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9. ABSTRACT  
 This trip report of a three-week visit to Brazil, Panama, El Salvador, and Guatemala describes the state-of-the-art of Latin American fisheries. Part I contains recommendations for A.I.D. Part II discusses the Brazilian situation, and Part III presents the situation in Central America. Recommendations for fishculture in Brazil include making a socioeconomic assessment of consumer acceptance of various fish species and of differing processing requirements, and assessing the need for more extension personnel to work with fish farmers on pond site selection, management, fish harvesting, and marketing. Also recommends continuity in funding to maintain the highly qualified personnel needed to allow the excellent research station at Pentecoste to reach its potential. The report recommends that in Central America, the consumer demand for fish be determined and the USAID-Auburn-Peace Corps-Government of El Salvador model for disseminating information on fishculture be expanded. Part II describes the station and focus of research at Pentecoste, Brazilian fish production and extension programs, and the need to expand the extent of fishculture training programs for Brazilians and for other Latin American countries. Topics treated in the section on Central America include consumer acceptance of fish as a protein source, descriptions of research stations, and the possibility of developing fish cooperatives and/or extension programs. The Appendix contains lists of persons contacted and bibliographic references.

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THE ROLE OF FISHERIES - AQUACULTURE  
IN LATIN AMERICA

1975

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The major purpose of the trip being reported here was to gain some insight into the state-of-the-art of Latin American fisheries development to assist in the formulation of policy and program priorities for AID. Orientation prior to the trip indicated the necessity of considering increased emphasis on country, regional, and international exchange of the latest technologies.

This could hopefully preclude repetitive research in various countries, and could greatly reduce the time span from basic research into applied/adaptive research. Additionally, it seems likely that there is much to gain in the areas of extension, fish processing, and marketing.

To accomplish this, and to better understand problems being encountered, country interest and support, and AID mission interest and support, three weeks were spent in Brazil and in three Central American countries (Panama, El Salvador, and Guatemala). This report covers that trip, articulating our impressions, and expressing our recommendations. In Part I, we have summarized those recommendations. In Part II we discuss the Brazilian situation, while in Part III we discuss the situation in Central America.

The Appendix to Parts II and III appears at the end of the report and contains lists of persons contacted, and appropriate bibliographic references.

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Mr. Lin was a fisheries consultant to AID who passed away shortly after the trip to Latin America.

## I. SUMMARY AND RECOMMENDATIONS

The summary and recommendations will be divided into two sections the first dealing with Brazil, and the second dealing with Central America.

### Brazil

The Brazilian government has an impressive program in Northeast Brazil for building small reservoirs, and the research station at Pentecoste may soon be the finest fishculture facility in the Southern Hemisphere, if not the world.

However, there is little scientific information regarding the nature and extent of consumer demand for various fish species that might be produced in Brazil--or in the Northeast for that matter. A thorough socioeconomic assessment is required in the area of consumer acceptance (preference) of various fish species, their willingness to pay for various fish species, alternative product distribution systems, and differing processing requirements.

In the area of fish production, expanded work is called for in the establishment and management of hatcheries, in induced propagation, in fingerling supply and distribution systems, in the discovery of new species for domestication, and in the training of fish production personnel.

Moving from research to extension, there is a critical need for additional extension personnel in Northeast Brazil to work with farmers regarding pond site selection based on availability of high quality water from natural sources, pond construction and management, juvenile stocks, delivery systems to reach the small farmer, fish production, fish harvesting, handling, processing, and marketing. Additionally, there is a need for extension work with consumers and fishermen's wives regarding recipes, fish selection, storage, processing, and preparation.

The uniquely excellent facilities at Pentecoste imply that the station could become a world center for research and training in tropical aquaculture. The Brazilian government has made a substantial commitment for physical facilities and the limiting factor is now the lack of adequate personnel to manage various aspects of the research/extension programs.

Finally, the year-to-year funding of the Pentecoste facility creates planning problems that jeopardize continuity for high quality research, maintenance of highly qualified personnel, and the general commitment to efficient and effective operation of the station. We cannot over-emphasize our belief that this situation should be remedied.

### Central America

The opportunities and problems in Central America are rather different from those in Brazil. In the area of consumer demand, it would seem appropriate to attempt to ascertain demand for fish in coastal areas where brackish water and fresh water fish might become more readily available. A second area of concern would be the demand for fish in inland areas where coastal fish are less likely to be a factor.

The Santa Cruz Porrillo research station in El Salvador is likely the only place with good chances for a viable long-term research program and we would urge that its program receive continued, if not larger, support. Much work remains in the areas of polyculture, species selection, fingerling supply, and distribution systems.

The optimal mix between research and extension is, however, more difficult to specify. The nature of the extension program in El Salvador (not the scope) impressed us very much; the USAID--Auburn--Peace Corps--Government of El Salvador is an impressive model and one which we believe should be expanded. The potential for disseminating information on fish production to individual farmers, as well as entire communities, is great and would comprise an essential ingredient in an expanded fish culture program in Central America. This is not to say that research should be neglected, since an extension program cannot operate in the absence of sound scientific information. However, abstract arguments over percentages of funds devoted to each activity do little to resolve the important resource allocation problem. More will be said on this later in the report.

## II. BRAZIL

In 1966, at the request of the Brazilian Government, the U.S. Bureau of Commercial Fisheries and USAID assigned a team of fish culturists from Auburn University to make a general survey of inland fishery resources in that country. The primary objective was to assess the potential for fish culture development as a source of low-cost protein primarily in North-eastern Brazil. One of the principal recommendations of the team called for the establishment of an aquacultural research center in the Northeast, with the primary objective of conducting limnological and fisheries investigations based upon the many reservoirs (acudes) being built in the area by the Brazilian. Departamento Nacional de Obras Contra as Secas (DNOCS) -- the "National Department for Works Against the Droughts." Not only was better reservoir management for fisheries of importance, but it was also vital to learn more about utilization of the lands below the reservoirs for small-pond construction and fish production.

Following these recommendations, an aquacultural research center was constructed at Pentecoste (90 km west of Fortaleza, Ceara) on DNOCS land. The location is excellent for fish culture research, and the site now includes laboratories, experimental ponds, and demonstration ponds, and there is room for more of the above, plus classrooms and dormitories. Most importantly, there is an adequate supply of good water.

During the 1970-72 period, W.D. Davies of Auburn University worked in Brazil to advise and train Brazilian fisheries biologists in limnological and biological studies of the reservoirs. This work included fish production studies of the important public reservoirs, studies of the types of gear utilized by the fishermen, and a description of the marketing system employed at that time.

At the present time, the Pentecoste Station consists of an office and laboratory building, a number of concrete holding tanks for fish handling, four ½ hectare ponds, 40 ponds of approximately 400 m<sup>2</sup> in size, 9 ponds of approximately 1000 m<sup>2</sup> in size, and 20 ponds of 400 m<sup>2</sup> in size which have yet to receive water. The Brazilian Government is expected to commit an additional \$1.1 million to improve the Pentecoste Station and to expand the research and teaching facilities. In all probability, it will then be one of the finest fish research centers in the world.

The research at Pentecoste has focused upon the possible domestication of species such as: apari (Astronotus ocellatus), curimata comum (Prochilodus scarensis), curimata pacu (P. argenteus), tilapia (Tilapia rendalli, T. hornorum, T. nilotica), traira (Hoplias malabaricus), escada (Plagioscion squamosissimus), tucunare (Cichla temensis and C. ocellaris), mandube (Aegoniosus brevifilis), surbubim (Pseudoplatystoma sp.), tambaqui (Myletes bidens), pirapitinga (Mylossoma sp.), grass carp (Ctenopharyngodon idella), and silver carp (Hypophthalmichthys molitrix). Among these species, the curimatas have been propagated in captivity with hormone injections and fingerlings made available for reservoir and pond stocking. Additionally, a tilapia hybrid of 100 percent males has been successfully produced by

crossing male Tilapia hornorum with female Tilapia nilotica. This culture of hybrids has been successfully tested and demonstrated in ponds: the major drawback being encountered in methods to produce a large quantity of the male hybrids to meet future demands. The potential for domestication of all other species cannot be determined at this time, either because of current inability to induce propagation under captivity, or because of difficulties in collecting eggs and fry from rivers or lakes.

The potential for expanded aquaculture in Northeastern Brazil is considered very good, with the abundance of public and private reservoirs providing an excellent resource base. The DNOCS organization has, over the past 30 years, built 856 reservoirs, 256 of which are public reservoirs, and the balance (600) private. In addition to these, there are about 1000 small reservoirs that have been built by individual farmers. Of the 256 public reservoirs, 104 (representing approximately 150,000 hectares in surface area) are under the direct control of the Director of Fisheries in DNOCS. There is an extensive program of limnological studies of the reservoirs, licensing of the fishermen, recording of the daily catch, and the regulation of the fishing gear employed.

In spite of the excellent research facilities at Pentecoste--and the impressive research results to date--the extension of fish culture practices to individual farmers is minimal at best. At the current time, John W. Jensen of Auburn University is performing extension work--along with a Brazilian counterpart--but his contract is due to expire June 1975 and he will return to Auburn. The DNOCS reservoirs are designed and operated to serve several purposes: (1) hydroelectric power; (2) irrigation; and (3) fish production. Both research and extension work is needed to assist in managing reservoirs so as to minimize conflicts in use. The combined reservoir surface area in the Northeast is estimated at over 1 million square kilometers and represents--under the right management strategies--a significant potential for production of high quality protein.

In discussions with Brazilian researchers and Dr. Leonard Lovshin (Auburn University, Chief of Party), it was learned that the total 1973 catch from 97 public reservoirs (total surface area of approximately 150,000 hectares) was 10,250 metric tons worth 17.3 million Cruzeiros (\$2.47 million). Additionally, some fish were consumed by the fishermen and their families and the value of this consumption is not included in the above figure (nor is the quantity included). Data from Davies (1972) on production from four reservoirs is presented below. It is to be expected that production per hectare could average approximately 500 kg/ha for most reservoirs less than 1000 ha in size, and hence current production figures are much below potential production.

Catch from four reservoirs in Northeast Brazil for 1965-1968.

Reservoir	Area hectare	Yield (catch) kg hectare			
		1965	1966	1967	1968
Araras	9,625	260	236	144	114
Pereira de Miranda	5,024	110	73	54	92
Lima Campaz	1,514	54	59	86	87
Forquilha	987	84	59	52	71

Source: Davies (1972)

In the above reservoirs, the most dominant species caught are apaiari, tucunare, pescada, piau verdadeiro (Leporinus sp.), piau comum (L.friderici), traíra, curimata comum, and curimata pacu. If predator fish such as tucunare, traíra, and pescada were absent, production of the frseh-water shrimp (Macrobrachium amazonica) could increase markedly.

The only good example of intensive pond culture we observed in Brazil was that of Sr. Edman Pereira 30km south of Fortaleza. There, a demonstration pond of 8,000 m<sup>2</sup> produced tilapia hybrids. It is a successful operation in that the pond was initially stocked with 8,000 hybrid fingerlings at the rate of 10-15 grams equivalent per 10,000 hectares, and now produces 350-600 grams of Tilapia every 9-10 months--a rate of over 5000 kg/ha/year.

The gross sale value of 5000 kg. of tilapia would be approximately 20-25,000 Cruzeiros (\$2,860-3,570). Although Sr. Pereira utilizes organic and inorganic fertilizer--at a substantial cash cost--the pond produces 4,000 Cruzeiros profit (\$571) annually. John Jensen (1974) reports that in the lower São Francisco Valley of Northeastern Brazil, 10 farmers have diversified from straight rice production to fish farming. Since 1965, four ponds of 22 hectares each have been studied and show an average net profit of Cr. 2,466/ha/year from a production of 674 kg/ha every 19 months.

In addition to the meetings in Fortaleza and Brazilia, we also met with several representatives of the Brazilian agency for national fisheries development (SUDEPE), and with the Fisheries Research and Development Division of the UN's Food and Agriculture Organization in Rio de Janeiro. These meetings were helpful in gaining a better understanding of both coastal and inland fisheries in Brazil, as well as learning of general fisheries research at SUDEPE's Pirasononga and Natal stations.

Turning now to problems and possible actions for Brazil, it is important to acknowledge the very considerable success of the fish research work carried out at Pentecoste; Auburn University can take pride in past and current accomplishments. This work has made a significant impression on the Government of Brazil, and must receive credit as a major factor in the decision to allocate \$1.1 million to expand the facilities at Pentecoste, as well as the willingness to make a commitment to fishculture research extension and training.

However, serious problems remain that require resolution. AID's declared interest in the provision of high-quality low-cost protein for persons in the LDC's means that the agency is at a critical period for choices regarding aquaculture. It is our judgement that if aquaculture is to be seriously considered as an alternative food source then several steps are called for immediately. And, if there is to be a special concern with the Latin American situation (as distinct from the Far East and Africa where the problems differ), then Brazil (Pentecoste) is the logical place to concentrate the agency's attention. The following discussion will highlight the problems and choices under three categories: (1) consumer acceptability of fish and fish products; (2) production aspects; and (3) extension programs.

#### Consumer Acceptability

Unlike the situation in Asia, fish has never constituted a significant part of the Latin diet. As a result, any program which makes significant commitments to increased production without first determining the likely demand for that incremental output is ill advised; supply has never created its own demand and will not do so in the case of aquacultural products. And merely because current production easily clears the market implies nothing about the likely response to subsequent fish production.

Thus we would recommend that two types of assessments be carried out in Brazil. The first pertains to general analyses of the demand for both fresh and brackish water species. Here, concern is with comparative markets in coastal versus inland towns, and work would focus on the geographic extent of fresh fish markets. The second would relate more closely to the research and training work at Pentecoste and would focus specific attention on the unique spatial production potential in the Northeast and the implications for product distribution and consumer acceptance. In both instances, work is needed on all aspects of product distribution, processing, and consumer demand.

#### Production Aspects

The problems of current production aspects can be grouped into ten general areas: (1) selection, development, and containment of brood stocks by species; (2) induced spawning and other accelerated propagation methods; (3) production methods and pond site selection based on environmental attributes and local economic conditions; (4) pond construction and management; (5) hatchery development and management; (6) economic production of fingerling and juvenile stock supply for distribution; (7) fingerling and juvenile stock distribution systems keyed to local situations; (8) production methods--



monoculture, polyculture, feeding, fish health, and harvesting; (9) fish processing; and (10) fish marketing.

The Amazon River represents one of the most diverse ecosystems in the world and it constitutes a valuable resource for new fish species. To facilitate the systematic search for new domesticable species efforts must be made to organize means to collect eggs and fry from the River. The Brazilian Government may take the lead in such a program but organizations such as FAO and AID could provide valuable financial assistance.

Early work on induced propagation was conducted in Brazil and some emphasis is currently devoted to this area at the Pentecoste station. This work is important and should continue.

Regarding hatcheries, the nearby Amanari facility suffers from questionable management practices and high priority should be given to the assignment of a highly qualified fish culturist to the station.

The principal obstacle to increased aquaculture in Northeast Brazil is the absence of satisfactory species for stocking ponds for commercial production; with tilapia the problem is one of inadequate numbers of fingerlings.

The primitive method of trapping fry from river flood water is inefficient, and is impossible throughout the vast majority of the country. The induced propagation of curimata is only partially helpful in this regard, largely due to the extremely slow rate of growth. The growth rate of tambaqui and pirapitinga is quite satisfactory, particularly with supplemental feeding. However, little is known of these latter two species and their suitability for intensive culturing.

As indicated earlier, the most promising fingerling for stocking is the male tilapia hybrid. The species is fast growing, particularly with supplemental feeding, and finds general consumer acceptability. However, to provide sufficient fingerlings for only 3 hectares of commercial ponds would require approximately 30,000 male hybrids annually. Under current techniques this would require a spawning pond of 400 m<sup>2</sup> in size. Estimates vary but 50,000 hectares of commercial ponds would require approximately 16,000 spawning ponds of 400 m<sup>2</sup> in size to produce 500 million hybrid offspring annually. Additionally, there would have to be approximately 1,500 small ponds available for keeping pure stocks of T. hornorum and T. nilotica. This attests to the significant role of efficient hatcheries.

#### Extension Programs

It is possible to divide this area into two components: (1) the training of aquaculturalists to broaden the base of scientifically trained personnel; and (2) extension programs to reach potential producers and consumers.

One of the principal objectives of USAID assistance to Brazil in fishculture is to train Brazilians. It is our understanding that the agreement with Auburn University has been transferred from the USAID Mission in Brazilia to the Technical Assistance Bureau in Washington. It is also our understanding that this contract is now extended for annual increments. The uncertainties imposed on a research/training operation from funding that only extends one year at a time are too obvious to warrant further discussion but that situation--in our view--is most serious.

More substantively, the training programs of the past (which provided scholarships to Brazilians for study in the U.S.) have enhanced the very technical knowledge of the Brazilians, but they have also created a "gap" in the indigenous fisheries personnel. That is, those with high technical skills have all moved up rapidly to position of administrative responsibility, leaving few individuals with practical fisheries knowledge to perform much of the more routine work. Moreover, those with the advanced skills have little time to apply what practical knowledge they may possess. This is particularly crucial when it is realized that much of the thrust in Brazil should now be directed towards the fish farmer--whether small farmer or commercial operator.

In this regard, there is a very real need to expand the extent of the fishculture training program for Brazilians, but also for other Latins. This would have two components. The first would consist of training at fish research centers outside of South America. The second would be a program to bring Brazilians and other Latins to the Pentecoste station for applied study and training. With the University of Ceará located in Fortaleza, it seems even more likely that a comprehensive program in fishculture could be developed. It is our understanding that some effort has been undertaken to establish an academic program in fishculture in the Northeast and we support further exploration of that possibility. The careful integration of that curriculum with the traditional agricultural sciences would be a significant step towards improving the food production potential of the Northeast--as well as the rest of Latin America.

The extension aspect of the fishculture program in the Northeast is extremely limited (2 persons) and when John Jensen leaves in June of 1975 there will be only one person (Jensen's Brazilian counterpart) to carry on that work. Additionally, the Pentecoste facility could be improved to better serve extension needs.

Considering first the off-site extension activities, it is clear that the current two-man team is entirely inadequate for dealing with fishculture in the Northeast. Production techniques, harvesting, distribution, and marketing are all areas that require more extension assistance for existing ponds and reservoirs. Added to this is the opportunity to work with farmers and DNOCS on the design and construction of additional ponds. It is our recommendation that USAID seriously consider expanding the fishculture

extension program based upon the Pentecoste work.

In addition to extension programs on the production side, there is a real need for extension assistance in the general area of fish purchasing, processing-preservation, storing and preparation (recipes). Mrs. Sue Jensen is currently working on an extension publication aimed at the low-income Brazilian housewife. In a nation where fish are a minor part of the diet, it is important that information be disseminated regarding consumption of the product. This is a crucial area and one that we believe should be expanded.

Regarding on-site extension activities, the apparent commitment of the Brazilian government to improve the Pentecoste station will include provisions for classrooms, living space, and demonstration ponds. All are vital to a successful program of showing and teaching farmers about fishculture. However, it is the financing of individuals to spend several weeks at Pentecoste that might constitute the most significant barrier to an effective on-site training and extension program. Equally important is the fact that such a program would surely compete for the staff time of those at Pentecoste. In this regard, the various international development agencies could play a significant role in supplemental funding for personnel at the Pentecoste station. With the Brazilian government committed to improving the facilities at Pentecoste, personnel becomes the limiting factor.

#### Summary

With the excellent hatchery facilities at Amanari, with the excellent fish research facilities at Pentecoste, and with the intent of the Brazilian government to spend an additional \$1.15 million to improve the Pentecoste station, it is apparent that Fortaleza lies at the center of what will likely become the finest fishculture facilities in South America, if not the entire world. It is our view that the potential exists--along with the general interest of the Brazilian government--for making this complex the center of fishculture research/training/extension for all of South America. Indeed we would urge that it be so considered.

As indicated above, two factors are necessary. The first is that the current yearly funding commitment be altered to provide scientists and the Brazilian government some reasonable assurance of longevity. The way for this alteration has been initiated by a transfer from Mission to TAB funding but some greater degree of certainty is required.

In addition, we have already spoken to the personnel needs and will only briefly repeat that argument here. There is a serious need for extension personnel to work on both the production side, and on the consumption (product) side. There is a need for a thorough assessment of the demand situation for fish and fish products in Northeastern Brazil (but also for the rest of the country). Finally, there is a need for a first-rate fish-hatchery expert to work both at Amanari and at the expanded Pentecoste facility. We resist the temptation to specify the number of extension persons needed, but believe that it would take more than 4 (plus 4 Brazilian counterparts) to make much progress.

### III. CENTRAL AMERICA

Because of the significance of coastal zone fisheries in Central America, the aquacultural potential takes on a different character than for much of South America. Here, the situation in each of the three countries visited-- El Salvador, Panama, and Guatemala--will be discussed.

#### El Salvador

Inland fisheries and aquaculture development programs were initiated in 1958 when, at the request of the Government of El Salvador, FAO assigned S.Y. Lin to make a general survey of the inland fishery resources. Out of that assessment a fishculture station was established at Santa Cruz Porrillo. For the period following establishment of the station through 1962, Lin and his counterparts--Carlos Alberto Fuentes and Hector Henrique Hinds--tested a number of fresh-water fishes for domestication. Among those species tested were: common carp (Cyprinus carpio), blue gill (Lepomis macrochirus), mojarra arul (C. guttulatum) and tilapia (Tilapia mossombica; T. nilotica; and T. melanopleura).

Following 1972, not much progress was achieved in fishculture research but the extension program continued and resulted in the building of many farm ponds which were stocked with fingerlings from the Santa Cruz Porrillo station.

In 1970 the Government of El Salvador sought advice on their marine and fresh-water fisheries programs. Out of those deliberations, a joint USAID/Auburn University program was initiated consisting of Peace Corps Volunteers and Auburn specialists working in concert with the Government, specifically with the Director of Renewable Natural Resources in the Ministry of Agriculture.

An assessment of Salvadorean fishculture potential by Jensen (1972) showed that the bulk of farm ponds were quite small. Of the 397 ponds surveyed, 75 percent were less than 1000 m<sup>2</sup> in size, and 40 percent were between 100 and 499 m<sup>2</sup>; only 2 percent were in the 1-2 hectare size category. It was estimated that there were approximately 400-500 fish ponds in El Salvador with a total surface area of approximately 54 hectares.

Jensen concluded that there is a good potential for expanded fishculture in El Salvador, with a potential harvest of 10,000 kg/ha/year with supplemental feeding. Water supply is adequate throughout much of the country, and water quality is good. Various species of tilapia appear promising and the industrious Salvadoreans should have little trouble in enhancing the fish-culture situation.

Turning briefly to coastal fisheries, in 1960 there were 14 firms operating 53 shrimp boats out of El Salvador ports; by 1973 that had changed to 12 firms operating 69 boats. Over that same period, total catch increased

from 7,807,000 pounds to 8,353,000 pounds. Estimates vary but it seems safe to state that the average landing of shrimp for a shrimp boat may contain as much as 60-80 percent "incidental catch" (non-shrimp). These various classes of fish are sometimes picked through and the top several classes brought back to port as the shrimp boat gets ready to return to off-load its shrimp catch. The bulk of this retained incidental catch is offered for sale at the ports (El Union, Triunfo) and a small fraction is trucked to markets in San Salvador.

Finding ways to retain a larger share of this incidental catch would greatly augment the fresh fish supply situation and could prove effective in providing protein for urban residents. The Canadian International Development Association is currently assisting the Government of El Salvador in processing these fish species, and the bulk of the product is used in fattening cattle. The possibility also exists for production of processed fish for human consumption, and various types of animal food.

By way of recommendations, it will be useful to deal first with ocean fisheries and then inland fisheries.

Coastal Zone Fisheries. The waste incurred when the incidental catch is thrown back represents a significant source of protein for a nation where protein deficiency is a considerable problem. And, the feeding of fish meal to cattle represents yet a further loss of badly needed protein. It is recommended that an analysis of the potential for expanded retention of the incidental catch be undertaken to assess the consumer acceptance of various fish and fish products. Also, the required product distribution system is of vital importance and should be thoroughly assessed. Because a sizeable incidental catch is a common characteristic among Central American shrimpers we would urge that an organization such as ROCAP play a leadership role in such an assessment.

Inland Fisheries. The Government of El Salvador is enthusiastic about the inland fisheries project, and has budgeted approximately \$160,000 for 1974. Additionally, the President of El Salvador maintains a special fisheries fund that is used at his discretion to build community ponds at certain locations in the country. To date, eleven ponds have been constructed, with two of them approximately 15,000 m<sup>2</sup> each.

Research at Santa Cruz Porrillo is currently directed towards: (1) production of 100 percent male tilapia hybrids; (2) pond fertilization; (3) feeding with various material including coffee pulp; (4) understanding different systems of polyculture--especially tilapia hybrids with grey mullet, mojarra, and guapote; and (5) the study of propagation of fresh-water shrimp (Macrobrachium tenellum). This work should continue and it seems appropriate that some of this research might be funded out of the Technical Assistance Bureau of AID/Washington.

At the present time David Hughes of Auburn University works with the Director of Fisheries as an extension fisheries biologist; his time is divided between: (1) extension work with farmers and communities in matters of pond management, cooperative organization, fish production, harvesting, and marketing; and (2) research work at Santa Cruz Porrillo. He estimates that 75 percent of his time is devoted to the first category, with the balance devoted to research.

It is our judgement--and that of everyone we talked with in El Salvador --that much greater emphasis should be placed on the extension aspects of fish culture. The several Peace Corps Volunteers dealing with fishculture are doing excellent work and would greatly benefit from additional extension expertise in fishculture. The large number of small farm ponds comprises a valuable national resource, but in the absence of proper management their continued production is problematical.

A successful fishculture program in El Salvador (as well as in the rest of Central America) will depend upon how several important constraints are confronted. The first pertains to the actual growth and reproduction of fish. All of the tilapia species reproduce in ponds at such a rate that the ponds become dominated by small fishes with little if any market value. The solution to this is the discovery of fast-growing species that do not reproduce in ponds.

Secondly it is necessary to develop better pure phytoplankton and zooplankton feeders, as well as aquatic weed feeders for polyculture in tropical ponds.

Both of these research areas are under study at Santa Cruz Porrillo and it is important that this work continue.

Another problem area concerns more effective ways to disseminate knowledge to present and potential fish farmers. In this regard, demonstration ponds, short courses at Santa Cruz Porrillo, and extension meetings near actual ponds are vital to a successful national fishculture program.

Finally, the use of chemicals in conventional agriculture along the coastal plain poses a serious pollution problem and threatens the development of a viable aquaculture in those areas. Such conflicts must be carefully considered by the Government of El Salvador such that limited resources are used in the wisest possible way.

#### Panama

As a result of a survey of inland fisheries in Panama conducted in 1970, an aquacultural research station was added to the program of the National Institute of Agriculture's school at Divisa, Province of Veragua, Panama. At the present time there are 33 experimental ponds of approximately 40 m<sup>2</sup> each, and 1 meter deep. There is still a 2-hectare demonstration pond to be

constructed, as well as laboratory facilities, offices, and library. At the present time the National Institute offers training to approximately 200 students in agronomy, horticulture, animal husbandry, and forestry. It is understood that aquaculture will be added to the curriculum in the future.

At the time of our visit, 24 of the 33 earthen ponds were stocked with species such as tucunare (Cichla ocellaris), tilapia (T. mossambica, T. aurea) chogorao-blue acara, and guepote tigre (Cichlasoma managuense).

Problems abound at Divisa with the two most prominent ones being: (1) organization; and (2) water supply. First, the National Institute of Agriculture is directly under the jurisdiction of the Ministry of Agriculture and Livestock, while the new Aquacultural Research Station is under the jurisdiction of the Project of Fishculture of the Director General of Renewable Natural Resources in the Ministry of Agriculture and Livestock.

It is our understanding that there has not been much cooperation between the two entities, a problem which may threaten the success of the research program. Of perhaps greater importance is the problem with both water quantity and water quality. The sole water source is currently that of pumping from a nearby river. The new laboratories will utilize ground-water which is the regular source for the school. Because of mechanical problems, the water supply is intermittent at best, usually requiring reliance upon rainwater.

As for water quality, the supply canal bypasses the farm equipment workshop and serves as a dumping place for oil, grease, and soapy water. Additionally, farm chemicals stored nearby often find their way into this channel. Relating back to the organizational problems mentioned earlier, the fish research staff seems powerless to prevent this.

We found general enthusiasm among Panama and USAID officials regarding fish culture, but did not see the evidence of either a viable research or extension program. The organizational and water supply problems mentioned above are serious and pose a considerable threat to the development of a viable program at Divisa. We are not optimistic about inland fisheries in Panama. The government has plans to build 100 reservoirs in Veragua, Code, and Los Angeles provinces which will be used for irrigation and fish culture. But, without a serious extension effort the aquacultural outlook appears dim at best.

It is our understanding that an \$8 million loan for cooperative development is currently being negotiated between USAID and the government of Panama and some of this might be used to assist in the development of fisheries cooperatives.

Guatemala

The inland fisheries program in Guatemala is quite weak, and seems consistent with the minimal program emphasis on aquaculture. During our brief visit we managed to arrange some meetings with various officials in the office of Renewable Natural Resources where brief discussions were held regarding both inland and coastal fisheries.

The Government of Guatemala is able to maintain three fishculture stations: (1) 18 small ponds at Lake Amatitlan; (2) 8 small ponds at Zacapa; and (3) 10 small ponds at San Jeronimo, Salama. Species cultured are common carp, tilapia, and guapote. The Amatitlan Station is currently utilized by a Chinese technical assistance team from Taiwan for studying grass carp and fresh-water shrimp. There is no active program in fish-culture extension.

A discussion with Don Feister of ROCAP highlighted the problem of incidental catch as mentioned earlier (El Salvador). There are approximately 32 shrimp trawlers operating on the Pacific side of Guatemala, and 10 operating on the Caribbean side. Discussions with Guatemalan officials confirmed the estimates of wasted fish and they explained the operation of a fish processing plant located at Chimparico. The plant will convert trash fish into sausage, fish balls, and small tortillas. The consumer acceptance of these products is not yet known and this factor would merit some analysis.

We were not encouraged by the Guatemalan visit, and are dubious that inland fisheries hold much promise. Neither USAID personnel, nor those we visited in the Guatemalan government did much to alter our pessimism.



APPENDIX A

Persons Contacted in Brazil

Brazilia

William Rodgers	USAID
F.T. de Siqueira	USAID
Robert Standley	USAID
Frank Campbell	USAID
Ken Corum	IMBRAPA (Brazil agricultural reserach agency)
Wayne Kussow	IMBRAPA

Fortaleza

Jarbo Studart Gurgel	DNOCS
Jose William Bezerra e Silva	DNOCS
Anaury Bezerra de Silva	DNOCS
Expedito A. Vasconcelos	DNOCS
Odilo Dourado	DNOCS
Leonard Lovshin	USAID
John Jensen	USAID
John Sanders	Ford Foundation

Persons Contacted in Brazil

Rio de Janeiro

Soloncy Moura	SUDEPE (Brazilian fisheries development agency)
Arno Meschkat	FAO/UN
Acisclo Miyares del Valle	FAO/UN
Eduardo Venezian	Ford Foundation

Persons Contacted in El Salvador

Ed Anderson	USAID
Al Goldstein	USAID
Jack Morris	USAID
Tim Brown	USAID
Ralph Parkman	Peace Corps
David Hughes	Auburn/USAID
Joaquin A. Guevara, Director of Natural Resources	
Enrique Castro Butter, Chief of Fishculture Service	
Carlos Sanchez, Chief of Santa Cruz Porrillo	
Carlos Alberto Fuentes, Chief of Marine Fisheries, Ministry of Economy	
Myor Villatta, Ministry of Defense	
Guy de Aloras,	PNUP
Francisco Menendez,	Central Reserve Bank
Jose Ernesto Maucial	Ministry of Foreign Affairs
Leonel Zavala	Ministry of Economy
Julio Namos Chorro,	CONAPLAN

#### Persons Contacted in Panama

Ray White	USAID
Ron Ulbrich	USAID
Rene Sanchez	Ministry of Agriculture
Remberito Rosas	Chief of Fishculture, Divisa
Irving Diaz	Director of Renewable Natural Resources, Ministry of Agriculture

#### Persons Contacted In Guatemala

Carl Koone	USAID
John O'Donnell	USAID
Don Feister	ROCAP
Jose Ovidio	Ministry of Agriculture
Salvador Sosa	Chief, Department of Fishculture
Juan Trabanino,	Chief, Department of Marine Fisheries

## APPENDIX B

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