

## MANAGED FISH PRODUCTION PROJECT

### Interim Report

This interim report provides a summary of the modifications in the design of Project No. 525-0216 which have occurred since submission of the PID. The issues noted in the DAEC cable (STATE 278869) are addressed below and take into account the project design modifications made since the PID was drafted.

#### I. Project Design Status Summary

Project design is being adjusted to focus on the need to resolve, through this small pilot project, feasibility questions relating to development of a full scale Managed Fish Production Project. Technical, nutritional and social soundness analyses conducted subsequent to PID submission have raised additional questions about the roles which the Ministry of Agricultural Development (MIDA), particularly the National Directorate of Aquaculture (DINAAC) and the communities could and should play in the implementation of a long-term managed fish production program. Specifically, the analyses have highlighted the important role for extension in such a program, and have raised the issue of the degree to which the dependence of the communities on MIDA/DINAAC for many project inputs and for fishponds could and/or should be reduced. They have re-confirmed the Mission's earlier concern about the financial/economic and administrative feasibility of a managed fish production program. Hence, changes in project purpose and design are being made.

The revised project design will include new activities which are intended to resolve pending issues of program feasibility. It will also include those institution-building activities proposed in the PID which are necessary prerequisites for testing program feasibility. The major components of a revised project design include:

(1) Demonstration Ponds. A series of pond projects will be carried out under semi-controlled conditions. These pond projects, which will include various technological and institutional mixes, will provide basic data for a series of feasibility studies to be undertaken as part of the project.

(2) Feasibility Studies. These will include economic/financial, consumption impact, and program impact analyses. The economic/financial analysis will quantify benefits and costs for the participating communities and for individual families within those communities. It will also study the impact of integrated fishpond activities on the household budgets of participants. The consumption impact study will assess the magnitude and distribution of

increases in protein intake which may be expected from continual harvest fishponds. The program impact study will focus on the effectiveness of alternative types of linkages between MIDA/DINAAC and the community interest groups which carry out fishpond projects. It will especially focus on concerns such as extension services, credit availability and community dependency on MIDA/DINAAC. It will evaluate the results of a number of alternative institutional arrangements to be tested in the project.

(3) Training. The training component will now focus on training extension personnel and community leaders. Trained outreach personnel must be in place in order to test proposed alternative institutional arrangements for delivery of extension-type services.

(4) Technical Assistance. Two long-term U.S. experts will be financed under the grant. One will be a highly qualified expert in fishculture who will provide technical assistance in the areas of fish hatchery operations and will provide in-service training to DINAAC employees and MIDA production technicians. The other expert will be an experienced anthropologist or rural sociologist who will have over-all responsibility for coordinating the feasibility studies. This expert will carry out the program impact study and will supervise execution of the consumption impact and economic/financial analyses in order to assure their timely completion.

(5) Hatchery Expansion. The fish hatchery at Divisa will be expanded and equipped to permit increased production of fish. The current hatchery cannot meet current demand for fingerlings nor can it efficiently produce more than one species at a time. Hatchery expansion will facilitate implementation of poly-culture systems in the demonstration ponds.

The rationale for these adjustments in project purpose and design is more fully explained in the response to Issue B -- Project Strategy - Purpose Level.

## II. Issues and Responses

### A. Project Strategy -- Goal Level

#### 1. Issues

"The project goal is to improve the nutritional status of the Panamanian rural poor. However, the PID does not clearly describe how the proposed project activities would achieve that goal. Whether the strategy is to improve nutrition through on-site consumption or as a result of increased income obtained from commercial fish production, that strategy should be clearly stated and explained, and the means for carrying out the strategy should be fully described. To the extent that the project contemplates commercial fish production, the subsidization of the costs of constructing and operating the fish ponds becomes questionable and any such proposal would have to be adequately justified."

## 2. Response

The sector goal is to improve nutritional status of the rural poor in Panama through a network of fresh-water fishponds in poor rural communities. The strategy to reach this goal is to improve nutrition directly through on-site consumption of fish. Commercial fish production, to be marketed outside the environs of the pond site and near-by communities, is not contemplated in the program. The fish will primarily be consumed by project participants, although part of the fish catch may be sold to other families in the immediate area as a means of generating cash to cover cash operating costs of the fishponds. This situation often occurs in existing fishponds where commercial feed is given to the fish. The integrated animal husbandry/fishpond operations will minimize the need to generate cash through the sale of fish, although the integrated ponds will require monetary outlays for the animal operations and the utilization of cash and/or credit cannot be avoided entirely.

### B. Project Strategy - Purpose Level.

#### 1. Issue

"The project strategy at the sub-purpose level should be clarified in the IR. Is it to increase GOP capacity to carry out a nationwide program of fish production, or to establish GOP capability to evaluate the need for and feasibility of such a nationwide program? The latter seems more desirable, but if Mission opts for the former the IR should contain ample justification. In either case the project components should reflect this strategy decision. Please note that the discussion on such project components is not necessary for review of the IR and may be held for the PP."

#### 2. Response

As indicated in Section I, project analyses have raised additional feasibility issues which do not appear to be soluble in the normal course of project development. Hence, the project strategy at the purpose level will be to evaluate the need for and feasibility of a nation-wide program of managed fish production.

Although the Mission believes that a nation-wide program is likely to be successful, this small grant project is being proposed rather than a larger loan because there are a number of important questions of consumption impact and of economic, social, and especially administrative feasibility which can not be answered without further investigation. For example, there has been a recent shift in extension service responsibilities from DINAAC to MIDA's regional offices which might impinge upon

program success. Also, community interest groups are now highly dependent on the GOP for services related to fishpond operations such as the provision of fingerlings, the provision of nets for harvesting, the transportation of fingerlings and fishfeed, the transportation of piglets and pig feed to pond sites, and the marketing of the pigs. The Mission believes that the most effective means of resolving these feasibility questions is to implement a pilot project in which major issues of feasibility are answered through the development of carefully monitored field activities and in which institutional arrangements about which significant uncertainty exists are implemented on a limited scale.

The pilot project will test the technical and economic/financial feasibility of integrated animal/fish/garden operations. It will measure the consumption impact of such projects. It will also provide evidence on whether a MIDA extension program in aquaculture can be effectively administered through regional offices and whether community interest groups can be reasonably expected to become less dependent on MIDA/DIMAC and other GOP entities for essential services related to fish pond operations. Specifically, an approach for supporting and strengthening the role of community interest groups engaged in fishpond activities will be tested in the project. This approach consists of (1) developing an evaluation process to select those communities most likely to effectively implement fishpond projects, (2) relying on other existing organizational and financial resources which can assist community interest groups to develop fishpond activities, and (3) experimenting with different organizational modes in order to find promising alternative institutional arrangements.

As indicated in Part I of this Interim Report, project components are being adjusted to reflect the revised strategy to achieve project purpose i.e., the monitoring mechanisms and studies which are necessary to gather sufficient data to provide reliable answers to unresolved questions of impact and feasibility are being incorporated into the project design, while institution-building activities are limited to those needed to test program feasibility. A complete discussion of the revised project components will be included in the PP.

### C. Community Organizations

#### 1. Issue

"The nature of the community organizations and the matter in which they would function has not clearly set forth in the PID. The interim report should treat these subjects in detail, answering such questions as the following:

(1) What kind of organizations are envisioned? What has been the experience with these organizations in other activities (including present fish pond operation)? How prevalent

are these organizations in Panama? What is the nature of their competence and capacity, and how will this be appraised in the selection process? What resources are currently available that could be used to strengthen the organizations? What will be the legal form of the organizations? What will be the responsibilities, duties, liabilities of their members? How are decisions made? Who may join? Is membership open to anyone who wishes to participate in the particular project? What about existing members who do not wish to participate? In the event the organization contracts credit, to what extent is an individual member liable for repayment, including any member who does not wish to participate in the project?

## 2. Response

This response is divided into three parts. The first part briefly summarizes the major findings and recommendations of the Social Soundness Analysis relevant to the issue of community organizations. This second part discusses the nature of existing fishpond committees in somewhat more detail. The third part discusses the approach which MIDA will employ on an experimental basis to support and strengthen the fishpond committees.

### (a) Major Findings and Recommendations of Social Soundness Analysis

(1) The organizational basis of community interest groups which are operating fishponds is diverse.

(2) Successful projects are positively correlated with prior interest within the community but not with a specific organizational type.

(3) Existing community interest groups are highly dependent on GOP agencies for supervision and inputs for fishpond operation. This dependence cannot be completely eliminated, especially in the initial phases of a fishpond operation but measures can be tried which may somewhat reduce such dependency.

(4) Participation rates are variable but are positively correlated with the degree of community interest in fishponds prior to initiation of the activity. Participation is motivated by the desire to have an additional source of food, especially one which is highly esteemed such as fish. In a number of communities, especially in Latin America, women have been instrumental in implementing fish projects.

(5) The aquaculture program should focus on consolidation of efforts in the current program area (Veraguas province) and then expand into adjacent areas (Coclé Province and eastern Chiriquí province). Within these geographic limits new ponds should be limited to communities which have made spontaneous requests for ponds.

(6) DINAAC should not impose complex integrated projects but rather should experiment with incremental models which gradually add more complex technologies, e.g. animal husbandry and horticulture, to fishpond operations.

(7) Outreach by MIDA/DINAAC is constrained by work overloads and vehicle shortages. Other sources of outreach should be utilized where possible. Basic training in aquaculture, pig-raising and horticulture and in simple financial management, credit and cooperative management should be gradually provided to community leaders and local paraprofessionals as these communities move from simple fishpond operation to more complex activities.

(8) DINAAC must gather systematic data on fishpond project histories and impacts.

(b) Existing Fishpond Committees

(1) Number, Origin and Responsibilities of Fishpond Committees

By the end of 1979, 198 fishponds had been built in Panama of which 162 are currently active. Of these ponds all but 24 serve five or more households. While some ponds are organized as part of a formal organizational structure such as asentamientos campesinos (5 ponds) or on the basis of extended family relationships, the vast majority of ponds function on the basis of fishpond committees. These fishpond committees are cooperative organizations of community members established to build and maintain fishponds which operate on an informal basis much like health committees and parent-teacher groups.

The organizational basis and experience of the community interest groups which are implementing existing fishpond projects is diverse. No specific type of pre-existing community group serves as a consistent nucleus for the establishment of fishpond sites. A survey of twelve communities with fishponds was carried out as part of the project's social soundness analysis showed that all of the communities surveyed had some sort of pre-existing organization such as health committees (Comités de Salud), parent-teacher groups (padres de familia), community groups (grupos comunales), CARITAS agricultural groups (Grupos Arados) and locally-selected quasi-political governing bodies (juntas locales). Fishpond committees generally have either the same membership as these organizations or draw part of their membership from them; although in some cases individuals within communities may promote fishpond activities. These organizations are common in most rural areas of Panama and the majority of rural communities have at least one of these organizations.

The type of the community organization is not identified by the social soundness analysis as a factor which has a critical impact on the success of existing fishponds. Successful projects (defined as those projects which continue to operate with high community participation rates, which have amplified their scope of activities, e.g. pond expansion, addition of a complementary activity such as pigs and/or gardens, and where ponds have been replicated) are more closely correlated to a high degree of prior interest within the community than to a specific organizational form. This prior community interest, is generated by factors such as radio promotion or seeing a near-by pond and, most importantly, by purchasing some of the catch. An on-going relationship with an active promoter from a governmental or private voluntary organization, e.g. CARITAS, together with previous community development experience and an extended family settlement base, also contribute to project success.

Despite the diverse origins of the fishpond committees their operation is similar (because it is largely determined by the task environment). Fishpond construction is carried out by the mutual effort of community members. Participation rates are high, with men, women, and children engaged in construction activities requiring hand labor (land clearing, excavation, planting grass banks).

At the fish production stage, families (men, women, and children) within the community take turns feeding the fish and, if present, caring for the hogs. This work is carried out on a rotational basis under the supervision of a management committee or leader appointed by the community at DINAAC's request. This committee or leader is also responsible for handling any funds used to purchase fish feed and/or pigs and pig feed.

At harvest time all members of the community interest group participate. The sale and distribution of fish is handled by the fishpond committee leader and women members of the committee.

## (2) Nature of Capacity and Competence of Existing Fishpond Committees

Most existing fishpond committees are highly dependent on DINAAC and other Ministry of Agricultural Development (MIDA) personnel, particularly during the initial year of operation. DINAAC personnel supervise the site selection and construction of fishponds and provide technical backstopping to MIDA production (extension) technicians in the stocking, maintenance and harvesting of ponds. In the case of machine-dug ponds DINAAC usually assists the fishpond committees to make arrangements for pond excavation. In many instances DINAAC also

(c) Proposed Strategy for Supporting and Strengthening Fishpond Committees

On the basis of DINAAC's current experience with fishpond committees, the proposed strategy for strengthening these groups will be multi-faceted and incremental. The objective of this strategy, which will be tested in the project, will be to reduce the necessary initial dependency of the community on DINAAC's support by gradually transferring responsibility for major aspects of integrated fishpond management to the fishpond committees or to organizations which have a direct and on-going association with the community interest groups.

This strategy will consist of (1) developing a selection process which will allow DINAAC to identify those communities which are most likely to successfully implement fish pond projects, (2) utilizing existing organizational and financial resources to assist fishpond committees to undertake fishpond projects, and (3) experimenting with various organizational modes in order to identify efficient ways to supply technical advice and supporting services to fishpond committees,

(1) The Basis for Selection of Pond Sites

The current policy is, within the limits of available resources, to work with any formal or informal community interest group in DINAAC's present area of influence (primarily Veraguas Province) which manifests a strong interest in fishponds. No single standard formal organizational structure is required or expected. In view of the findings of the social soundness analysis that successful fishponds are positively correlated with the degree of community interest prior to pond construction but not with formal organizational structure, this policy is sound and will continue to be implemented by DINAAC. It provides a substantial degree of flexibility and encourages a dynamism not often found in government programs. Additional factors such as community initiative, as demonstrated by implementation of other community development activities, and accessibility, will also serve as community selection criteria.

There are currently 89 outstanding requests for fishponds. New ponds will be built in those communities or in other communities which may make such requests in the future if they are in DINAAC's current program area or in its planned expansion area (Coelá and eastern Chiriquí provinces), and if they meet the other selection criteria. Based on the recommendations of the social soundness analysis, the new ponds will be "fish only" ponds and MIDA/DINAAC will focus a major part of its near-term efforts on incrementally up-grading existing fish-only ponds. That is, successful single-harvest fish ponds will be converted to a continuous harvest basis, and animal husbandry and gardening



activities will be added where community interest groups demonstrate sufficient interest in and potential for these changes. This procedure will permit the development of integrated animal/fish/garden projects while minimizing the risk of failure.

The validity of this proposed incremental approach will be tested in the demonstration pond component of the Managed Fish Production project. Although some fish-only demonstration ponds will be built to ascertain the acceptance of fishponds in areas where no ponds currently exist, the majority of the demonstration ponds will be existing pond sites that are up-graded under controlled conditions in which a variety of technological/institutional mixes are tried. The Managed Fish Production project will provide adequate resources for DINAAC to carefully monitor and evaluate these demonstration projects and their related activities. This approach will provide ample opportunities to assess the economic/financial, technical, social, and administrative feasibility of different project activity/mixes and organizational/operational modes. The FP will fully describe the methodology which DINAAC will employ to monitor and evaluate the demonstration pond activities and will discuss the pond site selection criteria in detail.

(2) Public and Private Sector Resources Available to Assist Fishpond Committees

A number of governmental and non-governmental resources are available to help strengthen the community groups engaged in fishpond activities. The heterogeneity of organizational types means that certain resources may be available for all ponds but it also means that there are multiple resources to draw upon. These resources are currently insufficient to permit implementation of a large-scale managed fish production program but they do provide a means to extend MIDA/DINAAC's support for fishpond activities. In some cases, e.g. in MIDA regional offices and in the Guaymá Area Development project, the degree of future commitment to assisting fishpond activities is still uncertain. In other instances, organizations which are carrying out programs complementary to fishponds, such as the Ministry of Health through its community nutrition program, and CARITAS, have demonstrated a significant interest and willingness to promote fishpond activities.

MIDA production (extension) technicians operating out of regional offices will most probably be a key resource for the implementation of a large-scale managed fish production program. A recent policy directive of the Ministry of Agricultural Development has emphasized the importance of the regional offices in outreach activities and has limited central staff offices such as DINAAC to primarily technical backstopping

roles. The implications of this policy directive for a managed fish production program are of concern to the Mission and they will be fully explored during project development by a public administration specialist. In particular, the willingness and ability of MIDA regional directorates to devote resources to a program of managed fish production must be verified, given the severe limitations on their financial and human resources and on supporting services such as vehicles. Despite the short-run obstacles to an expansion of the fish pond activity which will apparently be created by this ministerial policy directive, the Mission believes that it may strengthen MIDA's operational capabilities and that it will be advantageous to a managed fish production program in the long run. In particular, it should promote the integration of fishpond activities with other agricultural disciplines and, since the technicians will have multiple responsibilities, it should result in a more efficient utilization of the limited resources which are available. The Mission recognizes the critical role of extension technicians in such a program and will assure that adequate extension support for a managed fish production program will be forthcoming before the project is authorized.

In the Guaymí Indian region, the Guaymí Area Development Project (525-0200), coordinated by the Directorate of Indian Affairs of the Ministry of Agricultural Development, includes fishponds among the agricultural activities eligible for financing with project funds. Requests for new fishpond construction or for up-grading of ponds to integrated animal/fish/garden projects in the Guaymí area will be channelled through the Directorate of Indian Affairs to be financed with Guaymí Area Development project funds. DINAAC's participation will be limited to the provision of technical assistance and technical training for Guaymí promoters, and to the provision of fingerlings. Currently, the Directorate of Indian Affairs is trying to improve the operation of existing ponds. The extent to which it will actively promote new ponds is uncertain; however, the Directorate has recently acquired bulldozer for, among other uses, the construction of fishponds in the Guaymí area. The Mission will strongly encourage the expansion of fishpond activities in the Guaymí project.

Another public sector resource is the Ministry of Health which has established a number of pig projects that are being financed by the community nutrition component of AID's Rural Health Delivery Loan (525-U-045). To date pig projects have been established in 33 communities. Fishponds have been built in conjunction with seven of these pig projects. Other communities with pig projects have requests pending for fishpond construction. In those communities where fish and pigs are raised together, the fish production is consumed locally, while most of the pigs are marketed outside of the community.

Several communities with fishponds have received assistance in the construction of their ponds from the La Victoria Sugar Corporation which has provided bulldozer services sufficient to excavate small ponds (approximately 1000m<sup>2</sup>) in exchange for fifteen person-days of cane cutting provided by community members. Another MIDA directorate, RENARE, has also provided bulldozer services to some communities. In these cases DINAAC makes the initial contact for the community interest group with the government agency and provides technical supervision of pond construction.

The major sources of private sector assistance are CARITAS and, potentially, the cooperative movement. CARITAS outreach personnel are working in more than 90 of the poorest rural communities in Panama. CARITAS, which is already working to develop a number of small fishponds, has informally agreed with DINAAC that its personnel will be trained by DINAAC and that it will incorporate fishpond promotion and extension activities into its workplan. DINAAC will provide on-going technical backstopping for these activities. An additional private sector resource, Panama's rural cooperative movement, is discussed in the following section.

### (3) Testing of Alternative Institutional Arrangements

In order to significantly expand the managed fish culture program, either MIDA/DINAAC must substantially increase its staff or existing institutional arrangements must be adjusted to reduce the reliance of fishpond committees on the Ministry of Agricultural Development. A major objective of this grant project, which is consonant with the revised project purpose, is to test the extent and ways in which fishpond committees might be gradually be weaned from their necessary initial high degree of dependence on government institutions. To this end new institutional arrangements will be tested during the project.

A number of factors may affect the communities' ability to successfully manage integrated fishpond project on a relatively independent basis. These include not only such factors such as technical knowledge and coordination of community participation but, more fundamentally, credit use and availability.

Currently two sources of credit are utilized for community fishpond activities. These are DINAAC and the Ministry of Health. DINAAC provides informal credit for fish and fish feed, while the Ministry of Health provides funds for pig projects through the Rural Health Loan (525-V-045). In both instances inputs, i.e. fingerlings, feed and pigs, are provided in kind rather than through cash transfers to the communities. Under this informal arrangement, the government entities are themselves involved in the purchase and delivery of

fish feed, pigs and/or pig feed as well as in the sale of the grown pigs. These informal mechanisms appear to be functioning satisfactorily at current levels of operations; however, it is uncertain whether a larger program of integrated fishpond activities could be carried out with these arrangements.

The social soundness analysis recommends continuation of the informal credit system, if possible, since it has been effective to date, providing a significant amount of flexibility while experiencing low default rates. However, modifications such as introducing a service fee or charging interest could be gradually introduced in order to reduce the financial burden on the GOP implicit in this system. These modifications will be tested in the pilot project.

A possible alternative institutional relationship between MIDA/DINAAC and the community interest groups would be to work through the rural cooperative movement. This alternative which would relieve MIDA of the responsibility for credit supply will also be tested by DINAAC in the pilot project. DINAAC has already reached an accord with a large multiple services cooperative, the Juan XXIII cooperative, and with the community of San Bartolo, that the fishpond committee members will join the cooperative which would then provide credit for an integrated pig/fishpond activity. Active fishpond committee members will be co-signatories of the loan and the pigs will serve as collateral.

Should this experimental effort prove economically and administratively successful, the Juan XXIII cooperative, which has 1100 active members and 13 branches located throughout Veraguas Province, would be willing to enter into agreements with other communities. This relationship would be particularly attractive for a large number of communities in Veraguas because of the cooperative's relative accessibility to isolated communities and because the cooperative has its own animal feed-mixing plant that produces chicken, pig, and cattle feed. (Note: This cooperative has received three sub-loans for a total of \$450,000 through the revolving fund of the recently completed Rural Cooperative Development Loan 525-T-041, including \$150,000 for production credit and \$125,000 for working capital for the feed-mixing plant. A large percentage of the production credit has been allocated to pig projects.) This alternative has an additional advantage in that many functioning cooperatives such as Juan XXIII have well-developed education/ outreach programs. Community interest groups thus have the opportunity to receive instruction not only on the elements of,

cooperativism but also on the rudiments of cost accounting and basic financial management which are necessary prerequisites to the assumption of major management responsibility by the communities.

Another institutional adjustment which will be tested by DINAAC in this pilot project is the utilization of trained volunteer community leaders and local paraprofessional personnel. This mechanism is already being employed in the Guaymí Area Development Project. In this project local-level volunteers and/or paid workers will be trained in pond promotion and in basic pond operation and maintenance as well as in the rudiments of animal husbandry, financial management and credit use. These local-level workers will in turn provide outreach services, with backstopping from MIDA extensionists and DINAAC technicians, to communities in the areas in which they live.

The pilot project will support the trial implementation of these institutional innovations and will provide feedback on their potential long-term viability as elements of a large-scale managed fish production program.

D. Initial Environmental Examination (IEE):

1. Issues

"A review of the IEE submitted with the PID raised the following concerns over the project's possible impact on the physical and human environment: (1) infection of fish intended for human consumption by viruses and other pathogenic organisms from livestock wastes that may not be adequately composted; (2) damage to local ecosystems resulting from the introduction of exotic fish species; and (3) reduction in the quality of water in streams and rivers because of the pond draining and flushing. The Mission is requested to examine the possible impact of these concerns and submit its findings with the interim report. The IEE will be held in abeyance until these concerns are resolved".

2. Response

a. Infection of Fish by Viruses and other Pathogenic Organisms

Information available in the scientific literature at this time does not indicate that any significant health hazard might exist as a result of using untreated animal wastes to fertilize fish ponds. Long experience with ponds receiving untreated animal wastes in Germany, Hungary, Israel and several Asian countries has not produced documented evidence of human illness as a result of consumption of fish grown in these ponds.

Although some species of fish to be cultivated in Panama including the tilapia and the common carp will directly consume animal manure, this does not appear to pose a health problem. Evidence indicates that pathogenic bacteria are not found in the flesh of fish in ponds receiving animal waste water, but that they are found in the fish intestines. However, fish intestines are not consumed, and fish raised in ponds receiving untreated animal wastes are well cooked before eating. The cooking process would kill any parasites or other pathogens that might be found in the fish flesh. Non-organic contaminants, e.g. chemical wastes such as pesticide and mineral wastes, pose no problems in areas where fishponds might be built.

b. Damage to Local Ecosystems Resulting from the Introduction of Exotic Fish Species

Fish which might potentially be used in this project include several species of Tilapia, Chinese (silver, grass, big-head) carps, and common carps. Tilapia have been widely introduced throughout the tropical world. Tilapia mossambica and Tilapia rendalli were introduced to Panama in the 1950's. Tilapia do not become well established in stream and river environments. Neither Tilapia mossambica nor Tilapia rendalli has become established in the fast flowing streams of Panama. Tilapias, however, can become established in standing water environments such as lakes, reservoirs and estuaries. Although the reproductive potential of tilapias is substantial, expansion of the tilapia population is controlled in most standing water environments, where carnivorous fish populations are present. In Panama the native guapote tigre is an effective control on tilapia. In northeast Brazil where tilapia have been introduced into reservoirs, they have become established without harming native fish populations. No known ecological harm has occurred to date from the introduction of tilapia into Panama and there is no reason to believe that widespread use of tilapia as a culture fish will have a negative impact on Panamanian ecosystems.

Chinese carps do not spawn in standing water and require large rivers to successfully spawn and hatch their eggs. Panama has no rivers of sufficient size for Chinese carp to spawn. The few Chinese carp that may escape from hatcheries or fish ponds are unlikely to cause ecological damage.

The common carp, which can spawn in standing water, could become established in the local environment. However, in most of the world common carp is a widely accepted food fish and its introduction has been beneficial.

## Reduction of Water Quality in Streams and Rivers because of Pond Draining and Flushing

Fish ponds can be viewed as oxidation lagoons. Wastes from animal husbandry operations are washed into ponds where bacterial decomposition breaks the wastes down into basic elements. During the decomposition process a high biological oxygen demand, BOD, will cause the lowering of dissolved oxygen levels. When organic wastes are released directly into natural waters, the decomposition of these wastes can lower dissolved oxygen concentrations to lethal levels so that in extreme cases, fish kills will occur. However, when the decomposition process takes place in an oxidation pond, high BOD levels are reduced in the pond and the BOD in the effluent from the oxidation pond is considerably lower and normally, not harmful to the environment.

In the decomposition process, bacteria break down manures into elements usable to aquatic microorganisms. Nitrogen, phosphorous, and potassium, not lost chemically in the bottom muds, are utilized to form high densities of phyto and zooplankton. Phytoplankton is beneficial to the oxidation of animal wastes by producing oxygen during the photosynthetic process which in turn is utilized by bacteria enhancing the decomposition process. Phytoplankton and zooplankton are also important fish food organisms. A number of fish species are able to feed directly on planktonic organisms. Thus, the microscopic organisms produced with the elements released during the decomposition process can be used to grow fish. Several species of tilapia and chinese carps consume plankton filtered from the water. The fish reduce plankton populations by continual cropping thereby stimulating additional plankton growth which utilizes more nitrogen, phosphorous, and potassium. Thus, the fish have a beneficial effect on pond water quality. It has been documented that for equivalent amount of organic wastes, the effluent from a pond with fish will be cleaner than the effluent from an oxidation pond without fish.

Although fish ponds are efficient oxidization ponds any system can be overloaded and care must be taken to provide only the amount of animal wastes that can be effectively oxidized in a pond without killing the fish or producing an effluent that will have an adverse effect on natural waters. However, with proper training of fishpond committee members system overload should not occur under production methods practiced in Panama. In the continuous harvest system which will be promoted in the Managed Fish Production project, ponds will be completely drained and cleaned at most once a year and generally only every 3 or 4 years. The limited frequency of complete draining, the slow rate of drain during pond operation and the oxidization which occurs in the ponds, greatly reduce the probability of significant reduction of water quality in streams and rivers.