Environmental Potential for Saltwater Cage Culture of the Florida Red Hybrid Tilapia Along the Northeast Coast of Haiti

MICHAEL B. RUST, ROBERT I. WICKLUND, AND BORI L. OLLA*
Caribbean Marine Research Center
100 E. 17th Street
Riviera Beach, Florida 33404
**Cooperative Institute for Marine Resources Studies*
National Marine Fisheries Service
Hatfield Marine Science Center
Newport, Oregon 97365

ABSTRACT

Twenty-five marine or brackish water sites in four bays along the northeast coast of Haiti were identified as having potential for cage culture of Florida red hybrid Tilapia (*Oreochromis urolepis hornorum* female XQ. *mossambicus* male). The four bays investigated were Baie de l'Acul, Baie du Cap Haitien, Baie de Caracol and Baie de Ft. Liberté.

Protection from prevailing wind and wave action was of primary consideration in initial site selection. Temperature (27-31 °C), dissolved oxygen (3.6-6.3 mg/l), salinity (16.0-40.2 ppt), and turbidity (1-7+ m, secchi disk) were measured at 18 of the sites from June 15th to October 10, 1987. Water quality at all sites was considered acceptable for Tilapia culture although important differences among sites were noted.

Two ecotypes were identified within the bays: mangrove swamps with shallow water (< 3m) and mud bottoms, and bays with steep sides, relatively deep water (> 3m) and sand/mud bottoms covered with grass. In general, areas with deeper water and grass bottoms were associated with higher dissolved oxygen levels and lowest turbidity.

INTRODUCTION

Haiti is a country of six million people located on the western third of the island of Hispanola. Poverty, political oppression, and over-population have combined to erode the resource bases of Haiti. Overfishing and sediments washed into the sea from eroded hills have severely reduced the amount and quality of fish harvested from Haiti's coastal waters. These conditions have added to Haiti's widespread shortages of food, high unemployment and the lowest standard of living in the western hemisphere.

Tilapia (Family Cichlidae) have been widely cultured in freshwater or low-salinity brackish water in many developing countries. Tilapia have proven themselves to be hardy, fast growing and easy to reproduce. Since most tilapias feed low on the food chain they are excellent converters of low value feedstuffs into high value protein. Tilapia have been easily adapted to both intensive

culture, using artificial feeds; and to extensive culture, relying on manure enrichment of the ecosystem for nutrition (Balarin and Haller 1979, Hopkins *et al.* 1985).

Recently, attempts to culture tilapia in seawater have shown promise (Stickney 1986, Watanabe *et al.* 1987a, 1987b and 1989, Ernst *et al.* in preparation, Hopkins *et al.* 1985). Culturing tilapia in floating seawater cages has several important benefits over freshwater culture. Cages in seawater do not compete with agriculture for limited land and freshwater resources, and tilapia have elevated growth rates and better food conversion efficiency when cultured in seawater (Watanabe *et al.* 1987a). The seawater culture of the Florida red hybrid (*Oreochromis urolepis hornorum* female XQ. *mossambicus* male) has been widely studied in the Bahamas with promising results (Watanabe *et al.* 1987a, 1987b and 1989, Ernst *et al.* in preparation). This hybrid is being grown commercially in freshwater in the Bahamas, Jamaica, and the Dominican Republic. Although the research presented in this paper applied to other mariculture activities, the seawater culture of the Florida red hybrid tilapia provided the focus.

There have been very few studies of Haiti's living marine resources and environmental data is scarce. This basic information is necessary to determine whether mariculture is feasible. This study attempts to determine if marine environmental conditions are favorable for seawater cage culture of Florida red hybrid tilapia in northeast Haiti.

MATERIALS AND METHODS

Water quality and weather patterns in four bays along the northeastern coast of Haiti were investigated to determine their suitability for mariculture (Figure 1). The four bays investigated were Baie de l'Acul (Figure 2), Baie du Cap Haitian (Figure 3), Baie de Caracol (Figure 4) and Baie de Ft. Liberté (Figure 5). Primary site selection was based upon the degree of protection each site afforded from prevailing wind and waves. These data were determined from interviews with local fishermen and by observation. Twenty-five sites were considered suitable for cage culture, 18 of which were measured for water quality.

Water quality measurements consisted of: surface temperature, dissolved oxygen, salinity and secchi disk transparency. All water quality measurements were taken between the hours of 8:00 AM and noon from June 15 to October 10, 1987. Temperature was taken at the surface using a standard laboratory thermometer encased in a steel sleeve. Dissolved oxygen was measured at the surface using a YSI model 51 dissolved oxygen meter which was air calibrated before each use and adjusted for temperature and salinity. Salinity was determined by hydrometry. The secchi disk used for transparency comparisons was a standard marine disk with a 7 meter (20 feet) cord marked off in feet.

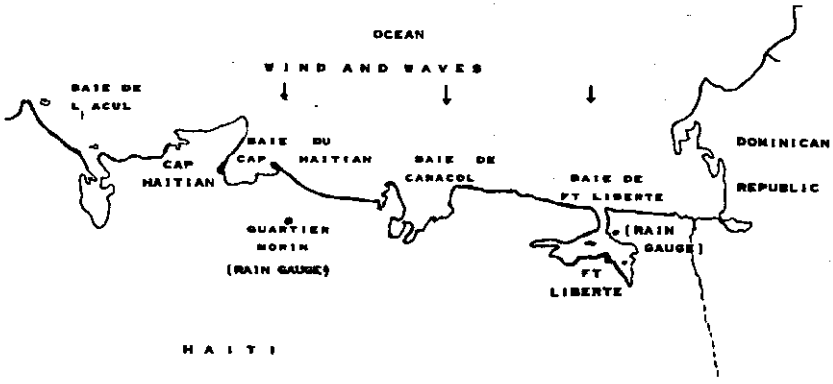

Figure 1. Map of Northeastern Haiti showing prevailing wind and wave patterns and rain guage sites.

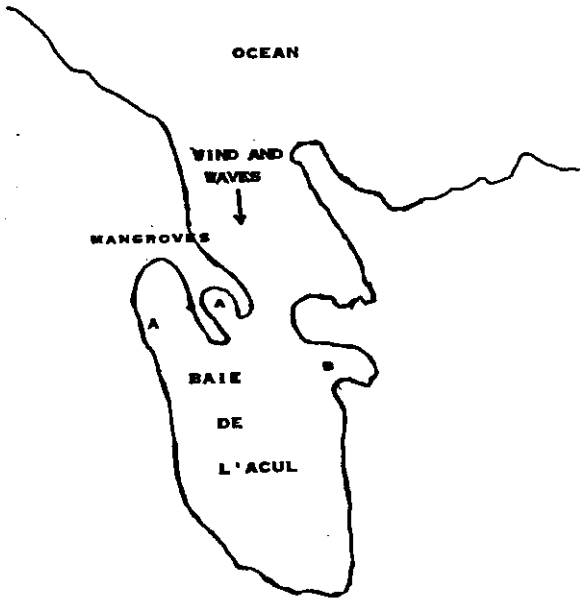

Figure 2. Map of Baie de l'Acul showing prevailing wind and wave patterns and the location of type A and type B sites.

Values over 7 meters were recorded as 7 meters due to the length of the cord on the secchi disk.

Sites were categorized based on; bathemetry from marine charts, bottom types checked by observation either from the surface or by skin diving, and topography of the nearest shoreline.

Rain gauge recordings at Quartier Morin in the central western portion of the study area and in Ft. Liberté, located in the eastern portion, gave us data on the relative regional differences in rainfall. Interviews with local people, development workers and missionaries were also conducted to assess differences in rainfall patterns.

One site, in Baie de Ft. Liberté where our pilot tilapia cage culture experiment was being conducted was visited a total of 28 times at intervals of 1-5 days in order to establish a seasonal trend in water quality. Data was collected from the other 17 sites irregularly during the study period.

RESULTS

We identified potential marine cage culture sites in northeast Haiti as follows: three in Baie de l'Acul, two in Baie du Cap Haitian, two in Baie de Caracol and 18 in Baie de Ft. Liberté (Figures 1 through 5). Baie de Ft. Liberté has more than twice as many protected sites as the other three bays combined. Well-protected sites were also divided based on surrounding topography, bathemetry and bottom type. Nineteen of the sites were areas of open water located in extensive mangrove swamps, with shallow (< 3m) water and mud bottoms (type A sites). Here, topography of the shoreline and the bathemetry of the bays was gently sloped or flat. The other six sites were characterized by steeply sloping shorelines, with the bottom dropping off quickly to a deep (> 3m) sand/mud or grass bottom (type B sites). At these sites only a thin strip of mangroves separated dry land from the bay.

Dissolved oxygen ranged from 3.6 to 6.3 mg/l and averaged 5.65 mg/l for all of the bays (Figure 6). Although no difference existed between bays, type A sites had a consistently lower dissolved oxygen value than type B sites (Figure 7). No values at any of the sites were recorded which we consider to be too low for the cage culture of Florida red hybrid tilapia.

Salinity values at all sites ranged from 16.0 to 40.2 ppt. One recorded value of 16 ppt in Baie de Ft. Liberté was taken right after a heavy rain. Recordings at the same site two days before and after the rain were 37.6 ppt. Ocean salinity over the study period was stable at 36.3 ppt. Bay salinities were generally near this value, though type A sites in the Baie de Caracol and Baie du Cap Haitian reached as high as 40.2 ppt (Figure 8). Salinity tended to be higher at type A sites than type B sites (Figure 7).

Temperatures ranged from 27-31 °C and did not differ among the bays (Figure 9). Temperatures were stable from day to day except following heavy

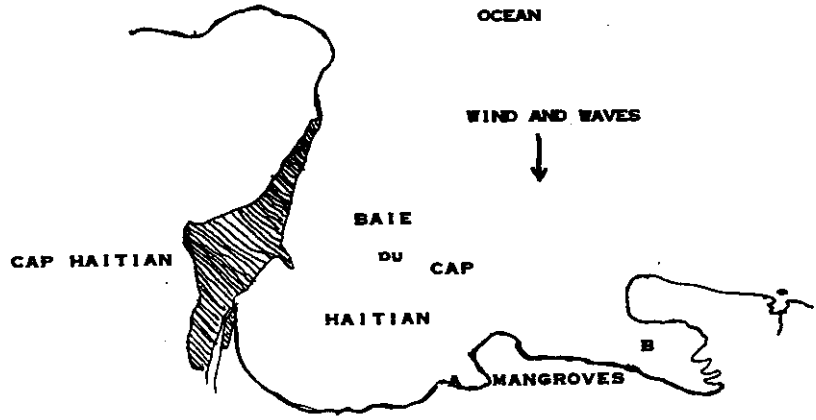

Figure 3. Map of Baie du Cap Haitian showing prevailing wind and wave patterns and the location of type A and type B sites.

rains when they would drop temporarily. Temperatures did not differ greatly between type A and type B sites (Figure 7).

Secchi disk transparency differed among the bays with water clarity decreasing from east to west along the coast (Figure 10). Values ranged from 1 to 7 meters. Type A sites generally had lower water clarity (2 m) than type B sites (6 m) (Figure 7).

Rainfall at Quartier Morin (Figure 11) was much greater (26.9 cm over the study period) than rainfall at Ft. Liberté (6.1 cm over the study period) (Figure 12). According to local residents, rainfall increases from east to west with Ft. Liberté being the driest and Baie de l'Acul being the wettest within the study area. This observation is supported by the data from the two rain gauge sites.

Water quality was measured regularly at the pilot cage culture site in Baie de Ft. Liberté (Figure 13). Dissolved oxygen at the site ranged from 5.5 - 6.4 mg/l during the study period (Figure 13). Morning temperature readings ranged from 28 - 30 °C gradually increasing during the study period. Salinity gradually increased over the first two months of the study period from 29.4 ppt to a peak of 38.6 ppt in August. Salinity maintained at about 36 - 37 ppt for the rest of the study period. At any time in the study period salinity would show downward spikes occurring during times of heavy run-off (Figure 13). Secchi disk clarity was always at least 7 meters (20 feet).

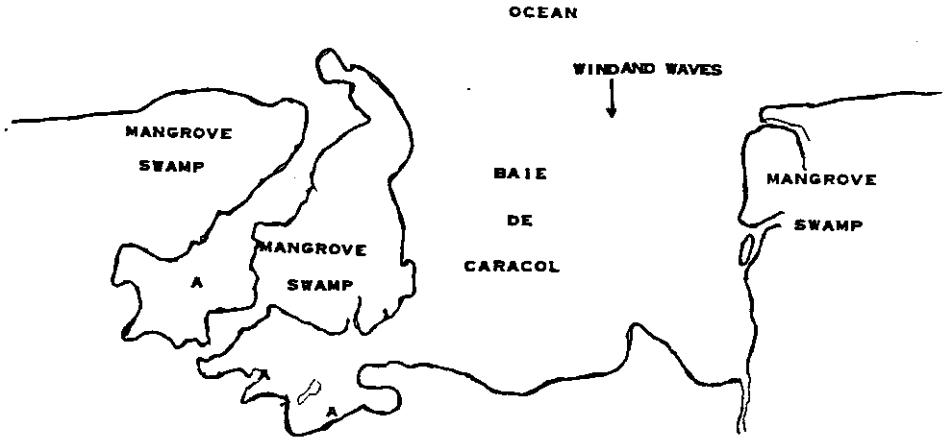

Figure 4. Map of Baie de Carcacol showing prevailing wind and wave patterns and the location of type A and type B sites.

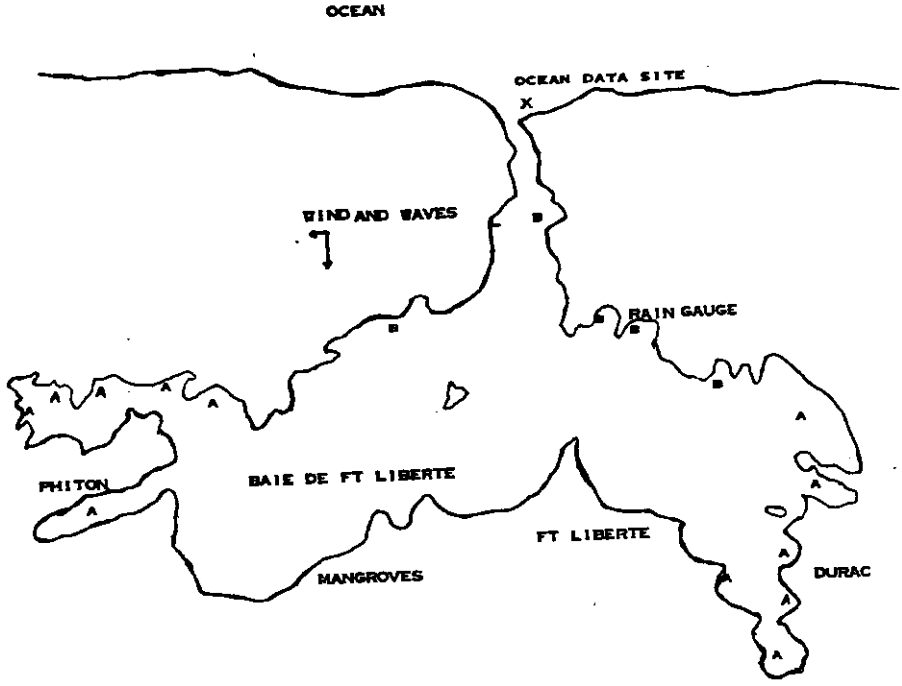

Figure 5. Map of Baie de Ft. Liberté showing prevailing wind and wave patterns and the location of type A and type B sites.

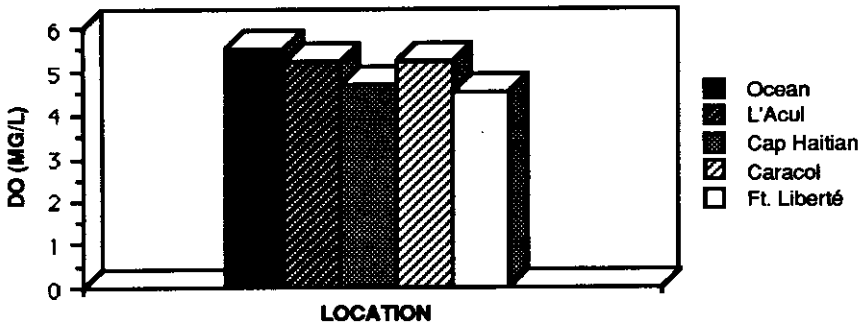

Figure 6. Minimum dissolved oxygen levels recorded from each bay

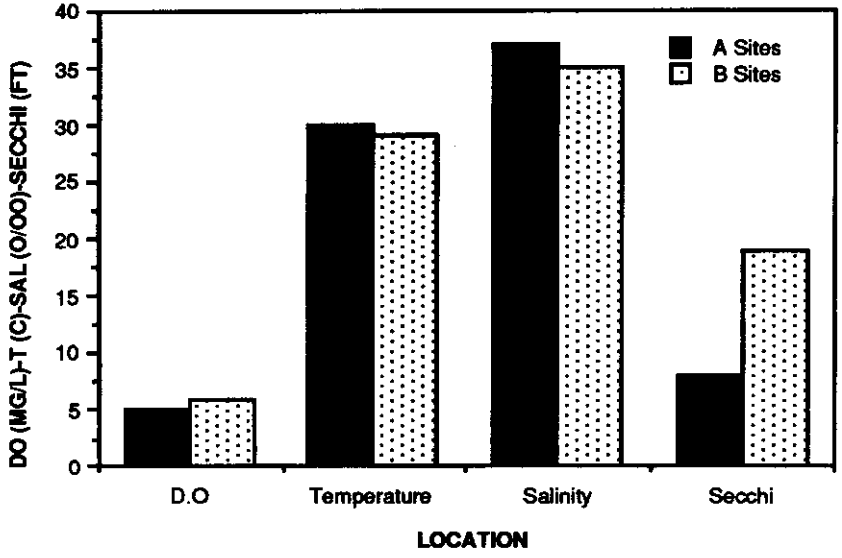

Figure 7. Mean differences in water quality between type A and type B sites.

DISCUSSION

Research conducted in the Bahamas indicates that Florida Red Hybrid tilapia grow faster and are more efficient at higher salinities (Watanabe *et al.* 1987a); however, they are also more susceptible to environmental and handling stresses (Hopkins *et al.* 1985, Ernst *et al.* in preparation). Due to this decrease in resistance to stress, determination of the optimum salinity is contingent on other water quality conditions and on whether the culturist wants to maximize growth

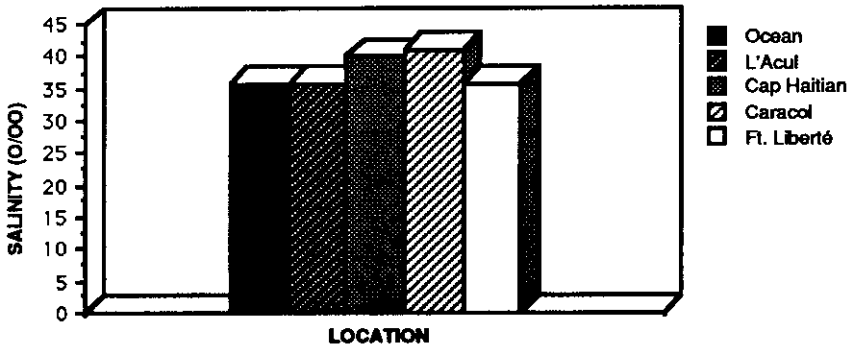

Figure 8. Maximum salinity values recorded from each bay.

or maximize hardiness. Given the lack of experience with fish culture in Haiti, attention to the hardiness of the cultured animal must be given primary importance without sacrificing good growth rates.

High salinity in conjunction with rapid temperature drops has been associated with mortalities in Florida red hybrid tilapia (Ernst *et al.* in preparation). In Haiti, both temperature and salinity are affected by run-off from rainfall in the watershed. The effect of reduced salinity from rainfall, theoretically, would reduce the physiological stress on the fish; however, we don't know if the accompanying temperature drop and turbidity would increase the physiological stress. The implications of these conflicting conditions for site selection is to choose sites for cage culture that have the least environmental changes including minimal run-off.

Data collected at Quartier Morin and in Ft. Liberté indicated that rainfall generally increased across the study area from east to west. This trend was confirmed by local residents, suggesting that temperature and salinity would be more stable in Baie de Ft. Liberté in the east than it would be in the bays to the west due to the relatively lower rainfall.

Water quality was better at type B sites than type A sites. In addition, type B sites were deeper and therefore contained more buffering capacity to sudden

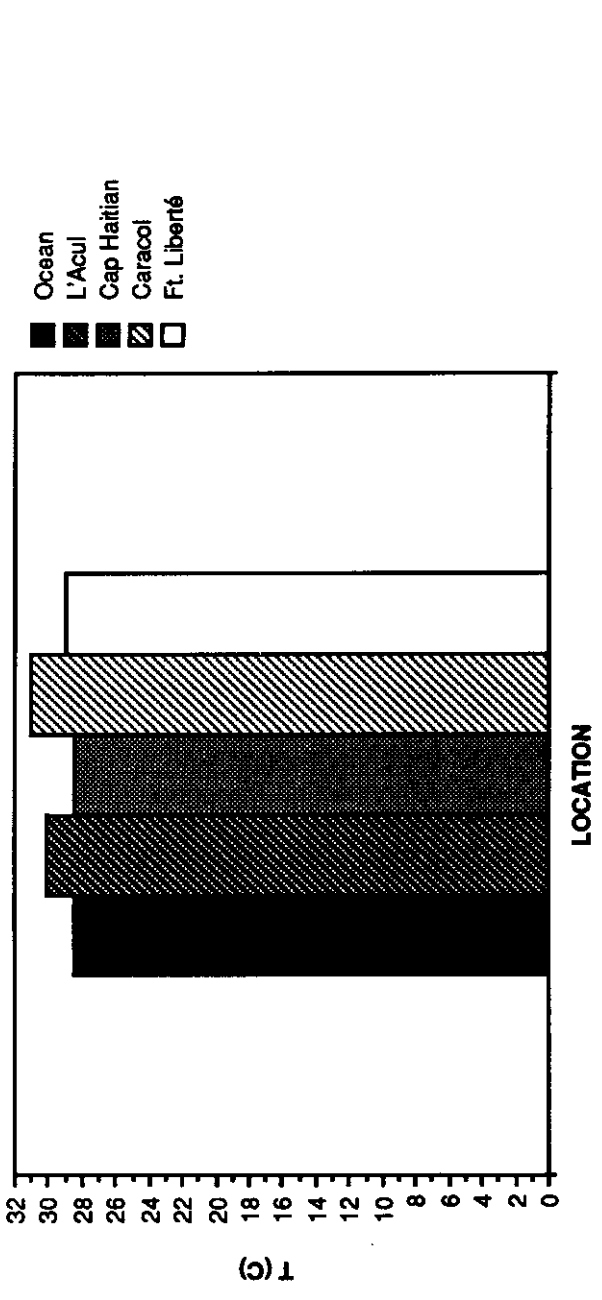

Figure 9. Mean temperatures recorded for each bay.

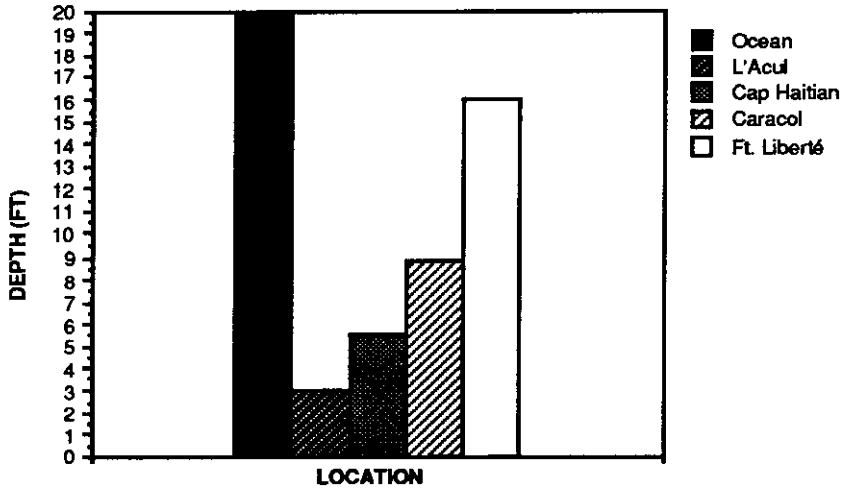

Figure 10. Mean secchi disk transparency recorded from each bay.

changes in water conditions.

Based upon the water quality parameters and the low rainfall in the watershed, type B sites in Baie de Ft. Liberté hold the best promise for development of Florida Red Hybrid tilapia cage culture. Type B sites in other bays could also be suitable for development using floating cages though only two were found outside of Baie de Ft. Liberté.

Type A sites, although inferior to type B sites for floating cage culture might be suitable for sea pens or coastal ponds. Ponds would allow the culturist some control of water quality during times of run-off and a choice between using manure or a complete feed for nutrition.

Although this study was conducted to evaluate sites for the culture of Florida red hybrid tilapia these sites may also be appropriate for the culture of other broadly euryhaline organisms such as the milkfish (*Chanos chanos*) or marine shrimp (*Penaeid* sp.).

Concurrent research in northeastern Haiti includes the growout of Florida red hybrid tilapia in cages in Baie de Ft. Liberté, and a social and marketing study of marine capture fishing and the impact of cultured fish on marketing channels (Brass *et al.* 1991, Brass in preparation, Rust *et al.* in preparation).

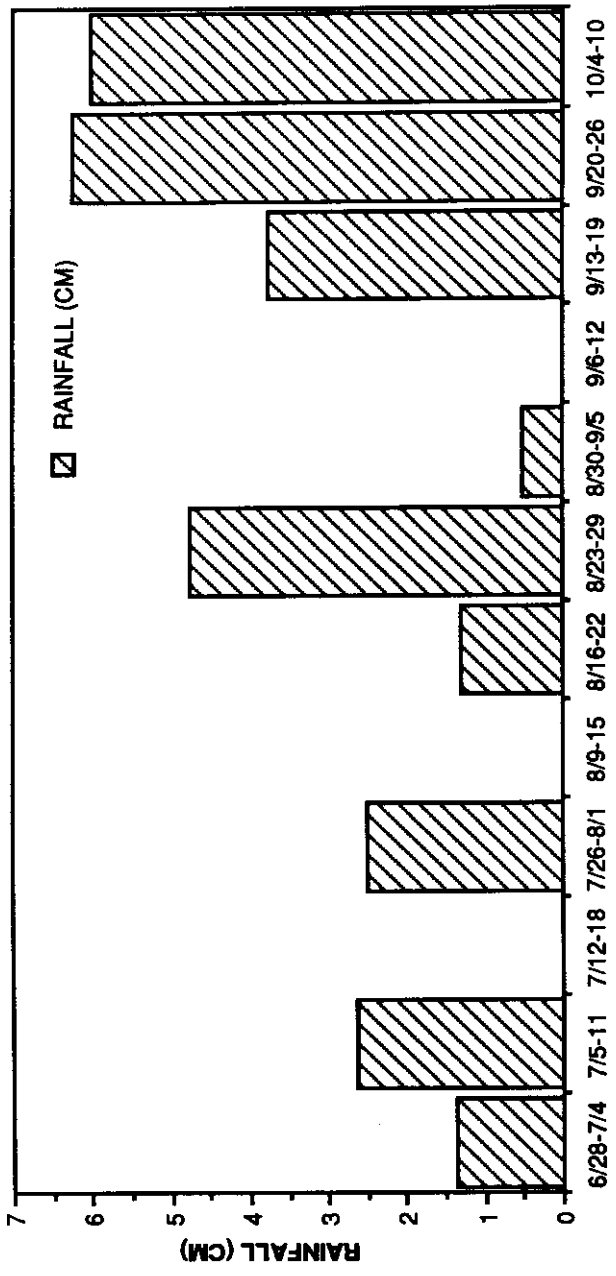

Figure 11. Weekly rainfall records at Quartier Morin, Haiti, during the period June 28—October 10, 1987.

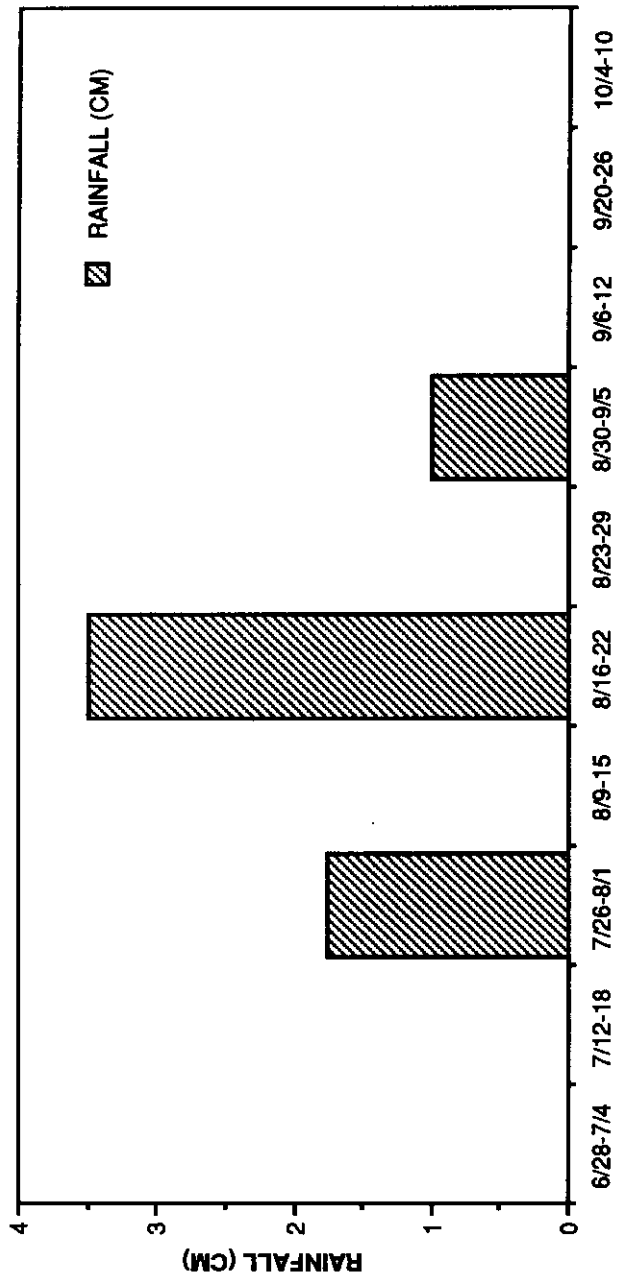

Figure 12. Weekly rainfall records at Baie de Ft. Liberté, Haiti, during the period June 28—October 10, 1987.

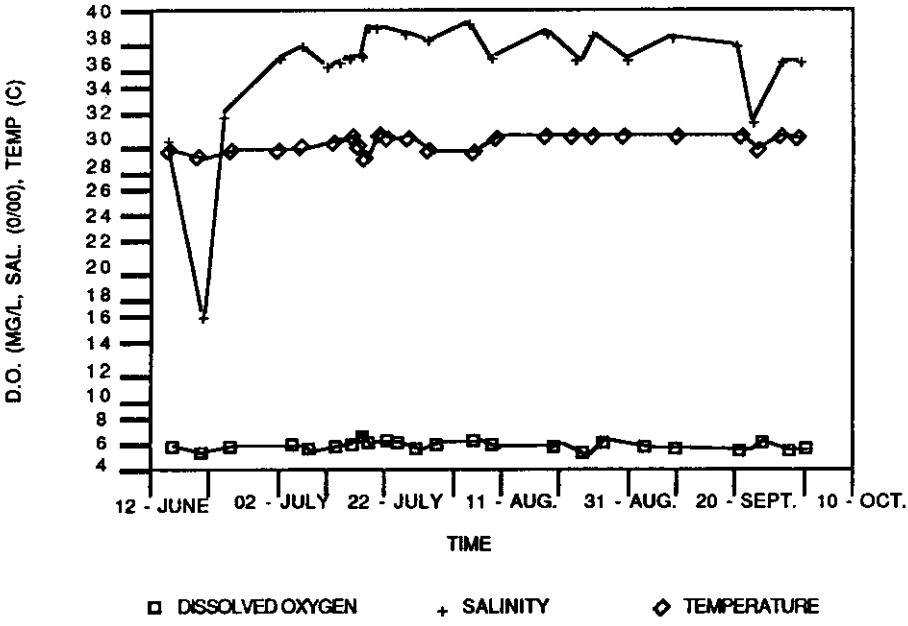

Figure 13. Changes in water quality at one type B site in Baie de Ft. Liberté Haiti during the period June 15 - October 1, 1987.

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