Scynescions sp.	(resident, commercial)

Mammals

Procyon cancrivorus	(resident)
Alouatta paliata	(migratory)
Cebus capucinus	(migratory)
Panthera inca	(migratory)

Insects

Melipona sp.	(resident)
Apis sp.	(resident)

Reptiles

Iguana iguana	(resident)
Crocodilus acutus	(resident)

It is important to note that due to the massive deforestation of the tropical dry forest areas adjacent to the estuary, the resident fauna of the forest has migrated to the mangrove areas, looking for shelter and feed, as the last resource available in the surroundings.

6.2 Chone Estuary

6.2.1 Existing situation

The Chone river estuary is so deteriorated that it is considered an estuary in great danger of suffering an ecological collapse by a massive degradation of the environmental quality and the loss of the ecosystem functions (29).

Existing problems associated with the Chone river estuary are summarized as follows:

1- Massive mangrove deforestation associated with the construction of shrimp farms and their expansion.

2- Urban invasion of the estuarine adjacent areas, without adequate sewerage disposal systems.

3- Recipient of the erosive process occurring because of the massive deforestation of the adjacent hills and upstream watershed

4- Water quality deterioration because of the shrimp farm effluent, agrichemical runoff from agricultural areas upstream, disposal of sewage and solid waste from the urbanization process.

5- Degradation of the artisanal fisheries resources by loss of natural habitat and deterioration of water quality

6- Deterioration of the water exchange capacity of the estuary because of excessive sedimentation

(1) Mangrove deforestation

The convertion of mangrove forest into shrimp farms is estimated in 80.3% of the mangrove covered area (39). This is considered the most critical sector in mangrove destruction for the Ecuadorian coast. The present mangrove coverage area is estimated in 780 ha. The existing species are Rhizophora sp, Aviscenia sp, Laguncularia sp, Conocarpus sp. The main physiographic type is border and island mangrove.

There is a tendency towards the expansion of shrimp farms to the upland areas, which is a response to the prohibition for cutting the mangrove forest.

(2) Urban colonization of adjacent areas

It is estimated by PMRC-ZEM in Bahia de Caraquez that between 35,000 to 40,000 persons live in the adjacent areas of the estuary, between the hills and the estuary channels. The population in this area is lacking adequate sewerage disposal systems and proper solid waste disposal mechanisms. Activities of this communities are related to the shrimp farms, through nursery operations, post-larvae capture and direct employment in the farms.

(3) Recipient of the erosive process

The highly deforested hills adjacent to the estuary are a direct source of sediment ending up in the estuary channels, and causing the emergence of mud flats and hampering water circulation in the estuary. This adjacent areas are to be considered under a management plan as a system directly related to the estuary environmental quality.

(4) Water quality deterioration

Water quality deterioration has multiple pollution sources, such as :

1- The shrimp farm industry with 5,800 ha of ponds fertilizes its ponds with urea, uses pelletized feeds and neutralizes soil ph with CaO and $CaCo_3$, releasing an effluent of 3.3-5.5 MCM per day into the estuary (20). This activity is considered of high pressure to the estuary, loading a considerable amount of nutrients, organic matter and mineralized matter into the estuary.

Random shrimp farm effluent analysis carried out in December 1993 shows the following results:

Turbidity	36.66	FTH
Dissolved Solids	18,065.00	mg/l
Total Solids	18,117.00	mg/l
Salinity as Chlorides	19.6	ppt
Nitrate-N	2.96	mg/l
Phosphate	0.23	mg/l
BOD	22.00	mg/l
COD	35.30	mg/l
DO	6.90	mg/l

2- The agricultural activity in the vicinity of the estuary is dedicated to short cycle produce such as corn, watermelon and cantaloupe. The agricultural residues are represented by fertilizers and pesticides.

3- Untreated sewage is released from the urban population adjacent to the estuary. The microbiological quality of the estuary shows less concentration of coliforms during the dry season at the mouth of the estuary, while there is an elevated number of coliforms (up to 75,000 MPN/100ml fecal coliforms) in the upper part of the estuary (La Margarita), probably caused by the raw sewage from Chone and Tosagua during the rainy season (May 11, 1989)

(5) Degradation of artisanal fisheries

As an evidence of the improper management strategies applied to the estuary, the artisanal fisheries catch has declined (29). The loss of habitat by deforestation, the deterioration of the water quality and possibly the pressure on the resources have joined to reduce the available catch of the resource.

Species of commercial importance found in the estuary are crustaceans such as Penaeus sp, Ucides occidentalis, Cardisoma crasum mollusks, such as Crassostrea

columbensis, Anadara similis, Anadara tuberculosa, Mytella guyanensis, and fish such as Mugil sp, Isopisthus sp, Dormitator sp.

(6) Deterioration of the water exchange capacity

Deterioration of the water exchange capacity is more evident in the upper reaches of the estuary, where eutrophication conditions have already been reported by PMRC-ZEM Bahia personnel, at the locality of Cinco Bocas.

Reported salinity concentrations exceed 40 parts per thousand at the end of the dry season, and reported microbiological water quality conditions become critical in the upper reaches of the Chone estuary (20).

The enlargement of the mud flats produced by excessive sedimentation downstream of Isla Corazon and spreading towards the right bank hamper adequate water circulation and contribute to reduce the incoming tidal flow.

6.2.2 Existing management efforts

In 1986, the government of Ecuador, USAID, and The University of Rhode Island signed an agreement for technical assistance to develop a management project that will allow the sustainable use of the coastal resources.

An area considered manageable and representative of the problems was selected for each province, and were called ZEM (Zona Especial de Manejo, or Special Management Zone). In Manabi, the area of Bahia-San Vicente-Canoa was selected. In January 1989 the Government created the Program for Management of Coastal Resources (PMRC), establishing 5 special management zones, including the one for the Manabi province.

For the ZEM related to the Chone river estuary, more than 15 organizations including larvae collectors, hotels, artisanal fishermen, tourist guides, and mollusk collectors have been incorporated, and specific projects in agroforestry (La Chiporina), restocking of bivalves, environmental education through radio programs, mangrove reforestation at Isla Corazon and Punta Conchero with high school students have been carried out.The purpose of the ZEM is to manage its resources, and for this purpose a management plan has been done.

The management plan as related to the Chone river estuary considers the following aspects:

1- Mangrove management, for the recuperation and protection of the remaining mangrove vegetation, and for its multiple use in a sustainable way.

2- Fisheries resource management, including the conservation of the resource, provision of fishing means, and technical assistance to fishermen and larvae collectors.

3- Mariculture management, including the control over the mangrove ecosystem, ecological protection of the estuary, and extension programs directed towards the shrimp nursery operators.

4- Water quality and environmental sanitary measures, including the improvement of sanitary conditions for the population, reduction in the volume of sewerage, solid waste and pollutants into the estuary, and ensuring the sufficient fresh water inflow to the estuary

5- Management of the Chone river estuary, to evaluate the key estuary matters, and to prove the feasibility and effectiveness of long term policies, and to generate a series of regulations, actions, and procedures, to reach adequate conditions and goals for the year 2020.

6.2.3 Proposed conservation program

Any proposed conservation program has to be in accord with the existing efforts and organizations, such as the ones being implemented by PMRC-ZEM-Bahia-San Vicente-Canoa, for the improvement of the ecosystem. A conservation program dealing with the mangrove forest must approach the efforts through an integral approach to the overall ecosystem.

For these reasons, the proposed conservation program is based on supporting the existing efforts, and pretends to implement corrective measures in the different components of the system.

The main issues affecting the estuary and the specific strategies proposed are stated ahead.

(1) Mangrove management

1- Reforestation and conservation of the areas adjacent to the estuary, located below elevation 100 m, and as a priority, the integral management of the Chone river basin, the main producer of sediments carried into the estuary.

2- Reforestation of drainage and inflow channels in the existing shrimp farms.A joint agreement could be sought between CRM and the existing shrimp farms, where CRM will provide the surplus fresh water flow during the dry season to reduce the excessive salinity in the estuary and improve water quality for the shrimp farms, and the shrimp farmers will engage in a reforestation process in their own farms.

3- Declare as protected the areas of Isla Corazon and the existing mangrove patch in the upper reach of the estuary-left margin, as shown in Fig 6.1. Estimated areas are 40 ha for Isla Corazon, and 123 ha for Calle Larga (29). Isla Corazon is already declared as forestry research area by DIGMER, and a zone of tourist interest by CETUR.

Isla de Pajaros and Isla de Las Fragatas are emerging islands with an approximate area of 200 ha in the low tide, which have been colonized by mangrove. These areas are used by extense bird colonies for nesting, feeding and residence (29) and should be considered as a protection area or bird sanctuary.

These areas are the only patches remaining with mangrove vegetation besides the fringe vegetation still remaining in the borders of the channels, and only comprising a thin line (2-6 m) along the channel borders, and between the shrimp farm dikes and the estuary channels.

4- Cooperate with the existing Units for Vigilance and Conservation (UCV) established by PMRC-ZEM, and strictly apply the law to avoid further deforestation.

5- Elaborate legal regulations, including municipal regulations to protect the special areas of the estuary such as Islas Fragatas, Corazon, de Los Pajaros, sectors of Simbocal and Calle Larga, and the still existing 780 ha of mangrove (29)

A summary of the existing laws, decrees and agreements is given in this report.

6- Promote the culture and seeding of bivalves such as Anadara sp., in an effort to establish a sustainable use of the forest, and educate the local people in the proper use and importance of the mangrove ecosystem, while deriving an economic benefit out of it.

7- Promote organized groups to visit Isla Corazon for educational purposes of estuary ecology. Organized groups such as schools, NGO's, etc. are important to diffuse environmental education and create a presence of interested people in the conservation of the system.

The creation of an ecological "station" in Isla Corazon is suggested as a mechanism to establish an environmentally concerned presence in the area. The station could be a simple refuge to allocate a room for workshops and receive visitors interested in the ecosystem. The refuge will also serve for vigilance purposes in the area.

8- Promote nature oriented tourism for bird watching, mangrove ecology education and leisure. Support the project oriented towards "Sendero de la Casa Verde" started by PMRC-ZEM with a specific route between spots with ecotourist potential.

(2) Mariculture management

1- Stop shrimp farming expansion in the estuary area and upper reaches of the estuary.

The only areas for the shrimp farming industry to expand are the few existing mangrove patches, especially in the upper reaches of the estuary, and the lands adjacent to the wetlands also in the upper reaches of the estuary. CRM must take measures so that the existing legislation is applied and the infractors are sanctioned. CRM must cooperate with the PMRC efforts in this respect and coordinate actions for the implementation of the law.

Only 10% of the shrimp farms are located in private property, and 90% are located in public land with a concession for 10 years, and under the jurisdiction of DIGMER. A summary of the legislation and permit process to establish a shrimp farm is given in this report.

2- Mapping of the existing shrimp farms allocated in public land through the review of the official registers.

3- Reforestation of shrimp farm channels as mentioned in the above strategies for mangrove management.

4- Technical assistance for shrimp farmers is suggested to be sought through ESPOL, in an effort to improve the efficiency of shrimp feeding practices and water quality management, to reduce excess feeding in shrimp ponds, reduce organic load of the shrimp farm effluent, and reduce volume of water exchange per day.

This practice will be welcomed by shrimp farmers since feeding is the highest operational cost in the shrimp grow out process, and pumping cost is also not meaningless.

5- Technical assistance for artisanal shrimp nursery operators in water quality management and feeding strategies is also suggested to be sought through ESPOL, in an effort to improve the quality and quantity of the effluent.

Artisanal nurseries are located mainly in the communities of Canoa, Barquero, Ebano and San Agustin (29)

(3) Water quality management

1- Implementation of the new design for Simbocal tidal gate and dyke.

The existing tidal gate at Simbocal is deteriorated, and its operational capacity diminished with the highest tides of the lunar cycle, ie. the wooden gate floats and allows the intrusion of salt water.

It is necessary to implement the new design by CRM, so that a proper management program be implemented for the benefit of the estuary ecosystem, shrimp farms, wetlands and farming areas upstream Simbocal.

2- Ensure adequate supply, in the dry season, of the available fresh water flow through proper operation of the Simbocal tidal gate.

The operational programming for Simbocal tidal gate is included in this report, and should be implemented to improve water quality conditions in the estuary, especially during the dry season.

3- Regulation, control and implementation of alternative management strategies for pesticide, herbicide and fertilizer use in the agricultural areas upstream from the estuary.

Implementation of alternative practices such as integrated pest management (IPM), carrying out soil analysis before applying fertilizers, use of nitrogen fixing crops, alternation of crops and pesticide use education and control are some of the recommended strategies to be applied in the agricultural areas, in an effort to reduce the use of pesticides and the leaching of pesticide residues to the estuary.

A detailed discussion on agricultural runoff and pesticide impacts, as well as alternative strategies is given ahead in this report.

4- Implementation of sewerage disposal systems according to sound sanitary engineering practices for the population adjacent to the estuary channels.

Communities identified (50) for this measure to be taken are the following:

Simbocal
Barquero
Salinas
Portovelo
El Charco
Mauricio
Verdum
Chipomia
Los Pozos

The above mentioned communities don't have sewerage system or solid waste disposal systems.

5- Implementation of a solid waste disposal system for the above mentioned communities, along with a recycling program for organic waste.

Experiences are being carried by PMRC-ZEM with the Colegio Tecnico San Vicente for the recycling of organic waste. This effort must be supported, as well as the location, design and implementation of a solid waste disposal area.

(4) Erosion management

Important erosion problems derived form the agricultural practices in the adjacent hills has already been reported by H.T. Odum (24). Joining efforts with PMRC in the following strategies to control erosion is recommended.

1- Geographic definition of the adjacent area of influence generating erosion and sediment deposition in the estuary.

The appended Fig. 6.1 in this report shows the delineation of the area of influence, adjacent to the estuary which is characterized by steep slopes, deforestation and which has risk of erosion.

This area is to be considered an area for special management strategies, including agricultural practices, directly related to the reduction of the erosion process. Strategies such as reforestation, agroforestry, terrace planting, use of nitrogen fixing crops and trees are recommendable, and should be implemented in coordination with the existing programs being implemented by PMRC-ZEM-Bahia-San Vicente-Canoa.

2- Development of forestry plantations or reforestation on the steep slopes of La Chiporina and Los Orconcitos.

The recently established nursery for tree production by the Portoviejo bishop in cooperation with the embassy of Finland is a source of plants for the reforestation process. Incentives created by INEFAN through PLANFOR, with the retribution of 70% of the reforestation cost once 75% survival of the plantation is achieved is a mechanism to develop the project.

Other financial funds for reforestation can be found through programs like the convertion of external debt to nature (debt swap), where international conservancy institutions could apply.

3- Implementation of agroforestry practices associated with the creation of erosion barriers in short term agricultural areas.

Successful experiences with Leucaena sp. have been carried out by personnel of the ZEM-Bahia-San Vicente-Canoa, incorporating erosion barriers and following specific elevations with the planting of leucaena. The multiple uses of Leucaena

and its adaptability to the local environment make it a choice species for this purpose.

4- Establishment of demonstrative parcels as part of an educational program to show the effects and consequences of soil loss at different slopes with different protection strategies, and with traditional agricultural practices.

The participation of INIAP is suggested as a technical institution with experience in the performance of such practices using local materials and simple methods to transmit the knowledge to the farmer.

5- Adequate supply of water for agriculture.

The way to promote change in the traditional agricultural practice and reduce their erosive effects is viewed in terms of agricultural development through an adequate supply of water for irrigation (29).

It is important then to support the development of pilot projects for the regulation of irrigation water. The community of Los Orconcitos has been selected by PMRC for the construction of a weir using local materials and local labor. The project will include an educational and technology transfer on the maintenance of the weir, and on the use of the water for irrigation.

The project will include training on soil management practices and water management practices.

(5) Agricultural runoff

The Chone river estuary will receive the drainage waters from 15,000 hectares of agricultural land to be abilitated for year round farming, when the flood control is operating with La Esperanza, and the impact on the estuary by increase in agrichemical runoff could be significant, although the increase in fresh water flow during the dry season will have positive effects in the ecosystem and fisheries of the area, by reducing the salinity, especially in the upper areas of the estuary, where eutrophic conditions have been already detected by PMRC (20).

The implementation of 15,000 ha for year round farming will inevitably promote the use of pesticides, herbicides and inorganic fertilizers. The concentration of pesticides and agrochemicals leaching from the agricultural area into the estuary will have a detrimental

effect in the ecosystem and fisheries. Shrimp post-larvae are one of the most sensitive organisms to be affected.

Regarding the possible effects of pesticides, the following should be taken into account:

- Organochlorine pesticides are relatively insoluble in water, but are absorbed readily by particular matter and easily transported to rivers. The toxic is accumulated in the fatty tissue, crustaceans (shrimps and crabs) being particularly sensitive to these compounds. Some chlorine insecticides such as Dieldrin, remain active in soil for an average of eight years (range 5-25 years).

- Organophosphorus pesticides are relatively water soluble, less stable than organochlorine types and, therefore, do not persist in the environment. Therefore, the degree of bioaccumulation is not important in these compounds, although they are highly toxic to aquatic organisms.

- Carbamate and other urea based herbicides are moderately soluble compared with the previous groups. These compounds are absorbed by particular matter, and remain in sediments for prolonged periods. They are of minor toxicity to fishes and mollusks, but highly toxic to crustaceans. For this reason, some carbamate have been used for control of crustaceans, which in some cases are considered pests.

The nutrient concentration will increase due to increased use of inorganic fertilizers in the proposed agricultural area. The use of fertilizers is not considered harmful to aquatic organisms, as long as they do not accumulate in waters that flush slowly. The accumulation of nutrients such as nitrogen and phosphorus can induce red tides, or excessive proliferation of phytoplankton with a consequent oxygen depletion and eventual anoxia, with detriment to the aquatic fauna.

Some foreseen effects of the agricultural area runoff are the following:

(i) Phytoplankton

Phytoplankton will be prone to bioaccumulation of pesticide residues, and to the transmittance of this residues through the food chain, where the original concentrations will eventually magnify at the higher trophic levels.

The phytoplankton population could be diminished by excessive use and/or misuse of herbicides, especially in the upper reaches of the estuary.

Very little is known about effects of herbicides in estuaries. Substituted urea herbicides Diuron, Monuron, Neburon and Fenuron are amongst the worst toxic compounds tested against several marine species of phytoplankton. Generally phytoplankton cannot tolerate concentrations as low as 0.5 ppb (40).

Low concentrations of urea herbicides inhibit both growth and photosynthesis in several marine unicellular algae. Triazine herbicides (ametryne, atrazine, simazine) are as toxic or more so than the ureas, and picloram herbicides is almost as persistent as chlorinated hydrocarbon insecticides.

2,4-D at 1 ppm concentrations reduces carbon uptake to 16% of the species in a natural population of plankton composed mainly of diatoms and flagellates. Continuos exposure to oysters to 3.75 ppm of 2,4-D reduces oyster shell growth by 50% (41).

Degradation rates have been found to vary from having a half life of 4-11 days to more than 80% being degraded in five weeks.

Also of special concern could be the effect of the increased runoff of nutrients, that could favor massive phytoplankton explosions, with the consequent dissolved oxygen diminution, or anoxia and in some cases red tides because of an excess supply of phosphates.

This phenomenons are common in the Gulf of Guayaquil and the inland waters of the Guayas River estuary, in areas near sewage outfalls, where concentrations of dissolved oxygen measured by Solorzano in 1981 were 3,5 ppm at 1 m depth and 2.0-2.5 ppm near the bottom. A dissolved oxygen concentration lower than 4 ppm is considered stressful to shrimp.

Plankton feeding fish such as Mullet regularly accumulate pesticide residues which are passed on to predators such as shark, fish eating birds and others. The biological magnification of residues in the food web may progress, for example from an estimated 1.0 ppb in water to 70 ppb in plankton to 15 ppm in fish, and up to 800 ppm in porpoise blubber.

(ii) Mangrove vegetation

The reduction of salinity during the dry season will contribute to a better metabolism of the plants, and the possible herbicide and pesticide load from the drainage area will negatively impact the mangroves through bioaccumulation.

A given load of herbicides could have a detrimental effect on the vegetation, if the concentrations achieve critical levels, or misuse of the product is committed. This will cause a gradual "drying" up of the plants, especially in the upper reaches of the estuary, where concentrations could be higher in the dry season.

(iii) Crustaceans

The increased fresh water flow during the dry season is considered to have a positive impact on the shrimp post-larvae population, especially in the populations occurring in the upper reaches of the estuary.

The expected increase in the load of pesticides and herbicides from the agricultural area is considered to have a detrimental effect on the survival, disease resistance, growth rate, and abundance of post-larvae, and in a possible bioaccumulation in fish.

Crustaceans, especially larvae are usually more sensitive to low concentrations of pesticides than other marine organisms. Lower growth and reproductive capacity in these organisms has been detected under sublethal concentrations of pesticides. In El Salvador, decreased shrimp yields probably resulted from the heavy use of pesticides in cotton farming during the 1960's and early 1970's (42).

Malathion concentrations of 0.017 and 0.02 ppm were acutely toxic for the crustacean Rhitropanopeus harisii (43). Even though Malathion decomposes at high temperatures, it might be highly toxic. 70-92% mortality has been observed in Calinectes sapidus (blue crab), at concentrations of 0.5 ppm (44). Residues of Malathion up to 48 hours after entering the estuary in Northwestern Florida were detected at concentrations of 2.67 ppm in tissue of living shrimp (45)

Concentrations of Heptachlor, Endrin, and Linndane in the range of 0.3-0.4 ppb killed or immobilized half of the adult commercial brown and pink shrimp exposed in 48 hour laboratory tests. Other chlorinated hydrocarbons including DDT, Chlordane, Toxaphene and Dieldrin showed similar effects at 1-6 ppb. Juveniles of the blue crab are about 100 times more resistant (40).

Few herbicides have been tested in shrimp, but are relatively low toxic to crabs. Acute and chronic toxicity of Propanil herbicide in Macrobrachium rosenberguii was tested, founding LC-50 concentrations for 24, 48 and 96 hours to be in the range of 12.5, 8.4, and 2.9 ppm respectively. Survival was 2.2% after 30 days exposure to 1 ppm Propanil (46).

Because of their habits and low toxicity tolerance, the commercial shrimps are particularly sensible to pesticide poisoning, especially the post-larval stages.

In El Salvador, studies have shown high levels of bioaccumulation of parathion in the fatty acid tissue of shrimp from Jaltepeque estuary (47)

More than 240 pesticides (technical grade) were tried in a bioassay program (40), and as many as 20% are toxic to shrimp at a level of less than 0.01 ppm.

(iv) Fish

Fish are generally more resistant to pesticides than shrimp and oysters, but are the most sensitive of all vertebrates to organochlorine pesticides. Fishes do, however, vary in their response to these toxicant. Because of their effects on the nervous system, it would be expected that pesticides cause behavioral pathology in fishes (41).

Fish are subject to bioaccumulation, such as Mullet through the ingestion of phytoplankton. Fish are somewhat more resistant to shrimp, and half of the juvenile stripped mullet tested with chlorinated hydrocarbons were generally killed in 48 hours at concentrations ranging from 0.0004 to 0.007 ppm.

BHC, Mirex, Keptone, Lindane and methoxychlor were exceptions, requiring concentrations 10-100 times greater.

Butler (48) reveals the acute toxicity of 240 pesticides to estuarine fish in concentrations of 0.1 to 0.01 ppm to 28-33% of the population tested.

If improper use and handling of pesticides takes place in the agricultural area to be irrigated, where the actual use of pesticides will probably be intensified with a year round cropping system, a diminution on the fish population, especially at the juvenile

stages and/or the bioaccumulation of pesticides will have a direct impact on the artisanal fisheries.

(v) Mollusks

The expected load of pesticide and herbicide residues is considered to have a detrimental effect on the mollusk population through bioaccumulation by the filtering feeding habit of the organism.

Tests have demonstrated the rather extraordinary capacity of oysters to store chlorinated hydrocarbon pesticides, when the concentration was only a fraction of a ppm. Residues were metabolized and flushed out of the oyster when the pollution terminated.

(vi) Shrimp Farming Industry

The existing 4,967 ha of shrimp ponds, with an estimated water draw out from the estuary of 3.3-5.5 MCM/day will have better salinity conditions during the dry season with the increased flow of 99 MCM/year of fresh water discharge programmed with the Simbocal tidal gate operation during the months of July through December.

This condition will improve individual growth rate, dry season overall production, and increased carrying capacity of the ponds, especially for the shrimp farms allocated in the upper part of the estuary, where water quality conditions are the worst.

Detrimental effects are expected in the post-larvae availability, resistance to disease, and other associated effects derived from the improper use of agrichemicals in the agricultural area if adequate control programs are not implemented.

(vii) Artisanal Fisheries

The artisanal fisheries are expected to receive a detrimental impact due to the agrichemical runoff, negative effects in the abundance, recruitment and quality of the fish for human consumption could be expected. Mollusks of commercial interest are expected to have a negative impact with the agricultural drainage situation because of bioaccumulation of agrichemicals.

(viii) Post-larvae collectors

The post-larvae collecting activity is particularly vulnerable to the negative impacts related to agrichemical runoff. Post-larvae will be the first resource to manifest a significative reduction of populations and abundance and/or an increased disease susceptibility, reduced growth rates and increased mortality rates.

(ix) Wildlife

Wildlife in general, including birds, mammals, reptiles and others, will be negatively affected in a long run, by bioaccumulation of pesticide residues through the ingestion of aquatic related feeds.

The environmental quality at the estuary is intimately related to the adequate use of pesticides, herbicides and agrichemicals in the agricultural area upstream of the estuary, and it should be stressed that the control in the type, amounts, application methods, and time of application is essential to reduce the expected negative impacts in the estuary area. A list with toxicity value of some common use pesticides is appended to this report.

Some control mechanisms for the proper and alternative use of pesticides and agrichemicals are suggested ahead.

(x) Mitigating measures to reduce agrochemical runoff

Potential Negative Impacts	Mitigatig Measures
1. Deterioration of water quality by increased fertilizer used	1. Controlled use of inorganic fertilizers: • Optimal timing and rate of application. • Soil analysis to determine rates of application. • Use of nitrogen fixing crops. • Use crop rotation to enhance soil composition • Minimize water use in crops to reduce leaching.
2. Deterioration of water quality by increased pesticide & herbicide used	2. Controlled pesticide use and distribution. • Optimal time and rate of application. • Pest assessment before application. • Avoid the use of Organochloride pesticides. • Reduce the use of Organophosphorus pesticides. • Restrict the use of Carbamate and urea based herbicides • Evaluate mixed cropping systems for weed and pest reduction. • Implement Integrated Pest Control training. • Avoid aerial spraying • Enforce pesticide legislation and regulations. • Tie farmer loans to proper pesticide use and monitoring. • Determine a buffer zone between agricultural area and estuary/wetland
3. Accumulation of pesticide & herbicide residues in estuary and wetland soils.	3. Mitigating measures under 2. are also applicable.
4. Bioaccumulation of pesticide & herbicide in aquatic fauna & flora.	4. Mitigating measures under 2. are also applicable.
5. Increased residues of pesticides, herbicides & fertilizers at shrimp farm intake pumps.	5. Mitigating measures under 2. are also applicable.

(xi) Control of pesticides and herbicides

Organophosphate, Carbamate, and synthetic Pyretroids are less persistent than the organochlorines, and therefore, pose less danger to the environment than the more persistent Organochlorines.

The Triazines, and miscellaneous pesticides generally are the most water soluble. Usually, the higher the water solubility, the lower the soil absorption. The higher the water solubility, the greater the threat to water systems. As soil absorption coefficient increases, the stronger the chemical is stored in the soil, which lessens the chance of polluting the water system.

A table with water solubility and absorption coefficient of pesticides is included in this study.

Concerning the disposal of containers and leftover pesticides, these should be buried in pits in the soil, about one half meter deep, at as high elevation as possible. Bottoms and sides of the pit should be lined with lime, carbon, charcoal, and/or organic matter such as leaves, straw, or plant debris. Any of these materials is a good absorbent and facilitates breakdown of the chemical. The pits should be refilled and mounded above ground level with soil. Empty paper containers and bags should also be buried in similar pits.

6.2.4 Permits and controls for shrimp farm development

Between 1984-1985 the Merchant Marine and Coastal Directorate for Fisheries (DIGMER) adopted new policies with decision-making criteria specific for shrimp mariculture. However, the majority of leases and operating permits were issued before this new criteria were put into practice.

The laws and regulations for the establishment of shrimp farms have a three step process for shrimp farm owners:

1- To Acquire a site for the farm:

This may include areas in the beach and bay zone that must be leased from DIGMER. Vacant upland can be purchased from the National Institute of Agrarian Reform, and the use of private upland for shrimp farms requires clearence from the Ministry of Agriculture (MAG).

Land beyond the highest tide mark is considered upland, and DIGMER is charged with issuing leases to individuals and corporations seeking to carry out activities in this zone, and leasing is administered by the Beach and Bay Department of the National Marine Directorate of DIGMER. The Military Oceanographic Institute (INOCAR) was assigned the task of mapping this coastal strip.

An individual is allowed to lease a maximum of 50 ha of the beach zone, while corporations are limited to lease up to 250 ha. Since a shrimp farm could include both beach and bay zone and uplands, its total size can be greater than the limits set in the lease. Alien citizens and corporations must also obtain authorization from the joint chiefs of staff and president of the republic. This applies to all foreign owned land within the 50 km belt inland from the shoreland.

After these requirements are met, the application for a lease is submitted to the General Directorate for Fisheries, as well as the Ministry of Industry, Commerce and Finance (MICIP), and the Ministry of Defense.

Once the DIGMER issues a favorable report, the two ministries issue a joint agreement which is published in the official register, and the lease will be valid for 10 years and is renewable.

2- Permission to operate the farm:

Once the site is acquired, permission to operate the farm must be obtained from the Undersecretary of Fisheries through the General Directorate of Fisheries. Specific criteria for approving shrimp farm applications were adopted in 1985.

The person requiring an operation permit must first demonstrate the possession of a lease, and IERAC grant, or a certificate from MAG for private lands.

The petitioner has to provide a detailed map of the farm project, showing the design of the wall sections, pump stations, water channels and rights of way. The minimum distance between a shrimp farm and an agricultural area is 500 m. Nursery ponds must be at least 4 m away from an agricultural area.

The director general of fisheries has 15 days to issue a report on the project. In case of a favorable one, the documents are sent to the undersecretary of fisheries resources, and the agreement is drawn up and signed by the undersecretary. The last step is the publication of the agreement in the official register.

(1) Upland vacant site titles

By law all vacant land in Ecuador is the property of the state and is under control of the Ecuadorian Institute for Agrarian Reform (IERAC). This agency is able to dispose of upland that, according to legal standards, is not performing its social function. The IERAC executive director is empowered to award property rights in upland areas when the grantee pays its estimated commercial value.

It is also possible for peasants, cooperatives and private persons to claim vacant land and receive an IERAC grant. IERAC also has the power to expropriate land and grant it to third parties.

Prior to issuing a grant for the upland area, a certificate must be acquired from the provincial agriculture and livestock directorate in the Ministry of Agriculture (MAG), stating that the land is not fit for agriculture.

(2) Private land

Sites for privately owned shrimp farms must also be certified by the Ministry of Agriculture (MAG) as unfit for agriculture before a shrimp farm operating permit can be granted from the General Directorate of Fisheries. When the lot for the shrimp farm is to be purchased or incorporated from a larger holding, causing a property subdivision, a permit from IERAC is required in addition to the certificate from the MAG.

6.2.5 Legal elements mangrove conservation

The Direccion Nacional Forestal (DINAF) is a department of the Ministry of Agriculture (MAG) in charge of the development of forestry resources, preservation of natural areas and outstanding wildlife, flora, landscapes, historical and archaeological relics, and aquatic systems.

The MAG in 1986 incorporated mangrove forests in the category of protected forests. In title II of the forestry law, "Natural areas and flora and wildlife" refers to the conservation of the natural forest and its administration through a set of management categories. Unit chiefs, forestry district directors and the national forestry director are entitled to pass judgment on actions against the law (ley C.L. 74,1981)

Decreto Supremo 2939-B, 1978 and law A.0036, 1979, ruled that DINAF should zone the mangrove areas in the country. Law D.E. 824-A, 1985, declares mangrove

conservation, protection and restoration as of public interest, and mangrove exploitation and clearing are forbidden.

(1) Laws and decrees

Decree # 002939-B, published in the official register # 676, October 23, 1978: Areas not defined by MAG cannot be exploited.

Law # 74, published in the official register #64, August 24, 1981: Forestry, natural areas and wildlife law.

Executive Decree #824-A: declares mangrove forest as of public interest.

Law # 91, published in the official register # 495, August 7, 1990: Declares mangroves as state property, non commerciable, and not subject to any kind of appropriation,and they could only be exploited in conformity with the law.

Executive Decree # 1529, published in the official register #436, February 22, 1983: General forestry law implementation.

Ministry Agreement # 498, published in the official register #591, December 24, 1986: Declares 362.742 ha of mangrove forest protected.

Ministry Agreement #238, published in the official register # 722, July 6, 1987: Reform to #498, declaring 306,802 ha of mangrove forest protected.

Ministry Agreement #0322, published in the official register #69, November 20, 1979: Declares Churute mangrove area as an ecological reserve.

For all laws, decrees and ministry agreements, the competence and jurisdiction of MAG and INEFAN are established.

6.3 Portoviejo River Estuary

6.3.1 Introduction

There exists very little documentation on the Portoviejo river estuary. This is a small estuary, with fringe mangrove vegetation located at both sides of the river mouth and extending to some 2 km upstream. The vegetation type has an estimated average of 5 m height, with an estimated density of less than 25%, and the area is the nesting ground for

several species of birds that can be seen in the border vegetation limiting the main estuary channel.

The oceanside area between the mangrove vegetation and the ocean is a coarse sandy beach area, subject to strong wave action and periodic sand movements. The sandy soil condition between the ocean and the estuary, as well as the narrowness of the sand belt exclude the area for massive construction purposes.

The natural beauty and aesthetic value of the area, as well as the closeness to the city of Portoviejo, and the dynamic beach conditions qualify the area as a potential recreational park for the local population.

6.3.2 Existing situation

(1) Mangrove area and mariculture

The mangrove area in Las Gilces is estimated by CLIRSEN (1) in 81.3 ha for 1984 and 1987, with no reduction in the covered area, while the shrimp farm expansion is estimated in 103.1 ha for 1984 and 128.5 in 1987, with an increment in 25.3 ha.

(2) Water quality

Water samples analyzed in December 1994 showed the following results:

Parameter	Concentration (mg/l)
BOD	12.33
Dissolved Oxygen	4.56
Phosphates	0.63
Dissolved solids	1,165.33
Ammonia	1.16

The BOD is above the maximum recommendable of 6 mg/l, and the dissolved solids are above OPS standards for public health (100 mg/l) established, and the reported dissolved oxygen content is low for aquatic life support.

The Portoviejo river is the recipient of point source pollution loads from the cities of Portoviejo, Roca Fuerte, Mejia, Sosote, El Higueron and Salinas. Only in Portoviejo, there is a sewerage treatment plant to covers 18% of the urban population. This study has determined that the water quality in the Portoviejo river could be serious, mainly due to the waste water discharge from Portoviejo city, and could be a sewer channel by 2020, with

BOD readings 2 times of that of the present conditions during the dry season, with significant impacts on the environment.

6.3.3 Proposed conservation program

No conservation efforts are reported for the Portoviejo river estuary. Figure 6.2. shows the delimitation of the proposed conservation area, which includes the area of mangrove forest and the intermediate sandy beach belt existing between the mangrove area and the ocean.

The basic concept is to declare this area as protected with controlled use as a public recreational park for the adjacent population of Portoviejo city.

The proposed conservation program includes the following actions:

1- Declaration of a protected area according to the existing legislation for mangrove areas stated in the previous section of this report, and defined in Fig. 6.2 appended, stressing the reasons for the need of a public recreational area, mangrove conservation and bird sanctuary condition of the existing vegetation.

2- Stopping of further shrimp farm development in the area, through the existing legal entities incharge and annotated in the previous section of this report.

3- Declaration of the beach area as of public interest for recreational purposes, and not adequate for constructions such as hotels, resorts and the like.

4- Improvement of the sewerage system for Portoviejo city is highly recommended to maintain adequate water quality conditions for recreation and ecosystem.

5- Promote nature oriented tourism for bird watching, mangrove ecology education and leisure, and tourism oriented towards shore fishing (casting), which already is a popular activity in the area.

6- Implementation of an Integrated Pest Management program for the agricultural area to be implemented with the project, and control of the types of pesticide used, as detailed for the Chone river estuary conservation program.

The following actions are recommended to characterize the use of the area and gain control over improper uses:

1- Setting signs and defining areas for camping and leisure.

2- Provision of picnic tables and benches, trash cans and potable water faucets along the designated areas for leisure.

3- Designation of a park guard to make sure that regulations are implemented.

   It is suggested that the existing family located at the entrance of the beach area be considered for this purpose, since they already live in the area, and have demonstrated conservationist attitudes towards the environment (W. Navas, personal communication).

4- Alerting of the incoming visitors to the park on the water quality conditions when not suitable for recreational activities.

Regular monitoring is recommended at least once a month for the water quality at the mouth of the estuary, according to the microbiological, BOD, DO, suspended solids, phosphates and ammonia nitrogen parameters and the results should be related to the comparable standards stipulated in the program for the establishment of water quality standards in this report.

6.4 Wetland Habitat for Chame

6.4.1 Introduction

In the area where the Carrizal and Chone rivers converge, between Simbocal and La Margarita, there are 21 permanent lagoons, some of them up to 350 ha in extension, and 57 wetlands, with an average area of 60 ha/each, which dry out during the dry season. Traditionally, these areas have been used for the small scale culture of Chame (Dormitator latifrons), and fresh water prawns (Machrobrachium sp) (29).

There is a latent pressure to occupy this areas for the culture of shrimp, due to the lack of space to expand this activity in the mangrove area, and the existing legislation forbidding mangrove deforestation.

The culture of Chame is an extensive practice, carried out by local farmers, which derive a significant income to local farmers. A total estimated of 1,380 ha of permanently inundated areas in Chone have been identified in previous studies (17).

A permanently inundated area is an area which retains water even during the dry season, and the main objective of the present program is to protect and maintain the areas permanently inundated, to ensure the continiuation of this ecosystem and the local Chame production.

6.4.2 Importance of wetlands

(1) Ecological importance

Wetlands as well as mangroves serve as biological filters for the improvement of water quality flowing through them. These are fragile ecosystems, and should be managed carefully.

The given importance to wetland areas is based on multiple criteria such as:

1- Aesthetic value of the landscape

2- Depuration area for waters flowing through them, especially runoff waters from the agricultural areas upstream Carrizal river.

3- Feeding habitat for migratory and resident birds, as well as for fish and crustaceans of commercial importance. Economic use of species such as Dormitator sp, and Machrobrachium sp is discussed ahead.

4- Recreational area for hunting, fishing and bird watching.

5- Buffer zones against floods. The existing wetland area is a natural buffer zone preventing a flood situation for the populations of Calceta, La Estancilla, Tosagua, Bachillero.

6- Preservation of biological diversity acting as breeding/feeding grounds.

7- Staging areas for migration routes, and grazing areas for wild fauna, such as ducks, seagulls, eagerts, otters, a variety of amphibians, reptiles and other mammals.

8- Habitat for unique plant species, such as Totora.

Some species reported for the wetland area are the following:

Scientific Name	Common Name
Fish	
Dormitator latifrons	Chame
Aequidens rivulotus	Vieja Azul
Hoplios microlepis	Guachiche
Gobious maculatus	Guabina
Crustaceans	
Macrobrachium sp	Camaron
Mammals	
-	Racoon
-	Otter
Reptiles	
Iguana	Iguana
Crocodilus acutus	Lagarto
Birds: Most of the birds reported for the estuarine areas are common visitors to the wetland area, a detailed list has been presented for the estuary area in this report.	
Plants	
Eichornia sp	Jacinto
Pistia stratiotes	Lechuguin
Ceratophyllum sp	-
Echinodorus aracteatus	Lentejilla
Egletes sp	Platanillo
Cyperacea (family)	Junco
Limnocharis sp	Guinea
Najas sp	-
Nymphaea sp	-
Salvinia sp	Helecho

(2) Socio-economic importance

The most important socio-economic and permanently inundated area within the estimated 1,380 ha (between Simbocal and San Antonio), is La Sabana, with an estimated area of 400 ha, where 90-100 families derive an income through the culture of Chame (PMRC/ZEM-Bahia personal communication)

The average number per family in the area of Tosagua has been determined as follows (6):

Number of Members per Family	Family %
1 - 5	57.14
6 - 10	38.10
11 - 15	4.76
Total	100

The estimated Chame production for La Sabana, per family per year for an average area of 5 cuadras/family (1 cuadra= 0.75 ha) is 30 Chame boxes/year, this means a production of 30 boxes for 3,75 ha/family.

The estimated number of fish per box is reported by CRM-PHIMA as follows:

Fish per Box	Percentage of Producers
Less than 100	15.15
100	9.10
110-130	45.45
140-160	12.12
180-200	12.12
300 or more	6.06
Total	100

The estimated weight of the fish is reported by CRM-PHIMA as follows:

Weight in grams	Percentage of Producers
Less than 250	45.45
251-500	54.55
Total	100

Based on the above information, we can say that the most probable number of fish per box is between 100-130 fish, the most probable weight is between 251-500 grams/fish, and the most probable weight of fish per box is between 25 -65 kg.

The average sale price for a box of Chame in December 1993 is 100,000 sucres, or US$51, representing an average income of US$ 1,530/family/year (=2,998,800 sucres/family/year).

The monthly family income reported for the area of Tosagua and the percentage of families receiving that income is the following (6):

Monthly Family Income x 1000 Sucres	Family %
50 - 100	21.43
101 - 150	2.38
151 - 200	14.29
202 - 300	30.95
301 - 400	21.43
401 - Plus	9.52

Comparing the income from Chame production (2,998,800 sucres/family/year) with the monthly family income reported for the area, the allocation of the Chame producing families is with the reported income for 30.95% of the families, earning a monthly estimated of 249,900 sucres/family/month.

The above data shows how the Chame producing families can allocate an income equivalent to the one received by 30.95 % of the families of the area, with the Chame production as a secondary activity, since the culture of Chame is done in an extensive and artisanal mode of production, where operational costs and maintenance are minimum, ie. no feeding or pumping costs involved.

This condition allows the Chame producer to dedicate most of his time to other activities such as farming, commerce or cattle raising, and thus derive a second income which will allocate this families in the 301,000-400,000 sucres/month income, approaching the highest average reported income/family in the area.

From the nutritional view point, Chame is an excellent protein supplement for the local population, equivalent to sardine, and well accepted as a regular food by the population.

Fish Type	% Fatty Acids	% Protein
Sardine	8 - 12	18 - 21
Mullet	3 - 5	18 - 20
Chame	0.5 - 2.5	17 - 20

Chame is a hardy animal, capable of withstanding more than 24 hours outside the water if maintained humid, facilitating the transportation and storage in an area where refrigeration and electricity is scarce.

From the socio-cultural viewpoint , this is a traditional activity practiced in the area for more than 30 years, and 92% of the existing culture area is located in the Chone and Tosagua areas with an estimated area of 913.74 ha (6).

6.4.3 Significant areas

The following areas have been reported as subject to inundation in the province of Manabi (17):

Type of Inundation	Area of Inundation (ha)	
	Chone	Portoviejo
Permanent	1,380	120
Seasonal	5,320	4,680
Occasional	8,010	590

The permanent inundation areas are areas which retain water even during the dry season. The seasonal inundation area is an area subject to inundation during the rainy season; and occasional inundation area is the area inundated in periods of extraordinary floods.

The purpose of the flood control plan with the project is to protect the areas of occasional inundation against extraordinary floods of reasonable magnitude, and at the same time to protect part of the areas of seasonal inundation to allow a more intensive use of the land. The purpose is also to protect and maintain the areas of permanent inundation, in view of their ecological and socioeconomic importance.

The most significant areas of permanent inundation located between Simbocal and San Antonio are the existing and reported (29) 21 permanent lagoons, located between Simbocal and La Margarita, including La Pampa de Vellis, and La Sabana, a permanent inundated area located between La Margarita and San Antonio with an extension estimated between 1,750 ha (estimated for a 25 year flood) and 400 ha during the dry season.

La Sabana is located at the highest elevation in respect to the permanently inundated areas located between Simbocal and La Margarita.

6.4.4 Water dynamics

The water inflow to the permanently inundated areas has several sources:

1- Precipitation during the rainy season. The annual average precipitation for the area is 1,000-1,200 mm; and the annual average evapotranspiration is estimated in 1,000-1,100 mm.

2-Runoff from adjacent hills located north-east(NE) of la Sabana, and north, north-west (N-NW) of La Pampa de Vellis.

3-Floods caused by the Carrizal river for la Sabana, and floods caused by the Chone river for La Pampa de Vellis and adjacent areas between La Margarita and Simbocal.

The partial drainage of these areas occurs during the dry season, because of the difference in elevation between La Sabana and Simbocal, and eventually to the Chone river estuary. The magnitude of the drained volume is dependent on the surface water elevation maintained at Simbocal during the dry season by means of the artificial handling of the Simbocal tidal gate.

In the situation with project, where the flood condition of the Carrizal river is to be regulated, the remaining sources of water inflow will be the runoff and the rainfall, and the water supply scheme to be proposed in the conservation program for the area of La Sabana. It is considered that the adequate management of the Simbocal tidal gate is of vital importance to maintain the water level in this area during the dry season, and a detailed program for the operation of the Simbocal tidal gate is discussed further in this report.

The condition for the areas located between Simbocal and La Margarita are similar, except for the fact that the Chone river is not subject to flood control with the project condition, so these areas will still have the possibility of inundation by floods of the Chone river given that:

The maximum flow in La Segua for a 50 year return period is 720 m^3/sec and 580 m^3/sec for a 25 year return period, and the carrying capacity for the Chone river in this area is only 150 m^3/sec.

6.4.5 Existing uses

The use of the wetlands for artisanal production of fish and its socio-economic importance has been discussed. Other uses related to the area of interest are:

1- Short cycle agriculture in the adjacent areas of the water body, comprising seasonal crops such as watermelon, cantaloupe, tomatoes, peanuts, cassava, corn.

2- Cattle grazing areas adjacent to the body of water.

3- Artisanal fisheries of prawns (Machrobrachium sp)

4- Housing allocations of permanent dwellers in adjacent areas to the inundated area.

6.4.6 Existing conflicts

1- The agricultural activities adjacent to the inundated area are carried out during the dry season, and are expected to be done year round with the project condition. Conflicts arising between the agricultural practices and the wetland ecology and its human use are the following:

   i) Pesticide and agrochemical runoff from the agricultural area towards the inundated area could affect the trophic chain through bioaccumulation.

   ii) Maintaining an adequate surface water elevation at Simbocal during the dry season for the conservation of the inundated area promotes excessive soil humidity and development of diseases such as fungus to agricultural crops in the adjacent areas.

2- Shrimp farm expansion is exerting a pressure to move upstream of Simbocal, due to the lack of space to expand in the estuary area, and the existing legislation forbidding the cutting of mangrove.

3- Technified Chame farms are colonizing adjacent areas of the wetlands, and are carrying out massive dirt movement, invading potentially floodable areas, and eventually generating effluent high in BOD and nutrients that could affect the wetland.

6.4.7 Existing conservation efforts

In the proposed management plan for the Chone river estuary, PMRC has considered the existing wetlands, proposing the following actions:

1- To research the ecology and promote the sustainable use of the wetlands, implying:

i) A characterization of the flora and fauna.

ii) Research in the recycling of nutrients and pollutants

iii) Establishing the ecological relationship with the adjacent systems

iv) Detecting the critical points affecting the survival of the system

v) Clarify the life cycle of the main species inhabiting the wetlands

2- Specific actions proposed are:

i) Research on the biology of the species traditionally used for extensive culture in the wetlands, to evaluate their culture at a mayor scale

ii) Implementation of a management plan for the wetlands

iii) Structuring of an educational program to diffuse the importance of wetlands and promote their preservation and sustainable use.

6.4.8 Proposed conservation plan

The proposed conservation plan is mainly directed towards implementing strategies for the preservation of La Sabana, since this area is the one to be directly affected by the project through the regulation of flow in La Esperanza. As previously stated, the area of La Pampa de Vellis and adjacent areas between Simbocal and La Margarita will still be subject to inundation by overflow of the Chone river.

The successful implementation of the conservation program is directly related to the declaration of the wetland area shown in Figure 6.3, elevation 6.0 m, as a protected area of restricted use, based on its ecological and socio-economical importance. CRM should in cooperation with PMRC and the ZEM Bahia-San Vicente-Canoa approach the legal authorities related for this purpose.

The inclusion of the wetland area in the Ramsar List, developed through the Ramsar convention (the United Nations convention on wetlands of international importance) is

suggested to be promoted by CRM and PMRC in a joint effort to declare this area of international importance, and give status to the area for a better implementation of the conservation plan. The list is available from the World Bank Environmental Department.

(1) Hydrology

The proposed limit for the wetland conservation area is EL. 6 m above sea level, which will allow for the adequate hectarage and water depth for the artisanal culture of Chame.The stored volume in the wetland area at this elevation is estimated in 16 MCM.

A detail hydrological study is appended in the basic study for the operation of the Simbocal tidal gate. Based on this study it is concluded that the maximum storage water capacity at Simbocal is determined by elevation 3 m above sea level, which is the elevation at the crest of the retention dike designed by CRM. This possibility allows for the storage of 3 MCM, inundating 120 ha of wetlands during the dry season, this is not enought to maintain the wetlands proposed below elevatin 6 m, therefor, it is important a new design of the dyke to reach the proposed elevation up to El.6 m., this way, 1,170 ha of wetland can be maintained for Chame culture.

(2) Agrochemical runoff

The water quality management scheme is basically directed towards the reduction of the toxic pesticide runoff coming from the adjacent agricultural areas. The following actions are recommended:

1- Implementation of an integrated Pest Management program, for the reduction in the use of pesticides, herbicides and fungicides. This strategy is detailed for the estuary conservation program outlined in this report.

2- Reduction in the use of inorganic fertilizers by the use of nitrogen fixing crops, crop alternation, and soil analysis prior to fertilization.

(3) Use of adjacent land

The existing conflict between farmers and Chame culturists due to the water saturation of the soil when the water level at Simbocal is adequate to prevent wetland drainage can be attenuated if the farmers in the adjacent areas will grow water resistant plants, such as rice, which under inundated conditions will generate better yields than in a non inundated condition.

Rice is a common culture in Rocafuerte, not in the Tosagua area. None the less the adjacent areas to the wetland have ideal conditions for this crop, and the rice milling facilities to process are located in Rocafuerte, at 39 km from Tosagua.

It is recommended to incentivate the culture of rice in the area, where 2 crops a year could be obtained, while today only one agricultural crop during the dry season is obtained.

(4) Aquaculture farms colonizing

The change in the use of the land adjacent to the wetlands to the establishment of shrimp and/or Chame technified farms must be stopped.

Technified farms require high capital investment and will displace local farmers with low credit capability from their habitat, and subsistence resources, as it is the case for the artisanal fishermen and the shrimp farms in the estuary.

Technified aquaculture farms must operate with high yields to pay operational and investment costs, so their effluent will be highly loaded with organic matter and residual feeds. This effluent will inevitably reach the wetlands as they are in a lower elevation, and water quality conditions could deteriorate affecting local traditional resources and ecosystem.

It is recommended to attend the authorities and legislation exposed under the estuary management program, in an effort to discourage further colonization of aquaculture farms in the area. There is already a technified Chame farm under construction on the road side of the Pampa de Vellis.

(5) Support of existing efforts

Existing conservation efforts by PMRC must be supported by CRM in the implementation and management of the conservation program for the wetlands.

The existing mechanism is the participation of CRM in the Zonal Committee which meets every 3 months to discuss projects and their implementation.

7. OPERATION PROGRAM FOR SIMBOCAL TIDAL GATE

7.1 Simbocal Tidal Gate

The existing tidal gate at Simbocal (Station 5) is a wooden structure which has not been properly managed and operated. As was explained in Chapter 6, there is a need to conduct the right operation of this gate for the benefit of the Chame cultivators and farmers downstream the Chone river between La Margarita and Simbocal, and for the preservation of the wetlands.

In 1988, CRM prepared a new design of the gate (Station 5a), and it has not been implemented yet. The designed structure is a 49 m long structure located across the Chone river allocating 7 gates, which are 7 m long by 4 m wide each. The gate is intended to operate during the dry season for tide control, and during the rainy season, for the spillover of extraordinary floods in a safety way.

7.2 Main functions of the Tidal Gate

The following objectives are expected to fulfil the management program of the Simbocal Tidal Gate:

(a) During the dry season (July to December), the gate will allow the inflow of additional fresh water of 99 MCM from the transbasin, for the shrimp farm in the Chone river estuary. For this, the gate should be operated in the low tide, tuice a day for one hour every time , operating at its 35% in capacity. The remaining time, the gate must be kept closed for the following reasons:

i) To allow the rise of the water level for irrigation and aquaculture purposes and for the maintenance of the wetlands.

ii) To avoid the salt intrusion.

(b) During habitual rainy seasons, from january to june, the gate will allow the outflow of fresh water, retaining at the same time the required volume for the upstream uses.

In extraordinary floods, the gate should be fully open to minimize the partially inundated areas along the lower reach of the Chone river, allowing the outflow of the 25, 50 and 100 years return period floods.

7.3 Tidal Measurement

Six observation points were established between Salinas (Station 1) and Simbocal (Station 5A), as shown in Figure 3.4. Tidal measurements were conducted at the 6 stablished points, simultaneously, for the next 48 hours during the months (December 1993, June and August, 1994). Results of such measurements are in Tables 7.1 and 7.2, and in the Figures 7.1, 7.2, 7.3, and 7.4.

The tide reaches the Simbocal gate and it must be taken into account the operation manual for it to fulfil the planned objectives and proper management.

7.4 Salinity Measurement

Bottom and surface measurements of salinity were conducted in the estuary besides the tidal measurements, at the same 6 sampling station, in june and august, 1994, in a periodic measurement of 48 hours. Results are summarized in Tables 3.9. A full study of salinity is appended in the Program 3 (Water Quality Analysis and Prediction).

A summary on the results of the study is shown hereafter:

(a) Measurements in June (at the end of the rainy season)

- The salinity content at Simbocal, stations 5 and 5A, is low and within the range of allowable limits for irrigation and potable supply

- The longitudinal gradient of salinity (ds/dx) is 1.55 ppm/km, ocurring between Bahía de Caráquez and Salinas.

- Salinity changes directly with the height of the tide, that is, the greater the tidal height, the greater the salinity and viceversa.

(b) Measurements in August (dry season)

- The higher longitudinal concentration gradient of salinity is relocated upstream the estuary, and it is found between Ariaga and Barquero a value of 2.76 ppm/km.

- The expected salinity level at Simbocal, stations 5 and 5A, will go beyond 0.5 and 5 ppm, respectively, which is more than the allowable limits for irrigation and potable water.

During the dry season, the operation of the gates must provide security against the salinization of the vast areas upstream Simbocal as well as to mantain or improve the actual ecological conditions.

7.5 Flooded Area Upstream Simbocal Tidal Gate

Flooded areas and storage capacity against the flood level were calculated from the existing maps, as shown below:

Flood Level (m.a.s.l.)	Flooded Area (ha)	Storage capacity (MCM)
3	120	3
6	1,170	16
7	1,750	29
8	2,350	48

As a result, it is necessary a new design and the construction of the tidal gate at Nuevo Simbocal, to allow the overflows of extraordinary floods of 100 years of return period to stop the floodings of agricultural areas, and to control, during the dry season, the salinization of the irrigation areas. Besides, to re-design the dyke planned by the CRM, to reach the 6 m proposed in this study and to preserve the 1,170 ha of wetlands for the culture of Chame.

8. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)

8.1 Introduction

The present study is conceived as a first step of a management and monitoring plan, and should be understood as such. Programs and basic studies are well detailed in the different sections of the study, and the present section acts as a summary, with the objective of clarifying the environmental aspects to be managed and monitored, and to delineate a framework through the technical and financial viewpoints.

8.2 Institutional Aspect

The JICA study team (51) has delineated a structural organization consisting of three units, namely Environmental Management Unit (MAU), Environmental Monitoring Unit (MOU), and Laboratory (LAB). MAU has the function of overall management of the EMMP, including inter and inner institutional implementation of each plan and program. MOU has the planning and execution functions of the various kinds of studies, monitoring plans or programs in accordance with the policies decided by MAU. LAB has the roles of the physical, chemical, bacteriological and pesticide analysis for water and soil, and the Rd study for the establishment of appropriate EMMP of the project. Figure 8.1 shows the organizational structure of EMMP.

8.3 EMMP Administrative Costs

The annual cost for administration by CRM for EMMP has been estimated in US$ 207,000, as shown below.

Administrative Cost estimate for EMMP

Item	Unit Cost/Year (US$)	No.	Total Cost/Year (US$)
i) Personnel			
- Professionals	5,000	5	25,000
- Assistants	4,000	10	40,000
- Others	3,000	6	18,000
ii) Office Costs			
- Vehicles	6,000	4	24,000
- LAB equipment	-	1	50,000
- Others	-	1	50,000
Total:			207,000

Note: Overhead is not included because they are public offices

8.4 Technical Aspect

Based on the present and previous environmental studies, the following programs are selected for the management and monitoring process to be implemented by CRM in accord with the overall project scheduling of activities:

8.4.1 Program for establishment of water quality standard

(1) Introduction

The objective of the program is to establish water quality standards and criteria as a management goal and target.

The program for establishment of water quality standard is detailed under section 4 of this study, section 3 Water Quality Analysis and Prediction is complimentary to section 4.

Water quality and suitability for irrigation and potable water uses are of primary importance in the context of the transbasin project, and so the present program is of utmost importance for the monitoring of the other programs related to the prevention of the water quality deterioration.

(2) Items to be monitored

As a minimum, but not restricted to them, the same parameters as 4.5.1 should be measured:

(3) Monitoring stations

Monitoring stations to be surveyed should be the same ones as the ones surveyed during the present study to give continuity and a to take advantage of the baseline data generated in this study. Location of the sampling stations (17 stations) is detailed in the schematic map presented in Figure 3.1.

(4) Monitoring periods and frequency

Monitoring should be undertaken during both rainy and dry season, each sampling campaign will consist of 3 replicas per station, and samples per replica should be spaced 1-2 days.

Regular monitoring should be conducted at least once per month, starting the first year of construction and continuing for 5 years after construction.

After the first five years, regular monitoring should be conducted at least 6 times per year as a minimum (depending on future water quality conditions)

Biological parameters to be monitored are stated only for the reservoir impoundment areas, these parameters will contribute to the evaluation of the trophic condition of the reservoirs.

Biological parameters should be measured any time besides the above mentioned schedule, when conditions indicate a deviation towards a higher eutrophication stage. These biological parameters will provide an indication of such stage.

(5) Staff requirements and indicative cost

Personnel	Indicative Cost US $/2 years	
	Foreign Currency	Local Currency
Laboratory Director (Analytical chemist)	-	36,000
Laboratory analyst	-	14,000
Laboratory assistant	-	7,000
Secretary	-	4,000
Miscellaneous	-	2,400
Field collectors (4)	-	9,600
Total Personnel	-	73,000

(6) Equipment, supplies and indicative cost

Item	Indicative Cost US $
	Foreign Currency
Spectrophotometer	3,000
PH-meter	1,500
O-hauss balance (0.001 gr)	600
O-hauss balance (1.0 gr)	300
Analytical balance	1,500
Magnetic stirrers	1,000
D.O meter	1,500
Salinity meter	600
EC-meter	1,500
Thermometers	400
Glassware	3,000
Furnace	1,500
Incubator	2,000
Microscope	1,500
Stereoscope	1,000
Filters	1,000
Chemicals (1 year supply)	5,000
Pesticide Analysis (200 samples)	40,000
Air condition units	2,000
Refrigerators (2)	1,000
Distilled water apparatus	1,500
Pick-up truck	15,000
Office equipment	8,000
Computer/Printer/ Software	4,000
Others	3,000
Total Equipment/Supplies	101,500

(7) Implementation schedule

The laboratory is to be implemented in early 1995, and the program is to begin in 1995 and continue with the monthly sampling schedule until the year 2000, from 2000-2005 sampling is reduced to 6 campaigns per year.

8.4.2 Program for prevention of detrimental effects of agrochemicals

(1) Introduction

Training and education in the use and hazards of pesticides and Integrated Pest Management (IPM) will greatly contribute to modify the actual agricultural practices, relaying heavily in the use of pesticides.

Experience has shown that the best way to avoid pest resistance and also to increase and sustain agricultural production is to apply a variety of control tactics, including biological (predator, parasite, and pathogenic natural enemies of pests), cultural, genetic, physical, and legislative.

IPM crops are regularly monitored for presence of pests, natural enemies, and other factors that may influence a decision concerning a control measure. Pesticides are applied only if pests populations have exceeded unacceptable density levels and there is a reasonable assurance that pesticide use will be profitable and non disturbing to the environment.

(2) Items to be covered

A pesticide management course should include at least the following topics:

- The Pesticide Problem on a World Scale and in Ecuador
- Agroecosystems Concepts
- Integrated Pest Management Concepts
- Pesticide Toxicology: Emphasis on Locally Used Pesticides
- Pesticide formulation
- Elements of Chemical Control
- Pesticide Poisoning and First aid
- Worker Protection
- Pesticide Levels
- Precautions in Preparing and Spraying Pesticides
- Disposal of excess Pesticides and Pesticide Containers
- Pesticide Spill Cleanup

- Pesticide Storage Emphasis on Planned Purchases to Reduce Carry over of Products.
- Pesticide Application Equipment
- Calculation of Pesticide Dosage
- Calibration of Application Equipment, Field Calibration Exercise
- Factors Affecting Foliar Applied Pesticides
- Factors Affecting Soil Applied Pesticides.

(3) Program implementation requirements

The development and implementation of an IPM program will be a long term goal, and it will require research on specific crops and pests to provide alternative tactics of biological control. The implementation of the Integrated Pest Management program should take into consideration at least the following:

1. Identification of the nature and magnitude of existing pest management problems.

2. Assistance in design and identification of a testing/evaluation program on appropriate pesticide use and efficacy.

3. Design field trials and evaluation which will include some form of crop insurance for participant farmers.

4. Identification, training and use of appropriate personnel to monitor and evaluate field testing programs.

5. Training in the safe use, handling, application, and storage of pesticides.

6. Sensibilization of farmers as to the advantages of an integrated pest management program.

(4) Items to be managed

The field testing programs should include one or more studies related to:

1. Use of parasites, predators, and biorational pesticides as alternate pest control agents.

2. Investigation related to crop loss assessment and establishment of protocol treatment threshold.

3. Use of crop varieties which show acceptable levels of resistance to local pests.

4. Effectiveness of crop rotation to reduce nematodes, disease, and soil pests.

5. Maximize the use of mechanical control based on labor availability

6. Evaluation of the status of pesticide resistance and alternative control measures.

(5) Staff requirements and indicative cost

A budget for an IPM program should consider the following:

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
Technical Assistance (IPM specialist)	50,000	
Technical Assistance (Ecuador) To conduct field plot studies 12 person months/yr for 3 years		60,000
Research Technicians (Ecuador) 3 persons/yr for 3 years		24,000
Total Staffing	50,000	84,000

(6) Equipment, supplies and indicative cost

Equipment/Supplies	Indicative Cost (US$) Foreign Currency
Vehicles (2)	26,000
Transportation Expenses @ $1,000/yr	3,000
General Supplies	12,000
Computer Hardware & Software	5,000
Pesticide Application Equipment	4,500
Nematode Laboratory Equipment	45,000
Maintenance/Operation	9,000
Meteorological Monitoring Equipment	10,000
Test Plot Rental	4,500
Operation and Maintenance (Equipment and Vehicles)	6,000
Laboratory analysis	15,000
Audio Visual Equipment	5,000
Total Equipment/Supplies	145,000

The requirements for a monitoring program to implement controlled pesticide use by farmers is considered below, samples should be shipped to a commercial laboratory in the U.S., whose credentials are recognized, and multiresidue methodology, as used by FDA Regional Surveillance Laboratories, should be applied, or to a competent laboratory in Ecuador.

The requirements for a monitoring program are listed below:

Item	Indicative Cost (US$) Foreign Currency
Training of Inspector	$2,500
Transportation	none
Freezer for Sample Storage	700
Sample shipping Containers	900
Shipping Charges	1,200
Chemical Analysis(100 samples) over 3 years	20,000
Total Estimated	25,300

(7) Implementation schedule

The IPM program should be implemented one year before completion of the project construction, and continue for 2 years more during the operation phase of the project. Tentatively staring in 1999, and continuing until the end of 2001.

8.4.3 Program for plant biomass removal from La Esperanza impoundment area

(1) Introduction

Plant biomass from the impoundment area of la Esperanza must be removed before reservoir filling to avoid eutrophic or hipereutrophic conditions of water quality during reservoir and transbasin project operation.

(2) Items to be managed

Extraction of trees, brush, shrubs and other vegetable material should be extracted from the impoundment area.

(3) Items to be monitored

The elevation at which deforestation is being carried should not exceed maximum water elevation proposed for the impounded water. The deforestation process should be monitored to avoid extraction of trees above this limit elevation.

(4) Monitoring period and frequency

Monitoring should be done continuosly while the loggers are extracting trees from the area. Surveys should be carried out by designated persons at least twice a week on each sector of the area.

(5) Staff requirements and indicative cost

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
Four (4) forest guards for one year period	-	24,000
Total Personnel		24,000

(6) Equipment, supplies and indicative cost

Equipment/Supplies	Indicative Cost (US$)
	Foreign Currency
4 Horses	500
4 Saddles	500
4 compasses	100
4 Altimeters	200
Others	500
Total Equipment/Supplies	1,800

Plant extraction cost has been estimated by CRM in US$250,000.

(7) Implementation schedule

Cleaning of vegetable biomass should be carried during the dry season to avoid fallen trees and brush to be carried downstream to the dam site during the rainy season. Cleaning should be finished before reservoir filling, so it is estimated that extraction should start in the dry season of 1994, and the work should be finished by the end of the dry season of 1995.

8.4.4 Program for aquatic weed control in reservoir area.

(1) Introduction

Two strategies have been identified to control the aquatic weed infestation at Conguillo inlet, the short term strategy consisting in the physical isolation of the inlet adjacent area to avoid the introduction of weeds into the tunnel, when the later is operating, as shown in the design works for the Daule-Peripa tunnel inlet, and the medium term strategy, which considers the coordination with CEDEGE in terms of applying the same succesful methods and procedures they have been actually practicing.

(2) Items to be managed

- Prevention of the aquatic weed Eichhornia sp dispersal and colonization in La Esperanza and Poza Honda reservoirs with the transbasin project
- Control of the existing population growth at Conguillo inlet.
- Prevention of valve clugging at Conguillo-La Esperanza diversion tunnel

(3) Items to be monitored

- Existing area coverage of the aquatic plant in Daule Peripa reservoir
- Existing natural predators in the established plant population
- Procedures used by CEDEGE for the weed control in Daule-Peripa

(4) Monitoring period and frequency

Monitoring should be done at least every 2 months through a general recognaissance trip through the resrvoir to evaluate coverage area.

(5) Staff requirements and indicative costs

Staff requirements and indicative costs for the aquatic plant control, in the short term strategy are included in the construction cost for the transbasins, because the mecanical devices designed are part of the inlet works for all transbasins. Those devices must be constructed six (6) months before the beginning of the transbasin operation.

For the medium term strategy, consisting on the same succesful practices implemented in the Daule-Peripa reservoir, a 5 years plan is proposed (1996-2001), including, manual extraction, mechanical control, chemical control and hydraulic control (evacuating the plant over the spill weir), in coordination with CEDEGE and applying the following costs.

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
An (1) Agronomist Engineer US$ 18,000/year	-	90,000
Two (2) Assistants US$6,000/year each person	-	60,000
Total estimated		150,000

Unit cost to carry out the control is estimated in US$1,500/ha of weed, with an average quantity to be controled of 200/ha/year, which means US$300,000/year, giving a total of US$1,500,000 during the five (5) years of the program. These costs are to be

included in the anual maintenence cost budget of CRM and should not be included in the total cost of EMMP.

8.4.5 Program for reforestation and land use control around the reservoir areas

(1) Introduction

The eutrophication study carried out by CRM-INERHI-CONADE-OEA (32) determines that by 1983 already the mayor factors affecting the eutrophication process are the agricultural and cattle raising activities, which provide for 74% of the phosphorus load.

The objective of the present program is implementing land use control and reforestation practices in an effort to reduce the phosphorus load arriving the reservoir from the adjacent areas. Erosion and sedimentation are also to be reduced with the present program.

Detailed description of the different items to be implemented, as well as the coordination between CRM and CEDEGE, related to the policies, procedures and experiences that CEDEGE is carrying out in these matter in Daule-Peripa, can be found in Section 5 of this report.

The present program is strongly associated with a vigilance component to assure the control on the use of the land, the following requirements are suggested to comply with the vigilance component:

Vigilance-zone A

Rangers with CRM authority are to be permanently allocated in the area, the function of these rangers will be to make sure that the established policies and regulations for the immediate areas surrounding the reservoir are followed by the local population and visitors.

It is advisable that the designated rangers comply with the following requirements:

- That they have a technical level education in forestry, agronomy or the like.
- That they regularly attend available workshops carried out by Fundaci—n Natura, Non Guvernmental Organizations or others, in the areas of natural resources,

environmental issues related to water resources, deforestation, and conservation areas.

- That they belong to the nearby communities and are aware of the local environment, problems, and socio-cultural context.

- That they will be willing to live in the area, and show an interest in the preservation of the natural resources.

Some of the functions assigned for these rangers are suggested but not restricted to the following:

- Maintain people, cattle, hogs and other animals away from the water source of the reservoir.

- Provide maintenance to fences, signs and picnic areas of Zona A. Recollection and disposal of solid waste accumulated in this area.

- Make sure that the docking facility, truck and bus stop are complying with the pre-established rules.

- Cooperate in the resettlement of people dwelling in this area.

- Alert visitors and tourists of the proper use of the recreational areas

Vigilance for zone B & zone C

The forest guards will have the following requirements fulfilled:

- They will bear authority delegated by CRM and INEFAN to issue fines, confiscate axes, saws and other equipment involved in deforestation.Actions to this matter are to be coordinated with the local police station where confiscated equipment is to be secured.

- They will be willing to receive training workshops carried out by ONG's or institutions of the like, on forest protection, and environmental issues regarding soil conservation, erosion, forest fires, and natural resources and environmental education in general.

- They will be willing to live in the area and enforce the regulations among the population.

The following functions will be attributed to them:

- Distribute warnings among the population and alert on the forest regulations and status of the area in respect to the regulated use of the forest areas.

- Confiscate all instruments used for cutting wood which are caught in the hands of the offender.

- Issuing fines and fees for offenders

- Periodic patrolling of the area by horse, allocating infractor and avoiding of forest fires.

(2) Items to be managed

Zone A:

- Docking facility at Poza Honda
- Animal husbandry
- Washing clothing

Zone B:

- Improvement of pasture areas
- Agroforestry
- Forestry and pasture land
- Agroforestry and pasture land
- Forestry plantations
- Row plantations as sediment barriers
- Sewerage and waste disposal of human settlements
- Environmental education component

The previously mentioned activities are detailed in section 5 of this report.

Zone C:

- Forest reserve area vigilance

(3) Items to be monitored

- Liquid, solid, and fuel disposal from docking facility
- Animal access to reservoir
- Possible new settlements in zone A and zone c
- Forest cover in all zones
- Uncontrolled burning of shrubs
- Forest fires
- Human settlement or resource extraction from forest
- Land use condition in all zones

(4) Staff requirements and indicative costs

The following types personnel are required:

1- Agronomist, forestry or natural resource management oriented professional (Project Manager)
2- Agronomic technician
3- Sociologist or social worker with community organization experience
4- Social communication specialist
5- Topographer
6- Forest ranger
7- Forestry technician
8- General worker or peon
9- Secretary
10- Chauffeur

The personnel requirements are the following for the reservoirs:

Professional Category	Number of Professionals Required						Total
	Poza Honda Zone			La Esperanza Zone			
	A	B	C	A	B	C	
1		1 For All			1 For All		2
2	-	1	-	-	2	-	3
3	-	1	-	-	2	-	3
4	-	1	-	-	1	-	2
5	-	1	-	-	1	-	2
6	1	1	1	1	1	2	7
7	-	1	-	-	2	-	3
8	1	2	-	2	4	-	9
9		1 For All			1 For All		2
10		1 For All			1 For All		2

The estimated cost for the personnel required is as follows:

Professional Type	Indicative Cost (US$/2years)	
	Foreign Currency	Local Currency
Project Manager (2)	96,000	
Agronomic Technician (3)		21,600
Sociologist (3)		21,600
Social Communicator (2)		14,400
Topographer (2)		12,000
Forest Guard (7)		35,000
Nursery Expert expatriate for 6 months (ENSO Forest Development quotation)	60,000	
Mecanic for Nursery		400
Nursery Staff	50,000	
Forest Technician (3)		18,000
General worker (9)		23,400
Secretary (2)		5,600
Chauffer (2)		4,800
Total Personnel	206,000	156,800

(5) Equipment, supplies and indicative costs

The following machinery and equipment is required to carry out the tasks:

Item	Amount Required			Indicative Cost (US$)
	Poza Honda	La Esperanza	Total	Foreign Currency
Budget for 2 tree nurseries:				
Greenhouse and shaded area	1	1	2	140,000
Buildings	2	2	4	80,000
Irrigation System & Seed Storage	1	1	2	130,000
Tools,Equipment	1	1	2	120,000
Growing Containers	1 set	1 set	2	120,000
Chemicals (1 year)	1 set	1 set	2	15,000
Freight/insurance from Finland	1 set	1 set	2	70,000
Tractor	1	1	2	42,000
Civil works	*	*		70,000
Contingency				57,000

*Nursery budget by ENSO Forest Development-Finland

Item	Amount Required			Indicative Cost (US$)
	Poza Honda	La Esperanza	Total	Foreign Currency
Office Equipment:				
Desk	6	9	15	1,500
Chairs	11	14	25	400
Shelves	2	2	4	100
File	1	1	2	400
Drawing table	1	1	2	200
Work table	1	1	2	200
Type writer	2	4	6	600
Miscellaneous:				
Aerial Photos for forest cover evaluation	1 set	1 set	2	25,000
4WD Truck	1	1	2	40,000
Horses	6	9	15	3,000
Video camera	1	1	2	2,000
VHS	1	1	2	2,000
Xerox copier	1	1	2	6,000
35 mm camera	1	1	2	600
Slide projector	1	1	2	400
Slide screen	1	1	2	300
Color TV	1	1	2	2,000
Calculators	1	1	2	100
Portable generators	1	1	2	2,000
Portable PC	1	1	2	2,000
Printer	1	1	2	1,500
Binoculars	1	1	2	300
Compass	1	1	2	100
Topographic level	1	1	2	5,000
Tape measure	1	1	2	100
Radio communication	1	1	2	1,000
Portable radio	2	4	6	2,000
Machetes	6	10	16	200
Shovels	6	10	16	300
Bars	3	6	9	100
Picos	3	6	9	200
Wheel barrel	3	6	9	500
Hammers	4	6	10	100
Total Equipment/Supplies				943,200

The budget includes provisions for the environmental education component, which is viewed through the following activities with the community:

Technical assistance programs
Visit to experimental farms
Workshops and lectures
Using audio-visual aids
Direct involvement in specific projects

The strategies to be followed in the approach towards the involvement of the community and their education are the following:

1- Identify the activities they do, how they do it and why they do it, hat are there agronomic practices and their animal husbandry practices, locate their farm and characteristics in a map.

2- Identify their problems, concerns and regroup these in categories by similarity of cause.Find out their opinion on the transbasin project, and how do they think it will affect them, identify their concerns.

3- Identify community groups already established, like churches, clubs, associations, school, etc.

4- Identify occurring leaders in the community and their roles and activities.

Once the problems affecting the community are known, as well as their social structure and existing groups, the people and groups should be approached with specific ideas and programs previously defined. Filling out basic and specific needs detected is a way of starting a relationship, like a blackboard for the school, transporting people when the public bus fails, removing a fallen tree from the road etc.

Once the initial steps of approach are met, groups of different age and sex are to be approached with specific ideas and programs, and some of the strategies to follow are:

1- Incentivate the formation of groups such as clubs, associations, cometies around specific ideas or programs such as: organic waste recycling, grass covering of the football plaza etc.

2- Promote activities in which they perceive a material or quality gain, and let them take the initiative, let them do it. Use a simple language when communicating, it is useful to develop a glossary of terms used by the community, to use their language when communicating to them.

3- Explain the importance of the project to them and how it will positively affect their life. Explain the importance of the project to the area, ecology, and how this is related to them.

4- Explain the need for their participation and initiative to develop the programs. Explain and show examples of increased production in crops and cattle when using the proposed methods, the possibilities of getting credit and the medium and long term benefits of the strategies for conservation.

5- Start with projects that will give them an economic incentive, such as seed collection of endemic trees to be bought by the project, offering work to start the reforestation with trees and bamboo etc; make lists of people interested in reforestation.

(6) Strengthening of environmental management capabilities

The following institutions are existing entities with experience in different strategies related to production improvement in the areas of cattle raising, agroforestry, annual and permanent crops among others.

Cooperation and information knowledge transfer of the existing experiences is considered important to update the current local experience and adapt this knowledge to the specific conditions in the reservoirs.

Ministry of Agriculture (MAG), is the ministry with the functions of formulating and directing, and implementing the national policies on natural resource management, research, production and commercialization of forestry, fisheries and animal production.

Technical programs within the MAG include programs in coffee, bananas, cotton, seeds, animal health, soil conservation, forestry and oil producing plants

Instituto de Investigaciones Agropecuarias (INIAP), where research and experimental studies are being carried out for local species of trees. The purpose for the creation of INIAP was to increased agricultural yields, to generate technology on soil conservation, research on specific plants and offer better alternatives for food production. there is a research station in

Portoviejo, with an experimental farm: La Margarita. programs developed by INIAP include: cereals, vegetables, corn, grasses, cacao, coffee, fruit trees, cassava, and soil conservation.

Instituto Ecuatoriano Forestal y de Areas Naturales y Vida Silvestre (INEFAN) organism dealing with reforestation and extension services, actually carrying out programs oriented towards soil conservation and agroforestry, financing of forestry oriented programs and seed distribution.

Instituto Ecuatoriano de Obras Sanitarias (IEOS), organism dealing with the public sanitary system and sewage disposal systems in rural areas.

Successful trials have been carried out by INEFAN and PMRC-ZEM with the reforestation of degraded slopes in the hills around the Chone estuary. The experience involves the planting of Leucaena sp. following curves at given elevations.

CRM will coordinate and supervise the programs and activities with the support of MAG, INEFAN and INIAP, and will be responsible for the administration of the project

The MAG, and INIAP and INEFAN will have important roles in the support in the projects related to forestry plantations, agroforestry, pasture land improvement and through the research activities and soil conservation practices to be developed.

Each agronomic technician will be incharged of a group of farmers, and will visit each one of them once every two weeks, to provide information or implement practices related a specific program.One day per week will be dedicated to discussion and planning with the rest of the support staff specialists.

The extension work will follow a pre-established sequence such as:

- Area recognizance to detect the real situation, needs, priority areas of work, human resources and disposition. The production processes are identified and understood, planting seasons, agricultural practices etc. A mapping of the location of the different farmers and farms will be helpful.

- Identify the farmer problems and rank their priority, organize and group the problems by similarity of origin in an effort to detect common denominator causes.

- Explaining and making concience to the farmer about the soil loss and erosive process occurring when agricultural practices are carried out without adequate

conservation techniques. For direct communication, the reference to evident situations such as drought, pests and diseases are recommended. the use of videos, slides, field demonstrations are good tools.

- Once the farmer has made concience of the problems, it is important to approach solutions in a practical manner, mechanisms such as audiovisuals, trips to experimental farms, and the establishment of a sample area prepared by the technicians is a recommended activity for the farmer to experiment, evaluate and remember.

The INIAP has developed demonstrative areas where the farmer can evaluate the amount of soil loss by erosion using local materials and simple techniques. favorable results have been reported in this experience.

The last step in the extension service is the supervision of the techniques strategies put to practice by the farmer. This activity is to be carried out by the technician through regular visits. the size of the lot is not so important as the quality of the techniques applied. It is important that the farmer is able to compare the former practices with the new ones, to evaluate results and have a witness to compare with.

Control mechanisms must be developed to evaluate the program activities. the follow-up of activities will be related to the annual plan of activities developed, and to the monthly report of each technician. Once a year, an evaluation of the project should be made, the purpose is to evaluate the fulfillment of the ends, and the impact caused by the introduction of new practices,and technological packages. The results coming out of this evaluation will serve as feedback for next year program.

(7) Implementation schedule

- Environmental education component could start by 1995
- Nursery construction for tree seedlings could start by 1995
- Land use change projects could start by 1996, at completion of the tree nursery
- Vigilance component could start by 1995

8.4.6 Program for reforestation and conservation of the Chone river estuary

(1) Introduction

Any proposed conservation program has to be in accord with the existing efforts and organizations, such as the ones being implemented by PMRC-ZEM-Bahia-San Vicente-

Canoa, for the improvement of the ecosystem. a conservation program dealing with the mangrove forest must approach the efforts through an integral approach to the overall ecosystem.

For these reasons, the proposed conservation program is based in supporting the existing efforts, and pretends to implement corrective measures in the different components of the system.

(2) Items to be managed

The proposed conservation program is outlined in section 6.2.3 of this report.

- Reforestation of shrimp farm channels
- Management of the Simbocal tidal gate
- Reforestation of adjacent areas
- Environmental education
- Agrichemical runoff from adjacent areas
- Sustainable estuary resource use
- Improvement of sanitary condition
- Protected areas management
- Efficiency in mariculture practices to reduce effluent load
- Technical assistance to nursery aquaculturists to reduce effluent load

(3) Items to be monitored

- Mangrove forest coverage area
- Mangrove growth in shrimp farm channels
- Mangrove growth in mudflats
- Shrimp farm effluent discharge quality
- Forest cover in adjacent areas
- Estuary water quality including pesticides in water and mollusks
- Tidal, salinity and flow velocity measurements

(4) Monitoring stations

For water quality monitoring, stations are indicated in Figure 3.1.

For Tidal, salinity and flow velocity measurements, stations are indicated in Figure 3.4.

Existing mangrove area coverage is indicated in Figure 6.1.

(5) Monitoring period and frequency

Monitoring should take place during rainy and dry season.

Water quality parameters, frequency and sampling locations are indicated in the program for establishing a water quality standard.

Tidal, salinity, and flow velocity measurements should also occur during dry and rainy seasons, at least once a month, during two consecutive days. Salinity and flow velocity should be recorded for top and bottom in each consecutive station.

Forest coverage should be monitored once every 3 years for the first 9 years, and once every 5 years there after through areal photo survey.

(6) Staff requirements and indicative costs

Professional Type	Indicative Cost for 3 years in (US$)	
	Foreign Currency	Local Currency
Estuary Ecology Especialist for 5 months (Director)	50,000	
Assistant to the Program Director	90,000	-
Aquaculture Especialist (2)		144,000
Asistant of Aquaculture (2)		36,000
Forestry Especialist		36,000
Forestry Asistant		18,000
Sociologist		10,800
Social Worker (4)		10,800
Social Communicator Especialist		10,800
Draft man		7,200
Labor (10)		45,000
Secretary		4,200
Chauffer		4,200
Total Personnel	140,000	327,000

(7) Equipment, supplies and indicative costs

Item	Indicative Cost (US$) Foreign Currency
Outboard motor boat (2)	5,000
DO meter	1,500
Refractometer	500
Topographic tape	300
Edafic equipment	2,000
Miscellaneous forestry	5,000
Bivalve reproduction equipment	15,000
Audivisual equipment	4,500
Aerial photos (1 set)	7,000
Office equipment	5,000
4 WD Truck	12,000
Pesticide analysis 100 samples	20,000
Current meter	10,000
Motorcycles (5) @ $1,500	7,500
Nets	3,000
Computer/printer & software	4,000
Tree seedling area	25,000
Total Equipment/Supplies	127,800

For agrichemical runoff mitigation, the IPM program has been outlined with separate costs.

For the New Simbocal tidal gate operation a separate budget is considered ahead.

(8) Strengthening of the management capability

Section 6.2.2 of this report details the existing management efforts being conducted by PMRC in the Chone river estuary.

Section 6.2.4 of this report details the permits and controls for shrimp farm development, and section 6.2.5 details the legal elements of mangrove conservation in Ecuador.

The area comitee (Comite Zonal) is one of the organisms created under the management plan established by PMRC. The Comite Zonal is conformed by CRM and 18 other representatives of communal groups, schools, municipal and provincial authorities, portuary authorities, and governmental institutions such as IERAC, CETUR, IEOS, INEHRI, DINAF.

The Comite Zonal meets every three months, and it is the context to discuss problems and solutions, programs and projects to be implemented. PMRC will finance or execute the projects approved by the Comite Zonal. This is the existing framework for CRM to participate in the estuary management plan.

(9) Implementation schedule

The present program for the reforestation and conservation of the Chone river estuary could start implementation by early 1995.

8.4.7 Program for conservation of the Portoviejo river estuary

(1) Introduction

No conservation efforts are reported for the Portoviejo river estuary. Figure 6.2 shows the delimitation of the proposed conservation area, which includes the area of mangrove forest and the intermediate sandy beach belt existing between the mangrove area and the ocean.

The basic concept is to declare this area as protected with control use as a public recreational park for the adjacent population of Portoviejo city.

(2) Items to be managed

- Stopping further shrimp farm development
- Pesticide residue runoff
- Camping and leisure areas
- Mangrove conservation area

(3) Items to be monitored

- Water quality conditions including pesticides and bacteriological

(4) Monitoring stations

As indicated in Figure 3.1

(5) Monitoring period and frequency

For pesticides an physical-chemical as indicated in the program for establishing a water quality criteria.

(6) Staff requirements and indicative costs

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
Park guard	-	1,200
Maintenance (2)	-	1,200
Carpenters (4)	-	3,200
Total Personnel		5,600

(7) Equipment, materials and indicative cost

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
Construction materials	-	5,000
Miscellaneous tools	-	5,000
Signs	-	700
Trashcans	-	500
Fresh water line	-	2,000
Water pump, tank	-	2,000
Toilets	-	3,000
WC-Housing	-	4,000
Outboard motor boat	-	2,000
Total Materials		24,200

(8) Implementation schedule

The present program for the conservation of the Portoviejo river estuary could start by early 1995.

8.4.8 Program for conservation of wetlands and Chame habitat

(1) Introduction

The purpose of the flood control plan with the project is to protect the areas of occasional inundation against extraordinary floods of reasonable magnitude, and at the same time to protect part of the areas of seasonal inundation to allow a more intensive use of the land. The purpose is also to protect and maintain the areas of permanent inundation, given their ecological and socioeconomic importance.

(2) Items to be managed

- Water elevation at wetland area
- Agriculture practices in adjacent areas
- Agrichemical residue runoff
- Simbocal tidal gate
- Technified aquaculture farm colonization
- Pest control in agricultural areas

(3) Items to be monitored

- Water elevation at Simbocal tidal gate
- Pesticide residues
- Biodiversity composition
- Benthic macroinvertebrate composition

(4) Monitoring stations

Pesticide sampling should occur at 5 random stations inside the wetland area of La Sabana, where water depth is approximately 1.0 m.

Biodiversity composition should be carried out throughout the wetland for terrestrial and amphibian organisms, and a significative area should be sampled for aquatic organisms.

Benthic macroinvertebrate sampling should occur at 5 random areas of La Sabana wetland, and each station should cover at least 1.0 ha.

(5) Monitoring period and frequency

- Water elevation at New Simbocal should be permanently monitored, specially during the dry season, to avoid drainage of the wetland. Details are given in the operation program for Simbocal tidal gate.

Pesticide residue analysis should be done at least twice a year during dry and rainy seasons.

Biodiversity composition for aquatic and terrestrial organisms should be carried twice a year during rainy and dry seasons.

Benthic macroinvertebrate composition will provide a pollution index, and should be carried out at least twice a year during dry and rainy seasons.

(6) Staff requirements and indicative cost

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
Aquatic biologist 4 man-month/year for 3 years	72,000	24,000
Biologist on site for 3 years		36,000
Miscelaneous (2) for 3 years		7,200
Total Personnel	72,000	43,200

(7) Equipment, supplies and indicative cost

Item	Indicative Cost (US$) Foreign Currency
Outboard motor boat	2,000
Glassware	1,000
Pesticide analysis	
100 samples	20,000
Stereoscope	500
Basic lab. equipment	2,000
Binoculars	200
Signs	1,000
Motorcycle	1,500
Total Equipment/Supplies	29,200

(8) Strengthening of the environmental management capabilities

The existing legislation related to Protected areas and Wildlife is appended in this report, some of the main issues stated in the appended law are summarized as follows.

According to the law, it is the duty of the executive director of INEFAN, to declare a given area as protected. In case of urgency, with a preliminary study, an area could be declared protected, until the pertinent studies are done.

Entities related to the municipal development, like CRM are allowed to operate and manage protected areas. INEFAN will be responsible of the approval of the management plans for established protected areas.

The INIAP will inform INEFAN about the management plans and environmental evaluations of the areas managed by other institutions.

Activities of individuals within the protected areas are limited by the law and the corresponding environmental management plans, private properties within these areas could be expropriated by INEFAN, according to the common norms for this procedure.

The execution of activities not allowed within the protected area will be sanctioned with fines of 1-10 minimum salaries. When these actions generate pollution or destruction of natural resources, fines could be as much as the double cost of the damages caused, according with the evaluation done by INIAP.

(9) Implementation schedule

Implementation for the present program could start by early 1995 in respect to the pesticide monitoring and the biodiversity and benthic macroinvertebrate inventory.

Management related to the Simbocal gate operation should start as soon as the new Simbocal gate is operating, this is early 1998.

8.4.9 Program for the redesign, implementation and operation of the new Simbocal tidal gate

(1) Introduction

The existing conflicts between shrimp farmers, Chame aquaculturists and agriculture farmers in the Chone river estuary, wetlands of La Sabana and irrigation area upstream

Simbocal are centered in the operation of the Simbocal tidal gate, and provide the need for an re-design, implementation and operational program of the tidal gate.

The purpose of the present program is to alleviate this conflicts and coordinate the required water supply for the different users without interfering with the others.

(2) Items to be managed

- Re-design of the new Simbocal gate
- Construction of the new Simbocal gate
- Operation of the new Simbocal gate

(3) Items to be monitored

Once the new Simbocal gate is constructed, the following monitoring during operation should be done:

- Releasing of fresh water flow for shrimp farms during dry season
- Maintenance of appropriate water level upstream Simbocal to avoid wetland drainage and to use the water in agriculture
- Releasing of unusual river discharges
- Salinity, tidal flow, and tidal height and schedules

(4) Monitoring stations

Monitoring for salinity, tidal height, flow velocity and tidal schedule should be done according to stations shown in Figure 3.4.

Monitoring for the tidal gate operation should be done permanently on the site location of the tidal gate.

(5) Monitoring period and frequency

Monitoring for the proper operation of the Simbocal tidal gate should be done continiously during 24 hours a day. Detailed specifications and operation timing are explained under section 7.2 of this report.

Monitoring for salinity, tidal flow, height and schedule is specified under the program for the Chone river estuary.

(6) Staff requirements and indicative cost

Personnel	Indicative Cost (US $)	
	Foreign Currency	Local Currency
Gate operators (4)		7,200
Total Personnel		7,200

(7) Equipment, supplies and indicative cost

Personnel	Indicative Cost (US $) Foreign Currency
Outboard motor boat	2,000
Cronometro	500
Refractometer	500
Measurement rulers	200
Total Equipment/Supplies	3,200

Civil work cost was estimated by CRM in US$ 1,842,800. Flow meter cost is considered under the Chone estuary program.

(8) Implementation schedule

The redesign of the gate could start by early 1995, and the implementation could start by early 1996, it is estimated that construction period could be 2 years.

A summary of the indicative cost for the EMMP implementation is shown hereunder.

Indicative Cost Summary for EMMP

Program		Item	Indicative Cost (US$)	
			Foreign Currency	Local Currency
A-Water quality:				
	8.4.1	National Personnel	-	73,000
		Equipment	101,500	
	8.4.2	National Personnel	-	84,000
		Foreign Consultant	50,000	
		Equipments	170,300	
	8.4.3	National Personnel	-	24,000
		Equipment	1,800	
	8.4.4	National Personnel	-	150,000
B-Conservation & protection				
B-1 Reservoir areas				
	8.4.5	National Personnel	-	156,800
		Foreign Consultant and Local experts	206,000	
		Equipments	523,200	
		Civil Works	420,000	
B-2 Estuary & Wetland		areas		
	8.4.6	National Personnel		327,000
		Foreign Consultant & Local expert	140,000	
		Equipment	127,800	
	8.4.7	National Personnel	-	5,600
		Equipment	24,200	
	8.4.8	National Personnel	-	43,200
		Foreign Consultant	72,000	
		Equipment	29,200	
C-Simbocal Tidal Gate Operation				
	8.4.9	National Personnel	-	7,200
		Equipment	3,200	
Total estimated EMMP Cost			1,869,200	870,800

Total estimated cost to implement the EMMP with foreign and local currency composed of the following costs:

- Administrative and Operational Costs of EMMP is US$207,000/year , and
- Cost of EMMP Programs is US$2,740,000 for a period of five to seven years from 1995.