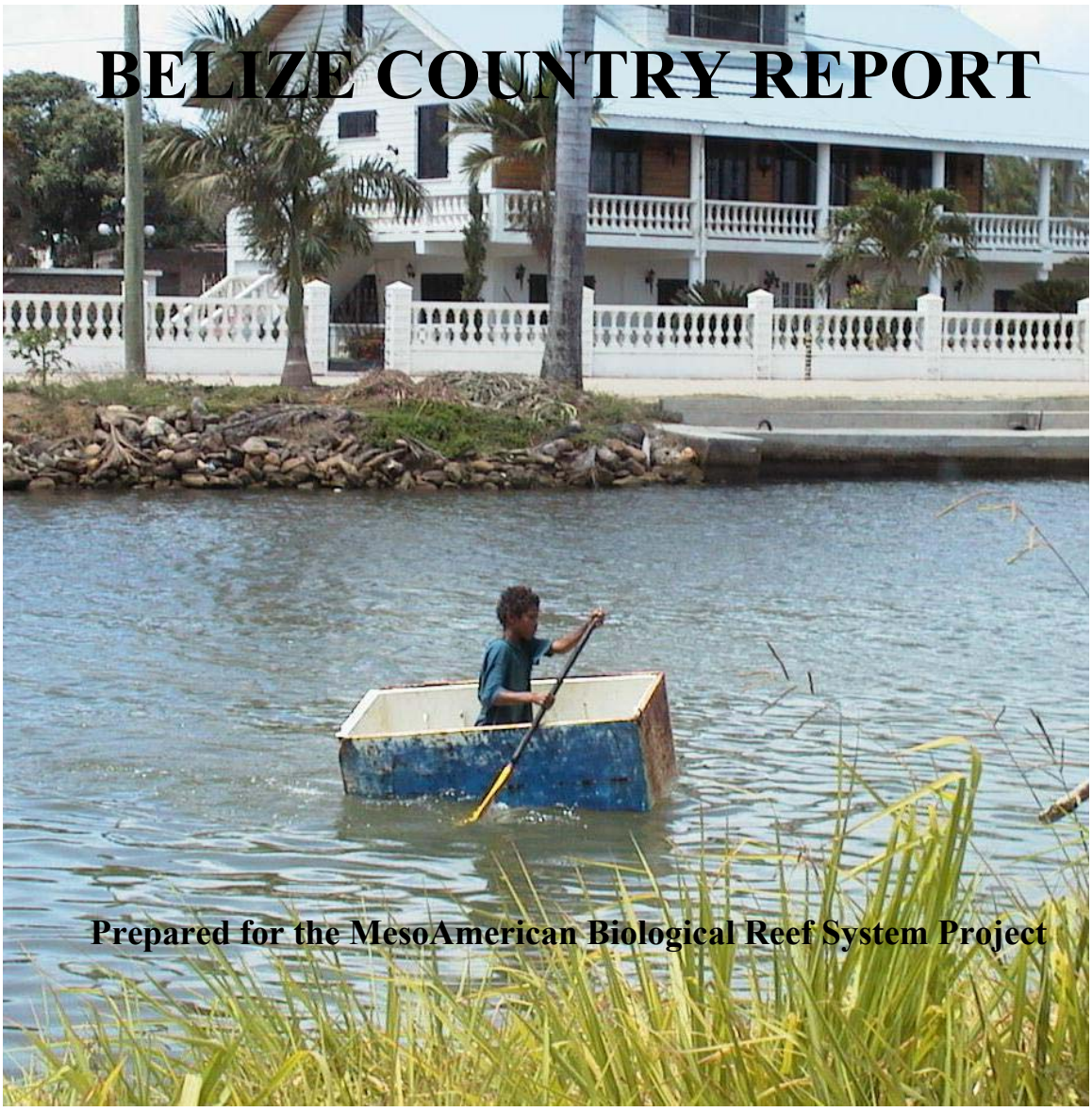
DEVELOPMENT OF A MARINE POLLUTION MONITORING PROJECT FOR THE MESOAMERICAN BARRIER REEF SYSTEMS PROJECT (MBRS)



BELIZE COUNTRY REPORT

Prepared for the MesoAmerican Biological Reef System Project

By: Mario Fernandez

August 2002

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EXECUTIVE SUMMARY

This report is being conducted through a contract between the Meso-American Biological Reef System Project (MBRS) and Mario Fernandez. This report will assist in the development of a Synoptic Monitoring Program on Marine Pollution for the MBRS Region. Belize is one of the four countries that make up the MBRS Region. This report provides information on sources of marine pollution as well as the technical, analytical, legislative, and administrative capacity to deal with the management of marine pollution.

The Fisheries Department is the designated focal point for the MBRS. At the same time other Agencies such as the Coastal Zone Management Authority/Institute, The Department of the Environment, and the Public Health Bureau should play a role in the overall monitoring program.

Belize is a small country with a population of around 240,000, of which roughly half live in urban areas and half in rural areas. It has a very young population employed in agriculture, tourism, and the service sector. The GDP in 2000 stood at approximately US$450,000,000. Belize has an agrarian based economy. Agricultural products accounted for about 90% of exports. Its industrial sector is limited to light manufacturing industries such as battery manufacturing, beer and rum production and feed processing. Raw material are all imported and assembled locally. Large industries include the processing of sugarcane in sugar at the Tower Hill factory in Orange Walk and the processing of Citrus into concentrate at Del Oro's Alta Vista and Pomona Processing Facility in the Stann Creek District. Packaging of bananas occurs in the Stann Creek District also

The Department of the Environment, established in 1992, has overall responsibility for the control and prevention of pollution of the environment. Several legislation have been enacted including the Pollution Regulations and the Effluent Limitation Regulations. These regulations set limits for the discharge of effluents and pollutants into the environment. The Schedule to the Pesticides Control Act (1992), has a list of hazardous substances which are prohibited from dumping into the sea.

The lack of a metallurgical industry in Belize greatly reduces the amount of intentional and non-intentional releases of heavy metals. There are no waste incinerators and all waste is burned in the

open air. Medical incinerators are also small in size. There are no measures in place to prevent leaching from these waste dumps.

The present legislation makes specific mention of pollution of the sea.. The legislative capacity is there to deal with marine pollution from point source pollution. The Fisheries Department as well as the Department of the Environment will need to be strengthened to be able to effectively reduce sources and instances of marine pollution.

There are a number of Institutions with the capability to conduct physical, chemical, and biological analysis of water samples. These include the Ministry of Health, The Coastal Zone Management Authority/Institute, Department of the Environment and the Belize Agricultural Health Authority. Parameters which can be analyzed include pH, water hardness, alkalinity, turbidity, total dissolved solids, total suspended solids, color, salinity, conductivity, temperature, Dissolved Oxygen, Biological Oxygen Demand, nitrates, phosphates, chlorides, sulfates, chlorophyll A, total coliform and feacal coliform. These parameters would be those to be included in the Synoptic Monitoring Program.

There is a need to hire and train personnel to carry out the monitoring program. The personnel in the various labs are presently fully occupied and do not have the time to additionally collect samples. Reagents will also need to be obtained. Additionally a boat and boatman need to be procured. A reliable transport has to be made available so as to minimize breaks in the monitoring program. A cooperative agreement may be possible with one or more of the Institutions already carrying out monitoring of the marine environment. For example TIDE in Punta Gorda possesses a boat and some field testing equipment as does the CZMA/I.

1. POLLUTION MANAGEMENT IN BELIZE, NATIONAL PROFILE

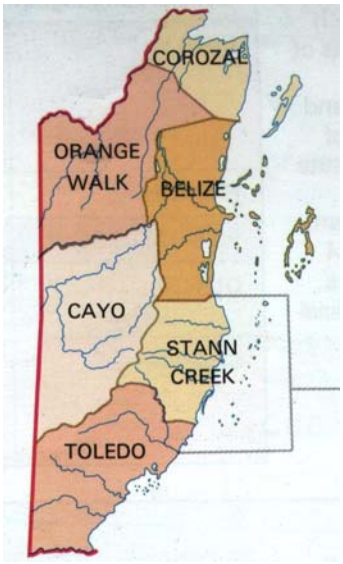
Belize does not produce any chemicals and all its requirements are met through imports. The principal agencies for the control of chemicals in Belize are the Department of the Environment (DOE) and the Pesticides Control Board. The Environmental Protection Act provides for the DOE to monitor all sources of pollution and to recommend measures for its control and management (section 4 of the EPA). To date a Pollution Regulations has been enacted which provides the DOE with the authority to halt or restrict any activity which may result in pollution to the environment. These regulations also set limit for the amount of releases allowed for various industries. The Effluent Limitation Regulations sets the maximum release levels of effluents for industries which release effluents into the environment. The Schedule to the EPA gives a list of hazardous substances which may not be dumped into the sea.

The Pesticides Control Board is responsible for the management of all aspects of pesticides in Belize. The Pesticides Control Act gives the Board the authority to ensure that pesticides are properly managed from the time they are imported or manufactured to the time of its final disposal. The Pesticides Control Board registers all pesticides for use in Belize but has little capacity to follow up on the use of pesticides after they are imported into the country.

While legislation is in place to address the management of marine pollution there is a lack of other services such as a proper laboratory or an environmental health monitoring system. The laboratories in the country are limited in their analytical capacity. The water lab of the Ministry of Health can only carry out minimal testing of physical and chemical parameters of liquids such as pH, dissolved oxygen, and elemental analysis. The BAHA lab at present is only capable of conducting qualitative analysis using the CHARM System for organophosphates and carbamates. The Laboratory Services will have to be upgraded to have the analytical capability to test for marine pollutants.

2. COUNTRY DEMOGRAPHIC PROFILE

Belize is an independent nation since September 11th 1981, with a democratically elected parliamentary government and is also a member of the British Commonwealth of Nations. Named by the British as British Honduras, it was renamed Belize in 1973. Belize covers an area of 8,866 square miles and is situated on the east coast of Central America on the Caribbean Sea (map I). Belize is bordered by Mexico to the north and Guatemala to the west and south. Approximately 40% of Belize's total land mass is dedicated as nature reserves.



The climate is considered tropical with temperatures ranging from 20^0 C to 40^0 C, with a mean temperature of 32^0 C. The main industries are agriculture, fisheries and eco-tourism.

The 2000 Census puts the population at 240,204 with a 2.7% growth per annum. The urban population is 48% (114541) and the rural is 52% (125663). The country's labour force is estimated at over 88,000.

Sixty nine percent of the population reported that they have at least a primary school education. The literacy rate has been placed at 72%. There is one University, the University of Belize (UB). The official language is English, however other languages are also spoken including Spanish, Chinese, Garifuna, German, Maya Kekchi, Maya Mopan, Maya Yucateca, Hindi, and Creole. Approximately 80% speak English and 55% speak Spanish

The total domestic export in 2000 was $389 million. The Gross Domestic Product for the year 2000 was US$447,964,000 with a 10.4% growth rate. The percentage contribution to GDP from the primary activities are: agriculture (22.2%), Forestry and Logging (14.7%), Fishing (5.1%), Manufacturing including utilities (18.7%), construction (6.7%) and mining (0.8%). The major exports of Belize are sugar, citrus, bananas, and shrimp (map 2). The major imports are fuel and

finished goods. Most of the exports are to USA, United Kingdom, Canada and CARICOM. Major imports are also from the same countries.

3. LEGISLATION DEALING WITH MARINE POLLUTION

The following laws and regulations directly or indirectly deal with control and management of marine pollution.

- Environmental Protection Act (1992), -Pollution Regulations, No. 56 of 1996, Environmental Protection (Effluent Limitation) Regulations, No. 94 0f 1995
- Public Health Act, Public Health Regulations
- Belize Port Authority Regulations
-Solid Waste Management Authority Act
- Fisheries Act, Fisheries Regulations
-Coastal Zone Management Act
- Water and Sewerage Act

ENVIRONMENTAL PROTECTION ACT, NO 22 OF 1992

The Environmental Protection Act establishes a Department of the Environment with responsibility to enforce the implementation of the Act and its Regulations[6]. The EPA gives the DOE broad regulatory and enforcement authority for prevention and control of environmental pollution.

Activities presently performed by the DOE include, monitoring of effluent discharges, site investigation of alleged environmental pollution, ensuring EIA's are completed for development projects requiring and EIA, and licensing companies that may produce effluents.

Section VI of the EPA allows for regulations specifying permitted levels of pollutants, emissions, discharges or deposit of pollutants into the environment. The Pollution Regulations enabled under this section gives the permitted levels of pollution arising from various industries.

Part IV of the Act provides for regulations controlling dumping at sea. Section 13(1) prohibits the dumping or disposal of any garbage, refuse, toxic substance or hazardous waste in any place where directly or indirectly it may pollute water resources or the environment while section 15 imposes restrictions on the loading of hazardous substances on any ship, aircraft, or tanker.

SOLID WASTE MANAGEMENT AUTHORITY ACT, No. 13 OF 1991

The Solid Waste management Authority Act provides for collection and disposal of solid waste. A Solid Waste Management Authority has been established with powers to declare service areas. Waste collection is mandatory in these service areas. The Authority is seeking to have a central waste collection facility situated somewhere near mile 24 on the Western Highway. To date this controversial site has not been developed. It is expected that there will be a designated area for the collection of hazardous material at this location.

PUBLIC HEALTH ACT

The Public Health Act gives the Chief Medial Officer general powers to inspect water and sewerage works. The Act contains a range of provisions relating to requiring privy accommodation for dwelling houses; regulating lavatories, wash houses. The Act prohibits the erection of privies over sea, river, or canal without permission.

PORT AUTHORITY ACT

The Act and its Regulations prohibit any person from depositing, placing, or discharging polluting matters into the territorial waters of Belize.

WATER AND SEWERAGE ACT

The Act vests all public property in all water supply areas in the Authority and empowers it to make bylaws to prevent waste, contamination of water supply, and the pollution of any water whether surface or underground.

FISHERIES ACT

The Fisheries Regulations are basically to protect and regulate the Fisheries Industry. It has provisions for the regulation of all watercourses in the country. Also incorporated in its regulations 66 of 1977, there are laws governing the declaration and incorporation of regulations for Marine Protected Areas and for Aquaculture Operations and Fresh Water Fishing.

Activities presently performed by the Fisheries Department include monitoring of coral reefs and fish populations in the marine reserves, with some minor water quality parameters being checked. These parameters are basically checked for fresh water areas, especially if near to an aquaculture site where water is abstracted from a source for use on a farm.

Although there exists no set parameters legally for these tests, the general parameters for the best management of these are utilized. In other instances, the parameters set by DOE are utilized.

COASTAL ZONE MANAGEMENT AUTHORITY ACT

The Coastal Zone Authority Act instituted the Coastal Zone Authority and Institute (CZMA/I). The CZMA/I is charged with the job of ensuring that the activities on the coast, development, dredging, etc., are conducted in an environmentally sustainable manner.

The CZMA/I presently performs water quality monitoring along a large area of the coast of Belize, including major areas on the inhabited islands and the atolls. It conducts constant monitoring of development areas or projects.

Although the Act does not give legislative authority to the CZMA/I, they get the authority from DOE, Fisheries, Public Health and other Departments that do not have the ability to conduct the test themselves.

4. INSTITUTIONS WITH ROLES AND RESPONSIBILITES IN MARINE POLLUTION MANAGEMENT

Institutions which have a role or responsibility for the management of marine pollution includes the Department of the Environment, The Fisheries Department, Public Health Department and Coastal Zone Management Authority/Institute.

DEPARTMENT OF THE ENVIRONMENT

The Department of the Environment is mandated by the Environmental Protection Act the overall responsibility for the control, prevention and management of pollution. This includes pollution of the marine environment. Present activities of the DOE includes monitoring effluents from industries, investigating cases of marine, estuarine, and riverine pollution, and initiating cleanup up measures in case of oil pollution. Under the EPA two relevant pieces of regulations have been enacted. These are the Pollution Regulations and the Effluent Limitations Regulations. The Pollution Regulations prescribe the level of pollution permissible from various activities while the Effluent Regulations prescribe the type and quantity of effluents from industries into any waterbody. Any industry which release effluents into the environment has to obtain a License from the DOE to discharge such effluents into the environment.

The DOE's pollution prevention strategy includes issuing effluent permits to all industries accompanied by quarterly monitoring by the industries. It also requires certain activities to prepare and Environmental Impact Assessment before construction can begin. Site visits are also conducted to determine compliance with the Environmental laws.

PUBLIC HEALTH DEPARTMENT

The Public Health Department has, as one of its responsibility to ensure that all refuse, garbage, or waste is removed from residential areas to a designated landfill site. This includes residential waste and medical waste. The responsibility of the Public Health Department extends to investigating and taking action concerning any matter which may be designated a public health risk. For example cases of sewage disposal in rivers and the sea is investigated. The Department does not have a unit specifically for this function but is instead treated on a case by case basis.

THE FISHERIES DEPARTMENT

The Fisheries Department has the responsibility of protecting the fishing industry. One way of doing this is by creating marine reserves such as the Hol Chan Marine Reserves. These reserves are regulated by Law and include a prohibition on the discharge of waste in the reserve. While the Fisheries department is not particularly involved in monitoring for pollution levels it regularly does monitoring of the reef and other marine environment which may be useful in determining any changes in the health of the environment.

COASTAL ZONE MANAGEMENT AUTHORITY/INSTITUTE

The CZMA is charged with the management of the coastal resources including such developments as coastal subdivisions and dredging. While they do not have an enforcement capability, their monitoring and investigative role is important to other agencies who can then take appropriate actions. In this respect the CZMA/I works closely with other Agencies when dealing with pollution cases.

None of the agencies mentioned above has a unit responsible solely for the control and prevention of pollution. Instead this is part of their mandate and as such there is no specific budget for this activity. For example in the case of an oil spill personnel from various agencies would be called to try to resolve the problem and the persons selected would depend on who is available.

5. INDUSTRIAL SOURCES OF MARINE POLLUTION

POTENTIAL POLLUTION FROM HEAVY METALS

The metallurgical industry is Belize is restricted to small industries which are mostly concentrated in Belize City. These include the production of batteries, welding shops, and mechanic shops. A nail factory was in operation for a couple of years but has been closed for the last four years.

Pesticides in Belize are registered by formulation. There are a number of pesticides, especially fungicides which may contain a heavy metal in their composition. This is usually copper in the form of copper sulfate, or copper oxide. Fungicides are used extensively in the banana industry, rice industry, and among small farmers. The only inorganic pesticide is Chromated Cooper Arsenate (CCA) which is a wood preservative used exclusively for the treatment of lumber. The restrictive license allows only two manufacturers to use the product.

POLLUTION FROM OTHER INDUSTRIAL SOURCES

There is a lack of heavy industries, such as metallurgical, textile, or manufacturing industries. Most of the raw products used in manufacturing are imported. The main industrial center is Belize City where a number of light manufacturing industries are situated. The Belize Brewing Company is located in Ladyville. Apart from the production of beer, soft drinks are also produced by a sister company Bowen & Bowen Ltd. PEBCO also has its factory in Ladyville. Belize Traveller's has its formulating plant on the Northern Highway along with Belize Mills who processes wheat into flour. Other manufacturing industries include manufacture of batteries, boats, and clothing,

The Commercial Free Zone, at the Santa Elena Border in the Corozal District is the largest source of industrial pollution in that district. While there are few manufacturing activities in the Zone there are over 200 stores and al least three gas stations. The Free Zone is built alongside the Rio Hondo.

In the Orange Walk District the Tower Hill Sugar Processing Plant situated on the banks of the New River is the largest polluter of that river. The Cuello's Distillery as well as the L&R Distillery is also found in this district. New River Enterprise is a sawmill operation operating on the banks of the New River.

The two Citrus Processing Plants at Alta Vista and Pomona in the Stann Creek Districts make the largest contribution of organic load to the North Stann Creek River. There are also a number of Shrimp Farms operating in the District. Waste from these farms can be a significant source of pollution

In the Cayo District there are a number of small industries. These include Running W Farms and B&H Meats who are involved in the processing of cattle and pigs, Quality Chicken and Homestead Acres who are involved in the processing of chicken, and Big H Juices and Western Dairies who produce milk, ice cream and juices. The Traveller's Distillery is located in Belmopan.

A list of land based industrial sources of pollution is given in appendix I.

6. AGRICULTURAL SOURCES OF POLLUTION

Belize has an agrarian based economy with tourism also making a significant contribution to the national economy. Agriculture, including aquaculture, accounts for 89.9% of total exports. The major agricultural products are sugarcane in the Corozal and Orange Walk District, Citrus in the Stann Creek and Cayo District, and Bananas in the Stann Creek and Toledo Districts. Other products include red kidney beans, papayas, rice, peanut, cocoa, mangoes, blackeye beans, and habanero pepper. There are over 15,000 small farmers who plant such produce as tomatoes, cabbage, peppers, potato, celery, and other vegetables. They are concentrated mainly in the Cayo, Orange Walk, and Corozal Districts. Farmers in Toledo practice slash and burn milpa system where they plant rice, corn and beans.

MAIN AGRICULTURAL PRODUCTION AREAS

There is a lot of agricultural activity occurring in the Belize River Valley and the Stann Creek Valley. The two northern districts also have a lot of agricultural activity as does Stann Creek and Toledo. In Stann Creek and Toledo agricultural activity is along the coast as further inland the unsuitability of the mountain pine ridge makes it impossible to engage in agriculture. The Cayo District also has a large area that is a forest reserve prohibiting agriculture in that area. For the Belize and Corozal Districts a large portion of the coast is unsuitable or unavailable for agricultural purposes. The map below shows the main areas under present agricultural establishment. This includes areas where aquaculture activities are occurring.

PESTICIDE IMPORTS

Pesticide and fertilizers are used widely throughout the country but especially in the sugarcane, banana, citrus, and papaya plantations. The sugarcane and citrus industry use a lot of herbicides, while the banana industry also uses a lot of nematicides, fungicides and insecticides. The small vegetable farmers use all types of pesticides and often use them more frequently. Various reports show that small farmers use greater amounts of pesticides than they require. Pesticides imports for the last three years are given in table 1. Imports have remained relatively constant over the last couple of years.

Table I: Pesticide Imports for the period 1999-2001

PESTICIDE	**QUANTITY (LBS)**		
	1999	**2000**	**2001**
INSECTICIDE	1,385,865		700,451
HERBICIDE	859,176		804,740
FUNGICIDE	353,863		341,052
NEMATICIDE/INS.*			192,939
OTHERS**	401,233		1,748,385
TOTAL	**3,000,137**	**2,854,765**	**3,787,570**

* The quantity for nematicide/insecticide for the year 1999 and 2000 is entered as insecticide

** Others include wood preservatives, rodenticidies, algaecidies, surfactants, acaricides, plant growth regulators, etc.

The top 20 pesticides imported in 2001 by chemical family are given in table II. These are total amount of formulated product. The actual amount of active ingredient is actually much lower. These quantities are however not readily available. The pyrethroids make up the largest group imported. These include insecticides, miticides, aerosols, and veterinary use products. The organophosphates are the next largest group. These are mostly insecticides. Inorganic Arsenicals, which is CCA is used solely for wood treatment. Its use is tightly controlled. The other two in the top five are Bipyridylium (such as paraquat) and carbamates (such as Temik used in the banana Industry as a nematicide).

Table II: 2001 Pesticide Import by Chemical Family

CHEMICAL FAMILY	QUANTITY (lbs)
Synthetic pyrethroid	499967
Organophosphate	280963
Inorganic Arsenicals	263971
Bipyridylium	244579
Carbamate	231967
Ethylene Bisdithiocarbamate	209412
Phosphoric Acid	171799
Glyphosphate	55912
Substituted Urea	36436
Chlorinated Phenoxy	30852
Triazine	25173
Thiourea	22702
Phenoxy propionate	20326
Triazole	18242
Amide	12100
Oximinoacetate	11870
Dinitroaniline	9302
Phenol	8192
Biological	7177
Benzimidazole	5140

Pollution from agricultural sources is mainly in the form of agricultural runoff and from cleaning of equipment in creeks and rivers. The custom of washing sprayers and other equipment in creeks and rivers contributes directly to the pollution of these water bodies. More importantly is the runoff from areas where pesticides and fertilizers have been use. This runoff eventually finds its way to rivers and finally to the sea. In 2000 Belize imported approximately 9 million pounds of pesticide.

7. LABORATORY ANALYTICAL CAPABILITY

There is limited Laboratory Services available in the Ministries of Agriculture, Health, National Security, the CZMA/I and the Department of the Environment. These laboratory services are tailored to the specific needs of the particular ministry.

MINISTRY OF AGRICULTURE

The Belize Agricultural Health Authority (BAHA) of the Ministry of Agriculture offers laboratory services such as microbiology and diagnosis testing. BAHA has 3 microbiologist, 2 pesticide residue testing technicians and a Lab Director at its Belize City Laboratory. BAHA has recently begun testing for pesticide residue at the Vet Lab in Belize City. This is a qualitative test using the CHARM assay kit which is specific for organophosphates and carbamates. A number of equipment including two GC's, an HPLC and an AA spectrophotometer are being purchased. When these are delivered, additional personnel will be hired to do residue testing. This will be the only Lab to have the capacity to conduct water testing for physical, chemical, and residue analysis.

MINISTRY OF HEALTH

The Ministry of Health has a water lab, which carries out routine testing of water samples from municipal water supply as well as from rural and rudimentary water supply sources. The Lab has a spectrophotometer along with other equipment to test for physical parameters such as DO, COD, TSS, pH, Salinity, and Conductivity. It has the capability to test for chemical species such as phosphates, nitrates, and iron, and for biological contaminants such as total and feacal coliform bacteria. There is presently one analyst only. The lab is limited to water testing only and its capability is restricted by the irregular supply of reagents. Samples are collected by the Public Health Inspectors in the districts and sent to the lab for analysis.

COASTAL ZONE MANAGEMENT AUTHORITY/INSTITUTE

The CZMA/I has been conducting monitoring studies of the Belize marine environment since 1997. The CZMA/I possesses a water lab, which they use to obtain their data. Physical parameters are measured in-situ while chemical species are analyzed in the lab. Typically monitoring is conducted on a monthly basis at designated areas. These areas include the Gales Point lagoon, Faber's Lagoon, San Pedro and Port Honduras Area. The CZMA/I owns its own boat so that it is capable of going out to do sampling on a regular basis. Monitoring has been suspended temporarily until the CZMA/I moves into a new building and sets up the lab again. There is one analyst who is in charge of sampling and analysis.

DEPARTMENT OF THE ENVIRONMENT

The Department of the Environment has field testing capability consisting of a DREL 2000 water lab which includes a Spectrophotomer, pH meter, TSS/Conductivity meter, DO meter and salinity meter. The absence of trained personnel as well as reagent has restricted the use of this equipment. The Department routinely collects samples (water, sediment) which is then sent to the Bowen & Bowen Lab for analysis. The condition of the DOE equipment is unknown but a number of the sensing units would need to be replaced.

MINISTRY OF NATIONAL SECURITY

The Forensic Lab of the Ministry of National Security is used solely for the analysis of forensic samples such as confiscated drugs. This lab would not normally be available to carry out analysis for other institutions given the nature and sensitivity of the analysis being conducted.

There does not exist a National Laboratory System. However with the establishment of BAHA there has been an attempt to group a number of labs together. It is unclear what the outcome of this will be. The lack of a proper lab has been one of the problems affecting Belizean exports. If BAHA is to acquire the aforementioned equipment it will be in a position to test a wide range of samples. The CZMA/I is in a position to take on the task on carrying out testing excluding pesticide residue analysis. Given its knowledge of the area it should play a key role in the implementation of the SMP.

PRIVATE LABORATORIES

There are number of private labs mainly in the large industries. The Citrus and Sugarcane processing plants have laboratory for both qualitative testing as well as for environmental monitoring. The shrimp farms also have their own lab as do the brewery and distilleries. These industries have to send quarterly effluent reports to the DOE. Bowen & Bowen Ltd. and Tower Hill Factory both have a good laboratory and analysis is done on a daily basis.

The only Non Governmental Organization that is involved in water monitoring is the Toledo Institute for Development and Education (TIDE). They have been conducting monitoring in the Gulf of Honduras area for the last 10 months. TIDE possesses field testing equipment as well as a boat.

8. WATER QUALITY STUDIES DONE IN BELIZE.

Water Quality data exists from several institutions and these can be divided into six major categories

1. Monitoring of water supply by WASA and now BWSL**.** This data is obtained to ensure that the water supplied by BWSL is potable and passes the standards set by WASA.

2 Water Quality Monitoring done by the National Hydrological Service at discharge gauging stations. This data is mainly to determine water discharge volume. On an infrequent basis other types of testing is done such as turbidity and TSS.

3. Water quality monitoring by the Public Health Department or the Department of the Environment. This is response to some incident or for monitoring purposes. These samples are collected from various sources and different tests are performed.

4. Water quality monitoring by consultants, technicians, or industry including effluent discharge monitoring. These data is used for enforcement, monitoring, and compliance purposes. Industry uses it for quality control purposes.

5. Water quality data collected for institutional purposes, e.g. rural and small water supply systems. These are to comply usually with the need for the water to be potable.

6. Water quality data collected by the Coastal Zone Management Authority/Institute. This data is used by the Authority to determine any changes in the health of the coastal environment.

Most of the literature cited falls under category four. However the DOE has effluents report from various industries. At the same time BWSL, the CZMA/I and Public Health also have data on monitoring done over a period of time. These can be useful in identifying baseline values to use in designing the SMP.

9. DESIGNING A MONITORING PROGRAM FOR BELIZE

In designing a monitoring program the three questions to ask are what should be done, what can be done and who will do it. Once these are resolved the design of the project can proceed. In the case of this monitoring program some data is already available for a baseline value to be assigned. The country can be divided into five major regions based on its agricultural activity and system of rivers (map 3).

1. The Rio Hondo and New River generally empty into the Chetumal Bay/Corozal Bay Region. These rivers carry waste from the sugarcane industry including agricultural runoff from the sugarcane fields and waste from the Tower Hill factory.

2. The Belize River empties into the Belize City area. This river forms from a confluence of the Macal amd Mopan River and later the Roaring creek. Pollution from this source is mainly agricultural and residential from the Towns (Benque Viejo, San Ignacio, Belmopan) and Villages along its path.

3. The North Stann Creek empties into the Dangriga Area. Agricultural runoff from the Stann Creek Valley as well as effluent from the two Citrus Processing plants empty into this river. Additionally both the Sittee and South Stann Creek River have banana plantations along its banks.

4. The Monkey River, Sennis River, August Creek empties into the Placencia Lagoon Region. The predominant agricultural activity is banana production and shrimp farming. Most of the shrimp farms are in this area.

5. The Sarstoon and Temash River empty into the Gulf of Honduras region. This region consists of mostly small vegetable farmers mostly involved in the planting of rice, beans, and corn. There are also some citrus orchards.

Typically the northern part of the country is generally flat and the rivers are slow moving. The slow moving nature of the New River is manifested in its low Dissolved Oxygen content. In the south the terrain is more hilly and as a result the rivers are more fast flowing. The flood plains of the north help in dispersing some of the sediments and detritus from these rivers. The mangroves in these plains help to hold back a lot of the waste being transported by the rivers during flooding. This effect is not as pronounced in the south.

MONITORING PROGRAM

A monitoring program will require that sampling points are divided into three zones; the zone of first impact (1), the zone of intermediate impact (2) and the zone of long distance impact (3). The further from the point where the river flows into the sea the less the impact should be. A series of sampling points should be placed in each zone. In Zone 1 a sampling point will be placed upstream and one at the mouth of the river. In zone 2 at least three sampling points should be placed at equal distance from zone 1. Zone 3 will have three or four sampling points also spread equidistant from zone 1. A sampling point may be placed outside the reef to act as a control point.

PARAMETERS TO BE ABNALYSED UNDER THE SMP

The following parameters should be analysed for :

Physical Parameters – Temperature, pH, TSS, Turbidity, color, salinity, Dissolved Oxygen, Biological Oxygen demand

Chemical Parameters – Nitrate, Phosphate, total coliform, faecal coliform

EQUIPMENT

Equipment to be used in the Monitoring Program includes:

Salinity/Conductivity/Temperature (SCT) Meter

pH Meter

Turbidity meter
DO Meter
BOD manometer
Spectrophotemeter

PROPOSED FOCAL(S) POINT

The three institutions mentioned in the report who have responsibility for the protection of the Marine Environment are the Department of the Environment (DOE), The Fisheries Department (FD), and the Coastal Zone Management Authority and Institute (CZMA/I). Of these three only the CZMA/I has been involved in any form of monitoring and research activities of the marine environment. The CZMA/I has a person who is fully involved in conducting monitoring studies at selected sites along the coast. Analysis is done both in-situ and also ex-situ at their lab in Belize City. The parameters studied are physical (pH, temperature, salinity, etc.) and chemical (nitrate, phosphate, etc.). The CZMA/I also has access to two boats, each about 30 feet in length.

It is proposed that the CZMA/I be the focal point for this synoptic monitoring project. Their previous experience makes them ideal to integrate this project into their ongoing monitoring program. This would however require acquiring additional staff as well as material. It will be necessary to hire a project manager as well an assistant and boat captain.

The Project Manager should have overall knowledge and experience in the design, implementation and analysis of a marine monitoring program. He would be responsible for the overall project, including designing of the project, initiating the monitoring program, analyzing the results, and preparing any reports. The Project manager will require the help of an assistant in the actual collection and analysis of samples.

The project assistant should preferably have a background in marine science, chemistry, or natural science, with some experience in environmental monitoring. He will be responsible for the collection of samples. This person should have at least an Associate's Degree.

It will also be necessary to hire a boatman. The present boatmen of the CZMA/I are used by all the various sections. At some time it will not be possible to have the services of these people available leading to a disruption of the monitoring program. It is preferable to have a boatman employed fulltime under the project to ensure it's uninterrupted progress.

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ABBREVIATIONS

DOE	Department of the Environment
BAHA	Belize Agriculture Health Authority
DO	Dissolved Oxygen
BSI	Belize Sugar Industries
CCB	Citrus Company of Belize
TIDE	Toledo Institute for Development and Environment
CZMA/I	Coastal Zone Management Authority/Institute
DO	Dissolved Oxygen
BOD	Biological Oxygen demand
TSS	Total suspended solids
TDS	Total dissolved solids
SCT	Salinity/Conductivity/temperature
MBRS	MesoAmerican Barrier Reef System
GDP	Gross Domestic Product
EPA	Environmental Protection Act
CARICOM	Caribbean Community
PEBCO	Pepsi Belize Company
GC	Gas Chromatograph
HPLC	High Performance Liquid Chromatograph
AA	Atomic Absorption
COD	Chemical Oxygen Demand
BWSL	Belize Water Services Limited

LIST OF PERSONS INTERVIEWED

Ismael Fabro	Chief Environmental Officer	Ministry of Natural Resources, Environment and Industry
Michael Polonio	Distribution Division	Belize Electricity Limited
Rony Maza	Environmetal Health Officer	PAHO Belize
Renzo Quiroz	Sugar Cane Development Project	Belize Sugar Industries
Eduardo Zetina	General Manager	Belize Sugar Industries
Dr. Michael Deshield	Head, Analytical Services	BAHA
Faye Smith	Director , Environmental Compliance Unit	Del Oro Citrus Company
Miguel Ricalde	Work Supervisor	Corozal Town Council
Alvaro Bautista	Policy Analysis Unit	Ministry of Agriculture, Fisheries, and Cooperatives
Rodrigo Blanco	Director, Pest & Disease Control	Banana Growers Association
Oswald Arzu	Environmental Monitoring Unit	Banana Growers Association
Lynette Gomez	Biologist	TIDE
Will Maheia	Director	TIDE
Ramon Frutos	Agrometeorologist	Belize Weather Bureau
Eugene Ariola	Water Quality Monitoring Unit	CZMA/I
John Flowers	Analyst	Ministry of Health Water Quality Lab

APPENDIX I

INDUSTRIAL SOURCES OF MARINE POLLUTION

COMPANY	ACTIVITY	LOCATION
B&H Meats	Meat Processing	Cayo
Running W Meats	Meat Processing	Cayo
Homestead acres	Meat Processing	Cayo
Quality chicken	Meat Processing	Cayo
Reimers Feed mill	Feed Processing	Cayo
Farmers feed supply	Feed Processing	Cayo
Western Dairy	Milk Processing	Cayo
Macal Dairy	Milk Processing	Cayo
Cayo tropical Fruits processing	Fruit Processing	Cayo
Belize Minerals Ltd.	Mining	Toledo
National Sand and gravel quarry	Mining	Belize
Belize Electricity Limited	Power Generation	Belize
Texaco Belize Ltd.	Fuel Storage/Distribution	Belize
Esso Standard Oil	Fuel Storage/Distribution	Belize
Shell Belize Ltd	Fuel Storage/Distribution	Belize
L&R Distillery	Distillery	Orange Walk
Travellers Rum	Distillery	Orange Walk
Cuellos Distillery Ltd	Distillery	Orange Walk
Belize Gases Ltd.	Liquid Gas Production	Belize
Messer Gas Co	Liquid Gas Production	Belize
Prosser Fertilizer and Agrotec Co. Ltd.	Fertilizer/Pesticide Formulation	Belize
Belize Mills Ltd	Food Processing	Belize
National Fishermen Cooperative	Seafood processing	Belize

Society Ltd.		
Northern Fishermen Cooperative Society Ltd.	Seafood Processing	Belize
Shrimps farms	Effluent Discharge Food Processing	Countrywide
Marie Sharps Habanero	Food Processing	Stann Creek
Tower Hill Factory	Cane processing	Orange Walk
Del-Oro factory, Pomona	Citrus processing	Stann Creek
Del-Oro Factory, Alta Vista	Citrus processing	Stann Creek
Williamson Industries	Apparel manufacture	Belize
Printing Press		
PEBCO	Soft drink production	Belize
Bowen and Bowen Ltd	Soft drink production	Belize
Belize Brewing Co. Ltd.	Beer production	Belize
Renco Battery	Battery manufacture	Belize

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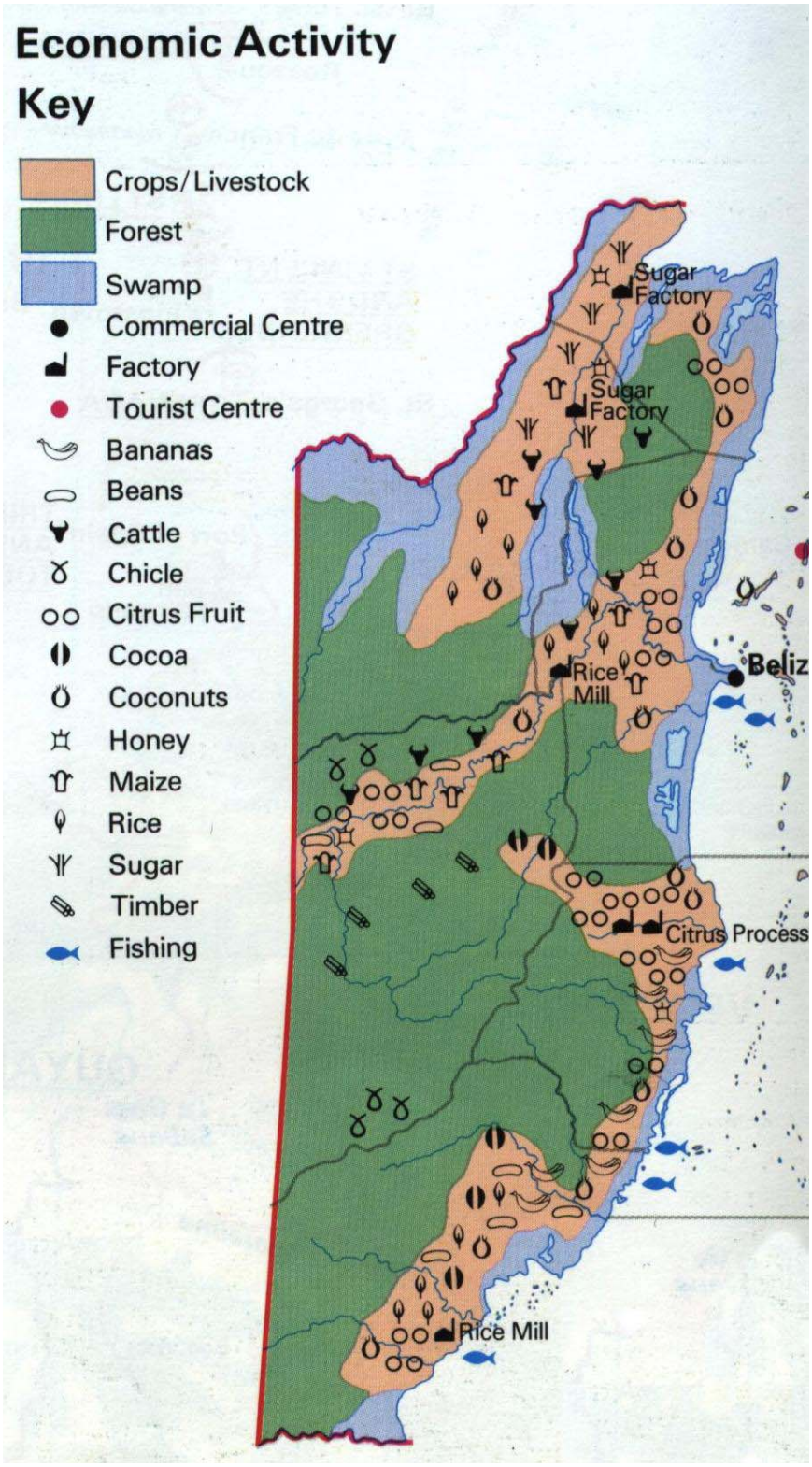
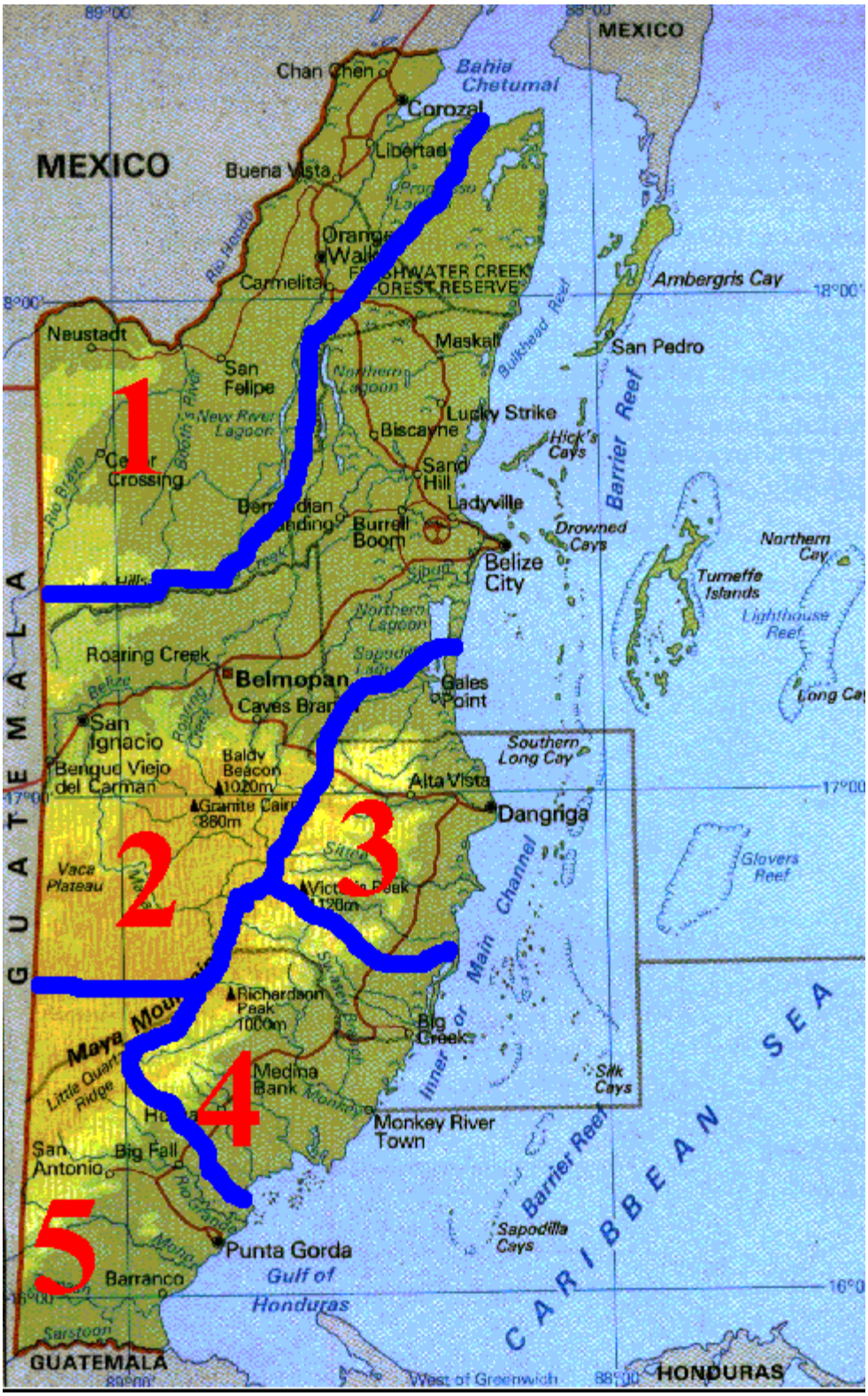
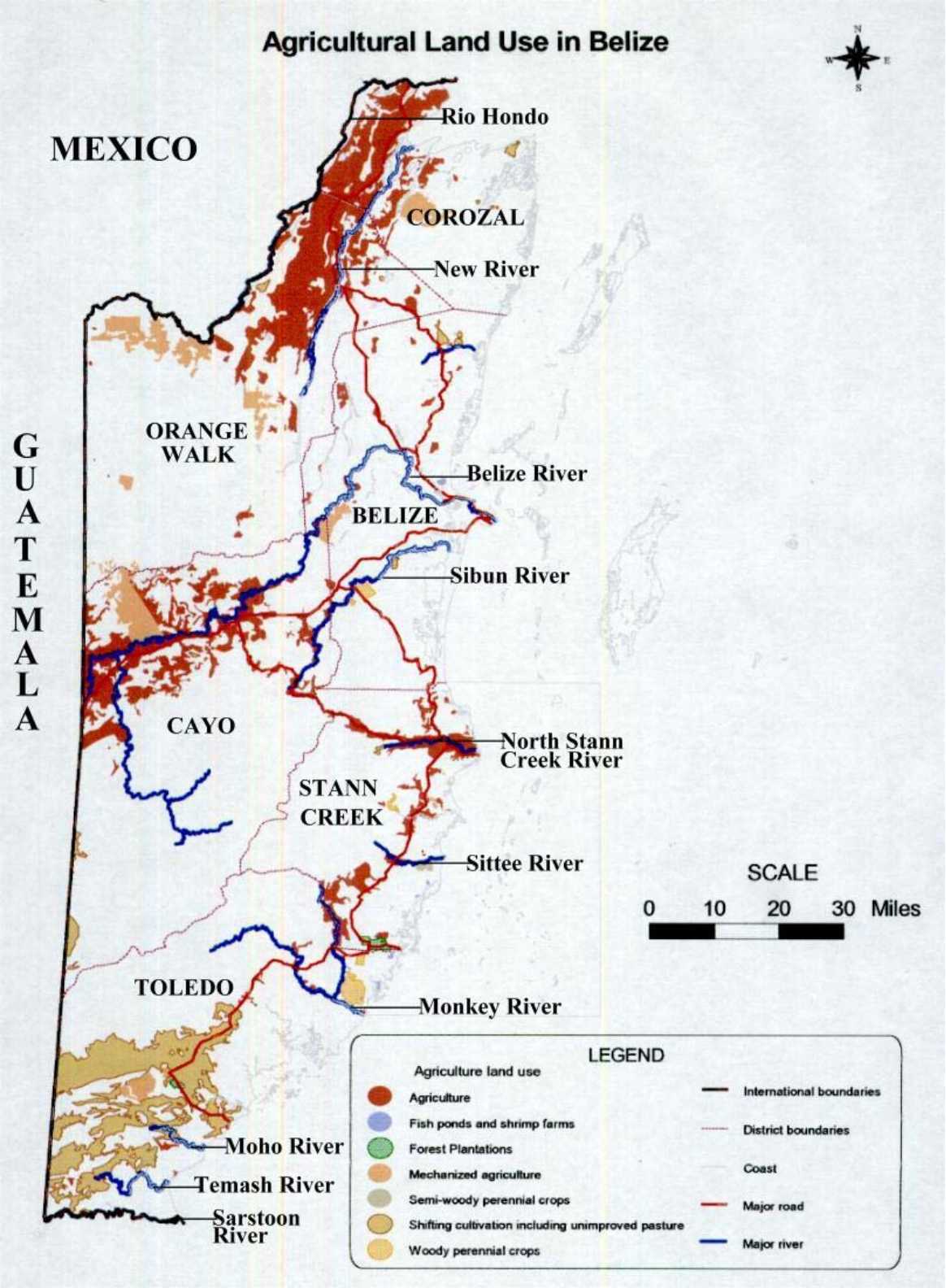


MAP 2: Production area in Belize



Map 3: Major monitoring regions by river systems



Map 4: Agriculture Land use map of Belize