A Characterization of Trout Farms

Specific to the Southern Highland Region of Costa Rica

12/12/2008

Instituto Costarricense de Pesca y Acuicultura
Worcester Polytechnic Institute
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December 12, 2008

Sr. Álvaro Otárola Fallas, Director
Instituto Costarricense de Pesca y Acuicultura
San José, Costa Rica

Dear Sr. Otárola:

Enclosed is our report entitled Characterization of Trout Farms. It was written at INCOPESCA during the period October 21st through December 12th 2008. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Costa Rica. Copies of this report are simultaneously being submitted to Professors Vernon-Gerstenfeld and Robertson for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you and Sr. Carlos Burantes have devoted to us.

Sincerely,

Andrew Emerson

Lindsay Wood

Robert Fitzpatrick

TITLE PAGE

Report Submitted to:

Susan Vernon-Gerstenfeld, Thomas Robertson

Costa Rica, San Jose

By

Andrew Emerson _____

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In Cooperation With

Sr. Álvaro Otárola Fallas, Director

Instituto Costarricense de Pesca y Acuicultura

CARACTERIZACIÓN DEL CULTIVO DE LA TRUCHA

December 12, 2008

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 the evaluation of academic achievement. The report should not be construed as a working document by the reader.

ABSTRACT

Insituto Costarricense de Pesca y Acuicultura (INCOPESCA) needed to confirm the information they had on record about trout farms in the southern highland region of Costa Rica. Our project goal was to gather economic, environmental, and technical data to characterize the trout farms. In addition, we made recommendations to increase the efficiency of trout farming and to improve the role of INCOPESCA as a government organization. In order to increase trout farmers' productivity, we supplied them with a basic technical manual. We found that INCOPESCA was having difficulties supplying the assistance that the trout farmers needed, and that trout farmers were having difficulties farming without consistent aid from INCOPESCA.

AUTHORSHIP:

This report was written and researched by Andrew Emerson, Robert Fitzpatrick and Lindsay Wood. All parts were done in collaboration and are the responsibility of the group.

ACKNOWLEDGEMENTS:

This Interactive Qualifying Project would not have been possible without the help of many people. We would like to thank the people that made this project possible and successful.

First, we would like to thank our liaison Sr. Álvaro Otárola Fallas and INCOPESCA. Sr. Carlos Luis Burantes Pineda was an incredible help while visiting trout farms and for information about INCOPESCA. The trout farmers of the southern highland region were a great help when collecting information about their businesses.

Our advisors, Professor Susan Vernon-Gerstenfeld and Professor Thomas Robertson, were a great help and resource throughout our project. Professor Isa Bar-On was also a great resource. Their guidance was indispensible.

We are additionally grateful for Sra. Marcela Music for her help with translation.

EXECUTIVE SUMMARY:

This report includes a detailed explanation of our project work while in Costa Rica between the dates of October 21, 2008 and December 8, 2008. Instituto Costarricense de Pesca y Acuicultura (INCOPESCA) requested a WPI project team to characterize the trout farms of the southern highland region of Costa Rica. The trout farming industry has been growing continuously in Costa Rica and INCOPESCA has not been able to oversee all trout farms and confirm the information they have about the farms in this region. Furthermore, the southern highland region is undeveloped, with trout farming being one of the only industries that operates in this region. The development of trout farming has the potential to increase the economic status of this region. Our goal was to analyze the economic, environmental, and technical characteristics of the trout farms in the southern highland region of Costa Rica and provide recommendations about how to improve trout farming and INCOPESCA's effectiveness as an organization.

We conducted interviews with thirty-nine trout farms in the southern highland region of Costa Rica and INCOPESCA personnel. Through these interviews, we collected data about the economic, environmental, and technical characteristics about the farms; we also collected information about the relationship between trout farmers and INCOPESCA. Then, we recorded the information we collected into a Microsoft Access database. We used this program because it is familiar with both the group and INCOPESCA.

We found that there is a large variance in the price at which trout farmers sell their trout. We also found that the majority of farmers sold trout on-site, and few sold to the community outside of their farm. We recommend that INCOPESCA performs a future study on the potential of a trout farmer cooperative, or other ways to encourage trout farmers to work together.

From our interviews, we discovered that most of the trout farmers have not obtained the licenses that they are required to have. We recommend that INCOPESCA informs the trout farmers about the licenses, how to apply for them, and the consequences of not obtaining them. Also, most of the trout farmers we interviewed do not use any filtration for the incoming our outgoing water. In the manual we created, we recommend the most appropriate filtration method for farmers to use.

We also found that most of the farms were operating with water with the proper pH, dissolved oxygen level, and temperature; only a few were outside the recommended ranges. But, in case the farmers find that they are not operating at the recommended ranges, we included in our manual simple methods to fix most problems that may occur.

Another problem we found was that several of the farms we interviewed did not know some or all of the operational information about their farm. This information included trout produced per year and amount of trout feed used per year. To make organizing data easier, we created a production record that the farmers can use to keep track of their production and progress daily. This production record is included in the manual the trout farmers will receive.

The majority of trout farmers requested that INCOPESCA visit their farms more frequently, and to supply fry more regularly to the farms. However, INCOPESCA does not have sufficient resources to visit trout farms as often as needed, and cannot supply fry more often than twice a year, because of a lack of capital. INCOPESCA also has problems making contact with trout farmers, and transferring information to trout farmers. We recommend that INCOPESCA establish an improved method of communication with trout farmers, and perform a future study on the routes the technician uses to visit trout farmers. We also recommend that INCOPESCA certifies trout farms to have hatcheries on their farms.

We recommend that INCOPESCA adds to the manual as needed by and to create newsletters. If INCOPESCA were to supply new information to trout farmers as needed, the trout farmers would be able to increase their production and development.

Our research resulted in: the creation of a database for the storage of economic, environmental, and technical data for trout farms; the assessment of the economic, environmental, and technical status of trout farms in the southern highland region; the creation of a manual including a production record, contact sheet, and technical recommendations for trout farmers; and the creation of a report for INCOPESCA with recommendations on how to improve their relationship with trout farmers in Costa Rica. We provided recommendations on the improvement of trout farming and INCOPESCA's effectiveness as an organization. The application of our recommendations will allow trout farming to grow as an industry in Costa Rica, which will in turn improve the economy in the southern highland region of the country.

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CHAPTER 1: INTRODUCTION

The most recently published *State of World Fisheries* from the United Nation's Food and Agriculture Organization claims that Latin America and the Caribbean have experienced a ten percent growth in aquaculture from 2005 to 2006, (FAO Fisheries and Aquaculture Department, 2007) one of the highest growth rates for any region in the world. More specifically, trout production has more than doubled in Costa Rica from 2000 to 2004 (FAO Fisheries and Aquaculture Department, 2006).

With the trout farming industry quickly growing, el Instituto Costarricense de Pesca y Acuicultura (INCOPESCA) has not been able to properly oversee all 355 trout farms in Costa Rica (A. Otárola Fallas, personal communication, November 28, 2008). Because of this, INCOPESCA asked our group to characterize trout farms to confirm the information INCOPESCA has on file. In order to sample of trout farms in rural, mountainous areas of Costa Rica, we focused on farms in the southern highland region. Trout need colder water to survive; therefore, mountainous regions are conducive to trout farming. Because trout farming is successful in this area, it is important to the economy. We aimed to provide INCOPESCA with tools to help them oversee these farms and we explored ways in which INCOPESCA could better aid trout farmers in the southern highland region of Costa Rica.

Our goal was to analyze the economic, environmental, and technical characteristics of the trout farms in the southern highland region of Costa Rica and provide recommendations about how to improve trout farming and improve INCOPESCA's role as an organization. Our first objective was to collect data on the economic, environmental, and technical characteristics of trout farms. To complete this objective, we conducted thirty-nine semi-structured interviews with farmers in the southern highland region of Costa Rica. We analyzed the data we gathered to find

noticeable trends, using Microsoft Access. Our second objective was to collect information about the relationship between INCOPESCA and trout farmers. Through interviews with the farmers and INCOPESCA personnel, we explored services INCOPESCA provides to trout farmers and services that trout farmers desire of INCOPESCA. Once we completed both of our objectives, we created a manual with simple changes that can be implemented on trout farms to improve their productivity and we created a Microsoft Access database that contained the data and information we collected.

CHAPTER 2: BACKGROUND

In this chapter, we discuss the history of aquaculture and trout farming, and problems that occur in trout farming. We also discuss the role of the INCOPESCA to assist trout farmers, and the major gaps that we have encountered in research.

AQUACULTURE AND TROUT FARMING

Aquaculture History

Baluyute (1989) of the United Nations provides a summary of the history of aquaculture, and it is the source for the brief history we provide in this section. The practice of aquaculture began in Asia approximately four thousand years ago, originating as a practice to maintain a steady supply of fish for consumption. Aquaculture allowed farmers to restrain environmental factors and disease, to a point, allowing for controlled fish growth.

Costa Rican Trout Farming History

Sr. Álvaro Otárola Fallas (n.d.), Director of INCOPESCA, provides a complete history of Costa Rican trout farming, a small portion of the country's aquaculture industry. INCOPESCA possesses the only source for this information. Sr. Álvaro Otárola's complete history will be summarized in this section.

From 1927 to 1928, in order to provide a source of entertainment for sport fishers, the Costa Rican government introduced rainbow trout into Costa Rica's rivers. Since the rivers in the mountainous regions of the country are beneficial to the growth trout, the trout industry has developed into an important economic factor in these regions. Starting in 1954, the Costa Rican government imported rainbow trout eggs from Mexico in order to hatch and grow trout in artificial tanks. Because of the economic gains trout farmers made, the popularity of trout farming increased throughout the country, caused an increased demand for trout eggs. Due to this

increase in demand, the Costa Rican government began to import trout eggs from the United States in 1959, an action that still continues today. In 1994, the government created the Instituto Costarricense de Pesca y Acuicultura (INCOPESCA) to help promote and develop the trout farming industry throughout the country. For more information on the creation of INCOPESCA, refer to Appendix A.

Reason to Cultivate Trout

According to Sr. Carlos Burantes (personal communication, November 18, 2008), INCOPESCA's technician for trout farms in Costa Rica, trout farming is one of the more expensive aquaculture methods in Costa Rica. But, he claims that it is worth the expense because trout have a higher quality meat than other fish cultivated in the country such as carp or tilapia. Trout is one of the only fish that can be grown in the mountainous regions of Costa Rica, making this a more economically feasible industry than carp or tilapia, which require warmer water temperatures.

Trout Farming in Costa Rica

Costa Rican trout farms are small scale, which often consist of no more than ten tanks. Because of their small size, the farms are unable to produce enough trout to warrant the exportation of trout to other countries. The trout farms in Costa Rica only supply trout to the trout farmers' families and the community around them. These farms are at a small production level since trout farmers do not have the necessary money, farm land, and ability to transport their trout over long distances (C. Burantes Pineda, personal observation, November 5, 2008).

PROBLEMS THAT OCCUR IN TROUT FARMING

Trout farmers must follow specific steps and conditions in order to productively raise trout; trout farmers rarely divert from the basic methods. Because little information exists on small scale trout farms, we explore the general problems that occur in trout farming.

Recommended Parameters for Water Quality

The quality of river and stream water can be unreliable since it varies depending upon environmental conditions (Food and Agriculture Organization, 2007). Because of this, trout farmers can encounter problems with water involve temperature, pH, and dissolved oxygen levels. The FAO (Food and Agriculture Organization) and INCOPESCA recommend safe parameters for water quality in which to grow trout. If any of the recommended parameters are not met, trout production could slow considerably due to slowed growth and mortalities.

Water pH Parameters.

The FAO recommends cultivating trout in water with a pH between six and eight (FAO, 2005). INCOPESCA does not provide a range for pH, but they do advise that the acidity of the water be maintained around seven (Otárola Fallas, n.d.).

Dissolved Oxygen Level Parameters.

The FAO does not provide a value or range for the recommended amount of dissolved oxygen at which trout can survive. However, INCOPESCA (Otárola Fallas, n.d.) and Wurts (n.d.) both agree that trout cannot survive in water with less than five milligrams of dissolved oxygen per liter of water.

Water Temperature Parameters.

The FAO states that the livable temperature range for trout is between twelve and twenty-one degrees Celsius (FAO, 2005). INCOPESCA adjusts the FAO's recommendation by reducing

the temperature range to be between thirteen and nineteen degrees Celsius. INCOPESCA also states that trout in Costa Rica should be cultivated above the altitude of 1500 meters in order to obtain the water temperatures naturally. If there are trout farms below 1500 meters, the water will be warmer than the recommended temperature range, and the trout farmers will not be producing trout as effectively as those at or above the recommended altitude (Otárola Fallas, n.d.).

SERVICES PROVIDED BY INCOPESCA

INCOPESCA offers many services to aid Costa Rican trout farmers. INCOPESCA supplies trout farmers with technical assistance, fry, and training (A. Otárola Fallas, personal communication, November 6, 2008).

Technical Assistance

INCOPESCA assists trout farmers with starting their farm and to keeping it operating properly. INCOPESCA will assess the potential for a trout farm if the farmer desires it; they will investigate if the land is best suited for the proposed project. Also, INCOPESCA will monitor projects in operation to insure that the farms are functioning properly (Otárola Fallas, n.d.).

INCOPESCA conducts research about trout farming and its methods, and then they provide their findings to the farmer once they discover information that can be valuable to them. INCOPESCA researches technology that may assist trout farmers, recommends the most fitting technology for each trout farm, and works to make the technology available to the farmers (Otárola Fallas, n.d.).

INCOPESCA also informs trout farmers about the licenses they need in order to use water for their farms and to assure that the trout they sell to the market are healthy and edible (Otárola Fallas, n.d.). Trout farmers are required by law to have the following three licenses:

Concesión de Agua, Certificado Veterinario de Operación, and Canon de Vertigo de Aguas. If the trout farms are not properly licensed, they could be shut down. However, INCOPESCA does not know how many trout farmers have obtained the licenses listed above. For more information on the licenses, refer to Appendix B.

Fry Supply

In 1994, INCOPESCA created a trout hatchery to grow fry to supply to trout farmers throughout Costa Rica (Otárola Fallas, n.d.). INCOPESCA scans all eggs for diseases and insures that they are safe to use before they are shipped to each farm. Fry are supplied to farmers twice a year. INCOPESCA recommends that all farmers buy from them to avoid buying unhealthy fry (A. Otárola Fallas, personal communication, October 21, 2008). INCOPESCA knows that trout farmers purchase eggs from other producers, but they do not know who the producers are, or if they provide the same guarantee of quality as INCOPESCA. INCOPESCA desires to be the only provider of fry, but they are not sure if they have the capacity to supply fry to all of the trout farmers in Costa Rica.

Training

To further help trout farmers, INCOPESCA supplies three types of training sessions. The three training session types are courses on trout farming topics, short discussions with the individual trout farmers, and cooperative programs. The courses that INCOPESCA offers focus on topics such as the basics of trout farming, how to properly feed the trout, and how to properly filter the water used at the trout farm. These courses last from two to three days, and cater to the needs of the trout farmers. The short discussions that INCOPESCA holds with trout farmers at their individual farms focus on the same topics as the courses, but these only last from two to three hours. This service is very beneficial to trout farmers as it allows for INCOPESCA to

advise each farmer on their particular farm while allowing to farmer to remain at his farm. These visitations require INCOPESCA personnel to spend a large amount of time traveling between farms, limiting the amount of assistance they can provide to farmers. For the cooperative programs, INCOPESCA works with the trout farmer for anywhere from a week to two months, supplying the trout farmer with on-the-job training. The cooperative programs put a large strain on INCOPESCA as they require a large investment of time from the limited INCOPESCA staff (Otárola Fallas, n.d.).

MAJOR RESEARCH GAPS

As indicated in the introduction, there is little information available about the trout farms in the southern highland region. While trout farming have been broken down into simple proven methods agreed upon by the United Nations Aquaculture divisions and INCOPESCA, trout farming in Costa Rica has not yet been documented. This lack of documentation is because INCOPESCA does not have the necessary resources they need to document trout farming in Costa Rica.

CHAPTER 3: METHODOLOGY

The goal of our project was to analyze the economic, environmental, and technical characteristics of the trout farms in the southern highland region of Costa Rica and provide recommendations about how to improve trout farming and improve INCOPESCA's role as an organization. We developed two objectives to achieve our goal:

1. To collect data on the economic, environmental, and technical characteristics of trout farms.
2. To collect information on the relationship between INCOPESCA and trout farmers.

In the following section, we discuss the steps we took to achieve each objective and complete our goal.

OBJECTIVE 1: TO COLLECT DATA ON THE ECONOMIC, ENVIRONMENTAL, AND TECHNICAL CHARACTERISTICS OF TROUT FARMS

To complete our first objective, we collected data on the economic, environmental, and technical characteristics of trout farms. Through collaboration with Sr. Álvaro Otárola, director of INCOPESCA, we identified the information that INCOPESCA needed to confirm in relation to the economic, environmental, and technical development of trout farms in the southern highland region of Costa Rica.

The information we identified included contact, economic, environmental, and technical information. The contact information was important so that INCOPESCA could identify each farm that we had visited. We identified economic information that included the number of fry the farms purchase, the number of trout the farms produce, and the price at which farms sell their trout. The fry information was important in order for INCOPESCA to determine if it was able to supply all of the farms with enough fry. The environmental information consisted of whether or not the farms filter their water, and the licenses the farms did or did not have. Information about

the licenses the trout farmers have was important because it is INCOPESCA's responsibility to inform the trout farmers about the licenses. If the trout farmers receive an official government inspection and do not have the licenses, the farm could be closed down. The technical information included the trout tank size and the condition of the water used by the farms. Information about the water the farms used was important to establish the pH, temperature, dissolved oxygen level and amount of water used by trout farmers in Costa Rica. INCOPESCA can use this information to investigate for any potential water problems for each trout farm.

To collect this information, we conducted semi-structured interviews with trout farmers. Refer to Appendix E for our interview form. We decided to use semi-structured interviews because they allowed us to collect specific data in the same format at each farm so that we could perform analysis of this data. The semi-structured interviews also allowed us to explore any additional information from the farms that we felt would be necessary to INCOPESCA as well as any observations we made. INCOPESCA created a list of over fifty specific trout farms for us to visit because they were located close to the city of San Jose and INCOPESCA's trout farming headquarters, and because it had been over a year since INCOPESCA personnel had visited them. INCOPESCA did not exhibit bias in selecting farms for us to visit because INCOPESCA asked that we visit any trout farms we passed in our travels that were not on the list.

We only interviewed thirty-nine trout farms due to the availability of the trout farmers. During the course of our three weeks of interviewing farmers, we encountered fifteen farms at which we were unable to conduct interviews because the trout farmers were not available. In most instances, the trout farmers were not on the premises, because they were working elsewhere. At a few farms we visited, a worker or a spouse was available to answer general questions, but they did not know any of the specific information we needed. Some of the trout

farmers did not know some of the information we asked for as well. Because of this, we have a few unanswered interview questions. Lastly, we found that farmers use a variety of units, and the units cannot be converted to be equal to each other. For example, we were provided 'pulgadas' and 'litros por segundo' for the flow rate of the water that enters the ponds. 'Pulgadas' are inches, and 'litros por segundo' are liters per second. We cannot understand the relationship between these two units without more information from the trout farmers.

In order to properly describe the economic, environmental, and technical characteristics of the trout farms, we created a Microsoft Access database to help us analyze the data we collected from the trout farms. We chose to use Microsoft Access instead of Microsoft Excel because Access provided the ability to analyze a large amount of interrelated information. We evaluated the average values for farm size, number of tanks, temperature, dissolved oxygen level, pH, number of trout produced, prices trout were sold at, number of fry purchased and we created a tally of how many farms possessed which licenses. This data was gathered from the interviews we mentioned above. We evaluated the feed conversion ratio as the number of trout raised verses the amount of feed the farms used. The feed ratio is important because it is an indication of the efficiency at which each trout farm is operating, and thus is an area of possible economic gain for the trout farmers.

OBJECTIVE 2: TO COLLECT INFORMATION ON THE RELATIONSHIP BETWEEN INCOPESCA AND TROUT FARMERS

To complete our second objective, we collected information on the relationship between INCOPESCA and trout farmers. The information we gathered from the trout farmers included what programs or services the trout farmers wanted INCOPESCA to offer or improve on, the reason why the trout farmers wanted those services and from who the trout farmers purchased their eggs and fry. In the interviews we performed in Objective One we included questions in

reference to services the trout farmers desired of INCOPESCA and the state of INCOPESCA's resources.

The information we collected from INCOPESCA personnel included the resources they possessed and the problems they experienced in providing assistance to trout farmers. This information was important to INCOPESCA as it could improve INCOPESCA's ability to assist the trout farmers as well as improve INCOPESCA's relationship with the trout farmers. We obtained this information through unstructured interviews with INCOPESCA personnel in person and via e-mail.

In our evaluation of the information we collected from INCOPESCA and the trout farmers, we examined problems from both INCOPESCA and the trout farmer's perspective. We evaluated INCOPESCA's resources and the needs of the trout farmers based upon the information we gathered. As a result of our evaluation, we made recommendations to INCOPESCA on how it might improve its role as an organization and its relationship with the trout farmers.

CHAPTER 4: ANALYSIS OF RESULTS

In this chapter, we discuss the problems experienced by trout farmers and INCOPESCA discovered through the completion of our objectives. The following sections discuss the economic, environmental, and technical characteristics of the problems trout farmers are experiencing, and problems INCOPESCA is experiencing.

ECONOMIC CHARACTERISTICS

We collected data on the economic characteristics of trout farms, which included pricing, the market trout are sold to, and the form in which the trout are sold.

Pricing of Trout is not Constant Between Farms

The average price per kilogram of trout was ¢2,700. But we found that the prices each farm uses varied from ¢1,000 to ¢5,000 per kilogram of trout. Because there is no set price for trout in Costa Rica, farmers can sell at whatever price they find fair and reasonable to their customers. There is a peak of eight out of thirty-nine farmers selling at ¢3,000, and another peak of six out of thirty-nine farmers selling at ¢4000. These peaks appear because these prices are most commonly preferred by trout farmers because the farmers feel these prices are the highest price they can sell their trout at without being unfair. They also appear because some trout farmers feel that they are able to ask a higher price per kilogram of trout and in the area that they operate. But, other than those two peaks, there is no consensus on the price at which trout

farmers sell their trout. See Figure 1 for the number of farmers who sell at each price.

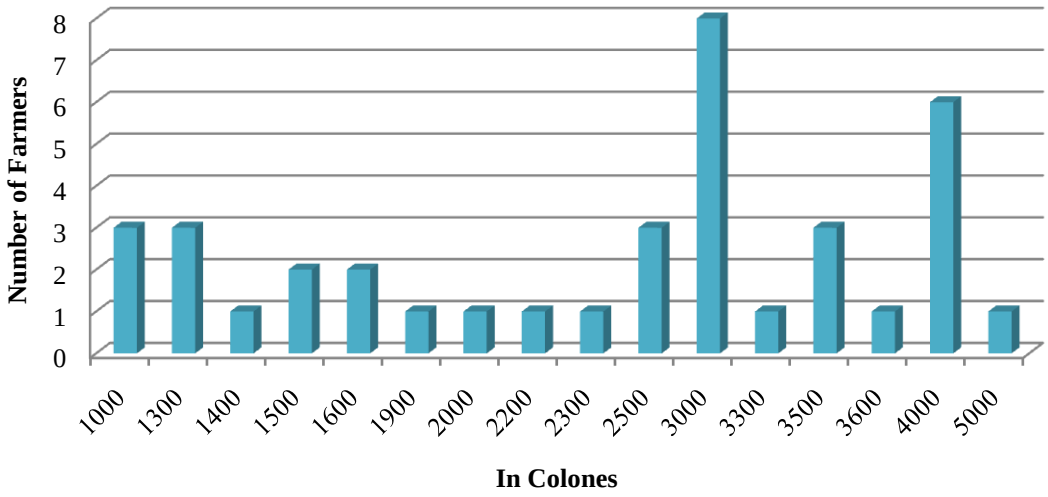

Figure 1: Prices of Trout per Kilogram

The Majority of Trout Markets are On-site

Nineteen out of thirty-nine (forty-nine percent) of the farms we visited supplied trout to their on-site restaurants. Another large market was recreational fishing; nineteen out of thirty-nine (forty-nine percent) of farms allowed customers to pay to fish for their own trout at the farms. Farmers also sell to the community around their farm, some sell to hotels that are on-site and there was a small portion that sells to markets in their communities. Refer to Figure 2 to see a graphical representation of the number of farmers using each market.

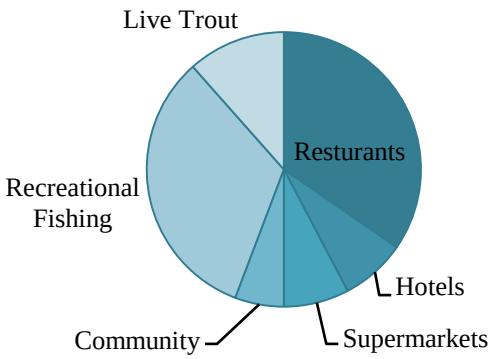

Figure 2: Markets for Trout Farmers

Most farmers do not sell to markets outside of their community because transportation is a problem. Many of the roads are not paved and the farms are in remote areas that require much road travel.

However, one of the farms we visited managed a community program in which four farms sold their trout together. One farmer supplied fry raised from eggs he purchased directly from the United States and Canada. Because they had a large number of trout to sell, the four farmers were able to sell to larger markets. This included supermarket chains such as Automercado and Mas por Menos. This worked well for the four trout farms; however, Sr. Carlos Burantes informed us that other farmers have tried this but encountered difficulties agreeing on at which price to sell their trout and were not able to work together (personal communication, November 18, 2008).

ENVIRONMENTAL CHARACTERISTICS

We collected data on the environmental characteristics of trout farms, which included the filtration methods used and licenses the trout farmers do or do not have.

Few Farmers Use Filtration

Our interviews with trout farmers revealed that only two out of the thirty-nine (five percent) trout farmers used an intake filtration method. Both of the farmers used sedimentation

ponds. The interviews also revealed that none of the trout farmers used outtake filtration, since it requires money and resources to create and maintain a filtration system. And, all thirty-nine farmers claimed that the incoming and outgoing water were the same quality. However, none of the trout farmers had data to validate their claim because they do not test their water for pollution (personal observation, November 5, 2008).

Few Farmers are Licensed

Another problem we found is that only a small number of trout farmers have obtained the required licenses. Five out of thirty-nine (thirteen percent) trout farms are licensed for the Concesión de Agua, one out of thirty-nine (three percent) farmers was licensed for the Certificado Veterinario de Operación, and none were licensed for the Canon de Vertido de Agua. Refer to Appendix B for more information on these licenses. Trout farmers have not acquired the Concesión de Agua because: the farmers plan to, they are in the process of getting them, they have had trouble obtaining them, and they do not know how to apply for them. A few farmers stated that they were not planning to apply for licenses. Trout farmers have not obtained the Certificado Veterinario de Operación and the Canon de Vertido de Agua because they have not yet heard of these licenses. The number of trout farmers that do not possess the proper licenses suggests a lack of communication on INCOPESCA's part.

TECHNICAL CHARACTERISTICS

We collected data on the technical characteristics of trout farms, which included water quality and the ratio of trout feed to trout.

Problems Farmers Have with Water Quality

Water quality data taken at all the farms we visited included pH, dissolved oxygen level, and temperature. Each of these water conditions needs to be kept within certain parameters for

growing healthy trout, as described in the background. We found that all of the trout farms had pH levels that were within the acceptable range of six to eight, with an average pH value of 7.26.

Dissolved oxygen level was the second water quality measurement that we recorded from the thirty-nine trout farms. Dissolved oxygen level must be kept above five milligrams of dissolved oxygen per liter of water. The average dissolved oxygen level for trout farms in the southern highland region of Costa Rica is 6.55 milligrams per liter. Figure 3 shows the dissolved oxygen levels of all the trout farms. The red line on the figure indicates the lowest level of dissolved oxygen allowed in the tank in order for the trout to survive. Four of the thirty-nine (ten percent) trout farms were at or close to being below the allowable level.

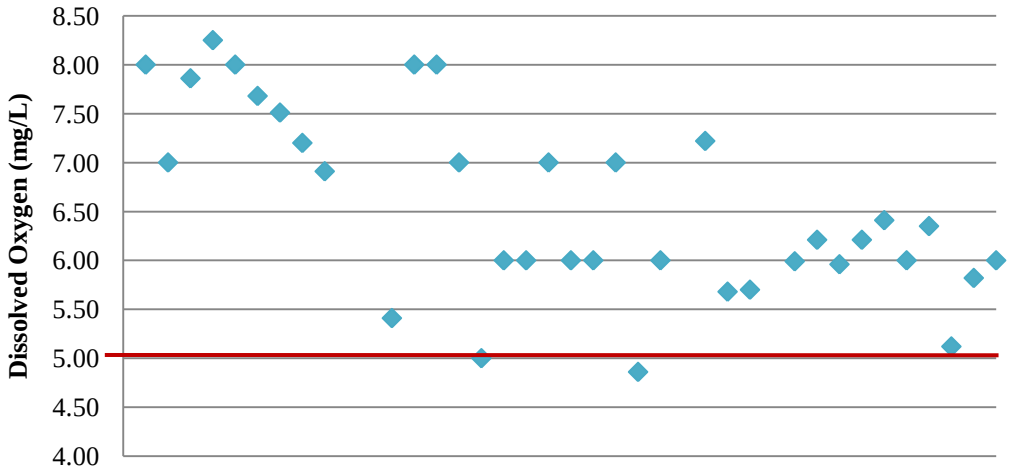

Figure 3: Dissolved Oxygen Level

Temperature was the third water quality measurement we recorded from the thirty-nine trout farms. As stated by INOPESCA, the best temperature range for trout survival is between thirteen and nineteen degrees Celsius (Otárola Fallas, n.d.). The average water temperature from the farms we interviewed was 15.23 degrees Celsius. Thirteen out of thirty-nine (thirty-three percent) of the trout farms we visited had water temperatures outside, or close to outside, the

recommended range. Figure 4 shows the water temperature of all the trout farms. The shaded region indicates the range of acceptable temperatures for trout.

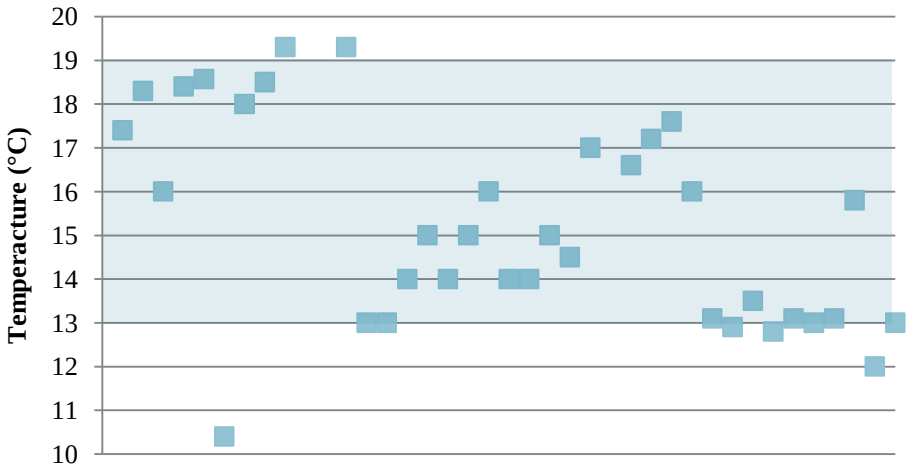

Figure 4: Water Temperature

Farmers Use an Inconsistent Ratio of Trout Feed to Trout

We found that the amount of trout feed Costa Rican trout farmers use is not proportional to the amount of trout they are raising. Trout will not grow any faster if they are fed more than they need, and feeding them too little will stunt their growth (C. Burantes Pineda, personal communication, November 9, 2008). Also, if the trout are fed too much, the trout farmer will lose money, because the trout will not eat the excess feed. Some trout farmers use almost four times as much trout feed as the average trout farmer. In order to explain the data we received, we use the feed conversion ratio. The feed conversion ratio is a tool used to compare the amount of feed in kilograms to the amount of trout produced in kilograms (Howerton, 2001). Refer to

Figure 5 for the feed conversion ratios for each farm.

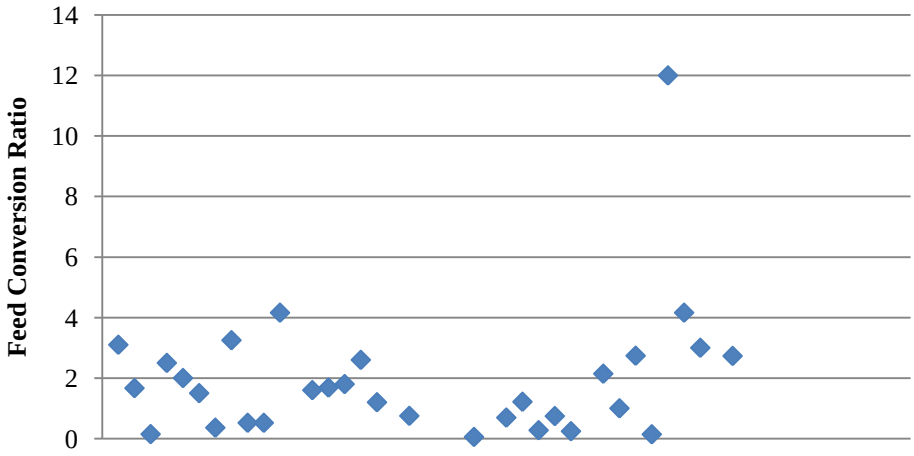

Figure 5: Feed Conversion Ratio

$$Feed\ Conversion\ Ratio = (Feed\ in\ kg)/(Trout\ Produced)$$

The average feed conversion ratio was 1.95, but the ratios ranged from 0.05 to 12.00. The difference in these numbers reveals that trout farmers are not buying the proper amount of trout feed to use. Some farmers are spending too much money on feed, while others are spending too little.

There was one outlier in our data, with a feed conversion ratio of 138.67. We believe that this outlier occurred because the trout farmer was not sure how much feed he used per year, and supplied us with a rough estimate. The outlier demonstrated that some of the trout farmers do not know the technical information for their farm.

INEFFICIENT RELATIONSHIP BETWEEN INCOPESCA AND TROUT FARMERS

While interviewing the trout farmers, we asked what services they would like INCOPESCA to provide or improve upon. In response, the trout farmers requested that INCOPESCA offer more classes about trout farming and trout feed. Also, they need a steady supply of fry, and one farmer asked for a manual about how to farm trout from start to finish.

But, the most requested service was for INCOPESCA's technician, Sr. Carlos Burantes, to visit more often.

Insufficient Technical Assistance

We found that INCOPESCA's technician cannot visit frequently because he is required to visit numerous farms, because the roads are in disrepair, and because of lack of communication. INCOPESCA's technician is responsible for all 355 trout farms in Costa Rica, and strives to visit every trout farm at least once every two months. But, in reality, he can only visit trout farms about once every year. Travel time is one of the main reasons why Sr. Carlos Burantes cannot visit the trout farms every two months. The number of trout farms in Costa Rica and the large distances between them make it difficult for Sr. Carlos Burantes to give the trout farmers the attention they need.

Communication and Contact Problems

Thirty-seven out of the thirty-nine (ninety-five percent) farms that we interviewed had personal phones. This allows farmers to directly communicate with INCOPESCA. However, trout farmers do not have a directory containing the contact numbers for trout farmers and INCOPESCA employees. Due to the lack of contact information, trout farmers do not know who to call when they experience problems. The technician's duties include facilitating networking between farmers and INCOPESCA as well as providing contact information to trout farmers. Unfortunately, because of the irregular visitations of the technician, trout farmers are unable to receive contact information and assistance in a timely manner.

INCOPESCA does not have a current directory of contact information for trout farmers in the southern highland region available to them. This causes difficulties when INCOPESCA needs to contact trout farms to inform them of available assistance opportunities. Also, the

INCOPESCA technician does not have a cellular phone, so he is often unable to call the farms while on the road to ensure that the trout farmers are available to visit. However, the region in which we interviewed did not have cellular service. But, according to Sr. Álvaro Otárola (personal communication, December 8, 2008), this is the only region in Costa Rica in which this problem occurs.

Farmers Experience Limited Fry Supply

Through interviews with trout farmers and INCOPESCA personnel, we found that trout farmers have a problem obtaining the fry they need. The trout farmers need INCOPESCA to supply them with fry more than twice a year in order for their production to be continuous. If INCOPESCA were able to consistently supply fry, trout farmers would be able to enjoy a more even production of trout and a more continuous profit. However, INCOPESCA only has the capital to purchase trout eggs and supply trout fry twice a year. This problem causes trout farmers to purchase their fry from other sources that are not guaranteed to be disease free.

INCOPESCA needed to know the demand for trout eggs and whether or not they could meet that demand, since it is charged by the Costa Rican government to supply fry to all of the trout farmers in Costa Rica (A. Otárola Fallas, personal communication, November 6, 2008). For the thirty-nine trout farms we interviewed, we found that there was an annual need of approximately 34,900 fry per year per farm in the southern highland region of Costa Rica. If these thirty-nine farms are representative of all 355 trout farms in Costa Rica, the data suggests that INCOPESCA would need to supply 12,389,500 fry in total per year. The Director of INCOPESCA, Sr. Álvaro Otárola, informed us that INCOPESCA only has the capacity to supply 800,000 fry per year (personal communication, November 20, 2008). From our estimation, INCOPESCA will not be able to supply the farmers with the fry they need.

CHAPTER 5: PRODUCTS RESULTING FROM OUR FINDINGS

In order to organize the information we collect for INCOPESCA, we designed a Microsoft Access Database. As we collected information from our semi-structured interviews, we entered the information into tables in the database. The purpose of the database was to make the collected information easy for INCOPESCA to use and allow them to continue making observations on trout farms in the future.

We organized our data into five different tables: Contact Information, Trout Information, Selling Information, Licences Information and Characteristics. This allowed for the information to be separated logically so that the viewer is not overwhelmed with data. The database also allows for the creation of reports, queries, charts, and forms. These features were used to allow easy access in the database. Reports, the first feature, was used to make our contact form. All of the contact information of trout farmers is arranged in an easy to read structure. This allows for quick access to phone numbers and the farms grouped by their district. Queries, the second feature, searches for information and includes it in a table. The query we created included all of the information we recorded in the database into one table. Charts, the third feature, were used to show the relationships between data in a graphic form. Form, the fourth feature, allows for data to be entered easily in the database. The form we created allows the user to enter all information for a farm on one page. Refer to Figure 6 for an outline of the information inluded in our database.

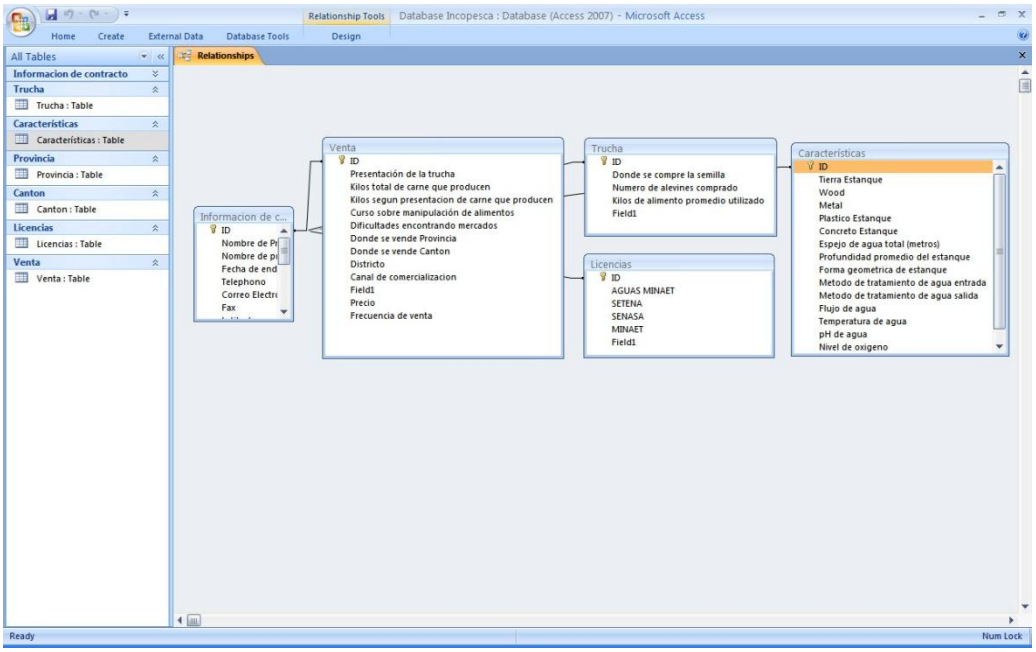

Figure 6: Outline of Information in the Microsoft Access Database

The second product we created was a manual for the use of trout farmers with all of the information that we collected. INCOPESCA suggested the use of a manual since they have shown it affective. When we created the manual, we considered the stucture of a well-designed manual. The layout on the page, and the amount of information on the page were important for the reader to be able to read everything without becoming bored or confused. We also needed to consider the information to include in the manual.

In the end, we decided to include the simplest changes that the trout farmers can make to their trout farm in order to fix the quality of the water. We also included information about the licenses that the trout farmers are required to have, a production record that the trout farmers can use to track their own progress from year to year, and a contact directory that supplies the trout farmers with contact information for other trout farmers and for INCOPESCA. Refer to Appendix C for our manual.

CHAPTER 6: RECOMMENDATIONS AND CONCLUSIONS

The recommendations we made focused on the problems we encountered while completing our project. Our recommendations focus on: environmental and technical problems trout farmers experienced; problems that affect the role of INCOPCESCA; and problems that require future research.

ENVIRONMENTAL RECOMMENDATIONS FOR TROUT FARMING

Trout Farmers Should Employ Sedimentation Tanks as the Least Expensive Method of Filtration

Thirty-seven out of thirty-nine (ninety-five percent) trout farmers do not have any intake filtration system, and none have outtake filtration. Sedimentation ponds are the most basic filtration system, which consist of a large tank with boards creating a permeable wall through the middle of the tank and flotation buoys on the surface to slow the flow of water and prevent sediment and debris from passing into the trout tanks. We recommend that trout farmers use sedimentation tanks as a system to purify the water they use for trout farming. We cannot describe the details of the sedimentation tank in this paper because parameters of a sedimentation tank are unique to each farm based on water quality, water demand of the trout farm, and geographical placement. Therefore, we recommend that trout farmers contact INCOPESCA for the specific design of a sedimentation tank that would be most appropriate for their trout farm.

INCOPESCA Should Inform Trout Farmers About Licenses

We found that thirty-four out of thirty-nine (eighty-three percent) were not licensed for the Concesión de Agua, thirty-eight out of thirty-nine (ninety-seven percent) farmers were not licensed for the Certificado Veterinario de Operación, and all farms were not licensed for the Canon de Vertido de Agua. We recommend that INCOPESCA inform the trout farmers of all necessary licenses and the consequences of not obtaining the licenses. In our manual, we

included brief information about the licenses as well as instructions to contact INCOPESCA for more information.

TECHNICAL RECOMMENDATIONS FOR TROUT FARMING

Trout Farmers Should Maintain Acceptable Dissolved Oxygen Levels By Frequent use of Water Feed Sources and Water Dispersal Mechanisms

We found that four of the thirty-nine (ten percent) we interviewed had tanks that were below the recommend dissolved oxygen level. We recommend trout farmers introduce more water sources to the tank in order to raise dissolved oxygen levels. Releasing the water from a higher height can also increase dissolved oxygen levels. In long raceways or tanks, we recommend introducing a water source towards the center of the tank since the dissolved oxygen in the water decreases significantly further away from the water source.

Trout Farmers Should Maintain Water Temperature Between Thirteen and Nineteen Degrees Celsius By Controlling The Water Feed Sources

We found that thirteen out of thirty-nine (thirty-three percent) of the trout farms we visited had water temperatures outside, or close to outside, the recommended range. Water temperature increases as it moves further from the water source. Therefore, we recommend that farmers introduce a new water source from the stream or river if the temperature is too high. That water will be cooler than the water in the tank. If the tank is a long raceway, we recommend introducing a new water source towards the center of the tank to decrease water temperature. If the temperature of the water in the tank is too low, we recommend using fewer independent water sources piped from the stream or river. This will decrease the level of dissolved oxygen in the water, and therefore we recommend increasing the aeration using the methods listed above, primarily using better dispersal mechanisms.

INCOPESCA Should Inform Trout Farmers Should On The Correct Amount Of Feed To Use For Their Trout.

The amount of feed that trout farmers use for their trout varies greatly. We recommend INCOPESCA inform trout farmers about the proper feeding techniques and feed amounts they should use. We recommend that INCOPESCA personnel visit trout farms and instruct trout farmers how to calculate and measure the values necessary to use the feed chart and provide them with a copy of the feed chart.

RECOMMENDATIONS TO IMPROVE INCOPESCA'S ROLE AS AN ORGANIZATION

INCOPESCA Should Provide Information Regularly to Trout Farmers

INCOPESCA experiences difficulties providing trout farmers with technical recommendations, information about licenses required by the government, and up to date contact information. We created a manual that addresses the information the trout farmers need. We recommend that INCOPESCA regularly update this manual and provide it to trout farmers in the form of an annual or biannual newsletter. Written information will strengthen the transfer of information from INCOPESCA to the trout farmers.

INCOPESCA Should Improve Technical Assistance

INCOPESCA'S technician has a difficult job trying to see all of the farms regularly. We identified three ways to increase his effectiveness. We recommend that INCOPESCA provide the technician with an updated contact sheet of all known trout farmers with their phone numbers. Also, while we recognize that cellular service is limited, we recommend that INCOPESCA provide the technician with a cellular phone for areas where cellular service is available. The combination of the first and second recommendations will allow the technician to use his time efficiently and contact trout farmers to learn if they are available for a technical

visit. Lastly, we recommend that INCOPESCA creates a travel calendar that would be made available to trout farmers in the annual or biannual newsletter. This calendar would list the dates during which INCOPESCA's technician would be in specific regions. Trout farmers could use the calendar as a way to know when INCOPESCA personnel would be in their region and contact INCOPESCA to ask for assistance. If our recommendations are followed, we believe that INCOPESCA's technician may experience an increase in his ability to visit trout farms more often.

INCOPESCA Should Provide a Detailed Contact Sheet to Trout Farmers

INCOPESCA and the trout farmers did not have a well developed contact list for networking business contacts and technician. We recommend that INCOPESCA continue to collect contact information from farmers to add to the contact information we gathered in order to create a complete contact sheet of trout farms in Costa Rica. We also recommend that INCOPESCA make the contact sheet available to trout farmers so that farmers can contact one another for assistance.

INCOPESCA Should Certify Trout Farmers to Grow Fry

Since INCOPESCA does not have the capacity to supply the amount of fry that the trout farmers in Costa Rica need, INCOPESCA would benefit from certifying trout farmers to sell fry to other trout farmers. INCOPESCA should also encourage trout farmers to work together to provide capital to grow eggs and fry among the group, and become mostly self-contained trout farmers. INCOPESCA should consider the benefits of privatizing fry supply.

INCOPESCA Should Offer More Classes Pertaining to Trout Farming

We found that one of the main problems that trout farmers have is lack of information on trout farming. We recommend that INCOPESCA creates new classes on topics that include: proper initiation of trout farms; proper type and amount of feed to use; and proper management

and marketing methods for trout farms. INCOPESCA should also assess their ability to offer these classes without charge to the trout farmers.

RECOMMENDATIONS FOR FUTURE RESEARCH

A Future Study on the Professional Relationship Between Trout Farmers in Costa Rica Should be Conducted to Establish if Relations Might Be Improved and a Trout Farming Cooperative Might be Created

Thirty-five out of Thirty-nine (eighty-seven percent) of trout farmers in the southern highland region of Costa Rica do not work cooperatively with each other. We believe that many of the economic, environmental, and technical problems we encountered while completing our project might be reduced if trout farmers in each region worked together. A trout farmer cooperative would relieve stress on the resources of INCOPESCA by easing the distribution of information as well as providing the trout farmers with support. Cooperation between trout farmers would also strengthen community ties as the farmers learned to work together. Trout farmers would be able to produce more trout for larger markets if they combined their produce. One of the largest impediments to a trout farmer cooperative is an agreement on the price at which trout should be sold.

If INCOPESCA changes its approach from visiting individual farms to visiting a group of farmers from the same area, the farmers may learn to work together. In these group meetings, the technician can supply information as well as photographs about operational examples from other trout farms in Costa Rica. These photographs were taken by our group during our visits to trout farms. This method of meeting has other benefits; it decreases the amount of time the technician needs to visit with all farmers because he does not need to travel to every farm.

A Future Study Should be Conducted on the Most Efficient Roads to Take to Visit Trout Farms

The technician for INCOPESCA has a large amount of trout farms to visit and does not have enough time to visit them all in a timely manner. In order to assist him in visiting as many trout farms as possible, we recommend that INCOPESCA map out specific traveling routes based upon the most efficient way to visit trout farms in a given area. This would allow INCOPESCA's technician to visit the largest amount of trout farms in the least amount of time.

A Future Study Should be Conducted to Determine if Trout Farmers are Using the Highest Quality Feed as their Budget Allows

Feed is one of the most expensive costs in trout farming. We found that trout farmers did not know if their feed was the correct quality, and desired to know what feed they should be using. This study should contain a cost benefit analysis to determine if using higher quality feed, in lesser amounts, is beneficial to the trout farmers.

CONCLUSION

Our research resulted in: the creation of a database for the storage of economic, environmental, and technical data for trout farms; the assessment of the economic, environmental, and technical status of trout farms in the southern highland region; the creation of a manual including a production record, contact sheet, and technical recommendations for trout farmers; and the creation of a report for INCOPESCA with recommendations on how to improve their relationship with trout farmers in Costa Rica. We provided recommendations on the improvement of trout farming and the improvement of INCOPESCA's role as an organization. The application of our recommendations will allow trout farming to grow as an industry in Costa Rica, which will in turn improve the economy in the southern highland region of the country.

APPENDIX A: INSTITUTO COSTARRICENSE DE PESCA Y ACUICULTURA

The following was taken and adapted from an Interactive Qualifying Projects by McShea & Sullivan (2007) and Bryand, Kadilak, & Pani (2006).

HISTORY AND DEVELOPMENT

The Instituto Costarricense de Pesca y Acuicultura, also called INCOPESCA, was created on the eighth of March, 1994 through law #7384 – Creación del Instituto Costarricense de Pesca y Acuicultura. INCOPESCA was formed to replace an organization called La Dirrección de Pesca to regulate the Costa Rican fishing and aquaculture industries. The former president of Costa Rica, Rafael Angel Calderon, signed the approval for this institute on the sixteenth of March 1994. Currently there are thirteen offices that provide assistance, technical education, and fry to Costa Rican producers. Costa Rica annually exports millions of dollars worth of tilapia and shrimp and this number is increasing annually. INCOPESCA is run by a main board of directors which includes a President assigned by the Government, the Minister of Agriculture and Livestock, the Minister of Science and Technology, a representative of the State assigned by the government, three 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.

BUDGETARY TRENDS

In 1998, INCOPESCA was in a critical economic situation which caused drastic measures to be taken in order to organize and control expenses. Being a government created agency, their annual budget of one billion colones, roughly equal to 1.9 million US dollars, seventy-five percent government funding and twenty-five percent fry sales. They also receive

funding from contributions from national and international institutions, fines, taxes and contributions associated with Law #7384, donations from other governments, private donations, and income from the Ministry of Agriculture and Livestock (Creación del Instituto Costarricense de Pesca y Acuicultura (INCOPESCA), 2005). Until 1998, generation of inventories was either nonexistent or incomplete. Measures were taken to remedy this problem and the monitoring of vehicle use was implemented as well. Specific entities were also organized to investigate and follow up expenses.

MISSION

In Costa Rica, INCOPESCA primarily serves to encourage the development of fishing and aquaculture, along with its supporting investigation of both. The organization also promotes environmental conservation. It does so by determining the rational utilization of natural resources that will produce the best economic results while still protecting marine and aquaculture species. In addition to these responsibilities mentioned above, INCOPESCA must be aware of and enforce the current legislation that regulates and prevents contamination of marine and aquaculture resources.

POLICIES

In order for INCOPESCA to fulfill the mission stated above, it developed a set of programs in conjunction with representatives from fishing industries, aquaculture industries, investigators of aquaculture, exporters and industrial producers during the "Congreso Nacional del Sector Pesquero in 1995." The set of policies they developed included the investigation and development of aquaculture, the development of subsistence fish farming, the marketing and

industrialization of fish products, the development of the industrial production of tuna, and the control of marine resources.

FISHING AND AQUACULTURE INVESTIGATION PROGRAM

In Costa Rica, many poorly organized investigations have been carried out in the field of aquaculture; this has prevented research objectives from being achieved. The lack of organization and the lack of defined priorities in Costa Rica forced INCOPESCA to accept the responsibility of establishing the "Plan Nacional de Investigación Pesquera y Acuícola." This plan coordinates fishing and aquaculture efforts among organizations such as universities and regional entities.

Along with establishing the aforementioned plan, INCOPESCA decided to strengthen fry research and production in hatcheries and stations through Costa Rica. Special efforts were made to improve the cultivation technology of well-defined products such as tilapia, shrimp, trout, and other marine organisms.

INCOPESCA also placed great emphasis on environmental protection. This action was simultaneous with the government's efforts to reduce and prevent the depletion and contamination of aquatic environments. Some specific examples of the efforts are hospital waste control, deforestation regulation, public education regarding environmental protection and water contamination monitoring.

ORGANIZATION AND EDUCATION

INCOPESCA dedicated its education and organizational efforts to helping aquaculture producers and fishermen in the forms of making technology available and improving commercial practices.

APPENDIX B: LICENSES

The Concesión de Agua determines the amount of water each household, person, or project has the right to; based on the amount of water available. This is because water in Costa Rica is considered public property, and those using it are required by law to obtain the Concesión de Agua to have ownership over their water. This ensures that no one person will use all of the available water. The Concesión de Agua is very important for trout farmers, since in the summer (the dry season) the amount of water available to everyone decreases significantly. But, those who have obtained the Concesión de Agua will have rights to the same amount of water as during the winter (the rainy season) (COMISIONES, 2005).

The Certificado Veterinario de Operación allows for el Servicio Nacional de Salud Animal to regulate the conditions under which trout are produced. This ensures that the trout were raised in sanitary conditions, and that the trout are safe for consumption (El Certificado Veterinario de Operación, 2006).

The Canon de Vertido de Agua gives monetary returns to projects that reduce the amount of waste they produce. A representative of el Ministerio del Ambiente y Energía will visit the trout farm and determine the level of contamination being added to the water source. Each year the farm will pay a given amount of money for the contamination they produce, and at the end of six years the representative will return. If the amount of contamination being produced is lower than when they first visited, the project receives a refund based on how much their contamination decreased. This law is very important as it encourages non-contaminating practices as well as encourages farmers to become conscious of the waste they put in the water (Canon por Vertidos y Canon de Aprovechamiento de Aguas, 2005).

APPENDIX C: MANUAL FOR TROUT FARMERS

INFORMATIONAL MANUAL FOR TROUT FARMERS IN COSTA RICA

Sponsored By: INCOPESCA

Written By:
Andrew Emerson
Robert Fitzpatrick
Lindsay Wood

Table of Contents

INFORMATIONAL MANUAL FOR TROUT FARMERS IN COSTA RICA

Chapter 1: Technical Aspects

In section, we will present ways to fix the simplest problems. We will supply you with instructions on how to adjust the quality of your water.

1. HOW TO: Maintain a Clean Tank

Tanks should be kept clean to prevent disease and maintain good water quality. If the water has more than 30 milligrams of suspended solids per liter of water than it must be cleaned to maintain healthy trout. pH can vary between 6.0 and 8.0 without significantly impacting the growth of the trout. The average pH in the Cartago region is 7.26.

If the pH is outside of the allowable limits, it is advisable that the trout be moved to a separate tank in order to avoid subjecting them to concentrated acidic or basic compounds.

If a change in pH is experienced; the first course of action should be to clean the tank. Decomposing debris may be causing a change in pH.

2. HOW TO: Adjust Water Temperature

The temperature range in which trout can be raised without seriously impacting their development is 13 - 18 ºC. The average temperature of trout ponds in the Cartago region is 15.23 ºC.

Water temperature will increase as it moves further from the feed source. Therefore, the water further down the raceway or long tank will be warmer than the water being introduced to the tank.

If tank temperature is too high, we recommend introducing a new water source from the river. This water will be cooler than the water in the tank. If the tank is a long raceway, we recommend introducing a new water source half way through the tank to decrease water temperature.

If the water temperature of the tank is too low, use fewer independent water sources piped from a stream or river. Instead, use the same source split several times to allow for warmer water while allowing for acceptable oxygenation.

3. HOW TO: Improve Water Dissolved Oxygen Level

The oxygen limit for the cultivation of trout is 5 mg/L. Levels higher than this are acceptable for the cultivation of trout. The average oxygen levels for trout farms in the Cartago region is 6.55 mg/L.

Oxygen levels can be raised by introducing more water sources to the tank and increasing the amount of bubbles the source creates. Placing objects in the water stream to disperse the water, or releasing the water from a height are both commonly used practices to increase oxygen levels.

In long raceway or tank situations, it is important to introduce a water source half way through the tank as the oxygen levels decrease significantly further away from the water source.

4. HOW TO: Filter Water

In farmers that operate close to highways, construction areas, or use water from turbulent rivers, all of which release a large amount of sediment, we recommend that trout farmers use sedimentation tanks as systems to purify the water they use for trout farming. Sedimentation tanks are the basic filtration system as they consist of a large tank with boards creating a permeable wall through the middle of the tank and flotation buoys on the surface which slow the flow of water and prevent sediment and debris from passing into the trout tanks.

We recommend if trout farmers are interested in creating a filtration system that they consult INCOPESCA as to the specific specifications of the system based upon the requirements of the specific trout farm.

5. INFORMATION: Licenses

For more detailed information on licenses or advice on how these license can be obtained, please contact INCOPESCA.

The Autorización Para Proyectos Acuícolas is article seventy–nine in the Fishing Law N. º8436. Trout farmers should register with the ICT and get a special licence from INCOPESCA. This allows INCOPESCA to evaluate the project to assess the design and impact of the project on the envirnonment.

The Viabilidad Ambiental is a license in which the project developer must comply with all regulations and norms technical, legal, and environmental in Costa Rica. It can be obtained through SETENA.

The Concesión de Agua determines the amount of water each household, person, or project has the right to; based on the amount of water available. The Concesión de Agua is very important for trout farmers, since in the summer (the dry season) the amount of water

available to everyone decreases significantly. But, those who have obtained the Concesión de Agua will have rights to the same amount of water as during the winter (the rainy season).

The Certificado Veterinario de Operación allows for el Servicio Nacional de Salud Animal to regulate the conditions under which trout are produced. This ensures that the trout were raised in sanitary conditions, and that the trout are safe for consumption. This license is especially important for any trout farmer who is raising trout in a restaurant business or is looking to expand to larger markets. Trout farmers only need to apply for this license one time and it is available from SENASA (el Servicio Nacional de Salud Agropecuaria).

The Canon de Vertido de Agua is very important as it encourages non-contaminating practices as well as encourages farmers to become conscious of the waste they put in the water. This license is also one which trout farmers need purchase only one time and is offered by MINAET

Chapter 2: A Registry

In section, we will present a tool with which trout farmers may keep records of their operation.

On the following page we have provided a registry form which trout farmers may use to keep records of their operational data. This information includes a per tank estimation of the average mass of a fish, the number of fish, the amount of feed used, the mortality of fish, and an area to include observations. We also have provided formulas to calculate the biomass and feed conversion ratio of each tank. The feed conversion ratio, or FC, is a way to track the amount of feed being used verses the amount of fish being fed. This number is a way for trout farmers to evaluate the efficiency with which they are feeding their trout and compare this efficiency to past feeding periods and possibly other trout farms.

The amount of feed that trout farmers are using for their trout varies greatly. The average amount of feed used by trout farmers in the Cartago region is two kilograms of feed per kilogram of trout produced throughout the development of the fry. Some farmers reported using ratios as low as 0.05 and some as high as 12. INCOPESCA possesses a feed chart which uses information such as number of fish per kilo, water temperature, and longitude. We recommend that INCOPESCA personnel visit trout farms and instruct trout farmers on how to calculate and measure the values necessary to use the feed chart and provide them with a copy of the feed chart.

HOJA DE MONITOREO DE ESTANQUES DE TRUCHA

ESTANQUE Nº:		ESPEJO DE AGUA (M2):		DENSIDAD SIEMBRA (ALEV/M3):			FECHA SIEMBRA:
DIA	PESO PROMEDIO (GRAMOS)	Nº PECES SEMBRADOS	BIOMASA (KG)	ALIMENTO (KG/DIA)	MORTALIDAD	FC	OBSERVACIONES
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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31							

BIOMASA = PESO PROMEDIO/PRECES SEMBRADOS FC = ALIMENTO / BIOMASA

Chapter 3: A Contact Sheet

In section, we present a tool trout farmers may use to contact other each other or INCOPESCA.

Contact Information					
Provincia	**Canton**	**Districto**	**Project Name**	**Producer's Name**	**Telephono**
Cartago	Central	San Fransisco	Trucheros Las Rojas	Alfredo Rojas Zamora	2575-0061
Cartago	Central	San Fransisco	Cipreces Preses	Jorge Vives	2551-1848
Cartago	El Guarco	Cima de Dota	Creador de Truchas	Oscar Gomez Calderon	2541-3273
Cartago	El Guarco	El Guarco	Puerta de Osaca	Ricardo Vensio Mora	8373-2426
Cartago	El Guarco	El Guarco	Rio Macho	Oscar Gomez Calderon	
Cartago	El Guarco	El Guarco	Guarco	Luis Eladia Tencio Camachu	8355-5071
Cartago	El Guarco	El Guarco	Finca de Rio Macho	Vidal Camacho Flores	8868-2359
Cartago	El Guarco	El Guarco	Lagos Santa Anna	Jose Luis Duran Cordero	8379-9946
Cartago	El Guarco	El Guarco	Madre Selva	Alejandro Solano	22000-447
Cartago	El Guarco	Estrella	Pesca la Estrella	Krispin Fuentes Ovan	2571-1131
Cartago	El Guarco	San Pedro	Lagos los Angeles	Cepertero Angelo Cerrar	2907-1307
Cartago	El Guarco	San Pedro	Herer Trucha	Felipe Rivera Chinchilla	5091-4393
Cartago	El Guarco	San Pedro	Trucha las Piedras	Sergio Navarro Arias	2571-1213
Cartago	El Guarco	San Isidro	Cespesesirian	Jesus Gonyalo Cespesesirian	8369-1997
Cartago	El Guarco	San Isidro		Miguel Angel Mena Camaecho	8828-5550
Cartago	El Guarco	San Isidro	Pesca Trucha La Paz	Porfidio Romero Gamaczo	8837-1238
Cartago	Paraiso	Cachi	Rancho Ursca	Juan Pablo Torres	2577-1680
Cartago	Paraiso	Cachi	La Tranquera	Pedro Oanco Nararro	
Cartago	Paraiso	Cachi	Moatana de Truchas	Ouidia Ohichilh Catiuz	2577-1457
Cartago	Paraiso	Cachi	Truchas la Fuente	Mariano Chinohilk	2577-1752
Cartago	Paraiso	Cachi	Truchos Chavolo	Isaac Rivera Mariz	1415-2577
Cartago	Paraiso	Orosi	Trucha Kiri Tapanti		2533-2272
Cartago	Paraiso	Orosi	Trucha Rancho Grande	Oligcer Avce Gomez	500-33-3958
Cartago	Turrialba	Santa Cruz		Virginia Guillen Varga	2538-7127
Cartago	Turrialba	Santa Cruz	La Trucha y El Gavlian	Roberto Cerdas	2538-8000
Cartago	Turrialba	Santa Cruz	El Sapito		2534-1818
San Jose	Dota	Capei	Finca Madre Selva	Marros Rojas	8871-9889
San Jose	Dota	Capei	Suyiga	Gerardo Chaca Suyiga	2640-1023
San Jose	Dota	Capei	Trucha Reiles de Costa Rica	Jose Miguel Viques	8376-4256
San Jose	Dota	Capei	Arco Iris de Los Santos	Carlos Shacon Suyniga	2740-1033
San Jose	Dota	Capei	Los Largos Locha	Mario Mangel Chinchilla	2740-1038
San Jose	Dota	Capei		Flore Lar Raso Cruz	2740-1003
San Jose	Dota	Capei	Tragon Lodge	Mauricio Dala	2740-1051
San Jose	Dota	Capei	La Facaya	Israel Gomez	8385-2703
San Jose	Dota	Cerrode la Muerte	Mirador de Quetzales	Leanor Duando Guillen	2200-5915
San Jose	Dota	Copey	Truchicultura	Fernando Guilizon de Churena	511-30-81
San Jose	Dota	Copey	Trucha Rica	Cesar Vindes Otaros	215-41-3323
San Jose	Dota	Copey	El Lago de Pesca	Mario Prado	8398-9976
San Jose	Dota	La Trimidad		Domimgo Gonzalgi Flores	2541-3278

APPENDIX D: MANUAL PARA TRUCHEROS EN COSTA RICA

Manual Para Trucheros en Costa Rica

Patrocinado por: INCOPESCA

Escrito por:
Andrew Emerson
Robert Fitzpatrick
Lindsay Wood

Índice de Contenidos

MANUAL PARA TRUCHEROS EN COSTA RICA

Capítulo 1: Aspectos Técnicos

En esta sección, presentaremos maneras de fijar los problemas técnicos más simples.

1. COMO: HACER UN ESTANQUE SANITARIO

Es muy importante mantener un estanque limpio y sanitario para impedir enfermedades y mantener la calidad del agua. Las partículas en suspensión se mantengan en niveles inferiores a 30 mg por litro. Si no mantenga estanque limpio, enfermedades pueden aumentar. También recomendemos mantener un pH entre 6.0 y 8.0. El pH promedio en la región al sur de San José es 7.26. Un parte de mantener un pH consistente es mantener un estanque limpio.

2. COMO: Cambiar la Temperatura de Agua

La temperatura para cultivar la trucha debe estar entre trece y diecinueve grados centígrados. La mayoría de los proyectos tienen una temperatura aceptable para cultivar trucha con un promedio de 15.23 ºC. El agua se calienta en cuando pasa por el estanque, y las nuevas fuentes de agua son más frías. Entonces recomendamos que si la temperatura del agua está alta, se debe añadir nuevas fuentes de agua. Si el agua está fría, recomendamos utilizar la misma fuente de agua y no utilizar nuevas pero utilizar un bien sistema de dispersión de agua para mantener bien aeración.

3. COMO: Mejorar el Nivel de Oxigeno Disuelto

La trucha requiere por lo menos cinco miligramos por litro de oxigeno. La mayoría de los proyectos de trucha tienen agua con niveles suficientes de oxigeno con un promedio de 6.55 mg/L en las zonas altas al sur de Cartago. Pero, para los proyectos de trucha que no tienen el nivel básico de oxigeno, recomendamos aumentar la aireación con mas fuentes de agua o con un sistema de dispersión del agua para que haya más burbujas. En estanques largos recomendamos poner un fuente de agua en el centro del estanque porque los niveles de oxigeno disuelto bajan cuando están lejos del fuente. Por eso si hay un estanque largo con un fuente por un lado, el nivel de oxigeno al otro lado estaría my bajo.

4. COMO: Filtración de Agua

Recomendamos que trucheros utilicen sistemas de filtración – en particular sistemas de sedimentación para purificar el agua que usan en sus proyectos. Estanques de sedimentación so los sistemas básicos para hacer filtración. Consisten de un grande estanque con un pared de madura que va desde un lado al otro y desde el abajo hasta encima del agua. La pared de agua debe ser permeable para dejar el agua pasar desde un lado a otro, pero no dejar cosas

como palos y hojas pasar. La pared va a hacer la agua pasar más lentamente por el estanque y por eso todo el sedimentación va a hundir y no pasar a los estanques de trucha.

Recomendemos que le interesa, contactar a un técnico de INCOPESCA para que INCOPESCA puede ayudarle diseñar un estanque de sedimentación especifico a su proyecto.

5. INFORMACIÓN: Licencias

Para más información de las licencias o consejas en cómo conseguirlas, por favor contacta a un técnico de INCOPESCA.

La Autorización Para Proyectos Acuícolas es articulo siete y nueve de Ley de Pesca N. º8436. Todos trucheros deben estar registrados en el ICT y sacar una licencia especial otorgada por el INCOPESCA. Eso deja INCOPESCA evaluar al proyecto para asesar el diseño e impacto al medio ambiente.

La Viabilidad Ambiental es una licencia de que el desarrollador del proyecto debe cumplir con todas las regulaciones y normas técnicas, legales y ambientales en Costa Rica. Se puede conseguir de SETENA.

La Concesión de Agua habla de la cantidad de a agua que puede utilizar cada persona. Si saca esta licencia, dice que tiene el derecho a una cantidad especifico de agua. La Concesión de Agua es muy importante a los trucheros porque en el verano la cantidad de agua disponible en los ríos baja. Pero los trucheros cuales tienen la Concesión de Agua van a tener derecho a la misma cantidad de agua que en el invierno.

El Certificado Veterinario de Operación permita el Servicio Nacional de Salud Animal regular las condiciones en que se produce la trucha. Aseguran que el proyecto de trucha tiene instalaciones sanitarias y que la trucha está segura para consumir. Está licencia es muy importante especialmente para un truchero que tiene también un restaurante o quiere vender a mercados más grandes. El Certificado Veterinario de Operación se puede conseguir de SENASA (el Servicio Nacional de Salud Agropecuaria).

El Canon de Vertido de Agua es muy importante porque hace un esfuerzo para reducir la contaminación y basura que pongan los trucheros en el rio. La trucha produce contaminación y los trucheros no saben la cantidad de la contaminación que hacen. Esta licencia se puede conseguir de MINAET.

Capítulo 2: Un Registro

En este capítulo presentamos a los trucheros una herramienta que pueden utilizar para recordar los datos de su operación.

En la siguiente página hay un registro que hemos designado para los trucheros para que puedan recordar los datos de operación en su proyecto. Esa información por cada estanque incluya un promedio de pesa de trucha, el numero de trucha, la cantidad de alimento utilizado, cuantos muertes, y un lugar para escribir observaciones. Hemos también escrito la fórmula para calcular la biomasa y ratio de alimento que utiliza. El ratio de alimento se llama FC (ratio de conversión de comida) y es una herramienta para decir la cantidad de alimento que utiliza en comparación a la cantidad de trucha a que les dan la comida. Si utilizan el ratio de alimento se puede evaluar la eficiencia a que dan comida a la trucha en el presente en comparación al pasado o a otros trucheros.

La cantidad de alimento que trucheros utilizan para su trucha varía mucho. El promedio que utiliza los trucheros en las zonas altas al sur de San José es dos kilogramos de alimento por kilogramo de trucha producido. INCOPESCA tiene un gráfico que utiliza información como el número de trucha por kilo, la temperatura del agua, y longitud. Recomendamos que trucheros llamen a INCOPESCA y piden una visita técnica para recibir información e instrucción en como calcular la cantidad correcto de alimento que deben utilizar.

HOJA DE MONITOREO DE ESTANQUES DE TRUCHA

ESTANQUE Nº:		ESPEJO DE AGUA (M2):		DENSIDAD SIEMBRA (ALEV/M3):			FECHA SIEMBRA:
DIA	PESO PROMEDIO (GRAMOS)	Nº PECES SEMBRADOS	BIOMASA (KG)	ALIMENTO (KG/DIA)	MORTALIDAD	FC	OBSERVACIONES
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

BIOMASA = PESO PROMEDIO/PRECES SEMBRADOS FC = ALIMENTO / BIOMASA

Capítulo 3: Información de Contacto

Presentamos una herramienta que trucheros pueden utilizar para contactarse y contactar a INCOPESCA.

Información de contracto					
Provincia	**Cantón**	**Distrito**	**Nombre de Proyecto**	**Nombre de productor**	**Teléfono**
Cartago	Central	San Fransisco	Trucheros Las Rojas	Alfredo Rojas Zamora	2575-0061
Cartago	Central	San Fransisco	Cipreces Preses	Jorge Vives	2551-1848
Cartago	El Guarco	Cima de Dota	Creador de Truchas	Oscar Gomez Calderon	2541-3273
Cartago	El Guarco	El Guarco	Puerta de Osaca	Ricardo Vensio Mora	8373-2426
Cartago	El Guarco	El Guarco	Rio Macho	Oscar Gomez Calderon	
Cartago	El Guarco	El Guarco	Guarco	Luis Eladia Tencio Camachu	8355-5071
Cartago	El Guarco	El Guarco	Finca de Rio Macho	Vidal Camacho Flores	8868-2359
Cartago	El Guarco	El Guarco	Lagos Santa Anna	Jose Luis Duran Cordero	8379-9946
Cartago	El Guarco	El Guarco	Madre Selva	Alejandro Solano	22000-447
Cartago	El Guarco	Estrella	Pesca la Estrella	Krispin Fuentes Ovan	2571-1131
Cartago	El Guarco	San Pedro	Lagos los Angeles	Cepertero Angelo Cerrar	2907-1307
Cartago	El Guarco	San Pedro	Herer Trucha	Felipe Rivera Chinchilla	5091-4393
Cartago	El Guarco	San Pedro	Trucha las Piedras	Sergio Navarro Arias	2571-1213
Cartago	El Guarco	San Isidro	Cespesesirian	Jesus Gonyalo Cespesesirian	8369-1997
Cartago	El Guarco	San Isidro		Miguel Angel Mena Camaecho	8828-5550
Cartago	El Guarco	San Isidro	Pesca Trucha La Paz	Porfidio Romero Gamaczo	8837-1238
Cartago	Paraiso	Cachi	Rancho Ursca	Juan Pablo Torres	2577-1680
Cartago	Paraiso	Cachi	La Tranquera	Pedro Oanco Nararro	
Cartago	Paraiso	Cachi	Moatana de Truchas	Ouidia Ohichilh Catiuz	2577-1457
Cartago	Paraiso	Cachi	Truchas la Fuente	Mariano Chinohilk	2577-1752
Cartago	Paraiso	Cachi	Truchos Chavolo	Isaac Rivera Mariz	1415-2577
Cartago	Paraiso	Orosi	Trucha Kiri Tapanti		2533-2272
Cartago	Paraiso	Orosi	Trucha Rancho Grande	Oligcer Avce Gomez	500-33-3958
Cartago	Turrialba	Santa Cruz		Virginia Guillen Varga	2538-7127
Cartago	Turrialba	Santa Cruz	La Trucha y El Gavlian	Roberto Cerdas	2538-8000
Cartago	Turrialba	Santa Cruz	El Sapito		2534-1818
San Jose	Dota	Capei	Finca Madre Selva	Marros Rojas	8871-9889
San Jose	Dota	Capei	Suyiga	Gerardo Chaca Suyiga	2640-1023
San Jose	Dota	Capei	Trucha Reiles de Costa Rica	Jose Miguel Viques	8376-4256
San Jose	Dota	Capei	Arco Iris de Los Santos	Carlos Shacon Suyniga	2740-1033
San Jose	Dota	Capei	Los Largos Locha	Mario Mangel Chinchilla	2740-1038
San Jose	Dota	Capei		Flore Lar Raso Cruz	2740-1003
San Jose	Dota	Capei	Tragon Lodge	Mauricio Dala	2740-1051
San Jose	Dota	Capei	La Facaya	Israel Gomez	8385-2703
San Jose	Dota	Cerrode la Muerte	Mirador de Quetzales	Leanor Duando Guillen	2200-5915
San Jose	Dota	Copey	Truchicultura	Fernando Guilizon de Churena	511-30-81
San Jose	Dota	Copey	Trucha Rica	Cesar Vindes Otaros	215-41-3323
San Jose	Dota	Copey	El Lago de Pesca	Mario Prado	8398-9976
San Jose	Dota	La Trimidad		Domimgo Gonzalgi Flores	2541-3278

APPENDIX E: INTERVIEW FORM

Interview form for Trout Farmers in the Southern highlands of Costa

Contact Information

Project Name:_____ Date:_____
E-mail:_____ Name of Owner: _____
Telephone Number:_____ Fax Number:_____
Latitude: _____ Longitude: _____ Altitude: _____
Web Page: _____

Province:

☐ San José	☐ Cartago	☐Heredia

County:

☐ Central	☐ Central	☐ Central
☐ Escazu	☐ Paraíso	☐ Barva
☐ Desamparados	☐ La Unión	☐ Santa Domingo
☐ Aserrí	☐ Alvarado	☐ Santa Bárbara
☐Mora	☐Oreamuno	☐San Rafael
☐ Goicoechea	☐ El Guarco	☐ San Isidro
☐ Santa Ana		☐ Belén
☐ Atenas		☐ Flores
☐ Poás		
☐ Alajuelita		
☐Vázquez de Coronado		
☐ Tibás		
☐ Moravia		
☐ Montes de Oca		
☐ Curridabat		

District:_____
Address: _____
Years of Experience:_____

Caracteristics of Production

Number of Tanks_____
Type of Tank

☐Concrete	☐Plastic
☐Earth	☐Acrylic

Total Area of Water (meters): ☐
Average Depth of Tanks: ☐
Geometric Form of Tanks: _____
Method of Water Treatment Entering: _____
Method of Water Treatment Leaving: _____
Flow of Water: _____
Temperature of Water (ºC): _____
pH of Water: _____
Oxygen Level (mg/L): _____
List of different economic activities performed on the project site:

Trout

Where do you purchase the fry from: _____
Average number of fry purchased per year: ☐
Average number of kilos of feed used per year: ☐

Sale

Presentation of the trout

☐ Whole Trout ☐ Fillet ☐ Smoked
☐ Surplus ☐ Other: _____

Number of kilos (biomass) in total of meat produced per year: ☐

Type and number of kilos (biomass) in total of meat produced per year:

☐ Whole Trout ☐ Fillet ☐ Smoked
☐ Surplus ☐ Other: _____

Method of transportation of trout meat (temperature):

_____

Have you received a course on the manipulation of trout feed:

☐ Yes ☐ No – why: _____

Have you had difficulties encountering markets:

☐ No ☐ Yes – why: _____

Where do you sell your trout

Province:

☐ San José	☐ Cartago	☐ Alajuela	☐Heredia

County:

☐ Central	☐ Central	☐ Alajuela	☐ Central
☐ Escazu	☐ Paraíso		☐ Barva
☐ Tibás	☐ La Unión		☐ Santa Domingo
☐ Aserrí	☐ Alvarado		☐ Santa Bárbara
☐ Mora	☐Oreamuno		☐San Rafael
☐ Poás	☐ El Guarco		☐ San Isidro
☐ Santa Ana			☐ Belén
☐ Atenas			☐ Flores
☐ Goicoechea			
☐ Alajuelita			
☐ Vázquez de Coronado			
☐ Desamparados			
☐ Moravia			
☐ Montes de Oca			
☐ Curridabat			

Other markets outside of the GAM: _____

District:_____

Channels of Commercialization

☐ Fisheries ☐Markets ☐Supermarkets
☐Recreational Fishing ☐Hotels ☐Restaurants
☐Wholesalers ☐Live Trout ☐Other: _____

Distance from the market:_____

Price at which you sell trout (in colones per kilogram):

Whole Trout: ☐ Fillet: ☐ On Ice: ☐
Surplus: ☐ Recreational fish ☐ Other: _____

Frequency of Sale

☐ Daily ☐ Weekly ☐ Fortnightly
☐ Monthly ☐ Other: _____

Licenses

Conservation of Water – by AGUAS MINAET (Ministerio de Ambiente Energía Telecomunicaciones)

☐ Yes ☐ Does not have and why: _____

Environmental Feasibility – por SETENA (Secretaría Técnica Nacional Ambiental)

☐ Yes ☐ Does not have and why: _____

Veterinary Certificate of Operation – by SENASA (Servicio Nacional de Salud Agropecuaria)

☐ Yes ☐ Does not have and why: _____

Canon of Water Discharges – by MINAET

☐ Yes ☐ Does not have and why: _____

Problems and Wishes

What was your motive for entering the aquaculture industry

_____
_____
_____
_____

What problems do you most frequently experience in your production system (diseases, bad feed quality, bad trout quality)

_____
_____
_____
_____

What advantages do you see to your system of production

_____
_____
_____
_____

What services do you wish INCOPESCA would offer or improve on

_____
_____
_____
_____

What technical documents do you think are necessary to improve your work in trout farming

_____
_____
_____
_____

What services does your trout farm offer to tourists

_____
_____
_____
_____

How many people do you employ on your trout farm

Family: ☐ External: ☐

APPENDIX F: ENTREVISTA

Encuesta a truchicultores de la zona sur de san jose

Información de contacto

Nombre de Proyecto:_____ Fecha:_____
Correo Electrónico:_____ Nombre de productor: _____
Numero de Teléfono:_____ Numero de Fax:_____
Latitud: _____ Longitud: _____ Altitud: _____
Pagina de web: _____
Provincia:

☐ San José	☐ Cartago	☐Heredia
Cantón:		
☐ Central	☐ Central	☐ Central
☐ Escazu	☐ Paraíso	☐ Barva
☐ Desamparados	☐ La Unión	☐ Santa Domingo
☐ Aserrí	☐ Alvarado	☐ Santa Bárbara
☐Mora	☐Oreamuno	☐San Rafael
☐ Goicoechea	☐ El Guarco	☐ San Isidro
☐ Santa Ana		☐ Belén
☐ Atenas		☐ Flores

☐ Poás
☐ Alajuelita
☐Vázquez de Coronado
☐ Tibás
☐ Moravia
☐ Montes de Oca
☐ Curridabat

Distrito:_____
Dirección: _____
Años de experiencia:_____

Características de la unidad productiva

Numero de estanques_____
Tipo de estanque
☐Concreto ☐Plástico
☐Tierra ☐Arcilla
Espejo de agua total (metros): ☐
Profundidad promedio del estanque: ☐
Forma geométrica de estanque: _____
Método de tratamiento de agua entrada: _____
Método de tratamiento de agua salida: _____
Flujo de agua: _____
Temperatura de agua (ºC): _____
pH de agua: _____
Nivel de oxigeno (mg/L): _____
Llevar registros de las diferentes actividades que realiza en el proyecto:

Trucha

Donde se compra la semilla: _____
Numero de alevines promedio comprados por año: ☐
Numero de kilos de alimento promedio utilizado por año: ☐

Venta

Presentación de la trucha

☐ Trucha entera ☐ Fileteada ☐ Ahumada

☐ Sobrantes ☐ Otro: _____

Numero de kilos (biomasa) total de carne que producen por año: ☐

Numero de kilos (biomasa) según presentación de carne que producen por año:

☐ Trucha entera ☐ Fileteada ☐ Ahumada

☐ Sobrantes ☐ Otro: _____

Método de transporte y conservación del producto (temperatura):

_____

Ha recibido algún curso sobre manipulación de alimentos:

☐ Si ☐ No – porque: _____

Dificultades encontrando mercados

☐ Si ☐ No – porque: _____

Donde se vende

Provincia:

☐ San José	☐ Cartago	☐ Alajuela	☐Heredia
Cantón:			
☐ Central	☐ Central	☐ Alajuela	☐ Central
☐ Escazu	☐ Paraíso		☐ Barva
☐ Tibás	☐ La Unión		☐ Santa Domingo
☐ Aserrí	☐ Alvarado		☐ Santa Bárbara
☐ Mora	☐Oreamuno		☐San Rafael
☐ Poás	☐ El Guarco		☐ San Isidro
☐ Santa Ana			☐ Belén
☐ Atenas			☐ Flores
☐ Goicoechea			
☐ Alajuelita			
☐ Vázquez de Coronado			
☐ Desamparados			
☐ Moravia			
☐ Montes de Oca			
☐ Curridabat			

Otros mercados fuera del GAM: _____

Distrito:_____

Canal de comercialización

☐ Pesquería ☐Mercados ☐Supermercados

☐Pesca Recreativa ☐Hoteles ☐Restaurantes

☐Mayoristas ☐Trucha Viva ☐Otro: _____

Distancia promedio al punto de venta:_____

Precio a que se vende (en colones por kilogramo):

Trucha entera: ☐ Fileteada: ☐ Con Hielo: ☐

Sobrantes: ☐ Pesca Recreativa ☐ Otro: _____

Frecuencia de venta

☐ Diaria ☐ Semanal ☐ Quincenal

☐ Mensual ☐ Otro: _____

Licencias

Concesión de agua – por departamento de AGUAS MINAET (Ministerio de Ambiente Energía Telecomunicaciones)

☐ Si tiene ☐ No tiene porque: _____

Viabilidad Ambiental – por SETENA (Secretaría Técnica Nacional Ambiental)

☐ Si tiene ☐ No tiene – porque: _____

Certificado Veterinario de Operación – por SENASA (Servicio Nacional de Salud Agropecuaria)

☐ Si tiene ☐ No tiene – porque: _____

Canon de Vertido de Aguas – por MINAET

☐ Si tiene ☐ No tiene – porque: _____

Problemas y deseos

Motivo por cual entró en la industria de acuacultura

_____
_____
_____
_____

Problemas más frecuentes en su sistema producción (enfermedades, mala calidad del alimento, mala calidad de semilla)

_____
_____
_____
_____

Ventas de su sistema de producción

_____
_____
_____
_____

Qué servicio requiere INCOPESCA?

_____
_____
_____
_____

Qué clase de capacitación o documentos técnicos cree usted necesarios para mejorar su trabajo en su proyecto cultivo trucha.

_____
_____
_____
_____

Que servicios ofrecen a las turistas

_____
_____
_____
_____

Cuanta mano de obra se utiliza en el proyecto

Familiar: ☐ Externa: ☐

APPENDIX G: MANUAL FOR DATABASE

DATABASE OF TROUT FARMERS IN COSTA RICA

Property of INCOPESCA, Written by students of Worcester Polytechnic Institute

INTRODUCTION

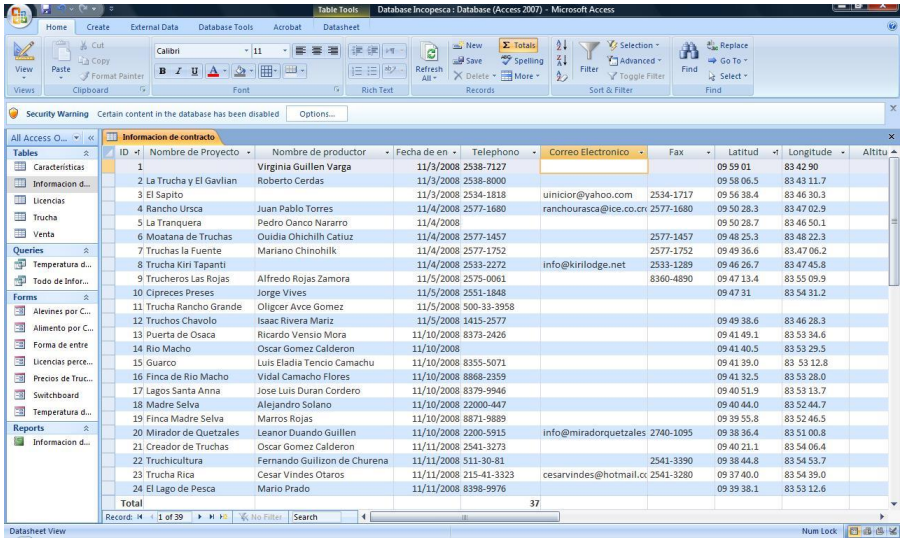
This database has been created as part of an Interactive Qualifying Project by Worcester Polytechnic students in cooperation with Instituto Costarricense de Pesca y Acuicultura (INCOPESCA) and is for the use of INCOPESCA. The purpose of this database is to aid in the organization of information about trout farmers in Costa Rica. It contains information specific to the farmers of southern highland region collect by interviews in November of 2008. It can be added to, to include information about farmers in all of Costa Rica and updated as needed. As much as possible this database was written in Spanish.

The information collected can be separated into five separate categories: contact information, information about trout, information about marketing, characteristics of the farm, and license information. The different ways to view and change information will be explained in the following sections by going through different Access Objects. Access Objects include tables, forms, graphs, queries, and reports. Objects that have already been created can be seen by the navigation pane on the left side of the screen. New objects can be created by clicking on the create tab at the top of the screen.

TABLES

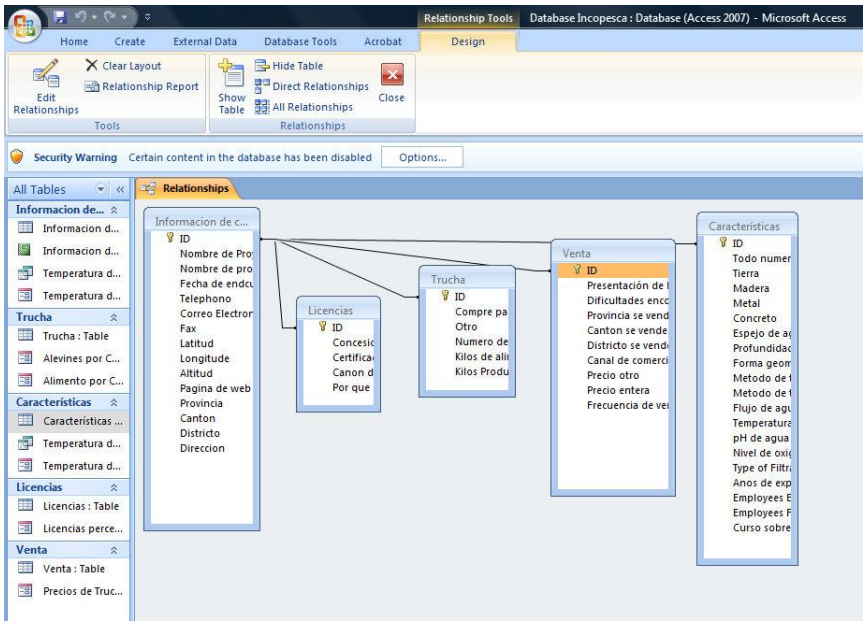
The database is separated into five tables. Tables are used to store all the information in the database and most commonly shown in spreadsheet form, see Figure 1. If fields or table properties are being changed, it is easy to change the table into design form. The five tables used in this database are titled Informacion de contacto, Trucha, Venta, Caracteristicas and Licencias and can be found in the navigation bar on the left side of the screen.

Figure 7: Table of Contact Information



Each table is connected to Informacion de contacto through a relationship between the ID numbers. The ID number for each of the tables is the primary key and will be unique for each record. This number is solely for organizational purposes and does not have any ranking or connections to the farms themselves. See Figure 2 for a diagram of the tables and their relationships.

Figure 8: Diagram of Relationships

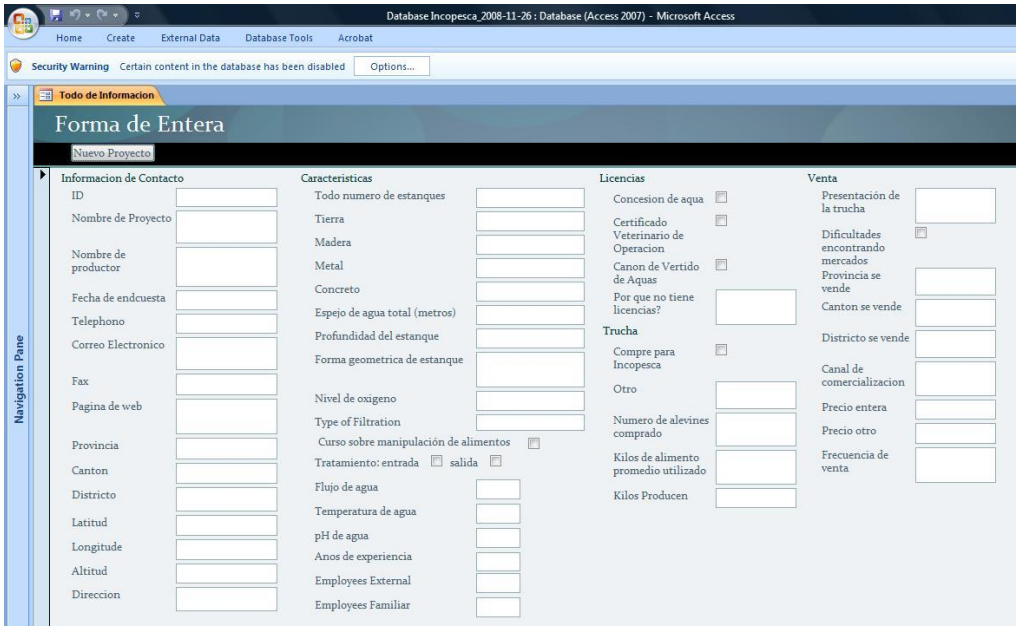


To add information to the tables information can be directly added while in spreadsheet view but also ban be entered using Forma de Entera, a form. See section on Forms for more information about Forma de Entera.

FORMS

Forms can be used to display information in the database. The two types of forms used in this database are pivot graphs and an entry form. Pivot graphs will be explained in the next section. The entry form is used to display all the information about one farm on one page and can be used to update the information about the farm. All information that is changed in the form will change the information in the table the field is connected to. This form can also be used to add information about a new farm into the database. This can be done by clicking the "Nuevo Proyecto" button at the top of the form. A sheet with blank fields will be shown and the user can add the respectable data to the fields. See Figure 3 for a picture of the blank entry form.

Figure 9: Entry Form



GRAPHS

Pivot graph is a type of form that allows the user to see select information from the tables and view in a visual format. Graphs are helpful when looking for relationships and trends in information. This database has five graphs but can be added to as needed. The graphs that are included are scatter plots and pie charts. The scatter plots that are include show the relationship with the amount of alimentos bought by the farmers and the final kilograms of trout produced and the alivenes bought and the final kilograms of trout produced. The pie chart included shows the percent of farms that

QUERIES

Query is a type of search in Microsoft Access that takes information from different tables and creates a new table to show the selected information. One use for queries is a base for reports and forms when information is needed from different tables. Another use for queries is to see information from different tables in one table. A query was formed in this database to show all five tables together. It allows for any type of form or report to be made from a master spreadsheet.

REPORTS

The report that is included with this database is a list of all the contact information of trout farmers in the database. The report will update automatically as new farmers are added to the database or information is changed. It can also be printed on its own so that a list of contact information can be given to INCOPESCA personnel as needed.

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