm) and K.

The density-dependence in growth is modelled using a 2-point SLP function with the Brody growth coefficient K being dependent on total ammocete density, *AmmDenTotal* (see the end of this section for discussion). The two points used are (*AmmDen1*, *AmmK1*) and (*AmmDen2*, *AmmK2*). The variable $AmmLen_{str,rea,age}$, holds the average size of an ammocete age class at the end of a growing season. Therefore, the size for age 0 is calculated by:

$$AmmLen_{str,rea,age} = L_{\infty} \times (1 - e^{(-K \times 1)})$$

Older ages are subject to varying densities, and therefore varying values of the Brody growth coefficient. Ammocete length is calculated incrementally by:

$$AmmLen_{str,rea,age} = AmmLen_{str,rea,age-1} + L_{\infty} \times e^{(-K \times age)} \times (1 - e^{-K})$$

where:

$AmmLen_{str,rea,age-1}$ is the length at the beginning of a given season;

$AmmLen_{str,rea,age}$ is the length at the end of a given season.

The following equations are derivations for the annual ammocete length increment:

$$L_{\infty}(1 - e^{-k(age + 1)}) - L_{\infty}(1 - e^{-k\,age})$$

$$= L_{\infty}((1 - e^{-k(age + 1)}) - (1 - e^{-k\,age}))$$

$$= L_{\infty}(e^{-k\,age} - e^{-k(age+1)})$$

$$=L_{\infty}(e^{-k\,age} - e^{-k}(e^{-k\,age}))$$

$$=L_{\infty}e^{-k\,age}(1 - e^{-k})$$

Ammocete survival

Ammocete survival for ages 0+, 1+, ..., 9+ to the next age class in a reach at low total ammocete density is estimated by multiplying an empiric annual survival rates ($AmmSurv_{str,rea,age}$) by the ammocete year class strength ($AmmDen_{str,rea,age}$). The density-dependent survival rate, $AmmSurv_{str,rea}$, is calculated using 2 point SLP functions with the survival rate dependent on total ammocete density. Points used are ($AmmSurvDen1, AmmSurvRt1$) and ($AmmSurvDen2, AmmSurvRt2$).

$$AmmDen_{str,rea,age} = AmmSurv_{str,rea,age} \times AmmDen_{str,rea,age-1} + \frac{AmmMigrIn_{str,rea} - AmmMigrOut_{str,rea}}{HabArea_{str,rea}}$$

The final age class, 10+, is assumed never to transform and is dropped from the calculations.

SIMULATING THE EFFECTS OF CHEMICAL TREATMENTS

The effectiveness of TFM and Bayer is reach and age specific. The surviving number of ammocetes in each age class following chemical treatment ($AmmDen_{str,rea,age}$) is calculated by multiplying the current number of ammocetes in each age class by effectiveness factors for TFM, or TFM and Bayer ($ChemEff_{str,rea,age}$) and the portion of the reach treated ($ChemTreatPart_{str,rea}$). Application time (spring vs fall) will determine treatment effectiveness for 0+ ammocetes. The effectiveness factors can be defined by treatment windows to account for this seasonal variation. Treatment effectiveness has been estimated by treatment personnel as High (99%), Medium (98%) or Low (95%) for each chemical option for each treatable reach. In the current model, the same effectiveness values are applied to all ages (including age 0) and to all windows for a given reach.

$$AmmDenKill_{str,rea,age} = ChemTreatPart_{str,rea} \times ChemEff_{str,rea,age} \times AmmDen_{str,rea,age}$$

$$AmmDen_{str,rea,age} = AmmDen_{str,rea,age} - AmmDenKill_{str,rea,age}$$

where:

$AmmDenKill_{str,rea,age}$ = kill density by age.

The density for reaches of which only a part was treated is assumed to become uniform before the next year.

SIMULATING TRANSFORMATION TO THE PARASITIC PHASE

The model uses a four stage transformation model with the user-determined yearly transformation rates, $TransRt_{stage}$, (e.g. 10%, 33%, 66%, 100%). Each transformation rate applies to the remaining population size ($AmmDen_{str,rea,age}$) for a specific age class, as is shown in Figure A.6 below. Transformer production is accumulated across all of the transforming age classes:

$$TransDen_{str,rea,age} = TransRt_{stage} \times AmmDen_{str,rea,age}$$

$$TransProd_{str,rea} = \sum_{age} TransDen_{str,rea,age} \times HabArea_{str,rea}$$

As described above, the transformation is triggered by a global parameter, *AvgLen1stTrans*, average length at first transformation. All of the transformers are considered to be the same basin-specific size, $PreSpawnWeight_{basin}$.

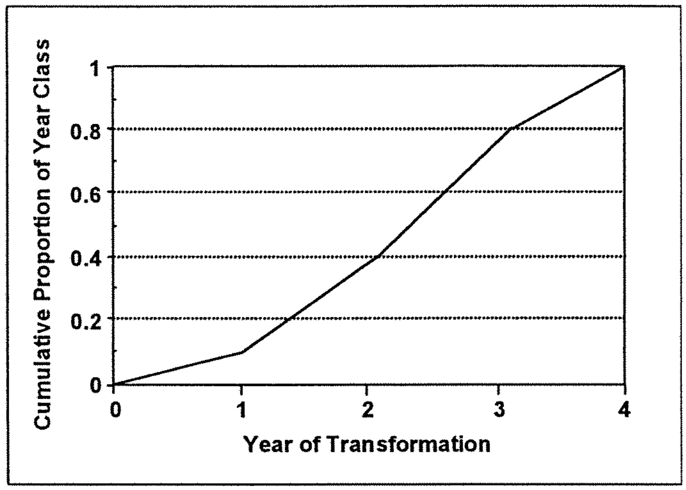


Figure A.6: Cumulative proportion of a year class transforming where year 1 = age of first transformation and the yearly transformation rates are 10%, 33%, 66%, 100%.

Sex Ratio

Transformer sex ratio is dependent on total density, *AmmDenTotal*, and is modelled using a 2 point SLP function with the proportion of females dependent on density. The two points used are (*SexFemDen1*, *SexFem1*) and (*SexFemDen2*, *SexFem2*). In the current model, the *SexFem1* and *SexFem2* values are equal and set to the current basin average sex ratios.

Allocation to basins

Each stream contributes transformers to one or more basins. The total number of transformers entering a basin is calculated by:

$$TransCount_{basin} = \sum_{str,rea} TransProd_{str,rea} \times PropToBasin_{str,basin}$$

Transformer sex ratio for a basin, $TransSexRatioFem_{basin}$, is calculated using a weighted average.

SIMULATING ADULT (PARASITIC PHASE) INTERACTIONS

The transformers leaving the reaches, which now become "origin" streams, to become a part of the adult parasitic population that preys on the salmonid stock. Transformer survival to the parasitic phase, $PPLampMort_{basin}$, is constant for the basin, and the sex ratio, $PPSexRatioFem_{basin}$, does not change:

$$PPCount_{basin} = PPLampMort_{basin} \times TransCount_{basin}$$

$$PPSexRatioFem_{basin} = TransSexRatioFem_{basin}$$

In the current model, PPLampMortbasin = 0.5.

DENSITY DEPENDENCE AND SLP FUNCTION

As mentioned earlier, many of the ammocete characteristics are density dependent. The magnitude of density dependence is determined using a 2 point SLP function. The two points used in this example are (*AmmDenLow*, *AmmValLow*), and (*AmmDenHigh*, *AmmValHigh*). At density below the lower threshold (*AmmDenLow*) the density dependent value is equal to *AmmValLow*. Between the two threshold densities the value is interpolated. Above the upper threshold (*AmmDenHigh*) the density-dependent value again becomes constant at *AmmDenHigh*. Even though LCSS uses a 2 point SLP function, in general the SLP functions can contain any number of points.

Figure A.7 shows the general form of the hypothesis function used to determine ammocete dynamic rates versus total ammocete density. Form 1 shows the effect of upper and lower density thresholds. Form 2 shows a constant rate where the low and high values are equal.

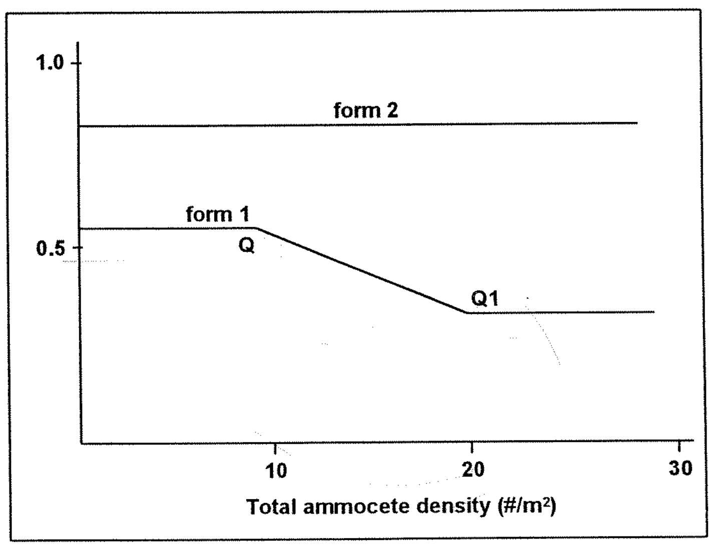


Figure A.7: General form of the hypothesis function to determine ammocete dynamic rates versus total ammocete density.

The density thresholds for all of the SLP functions have been initially set to the same values. The first threshold is set to equal the geometric mean density plus 2 standard deviations ($10/m^2$) as estimated from Lake Superior quantitative assessment results. The second threshold is at 3 standard deviations above the geometric mean ($20/m^2$). The effect of these thresholds is to set most rates constant under the current regime of treatments and densities. The lower values for all of the rates have been arbitrarily set to one half of the current rate estimate.

LITERATURE CITED

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Appendix B: Database Structure

Overview of the Database Structure

The review of existing structures was guided by the objective of identifying opportunities for improving consistency and/or simplification of the database. In many respects, the objective of simplifying the database structures arose not from specific technical design concerns but rather from the early difficulties which LCSS users were experiencing in working with some of the concepts employed within the design. In particular, three areas were targeted as foci for review:

1) the concept of stream configuration (i.e. alternative definitions of the physical structure, i.e. sets of reaches, of an individual stream);
2) stream barrier activity (closely related to stream configuration); and
3) lamprey basins.

Each of these three components of the database design deal with the representation of spatial structures within the IMSL/LCSS database. They are central to the overall utility of the system and their implementation is moderately to highly complex with regard to the relationships between database tables.

Additionally, the database structures related to budget groups and reporting basins were of special concern. These features are only partially implemented in the current system and there are outstanding issues related to their definition and utility within the overall system.

Stream Configuration

The primary focus of the review of the implementation of reach sets was to determine whether the structure of the database could be re-engineered so as to dispense with the concept and terminology of 'stream configuration' or whether an alternative implementation could buffer general users of the system from having to work with the stream configuration concept. A clear understanding of the concept and rationale for our recommendations requires at least an overview of the current implementation of the stream configuration concept.

The basic function of the stream configuration concept within the IMSL/LCSS database is to provide a mechanism for representing scenarios which would explore proposed (theoretical) barrier dam placements for lamprey control. When barriers are placed on a stream, their intended purpose is to restrict access to spawning and potential rearing habitat. Barrier placement therefore potentially influences the number of reaches in which it is necessary to simulate lamprey populations within the stream (multi-reach streams only), habitat characteristics of the 'reach' where the barrier is placed, and the selection/definition of chemical, trap and SMRT options for treatment of any residual lamprey populations. The related concept of stream barrier activity deals with the efficiency of a barrier in blocking upstream passage of lamprey.

The interdependence of the various tables in the database can best be described by presenting the modifications involved in adding a stream configuration to the present database structure. Some of the tasks presented here can be accomplished using LCSS, but the changes have been described for the sake of completeness.

Reaches represent distinct areas of ammocete habitat to be simulated. These may or may not represent the configuration of ammocete habitat found in a stream. In most cases it is not necessary to simulate all of the distinct areas of ammocete habitat separately. If a stream is always referred to as a single unit, all of the areas can be dealt with together. It is important to distinguish between areas if a density of ammocetes in one area will change differently than in others, due to some external factors (such as a barrier, treatments which sometimes treat only a part of the stream, etc.).

Stream configurations are sets of reaches which taken together represent the whole stream. There can only be one stream configuration per stream for any given simulation run although its behaviour may change (see Stream Barrier Activity). Alternative stream configurations are used to represent different configurations of a stream (e.g. with presence of a barrier simulated or with no barrier throughout the simulation).

Adding stream configurations is necessary if a new representation of a stream is required (eg. a new barrier is planned). Let's suppose we would like to add a barrier to an existing simple one-reach stream. Suppose that the new barrier will split the reach in two. (If it did not we could easily utilize the existing reach structure.)

The first step in adding a barrier is to add a new entry into the **ReachSet** table. This step automatically generates a new ReachSetID value. This value will be used throughout the database to refer to the new stream configuration.

Next we will add new reach definitions in the **Reach** table. It is up to us to select values for the Reach field. These cannot conflict with other values of Reach field for the same Lake and Stream. In our example, assuming that the original reach value was 1, the new values could be reaches 2 and 3. Reach 2 represents the area below the barrier and reach 3 represents the area above the barrier. Most of the attributes of the new reaches are the same as for reach 1. The main difference is the habitat area (Habitat Area), which is now split into two. A description of how to initialize the population structure in each of the reaches can be found later in the *Results Database* section.

One situation that may arise when adding a barrier is that the barrier will block lampreys' access to all of the spawning habitat. This situation can be handled in one of the following ways:

1) Do not allocate any lamprey to any of the reaches (**SpawnAllocFtr** set to 0). This will simulate lamprey staying at the mouth of the river and not swimming up the stream. In this approach the barrier trap, if present, will not catch any lamprey.

2) Create a "dummy" reach below the barrier and set the egg survival rate (**EggSurvRt** in **ModelReachParms**) to 0. This will simulate lamprey swimming to the barrier, spawning at the site with no eggs surviving. This approach will allow the barrier trap to catch lamprey swimming to the barrier. When the barrier is not active, the allocation to the dummy reach should be set to 0.

The new reaches should also be added to the **ModelReachParms** and **ModelReachAgeParms** tables. The entries will most likely be simply copies of the original reach number 1.

The two new reach numbers must also be added to the table **ReachSetReachLL** along with the ReachSetID of the new stream configuration. This step provides a formal link between the new reaches and the stream configuration. The value of DownStrReach indicates which reach is down-stream and which is up-stream. The reach flowing directly into a lake should have the value of DownStrReach set to its reach number. In our example the stream may have reach 3 flowing into 2 and reach 2 into the lake (set to flow into 2). Some of the reaches can be present in more than one stream configuration. For example, if the original stream configuration was composed of two reaches, the reach not split would be present in both stream configurations.

Next we should add the actual barrier. The information describing the barrier is stored in the **BarrDef** table. As with the **ReachSet** table, adding an entry here generates another reference number: BarrID. This number will be used as a reference to the barrier itself. To link the barrier to the stream configuration we must also add a record to the **ReachSetBarrLL** table along with the location of the barrier (the reach immediately above the barrier).

Some of the old chemical options will apply, so we should refer to them in the **ReachSetChemOptLL** table with the new ID. (All of the chemical options relevant to the original (one reach) stream configuration should be applicable since the stream must be able to behave with the barrier active and inactive (i.e. not yet present).) The **ChemEff** table's most important purpose is to specify which reaches are affected by a given chemical option. A presence of a record with the appropriate reach number signifies that a reach is affected. A chemical option can affect reaches from multiple alternative configurations for a given stream. Only the reaches included in the currently selected stream configuration are actually used. In our example, we should add reaches 2 and 3 to all of the chemical options relevant to the original stream configuration.

Adding values to the **ChemEff** table generates new values of the ChemEffKey field. These should be added to the **ChemEffAge** with the appropriate chemical efficiencies by age.

Next we must check the table **BarrEffHyp** for existing stream barrier activities relevant to the new stream configuration. All of the stream barrier activities relevant to the original (one reach) stream configuration should be applicable since the stream must be able to behave with the barrier active and inactive (or not present).

In order to use these stream barrier activities, we have to replicate them for the new value of ReachSetID along with the relevant records in tables **SpawnAllocFtr** and **TrapDef**.

There may be new stream barrier activity which describe activity with the barrier active, which should be added as well. See the following section for a detailed description of **BarrEffHyp** and related tables.

All of relevant existing stream barrier activities should be added to the **BarrBarrEffHypLL** table along with the new ReachSetID and BarrID. The value of the field IsActive should most probably be false since the original stream configuration did not contain the barrier. One of the **BarrEffHyp** entries should become the default stored in the **ReachSet** table. The most likely candidate is the one equivalent to the default in the original stream configuration.

The next step is setting up new spawner allocation within the stream. Information about that is stored in **SpawnAllocFtr** table. The table combines ReachSetID, Reach, and BarrEffHyp values determined earlier.

If applicable, trap information should be added to the **TrapDef** and the **TrapType** tables.

If there were any entries in the **ScenarioSMRT**, **ScenarioTrap**, **ScenarioEffHyp**, or **ScenarioEffHyp** these may also have to be duplicated.

As the last step, if the new stream configuration should become a default for the stream, the field ReachSetID in the table **SimStream** should be updated to the new value.

Stream Barrier Activity

Stream barrier activities are used to represent the various ways in which a stream can act. Some examples of these activities are appearance of a barrier, or a partial or a full failure of a barrier. There can be multiple stream barrier activities defined for any stream configuration and the behaviour can change during a simulation run.

To illustrate relationships within the database of stream barrier activities, let us manually add a new stream barrier activity to the database. The new stream barrier activity will describe an active barrier within the stream we added in the Stream Configuration section above.

Before we proceed with adding a stream barrier activity, we will add a chemical option which would be relevant to the new stream activity.

First we should add an entry into the **ChemOpt** table. The chemical option will treat only the part of the stream below the barrier, ie. only reach 2. A new entry will automatically acquire a value of ChemOpt. We use this value to add entries to the **ChemEff** table with only reach 2 (reach 3 is not treated) which in turn generates a new value of **ChemEffKey** which is used for entering chemical efficiencies in **ChemEffAge** table.

Next we should link the new chemical option with the reach configuration by adding an entry containing the new ChemOpt and the new ReachSetID into the **ReachSetChemOptLL** table.

Now we can add a new entry to the **BarrEffHyp** table. The newly created ChemOpt value will become the default option for this stream barrier activity. If there are also values for the default annual release of sterile males, they should be added as well.

The new stream barrier activity will have a new set of spawner allocation values. These should be added to the **SpawnAllocFtr** with all of the reaches present. The reaches where there will be no spawners should receive an allocation of 0. All entries for a particular BarrEffHyp should add up to 1, but values less than 1 can be used to simulate lower nesting success (for more information about spawner allocation and nesting success, see the section on adding reaches to stream configurations).

It there are any traps placed on the stream which are active year after year (eg. a barrier trap) those should be added to the **TrapDef** table.

With the new activity set up we can turn the new barrier on. An entry in the **ScenarioEffHyp** table will turn the barrier on at the appropriate time in the simulation. The spawner allocation will automatically change to the new one we just set up. Additionally, should the stream be scheduled for treatment, the default will be the new chemical option. The new entry in the **ScenarioEffHyp** table should only be placed there once. It will automatically be carried forward until another change is encountered. For example, should there be a time where we wish to simulate a complete barrier failure, we would need to add another value to the **ScenarioEffHyp** table with the old stream barrier activity. The spawner allocation and the default chemical option will revert back to the old ones.

Lamprey Basins

Lamprey basins have a function in the Great Lakes similar to the function of stream configurations in streams. Lamprey basins partition the Great Lakes into distinct sections. These sections can represent whole lakes or the parts of lakes to be simulated separately. Not all lakes need to be present in all of the configurations. If only a part of the Great Lakes basin needs to be simulated, it is more efficient to set up a lamprey basin configuration containing only those sections needed for simulation. As with stream configurations, there are many ways in which the Great Lakes can be partitioned, although only one can be used in any one simulation.

There are four tables representing the lamprey basins. **LampBasinDef** contains a general description of the definition itself. This description allows for the identification of the lamprey basin and aids in the selection of which basin configuration is most appropriate for the simulation.

The table **LampBasinSubDef** lists all of the sub-basins included in the configuration. If we were to simultaneously simulate all of the Great Lakes we could define an entry for each lake in this table.

Tables **LampBasinToStream** and **LampStreamToBasin** are used to list all of the basins contributing spawners to streams and all of the streams contributing transformers to basins. There can be multiple basins from which spawners migrate up a single stream, just as a single stream can contribute transformers to multiple basins. An example of this is the St. Mary's river which contributes and receives lamprey from Lake Huron and Lake Michigan.

It is important to ensure that the sum of proportions of spawners for each basin and transformers for each stream add up to one, otherwise lamprey may be miscounted.

Database Files

The IMSL database was designed to protect static data and to provide a facility for keeping multiple sets of results generated by minor modifications to a single scenario database (e.g. budget size, crew combination, etc.). This led to the creation of three separate component databases for each type of data:

1) Static and rarely changing parameters are stored in the options database;
2) Dynamic parameters subject to change between individual runs are stored in the scenario database; and
3) Results of the runs are stored in the results database.

1. Options Database

The options database (OPTIONS.MDB) contains data which rarely changes between runs. The database contains the following tables: **BarrDef**, **Criteria**, **Lake**, **Reach**, **ReachSetBarrLL** and **Stream**.

The tables **BarrDef** and **ReachSetBarrLL** define the barriers and contain the links between the stream configurations and the barriers (which barriers are placed on which streams).

Tables **Lake**, **Reach**, and **Stream** contain the names and the information about the size and location of streams.

The **Criteria** table contains the descriptions of the four evaluation criteria.

2. Scenario Database

The scenario database (e.g. SHIST.MDB) contains dynamic data, potentially subject to change from run to run. It contains the following tables: **BarrBarrEffHypLL**, **BarrEffHyp**, **BaseCamp**, **BaseCampDeplSiteLL**, **BudgetChem**, **BudgetCrew**, **BudgetGen**, **ChemEff**, **ChemEffAge**, **ChemOpt**, **CummInfRt**, **DeplSite**, **DeplSiteStreamLL**, **LampBasin2Stream**, **LampBasinDef**, **LampBasinSubDef**, **LampStream2Basin**, **ModelBasinParms**, **ModelGenParms**, **ModelReachAgeParms**, **ModelReachParms**, **NetTrapEff**, **ReachSet**, **ReachSetChemOptLL**, **ReachSetReachLL**, **ScenarioAction**, **ScenarioBarr**, **ScenarioDescription**, **ScenarioEffHyp**, **ScenarioFish**, **ScenarioSMRT**, **ScenarioTrap**, **SimStream**, **SpawmAllocFtr**, **TrapDef**, **TrapSummary**, **TrapType**, **TripLL**, and **UserEventOpt**.

Descriptions for many of these tables have been presented earlier in this Appendix.

Additionally, the tables **BaseCamp**, **BaseCampDeplSiteLL**, **DeplSite**, and **DeplSiteStreamLL** provide information on the three base camps and the deployment sites used from those base camps.

Tables **BudgetChem**, **BudgetCrew**, and **BudgetGen** hold the information about resource availability.

Tables **LampBasin2Stream**, **LampBasinDef**, **LampBasinSubDef**, and **LampStream2Basin** control the stream-to-basin and basin-to-stream allocations

Tables **ScenarioAction**, and **TripLL** allow for the building of treatment schedules, and **UserEventOpt** holds the list of user-defined options.

Tables **ScenarioBarr**, **ScenarioEffHyp**, **ScenarioFish**, **ScenarioSMRT**, and **ScenarioTrap** provide non-default selections for specifications.

3. Results Database

The results database (e.g. RHIST.MDB) contains the individual age structured populations, basin populations and the stream rank list. All of this data is stored in five tables: **LampByBasin**, **LampByStream**, **LampByReach**, **AmmReachPop**, and **RankStream**.

Table **LampByBasin** contains the information about the size and the composition of all of the basin populations for the current configuration (definition). The simulation initial conditions consist of data for one year just prior to the first year of the simulation (new data are added during the simulation).

Table **LampByStream** contains the spawning run information for each of the streams in the simulation. Entries in this table are generated from the basin population sizes and the allocation found in the **LampBasinToStream** table described earlier.

The **AmmReachPop** table contains the age structure for all of the reaches in the simulation. The initial population structure for a particular year of simulation is stored in records dated one year prior to that simulation year. Entries for each subsequent year are generated by the model. If new reaches (and new stream configurations) are added to the scenario database, the initial population structures must be added to the **AmmReachPop** table. This is the largest of all tables in all of the IMSL databases.

Table **LampByReach** contains the size of the spawner run and the summary information on the transformer production for the reach.

Appendix C: DB-Based Graphing

The graphing component of LCSS was designed with flexibility in mind. It allows adding new graphs without modifications to the program itself. The graph information is stored in 2 LCSS Scenario database tables in Microsoft Access: **Graph** and **GraphIVar**. The data for the graph are collected in a user-defined query.

The **Graph** table consists of the following fields (columns):

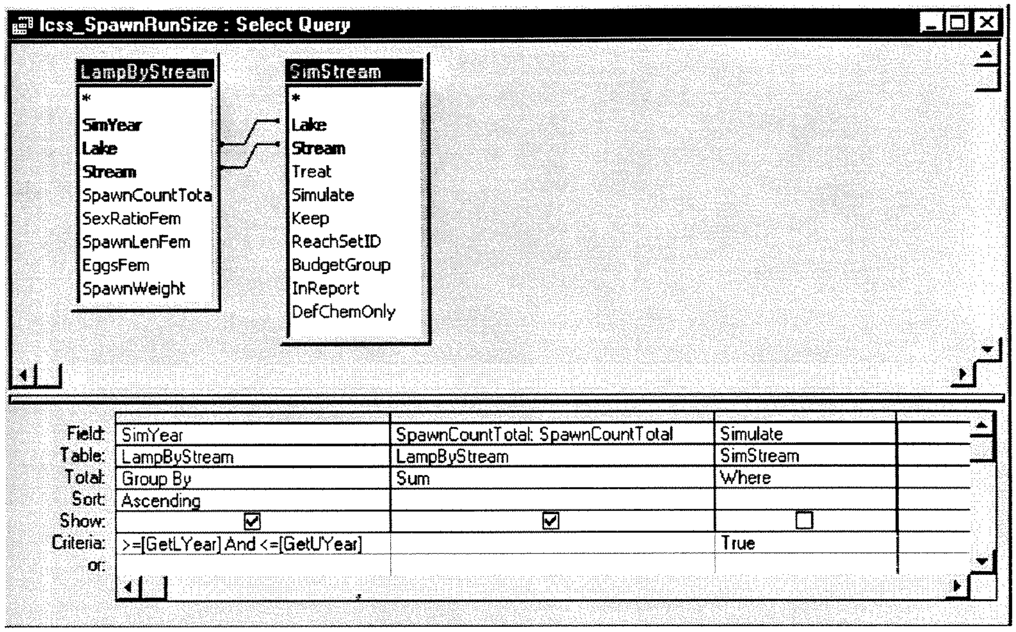
Graph	Internal graph identifier (generated automatically)
GraphDescription	The description of the graph is used in the list of available graphs and the title of the graphs
QueryName	The name of the query which collects the data
DVarName	Dependent variable name used in the query
DVarDescription	Dependent variable description used in the legend
DispType	0 - Graph; 1 - Table (only graph is supported)
View	Selection of graphs to be currently displayed (entered through LCSS)
GraphType	The type of the graph in which the data should be displayed

The GraphType column of the **Graph** table contains numbers that identify which of eight available graph types will be displayed. The numbers in this field can be modified to change the type of graph displayed by LCSS for a particular parameter.

ID #	Graph Type
1	2-Dimensional Pie Diagram
2	3-Dimensional Pie Diagram
3	2-Dimensional Bar Graph
4	3-Dimensional Bar Graph
6	Line Diagram
7	Log/Lin Graph
8	Area Diagram
10	Polar Graph

To add a new graph to the list, enter the appropriate information into a new row of the **Graph** table and write the Query that will gather the data required to generate the graph in LCSS.

The queries used by graphs must have at least 2 output fields: an independent variable (listed in the **GraphIVar** table, see below) and the dependent variable (listed in the **Graph** table). The queries must be designed and stored in the LCSS Scenario database. As a convention all of the queries should use "lcss_" as a prefix, e.g., lcss_SpawnRunSize. The full name of the query should be stored in the **Graph** table.



In some cases information cannot be stored in the query or storing all of the permutations of possible values would be too tedious (e.g. all of the streams). For that purpose LCSS supports parameters. Only a limited number of them is currently supported:

LSimYear	First year within the simulated data obtained from the population structure (**AmmReachPop**) table
USimYear	Last year within the simulated data obtained from the population structure (**AmmReachPop**) table
CurrLake	Currently selected/simulated lake (used in ISIS)
CurrStream	Currently selected/simulated stream (used in ISIS)
Run	Simulation run ID (used in ISIS)
GetLYear	Ask user for the lower bound of the range of years to display
GetUYear	Ask user for the upper bound of the range of years to display
GetAge	Ask user for age (single value)
[Simulation Year]	Asks user for a specific simulation year

[Lake First Letter]	Asks user for the first letter of a lake to be displayed (O, E, S, M, or H)
[Stream #]	Asks user for a stream number

In order to use any of these parameters, the exact spelling and spacing must be used (including the square brackets "[ ]").

The **GraphIVar** table stores information about the independent variables for the graph. While the table structure is designed to support multiple independent variables, graphing module will support only one. It has the following fields (columns):

Graph	Internal graph identifier generated automatically
Ivar	The "count" of the current variable
IvarName	Independent variable name used in the query
IVarDescription	Independent variable description

Appendix D: Quick Tips for the Use of LCSS and ISIS

LCSS Quick Tips

Biological Parameters – Simulating No Suitable Habitat (page 4-39)

☞ You can simulate no suitable spawning habitat (remember that you cannot set *Habitat Area* to 0, see page 4-26) by setting *Egg Survival Rate* here on the *Reach* parameters screen to 0.

Biological Parameters – Simulating Reproductive Success (page 4-39)

☞ You can simulate reproductive success by modifying egg survival rate.

Budget and Resources – Barrier Extraneous Expenses (page 4-8)

☞ Barrier extraneous expenses can be specified by selecting the ***Barriers*** command button which activates the *Stream Barriers* screen (see page 4-28). From there, select extraneous expenses (***Ex. Expenses***) to access the *Extraneous Stream Barrier Costs* screen (see page 4-29).

Budget and Resources - Budget Groups (page 4-7)

☞ In future versions of the program, different organizational units or institutional groups will be able to set new budgets, as specified by the Budget Group category (top of screen). At present, LCSS uses a single budget group to represent the Great Lakes Fishery Commission Program for all lakes.

Budget and Resources - Chemical Stocks (page 4-12)

☞ You can set both the *Current Stock* and the *Stock Cost/Unit* values and keep them at those values. To do so, you need to turn off the automatic stock update command in the *General Options* screen. Otherwise, the system will overwrite the entered value.

Budget and Resources – Total Program Costs (page 4-13)

☞ In order for the system to calculate the total SMRT costs, you must conduct a simulation run before calculating the budget.

Lamprey Allocation – *Basins* screen (page 4-41)

☞ The selected basin configuration will affect the allocation of lamprey when running the model. For example, if you choose a lamprey basin configuration that contains only Lake Superior, you should not simulate streams from other lakes. The current lamprey basin configuration is always displayed on the status bar at the bottom of the screen.

Ranking Criteria – Fish-related Criteria (page 4-14)

☞ The fish model has not yet been linked to the lamprey model, so the two fish-related ranking criteria are not supported by the Treatment Schedule.

Stream Barrier Activity - Allocating Spawners to Reaches (page 4-37)

☞ This screen is used to allocate spawners from streams to reaches. If you want to allocate spawners from basins to streams, you must use the **Lamprey Allocation** option under the **Edit** Menu.

Stream Configuration – Habitat Area (page 4-27)

☞ It is important to ensure that the value set for *Habitat Area* is greater than 0. Otherwise, the system will not perform its simulation properly. To represent a situation in which there is no suitable habitat for lamprey, set *Habitat Area* (on the *Physical Reach Parameters* screen) to 1 and *Egg Survival* (on the *Reach* tab of the *Biological Parameters* set of screens, see page 4-39) to 0.

Stream Population – ***New Population Records*** **screen** (page 4-57)

☞ When a new reach is created using **Edit|Stream Setup**, the system adds it to the list of reaches in the *Stream Population* screen. The reverse, however, is not true. The ***Del Year*** function in the *Stream Population* screen deletes only the lamprey population information associated with the selected reach and not the physical reach itself. To delete a reach altogether, you must use the *Physical Reach Parameters* screen in **Stream Setup**.

Stream Population – ***Stream Ammocete Number by Size*** **screen** (page 4-56)

☞ Values entered in this screen are for display purposes only and will not affect the simulation.

Stream Setup – Selecting Streams for Treatment or Simulation (page 4-24)

☞ The simulate flag and the basin-to-stream allocation are not linked. If you do not include a stream on the simulation list, you must delete the allocation to that stream (see the **Lamprey Allocation** option on the **Edit** Menu).

Stream Setup – Selecting Streams for Treatment or Simulation (page 4-24)

☞ It is currently impossible to define new streams through the LCSS interface. To do so, you must use the native MS Access interface, and add the new record to 2 tables: Stream and SimStream (see Appendix B). Once the records are there, the *Stream Setup* family of screens in LCSS can be used to define the stream.

Trip Management – Ordering Events in a Trip (page 4-18)

☞ To make it easier to change the order of events in a trip, put "dummy" user events as the first and the last event in a trip. When you have changed the order, remove the "dummy" events. LCSS will automatically move the start date of the first event up and add the appropriate travel time at the beginning and the end of the trip.

ISIS Quick Tips

Stream Configuration – Habitat Area (page 5-9)

☞ It is important to ensure that the value set for *Habitat Area* is greater than 0, otherwise the system will not perform its simulations properly. To represent a situation in which there is no suitable habitat for lamprey (i.e., *Habitat Area* is 0), set *Habitat Area* to 1 and *Egg Survival Rate* (using the *BioParms* tab, below) to 0.

Stream Parameters|Activity tab – *Spawner Allocation to Reaches* screen (page 5-17)

☞ This screen allocates spawners from streams to reaches. To allocate spawners from basins to streams, go to the **Lamprey Allocation** option in LCSS (page 4-40).

Stream Parameters|*Spawners* tab (page 5-22)

☞ CAUTION: To avoid the possibility of conflicts, currently loaded stream-basin-stream allocation data are deleted prior to loading a new set of values. This may cause some streams to behave differently following the loading of an unrelated stream (due to different survival rates of parasitic phase lamprey and different proportions of returning spawners).

Stream Parameters|*Traps* tab (page 5-18)

☞ A *default* trap placement is specific to the stream barrier activity being simulated on the stream to which the trap is added. For example, if the stream barrier activity for the Amnicon River is set to "no barrier or barrier not active", the trap is present whenever this stream barrier activity is simulated.

Stream Parameters|*Traps* tab (page 5-18)

☞ Whereas default traps are linked to stream barrier activity, *non-default* traps are defined for a given year and are not dependent upon the stream barrier activity being simulated.

7.0 Subject Index