February 17th, 2003

Dr. Lucky One
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 *Fish Spawning Data Collection System Functional Specification*

Dear Dr. One:

Attached you will find Aqua Ichiban Innovations' Functional Specification for a Fish Counter. This document lists the functional specifications for our ENSC 440 project.

We are currently designing a fish counting system that will be used by members of the Pacific Streamkeepers volunteer program to determine the number of salmon spawning in a section of stream at any given time. Using underwater sensors and a microprocessor, our project will detect passing fish and store the data until a streamkeeper retrieves it. From there the data will be passed on to the home computer of a streamkeeper for further processing and submission to the StreamKeepers database.

The purpose of this functional specification is to list the parameters that our fish counting system will satisfy and explain our system layout in greater detail.

Aqua Ichiban Innovations is comprised of 4 students: J.P. Lee, Jason Mahony, Roger Stock and Willy Wu. For further information about our project please contact the group mailing list at 440-fish@sfu.ca.

Sincerely,

J.P. Lee
Aqua Ichiban Innovations

Enclosure: *Fish Spawning Data Collection System Functional Specification*

Fish Spawning Data Collection System Functional Specification

Submitted by:	Aqua Ichiban Innovations: J.P. Lee Roger Stock Willy Wu Jason Mahony
Submitted to:	Lucky One School of Engineering Science Simon Fraser University
Contact:	J.P. Lee jplee@smassive.com

Date: Feb. 17, 2003
Revision: 1.1

Executive Summary

The Pacific Streamkeepers Foundation is a community based organization whose goal is to care for the streams that the pacific fish population uses for the purposes of reproduction and spawning. Aqua Ichiban Innovations acknowledges the important contributions that the Pacific Streamkeepers Foundation gives to society and has established a goal of assisting this group of volunteers with improving the fish monitoring aspect of the Foundation.

At present, the Streamkeepers have methods of counting that is prone to error through the inherent problem of infrequent sampling intervals. As well, the way in which the information is transferred from the volunteer members to the central database is subject to replication of keying and writing down data and the possibility of making a mistake while doing so.

In this document, we will discuss the Functional Specifications of the Fish Spawning Data Collection System, a system that Aqua Ichiban proposes will address these two issues of information accuracy in spawning fish data collection and the delivery of this information to the Streamkeepers Database.

This functional specification describes each of the significant portions of the project and establishes the expected behaviour and performance of the portion and how it will contribute to the entire system. The project was divided into portions each with a specific purpose. The five portions are:

- A Field Component whose purpose is to determine when fish enter the selected volume of water, when they leave, and hold the information until its time is collected by the streamkeeper;
- A Field Component User Interface that allows the streamkeeper to interact with the Field Component and perform maintenance functions upon it;
- A Data Exchange Mechanism, which allows the streamkeeper to transfer the information obtained from the Field Component as soft data;
- A Home Component, whose purpose is to combine, process and perform computational functions upon the data collected, and
- A Home Component User Interface, which allows the streamkeeper to transfer the information from the Data Exchange Mechanism and to initiate the Home Component's Core functions.

Through this project, it is Aqua Ichiban's goal as well as hope that society and the environment will be the beneficiary of the improved information on Pacific fish migratory patterns that the Pacific Streamkeepers so dutifully obtain.

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1 Introduction

Aqua Ichiban aims to improve the existing fish spawning data collection methods under the StreamKeepers volunteer program. Firstly, we would like our devised system to improve the data collected in accuracy and detail. Secondly we would like to enhance the efficiency of data flow within the StreamKeepers.

From this project description, we can give the following major problem definitions:

a) To determine the “evaporation” of fish in a specified volume over time.
b) To transport data collected within the system to target destinations.

The volume is the surveyed section of stream, defined by two boundaries. Since it is assumed that fish entering the volume to spawn will die, “evaporation” of fish implies the eventual disappearance of live fish from the volume (e.g. death, bear eating live or dead fish in the volume, etc). Therefore, our goal is to determine the disappearance of fish in the volume over time (whatever the reason) as an accurate estimate of the fish spawning count in the volume.

In the existing data collection method, volunteers manually record data onto data sheets at the stream. By introducing a system to determine the evaporation of fish, we must determine the methods of collecting and transporting the data for this new system.

1.1 Requirement Notation

The following notation will be used throughout the document:

[R1] Functional Requirement

This notation lists the number of the requirement followed by a text description of the requirements’ specifics.

1.2 Scope and Intended Audience

This document describes the functional requirements that must be met by our Fish Counting System. Each requirement is necessary to establish the functionality of the proof of concept device. Because our project is to be used solely by trained members of the Pacific Streamkeepers Foundation our product is not geared towards the general public. Our Fish Counting System design will only follow these proof of concept specifications and as a result, does not necessarily attempt to address the practicalities that a device of this nature would require to work in the harsh environment of a stream in the wild. The requirements listed here drive the design of the Fish Counting System. All requirements are recorded in our design documentation.

1.3 Acronyms

FC	Field Component
FCUI	Field Component User Interface
DXM	Data Exchange Mechanism
HC	Home Component
HCUI	Home Component User Interface

2 System Overview

2.1 High Level Overview

The following figure shows the high level organization of our system, including the five major system components.

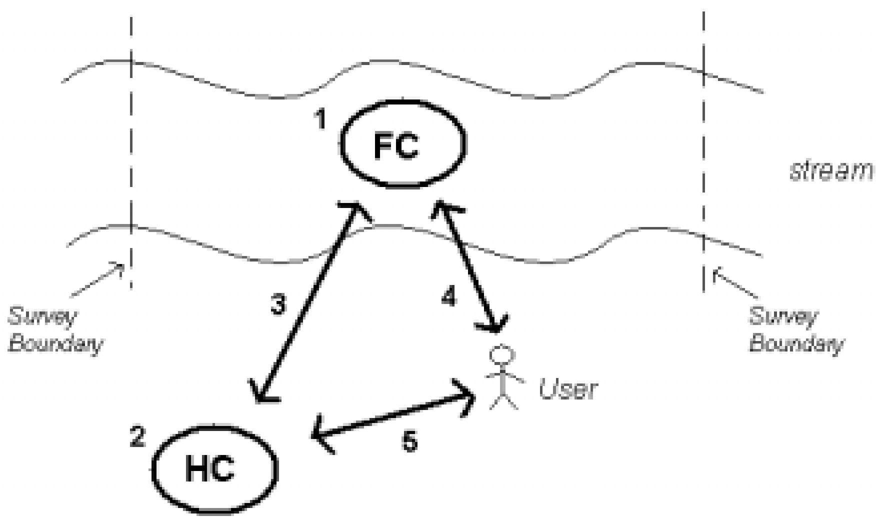

Figure 1: System Overview

The five numbered system components and their acronyms are:

1. Field Component (FC)
2. Home Component (HC)
3. Data Exchange Mechanism (DXM)
4. Field Component User Interface (FC-UI)
5. Home Component User Interface (HC-UI)

Other objects of interest are the stream itself, the section of stream defined by two boundaries (called the volume) and a user that interacts with the system.

[R2] The defined volume should have no stream forks or branches between the two chosen boundaries.

2.2 Field Component Overview

The FC is represented "in" the stream because it involves information collection from fish. This component is critical in determining the evaporation of fish.

Two possible approaches to determining evaporation of fish in the volume are:

a) Boundary Fish Flux
b) Volume Fish Count

The Volume Fish Count approach could be described as a count of fish in the volume at any instance in time – a snapshot. The existing methodology uses this approach. A single count gives us information only for that instance; to understand what is happened over time, recurring counts must be performed.

The Boundary Fish Flux approach monitors the (2) boundaries to determine what is happening. Again, to understand what is happening over time, information at the boundaries must be collected periodically.

In either case, we are attempting to determine fish evaporation over *time* so we would want as much data collected as possible (constant boundary monitoring or fish counts). Since collecting information at a boundary is less complex than collecting information over the entire volume and varying volume size doesn't affect the boundary approach but changes the volume count complexity, we will mainly on focus the Boundary Fish Flux approach.

[R3] Our system will employ a Boundary Fish Flux approach to determining evaporation of fish in the volume.

The following sections describe two subsystems within the Field Component. Note that Functional Requirements are listed under these sections as well as under a general specification section to follow.

2.2.1 FC Gate Subsystem

The following figure represents a model for a Gate Subsystem within the Field Component.

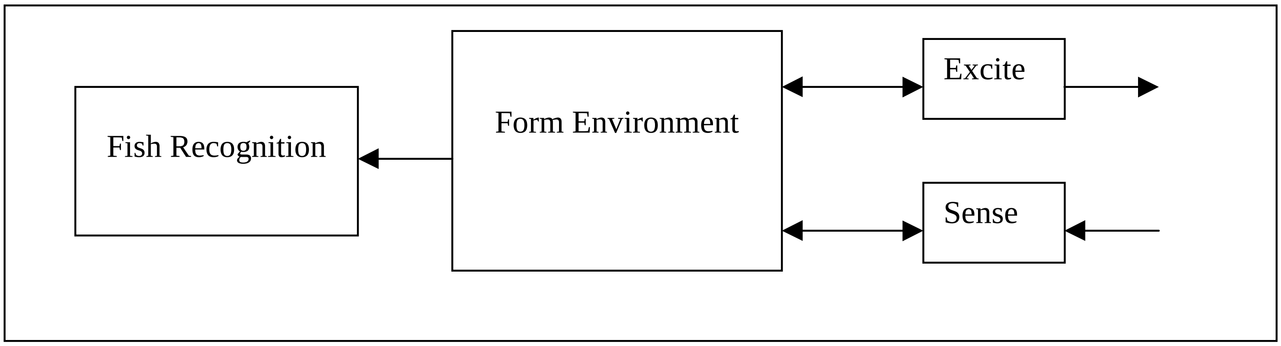

Figure 2: Gate Subsystem Model

This model shows that to detect fish at the boundary, the subsystem must excite the environment (e.g. sensing into the stream). From the feedback received, the environment can be determined (e.g. objects crossing the boundary). The last logical block must determine whether a fish or other object has crossed the boundary.

[R4] The Gate Subsystem will be implemented as a distributed, rather than centralized, system. There will be a Gate Subsystem located at each boundary location and they shall be equivalent in functionality.

[R5] A Gate Subsystem will recognize a fish as an object crossing a boundary in the upstream direction.

[R6] A Gate Subsystem will disregard any object crossing a boundary in the downstream direction.

[R7] A Gate Subsystem will be the only system component that has direct physical contact with the stream.

2.2.2 FC Bank Subsystem

The following figure represents a model for a Bank Subsystem within the Field Component.

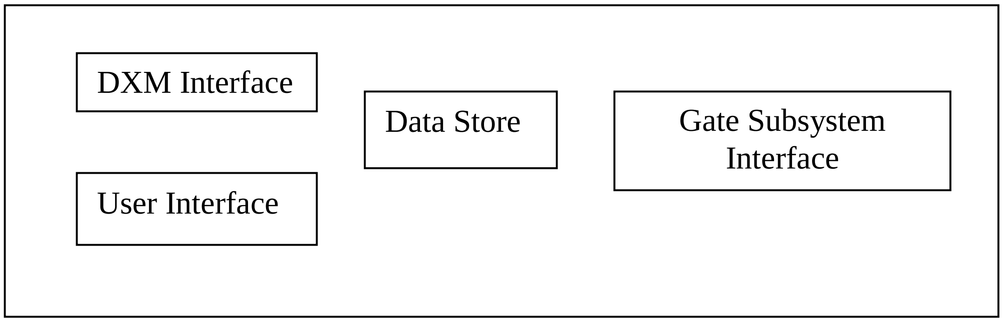

Figure 3: Bank Subsystem Model

The purpose of the bank subsystem is to provide a dry-land access point to the FC for the user. Data obtained from the Gate Subsystem is to be stored in the Bank Subsystem for the user to retrieve.

Since there are two Gate Subsystems, there is a possibility for a centralized Bank Subsystem (a single system receiving data from both Gate Subsystems) or a distributed Bank Subsystem (a Bank Subsystem for each Gate Subsystem). In a centralized system, the Boundary Subsystem Interface increases in complexity, as information from each gate must be transmitted over potentially large distances to the centralized Bank Subsystem. In a decentralized system, the Boundary Subsystem interface is simplified as the Boundary and Bank Subsystems can be within close proximity of each other. A decentralized system will increase the user interaction, as the user must deal with two systems instead of one.

[R8] The Bank Subsystem will be implemented as a distributed, rather than centralized, system. There will be a Bank Subsystem coupled with each Gate Subsystem and they shall be equivalent in functionality

[R9] A Bank Subsystem will provide the access point for user interaction with the Field Component.

[R10] A maximum distance of 3 meters will separate a Bank Subsystem from its corresponding Gate Subsystem.

[R11] The data collected by the Field Component will be stored within the Bank Subsystem.

[R12] The data store will keep records of counted fish using timestamps for boundary crossings. Refer to requirements **R5** and **R6**.

[R13] A Bank Subsystem will be contained in a single enclosure with maximum dimensions of 1.5 cubic feet.

Specifications on the User Interface and DXM interface will be given in their respective overviews to come.

2.2.3 Field Component General Specifications

[R14] The Field Component should not change the flow or velocity of the stream by more than 5 percent.

[R15] The Field Component should not require the fish to swim to or through a specific location to be counted.

[R16] The Field Component should not impede the natural path of objects traveling in the stream.

[R17] The Field Component should not cause the collection or buildup of any objects in the stream at the boundary locations.

[R18] The Field Component should not change the water temperature of the stream by any significant amount.

[R19] The width of the stream at a chosen boundary location should be between 0.5 and 1.5 meters.

[R20] The depth of the stream at a chosen boundary location should be between 1 foot and 1 meter.

[R21] There is no restriction on the distance between the boundary locations.

[R22] The Field Component should provide data that is accurate within 10% of the true count of fish within the volume.

[R23] Design of the Field Component should not take possible theft or vandalism into account.

[R24] The Field Component should be capable of operating in a temperature range of 1°C to 40°C.

[R25] The Field Component should be capable of operating under any outdoor weather condition.

[R26] The Field Component should be capable of operating under any outdoor weather condition.

[R27] The data store at each boundary should be able to store 2000 data records.

[R28] When the data store holds the maximum number of data records, all new data records collected will be discarded.

[R29] The Field Component should be capable of operating under any outdoor weather condition.

[R30] The Field Component will be powered only by a system of local power cells.

[R31] The Field Component should be able to run for 3 months continually before its power supply becomes fully depleted.

[R32] The Field Component will have battery low indicators to show when the power supply has been depleted by 50%, 80%, and 95%.

[R33] The Field Component will sense its environment 6 times per second.

Functional requirement **R33** states that the Field Component, more specifically the Gate Subsystem, will sense its environment (the stream) 6 times per second. Assuming a 30 cm fish would swim upstream at a maximum speed of 3 m/s, this specification will allow us to meet the requirements of specification Y.

2.3 Data Exchange Mechanism Overview

This component is a mechanism to facilitate data transfer between the Field and Home components. In the existing method, the volunteer manually collects data onto data sheets at the stream. The volunteer will then send the data to the stream keepers database, either by online entry or mailing the data sheets.

Our system needs to manage the increased complexity of data flow created by introducing the Field Component into the system. The user must now retrieve and transport the data already collected by the Field Component.

[R34] The Data Exchange Mechanism will transport the data between the Field and Home Components as a soft copy on some form of computer media.

This requirement is in contrast to having the data as a hard copy (e.g. a data printout, or data copied onto a sheet).

As to be discussed later, the home component will involve data processing functionality. Therefore, by having the DXM keep the data in soft form, conversions back and forth are avoided (e.g. if the data were to be collected from the Field Component as a printout it would have to be converted to soft data for the Home Component- perhaps by manually entering the data into a software application). Also, as the volume of data increases, the tasks of converting the data back and forth become inefficient.

Since there are two sources of data coming from the two Bank Subsystems, the Data Exchange Mechanism will have a component corresponding to each Bank Subsystem. It is the functionality of the Home Component to merge and process the two sets of soft data that make up the DXM.

[R35] Two pieces of computer media will be used to collect data from the Field Component- one for each Bank Subsystem interface point.

[R36] The data sets on the media are indistinguishable. The user must keep track of which boundary each set of data was collected from.

[R37] The chosen media must allow labeling by the user.

[R38] The chosen media should be able to hold the maximum amount of data stored in a Bank Subsystem (see requirement **R27**)

[R39] The chosen media should be lightweight and relatively compact. Ideally, it should be able to fit in one's pocket.

[R40] The chosen media should be robust enough to withstand a reasonable amount of physical stress.

2.4 Field Component User Interface Overview

The field component user interface defines the user interaction with each Bank Subsystem.

[R41] The Field Component will have a power switch on each Bank Subsystem enclosure.

[R42] The system must be powered off when replacing the power supply.

[R43] Powering on the system will empty the data store and initialize the system to begin data collection

[R44] The user downloads the data from the Bank Subsystem through a hardware interface whose technology is dependent on the chosen DXM media.

[R45] The Bank Subsystem shall provide an interface of two buttons and an electronic display.

[R46] The two interface buttons will have associated *DUMP* and *RESET* functionality.

[R47] When the user executes a *DUMP*, the data currently held in the data store will be transferred to the media if the media is properly connected to the hardware interface. The display will provide text feedback to the user.

[R48] If the user executes a *DUMP* and the media is not properly connected, the function will fail and the display will inform the user.

[R49] Execution of a *DUMP* command does not affect or erase the data from the data store.

[R50] When the user executes a *RESET* command, the data store will be erased and the system will restart data collection.

[R51] When the user isn't executing a command, the display will show the number of data records kept in the data store relative to the maximum data store capacity.

[R52] The Bank subsystem will implement some form of safeguard against accidental data loss through the reset function.

2.5 Home Component Overview

This section discusses the Home Component and its User Interface together.

The Home Component has the following responsibilities:

a) Received the raw data from the Field Component via the DXM.
b) Process the data (interpret it).
c) Prepare the data in presentable form.

The user previously could mail in data sheets or enter data into the data from their home computer. Either case had the user dealing with a hard copy of data. With most of the data staying in soft from in our system, the Home Component represents the final system component needed for the user to present his or her data to the StreamKeepers Program - that being a software tool or application on their home computer.

The intention is that the data collected from our system is more comprehensive than the current data set and that the StreamKeepers Program could change accordingly to handle our new system (e.g. change the online database entry tool to accommodate our new data).

The following figure shows high-level organization of the Home Component:

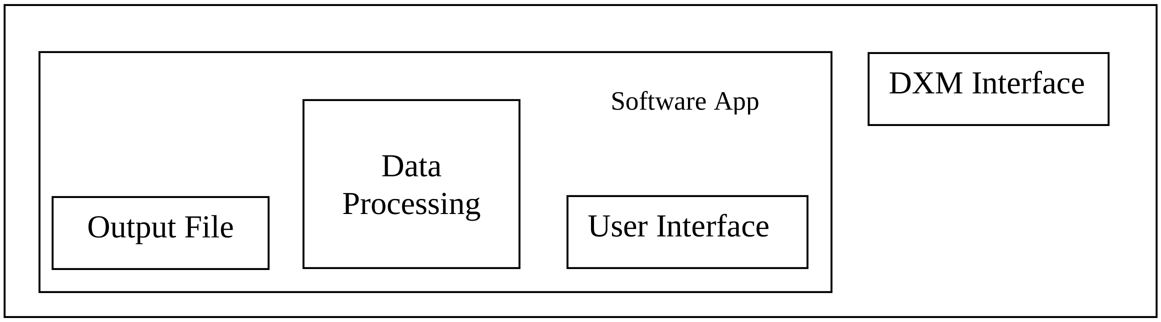

Figure 4: High-Level Home Component Organization

[R53] The Home Component will use Windows 95 / 98 / 2000 / Me / NT / XP compatible PC as its environment.

[R54] A software application running on the Home Component computer manages the transferring and processing of data.

[R55] This software application generates an output data file that is the final system output for the user.

[R56] This software application will provide standard windows GUI for all user functions.

[R57] The user downloads the data from the DXM to the Home Component PC through a hardware interface whose technology is dependent on the chosen DXM media.

[R58] The application will have a download functionality that will prompt the user to interface the DXM media to the media interface.

[R59] The application will first prompt the user for the downstream boundary data set and then prompt for the upstream boundary data set.

[R60] After both sets of data have been successfully downloaded, the application will automatically process the data and generate the output file.

[R61] The application will prompt the user for the name and location of the output file.

[R62] The output file will be ASCII text database in CSV (Comma Separated Value) format.

[R63] The database will have two fields per record: Time and Total Fish Count. Every data record from the two input data sets will be represented in the database along with the computed Total Fish Count for that timestamp.

[R64] The application will provide feedback if the media is not interfaced properly or if the data is invalid or corrupted to the application.

[R65] The download functionality will not automatically erase the data from the media after a download

[R66] The application will provide functionality to erase the data from the

3 Conclusion

Aqua Ichiban Innovations is committed to producing a project that will lead towards a positive contribution towards society and provide more information, allowing clearer decisions to be made by those entrusted to preserving and protecting our natural resources.

This Fish Spawning Data Collection System Functional Specification outlines the minimum functional requirements of our proposed system to develop a functional prototype. Many of these requirements may change as the project continues to develop and define itself.

4 Sources and References

1) The Pacific StreamKeepers Federation, www.pskf.ca

2) Dr. Richard Schwindt, Economics, Simon Fraser University

3) The Streamkeepers Handbook and Modules, Salmonid Enhancement Program, Dept. Fisheries and Oceans

4) Pacific Fisheries Resource Conservation Council, www.fish.bc.ca