Design of an Aquaculture Database for INCOPESCA

Incopesca
Instituto Costarricense de Pesca y Acuicultura

WORCESTER POLYTECHNIC INSTITUTE 1865 WPI

July 5, 2007

Lic. Álvaro Otárola Fallas
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San José, Costa Rica

Dear Sr. Otárola:

Enclosed is our report entitled Design of an Aquaculture Database for INCOPESCA. It was written in San José between the dates of May 14, 2007 and July 5, 2007. Initial research was conducted in Worcester, Massachusetts prior to our arrival in Costa Rica. A copy of this report is also being submitted to Professor Tahar El-Korchi and Professor Lorraine Higgins for evaluation. After being reviewed by faculty, an electronic version of this report will be available through the website of the Gordon Library at Worcester Polytechnic Institute. We thank you for providing us with the opportunity to complete our project with the Instituto Costarricense de Pesca y Acuicultura, and we appreciate the time you and your coworker Sr. Adán Chacón devoted to us.

Sincerely,

Molly McShea

Jo-Ellen Sullivan

Report Submitted to:

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This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of the Instituto Costarricense de Pesca y Acuicultura or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

Aquaculture is a growing industry in Costa Rica and a significant contributor to the nation's GDP. INCOPESCA monitors and promotes the development of this industry using a database in MS Excel, but recent industry expansion led to an increase in information that must be collected, making the database outdated. The purpose of this project was to create a new database in Microsoft Access to replace the original. Development of this database was accomplished through liaison interviews and user-testing of four INCOPESCA employees.

Authorship Page

All writing and research conducted for the completion of this report was done in equal measures by Molly McShea and Jo-Ellen Sullivan.

Acknowledgements

The completion of our Interactive Qualifying Project would not have been possible without the generous contributions of many individuals. We would like to extend our greatest appreciation to them now for their invaluable assistance.

First, we would like to thank our liaison, Lic. Álvaro Otárola Fallas as well as Sr. Adán Chacón Cascante for guiding us in our design of the database and arranging our user-testing sessions at two INCOPESCA stations.

We extend our gratitude to our project advisors, Professor Lorraine Higgins and Professor Tahar El-Korchi, for their guidance and tireless assistance in revising all drafts of the report.

We would also like to thank Professor Susan Vernon-Gerstenfeld and Mr. Jimmy Music for their indispensable translation services.

Finally, we would like to thank the numerous producers who kindly showed us their farms as well as the four INCOPESCA employees who participated in user-testing. The information provided by these individuals made it possible to complete our project.

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Executive Summary

INCOPESCA is an agency within the Costa Rican government that stores information on the aquaculture industry in order to promote its development and sustain its significant contribution to the economy (FAO, 2007). The agency previously stored its information in Microsoft Excel. Recent expansion of the industry was accompanied by a significant increase in the amount of information the agency needed to collect. Data collection and analysis quickly became tedious with the use of Microsoft Excel as the program did not allow for complex searches through the data, which are essential to the efficient maintenance and management of large amounts of information. Inefficient maintenance also led to frequent occurrences of errors that compromised the reliability of the data, and the information contained in the database was not being updated as the industry continued to expand.

In seeking a solution to this problem, the agency requested that a WPI project team design a database in Microsoft Access and transfer the pre-existing records into this new database. Microsoft Access has many of the same features as its Microsoft Excel counterpart as well as additional features that would significantly improve INCOPESCA's ability to store, access and relate information on fish farming. For example, the query is a feature that allows for the execution of searches involving multiple variables. The use of this feature would decrease the steps an INCOPESCA employee would be required to make when performing routine, complex analyses of the data.

Although the solution to the problem of poor data management seemed to be a simple software conversion, this was compounded by the facts that: (1) multiple groups of users accessed the database and (2) the users were unfamiliar with Microsoft Access. To address these issues, research needed to be conducted to design an interface that was comprehensible and

acceptable to all users. This research aimed to: (1) determine the major uses of the database, (2) determine the information that needed to be included in the database, (3) determine the most appropriate display features to include in the database, and (4) determine if utilization of the database by users coincided with an increase in the efficiency and ease of use with which tasks were performed.

These determinations were made in two different stages. The first stage consisted of interviews with Sr. Álvaro Otárola Fallas, INCOPESCA's head of the Department of Aquaculture, and his partner Sr. Adán Chacón Cascante. During these interviews we learned that the Microsoft Excel database had been used to optimize the construction of a shrimp processing facility and was regularly used to recommend tax breaks for producers.

We also worked with our liaison and his partner to develop an initial prototype from a sample MS Access database and their feedback. The initial prototype consisted of approximately ninety-five new fields on eight main input pages and eight corresponding output pages. Drop-down menus were added to many fields to increase the consistency of data input. Four new searches based on queries were created to summarize different aspects of production by region and display either all active or inactive projects.

After we finished preparing the initial prototype, it underwent two user-testing sessions with four INCOPESCA employees. Each employee was instructed by our liaison on how the interface was set up and how to navigate through it. Each participant was then asked to complete five basic tasks in the database and then fill out a survey to evaluate certain aspects. The aspects users were asked to assess included the information contained in the database, the layout of the database, the difficulty or ease with which tasks were performed, and the time required to complete these tasks.

The results of these surveys showed users felt that (1) the information in the database was relevant and complete, (2) the structure and layout were easy to understand and navigate, (3) the MS Access database was easier to use than its MS Excel precursor, and (4) direct comparison of the two databases in terms of efficiency was not possible because they differed drastically in content and capabilities. Other survey results added to findings that had been drawn from the interviews. Our observations from user-testing were also used to create a set of instructions on using the database to guide users through certain aspects that were initially confusing.

After analyzing our results, we were able to draw conclusions from our data. Our four major findings were: (1) INCOPESCA employees constitute the primary stakeholder of the database, and as such it was appropriate to model our design around these employees' needs, (2) the agency's major uses of the database fall into the areas of research and development of infrastructure, enforcement of environmental and tax policies, and analysis of industry sectors, and (3) the database adequately met the needs of INCOPESCA, and (4) the query is a feature of the new database that can be utilized to simplify tasks and shape the database around the needs of multiple user groups.

The core of our project was the creation of a database for INCOPESCA, but our investigations uncovered many new ways in which the database could be improved and modified in the future. Our key findings were used as a basis for making the following recommendations on how the agency should develop the database in the future:

- Research similar to our own should be conducted to identify major uses of other stakeholders and make design modifications to the database to make it more accessible to these stakeholders. Granting access to the database to other groups will give people who are not directly involved in the aquaculture industry a greater perspective of its

importance to the nation's economy. Greater awareness could lead to further development of the industry through increased government assistance which would create more jobs for Costa Ricans. In addition, the environmental impacts of the industry would be understood by a wider audience, allowing the nation to make more informed decisions about the preservation of its natural resources. Environmental aspects vary and include the impact the industry has on water sources used to supply farms as well as the indirect effects it could have on marine ecosystems as an alternative to commercial fishing.

- Additional queries should be developed to simplify more routine tasks that INCOPESCA employees perform as well as tasks that other stakeholders may need to perform in the future. This could be accomplished by surveying users to determine what tasks they complete on a regular basis and what information they need to gather from the database to complete these tasks.
- The agency should sponsor an IQP in the future to expand the capabilities of the current database, such as making it accessible via the Internet with conversion to a different software program. Students majoring in computer science would be best suited for such a project. Placing the database online would make it easier for other stakeholders to access the database and would make it easier for INCOPESCA to routinely add new information collected at each station to the main database, which must now be done manually.

The true utility of the database will likely not be fully realized until users become familiar with the new program. We designed the interface to meet the users' needs and expectations so they can become acquainted with it more quickly. The results of user-testing seemed to confirm that it will be easier to use than the pre-existing MS Excel database. Continued improvement of the database will allow for INCOPESCA employees to gain a more accurate understanding of

trends in all sectors of the industry and their associated environmental and economical impacts. This knowledge will allow for better management of the effects of the industry so that aquaculture can continue to be a means of financial sustenance for thousands of Costa Ricans and the nation's natural resources can remain unspoiled.

Chapter 1: Introduction

Aquaculture is defined by the US National Marine Fisheries Service (2007) as the cultivation of freshwater or marine species under controlled conditions for human consumption. According to the Food and Agriculture Organization of the United Nations (FAO), it is an important industry in many countries because it is a vital part of the economy and a source of healthy food. Aquaculture is especially important in Costa Rica where 209.4 million dollars of the nation's gross domestic product in 2002 came from the aquaculture industry. Also, over 25,000 Costa Ricans are employed by the various branches of the industry (FAO, 2007).

To oversee the development of this important industry, the Costa Rican government established the Instituto Costarricense de Pesca y Acuicultura (INCOPESCA). INCOPESCA gathers a variety of information about the aquaculture industry, such as information about the types of fish being produced, who produces them, how many fish are produced, and where the farms are located in the country. The agency has used several Microsoft Excel data files that contained these details to monitor the aquaculture industry, with this oversight divided into the areas of research and development, government funding, and statistic production by international agencies. In the past, the information in these files has been vital to the development of a shrimp processing plant because the planning of the pond's capacity depended on the number of shrimp producers in the area. In addition the information on each producer has been used to secure tax breaks from the government that can reduce the cost of certain types of equipment by up to 80%, which allows small scale farmers to acquire necessary equipment that they could not otherwise afford (Sr. Álvaro Otárola Fallas, personal communication, May 14, 2007).

Even though the use of Microsoft Excel contributed these accomplishments, the program was limited in its ability to manage and manipulate the data as efficiently as needed. Therefore,

we transferred the data from Microsoft Excel to Microsoft Access. Microsoft Access is a program designed to define relationships between different data entities that allow for more complex analysis of the data. In contrast, Microsoft Excel does not have this capability (Dong et al., 1997). Thus, placing the database in Microsoft Access allowed the users, which include universities, students, the national bank, the government, international cooperation agencies, and producers, to search the data more efficiently. Another problem that was addressed by this project was the incorrect categorization of data that occurred frequently in the spreadsheets. For example, numerous dates appeared in the trout database that were supposed to be in one field but appeared in several columns in several different formats. Correcting this problem made the data the users searched for more reliable.

Since MS Access is quite different from MS Excel, we expected that users would initially find Microsoft Access unfamiliar. To fully recognize the benefits of the software conversion, the interface of the program needed to be designed around users' needs and preferences so that users would be able to easily access the data (Preece, Rogers, & Sharp, 2002). We were able to identify the needs and preferences of the users of the database through user-testing, the administration of surveys, and interviews with our liaison, the Head of the Department of Aquaculture in INCOPESCA, Álvaro Otárola Fallas and his partner, Adán Chacón Cascante. Our findings from these sources were then used to refine the database accordingly. We also based the new design of the database on a CD with an Access prototype that INCOPESCA gave to us, which was developed by a consulting company prior to the beginning of our project. After completing our initial design, we sought to evaluate the relative efficiency of the new database in comparison with the former Microsoft Excel spreadsheets through user-testing and surveys.

We predicted that redesigning the former spreadsheets in Microsoft Access would allow users to search through the data more easily and quickly. Correction of the errors made in the data categorization allowed the data to become more reliable and accurate. The powerful searching tools in Microsoft Access that were implemented in the new database, such as queries, are not found in Microsoft Excel. The incorporation of such tools allowed users to more readily interpret complex trends in the data, such as the total area devoted to the production of one species in each region of the country.

The introduction of these tools with the creation of the new Microsoft Access database was especially important as the aquaculture industry in Costa Rica is on the verge of a large expansion into the production of mussels, catfish, and ocean species. The expansion will lead to the need for the collection of more data for all of these species, the analysis of which would have been overwhelming without the tools provided by Microsoft Access. Thus we hope that our creation of a user-friendly interface in Microsoft Access will compliment the growth of the aquaculture industry by allowing users to exercise better management of large amounts of data.

Chapter 2: Literature Review

The government agency responsible for the promotion of aquaculture in Costa Rica (INCOPESCA) had previously stored information on shrimp, trout, and tilapia production in Costa Rica in five Microsoft Excel files. The immediate purpose of our project was to transfer and consolidate these files in Microsoft Access in order to increase the efficiency with which a user could search through the data.

In this chapter we discuss the history of the aquacultural industry as well as its effects on the Costa Rican economy. Once this relationship is made clear, the effects that the improvement and restructuring of the database may have on the industry and economy will be clear. Finally, the process of designing the interface for the new database is discussed.

2A. Aquaculture: An Important Industry Worldwide and in Costa Rica

According to the US National Marine Fisheries Service (2007), aquaculture is the "process of cultivating freshwater or marine species under controlled conditions for any commercial, recreational, or public intention."

The FAO stated that modern aquaculture started in the mid 1930s following the introduction of the common carp at two research farms in Egypt. The first modern semi-intensive commercial farm was built by the Egyptian Government in 1961 in Egypt. This farm had a total area of almost 300 acres of earthen ponds growing Nile Tilapia, common carp and flathead grey mullet (2007).

According to Dudley-Cash, "Aquaculture has been the world's fastest growing food production system," and since 1984 the industry has had an average annual growth rate of 9.6%

per year. Moreover, in 1995 the total global aquacultural production was estimated to have weighed in at a hefty 27.8 million metric tons, and was valued at over 40 billion dollars. In less than 20 years (1984-1998) the contribution of aquaculture to the world fisheries supply has increased two fold from 11.5% of the total weight of fish produced, to 23% of the total weight of fish produced (1998, p.1)

Costa Rica is a thriving aquacultural country. Costa Rica mostly produces tilapia, trout, catfish, carp, guapotes, marine shrimp, giant Malaysian crayfish, and freshwater crayfish, according to the Food and Agricultural Organization of the United States (FAO) (2007). Señor Álvaro Otárola Fallas of INCOPESCA has indicated that the industry will soon be expanding to include mussels and ocean farming. There are hundreds of producers located all over the country, all of whom are of great importance to the industry (personal communication, 2007).

Figure 1 summarizes the growth of the aquaculture industry in Costa Rica with a comparison to the growth of fish production by fish catch means. If you take note of the lighter aquaculture line in the figure, mainly from 1980 to 2000, you will notice that there was a considerable increase in the amount of fish produced in Costa Rica by aquacultural means. If the global increase of fish is traced back even further, the amount of world fish production has more than quadrupled since 1950, from 21 million metric tons to 98 million metric tons, (The US Committee on Assessment of Technology and Opportunities for Marine Aquaculture, & Marine Board Commission on Engineering and Technical Systems National Research Council 1992, p. 20). This shows that the aquaculture industry is a growing industry in Costa Rica as well as worldwide.

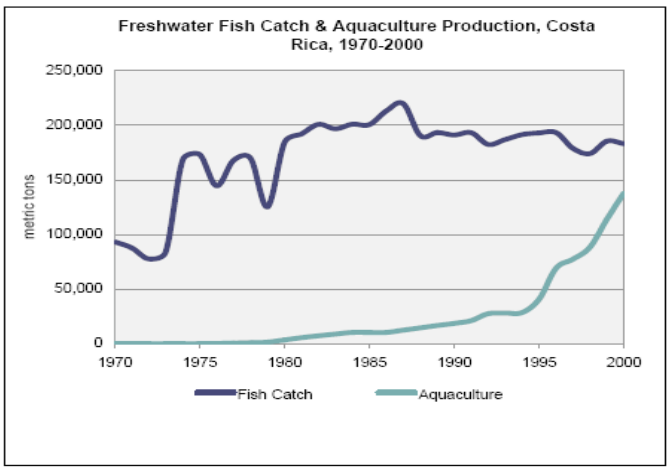

Figure 1: Freshwater Fish Catch & Aquaculture Production, Costa Rica, 1970-2000 (EarthTrends, 2003)

Figure 2 also exemplifies the large growth that the aquaculture industry has endured. Even within this most recent decade (1997-2007) the amount of fish that the Costa Rican aquaculture industry has produced has increased greatly (Note the large spike in Figure 2). This is most likely due to the recent and rapid advances in technology, which could be a result of increased investment and development of the industry. This trend suggests aquaculture will continue to grow well into the future, largely due to technological developments.

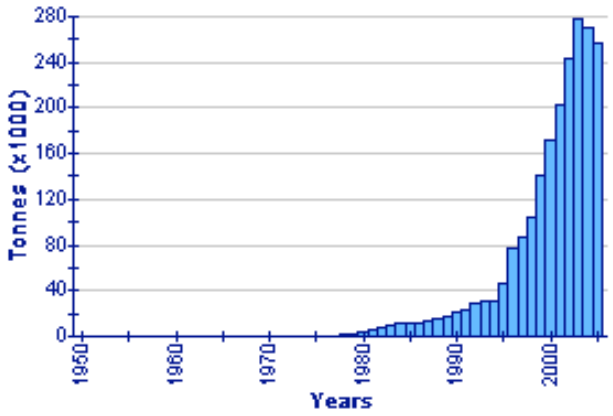

Figure 2: Costa Rica Aquaculture Production from 1950-2007, Measured in Tonnes S

(Food and Agricultural Organization of the United Nations, 2007)

I. Importance of Aquaculture for the Costa Rican National Economy

The steady growth of the aquacultural industry suggests that it is a major source of income for many developed and developing countries. The growth of any industry also opens up many new employment positions varying from minimum wage earning factory workers to people working in executive and management positions, earning far greater salaries.

A. Exports and Gross Domestic Product[1]

According to the FAO, agriculture and fish products (aquaculture) represented over half of Costa Rica's total national exports in 1998. Aquaculture accounts for a large portion of the gross domestic product for Costa Rica. In 2002, 38.9 million dollars of the country's gross domestic product of 16,818 million dollars came from fishery production alone (2007). When the value of imports (32.1 million dollars) and exports (138.4 million dollars) are added to the 38.9 million dollars, they make up 209.4 million dollars of the country's gross domestic product.

Figure 3 illustrates the large amount of money generated by the Costa Rican aquaculture industry. During the previous 25+ years, the capital obtained by Costa Rica through means of the trade of fish and fishery products was very large. Note the rapid increase of earnings in the aquaculture industry in Costa Rica indicated by the darker colored "exports" bars present in Figure 3.

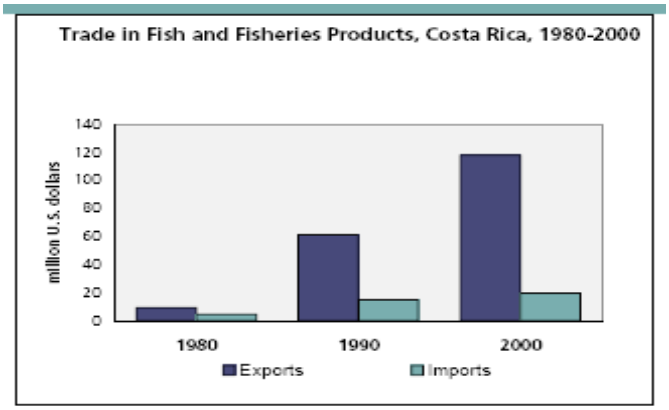

Figure 3: Trade in Fish and Fisheries Products, Costa Rica 1980-2000 (EarthTrends, 2003)

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1. All monetary values in US Dollars

Valverde has shown that the primary destination for Costa Rican fish production is the United States, which consumes 73% of the product, and the other 27% of the product is exported to other countries in Central America and Europe (2002, p. 6). As a result, the majority of the national aquacultural income is obtained from the United States.

B. Employment

When the aquaculture industry first began in Costa Rica, it resulted in numerous new opportunities for employment. The FAO (2007) stated that as of 2002, 8,567 Costa Ricans were employed within the primary sector of the aquaculture industry. This sector includes those whose work is directly related to the industry, such as employees at fish farms and hatcheries, as well as the executives and managers of the agencies who oversee the aquacultural production at these fish farms and hatcheries.

According to the FAO, as of 2002 an estimated 16,500 Costa Ricans were employed within the secondary sector of Costa Rica's aquaculture industry (2007). The secondary sector includes all other employees whose profession indirectly relates to the industry, for example, the people who work in a seafood market selling the product, as well as the people who are responsible for the transport of the products to their destination, which may be as distant as the United States or Europe, or as close as a seafood market in a nearby town. 25,067 out of the 4,000,000 total Costa Ricans (FAO, 2007) are employed by the various branches of the aquaculture industry. This accounts for a sizeable fraction of the employment of Costa Rica. Also, given that not all of the 4 million residents of Costa Rica are employed, the ratio is even

higher. With this, it is easy to understand that without this industry, many people would be out of a job, resulting in loss of revenue for the country as a whole.

II. Fish Products as a Source of Nutrients

The aquaculture industry is not only beneficial economically to the country as a whole, but it is also of great importance in the personal life of the people of Costa Rica. According to EarthTrends, fish provides the residents with a great deal of nutrition. They receive a fair amount of their daily protein intake from fish and fish products (2007).

The aquaculture industry provides the country with a substantial amount of fish and fish products. This allows the residents to integrate fish into their daily diet more easily than other countries without such a large aquacultural industry. Costa Ricans obtain 2.2% of their daily protein from fish products (Earth Trends, 2003). FAO reported that other protein sources are milk, cheese, meat, rice, beans, and nuts.

It is common knowledge that eating fish is one of the healthier ways to get protein into your diet. Biesanz, Biesanz, & Biesanz (1999) asserted that on average, the life expectancy of a Costa Rican is seven and a half years longer than the average worldwide life expectancy (p. 150). This could easily be due in part to their daily consumption of fish. Fish is high in protein, and very low in fat and carbohydrates. The NutritionData (2007) website states that fish also provides people with other necessities, such as vitamins A, K, B6, and B12, riboflavin, niacin, folate, calcium, iron, phosphorus, potassium, zinc, and many more. These nutrients also play a part in lengthening life expectancy. It is easy to derive from this information that the prevalence of aquaculture in Costa Rica has affected the health of the natives in a very good way.

III. The Government's Role in the Development of the Aquaculture Industry

To realize the benefits of the aquaculture industry mentioned in the last section, the Costa Rican government created the agency INCOPESCA (Instituto Costarricense de Pesca y Acuicultura) to promote the development and growth of the nation's industry. In addition to promoting aquaculture, the agency also works to regulate commercial fishing by protecting marine life and resources (*Instituto Costarricense de Pesca y Acuicultura*, 2007). Although the agency focuses on both commercial fishing and fish farming, our project focused on the means through which INCOPESCA promotes fish farming.

INCOPESCA employs various methods to accomplish its goals of aquacultural development. According to a previous IQP team (Graham, Johnson, and Lee, 2002), training programs have been established in the past to help educate fish farmers on the latest advances in aquacultural technology and the best methods for feeding and growing fish. The organization also tries to provide socioeconomic support to fish farmers by helping them obtain credit from the national bank (*Instituto Costarricense de Pesca y Acuicultura*, 2007). Señor Álvaro Otárola Fallas indicated that the agency helps secure tax breaks for small-scale farmers that allow them to purchase equipment needed for enhancement of their fish production that they otherwise would be unable to afford (personal communication, May 14, 2007).

When INCOPESCA makes decisions that pertain to development of the aquaculture industry, such as the creation of a training program or recommendation of a producer for a loan from the national bank, the agency needs to consider accurate and relevant information. For example, the agency would need to know how many of its producers are located in each region

to effectively administer educational pamphlets, or it would need to know how much income a particular producer earns each year in recommending the individual to the bank for loans, since only small and medium scale producers can be supported (*Instituto Costarricense de Pesca y Acuicultura*, 2007). In seeking to provide readily available information to assist in guiding the agency in making these decisions, INCOPESCA collected information on its shrimp, trout, and tilapia producers and had stored it electronically in Microsoft Excel. In the following sections we focus on these Microsoft Excel files, the reasons why transferring them into Microsoft Access was necessary, and the process of effective database design.

2B. The INCOPESCA Database and the Process of Redesign

The original data that INCOPESCA had maintained on shrimp, tilapia, and trout was divided among five different Microsoft Excel spreadsheets. Each sheet contained personal information about each producer and technical information related to the production of fish. Some examples of common fields contained in the Excel databases are shown in Table 1. The information was sorted into fields based on these topics and others that are similar, and each Excel database had approximately thirty fields in total.

Table 1: Examples of Fields of Information in INCOPESCA's Excel Databases

Fields:
Name of Producer
Identification Code of Producer
Producer's Address
Producer's Telephone Number
Producer's E-mail Address
Number of Tanks

In addition to the producers, users of the spreadsheets include universities, students, the national bank, and the government (Á. Otárola Fallas, personal communication, April 15, 2007). Some users may be interested in monitoring trends in the aquaculture industry as a whole, which is difficult when they must search through separate spreadsheets to obtain information from all sectors of the industry. This problem would only become worse under the old system as new spreadsheets would need to be created to include information on emerging areas in the aquaculture industry, such as the production of catfish, mussels, and marine fish (Á. Otárola Fallas, personal communication, May 15, 2007).

It was also difficult for users to search through approximately thirty categories of information if they were looking for a specific record that matched several specific criteria because Microsoft Excel has no "query" feature for executing searches involving multiple variables (Dong et al., 1997). For example, Sr. Otárola Fallas explained that many users might need a report of the total amount of production of a particular species of fish within a certain region (personal communication, 2007). Microsoft Excel has no simple feature that allows the user to specify what species of fish and which area of the country is of interest so all records matching these two criteria can then be found and displayed. Thus, Microsoft Excel only allows for simple analyses of the data, and in INCOPESCA's situation, more complex analyses involving many different factors are needed.

Besides the fact that MS Excel was not the most appropriate program to store the data in due to the lack of a complex searching tool, there were more basic problems with how the data were managed. Information was not entered under the appropriate categories, and the MS Excel spreadsheets were not merged into one file. For example, in a spreadsheet for trout, phone numbers appeared in the address field in some records rather than in the phone number field and dates were entered in two different formats in several columns rather than appearing in one format under one column. One consequence of such inefficient data management was that monitoring trends in the industry represented by information contained in the spreadsheets was made overly difficult because a user had to switch between files. Additionally, the risk of collecting erroneous or incomplete data due to errors in information entry was high. This had the potential to adversely affect a user's ability to gather and interpret data accurately. This could have led to a poor understanding of the industry as a whole if the user utilized the collected data to analyze the aquaculture industry.

I. Differences between Microsoft Excel and Microsoft Access

Understanding the benefits that could arise from a database conversion required some knowledge about the fundamental differences between the Microsoft programs Excel and Access. Both programs can be used to store large amounts of data, but they are designed to process this data in slightly different ways. Microsoft Excel is a spreadsheet program, and as such it is ideal for storing large amounts of numerical data because it can perform complex calculations, so the program is well suited for storing and managing financial information (Ayers, 2006).

In the original Microsoft Excel databases maintained by INCOPESCA, none of Microsoft Excel's unique computational functions were being utilized to process numerical data. The spreadsheets were instead only used as a means of organizing information about hundreds of producers into columns and rows. Thus, the relationships between all information in the Microsoft Excel files were inferred by the user based on their physical positioning, but the program itself did not recognize that the data in a particular row were related. For example, the addresses listed in the "Dirrecion Exacta" field were understood by the user to belong to the producers listed in the "Nombre del Productor" field because the columns appeared next to each other in the file. However, Microsoft Excel has no capabilities that would allow it to recognize that one address is associated with one producer. As a result, a task such as changing the address of a particular producer required the user to search through the producer column for the producer of interest, move to the address column after finding the appropriate user, and then change the address.

Microsoft Access is a relational database, which is a kind of software that is capable of relating independent sets of data to each other (Ramakrishnan & Gehrke, 2000). The relationships that can be inferred based on the tabular layout in Microsoft Access are also reinforced at a deeper level by the software. The same task of changing an address mentioned previously can be accomplished with greater ease in Microsoft Access than it can in Microsoft Excel because Microsoft Access recognizes that the data in one row are related and form a complete record. A user could save a great deal of time searching through all of the data by simply using one of the features in Microsoft Access such as a query, which is simply a means of searching through the data and finding all records that match a certain characteristic or set of characteristics described by the user (mathematical operations and other changes can then also be

made to these records). Thus, the user would simply employ the query feature to find the record in a table that contains the producer of interest and could then make the appropriate changes to the address.

Before the benefits of the greater efficiency associated with the software conversion could be realized, an interface needed to be developed to make the software easy for users to operate. A special feature of Microsoft Access is that it is programmed to provide several different objects, which are different layouts that display the data. A combination of these objects is then used to design a unique interface in Microsoft Access.

II. The Best Practices of Interface Design

Unlike professional interface designers who are challenged to create new, unique interfaces, we were limited to designing an interface in MS Access entirely from elements that already existed within the program. However, an understanding of the design process and the design features that are commonly incorporated into interfaces was helpful in our creation of an interface.

As Preece, Rogers, and Sharp (2002) wrote, interaction design is defined as "designing interactive products to support people in their everyday and working lives" (p. 6). It is a design process that can be applied to any electronic program or device that users interact with, such as a database, in which the needs of the users are the focus. The design of an interface involves a variety of disciplines in addition to technical fields, such as sociology and psychology (Preece, Rogers & Sharp, 2002, p. 18).

The goals of any interactive design are to produce a product that is effective and efficient while also assuring that users will find the product easy to learn and will remember how to use it

(Preece, Rogers & Sharp, 2002, p. 18). Thus, the success of any design in meeting these goals is linked to modeling the interface around users. The process of interaction design begins by identifying what users need from the interface, developing a design based on these needs, and then evaluating the design to determine how effectively it meets its goals (Preece, Rogers & Sharp, 2002, p. 169). Interaction with the users is essential to the process, and understanding who they are and what needs they have is the vital first step.

In our case, the users of the MS Excel databases consisted of producers, international cooperation agencies, students, universities, the Costa Rican national bank, and the government (Á. Otárola Fallas, personal communication, April 15, 2007). Each group has different reasons for using the databases and needs slightly different kinds of information from them. For example, the original Microsoft Excel files were used by the shrimp producers in a certain area of the country to plan the construction of a shrimp processing facility. They were also frequently used by INCOPESCA to help award tax breaks to small scale farmers that allowed them to purchase necessary equipment that they could not have otherwise afforded (Sr. Álvaro Otárola Fallas, personal communication, May 14, 2007). In these examples, the users needed different types of information. For example, the shrimp producers needed information related to the amount of shrimp that each producer in the region of interest could produce, such as the number of tanks, their sizes, and the total number of organisms in order to determine the capacity of the processing facility. INCOPESCA needed personal information on each producer such as marital status and the number of dependents to determine the producer's eligibility for tax breaks. Although all of this information was contained in the spreadsheets, different users were only interested in certain parts of this information, as was illustrated in the previous two examples.

The existence of multiple user groups means that it is important to design features in the database that allow each group to perform its tasks of interest without compromising other groups' abilities to do the same. In our case, we quickly established that INCOPESCA was the primary user of the database. Due to time constraints and the limited accessibility of the other user groups, we therefore focused our design of the database on INCOPESCA. However, understanding the views of a collection of INCOPESCA employees was still important in modeling the database around the agency's needs.

III. Key Interface Design Elements and the Need for Simplicity

User participation in the design process is crucial in understanding how to structure an interface. However, a certain set of generalized design elements and principles can also be used to design an effective interface. A brief list of these elements is given in Table 2 (Gerlach & Kuo, 1991; Preece, Rogers & Sharp, 2002; Raskin, 2000). As Preece, Rogers, and Sharp (2002) explain, the user's mental model is the user's expectation of how the program should work when he or she uses it for the first time based on prior experience with similar programs. Users rely on their mental models to determine the actual layout of the program and how to use it, meaning that anticipating the mental model and creating a program that resembles it is important in making it easy for users to learn the program. As we discuss later, modes and the simplicity and consistency of the interface layout are several features that affect the mental model and how quickly a user can become familiar with a new program. Specific details of the user groups do not need to be considered when incorporating these design aspects because they are more dependent on basic human psychology (p. 92).

Table 2: Important Elements Involved in Interface Design

Feature Associated with Interface	User Abilities that are Affected
Mental Model	Developing familiarity with the database
Simplicity of Layout	Developing familiarity with the database, Ability to focus on work
Modes	Developing a familiarity with the database, Level of confusion or distraction with database

Gerlach and Kuo (1991) suggest that in a basic interaction with a computer, the user engages in a cycle in which he or she sees and interprets the presentation on the screen, searches his or her memory to determine a response, and then inputs the response into the computer (p. 528). Thus, cognition and memory play very important roles in a user's interaction with an interface. Each of these factors is vital to the development of the mental model. A common problem with mental models is that they often diverge from the system model, or true layout of the program, so that the user has greater difficulty in learning the system (Gerlach & Kuo, 1991, p. 531). For example, users of INCOPESCA might have already developed a mental model of how tables function based on their prior experience with the tabular layout in Microsoft Excel. In some respects, this model might have been helpful as they learned how to use the tables in the new system. They may have understood for example that entries in the table were categorized by shared characteristics into columns, such as grouping by producer name, while each row represented a single unique entry. However, problems might arise when a user enters text in a field that had been designed in Microsoft Access to only allow for input of numerical data, as this was not encountered in the Microsoft Excel spreadsheets (Microsoft Access allows a designer to restrict the data that can be entered in each field to reduce to risk of entering inappropriate data). Thus, in the short term, users might have been prevented from using the database as effectively as possible due to their unfamiliarity with it.

In developing an interface that meets user expectations, simplicity must always be stressed and elements such as cognition that are involved in the user-computer interaction process must be considered. Cognition refers to thinking, remembering, and learning that occur in a person's mind as he or she carries out routine activities (Preece, Rogers & Sharp, 2002, p. 74). According to Raskin (2000), cognition can be broken down into two main types: unconscious and conscious (p. 11). Unconscious cognition refers to all the thought processes that occur in an individual's mind that he or she is unaware of while conscious cognition includes the thought processes of which the individual is actively aware. Moreover, the cognitive conscious is only capable of focusing on about one task at a time, after which switching to another task causes all information that was associated with the original task to pass into the cognitive unconscious (Raskin, 2000, p. 13). For example, if a student were sitting in class taking a biology test and he/she were working on a problem about cells, his/her cognitive conscious would likely be actively engaged in recalling information specific to cells such as their structure and metabolism. If the professor were to suddenly ask the student his/her name, all information pertaining to the cells would pass into the student's cognitive unconscious while other information—his/her name—would pass into his/her cognitive conscious.

The previous example demonstrates the limited capacity of the cognitive conscious and shows that cues from the outside environment determine how information passes between the two states of cognition. In terms of a database interface, the designer must accommodate the limits of cognition in two ways. First, he or she must minimize the amount of switching between tasks that a user must do, and secondly, he or she must limit the amount of information displayed on a page at one time.

The example with the student taking a test demonstrates how difficult it can be to focus when an individual suddenly is asked to think about something other than what he or she had been focusing on. One implication of this restriction in the design of an interface is that frequent task-switching must be avoided. For example, a user should not be asked to recall information he or she had been looking at before performing the task at hand, as the information will be difficult to recall.

Another design feature that can be equally frustrating for the user is cluttered pages. A display with too much information can cause the user to become distracted so that he or she cannot become absorbed in the task at hand, which prevents the user from being productive (Raskin, 2002, p. 31). Keeping the layout of information simple allows the user to remain productive and avoid the complications associated with the limits of cognition.

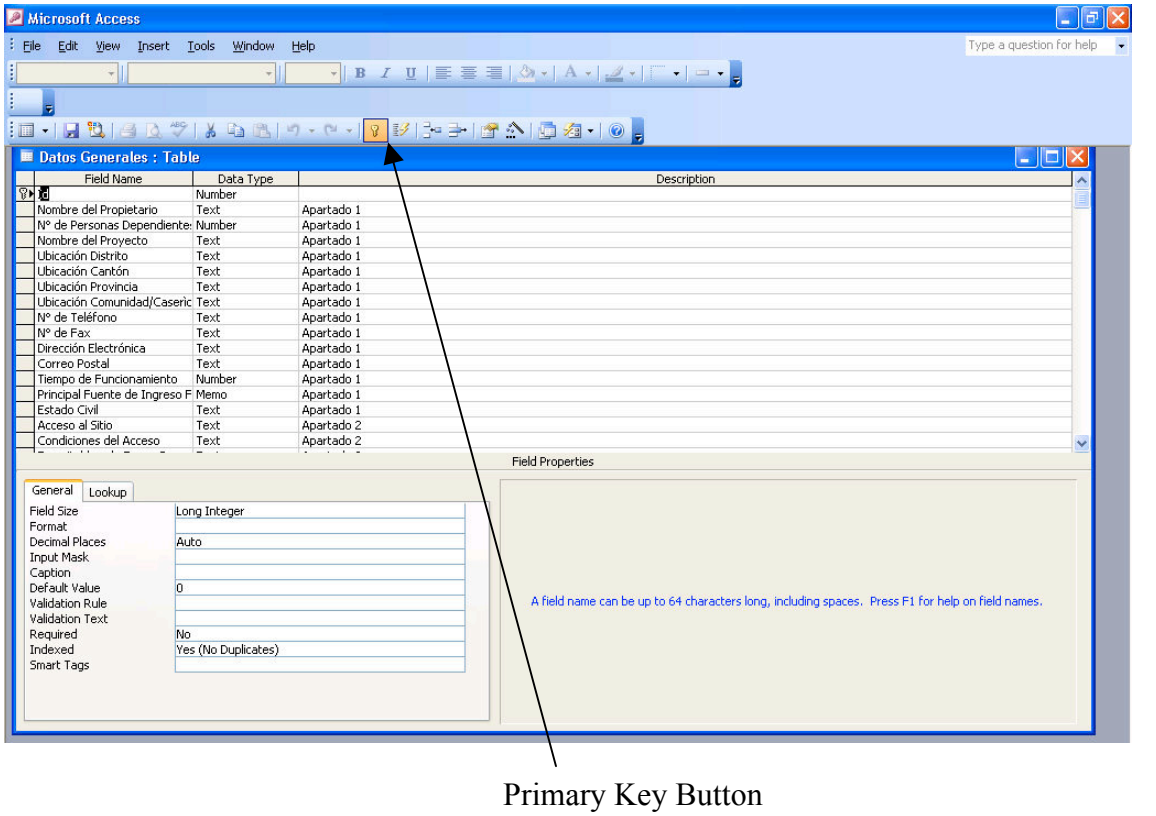
Consistency in the design of a database interface is important in terms of habit formation. Habit formation is a process that each user inevitably goes through in learning to use a new computer program. Habits are formed by repeatedly performing the same task (Raskin, 2000, p. 18). It is therefore important that an interface accounts for habit formation by being consistent in how users are required to complete tasks. A database that has been designed around this principle would have a consistent means of data input and output as well as a consistent layout among different pages with buttons and controls in the same position on each page.

For instance, Microsoft Access is designed to have several different alternative objects that are used to display the information a database contains, such as tables, forms and reports. Each of these objects ultimately shows the same data to the user, but the presentation styles differ. Data displayed in a table is divided into columns and rows while data in a form is separated by record, meaning each entry in the database is displayed individually with the

contents organized into categories (Dong et al., 1997). Inconsistencies in what object is used as the means of displaying information in the database could interfere with habit formation and slow the pace at which the user becomes accustomed to the new interface. For example, an Access interface in which users were required to enter data into both forms and tables would be more confusing to new users than an interface that solely used one of these options as the means of data entry. This confusion arises because the layout of each object is fundamentally different and even some of the means of inputting data differ. For example, forms can utilize features that tables cannot, such as drop down menus.

Another complication in keeping the program consistent is that MS Access has two different modes, design mode and view mode. Modes are essentially alternative states that a computer program can be placed in so that the commands in one state have different effects than in another (Raskin, 2000, p. 37). An example of each of these modes is given in Figure 4 in which the top screenshot shows a table in design mode and the bottom screenshot shows the same table in view mode. In Access' design mode, data is entered into a table to create fields with certain properties that will be used to store the data of interest. By switching to view mode, a table would appear with the fields created in design mode so that the actual data of interest can be entered. Although tables are manipulated in each mode in the same way (by entering text), the structure of the database is determined in one mode while the contents are specified through the same means in another mode (Dong et al., 1997). A novice user who is unaware of these differences may become confused when the data he or she is interested in suddenly disappears and properties of the database's display appear because the user has switched modes. Furthermore, switching between modes changes the commands that are available for execution. For example, when a user switches from datasheet view of data in a table in Access to the table's

design view, the command “primary key” suddenly appears in the menu toolbar. The “primary key” command is used to identify a particular field whose contents must be unique for each record in order to prevent unnecessary duplication of records. Switching back into the datasheet view of the table, which is the view used to search through the data, would cause the “primary key” command to disappear from the menu as it cannot be used in this view. This is apparent from Figure 4 in which the primary key button is selected in the menu in design mode but is not visible in view mode. A user who is unfamiliar with Access might find this change in the availability of commands as confusing as the change in the function of tables from switching modes mentioned previously. This suggests that users should be kept from switching modes when possible; however some users need to work in design mode so they can modify the structure of the database when changes are needed.



Primary Key Button

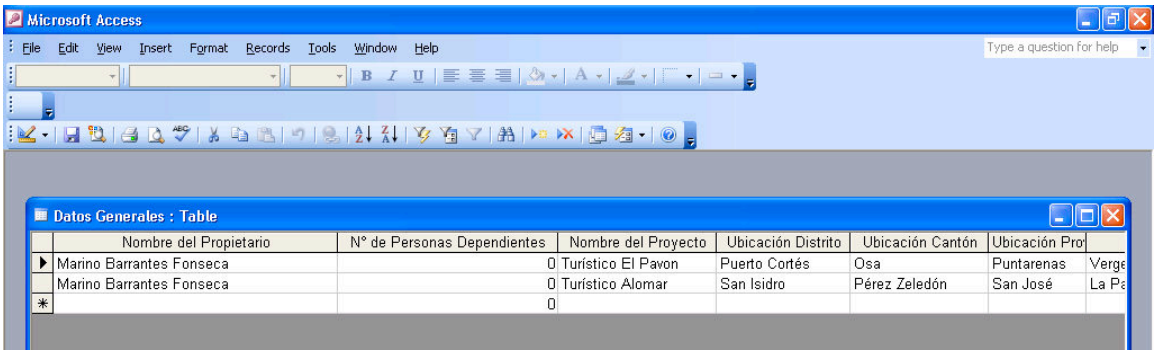


Figure 4: Comparison of Design Mode and View Mode in Microsoft Access

Conclusion

The aquaculture industry in Costa Rica is a major contributor to the economy, making its continued development a matter of great importance to INCOPESCA. All of the data that the agency uses to monitor and promote the development of the industry had been divided among five Microsoft Excel files. Centralizing the data and making it easier to manage will help INCOPESCA use its tools for monitoring the industry more effectively. Transferring the Microsoft Excel files to Microsoft Access is a logical solution; however, literature reviewed in this chapter suggests that the interface needs to be designed carefully around the users' needs and key principles of interface design. In the next chapter, we explain the techniques that were used to assure the interface was designed according to these guidelines.

Chapter 3: Methodology

Effectively creating a user-friendly database requires an understanding of what the users do with the data they gather and how they prefer to search through the database. We needed to make these determinations through our on-site research. Before carrying out this research, we developed a prototype based on a sample Microsoft Access database that INCOPESCA provided. We then addressed our four research questions so that the database could be modified to better suit the users.

3A. For What Purpose is the Information Used?

Our first research question was designed to determine what users needed to accomplish using the database. This information was important in designing the most common queries that users would execute to analyze the data, and to make recommendations for future queries that could be developed. This question was also important in documenting how the database affects the aquaculture industry, and why it should continue to be developed and improved in the future.

The first method we used to gather this information was interviewing our sponsor, Sr. Álvaro Otárola Fallas. We asked him directly what users did with the information, and also asked for examples. This interview was un-standardized, because we had no prepared questions and the relevant questions occurred naturally during our first on-site meeting. Our second method to gather this information was to survey four users, all of whom worked for INCOPESCA. These surveys took place during visits to two stations that were planned by our liaison to present the new database to employees who will regularly enter information into it.

In order to analyze the data gathered by these methods we grouped common uses together and recorded each use in our final report. This allowed for the most accurate documentation of the important uses of the database. The analyses of these uses were vital in the development of appropriate and useful queries in addition to making recommendations on how the database could be improved in the future.

3B. What are the Main Fields Needed in the Database?

Discovering the necessary fields to include within the database was important in that they are used to present the data. Thus, these fields must be the most accurate and appropriate means of displaying these data to assure that users can make reliable decisions. Addressing this question also helped us determine if any vital information was not included in the database which could be used to better monitor the industry.

We were given a CD with an Access database as an example of how our sponsor wanted the database formatted, including the fields he found most important to incorporate. We developed a prototype from the CD, and refined it based on a series of interviews with our sponsor, which included his critiques of the database. These critiques concerned the addition and removal of certain fields that he felt were or were not necessary to the individual forms and reports in the database. We took detailed notes during these interviews in order to easily identify the key points discussed. Similarly, our sponsor critiqued the database during user-testing and careful notes were taken of the changes he wanted. We also needed to find out directly from the users what fields they felt were or were not necessary. This was achieved by the administration of surveys to four INCOPESCA employees after they completed user-testing.

The portion of the survey that addressed the contents of the database consisted of two main questions. The first asked users if they felt any key information was missing from the database and to identify what (if any) information this was. The second asked users if they felt any information in the database was unnecessary, and if so, to indicate what information this was.

3C. How Should the Information be Structured and Displayed?

This question was essential because the layout of the database is related to how effectively it can be utilized by the users. As was previously discussed in the background chapter, the layout affects how quickly the user becomes familiar with the database and the user's ability to stay focused and complete tasks efficiently. We planned to apply the concepts of simplicity and consistency discussed in the background to the design of the new database to make it user-friendly.

To further refine the database, we conducted user-testing to identify features that could be displayed more appropriately. Preece, Rogers, and Sharp (2002) described an actual implementation of user-testing in the design of an interface. The user-testing involved seven participants who were given five minutes to explore the interface on their own and were then asked to perform basic tasks while describing what features they were thinking about and paying attention to. At the end of the test, each user was asked to complete a survey in order to express what they liked and disliked about the interface, what they felt needed to be improved, and to rank the difficulty of each task on a scale of 1 to 10 with 1 being the easiest and 10 being the most difficult. The design team was able to use this data to identify what aspects needed to be improved and to prioritize the changes that needed to be made (p. 327-329).

We planned to model our user-testing around the previously described format. There were four major differences between our user-testing and that described in the example. First, our sample was limited to the employees that our sponsor put us in contact with. Second, we created instructions to guide users in using the database and gave them approximately 30 to 45 minutes to become familiar with the program, since they had likely never used anything similar to the program before. Third, our sponsor guided each employee through our basic instructions on using the program as they explored the new database to assure that our instructions in Spanish were clear. Finally, we recorded any problems or concerns that the participants mentioned while taking part in the user-testing, but we did not ask them to describe their thoughts during the test as recording this information would have been difficult due to the language barrier.

After allowing the users to become familiar with Microsoft Access, we gave them a specific set of 5 basic tasks to perform. The specific tasks included in the test were developed on-site based on our liaison's description of how the database is typically used. We observed the users as they underwent the testing so that they could describe to us any design features they found confusing and explain to us why they were confusing. After completing all tasks, we asked the users to fill out a survey that we had created to accompany the user-testing. We also asked users to rank the difficulty of performing the delegated tasks and to provide a brief description as to why each task was easy or difficult.

We analyzed the responses by tallying the responses to standardized questions concerning efficiency and ease of use. The numerical rankings of each task were averaged and analyzed. Written responses common to at least two users were recorded in our report. After identifying features that users found confusing, we made the necessary modifications to the database.

3D. How Efficient and Easy to Use is the New Database Compared to MS Excel Database?

We felt this research question was very important to try to address because it was related to how successfully we had modeled the new database around users. We predicted the most significant improvement in the new database compared to the MS Excel database would be the increase in the efficiency with which users could complete tasks. In addition, we believed this assessment of the efficiency would reveal if further improvements could be made.

To determine the efficiency and ease of use of the new database relative to the original we included two questions in our survey that followed user-testing. These questions asked users to give their personal opinion of whether they could complete tasks in less time in the new database than in the old and if they felt the new database was easier to use than the original. Comparative usability testing between the new database and the original would have allowed us to compare quantitative data, but this was not feasible (Preece, Rogers & Sharp, 2002). In order to evaluate efficiency by these means, we would have needed to set up specific tasks that could be performed in both Microsoft Excel and Microsoft Access, ask each user to perform the tasks, and record the time that each user took to perform the tasks. This process would have required more time than we had available, and differences in how the users performed the tasks and how these differences affected the time it took for them to complete the tasks (or even how many errors they made) would be too difficult to account for. A more feasible means of evaluating the efficiency and ease of use in our case was to ask users questions related to efficiency and ease of use in the survey that followed user-testing. .

Since users selected from a set of standard responses to these questions, we were able to tally the responses easily and determine how the majority of users felt. Due to the simplicity of our analyzing method for this gathered data, we were able to promptly assess the comparative efficiency and ease of use of the two databases.

Conclusion

Our main objective while on-site was to answer the four research questions presented in this chapter. The research techniques that we used to address these questions included interviews with our sponsor and user-testing and surveying of four INCOPESCA employees. Through the use of these methods, we were able to gather data that allowed us to answer our research questions. In the following chapters, we present our results, discuss their implications, and summarize our key findings.

Chapter 4: Results and Discussion

Our research conducted on-site in Costa Rica aimed to determine how information in INCOPESCA's original database was used, what fields needed to be included in the new database, how the information should be displayed and structured, and the relative efficiency and ease of use of the new database compared to the original. Our investigations provided answers to these questions and allowed us to design a new Microsoft Access database to replace the pre-existing MS Excel spreadsheets. In this chapter, we discuss the features of the new database and how the creation of these features was determined through our investigative techniques. We then consider the relative efficiency and ease of use of the two databases and discuss what implications these findings have for our project.

4A. Current Uses of the Information Contained in the INCOPESCA Database

Prior to our arrival in Costa Rica, we were informed that the users of the original Microsoft Excel database included producers, students, universities, the national bank, the government, and international cooperation agencies (Á. Otárola Fallas, personal communication, April 15, 2007). We felt that the uses each of these groups had for the database were not clearly defined and that this information was vital to designing a database that would allow the users to gather the data they needed to perform their tasks. Therefore, we sought to determine the most common uses of the database and to determine which group or groups used the database most in order to prioritize the necessary modifications to the database.

Through our interview with our liaison, Sr. Álvaro Otárola Fallas, and the results we obtained from surveys administered following user-testing, we learned that INCOPESCA is the main user of the database. Sr. Álvaro Otárola explained that INCOPESCA's uses of the database fall into the areas of research and development, operational decisions and policy making. Survey results from four employees in two regional INCOPESCA stations confirmed these findings. They indicated the database is used to maintain information on all producers in the surrounding area and to understand regional and national markets, which is essential in making decisions about planning future development and setting future policy.

We discovered some specific uses of the database through our first interview with Sr. Álvaro Otárola and our discussions with him during our visits to two INCOPESCA stations and surrounding farms. At our first meeting we were told the MS Excel database had been used to determine how to optimize the construction of a shrimp processing facility. Sr. Otárola also explained that the MS Excel database had been used to secure tax breaks for producers. Obtainment of these tax breaks allowed producers to save as much as 80% on the cost of equipment necessary for the continued expansion of their farms. Without these tax breaks, many of these producers would have been unable to obtain this equipment (personal communication, May 14, 2007).

During our visit to a tilapia farm, Sr. Otárola explained that due to the nation's desire to maintain a clean environment, each new fish producer is supposed to submit documentation that explains how their project will affect the environment. Most projects use natural sources of water to supply their tanks and then release this water directly back into the same source without filtering or re-circulating it. Each producer is also required to purchase rights to the water they use to supply their tanks. Without such concession from the government, farmers have no means

of staking their claim to a water source if another producer starts a project upstream that compromises the water quality or supply. The new database we have created will store information related to these issues, such as whether or not a project is environmentally sound, has the authorization of INCOPESCA, and has been granted rights to a water source. With these additions to the database, INCOPESCA will be able to more effectively monitor the environmental impacts of the aquaculture industry. This will facilitate the improvement of the quality of water that is released back into the environment after circulating through tanks, since the majority of producers do not currently abide by the agency's requirements (personal communication, June 13, 2007).

As Sr. Otárola explained to us, the two INCOPESCA stations we visited supplied many of the local producers with trout or tilapia fry, or young fish (personal communication, June 12 and 13, 2007). Thus, another important use of the database is to determine how many fry need to be hatched at each station to meet the local demand. In making these decisions, the stations may need to know information such as the total number of producers in a particular region and the total production capacity. Such information can be gathered easily from the database.

Important findings can be drawn from our investigation of the uses of the database. First, we learned that although many user groups may be associated with the database, INCOPESCA is the only stakeholder that uses it on a regular basis. Copies of the database will be stored at each INCOPESCA station, and as was done in the past, information about producers will be collected by designated employees at each site either during visits to each producer's farm or when each producer comes to the station to get fry (Á. Otárola Fallas, personal communication, June 12 and 13, 2007). Secondly, the most important and routine uses of the database are granting tax breaks to producers, managing and creating policy, and planning future development. Thus, the

database we created was designed specifically to help INCOPESCA carry out the most significant uses that were identified.

4B. Necessary Fields in the Database

To make the database truly useful, the information it contained needed to be relevant to the tasks that users performed on a regular basis. We identified INCOPESCA as the main user of the database and determined that the tasks performed most often were related to the areas of development, assisting producers in obtaining tax breaks, and making policy decisions. As a result, our design of the database focused on meeting the needs of INCOPESCA and providing information that would allow for the agency to carry out a variety of tasks within these areas.

The database we have created in Microsoft Access is more extensive than the original Microsoft Excel spreadsheets. A total of 95 new categories were included in the MS Access database. The database has three main components: pages for the input of new information, pages for the output of information stored in the database, and a search page that allows users to gather specific information from the database. Many of the categories on the output pages are identical to those on the input pages, although some categories in the output pages contain values that are calculated from information contained in the database. The information within each major section is further divided by page, with each page showing information related to a particular area of interest. The main pages in both the input and output sections display general information, such as the producer's name and address, market conditions, technical data, information related to associations, organizations, and institutions that assist producers, and a

bibliography of all papers and publications that have been written about the nation's aquaculture industry.

A. The "General Information About the Project" Page

On this page, categories such as the producer's name, address, and telephone number(s) are found. The information in this page is vital to making socioeconomic decisions, such as awarding tax breaks to producers, since it also contains information about the producer's marital status and the number of dependents.

Most of the information on this page is identical to that contained in the prototype provided by INCOPESCA, but some changes were made at the request of our sponsor. Information in the geographic location section was refined with the removal of fields for GPS coordinates because our liaison felt this information was unnecessary. The section on legal aspects at the bottom of the page was added at the request of our sponsor and contains the three "yes" or "no" fields of whether or not the project is environmentally viable, whether the project has rights to a water source, and whether it has the authorization of INCOPESCA. As we discussed in the first section within this chapter, these fields are needed to help the government improve environmental conditions. The project code field was added to allow INCOPESCA to create a code in the future that will identify the producer, the location, and the type of fish produced in order to better manage their data. Finally, we also added the "project status field" that allows the agency to store information on active and inactive projects in the same geographical area. This will allow INCOPESCA to identify projects in certain areas that may require additional assistance to increase their rate of success.

A complete list of the fields on this page can be found in Table 3.

Table 3: Fields in the "General Information About the Project" Page

Field	Field Type and Description of Possible Responses	Justification
Name of Person Recording the Data	Text	Requested by INCOPESCA
Date on which Data was recorded	Text	Requested by INCOPESCA
Name of Project	Text	Requested by INCOPESCA
Duration of Project's Activity	Number	Requested by INCOPESCA
Current State of Project	Drop-Down Menu, Options are "Active" or "Inactive"	Requested by INCOPESCA
Address	Text	Requested by INCOPESCA
District	Text	Requested by INCOPESCA
Cantón	Drop-Down Menu, Options are all Cantons in Costa Rica	Requested by INCOPESCA
Province	Drop-Down Menu, Options are all Provinces in Costa Rica	Requested by INCOPESCA
Telephone Number 1	Text	Requested by INCOPESCA
Telephone Number 2	Text	Requested by INCOPESCA, to accommodate additional phone numbers found in Excel databases
Telephone Number 3	Text	Requested by INCOPESCA, to accommodate additional phone numbers found in Excel databases
Fax or Cell Phone Number	Text	Requested by INCOPESCA
Nearest INCOPESCA Office	Text	Requested by INCOPESCA
E-mail Address	Text	Requested by INCOPESCA
Postal Address	Text	Requested by INCOPESCA
Name of Producer	Text	Requested by INCOPESCA
Marital Status	Drop-Down Menu, Options are "Married", "Single", "Widower", "Free Union", "Divorced", and "No Response"	Requested by INCOPESCA
Number of Dependents	Number	Requested by INCOPESCA
Main Source of Family Income	Text	Requested by INCOPESCA
Latitude North	Text	Requested by INCOPESCA
Longitude West	Text	Requested by INCOPESCA
Altitude	Number	Requested by INCOPESCA
Environmental Viability	Yes or No	Requested by INCOPESCA
Concession of Water	Yes or No	Requested by INCOPESCA
Authorization of INCOPESCA	Yes or No	Requested by INCOPESCA

B. The "Aspects of the Surroundings" Page

The second major page in the database contains fields related to the physical aspects of a producer's farm. Like the previous page, this page is important in making socioeconomic decisions that would benefit the producer since information related to the basic services available in the area is present. In addition, this page contains information that describes physical risks, such as the likelihood of natural disasters, and the project's accessibility. These are important factors to monitor in case INCOPESCA can find means of improving projects with many physical risks or limited accessibility.

Only one major change was made to this page at the request of our sponsor after we created the initial model of the database from the prototype. Our sponsor asked that we add three new options to the list of basic available services. These additions were "school", "college", and "transportation" (the only options that had existed initially were "telephone", "Internet", "electricity", and "potable water"), factors which are again important in establishing a producer's socioeconomic status.

A complete list of all the fields that are included in this page is given in Table 4.

Table 4: Fields in the "Aspects of the Surroundings" Page

Field	Field Type and Description of Possible Responses	Justification
The Project is Accessible by Land	Yes or No	Requested by INCOPESCA
Actual State of Access to the Project	Drop-Down Menu, Options are "Regular", "Bad", or "Good"	Requested by INCOPESCA
Accessible Only in the Dry Season	Yes or No	Requested by INCOPESCA
Accessible All Year	Yes or No	Requested by INCOPESCA
Other Means of Access	Text	Requested by INCOPESCA
Basic Available Services	Drop-Down Menus, Options are "telephone", "Internet", "electricity", "potable water", "school", "college", and "transportation"	Requested by INCOPESCA
Nearest Population Center	Text	Requested by INCOPESCA
Distance to the Nearest Population Center	Text	Requested by INCOPESCA
Nearest Educational Facilities	Text	Requested by INCOPESCA
Presence of Pollution	Yes or No	Requested by INCOPESCA
Sources of Pollution	Drop-Down Menus, Options are "Urban", "Industrial or Agroindustrial", "Agricultural" and "Other"	Requested by INCOPESCA
Other Source of Pollution (Describe)	Text	Requested by INCOPESCA
Physical Risks	Drop-Down Menus, Options are "Flooding", "Landslide", and "Main Avenue"	Requested by INCOPESCA
Other Risks (Describe)	Text	Requested by INCOPESCA
Climate Factors that Affect the Project	Text	Requested by INCOPESCA

C. The "Market Aspects" Page

The page that contains information related to the market for the fish grown by producers allows INCOPESCA to track the economic aspects of the aquaculture industry. Some of the information in this page includes the sale price of the product and the main commercial objective of each farm (such as recreational fishing or production and sale of fry to other producers). In making decisions concerning policy or further development of the industry, analysis of this information is needed to understand which production objectives are the most profitable and which are the least profitable.

Most of the information displayed on this page is identical to the prototype that INCOPESCA wanted to use as a basis for the design of the new database. The only major change made was the transfer of fields related to how often the fish on a particular farm were fed each day to the technical data page of the database. This change was made at the request of our sponsor because they felt this information was more closely related to the technical aspects of each project.

A complete list of all of the fields contained within this page is shown in Table 5.

Table 5: Fields in the "Market Aspects" Page

Field	Field Type and Description of Possible Responses	Justification
Main Provider of Fry (or Seed Organisms)	Text	Requested by INCOPESCA
Cost of the Fry (or Seed Organisms)	Number	Requested by INCOPESCA
Main Purchaser of the Product	Text	Requested by INCOPESCA
Cost of Production per Kilogram	Number	Requested by INCOPESCA
Sale Price	Number	Requested by INCOPESCA
Market for Product	Text	Requested by INCOPESCA
Destination of Product	Text	Requested by INCOPESCA
Main Objective of the Project	Drop-Down Menu, Options are "Production of Fry/Seed", "Sale of Fry/Seed", "Only for fishing and prepared for visitors", "Only for sale to establishments", and "Recreational without commercial objective"	Requested by INCOPESCA
Other Objective (Describe)	Text	Requested by INCOPESCA
Facilities that the Project Offers	Drop-Down Menu, Options are "Restaurant", "Accommodation", and "Fishing Facilities"	Requested by INCOPESCA
Other Facilities (Describe)	Text	Requested by INCOPESCA
Rights to the Land where the Project is Located	Drop-Down Menu, Options are "Permission to use", "owned by producer", "rented", and "in concession"	Requested by INCOPESCA
Presence of Conditions for Increasing the Area of Production	Yes or No	Requested by INCOPESCA
If Conditions are Present, the Area is...	Number	Requested by INCOPESCA

D. The "Technical Data" Page

The information displayed on this page is related to the aspects of production. This information is necessary because it allows INCOPESCA to understand what production techniques are currently being employed by producers. The agency can then identify weaknesses in these techniques and suggest possible improvements. For example, we visited a catfish farm in which water circulated from the source through a succession of tanks instead of flowing directly from the source into each tank. Sr. Otárola explained that this allows diseases to be spread more easily among the tanks and prevents oxygen from being delivered to the lower levels of the tanks in the beginning of each series. Tracking information related to tank structure displayed on this page would allow INCOPESCA to identify flaws in tank design that could lead to these problems.

Several significant changes were made to the layout of the prototype version of this page. For example, all fields found in the technical data page that relate to the feeding of the fish were moved to this page from the "Market Aspects" page. Information regarding the type of terrain was moved from the "Aspects of the Surroundings" page. Our sponsors requested that these changes were made because they felt that this information was more closely related to production. For example, the information regarding how often the fish are fed is more closely related to the density of organisms for each farm and even to the mortality rate than it is to market aspects because it affects the growth rate of the fish. Logically, this information now appears on the technical data page along with information about mortality and density of the organisms.

Additionally, new fields were created to record the size range of all the tanks in a particular project and the amount of tanks in each size range. Such specific information about

tank size was found in the original Microsoft Excel database and is used to determine the total production capacity for each project.

A complete list of all fields that appear on this page is given in Table 6.

Table 6: Fields in the "Technical Data" Page

Field	Field Type and Description of Possible Responses	Justification
Type of Organism	Text	Requested by INCOPESCA
Species	Text	Requested by INCOPESCA
Quantity of Tanks	Total Calculated from number of tanks in each size range	Requested by INCOPESCA
Number of Cement Tanks	Number	Requested by INCOPESCA
Number of Earthen Tanks	Number	Requested by INCOPESCA
Tank Size Range 1 (10 Fields Total)	Drop-Down Menu with sizes ranging from 0 to 5000 m^2	Requested by INCOPESCA
Number of Tanks in Size Range 1 (10 Fields Total)	Number	Requested by INCOPESCA
Total Area	Number	Requested by INCOPESCA
Water Flow	Number	Requested by INCOPESCA
Percent of Water Replaced Each Day	Number	Requested by INCOPESCA
Density of the Immature Organisms	Number	Requested by INCOPESCA
Final Density of the Immature Organisms	Number	Requested by INCOPESCA
Total of Immature Organisms	Number	Requested by INCOPESCA
Possibility of Acquiring More Water	Text	Requested by INCOPESCA
pH	Number	Requested by INCOPESCA
Oxygen Level	Number	Requested by INCOPESCA
Temperature	Number	Requested by INCOPESCA
Opacity of the Water	Number	Requested by INCOPESCA
Harvest Weight	Number	Requested by INCOPESCA
Biomass	Number	Requested by INCOPESCA
Mortality	Text	Requested by INCOPESCA
Cause of Mortality	Text	Requested by INCOPESCA
Diseases	Text	Requested by INCOPESCA
Number of Times the Organisms are Fed Each Day	Number	Requested by INCOPESCA
Feeding Schedule	Text	Requested by INCOPESCA
Type of Food	Text	Requested by INCOPESCA
Main Provider of Food	Text	Requested by INCOPESCA
Monthly Consumption of Food	Number	Requested by INCOPESCA
Percentage of the Ration	Number	Requested by INCOPESCA
Topography of the Terrain	Drop-Down Menu, Options are "Hilly", "Semi-hilly", and "Flat"	Requested by INCOPESCA
Soil Type	Drop-Down Menu, Options are "Sandy", "Clayish", "Sandy-clayish", and "Stony"	Requested by INCOPESCA
Origin of Water for Human Consumption	Text	Requested by INCOPESCA
Origin of Water for Tanks	Text	Requested by INCOPESCA
Observations	Text	Requested by INCOPESCA

E. The "Institutions" and "Associations and Organizations" Pages

The "Institutions" and "Associations and Organizations" pages were not found in the original prototype that was used as the main basis for our design. They were created at the request of our sponsor so information on organizations, associations, and institutions that provide assistance to producers in Costa Rica could be maintained in the same database as information on the producers.

These two pages were modeled after the "General Information About the Project" page and contain many of the same fields. The only new fields that were created for these pages were those that ask for the number of people that work for the organization, institution, or association, a field that asks for the national ID number for an institution, and a field that displays the country where an association or organization is located. These additional categories were made at the request of our sponsor so that adequate information about these groups could be stored in the database.

A complete list of all of the information found on these pages is given in Table 7.

Table 7: Fields in the "Institutions" and "Associations and Organizations" Pages

Field	Field Type and Description of Possible Responses	Justification
Name of the Association, Organization, or Institution	Text	Requested by INCOPESCA
Length of Time of Activity	Number	Requested by INCOPESCA
Address	Text	Requested by INCOPESCA
District	Text	Requested by INCOPESCA
Cantón	Drop-Down Menu, Options are all Cantons in Costa Rica	Requested by INCOPESCA
Province	Drop-Down Menu, Options are all Provinces in Costa Rica	Requested by INCOPESCA
Telephone Number	Text	Requested by INCOPESCA
Fax or Cell Phone Number	Text	Requested by INCOPESCA
E-mail Address	Text	Requested by INCOPESCA
Postal Address	Text	Requested by INCOPESCA
Number of People that Work for Association, Organization, or Institution	Number	Requested by INCOPESCA
National ID Number (Only for Associations or Organizations)	Number	Requested by INCOPESCA
Country (Only for Institutions)	Drop-Down Menu, Options are "Guatemala", "Costa Rica", "El Salvador", "Honduras", and "Nicaragua"	Requested by INCOPESCA
Name of the Unit (Only for Institutions)	Text	Requested by INCOPESCA

F. The "Bibliography" Page

The "Bibliography" page did not exist in the original prototype and was created at the request of our sponsor. It was designed to store information about all papers and publications that have been written about INCOPESCA and the aquaculture industry so that the agency can refer to this information when making decisions.

The only minor modifications that were made to the bibliography page after user-testing were the addition of a field to record the year in which each document was published and a change in the definition of the primary key. The primary key is simply an indicator that Microsoft Access uses to identify each record as being unique to prevent duplicate records from appearing in the database. The field that is designed as the primary key must contain a unique

value for each record. We originally defined the primary key for this page as a combination of the title of the publication and the author to prevent entries of the same publications from accidentally being placed in the database multiple times. However, during user-testing, we found that this led to some confusion among users since they could not exit the bibliography page after selecting a new record and leaving it blank, as the primary key fields cannot be left blank. To prevent frustration among users in the future, we decided to eliminate primary keys altogether on this page. We felt the increase in the ease of using this page with this change outweighed the clutter that would arise from the possible entry of duplicates of the same record.

A complete list of the fields found on this page is shown in Table 8.

Table 8: Fields in the "Bibliography" Page

Field	Field Type and Description of Possible Responses	Justification
Theme	Text	Requested by INCOPESCA
Year of Publication	Number	Requested by INCOPESCA
Name of the Publication	Text	Requested by INCOPESCA
Author	Text	Requested by INCOPESCA
Location of the Document	Text	Requested by INCOPESCA

G. The "Search" Page

Unlike the other pages in the database, this page only displays information that is already stored elsewhere in the database. The purpose of this page is to make it easier for users to search for information about a specific producer or to quickly find summaries of information that meet specific requirements.

The additions to this page were four new searches that reflect routine data gathering tasks performed by the agency. Three of the searches summarize production by region and the fourth summarizes the state of activity of all projects in the database. A user can specify the species

and province or cantón of interest and then view either the total number of producers, the total area devoted to production of the chosen species, or the total production of the chosen species in kilograms for the selected area. The fourth type of search allows the user to view a report of all active projects in the database as well as one for all inactive reports. Microsoft Access automatically gathers the relevant data when any of these four searches is executed. Thus, INCOPESCA is able to find the same kind of information needed in the past, but in a simpler manner than could be done in Microsoft Excel.

The reason why gathering information with these searches is easier than gathering it in MS Excel is that the searches are each based on a query. A query allows an unlimited amount of criteria to be set when searching through data, where as only a single criterion can be applied in Microsoft Excel. The amount of steps a user needs to go through in determining regional production, in which criteria for the region and species of interest must be set, is minimized with the use of a query in Microsoft Access. Thus, the design of these searches in the new database utilizes some of the technology that was not available previously and allows users to find information they need more easily.

II. User-Testing Assessment of the Fields in the Database

During user-testing, our sponsor and some of the participants informed us of minor changes that needed to be made to the spelling and grammar in the fields presented in the database. For example, in the field that asks the user to list the current state of the activity of the project (as either active or inactive), the verb ser was used when the verb estar was more appropriate. In addition, our sponsor requested that we add some new categories to the database

as a result of user-testing. These include the "Year" field in the bibliography page and two fields to the main page to record the date the information about a producer was entered and who entered it.

Overall, user-testing revealed that the majority of the information presented in the database was adequate. The four INCOPESCA employees who underwent user-testing all indicated that they felt there was no unnecessary information in the database and none suggested any additional information to include. Thus, our findings seem to indicate that after the minor modifications discussed during user-testing were made, the information contained within the database is sufficient and appropriate.

4C. The Display and Organization of the Data

Although it was important to determine what information needed to be gathered from the database, it was also necessary to assure that the user could accurately access this information. To do so, the layout of the interface needed to be carefully structured so all users would find it comprehensible. Design features of the interface were based off the prototype and then refined at the request of our sponsor. We aimed to make the organization of the data logical, to simplify tasks, and to keep data entry consistent by organizing responses into pre-set lists of options from which users could choose. User-testing was then conducted to determine if the overall layout of the database needed to be changed or improved to make it more user-friendly.

Upon receipt of the database prototype from INCOPESCA, the first major design features changed were the background color and the size of the heading on each page. The background color was changed because INCOPESCA felt that the light blue color of the current database is

more pleasing than the original green color. Our sponsor also felt that maximizing the amount of information displayed on the screen at one time by shrinking the headings on each page would be more beneficial to the user. Next, we assured that the appropriate navigation buttons were displayed on each page so that users could easily maneuver through the forms (buttons cannot be placed within reports, which are the basis of the output section of the database). The buttons were then placed in the upper right margin of each input page to keep the location consistent, thereby making it easier for users to become familiar with the layout. Finally, we changed many of the yes/no fields that already existed in the database to drop-down menus and added drop-down menus for the cantón and province categories. By making preset lists of options from which users could choose a response, the process of entering data into these categories was simplified and made more consistent. Consistency in terms of the spelling of the cantón and province in each record is especially important because the searches that summarize production depend on matching records exactly to the cantón or province chosen from a list by the user.

The results of user-testing indicated that the design of the database was easy for users to understand and follow. In fact, for the question that asked if the layout was easy to understand and navigate, all four participants in user-testing answered yes. The overall rating of each task in terms of difficulty showed that participants felt the tasks were very easy to carry out (the average rank of difficulty of each task is shown in Table 9). It was observed during user-testing that the only complications users had were with the North American keyboard (testing was conducted on one of our laptops), which users will not need to interact with in the future. There was also some initial confusion when buttons were clicked to access new pages because the icon that appears for the new page must be clicked to bring the page up on the screen. However, users quickly became accustomed to making this extra click. Additionally, basic instructions were created

concerning installation and use of the database in which users were made aware of the need to select these icons when opening a new page. In spite of these complications, the results indicated that users felt the design of the interface made the database very easy to use.

Table 9: Average Rating of Difficulty of Each User-Testing Task

Task	Average Rating*
Task 1	1.25
Task 2	1.75
Task 3	1.25
Task 4	1.33
Task 5	1.25

*Tasks were ranked on a scale of 1 to 10 in which 1 corresponded to easy and 10 corresponded to difficult.

4D. Relative Efficiency and Ease of Use

One benefit we anticipated with the transfer of the INCOPESCA database to Microsoft Access was an increase in the efficiency with which tasks could be performed. This prediction was based on the fact that features unique to Microsoft Access, such as queries, would be implemented to gather information in fewer steps than had been possible with Microsoft Excel. Logically, it seemed that if we could prove users felt they could perform such tasks in less time and more easily than they had in the past, our design would have been successful in the sense that tasks could be completed more readily in the new database. Thus, we asked users to evaluate the efficiency and ease of use of the new database in the survey following user-testing.

During user-testing, it quickly became apparent that a direct comparison of the two databases in terms of efficiency was not possible. As several of the users indicated (all of whom had previously used the Microsoft Excel database), there was simply far more information in the new database than in the MS Excel database. A task such as entering information on a producer would require more time to perform simply because there would be more data to enter. Another

user also indicated that more time was needed to become familiar with the system. Thus, it seems that a determination of whether the new database is truly more efficient than the original cannot be made.

In spite of the fact that we were unable to find answers to our questions concerning the efficiency of the new database, we were able to make some conclusions about the ease of use of the new database relative to the old. Three of the four participants who underwent user-testing said they felt the new database was easier to use than the old, and one user felt that it was more difficult to use. Such results show that it is likely the majority of users will find the new database more user-friendly once they become familiar with it.

Conclusion

The findings from the user-testing we conducted with four INCOPESCA employees showed that the new database adequately meets the needs of the agency. Although sampling multiple user groups for user-testing would have been ideal, we discovered that INCOPESCA uses the database far more often than the other user groups, meaning the agency's needs were of a much higher priority. In addition, we were limited by time and accessibility to these groups and thus we could only conduct one round of user-testing with four of the agency's employees. These employees felt that the information in the database was sufficient and all categories were necessary, that the structure was easy to understand and navigate, and that the new database was easier to use overall than the original. Thus, our findings show that the Microsoft Access database created over the course of our stay in Costa Rica is an improvement over the original

and that it will successfully help INCOPESCA manage information on the aquaculture industry so that the agency can make well-informed decisions in the future.

Chapter 5: Conclusions and Recommendations

In the past, information on the aquaculture industry in Costa Rica had been stored in several Microsoft Excel spreadsheets by the government agency INCOPESCA. Several problems with this means of storage led the agency to seek to transfer this data into Microsoft Access. First, the searching capabilities of MS Excel were inadequate for the complex analyses of the data that INCOPESCA routinely needed to perform. Second, the Microsoft Excel files contained numerous occurrences of erroneous data categorization. Finally, the agency needed to consolidate the files and increase the amount of information they maintained to make management of the expanding industry easier and more accurate.

The research and work we conducted over the course of our stay in Costa Rica focused on addressing these three problems through the design of a new Microsoft Access database. Queries were created that allow more complex searches involving multiple sets of criteria. Ninety-five fields were added to the new database so that more information can be stored on different aspects of the industry. The page layout and tools for entering and accessing data were designed around users' needs, and user-testing showed that users found the layout comprehensible. Finally, in the transfer of the data from Microsoft Excel to Microsoft Access, many of the categorization errors found in the original files were corrected.

Initially, our project sought to model the new Microsoft Access database around multiple user groups' needs by user-testing our initial design on members from each group. We were unable to follow this plan since we were limited to the sample of users our sponsor could provide and we were constrained by time. Moreover we discovered that the primary user of the database was INCOPESCA, so we focused our efforts on the agency's needs, which are to access information that can help: (1) make decisions concerning research and development of fish farm

infrastructure, (2) enforce environmental and tax policies, and (3) analyze the local and national sectors of the aquaculture industry. We designed and refined the database with fields and queries that would provide information in these areas. For example, four queries were designed that: (1) show the total number of producers of a particular species in a specific cantón or province, (2) display the total area devoted to the production of a species within a specified cantón or province, (3) show the total weight of one type of organism produced in a certain cantón or province, and (4) show all inactive or active projects listed in the database.

The four employees who participated in user-testing seemed to be a good representation of the employees who regularly use the database, and both they and our sponsors indicated that the structure and content of the database was useful for the three purposes described above. We do see the possibility of adding additional fields and queries as the industry continues to expand and more users are given access to the database. However, constraints on time and accessibility of members of other user groups limited the amount of changes that could currently be made.

Many queries could be created in addition to those we made to help INCOPESCA's users complete other tasks. For example, a query could be created to find all of the producers with annual incomes in a certain range. This query could be of immense assistance to an INCOPESCA employee who is trying to secure tax breaks for small-scale farmers. We recommend that in the future INCOPESCA create additional queries to help its employees complete basic tasks such as the one just described. Determination of what queries to create could be accomplished by surveying any employees who analyze the data on a regular basis. The use of these queries will allow information to be gathered more quickly and efficiently, allowing the agency to follow industry trends more accurately.

The database is currently modeled after the uses and needs of INCOPESCA. However, future changes also could be made to give access to more users from other identified stakeholder groups, such as the national bank, universities, cooperative agencies, and students. We learned that these groups use the database for these general purposes: (1) collecting industry statistics and (2) granting credit and loans to small-scale farmers (*Instituto Costarricense de Pesca y Acuicultura*, 2007; Á. Otárola Fallas, personal communication, 2007). Thus, we recommend that INCOPESCA consider assembling samples of users from each of these groups, identifying more specific needs, designing new queries and fields related to those needs, and conducting user-testing to refine the database to accommodate these different user groups. Our project provides a model for how this future development might be undertaken.

Granting access to the database to other groups will give Costa Ricans who are not directly involved in the aquaculture industry a greater perspective of its importance to the nation's economy. Greater awareness could lead to further development of the industry through increased government assistance, which would create more jobs for Costa Ricans. In addition, the environmental impacts of the industry would be understood by a wider audience, allowing the nation to make better informed decisions about the preservation of its natural resources. Environmental aspects vary and include the impact the industry has on water sources used to supply farms as well as the indirect effects it could have on marine ecosystems as an alternative to commercial fishing. For example, Carvajal (2005) reports that a new area in aquaculture research in Costa Rica is the growth of yellowfin tuna in captivity as an alternative to catching the fish from the wild. Yellowfin tuna have never been grown from eggs in captivity on a commercial scale, so little is known about the proper conditions under which these eggs should be fertilized and hatched. To supplement this information and expand into the production of

tuna, INCOPESCA could use the database to store technical information related to hatching eggs, such as water temperature and circulation in incubators. Using the database to broaden the aquaculture industry in this way would be economically beneficial since the markets for fresh tuna in the U.S. and Japan are quite large (*Costa Rica to farm yellow tuna*). Additionally, queries could be designed to find all producers listed in the database whose annual incomes and production capacity qualify them for loans from the national bank. This query would allow the bank to determine which producers are eligible for loans more quickly and easily, meaning that subsidies can be delivered to farmers more quickly so that the pace of development could increase.

The new database contains a much greater amount of information than was found in the spreadsheets that comprised the original MS Excel database. This fact prevented us from being able to compare efficiency in any meaningful way. Even if an evaluation could have been made, it is likely that any increase in efficiency brought about by the software transfer would not have been recognized immediately as users would need time to become familiar with the new program. Although it was likely that users would also be unable to assess the ease of use of the interface, they did make evaluations in this area. The four participants in user-testing stated that the database's structure was easy to understand and navigate. They also indicated that all of the information contained in the database was important and that there was no essential information missing. Thus, our results seem to show that we have met our goal of creating a database that meets users' needs and expectations.

To assure that the database remains effective and easy to use in the future, it must be maintained as the aquaculture industry in Costa Rica continues to expand. It was evident from the MS Excel files of the original database that inconsistencies and errors in categorization

occurred frequently, which is a sign of poor data maintenance. This problem must be addressed in the future to assure that the data stored in the database is accurate and reliable. We recommend that INCOPESCA take the following actions to maintain and improve the database:

- The agency should hire a technician to address any technical problems that could be encountered while using the new database and to update the structure of the database to accommodate future changes in the industry. If hiring an additional employee is not possible due to budget constraints, at least one current employee should be trained to address these issues.
- The INCOPESCA employees who will interact with the database should review the instructions we have created. Our intent in creating these instructions was to help users become familiar with the program more quickly so that its advantages over MS Excel can be fully realized.
- INCOPESCA should make an effort to collect data for the new fields included in the database as soon as possible. This will give the agency an opportunity to check with producers to assure that the information currently in the database is accurate. Also, collection of this additional data will allow the agency to monitor more aspects of the industry.
- The agency should sponsor an IQP in the future to expand the capabilities of the current database, such as making it accessible via the Internet with conversion to a different software program. Students majoring in computer science would be best suited for such a project. Placing the database online would make it easier for other stakeholders to access the database and would make it easier for INCOPESCA to routinely add new information collected at each station to the main database, which must now be done manually.

- Passwords should be created to restrict access to all parts of the database or just to the design components that determine the structure. Limitations on access to the database reduce the amount of errors that could be committed by individuals who are unfamiliar with the program.

The research we have completed has resulted in the design and implementation of an aquaculture database in Microsoft Access for INCOPESCA. The new database contains more information than was found in the original Microsoft Excel spreadsheets, which will allow the agency to monitor more aspects of the industry than it could in the past. Additionally, the inclusion of queries in the new database allows users to search through information more efficiently.

We have acknowledged the limitations to our project and we have made recommendations to assist INCOPESCA in furthering the development of the database we created. Adherence to our suggestions will allow the agency to fully utilize the program's benefits, maintain the information stored in the database, and update the database as the industry continues to expand in the future. Using the database to effectively enhance this expansion is crucial due to the industry's contribution to the economy. Growth in the aquaculture industry would not only increase Costa Rica's GDP, but it would also provide many Costa Ricans with new job opportunities, especially in rural areas. As we discovered on a visit to a trout farm, such opportunities are vital to the producer's financial success and that of his family. Without the attraction of sport fishing that the cultivation of fish provides many producers would be unable to find markets for their other products, such as cheese and blackberries, which constitute a significant source of income (A Otárola Fallas, personal communication, June 11, 2007).

Perhaps the most important social impact of our project is on the lives of these average Costa Ricans. Their careers are bound to the nation's aquaculture industry, and development of the industry is in turn guided by the database. Thus, continued improvement and maintenance of the database is essential to the continued success of the aquaculture industry and the financial success of producers throughout the nation.

Appendix A: INCOPESCA Sponsor Description

The Instituto Costarricense de Pesca y Acuicultura (INCOPESCA) was created on March 16th, 1994 through law #7384, Creación del Instituto Costarricense de Pesca y Acuicultura (The Creation of INCOPESCA) by the Legislative Assembly of the Republic of Costa Rica as a replacement for the inadequately resourced organization called La Dirección de Pesca, as an independent institute to regulate the Costa Rican fishing and aquaculture industries.

INCOPESCA has thirteen offices located throughout the nation that dedicate themselves to the control and improvement of Costa Rica's aquaculture industry. INCOPESCA also sells fry to small and medium tilapia producers. Their yearly budget is 1 billion colones (~2.3 million American dollars); 75% of this is funded by the government, and the other 25% comes from the tilapia fry sales.

INCOPESCA's primary objectives include the conservation of marine ecology, enforcing fishing laws, and spreading technology and information to aquaculturists and fishers. More specifically, INCOPESCA studies the marine ecosystems to develop new regulations and restrictions on fishing. It also promotes aquatic industries by subsidizing fishermen during bans on their products or bans due to declining fish populations. Additionally, INCOPESCA encourages internal and international trade, as well as registering fishermen and aquaculturists (*Creación del Instituto Costarricense de Pesca y Acuacultura (INCOPESCA),* 2005).

INCOPESCA is a public institution established by the government, but is also a semiautonomous and non-profit organization. INCOPESCA is run by a main board of directors, which includes a President (assigned by the Government), the Minister of Agriculture and Livestock (director of the Ministerio de Agricultura y Ganadería, or MAG), the Minister of Science and Technology, a representative of the State assigned by the Government, three

members of the fishing sector (representatives of fishing or aquaculture organizations), a representative of the industrial sector of fishing or aquaculture, and a representative of the National Commission of Fishing and Aquaculture Consulting (Bryand, Kadilak, & Pani, 2006).

Our primary liaison in INCOPESCA was Sr. Álvaro Otárola Fallas, the director of the Department of Aquaculture. In his position he oversees most of the administrative aspects of this department. He is also very involved in the training and education of farmers in Costa Rica. Because of this, he organizes and participates in courses that INCOPESCA and the Department of Aquaculture provide.

Currently INCOPESCA is independent, but has to follow regulations and laws set by the government. The MAG can place regulations on different aspects of agriculture and livestock, including aquaculture and fishing, which independent institutions such as INCOPESCA have to follow. In the 2006 elections, a new administration came into power. This administration is looking towards restructuring various aspects of the government and its agencies. The government is planning to create a new ministry called the Ministry of Production, which would absorb MAG and other institutions such as INCOPESCA. If this happens, INCOPESCA will lose its autonomy and independent budget. The employees at INCOPESCA are divided on the subject, but many are fighting for keeping their own finances and budget even if INCOPESCA is absorbed into the Ministry of Production (Bryand, Kadilak, & Pani, 2006).

INCOPESCA's funding comes from various sources, which include the following: government support, contributions from national and international institutions, fines, taxes and contributions associated with Law #7384, donations from other governments, private donations, and income of the Ministry of Agriculture and Livestock (*Creación del Instituto Costarricense de Pesca y Acuacultura (INCOPESCA),* 2005). According to the Sección de Presupuesto of

INCOPESCA, the organization received a total of 1,032.66 million colones in the year 2005. Of this, 595 million colones were received as transfers from the Central Government, 73.7 million colones were from sales of goods and services, and 363.9 million colones were received from sales of licenses. The 2006 budget was projected at a total of 1,928 million colones. Of this budget, it is estimated that 711 million colones would be appropriated to other "entities" according to the new Ley de Pesca y Acuicultura. After this is subtracted from the budget, 1,217 million colones will remain for operation of INCOPESCA. Of this last number, 614 million colones would be provided by the Central Government, an increase from the previous year. Finally, 603 million colones are estimated to be generated by INCOPESCA by sales of permits, goods and services rendered (Bryand, Kadilak, & Pani, 2006, p. 114).

INCOPESCA's mission is the following:

INCOPESCA, as a governing entity, promotes the fishing and aquaculture development of the country. The organization regulates, protects and administrates marine and aquaculture resources, providing a sustainable contribution to the economic development of the country.

Appendix B: Survey

(English Version)

Survey

We would appreciate it very much if you would please take a few moments to answer these questions about the database. We thank you very much for your time and cooperation.

Molly McShea and Jo-Ellen Sullivan

1. Why do you need the information in the database (How do you use it in your work)?

2. Do you feel that there was any important information missing from the database that you would like to have available? If yes, what categories of information should we add, and why is it important to you or the industry?

3. Do you feel that there was any unnecessary information included within the database? If yes, what information was it, and why is it unnecessary?

4. Is the format (physical structure) of the database easy to understand and navigate? (Please circle one of the responses below.)

   YES NO

5. If your answer to question 4 is yes, please list features you liked.

6. If your answer to question 4 is no, please list features you did not like and suggest what we can do to improve these features.

User-Testing Assessment

While we administer the user-testing, we would appreciate it if you would evaluate the given tasks in the spaces below. Please evaluate each task after completing it. Again, we thank you very much for your time and cooperation.

Molly McShea and Jo-Ellen Sullivan

1. Have you used the Microsoft Excel spreadsheets before?

   YES NO

Please rate the following tasks on a scale of 1 to 10, 1 being the easiest, and 10 being the most difficult.

Task 1:

1 2 3 4 5 6 7 8 9 10

Comments:

Task 2:

1 2 3 4 5 6 7 8 9 10

Comments:

Task 3:

1 2 3 4 5 6 7 8 9 10

Comments:

Task 4:

1 2 3 4 5 6 7 8 9 10

Comments:

Task 5:

1 2 3 4 5 6 7 8 9 10

Comments:

2. Please compare the amount of time you spent gathering information from the new database we introduced today with the original Excel spreadsheets. Circle one of the options given below.

A) I spent less time gathering information today than in the original Excel spreadsheets

B) I spent the same amount of time gathering information in the two databases

C) I spent more time gathering information today than in the original Excel spreadsheets

3. Compare the new database to the old database in terms of how easy it is to use. Please circle one response: The new database is…

A) Easier to use

B) About the same

C) More difficult to use

4. Please list any additional comments or suggestions you have in the space provided below.

(Spanish Version)

Encuesta

Apreciaríamos mucho si Ud. pase unos momentos para contestar estas preguntas sobre la base de datos. Damos gracias a Ud. para su tiempo y cooperación.
Molly McShea y Jo-Ellen Sullivan

1. ¿Por qué necesita Ud. la información en la base de datos? ¿Cómo la usa en su trabajo?

2. ¿Piensa Ud. que hay alguna información importante que no está incluida en la base de datos que le gustaría tener disponible? Si su respuesta es afirmativa, ¿cuáles son las categorías de información que debemos poner en la y por qué son importantes a Ud. o a la industria?

3. ¿Piensa Ud. que hay información innecesaria en la base de datos? Si su respuesta es afirmitiva, ¿cuál es esta información y por qué es innecesaria?

4. ¿Es el formato (estructura física) de la base de datos fácil para comprender y navegar? Por favor, circule una de las respuestas abajo.

SÍ NO

5. Si su respuesta a Pregunta 4 es afirmitiva, escriba las facciones que le gustan en el espacio abajo por favor.

6. Si su respuesta a Pregunta 4 es negativa, escriba las facciones que no le gustan en el espacio abajo y diganos cómo podríamos mejorar estas facciones.

Avaluación de Probando de los Usarios

Mientras Ud. prueba la base de datos, apreciaríamos si Ud. pueda valorar las tareas en los espacios dados abajo. Por favor, valore cada tarea después de terminándola. Otra vez, damos gracias a Ud. para su tiempo y cooperación.

Molly McShea y Jo-Ellen Sullivan

Por favor califique las tareas en una escala numérica de 1 a 10 donde 1 corresponde a más fácil y 10 corresponde a más difícil.

Tarea 1:

1 2 3 4 5 6 7 8 9 10

Comentarios:

Tarea 2:

1 2 3 4 5 6 7 8 9 10

Comentarios:

Tarea 3:

1 2 3 4 5 6 7 8 9 10

Comentarios:

Tarea 4:

1 2 3 4 5 6 7 8 9 10

Comentarios:

Tarea 5:

1 2 3 4 5 6 7 8 9 10

Comentarios:

2. ¿Ha usado Ud. las hojas electrónicas de Microsoft Excel (la base de datos original) en el pasado?

SÍ NO

2. Compare la duración de tiempo que Ud. pasó recogiendo la información de la nueva base de datos que usó hoy con la en la original base de datos de Microsoft Excel. Circule una de las opciones abajo.

A) Pasé menos tiempo recogiendo información hoy que en la original base de datos.

B) Pasé la misma duración de tiempo recogiendo información en las dos.

C) Pasé más tiempo recogiendo información hoy que en la original base de datos.

3. Compare la facilidad de usando la nueva base de datos con la facilidad de usando la original base de datos en Microsoft Excel. Por favor, circule una respuesta abajo. La facilidad de usando la nueva base de datos...

A) Es mas que usando la original base de datos

B) Es igual a la original

C) Es menos que usando la original base de datos

4. Escribe cualquieras comentarias y sugerencias adicionales que tenga en el espacio abajo por favor.

Appendix C: User-testing Instructions and Tasks

(English Version)

User-Testing an Aquacultural Database for INCOPESCA

We are students from a university in the United States who have come to Costa Rica to help design a database for INCOPESCA that will be used to store information related to the aquaculture industry. The database is in a program called Microsoft Access and it will replace the Microsoft Excel spreadsheets that have been used in the past to store information about fish producers.

The purpose of our visit with you today is to show you the database, give you a brief description of how it works, and give you some tasks to perform in the database so that you become better acquainted with it. We will observe you as you complete these tasks and take notes on how you complete them and any problems that you may encounter. We will then ask you to fill out a survey so that we can better understand your opinions of the new database and use them to improve it.

We thank you for taking the time to test the database today. The results of your test are vital in our continued efforts to make an efficient database that is easy to use.

Molly McShea and Jo-Ellen Sullivan

Instructions for Using the Microsoft Access Database

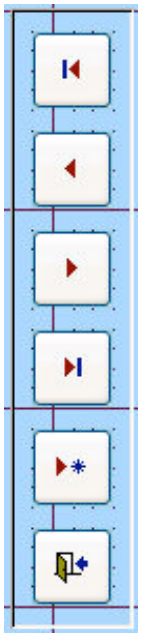
Please read these basic instructions on how to use the new database, and look through some of these features in the database yourself. If at any point you are confused by the instructions, please tell us.

1. The "Menú de Inicio" Page

This is the first page that you will see after opening the database. Click on any buttons in the "Ingreso de Datos" region of the page to input information into the database. Click on any button in the "Salida de Información" region to see a summary of all relevant entries that are currently in the database. Click on the "Ir a Menú de Búsqueda" button located towards the bottom of the page to go to a page that allows you to search for more specific information about each producer and regional production information about each species. The "Salir de la Aplicación" button at the bottom of the page closes Microsoft Access when it is clicked.

2. Using the Ingreso de Datos Pages

All pages in the Ingreso de Datos area allow for the input of new information into the database. Each page is set up like a form where information is entered into white boxes located next to a description of what type of information should be entered into each box. If you see a white box with an arrow on the right side of the box, click this arrow with the mouse and select a response from the list that appears. The buttons shown in the picture below appear on each page and are used to move through records, or different entries in the database. Descriptions of each button's function are given below.



Returns to the first record.

Goes to previous record.

Goes to the next record.

Goes to the last complete record.

Creates a new record.

Closes the page.

3. The “Ingreso de Datos Bibliografía” Page

To enter new information in this page, scroll to the bottom of the page to find the first available blank record. New records generate automatically on this page, so all information will always appear on a single page.

4. The “Búsqueda” Page

To find a summary of information about each specific producer, select the producer’s name from the list in the “Por Nombre de Productor” area and then click the button with the information you would like to see for that producer. A summary of all producers with certain basic services can be found by selecting the service of interest and then clicking “Ver Resultado”. To find a summary of production of each species for a certain region, select either the province or canton and the species and then click the appropriate button to see the total amount of producers in a certain region or the total production area for a specific region.

User-Testing Tasks

We would now like you to perform the following tasks in the database while we observe you. We will ask you to complete a survey about these tasks and other aspects of the database after you finish these tasks. If you encounter any problems while completing these tasks, please tell us.

1. Find the total number of tilapia producers in the province of San José.

2. Find the Espejo de Agua en Producción for the canton of Pérez Zeledón.

3. Enter the following technical data in a new record: the organism produced is tilapia, the species is nilotica, there are 3 cement tanks and 2 earthen tanks, and all 5 tanks are in the size range of 2001-2500 m^2.

4. A new project has been running for three years and is titled “Proyecto 1”. The producer’s address is Barrio Concepción San Francisco, León Cortéz, San José, his cell phone number is (506)-832-9074, and the name of the producer is José Miguel Arias Gutierrez, who is divorced. Enter this information in a new record.

5. Enter information about a new aquacultural publication. The new publication about shrimp is titled “Maneras nuevas para criar camarones” by Carlos Rodriguez Hernandez and is stored at the University of Costa Rica.

(Spanish Version)

Probando de los Usarios de la Base de Datos de Acuicultura para INCOPESCA

Somos estudiantes de una universidad en EE.UU. y hemos venido a Costa Rica para diseñar una base de datos para INCOPESCA que usará para mantener información sobre la industria de acuicultura. La nueva base de datos es en un programa que se llama Microsoft Access y repondrá las hojas electrónicas de Microsoft Excel que han usado en el pasado para mantener información sobre los productores de la industria de acuicultura.

El propósito de nuestra visita con Ud. hoy es a mostrarle la base de datos, dar a Ud. una descripción breve de cómo usarla, y dar a Ud. algunas tareas a ejecutar en la base de datos para que Ud. desarrolla una familiaridad con la. Observaremos Ud. mientras está haciendo estas tareas y sacaremos apuntes sobre sus maneras de hacerlos y cualquieres problemas que podría encontrar. Entonces preguntaremos que completa una encuesta para que podremos entender sus opiniones de la nueva base de datos y usarlas para mejorarla.

Damos muchas gracias a Ud. por pasar el tiempo hoy a probar la base de datos. Las resultas de su prueba son muy importantes en nuestros esfuerzos continuados a hacer una base de datos que es eficiente y fácil a usar.

Molly McShea y Jo-Ellen Sullivan

Instrucciones para Usar la Base de Datos de Microsoft Access

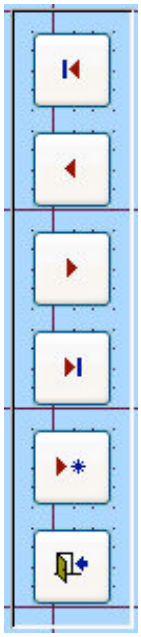
Por favor, lea estas instrucciones básicas sobre cómo usar la nueva base de datos, y investigue algunas de estas facciones en la base de datos a su mismo. Si en algún momento esté confundido sobre las instrucciones, diganos por favor.

1. La Página"Menú de Inicio"

Esta es la primera página (y es la página principal) que Ud. verá después de abriendo la base de datos. Haga clic en los botones en la región de "Ingreso de Datos" para ingresar información en la base de datos. Haga clic en los botones en la región de "Salida de Información" para ver un sumario de todos los ingresos pertinentes que están en la base de datos. Haga clic en el botón "Ir a Menú de Búsqueda" que está en el fondo de la página principal para ir a otra página que le permite a buscar información específica sobre cada productor y información sobre la producción de cada especie por cantón o provincia. El botón "Salir de la Aplicación" que está en el fondo de la página principal se cerra la base de datos y Microsoft Access cuando lo haga clic.

2. Usar las Páginas de Ingreso de Datos

Todas las páginas en el área de "Ingreso de Datos" permiten el ingreso de nueva información en la base de datos. Cada página se parece un formulario donde información está ingresado en las cajas blancas que están al lado de descripciones del tipo de información que Ud. debe ingresar en cada caja. Si vea una caja blanca con una flecha en el lado a la derecha, haga clic en esta flecha con el ratón y escoja una respuesta de la lista que aparece. Los botones en la foto que está abajo aparecen en cada página y están usados a mover por los registros, o ingresos diferentes, en la base de datos. Descripciones de la función de cada botón son dados al lado de la foto



Regresa al primer registro.

Va al registro previo.

Va al próximo registro.

Va al último registro completo.

Hace un registro nuevo.

Se cierra la página.

3. La Página “Ingreso de Datos Bibliografía”

Para ingresar información nueva en esta página, va al fondo de la página para encontrar el primer registro vacío. Nuevos registros aparecen automáticamente en esta página, así todos los registros siempre estarán en la misma página.

4. La Página “Búsqueda”

Para encontrar un sumario de información sobre cada específico productor, escoja el nombre del productor de la lista en el área “Por Nombre de Productor” y entonces haga clic el botón con la información que le gustaría ver para eso productor. Ud. puede encontrar un sumario de todos los productores con específicos servicios básicos por escogiendo el servicio de interés y entonces haciendo clic el botón “Ver Resultado”. Para encontrar un sumario del espejo de agua en producción de cada especie por una región específica, escoja la provincia o el cantón y la especie y entonces haga clic en el botón apropiado para ver el total de los productores o el total del espejo de agua en producción en esa región.

Tareas del Probando de los Usarios

Ahora queremos que Ud. complete las tareas siguientes en la base de datos mientras observamos Ud. Preguntaremos a Ud. que completa una encuesta sobre estas tareas y otros aspectos de la base de datos después de que termina estas tareas. Si encuentra algunos problemas mientras completando estas tareas, diganos por favor.

1. Encuentra el total de los productores de tilapia en la provincia de San José.

2. Encuentra el espejo de agua en producción para el cantón de Pérez Zeledón.

3. Ingrese estos datos técnicos en un registro nuevo: el organismo es tilapia, la especie es nilotica, hay 3 estanques de cemento y 2 estanques sobre tierra, y todos los 5 estanques son en el rango de tamaños de 2001-2500 m^2.

4. Un nuevo proyecto ha estado funcionando por tres años y el título es “Proyecto 1”. La dirección del productor es Barrio Concepción San Francisco, León Cortéz, San José, su número del teléfono celular es (506)-832-9074, y el nombre del productor es José Miguel Arias Gutierrez, quién es divorciado. Ingrese esta información en un registro nuevo.

5. Ingrese información sobre una publicación nueva de acuicultura. La nueva publicación sobre camarones se llama “Maneras nuevas para criar camarones” por Carlos Rodriguez Hernandez y está en la Universidad de Costa Rica.

Appendix D: Final Instructions for Using Database

(English Version)

The INCOPESCA Microsoft Access Database

Instructions for Installing the Database

The new database actually has two files, one called “INCOPESCA Base de Datos” and the other called “INCOPESCA Base de Datos PARA USAR”. To put the files on a new computer, do the following steps:

1. Copy the two files and put them in a folder on the new computer.
2. Open the file “INCOPESCA Base de Datos PARA USAR”.
3. Click the ”Tables” menu that appears on the screen.
4. Delete all the tables that appear in this category.
5. Click the File menu, select “Get External Data” from the list, and then select ”Link Tables”
6. Select the copy of the file “INCOPESCA Base de Datos” that is on the computer.
7. Click the “Select all” button.
8. Click the “Accept” button.

General Use of the Database

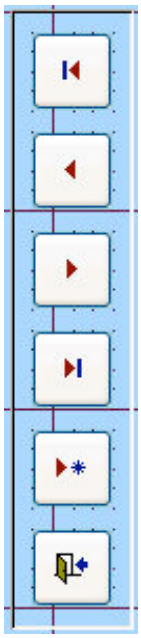
The file “INCOPESCA Base de Datos” only maintains information and is not the main file for using. Users who need to input or see information about the aquaculture industry should use the file “INCOPESCA Base de Datos PARA USAR”.

1. The “Menú de Inicio” Page

This is the first page that you will see after opening the database. Click on any buttons in the “Ingreso de Datos” region of the page to input information into the database. **Alter clicking a button in the “Salida de Información” region, the page that you want to open will appear for a moment and then the “Menu de Inicio” will appear in its place. Click on the box at the bottom of the screen to see the other page.** Click on any button in the “Salida de Información” region to see a summary of all relevant entries that are currently in the database. Click on the “Ir a Menú de Búsqueda” button located towards the bottom of the page to go to a page that allows you to search for more specific information about each producer and regional production information about each species. The “Salir de la Aplicación” button at the bottom of the page closes Microsoft Access when it is clicked.

2. Using the Ingreso de Datos Pages

All pages in the Ingreso de Datos area allow for the input of new information into the database. Each page is set up like a form where information is entered into white boxes located next to a description of what type of information should be entered into each box. If you see a white box with an arrow on the right side of the box, click this arrow with the mouse and select a response from the list that appears. The buttons shown in the picture below appear on each page and are used to move through records, or different entries in the database. Descriptions of each button's function are given below.



Returns to the first record.

Goes to previous record.

Goes to the next record.

Goes to the last complete record.

Creates a new record.

Closes the page.

3. The "Ingreso de Datos Bibliografía" Page

To enter new information in this page, scroll to the bottom of the page to find the first available blank record. New records generate automatically on this page, so all information will always appear on a single page.

4. The "Búsqueda" Page

To find a summary of information about each specific producer, select the producer's name from the list in the "Por Nombre de Productor" area and then click the button with the information you would like to see for that producer. A summary of all producers with certain basic services can be found by selecting the service of interest and then clicking "Ver Resultado". To find a summary of production of each species for a certain region, select either the province or canton and the species and then click the appropriate button to see the total amount of producers in a certain region or the total production area for a specific region.

(Spanish Version)

La Base de Datos de INCOPESCA de Microsoft Access

Instrucciones para Instalar la Base de Datos

La nueva base de datos actualmente tiene dos archivos, uno que se llama "INCOPESCA Base de Datos" y el otro que se llama "INCOPESCA Base de Datos PARA USAR".

1. Copie los dos archivos y los ponga en una carpeta en la computadora.
2. Abra el archivo "INCOPESCA Base de Datos PARA USAR".
3. Haga "clic" en el botón que se llama "Tablas" en el menú que aparece en la pantalla.
4. Elimine todas las tablas que aparacen en esta categoría.
5. Haga "clic" en el menú de Archivo, selecione "Obtener Datos Externos" de la lista, después selecione "Vincular Tablas".
6. Selecione la copia del archivo "INCOPESCA Base de Datos" que está en la computadora.
7. Haga "clic" el botón "Selecionar todos"
8. Haga "clic" el botón "Aceptar"

Uso General de La Base de Datos

El archivo "INCOPESCA Base de Datos" solamente mantiene información y no es el archivo principal para usar. Los usarios que necesitan ingresar o ver información sobre la industria de acuicultura deben usar el archivo "INCOPESCA Base de Datos PARA USAR".

Instrucciones para Usar la Base de Datos de Microsoft Access

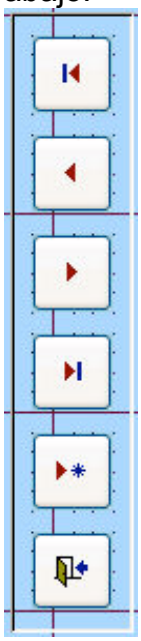
1. La Página"Menú de Inicio"

Esta es la primera página (y es la página principal) que Ud. verá después de abrir la base de datos. Haga "clic" en los botones en la región de "Ingreso de Datos" para ingresar información en la base de datos. **Después de hacer "clic" en un botón en la región de "Salida de Información", la página que quiere abrir aparecerá por uno momento y entonces el Menu de Inicio aparecerá en lugar de esta. Haga "clic" en la caja en el fondo de la pantalla para ver la otra página.** Haga "clic" en los botones en la región de "Salida de Información" para ver un sumario de todos los ingresos pertinentes que están en la base de datos. Haga "clic" en el botón "Ir a Menú de Búsqueda" que está en el fondo de la página principal para ir a otra página que le permite buscar información específica sobre cada productor y información sobre la

producción de cada especie por cantón o provincia. El botón “Salir de la Aplicación” que está en el fondo de la página principal se cerra la base de datos y Microsoft Access cuando lo hace “clic”.

2. Usar las Páginas de Ingreso de Datos

Todas las páginas en el área de “Ingreso de Datos” permiten el ingreso de nueva información en la base de datos. Cada página se parece un formulario donde información está ingresado en las cajas blancas. Si ve una caja blanca con una flecha en el lado a la derecha, haga “clic” en esta flecha con el ratón y escoja una respuesta de la lista que aparece. Los botones en la foto que está abajo aparecen en cada página y son usados a mover por los registros, o ingresos diferentes, en la base de datos. Descripciones de la función de cada botón son dados al lado de la foto que está abajo.



Regresar al primer registro.

Ir al registro previo.

Ir al próximo registro.

Ir al último registro completo.

Hacer un registro nuevo.

Cerrar la página.

3. La Página “Ingreso de Datos Bibliografía”

Para ingresar información nueva en esta página, vaya al fondo de la página para encontrar el primer registro vacío. Nuevos registros aparecen automáticamente en esta página, así todos los registros siempre estarán en la misma página.

4. La Página “Búsqueda”

Para encontrar un sumario de información sobre cada específico productor, escoja el nombre del productor de la lista en el área “Por Nombre de Productor” y entonces haga “clic” el botón con la información que le gustaría ver para eso productor. Ud. puede encontrar un sumario de todos los productores con específicos servicios básicos por escogiendo el servicio de interés y entonces haciendo “clic” el botón “Ver Resultado”. Para encontrar un sumario del espejo de agua en producción de cada especie por una

región específica, escoja la provincia o el cantón y la especie y entonces haga “clic” en el botón apropiado para ver el total de los productores o el total del espejo de agua en producción en esa región.

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