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A GUIDE TO THE USE OF
THE FISHCULTURE INFORMATION
SYSTEM FOR HATCHERIES (FISH)
UTILITY PROGRAMS
AND THE APPLE II+ MICROCOMPUTER

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TABLE OF CONTENTS

Introduction	I-1
General Apple User's Guide	1-1
System Components	1-1
Running the Apple	1-3
What Happens When you Turn on the Apple	1-7
Simple Commands	1-9
Glossary	1-11
The FISH System	2-1
A Brief Description of FISH	2-1
General Comments on Using the FISH System	2-5
A Detailed Description of the FISH Utility Programs.....	3-1
Menu	3-1
Aeration constant	4-1
Aeration model	5-1
Bio-load	6-1
Case reporter	7-1
Fish health	8-1
Flush treatment	9-1
Growth model	10-1
Heath stack	11-1
Histogram	12-1
Load rate	13-1
Mean & Sd	14-1
Pond inventory	15-1
Pond O2 level	16-1
Single mark group	17-1
Total gas pressure	18-1
Two mark group - equal	19-1
Two mark group - unequal	20-1
Appendices	21-1
Growth model	21-1
Single mark group	22-1
Total gas pressure	23-1

Figures

1	Components of the Apple II+ Package	1-1
2	Malachite green concentration profiles	9-5
3	Fraction of the maximum specific growth rate as a function of the ration level	21-2
4	Specific growth x100 for one gram fish at the maximum ration as a function of water temperature	21-4
5	Comparison of predicted and measured growth at reduced ration levels	21-9

Tables

1	The maximum ration (Stauffer, 1973) expressed in terms of grams of OMP per 100 gram of fish per day	10-3
2	Maximum ration guide developed by Moore-Clark ..	10-4
3	Dissolved oxygen concentration (mg/L) at 100 percent saturation as a function of temperature ('C) and pressure (mmHg).....	23-4
4	Calculated water vapour pressure (mmHg) as a function of water temperature ('C)	23-5

INTRODUCTION

This manual will familiarize you with the Apple II+ computer and the use of the Fishculture Information System for Hatcheries (FISH) Utility programs. The manual is divided into three parts:

- a general guide to running the APPLE II+
- a brief description of the FISH system and how to begin using it
- a step-by-step description of each FISH Utility program with illustration of the screens

Read the first two sections before using the APPLE and the detailed description section when using particular programs. You may like to read some of the APPLE manuals, especially the "APPLE TUTORIAL". When you are comfortable with the manual(s), try working along with some of the programs.

Please note that the sharp brackets (eg. <S>, <Return> or <Y/N>) mean the specific key, or one of those keys separated by the slashes must be pressed in order to continue.

If you find a bug, please tell us the name of the program and the particular steps which led to the error message. We need feedback to refine and improve the system.

Please call us in Vancouver if you have any problems, comments, or suggestions. Any revisions made in this manual will be forwarded to you as they are prepared.

ANNE KLING 666-6126

GENERAL APPLE USER'S GUIDE

SYSTEM COMPONENTS

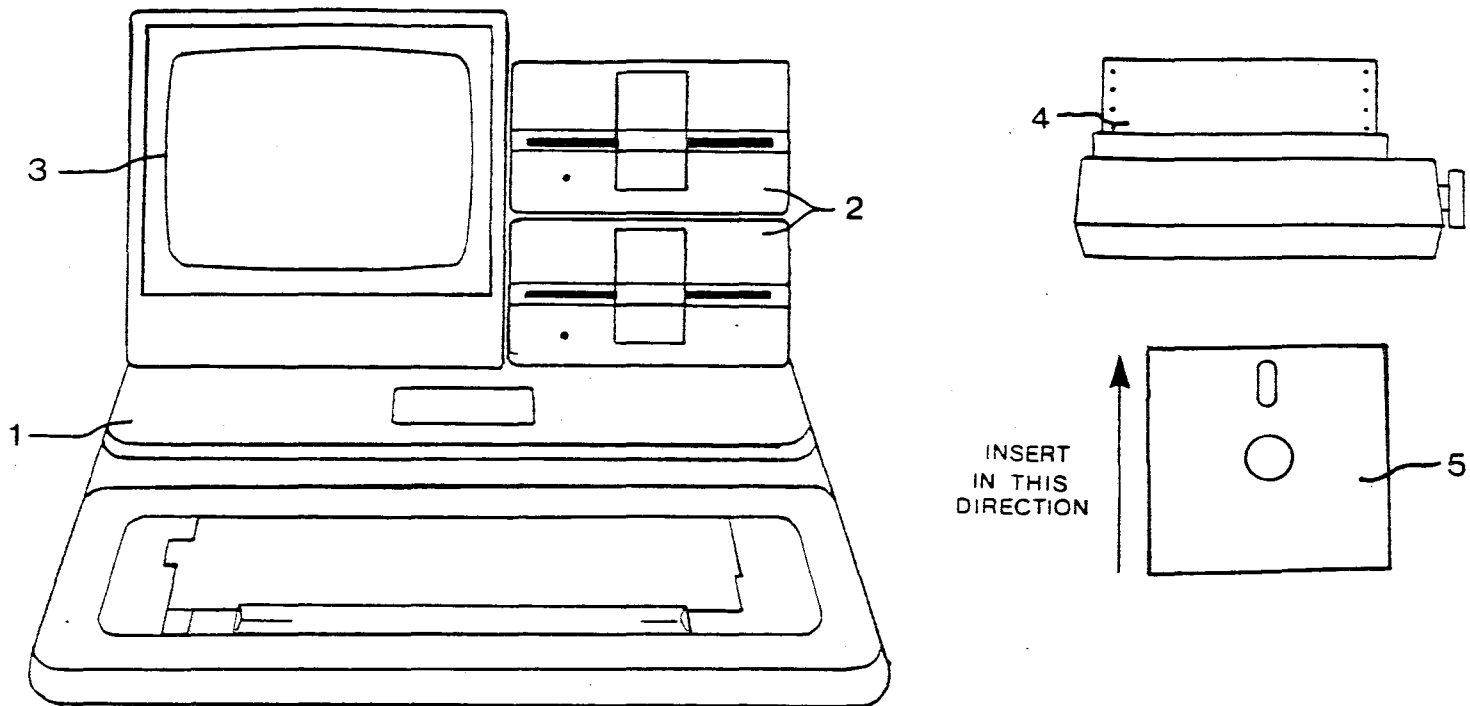


Figure 1: Components of the Apple II+ Package

- 1 Apple II+ Microcomputer - the actual data manipulating, "thinking" part of the system.
- 2 Disc Drives - labelled Drive 1 and Drive 2. These store and retrieve data.
- 3 Monitor - the video display.
- 4 Printer - produces "hardcopy" printouts of program results.
- 5 Disc or Diskette - the information storage medium, 5.25 inch floppy discs.

RUNNING THE APPLE

Insert your disc

Discs should be handled carefully. Touch only the black plastic cover.

Lift up the small door in drive one and slide the disc gently into the slot until it is entirely in the drive. Make sure that the end of the disc with the oval cutout enters the drive first and that the label side is up (see Figure 1, p. 1-1). Close the drive door.

NEVER :

Bend the disc

Expose it to temperatures above 50°C

Expose it to magnetic fields such as T.V.'s or airport metal detectors (don't lay your discs on top of the Apple or the disc drives)

Write on the label of the disc with anything other than a FELT TIP pen (always press lightly)

Open the drive door when the red "in use" light is on (you may lose ALL your data and damage your drive or disc)

Turn everything on.

There is no particular order for turning everything on. Make sure that your disc is in drive one with the drive door closed before you turn on the Apple.

The Apple II+ power switch is on the back lower left hand corner. When you have turned it on the power light on the keyboard will light up. The red "in use" light on the front of the disc drive will come on and the drive will make whirring, clicking noises. If you have a disc in the drive with the drive door closed, the light will eventually go off.

If you have no disc in the drive, the "in use" light will stay on and the drive will keep spinning. Stop it by pressing <Reset>, placing a disc in the drive, and rebooting (turning the Apple off and on again).

Remember, NEVER open the drive door when the red light is on.

The Monitor switch is on the front lower left of the monitor. Screen brightness and contrast can be adjusted by using the appropriate knobs on the front.

The Printer switch is at the bottom of the right hand side towards the back; the green "power" light will come on when the printer is turned on. The "on line" light must also be on before the printer will work. Pressing the "on line" button will turn it on and off. The "on line" light must be off to advance the paper. Pressing LF (line feed) advances the paper one line at a time, while FF (form feed) advances one sheet at a time. (Please note that these instructions are specific to the Epson MX-100 printer.)

The Keyboard

The Apple II+ keyboard is much like a typewriter keyboard. The space bar is located at the bottom of the keyboard and the shift keys are in the lower left and right hand corners. Pressing the shift key in combination with any other key that has two symbols on it will result in the upper symbol appearing on the screen. Without the shift key the lower symbol will appear.

Note a few keys which are different from a typewriter keyboard. These are:

REPT If you press the <Rept> (repeat) key while holding down any other key, that key's character appears repeatedly on the screen. <Rept> works with all the keys of the keyboard (including the space bar) except <Reset>, <Esc> <Shift> and <Ctrl>.

If you have an Apple IIc, hold the key you wish to repeat down. After a short hesitation, this key repeats until you release it.

RETURN Pressing this key moves the cursor to the left edge of the screen one line down from the current line (it works like a carriage return on a typewriter). Typing <Return> after each instruction or response tells the computer that you are finished with that statement and are ready to move on to the next. Until the <Return> key is pressed the computer does not realize anything has happened. Therefore, you may backspace and correct "typos" before completing an input with a <Return>.

-> <- These two "arrow" keys move the cursor right and left to make editing changes before pressing <Return>. If you backspace with the <- key and make a change, you must use the -> key to get to the end of the line again or you will not have entered whatever was to the right of, or underneath the cursor when the <Return> key was pressed.

For example, you can type "DAT", backspace to the "D" and press "C". Unless you use the -> key to return the cursor to the space after the "T", you will see "C", not "CAT" when you press <Return>.

On the Apple IIc, you also have vertical arrow keys which are useful in VisiCalc.

CTRL The <Ctrl> (control) key brings out some hidden features of certain keys. For example, <Ctrl>-<S> pressed during a screen listing of a program or data will cause a pause so that individual lines may be read. <Ctrl> must be held down while the other key is pressed.

RESET Pressing <Reset> (or <Ctrl>-<Reset> for some Apples) will cause a beep to sound and will stop execution of a program. The machine will then wait for your instructions. If you press <Reset> during a program (either accidentally or on purpose) you can get back to the beginning of the program again by typing RUN. However, the computer will have lost all memory of previously entered data.

You are now ready to begin using your Apple.

WARNING : Make sure that the electrical plug and cord are in a protected spot so that no one will accidentally pull or kick the plug from the outlet. Such an accident could cause you to lose the reams of data you've just spent hours inputting.

WHAT HAPPENS WHEN YOU TURN ON THE APPLE

You don't need to read this section to use the Apple. It is for those who are curious about WHY things happen.

When you place your disc in the drive and turn on the Apple, it automatically loads in a control program from the disc. This program allows you to use a number of commands (see SIMPLE COMMANDS) to access files on disc. This control program is called the Disc Operating System or DOS. The automatic process of loading DOS into the Apple memory is called booting.

Without DOS in the Apple memory, the Apple can't understand any DOS commands and returns ?SYNTAX ERROR if you try to use the commands. This occurs if DOS was not initially booted or if the DOS copy in memory was changed by some program. In this case, you must boot DOS by turning the Apple off and on, or by typing PR#6<Return>. Make sure that you boot with a disc that has DOS on it. Any disc initialized with DOS command INIT will have a copy of DOS 3.3. Discs initialized by VisiCalc have no DOS, which is why we do not recommend using VisiCalc's initialization command.

After DOS is loaded during the boot, a right hand square bracket called the prompt appears on the left margin of the screen. DOS then RUNs the first program on the disc. In the case of FISH and FISH Utilities, MENU is the first program.

If you boot with an initialized disc other than FISH or FISH UTILITIES, the prompt and the cursor will appear. You may now create and run BASIC programs. You may also use DOS commands such as SAVE and LOAD to store and retrieve your BASIC programs from disc. Refer to SIMPLE COMMANDS (p.1-9) for details on some DOS commands you could use, refer to The Dos Manual for all the DOS commands, and refer to the Applesoft Manual for all the BASIC commands and statements.

You do not need to know the details of DOS and Applesoft since they are invisible to you as a computer user. However, understanding that DOS and Applesoft are simply two special programs which interpret everything you type makes operating a computer less mysterious.

SIMPLE COMMANDS

Here are some commands you may find useful when working with DOS 3.3. Please note that these commands work only when the square bracket is showing at the left side of the screen.

DRIVE OPTION

Most DOS commands allow you to specify the drive number. When you wish to transfer from one drive to another, add ",Dn" to the end of your command where "n" is the drive number. For example, "CATALOG,D2" will catalog the contents of the disc in drive 2. The system always boots from drive 1 and control always reverts to the last used drive. See the following commands for examples.

CATALOG

Type in CATALOG to list the files stored on the disc currently in the disc drive.

eg. CATALOG <Return>
CATALOG,D2 <Return>

LOAD filename

Filename is the name of the file on disc that you have selected. When this command is executed a copy of the file is read from the disc to the computer memory.

eg. LOAD MYPROG <Return>
LOAD MYPROG2,D2 <Return>

SAVE "FILENAME"

"FILENAME" is the name that you want to call your BASIC program. This command will store the program currently in memory onto the disc. If no file with that "FILENAME" exists, then a new file will be created. If the file already exists, the original will be overwritten by the program in memory and the old file will be lost forever.

eg. SAVE NEWPROG 1.2 <Return>
SAVE DEC25PROG,D2 <Return>

RUN

Typing RUN begins execution of a program after it is LOAded.

RUN "FILENAME"

This command allows you to circumvent the LOAD command; it both LOADs and RUNs the program.

eg. RUN MENU,D1

INITIALIZING A DISC

All new discs must be initialized before they can be used. Initializing formats the disc, SAVES a DOS copy, and the first program. You can see if a disc has been initialized by CATALOGing. If the disc is not formatted, DOS will not be able to read the file names and will respond with I/O ERROR. Initialize the disc as follows:

CAUTION : be sure the disc to be initialized is blank because initialization completely erases the entire disc

- 1 Place the System Master disc (or any initialized disc) in drive 1.
- 2 Turn on the Apple.
- 3 When the drive's "in use" light goes out, remove the System Master and place the new disc in the drive.
- 4 Type NEW <Return>.
- 5 Type INIT HELLO <Return>. Note that your first program, HELLO, will be a blank program because you typed NEW. If you want a specific program to be automatically run during a boot, load that program into memory after step 4 and then proceed.
- 6 Wait for the "in use" light to go off. Your disc is now ready to use.

GLOSSARY

Applesoft	A version of the computer language BASIC used by the Apple II+/Ile computers.
BASIC	A programming language. BASIC is an acronym for "Beginner's All-Purpose Symbolic Instruction Code".
Booting	Restarting the DOS system; done by putting the disc in drive 1 and turning the Apple on or by typing in "PR# 6 <Return>".
Bug	An error. Most common is the "software bug" which occurs in programs as a result of a programming error by the author.
Cursor	The blinking square visible on the monitor.
Debug	To remove all the errors from a program.
Disc	The plastic disc upon which data and programs are stored
Diskette	See Disc
DOS	Disc Operating System (pronounced doss, or dee-oh-ess). The controlling program which allows you to use discs and disc drives for information storage and retrieval.
Enter	An instruction indicating that you should press a series of keys and end by pressing the <Return> key.
File	DOS stores information in files. A file may contain a program or data. If a program is stored, it will be stored under its file name.
FISH	The Fishculture Information System for Hatcheries.
Floppy disc	See Disc.
Hardcopy	A print-out (using the printer) of a program or its results.
Initialize	The process by which the disc is prepared for information storage. Every new blank disc must be initialized before use.
Input	Reading information into a program from the keyboard or from a disc. Also used as a synonym for enter.
I/O	The accepted abbreviation for Input/Output. If an error is encountered during reading from or writing to a disc, you

will be informed of an "I/O" ERROR.

- Menu A numbered list of options which allows you to select a desired operation or program by typing in the appropriate number. When written in capitals (MENU) it refers to the program named MENU.
- Output Communicating the results of processing to the monitor, printer or to a disc.
- Utilities Programs which perform specific problem-solving tasks. They are found on the FISH Utilities disc.

A BRIEF DESCRIPTION OF FISH

The Fishculture Information System for Hatcheries (FISH) consists of two parts, a data management system and a set of utility programs.

FISH System Structure

MENU

(MAILBAG)

(INC/JUV) (DATA)	(ADULT) (DATA)	(UTILITY) (PROGRAMS)
-CREATE BROOD DISC	-CREATE ADULT DISC	-POND INVENTORY
-ENTER INC. DATA	-ENTER ADULT DATA	-SINGLE MARK GROUP
-ENTER JUV. DATA	-UPDATE ADULT DATA	-TWO MARK GROUP - EQUAL
-RETRIEVE INC/JUV	-REPORT ADULT DATA	-TWO MARK GROUP - UNEQUAL
-FISH PLOT	-EDIT ADULT RECORDS	-AERATION CONSTANT
	-FISH PLOT	-AERATION MODEL
		-TOTAL GAS PRESSURE
		-GROWTH MODEL
		-LOAD RATE
		-BIoload
		-HEATH STACK
		-POND O2 LEVEL
		-FLUSH TREATMENT
		-FISH HEALTH
		-CASE REPORTER
		-HISTOGRAM

Utility programs are stored on the UTILITY disc. These programs are run by menu selection.

The incubation, juvenile and adult data management programs are on the FISH DISC. they also run by menu selection.

FISH Utility Program Descriptions

Statistical Design for Mark/Recovery Program

POND INVENTORY

Calculates the number of fish to mark in pond, number to sample, error rate of estimate, or Petersen population estimate.

SINGLE MARK GROUP

Calculates number to mark, sample rate, expected sample size, or confidence intervals, using mark recovery formulae based on binomial statistics. This program is used for single groups.

TWO MARK GROUP - EQUAL

Modified from Single Mark Group for comparisons between different release groups of equal size.

TWO MARK GROUP - UNEQUAL

Similar to Two Mark Group - Equal, for comparisons between release groups of unequal size.

Bio-Engineering Design

AERATION CONSTANT

Calculates aeration coefficients of towers. Useful for modelling variations of towers of known performance.

AERATION MODEL

Simulates aeration towers with flat screen or packed column (bio-ring) designs. Useful for calculating optimum tower height, and separation of screens or packed columns.

MEAN & SD

Calculates the mean and standard deviation for one variable.

TOTAL GAS PRESSURE

Calculates oxygen, nitrogen and total gas pressures of water supplies and predicts results of any combination of heating, cooling or mixing with another known water supply.

Biological models

GROWTH MODEL

Simulates fish growth in a rearing pond, as forecast over a month, with estimates of fish size, growth rate, and food fed. The model is based on Stauffer's growth formula and

has tabulated output.

LOAD RATE

Calculates metabolic oxygen uptake rate and recommended load rate.

BIOLOAD

Calculates load rates and load requirements.

HEATH STACK

Calculates oxygen drop through a stack of Heath trays prior to ponding. The standard inputs are suggested to you when necessary.

POND O2 LEVEL

Calculates the metabolic rate of oxygen uptake, average oxygen levels of a pond, minimum allowable oxygen and maximum food ration.

Fishculture Applications

FLUSH TREATMENT

For prophylactic treatments in fish ponds with flowing water. Calculates either stock solution recipe, pond concentration, pond flow or stock application rate given the other three inputs. This has proven to be a valuable program for common treatment of fish diseases.

FISH HEALTH

A comprehensive version of the Flush Treatment program. It provides suggested treatments and application methods for; 1) twenty-four fish diseases common to B.C. waters, 2) four life stages of fish, and 3) prevention or control of the selected disease. Standard dosages and the appropriate selection of calculations are then presented.

Miscellaneous options such as unit conversions or volume calculations are given throughout the program. Notes on chemicals and supply sources, equipment disinfection, sample preparation and anesthetics are also available in this program.

CASE REPORTER

A subsection of Fish Health, this program asks questions necessary for fish disease diagnosis, and generates hard copy reports and blank forms.

Frequency Histogram Graphics

HISTOGRAM

This program allows input of data to produce a frequency histogram. It can also use data from a disc.

GENERAL COMMENTS ON USING THE FISH SYSTEM

Starting Up

Insert the FISH disc into disc drive 1 and turn on the Apple, monitor, and printer.

Responses

You are often asked to select from a series of options or to respond to a question. You will usually be prompted for the expected responses. Your response is often checked for you (eg.°if you are asked for a number, you must respond with a number, not a letter). A beep may sound if the response is not within expected values and the cursor will return to the beginning of the response prompt so you may try again. The computer will wait until your response is correct.

Note : Hit the <Return> key after each response.

Correcting Mistakes - OK <Y/N>

All questions are presented in a set that is just long enough to fill the screen of the monitor. At the end of each screen you will usually be asked "OK <Y/N> ?". If you are satisfied with your entries press <Y> (yes) and you will go to the next screen. If there is something you would like to change, press <N> (no) and you will start over at the first question on the screen.

For "OK <Y/N>" only, you do not need to press <Return> after your response.

Some programs offer a Correct or End <C/E> option. This allows you to correct individual errors without redoing all the input on a screen.

Hardcopy

In most programs you will be asked "HARDCOPY <Y/N>". Type <Y> and the results will be printed out.

Error Messages

If you get an error message such as "? SYNTAX ERROR" or "BREAK IN 150" that stops the program, make a note of the program, the sequence of steps that led to the message and call Vancouver. If you have any data entered, do nothing more. Often data can be salvaged if the machine is left alone.

A DETAILED DESCRIPTION OF THE FISH SYSTEM

MENU

PURPOSE MENU is the control program for the FISH Utility programs. It runs the programs you select and is the central point of access to any part of the FISH Utilities. The version number in the upper right corner indicates how recent the disc is.

INPUT Select item number.

NOTE The selected program will automatically return to the MENU program when finished.

MENU

Screen 1

SELECT UTILITY PROGRAM # VERSION 3.6

- 1 POND INVENTORY
- 2 SINGLE MARK GROUP
- 3 TWO MARK GROUP - EQUAL
- 4 TWO MARK GROUP - UNEQUAL
- 5 MEAN & SD

- 6 AERATION CONSTANT
- 7 AERATION MODEL
- 8 TOTAL GAS PRESSURE

- 9 GROWTH MODEL
- 10 LOAD RATE OR BIO-LOAD
- 11 HEATH STACK
- 12 POND O2 LEVEL

- 13 FLUSH TREATMENT
- 14 FISH HEALTH
- 15 CASE REPORTER

- 16 HISTOGRAM

OK <Y/N>

The selected program will be highlighted and, if verified, will be loaded and executed by MENU. If you select LOAD RATE OR BIO-LOAD you will proceed to screen 2.

MENU

Screen 2

SELECT LOADING PROGRAM # VERSION 3.5

- 1 LOAD RATE (BILL MCLEAN)
- 2 BIO-LOAD (DON MACKINLAY)

OK <Y/N>

This screen appears if you selected program 10, LOAD RATE
OR BIOLOAD, in screen 1. You may select which loading
program you wish.

AERATION CONSTANT

PURPOSE AERATION CONSTANT complements the program AERATION MODEL. You must have an established aeration tower or model at a specific flow rate to calculate the aeration constant of the screens within the system. You may use the constant to test varying systems under different conditions with AERATION MODEL.

NOTE This program applies to bio-rings and other aeration substrates as well, provided that they are arranged in similar units, with a constant distance between them.

INPUT Gas (Oxygen or Nitrogen)
 Inflow concentration (% saturation)
 Outflow concentration (% saturation)
 Number of screens
 Distance between screens (cm)
 Type of screens (optional label)

OUTPUT Aeration constant

AERATION CONSTANT

Screen 1 (sample screen)

AERATION CONSTANT
D.HARDING DEC.1980

CHOOSE OPTION : 1

- 1 OXYGEN (O2)
- 2 NITROGEN (N2)

ENTER :

INFLOW O2 CONC. (% SAT.) = 50
NUMBER OF SCREENS = 30
OUTFLOW O2 CONC. (% SAT.) = 98
DISTANCE BETWEEN SCREENS (CM) = 3
SCREEN TYPE (OPTIONAL) = ST

AERATION CONSTANT = .279293481

HARDCOPY <Y/N>
ANOTHER RUN <Y/N>
USING O2 AGAIN <Y/N>

You are presented with the choice of oxygen (O2) or nitrogen (N2). This affects only the phrasing of the questions, not the calculations. Input data as prompted. Note that you can not enter 100% saturation in either inflow or outflow concentrations. This is because the equation for deriving the aeration constant contains the factor :

$$\ln ((\% \text{ inflow sat.} - 100) / (\% \text{ outflow sat.} - 100)),$$

and 100% in either position would cause a breakdown of the equation. Therefore, if you wish to enter 100%, you must instead enter an approximation (Eg. 99.999). Screen type is an optional entry, which can be any length. To erase an entry in this position, type </>. At the end of the program you are asked if you want another run. If you wish to repeat the program, press <Y>. You will then be asked if you wish to use the same gas again. If you choose <Y>, you will return to the first data entry point, and by pressing <Return>, you may re-enter any value. To change a value, type over top of it.

AERATION MODEL

PURPOSE This program calculates the changes of oxygen or nitrogen saturation in water as it flows through the levels of an aeration tower. The aeration constant of the screening material must be known and can be calculated from an existing system using the program AERATION CONSTANT.

NOTE This program is valid for bio-rings and other aeration substrate materials, provided that they are arranged in similar units, with constant distances between them.

INPUT	Gas (Oxygen or Nitrogen)	Screen 1
	Inflow concentration (% saturation)	Screen 2
	Number of screens	"
	Distance between screens (cm)	"
	Type of screens (optional label)	"
	Aeration constant	"

OUTPUT Saturation of gas at each screen level

AERATION MODEL

Screen 1

AERATION MODEL

MCLEAN & BOREHAM 1980

CHOOSE OPTION : 1

1 OXYGEN (O2)

2 NITROGEN (N2)

Choose the gas (oxygen or nitrogen) which is to be used in calculations. This affects only the format of the questions, not the calculations.

Screen 2 (sample screen)

AERATION MODEL

MCLEAN & BOREHAM 1980

ENTER :

INFLOW O2 CONC. (% SAT) = 50

NUMBER OF SCREENS = 5

DISTANCE BETWEEN SCREENS (CM) = 3

SCREEN TYPE (OPTIONAL) = ST

AERATION CONSTANT = .3

Input data as requested. Screen type is an optional entry, which can be any length. To erase an entry in this position type </>.

AERATION MODEL

Screen 3 (sample screen)

SCREEN #	O2 (% SAT)
.....	
0	50
1	55.44
2	60.29
3	64.62
4	68.47
5	71.9

HARDCOPY <Y/N>
REVIEW DATA AGAIN <Y/N>
SELECT #
1 LIST TABLE AGAIN
2 ANOTHER RUN
3 RETURN TO MENU

This screen presents a table of the changes in saturation across the screens.

HARDCOPY will generate a printed copy of the data as entered and the resultant table.

REVIEW DATA AGAIN will show the data as entered, but will not give you access to it for changes.

LIST TABLE AGAIN puts you back to screen 3.

ANOTHER RUN gives you the choice of using the same gas again. If you choose <Y> for yes, you will be returned to screen 2 with all previously entered data still shown. You can re-enter any value by pressing <Return>. To change an entry, type the new value over the old.

BIO-LOAD

PURPOSE This program calculates maximum safe loading rates in kg/lpm and kg/cu.m. Its theory is similar to LOAD RATE's but produces slightly different outputs.

INPUT Water temperature (°C)
Number of fish reared
Species
and if chosen -
Inflow dissolved oxygen (%)
Dissolved oxygen outflow (mg/L) (Davis' B level)
Weight (individual) (grams)
Food rate (% OMP of body weight/day)
Metabolic correction factor

OUTPUT Biomass
Maximum safe loading rates in kg/lpm and kg/cu.m
Loading requirements in lpm and cu.m

BIO-LOAD

Screen 1 (sample screen)

<<<<<BIO-LOAD PROGRAM>>>>>

WATER TEMPERATURE (°C) = 10
NUMBER OF FISH REARED = 10000
SPECIES RAISED IS = 1
(SELECT NUMBER)
1 CHINOOK
2 COHO
3 CHUM

ASSUMED VALUES :

1 % INFLOW D.OX(% SAT.)= 95
2 D.OX OUTFLOW (MG/ML) = 6.44
(DAVIS' 'B' LEVEL)
3 WEIGHT PER FISH (GMS)= 5
4 % OMP FEEDING RATE = 90
5 METABOLIC CORRECTION = 1.35

C*ANGE ANY <Y/N> Y

CHOOSE NUMBER:

BIOMASS (KGS) = 50

MAXIMUM SAFE LOADING RATES ARE:

FLOW LOADING (KG/LPM) = .646
VOLUME LOAD (KG/CU.M) =12.229

LOADING REQUIREMENTS ARE:

FLOW (LPM) = 77.399
VOLUME (CU.M) = 4.089

HARDCOPY <Y/N>

ANOTHER RUN <Y/N>

Enter data as prompted. When you select the species, the program makes assumptions regarding the weight of the fish and the rate at which they are fed. All assumptions can be changed to suit your situation.

CASE REPORTER

PURPOSE CASE REPORTER is an aid to the speedy and accurate diagnoses of fish diseases. If the questions in this program are answered as completely as possible, they provide vital background information for the diagnostician. The questions in this program are presented in small groups. Those which are not applicable or answerable may be skipped. It is to your advantage to answer as many questions as possible, because the more information, the more certain the diagnosis.

INPUT Answers as appropriate.

OUTPUT Hard copies of method for diagnosis.

NOTE Editing
CASE REPORTER is presented in a series of screens. At the end of each screen, the question OK <Y/N> appears. Pressing <Y> advances you to the next screen, <N> returns the cursor to the first entry of the screen. To re-enter any piece of data press <Return>. To change an entry type over the old data. Where data entry is selected by number, enter the correct data number over the incorrect data word(s). To change a data entry to a blank, press </> and <Return>. This blanks out any data except date entries which require an entry at all times.
If you wish to edit data which was entered under the "other" option, you must first reselect the option number ("other" again or a regular option). Then you may enter the correct version.

CASE REPORTER

Screen 1

CHOOSE MENU OPTION

- 1 INPUT FOR REPORT
- 2 REVIEW OF REPORT
- 3 HARDCOPY OF REPORT

- 4 STORE DATA ON DISC
- 5 RECALL DATA FROM DISC

- 6 HARDCOPY OF BLANK FORM

- 7 RETURN TO FISH HEALTH MENU
- 8 RETURN TO UTILITIES MENU

Select the option you desire.

Option 1 Enter data on the keyboard.

Option 2 Review the currently entered data. See p. 7-1 for editing instructions.

Option 3 Generate a hardcopy, including your responses, which can be filed or sent along with samples of ailing fish to the Fish Disease Diagnostics Lab.

Option 4 Store the current report for future reference. If you do not store the data, it will be lost when the computer is turned off.

Option 5 Retrieve a report from the disc.

Option 6 Print a hardcopy blank form for use in the field.

Option 7 Return to the FISH HEALTH menu.

Option 8 Return to the UTILITIES menu.

NOTE For options 7 and 8, be sure that you have the UTILITIES DISC in drive 1

CASE REPORTER

Screen 2

CASE REPORTER

=====

DATE : DDMMYY

SAMPLE SITE :

CONTRIBUTOR :

SPECIES :

AGE :

LENGTH (MM) :

WEIGHT (GM) :

SEX :

OK <Y/N>

This is the first page of the data input screens. When you are asked for a date entry, you MUST input one. All other entries are optional, although it is recommended that you answer as many as possible.

When a display of suggested entries is shown, select the entry which you desire by the number in front of it. "Other" is often included in the options available. If selected, you may enter a series of numbers or words. For example "unidentified species", or "3;4" signifying both summer and fall chinook, are acceptable entries.

NEVER use a comma or colon. It and everything following, will be ignored by the program. If you wish to punctuate, use periods, semicolons and spaces. Also words and numbers should not be combined in the same entry.

CASE REPORTER

Screen 2.1

CASE REPORTER

=====

REASON FOR SUBMISSION:

DATE COLLECTED : DDMMYY

STOCK ORIGIN :

LOSSES	WATER TEMP 'C
TODAY'S (7)	
PAST WEEK (6)	
(5)	
(4)	
(3)	
(2)	
(1)	

OK <Y/N>

In this screen, you are asked for the previous week's water temperatures and losses. Begin with today's temperature and losses, followed by yesterday's, the day before's, etc. You must make an entry at the prompt for date collected.

CASE REPORTER

Screen 2.2

CASE REPORTER

=====

SAMPLE SIZE :

SAMPLE TYPE :

NO. AFFECTED CONTAINERS :

CONTAINER I.D. :

CONTAINER TYPE :

SIZE WIDTH :

LENGTH :

DEPTH :

DIAMETER :

UNKNOWN :

LOAD (FISH/CONTAINER) :

POND INFLOW :

POND VELOCITY :

OK <Y/N>

Enter sample size, sample type, and container specifics, including the units of measurement (e.g. "2.5 meters"). The two questions asking for pond inflow and pond velocity are particularly aimed at circular containers. Pond inflow alone is generally sufficient.

CASE REPORTER

Screen 2.3

CASE REPORTER

=====

DIET :

DIET TYPE :

FEED RATE :

(% OF BODY WEIGHT)

FEEDING METHOD :

PELLET SIZE :

OK <Y/N>

Enter diet particulars. OMP may be considered a "wet" food. For pellet size you may enter a combination of sizes as long as they are separated by a semi-colon, space or period (1/16; 3/32 is acceptable while 1/16, 3/32 is not).

CASE REPORTER

Screen 2.4

CASE REPORTER

=====

BEHAVIOR :

GROSS SIGNS :

RECENT HANDLING :

PREVIOUS DIAGNOSIS : DDMMYY

DIAGNOSTICIAN :

DIAGNOSIS :

PREVIOUS MEDICATION : DDMMYY

TYPE :

VACCINATION : DDMMYY

OK <Y/N>

Enter a case history of the problem, and of any previous diagnoses and medications. Entries for behavior and gross signs may be combinations of the suggested entries or descriptive phrases. If you wish this sort of entry, remember to select "Other" first. If there has previously been a disease diagnosis for your fish, please enter the date of diagnosis, the diagnostician, and the disease. Also, please enter any previous medications and vaccinations administered.

CASE REPORTER

Screen 2.5

CASE REPORTER

=====

WATER SOURCE :

SALINITY :

DISSOLVED OXYGEN : IN :
OUT :

TGP :

HARDNESS :

PH :

NH3 :

OK <Y/N>

Enter data relating to water conditions. If you have a specific reading for water hardness, enter it in screen 2.6 as a comment.

CASE REPORTER

Screen 2.6

CASE REPORTER

=====

ENTER ANY SPECIFIC COMMENTS YOU WISH TO
MAKE REGARDING THIS REPORT
PLEASE LIMIT SENTENCES TO LESS THAN 240
CHARACTERS (APPROX. 6 LINES)
WHEN FINISHED, TYPE <RETURN>

OK <Y/N>

Here you may enter free format comments. There are three
limitations on your input:

use ONLY semi-colons and periods for punctuation (no
commas or colons)

each sentence must be less than 240 characters long
100 sentences maximum.

Press <Return> after each sentence, and <Return> again to
conclude comment entry.

Screen 3

PLEASE SET TOP OF FORM, TURN PRINTER OFF
AND ON, AND PRESS <RETURN> WHEN READY

Hardcopy (option 3)

This option generates a hardcopy of the data you have
entered or loaded from the disc. If you are sending fish
to the Fish Pathology lab, please send a hardcopy report
along with the sample. You will be helping the
diagnostician and yourself.

CASE REPORTER

Screen 4

CASE REPORTER

=====

A FILE CONTAINING ALL THE DATA WILL NOW
BE SAVED UNDER THE NAME :

*DS DDMMYY SPECIES LOCATION *

WILL THIS NAME BE SUFFICIENT FOR
IDENTIFICATION ? <Y/N>

RENAME THE FILE INCLUDING SPECIES
NEW NAME MUST BE LESS THAN 30 CHARACTERS

NOTE : NAME MUST ALSO BE UNIQUE !

*DS DDMMYY *

Store Data on Disc (option 4)

If you wish to keep a record of your fish health problems
for future reference, you may save all the data you have
entered directly on a disc. It is not recommended that you
use the Utilities disc because it is full. Instead, use an
initialized disc which is otherwise empty (or close to it).

CASE REPORTER

Screen 5

CATALOG

ALL DISEASE DATA FILES BEGIN WITH 'DS'
CHOOSE ONE

Recall Data from Disc (option 5)

Once you have saved data onto a disc, you may want to look at it again. This option will show you the names of all files on the disc. CASE REPORTER files are prefaced by the letters "DS". Type in the name of the file, including the "DS" and press <Return>. The file will be loaded into memory and you may review it, change it, get a hardcopy, or whatever.

CASE REPORTER

Screen 6

WARNING

THIS OUTPUT ERASES ALL DATA
NOW IN THE APPLE MEMORY

IF YOU WISH TO CONTINUE TYPE <C>

Hardcopy of Blank Form (option 6)

This option generates a hardcopy version of the report with lines for writing on and suggested responses listed at the bottom of each page. This report can be filled out on site when it is not convenient to enter the data directly into the computer.

Screen 7

MAKE SURE YOU HAVE THE UTILITIES DISC IN
DRIVE 1 AND PRESS <RETURN>

Return to MENU (options 7 and 8)

Depending on your selection, you will return to the FISH HEALTH menu or the general Utility programs MENU. Please be sure that you have the Utilities disc in the drive.

FISH HEALTH

PURPOSE This program provides a list of suggested treatments and application methods for twenty-four fish diseases common to B.C. waters. The program also makes accommodation for four life stages of fish and for the prevention or control of the selected disease. Calculations for treatment dosages can be selected as appropriate to the situation, and standard dosages are provided.

INPUT Variables as prompted.

OUTPUT Hardcopy of treatment regimes.

CONTENTS	Menu	8-2
	Introduction	8-3
	Anesthetics	8-8
	Chemical notes	8-13
	Equipment disinfectants	8-15
	Disease treatment	8-17

NOTE A stock solution is a pre-mixed solution of chemical, ready to be given in a treatment.

If there is any doubt to the fishes' reaction to a treatment, test a control group first.

FISH HEALTH

Screen 1

```
***** FISH HEALTH *****
*
*          ( VERSION 16/03/83 )
*
*  SELECT ITEM #
*
*      1    INTRODUCTORY NOTES
*
*      2    ANESTHETICS
*
*      3    CHEMICAL NOTES
*
*      4    EQUIPMENT DISINFECTANTS
*
*      5    CASE REPORTER
*
*      6    DISEASE TREATMENT
*
*      7    RETURN TO MENU
*
*****
OK <Y/N>
```

The menu offers a selection of options to be chosen. It also indicates the last revision date of the program. If you select option 5, Case Reporter, turn to page 7-1 for documentation.

FISH HEALTH

INTRODUCTORY NOTES

Screen 2

THIS PROGRAM HAS BEEN PREPARED FOR
USE IN THE FEDERAL FACILITIES OF THE
SALMONID ENHANCEMENT PROGRAM IN
BRITISH COLUMBIA.

CARE SHOULD BE TAKEN WHEN USING
THIS PROGRAM AT ANY OTHER LOCATION.

(PRESS ANY KEY TO CONTINUE)

Introductory notes indicating where the program is used.

FISH HEALTH

Screen 2.1

FOR INFORMATION, CONTACT:

- GARY HOSKINS
DIAGNOSTIC SERVICE
DEPT. OF FISHERIES & OCEANS
PACIFIC BIOLOGICAL STATION
NANAIMO, BC
- CAM WEST OR BILL MCLEAN
SALMONID ENHANCEMENT PROGRAM
DEPT. OF FISHERIES & OCEANS
1090 WEST PENDER ST
VANCOUVER, BC

(PRESS ANY KEY TO CONTINUE)

The program authors are listed.

FISH HEALTH

Screen 2.2

NOTE !!!

THE CHEMICALS REFERRED TO ARE COMMONLY
USED IN FEDERAL B.C. FACILITIES.

THE SELECTION OF DISEASE IN THIS
PROGRAM ARE FOUND IN B.C. WATERS. THE
TREATMENTS GIVEN ARE RECOMMENDED BY THE
DISEASE DIAGNOSTICS LAB, DFO.

TREATMENT/APPLICATIONS ARE LISTED IN
ORDER OF PREFERENCE. THEREFORE, THOSE
AT THE TOP OF THE LIST ARE THE MOST
HIGHLY RECOMMENDED.

OPERATION OF THE DISEASE PROGRAM IS
SIMPLE. ILLEGAL ENTRIES ARE NOT RECOG-
NIZED. ANY ENTRY CAN BE CHANGED BY
PRESSING <N> WHEN ASKED 'OK <Y/N>'.
THIS REPEATS THE MOST RECENT SCREEN OF
QUESTIONS.

OK <Y/N>

Treatments are listed in order of preference. At any
point, entries may be changed by pressing <N> to the
question "OK <Y/N>". You will then be presented with the
most recent screen of questions.

FISH HEALTH

Screen 2.3

OPTIONS HAVE BEEN GIVEN FOR ALL FORESEEN INSTANCES IN WHICH THE USER MAY REFER TO DIFFERENT PONDS AND/OR USE ONE OF MANY POSSIBLE UNITS OF MEASURE.

WHEN ENTERING THE POND FLOW FOR LONG BATH OR 1 HOUR BATH CALCULATIONS, PRESSING THE RETURN KEY WILL ALTERNATE THE UNITS BETWEEN LPM AND CFS.

BY PRESSING <CTRL>-<R> YOU MAY RETURN DIRECTLY TO THE MAIN MENU FROM ANY PART OF THE PROGRAM. <CTRL>-<P> WILL COPY VIDEO DISPLAYS ONTO THE PRINTER. <CTRL> COMMANDS MAY BE USED WHEN THESE REQUESTS APPEAR :

- 1) OK <Y/N>
- 2) SELECT #
- 3) (PRESS ANY KEY TO CONTINUE)

(PRESS ANY KEY TO CONTINUE)

Particularly note the option of exchanging pond flow rate between CFS and LPM by pressing <Return>. Also note that you may return to screen 1 at any time by pressing <Ctrl>-<R>. In some cases, this must be followed by a <Return> before it will execute. Similarly, <Ctrl>-<P> will give a hard copy of the screen showing.

FISH HEALTH

Screen 2.4

NOTE : A.I. IS USED AS THE SHORT FORM OF
ACTIVE INGREDIENT.

(ANY SUGGESTIONS TO IMPROVE THE
FISH HEALTH PROGRAM ARE WELCOME)

PRESS ANY KEY TO RETURN TO THE MENU

Suggestions regarding the program are welcome. Press any
key to return to the menu in screen 1.

FISH HEALTH

ANESTHETICS

Screen 3 (sample screen)

ANESTHETIC

SELECT ANESTHETIC # 1

- 1 MS222 - 75 MG / L FOR GENERAL USE
- 2 MS222 - 400 MG / L TO KILL FISH
- 3 2-PHENOXYETHANOL - 0.2 ML / LITER
FOR GENERAL USE
- 4 CO2 - 200 TO 400 MG/L

ARE YOU USING A STOCK SOLUTION ? Y

STOCK CONCENTRATION (A.I. %) =

This screen presents three commonly used fish anesthetics. If you respond <N> to the question "Are you using a stock solution?", you continue to screen 3.1. If <Y>, you are asked for the percentage of active ingredient in the stock solution.

FISH HEALTH

Screen 3.1

MS222 :

1 ACTIVE INGREDIENT 100% IN POWDER FORM.

2 TEST EACH BATCH FOR FISH TOXICITY

BEFORE ALLOWING GENERAL HATCHERY USE,

THERE HAVE BEEN SOME TOXIC LOTS.

3 IN VERY SOFT WATER SOLUTIONS OF MS-222

MAY REQUIRE BUFFERING. ADJUST TO

PH 7.0 USING SODIUM BICARBONATE

(BAKING SODA).

(PRESS ANY KEY TO CONTINUE)

4 *** ACTUAL AMOUNT NEEDED FOR DESIRED

RESULTS DEPENDS ON WATER TEMP,

SPECIES, AGE & HEALTH.

OK <Y/N> (N = ANOTHER ANESTHETIC)

This screen consists of warnings and recommendations regarding the use of your selected chemical. Please read these. (See also screen 4.1).

FISH HEALTH

Screen 3.2 (sample screen)

ARE VOLUME CALCULATIONS NEEDED ?
(Y = CALCULATIONS), <Y/N> N

SELECT UNIT # 1

- 1 GAL(IMP)
- 2 GAL(US)
- 3 CU.FT.
- 4 CU.M.
- 5 LITERS

ENTER VOL IN GAL(IMP)

OK <Y/N>

If container volume must be calculated, respond <Y> to the appropriate question and you will proceed to screen 3.3. If you responded <N>, you may directly enter the volume of water in the unit you prefer.

FISH HEALTH

Screen 3.3 (sample screen)

```
SELECT CONTAINER # 1

1 RECTANGULAR
2 CIRCULAR
3 OVAL
* SLOPE SIDED RACEWAY

SELECT UNIT # 5

* METERS
2 CM
3 FEET
4 YARDS
5 INCHES

ENTER RECTANGULAR DIMENSIONS
IN INCHES

- DEPTH      3
- WIDTH      10
- LENGTH     12

VOLUME ( CU. INCHES ) = 360
          ( LITERS ) = 5.899
OK <Y/N>
```

Select a container shape and unit of measurement. Enter the dimensions of the water in the container. If, for example, you have a container twelve inches high which is to be filled only to ten inches, input ten as the depth.

FISH HEALTH

Screen 3.4 (sample screen)

CHEMICAL NOTES

***** MS222 ANESTHETIC BATH *****

TREATMENT CONC. = 75 PPM A.I.

***** BATH PREPARATION *****

4.425 ML MS222 (10 % A.I.)

IN 360 CU INCHES (5.9 LITERS)

THIS IS A GUIDELINE AND VARIES WITH TEMP
TRY A TEST GROUP IF NOT FAMILIAR !!!!!

HARDCOPY <Y/N> (N = RETURN TO MENU)

This screen shows the amount of anesthetic which must be used. Note that, when making a solution, all chemicals must be added first and then water added to make the necessary volume. You may also select a hardcopy of the report or return to screen 1.

FISH HEALTH

CHEMICAL NOTES

Screen 4

SELECT

- | | | | |
|----|---------------------------------|----|-----------|
| 1 | BETADINE | | |
| 2 | ERYTHROMYCIN | | |
| 3 | FORMALIN | | |
| 4 | FURANACE | | |
| 5 | FURAZOLIDONE | | |
| 6 | GALLAMYCIN | | |
| 7 | MALACHITE | | |
| 8 | OVADINE | | |
| 9 | POTASSIUM PERMANGANATE | | |
| 10 | ROCCAL | | |
| 11 | SULFAMERAZINE | | |
| 12 | SULFAMETHAZINE | | |
| 13 | TERRAMYCIN | | |
| 14 | VACCINE | | |
| 15 | BRIDINE | 21 | MS-222 |
| 16 | HYAMINE 1622 | 22 | 2-PHENOXY |
| 17 | OVADINE | 23 | CO2 |
| 18 | ROCCAL | | |
| 19 | WESCODYNE | | |
| 20 | CHLORINE, BLEACH, HYPOCHLORITES | | |

Select from a list of twenty-three chemicals in common use in B.C. hatcheries. The list is divided into medications, disinfectants and anesthetics.

FISH HEALTH

Screen 4.1 (sample screen)

BETADINE :

1 KNOWN AS BETADINE OR BRIDINE.

~ 10,000 MG/L AVAILABLE IODINE (1% A.I.)

3 USE FOR EGG OR EQUIPMENT DISINFECTION.

4 IF USED TO DISINFECT EGGS, CHECK PH.

ADJUST TO 7.0 WITH SODIUM BICARBONATE

(BAKING SODA) BEFORE USE.

5 OVADINE AND WESCODYNE ARE ALTERNATIVE

DISINFECTANTS.

(Y = RETURN TO MENU)

OK <Y/N> (N = SELECT ANOTHER NOTE)

Appropriate cautions and warnings are presented.

READ THESE!!

This program is designed to reduce the chances of chemical misuse but warnings are useless unless they are heeded. These notes are specific for the chemical chosen. Please don't skip over them.

FISH HEALTH

EQUIPMENT DISINFECTANTS

Screen 5

**** DISINFECTANTS ****

SELECT DISINFECTANT #

- 1 ROCCAL
- 2 HYAMINE 1622
- 3 WESCODYNE
- 4 OVADINE
- 5 BETADINE
- 6 DOMESTIC BLEACH (5.25%)
- 7 HTH (SOLID CHLORINE)

OK <Y/N>

Select from a list of seven common disinfectants. In some cases, you are asked for the specific form of the disinfectant, or the specific purpose.

FISH HEALTH

Screen 5.1 (sample screen)

ROCCAL

DISINFECTANTS

STANDARD DOSE : (ACTIVE INGREDIENT)

=====

600 PPM

STANDARD DOSE OK Y

A.I. OF CHEMICALS :

=====

10 % ROCCAL

A.I.'S OK ?

This screen allows changes to the standard dosage of the chemical chosen. You then continue to the volume questions shown in screens 3.2 and 3.3, and to the report in screen 3.4.

FISH HEALTH

DISEASE TREATMENT

Screen 6

SELECT DIAGNOSIS

- | | |
|--------------------------------|-------------------|
| 1 BACT GILL DISEASE | 19 SALMONCOLA |
| 2 BKD | 20 SPOROCYTOPHAGA |
| 3 COLDWATER DISEASE | 21 TRICHODINA |
| 4 COLUMNARIS DISEASE | 22 TRICHOPHYRA |
| 5 COSTIA | 23 TUBERCULOSIS |
| 6 CRYPTOBLA | 24 VIBRIOSIS |
| 7 ENTERIC REDMOUTH | |
| 8 EPISTYLIS | |
| 9 FUNGUS | |
| 10 FURUNCULOSIS | |
| 11 FUSIFORM GILL DISEASE | |
| 12 GLOCHIDA (CLAM) | |
| 13 GYRODACTYLUS | |
| 14 HEXAMITA | |
| 15 ICH | |
| 16 MOTILE AEROMONAS SEPTICEMIA | |
| 17 MYXOBACTERIAL GILL DISEASE | |
| 18 PSUEDOMONAS INFECTION | |

OK <Y/N>

Select the diagnosed disease from a list of twenty-four diseases common to B.C. waters.

FISH HEALTH

Screen 6.1

SELECT STAGE #

- 1 ADULT/FINGERLING
- 2 FRY
- 3 SAC FRY
- 4 EGG

SELECT PREVENT/CONTROL #

- 1 PREVENTION
- 2 CONTROL

OK <Y/N>

Select the stage of life appropriate for your fish, and whether you wish to prevent an outbreak or control an already present disease.

FISH HEALTH

Screen 6.2 (sample screen)

SELECTED : DIAGNOSIS : BACT GILL DISEASE

===== PURPOSE : CONTROL

STAGE : FRY

SELECT TREATMENT / APPLICATION #

1 POTASSIUM PERMANGANATE / 1 HR BATH

2 TERRAMYCIN / ORAL

3 ROCCAL / 1 HOUR BATH

OK <Y/N>

This screen offers a selection of suitable treatments and applications. Treatments are listed in order of preference with the most recommended at the top of the list. Select the treatment and application you wish to use.

NOTE : if formalin is one of the treatments you will be asked for the water temperature. If this is over 18°C, formalin is eliminated from the selection list as it is toxic at temperatures above 18°C.

FISH HEALTH

Screen 6.3 (sample screen)

POTASSIUM PERMANGANATE

GENERAL :

- 1 ALWAYS HAVE CALCULATIONS CHECKED BY
A SECOND PERSON.
- 2 IF NOT SURE OF FISH REACTION TO A
TREATMENT, TEST A CONTROL GROUP FIRST.
- 3 ALWAYS CONSIDER THE ENVIRONMENTAL
IMPACT OF THE SPENT CHEMICAL.
- 4 ALL CHEMICAL USED TO TREAT FISH
SHOULD BE HANDLED WITH CARE.
- 5 USE RECOMMENDED CHEMICAL DOSAGES.

(PRESS ANY KEY TO CONTINUE)

This is a general screen carrying several recommendations.

- 1 Always have your calculations checked by a second person.
- 2 If there is ANY doubt to the fishes' reaction to a
treatment, test a control group first.
- 3 Always consider the environmental impact of spent
chemicals.
- 4 All chemicals used to treat fish should be handled with
care.
- 5 Use recommended chemical dosages.

FISH HEALTH

Screen 6.4 (sample screen)

POTASSIUM PERMANGANATE

1 IN VERY SOFT WATER USE WITH CAUTION.

2 10 PPM IS HIGHLY TOXIC TO SALMONIDS.

3 AVAILABLE IN LOCAL DRUG STORES.

4 EXPLOSIVE IF BROUGHT INTO CONTACT WITH
READILY OXIDIZABLE SUBSTANCES
(EG. GLYCEROL).

OK <Y/N> (N=SELECT ANOTHER TREATMENT)

Here are appropriate cautions and warnings for the selected chemical are presented, as in screen 4.1.

READ THESE!!

This program is designed to reduce the chances of chemical misuse, but warnings are useless unless they are heeded. These notes are specific for the chemical chosen. Please don't skip over them.

FISH HEALTH

Screen 6.5 (sample screen)

DEFINITION OF SELECTED APPLICATION

1 HR BATH :

ONE HOUR EXPOSURE TO MODERATE
CONCENTRATIONS OF CHEMICALS WITH
INFLOWING WATER.

OK <Y/N> (N = ANOTHER APPLICATION)

This screen defines the manner of application.

FISH HEALTH

Screen 6.6 (sample screen)

SELECTED : FRY
===== POTASSIUM PERMANGANATE
1 HR BATH
BACT GILL DISEASE CONTROL

STANDARD DOSE : (ACTIVE INGREDIENT)
=====

1 PPM
2 DAY

STANDARD DOSE OK ? Y

A.I. OF CHEMICALS :
=====

100 % POTASSIUM PERMANGANATE

A.I.'S OK ? Y

OK <Y/N>

Once a chemical and treatment have been selected, this screen shows the specific aspects of the treatment (dosage, duration, etc.) You must approve the active ingredient (A.I.) or edit it if your chemical source possesses a different proportion of active ingredient.

Depending on the treatment application, only some of the following screens will be seen.

Dip
Static Bath

If your treatment method is a dip or a static bath, you will return to the volume questions of screens 3.2 and 3.3, and continue from there to screen 6.11.

FISH HEALTH

Screen 6.7 (One Hour Bath sample screen)

** POTASSIUM PERMANGANATE 1 HR BATH **

SELECT ITEM TO BE CALCULATED #1

- 1 STOCK SOLUTION CONC.
- 2 PUMP METERING SPEED
- 3 POND INFLOW
- 4 POND CONCENTRATION

ENTER PUMP SPEED	(ML/MIN)	250
ENTER POND FLOW	(LPM)	300
ENTER POND CONC.	(PPM)	1

OK <Y/N>

Long Bath
One Hour Bath

If the method is a long bath or a one hour bath, you may select to solve for any one of the four options shown on this screen. Pump metering speed is the speed at which the stock solution is added to the system.

FISH HEALTH

Screen 6.8 (Oral sample screen)

INPUT TOTAL FISH WEIGHT IN POND

SELECT METHOD # 4

1 TOTAL WEIGHT (LBS) =

2 TOTAL WEIGHT (KGS) =

3 NO. OF FISH =
FISH / LB =

4 NO. OF FISH = 100000
GMS / FISH = 12

**** TOTAL WEIGHT OF FISH IN POND ****

= 2643 LBS

OK <Y/N>

Oral

You must enter the weight of the fish being treated in one of the four methods shown so that the dosage may be calculated.

FISH HEALTH

Screen 6.9 (Flush sample screen)

INPUT FLOW

SELECT METHOD # 4

1 GPM(IMP) =

2 GPM(US) =

3 CFS =

4 LPM = 12

FLOW = 12 LPM

MALACHITE DOSE = 25 PPM/MIN

STOCK MALACHITE SOLUTION = 1 % A.I.

OK <Y/N>

Flush

Supply the system flow in one of the units allowed.

FISH HEALTH

Screen 6.10 (Injection sample screen)

SELECTED : ADULT/FINGERLING
===== TERRAMYCIN
INJECTED
FURUNCULOSIS PREVENTION

STANDARD DOSE : (ACTIVE INGREDIENT)
=====

7.5 MGS A.I./ LB FISH

INJECTION SOLUTION
=====

MG A.I. / ML = 50

OK <Y/N>

Injection

Input the amount of active ingredient in the solution to be administered. If the solution is too weak, you will be informed that the injection volume is too great. Redefine your solution.

FISH HEALTH

Screen 6.11 (sample screen)

BACT GILL DISEASE CONTROL
FRY

* POTASSIUM PERMANGANATE 1 HR BATH *

POND FLOW (LPM) = 300

PUMP SPEED (ML/MIN) = 250

STOCK CONC.(PPM A.I.) = 1201

POND CONC. (PPM A.I.) = 1

***** STOCK RECIPE *****

18 GM POTASSIUM PERMANGANATE (100 % A.I.)

MADE UP TO 15 LITERS WITH WATER

HARDCOPY <Y/N> (N = RETURN TO MENU)

This screen is the same as screen 3.4. It shows the treatment method and chemical, the life stage of the fish, whether the treatment is to protect or control, the way treatment is to be administered, and the stock solution

FLUSH TREATMENT

PURPOSE FLUSH TREATMENT does calculations for prophylactic treatments in fish ponds with flowing water. It can calculate any one of stock solution recipe, pond concentration, pond flow or stock application rate, provided it is given the other three variables.

INPUT	Chemical name	Screen 1
	Three of the following:	
	Stock concentration (mL/L or mg/L)	Screen 2
	Pump speed (mL/minute)	"
	Pond concentration (uL/L or mg/L)	"
	Pond flow (l/minute or CFS)	"

PROGRAM PARTICULARS

Some diseases (ectoparasites, bacterial gill disease, fungus, etc.) can be treated by exposing the infected fish to a low constant concentration of treatment chemical for a specified time. In production hatcheries this can often be accomplished by pumping the treatment chemical to the pond inflow for the desired exposure time. The concentration achieved in the pond depends on the stock concentration of the treatment chemical, the pond flow rate and the pumping rate. FLUSH TREATMENT is designed to aid in setting up such a treatment.

Consider a pond of fish with bacterial gill disease where a potassium permanganate treatment of 2 mg/L for one hour has been recommended. If the pond inflow is $Q = 100$ L/min and a pump speed "q" of 200 mL/min can be obtained (dependent on available pump) then the required stock concentration "Cs" can be calculated from:

$$Cs \ q = (q + Q) \ Cp$$

where : Cs = stock concentration (mg/L)
q = pump flow (L/min)
Q = pond flow (L/min)
Cp = pond concentration (mg/L)
(2 mg/L in this case)

The required stock concentration would be:

$$Cs = \frac{(q+Q)Cp}{q} = \frac{(0.2+100)2}{0.2} = 1002 \text{ mg/L}$$

FLUSH TREATMENT

In other words, if a stock concentration of 1002 mg/L (or 1.002 g/L) is pumped into the pond (inflow = 100 L/min) at a rate of 200 mL/min, a pond concentration of 2 mg/L is achieved. For a one hour treatment, 12.0 liters of stock would be required (0.2 L/min X 60 min/hour). This would be prepared by dissolving 12.024 g of KMnO₄ in 12 liters of water.

Sometimes fish culturists have a known stock concentration and achieve the desired pond concentration by setting the pump speed. This can be calculated by rearranging the first equation to solve for pump speed "q":

$$q = \frac{Q C_p}{C_s - C_p}$$

In this example, the pump speed would have to be :

$$q = \frac{100 \times 2}{1002 - 2} = 0.2 \text{ L/min or } 200 \text{ mL/min}$$

The program can calculate the stock concentration, the pumping rate or the pond flow required to achieve the desired pond concentration.

Calculations involving formalin can also be handled by this program. It should be noted the conventions developed by Schnick (1973) are used in FLUSH TREATMENT and FISH HEALTH. In this system, formalin refers to a 37% by weight formaldehyde gas solution (37% by weight formaldehyde in 100 mL of aqueous solution). Furthermore, all concentrations are stated relative to formalin in units of microliters per liter (uL/L). For example, if 50 mL (50000 uL) of formalin are made up to 1000 mL (1 liter) with water the resulting concentration is :

$$\frac{50 \text{ mL} \times 1000 \text{ uL/mL}}{1000 \text{ mL} \times 1/1000 \text{ L/mL}} = 50,000 \text{ uL/L}$$

This is equivalent to a 50,000 ppm formalin solution. The more familiar ppm (parts per million) notation (rather than the more correct uL/L) is used in FLUSH TREATMENT.

FLUSH TREATMENT

This terminology can be illustrated with a simple example. Suppose the pond inflow is $Q = 100$ L/min and a 25 uL/L formalin concentration is required. If the pump flow rate is 200 mL/min then the stock concentration "Cs" can be calculated :

$$C_s = \frac{(q + Q)C_p}{q} = \frac{(0.2 + 100)25}{0.2} = 12,525 \text{ uL/L}$$

A formalin stock concentration of 12,525 uL/L (12.525 mL/L) is required. This could be made by measuring 12.5 mL of formalin into a one liter graduated cylinder and making up to the 1 liter mark with water.

If an eight hour treatment is required, we would have to make :

$$8 \text{ hr} \times 0.2 \text{ L/min} \times 60 \text{ min/hr} = 96 \text{ liters}$$

of stock. This would be made up by measuring 96L X 12.5mL/L = 1200 mL of formalin into a container and adding 94.8 liters of water (to make up 96 liters of solution).

In practice, it would be advisable to prepare slightly more than 96 liters of stock for an eight hour treatment in order to avoid having to pump the the stock container right to the bottom.

FLUSH TREATMENT is just one small part of the more general FISH HEALTH program. It has been separated from the larger program for ease of use. It should only be used after the precautions and treatment notes included in FISH HEALTH have been read.

The program has a number of limitations. It assumes that the chemical treatment is not consumed as it passes through the pond. It also assumes that the chemical can be well mixed with the inflow water.

NOTE : the pond flow must be known with some accuracy. Guessing at pond inflow could result in mortalities.

NOTE : when flushing through Heath trays it is far preferable to use a pump. Pouring the solution in by hand will result in the first trays receiving too high a concentration and the last trays receiving too low a concentration to do any good. (see graph p. 9-5)

FLUSH TREATMENT

References :

Schnick, R. A. 1973. Formalin as a therapeutant in fish culture. U.S. Fish and Wildlife Service, distributed by N.T.I.S. (National Technical Information Service) U.S. Dept. of Commerce, Springfield Va. 22151. 134 p.

Jensen, J. O. T., and B. B. Windecker. 1982 Measurement of malachite green distribution in vertical flow incubator trays during a salmonid egg flush treatment. Can. Tech. Rep. Fish. Aquat. Sci. 1106: iii + 11 p.

FLUSH TREATMENT

Screen 1

FLUSH TREATMENT

SELECT #

- 1 KMNO4
- 2 MALACHITE
- 3 FORMALIN
- 4 OTHER

You are asked for the chemical which is to be used. If you wish to use something other than the suggested three, enter <4>, <Return> and then enter the chemical name.

FLUSH TREATMENT

Screen 2 (sample screen option 1)

SELECT CALCULATION # 1

- 1 STOCK CONCENTRATION
- 2 PUMP SPEED
- 3 POND CONCENTRATION
- 4 POND FLOW

PUMP SPEED (ML/MIN) =

POND CONC. (MG/L) =

POND FLOW (L/MIN) =

Choose which calculation you wish performed. You may choose from stock concentration, pump speed, pond concentration, and pond flow. Pump speed is the rate at which the stock solution is added to the pond. In the second part of the screen you are asked for the three inputs required to calculate your chosen factor.

Pond flow may be changed from liters/minute to CFS by hitting the space bar.

Pond and stock concentrations are in mL/L for formalin, mg/L for all other chemicals.

FLUSH TREATMENT

Screen 3 (sample screen)

**** SINGLE CHEMICAL - FLOW THRU ****

POND FLOW (L/MIN) = 5000

PUMP SPEED (ML/MIN) = 250

PUMP CONC. (PPM) = 1

STOCK CONC. (PPM) = 20001

STOCK SOLUTION RECIPE

20 GM KMNO4 / LITER

**** STANDARD KMNO4 TREATMENT ****

1 HOUR PER DAY

15 LITERS PER HOUR (300 GM)

3 DAYS PER TREATMENT

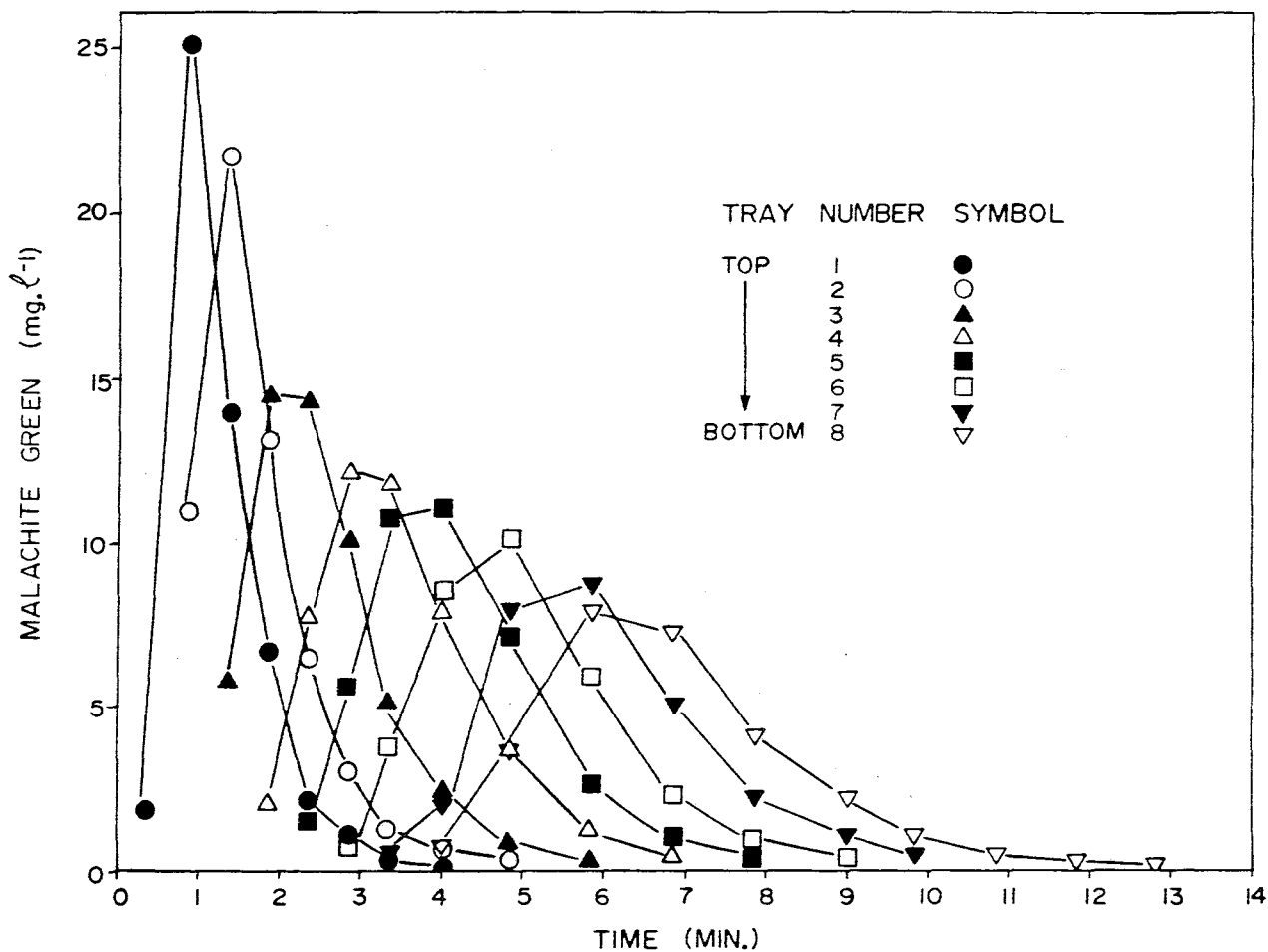
HARDCOPY ? <Y/N>

ANOTHER RUN ? <Y/N>

Results are tabulated. As the program is oriented to hardcopy records, sometimes results may scroll off the screen before they can be read. If you wish a hardcopy you will be asked for a label to help you identify your printout later.

FLUSH TREATMENT

Figure 2 Malachite green concentration profiles in a stack of eight Heath trays after dosing the top tray with 20 milliliters of malachite stock. The malachite stock concentration was 20 grams per liter (2%), the stack flow was 12 L/min and the trays were half full of 1/4 inch Intalok Saddles.



GROWTH MODEL

PURPOSE GROWTH MODEL will predict mean fish weight over a period of time at any particular level of feed rate.

INPUT	Food type	Screen 1
	Initial mean fish weight (g)	"
	Mean monthly temperature (°C)	"
	Ration level (%)	"

OUTPUT Fish weight
Specific growth rate
Feed rate

PROGRAM PARTICULARS

This program is designed to predict the average fish weight (grams) over time (days). The initial weight, the average water temperature (°C) over the time period of interest (up to 30 days) and the ration level must be known. With these inputs, the program predicts the average weight at five day intervals. At the end of 30 days an option is provided for new input data and continuation of the program. Ration input must be expressed in terms of the fraction of the maximum Stauffer ration. Typical levels are shown in Table 1, which is very close, but not identical to the NEW O.M.P. maximum ration guide (Table 2).

With the proper input data the program proceeds to calculate the following values daily (output every fifth day):

the mean fish weight (grams)

the specific growth rate in units of gram of growth per gram of fish per day. (Note : multiply by 100 to get % weight gain per day)

the feed rate in units of grams of dry feed or OMP per 100 grams of fish per day (this is just % dry food or OMP per day; i.e. % body weight).

the predicted food conversion calculated from:

Food rate (% food/day)

Specific growth rate * 100

GROWTH MODEL

This model was developed by Gary Stauffer (1973). It has many assumptions and weak points but we believe it is the best to date. The Stauffer growth model is a more general case of the Fish and Wildlife steelhead growth model (Iwama and Tautz, 1981). Under conditions of maximum ration (ration level = 1) and constant temperature the two growth models are almost identical. Because growth is dependent on ration level, Stauffer's model should be used in place of the steelhead model when the maximum ration is not fed throughout. Both of these models have a number of limitations :

They do not apply to newly ponded fish. Swim-up fry can be very inefficient feeders and we often feed over the maximum ration just to get the fish started. Of course, the model assumes that all the food presented is ingested, so growth predictions are optimistic.

The models do not take into account seasonal variations in growth. For example, it is well known that coho growth slows down in October-November. This reduction occurs even at ground water hatcheries where the temperature is nearly constant. The reduction is probably a response to decreases in photoperiod or light intensity and is not taken into account by the model. For coho the program gives realistic predictions from May to October and from December to release.

Growth models assume healthy fish and reasonable fish culture practices.

Predicted values have little value during periods of intensive pond disturbance. (eg. marking, predation, etc.)

The program is not sensitive to species (however the program was developed with coho, chinook and steelhead in mind).

A more complete description of the Stauffer model (1973) and the Fish and Wildlife model (Iwama and Tautz, 1981) is given in Appendix 1.

Table 1. The maximum ration (Stauffer, 1973) expressed in terms of grams of O.M.P. per 100 grams of fish per day (or % O.M.P. per day)*

TEMP. C	.80	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0	18.0	20.0
3	1.77	1.64	1.30	1.14	1.04	.96	.90	.86	.82	.79	.76	.72	.68	.65	.63	.61
4	2.55	2.36	1.88	1.64	1.49	1.38	1.30	1.24	1.18	1.14	1.10	1.03	.98	.94	.90	.87
5	3.29	3.05	2.42	2.12	1.92	1.79	1.68	1.60	1.53	1.47	1.42	1.33	1.27	1.21	1.16	1.12
6	4.00	3.71	2.95	2.57	2.34	2.17	2.04	1.94	1.86	1.78	1.72	1.62	1.54	1.47	1.42	1.37
7	4.68	4.34	3.45	3.01	2.74	2.54	2.39	2.27	2.17	2.09	2.02	1.90	1.80	1.72	1.66	1.60
8	5.33	4.95	3.93	3.43	3.12	2.89	2.72	2.59	2.47	2.38	2.30	2.16	2.05	1.96	1.89	1.82
9	5.96	5.53	4.39	3.84	3.49	3.24	3.04	2.89	2.77	2.66	2.57	2.42	2.30	2.20	2.11	2.04
10	6.56	6.09	4.84	4.23	3.84	3.56	3.35	3.19	3.05	2.93	2.83	2.66	2.53	2.42	2.33	2.25
11	7.15	6.64	5.27	4.69	4.18	3.88	3.65	3.47	3.32	3.19	3.08	2.90	2.75	2.63	2.53	2.45
12	7.71	7.16	5.68	4.96	4.51	4.19	3.94	3.74	3.58	3.44	3.32	3.13	2.97	2.84	2.73	2.64
13	8.26	7.67	6.08	5.32	4.83	4.48	4.22	4.01	3.83	3.69	3.56	3.35	3.18	3.04	2.93	2.82
14	8.79	8.16	6.47	5.66	5.14	4.77	4.49	4.26	4.08	3.92	3.79	3.56	3.38	3.24	3.11	3.01
15	9.30	8.63	6.85	5.98	5.44	5.05	4.75	4.51	4.32	4.15	4.01	3.77	3.58	3.43	3.29	3.18
16	9.79	9.09	7.22	6.30	5.73	5.32	5.00	4.75	4.55	4.37	4.22	3.97	3.77	3.61	3.47	3.35
17	10.28	9.54	7.57	6.61	6.01	5.58	5.25	4.99	4.77	4.59	4.43	4.17	3.96	3.79	3.64	3.51
18	10.74	9.97	7.92	6.92	6.28	5.83	5.49	5.21	4.99	4.80	4.63	4.36	4.14	3.96	3.81	3.67
19	11.20	10.40	8.25	7.21	6.55	6.08	5.72	5.44	5.20	5.00	4.83	4.54	4.31	4.13	3.97	3.83
20	11.64	10.81	8.58	7.49	6.81	6.32	5.95	5.65	5.40	5.20	5.02	4.72	4.48	4.29	4.12	3.98

*It is assumed that the O.M.P. has a 30% moisture content.

To get the quantity of dry food per 100 grams of fish per day multiply the values shown in the Table by 0.7.

Table 2. Maximum ration guide developed by Moore-Clark.

OREGON PELLET FEEDING CHART								
Estimated quantity of food that fish will consume if held at constant water temperature and fed <u>two (2) times per day - seven (7) days per week</u> ¹								
(Feeding rates expressed as percentages of body weight; ie. grams of OMP per 100 grams of fish <u>per day</u>)								
Water Temperature (F)	FISH SIZE - NUMBER PER POUND							
	90	75	65	55	45	39	34	29
	to 75	to 65	to 55	to 45	to 39	to 34	to 29	to 25.5
38					0.90	0.85	0.85	0.80
39					0.95	0.90	0.90	0.85
40	1.45	1.30	1.20	1.10	1.00	1.00	0.90	0.90
1	1.65	1.50	1.40	1.25	1.15	1.10	1.00	0.90
2	1.85	1.70	1.60	1.40	1.30	1.20	1.10	1.00
3	2.05	1.90	1.80	1.60	1.50	1.40	1.30	1.20
4	2.20	2.10	2.00	1.80	1.70	1.60	1.50	1.40
45	2.45	2.30	2.15	2.00	1.90	1.80	1.70	1.60
6	2.65	2.50	2.30	2.20	2.10	1.95	1.85	1.75
7	2.85	2.65	2.50	2.40	2.25	2.10	2.00	1.90
8	3.05	2.80	2.65	2.50	2.40	2.25	2.15	2.05
9	3.25	2.95	2.80	2.70	2.55	2.45	2.30	2.20
50	3.50	3.20	3.00	2.85	2.75	2.65	2.50	2.40
1	3.65	3.30	3.15	3.00	2.90	2.75	2.65	2.55
2	3.80	3.45	3.30	3.20	3.05	2.95	2.80	2.70
3	3.95	3.60	3.45	3.35	3.20	3.05	2.90	2.80
4	4.10	3.75	3.60	3.50	3.35	3.20	3.10	2.95
55	4.25	3.90	3.75	3.65	3.50	3.35	3.20	3.05
6	4.40	4.05	3.90	3.75	3.60	3.45	3.35	3.20
7	4.60	4.20	4.05	3.90	3.70	3.60	3.50	3.30
8	4.80	4.35	4.20	4.05	3.90	3.75	3.60	3.40
9	4.95	4.50	4.35	4.15	4.00	3.85	3.70	3.50
60	5.10	4.70	4.50	4.30	4.10	3.95	3.80	3.60

¹ Based on laboratory experiments with coho fingerlings held at constant water temperatures.

GROWTH MODEL

Screen 1

*** GROWTH MODEL ***

SELECT #

- (1) OMP (30% MOISTURE)
- (2) DRY FOOD (0 % MOISTURE)

Enter the type of food being fed. Note that OMP is considered to have 30% moisture and dry food 0% moisture.

GROWTH MODEL

Screen 2 (sample screen, dry food)

*** GROWTH MODEL ***

INITIAL WEIGHT (GM) = 5

MEAN TEMP (30 DAY AVERAGE (°C)) = 10

RATION (PERCENT OF MAXIMUM) = 80

DAY	WEIGHT	SPEC. GROWTH RATE	FEED RATE (% DRY / DAY)	FOOD CONVERS'N RATE
0	5	.0166	1.9959	1.202
5	5.427	.0162	1.9421	1.205
10	5.878	.0158	1.8911	1.197
15	6.353	.0154	1.8428	1.197
20	6.853	.015	1.7969	1.198
25	7.378	.0146	1.7532	1.201
30	7.929	.0143	1.7116	1.197

HARDCOPY <Y/N>

TITLE =

anOTHER RUN <Y/N>

Enter data as prompted (for more information see program particulars; p. 10-1).

If you want a HARDCOPY, you are asked to enter a title for the table. If you wish to run the program again, type <Y> in response to "ANOTHER RUN <Y/N>". If you choose to use the same food again, the output will remain on the screen and you may enter the weight at day 30 as the initial weight for this cycle thus producing progressive growth. To re-enter any value, press <Return>.

NOTE : if the entered ration level is more than 100%, the program automatically reduces it to 100% for all calculations.

HEATH STACK

PURPOSE HEATH STACK (Heath tray & alevin model) is a model to calculate oxygen uptake in ppm through a stack of Heath trays. The model applies ONLY to alevins prior to ponding. You may choose to enter barometric pressure and oxygen uptake rate directly or have either of them calculated for you.

INPUT	Altitude (optional, for barometric calculations)	Screen 2
	Temperature (°C)	Screen 3
	Weight (individual alevin, gm)	"
	Flow through trays (lpm)	"
	Inflow oxygen (% saturation)	"
	Barometric pressure (mmHg)	"
	Number of alevins per tray	"
	Aeration coefficient	"
	Metabolic oxygen uptake rate (RO) (mg O ₂ /kg/hr)	"
	(can be calculated for you)	

OUTPUT Oxygen levels (ppm) in each of 10 trays
Davis' O₂ B value
Davis' O₂ C value

HEATH STACK

Screen 1

HEATH TRAY & ALEVIN MODEL

THIS MODEL CALCULATES OXYGEN (PPM)
UPTAKE THROUGH A STACK OF HEATH TRAYS,
<<<< FOR ALEVINS PRIOR TO PONDING >>>>

PARAMETERS MAY BE CHANGED AFTER EACH
RUN. JUST ENTER THE NEW VALUE AT THE
APPROPRIATE ITEM (INDICATED BY THE
FLASHING CURSOR)

PRESSING <RETURN> WILL AUTOMATICALLY
RE-ENTER THE VALUE OF THE CURRENT ITEM.

STANDARD BAROMETRIC PRESSURES (MMHG)
ARE GIVEN FOR ELEVATIONS ABOVE SEA-LEVEL
FOR SOME SITES THIS MAY BE SIGNIFICANT.

PRESS FOR BAR./ALTITUDE CALCULATION

PRESS ANY OTHER KEY TO CONTINUE

Introduction to the program. You may enter barometric
pressure directly or have the program calculate it from
your altitude. Press to have it calculated, or any
other key to continue when ready.

HEATH STACK

Screen 2 (optional)

ALTITUDE (FEET) =

PRESSURE (MMHG) =

OK <Y/N>

This screen only appears if you are calculating pressure
from altitude.

HEATH STACK

Screen 3

INPUT INITIAL PARAMETERS

TEMP (°C) =

WEIGHT (GM) =

FLOW (LPM) =

INFLOW O2 (%) =

BAR (STND = 760 MMHG) =

ALEVINS / TRAY =

K (AERATION COEF .055) =

RO - METABOLIC O2 UPTAKE =
(MG/KG/HR)

PRESS <0> TO ENTER OWN RATE

" <1> TO CALCULATE RATE

Enter data as requested. If barometric pressure was calculated by the program, it will appear when needed. The suggested value for K, the aeration coefficient for Heath trays, is .055. This should be used unless a different value is known. You may enter metabolic oxygen uptake rate yourself (press <0>) or have it calculated for you (press <1>). Note that the calculated value assumes the maximum oxygen consumption of a late alevin stage.

HEATH STACK

Screen 4 (sample screen)

HEATH TRAY & ALEVIN MODEL

TRAY #	OXYGEN OUT (PPM)
=====	=====
INFLOW	11.583
1	11.281
2	10.994
3	10.723
4	10.466
5	10.223
6	9.993
7	9.776
8	9.57
9	9.375
10	9.19

DAVIS' O2 LEVELS

B 9 (PPM)

C 6.7

T (°C) = 8

BAR (760 MMHG) =760

W (GM) = .4

ALEVINS/TRAY =4000

Q (LPM) = 12

K (AERATION

O2 (%IN) = 98

COEF .055) =.055

OK <Y/N/H/E> ?

Results are tabulated for 10 trays. You may change any parameters you wish. <Return> will re-enter a number or you may type over for a new value. The parameters may be changed as often as wanted. OK <Y/N/H/E> asks if the parameters are correct. <Y> will have the output recalculated for the present values and <N> will move the cursor back to the first value (temperature) in order to change any values. <H> will give a hardcopy of the results presently on the screen, and <E> will end the program, taking you back to the Utilities MENU.

HISTOGRAM

PURPOSE This program will draw a relative frequency histogram of data. Please note that this program only works if you have a dot matrix printer and an Orange Micro Grappler interface card. A version for the Interactive Structures Pkaso interface is also available from our Vancouver office.

INPUT Data to be graphed
 or
 File Name

OUTPUT Relative frequency histogram

HISTOGRAM

Screen 1

*** HISTOGRAM : CAM WEST NOV 15, 82 ***

SELECT #

- 1 INPUT FROM KEYBOARD
- 2 LOAD FILE FROM DISC
- 3 SAVE FILE ON DISC FILE
- 4 CLEAR MEMORY
- 5 CATALOG
- 6 PLOT
- 7 RETURN TO MENU

OK <Y/N>

Choose option from those presented

- 1 Input from keyboard
Enter data using the keyboard or keypad. If you interrupt the input (as in getting a plot), you may continue to add data to that previously entered by choosing this option.
- 2 Load disc file
This option will load a previously saved file from the disc to make it available for changes and plotting. If you have your data on a different disc, exchange the discs in drive 1 before pressing <Return>. Most files are numeric files, unless they have been written by VisiCalc using the data interchange format (DIF).
- 3 Save disc file
This will save data onto the disc for future reference. It is best to use an empty, initialized disc for this storage as the Utilities disc is very close to full. Save files as numeric files.

HISTOGRAM

- 4 Clear memory
This option will empty the memory of the computer of all previously entered or loaded data. It is the same as starting the first time.
- 5 Catalog
If you are saving or loading a file, this option is useful because you can see the names of all the text files which are present on the disc (indicated by a leading "T"). Press <Return> at the end of the catalog to bring you back to the program.
- 6 Plot
This option draws the graph of the relative frequencies.
- 7 Return to menu
If you have been storing data on another disc, be sure to replace the Utilities disc in drive 1.

HISTOGRAM

Screen 2

*** DATA INPUT ***

CORRECT = C

DELETE = D

LIST = L

END = E

#1

#2

#3

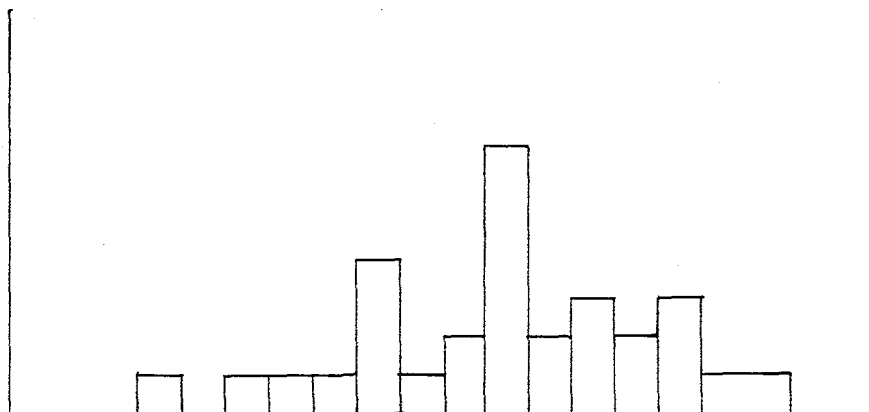
(etc.)

Data input screen

There are several commands which control data entry. "C" gives you the option to go back and correct any data entry. "D" will delete any entry. "L" provides a listing of all data (use <Control>-<S> once to interrupt the listing and again to restart it) and "E" ends the input, sending you back to screen 1.

HISTOGRAM

Screen 3



WT***: M =4.53 S =1.32 L =1.24 H =6.85

SCALE:XL=0 XH=8 XN=20 N =30

The data is graphed in a frequency histogram with certain information listed in the three lines below the graph. There are abbreviations followed by values. These abbreviations are :

- M - Mean
- S - Standard deviation
- L - Lowest sample value
- H - Highest sample value
- XL - X-axis minimum (x-low)
- XH - X-axis maximum (x-high)
- XN - Number of divisions on x-axis
- N - Number of samples

You may adjust the graph by replying Y to RESCALE ? <Y/N>. The values you may adjust are the minimum point on the x-axis, the maximum point, and the number of divisions (the maximum number of divisions is 50).

If you have a Grappler Interface card, you will be asked if you want a HARDCOPY: D,R,I,E OR <N>=NO. By pressing the appropriate key, you may get <D>ouble sized graph, a <R>otated graph (turned 90'), an <I>nverse graph (white lines on a black background) or an <E>mphasized graph. You may get any combination of these options by pressing each desired option key in turn. When you have selected your options press <Return>. If you do not want a graph, press: <N> <Return>. With the hardcopy, you are automatically

HISTOGRAM

given a printout of the divisions of the graph and the frequency of occurrence within each division.

Note : when the graph is first presented, XL is set to 0 and XH is set to the highest sample value (H).

LOAD RATE

PURPOSE This program calculates the metabolic oxygen uptake rate of the fish in a pond, and the recommended loading rates ("maximum" and "safe").

INPUT	Oxygen concentration in outflow (ppm)	Screen 1
	Food rate (percent of maximum)	"
	Weight (individual) (grams)	"
	Temperature (°C)	"
	Barometric pressure (mmHg) (default = 760 mmHg)	"
	Salinity (ppt)	"
	Inflow dissolved O2 concentration (% of saturation)	"

OUTPUT Load rate (Kg/liter/minute)
Safe load rate (Kg/liter/minute)
Metabolic rate of oxygen uptake (RO) (mg O2/kg/hour)
Inflow dissolved oxygen (mg/L)
Daily ration (% dry / day)

NOTE The model is only valid between 3°C and 16°C because of inbuilt limitations. However this is the best model presently available.

LOAD RATE

Screen 1

*** LOAD RATE CALCULATION ***
W. MCLEAN , AUG. 31/81

SELECT FOOD #

- 1 OMP (30 % MOISTURE)
- 2 DRY (0 % MOISTURE)

ENTER :

CO₂ PPM IN OUTFLOW =
% OF MAXIMUM RATION (OMP) =
WEIGHT (GMS) (INDIVIDUAL) =
TEMPERATURE (°C) =
BAROMETRIC PRESSURE (MMHG) = 760
SALINITY (PPT) =
INFLOW DO
(PERCENT OF SATURATION) =

LOAD RATE (KG/LPM) =
SAFE LOAD RATE (KG/LPM) =
RO (MG/KG HR) =
INFLOW DO (MG/L) =
DAILY RATION (%DRY/DAY) =

HARDCOPY <Y/N>
ANOTHER RUN <Y/N>

Enter data as prompted.

Food rate is the percent of the maximum recommended food level which is being fed. If food rate is greater than 100%, it will automatically be reduced to 100% for the calculations.

Barometric pressure defaults to 760 mmHg. If this value is suitable, press <Return>. If not, enter the appropriate value over the 760.

If you ask for another run, <Return> will re-enter any value.

MEAN & SD

PURPOSE This program calculates mean and standard deviation quickly and easily. It will only accept one input variable.

INPUT Data entries (200 maximum)

OUTPUT Mean
 Standard deviation
 Coefficient of variation
 Number of data points

MEAN & SD

Screen 1

QUICK MEAN AND STANDARD DEVIATION

TO CORRECT AN ENTRY, TYPE <C>

TO END DATA ENTRY TYPE <E>

(MAXIMUM 200 ENTRIES)

#1

#2

#3

<C/E> (etc.)

LIST DATA <Y/N>

ANY CORRECTIONS <Y/N>

CORRECT #

MEAN =

STANDARD DEVIATION =

COEFFICIENT OF VARIATION (%) =

NUMBER OF POINTS =

HARDCOPY <Y/N>

ANOTHER RUN <Y/N>

Enter each data point in turn. To end the input type <E>. To correct an entry type <C>, <Return>, and the number of the entry to be changed.

You may select the option to list the data items. Use <Ctrl>-<S> to stop and restart the listing. Note the numbers of any data points which need correction since you may correct entries after the listing is finished.

POND INVENTORY

PURPOSE This program will calculate, for pond inventory purposes, the number of fish to mark in a pond, the number to sample, the error rate of a pond population estimate based on a mark recovery sample or the Petersen population estimate with confidence intervals given.

INPUT (will vary with option)
Z (2 - tailed probability) (95% = 1.96) (default = 1.96)
Pond population (closest estimate)
Number of marks in pond
Sample size
Number of marks recovered
Error rate (default = 10 %)

OUTPUT Sample size
Number of fish to mark
Error rate
or
Pond population estimate

POND INVENTORY

Screen 1

**** POND INVENTORY ****

CHOOSE CALCULATION : 1

- 1 SAMPLE SIZE
- 2 NUMBER TO MARK
- 3 ERROR RATE
- 4 PETERSEN ESTIMATE

Select one of the four calculation options and enter the appropriate number. If option 4, is selected, the Petersen pond population estimate will be chosen and screen 3 will appear.

POND INVENTORY

Screen 2 (sample screen, option 1)

**** POND INVENTORY ****

ENTER :

Z (95% 2-TAILED = 1.96). 1.96
POND POPULATION..... 50000
MARKS IN POND..... 20000
ERROR RATE (%)..... 10

SAMPLE RATE (%) = 1.2
NO. TO SAMPLE = 580

HARDCOPY <Y/N>

SELECT #

- 1 ANOTHER RUN
- 2 ANOTHER RUN, SAME OUTPUT OPTION
- 3 RETURN TO MENU

Enter data as prompted. At the end of both screens 2 and 3, you will be offered the choice of a hardcopy printout. Also you may also choose to run the program again, to run it with the same output option as in selection 1, in which case your input data will remain on the screen and may be re-entered by pressing <Return>, or to return to the general Utility programs Menu.

POND INVENTORY

Screen 3 (sample screen, option 4)

*** PETERSEN POPULATION ESTIMATE ***

TOTAL MARKS IN POND 20000

MARKS RECOVERED IN SAMPLE 232

TOTAL NUMBER OF FISH IN SAMPLE . 580

POND POPULATION EST = 50000

AVERAGE ERROR = +/- 5004 (10%)

ACTUAL LOWER EST. = 45491

ACTUAL UPPER EST. = 55499

HARDCOPY <Y/N>

SELECT #

1 ANOTHER RUN

2 ANOTHER RUN, SAME OUTPUT OPTION

3 RETURN TO MENU

Enter the appropriate data as prompted. In the results, you will be given the estimated total population of the pond and the upper and lower values of the probable range.
NOTE : The average error is given as the mean error of the skewed upper and lower population estimates.

POND O2 LEVEL

PURPOSE This program calculates the metabolic rate of oxygen uptake, the average oxygen level of the pond, the minimum allowable oxygen level, and the maximum ration which should be fed.

INPUT	Pond load rate (kg/Lpm)	Screen #1
	Daily ration (% dry / day)	"
	Weight (individual) (grams)	"
	Temperature (°C)	"
	Barometric pressure (mmHg) (default = 760)	"
	Salinity (ppt)	"
	Inflow dissolved oxygen (% saturation)	"

OUTPUT	Metabolic rate of oxygen uptake (RO) (mg O2/kg/hr)
	Inflow dissolved oxygen (mg/L)
	Maximum ration (% dry / day)
	Average daily oxygen level (mg/L)
	Minimum daily oxygen level (mg/L)

POND O2 LEVEL

Screen 1

POND O2 LEVEL

REARING POND OXYGEN
CONCENTRATION CALCULATION
(W. MCLEAN , AUG 31/81)

ENTER :

POND LOAD RATE (KG/LPM) =
DAILY RATION (% DRY/DAY) =
WEIGHT (GMS) (INDIVIDUAL) =
TEMPERATURE ('C) =
BAROMETRIC PRESSURE (MMHG) = 760
SALINITY (PPT) =
INFLOW DO
(PERCENT OF SATURATION) =

RO (MG/KG/HR)=
INFLOW DO (MG/L)=
MAXIMUM RATION (%DRY/DAY)=
AVERAGE DAILY O2 LEVEL (MG/L)=
MINIMUM O2 LEVEL (MG/L)=

HARDCOPY <Y/N>
ANOTHER RUN <Y/N>

Enter data as required.

Daily ration is measured in % dry food per day, or grams of dry food per 100 grams of fish. If you are feeding OMP, reduce the number of grams of OMP per 100 grams of fish by 30% as OMP is 30% moisture.

To enter the barometric pressure default value, press <Return>.

If you choose "ANOTHER RUN", you may re-enter any data from the previous run by pressing <Return>. To enter new data, simply type over the old.

SINGLE MARK GROUP

PURPOSE This program calculates mark recovery formulae based on binomial statistics. You may calculate any one of the number to mark, the sample rate, the expected sample size or confidence intervals.

INPUT Z for a two tailed test (default = 1.96) Screen 1
Survival rate (% egg to return) "
Total release "
Two of the following:
Expected sample rate (% of returning fish) "
Number of marked fish released "
Confidence interval (default = 10%) "

OUTPUT Sample rate (% of returning fish to sample),
Number to mark
or
Error rate

NOTE This program was designed for CWT programs where two errors exist (see appendix 2). Binomial variance occurs because
a fraction of the pond population is marked, and
a fraction of the return is sampled.

The Petersen mark recovery portion of POND INVENTORY should be used for inventory purposes.

SINGLE MARK GROUP

Screen 1 (option 2 sample screen)

SELECT # 2

- 1 SAMPLE RATE
- 2 NUMBER TO MARK
- 3 ERROR RATE

ENTER :

Z 2 - TAILED	= 1.96
SURVIVAL RATE (%)	= 2
TOTAL RELEASE	= 100000
SAMPLE RATE (%)	= 50
ERROR RATE (%)	= 10

NUMBER TO MARK = 32007

HARDCOPY <Y/N>
SELECT #

- 1 ANOTHER RUN
- 2 ANOTHER RUN, SAME OUTPUT OPTION
- 3 RETURN TO MENU

Choose the solution you desire. Enter data as appropriate.
In a two tailed test with 95% confidence limits, Z equals 1.96. To enter default values, press <Return>.

Survival rate is from egg to returning adult.

If you run the program again, pressing <Return> will re-enter any data from the previous run.

Note : occasionally, data may cause results of greater than 100% marking, sampling or error rates. In most cases these are reduced to 100% and the data reworked with new parameters.

TOTAL GAS PRESSURE

PURPOSE This program calculates oxygen, nitrogen and total gas pressures of water supplies. It also predicts the effects of heating, cooling, or mixing two water supplies in any amounts.

INPUT	Gas tensiometer reading (mmHg)	Screen 6.0
	Barometric pressure (mmHg)	"
	Oxygen concentration (mg/L)	"
	Temperature (°C)	"
	or	
	Oxygen (O ₂) saturation (%)	Screen 5.1
	Nitrogen (N ₂) saturation (%)	"
	Barometric pressure (mmHg)	"
	Temperature (°C)	"

OUTPUT	Tension (mmHg)	(s)
	Barometric pressure (mmHg)	(s)
	Dissolved oxygen concentration (mg/L)	(s)
	Water temperature (°C)	(s)
	Bunsen oxygen coefficient (alpha)	
	Water vapour pressure (mmHg)	
	Nitrogen saturation concentration (mg/L)	
	Oxygen saturation concentration (mg/L)	
	Total gas pressure (%)	(s)
	Nitrogen as % of saturation (%)	(s)
	Oxygen as % of saturation (%)	(s)
	Dissolved nitrogen concentration	

(Note : (s) indicates contained in short summary)

PROGRAM PARTICULARS

TOTAL GAS PRESSURE was initially developed to calculate nitrogen and oxygen values from "saturometer" data. Total gas tension (mmHg) values from a Nova-Tech saturometer (or similar instrument) along with the oxygen concentration (mg/L), water temperature and barometric pressure provide the input for the calculation of Bunsen coefficients, water vapour pressure, nitrogen and oxygen at 100% saturation (mg/L) and the actual total gas pressure, nitrogen and oxygen saturation levels (%).

This program has been modified so a number of options are available. Firstly, the temperature of the water supply can be altered. The effect on gas values are predicted assuming no aeration after the temperature change.

TOTAL GAS PRESSURE

Secondly, provision has been made for the mixing of two water supplies. In this case, the resulting water temperature, nitrogen level (mg/L) and oxygen level (mg/L) have been calculated by taking the flow weighted average for each stream. The Bunsen coefficients, water vapour pressure, total gas pressure and the gas saturation values for the mixed stream are then predicted from this information.

Thirdly, a "short" version of the program is also available. This option excludes Bunsen coefficient and water vapour pressure data from the output.

Lastly, oxygen and nitrogen data may be entered in units of "% saturation". Output data would then include the oxygen and nitrogen concentration in units of "mg/L". Entering data in this way is often convenient if % saturation levels are known from previous saturometer measurements. The "temperature change", "mix" and "short" options can also be used.

The relationships used throughout this program have been presented in Appendix 3 (p. 23-1). A statement of relevant physical constants has also been provided.

It should be noted that throughout this program the term "nitrogen" means nitrogen plus argon. Also, the program can only be used with fresh water data. The model could easily be extended to saltwater, however this refinement has not been included in the program at present.

TOTAL GAS PRESSURE

Screen 1

TOTAL GAS PRESSURE

JUNE 29 /82

MCLEAN & WEST

This screen lists the authors. Press <Return> to continue.

Screen 2

***** ASSUMPTIONS *****

- 1 FRESH WATER
- 2 MOLE. WT. OXYGEN = 31.9988 G/MOLE
- 3 GAS MOLE. VOL. (STP) = 22.414 L/MOLE
- 4 OXYGEN (DRY AIR) = .20946(CRC HANDBOOK)
- 5 NITROGEN + ARGON (DRY AIR) = .79018(CRC)
- 6 NITROGEN = NITROGEN + ARGON
- 7 WATER VAPOUR PH20 (SHRIMPTON, 1975)
- 8 BUNSEN O2 COEFF, ALPHA (HITCHMAN, '78)
- 9 TGP% = $\text{BAR.} + \text{SAT.} - \text{PH20} / (\text{BAR.} - \text{PH20}) * 100\%$
- 10 MOLE. WT. NITROGEN = 28.0134

This screen is a list of the assumptions used in the program, along with references. Press <Return> when you are ready to continue.

TOTAL GAS PRESSURE

Screen 3

SHORT OR DETAILED SUMMARY <S/D>

You are offered the choice of short or detailed summaries.

The short summary consists of:

- tension
- barometric pressure
- dissolved oxygen concentration
- water temperature
- total gas pressure
- nitrogen and oxygen as percents of saturation.

The detailed summary consists of the preceding plus: Bunsen

- oxygen coefficient
- water vapour pressure
- nitrogen saturation concentration
- oxygen saturation concentration
- dissoved nitrogen concentration.

TOTAL GAS PRESSURE

Screen 4

*** TOTAL GAS PRESSURE ***

YOU MAY ENTER DATA IN ONE OF TWO METHODS

METHOD 1 : SATUROMETER READING (MMHG)
OXYGEN CONCENTRATION (MG/L)

METHOD 2 : % OXYGEN SATURATION
% NITROGEN SATURATION

WHICH METHOD <1 OR 2>

Select the method you wish to follow in entering data.

TOTAL GAS PRESSURE

Screen 5.0

*** TOTAL GAS PRESSURE ***

MEASURED SATUROMETER VALUE (MMHG)

MEASURED BAROMETRIC PRESSURE (MMHG)

MEASURED DISSOLVED OXYGEN (MG/L)

MEASURED WATER TEMPERATURE (°C)

OK <Y/N>

Enter the measurements in the form specified by "METHOD 1":
saturometer value, barometric pressure, dissolved oxygen
and water temperature.

Screen 5.1

*** TOTAL GAS PRESSURE ***

OXYGEN SATURATION (%)

NITROGEN SATURATION (%)

BAROMETRIC PRESSURE (MMHG)

MEASURED WATER TEMPERATURE (°C)

OK <Y/N>

Enter the measurements in the form specified by "METHOD 2":
oxygen saturation, nitrogen saturation, barometric pressure
and water temperature.

TOTAL GAS PRESSURE

Screen 6.0 (short summary)

	SOURCE #
MEASURED TENSION (MMHG) =	
MEASURED BAR.PRESSURE (MMHG) =	
MEASURED DISS. O2 CONC. (MG/L) =	
MEASURED WATER TEMP (°C) =	
TOTAL GAS PRESSURE (%) =	
N2 AS % OF SATURATION (%) =	
O2 AS % OF SATURATION (%) =	

This screen displays the results in the short summary format.

There will appear a series of questions regarding changes, a second source of water, and combinations of two sources. Depending on your answers, you will be carried back to previous screens for additional input. If you desire to change the details of source one after having combined the two, you must re-enter both sources.

TOTAL GAS PRESSURE

Screen 6.1 (detailed summary)

MEASURED TENSION (MMHG) =
MEASURED BAR.PRESSURE (MMHG) =
MEASURED DISS. O2 CONC. (MG/L) =
MEASURED WATER TEMP (°C) =

BUNSEN O2 COEFF. (ALPHA) =
WATER VAPOR PRESSURE (MMHG) =

N2 SATURATION CONC. (MG/L) =
O2 SATURATION CONC. (MG/L) =

TOTAL GAS PRESSURE (%) =
N2 AS % OF SATURATION (%) =
O2 AS % OF SATURATION (%) =
DISSOLVED N2 CONC. (MG/L) =

This screen displays the results in the detailed summary format.

There will appear a series of questions regarding changes, a second source of water, and combinations of two sources. Depending on your answers, you will be carried back to previous screens for additional input. If you desire to change the details of source one after having combined the two, you must re-enter both sources.

TOTAL GAS PRESSURE

Screen 7

<<<<< MIXING OF TWO SOURCES >>>>>

ENTER FLOW OF EACH SOURCE (IN ANY UNITS)
TO CALCULATE THE MIXTURE TENSIONS

ENTER FLOW FROM SOURCE 1

ENTER FLOW FROM SOURCE 2

This screen asks for the flows of the two sources of water.
The units of measurement are not important, only that they
are the same for both. You will return to screen 6.0 or
6.1 after mixing the flows.

TWO MARK GROUP - EQUAL

PURPOSE This program calculates mark recovery formulae similar to those in SINGLE MARK GROUP, but for two release groups of equal size. You may calculate any one of the number to mark, the adult sample rate or mean survival rate.

INPUT

Higher survival rate (%)	Screen 1
Lower survival rate (%)	"
Z for a one tailed test (once for each group) (default= 1.65)	"
Two of the following:	
Number of fish to be marked	Screen 2
Mean survival rate (%)	"
Adult sample rate (%)	"

OUTPUT

Number to mark,
Mean survival (%),
or
Adult sample rate (%)

TWO MARK GROUP - EQUAL

Screen 1

*** TWO MARK GROUP - EQUAL ***

FOR TWO GROUPS OF EQUAL RELEASE SIZE

ENTER :

HIGHER SURVIVAL RATE (%) =

LOWER SURVIVAL RATE (%) =

ZA (1 TAILED) = 1.65

ZB (1 TAILED) = 1.65

NOTE : FOR 1 TAILED TEST AT 95%
CONFIDENCE, ZA AND ZB = 1.65

SELECT #

- 1 NUMBER TO MARK
- 2 MEAN SURVIVAL RATE
- 3 ADULT SURVIVAL RATE

Enter data as appropriate.

Survival rate is from egg to returning adult.

In a one tailed test with 95% confidence limits, Z equals 1.65 (default value). To enter a default value (already shown on screen), press <Return>.

TWO MARK GROUP - EQUAL

Screen 2 (option 1)

CALCULATING NUMBER TO MARK

ENTER MEAN SURVIVAL RATE =
ENTER ADULT SAMPLE RATE =

NUMBER TO MARK =

HARDCOPY <Y/N>

SELECT #

1 ANOTHER RUN

2 ' ' ' ' WITH SAME ZA, ZB AND
SURVIVAL RATIO

3 RETURN TO MENU

Enter data as prompted.

TWO MARK GROUP - UNEQUAL

PURPOSE This program calculates mark recovery formulae similarly to SINGLE MARK GROUP and TWO MARK GROUP - EQUAL, but for two release groups of unequal size. It calculates the total marked return, the adult sample rate and the number of marks to recover.

INPUT	Number in each of the two release groups	Screen 1
	Z for a one tailed test (once for each group)	"
	One of the following:	
	Ratio of higher survival to lower and	Screen 2
	Mean survival rate	"
	or	
	Higher survival rate and	"
	Lower survival rate	"

OUTPUT Total marked return
Adult sample rate
Number of marks to recover

TWO MARK GROUP - UNEQUAL

Screen 1

**** TWO MARK GROUP - UNEQUAL **

FOR TWO GROUPS OF UNEQUAL RELEASE SIZE

ENTER :

NUMBER IN LARGER GROUP =

NUMBER IN SMALLER GROUP =

ZA (1 TAILED) = 1.65

ZB (1 TAILED) = 1.65

NOTE : FOR 1 TAILED TEST AT 95%
CONFIDENCE, ZA AND ZB = 1.65

SELECT # (DATA INPUT OPTIONS)

1 MEAN SURVIVAL RATE AND
SURVIVAL RATIO

2 HIGHER SURVIVAL RATE AND
LOWER SURVIVAL RATE

Enter data as appropriate. In a one tailed test with 95% confidence limits, Z equals 1.65. Select the method for data entry you wish.

TWO MARK GROUP -- UNEQUAL

Screen 2 (option 1)

ENTER :

MEAN SURVIVAL RATE =

SURVIVAL RATIO :

$$\frac{\text{HIGHER SURVIVAL RATE}}{\text{LOWER SURVIVAL RATE}} =$$

TOTAL MARKED RETURN =

ADULT SAMPLING RATE =

NO. OF MARKS TO RECOVER =

HARDCOPY <Y/N>

SELECT #

- 1 ANOTHER RUN
- 2 '' '' WITH THE SAME ZA, ZB,
 NUMBER IN LARGER GROUP AND
 NUMBER IN SMALLER GROUP
- 3 RETURN TO MENU

Enter data as prompted. There are two variations of this screen, depending on your choice of data entry in screen 1. The ratio of survivals must be greater than one.

APPENDIX 1.

Derivation of the Growth Model

The specific or instantaneous growth rate "g" is defined as:

$$g = \frac{1}{w} \frac{dw}{dt} \quad (1)$$

solving gives:

$$w = w_o e^{gt} \quad (2)$$

where:

w_o = initial weight (gm)
 w = final weight (gm)
 t = time (days)

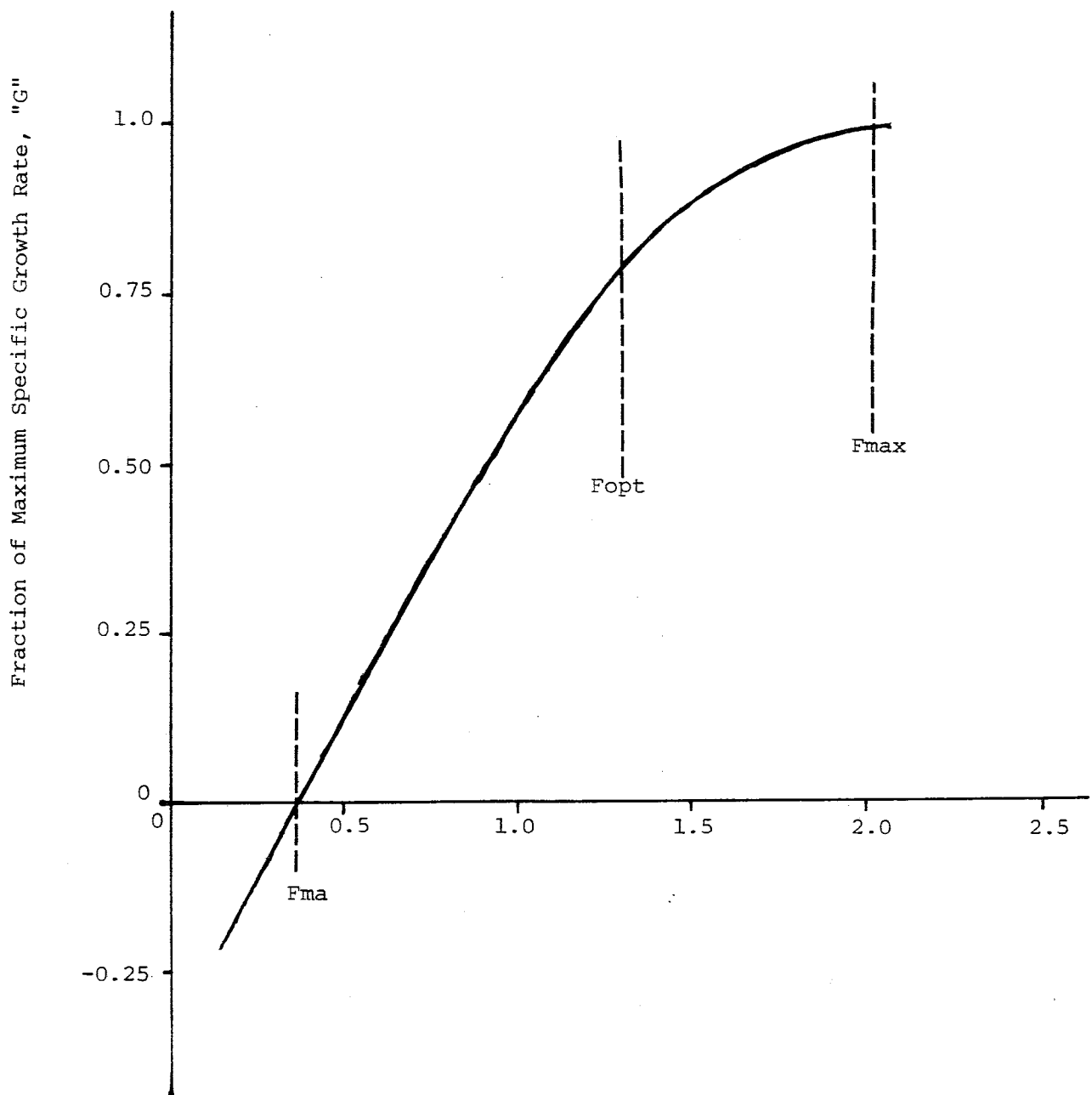
Equation 2 predicts fish growth accurately only under conditions where "g" is constant. Since "g" varies with the weight of the fish itself and the pond environmental conditions, equation 2 is valid only over short time intervals.

In this model, a time interval of 1 day has been used. Stauffer (1973) has provided a method for relating "g" to "w" and certain environmental conditions. Hence "g" can be recalculated on a daily basis and a new weight can be predicted using equation 2.

Stauffer (1973) has provided an excellent analysis of coho and chinook growth derived in part from studies carried out at Washington State Hatcheries. Of the many factors considered; diets, disease, maturity, photoperiod, ration and feeding frequency, social hierarchy, species and race, swimming activity and exercise size and age, and water temperature, it was concluded that ration, fish weight and water temperatures have the most important predictable influence on fish growth. Standard hatchery diets such as O.M.P. (Oregon Moist Pellet) were assumed.

The relationship between specific growth rate "g" and ration level "F" has been investigated by Brett et. al. (1969). Figure 3 shows the general shape of the curve relating "g" and "F".

FIGURE 3. Fraction of the maximum specific growth rate as a function of the ration level; values shown have been calculated for 10 gm fish at a water temperature of 10°C. The maintenance ration "F_{ma}" yields maximum growth (1.0). The relationship has been described by a sine curve.



It can be seen that the maintenance ration corresponds to zero growth, while the maximum ration by definition is required to achieve the maximum growth rate. If efficiency is defined as g/F for a given ration input "F" (the slope of a line passing from the origin to the curve at point F), then the optimum ration occurs at F_{opt} . (Figure 3).

Stauffer has mathematically described this curve by:

$$g = G \sin \frac{\pi}{2} \frac{(F - F_{ma})}{(F_{max} - F_{ma})} \quad (3)$$

where g = specific growth rate

G = maximum specific growth rate

F = ration level in units of gm dry food per 100 gm

fish flesh per day = fF_{max} (f = fraction of maximum ration)

F_{ma} = maintenance ration (gm dry food per 100 gm fish per day)

F_{max} = maximum ration (gm dry food per 100 gm fish
per day or percent biomass per day)

A 75% moisture has been assumed in the conversion from oven dried fish to fish flesh.

The maximum growth rate "G" is a function of temperature and is apparently best described by a polynomial (Stauffer, 1973):

$$G = a_1 + a_2(1.8T+32) + a_3(1.8T+32)^2 + a_4(1.8T+32)^3 + a_5(1.8T+32)^4 \quad (4)$$

$$0.0304w^{-0.3333}$$

where: $a_1 = 15.949$

$a_2 = 1.3849$

$a_3 = 0.946918$

$a_4 = 6.9698 \times 10^{-4}$

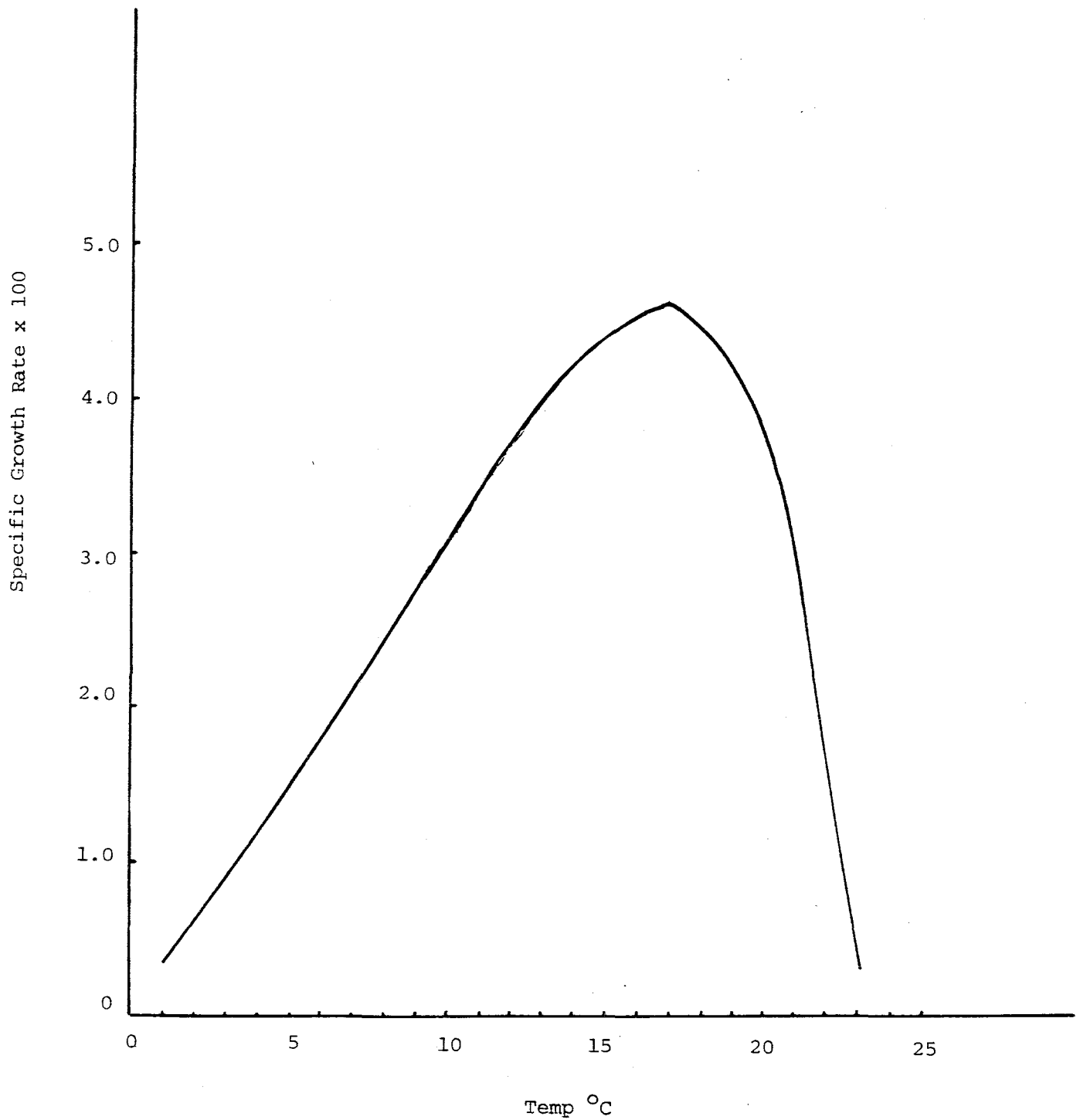
$a_5 = 3.8991 \times 10^{-6}$

T = temperature (daily average) $^{\circ}C$

w = weight (gm)

The relationship between "G" and temperature for 1 gm fish is shown graphically in Figure 4.

FIGURE 4. Specific growth rate $\times 100$ for 1 gm fish at the maximum ration as a function of water temperature. The relationship is described by a polynomial.



Stauffer has thoroughly reviewed the literature to find expressions for F_{ma} and F_{max} . These expressions will merely be stated:

$$F_{ma} = 0.1844(10)^{0.0504T_w + 0.200} \quad (5)$$

$$F_{max} = {}_w^{-0.333} - 37.71 + 10.73 \ln(1.8T + 32) \quad (6)$$

It should be noted that equation 5 and 6 are not valid at temperature extremes. At temperatures within 2 or 3°C of the upper lethal limit, loss of appetite occurs and equation 6 is not valid. Also, exact limits cannot be specified, these equations have been used only between 3°C and 20°C in the present study.

Solutions of the Growth Equations

At maximum ration and a constant temperature, the growth equations can be solved explicitly. Equation 3 reduces to:

$$g = G \text{ at } F = F_{\max}$$

and equation 4 reduces to:

$$G = Aw^{-B} \quad (7)$$

where:

A = a function of temperature

$$(0.0304) (a_1 + a_2 (1.8T + 32) + \dots \text{see equation 4})$$

$$B = 0.3333.$$

Since the expression for "g" is known, equation 1 becomes:

$$\frac{1}{w} \frac{dw}{dt} = Aw^{-B} \quad (8)$$

Solving for "w" as a function of time "t" gives:

$$w = (w_0^B + ABt)^{1/B} \quad (9)$$

where: w_0 = initial fish weight (gm)
w = final fish weight (gm)
t = time (days).

At 10°C, the relationship between "w" and "t" is:

$$w = (w_0^{0.3333} + 0.0101741t)^{3.0003} \quad (10)$$

Equation 10 provides an exact solution of the growth equation at 10°C and maximum ration.

It is interesting to note that equation 4 (Figure 4) is almost linear between 2°C and 12°C. Because of the linearity, a constant temperature within this range is not required for an explicit solution of equation 10; a good approximation can be obtained by using the average temperature. In other words, a predicted final weight based on a constant temperature of 10°C is the same as the predicted weight based on an average temperature of 10°C (as long as the temperatures range between 2°C and 12°C).

If the ration is less than maximum and the temperature is not constant, equation 2 cannot be solved explicitly.

The Apple II program calculates the growth daily and displays results every 5th day.

The Fish and Wildlife model (Iwama and Tautz, 1981) can be written in the form:

$$w^{1/3} = w_0^{1/3} + \left(\frac{T}{1000} \right) t \quad (11)$$

where: w = final weight (g)

w₀ = initial weight (g)

T = average temperature (°C)

t = time (days).

At 10°C this equation can be written as:

$$w = (w_0^{0.3333} + (0.010t))^3$$

This is very similar to equation 10 which was derived from Stauffer's model with a maximum ration and a constant temperature of 10°C.

Comparison with Measured Values

Model predictions must be compared with the actual growth records of production hatcheries in order to verify and define the limitations of the growth equations.

Stauffer has compared growth model predictions with the growth data from many U.S. coho and chinook hatcheries. Given the uncertainty of hatchery data, it is remarkable that growth was accurately predicted in nine out of fifteen chinook runs. Predicting coho growth was less successful; however, by making one reset during the run, growth was accurately predicted in eight out of fifteen trials.

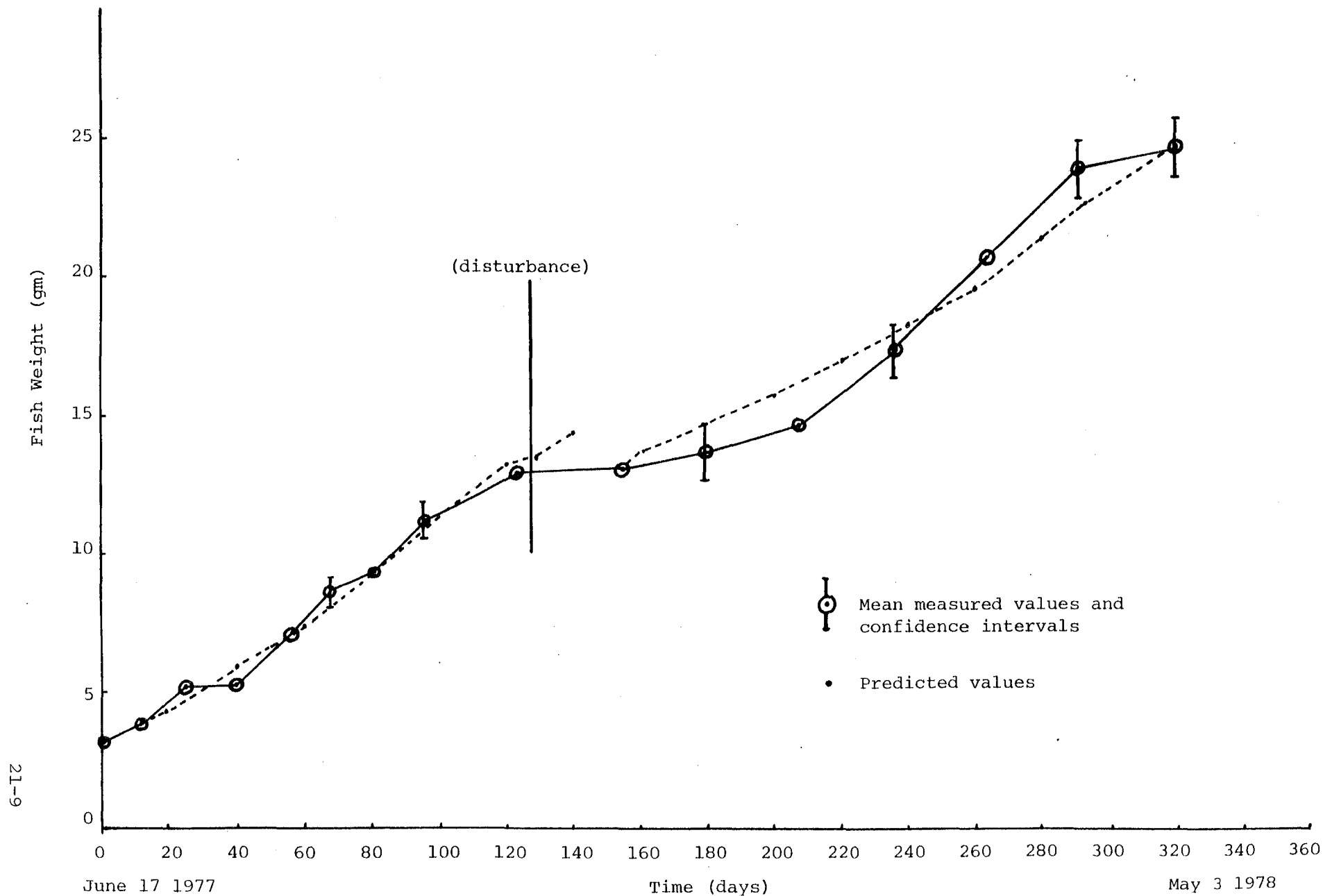
The growth of coho salmon in a 75-foot Burrows pond located at the Quinsam Hatchery was also compared to model predictions. Pond 5 (1976 brood) was monitored intensively from June 17, 1977 to May 3, 1978. Oregon Moist Pellet (O.M.P.) ration levels were apparently 80% of those specified by the O.M.P. Feeding Schedule. Inventory values were based on an initial weight count on June 17, 1977, followed by a statistical estimation of pond numbers on November 30, 1977. The estimate was based on the marked to unmarked ratio of a sample of 1169 fish from a population containing a known number of marks. The pond population estimate on November 30, 1977, was 48400 while the 95% confidence interval ranged between 45817 to 51291 fish.

Figure 5 shows actual growth and predicted growth from June 1977 to May 1978. Predicted growth was calculated by updating the specific growth rate "g" daily using Stauffer's growth equations, the average daily temperature and the daily ration level.

It can be seen from Figure 5 that growth is accurately predicted up until early October. At this time some effect other than fish size, temperature, or ration level suppressed growth and the model began to predict higher than actual values. However, by restarting the model at a mean weight of 13.2 gm on day 154, accurate projections were made to the end of the rearing period.

Actual and predicted weights on days 94 and 321 are compared in Table 1.

FIGURE 5 Comparison of predicted and measured growth at reduced ration levels. Ninety-five percent confidence intervals of selected measured values are shown.



Both days are near the end of computing periods when differences should be greatest. In both cases differences between predicted and actual values were not significant at the 0.05 level.

Actual mean weights were estimated from a random sample of 150 fish. The 95% confidence intervals were calculated in the usual manner (mean + 1.96 S $\sqrt{150}$). Because of uncertainties in the pond inventory and hence in the feeding levels, confidence limits were also calculated for predicted values.

TABLE 1. A comparison of predicted and actual weights for hatchery coho on a reduced ration.

Day	Predicted Weight (gm)	95% Confidence Interval	Measured Mean weight	95% Confidence Interval
94	10.87	10.73 to 11.01	11.28	10.62 to 11.93
321	25.06	24.05 to 26.06	24.83	23.68 to 25.98

The period between the middle of October and the end of November is important because it identifies a limitation of the model. It is interesting to note that this is a period of diminishing light intensity and shortening photoperiod. It should also be noted that an intensive marking program and pond transfer were begun on October 23rd. During the next five days, the ration was drastically reduced and intensive fish handling occurred.

To thoroughly define the limitations of the growth model, many comparisons should be made over a wide range of temperatures and ration levels. This process has begun but is difficult due to the uncertainty associated with hatchery data. At present, it will be hypothesized that the growth equations provide a realistic means for specifying the potential for growth under a given temperature regime and ration level.

References

- Stauffer, G.D. 1973. A growth model for salmonids reared in hatchery environments. PhD. Thesis. University of Washington, Seattle, Washington. 213 pp.
- Iwama, G.K. and A.F. Tautz. 1981. A simple growth model for salmonids in hatcheries. Can. J. Fish. Aquat. Sci. 38: 649-656.
- Brett, J.R., J.E. Selbourn and C.T. Shoop. 1969. Growth rate and body composition of fingerling sockeye salmon, (Oncorhynchus nerka), in relation to temperature and ration size. J. Fish Res. Board Can. 2363: 2394.

Appendix 2

Single Mark Group



Government of Canada Gouvernement du Canada

MEMORANDUM

NOTE DE SERVICE

TO
A

Cam J. West
Assessment Biologist

Dave R. Harding
Operations Support Biologist

FROM
DE

Bill McLean
Operations Support Biologist

SUBJECT
OBJET

SECURITY - CLASSIFICATION - DE SÉCURITÉ
OUR FILE / NOTRE RÉFÉRENCE
YOUR FILE / VOTRE RÉFÉRENCE
DATE

We have been considering only the survival of marked groups in our analysis. This is valid for comparison between groups. However, for assessing the contribution of say a single production group we must consider the marked group " n_1 " as a sample of the entire production " H ". The estimate of the survival of a single production group will have uncertainty due to the fact that:

- (a) only a proportion of the catch is samples (and so the survival of the marked group has uncertainty).
- (b) only a proportion of the production group was marked in the first place.

If we let the uncertainty in the survival (S_{n_1}) of the marked group be " e " and if we let " d " be the uncertainty in the estimate of the survival of the production group (S_H) (if S_{n_1} is known exactly) then the overall uncertainty " E " due to both errors is:

$$(1) \quad E^2 = e^2 + d^2$$

$$\text{or } S \pm E \text{ or } S \pm \sqrt{e^2 + d^2}.$$

where S = survival of the production group.

We want the overall error expressed in fractional form so:

$$(2) \quad S \pm ES = S \pm E = S \pm \sqrt{d^2 + e^2}$$

so $ES = \sqrt{d^2 + e^2}.$

The terms "d" and "e" can be found so that either the overall uncertainty in survival can be found or the number of fish to mark to achieve a certain degree of uncertainty can be found.

A. Find "d"

The uncertainty in the estimate of the survival of the marked group has been derived in the previous memo's. Briefly:

$$(3) \quad \begin{array}{ll} \text{Let } n &= \text{number of marked fish released} \\ H &= \text{total no. of hatchery fish} \\ \alpha &= \text{propation of catch sampled for marks} \\ S &= \text{survival of the marked group} \\ N &= \text{total catch} \end{array}$$

Let the propation of group (1) marks in the adult sample (αN) be given by p . Then confidence limits on p^1 are given by:

$$(4) \quad p^1 \pm Z \sqrt{\frac{p^1 (1-p^1)}{\alpha N} \left(1 - \frac{\alpha N}{N}\right)}$$

The survival of group (1) fish is given by:

$$S = \frac{p^1 N}{n_1}$$

This is a basic assumption: The survival of marked group $\pm$ uncertainty = survival of production group $\pm$ uncertainty.

In fact the uncertainties are equal only if the whole production group is marked.

$$\text{oo} \quad S = p^1 \frac{N}{n_1} \pm \frac{N}{n_1} Z \sqrt{\frac{p^1 (1-p^1)}{\alpha N} \left(1 - \frac{\alpha N}{N}\right)}$$

If we define the uncertainty in "S" by "d" as $S \pm$ then:

$$(5) \quad d = \frac{NZ}{n_1} \sqrt{\frac{p^1 (1-p^1)}{\alpha N} (1-\alpha)}.$$

Substitute $p^1 = \frac{Sn_1}{N}$ and simplify:

$$d^2 = \frac{Z^2}{n_1^2} \left[\left[\frac{Sn_1}{\alpha} - \frac{Sn_1^2}{\alpha N} \right] (1-\alpha) \right]$$

If N is large d^2 can be approximated by:

$$(6) \quad d^2 \approx \frac{Z^2 S (1-\alpha)}{n_1 \alpha}$$

B. Find e

Even if we sample the entire catch ($\alpha = 1$) there would still be uncertainty in our estimate of the overall survival because our marked group (n_1) represents only a sample of the entire production group (H). If we know the survival of the marked group is "S" then the confidence interval is given by:

$$(7) \quad S \pm Z \sqrt{\frac{S(1-S)}{n_1} \left(1 - \frac{n_1}{H}\right)}$$

Expressing the uncertainty in S by $S \pm e$ gives:

$$e = Z \sqrt{\frac{S(1-S)}{n_1} \left(1 - \frac{n_1}{H}\right)}$$

$$(8) \quad \text{or} \quad e^2 = \frac{Z^2}{n_1 H} \left[SH - S^2 H - n_1 S + n_1 S^2 \right]$$

C. Overall uncertainty

The overall uncertainty in the estimate of group survival is given by:

$$\sqrt{d^2 + e^2}$$

If we express the uncertainty as a fraction, ie. $S \pm ES$ then

$$SE = \sqrt{d^2 + e^2}$$

substituting expressions for "d" and "e" gives

$$(11) \quad E = \left[\frac{\frac{Z^2 S (1-\alpha)}{n_1 \alpha} + \frac{Z^2 (SH - S^2 H - n_1 S + n_1 S^2)}{n_1 k}}{S} \right]^{\frac{1}{2}}$$

$$\text{or} \quad E^2 = \frac{Z^2}{n_1 S} \left[\frac{(1-\alpha) H + (H - SH - n_1 + n_1 S) \alpha}{\alpha k} \right]$$

$$\text{or} \quad E^2 = \frac{Z^2}{n_1 S \alpha k} \left[H - SH \alpha - n_1 \alpha + n_1 S \alpha \right]$$

$$E = \frac{Z^2}{n_1 S \alpha H} \left[H (1 - S \alpha) - n_1 \alpha (1 - S) \right]$$

Solve for "n₁"

$$(12) \quad n_1 = \frac{Z^2 H (1 - \alpha S)}{E^2 S \alpha H + Z^2 \alpha (1 - S)}$$

Note:

- (1) If we mark the entire group ie. n₁ = k then eg. (12) reduces to:

$$(13) \quad n_1 = \frac{Z^2 (1 - \alpha)}{E^2 S \alpha}$$

ie. the only error is due to sampling the catch.

- (2) If we sample the entire catch ie. α = 1 then we know the survival of the marked group exactly, but we still do not know the survival of the production group exactly (unless n₁ = k). If α = 1 eg. (12) reduces to:

$$n_1 = \frac{Z^2 H (1 - S)}{E^2 S H + Z^2 (1 - S)}$$

If n₁ = k in this case (as well as α = 1) then E = 0, ie. we know the survival and hence contribution of the production group exactly.

The confidence limits for "S" will be given by:

$$S \pm ES$$

$$ES = \left[\frac{Z^2 S (1 - \alpha)}{n_1 \alpha} + \frac{Z^2 S (H - SH - n_1 + n_1 S)}{n_1 H} \right]^{\frac{1}{2}}$$

$$ES = Z \sqrt{\frac{S}{n_1}} \left[\frac{1 - \alpha}{\alpha} + \frac{(H - HS - n_1 + n_1 S)}{H} \right]^{\frac{1}{2}}$$

$$ES = Z \sqrt{\frac{S}{n_1}} \left[\frac{H - HS \alpha - n_1 \alpha + n_1 S \alpha}{k \alpha} \right]^{\frac{1}{2}}$$

$$ES = Z \sqrt{\frac{S}{n_1}} \left[\frac{H (1-S\alpha) - n_1 \alpha (1-S)}{H\alpha} \right]^{\frac{1}{2}}$$

Lower conf. limit

$$= S - \left\{ Z \sqrt{\frac{S}{n_1}} \left(\frac{H (1-S\alpha) - n_1 \alpha (1-S)}{H\alpha} \right)^{\frac{1}{2}} \right\}$$

Upper limit

$$= S + \left\{ Z \sqrt{\frac{S}{n_1}} \left(\frac{H (1-S\alpha) - n_1 \alpha (1-S)}{H\alpha} \right)^{\frac{1}{2}} \right\}$$

APPENDIX 3

Equations 1 to 30 are the basis of the "Total Gas Pressure" program. Most of the equations relating to Oxygen were taken from Hitchman (1978). The nitrogen and argon relationships were developed by Weiss (1970).

Constants used throughout the program were taken from the Handbook of Physics and Chemistry.

Summary

1. Molecular weight of oxygen (O_2) = 31.9988 g
2. Molecular weight of nitrogen (N_2) = 28.0134 g
3. Volume occupied by 1 mole of gas at standard temp. ($^{\circ}C$) and pressure (760 mmHg) = 22414 ml
4. Molecular weight of argon (Ar) = 39.948 g
5. Fraction of oxygen in dry air = 0.20946
6. Fraction of nitrogen in dry air = 0.78084
7. Fraction of argon in dry air = 0.00934
8. Temperature: $^{\circ}K = ^{\circ}C + 273.16^{\circ}$

Oxygen

The percent oxygen saturation was calculated according to:

$$X = \frac{C}{C_S} \times 100\% \quad (1)$$

where: X = % saturation

C = oxygen concentration (mgÅ l)

C_S = oxygen concentration at 100% saturation (mgÅ l).

The 100 percent oxygen concentration values " C_S " were calculated from equation 2 (Hitchman, 1978).

$$C_S = 0.39346 \alpha (P_a - P_w) \quad (2)$$

where C_S = oxygen concentration at 100% saturation (mg/ l)

P_a = barometric pressure (mmHg)

P_w = water vapor pressure (mmHg)

α = Bunsen absorption coefficient

(α is defined as the volume of oxygen, m l (reduced to 0°C and 760 mmHg) which, at the temperature of the measurement, is dissolved in 1 m l of water when the partial pressure of the gas is 760 mmHg, ($P_{O_2} = 760$ mmHg).

Equation 2 can be derived by converting " α " to common units. The saturation value of dissolved oxygen in units of mg of oxygen per liter of water at a partial pressure of 760 mmHg is given by:

$$\alpha = \frac{31998.8 \times 10^3}{22414} \quad (3)$$

where 31998.8 is the molecular weight of oxygen (mg/mole) and 22414 is the molar volume (m l /mole). We are considering oxygen/water systems so the partial pressure of the oxygen at a total pressure of 760 mmHg will be slightly reduced due to the vapour pressure of the water. So, for oxygen-saturated water (where $P_{O_2} = 760 - P_w$):

$$C_S = \alpha \frac{31998.8 \times 10^3}{22414} \left[\frac{760 - P_w}{760} \right] \quad (4)$$

However, at atmospheric conditions dry air is only 20.946 percent oxygen by volume, so " C_S " is given by:

$$C_S = (0.20946) \alpha \frac{31998.8}{22414} 10^3 \left[\frac{760 - P_w}{760} \right] \quad (5)$$

If atmospheric pressures change from 760 to P_a , the value of " C_s " will change by a factor of:

$$\frac{P_a - P_w}{760 - P_w}$$

Multiplying equation 5 by this factor gives the general expression for " C_s " (equation 2):

$$C_s = (0.20946) \propto \frac{31998.8}{22414} 10^3 \left[\frac{P_a - P_w}{760} \right]$$

or

$$C_s = 0.39346 \propto (P_a - P_w). \quad (5a)$$

The Bunsen coefficient " α " was calculated according to equation 6 (Hitchman, 1978):

$$\alpha = (a + bT + cT^2 + dT^3 + eT^4) 10^{-3} \quad (6)$$

where: $a = 49.01$
 $b = -1.335$
 $c = 2.759 \times 10^{-2}$
 $d = 3.235 \times 10^{-4}$
 $e = 1.614 \times 10^{-6}$
 $T = \text{temperature } ^\circ\text{C}.$

The water vapour pressure term " P_w " was calculated from equation 7 (Shrimpton, 1975):

$$P_w = 760 \exp \left[70.4346943 - \frac{7362.6981}{T} + 0.006952085T - 9 \ln T + 0.002 \right] \quad (7)$$

where: $P_w = \text{water vapour pressure (mmHg)}$

$T = \text{temperature } (^\circ\text{K})$

Note: $T(^{\circ}\text{K}) = T(^{\circ}\text{C}) + 273.16$

$\ln = \text{natural log}.$

Values for C_s as a function of temperature and pressure are shown in Table 1. Calculated values for water vapour pressure are displayed in Table 2.

TABLE 1: Dissolved oxygen concentration (mg/ l) at 100% saturation as a function of temperature (°C) and pressure (mmHg) (from Hitchman, 1978).

TEMP(°C)	<u>Atmospheric Pressure (mmHg)</u>									
	750	755	760	765	770	775	780	785	790	795
0	14.37	14.47	14.57	14.66	14.76	14.86	14.95	15.05	15.15	15.24
1	13.98	14.08	14.17	14.27	14.36	14.45	14.55	14.64	14.73	14.83
2	13.61	13.70	13.79	13.88	13.97	14.07	14.16	14.25	14.34	14.43
3	13.25	13.34	13.43	13.52	13.61	13.69	13.78	13.87	13.96	14.05
4	12.90	12.99	13.08	13.16	13.25	13.34	13.42	13.51	13.60	13.68
5	12.57	12.66	12.74	12.83	12.91	13.00	13.08	13.16	13.25	13.33
6	12.25	12.34	12.42	12.50	12.58	12.67	12.75	12.83	12.91	13.00
7	11.95	12.03	12.11	12.19	12.27	12.35	12.43	12.51	12.59	12.67
8	11.66	11.74	11.81	11.89	11.97	12.05	12.13	12.21	12.29	12.36
9	11.38	11.45	11.53	11.61	11.68	11.76	11.84	11.91	11.99	12.07
10	11.11	11.18	11.26	11.33	11.41	11.48	11.56	11.63	11.71	11.78
11	10.85	10.92	10.99	11.07	11.14	11.21	11.29	11.36	11.43	11.51
12	10.60	10.67	10.74	10.81	10.89	10.96	11.03	11.10	11.17	11.24
13	10.36	10.43	10.50	10.57	10.64	10.71	10.78	10.85	10.92	10.99
14	10.13	10.20	10.27	10.34	10.41	10.48	10.54	10.61	10.68	10.75
15	9.91	9.98	10.05	10.11	10.18	10.25	10.32	10.38	10.45	10.52
16	9.70	9.77	9.83	9.90	9.96	10.03	10.10	10.16	10.23	10.29
17	9.50	9.56	9.63	9.69	9.76	9.82	9.89	9.95	10.01	10.08
18	9.30	9.37	9.43	9.49	9.56	9.62	9.68	9.75	9.81	9.87
19	9.12	9.18	9.24	9.30	9.36	9.43	9.49	9.55	9.61	9.67
20	8.93	9.00	9.06	9.12	9.18	9.24	9.30	9.36	9.42	9.48
21	8.76	8.82	8.88	8.94	9.00	9.06	9.12	9.18	9.24	9.30
22	8.59	8.65	8.71	8.77	8.83	8.89	8.95	9.01	9.06	9.12
23	8.43	8.49	8.55	8.61	8.66	8.72	8.78	8.84	8.90	8.95
24	8.28	8.33	8.39	8.45	8.50	8.56	8.62	8.67	8.73	8.79
25	8.13	8.18	8.24	8.29	8.35	8.41	8.46	8.52	8.57	8.63
26	7.98	8.04	8.09	8.15	8.20	8.26	8.31	8.37	8.42	8.48
27	7.84	7.89	7.95	8.00	8.06	8.11	8.17	8.22	8.27	8.33
28	7.70	7.76	7.81	7.86	7.92	7.97	8.02	8.08	8.13	8.18
29	7.57	7.63	7.68	7.73	7.78	7.84	7.89	7.94	7.99	8.05
30	7.44	7.50	7.55	7.60	7.65	7.70	7.76	7.81	7.86	7.91
31	7.32	7.37	7.42	7.47	7.52	7.58	7.63	7.68	7.73	7.78
32	7.20	7.25	7.30	7.35	7.40	7.45	7.50	7.55	7.60	7.65
33	7.08	7.13	7.18	7.23	7.28	7.33	7.38	7.43	7.48	7.53
34	6.97	7.02	7.07	7.11	7.16	7.21	7.26	7.31	7.36	7.41
35	6.86	6.90	6.95	7.00	7.05	7.10	7.15	7.19	7.24	7.29

TABLE 2: Calculated water vapour pressure (mmHg) as a function of water temperature (°C) (from Shrimpton, 1975).

<u>Temperature °C</u>	<u>Water Vapour Pressure (mmHg)</u>
0	4.5834
2	5.2939
4	6.1002
6	7.0133
8	8.0450
10	9.2083
12	10.5172
14	11.9871
16	13.6344
18	15.4771
20	17.5344

Nitrogen

The percent nitrogen saturation was calculated from equation 8:

$$N = \frac{S}{N_2} \times 100\% \quad (8)$$

where: N = % saturation in nitrogen gas

S = nitrogen concentration (mg/ ℓ)

N_2 = nitrogen concentration at 100% saturation (mg/ ℓ)

The 100% nitrogen concentration values " N_2 " were calculated from equation 9:

$$N_2 = 1.28409 \beta (P_a - P_w) \quad (9)$$

where: P_a = barometric pressure (mmHg)

P_w = water vapour pressure (mmHg)

β = Bunsen absorption coefficient for nitrogen (β is defined as the volume of nitrogen, ml (reduced to °C and 760 mmHg) which, at the temperature of the measurement, is dissolved in 1 m ℓ of water when the partial pressure of the gas is 760 mmHg.

Equation 9 can be derived by converting " β " into units of mg/ ℓ :

$$\text{mg of nitrogen per liter} = \beta \frac{28013.4}{22414} \times 10^3 \quad (10)$$

The molecular weight of nitrogen is 28013.4 mg per mole while the volume at standard temperature and pressure is 22414 m ℓ per mole. Since " β " denotes the volume of nitrogen (at standard conditions) per m ℓ of water, equation 10 indicates the weight of nitrogen dissolved in the water in units of mg/ ℓ . Equation 10 applies when the partial pressure of the nitrogen is 760 mmHg. In air/water systems the water vapour pressure " P_w " must be taken into account:

$$N_2 = \beta \frac{28013.4}{22414} \times 10^3 \times \left[\frac{760 - P_w}{760} \right] \quad (11)$$

However, at atmospheric conditions dry air is only 78.084% nitrogen by volume, so:

$$N_2 = (0.78084) \beta \left[\frac{28013.4}{22414} \right] 10^3 \left[\frac{760 - P_w}{760} \right] \quad (12)$$

If atmospheric conditions change from 760 mmHg to " P_a " then the expression for N_2 becomes:

$$N_2 = (0.78084) \beta \left[\frac{28013.4}{22414} \right] 10^3 \left[\frac{P_a - P_w}{760} \right] \quad (13)$$

or

$$N_2 = 1.28409 \beta (P_a - P_w)$$

The Bunsen coefficient for nitrogen was calculated from equation (14):

$$\ln \beta = -59.6274 + 85.7661 \left[\frac{100}{T} \right] + 24.3696 \ln \left[\frac{T}{100} \right] \quad (14)$$

(Weiss, 1970).

where: T = temperature ($^{\circ}K$)

$\ln$ = natural log

β = Bunsen coefficient for nitrogen

Argon

Similar expressions can be derived for argon:

$$Ar = (0.00934) R \left[\frac{39948}{22414} \right] 10^3 \left[\frac{P_a - P_w}{760} \right] \quad (15)$$

$$\text{or } Ar = 0.02190 R (P_a - P_w) \quad (16)$$

where: 0.00934 = fraction of argon in dry air

Ar = argon concentration at 100% saturation (mg/ l)

R = Bunsen coefficient for argon

The Bunsen coefficient "R" was calculated from equation 17 (Weiss, 1970):

$$\ln R = -55.6578 + 82.0262 \left[\frac{100}{T} \right] + 22.5929 \ln \left[\frac{T}{100} \right] \quad (17)$$

where: T = temperature (°K)

Nitrogen + Argon

In fish culture, nitrogen and argon concentrations are usually combined. The saturation value for nitrogen and argon, "N₂ + Ar", can be found by adding equations 9 and 16:

$$N_2 + Ar = 1.28409 \beta (P_a - P_w) + 0.02190 R (P_a - P_w) \quad (18)$$

$$\text{or } N_2 + Ar = (P_a - P_w) (1.28409 \beta + 0.02190 R) \quad (19)$$

where: β and R are given by equations 14 and 17.

The expression for nitrogen (nitrogen + argon) shown in equation 19 denotes the concentration at 100% saturation. In fish culture, nitrogen levels are often supersaturated. Nitrogen levels can be calculated by combining accurate temperature, barometric pressure and dissolved oxygen data with total gas tension values (as measured by a Tensionometer).

The partial pressure of the nitrogen at equilibrium is given by:

$$(P_a - P_w) 0.79018 \quad (20)$$

The partial pressure of the nitrogen in the fish culture environment can be calculated from:

$$(P_a + \Delta P) - P_{O_2} - P_w \quad (21)$$

where: P_a = barometric pressure (mmHg)
 ΔP = measured tensionometer value (mmHg)
 P_{O_2} = partial pressure due to oxygen
 P_w = water vapour pressure (mmHg)

Equation 21 assumes that oxygen and water vapour are the only other components contributing to the total gas tension.

The ratio of these two terms gives the supersaturation level of nitrogen + argon, "N%".

$$N(\%) = \frac{((P_a + \Delta P) - P_{O_2} - P_w)}{0.79018 (P_a - P_w)} \times 100\% \quad (22)$$

The partial pressure of the oxygen can be calculated from the measured value "C" and the saturation value:

$$P_{O_2} = \frac{C (0.20946)(P_a - P_w)}{C_s} \quad (23)$$

Substituting the expression for " C_s " (equation 5a) into equation 28 gives:

$$P_{O_2} = \frac{C(0.20946)}{\propto 0.39346} = \frac{C(0.53235)}{\propto} \quad (24)$$

Substituting this expression into equation 22 gives the working formula for calculating the % saturation in nitrogen and argon, "N%":

$$N(\%) = \left[\frac{(P_a + \Delta P) - \frac{C(0.53235)}{\alpha} - P_w}{(P_a - P_w) 0.79018} \right] \times 100\% \quad (25)$$

where: α = Bunsen coefficient for oxygen (eq 6).

P_w = water vapour pressure, mmHg (eq 7)

ΔP = measured tensionometer value, mmHg

C = measured dissolved oxygen level, mg/l

P_a = barometric pressure, mmHg.

Total Gas Pressure

Total gas pressure values have been calculated from equation 26:

$$TGP = \frac{(P_a + \Delta P - P_w)}{P_a - P_w} \times 100\% \quad (26)$$

$$P_a - P_w$$

where: TGP = total gas pressure (%)

ΔP = gas pressure above or below saturation (reading from a tensionometer zeroed in the atmosphere)

Equation 26 can be re-arranged to give:

$$TGP = 100 + \frac{\Delta P}{P_a - P_w} 100 \quad (27)$$

$$P_a - P_w$$

If the tensionometer is zeroed in water saturated air, the " ΔP " value represents the partial pressure of oxygen and nitrogen above the equilibrium value, ie:

$$\Delta P = P_{O_2} - 0.20946 (P_a - P_w) + P_{N_2} - 0.79018(P_a - P_w) \quad (28)$$

where: P_{O_2} = partial pressure of oxygen

P_{N_2} = partial pressure of nitrogen + argon

$$\text{Since: } P_{O_2} = \frac{C}{C_s} (0.20946)(P_a - P_w)$$

$$\text{and } P_{N_2} = \frac{S}{N_2} (0.79018)(P_a - P_w)$$

$$\Delta P = (0.20946)(P_a - P_w) \left[\frac{C}{C_s} - 1 \right] + (0.79018)(P_a - P_w) \left[\frac{S}{N_2} - 1 \right] \quad (29)$$

Substituting this expression for ΔP into equation 27 gives:

$$TGP = 100 + 20.946 \left[\frac{C - C_s}{C_s} \right] + 79.018 \left[\frac{S - N_2}{N_2} \right] \quad (30)$$

where: TGP = total gas pressure (%)

C = measured oxygen concentration (mg/ l)

C_s = oxygen concentration at 100% (mg/ l)

S = nitrogen concentration (mg/ l)

N_2 = nitrogen concentration at 100% (mg/ l)

Mixture of Water Sources

If water supply "1" has a flow of " Q_1 " and supply "2" has a flow of " Q_2 " (in the same units) then the resulting temperature " T ", oxygen level " C " (mg/ l) and nitrogen level " S " (mg/ l) are:

$$T = \frac{T_1 Q_1}{Q_1 + Q_2} + \frac{T_2 Q_2}{Q_1 + Q_2} = \frac{T_2 + FT_1}{1 + F} \quad (31)$$

where: T_1 = temperature of source 1

T_2 = temperature of source 2

T = resulting temperature

F = mix ratio = Q_1/Q_2

(note: if we are mixing equal flows then $F = 1$ and we have a simple average)

Similarly:

$$C = \frac{C_2 + FC_1}{1 + F} \quad (32)$$

and

$$S = \frac{S_2 + FS_1}{1 + F} \quad (33)$$

where: C_1 = oxygen concentration source 1 (mg/ l)

C_2 = oxygen concentration source 2 (mg/ l)

S_1 = nitrogen concentration source 1 (mg/ l)

S_2 = nitrogen concentration source 2 (mg/ l)

F = mix ratio Q_1/Q_2

The mixed temperature value " T " can be used to calculate Bunsen coefficients (α and β , eq. 6 and eq. 14). This allows calculation of oxygen and nitrogen saturation values (mg/ l) " C_s " and " N_2 " (eq 5a and 19) which in turn gives % saturation values for oxygen and nitrogen (eq 1 and 8). Total gas pressure for the mixed stream can be calculated from equation 30.

References

Hitchman, M.L. 1978. Measurement of dissolved oxygen. Wiley - Interscience, New York, N.Y. 255 p.

Shrimpton, N. 1975. Dissolved gas program designed in 1975 by Mr. Neil Shrimpton, for use on WANG-500TP, draft. Pollution Control Branch, Environmental Protection Service, Ministry of the Environment, Victoria, B.C.

Weiss, R.F. 1970. The solubility of nitrogen and oxygen and argon in water and seawater. Deep-sea Research 17: 721-735.

