Sustainable Schemes For Healthy Growth of Colossoma Macropomum and Its Prospective Impact on the Local Economy of Northeastern Peruvian Cities

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***Abstract*—We report the results of the application of a study based on a statistical scheme based on continuous measurement of the properties of the *Colossoma Macropomum* from an initial phase up to the first 5 months, resulting in an optimal quality as seen in their weight, size and conservation of total number of cultivated species at a Peruvian Norteastern city. The methodology have consisted in applying successive measurements on physical properties, such as size, weight, pH and food over the first 20 weeks. All information is incorporated in a statistic framework in order to extract and interpret the most sensitive parameters. The results have shown that the Logarithm shape of fitted histograms would express to some extent the healthy and highly quality of Gamitana fish meat as demanded by human consume and other uses.**

I. Introduction

It is well-known the tremendous impact of fishing activities which were accomplished in South American countries during the last decades, especially at Peru, where fishing extraction and subsequent international commerce was the top economic activity during the 70s [1]. In fact, most of the fishing activity achieved in Peru is performed along the coast in seaport municipalities, but with a minor presence of those from locations along the Amazon basin [2], apparently. Exceptionally, locations and small cities around the large Amazon River and secondary branches are considered as the most close to be potentially places, where Aquaculture of white-like fish species (for instance) constitutes a prospect for local self-sustained growth. However, most of the fishing techniques in Amazon River consist [3][4] in artisan techniques in which are seen far from notable and advanced technologies achieved in coast cities. With the advent of noteworthy technologies that play crucial role in the coast fishing industry, the dynamics of the extraction, processing and market has been successful in various aspects. It is because global markets demand schemes that must activate in a much more profitable manner the fishing commerce through crucial indicators like time, quality and prices [5][6]. The case of study of the Amazon basin turns out to be an interesting scenario in which one can assume that the fishing methodologies achieved over the coast might be transferred to the locations which employs artisan techniques probed to be valid and relatively flourishing along the past decades. A point that should be noted is that of the artisan potential of natives for hunting, extraction and processing of white-like fish and similar species. We argue that this potential that keeps still techniques since past epochs might be improved with the support of technologies used in coast fishing industrial activities. Concretely, this expected improvement would be in the enhancement of cultivation, trade, and employment which is evidently beneficial for local natives. So that, one can see from the social-economic angle an important force for local self-sustained development. In this way, this paper present a scheme to study the prospective development of local cities adjacent to the Amazon River (and secondary branches) through modern techniques of growth of well-known white-like fish species like Gamitana (Colossoma Macropomum) [7][8] by remarking their optimal processing for commerce in local and international markets. In this first phase, we target to establish the natural conditions of environment that conducts to an efficient handling of fry for an appropriate growth under healthy conditions [9]. The scenario of study is the implementation of well designed pounds which are monitored by means of modern methodologies for an efficient fish growing. In this investigation, Gamitana and Paco species appear as the ideal ones for testing the proposed scheme. Both species are also featured for being profitable thereby reaching average values of weight of 1 Kg in 8 months, approximately. Another aspect is related to the international interest of white meat as noted in Asia and European specialized markets. We use methods which allow us to optimize the quantitative indexes related to the possible ways of economic progress. Our research is based in Moyobamba, Peruvian city located in the North West of Lima. This city is bordered by minor Rivers but with substantial caudal containing an interesting Biodiversity which is of great importance for local Aquaculture. Our choice of pounds would encompasses the main objectives of this

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scheme: (i) adequate water for optimal eggs growing, (ii) removing of contaminated agents [11], (iii) precise identification of size-time curve, (iv) white meat extraction and (vi) subsequent commerce. Moyobamba is a 300K people city located in the San Martin department, a tropical rain forest city characterized by having various economic activities. Among the main activities is noted: agriculture, forest, mining, etc. But in a minor level the activity of Aquaculture. This city is enclosed inside a territory plagued by Rivers of various types, being all them ramifications from the Amazon River. One of the most representative specie has been the so-called Paiche of relevant importance for human consume. In Peruvian Amazon cities is said that this specie occupies a preferred place in consumers by displacing the commerce of chicken which is the central ingredient in Peruvian foods.

II. What's done in this Paper?

The so-called Gamitana or *Colossoma Macropomum*[11] is a middle-size fish that lives in large rivers at Peruvian and Brazilian Amazon. This specie have served as main food supplier of habitants of nearest locations to Amazon River. Since a decade ago, Gamitana have been used in Aquaculture activities by targeting to produce a fish meat of highly quality, In addition, literature has reported various strategies to improve the Gamitana meat were performed [12][13]. One point of importance is that of the healthy growing under various conditions of climate and ponds [14][15][16][17]. This specie is featured for being profitable in diverse aspects by thereby reaching average values of weight of 1 Kg in 12 months, approximately. We have achieved successive tests in experimental ponds at Moyobamba city and found various correlations between fish properties which would provide interesting information for cultivation decisions in well-defined ponds. Indeed, the choice of ponds would encompass the main objectives of this study:

- adequate water for optimal juvenile species growing,
- removing of contaminated agents,
- precise identification of size-time curve,
- high white meat extraction and
- subsequent optimal commerce.

The objective of this study is the identification of properties through a statistical analysis which would correlate the observation and measurement of size and weight, essentially. We have found that the Gamitana growth in middle ponds might be fast of order of 5 cm per month under special conditions of feed and care. At the present trials, up to 2 healthy ponds were selected. Water conditions hold standards and were consistently evaluated by external supplier of services required prior to the experimental tests. The juvenile Gamitana have presented an initial average size of 2.5 cm in the very beginning of cultivation, and 28 cm at the end of the first 5 months. Our results have indicated that the permanent monitoring permit us to drive the sens of cultivation and allows us to execute decisions which would improve the quality of cultivation.

A. The Economic Model

We use the following economic model emphasizing these items:

- Identification of the Resources
- Building the Plan of Invest
- Minimizing Cost-Benefit
- Executing the Model
- Self-assessment and validation of the method
- Compare before and after
- Analyze the prospects of self-developing

III. Methodology

The present study have paid attention on quantitative information such as size and weight of fishes, instead of chemical information. We target to understand and calculate the effective measurements during a tie of 150 days or 5 months. In addition, pH measurement is also applied to a minor extent. The place of study is the middle-size ponds located at Moyobamba city. Each one is of around 1500 square meters, and exposed to free air. For simplicity ends, this study have selected two adjacent ponds labeled by 11 and 12. This ones were prepared under the condition of having Nitrogen, Potassium and Phosphor around of 5o Kg per 1000 m^2. The ponds have been checked in

- water,
- chemical standards,
- phytoplankton standard,
- pH, and
- Oxygen.

We have used young fry with the following information: size 2.5 cm and 5 gr. The initial amount yielded to the ponds 1450 juvenile Gamitanas (pond 11) and 1525 (pond 12) on July 5th. From July to August, the average temperature of 28 degrees was measured. The ponds water composition turned out to be not sensitive to local precipitations (2mm). The feeding of juvenile Gamitanas were given in according to well-established schedule consisting in a diet-based portion of 50% and 15% biomass [12][13][14]. In addition, Oxygen and temperature measurements were performed daily. The sample procedure have opted by selecting in a random manner the juvenile Gamitanas. Only 50 units were spatially and aleatory selected. These actions have required the participation of young natives which have provided their artisan techniques to collect Gamitanas. The measurement by single observation and weighting by using a digit balance have allowed to join data $in-situ$. It has not required to attain systematics errors which would produce substantial changes on data [13][14][15].

IV. Statistical Results

In Fig. 1 is shown the histogram corresponding to the collected data from experimental pond labeled by 11. Length versus It is quite evident the displacement of the histogram peak moving from its value of 10 cm at the first month up to 28 cm for the fifth one (December). One can calculate the 'peak velocity' yielding a value of 5cm/month. On right

side, the same for pond 12 are plotted in Fig.2. However, in contrast to pond 11, the data exhibit much more nonlinearity [16][17]. Although these nonlinearities can be translated in terms of observation error, the trials have found evidence of asymmetric growth of Spirogyra of up to 1Kg/m^2, which would play the role of extra system acquiring and taking oxygen from water and producing oxides that are undesirable ions to fish metabolism. Fig.3 displays a sustainable evidence of the growth of babies Gamitana from 1.5cm that is the initial length to 15cm for 33 days of nurture.

V. Data Fitting

In Fig. 4 curves of size and weight for 5 months combined data (ponds 11 and 12) are displayed. These curves are superimposed to the histograms for 5 month of data taking and with the mean values on each month. It is interesting that the data in Top fitting obey to a polynomial trajectory without pronounced fluctuations neither strong nonlinearities. In effect, it leads to propose a log fitting with a 3-parameter adjusted to data as seen in the bottom panel. As result the fitting was adjusted to a logarithm distribution which follows quite closely to data and the fitting errors were small than 0.1%. In Fig. 4 bottom panel the log distribution appears to be stable with a slow growth from the 5th month. It actually warns that the Gamitana specie might be ready to be prepared for commerce ends.

The resulting data is adjusted to a log distribution given by the curve written as

$$g(t) = \sum_{k=\text{MONTHS}}^{5} \left[\text{Log}\{a_k + b_k t + c_k t^2\}\right] \qquad (1)$$

	a_1	b_1	c_1	a_2	b_2	c_2
Size	7.3	4.2	0.15	-	-	-
Weight	-	-	-	51.3	-36.9	25.2

VI. Estimation of the Efficiency Parameter

From data results it is now feasible to propose an efficiency parameter which would gives account of the optimization procedures along the first 5 months of cultivation. To this end we use the fitting coefficients to be inserted in the following relationship below

$$\text{Eff} = \frac{1 - \frac{c_k}{\bar{c}}}{1 - \rho\bar{c}} \qquad (2)$$

where $\bar{c}$ is the average of the fitting parameters Fig.5 which turns out to be the most sensitive, ρ a free parameters which incorporates the size and weight synchronization (size and weight should be measured at the same time) measurements, and c_k the fitting parameter. For the present work, an efficiency of 85% have been obtained. It means that the optimal conditions for fitting procedure, as well as a coherence between optimal growth of Gamitana and must be reflected in the meat quality for human consumption [16].

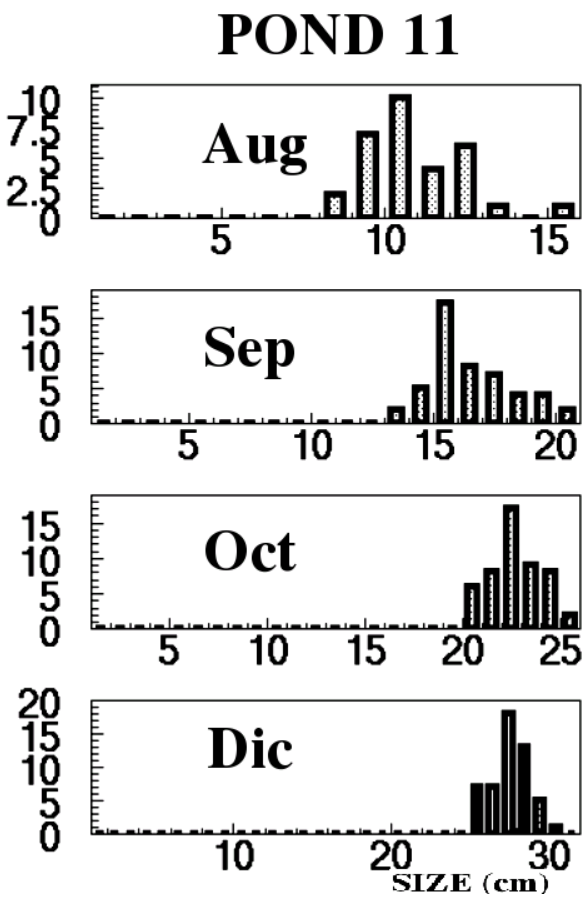

Fig. 1. Resulting histogram of measurement on ponds 11 showing peaks for 10 cm for the first month of tests.

VII. Conclusion

In this paper we have studied the prospects of local development through as to extract, process and market the end-products based on white-like fish and related species. We have focused our study in areas near to Moyobamba city. Noteworthy potential in artisan fish extraction has been identified in small-population zones, fact which might be engaged to a production and commerce chain targeting to have a noted presence in local and external markets. Concretely, the goal of this experience was to transfer the know-how from the technological side to the artisan activities in a systematic way. This transfer has been experienced in the obtained efficiency of the whole procedure as seen in the 85%. Whereas studies at the past have consisted in to implement external methodologies which turns out to be intractable for local people, this study tries to fusion those well-known industrial strategies for fish processing together with the local techniques that contemplates most dedication for artisan processing. We paid attention to the local development manifested in the implementation of modern techniques already used in coast fish industrial facilities to the local actors. We focus in a few known species which fits well with the curve of size-time approximately. The expected results are enclosed in a framework of methods for

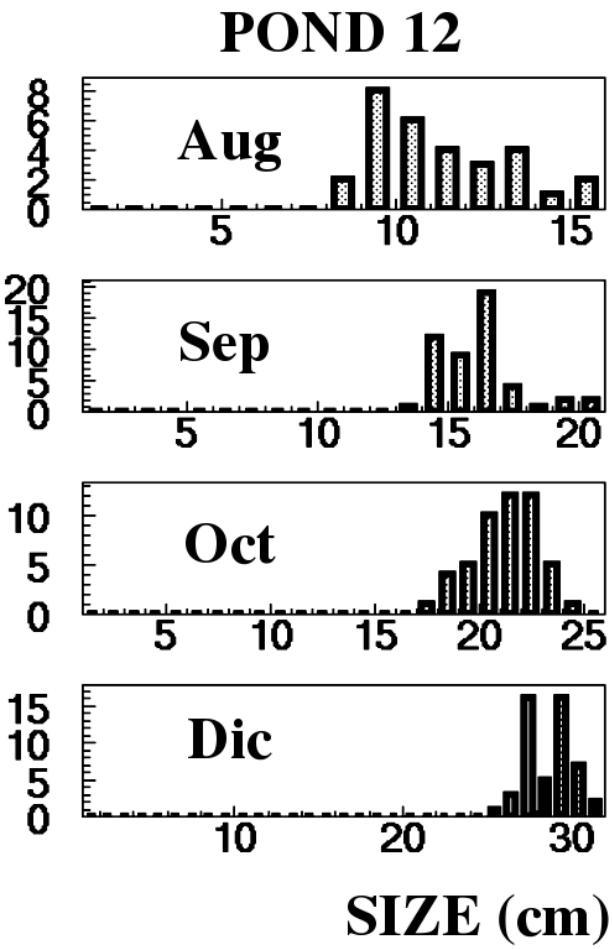

Fig. 2. Resulting histogram of measurement on ponds 12 in according to the histogram of pond 11.

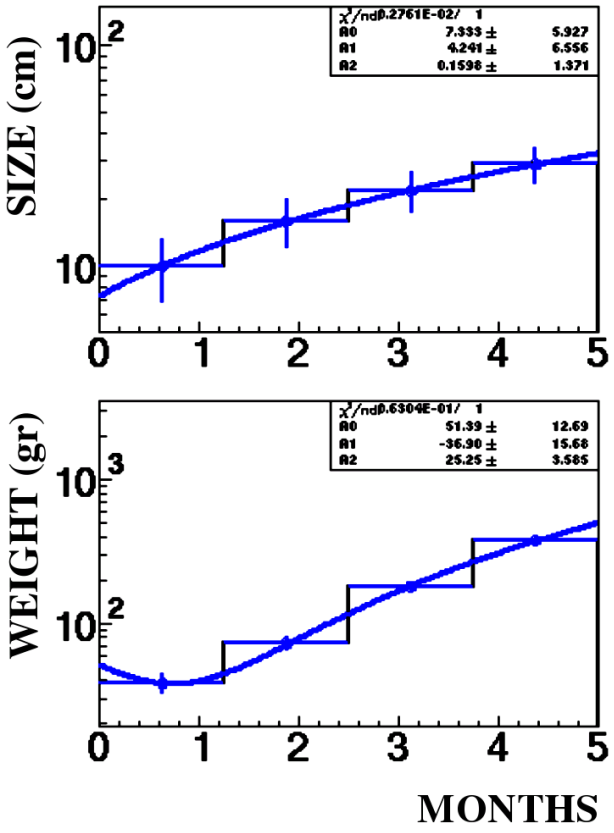

Fig. 4. Polynomial and Logarithm distributions of size and weight for Gamitana species during a time of 5 months. Top panel: The effective growth is seen as a polynomial distribution and satisfying a quadratic polynomial. Bottom panel: the curve of weight displays a logarithm growth by expecting a further increasing in weight. In both cases the n.d.f number of the degree of freedom of the fitting is negligible.

Fig. 3. Evidence of the sustainable growth of Gamitana. For this example is shown the fast growth equivalent to more than 10cm or 33 days of surveillance.

improving the self-sustained local economy by which has been the objective of this study. We reached an interesting size-time curve for the case of the colossoma Macropomum or known also as Gamitana. In fact the prospective study for a high-quality of Gamitana growth at normal conditions of water and climate at North-Eastern city of Peru, was presented. Basically, the analysis have been of statistical character were the data has been adjusted to a logarithm distribution and a small fitting error. The data clearly have adjusted to a continuous distribution without disturbs and fluctuations. It certainly demonstrates that the size and weight would increase efficiently, fact which would reflect on the meat quality and chemical composition. Thus, our main conclusion is that the well-pronounced soft continuous growing of size and weight fish by following a log behavior, becomes analog to speak of a high-quality fish growing. We claim that any negative element which would stop the normal increasing of size would reflect on the possible changes of the chemical composition of fish, therefore their statistics might be nonlinear. Clearly this methodology would provide alternatively a advantageous

scheme for a sustainable growth of river's fishes [17] as part of the local economic growth in the region.

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