GREAT LAKES FISHERY COMMISSION

1996 Project Completion Report[1]

Integrated Management of Sea Lamprey Decision Support Tools Version 1.11 Users Guide

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Integrated Management of Sea Lamprey

Decision Support Tools

Version 1.11

User's Guide

Prepared for

Great Lakes Fishery Commission

by

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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. Appendix A describes the model that forms the foundation of LCSS, Appendix B provides an overview of the database structure and Appendix C describes the database interface.

Hardware & Software Requirements

LCSS requires an IBM-compatible computer capable of running Microsoft® WINDOWS™ version 3.1. We recommend that you run LCSS on no less than a 486 DX2-66 MHZ with 8MB 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 also requires the presence of a program called SHARE.EXE, which is part of both MS-DOS and MS-Windows. A statement in your AUTOEXEC.BAT should look similar to:

```
C:\DOS\SHARE.EXE /L:500  /F:4096
```

If this line must be inserted or modified during the installation process, you should reboot the computer after installing LCSS.

LCSS is an application that was developed using Visual Basic (version 3.0).

Installation Instructions

1. Start Microsoft Windows.
2. Place the installation disk in drive A or B.
3. In Program Manager, select the **File** menu and click on ***Run***.
4. Type A:SETIMSL (or B:SETIMSL if you insert the disk into drive B).

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.

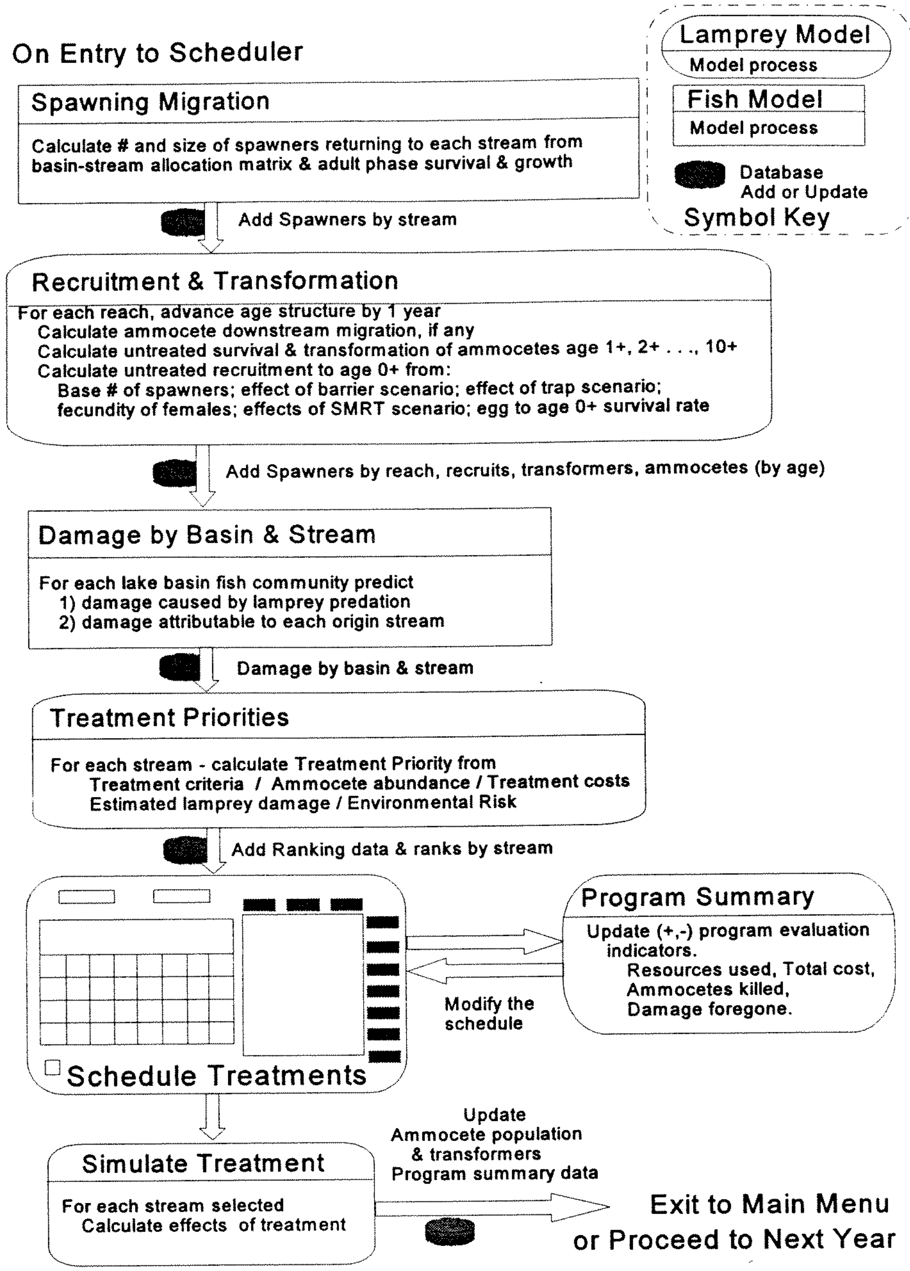


Figure 2.1: Steps in the simulation of sea lamprey populations

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 & 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.

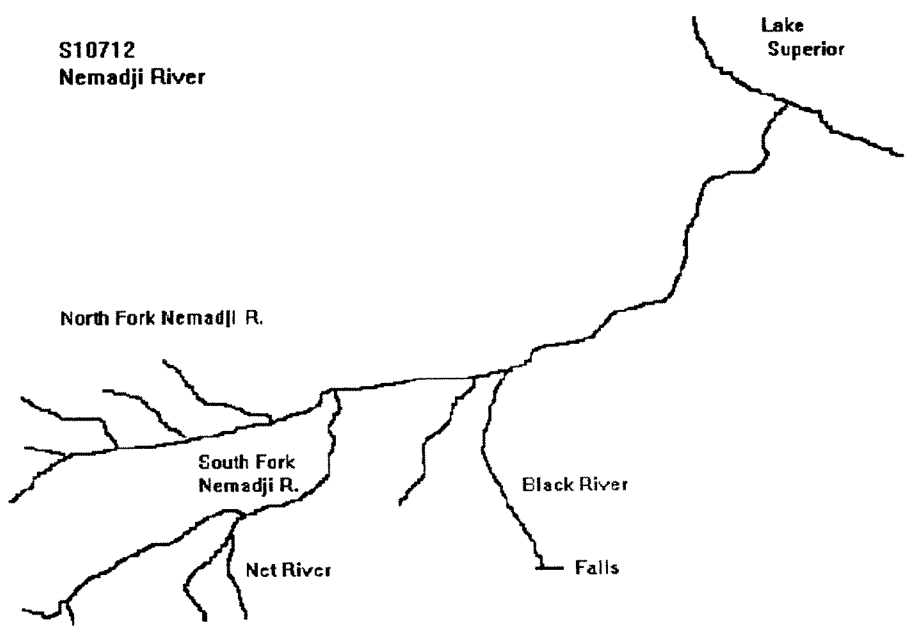
Reach

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
2. 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 steamspecific. 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

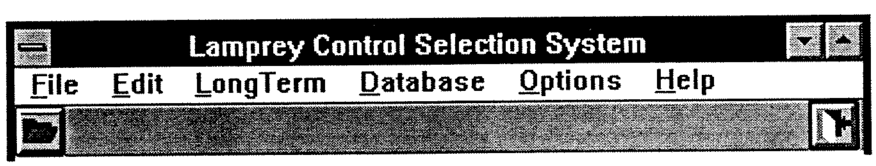
The IMSL Decision Support System is composed of two major elements: the Lamprey Control Selection System (LCSS) and the IMSL Database Access Module. This section describes the user interface of LCSS and provides an overview of all of the menu commands and associated functions. The IMSL Database Access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

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

Example	Description
Stream Configuration	screen name
Reach	field name
Stream	list, table, column
AddConf	command button
Lamprey Allocation	cross-reference to other sections
■ ***To edit reach parameters:***	identifies "how-to" sections
Treat Specifies if the stream will be considered for treatment.	indented lists of field descriptions

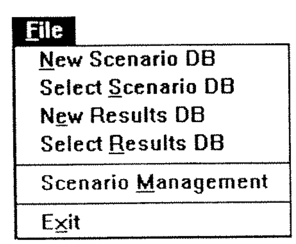
LCSS Main Menu

The **Main** Menu gives you access to all parts of LCSS. Each of the submenus of the Main Menu and associated functions are described below.



File Menu

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



To create a new scenario based upon the default scenario, select *New Scenario DB*. *Select Scenario*

DB lets you choose from one of the existing scenarios.

The *New Results DB* and *Select Results DB* are used to specify which databases will contain the results of the simulations.

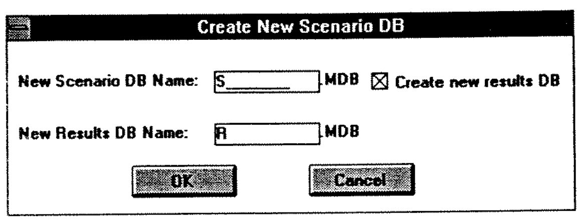
Use the *Scenario Management* option to delete scenarios or results database files. *(Note: this function has not yet been implemented.)*

The *Exit* option quits the LCSS program.

Each of these options is described in detail below.

New Scenario DB

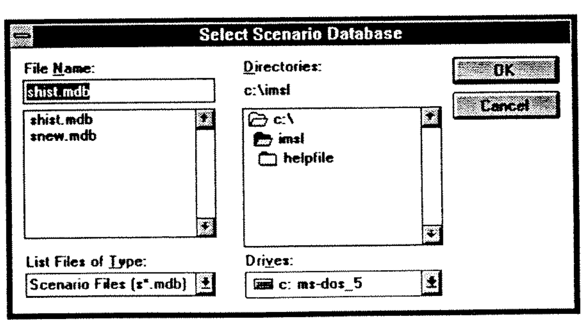
The *New Scenario DB* option can be used to make a copy of the default scenario database. The default scenario includes the starting conditions for lamprey in all basins, streams and reaches to be simulated; the available budget and treatment resources; and detailed descriptions of the control treatments.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



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".

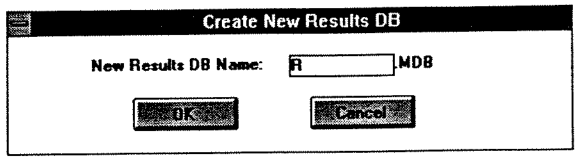
Select Scenario DB

The *Select Scenario DB* option allows you to choose an existing scenario database for use in the simulation.



New Results DB

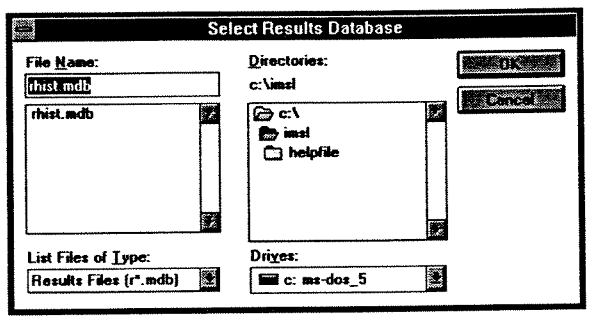
This option creates a new database in which to store the results of the simulation. Note that the Results Databases all begin with the prefix "R" to distinguish them from the Scenario Databases that begin with the prefix "S".



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

Select Results DB

Select Results DB lets you choose an existing database to contain the results of your simulation.



Exit

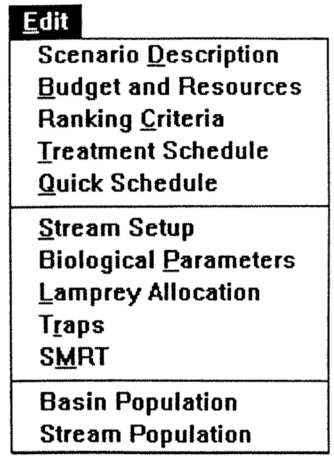
Press *Exit* to close the program.

Edit Menu

The **Edit** Menu allows the parameters of the current scenario to be modified. A scenario represents a set of conditions being simulated by the model, and includes parameter values, management options and results. Scenarios include 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 to be simulated by LCSS.

You are not required to specify all values, as a series of default values exist. However, you can modify and manipulate the default values for existing scenarios by using the options available under the **Edit** Menu. Each option is described in detail in this section.

Selecting the *Scenario Description* option allows you to modify the scenario description.



The *Budget and Resources* option is used to enter and modify the budgets, resources, and resource costs for all of the years within the calculation horizon.

The *Ranking Criteria* option lets you select which ranking criterion will be applied when streams are ranked for treatment.

Treatment Schedule ranks the streams and helps create treatment schedules.

Quick Schedule is used to quickly select streams for treatment without taking into account logistics or exact chemical details (default chemical options are used).

Stream Setup provides information about configurations, barriers and activities for each stream in the database.

The *Biological Parameters* option is used to modify the lamprey model parameters.

Lamprey Allocation is used to allocate spawners from basins to streams and to allocate transformers from streams to basins.

The *Traps* option sets the traps for streams and reaches.

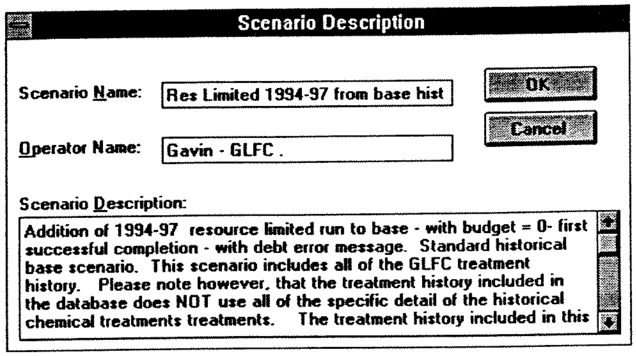
SMRT allows definition of the release of sterile males into streams.

The *Basin Population* screen defines the number of lamprey in each basin of the currently selected lake.

The *Stream Population* screen defines the survival, density and length parameters of lamprey ammocetes in selected streams and reaches.

Scenario Description

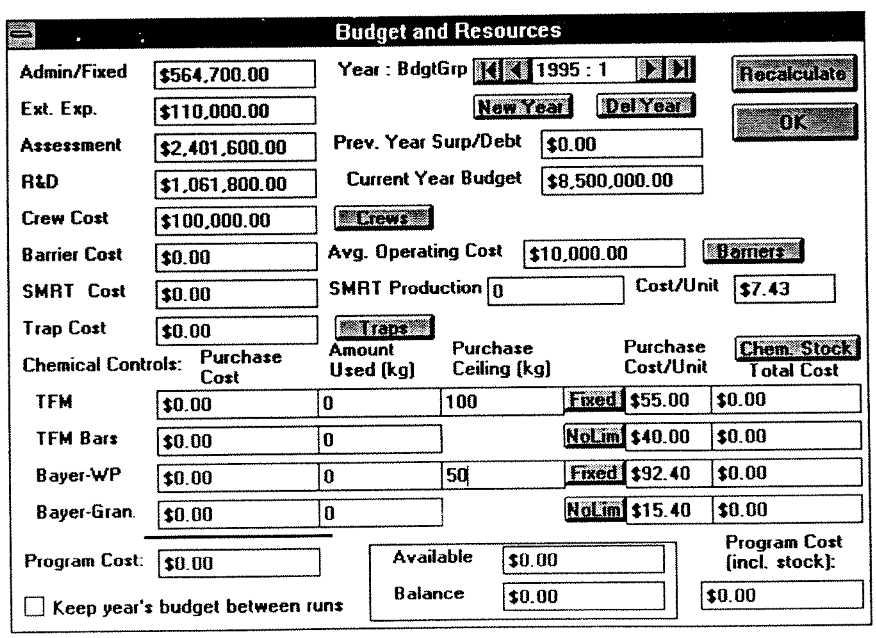
The *Scenario Description* screen allows you to describe the content of the currently selected scenario.



In addition to the explicit option under the **Edit** Menu, this screen appears whenever the nature of the current scenario is likely to have been changed. For example, when a new scenario is created (*New Scenario*, *Save Scenario As...* options in the **File** Menu) and when a treatment schedule is altered (***OK*** command button in *Treatment Schedule*) 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. Upon activation, this screen gives the option to recalculate trap costs. This needs to be done only when trap costs have been changed by the user (see **Traps** section on pg. 4-37).



This screen contains an extensive amount of data. Generally, the fields in the top third of the screen represent known program costs plus information about the budget year and total budget; the middle third of the screen contains information on the costs of crews, barriers, SMRT, and traps; and the bottom third of the screen displays details about the chemical control program. These options are discussed in detail below.

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, the system 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 unique budgets. This option will be specified through the Budget Group category. At the present time, LCSS uses a single budget for all of the Great Lakes.

■ ***To enter a new budget:***

1. Choose the year you wish to serve as a template.
2. Click on the ***New Year*** button and enter the new values. Modify the values in the available fields as necessary (descriptions below).
3. Click ***OK*** to leave the screen and return to the **Main** Menu.

You may want to delete an existing budget for a particular year. Select ***Del Year*** and specify whether you want to delete budget information only, or whether you want to delete all information on the budget, crews, and schedule that was entered for the selected year. 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.

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*** button which activates the *Stream Barriers* screen. From there, select extraneous expenses (***Ex. Expenses*** button) to access the *Extraneous Stream Barrier Costs* screen.

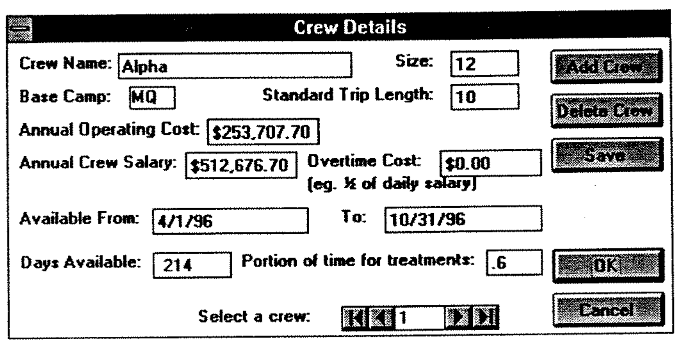
The two fields immediately below the year field display the surplus or debt (specified as negative) from the previous year along with the current year's budget. In the first year of the program, you will need to input the previous year's surplus or debt; in subsequent years, you can choose to have this value calculated automatically by flagging an option in the *General Options* screen (in **Options** from the **Main** Menu).

Once you have entered (or edited) the known program costs for the current year's budget, you will need to provide the system with further information about the crews and the control program for barriers, sterile male release and traps. Each of these options is discussed below.

Based on the information that you provide in the *Budget and Resources* screen and the current treatment schedule, the system will calculate and display the new total cost when you click on the ***Recalculate*** button.

Crew Cost

The number value in the Crew Cost field is calculated based on data provided about crews in the *Crew Details* screen. You can access this screen by selecting the ***Crews*** button in the *Budget and Resources* screen.



The *Crew Details* screen displays default information for each crew. To modify crew data, start by selecting the crew that you want to edit by using the scroll arrows at the bottom of the screen. The crew name is displayed at the top of the screen, along with data for that particular crew. Enter or modify data on the crew name, size, base camp, standard trip length, annual operating cost, annual crew salary, overtime cost, and availability dates. Based on this information, the system will calculate the total crew cost for the *Budget and Resources* screen. When done, press ***Save*** to save your changes and retain the *Crew Details* screen. Press ***OK*** to save your changes and return to the *Budget and Resources* screen.

To add a crew, press ***Add Crew***. Enter data into all of the fields. To delete a crew, select the crew that you want to delete. Press ***Delete Crew***. All information on the currently selected crew will be deleted.

Barriers Cost

LCSS automatically calculates the total cost for the barrier program according to the current barrier schedule. You can review individual barrier costs by selecting the ***Barriers*** button on the *Budget and Resources* screen, which accesses the *Stream Barriers* screen (see pg. 4-21).

SMRT Cost

The Sterile Male Release Technique (SMRT) cost is calculated according to the parameters provided in the *SMRT* screens (see pg. 4-41) and the current year's treatment schedule, along with the unit cost per sterile male provided on the main *Budget and Resources* screen.

Trap Cost

The Trap Cost is calculated according to the current schedule. Choose the ***Traps*** button to bring up the *Default Trap Placement* screen and alter the number, type and location of the traps as necessary.

A full discussion of the options available on the set of screens associated with *Default Trap Placement* is given later in this chapter on page 4-38 (see also pg. 5-16, 17).

Chemical Controls

Chemical treatment is an important component of the lamprey control. The fields on the lower third of the *Budget and Resources* screen allow you to establish a chemical purchasing strategy.

The LCSS considers four chemical controls: TFM, TFM bars, Bayer (Wettable Powder), and Bayer (Granular). For each chemical, data are displayed on Purchase Cost, Amount Used, Purchase Ceiling, Purchase Cost/Unit, and Total Cost. The first two fields, Purchase Cost and Amount Used are calculated by the system based on the treatment schedule.

The chemical purchase strategy can be changed by clicking on the button displaying the current strategy (e.g., ***NoLim***). As you click on this button, other strategies are displayed and the *Purchase Ceiling* field will become visible. The four purchase strategies are described below:

Fixed

The amount of chemical specified in the Purchase Ceiling column is purchased regardless of how much will be used according to the schedule. If the purchase does not cover the current year's needs, the difference will be made up from the chemical stocks available, or fewer potential streams will be treated. If there is extra chemical left at the end of the year's control program, the remainder will be added to the chemical stock for use in subsequent years.

Max

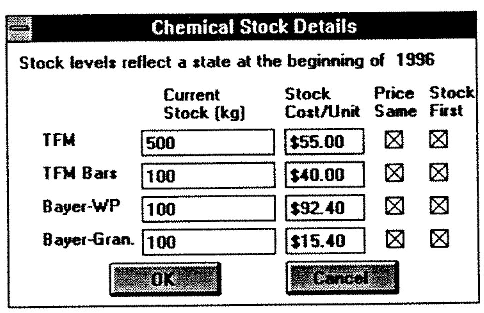
This limits the amount of chemical available for purchase. However, the money assigned to purchasing chemicals can be used, if needed, for other costs incurred during the year, such as purchasing other chemicals, paying for crews, overtime etc. If less chemical is required for the year's program, less is purchased. If more is required, the difference is made up from the stocks.

Min The amount shown in the Purchase Ceiling field is the minimum amount that can be purchased. If the schedule specifies more than the minimum and the funds are available, additional chemical purchases will be scheduled. Any excess amount will be added to the next year's stock.

NoLim No limit is placed on chemical availability. The only limiting factor is the availability of funds.

The chemical purchase strategy is very important when using the automatically scheduled treatments. For example, when you are conducting a resource limited or automatic schedule Long-Term Run, the amounts you indicate in the chemical control fields will be used as guides to determine treatment possibilities. When you are creating a manual schedule, however, these settings are ignored.

The *Chemical Stock Details* screen can be activates by clicking on the ***Chem. Stock*** command button on the *Budget and Resources* screen. It allows the user to define the availability and cost of chemicals. Chemical stocks cover any shortfall or absorb any excess chemical in the treatment schedule. When extra chemical is added to the stock, the purchase price is blended into the stock cost/unit by averaging weighted by relative amount of stock and new chemical.



Each field displayed on this screen is described below:

Current Stock Represents the amount of chemical that is currently available in stock.

StockCost/Unit Indicates the average cost per unit of stock. This value may change as chemicals are put into stock at different purchase prices.

Price Same When this option is selected, the system ignores the calculated stock cost per unit and uses the purchase cost per unit for that year to calculate stock cost. In effect, this calculates the replacement cost for the chemical used for treatment. This cost will be added to the current year's total program cost, but will not be contained in the year's expenditure.

Stock First When this option is selected, the system uses the chemicals in stock before making use of recently purchased chemicals. The amount of chemicals in stock will be updated from year to year when the update budget/stocks option is flagged in the *General Options* screen under the **Options** Menu.

☞ 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.

Total Program Costs

Once you have entered (or modified) all of the program cost fields, as well as details about crews, barriers, sterile male release, traps, and the chemical control program, you are ready to calculate the total program costs for the year.

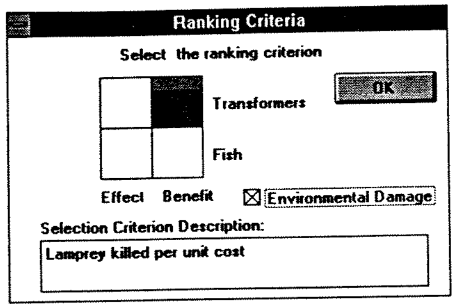
Press ***Recalculate***. The total program costs will be calculated. Note that the fields at the very bottom of the *Budget and Resources* screen display the *Total Program Cost* and the *Program Cost Including Stock*. The *Total Program Cost* represents the amount of money needed for the current year. This does not include the cost of the stock used (since it was not necessary to buy it). The stock cost is included in the *Program Cost Including Stock*. This allows better tracking of the use of resources from year to year.

The total amount of money available for the selected year, determined by adding the previous year's surplus or debt to the current year's budget, is represented in the *Available* field. The surplus or debt for the current year is displayed in the *Balance* field.

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

Ranking Criteria

Ranking Criteria establishes which criterion will be applied when ranking streams for treatment. Before you schedule streams for treatment, you need to specify the criterion that should be used to estimate the relative importance of applying treatments to each stream.



Clicking on the appropriate square in the grid selects the ranking criterion, which is described in the box at the bottom of the screen. Each ranking criterion is described below:

Transformers-Effect Streams are ranked according to the maximum effect on lamprey, i.e. the number of future transformers killed per treatment. It does not take into account the cost of the treatment.

Transformers-Benefit Streams are ranked according to the benefit/cost ratio of lamprey reduction, i.e. the number of future transformers killed per unit cost.

Fish-Effect Streams are ranked according to the maximum reduction in damage to the fish community (maximum number of fish saved). (Note: the fish model has not yet been linked to the lamprey model, so this ranking criterion is not supported by the Treatment Schedule.)

Fish-Benefit Streams are ranked according to the benefit/cost of damage reduction (most valuable stocks saved for the least cost). (Note: the fish model has not yet been linked to the lamprey model, so this ranking criterion is not supported by the Treatment Schedule.)

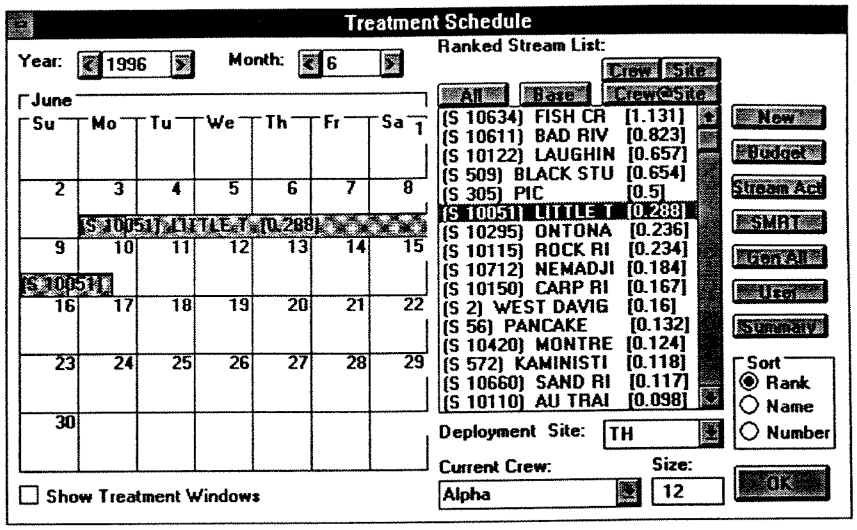
When either Transformers-Benefit or Fish-Benefit is selected, the *Environmental Damage* checkbox is displayed. By checking the box, the costs of potential environmental damage are incorporated into the ranking criterion. Options with lower probabilities or costs of environmental damage and/or mitigation will be given a higher rank than other options. However, since environmental damage/mitigation adds to the cost of treatment, this option is only available when you have chosen to rank streams using benefits as the central criteria. The values for environmental damage/mitigation can be modified on the *Chemical Option Details* screen (see pg. 4-26).

Treatment Schedule

The *Treatment Schedule* screen is one of the most important parts of LCSS.

It allows you to interactively create a treatment schedule for all the years within the calculation horizon.

The screen has two major components: the graphical representation of the current month and the list of ranked streams. The features of this screen are described below.

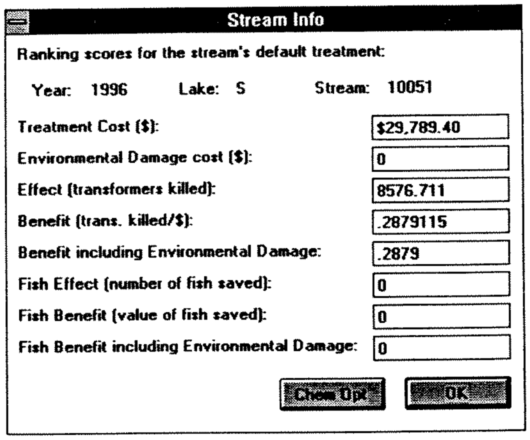


Month, Year The current month and year can be selected by clicking the "arrow" buttons above the calendar. As you move through the years in this screen, LCSS will give you the opportunity to update the budget (to accommodate changes in the schedule from year to year) and population age structure.

Calendar Whenever applicable, the calendar will display scheduled events (treatments or user-defined events) for the currently selected year. The total time required to undertake the scheduled event (including travel to and from the deployment site) is represented graphically on the calendar by means of a coloured rectangle. Clicking once on an event displays the deployment site for the event (displayed below the ranked list). Double-clicking on the scheduled event invokes the *Trip Management* screen (pg. 4-14), where you can view and modify details of a trip's event.

Show Treatment Windows Each treatment option is assigned one of three treatment window types, i.e., preferred, acceptable or not acceptable (see **Window**, pg. 4-27). 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).

Ranked Streams List This field displays a list of untreated streams (unless you have selected the *Keep* option in the *Trip Management* screen - see the **Trip Management** section, pg. 4-14). Each entry on the ranked streams list shows the lake (represented by the first initial), the stream number, the stream name, and its rank value. The streams are listed in descending order according to ranking value. Clicking once on a stream in this list updates the *Deployment Site* field. Ranking scores for each stream's default treatment are displayed in the *Stream Info* screen, which is invoked by double-clicking on a stream name.



All, Base, Crew, Site, Crew@Site You can limit the list of streams in the Ranked Streams List. You can choose to display all of the streams in the Great Lakes basin (*All*); those corresponding to a given crew's base (*Base*); those matching only the selected crew's size (*Crew*); those that can only be treated from the specified deployment site (*Site*); or a combination of a crew of a certain size at a specified site (*Crew@Site*).

☞ Remember, if you want to select a new ranking criterion, use the *Ranking Criteria* option in the **Edit** Menu. If you have entered new parameters or modified the scenario since you last selected a ranking criterion, you should press *New* before you begin to create a treatment schedule. This will rebuild the list of ranked streams.

■ ***To schedule streams for treatment:***

1. Using the arrow keys on either side of the year and month fields, select the year and the month for which you wish to schedule treatments. A calendar is automatically displayed for the selected month, along with a list of streams ranked in priority for treatment.
2. Customize the Ranked Stream List using *All*, *Base*, *Crew*, *Site* or *Crew@Site* options described above.
3. Select the name of the stream you wish to schedule for treatment and drag it to the desired start date. (Note that this action will remove the selected stream from the ranked streams list unless you have selected the *Keep* option in the *Trip Management* screen, pg. 4-14) If you wish to schedule adjacent treatments, drop the second stream on top of the first.

You will be asked to confirm whether you wish to join the two streams into a single trip.

4. If there is a need to modify treatment attributes (dates, travel time, chemical options, etc.), double-click on the scheduled treatment event displayed on the calendar to invoke the *Trip Management* screen.

Other treatment schedule options

There are several other options in the central *Treatment Schedule* screen, accessed by selecting the buttons along the right side of the screen. Each button is described below:

New Removes all events from the schedule for the current year and recalculates the current rank list.

Budget Accesses the *Budget and Resources* screen, letting you view and/or modify the budget for any year.

StreamAct Brings up the *Stream Barrier Activity* screen.

SMRT Accesses SMRT options.

GenAll In future versions of LCSS, this option will use the built-in expert system to automatically create a schedule for the current year.

User Allows you to create user-defined events. Enter the event name and its duration in the appropriate fields. Each user-defined event is stored in a database and can be used for other crews or other schedules. To schedule a user-defined event for treatment, click anywhere on the white space of the *User Event* screen, and, holding down the mouse button, drag the event to the calendar and drop it on the appropriate starting day.

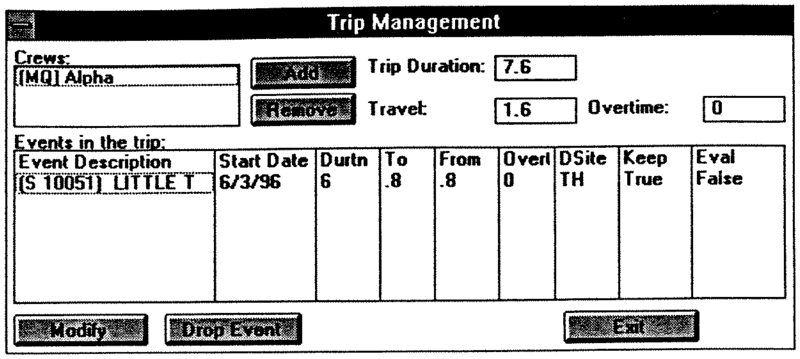
Summary Produces statistics about the current schedule. These include: projected future transformers killed, mean cost per transformer killed, crew time utilization, cumulative cost, unused budget, resources used (TFM, Bayer, Sterile Males), and others. Some of this information will also be available from the *Budget and Resources* screen.

Sort Allows you to sort lakes and streams according to their rank (see *Ranking Criteria* screen). In future versions of the program, users will be able to sort by name and number as well as by rank.

OK Exits the screen.

Trip Management

The options displayed on the *Trip Management* screen are used to edit the attributes of a scheduled treatment event.



This screen, activated by double-clicking on a scheduled event in the *Treatment Schedule* screen, displays details about each event in a trip. You can modify all of the values in this table except the three summary fields *Trip Duration*, *Travel* and *Overtime*.

Crews The *Crews* field provides lists of all crews participating in the trip. Use ***Add*** and ***Remove*** command buttons to modify the list.

Add Click on ***Add*** to add a crew to the trip. This allows multiple crews to treat a set of streams.

Remove ***Remove*** a crew from the trip.

Trip Duration This is a calculated field indicating the total trip duration (sum of durations of individual events plus travel time).

Travel This field indicates the total time required for travel from the crew's base to the deployment site.

Overtime This field shows the time over the recommended trip duration (crew specific). This value is used for calculations of total program cost.

Event Description This is the description used in the event box on the calendar.

Start Date The start date of the event.

Duration Event duration (in days).

To, From Travel time to and from the deployment site. By default, this is applied only for the first and last event in a trip.

Overt # of days in the event that are overtime.

DSite Deployment site.

Keep This field is used to indicate whether the stream should be retained in the *Ranked Stream List* on the *Treatment Schedule.* A value of *True* retains the stream on the rank list, allowing you to treat the stream on multiple occasions throughout the year. The default value of *False* removes the stream from the *Ranked Stream List* once it has been scheduled for treatment.

Eval This field offers users the opportunity to have the computer to search for the best chemical option (see **Long Term Menu**, pg. 4-45). A value of *True* instructs the system to re-evaluate and find the chemical option that will treat all reaches with lamprey for minimal cost. *False* indicates that the system will use the chemical option entered by the user.

Drop Event To remove an event from treatment, select the event and click on the ***Drop Event*** button.

Modify Clicking ***Modify*** accesses the *Chemical Option Details* screen (see pg. 4-26) where you can edit values for the current treatment program (or user-defined events).

Altering the order of treatment events is also possible, although it does require some juggling. To rearrange the existing order of events, edit the starting date of a given event. The system will automatically change the starting dates of the other events in the trip to accommodate the new date.

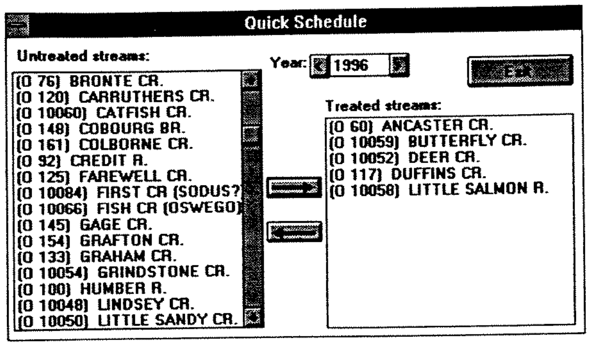
In some cases, moving an event may be a multi-step process. For example, to move an event to the front of the trip you must change the start date of the first event to a later date (e.g. next day) and then move the desired event to the front and modify the travel appropriately.

☞ 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.

☞ For further information about the *Chemical Option Details* screen, please refer to page 4-26.

Quick Schedule

The *Quick Schedule* option provides an easy way to select streams for treatment. It ignores the logistical constraints and uses the default chemical options. All of the selected streams are placed on the calendar of a single (first) crew starting on January 1 of the selected year.



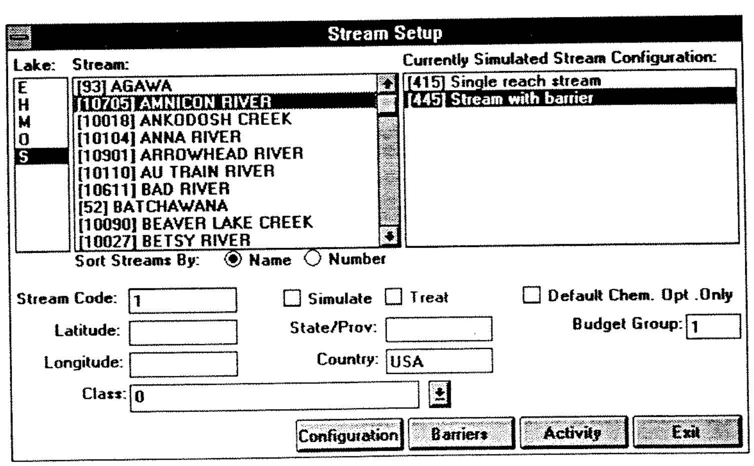
- ***To schedule streams for treatment:***
  1. Select the treatment year.
  2. Select all of the untreated streams you want to transfer by clicking on each with your mouse. Click on the right-pointing arrow to move the stream(s) from the Untreated Streams list to the Treated Streams list.

- ***To remove streams from treatment:***
  1. Select the treatment year.
  2. Select all of the treated streams you want to remove from treatment. Click on the left-pointing arrow to move the stream(s) from the Treated Streams list to the Untreated Streams list.

☞ This option is most appropriately applied when you want to quickly enter historical treatments for use in *Scheduled Treatment*-type long-term runs.

Stream Setup

This screen is a centre for defining physical characteristics of streams and their "behaviour", including barriers and chemical options.



The *Lake* and *Stream* lists allow selection of a stream to be viewed or modified. The list can be sorted by either the stream name or the stream number. The sort order can be chosen under the stream list. The stream selection made here is propagated through all of the screens accessible from the *Stream Setup* screen. Similarly, stream selections made on other screens will be reflected here.

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 (pg. 4-19).

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

Stream Code Code used in some of the other lamprey program documentation.

Simulate Specifies if the stream will be simulated in the next run. The selection made here should be coordinated with lamprey allocation between the basins and streams (see **Lamprey Allocation** section, pg. 4-31).

Treat Specifies if the stream will be considered for treatment. Streams not simulated cannot be selected for treatment.

Default Chem. Opt. Only Specifies if LCSS will re-evaluate the chemical option used for the stream (see **Long Term Menu**, pg. 4-45).

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, pg. 4-31).

Budget Group Is currently unused and should always be set to 1.

The Stream Setup screen allows access to 3 other screens:

Configuration: allows definition of stream configurations (see **Stream Configuration** section, pg. 4-19).

Barriers: allows definition of barriers (see **Stream Barriers** section, pg. 4-21).

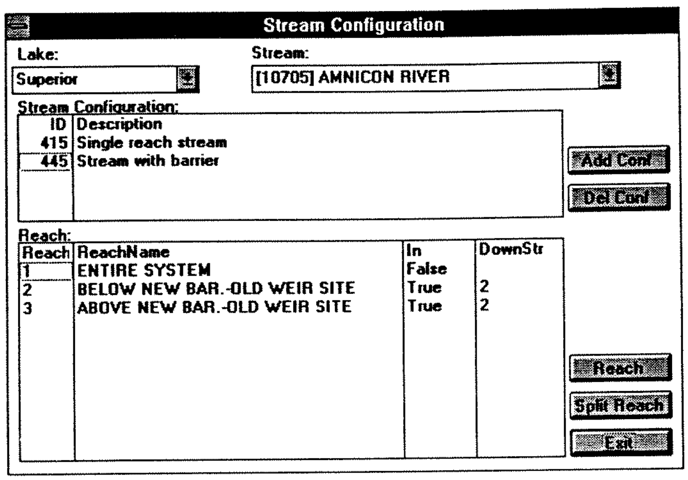
Activity: allows modification of stream "behaviour" (see **Stream Barrier Activity** section, pg. 4-23).

☞ At the present time, the simulate flag and the basin-to-stream allocation are not implicitly linked. This means that to alter the simulation status of a stream you must also modify the lamprey allocation to and from the stream (see **Lamprey Allocation** section pg. 4-31).

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

Stream Configuration

The *Stream Configuration* screen allows entry and modification of stream configurations. This screen can be accessed by clicking on the ***Configuration*** button in the *Stream Setup* screen.



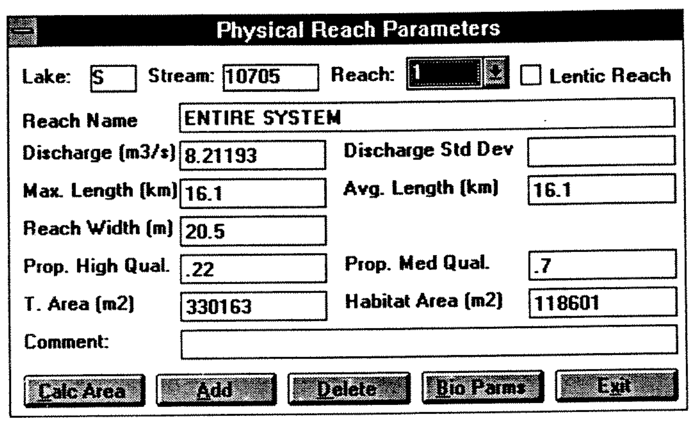
A stream configuration is a definition of the physical layout of the stream. It is composed of "reaches", non-overlapping sections of the stream acting as homogenous units. The reaches are connected by defining a downstream reach. The lowest single reach in a group should be defined to flow into itself. 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 are listed in the *Stream Configuration* table. 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.

Reaches can be added in two ways. The ***Reach*** button opens a screen where individual reaches can be added, removed, or modified (see below). The ***Split Reach*** button opens a screen that divides the currently selected reach into 2 or more sub-reaches.

Clicking on the ***Reach*** button in the *Stream Configuration* screen opens the *Physical Reach Parameters* screen.



This screen allows addition/deletion of reaches and modification of physical reach parameters. The reaches for the current stream can be selected from a drop down list. Parameters available for modification are:

Lentic Reach This field consists of a checkbox to indicate whether the current reach is a lentic reach.

Reach Name A short description of the reach.

Discharge Mean annual flow (in cubic metres per second) at the lowest most part of the reach.

Discharge Std Dev Standard deviation of the discharge within the year.

Max. Length The total length (in kilometres) of the reach.

Avg. Length The length of the reach (in kilometres) inhabited by lamprey.

Reach Width Width of the reach (in metres) at the lowest most part of the reach.

Prop. High Qual. Proportion of the potential habitat area of high quality.

Prop. Med Qual. Proportion of the potential habitat area of medium quality.

T. Area Total reach area (usually Reach Width * Avg. Length) (in square metres). This value can also be generated by clicking on the ***Calc Area*** command button (see below).

Habitat Area High quality equivalent of the area (usually T. Area * (Prop. High Qual + 0.2 * Prop. Med Qual.)) (in square metres). This value can be generated by clicking on the ***Calc Area*** command button (see below).

☞ 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* (see the section on setting **Biological Parameters**, pg. 4-29) to 0.

Comments Any special comments (eg. source of the information used).

The actions available from the *Physical Reach Parameters* screen are:

Calc Area This feature is a calculation aid that generates values for the *T. Area* and *Habitat Area* fields using the formulae shown in the field descriptions for each (above).

Add Add a reach definition (either a copy of the current reach or with a set of default parameters). This command adds the physical, biological and age parameters for the new reach.

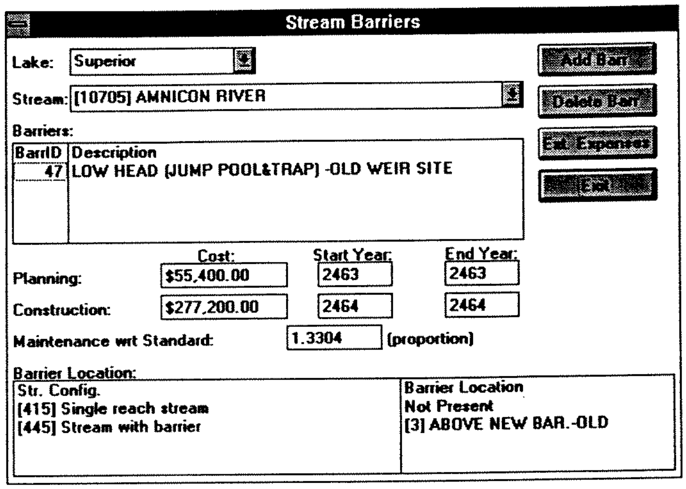
Delete Delete the current reach. This command removes the physical, biological and age parameters for the current reach. It also removes reach references from the stream configurations (of which the reach may be part), spawner allocation factors to the reach, traps defined on the reach, references to locations of any barriers located on the reach (barriers definitions are not deleted), and effect of chemical options on the reach (chemical options are not deleted).

Bio Parms Reach biological parameters (see **Biological Parameters** section, pg. 4-29).

Exit Exits this screen.

Stream Barriers

The *Stream Barriers* screen allows addition (***Add Barr*** button), removal (***Del Barr*** button) and modification of barriers to be simulated. This screen can be accessed from the *Stream Setup* or *Budget and Resources* screens.



The *Lake* and *Stream* fields display the names of the selected lake and stream respectively. The *Barriers* field lists all of the barriers, both the alternate and the concurrent, defined for a given stream. The *BarrID* column uniquely identifies the barrier and the *Description* column provides a short description of the barrier.

Barriers are brought "on-line" in three stages: planning, construction, and operation. The planning and construction phases are described on the *Stream Barriers* screen. The operation phase is described on the *Stream Barrier Activity* and *Budget and Resources* screens. Both planning and construction are described in terms of *Cost* from *Start Year* to *End Year*. The cost is evenly distributed over the length of each phase.

The operating cost of a barrier is calculated according to its size, which is expressed as a proportion of the size of a standard ($250,000) barrier in the *Maintenance wrt Standard* field (wrt = with respect to). This proportional value is currently calculated by:

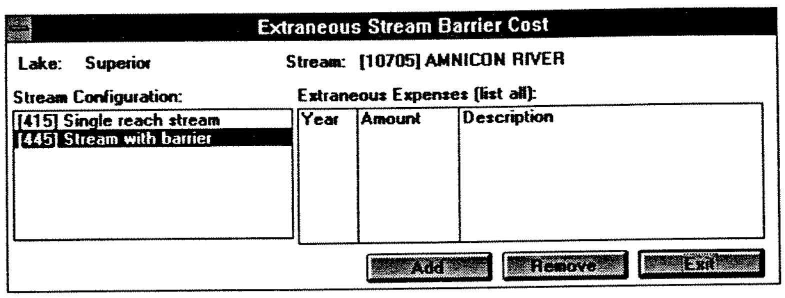
$$\frac{\text{Planning Cost} + \text{Construction Cost}}{\$250{,}000}$$

Maintenance cost is calculated yearly by multiplying the average annual operating cost of a standard-sized barrier (entered by the user in the *Budget and Resources* screen) by the proportional value in the *Maintenance wrt Standard* field. Additional non-recurring costs can be specified on the *Extraneous Stream Barrier Costs* screen (see **Ext. Expenses**, below). The years of operation (and thus start of maintenance) are defined on the *Stream Barrier Activity* screen.

A barrier may be present in one or more stream configurations. As well, multiple barriers may be present within a single stream configuration.

The *Barrier Location* field lists the configurations that have been defined for the current stream (*Str. Config* column) and describes the location of barriers on each (*Barrier Location* column). If the currently selected barrier is not present in the currently selected stream configuration, the *Barrier Location* should be set to "not present".

Clicking on the ***Ext. Expenses*** button opens the *Extraneous Stream Barrier Cost* screen. This screen lists all of the non-recurring costs related to the operation of a barrier. Different sets of extraneous expenses are listed for each stream configuration where a barrier is present.



Expenses are described by the fields:

Year The year of the expense.

Amount The dollar amount.

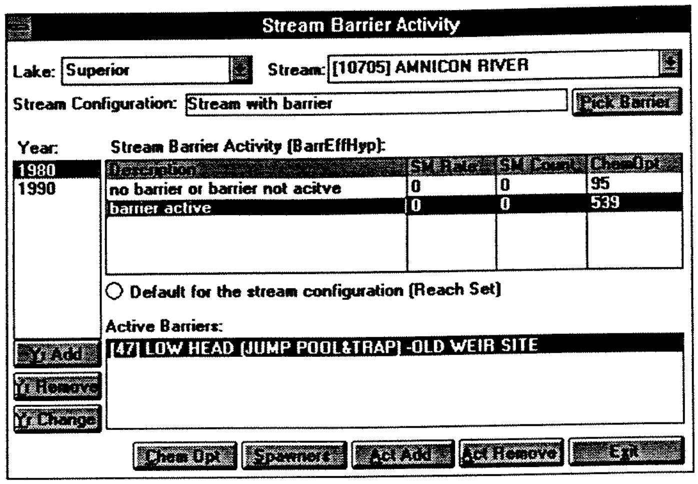
Description A short description.

Expenses can be added and removed by pressing ***Add*** and ***Remove*** command buttons respectively. You can modify the values by simply overtyping existing values. The ***Exit*** button exits the screen.

☞ Other extraneous expenses can be specified on the *Budget and Resources* screen.

Stream Barrier Activity

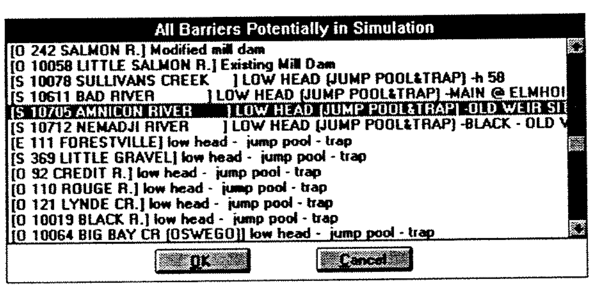
Press the ***Activity*** button on the *Stream Setup* screen to reach the *Stream Barrier Activity* screen. You can also access this screen by pressing ***Barriers*** from the *Budget and Resources* screen.



Stream barrier activities define what happens in the stream over the course of the simulation. They affect the allocation of spawners within a stream. Information displayed relates only to the currently simulated stream configuration.

By default, the *Lake*, *Stream* and *Stream Configuration* selected on the *Stream Setup* screen are displayed. If you wish to examine a different lake or stream, make your selection using the drop-down lists at the top of the screen.

To select a stream with a specific barrier, press the ***Pick Barrier*** button. This brings up a list of all of the barriers that have been defined for use in the simulation, as shown below.



To select a barrier, click on the name and press ***OK***. This will return you to the *Stream Barrier Activity* screen with your new stream selection in place.

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*) used for SMRT, 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. Click on the ***Act Add*** button in the *Stream Barrier Activity* screen.
  2. Highlight your new entry with the cursor and enter a description of the 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. (More information on these two screens is provided 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.

When you select a year in the year list, the stream barrier activity that is associated with that year is highlighted. Likewise, if you select a stream barrier activity, all of the years when that activity is turned on are highlighted.

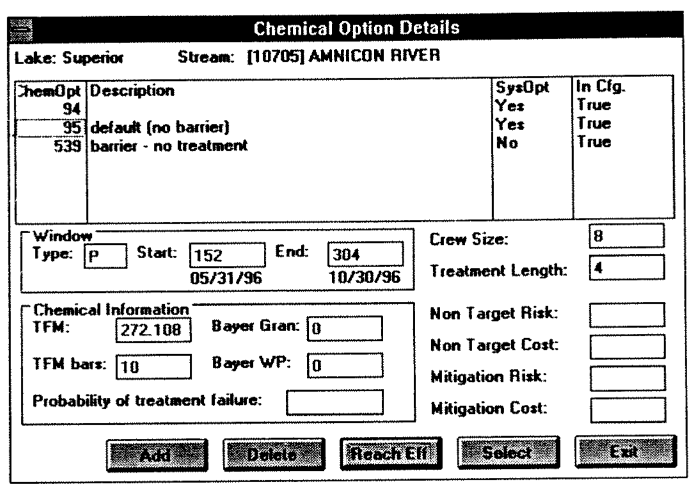
For example, for the Amnicon River (as displayed in the *Stream Barrier Activity* screen above), the default stream barrier activity is "no barrier or barrier not active". This default activity is in effect from 1958 (the first year of the simulation) until 1979. In 1980 the stream barrier activity changes to "barrier active". The barrier remains active until 1989, when the barrier activity changes again to "no barrier or barrier not active".

Use this screen 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. More details about SMRT are found later in this section (page 4-41).

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.

Chemical Option Details

The *Chemical Option Details* screen is used to view and modify the chemical treatment option for the currently selected lake and stream. This screen can be accessed from the *Stream Barrier Activity* screen by selecting the ***Chem Opt*** button. The default chemical option for the activity will be selected. The *Chemical Option Details* screen can also be accessed from the *Trip Management* screen by clicking on ***Modify***. In this case, the currently selected chemical option will be used. Finally, the *Chemical Option Details* screen can be accessed when you select ***Chem Opt*** from the *Stream Info* screen (double-click on any stream displayed in the Ranked Stream List on the Treatment Scheduler to access *Stream Info*). Here, the chemical option shown as selected will be the one the system uses in the stream ranking process.



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

Lake Identifies the current lake.

Stream Identifies the current stream.

ChemOpt A unique identifier that references the chemical treatment option.

Description Provides a brief description.

SysOpt Choose "Yes" 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.

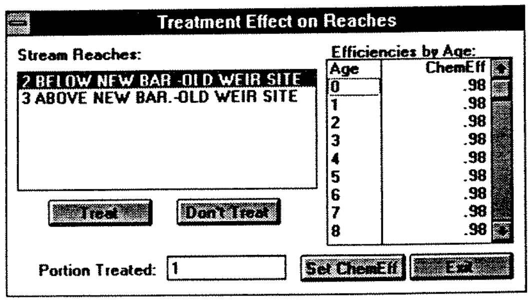
Select Selects the current chemical option to be the new default option for the *Stream Barrier Activity* screen or to be used as the current treatment in the *Trip Management* screen. This button has no affect on the *Stream Info* screen.

ReachEff Takes the user to the *Treatment Effect on Reaches* screen.

Exit Saves the current chemical option and exits the *Chemical Option Details* screen.

Treatment Effect on Reaches

The *Treatment Effect on Reaches* screen is accessed by pressing the ***Reach Eff*** button in the *Chemical Options* 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.

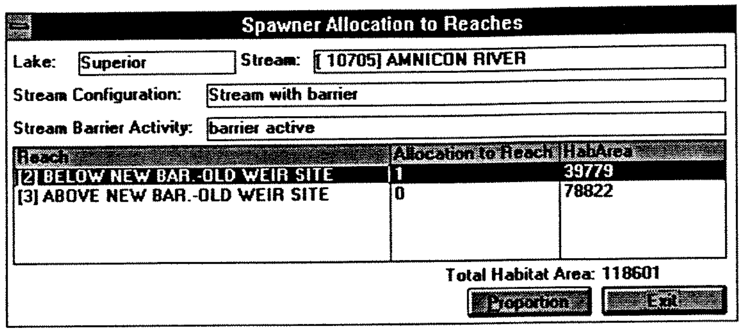
Don't Treat Removes a reach from treatment by the current chemical option.

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.

Spawner Allocation to Reaches

The *Spawner Allocation to Reaches* screen is accessed from the *Stream Barrier Activity* screen by pressing the ***Spawners*** button. 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, choose the *Lamprey Allocation* option in the **Edit** Menu.



As a general rule, the spawner allocation is set proportional to the habitat area in each reach. 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 (see screen example above) 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.

Biological Parameters

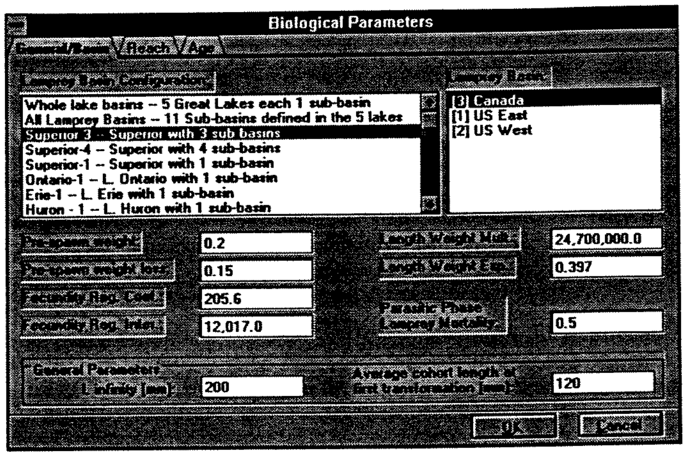
Choosing *Biological Parameters* from the **Edit** Menu lets you modify the lamprey model parameters. Three categories of parameters are available for editing: General and Basin parameters, Reach parameters, and Age parameters. This set of screens can also be accessed from *Stream Setup* by clicking on the ***Configuration*** button (→ *Stream Configuration* screen), the ***Reach*** button (→ *Physical Reach Parameters* screen) and the ***Bio Parms*** button (→ *Biological Parameters* screen). Parameters can be modified simply by overtyping the old values with the new.

Details on how the parameters are used can be found in the model description in Appendix A.

Each category of parameters is listed on a tab at the top of this screen. By clicking on a tab, you access screens for each.

General/Basin Parameters

The *General/Basin Parameters* screen contains two types of parameters, those global to the whole simulation and parameters constant for the lamprey basins. This screen is the first of three *Biological Parameters* screens.



This screen is one of two places where the currently simulated basin configuration can be selected (see **Lamprey Allocation**, pg. 4-31). The configuration highlighted upon exit from this screen will be used for the next simulation (see **Lamprey Basins** in Chapter 2 for details on lamprey basins).

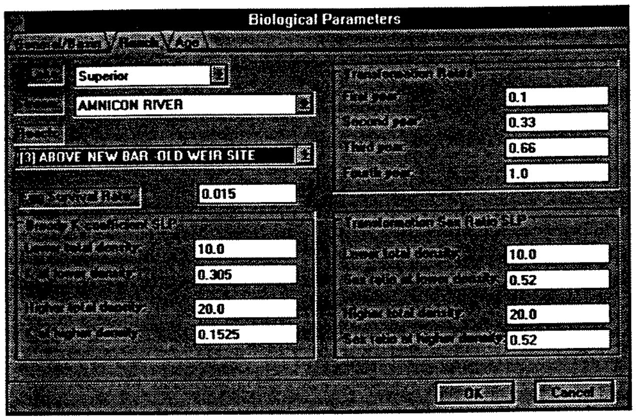
The *Lamprey Basin Configuration* list holds all of the available lamprey basin configurations. The *Lamprey Basin* list contains all of the basins defined for the currently selected configuration. Adding, deleting and modifying configurations can be done using the *Lamprey Allocation* screen (see pg. 4-31).

> Make sure that the streams simulated are those affected by the lamprey basin definition. For example, if you choose a lamprey basin definition that contains only Lake Superior, you should simulate only Lake Superior streams, and not streams from the other lakes.

☞ Note that the current lamprey basin definition is always displayed on the status bar at the bottom of the LCSS application screen.

Reach Parameters

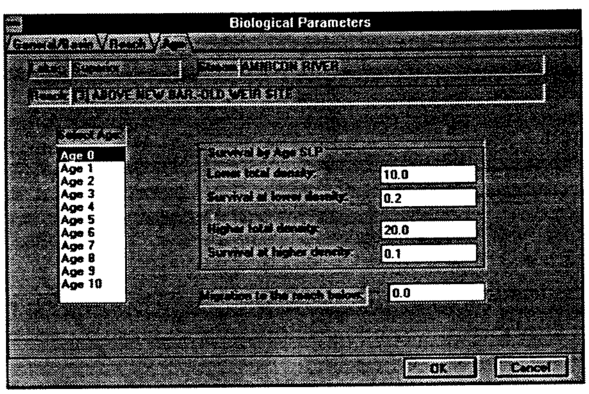
The *Reach Parameters* screen displays parameters which are constant for each reach. This screen is the second of three *Biological Parameters* screens.



☞ You can simulate no suitable spawning habitat (remember that you cannot set *Habitat Area* to 0, see pg. 4-21) by setting *Egg Survival Rate* here on the *Reach Parameters* screen to 0.

Age Parameters

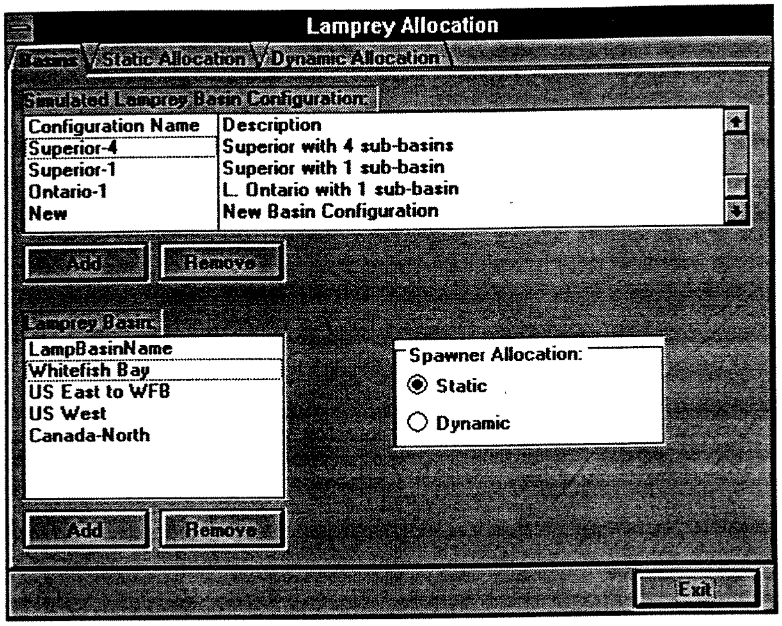
The *Age Parameters* screen contains parameters specific to each ammocete age class. This is the third of the *Biological Parameters* screens.



Lamprey Allocation

The *Lamprey Allocation* set of screens, accessed via the **Edit** Menu, governs movement of transformers and spawners between lakes and streams.

There are three sets of parameters accessible through the following tabs: *Basins*, *Static Allocation*, and *Dynamic Allocation*.



The *Exit* button, located below the tabs, exits the *Lamprey Allocation* set of screens.

Basins

The *Basins* screen is the first of three *Lamprey Allocation* screens. It allows addition, removal, modification and selection of the lamprey basin configurations (also see **General/Basin Parameters** section, pg. 4-29). This screen also allows selection of the spawner allocation strategy to be used in the next simulation (static vs. dynamic).

The lamprey basin configurations subdivide the lake lamprey population into distinct groups (see also **Lamprey Basins** in Section 2 of this manual). The lamprey basin configurations can be added and removed by pressing the ***Add*** and ***Remove*** command buttons just below the list of configurations. 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 used in the next simulation. The *Lamprey Basin* field, located below with its own ***Add*** and ***Remove*** buttons, lists the basins which define the selected configuration.

The spawner allocation strategy can be selected by clicking on one of the two choices listed. Detailed descriptions of each are given below.

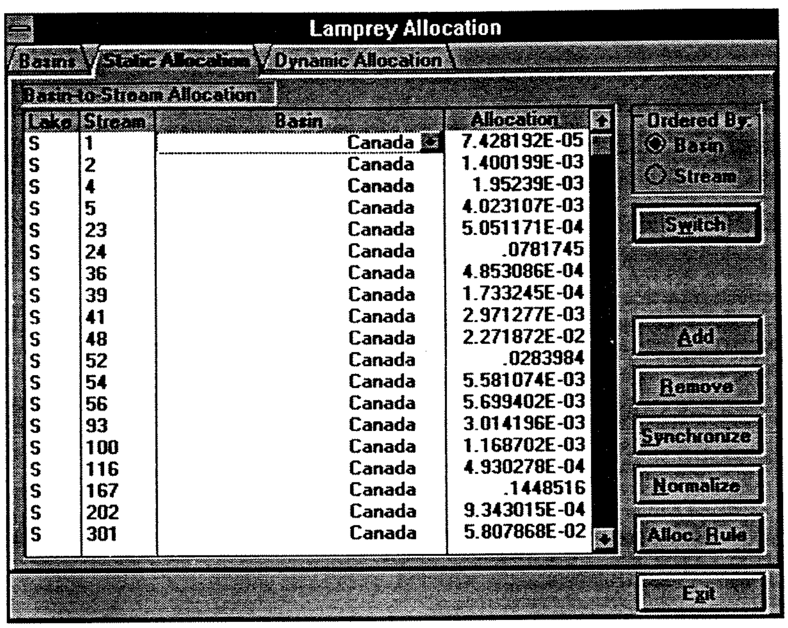
Press ***Exit*** if you want to exit *Lamprey Allocation*, or press one of the other tabs at the top of the screen to edit values in the *Static Allocation* or *Dynamic Allocation* screens.

> Make sure that the streams simulated are those affected by the lamprey basin definition. For example, if you choose a lamprey basin definition that contains only Lake Superior, you should simulate only Lake Superior streams, and not streams from the other lakes.

☞ Note that the current lamprey basin definition is always displayed on the status bar at the bottom of the LCSS application screen.

Static Allocation

The *Static Allocation* screen is the second of three *Lamprey Allocation* screens. It contains parameters that govern the static allocation of transformers from streams to lamprey basins and from lamprey basins to streams.



Static lamprey allocation is one of 2 strategies available for simulating movement of lamprey between the basins and streams (see also **Dynamic Allocation**, pg. 4-36). 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).

The *Allocation* field in 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 **Normalize**, below).

The ***Switch*** button switches the screen between basin-to-stream allocation and stream-to-basin allocation. In the *Stream-to-Basin* 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 up to 1.

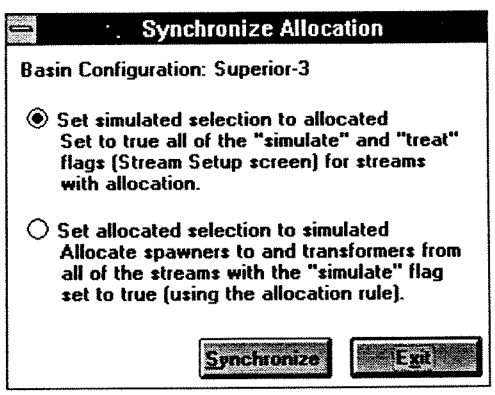
The allocation proportions can be modified either manually by overtyping the values in the table or according to an allocation rule (see **Static Allocation Rule** below).

Command buttons ***Add*** and ***Remove*** allow adding and removing 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.

☞ The lamprey basins displayed in the allocation tables belong to the lamprey basin configuration selected on the *Basins* tab.

Synchronize Allocation

The *Synchronize Allocation* screen automates the synchronization of selections of streams to be simulated with the stream-basin-stream allocations. It can be accessed by pressing the ***Synchronize*** button in the *Static Allocation* screen.



The *Synchronize Allocation* screen has 2 choices. The first modifies the list of simulated streams to match those with allocation, the second modifies the allocation list to match the simulated streams.

The ***Synchronize*** button in this screen initiates the synchronization process.

Normalize

The ***Normalize*** function scans all of the Allocation values and ensures that all values for any given stream add up to 1 (100%). If you have changed any of the values, they 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. The allocations to streams are scaled in a way that would preserve the original ratio.

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 this case, an error message is displayed when you try to normalize the allocation.

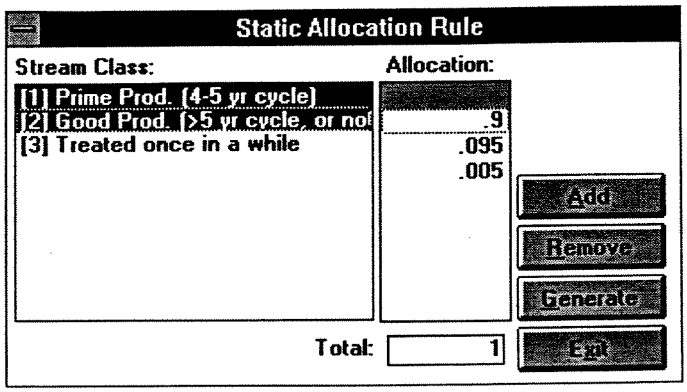
The normalization routine is automatically invoked when you ***Exit*** the Lamprey Allocation set of screens.

- ***To allocate spawners from a basin to a stream***:
  1. Go to the *Static Allocation* screen. Ensure that the description at the top of this screen reads Basin-to-Stream Allocation. If it doesn't, press the ***Switch*** button.
  2. Select the stream for which you wish to edit the lamprey allocation. (If you need to verify the stream name or number, go to the *Stream Setup* screen.)
  3. Enter a new value (from 0 to 1) in the *Allocation* field. Repeat steps 3 and 4 for all of the streams you wish to modify.
  4. Press ***Normalize*** to redistribute lamprey allocation evenly across all of the streams.

- ***To allocate transformers from a stream to a basin***:
  1. Go to the *Static Allocation* screen. Ensure that the description at the top of this screen reads Stream-to-Basin Allocation. If it doesn't, press the ***Switch*** button.
  2. Select the stream for which you wish to edit the lamprey allocation.
  3. Edit the values in the *Allocation* field to change the current allocation of transformers from the stream to the basin. 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. Press ***Normalize*** to re-normalize the transformer allocation.

Static Allocation Rule

The *Static Allocation Rule* screen allows entry and modification of the allocation rule used to generate the static basin-to-stream allocation. The screen can be accessed from the Static Allocation tab on the *Lamprey Allocation* screen.

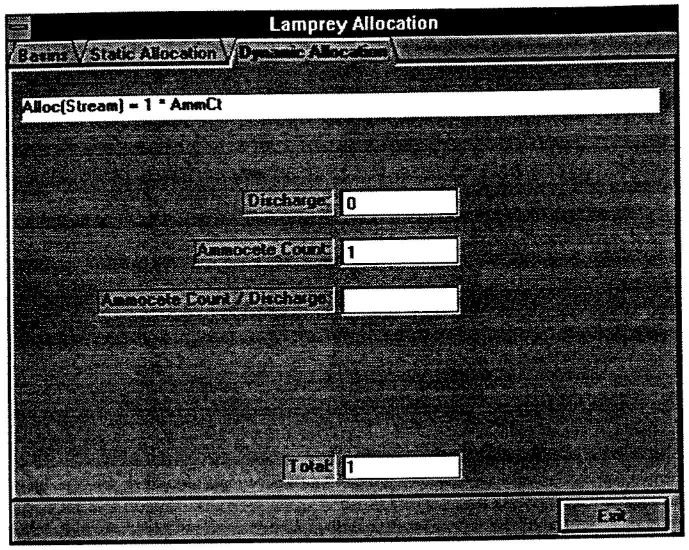


The static allocation rule is centered around stream classes (see the **Stream Configuration** section, pg. 4-19). These classes represent the "attraction" of lamprey to streams. The *Stream Class* list contains all of the classes present in the simulation. The static allocation rule allows the grouping of one or more classes and the *Allocation* of proportions (*Total* = 1) of basin spawners to these groups. The ***Add*** and ***Remove*** buttons add and remove *Allocation* values. Selecting stream classes adds them to the current group.

The ***Generate*** 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}, 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 allocation and the stream receives spawners from each basin based on the portion assigned to the basin.

Dynamic Allocation

The *Dynamic Allocation* screen is the third of the three Lamprey Allocation screen. It allows the definition of the dynamic allocation rule.



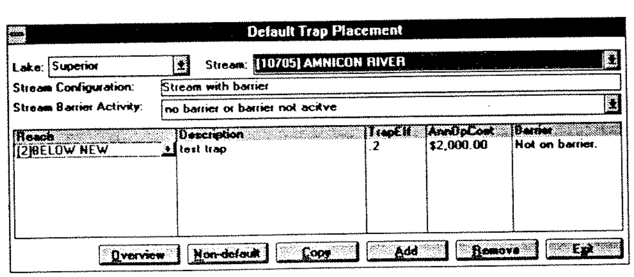
Dynamic allocation is the second of 2 alternative strategies for allocating spawners returning from basins to streams (see **Static Allocation**, pg. 4-33 above). It incorporates dynamic criteria (e.g., ammocete count) into the allocation in addition to static criteria. This approach allows exploration of criteria for "attractiveness" of a stream to lamprey.

Currently there are 3 criteria supported:
Discharge - stream spring discharge (a static criterion)
Ammocete Count - total number of ammocetes within a stream
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 placement of traps in reaches by using the *Traps* option. This option is available by selecting **Traps** from the **Edit** Menu, or by pressing the *Traps* button on the *Budget and Resources* screen.



Default Trap Placement

This screen allows you to define the placement, efficiency, and cost of default traps. (To add, modify or remove non-default traps, see the section on **Non-default Trap Placement**, below.)

☞ A *default* trap placement is specific to the stream barrier activity being simulated on the stream to which the trap is added. In the example above, the stream barrier activity for the Amnicon River is set to "no barrier or barrier not active". The trap is present (on Reach 2) whenever this stream barrier activity is simulated.

Fields and buttons on the *Default Trap Placement* screen include:

Lake/Stream Click on the drop-down list to choose the lake and stream on which you wish to place the trap.

Stream Configuration Currently simulated stream configuration.

Stream Barrier Activity One of the stream barrier activities created for the current stream configuration.

Reach Click on the drop-down list to place the trap on a particular reach.

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 A barrier (if there is one) with which the trap is associated. By clicking on the arrow button, you can choose from a drop-down list of barriers present on the stream.

Overview Activates a summary screen which shows the cumulative effect of the default and non-default traps (see **Summary of Trap Activity** below for more detail about ***Overview***).

Non-default Switches the user to the *Non-default Trap Placement* screen (see below).

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

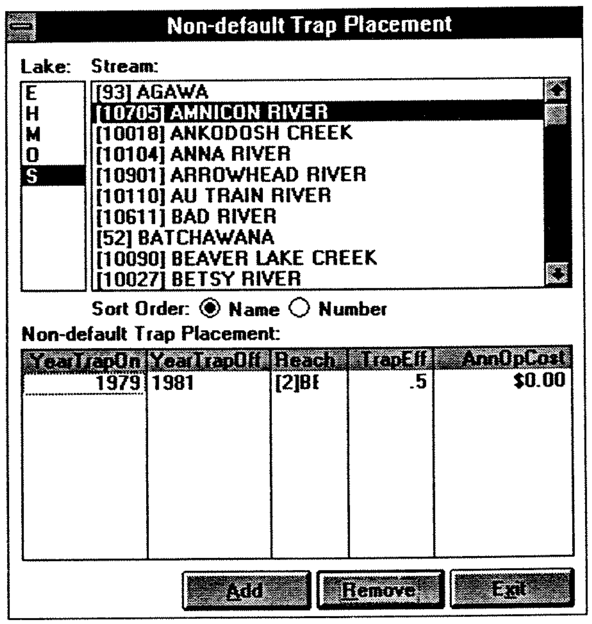
Add Inserts a "blank" entry.

Remove Removes the currently selected trap.

Exit Saves your changes and exits this screen.

Non-default Trap Placement

To place traps at specific times, click on the ***Non-default*** button in the *Default Trap Placement* screen. This action activates the *Non-default Trap Placement* screen. 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 on the *Non-default Trap Placement* screen are:

Lake/Stream Select the lake and stream on which you wish to place the trap.

Sort Order You can choose to sort lake and stream lists by name or by number.

YearTrapOn First year the trap is active.

YearTrapOff First year the trap becomes inactive.

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 Trap Placement* table.

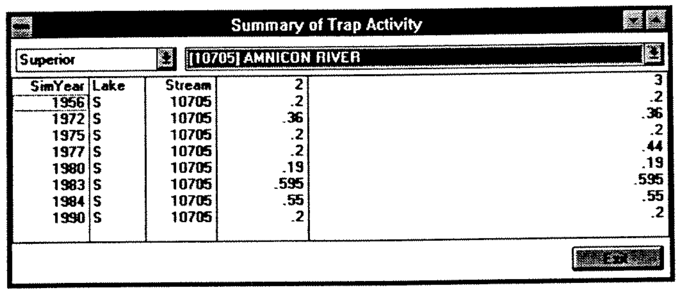
Remove Removes the currently selected entry from the *Non-default Trap Placement* table.

Exit Exits the 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 (see **Summary of Trap Activity** below for an example).

Summary of Trap Activity

The *Summary of Trap Activity* screen is accessed by selecting the ***Overview*** button on the *Default Trap Placement* screen. This screen allows you to view summary information about the cumulative effects of default and non-default trap placements on the reaches of a particular stream.



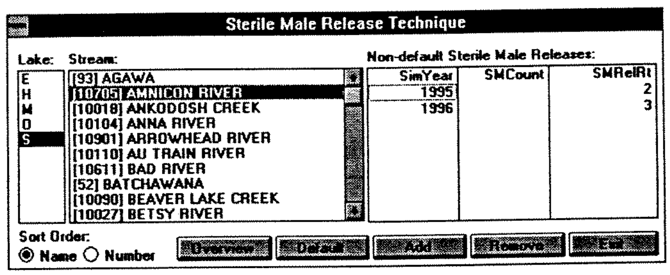
The fields on this screen show the simulation year, the lake, the stream number, and the reaches of the stream. In the example above you can see that Amnicon River has two reaches, numbered "2" and "3". Note, that if multiple streams are displayed, all of the reach numbers are shown. Some of these may not be relevant for some of the streams.

The summary table displays the net effect of the various traps.

From 1956 until 1971 the default stream barrier activity is "no barrier or barrier not active", so the trap efficiency is 0.2 (to double-check these values, look at the *Default Trap Placement, Non-default Trap Placement*, and *Stream Setup* screens). In 1972, a trap is placed on reach 2 with a trap efficiency of 0.2. The net effect of both traps is a trap efficiency of 0.36 (64% of the lamprey are not caught). This trap efficiency remains in effect until 1975, when the trap is removed. Note that the trap efficiency affects both reaches equally.

In 1977, another trap is placed on reach 3 (which is located above reach 2). Its trap efficiency is 0.3, so the net effect of the traps is 0.44 (56% of the lamprey are not caught) on reach 3. In 1980, the stream barrier activity changes from "no barrier or barrier not active" to "barrier active". The default trap placement for this barrier activity is a trap with an efficiency of 0.1. However, a trap was also placed on reach 2 in 1980, so the trap efficiency for both reaches for this period is 0.19. In 1983, a second trap is placed on the stream with an efficiency of 0.5; the cumulative effect of all three barriers is 0.595. Finally, in 1990, the stream barrier activity changes back to the default activity which is "no barrier or barrier not active". The trap associated with this barrier activity has an efficiency of 0.2.

SMRT The *Sterile Male Release Technique* screen is accessed when you choose SMRT from the **Edit** Menu. This option is used to set the non-default release of sterile males to any stream present in the database.



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 You can choose to sort lake and stream lists by name or by number.

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 the Amnicon River, as shown above, the SMRelRt in 1995 is 2, which means that 2 sterile males are released for every 1 non-sterile male.

Overview Not implemented. Shows the summary of the SMRT program.

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

Add Adds release entries for the currently selected stream.

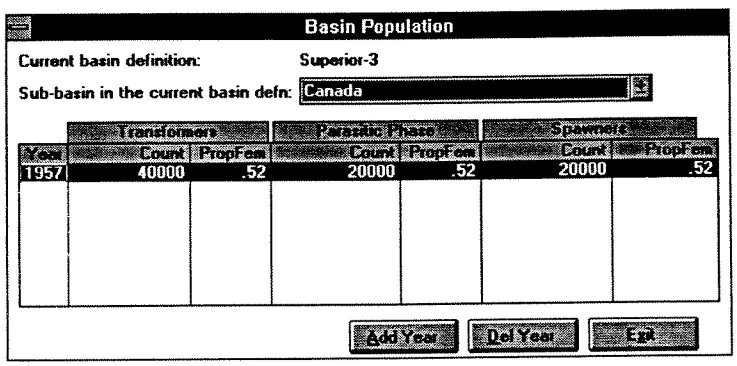
Remove Removes release entries for the currently selected stream.

Exit Exits the *SMRT* screen.

☞ The entered sterile male values will only apply to the currently selected stream configuration. If at a later time you select a different stream configuration, the values will change to the default values associated with the new stream configuration and you will have to enter a new non-default release schedule. If, in a later simulation, you select the old stream configuration, the schedule you chose earlier will apply once more.

Basin Population

The *Basin Population* screen is used to view/enter population values (eg. 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.

At the top of this screen is the *Current basin definition* field. This field identifies the currently selected basin definition. To select a different basin definition, go to the *Lamprey Allocation* set of screens in LCSS (see *Basins*, pg. 4-32). Below this, the *Sub-basin in the current basin defn* field allows users to select the specific sub-basin for which they wish to view/enter population data using the accompanying drop-down list.

Other fields in this screen are:

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.
PropFem	The proportion of the total transformer count that is female.

Parasitic Phase

Count	The number of parasitic phase lamprey in the basin.
PropFem	The proportion of the total parasitic phase count that is female.

Spawners

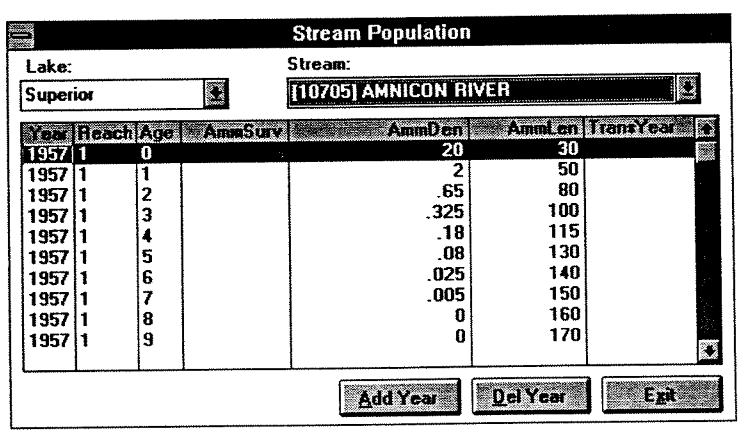
Count	The number of spawners in the basin.
PropFem	The proportion of the total spawner count that is female.

To enter data for a new year, click ***Add Year***. You will be prompted to enter a specific year, then click ***OK*** (or ***Cancel*** to abandon the request). A default set of population values for the new year will be automatically entered into the *Basin Population* table. Modify these data as appropriate by clicking on each field and typing in the new values. To delete a row of data, select it with the mouse and click ***Del Year***.

To return to the **Main** Menu, click ***Exit***.

Stream Population

The *Stream Population* screen is used to view/enter ammocete population values (eg. ammocete density) in the currently selected stream. Data are organized by year, specific reach and lamprey age (these three fields cannot be modified) and users can modify/enter data in the remaining four fields by simply clicking on the field to be modified and typing in the new value.



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.

Choose the *Lake* and *Stream* from the drop-down lists at the top of the screen. The fields in the table are:

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

Reach — This field shows the number of the reach. This field cannot be modified.

Age — Lamprey age (from 0 to 10 years) appears in this field. This field 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 **Biological Parameters**, *Age* tab in LCSS, pg. 4-29).

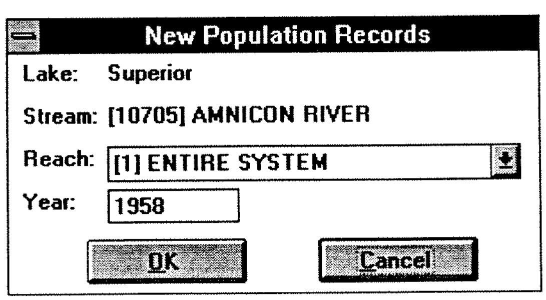
AmmDen — Ammocete density is expressed in number of individuals per square metre ($\#/m^2$).

AmmLen — Ammocete length is expressed in millimetres (mm).

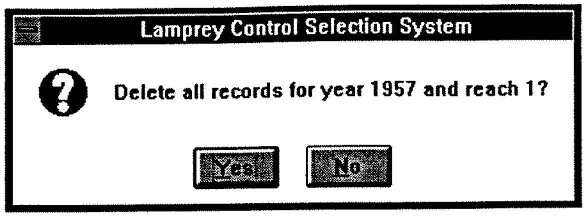
TransYear — This field describes the stage of transformation for lamprey in each age class (see section **Simulating Transformation to the Parasitic Phase** in Appendix A).

The two command buttons on the *Stream Population* screen are ***Add Year*** and ***Del Year***.

Add Year 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***. 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.



To delete population records for a specific year and reach, use the mouse to select any row of data in the year and reach you wish to delete. Click on the ***Del Year*** command button.



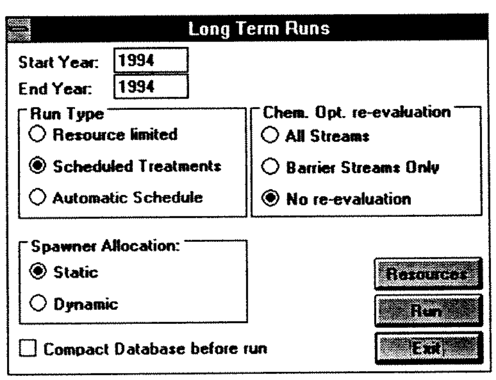
Repeat this process for every reach you wish to remove for the specified year.

When a new reach is created using the *Stream Setup* family of screens (see pg. 4-17 in LCSS), the system adds it to the list of reaches in the *Stream Populations* screen. Population information can be entered/modified as appropriate. Note, however, that the reverse is not true. The ***Del Year*** function in the *Stream Populations* 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* (pg. 4-20) screen in *Stream Setup*.

Exit returns the user to the **Main** Menu.

LongTerm Menu

Long-term runs help you evaluate the long-term performance of alternative selection criteria and budget limitations.



■ ***To carry out a long-term run***:

1. Enter the start and end year dates (the calculation horizon).
2. Choose the desired run type (see below for descriptions).
3. Select the optional database compacting command. Compacting can be disabled if a run is extended for a few years.
4. Indicate which chemical option re-evaluation you wish to use.
5. Select a spawner allocation strategy.

6. Press ***Run***.

There are three run types: resource limited, scheduled treatments and automatic schedule.

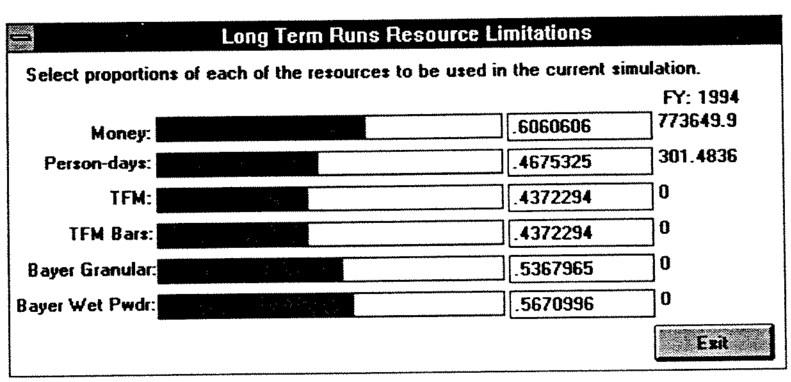
Resource Limited Erases the existing schedule, and selects streams for treatment in priority (as determined by the ranking criteria), using the availability of chemicals, time, and money as the only limitations.

ScheduledTreatments Applies 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.

Automatic Schedule Not implemented. Erases the current schedule and uses the built-in expert system to build a treatment schedule. This option adds logistic constraints to the suite of limitations examined in the *Resource Limited* runs. This option is the same as pressing the ***GenAll*** button in the scheduler.

During a run, a ***Stop Run*** button will appear. Pressing this button allows you to interrupt a long-term run before the beginning of the next simulation year. When the button is pressed, the system finishes the current year's calculations and then stops. The *Start Year* field is automatically updated to one year after the last simulated year. To continue the run, you need only press the ***Run*** button again.

Clicking on the ***Resources*** button activates the *Long Term Runs Resource Limitations* screen. This screen allows the user to specify how much of each resource (e.g., money, person-days, chemical) is to be used in the simulation run.



Limiting the resources allows simulation of reduction of overall resources (e.g., budget) for all of the Great Lakes or it can be used in runs where only a part of the Great Lakes system is simulated (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 right is the amount of the resource available for simulation 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 or enter the proportion directly.

The ***Exit*** button exits the *Long Term Runs Resource Limitations* screen.

Results of the run can be viewed in Microsoft Access, by choosing **Database** from the menu bar.

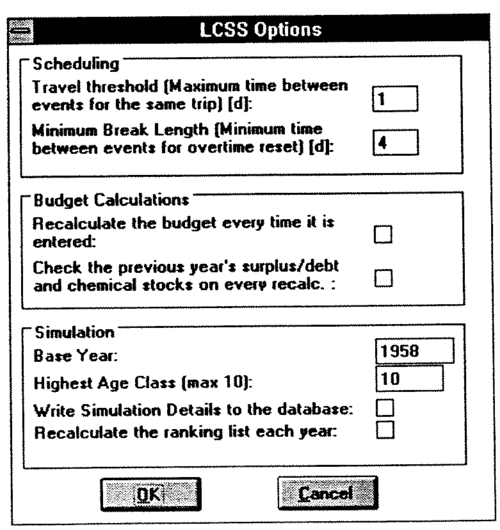
Database Menu

You can access the Microsoft Access database by choosing **Database** from the **Main** Menu. You will be able to enter data and generate results from the database.

See Appendix C for an overview of the database interface.

Options Menu

Options which affect the system as a whole are accessed in the **Options** Menu.



Each option is described below:

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 the budget screen 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 (eg. lamprey numbers, density, length, allocation to reaches, etc. for 1958) into the database. If you wish to run simulations for any years following the year you are currently running (eg. 1959), you must select 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 select this option, the system will re-assess the order in which the streams will appear in the Ranked Stream List (see *Ranked Stream List* field description, pg. 4-12). As for the previous option, enabling 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 section of the **Help** Menu most applicable to the current screen.

The help files follow the standard Microsoft Windows Help format.

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.

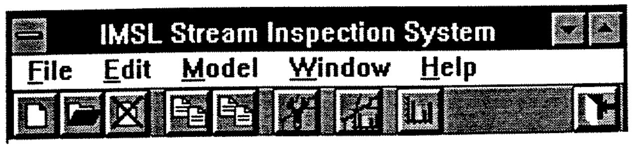
ISIS has four major components:

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, p. 5-20); 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 or intended function.

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

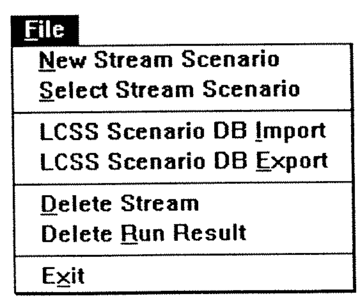
from the **File** Menu:
- Exit

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* screen.

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 **Stream Parameters** (see p. 5-4).

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

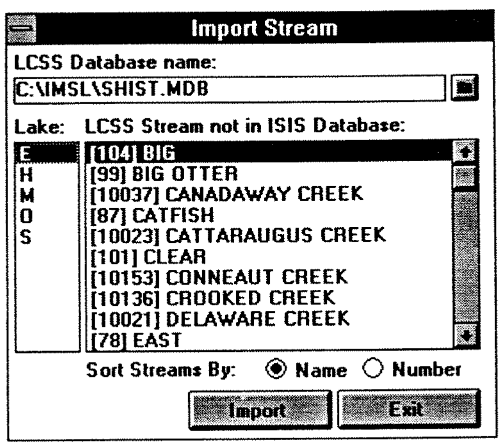
Delete Stream allows the removal of stream parameters and run results for a particular stream from the ISIS database.

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

The *Exit* option ends the program execution.

LCSS Scenario DB Import

ISIS provides a facility for importing data from the LCSS database. This function is available under the *LCSS Scenario DB Import* menu option in the **File** Menu and 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.

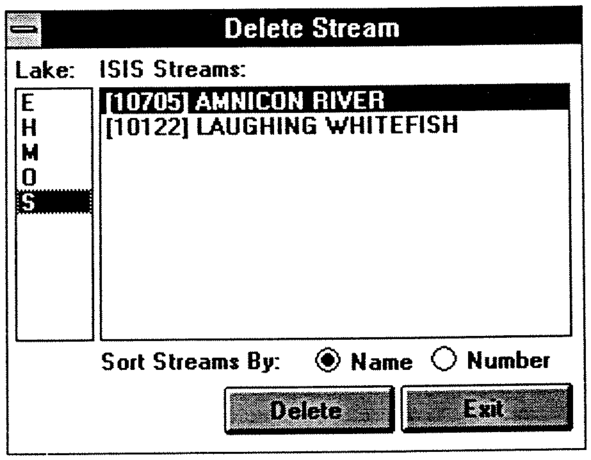
To avoid the possibility of conflicts, currently loaded stream-basin-stream allocation data are deleted prior to loading a new set of values. This may cause some streams to behave differently following the loading of an unrelated stream (due to different survival rates of parasitic phase lamprey and different proportions of returning spawners, see *Spawners* tab pg. 5-19).

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.



Edit Menu

The **Edit** Menu contains the stream parameters that characterize each stream. The only option, *Stream Parameters*, invokes the **Stream Parameters** dialog.

Stream Parameters

The *Stream Parameters* dialog provides access to all stream-related parameters. These are grouped into 9 tabs placed along the top of the dialog. 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 ( ). The nine tabs are:

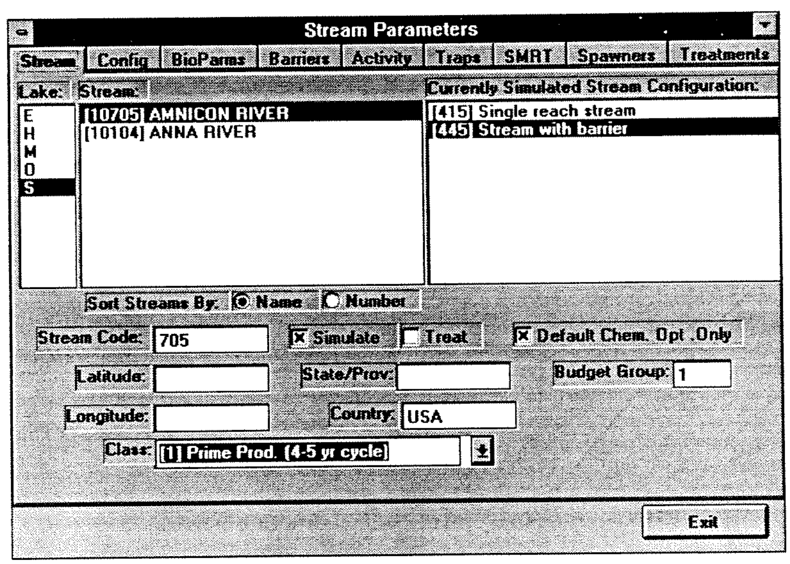
Stream Contains the general stream information. A stream selected here is later simulated in ISIS. The current selection is reflected at the bottom of the main screen.

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 pg. 4-17). 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 (pg. 4-19).

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), ie., 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, pg. 4-31).

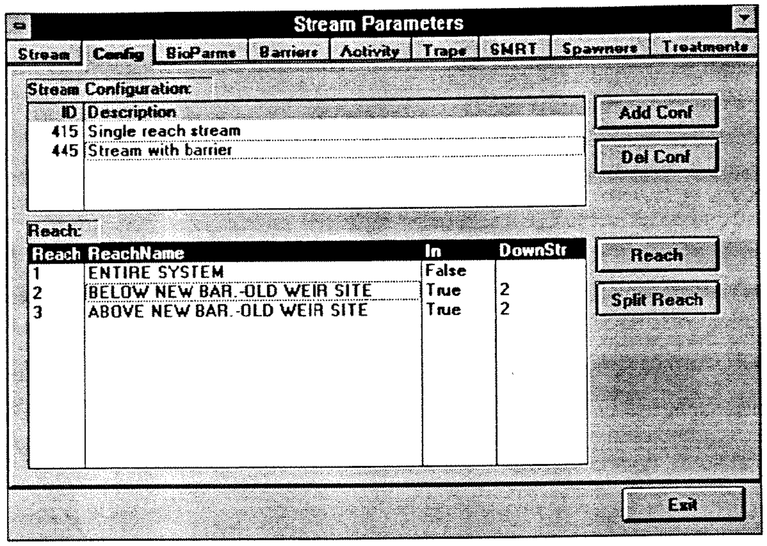
Budget Group Is currently unused and should always be set to 1.

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 pg. 4-19).

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.

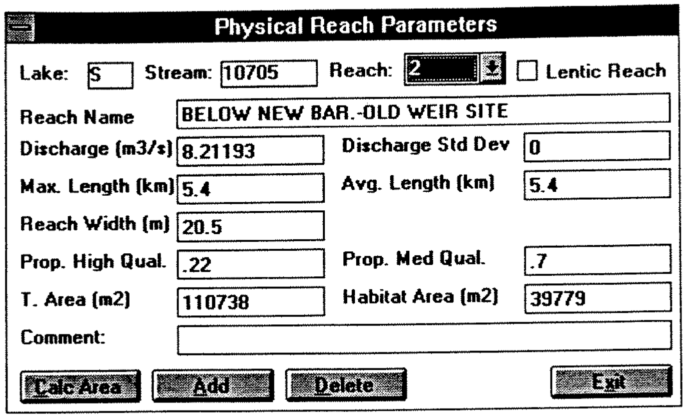


The *ID* column in the table automatically generates unique identifiers for stream configurations. The *Description* column provides short descriptions of each configuration. New stream configurations can be added using the ***Add Conf*** command button. Existing stream configurations can be removed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

Reaches can be added in two ways. The ***Reach*** button opens a screen where individual reaches can be added, removed, or modified (see below). The ***Split Reach*** button opens a screen that divides the currently selected reach into 2 or more sub-reaches and allows users to define the habitat area covered by each new sub-reach (see also LCSS pg. 4-19).

Clicking on the ***Reach*** button in the *Config* tab screen opens the *Physical Reach Parameters* screen. This screen is identical to the *Physical Reach Parameters* screen in LCSS. It allows addition/deletion of reaches and modification of physical reach parameters.



The reaches for the current stream can be selected from a drop down list. Parameters available for modification are:

Lentic Reach This field consists of a checkbox to indicate whether the current reach is a lentic reach.

Reach Name A short description of the reach.

Discharge Mean annual flow (in cubic metres per second) at the lowest most part of the reach.

Discharge Std Dev Standard deviation of the discharge within the year.

Max. Length The total length (in kilometres) of the reach.

Avg. Length The length of the reach (in kilometres) inhabited by lamprey.

Reach Width Width of the reach (in metres) at the lowest most part of the reach.

Prop. High Qual. Proportion of the potential habitat area of high quality.

Prop. Med Qual. Proportion of the potential habitat area of medium quality.

T. Area Total reach area (usually Reach Width * Avg. Length) (in square metres). This value can also be generated by clicking on the ***Calc Area*** command button (see below).

Habitat Area High quality equivalent of the area (usually T. Area * (Prop. High Qual + 0.2 * Prop. Med Qual.)) (in square metres). This value can be generated by clicking on the ***Calc Area*** command button (see below).

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.

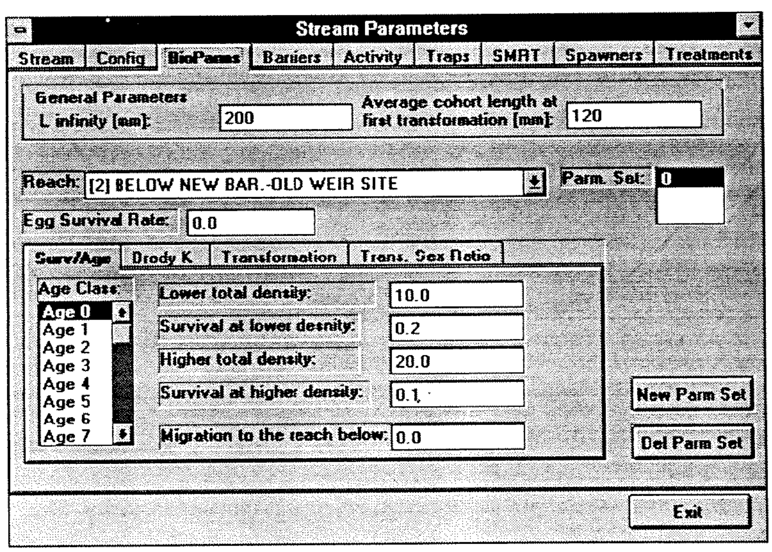
Comments	Any special comments (eg. source of the information used).

The actions available from the *Physical Reach Parameters* screen are:

Calc Area	This feature is a calculation aid that generates values for the *T. Area* and *Habitat Area* fields using the formulae shown in the field descriptions for each (above).
Add	Add a reach definition (either a copy of the current reach or with a set of default parameters). This command adds the physical, biological and age parameters for the new reach.
Delete	Delete the current reach. This command removes the physical, biological and age parameters for the current reach. It also removes reach references from the stream configurations (of which the reach may be part), spawner allocation factors to the reach, traps defined on the reach, references to locations of any barriers located on the reach (barriers definitions are not deleted), and effect of chemical options on the reach (chemical options are not deleted).
Bio Parms	Reach biological parameters (see **Biological Parameters** section in LCSS, pg. 4-29).
Exit	Exits this screen.

Biological Parameters

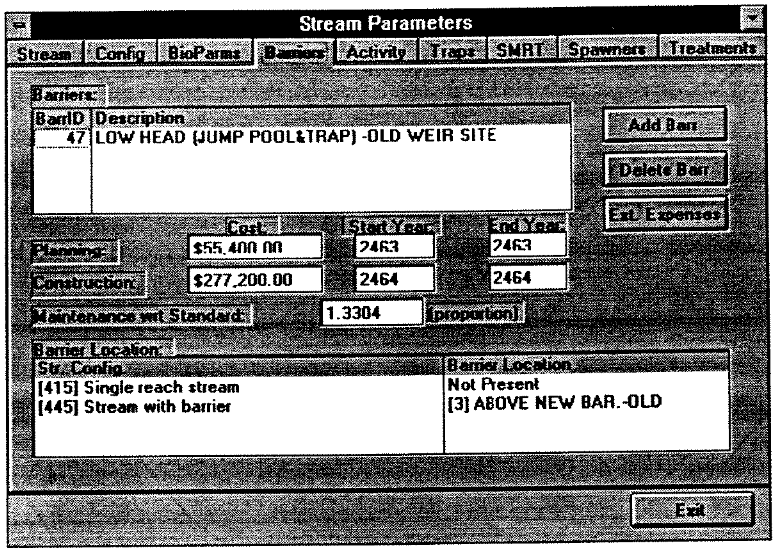
The *BioParms* tab lets you modify the lamprey model parameters. Three categories of parameters are available for editing: General parameters, Reach parameters, and Age/Size parameters.



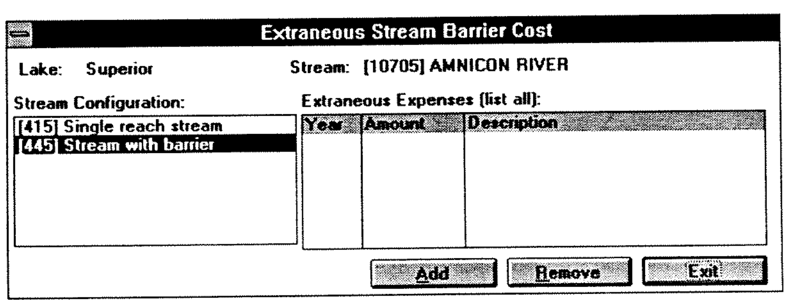
To create a new set of parameters, click on the ***New Parm Set*** command button. This action inserts a new set of parameters in all fields ready for modification by overtyping. ***Del Parm Set*** removes the set of biological parameters currently displayed on the screen. The parameters set chosen here will be used in subsequent simulations of the currently selected stream.

Details on how the parameters are used can be found in the model description in Appendix A.

Barriers The *Barriers* tab contains a screen that allows users to modify the physical and economic details of lamprey barriers.



The currently selected barrier and reach are listed at the top of the screen. Barriers can be added to this list (***Add Barr*** command button) or deleted (***Del Barr***). The ***Ext. Expenses*** command button opens an *Extraneous Stream Barrier Cost* screen which is identical to the one in LCSS (see pg. 4-23).

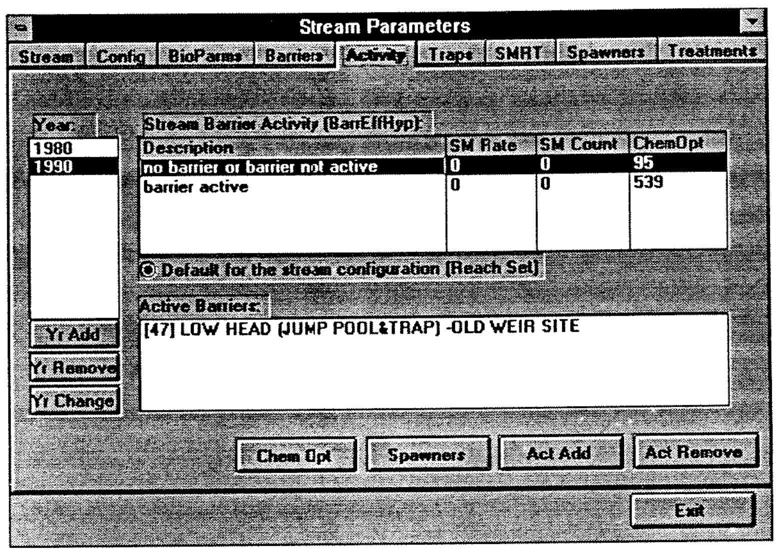


Expenses are reported in the fields *Year*, *Amount* and *Description*. Existing values can be modified by clicking on a cell and simply overtyping the current contents. Expense information can be added and deleted from the table using the ***Add*** and ***Remove*** command buttons.

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 pg. 4-23). 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. Click on the ***Act Add*** button in the *Stream Barrier Activity* screen.
2. Highlight your new entry with the cursor and enter a description of the 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:***

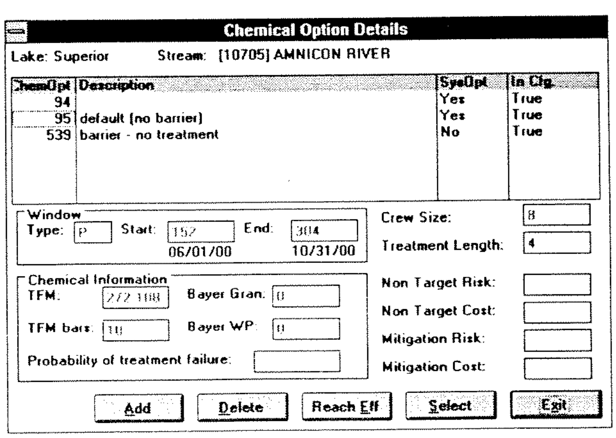
1. Select the stream barrier activity you wish to remove.
2. Press ***Act Remove***. All associated spawner allocation information will also be deleted by this action.

When you select a year in the year list, the stream barrier activity that is associated with that year is highlighted. Likewise, if you select a stream barrier activity, all of the years when that activity is turned on are highlighted. For a more detailed description of this screen, see pg. 4-23 in LCSS.

This screen 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, pg. 4-41).

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 Identifies the current lake.

Stream Identifies the current stream.

ChemOpt A unique identifier that references the chemical treatment option.

Description Provides a brief description.

SysOpt Choose "Yes" 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.

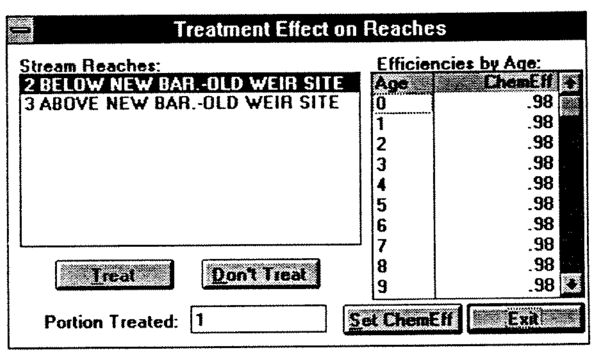
Delete To delete a selected chemical option.

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.

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

Exit Saves the current chemical option and exits the *Chemical Option Details* screen.

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.

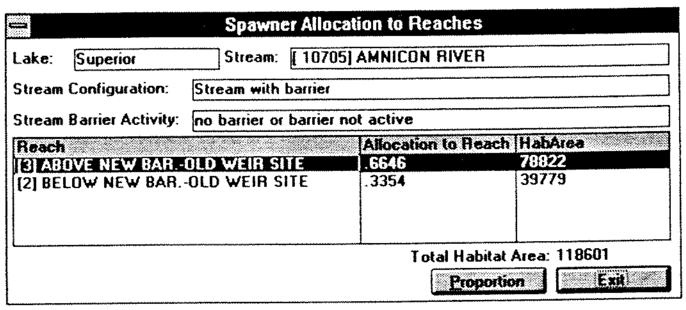
Efficiencies by Age Treatment efficiencies for individual age classes. The usual settings are .99 for high, .98 for medium and .95 for low efficiency.

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.

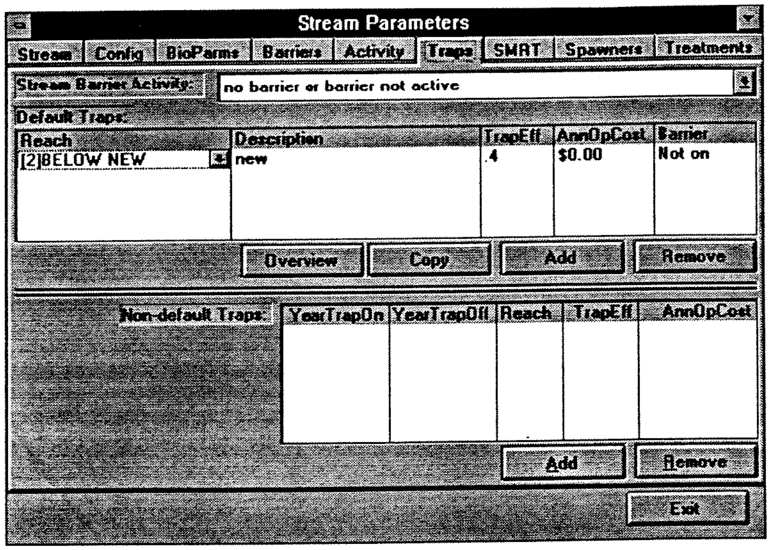


This screen allocates spawners from streams to reaches. To allocate spawners from basins to streams, go to the *Lamprey Allocation* option in LCSS (pg. 4-31).

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 dpendent 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, pg. 4-40).

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.

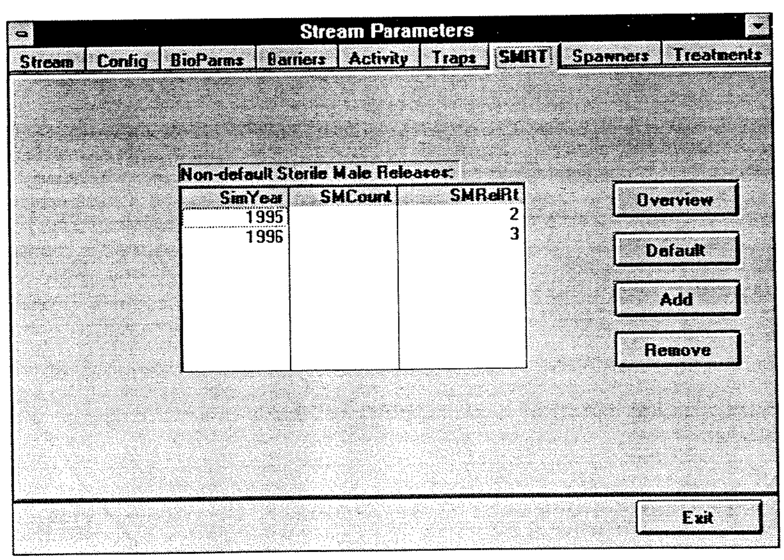
AnnOpCost Annual operating cost for the trap.

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.

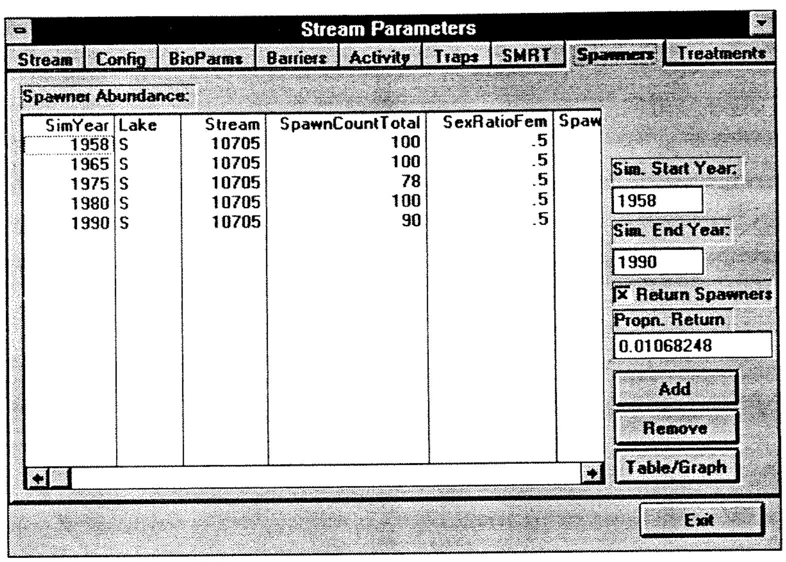
Overview Activates a screen that provides a summary of the SMRT program.

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, pg. 4-33).

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 pg. 4-33). 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.

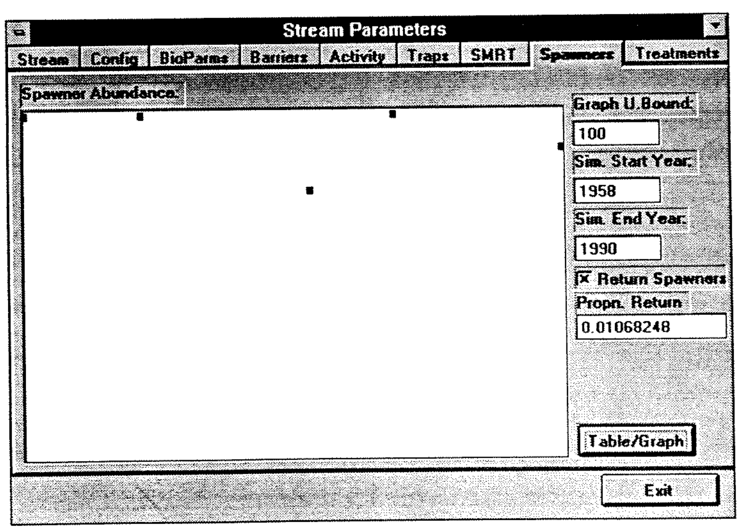
Although the *Propn. Return* value on the *Spawners* tab can be modified to simulate various hypothetical situations, the original value cannot be recovered unless you import a new stream.

☞ *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.

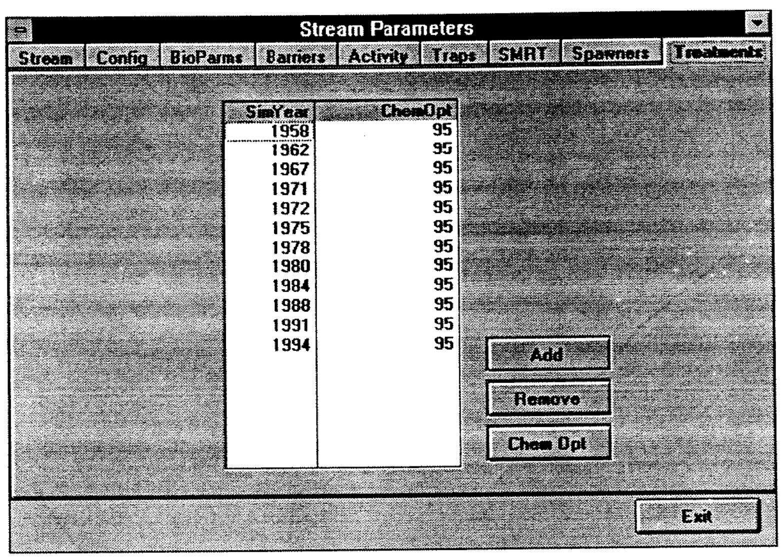


In the graph of spawner abundance, the horizontal x-axis ranges from the year entered for *Sim. Start Year* to the year entered for *Sim. End Year*. These values represent the start and end years for the simulation. The vertical y-axis depicts spawner abundance. The y-axis maximum is set to the value 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

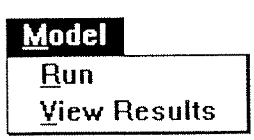
The *Treatments* tab is used to view and modify chemical options for the currently selected stream. Access to this tab will be denied if the *Treat* flag on the *Stream* tab is not set to "true" (see pg. 5-6).



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 pg. 5-11).

Model Menu

The **Model** Menu contains two options.

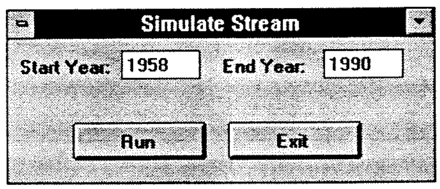


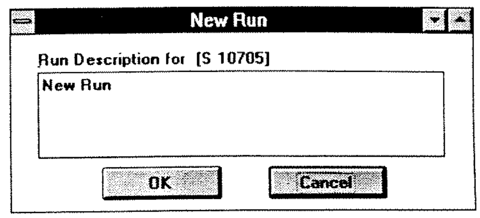
The *Run* option executes the model for the currently selected stream.

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.



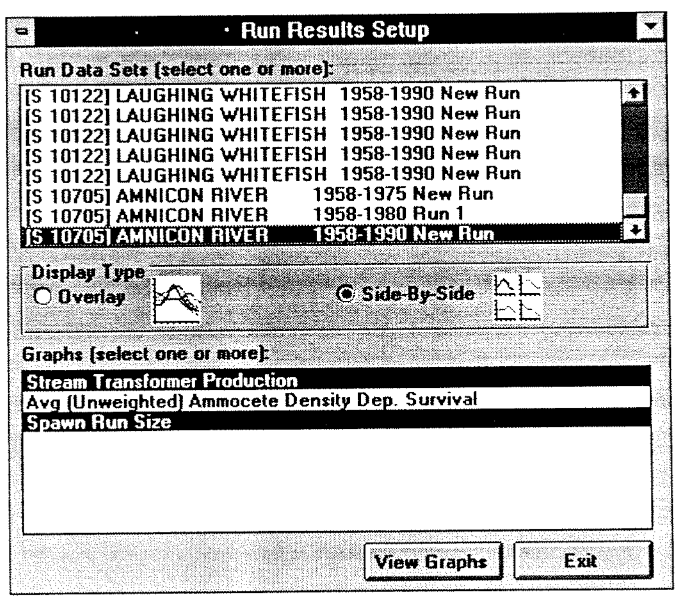


The model simulates all of the aspects of the stream including the barriers, SMRT and Traps.

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.



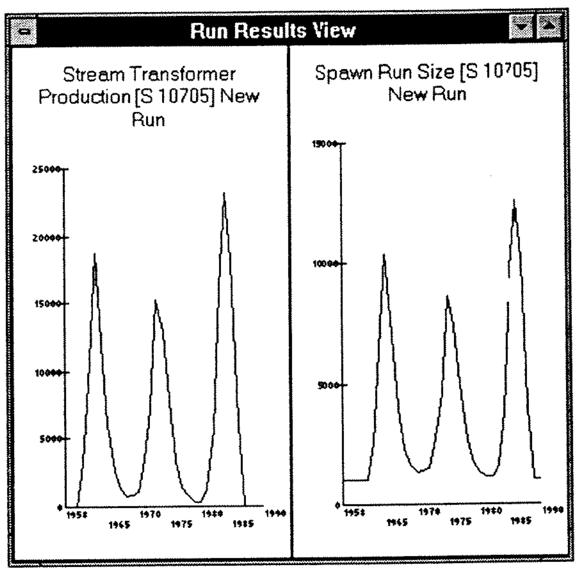
Run Data Sets Lists all of the runs available in the database. One or more runs can be selected for graphical display.

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).

Exit Returns the user to the **Main** Menu bar.



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.

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:

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

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 alloction 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).

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.

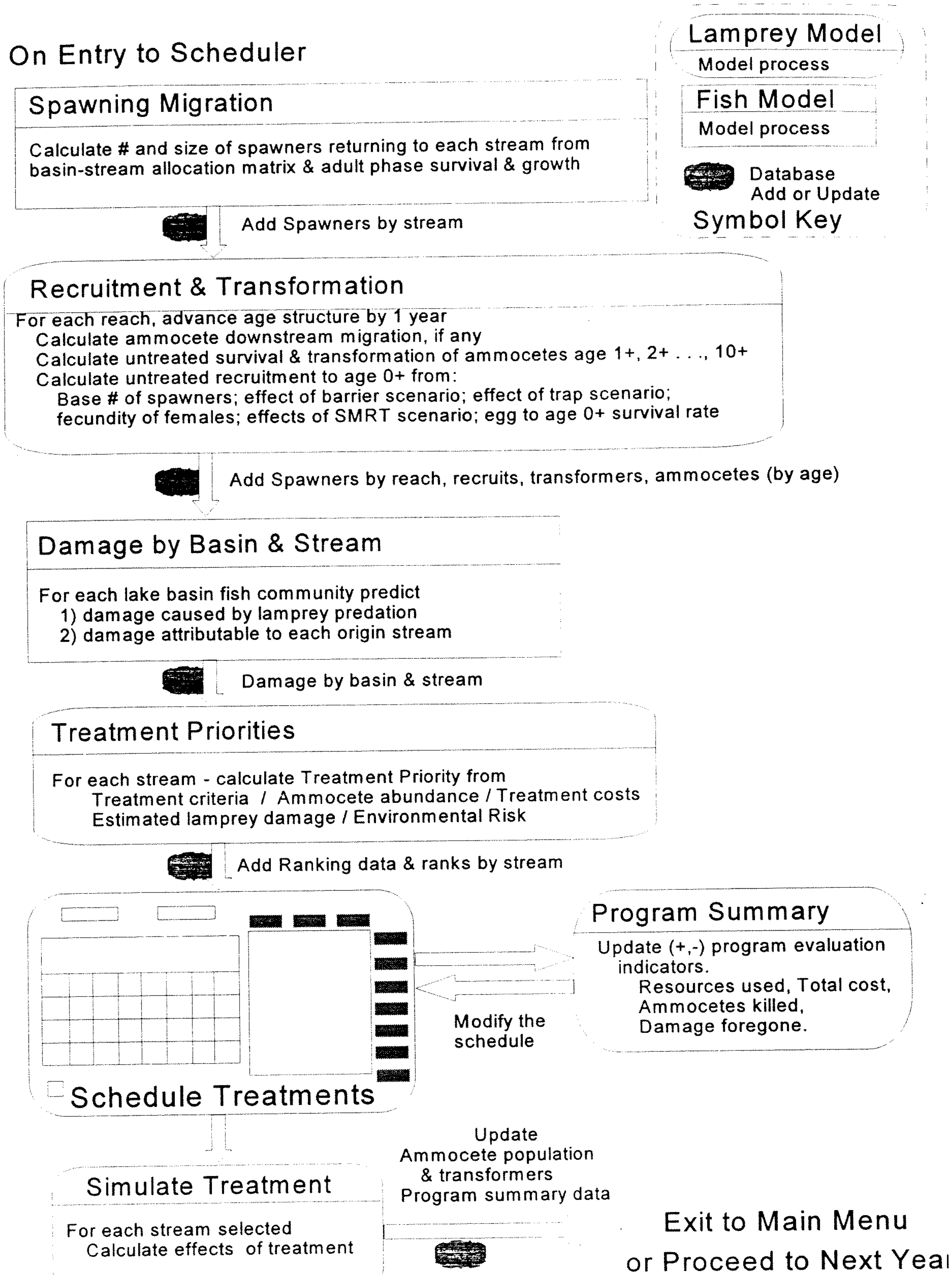


Figure A.1: LCSS Interactions with the IMSL lamprey and fish community models

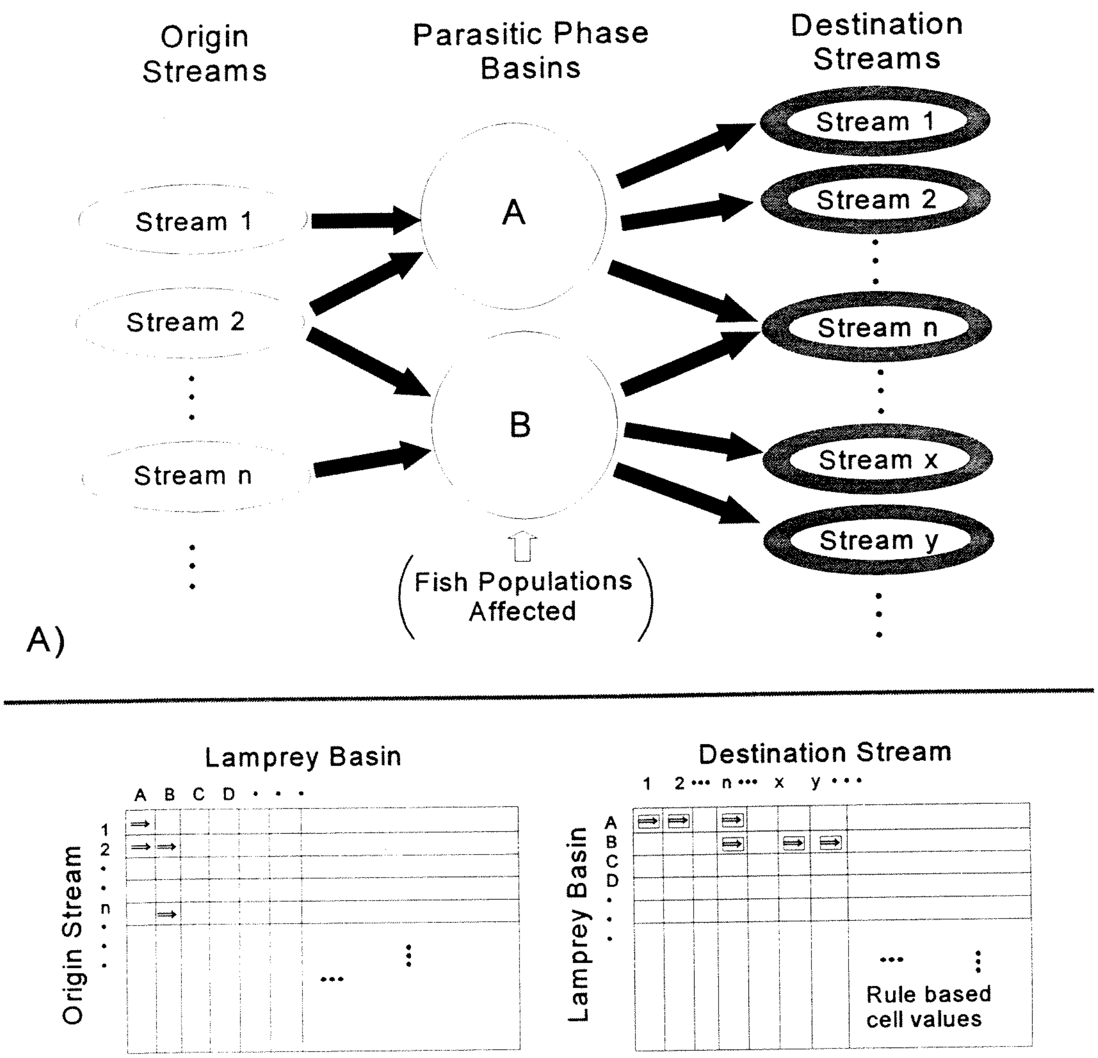


Figure A.2: Conceptual model for representing the spatial movements of transforming ammocete and spawning adults between streams and lake lamprey basins.

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:

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

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 ot 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 afffects 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:

$LenWeightMult = 2.47E7$ 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 ($SMRelRt_{str} = 0$) 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

Ammocete Migration

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.

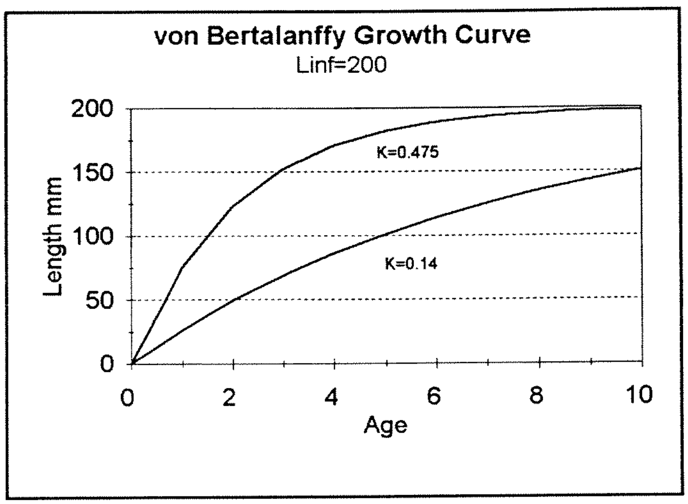


Figure A.3 Simulated ammocoete growth in length for minimum and maximum observed values of K and L_{∞}=200mm.

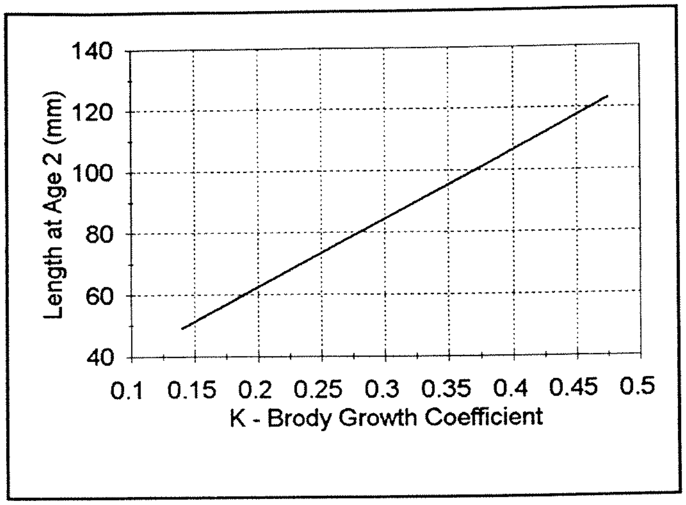


Figure A.4 Relationship between mean length at age 2 and K.

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.

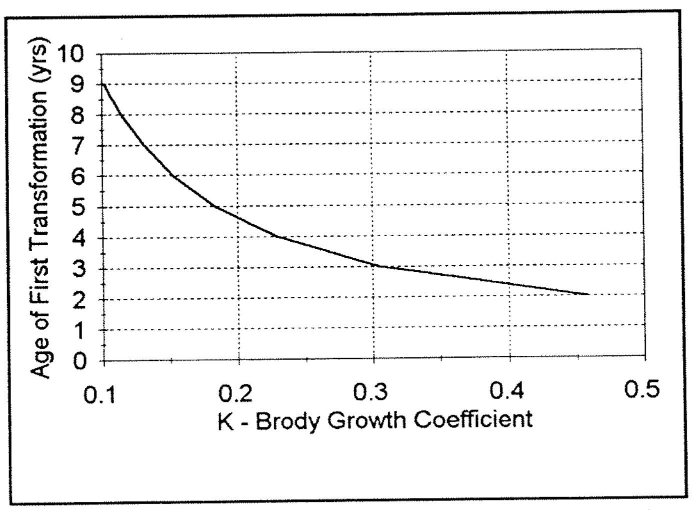


Figure A.5: Relationship between age of first transformation (mean length = 120 mm) and K.

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, and $AmmLen_{str,rea,age}$ 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, $PreSpawnWeight_{basin}$.

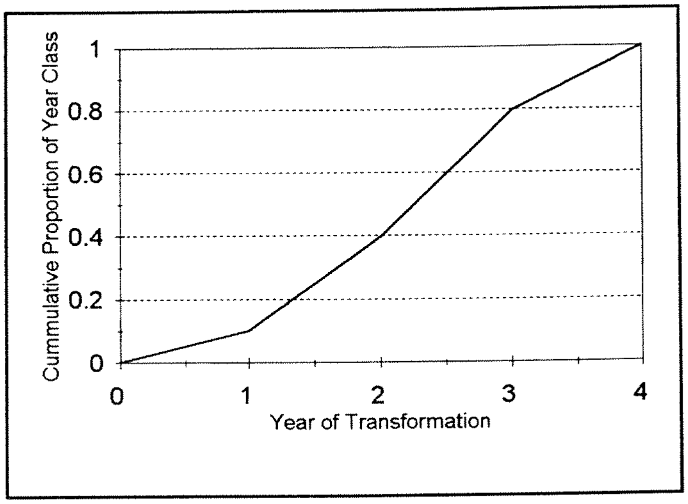


Figure A.6: Cummulative proportion of a year class transforming where year 1 = age of first transformation and the yearly transformation rates are 10%, 33%, 66%, 100%.

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 *AmmVal Low*. 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.

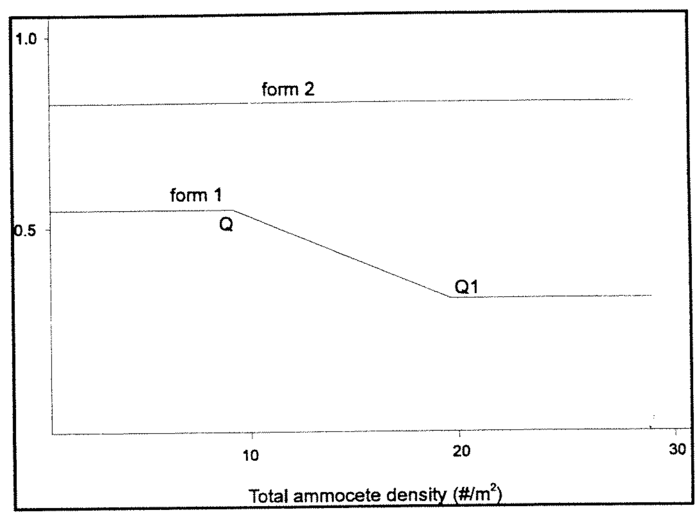


Figure A.7: General form of the hypothesis function to determine ammocete dynamic rates versus total ammocete density.

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.

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.

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**, **BudgetGen** hold the information about resource availability.

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

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

Tables **ScenarioBarr**, **ScenarioEffHyp**, **ScenarioFish**, **ScenarioSMRT**, **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: Database Interface

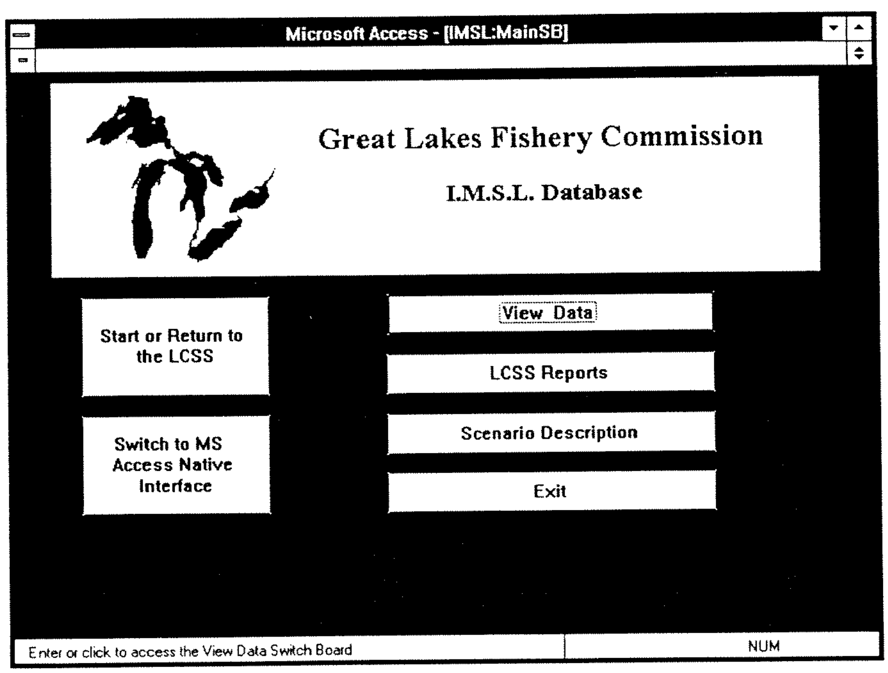
IMSL Database Interface

IMSL database provides a set of screens which ease access to the data contained there. In many cases it complements the interface present in the LCSS. Where available (all except for ammocete, parasitic phase and spawner populations and maps) the interface available through LCSS is more complete and up to date.

Modifying any of the data accessed through the database (menus or the native access) should be done with caution since data inconsistencies may render the database unusable by LCSS. As a general guide, values of parameters can be modified but modifying data on membership in sets (e.g., reaches in stream configurations) and element numbers (e.g., chemical option numbers, stream numbers, etc.) will cause problems within LCSS.

Main Switch Board

The *Main Switch Board* is the principal screen in the database interface.



This screen allows access to two main areas within the database interface: **Data Views** containing the input data, and **LCSS Reports** containing results. These areas correspond to two buttons on the main screen in the database interface: ***View Data*** and ***LCSS Reports*** respectively.

Other buttons on the main screen are:

Start or Return to the LCSS transfers you to Lemprey Control Selection System (LCSS).

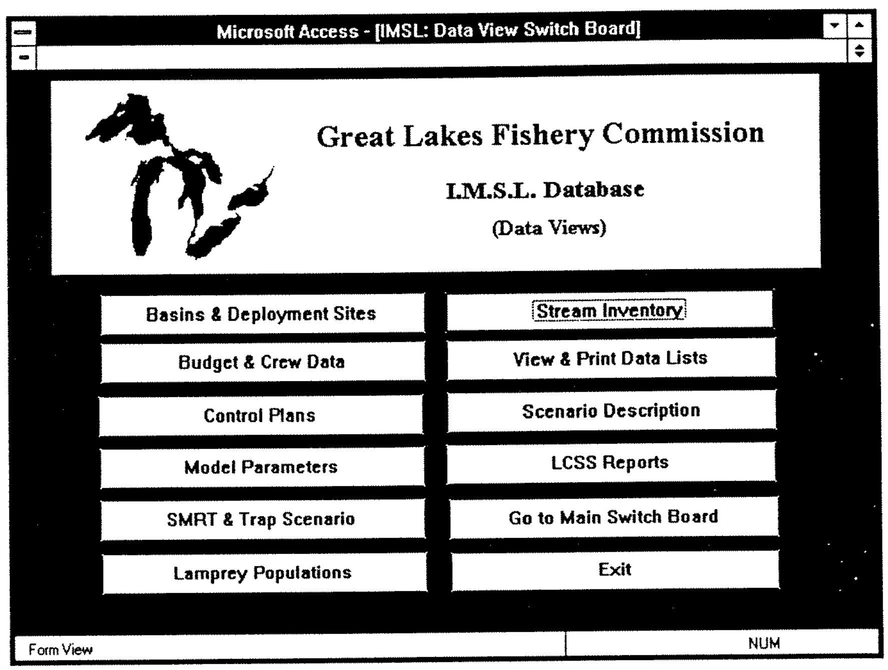
Switch to MS Access Native Interface gives you access to the data via the native MS Access interface.

Scenario Description displays the scenario description for the current database.

Exit closes the database and shuts down the MS Access.

Data Views

The *Data Views* screen allows access to source data for the simulation. It can be accessed from the *Main Switch Board* by pressing the ***Data Views*** button.

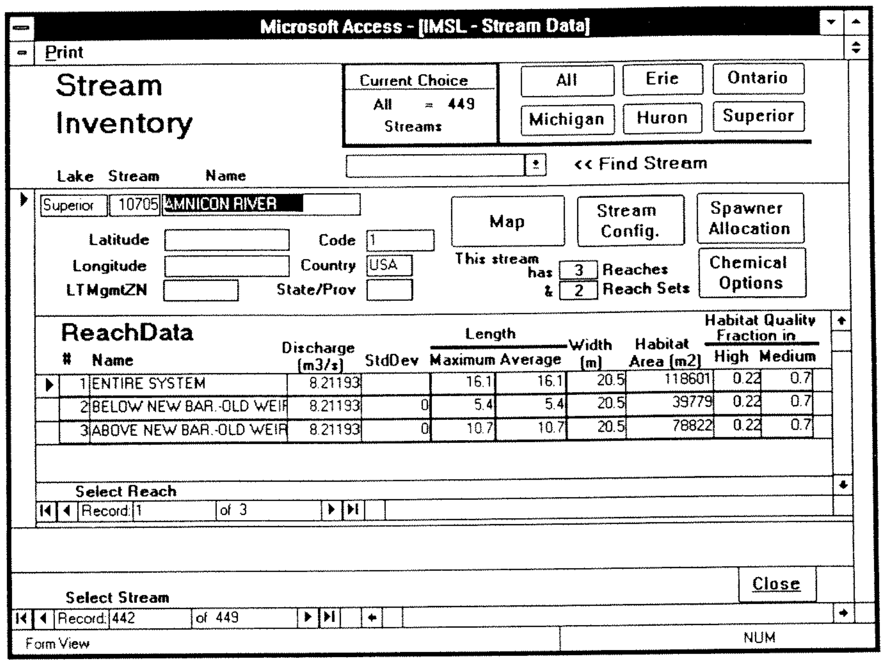


At present there are three screens allowing modification of the data: *Stream Inventory* containing some stream specific data (stream parameters, maps, spawner allocation, chemical options), *Lamprey Population* providing information about lamprey population in various streams for any of the years in the last simulation, and *Data Listings* (most of the individual tables).

Additionally, the *Data Views* screen allows transfer of control to **Scenario Description**, **LCSS Reports** and the **Main Switch Board**. The ***Exit*** button exits the database.

1. Stream Inventory

The *Stream Inventory* screen allows review and modification of the stream and reach data, and gives accesss to the stream map (if available), stream configurations, spawner allocations, and chemical options. It can be accessed from the *Data Views* screen by selecting the ***Stream Inventory*** button.



The screen has 3 sections. At the top, buttons allow selecting subsets of data to review by selecting one of the lakes or selecting all of the lakes at once, left-central and the lower section present the stream and reach data, and the right-central section gives access to other sets of information.

The data for individual streams can be selected by pressing the data control at the bottom of the screen. This action scrolls through the set of stream records currently selected (i.e. either all of the lakes together or one of the individual lakes). To search for an individual stream you can also use the *Find Stream* list. The list contains all of the streams in the database.

Individual stream information consists of the stream location and designation and information about the individual reaches defined for the stream. The list includes all of the reaches defined even if they exist in multiple stream configurations and overlap. A more complete set of this information is available through LCSS (see sections **Biological Parameters** and **Stream Setup**).

Additional information about the streams can be accessed through the following buttons:

Map stream map, if available within the database.

Stream Config stream configuration tables (for discussion on stream configurations see **LCSS Concepts** chapter). This information is also available through LCSS.

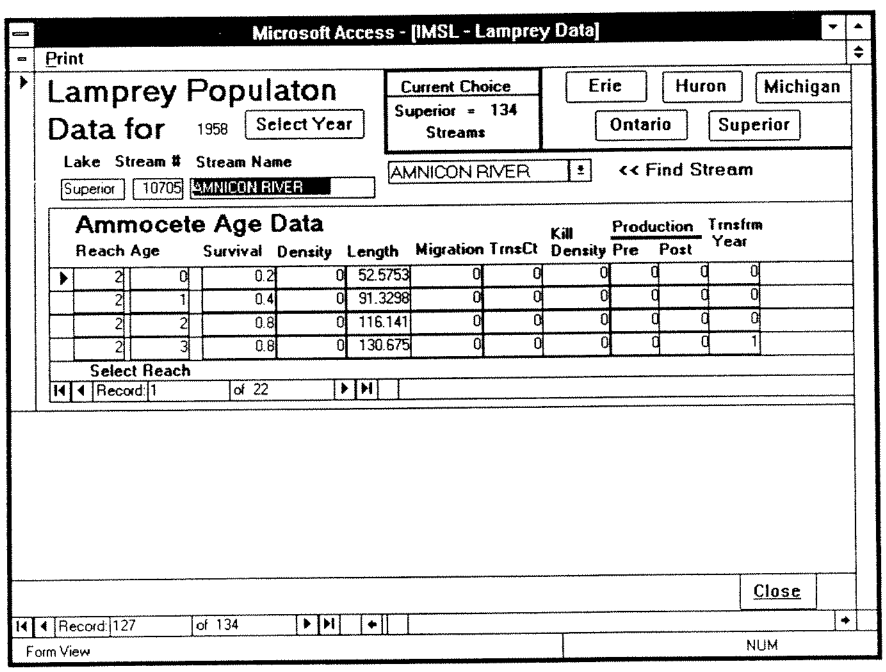
Spawner Allocation spawner allocation organized by stream configuration and stream barrier activity. This information is also available through LCSS.

Chemical Options all chemical options defined for the stream (all stream configurations). This information is also available through LCSS.

The ***Close*** button exits the screen and returns you to Data Views screen.

2. Lamprey Populations

The *Lamprey Populations* screen allows you access to entered and simulated values for the lamprey ammocete population. It can be accessed from the *Data Views* screen by selecting the ***Lamprey Populations*** button.

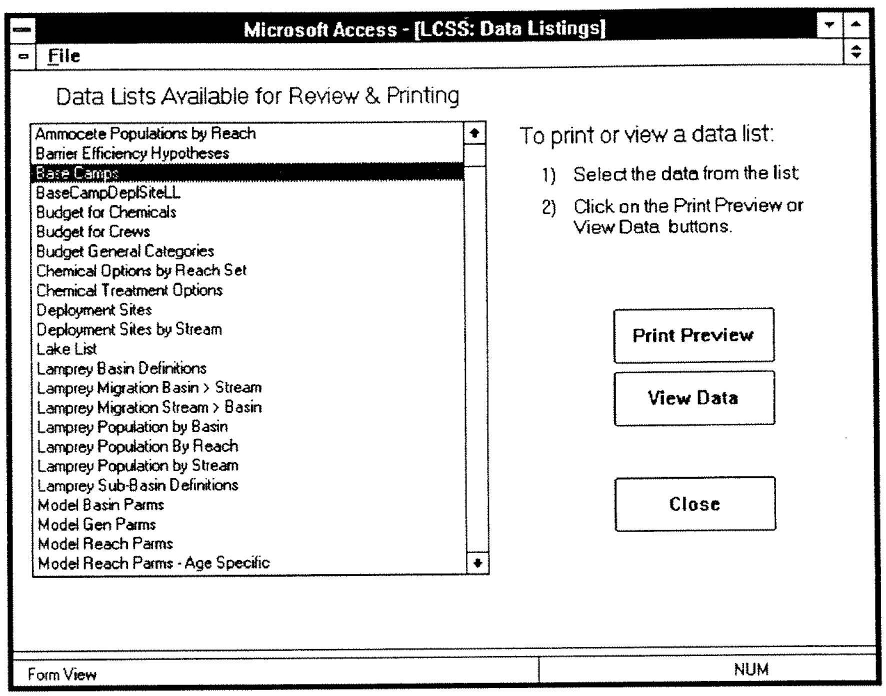


The top of the screen contains selection buttons for simulation year and the lake for which you wish to view data. The central part of the screen contains a list of all ammocete characteristics by all of the reaches and ages being simulated.

As in the *Stream Inventory*, screen there are 2 data controls. One allows selection of reach and age class to be viewed or modified, the other allows selection of a stream. To select a stream from a list, use the *Find Stream* dropdown list.

3. Data Lists

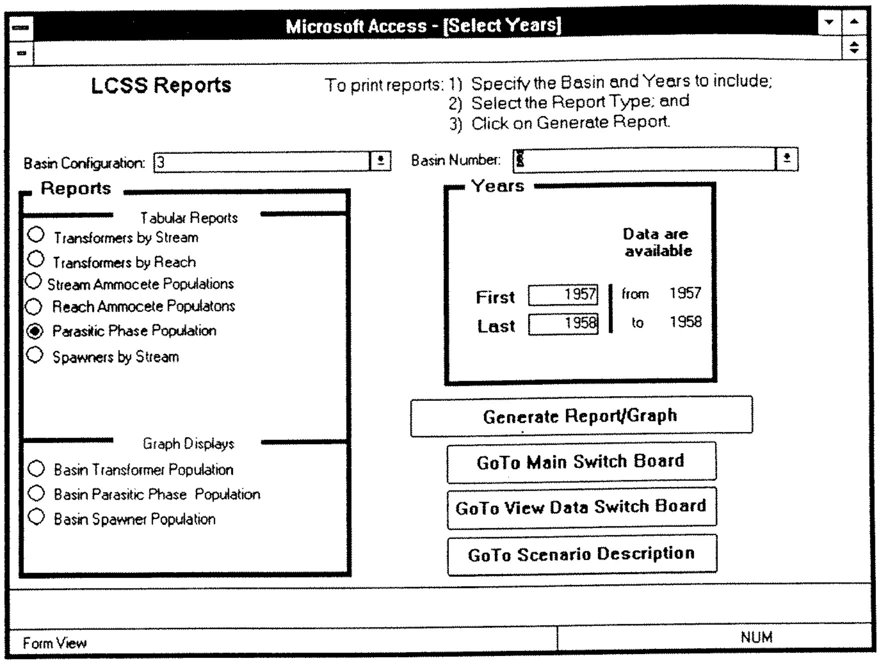
The *Data Lists* screen is a "catch all" screen and is accessed by clicking the ***View & Print Data Lists*** command button on the *Data Views* screen. It contains a list of all of the tables in the database available for printing, viewing and/or modification.



To use the data, select a table from the list and selelct either ***Print Preview*** or ***View Data***.

LCSS Reports

The *LCSS Reports* screen, accessible from the *Main Switchboard* and *Data Views* screens, provides access to 2 reports and 3 graphs.



The available reports are:

Parasitic Phase Population
Spawners by Stream

The available graphs are:

Basin Transformer Population
Basin Parasitic Phase Population
Basin Spawner Population

The summaries can only be displayed for one specific lamprey basin. In order to activate a report or a graph you must first select a basin configuration and a basin number for which there are data and a range of years for which the data are to be displayed.

Subject Index