ISLAND RESOURCES FOUNDATION

VIRGIN GORDA NATURAL RESOURCES SURVEY:

A REVIEW OF SELECTED ECONOMIC DEVELOPMENT

POSSIBILITIES AND CONSTRAINTS

MARCH 15, 1976

FINAL REPORT

AND RECOMMENDATIONS

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CHAPTER 1

Introduction, Terms of Reference and Recommendations Summary

1.1. The future development of Virgin Gorda hinges significantly on the evolution of meaningful community participation in the planning and development process. But the effectiveness of local leadership and any internal or external organizational participation are contingent upon an understanding about the implicit limitations and potential of the natural and physical resource base of Virgin Gorda.

1.2. To provide a point of departure, the Island Resources Foundation has been requested to review the intrinsic resource structure of Virgin Gorda and assess its potential for economic development with a special focus on historic uses, exploitation levels, resource potential and possible environmental impacts of economic activity in various sectors.

1.3. Some additional emphasis has been additionally given to selected environmental guidelines, competing uses, projected benefits, social costs and sources of funding for small scale, generally more traditional types of activity which might enhance the island's self-sufficiency and reduce its dependency on external sources of supply by better utilization of local resources.

1.4. The principal difficulty in accomplishing the above tasks has been the severe paucity of quantitative historical and statistical data pertinent to Virgin Gorda. With only a few exceptions, much of the data available is for the British Virgin Islands *in toto*, with no break-out of the Virgin Gorda segment. Hence, a fair amount of extrapolating and interpolating has been necessary, utilizing a variety of statistical methods, subjective translation and, in all too many cases, educated guesses, tempered by information obtained through extensive interviews, site visits and familiarity with other neighboring islands.

1. 5. General Recommendations

1. 5. 1. Request a formal "soil study" preferably by the University of the West Indies College of Agriculture staff. Possibly the British Development Division would provide the necessary funds.

1. 5. 2. Install and monitor at least four - preferably six rain gauges and provide a central reference source on Virgin Gorda for the data collected. Additional efforts should be made to obtain any additional "historical" rain fall data previously collected and not included in the statistical section of this report (Table 9. 6. 32). Interpretive analysis of collected data will be provided by the Island Resources Foundation upon request.

1. 5. 3. Develop appropriate inducement mechanisms and incentives to encourage young persons to take up employment as "trainees" with local farmers, fishermen, guest house operators and with selected "professional" and skilled persons residing in Virgin Gorda. At the same time provide, possibly through the mechanism of a Community Planning Group or organization basic "skills training" both formal and non-formal, in the following types of areas:

A. simple windmill construction (i. e. actually build one - see below) to pump water;

B. simple solar still or solar heating device construction and installation (again, actually build several - possibly for a public building like a community center);

C. personal "accounting and bookkeeping";

D. keeping records and basic statistics (i. e., comparative agricultural production, fish catch/unit effort ratios, comparative energy costs (mains versus wind versus solar), marketing products;

E. hydroponics (see Annex E);

F. mulching (see Chapter 5);

G. marketing

1. 5. 4. Explore the possibility of modifying the airport runway and apron to serve as a grey water catchment, building the necessary sumps, installing the requisite pumps, and adjacent cistern capacity. Then haul

or pipe the water for agricultural irrigation use on a long term cost recovery low fee basis. Technical counsel if needed available from the Island Resources Foundation, the Agricultural Experiement Station on St. Croix and funding could probably be arranged from the British Development Division or Caribbean Development Bank.

1.5.5. Develop as a community effort, but where possible involving both local experienced farmers and young trainees, a series of experimental test agricultural plots keyed to existing local product demand as established by a systematic survey to be carried out under the supervision of a community development group. Maintain detailed data on all costs, conditions, seed types, fertilization, pest problems, insecticides and pesticides used, water supplied, etc. The ultimate objective is to find ways to:

A. select the best species for the various soils;

B. grow various products at levels keyed to market demand (i.e., overcome the erratic rainfall limitation;

C. provide a marketing procedure that is efficient and effective;

D. establish a central information center on local agriculture;

E. provide cost control;

F. provide income and

G. reduce local food costs.

1.5.6. Locate individuals with skills at weaving wicker fish pots and experiment in making marketable and useful items for sale to visitors. "Wicker" is very popular.

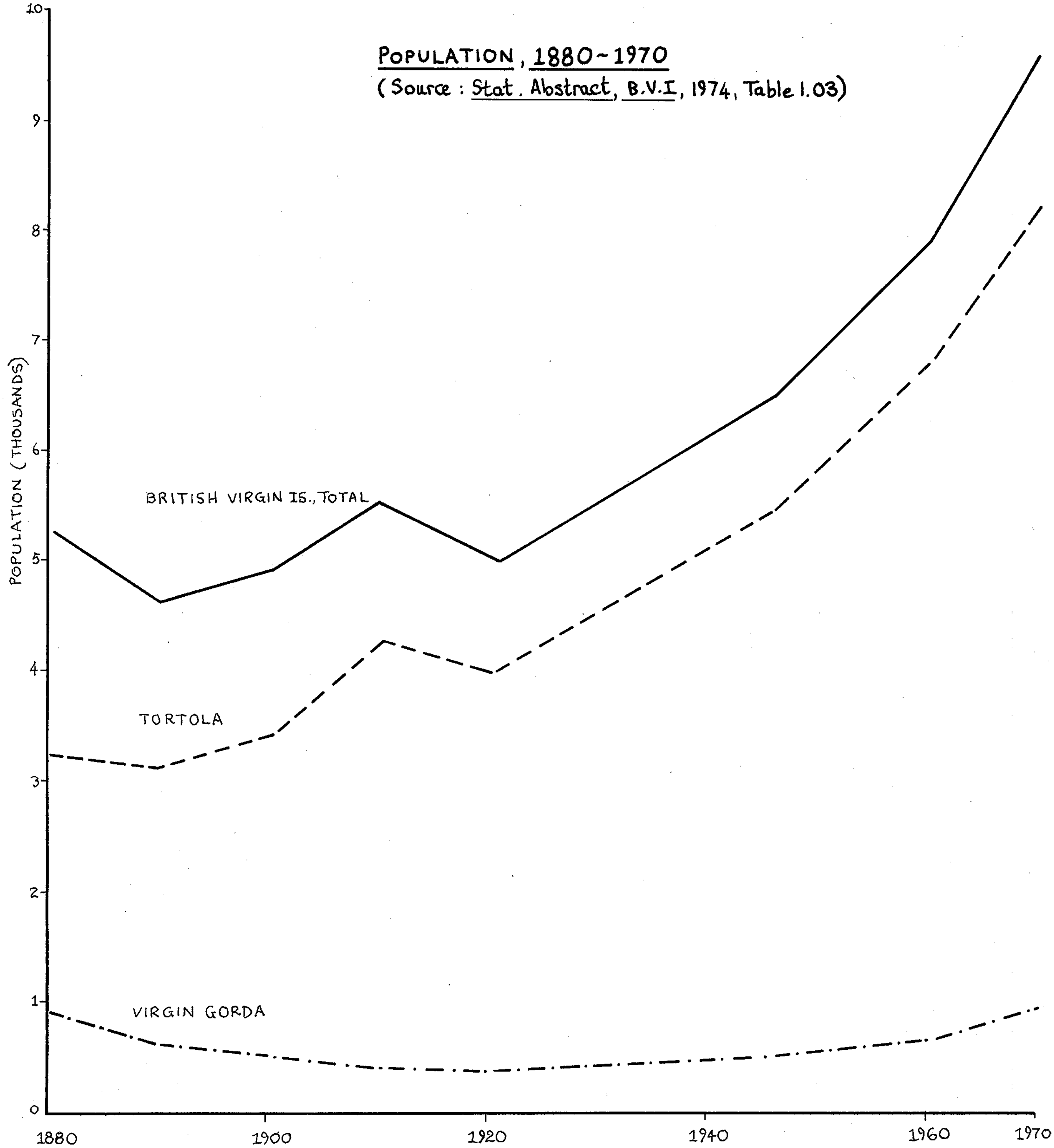
1.5.7. Arrange for a regular visit and technical assistance by the Agricultural Officer. Develop a plan for utilizing the various services provided by the Agricultural Station in Road Town. Investigate the feasibility of establishing a branch station and post for an "extension agent" on Virgin Gorda.

1.5.8. Acquire an experimental fishing boat outfitted with pot haulers and other labor saving gear. Following the pattern of "test" operations of the Fisheries Development program of the Bureau of Fish and Wildlife, Department of Conservation and Cultural Affairs, Government of the U.S. Virgin Islands (consult with Dr. David Olsen) carry out various exploratory fishing activities to determine optimum methods, designed to improve "catch per unit of effort". Experimentation should also be undertaken with improved marketing methods, stackable pots, a freezer operation and possibly a fisherman's cooperative.

1.6. Recommendations Summary (see sections cited)

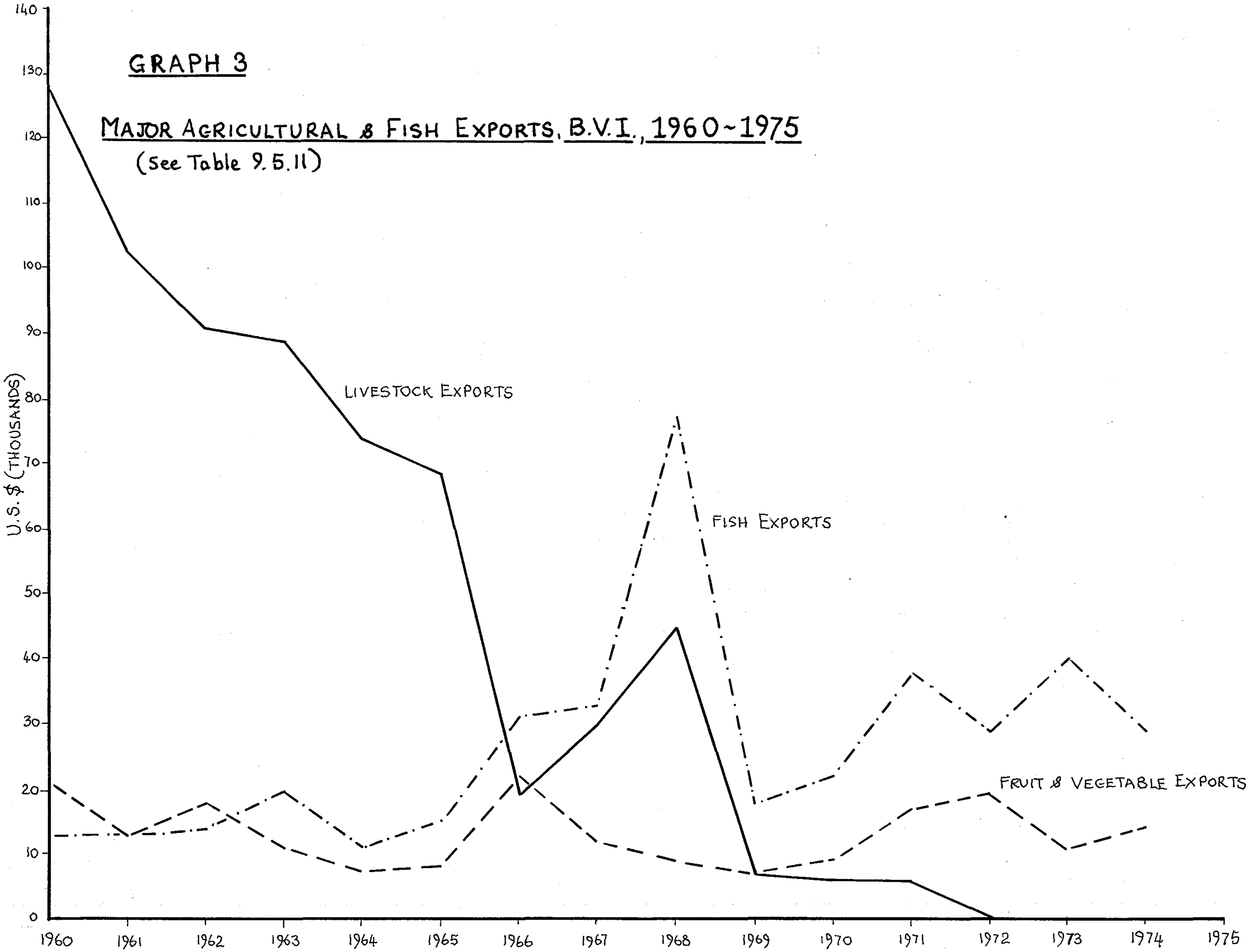
3.1.13.	(Funding)
3.2.7.	(Funding)
4.6.	(Fisheries)
5.9.	(Agriculture)
6.6.	(Tourism)
7.6.	(Mining)
8.5.	(Energy)

GRAPH 1

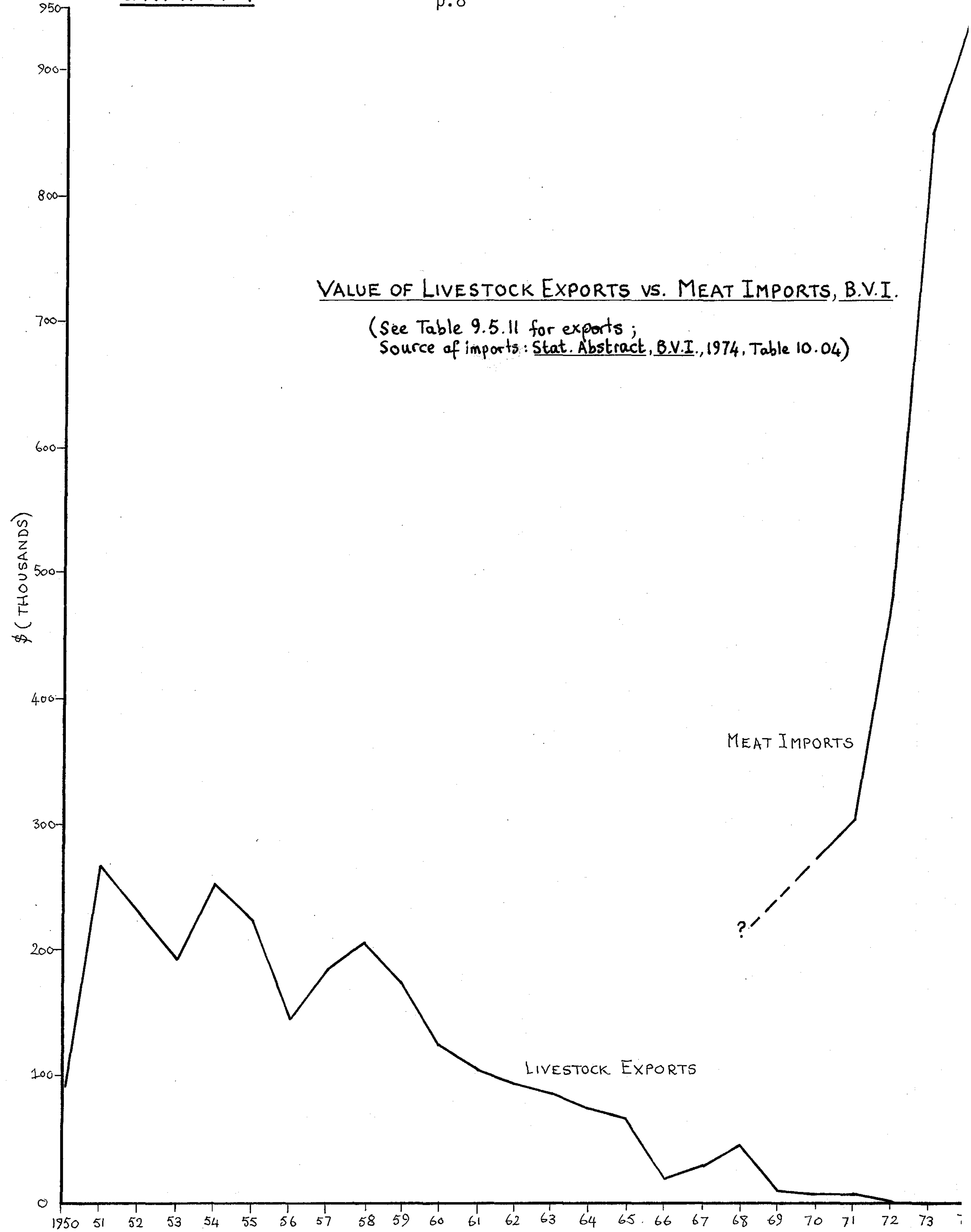

POPULATION, 1880~1970
(Source : Stat. Abstract, B.V.I, 1974, Table 1.03)
POPULATION (THOUSANDS)
10
9
8
7
6
5
4
3
2
1
0
BRITISH VIRGIN IS., TOTAL
TORTOLA
VIRGIN GORDA
1880
1900
1920
1940
1960
1970

GRAPH 2

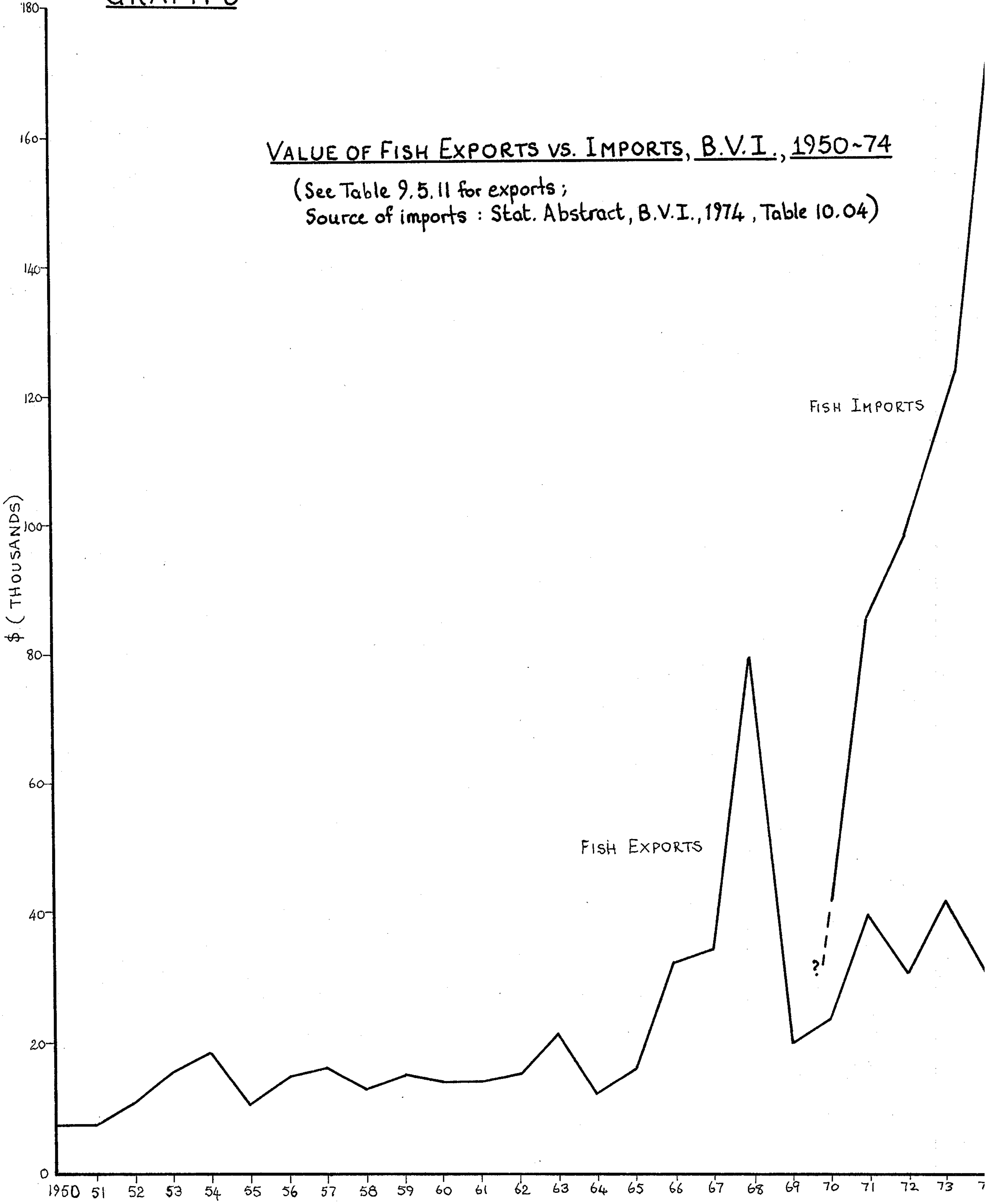

CHARCOAL EXPORTS, B.V.I., 1960~74 ($)
(See Table 8.3)
($)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
1960
61
62
63
64
65
66
67
68
69
70
71
72
73
74


GRAPH 3
MAJOR AGRICULTURAL & FISH EXPORTS, B.V.I., 1960~1975
(See Table 9.5.11)
U.S. $ (THOUSANDS)
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
LIVESTOCK EXPORTS
FISH EXPORTS
FRUIT & VEGETABLE EXPORTS
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975

GRAPH 4


VALUE OF LIVESTOCK EXPORTS VS. MEAT IMPORTS, B.V.I.
(See Table 9.5.11 for exports ;
Source of imports: Stat. Abstract, B.V.I., 1974, Table 10.04)
$ (THOUSANDS)
950
900
800
700
600
500
400
300
200
100
0
1950
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
MEAT IMPORTS
?
LIVESTOCK EXPORTS

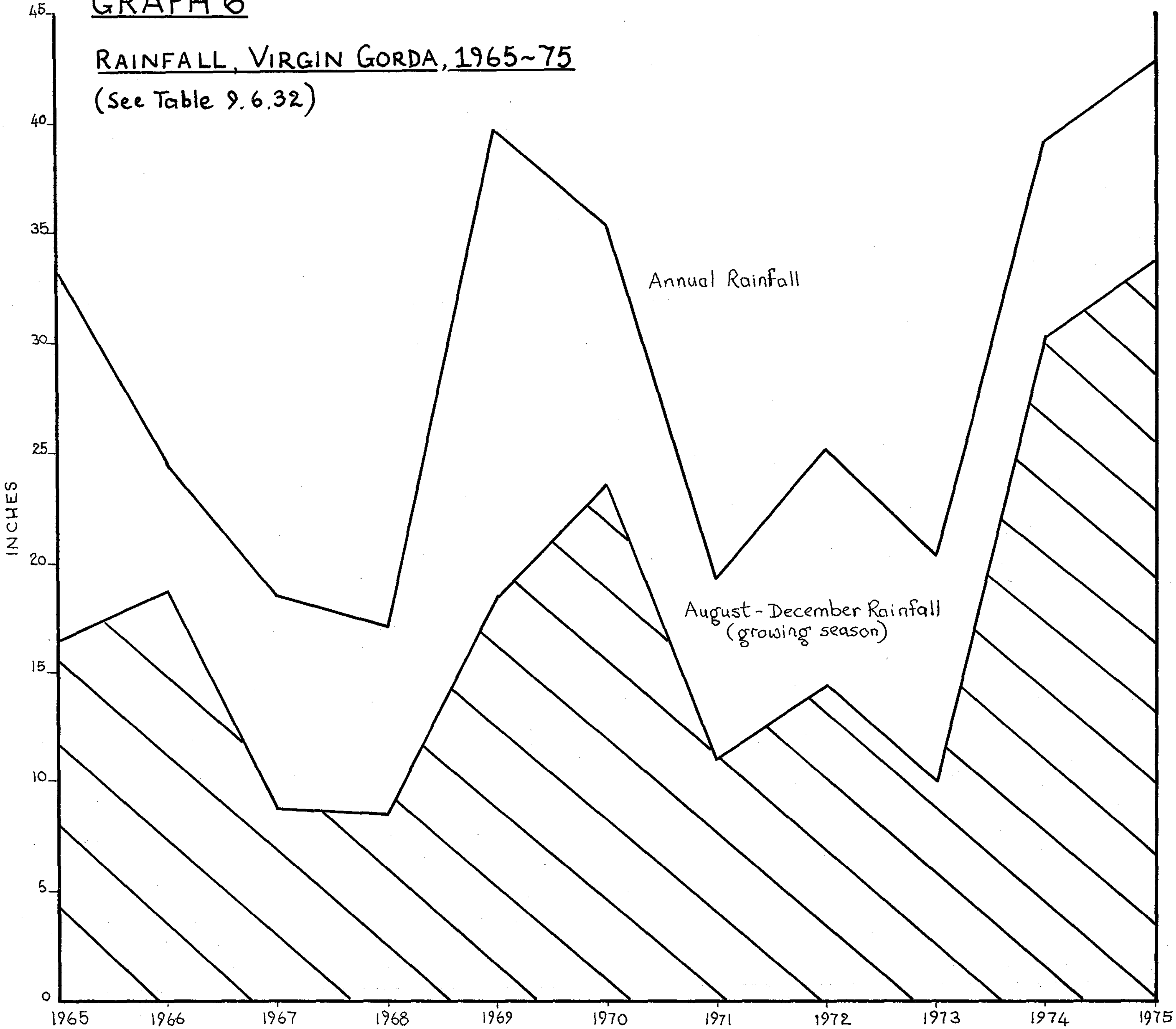
GRAPH 5


VALUE OF FISH EXPORTS VS. IMPORTS, B.V.I., 1950-74
(See Table 9.5.11 for exports;
Source of imports : Stat. Abstract, B.V.I., 1974, Table 10.04)
$ (THOUSANDS)
180
160
140
120
100
80
60
40
20
0
1950
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
FISH IMPORTS
FISH EXPORTS
?

GRAPH 6

RAINFALL, VIRGIN GORDA, 1965~75

(See Table 9.6.32)



CHAPTER 2

TERRITORIAL OVERVIEW

2.1. It is self-evident to suggest that the development of a country is reliant at least partially upon the mix of resources it has at its disposal. Equally as important, however, are the political, social and cultural values that characterise an economy, as well as governmental policy regarding future development modes. The structuring of guidelines for development must necessarily account for all of these factors -- in other words, be tailored to suit the individual needs of a country. Uses and abuses of resources accordingly will vary in relation to a country's specific requirements and aspirations.

2.2. In the British Virgin Islands, it is the present government's policy to rely on tourism as the lead sector in general economic advancement, to be supported by the more traditional agricultural and fishing industries. An holistic overview would therefore suggest that careful conservation and preservation of resources are called for. Endemic to each of these sectors, however, lies the seed of disruption for all other sectors. A massive revival of agriculture, for example, may make drastic inroads into areas of natural vegetation, which may be cherished by tourists, and have some vital role in the balance of living things in the island ecosystem. The encouragement of hotels and other tourist facilities may not only deny the agricultural and fishing sectors of their best labour force, but also occupy otherwise good farming land. These considerations point most obviously to the need for a balanced, realistic and integrated development of resources, denying the hegemony of any particular sector.

2.3. Good management policy essentially entails the maximization of a resource use and the minimization of its abuse. In this context, abuse covers the wastage or underemployment of a resource, as well as deleterious pollution affecting air, water, land -- or even society, in the form of overcrowding and alienation. In small islands, where resources most commonly are severely limited, use/abuse problems must necessarily be considered carefully. The material which follows addresses these problems as they relate to Virgin Gorda both in an historical and contemporary context.

2.4. Within the last decade, the British Virgin Islands have witnessed a dramatic transformation of their economy. With incentive legislation encouraging hotel construction, the tourist sector has become rapidly more important. According to one source (Bryden, 1973, Table 5.2), by 1965 the proportion of tourist arrivals to total land area already was the third highest in the British Caribbean, surpassed only by that for Barbados and Antigua, and equalling that for the Cayman Islands. Since 1965, the number of visiting tourists has trebled, 2.4 (cont.)

increasing from 16,316 in that year to 53,300 in 1974 (B.V.I. Statistical Abstract, 1974). Moreover, under the impetus of tourism, the Islands' general economic growth increased rapidly during the 1960's; between 1966 to 1968, for example, an annual average increase of 31% in gross domestic product was achieved.

2.5. Concurrent with the rapid increase in tourism, however, has been the equally rapid decline of domestic agriculture. Traditionally the most important sector, its contribution to the gross domestic product fell from 21.9% in 1964 (Phillips, 1966) to 6.2% in 1968 along (British Development Division, 1969) and at present it "has dwindled to the status of an almost peripheral activity" (Bryden, 1973, 44).

2.6. Some reasons for the near total demise of the agricultural sector are obvious. Even before the advent of tourism, a combination of steep slopes, intermittent drought, generally poor soils and insecure land titles were associated with shifting cultivation and stock farming on poor pasture-land. Elkan and Morely (1971), found that the median earnings of farmers in the British Virgin Islands were the lowest of the employment groups studied. The developing tourism industry not only offered higher wages, but also competed for land and local capital resources. By 1968, most of the required foodstuffs had to be imported, and at present probably less than 10% is home produced.

2.7. The replacement of small-farming by tourism has generated a return of Virgin Islanders as well as an influx of non-BVI islanders ("non-belongers"). Traditionally, many of the local semi-skilled and unskilled labourers had found work in the tourist sector of St. Thomas. Estimates made in 1960 suggested that approximately 12 to 15% of the British territory's population -- equivalent to a quarter or more of the total working force -- resided temporarily in the U.S. Virgin Islands (Kingsbury, 1960, 19-20). Many of these workers began to return as employment opportunities and wages improved within the British Virgins.

2.8. The homeward movement was reinforced in the latter half of the 1960's by workers from other Caribbean islands seeking employment. Moreover, because of increased business opportunities, the number of expatriates has risen steadily.

2.8 (cont.)

In the Phillips Report (1966), it was estimated that at that time approximately 450 expatriates resided in the Islands; although no more recent figures have been found, this total has undoubtedly increased during the interim period for the Territory as a whole. Although some sources (West Indies and Caribbean Yearbook, 1973, 163) still consider the Islands to be underpopulated, the total population nevertheless increased 32% in ten years -- from 8,000 in 1960 to 10,500 in 1970. Because of the increasing number of tourists, however, the tourist arrivals/residents ratio rose from 1.75 in 1965 to 3.16 in 1970 (tourist arrivals: West Indies Chronicle, September 1967, October 1972; residents: British Development Division, 1969 and 1970 Census).

2.9. Tourism has proved to be a feasible means of economic development for the Islands, and many studies have been undertaken to evaluate its economic impact. Its full effect on physical, social and cultural aspects of the Islands, however, has not been examined as thoroughly, partly because of the lack of readily available data. Since it is extremely doubtful whether changes in these elements can be analyzed adequately by the use of economic criteria alone, it is not known at what level tourism development becomes actively detrimental to the physical, social and cultural environment. In fact, it is possible that at some future point in development, the economic benefits accruing from tourism may be more than outweighed by its social costs, a consequence which must be borne primarily by the British Virgin Islanders themselves. In the meanwhile, it is quite defensible to proceed with a limited development plan incorporating specialized, small scale tourism elements, seeking wherever possible to deal constructively with the interfacing aspects with agriculture, fisheries, environmental quality and community development. But, tourism, to be optimally productive of income to the territory must be linked to more labor intensive secondary economic activity. Virgin Gorda could lead the way in this regard.

Chapter 3. Potential Sources of Development Funding

3.1. Caribbean Development Bank (CDB) Credit for Virgin Gorda Development Projects

3.1.1. Two types of CDB credit appear to be suited to small scale development for Virgin Gorda -- the Small Industries Credit (SIC) and Farm Improvement Credit (FIC). The British Virgin Islands' Government already has been approved funding for both SIC and FIC, and a Statutory body -- the Virgin Islands' Development Bank -- has been established to deal expressly with the CDB loans.

Dr. Kurleigh D. King is Head of the Industry Division and Dr. Lewis Campbell is Head of the Agricultural Division of CDB in Barbados.

3.1.2. Basically, there are three types of loans which CDB disburses:

"Hard" loans, on lending at 10% to private individuals whose net assets do not exceed US $75,000. The individual applies directly to CDB for the loan. Both long-term (10 years) and short-term (2-10 years) loans are available, the minimum amount of the loan considered being US $1,500.

Small Industries Credit (SIC), a "soft" loan to be used for the development and purchase of buildings, hotels and any other non-farming or service activity, together with the maintenance and construction of small infrastructural works.

Farm Improvement Credit (FIC), another "soft" loan, which may be used to acquire farming materials and equipment, crops and livestock, drains, water supply facilities, agricultural buildings, land clearing and other improvements, as well as the purchase of boats and engines.

None of the loans are to be used for the actual purchase of land.

3.1.3. Both the SIC and FIC funds are disbursed through an intermediary body, such as a Government institution or other statutory body. If approved, the intermediary body receives a lump sum from CDB on loan at 4% interest. However, it is up to the discretion of the intermediary body as to what the lending rate to individuals would be; it is usually in the range of 6 to 8%. (In the British Virgin Islands, the on-lending rate apparently has not been determined as yet).

3.1.4. As with the "hard" loans, the minimum loan considered is for US $1,500, to individuals whose net assets do not exceed US $75,000. Both short- and long-term loans are available.

3.1.5. Purchase of equipment by SIC or FIC must be made from a Canadian, U.S., British or Caribbean firm (see Guidelines for Procurement). Also, the CDB must be notified at the very outset of the intention to buy equipment; no reimbursement is available after equipment is bought.

3.1.6. When an individual "soft" loan is considered, the local body notifies CDB, who dispatches a SIC or FIC official to review the project and submit an appraisal to both CDB and the local intermediary body. It is up to the local body, however, to decide eventually whether or not to grant the loan.

3.1.7. The amount from a SIC or FIC covers only up to 2/3 of the total amount required, and equity is needed for the remainder (although there have been cases where the full amount has been granted for the purchase of a boat or other equipment where full or partial recovery of the loan can be realized by its sale). The Caribbean Investment Corporation provides equity funding for projects under the SIC and FIC scheme, but only to the less developed CARICOM countries; thus the British Virgin Islands are excluded from this source of funding. Montserrat, in a similar position to the BVI, has persuaded the British Government's Development Division to provide the equity part of the CDB loans, and perhaps a similar scheme could be established for the BVI.

3.1.8. The BVI Government has been granted both SIC and FIC, each for US $100,000, with counterpart matching funds (to be supplied by Dev. Div. of US $20,000. The credit is for 20 years, including a grace period of 5 years, at 4% interest. The original agreement stipulated that US $25,000 would be provided as counterpart matching funds, but Dev. Div. thought this was "excessive". The FIC portion was approved by CDB as long ago as October 1972, but apparently the BVI Government is still waiting on the total of the promised US $40,000 from Dev. Div. ($20,000 each for SIC and FIC). When this materializes, it could be used as equity funding for the individual loans; if the Government does supply the equity from this source, it usually assumes ownership, but does not operate the business (it would be a form of sleeping partner). The ideal eventual arrangement, of course, would be for a Virgin Gordian Cooperative Credit Union to supply the equity -- this may be worth talking about to the BVI Government.

3.1.9. In order to receive the FIC and SIC, a Virgin Islands Development Bank was established by statutory order in 1974. Mr. Tony Frost, the present Financial Secretary to the Government, is the principal acting member.

3.1.10. The FIC and SIC -- which as far as CDB are concerned are available whenever the $40,000 matching funds materialize -- are for no particular island, but are to be used for the BVI as a whole.

3.1.11. According to the agreement between the CDB and BVI Government, the credit "is expected to increase productivity and encourage local entrepreneurship", especially relevant to Virgin Gorda.

3.1.12. At the time of the application for the credit, an appraisal by FIC and SIC officials concluded that profitable enterprises in farming would include livestock farming, fishing and vegetable gardening, and those in industry would include concrete block construction and any other small manufacturing industries (the appraisal apparently is confidential); however, it is not known whether the officials travelled outside Tortola -- they probably made a short tour of Virgin Gorda.

3.1.13. PROPOSED ACTION

1. A trip to Tortola should be made to discuss with Tony Frost the present standing of the VIDB, its planned lending rate, possible sources of equity funding, and the general question of using the approved credit for development in Virgin Gorda.

2. Possibly a copy of this Virgin Gorda report and plan should be sent to Dr. King at CDB.

3.2. Barclays Bank Development Fund

3.2.1. The "Development Fund" of Barclays Bank was organized to bridge the gap between projects "which seem desirable on economic and social grounds" and those which fail cost/benefit analysis from a commercial point of view. Offering risk capital through grants, equity participation, loans (or a mix), the Fund contributes support to local projects not otherwise warranting funding from traditional sources.

3.2.2. Purpose - a "pump priming" role in support of relatively small scale, indigenous practical development projects designed to generate an increase in production and improve services in agricultural, industrial and commercial ventures. They <u>may not</u> be commercially viable in the early stages.

3.2.3. Location considerations - emphasis is on areas where Barclays Bank is represented.

3.2.4. Levels of support - Funds have been provided in amounts varying from $100. to $100,000. (with the larger amounts generally representing multiple year support).

3.2.5. Methods of Support -

(1) Equity participation when the Development Fund provides risk capital for entrepreneurs who may, later, elect to buy out the equity at a reasonable rate.

(2) Interest-bearing Loans (various time and rate terms).

(3) Interest-free Loans

(4) Grants

3.2.6. Criteria -

(1) The Funds' initial participation (or contribution) should generate the prospect of continuing development, a positive cash flow and a transition to normal financing.

(2) The project should have worthwhile social and economic benefits locally or a particular underprivileged sector or group.

3.2.7. <u>PROPOSED ACTION</u>

1. Arrange a meeting of CDB and Barclays Development Fund representatives with Virgin Gorda Community Development group.

2. Develop formal "project feasibility statements" (i.e., in fishing, agriculture, etc.).

3. Monitor CDB and Barclays Development Fund activity in the region.

3.3. The Development Bank of the Virgin Islands.

3.3.1. Established by Ordinance, 28 June 1974, the DB of the V.I. is the local operating vehicle for CDB soft loan support. (See Annex 3 for copy of Ordinance.)

3.3.2. The objectives are to "promote, direct and influence" the agricultural, industrial and economic development of the (British) Virgin Islands, assisting in the following:

(1) the financing, management and establishment of new undertakings; schemes for expansion, better organization, modernization and more beneficial exploitation of any undertaking;

(2) the conduct of research into the industrial, agricultural, mineral, maritime and commercial potentialities of the Virgin Islands; and

(3) the participation of private enterprise and capital whether from abroad or within the Virgin Islands in the said activities.

3.3.3. The DB of the V.I. may help

(1) to promote, finance or manage any undertaking;

(2) to lend or advance money with or without security;

(3) to purchase or subscribe for shares or other securities or to acquire any other form of interest in a business or undertaking;

(4) to conduct, promote, assist or finance research and research institutes and bodies;

(5) miscellaneous other related activities (see Annex 3).

3.4. Other Sources

3.4.1. CADEC (Christian Action for Development in the Caribbean) based in Barbados and committed to both rural and urban social action and self-help programs featuring local resources, small scale technology and indigenous planning project definition.

3.4.2. Private sector sources (venture capital)

3.4.3. Foundations and non-profit technical assistance organizations (list available from Caribbean Development Bank).

Chapter 4. Fisheries

4. 0. Introduction

The striking similarity of various studies of fishing in the Virgin Islands going back over forty years emphasizes how fisheries have been relatively static in a period of generally rapid change. The outboard motor, galvanized mesh fish pots, and nylon nets have largely replaced sails, woven wicker pots, and cotton or hemp nets. Diving has acquired greater importance as a fishery method. Catches have climbed gradually in association with improved technology and fishery resources; particularly high value semi-sedentary organisms such as conch, whelk, mangrove oyster, etc. have been reduced to very low densities in accessible areas near population centers.

As the economy and population have burgeoned, the demand for fish and the price/pound have climbed, but the number of fishermen has not changed significantly. The retarded growth (or decline in some locales) of fishing is part of the general decline of fisheries and agriculture in the West Indies, but only specific constraints on fisheries will be treated here. Annex 12 A is a series of extracts from a 1945 survey of the fisheries in the then British islands by H. H. Brown. The circumstances of fishermen still are much the same, and the bulk of the recommendations made in 1945 still need to be implemented today. A number of brief papers referred to in the Bibliography provide background material or specific guidelines (e. g., for fish trap construction).

4. 1. The Resource Base

4. 1. 1. Finfish

Physiographic and biological features of the Virgin Islands plateau and over-lying waters restrain the fishery to something akin to traditional methods, although gear innovations appropriate to the existing, artisanal scale can improve the catch per unit effort and yield.

The limited pelagic fish resources (billfish, tuna, wahoo, etc.) of the northern Virgin Islands support a sport fishery along the edges of one shelf, but repeated exploratory fishing has made it clear that stocks are not sufficient to support an industrial fishery. The primary resources are demersal fish (and invertebrates) associated with coral reefs and other, usually irregular, "live bottom". A secondary finfish resource is inshore schooling fish, generally jacks, which are traditionally taken with haul seines. The irregular, hard bottom of most of the Virgin Islands shelf and the concentration of fish in areas of physiographic relief makes trawling impractical, and interferes with the use of bottom setlines, multiple traps on a single groundline, and stationary nets of various sorts.

The low productivity of the fishery (both in total catch and catch per unit effort) is also a reflection of the low primary productivity (little growth of phytoplankton, the base of oceanic food chains) of Virgin Islands waters. Most primary production inshore is benthic -- the coral reefs, algae and grass beds -- and most fish are caught in these areas. Much of the open shelf of the Virgin Islands is relatively flat and too deep (thus the light is too dim) for sea grasses or vigorous coral reef growth (the broad shallow area between Anegada and Virgin Gorda is exceptional). Fish tend to be concentrated around even small irregularities in the bottom which provide refuge. Many of the irregularities on the open shelf and the elevated margin of the shelf are coral reefs produced at lower sea levels during the Pleistocene and now only veneered with living coral or other organisms. Even though primary productivity of these deeper reefs (below 20 fathoms) is lower than shallower reefs, the areas are extensive and currently little exploited, so substantial stocks of fish are present. On deeper reefs, the herbivores (surgeon fish, damsel fish, parrot fish, etc.) which may dominate shallow water trap catches are less common, and catches are more often snappers and groupers (which bring a higher price).

Beyond the shelf edge reefs, the bottom drops to 100 fathoms or more before gently sloping again. On the south of the Virgin Islands plateau the "drop off" is often a sheer wall from 40 to 100 fathoms, but there are areas, particularly along the northern edge, where the slope is relatively gradual down to 80 fathoms or more. The resources of the shelf edge zone are considerable (primarily several species of red snapper and grouper), but the rougher seas and the greater working depths demand a substantial increase in capital investment in gear and boats for effective fishing.

4.1.2. Other vertebrates

Two other groups make up a small part of the biomass of marine vertebrates on the Virgin Islands shelf -- sea turtles and marine mammals. Marine mammals (here whales, dolphins, porpoises, and manatees) are not currently regarded as an exploitable resource by Virgin Islanders, but the establishment of a system for reporting sightings or strandings would be of scientific interest.

Sea turtles have been a traditional fishery in the Virgin Islands, and, although relatively few people still fish for them regularly, any turtle encountered incidentally is caught. Virgin Gordians and other islanders still seasonally monitor beaches where turtles are known to nest in order to collect eggs and perhaps capture the nesting females.

Sea turtles are overexploited worldwide and are being displaced from nesting beaches by lighted coastal developments and frightened from shallow feeding grounds by constant boat traffic. They do not have nearly the reproductive potential of marine fishes (a few hundred eggs per year vs. many thousands) and at present low population levels, they are not likely to withstand even current desultory exploitation (See Rainey and Pritchard, 1971, for a Caribbean overview).

The present 1959 Turtle Ordinance for the Territory might be politely characterized as a travesty of conservation law, partly for the brevity of the closed season, but primarily for the specific exclusion of the trunk turtle from protection. The trunk is eagerly sought after because the oil rendered from their cartilagenous body armour is considered to have medicinal properties. * The immense trunk turtle (or leatherback) has probably the lowest equilibrium population of any sea turtle. The species does not generally nest on islands and the British Virgin Islands are remarkable for having a small nesting colony. The numerous "Trunk Bays" on Virgin Gorda suggest formerly extensive nesting, but now it would appear a single nesting is an event. Trunk turtles are migratory (probably swimming from Virgin Gorda to waters off West Africa or Nova Scotia) and regularly return to the same place to nest. Unlike lobster or other animals with pelagic larvae, once a sea turtle nesting colony is extirpated it is probably, in a human time frame, gone forever.

Three other sea turtle species in probable order of abundance in Virgin Gorda waters are: hawksbill, green turtle, loggerhead. Despite its relative abundance in the Virgin Islands, the hawksbill turtle is seriously endangered world wide, by the combination of hunting for food and shell. The UNDP crafts training project in Tortola has contributed to the general resurgence of sales of hawksbill shell artifacts. In the U. S. V. I., the hawksbill and leatherback are completely protected (and the green and loggerhead may be shortly) under the Federal Endangered Species Act. Consequently, it is illegal for a tourist to purchase hawksbill products in the B. V. I. or elsewhere and import them into the United States. Seizing of endangered species products in U. S. Customs is becoming increasingly likely. (The stocks of hawksbill shell being sold in St. Thomas shops were confiscated several years ago.) B. V. I. shopowners, some of whom are aware of the laws, make no effort to inform their customers. Also the hawksbill is in Appendix I (endangered species) of the Conservation on International Trade in Endangered Species which Britain is expected to ratify shortly. Effectiveness of implementation of the convention will vary from country to country, but its intent is to severely limit trade in endangered species.

4. 1. 3. Spiny Lobsters

In the Virgin Islands, the spiny lobster fishery is second only to finfish in economic importance. The current fishery is a relatively young one which has developed in response to tourist demand and with improved transportation providing access to more distant markets. Conversations with older V. I. fishermen suggest that spiny lobsters were not formerly relished as food by most of the residents of the English-speaking Caribbean, but, like conch, they were abundant and easily caught and made excellent bait for traps or handline fishing (see Annex 12A, pages 4 and 8).

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* Not long ago the oil sold for $15 for a Heineken beer bottle full. This use alone puts a price of several hundred dollars on an 800-pound turtle.

The rapid expansion of lobster fisheries in the northern Leeward Islands has reduced lobster stocks around major population centers. A considerable poundage of local live lobster for the tourist trade is flown in from relatively remote areas such as Anegada and Barbuda. In addition to initially lower exploitation these islands have substantially greater shallow water habitat than their neighbors and, consequently, a potential for a greater sustained yield of lobster. However, even at Anegada, current stocks are considerably below twenty years ago when lobster were collected in commercial quantities for export by wading in the shallows at night with a light and a sack.

Currently, lobsters are fished by traps and by divers generally using wire snares. Relatively small amounts of lobster per haul are caught in traditional fish traps, but specialized lobster traps catch virtually no fish, and there is no clear evidence that they are superior for catching lobsters in this region. For most fishermen it is a better strategy to set fish traps. A few Virgin Islands fishermen, who have made a substantial investment in a large boat and power hauling equipment, have also tried using substantial numbers of lobster pots. Many have eventually rejected them. In 1967, there were no lobster pots in the U.S. Virgin Islands and 100 in use in the British Virgin Islands, probably all belonging to Vernon Soares (Swingle, Dammann and Yntema, 1969). The average annual catch per boat of lobster by St. Thomas - St. John fishermen using fishtraps and fishing 5.8 days/month is reported at 200 pounds (Olsen, 1975) -- a yield of 0.17 pound/lobster/trap/haul. Free diving for lobsters requires relatively little capital investment (in addition to a boat) and can provide substantial cash rewards for even weekend efforts. Diving for lobster is the primary employment for only a few Virgin Islanders. For a relatively small sample of boat days (21) distributed over 9 months, the mean catch by St. Thomas fishermen diving for lobsters was 44.7/pounds/boat/day (Olsen, 1975). Even though remembrances of people who dive incidentally often favor unusually high catches, the general impression is that catch rates by Virgin Gordians diving lobster part-time on Anegada's reefs is higher. Diving is more readily restricted by sea conditions than trap-fishing. At Anegada the lobsters migrate out of the shallows during the winter ground swell and diving stops.

Lobster landings in the U.S. Virgin Islands in 1967 were 85,900 pounds from U.S.V.I. fishermen and 18,640 pounds worth $15,844 (at $.75 /pound) from B.V.I. fishermen (Swingle, et al, 1969). Most local lobster were and are sold whole. If 1967 imports from non-Virgin Islands sources of lobster tail are multiplied to approximate live weight, local lobster made up approximately one-fourth of the total consumed. Thus, a substantial demand exists, but marketing problems, as usual, are serious. In the U.S.V.I. and elsewhere contractual buying by commercial consumers of lobsters (restaurants, hotels) assures a steady source of supply in the face of fluctuating availability of local product, but this means that the local fisherman, particularly the one who dives for lobster on occasional days-off, has no assured market and may actually lose his catch to spoilage before he can sell it. A substantial (but unknown) proportion of the demand in St. Thomas is now supplied by small-scale entrepreneurs flying lobster in from nearby islands.

Because of economic importance, there is a fairly voluminous literature on spiny lobster. Idyll (1971) provides a general review of the fishery throughout the Caribbean and Munro (1974b) provides an excellent, but fairly sophisticated management-oriented analysis of the spiny lobster fishery in Jamaica.

The primary species in the northern Caribbean lobster fishery is Panulirus argus; a few individuals of other species are caught.

The life history of the spiny lobster is reasonably well known from recent investigations. The larval spiny lobster goes through a series of about 12 moults involving growth and change of form during its planktonic life, but on making its final moult into a relatively lobster-like form, it moves inshore and generally settles in sheltered waters in the abundant algae growths on the submerged roots of the red mangrove tree. The lobster, even at this small size, is an omnivore, generally secretive and feeds nocturnally. Lobsters of all sizes feed primarily on sessile or slow-moving benthic invertebrates. When juvenile lobsters attain a total length of a few inches they typically migrate into shallow seagrass pastures adjacent to mangrove areas. They hide, often in groups, next to small coral heads, sponges, or under sea urchins during the day and forage in the grass at night. The shallows of North Sound, Virgin Gorda, are a typical habitat. As they begin to approach maturity they migrate into deeper water near shallow reefs and eventually, perhaps seasonally, may disperse on to deeper reefs on the open shelf. This pattern is not absolute, but is reflected in the size distribution of lobsters caught across these habitats and depths. Very small lobsters predominate mangrove areas and are uncommon at depths over 30 feet. As significant lobster populations do occur on submerged banks surrounded by oceanic depths, clearly lobster can be recruited directly into the coral reef without this progression of habitats.

4.1.3.1. Specific comments

Currently, the lobster fishery in the B.V.I., like the rest of the fishery, is unregulated and unmonitored. A Fisheries Ordinance drafted in 1964 is still pending. As written, it would provide the legal basis for regulation but no infrastructure necessary for monitoring catch and effort in order to provide the date necessary for regulations which encourage good long-term yield. An amended law, or the establishment through other mechanisms (such as any local fishery cooperative or centralized market), of a system for recording catch and effort and regular sampling of the catch for biological information, will help to assure long term economic viability for the fishery.

Though the imposition of legal restrictions on the B.V.I. lobster fishery is probably in the distant future, some voluntary restrictions on any group fishing or marketing effort would be desirable. A wide spectrum of criterion is a fairly enforceable way to make use of the lobster's growth potential. This should be in excess of the minimum size for reproduction (a carapace length of about 98 mm. equivalent to weight of about one pound), but how far in excess it should be of that depends on the acquisition of data on the particular population.

Most lobsters are not recruited to the trap fishery (at depths between 5 and 50 fathoms) until they have exceeded this size, so this would impose little hardship on most fishermen. However, traps or divers working in the shallows (less than 5 fathoms) may catch substantial numbers of juveniles. On Anegada apparently few of these small lobsters are taken except in the summertime when children home from school spearfish for them. At least some people recognize that this is a wasteful practice in the long run and should be controllable.

At the risk of heresy, it is worth pointing out that there is little biological reason to selectively protect egg-bearing females (though there may be reason to exclude them from the catch if being egg-bearing leaves them in poorer condition for market). Lobster, unlike more familiar livestock or other terrestrial vertebrates, produce immense numbers of eggs and consequent planktonic larvae. These larvae live in the plankton for 6-12 months, so that recruitment to the Virgin Islands lobster populations is probably derived from larvae spawned at some distant unknown point. Recruitment in any given year is dependent on physical conditions and, in turn, food availability in the water mass with which the larvae move, not on the number of eggs produced locally. People are concerned about egg-bearing lobsters but not egg-bearing fish, presumably because the eggs are incubated externally before being shed and are consequently more evident.

4.1.4. Queen Conch

Aboriginal conch shell mounds on Anegada and elsewhere in the Caribbean attest to a long history of exploitation, but despite its continuing economic importance, relatively little is known about the status of conch populations in Virgin Islands waters. Most of our limited knowledge of the biology of the queen conch (*Strombus gigas*) is contained in a paper by Jack Randall (1964) based on work on St. John, U.S.V.I. Adult conchs generally occur in areas of low wave energy in beds of sea grass (admixed or sometimes dominated by algae), on open sand, and on rocky pavements veneered with sediment and an algal mat. Adult queen conchs are not frequently encountered below 80 feet, roughly the lower depth limit of sea grasses.

Juvenile conchs generally occur in shallow, relatively quiet water (less than 40 feet) on coral rubble, sand, or sediment with sparse growths of sea grass. Juveniles smaller than about three inches are rarely, if ever, found and are presumed to be buried in bottom sediments most of the time. Conchs feed on plant material (primarily soft algae) and organic detritus.

Female conchs deposit large masses of eggs in open sandy areas. These hatch releasing larvae with a pelagic life of about three weeks. Like Virgin Islands lobsters, unless larval adaptations to local water circulation patterns deposit them back more or less where they hatched, then conch populations in one area are probably dependent for recruitment on larvae produced in some distant unknown area and more directly on the vagaries of water mass movements. For reasons and in patterns as yet unknown conchs are migratory and seem to move in groups. Anegadians report high catches this year (1975) in areas which yielded increasingly fewer conch for the preceding several years. Therefore, any effort at monitoring the fishery must be sufficiently prolonged to differentiate low yields from natural causes and those from over exploitation.

Queen conch are collected in the Virgin Islands almost exclusively by diving, generally without compressed air. Where conch populations have been more or less exhausted in free diving range (to 50 feet), a few people have found it profitable to dive for them with compressed air. These deeper areas are less productive and probably conch growth rates are lower. In the past, they constituted a refuge which by migration probably provided some gradual input into the more heavily exploited inshore waters. Thoroughgoing extraction by SCUBA diving bodes ill for anyone still engaged in low technology, subsistence fishing in the same or adjacent areas.

Swingle, Dammann and Yntema (1969) report 1967 landingsof 11,760 pounds of conch worth $6,938 (at $0.59/pound) by B.V.I. fishermen, slightly less than landings from U.S.V.I. waters. In 1974, the four major food wholesalers in St. Thomas were importing 35,000 pounds/year from dealers in Flordia or Puerto Rico at roughly $0.65/pound delivered. At that time little or no local conch appeared to be moving through commercial channels (Stott ms., 1974). Most of the imported conch in 1974 and the local conch in 1967 was used by commercial outlets (restaurants, hotels). There is clearly a strong market for conch, but consistent availability is important for large scale commercial outlets.

Currently, a plane from Puerto Rico flies to Anegada weekly and will buy up to 400 pounds of cleaned conch at $0.65/pound. Anegadians supplying the plane indicate 4 men with a 10-foot outboard boat can collect 350 conch/hour free diving in 6-15 feet of water. A shelled conch generally weighs 0.3 to 0.5 pounds so this represents a catch rate of 35 pounds/hour/man. If we assume only two hours diving per day and 1 hour to shuck the shells, this is still substantially better than catch rates reported for St. Thomas (6 fishermen each caught a mean of 44.5 pounds/boat/day for a total of 15 days; Olsen, 1975).

In Virgin Gorda, conch were said to generally be too deep for convenient free diving (i.e., the conch which probably occupied the areas of shallow habitation in North Sound were fished out long ago), and it is best to go to Anegada where "any amount" could be collected.

The quantitative data are not available, but there are numberous instances in the Caribbean of economically serious local depletion of conch populations (e.g., the Grenadines). There are suggestions of similar trends in the Virgin Islands, with exploitation converging on Anegada, the only island with fairly extensive habitat and remaining stocks of conch.

4.1.5. Whelks

The whelk, wilk, or West Indian topshell (*Cittarium pica*) is a large marine snail formerly common on exposed rocky shores in the Virgin Islands and elsewhere in the West Indies. It is a traditional food in the Virgin Islands and is the only gastropod, other than the queen conch, of any general economic importance.

The narrow habitat zone occupied by whelk extends from the upper limit of rocks constantly wetted by wave splash to perhaps five feet (generally less) below the surface. The upper limit of whelk distribution probably is controlled by dessication and availability of algae for food and the lower limit by predation.

Generally, smaller animals occur in the upper intertidal and the largest animals (4 to 5 inches basal diameter) occur below the low tide mark in crevices in areas of heavy surge. *

Whelks are harvested by walking along rocky shores and picking them from the rock surface or by snorkeling near steep rock shores. The ease and lack of equipment required to gather whelks partly accounts for their virtual disappearance near populated areas. Whelk larvae are probably at least briefly planktonic, but marking experiments suggest that after juveniles settle out of the plankton, they move only short distances.

More mobile animals (fish, lobsters, and even conch) may disperse from unexploited areas into those which have been heavily fished and consequently maintain an exploitable population. However in areas depleted of whelk, it will take a number of years for newly recruited juveniles to grow to exploitable size.

Using boats and/or snorkeling gear to collect in previously unexploited areas (rocky cliffs inaccessible from land or the shores of isolated cays), it is possible to collect commercially significant quantities of whelk.

Swingle, et al (1969) reported that 22,305 pounds of whelk ($8,900 at $0.40/pound) were sold to commercial outlets in the U.S.V.I. in 1968. No whelk were imported from outside the Virgin Islands. Probably collection for home use is of equal or greater magnitude. In terms of catch per unit effort each of 6 U.S.V.I. fishermen reported collecting a mean of 500 pounds of whelks for a total of 15 days (Olsen, 1975).

As always, age and experience has a lot to do with subjective evaluation of changes in resources. On Virgin Gorda, one younger part-time fisherman felt that any amount of whelks could be collected on Virgin Gorda, but older people noted that the abundance of accessible whelk in the intertidal in accessible areas like Handsome Bay had declined considerably.

Whelk habitat is a narrow discontinuous band along the shores of the Virgin Islands. The total resource is small, but has subsistence value because extraction requires little or no capital investment. The more inaccessible rocky

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* The only paper on whelk biology useful to management is Helen Randall (1964), which includes studies on distribution, diet, size structure, growth, and reproduction in a population on the south shore of St. John, U.S.V.I.

portions of Virgin Gorda's windward shore probably support some considerable unexploited populations. As human settlement expands on Virgin Gorda over the next twenty years, increased shoreline access will lead to more intensive exploitation for home use.

4. 1. 6. Management

The preceding pastiche of biology, ecology, exploitation history and qualitative recommendations is intended to give a predominantly biological overview of the primary fishery resources of the Virgin Islands Shelf which are accessible to current fishing gear and methods. The basic objective of fishery management could be described as obtaining the greatest yield of useable produce at the least cost in effort (either in human or, ultimately, in overall energy expenditure) over some extended period of time. It is also desirable that the yield be, if not uniform, at least predictable through time (so that large amounts of effort are not wasted at the wrong time looking for resources that are not there).

Some of the technological and cultural aspects of this optimization effort are treated later, but this section is an effort to make the rationale for minimum sizes (and other related regulations) seem a little less arbitrary and point up the complexities and interactions of fishing a multi-species community.

4. 1. 6. 1. As pointed out in the individual resource discussions, the life histories and primarily the lower reproductive potential of marine mammals and turtles make their management very different from that of most fish and marine invertebrates. This latter group, including virtually all of the species exploited in the Virgin Islands, produce large numbers of planktonic larvae which drift for weeks or months before transforming into something resembling the adult form. In the case of reef associated organisms, they then may establish themselves in some possible permanent abode on the bottom. The survival of the dispersing planktonic larvae is related to nutrient availability, temperature, and related physical paramenters in the water in which they drift. The number of new recruits annually to a fish or lobster population is not dependent on local egg production. *

Though overexploitation of a fish stock is possible, planktonic larvae and wide distribution make biological extinction of a species by traditional fishing methods extremely unlikely. However, the substantially lower reproductive potential of marine mammals (for many, 1 young/2 years) and sea turtles (a few hundred eggs/3-4years) makes it quite possible that fishing will lead to biological extinction within a region.

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* There are some unexplained activities of tropical fish which make one somewhat uneasy about the completeness of the picture presented by these assertions, but they are, in the main, true.

4.1.6.2. Geographic extent of habitat and mobility (and/or site fixity) of a species also affect the vulnerability for local stock depletion by exploitation. Contrast the restricted habitat and low mobility of whelks with coral reef fish which are relatively rapidly recuited from adjacent areas to occupy desirable habitats from which other fish have been caught.

4.1.6.3. The growth of most animals asymptotically approaches an upper limit, so growth per unit time decreases. Any fish population is also subject to some mortality (probably primarily through predation and fishing pressure). The mortality is reflected in the size structure of a population (many small fish and few large ones). Using basically this information and some assumptions which are reasonably well-founded, it is possible to calculate a minimum size limit which will provide a maximum yield. Market preferences and available gear may require modifying the figure somewhat, but it may also turn out that some fisheries are, in a sense, self-regulating, in that fish are caught only at or above the recommended minimum. The issue that then remains is whether the regulatory agency proposes to control the number of fishermen between whom the available catch is distributed or will permit economics to take its course.

4.1.6.4. In a multi-species fishery, like a coral reef trap fishery, interactions may develop, i.e., if heavy selective fishing removes large predatory species like snapper and grouper, their prey species, including smaller herbivorous species and lobster, may increase in numbers.

4.2. Methods of Exploitation

4.2.1. Traps

The predominant traditional method of fishing in the Virgin Islands (and many of the Caribbean Island nations) is the Antillean fish trap. Figure 4.1 shows several traditional designs. Traps are now fabricated from galvanized wire mesh (generally $1\frac{1}{2}$ inch mesh) braced by small sticks (preferably of a dense wood resistant to borers), but are occasionally still constructed by weaving galvanized wire or pliable wooden withes into panels, which are then joined together (see Annex 12A, page 4).

Detailed work analyzing the variables affecting fish trap catches in Jamaica has been recently summarized in Munro (1974). Some small scale work in the Virgin Islands has had generally parallel results. The salient points are:

1) When set unbaited, traditional trap designs of equal size have somewhat different efficiencies, listed in decreasing order of effectiveness:

   a) S-shaped pots with two "horseneck" (downturned) funnel entrances.
   b) Z-shaped (or double chevron) pots with two funnels.
   c) Arrowhead (or chevron) pots with a single funnel.
   d) Rectangular or round pots with a single funnel.

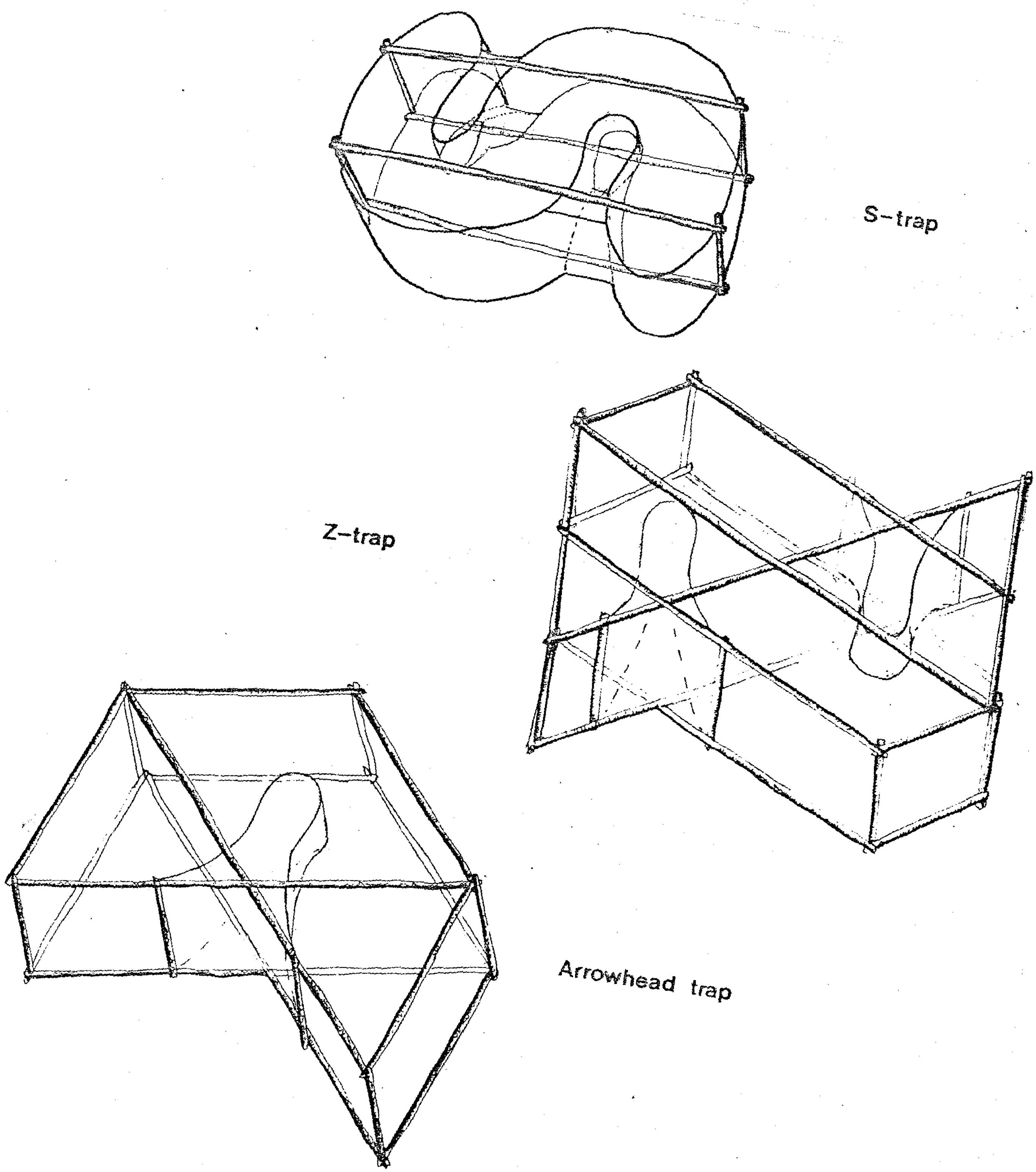


FIGURE 4.1 ANTILLEAN FISH TRAPS.

2) When baited, the efficiency differences between the designs is less significant. But for both baited and unbaited traps, the catch increases with the size of the trap. The upper limit of this effect is not known or at what size the additional costs (materials, etc.) outweigh the increase in catch. Large traps present handling problems in small boats both in hauling to extract the catch and in moving traps because of impending weather or a change of fishing locations. The value of baiting traps must be determined locally, but for short (2-3 days) soaks (the lenth of time the trap is left in the water between haulings), particularly in deep water (greater than 40 fathoms) or unfished areas, baiting usually increases catches substantially. For soaks of over a week in shallower water (perhaps 20 fathoms or less) the value of baiting is less consistent (on such long soaks the traps are to some extent self-baiting).

3) In general, the number of fish entering a trap per day is constant, but a constant proportion of the accumulating fish escape so that the maximum catch is obtained when ingress is matched by escape. However, this value is approached asymptotically (after 7-10 days in experiments in Jamaica) and yield per trap per month may be much higher if the trap is pulled more frequently. Bait may increase the rate of ingress until the bait is consumed, then the trap will tend toward the equilibrium of an unbaited trap. Thus if baiting appears to yield improved catches, it is important to haul the trap before the bait is exhausted. There may be a gradual succession in the species composition within the traps which is particularly evident on long soaks (over a week) towards more valuable species (snapper, grouper, and spiny lobster) even though the total poundage may remain constant.

4) The variability in catches from trap to trap is extremely high, even in identical traps set side by side. Chance events such as the capture of one individual of a fish which tends to attract others of its own species makes it difficult for a fisherman to sort out the most effective deployment of his gear and time, but some record-keeping will help.

5) Catches of fish in traps in Jamaica show strong correlation with the lunar or tidal cycle. There is a marked depression in catches around the time of the quarter moons (moon ages of 10 and 24 days). In a year of exploratory line fishing by the FAO, on the margins of Caribbean continental and island shelves, over half the total catch was taken from full moon to last quarter, the brightest period.

6) Munro (1973) designed and tested a large volume, metal-framed trap which breaks in half to stack, allowing a boat to carry ten traps for each one of the traditional design. The metal-framed traps catch roughly 20 per cent less fish than a traditional trap and require welding for the construction of the frame, but offer substantial advantages in mobility and rapid handling. The 1973 cost for these traps in Jamaica for labor and materials, but not rope or buoy, was $24 U. S. per trap, and the estimated life was 12-18 months.

The catch rate in pounds per hour of a trap is generally less than that of handlining or other methods in areas where there are substantial stocks of fish. However, even the most unskilled fisherman will usually catch some fish with a trap, and low-density stocks (including areas both which are naturally depauperate or have been overfished) can often be exploited by traps when other more effort-intensive methods would be uneconomical. Also, traps catch several relatively abundant groups of reef fishes (parrot fish, surgeon fish, goat fish, etc.) which are difficult to exploit economically by other means.

The working life of a trap depends on the quality of the materials, the skill with which it is constructed, the manner in which it is hauled and where it is set. In the U. S. Virgin Islands trap theft has reached such a level that traps are normally stolen before their working life is exceeded, but estimates of working life for galvanized mesh traps vary from 8 to 18 months. Handwoven "hard wire" pots are said to last longer than mesh. The addition of sacrificial zinc anodes to traps, particularly those with metal frames, should increase their life span towards or beyond the upper limit of the period mentioned. The anode may also serve to reduce the electric field around the trap and may improve catches of lobster and crab; traps with corroding (and thus electrolytically-active) funnels in north temperate fisheries for crustaceans produce distinctly lower yields.

Most fishermen haul their traps by manually pulling the line over the gunnel of the boat. Even when they are set in shallow water this is slow, heavy work and generally the boat drifts once the pot is off the bottom, so considerable time is spend relocating the spot to re-set the trap. The prolonged time involved (10-30 minutes/pot) in hauling, resetting and emptying a trap limits the depth (generally no more than 30 fathoms) and number of pots they can handle in a day (few handle more than twenty - see Annex 12 A, page 5).

Effort-reducing innovations are possible which could increase productivity at various levels of investment. The simplest is a dory roller or short, removable davit with an open sheave. This would reduce the friction in hauling and change the fisherman's working position to a more comfortable one. In some boats it may be possible with a swinging davit to lift the trap nearly clear of the water and swing it over the boat.

The least expensive power hauling equipment is a 3 - 8 HP gasoline engine geared down to drive a slowly turning capstan. These were introduced in exploratory fishing in the USVI several years ago and, unlike most other gear innovations used in that work, can now be seen in use by a few local fishermen. They are noisy, asphyxiating devices which rust with phenomenal rapidity even when housed, but they are also reasonably reliable, and easy to repair. An 8 HP pot hauler (the largest offered) is $350 on the shelf at Atlantic and Gulf Fishery Supply, a major gear dealer in Miami. Hydraulic haulers for installation on inboard engines are potentially more versatile, but cost roughly twice as much from the same supplier.

A third option may be the most promising mix. Under a Sea Grant program Barry Fisher at Oregon State University adapted hydraulic pumps to the flywheels of several brands of outboard motors and then evaluated them in a small boat salmon trolling fishery off Oregon. Since then, their system has also been applied in a small boat fishery in the American Pacific territories.

The installation of hydraulics on the outboard requires some engineering skills, but eliminates the cost, weight, and maintenance of a second power plant. The power supplied by hydraulic lines from the pump can be fed to small capstans or other devices conveniently located on the boat. If a first evaluation looks promising, a technician might be brought down to instruct in the installation of this equipment or a Virgin Gordian with mechanical skills might be sent to Oregon or nearer points where this gear is in use.

A significant part of the time spent in hauling and resetting a typical Virgin Islands fish trap is in getting the door open and closed and getting the fish out. A few more minutes expended in trap construction to build a hinged, framed door with a simple latch (all from sticks and wire) would save substantial time each time the pot is hauled.

Munro's stackable traps (1973) are hinged at the midpoint and the halves lock together with a pin. Extracting the pin empties these pots in a few seconds and allows easy rebaiting.

The trap loss, both through theft and loss of buoys to boat traffic, can be reduced by the use of pop-ups -- time-release, corroding metal links which hold a loop of line and the pot buoy below the surface for a predictable number of days. They currently cost roughly $0.30 (50/$14) and are available for soaks between three and ten days. Because the rate of reaction is temperature-dependent, they should be checked out in local waters.

Traps which have lost their buoys continue to catch and kill some fish for the life of the trap (probably at least a year if not hauled). In other fisheries, the addition of a cotton mesh panel which rots out in six months or less is required as a conservation measure.

Availability rather than preference usually dictates the size of wire mesh used in fish traps, but the use of wire mesh no smaller than $1\frac{1}{2}$ inch (and preferably larger) should be encouraged to avoid killing numbers of unmarketable, small fish (see Annex 12 A, page 13).

Damage to their swimbladders from pressure change generally seriously injures fish in pots hauled from any depth (they get "the bends"), so it is preferable to avoid catching them rather than releasing them. Lobsters are not affected in this way, but small lobsters thrown over the side are extremely likely to be eaten before they reach the bottom.

4.2.1. (continued)

The yield in the current fishery around St. Thomas/St. John is roughly 4 pounds of fish and 0.17 pounds of lobster/trap/haul using a six day soak (calculated from data in Olsen, 1975). Using the local price estimate per trap complete of $40 it takes approximately 10 hauls, or 2 months when hauled every six days, to recover the cost of a trap. Considering that this represents nearly one-fourth of the life of a trap without a protective anode and does not consider trap losses (a mean of 0.5 traps/month for St. Thomas-St. John boats with 16.7 traps) or other operating expenses, the economics look fairly grim. Most other, more effort-intensive methods look even less promising, but some involve less investment.

4.2.2. Hook and Line

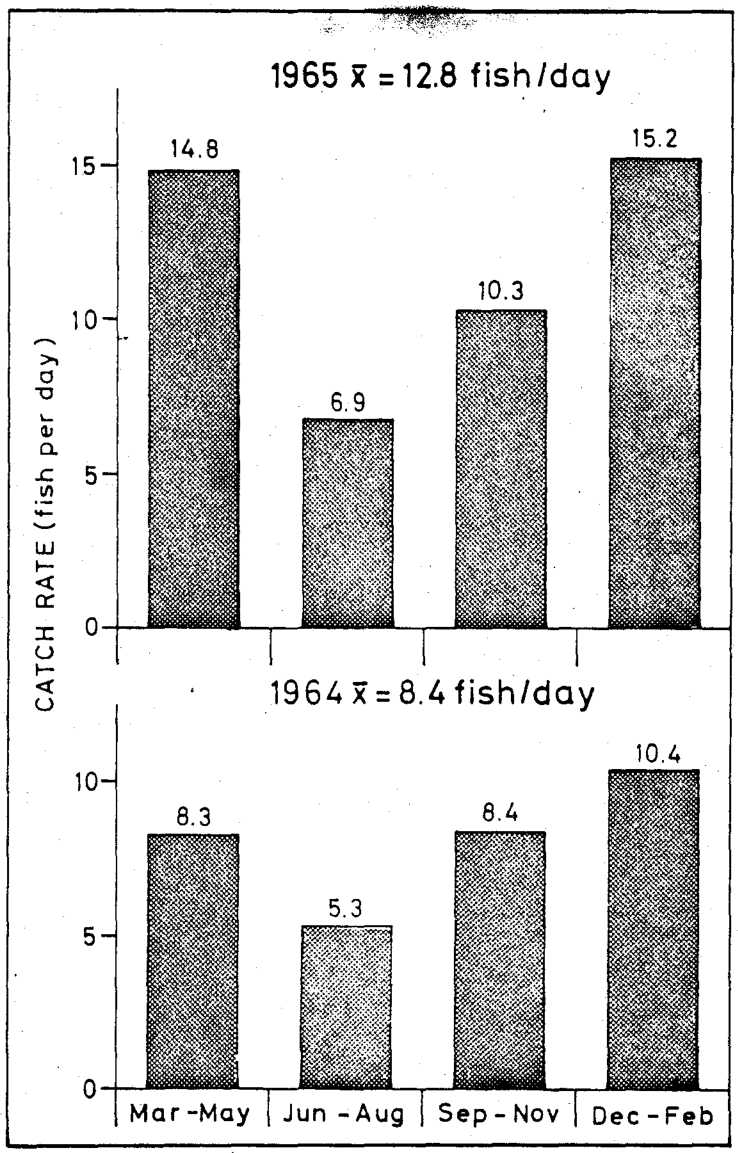
As noted earlier, low stocks, irregular hard bottom, and sharks in some combination make intensive hook and line fishing such as surface or bottom longlines uneconomical through low yields and gear loss. In general yield/hour for trolling with two or more lines on the Virgin Islands Shelf are also very low, but if sea conditions force travel at trolling speeds, there is no reason not to trail a feather jig using an oar for an outrigger.

Particularly near the edge of the Shelf and to some extent seasonally (see Dammann, 1969, for graphs of seasonality of some gamefish catches), fishing boats may encounter feeding schools of pelagic fish. Usually a boil at the surface and feeding sea birds reveal their presence from some distance. Trolling through these areas or around concentrations of floating debris can yield higher catches (estimated at 4.0 pounds/hour with two lines by Olsen), but considering even a portion of operating expenses (roughly 2 gallons/hour fuel at $0.80/gallon in Virgin Gorda), this does not look economically viable.

Limited incidental and simulated production troll fishing catches by F.A.O. using large vessels (40-80 feet) and 3-7 lines around northern Caribbean banks yielded an average of 70 pounds/hour. They made no analysis of economic feasibility but noted that catch rates per man day compared favorably with bottom fishing with electric reels (Yesaki, undated ms.) with the same vessels. More directly relevant to the V.I., Yesaki also presents(Figure 4.2) the seasonal and annual variability distribution of trolling catches by two V.I. sport fishing boats. These suggest at least when trolling is most likely to be effective.

Vertical handlines are the second most important traditional fishery method in the V.I. Their catch per unit effort is highly dependent on the skill of the fisherman. As noted earlier, line fishing is effort-intensive and yields are best when exploiting concentrations of fish (baited hooks and chumming serve to concentrate them). The mean reported catch per unit effort in pounds/boat/day for St. Thomas fishermen (generally 2 men/boat) by trap and line fishing are identical (58/pounds vs. 57 pounds, not a significant difference), but many fewer days of line fishing were reported.

Figure 4.2



Catch rates by season of two Virgin Islands sport cruisers.

from Yesaki (ms.)

Rod and reel are rarely used by full or part-time local commercial fishermen, although many V.I. residents use them in recreational fishing. Power reels (hydraulic or electric) have been used in exploratory deep water line fishing by both scientific efforts and expatriate commercial fishermen. Average catch per unit effort in exploratory fishing at the shelf edge in the Virgin Islands was 4.5 fish/hour/reel (with considerable variance depending on sea state and location) which converts to about 6.3 pounds/hour/reel (Sylvester, 1973). The capital investment for this sort of fishing is high, partly because the rough conditions at the shelf edge dictate larger boats. None of the several exploratory efforts by commercial snapper fishermen from the U.S. with well equipped, relatively small (30-40 feet) boats have persisted. Also, not surprisingly, power reels have not found acceptance among local fishermen.

4.2.3. Nets

Traditionally, three types of nets are used in the Virgin Islands. One is the circular cast net used for collecting sprat or fry (anchovies, sardines and other clupeid fishes) for bait or occasionally to eat (see Annex 12 A, page 6). Cast nets of fine mesh (less than $\frac{1}{4}$ inch) for retaining extremely small fish have not been available commercially and were (are?) handmade locally for several hundred dollars each (a complete commercially made 3/8 inch stretched mesh cast net is under $70). Turtle nets are an extremely large mesh tangle net (square mesh 4 inches to 12 inches) of heavy nylon seine twine. They are usually handmade, but may be purchased. These are set in a number of ways but are generally left untended overnight or occasionally even longer.

Beach haul seines are used by relatively few fishermen in the Virgin Islands, but they make significant contributions to the total catch. The description of haul seine fishing in Brown, 1945 (Annex 12 A, page 6) is appropriate to the Virgin Islands except that the nets are now often handled by fewer men. Schools of fish, usually jacks, are followed or watched for several days to determine their movements and then encircled with the net. Divers work to free the net from snags and keep the leadline on the bottom. In St. Thomas catches of 500-800 pounds are not unusual and even with two to three days effort involved, the catch/man/hour may still be 6 pounds (Olsen, pers. comm.). Smaller, finer seines are used to catch schooling bait fish in much the same, but a less elaborate, manner.

The cost of a large seine is substantial (replacement value in 1945, $1,000; today, roughly twice that) and although modern materials have reduced degradation, considerable skilled maintenance is essential. Relatively few beaches are suitable for using haul seines and access to beaches has been increasingly restricted by coastal development. The use of seines tends to be opportunistic, i.e., whenever schools of fish are sighted in appropriate areas. The V. I. Bureau of Fish and Wildlife will be testing this year (1975) a modified haul seine designed and constructed by one of their employees, a lifelong V. I. fisherman. The result of this study in terms of catch per unit effort and overall return on investment will be valuable.

4.2.4. Diving

Diving has only acquired widespread importance as a fishery method in the West Indies since the relatively recent availability of mass-produced equipment, i.e., spear guns, masks, snorkels, fins, etc. The average age of fishermen who dive is probably considerably less than that of fishermen as a group. A large proportion of older West Indian fishermen and seamen freely admit a fear of the water and are unable to swim, let alone dive. There are some ethnic groups, however, that have traditionally used diving, such as the French residents of St. Thomas. Perhaps to a greater extent than other methods of fishing, which require more capital investment, diving mixes recreation with incidental income production. Almost all of this semi-commercial diving (except for non-indigenous activities like black coral collecting) is done without compressed air.

Diving is the primary method of collecting conch and some catch per unit effort figures based on very small samples were noted in Section 4.1.4. Similarly, catch and effort estimates for lobster diving were covered in Section 4.1.3. Lobsters are normally taken with a wire snare, which is passed over the lobster's tail and then pulled tight at the junction of the body and the tail. An occasional recently-molted (soft) lobster may be cut in half by this method, but it is far superior to gigs, spears, or bare hands which damage both escaping and captured animals.

Spearfishing can be a highly selective fishing method which extracts older, larger fish with high marketability and low remaining growth potential. It is a strenuous activity requiring considerable skill to make a good living working full time, but in the not too distant past a number of expatriates living in Virgin Gorda and fishing the Anegada reefs in one or two man operations have done well. Virgin Gordians report that a group of five to six divers can go to Anegada for a day and get 400-500 pounds of fish. As noted earlier, diving is somewhat more sensitive to sea conditions than other methods of fishing.

Current widespread controversy highlights the point that commercial or intensive sport spearfishing are not compatible with observation-oriented recreational diving. Not only are the larger, bolder or more inquisitive fish rapidly removed, but most of the remaining fish head for cover at the sight of a diver. Indiscriminate killing for "sport" has given spear fishing an increasingly bad name, but it is no more inherently immoral than baiting wild fowl. It is a matter of social decisions about how a resource will be exploited and by whom.

4.3. Trade and Consumption of Fishery Products

4.3.1. Imports and Exports

The paucity of agricultural statistics in the British Virgin Islands is exceeded by the lack of fishery statistics. Table 4.1 attempts to delineate trends in landings, import and export of fishery products for the Territory. The general increase in catch and value of exports since 1930 is probably real and linked to an order of magnitude increase in price and partial mechanization of the fishery.

There are obvious inconsistencies between different sources of information showing under-reporting of exports, however. The U.S.V.I. is the major export market for B.V.I. fishery products, but some additional export of fishery products (partly by air) to Puerto Rico and elsewhere has occurred.

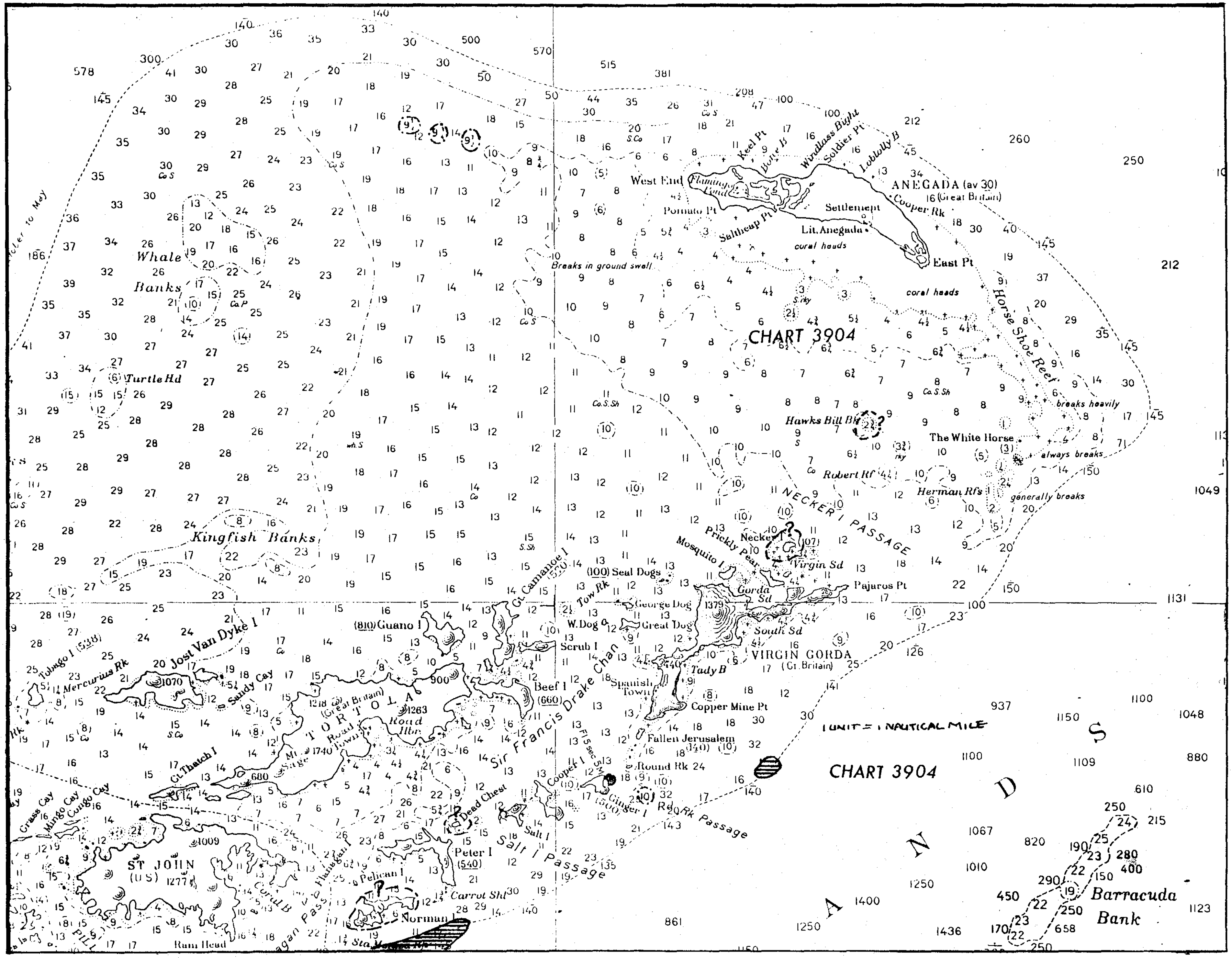


Figure 4.3 Bathymetric chart of waters surrounding Virgin Gorda (from N.O. 25024). Hatched areas produced ciguatoxic fish. Circled areas with question

4.3.1. (continued)

Despite the likelihood that total fishery exports exceed those to the U.S.V.I., the estimated value of U.S.V.I. landings for 1967 by B.V.I. fishermen ($172,000) is over five times the reported exports ($33,000). (Note that the import estimate does not include landings by the 36 percent of the St. Thomas-St. John resident fishermen who were born in the B.V.I. and may well have been fishing in B.V.I. waters.)

Tables 9.5.11 and 9.5.12 give reported value of B.V.I. exports from 1950-1974 of fish products. Considering the above mentioned inconsistency between U.S.V.I. imports and B.V.I. exports, one wonders whether the substantial year to year fluctuations in B.V.I. exports from a traditional fishery exploiting largely low yield, stable resources is real or reflects inconsistent sampling. If we treat entries in Table 9.5.12 as being equivalently sampled, then the fairly constant export value since 1967 means that the poundage of exports has decreased by half (since the price/pound has doubled). Fishermen comments about catch per unit effort and direct observation suggest that fish stocks have not declined precipitously, so presumably reduced catch represents reduced fishing effort. Probably some fishermen are abandoning fishing as unrewarding compared to other options. Table 4.2 shows the estimated or declared number of fishermen since 1945 revealing an absolute and more rapid relative decline in numbers.

Table 9.5.13 gives two months of recent domestic exports of fish from Virgin Gorda which shows at least that occasional surpluses are exported <u>and recorded</u>. These are the only extant statistics for anything exported from Virgin Gorda, though obviously there is export of agricultural products to Tortola.

Table 9.5.14 gives summary statistics for monthly imports including fish for Virgin Gorda from 1973-75. Table 9.5.16 gives current prices for food including fish in Virgin Gorda supermarkets. Table 9.5.15 (extracted from a more extensive table in B.V.I. <u>General Statistical Abstract</u>, 1974) gives <u>average</u> retail food prices including fresh and frozen fish in Roadtown, Tortola in 1972 and 1974. (N.B. These average retail prices are derived in a fashion which limits their applicability for some purposes, e.g., the figure for frozen fish of $2.84/pound must involve averaging everything from kingfish heads to lobster tails with some emphasis on the latter, but, if derived by a constant method, they provide a relative index of price increases.)

TABLE 4-1

BRITISH VIRGIN ISLANDS FISHERY STATISTICS

Landings

	1945[1]	1958[2]	1968[2]
Weight (1,000 lbs.)	615	880	2650
Value ($1,000)	61.5		1392[7]

Fish Exported[3]

	1930[4]	1945[1]	1950[6]	1956	1960[6]	1967[4]	1970[6]	1974[6]
Weight (1,000 lbs.)	13	150		12,067.6[5]		326		
Value ($1,000)	1.1	15	7	14[6]	13	172 (33)[8]	21.6	28.5

Fish Imported

	1970[6]	1974[6]
Value	$38,374	$177,289

[1] *Brown, 1945. Catch estimated. Values at 10¢/lb.*

[2] *FAO, 1969. Estimates.*

[3] *Exports of fish go primarily to St. Thomas. For continuous 1950-1974 data based on B.V.I. Government sources only, see 1974 Statistical Abstract.*

[4] *Swingle, et al., 1969. Imports from B.V.I. into U.S.V.I. only.*

[5] *Kingsbury, 1960. (Mean of years 1953-1959). Wildly in error.*

[6] *1974, B.V.I. Statistical Abstract.*

[7] *Calculated at $0.52/lb. based on 1967 figures from Swingle, 1969.*

[8] *Value in parentheses is exports from B.V.I. Statistical Abstract. Imports to U.S.V.I. are 5 times exports (!).*

TABLE 4-2

NUMBER OF FISHERMEN, BOATS AND GEAR

	1945[1]		1946[2]		1960[3]	1970[3]
	Territory	Virgin Gorda	Territory	Virgin Gorda	Territory	Territory
Total population	6505	509	6505	509	7921	9672
Fishermen	765	106	175	33	170 (3)	80 (1)
Fishermen as % of total of population	11%	21%	3%	6%	2%	.8%
Boats:						
Decked sailing boats	39	6		1		
Open - sailing or rowing under 20 ft.	162	20		21		
Motorboats	-	-		-		
Fish Pots				96		

[1] Brown, 1945 (Annex A, page 27). Number of fishermen includes parttime and is estimated. Populations are from 1946 census.

[2] 1946 B.V.I. census. Presumably fishing is primary occupation for declared fishermen.

[3] 1960 and 1970 census, B.V.I. *Statistical Abstract*, 1974. (Figure in parentheses is number of women.)

4.3.2. Local Consumption of Fishery Products

From Table 6.2 we can conclude that there were 283 tourists present on Virgin Gorda on any given day, 16 percent of the total daily population (resident and tourist). If we take the mean monthly imports of fish from Table 9.5.14 and ignore the probable differences in spending between tourists and residents, the annual per capita expenditure on imported fish is $53.00 (total annual expenditure $70,000). As there is no breakdown of imports by product type (canned vs. frozen, etc.), it is difficult to say how much of this might be displaced if local products were available. In any case, the imported products displaced if more local seafood were available are not necessarily seafood, particularly in the tourist market.

In Virgin Gorda there are no recrods of landings of local fish. Distribution and marketing are conducted individually by the fishermen. Fish are generally sold at the dockside to residents (or sometimes to hotel representatives), or taken around to hotels and offered for sale. The supermarket in the shopping plaza was not handling local fish at the time of our survey and Osborne's supermarket carried one type of fish (frozen whole mackerel) which might have been, but probably were not, local.

Fresh fish are sold at $1.10/pound whole, unprocessed for snappers and groupers and $0.70 - $0.80/pound for mixed "pot" fish (the full assemblage of reef species with perhaps 30 species being relatively common). One fisherman sells primarily grouper to the hotels in lots over 100 pounds for $1.10/pound gutted. For comparison, the price for virtually any fish, including pot fish, in St. Thomas is $1.00/pound and premium species such as red snapper gutted and iced may bring substantially more. The Road Town, Tortola, prices are said to be comparable to Virgin Gorda. In Virgin Gorda, the price/pound of live lobster is variously quoted at $2.50 or $2.25 (comparable to St. Thomas). Conch on Virgin Gorda was quoted at $1.10/pound cleaned but not skinned. (As noted earlier, conch is being sold on Anegada at $0.65/pound to Puerto Rico. Hopefully, it is not processed, packaged and shipped back to Virgin Gorda.)

In November, 1975, four of the hotels surveyed on Virgin Gorda estimated they used a total of 840 pounds/month of fish. With substantially less certainty the same hotels use of local lobster and conch is approximately 600 pounds and 350/pounds/month respectively. These hotels include 56 percent of the hotel beds on Virgin Gorda; if we assume equivalent occupancy and consumption by other hotels, the estimates of overall hotel consumption will be 1500, 1100, and 600 pounds for the month of November. From Table 6.2, we see that November is somewhat below the mean for total tourist days in Virgin Gorda. Using November as a hopefully conservative estimate of mean monthly commercial consumption of local seafood, we obtain annual estimates of 18,000; 13,200; 2,400 pounds of fish lobster and conch respectively. *

* Correcting for the difference between the mean tourist days/month and the November value would increase these estimates by 30 percent, but amid numerous calculations, it is easy to lose sight of the very real uncertainties in the basic guesstimates.

4.4. General Observations on the Fishing Industry

4.4.1. Marketing and Product Preference

Most hotels on Virgin Gorda indicated a willingness to use more local fish, but generally indicated a preference for cleaned (gilled, gutted and scaled) and a proportion of fillets or pre-cut portions. Some indicated a willingness to pay higher prices for more completely processed fish. Others felt that current Virgin Gorda prices were clearly not competitive with imports, and higher volume sales were possible if more completely processed fish were offered at current or lower prices. Labor costs and weight losses on filleting local fish brought the price up to excessive levels. Some who would purchase processed conch or whelk did not want to deal with cleaning them.

The market structure is a problem for both producers and commercial consumers. As noted earlier, commercial consumers with predictable demand import seafood on contract in order to have an assured supply even if they would prefer a local product, because local availability fluctuates. Because of economics of scale in importing and to some extent the slowness and unpredictability of transport, some indicated they imported lots that are large in proportion to their storage for perishables, and sometimes had to refuse local fish which were offered because they had no storage space or too big a stock of local and/or imported fish. Particularly the incidental fisherman who is not constantly aware of who needs what and has no cold storage capacity may then lose a catch to spoilage or have to sell it at lower price in smaller lots to residents. Some local parttime lobster fishermen have adapted to this system by telephoning to determine the current demand for lobster and then catching that amount. This is a good individual strategy but the overall problem of sporadic production reflects the incidental nature of the fishing.

A central market for fresh fish and other local products would avoid the system of individual distribution which consumes a substantial proportion of the fishermen's time. St. Croix fishermen spend forty percent of their time in marketing fish according to Williams (1974). A small cold storage facility on Virgin Gorda with plate or other rapid freezing capability would serve to level out temporary surpluses and shortages in supply, but to survive economically would probably require that the fishermen sell to it at lower than the current price. If such projects were to be self-supporting, a number of substantial changes in the fishery would probably have to be made (e.g., contractual buying between the cooperative and major consumers which would route most local production through the central market). Williams (1974) details a feasibility survey for a marketing cooperative on St. Croix. Aside from the site specific aspects, it has considerable relevance to Virgin Gorda. It is worth noting that catches reported in Williams' survey of St. Croix fishermen (who wanted to join a cooperative) are over seven times the catches reported to the U. S. Bureau of Fisheries and Wildlife. Presumably, reality lies somewhere in between, but the scale of investment in a cooperative has to be reasonably well keyed to the production. Annex 12A contains some useful comments on marketing and general improvements in fisheries.

4. 4. 2. Ciguatera

Fish poisoning is a relatively common event in the Virgin Islands and, in addition to the public health problem, constitutes a major impediment to fishery development, particularly in expanding marketing to the tourism sector. In St. Thomas, any mass poisoning resulting from sales of toxic fish to residents temporarily depresses the market for local fish.

The general strategy of fishermen is to avoid particular localities, or particular species in particular localities which are traditionally known to harbor poisonous fish. A number of localities near Virgin Gorda which produced toxic fish either in exploratory fishing (Brownell and Rainey, 1971) or were reported as toxic during this study are marked on Figure 4. 3.

Incidental poisonings of nonresidents unfamiliar with ciguatera are relatively common (bare-boat charters, down-islanders, etc.). Fishermen are also poisoned by taking a chance eating a fish they are unwilling to sell. However, toxic localities are subject to little fishing pressure and a somewhat unscrupulous fisherman can readily make a good catch (and substantial income) if he is willing to risk poisoning his customers. As populations rise in the Virgin Islands and community cohesiveness declines, this problem is likely to increase. Any middleman (e.g., a cooperative marketing operation) can fall victim to this unless some system of fisherman accountability is established.

Many potential commercial consumers of local fish in St. Thomas avoid it not only because of high price for unprocessed fish, but because of concern about poisoning their guests (presumably part of this is reputation and the other concerns about liability). Ciguatera was not mentioned as a problem by hoteliers on Virgin Gorda, which suggests local fishermen have a good track record, despite proximity to toxic areas on Virgin Gorda.

The laboratory at Bitter End, North Sound, Virgin Gorda is surveying the distribution of toxic fish and collecting them in order to extract and characterize the toxin. Work is also going on in other parts of the world, but despite considerable effort (Brody, 1972, includes a summary of ciguatera in the Virgin Islands, including lists of toxic species), there is no simple way to determine if a fish is toxic.

In the context of any cooperative venture on fishing, an effort should be made to pool and compile local knowledge on the distribution of fish poisoning (implicated species; seasonality, if any; bottom type; depth range; etc.). This would inevitably generate some arguments, and accumulate some nonsense, but would be important to anyone entering the fishery and valuable to fishery scientists. Any useful component of the scientific literature could be compiled into a pamphlet directed toward fishermen for their edification and comment.

If a central market is established, potentially toxic fish which fishermen would ordinarily discard could be brought in and held for pickup by the staff of the Bitter End laboratory (perhaps with some fee as an incentive to the fisherman to bring it in). Some system of reporting cases of poisoning and recovering any uneaten portions of toxic fish should be part of this program.

4.5. The Fishery Potential

> "No man will be a sailor who has contrivance enough to get himself into a jail...." Samuel Johnson.

4.5.1. Various publications cited previously (Brown, 1945; Swingle, et al, 1969; Dammann, 1969; Brownell and Rainey, 1971; Williams, 1974, etc.) detail the litany of problems which reinforce each other and beset Virgin Islands fishermen:

1. Low biological productivity accessible only to certain types of gear.
2. Excessively high cost and limited availability of manufactured materials and of equipment, even more serious problems with spare parts.
3. Low risk capital (partly a product of items 1 and 2) restricts investments and consequent access to more distant, less exploited areas with potential for high C. P. U. (catch for unit of effort) and better overall return.
4. Item 3 leads to overexploitation of readily accessible areas and reinforces Item 1.

A "cultural preference" for one day fishing trips and a general resistance to change are often cited as impediments to fishery development, but the latter at least may be simply good economic gamesmanship on the part of the artesanal fisherman: "You don't win big but neither do you starve".

4.5.2. The present pattern and technology of fishing incidental to other activities predates the advent of tourism and expanded opportunity for wage earning as shown in this comment from Brown (1945, Annex 12A):

4.5.2. (continued)

Where fishing is poor, however good the market, the standards of fishermen will be poor and considerable reliance must be placed on alternative sources of income. This is one reason why potfishing is so preferred as a part time occupation particularly in the Leewards; it might be possible to make larger catches by handlining all day, but if quite apart from the labour and exposure involved, this still does not bring an adequate reward, fishing with a few pots will be preferred since by lifting his pots very early in the morning, the fisherman still has the best part of the day before him in which to cultivate his garden.

Simple infusions of money such as loan schemes for the purchase of motors or larger vessels with inboard engines with the objective of increasing range and consequent total production have not generally been successful in the former British Caribbean territories. The increases in catch have been low, perhaps partly because the technological innovations have not been fully utilized, and loan repayment has been poor (partly because of little effort to collect).

Marketing systems do not alleviate the production problem but do serve to free the fishermen's time for other activities. Generally speaking, demonstration projects particularly those with a wide spectrum of technological innovations have had little long term impact. The massive FAO-UNDP Fishery Development Project was completely divorced from the needs of artesanal fishermen (and consequently the bulk of the fishery industry) in the Lesser Antilles.

Reductions in the cost of gear through government (or cooperatively) capitalized bulk buying and/or elimination of import taxes on bona fide supplies is one which would probably have prompt acceptance and show the most immediate impact. Fishermen are squeezed between rapidly increasing costs of equipment and less rapidly rising prices for their product. They cannot compete effectively with large scale more efficient operations.

4.6. Recommendations

4.6.1. Finfish stocks alone among the living marine resources examined offer long-term potential for increased yields, primarily by fishing stocks which are now only lightly exploited. See 4.1.6. on management and later sections for changes necessary to permit expanded fishing.

4.6.2. Statutory protection for all marine mammals and ideally statutory protection (including some effort at stock evaluation) for all sea turtles. Failing that, protection for all nesting sea turtles and their eggs; total protection for the hawksbill and leatherback and a closed season on green and loggerhead turtles from June to November. Since regulatory mechanisms do not exist to enforce protection, particularly of nesting beaches, educational efforts will be critical if nesting turtles are to survive. Efforts to de-emphasize the sale of turtle products through hotels, restaurants and gift shops would also be useful (though it does not appear that sales are significant now on Virgin Gorda).

4.6.3. Pending the acquisition of information on size structure of the local population, catch and effort, we would not recommend support for any new fishery effort focusing on lobsters. The momentum of the present fishery may already be excessive.

4.6.4. Intensification of the existing conch fishery should not be contemplated until a serious evaluation of stocks is undertaken. This may require an investment of man days seemingly disproportionate to the commercial value of the fishery, but it should be remembered that conch have some traditional subsistence role. The indirect costs (in imported food purchased, for instance) of eliminating (or at least making inaccessible) the resource for some years are rarely properly tallied up against the small gains in cash income.

4.6.5. Again, without some stock assessment and monitoring of catch, we recommend no emphasis on whelk collecting, even as means of diversifying the fishery. The pelagic phase of the life cycle, secretiveness and a preference for rough water on rocky coasts means that some whelks will always be present, if unexploitable, but some decision needs to be made whether whelk are to be viewed as a subsistence or "recreational" resource or one to be exploited commercially. In the event of the development of a regulatory mechanism, any number of arrangements are possible, but the simplest for optimizing yield will probably be a minimum size. If the subsistence aspect is important a catch limit is also useful.

4.6.6. Encourage the use of mechanical pot haulers, both gasoline and hydraulically powered and compare cost/productivity data, encourage the use of zinc anodes on fish pots to extend their useful life, and improve fish trap door design.

4.6.7. Prohibit spear fishing tournaments and discourage sport spear-fishing.

4.6.8. Develop a central marketing facility - possibly a cooperative with freezer facilities.

Chapter 5. Agriculture

5.1. Historical Trends

The amount of agricultural data available for the British Virgin Islands is aptly summed up in the BVI General Abstract 1974:

> Agricultural statistics in the BVI are virtually non-existent. There has been no survey of livestock since 1960 although a sketchy survey of fisheries was conducted in February 1975... It was originally intended to include a table giving the history of agricultural production and exportation..... This table had to be abandoned due to the difficulty of locating the relevant source material within the BVI.

It is known, however, that cotton was produced in Virgin Gorda until as late as the 1930's, when the crop was infested by the pink boll worm, after which time production ceased. Livestock, vegetable and charcoal production continued to be significant until the advent of tourism, however, with some exports to Tortola and the U.S. Virgin Islands.

The only comprehensive agricultural data existing for Virgin Gorda up to the present time are those for 1946 (see Tables 9.5.1 to 9.5.9). In that year, 449 persons out of a total population of 504 were living on farms, of which 226 were family farm workers (as opposed to 70 in 1960; see Table 9.5.11). Of the total 104 farm units, the majority (69) raised cattle (402 animals), while another 16 units raised a total of 491 small livestock.

Tables 9.5.11 and 9.5.12 list data for Territorial domestic exports from 1950 - 1974. Overall trends include the demise of live animal exports since 1972, the steady exportation of coconuts, and the fluctuating exports of fish, fresh fruit and vegetables. Since 1950, however, it can be stated that the Territory - as well as Virgin Gorda - has changed from a small exporter of farm produce to a mass importer.

5.2. General Considerations

The prevailing physical conditions appear not to be conducive to the carrying of high-yield agricultural activities under the present methods practised. Although the soils themselves are reputed to be productive given sufficient moisture, Virgin Gorda in the recent past has experienced prolonged periods of drought, and there is no reason to presume that this climatic trend will alter in the near future. Unfortunately, little rainfall data and no temperature data exist; it thus was impossible to calculate any potential evapotranspiration levels for the island.

5.2.1. Soils

The surface rocks of Virgin Gorda are primarily diorite and other related intrusives, which weather to a loose, sandy soil with large residual boulders and boulder piles. Recent superficial deposits are located in lowland areas adjacent to the sea, such as at South Sound and Pond Bay (see Geology Map).

A soils study for the island, although much needed, has never been undertaken. Soils in certain areas, such as North Sound, the lower slopes of the Peak and the southernmost portion of the Valley, are reputed to be moister than those soils found in the central Valley. Without an adequate survey, however, it is uncertain whether these soils possess superior moisture retention capability, or are kept moist by groundwater seepage and capillarity. In general, the shallowness and loose texture of the soils permit a fairly rapid run through of water. A formal soil study should be undertaken at the earliest possible date.

5.2.2. Rainfall

The only rainfall data available are for the years 1909-20 (Spanish Town), 1904-14 (location unknown), 1965 to date (Little Dix Bay Hotel - see Table 9.6.32), and for those collected by Father Jacoby (the Valley, data possibly destroyed by fire in Tortola).

From conversations held with Virgin Gordians, it would appear that rainfall - although never copious - has diminished over the last few decades. This trend is substantiated by the data for Road Town, Tortola: during the period 1901 to 1950, average annual precipitation was approximately 53", whereas over the longer period of 1901 to 1974 the figure dropped to 48". De Booy and Farris in 1918 described the island as "poorly watered and unproductive", but estimated that annual rainfall approximated 35-40" in the Valley (Bowden et. al., 1970). In contrast, during the period 1965-1975, the Valley experienced only four years when precipitation exceeded 35".

5.2.2. (cont.)

As shown in Table 9.6.33, the concept of mean or even median average rainfall is of limited value in the British Virgin Islands. Not only is monthly distribution uneven, but wide fluctuations occur from year to year (see Table 9.6.32). As a result, agriculture is severely handicapped by occasionally prolonged and unpredictable periods of drought.

5.2.3. Labour Force

For any renaissance of agriculture to occur, the outward shift of labour from the agricultural sector into services, especially among the younger generation, will have to be reversed. The few full-time farmers remaining on Virgin Gorda are well over 50 years of age, and because of their limited income cannot afford to hire labour (the current wage is $16. to $20. per day), although they may occasionally be helped by their younger relatives. Reciprocity of labour, once a common practice for clearing land, has now almost totally vanished. Family heads in their 30's and 40's still undertake both farming and fishing, but on a part-time basis, secondary to salaried jobs. For people in their 20's to become interested in agriculture, as one Valley farmer commented, "the hotels would have to go".

It is uncertain whether higher financial returns alone would induce the younger people into agriculture, since alienation from the land appears also to be a problem.

Whether the BVI Government programme to encourage agriculture will be successful remains to be seen. However, this will greatly depend upon procuring a larger water supply, since under the present conditions and methods agriculture in Virgin Gorda is near carrying capacity. Because of its importance, present and potential water utilization is discussed first, after which potential markets and production are analyzed.

5.3. Water Utilization

5.3.1. Present Conditions

The primary sources of water for all purposes are obtained from shallow wells, roof catchment and storage tanks, and the Little Dix Bay Hotel desalinization plant.

5. 3. 1. (cont.)

A consequence of the uneven distribution of rainfall is that large fluctuations in groundwater reserves occur. Groundwater is held in the Eocene bedrock as well as within superficial deposits. Research undertaken by Jordan (1966) in St. Thomas suggests that water recharge to the bedrock may occur only once or twice each year as the result of a downfall of over two or three inches within a 24-hour period. Less heavy rainfall is dissipated by run-off, evaporation and soil absorption, although alluvial aquifers are partially recharged. During a prolonged dry period, wells near the coastline may produce brackish water - as is mostly the case in the Valley - owing to the high saline content of the bedrock, but those in North Sound purportedly are fresh year-round. The scarcity of perennially good well water in the southern portion of the island is of particular concern with regard to cattle production, since the water requirements of cattle are not insubstantial*, and are usually fulfilled by the wells.

Apart from groundwater, Virgin Gorda is dependent upon roof catchment and storage tanks except during a prolonged drought, when water is bought from the Little Dix Bay Hotel desalination plant. Of the 297 buildings inspected in 1971, however, only 58% possessed cisterns.

5. 3. 2. Potential Utilization

The financial cost to Virgin Gorda of increasing its water resources will vary according to the type of scheme undertaken. Some of the alternatives are mentioned below (see also, Bernstein et. al. 1974).

Desalination is an expensive process, but it does offer the advantage of producing a fixed amount of water irrespective of climatic conditions. This source of water, however, is not particularly feasible for agricultural purposes, since the cost to the farmer would be prohibitive unless a highly productive form of agriculture (such as hydroponics) was undertaken.

Far more utilization could be made of the present run-off water. On a large-scale, for communal use, it should be feasible to construct stormwater impoundment dams at the foot of a few chosen valleys or roads. This approach has the advantage of not only increasing the water supply available, but also partially controlling floodwater during the rainy season.

More water could be obtained by increasing rainwater catchment from buildings and paved areas. It has been estimated, for example, that 6.6 million gallons a year could be collected from the Beef Island airstrip; although smaller, the Virgin Gorda airstrip conceivably could collect 2 million or more gallons per annum.

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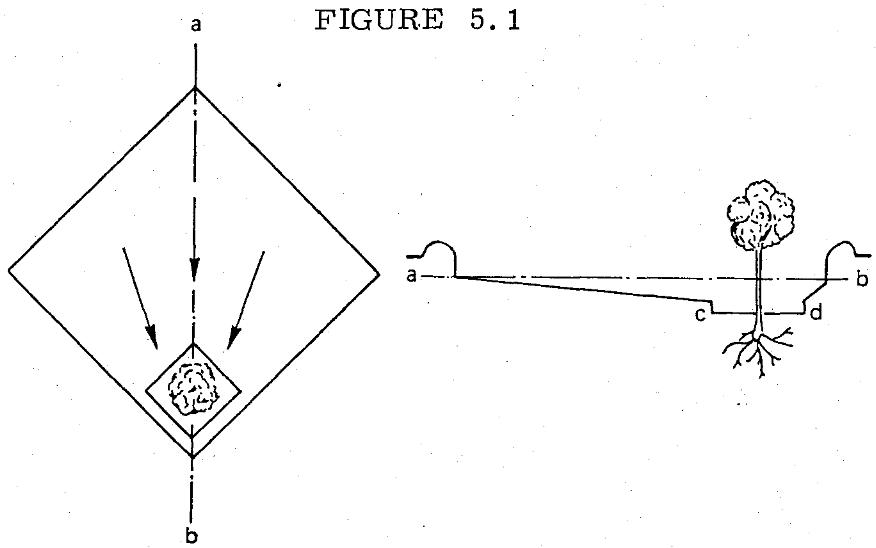
*The Anegada Report: Technical Studies, 1974, recommends that at least twenty gallons be available per head per day.

5. 3. 2.(cont.)

On a smaller scale, small earthen hillside dams should be built, such as those presently being constructed in Tortola, and which already have been constructed in number in the U. S. Virgin Islands (under the programmes of the Department of Agriculture, Soil and Water Conservation).

Increasing research is being undertaken into microcatchments - small catchment systems that are sited at the farm location, and enable a larger than normal area to irrigate the plants. These systems, if properly constructed and managed, are more efficient than the large-scale water-harvesting schemes because conveyance losses are minimised. Also, they do not need channels, conduits, terraces or terrace walls (see Figure 5-1).

FIGURE 5. 1



Plan and cross-section of a microcatchment. Arrows indicate direction of runoff flow. Cultivated plot (c–d) is placed at the lowest point of the natural terrain within the catchment; its position varies. Walls are 15-20 cm high; c–d is about 40 cm below the catchment, holding seeping water close to the plant; root-zone soil must be at least 1.5 m deep; the a–b distance can be less than 5 m or more than 30 m, depending on climate and crop. (M. Evenari)

5.3.2.(cont.)

A waterproof soil cover of plastic sheet, butyl rubber or metal foil acts as a low-cost local rainfall catchment. With a gravel layer on top, the underlying cover is protected against radiation and wind damage, and can last up to twenty years. Such a catchment is relatively cheap and - according to its size - can provide high quality water for less than $0.05 per cubic meter (just over a cubic yard) in a 12" annual rainfall zone.

Further studies have to be undertaken in Virgin Gorda, however, to evaluate the potential for micro and other small catchment systems. In general, perennial crops with deep tap roots are most suited to runoff agriculture, as are plants that become dormant during a dry season. Also, this type of agriculture needs approximately 1.5 to 2 meters of soil depth in the cultivated area, and the few areas in Virgin Gorda that qualify would have to be carefully located by field research.

Actual catchment of water is only part of the battle, however, since moisture evaporation from the soil also must be reduced. Rock, gravel and crop mulches are an age-old practice, and more recently paper and polythene plastic mulches have been employed. In Virgin Gorda, seaweed mulch formerly was utilized, but presently is only laid down for coconut slips. Apart from lowering evaporation (it is estimated, for example, that up to half the water used by unmulched corn may be lost through evaporation from the soil surface in a dry area), seaweed also enriches the soil as well as improving its texture. Much of the paper and plastic waste that presently ends up at the Copper Mine dump could be employed far more usefully as mulch.

If irrigation is used, evaporation can be substantially reduced by the 'trickle' method, where a system of pipes are placed among the plants on or under the soil, and the water drips out only next to the plants (see Figures 5-2 and 5-3).

Frequently, the low productivity of sandy soils is due to an inability to prevent water from percolating away too rapidly for plant growth. To avoid this, any water-resistant material can be laid down approximately 60cm (about two feet) below the surface with a few occasional gaps for drainage. One way to install a barrier is to remove the topsoil, hand-place the moisture barrier, and then refill the area. This is tedious, but machines have been built that will install a waterproof asphalt barrier without excavation (Erickson, 1972). Costs are high, however; in the United States, using the mechanised system, the price for each hectare (2.47 acres) is $625-$750 (Bernstein *et al*., 1974).

Transpiration from the plants themselves may be reduced by reducing air movement over a crop by windbreaks of interplanted rows of taller plants, by removing unproductive leaves on the crops, or by breeding plant varieties that transpire less. Since farmers in Virgin Gorda have used their own seeds over the generations, the latter problem may already be partially achieved, since hopefully the plants derived are more adapted to local conditions of drought than those grown from imported seeds.

5.3.2.(cont.)

Furthermore increased water supply could be possible via further exploitation of shallow wells, and a study to evaluate the potential of this source should be undertaken. Since most of the existing wells produce less than one gallon per minute, their use for crop cultivation is limited however.

Many of the methods mentioned above are relatively cheap, and a combination of methods should greatly improve the amount of water available to farm production. It should be emphasized, however, that further study and test sites are needed before many of the methods can be utilized. Secondly, the systems at least initially should be supervised by an expert agronomist or water systems analyst. Much potential harm to the soil can occur through well-intentioned but mismanaged improvement practices. Thirdly, far more

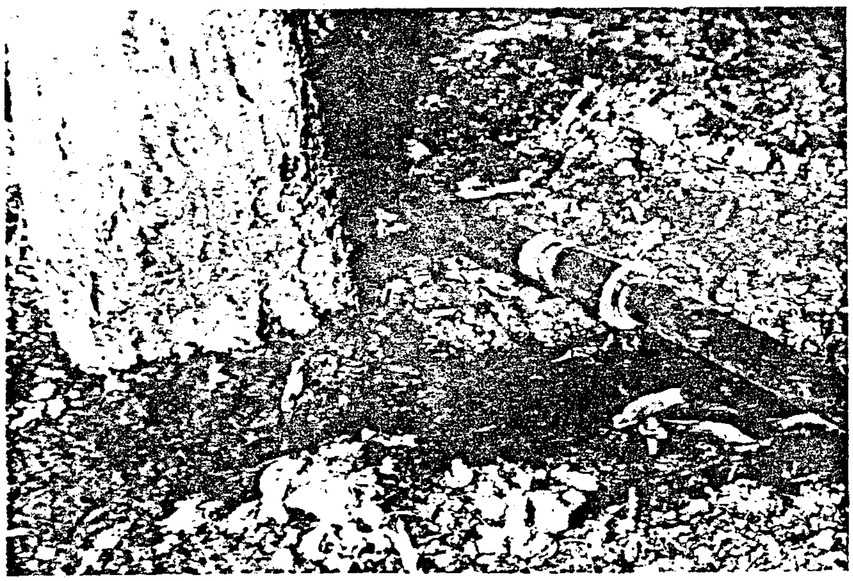
FIGURE 5-2

Trickle irrigation system in California, USA. Pipes lead the water to emitters beside the trees. (F. K. Aljibury)

Source: Bernstein et al, 1974

information concerning evaporation and transpiration rates for the island are needed before the viability of any particular method (or of any particular crop) can be assessed adequately. A series of experimental test plots should be planted and careful records kept in order to select the best combination of factors and approaches.

FIGURE 5-3



Trickle emitter dripping irrigation water. (F. K. Aljibury)

Source: Bernstein et al, 1974

5.4. Fruits and Vegetables

5.4.1. Present Production on Virgin Gorda

The growing season for produce has substantially changed since the early 1950's owing to the apparent decrease in rainfall. Before that time, the land was cleared and seeded in February/March, and again in August/September, whereas now these practices occur only in the latter period.

Farmers use primarily their own seed to grow a wide variety of crops, including okra, white beans, occasionally tomotoes, eggplant, lettuce, carrots, cabbages, sweet corn, guinea corn, black-eyed peas, string beans, and lima beans. Most of the produce is consumed at home, although sweet gourd, pumpkin and watermelon find a ready market at the hotels. During a particularly wet season, such as in 1975, the majority of households grow their own small kitchen plots.

Insecticides and pesticides are used little, if any, primarily because of their cost, although nematodes and other pests can do substantial damage. Seaweed mulch, once used for garden crops, is no longer generally employed, although certain of the hardier vegetables can survive a fairly prolonged drought if it is applied liberally (30 tons per acre has been suggested). During dry periods, some of the growers water their crops from well and cistern sources, whereas others apparently do not.

5.4.1.(cont.)

The more common fruit trees include mango, sugar apple, lime, coconut, cashew, tamarind and banana. They appear to thrive most readily in the southern end of the Valley, South Sound and North Sound. Bananas, for example, do well at North Sound, but few are found in the central Valley area.

5.4.2. Potential Market

The amount of produce locally grown is relatively insignificant (less than 10%) in comparison with the potential market existing, even though returns to the farmer (provided sufficient water) should be favourable.

A recent survey estimated that retail food prices in Virgin Gorda were approximately 60% higher than in Boston, Massachusetts. The Statistics Office, Road Town, computed in its Consumer Price Index that food prices rose from 100 in December, 1968 to 194.1 in December, 1974 - almost doubling in six years. During the year 1974 alone, prices of food increased by 25% (BVI General Statistics, 1974). The average cost to Virgin Gorda for importing its produce during the period 1973 to 1975 averaged just under $8,600 per month (see Table 9.5.14). Retail prices for certain foods in Road Town for the December months of 1972 and 1974, and for those in Virgin Gorda supermarkets towards the end of November, 1975, are shown in Tables 9.5.15 and 9.5.16 respectively.

Although occasional local surpluses of crops are sold in the small shops and groceries, none are carried by the two supermarkets. One receives all of its merchandise from its parent company in St. Thomas, and the potential sales of Virgin Gorda produce to the supermarket may be minimal. The other supermarket is owned by Dr. Osborne of Tortola, and would appear to offer a more promising market to growers.

Far more important to the producer, however, is the potential of sales to hotels and restaurants catering to the tourism trade. Of the five hotels surveyed in Virgin Gorda (Fischers Cove, Little Dix Bay, Lord Nelson, Ocean View and Olde Yard Inn), all expressed a preference for local produce, providing that the quality was not inferior to present imports. Since much of the imports may be at least a few months old, well-watered and well-managed crops should be able to compete favourably.

At present, local produce sales to hotels probably account for less than $500 per month, but could have exceeded $5,000 to the five hotels surveyed in November had the produce needed been available (one hotel alone offered a potential monthly market of approximately $3,750 with three-quarters room capacity).

5.4.2.(cont.)

An attempt is made in Table 6.2 to estimate the total tourist expenditure on meals each month for 1974. It was assumed that people staying at hotels would spend a minimum $10.00 per day for meals within the hotel, and a further $2.80 during in-season and $2.60 during off-season for meals outside of the hotel. It was also assumed that day visitors from elsewhere in the Territory would spend approximately the same $2.80 and $2.60, depending on the season. The total expenditure derived is in the order of $1,100,600 for 1974, with an average expenditure per month of $91,700. We view these estimates as conservative.

The proportion of the total amount that is accounted for by the cost of fruit and vegetables to the hotel and restaurant manager must be partially conjectural, but for the purpose of this study we estimated 10% on average per meal, of which 90% could be grown locally. The potential market, therefore, of locally grown produce in 1974 was approximately $99,000, or an average of $8,255 per month. Seasonally, the lowest monthly dollar tourist market that could be expected in 1974 was $3,492 (September), and the highest was $14,166 (December).

In addition to the tourist market, of course, must be added the resident population's demand for produce. Since it is not known what portion of the produce is grown locally, any estimate for this market probably would be so erroneous as to be misleading. On an average day the tourist population is less than 1/3 of the resident population, and thus the local market has significant potential.

5.4.3. Benchmark Farm Operations

In recent reports published by the Virgin Islands Agricultural Experimental Station, St. Croix, operating costs and profits were estimated for several benchmark farms, each concerned with a different farm product. Because of the paucity of other data for agriculture in the Virgin Islands, this study will rely heavily on those reports' findings.

A 15-acre fruit and vegetable farm, of which 13 acres would be planted each season, was taken as a model for the analysis (Mullins and Bohall, 1974). Depending on the amount of equipment that could be utilized effectively, two or three full time labourers in addition to the operator would be needed. Total gross sales at 1972-73 prices during the season were estimated to equal about $43,000, total costs about $12,400, and estimated returns above costs just under $31,000. This would result in a net return above costs of almost $2,400 per acre of crops grown (see Table 9.6.1). The 3 acres of onions grown at a cost of $2,200 accounted for 48% of this income.

Estimated costs per acre for growing eight selected products (mangoes, pineapples, papayas, okra, tomatoes, pepper, cucumbers and onions) are listed in Tables 9.6.2-9.6.11. On a per pound basis, tomatoes, mangoes,

5.4.3. (cont.)

papayas and okra provided the best prospects, followed by pineapples and onions. The growing of peppers could result in negative rates of profit with normal yields.

Mullins et al estimated that for the total U. S. Virgin Islands, if only the domestic requirements during the months of "favourable climate" (which for St. Croix they consider to be September to March) were met, the land required would be approximately 130 acres using benchmark farms. They emphasized, however, that year-round production would be dependent upon irrigation.

A farm unit of this nature is certainly worth considering for its potential in Virgin Gorda. Given the limited area of the island suited for agriculture, a 15-acre farm does not appear to be excessive in size. Although land ownership is fairly fragmented in the South Sound (see Chapter Eleven), the latter area may be appropriate for such a farm unit, with the use of run-off catchment from the surrounding hills and ground water sources. A far more detailed survey would have to be undertaken to assess the viability of such a scheme.

5.5. Beef and Dairy Production

5.5.1. Present Production

It is estimated that between 170 to 230 cattle are presently reared in Virgin Gorda (as compared with a total of 402 in 1946), the majority being Red Poll with some mixed Holstein. The animals appear to be in good health and are tick-free. Drought is the major problem in limiting cattle numbers.

Forage is supplied by either Pangola or Guinea Grass. The former generally is preferred by farmers, since it spreads rapidly and eliminates weeds. Even though both grasses die down during the drought, no feed supplements are used, since the cost is prohibitive. Instead, cattle are rotated from one small pasture to another. The major cattle rearing areas are found in the southern portion of the Valley and at North and South Sound. Animals used to be kept in the central part of the Valley, but the apparent declining rainfall has made this area too dry for adequate growth of pasture. Within the Valley, approximately ten farmers keep small herds of ten or so animals. In the North and South Sound areas, there are reputed to be approximately 70 cattle.

Present marketing is mostly local, although at least two farmers sell animals on the hoof to Tortola at 70¢ per pound live weight. For butchered cattle, the usual asking price is $1.30 per pound. Marketing is undertaken on an individual basis. If a farmer intends to slaughter an animal, he first solicits hotels for the larger orders, and displays a tree notice for the public's information stating the time of butchering and sale. The method of butchering itself has not changed over the centuries, and meat is still sold by the pound,

5.5.1.(cont.)

not by the cut. Efficient dressing by a qualified butcher would certainly enhance the product, but since a ready demand exists for all beef offered, the cattle owners have little incentive to change their methods. Unfortunately, a potentially valuable by-product - the cow's skin - is hacked up in the process, and used locally for fish bait. The meat is not hung, but sold immediately; there is no refrigerated storage facility on the island for community use.

Very occasionally during the wet season, milk and butter are made for the farmer's own consumption. The cattle are regarded as best suited for meat rather than dairy produce, and in the dry season have barely sufficient milk for their calves. If adequate pasture were available all year, however, a small amount of milk production could be feasible. Under the present system in the Valley, where the pastures may be some distance away from the owners house, few farmers are prepared to milk the cows even in the wet season.

5.5.2. Potential Market

The average monthly values of imported meats and dairy produce for the years 1973-75 are given in Table 9.5.14 as \$16,400 and \$4,500 respectively. No more detailed statistics are available, such as the proportion of canned meats and the relative importance of different types of meat.

As for vegetables and fruit, the potential market far exceeds the present local supply. Of the five hotels surveyed, it is doubtful whether they bought a total of much over 200 pounds of local beef during the month of November. They were willing to purchase between four and ten times the amount that they actually did, had sufficient amounts of sufficient quality been offered. The potential market for beef for the five hotels alone is in excess of 1500 pounds per month at average occupancy levels.

In one of the reports issued by the Virgin Islands Experiment Station (Stammer, 1974), an attempt was made to estimate the per-capita consumption figures for different sectors of the population in the U. S. Virgin Islands in 1971 (see Table 9.6.12). If these figures are used for Virgin Gorda, the derived \$ values for the resident market in 1975 and the tourist market in 1974 were, respectively, \$108,420 and \$39,780 for beef and veal (Table 9.6.13). These figures are probably too low.

Even assuming that the total consumption of 114,000 lbs given in Table 9.6.13 is correct, to meet poundage requirements alone (not cut requirements) would have necessitated the slaughtering of 213 animals (assuming each animal at slaughter weighs 825 lbs. and 40% is waste). Obviously meat will continue to be imported in large quantities.

5.5.2.(cont.)

The total consumption of fluid milk and cream in Table 9.6.13 is estimated to be 68,700 lbs. (34,400 U.S. quarts). This figure may be compared with the annual consumption of 38,000 lb. of milk by the island's largest hotel, and this also appears to be an underestimate.

5.5.3. Benchmark Farm Operations

The number of acres needed to support a cow and calf varies from place to place in response to the availability of moisture. It typically requires about four acres in St. Croix to support an animal unit if no supplemental feed is provided, but that island probably possesses higher moisture retaining soils than Virgin Gorda.

Although, theoretically, the total consumption of milk as given in Table 9.6.13 could be supplied by 6 cows, each producing an average of 11,500 lbs. milk per annum, the cost per quart to the consumer would be far greater than that of imported milk. Significant economies of scale are met in both beef and dairy farming, and Virgin Gorda simply has not sufficient suitable acreage to carry a cost-efficient farm unit.

In studying possible benchmark farms for beef production in St. Croix, Park and Park (1974) used two units, each comprising 1,000 acres of productive land. On Farm 1 only pasture was considered, while Farm 2 had 200 acres under sorghum in addition to pasture. The number of cattle that could be carried were, respectively, 443 and 754. Their findings were that neither farm was capable of generating sufficient income to cover full production and land costs. The costs and returns are shown in Table 9.6.14.

Dhillon and Park (1974) undertook a similar study for dairy farming, and found that significant economies of size were involved in moving from a 50-cow operation using 150 acres to a 75-cow herd using 225 acres. When all costs of production were considered, the 50-cow model farm incurred a loss of $4,106, whereas the larger model farm showed a profit of $6,754 (See Table 9.6.15).

The dairy farm models assumed that pasture alone was used for feed. An acre of well-worked pasture yields on average in St. Croix approximately 1,475 lbs. of ingested total digestible units (TDN), whereas an acre of sorghum may produce as much as 6,300 TDN (Park and Park, 1974). A nursing cow is expected to need 4,490 lbs of TDN each year, so by supplementing with sorghum silage, high carrying capacities per acre may be attained.

A feed supplement increases the utilization of grass during the wet season. Standing hay is one way of carrying nutrients into the season of insufficient moisture, but many of the nutrients are lost. (See Figure 5.4). Figure 5.5 illustrates the role that silage plays during a January - May deficit. It can be seen that less surplus is wasted.

5.5.3. (cont.)

The cost of producing and storing sorghum silage may not be insubstantial, however, and some estimates for a 50-acre field are shown in Tables 9.6.16 and 9.6.17. Using smaller fields, as in Virgin Gorda, much of the machinery could be replaced by labour - providing it was available - but the question remains whether sorghum production for cattle is worthwhile on the island in terms of cost expended and benefits accrued, including the use of land that otherwise may have been used more profitably.

The pasture presently used in Virgin Gorda is composed of Pangola and Guinea grass. The latter has a rather erratic growth rate, producing an abundance of forage with good soil moisture conditions, but no growth occurs during dry periods. Pangola is fairly well adapted to areas having an average rainfall over 35", acts as good forage, and has a good animal unit carrying capacity. When receiving less than 35", however, the grass dies back. Buffel Grass - reportedly not used on Virgin Gorda - is more drought tolerant and apparently initiates new growth more rapidly at the beginning of the rainy season than either Pangola or Guinea Grass. A trial plot on the island may be well worth considering.

Before sorghum or any other silage crop is introduced, turtle and sargassum grasses should be experimented with. The use of intertidal seaweeds, in more temperate climates, as fodder for cattle as well as pigs and sheep, has long been practised in small islands and coastal districts. Direct grazing on the shore is carried out, or the seaweeds are used chopped and boiled in feed supplements. Their value as sources of vitamins and trace elements is considered higher than that of dried grasses (Boney, 1965). Experiments with turtle grass as a 10% supplement for sheep have been successful, the sheep gaining significantly more weight than when fed a normal diet (Bauersfeld et al, 1969). Similar experimentation should be undertaken for use as a feed supplement for cattle.

It is doubtful whether returns per animal unit to the farmer would exceed returns under the present method. It is certain, however, that if most small livestock raising was undertaken in this manner, stress on vegetation in portions of the island would be far less acute. Goats should not be allowed to forage but should be restrained by proper fencing.

Figure 5.4

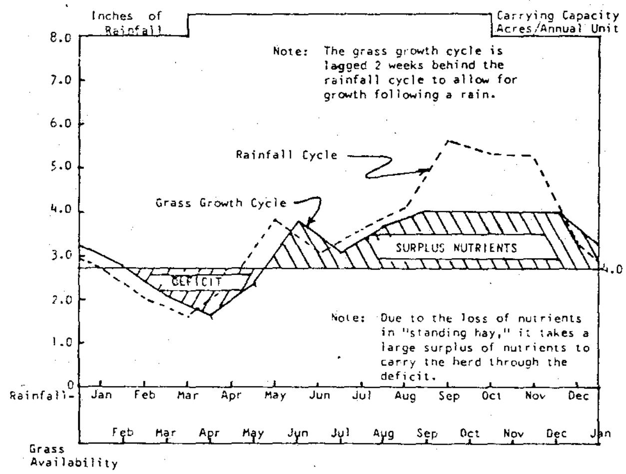


Illustration of stocking strategy which needs a large surplus forage production in the fall to carry herd through a spring deficit, U.S. Virgin Islands.

Figure 5.5

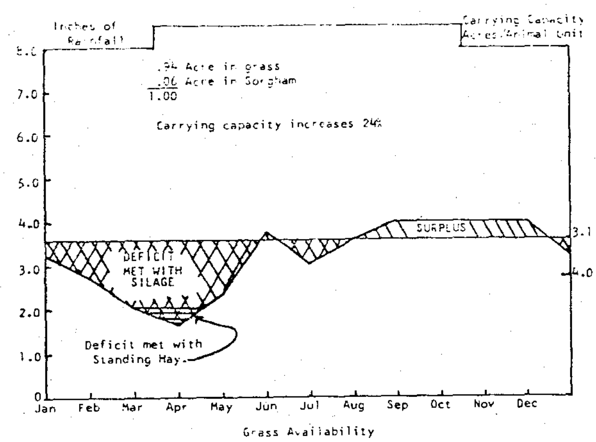


Illustration of stocking strategy which utilizes 90 percent of grass during rainy season and supplements with silage during dry season, St. Croix, U.S. Virgin Islands.

Source: Park and Park, 1974

5.6. Small Livestock Farming

5.6.1. Present Production

The relative importance of goats versus sheep has been reversed since 1946, when there were respectively 368 and 123 animals on Virgin Gorda. In the Valley alone, there are presently over 200 sheep, and less than 100 goats. This proportion in all likelihood is also found in the Peak and North Sound areas. The primary reason given for the decline in goat numbers was that the animals could not be kept under control, and had to be literally hunted down for slaughtering.

Although private pens exist, both goats and sheep freely roam on the island, especially in the Valley and Peak area. During a dry spell, the owners living in the Valley cut down branches from certain trees and taller bushes. In moderation, this practice may inflict no long-lasting damage to the plants. With an increasing sheep population, and combined with apparently less rainfall over the past few decades, the Valley's carrying capacity for small stock may soon be reached - at least, under present methods - after which significant damage may be done to vegetation. Any upgrading of the rather sparse vegetation in the Valley area would require a large reduction in the numbers roaming freely.

5.6.2. Potential Market

That goat meat is in short supply is evidenced by the fact that a large number of live animals are shipped in from Anegada. Because of the seasonality of demand, these shipments vary greatly, but a minimum number would appear to be between 20 and 30 each month. The goats are sold at 70¢ - 75¢ per pound liveweight. Dressed meat is usually sold for $1.50 per pound. Not all the goats from Anegada are slaughtered, as some are used for breeding purposes. The price per pound of local lamb and mutton and sheep on the hoof approximate those for goats.

Three of the five hotels surveyed served goat meat regularly (particularly Ocean View and Fischers Cove), and over 450 pounds were used in November. More meat would have been used by at least one of these hotels if it had been available. Lamb and mutton are also served in those hotels serving local dishes - one establishment alone using about 100 pounds per month.

A potential market that has not yet been tapped comprises the larger hotels, one of which expressed an interest in possibly buying up to ten legs per month if they were readily available.

5.6.2.(cont.)

Owing to the potentially large resident market, the estimated consumption of lamb and mutton in Table 9.6.13 was about 10,600 pounds in 1975, with a market value approaching $16,000. Increased production of small livestock would find a local market, but it must be emphasized that an expansion of numbers without the strict use of pens, and without supplemental feed other than local vegetation, would be detrimental to the island's environment. Rather, even with the existing numbers, far more should be penned and more food supplements used. As discussed below, even with imported supplements, a profit can be made on small livestock raising.

5.6.3. Benchmark Farm Operations

Park and Park have constructed four farm models to be managed as "family-oriented backyard operations" with the purpose in mind to "provide an opportunity for families...to create employment for older children and homemakers that is not generally available to them" (Report No. 7, 1974).

The farms - two of which cover five acres each, and the other two twenty acres each - have a simple physical layout, with pastures fenced into units of 2.5 to 3 acres to permit pasture management. Strong fences are used, comprising net wire and two barbed wire strands. Holding pens are provided to prevent losses from dogs, and a small shelter to store supplemental feed. Equipment is limited to hand tools. In the costing, it is assumed that water for the herds is provided by the farm well. Total capital requirements, including the land and animals, average between $331 to $386 per adult animal. Specifications, costs and profits are given in detail in Tables 9.6.18 - 9.6.27.

Returns to the family depend upon how efficiently it applies its labour. If the 20 acre goat enterprise can be operated on two hours a day, Park and Park estimated that the hourly return should be $2.01 (assuming 60¢ per pound liveweight for young stock sales and 50¢ per pound for cull brood females). Sheep operations are slightly less profitable because of a lower lambing percentage (300% compared with 350% for goats), and their hourly return averages $1.55. The small five acre operation is expected to return $1.61 and $1.42 per hour for goats and sheep, respectively.

The returns for Virgin Gorda farmers should be greater than those above, for the higher price of supplemental feed would be more than offset by the higher prices of meat. In addition, for many of the families, no land need be rented. The cost of feed supplement itself could be reduced by utilizing turtle and sargassum grass (see section 5.5.3) should experimentation be successful.

5.7. Hog Production

5.7.1. Present Production

Approximately fifty pigs are reputed to be kept in the Valley area in small units of up to four animals. The hog population of other areas in Virgin Gorda was not ascertained. The feed to the pigs is varied, making best use of whatever materials are available. Garbage from the hotels is heavily relied upon, but any other food, such as surplus crops of soursop, mangoes, sweet potatoes, papaya and cashew nuts, as well as small fish, are utilized. Too heavy dependence on hotel garbage causes an overgrowth of fatty tissues on the pig, and to remedy this, imported pig feed is used as a supplement.

Local pork has an excellent taste, and there is a ready market at the price of $1.20 to $1.25 per pound. As with cattle, meat is sold by weight and not by cut.

5.7.2. Potential Market

Pork purchases by the five hotels surveyed totalled more than 500 pounds of local meat during the month of November. In addition, an estimated 300 pounds of pork (mainly chops) were imported. According to Table 9.6.13, the estimated annual value of pork consumed in recent years has been $161,000. If all of the meat had originated from local sources, this would have necessitated the slaughtering of approximately 300 pigs, assuming an average weight of 220 pounds and 40% waste. It may be seen that the potential market is appreciable.

5.7.3. Benchmark Farm Operations

In considering possible farm models in St. Croix, Jensen and Park (Report No. 6, 1974) discounted the profitability of a full-time operation using commercial feed, but instead concentrated upon an eight sow model unit using part-time labour.

The results of their study, as shown in Tables 9.6.28 & 9.6.29 are noteworthy. Three model farms were used: one raising 66 pound hogs for roasting; another raising 132 pound hogs for the intermediate weight market; and the third raising 220 pound hogs. The heavier hogs proved to be the most profitable, but as the Tables show, return was minimal.

If expansion of hog production is contemplated on Virgin Gorda, a carefully researched study should be undertaken. One short-term improvement that could be made would be to reduce death losses of piglets by installing proper farrowing facilities affording adequate protection from the weather.

5.7.3.(cont.)

Since many of the owners have only one or two pigs, however, there may be little incentive (or need) for them to invest in such an improvement.

As a final remark, it should be noted that pig manure is a valuable additive to any produce garden, and could be used to grow such fruit as papaya, some of which in turn could be fed to the pigs.

5.8. Poultry

Domestic production of eggs has declined since 1970 owing to a combination of economies of scale enjoyed by Stateside producers and rising costs of imported chicken feed into Virgin Gorda. (A 50 pound bag of feed presently costs $8.00 delivered to the farm, of which $1.50 comprises shipping costs from Puerto Rico.) Whereas mainland eggs are purchased by the larger consumers for as little as 80¢ per dozen, the equivalent price for local eggs is $1.30. As a result, at least two of the three producers are being squeezed out of the market.

With regard to meat, a dressed local chicken costs approximately $4 to $5. Again, stiff competition is faced from mainland producers who can market a packet of frozen breasts or wings for around 80¢ per pound if bought in bulk.

5.8.2. Potential Market

The total purchase of eggs during November by four of the hotels surveyed approximated 35 cases (1,060 dozen eggs), of which 30 cases were bought by Little Dix Bay Hotel. Apparently, only about 45 dozen of the above eggs were bought locally.

Since the surveyed hotels account for 56% of the total number of beds in Virgin Gorda, egg consumption by all hotels (assuming equivalent occupancy levels) could have been over 1,850 dozen eggs (53 cases). If we include the day tourists' demands, consumption probably exceeded 2,000 dozen eggs for the month of November. Extrapolating this data for 1974, the potential tourist market would have fluctuated from 4,100 dozen eggs for December to 1,108 dozen eggs for September.

If we assume that an average resident consumes ten eggs per month, the local market approximates 1,256 dozen eggs. As a very tentative guideline, therefore, potential monthly market varies from 2,360 to 5,350 dozen eggs. (This compares with a monthly average of 2,490 dozen eggs given in Table 9.6.13. It would be unrealistic to assume, however, that any local production unit could gain more than a small share of this total market.

5.8.3. Benchmark Farm Operations

A 12,000 bird model has been constructed for St. Croix, to be run on a full-time basis by the owner and two employees (Jenson and Park, Report No. 5, 1974). To ensure fairly constant egg production, the birds were divided into three houses, each equipped with cages and automatic feeders and waterers. It was found that the most important cost factors in order of importance were feed costs, hen depreciation and hired labour.

Jenson and Park estimate that if feed prices were $9.50 per cwt., and the conversion rate was five pounds of feed per dozen eggs, the producer must sell at 85¢ per dozen to break even. It should be remarked that present feed costs in Virgin Gorda are approximately $17.60 per cwt. For any profit to be made on each dozen of eggs, a price of 90¢ must be obtained (see Tables 9.6.30 and 9.6.31).

With regard to Virgin Gorda, although costs will remain constant throughout the year, producers are faced with a widely fluctuating seasonal market, as discussed in the previous section. This, together with the high cost of feed, would suggest that chicken farming on the island is a marginal enterprise at best. If it were possible to cater to the specialised market of health food consumers in the Virgin Islands as a whole, then the free-range chickens and eggs would demand a far higher price.

5.9. Recommendations

In view of the almost total lack of agricultural data existing for Virgin Gorda, several major assumptions have had to be made in this chapter, hopefully some of which are valid. For any detailed study of agricultural improvements and new enterprises to be undertaken, far more rigorous statistics are needed. We can only concur with the following statement in the BVI General Abstract, 1974:

> In view of the necessity of reinvigorating agriculture in the BVI, as declared repeatedly by the Government, then agriculture statistics giving reasonable and periodic estimates of indigenous livestock, fish and fruit and vegetable production should perhaps be given greater priority in order that the progress of the aspired BVI agricultural renaissance can be measured.

Specific recommendations are mentioned below.

5.9.1. Insufficient rainfall data and no temperature and wind velocity data exist for Virgin Gorda. In order to remedy this situation, at least three other weather stations other than that at Little Dix Bay should be set up, in order to monitor the Valley area, the Peak area and North Sound. A small station consisting of manually read temperature, wind velocity, and rainfall gauges need cost no more than $20 in addition to labour costs. An evaporation tank could be installed at each site at practically no cost. For the more inaccessible areas such as the Peak, automatic recording instruments could be installed, although their cost would be significantly higher. At least a few stations should be established immediately.

5.9.2. A comprehensive soils study is much needed. The BVI Government should be able to obtain aid in this matter from the British Development Division.

5.9.3. A groundwater study is needed to ascertain potential water supplies, and aid, likewise, could be forthcoming from the British Development Division. An experimental microcatchment and small hillside runoff system should be constructed by an expert agronomist to consider their potential for agriculture. A small hydroponics scheme should also be tested (refer to Annex E).

5.9.4. In order to direct agricultural extension and improvement, a full-time agricultural extension officer is needed for the island. It is doubtful whether the BVI Government has sufficient funds to cover such a person's income, and local financial sources may be required. The latter approach to funding has its merits, for the extension officer would be liable directly to Virgin Gorda farmers and not to the BVI Government.

Among other duties, the officer would be responsible for fruit tree grafting, the management of a small nursery to supply farmers, the management of trial grasses for pasture, and for guidance in the use of environmentally safe insecticides and pesticides.

5.9.5. The dressing of local animals for sale could be greatly improved by the employment of a qualified butcher. Not only would specific cuts attain a higher income for the farmer, but the potentially valuable skin of cattle, sheep and goats could be used in the local manufacture of goods or sold for export.

5.9.6. Research into local feed supplements for domestic animals should be undertaken. Sorghum probably would adapt well to local conditions, but if grown, should be used for both human and animal consumption, with the grain for flour and stalks for forage.

Experiments should be undertaken to determine the cost and effectiveness of turtle and sargassum grasses as feed supplement.

Buffel grass appears promising for use in Virgin Gorda, and a small trial pasture could be established at little cost on either Crown or private land.

5.9.7. A refrigerated storage facility for the island was suggested several times by both fishermen and farmers. The amount of meat and produce wastage could be decreased, as well as permitting a more regular marketing of foodstuffs.

5.9.8. In order to protect the scant vegetation of the island, especially in the Valley area, small livestock should be managed in properly secured pens using a feed supplement. If a portion of the supplement has to be imported, it may be worthwhile in the long term to subsidize its cost so as to prevent further degradation of the vegetation.

5.9.9. Based on the potential market and production costs incurred in St. Croix, fruit and vegetable produce would appear to be the most profitable enterprises. This is dependent, however, upon an improved source of water. Given well-watered pasture and/or feed supplement, beef production also offers promise for a certain amount of expansion, although sufficient acreage may not be available. Hog production at present or only slightly expanded levels will continue to be profitable. Chicken farming, on the other hand, appears suited only to small household units. Other sources of protein, such as rabbit meat, which is presently offered in small quantities at $11 per rabbit, certainly are worth further consideration.

5.9.10. Land suited to agriculture in Virgin Gorda is limited. Before allocating any land for a particular use, all possible alternatives should be carefully studied so as to ensure that local financial returns from the land are maximised. Such an approach requires in-depth planning, a concern for data and continued research and a commitment to "traditional" agriculture as a way of life.

CHAPTER 6

TOURISM AND NATURAL RESOURCES

6.1. Numerous tourism planning and development studies for the Territory abound covering traditional local, social, economic, marketing criteria, infrastructure requirements, and revenue projections. Additionally, the recently published summary, Tourism in the British Virgin Islands, 1974, A Statistical Analysis, No. 2, prepared by Vaughn Evans and published by the Finance Department, contains extremely detailed breakdown on the present structure of tourism as an industry. These previously published and generally available documents obviate the need for any systematic treatment of tourism in this report, especially since its principal focus is on Virgin Gorda's resource base and contemporary and projected opportunities and constraints derived from that base. See also Table 6.1.

6.2. There are, however, several natural resource elements or features of Virgin Gorda that could be utilized to enhance the existing tourism industry, provide additional local employment and which, in some cases, offer the promise of tapping selected new tourism markets that would bring new revenue both to Virgin Gorda and the Territory without adversely affecting either the present industry or island environmental quality. Furthermore, a number of the concepts outlined below would provide additional recreational facilities and involve young people in interpreting their island and its features - a process often resulting in an enhanced understanding and appreciation for one's own locale, so often taken for granted or viewed as lacking value.

6.3. Scenic and Natural Amenities Development

6.3.1. Family campground facilities, styled along the lines of (a) Cinnamon Bay or (b) Lameshur Bay or (c) Strawberry Fields in Jamaica, or the new private venture by Mr. Stanley Selengut on St. John, could, if properly designed, located, managed and marketed, serve a growing north American market, require minimum invested capital, provide employment and bring to Virgin Gorda tourists who would be prospective guest house tourist returnees in future years. Careful planning and specialized employee training would be needed to guard against adverse side-effects. But a first class facility, especially one stressing "natural systems," perhaps a wind driven energy plant, a solar distillation system for supplementary water, an affiliated hydroponic "natural food garden" and possibly a water and waste recycling system, would hold enormous attractive value among a growing segment of "conservation minded continentals" concerned personally about wildlife, energy conservation, pollution, waste recycling, etc.

6.3.2. School groups, seeking low cost accommodations and a place for organized study are coming to the Caribbean as a form of "specialized tourist groups" in increasing numbers. Few places exist that are designed to serve the particular needs of these groups. Possibl the campground facility outlined above could be designed to accomplish this, although with minor modifications some guest houses could be adapted and the concept marketed via specialized media. But the emphasis on Virgin Gorda and the specific site as a natural laboratory, where the individual student and class have a direct dialogue with the natural environment, is a primary prerequisite to attracting serious students from responsible educational institution with responsive, effective leaders or supervisors.

6.3.3. The existing park areas should be expanded and improved upon by the addition of supplementary natural and scenic areas (specially protected) environmental study areas, nature trails, and possibly a small mini-museum/nature center with interpretive elements covering floral, faunal and historical features of Virgin Gorda. Professional counsel is available gratis on this latter undertaking from the Caribbean Conservation Association and segments of all of the above have been done as "community efforts" elsewhere in the Caribbean.

6.3.4. Simple inexpensive guides should be prepared for the islands' birds, trees, plants, historic sites, etc. These could be useful both in local schools and with visitors, especially if local names are included in all cases where appropriate.

6.4. Human Resource Potential

6.4.1. The recent development on Tortola of a "Handicraft Centre", offers a useful model for Virgin Gorda, which has the double option of providing products to the Tortola Centre and planning and implementing a small scale counterpart facility on Virgin Gorda. In addition to traditional jewelry, straw, shell and wood products, one might consider also a community effort to identify other unusual products such as the following.

6.4.2. Leather goods made from locally tanned goat skin and cow hide, along the lines of the present "Eastern Caribbean Leather Tanning Project (sponsored by FAO, ILO and CADEC), offer considerable employment and marketing potential. Initiated by Christian Action For Development in the Eastern Caribbean (CADEC), this training program could be utilized to upgrade the "value added" factor to the present flow of goat skins and cow hide produced in Virgin Gorda (especially given the level of live goat importation from Anegada documented in Chapter 5. Further information can be obtained from CADEC, P.O. Box 616, Bridgetown, Barbados, on this and other craft and community development projects.

6.4.3. Black coral, which works well into jewelry, is obtainable from coastal waters between six fathoms and thirty fathoms. Unfortunately, the better stands of this species (Anti-patharia) are in fairly deep water (100 to 175 feet) which make harvesting somewhat difficult and risky if done by amateurs. However, its extremely slow growth rate, as documented by Noome and Kristensen of the Curacao Marine Biological Institute, makes large scale indiscriminate harvesting also risky from a resource management point of view. But the coral is there, can be obtained at some yet unknown "sustainable yield" level and, represents at the present time an underutilized high value resource. Investigations as to the extent of the harvestable coral around Virgin Gorda and conservative estimates on extraction rates should be carried out prior to any large scale exploitation of this species.

6.5. Miscellaneous Aspects

6.5.1. Techniques and skills of weaving wicker fish pots could readily be adapted to producing woven wicker pot panels (as wall hangings), miniature "pots", and other items marketable in a craft type of outlet.

6.5.2. Properly packaged, exotic and traditional native fruits, jams, jellies, preserves, etc. could become a high value low volume product, especially if aimed at the "natural food" devotee. Packaging might include a locally-made re-cyclable pottery type container or include a tagged mini-booklet of local recipes, or on the local natural history of the plant or fruit being sold.

6.5.3. Sailing excursions (day trips) aboard a traditional large native sloop or schooner, should be considered. A coordinating, reservation center of some kind, a regular schedule, refreshments including local delicacies (i. e. like fresh coconuts, guava candy, fresh bananas, etc.) would be essential.

6.5.4. A special note of concern is conveyed concerning the use of turtle shell. The use of "tortoise shell" taken from the hawksbill sea turtle, though it is an attractive and easy to work material, should be reconsidered. Because of the demand for shell world-wide, the hawksbill has been driven to the brink of extinction. This may not be entirely evident to Virgin Islanders, but the hawksbill is considered by most international wildlife management organizations to be the second most severely endangered sea turtle (only the Atlantic ridley, which is limited to the Gulf of Mexico and whose total population of adult females at around 2,000, is in worse shape). It is listed in the Red Data Book of

6.5.4. (cont.)
the IUCN (International Union for Conservation of Nature and Natural Resources) along with other endangered species, as immediately threatened with extinction unless preventative measures are taken.

6.5.5. Trade in sea turtle products, including hawksbill shell is increasingly being restricted legally. The U.S. Endangered Species Act prohibits importation of hawksbill products. In the United States Pan American Airlines was heavily fined last year for permitting the shipment of a quantity of hawksbill shell. Hawksbill is also listed on the prohibited list of the Convention on International Trade in Endangered Species of Wild Fauna and Flora perpared in February of 1973 at an internal meeting in Washington, D.C. The general trend of governmental and public opinion seems to be turning against luxury trade in natural products from endangered species. The lack of biological data (density distribution, ecological factors affecting growth rate) point to the need for a resource survey. Since so little is known about the long term "supply" of the turtle shell, and since incidental records we have collected through the kindness of the B.V.I. residents suggests that unusual numbers of leatherbacks and hawksbills nest in the B.V.I., we suggest a sea turtle nesting survey in the B.V.I. Continued complacency towards local natural resources under stress from predation or pollution should not be tolerated and action by government is in order.

TABLE 6.1

HOTEL ROOMS, 1964 - 1975

Year:	64	65	66	67	68	69	70	71	72	73	74	75
Little Dix Bay	66	66	66	66	66	66	66	66	66	66	66	
Lord Nelson Inn		8	8	8	8	8	5	5	5	5	5	
Drake's Anchorage			5	5	5	5	10	10	10	10	10	
Olde Yard Inn						10	10	10	10	10	10	
Ocean View							12	12	12	12	12	
Guavaberry							10	10	10	10	10	
Biras Creek										30	30	
Fischers Cove										8	8	
Bitter End												9
TOTAL	66	74	79	79	79	89	113	113	113	151	151	160

TABLE 6.2

ESTIMATED TOTAL TOURISTS VISITING V.G. & EXPENDITURE ON MEALS, ($000) 1974

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MTHL AVE.
1 Total Days, Tourists staying in Virgin Gorda	11,856	7,948	9,305	9,563	5,772	7,784	4,852	6,287	2,917	3,697	5,398	6,458	81,837	6,820
2 Total Days, Tourists staying elsewhere in BVI, visiting Virgin Gorda	1,997	2,334	2,636	1,994	1,644	1,564	2,115	2,071	778	1,046	1,265	2,153	21,597	1,800
Total Tourist Days	13,853	10,282	11,941	11,557	7,416	9,348	6,967	8,358	3,695	4,743	6,663	8,611	103,434	8,620
3 Expend. on Meals by Tourists staying in V.G., in their own hotel	118.6	79.5	93.1	95.6	57.2	77.8	48.5	62.9	29.2	37.0	54.0	64.6	818.4	68.2
4 Expend. on Meals by Tourists outside their hotel & all meals by Tourists visiting V.G.	38.8	28.9	33.4	32.4	19.3	24.3	18.1	21.7	9.6	12.3	17.3	24.1	282.2	23.5
Total Expend. by Tourists on Meals	157.4	108.4	126.5	128.0	77.0	102.1	66.6	84.6	38.8	49.3	71.3	88.7	1,100.6	91.7

1. Assuming 7.8 days average per tourist staying in Virgin Gorda (Government statistics)
2. Assuming 55% of total tourists to BVI visit V.C. (Govt. stat.) and each tourist stays one day.
   The formula used was:
   $$.55\left[\frac{\text{V.G. Tourists}}{\text{Tot. BVI Tourists}}\right]\cdot\left[\text{Total BVI Tourists} - \text{V.G. Tourists}\right]$$
3. Assuming each tourist staying in a hotel in V.G. spends $10 on meals in that hotel.
4. Assuming each tourist staying in V.G. spends on average $2.80 and $2.60, respectively, for meals outside the hotel during in-season and off-season periods (Govt. stat.); assuming also that day tourists from elsewhere in the BVI spend an equivalent amount.

Partial source: BVI, Tourism in the BVI, 1974, Tables 16a, 34, 35, 37

6.6 Recommendations

6.6.1 Develop a family campground tourist facility, capable of serving student groups and shaped around a "natural history theme".

6.6.2 Expand the system of parks, and preserves and develop a few "nature trails.

6.6.3 Develop a Virgin Gorda handicraft center and explore with CADEC a training program for leather working.

6.6.4 Discourage the working and sale of "turtle shell" jewelry.

6.6.5 Carry out a full fledged market demand survey among all the hotels for locally grown products.

6.6.6. Establish a specific set of quantitative and qualitative goals for the growth and management of the tourism industry. In defining these goals or objectives an attempt should be made to examine the question of the "desirable"upper limits of growth and growth rates in Virgin Gorda and the Territory with specific reference to:

(a) the employment sector i.e. at what level of growth would it become necessary to recruit additional labor off island;

(b) the infrastructure sector i.e., roads, power, health service, waste disposal, employment, schools, other services; and

(c) the environmental sector i.e., what types and levels of growth can be accommodated without objectionable or irreversible negative impact (anticipated in advance) upon the social, physical, natural and cultural environment of Virgin Gorda.

Chapter 7. Mining

7.1. Virgin Gorda Copper Mine

7.1.1. History

It is possible that the mine was first worked by the Spaniards, using a horizontal adit at sea level. During the 19th century, however, Cornishmen were employed to extract the ore. According to Earle (1921), the first available records are those for 1840, when 20 tons of ore were raised. In the following year 90 tons were exported at £50 per ton. Thereafter, the mine was closed owing to lack of funds but was reopened during the period 1859-1867. In 1861, a total of 150 tons was exported, valued at £ 3,000, and over the period from 1860 to 1862 £ 16,224 of ore was sent to Britain.

It was during the early 1860's that the present mine buildings were erected, including the engine house, tall chimney, powder magazine, rainwater catchment platform and cistern, and the manager's house. Pumping and hauling machinery imported from Britain were installed, and used coal shipped in from Puerto Rico. The ore was hand cobbed at the mine and shipped as a hand concentrate to England for smelting (Helsley, 1960). Since the ore was tapped to a depth of over 300 feet below sea level, considerable amounts of sea water had to be pumped from the mine. Six stopes were used at 60 fathom intervals. The vein was worked both inland and seaward to a distance of 480 yards to ½ mile. Molybdenite and Molybdic Ochre were discarded as useless. Earle considers it possible that more valuable ores were found, such as tin, but there is no proof to support this theory.

Even though ore remained abundant to the south of the mine, work ceased in 1867. Several reasons have been suggested, including the low price fetched by copper at the time, a disastrous hurricane, the imposition of heavy export dues on the ore, and a severe financial crisis experienced in England. In all probability, each of the above contributed in a varying degree to the mine's demise. The shafts were timbered over near the top, and all the plant and machinery removed.

Since that time, a few small-scale attempts have been made to garner the discarded Molybdenite nodules occurring in the tailings dump (the extracted metal - molybdenum - is used for strengthening and hardening steel). During World War I a Mr. Hollings collected many of the larger lumps, and in 1917 exported about 30 cwt worth $1.50 a pound. During Earle's

History (cont.)

visit in 1920, the mine was leased to a private company which intended to crush the tailings and reopen the mine itself, but never did. Similar proposals by private concerns have been made to the B. V. I. Government up to the present day, but the latter so far has not granted permission.

7. 2. Mineral Analysis

7. 2. 1.

The tailings dump itself contains little copper, and is composed primarily of Malachite ($CuCo_3.Cu(OH)_2$) which has no commercial value. A very small quantity of Azurite ($2\ CuCo_3.Cu(OH)_2$) is present. Earle found no signs of tin, pitch blende or other radioactive minerals. The rumour of gold deposits is romantic if little else, and none have yet been detected. Miniscule amounts of silver are present, however, and are found in a few of the pegmatite veins, but are not of sufficient quantity to have any economic value.

7. 2. 2.

The Molybdenite and Molybdic Ochre found in the dump may be of some commerical value. Of the three samples analyzed in London in 1920, one was considered valuable, containing 43. 8% Molybdenite and 56. 2% Quartz. The Molybdenite portion comprised the following:

Mo	48. 90%
Fe	3. 32%
S	33. 20%
SiO_2	12. 15%
H_2O	1. 84%
	99. 41%

In addition, copper deposits are still present, although of an unknown quantity.

7. 3. Future Potential

Any large-scale extractive development would foreclose other potential used of the site, which is generally regarded as housing the finest industrial archaeological ruins in the Territory. Instead of mass crushing the tailings for commercial use, it may be more profitable, as discussed elsewhere, to market individual lumps as rock specimens to geological hobbyists, schools and museums. This latter approach also would be more desirable in that the ruins would be retained, together with the scenic beauty of the site. Properly boxed, labelled and with a card explain-

Future Potential (cont.)

ing the history of the "Copper Mine", geological specimens could be sold to visiting tourists throughout the Territory (not just on Virgin Gorda).

7.4. Other Mining Activities

7.4.1. Quarrying

A small quarry, initially exploited for road material, lies abandoned to the west of Handsome Bay. A further quarry is planned at Upper Soldier Bay, and will begin production within the near future. It is sited on Crown Land, and a royalty of $600 will be paid per annum for the lease of the 5.4 acres. In addition, a royalty of 50¢ is to be paid for each cubic foot of crushed stone. The quarry will be situated on the opposite side of the island to the major resort areas, and located in the upper section of the valley. Little aesthetic degradation is foreseen. If the quarry eventually is extended to more than a few acres, however, some restoration of the land should be undertaken upon completion of activities. Economically, the quarry is desirable, in that it should furnish all of the crushed stone needed locally.

7.4.2. Offshore Dredging

No dredging presently is undertaken in the vicinity of the island, although some small operations in the past have been undertaken by a few hotels (such as Little Dix Bay) in an attempt to refurbish tourist beaches or improve shorelines and channels at marina sites.

Damage caused by dredging can be severe, and extend over a large area. Within the immediate site of the dredging operation, recovery by marine biota is dependent upon the type of operation utilized. Deep hole dredging more than often creates "dead pockets", which are not reclaimed by biota, whereas shallow dredging appears to present less damaging consequences, although temporarily disturbing larger areas. A more detailed review of the problem is attached as Annex 12B.

Even some distance away from the dredging site, however, reef communities may be destroyed by a resulting reduction of photosynthesis, caused by the suspension of disturbed sand particles, and by the physical smothering of the reefs.

Offshore Dredging (cont.)

Although the guidelines pertaining to dredging activities (Land Development Control Guidelines, 1972) are thorough and extensive, no regulations exist pertaining to the types of dredging that should be allowed, nor for determining in which areas within the Territory should dredging be permitted or prohibited. In the view that some dredged areas will be able to renew themselves naturally, while others will not, that dredging operations in certain areas will be more detrimental to the surrounding marine environment than in others, and that certain types of dredging are more detrimental than others, there is a need for such regulations.

If properly undertaken, however, and after careful site research, dredging does offer the potential of being a valuable export commodity, both in terms of Government royalties (40¢ per cubic yard) and overseas income (sand is presently marketed at $8 to $9 per cubic yard in St. Thomas). Also, a cheap and reliable source of sand can only benefit the domestic construction industry.

Dredging to deepen the channel between Anguilla Point and Mosquito Island might (a) provide a source of sand for use on Virgin Gorda if stockpiled and sold by the Government and (b) improve water circulation and water quality in North Sound. It would need to be done, however, with extreme care so as not to damage the associated protective reef systems west of the channel between "Murdering Hole" and Hay Point.

7.4.3. Removal of Sand from Beaches

Several of the Territory's beaches are protected by law against sand removal (The Protected Beaches Order, 1961, under the provisions of the Beach Protection Ordinance, 1960). Thirteen of these, as shown in Table are situated in Virgin Gorda. All of the beaches of neighbouring Prickly Pear and Eustatia are protected. In the recent past, one permit has been granted for beach sand removal in St. Thomas Bay near Spanish Town.

TABLE 7.1
Protected Beaches, Virgin Gorda

Baths	Robin's Bay
Deep Bay	Saddle Bay
Handsome Bay	St. Thomas Bay
Little Trunk Bay	Spring Bay
Mountain Trunk Bay	Valley Trunk Bay
Nail Bay	White Bay
Plum Tree Bay	

Removal of Sand from Beaches (cont.)

In practice, however, sand removal ("progging") occurs on both protected and non-protected beaches, with or without a permit granted, including Handsome Bay and St. Thomas Bay. The Government has officially sanctioned sand removal from Copper Mine Bay, and has constructed a dirt road down to the beach to facilitate access. The bay is situated on the eastern side of the island (away from the popular beach areas on the western side) consists of relatively coarse sand, is partly overgrown with vegetation, and cannot be considered an aesthetically outstanding beach. Because of low swell activity, however, it is doubtful whether sand renewal will occur readily.

The removal of a small amount of sand, free of charge, by a local permit holder, probably causes little damage - if any - to the beaches. The amount of illegal "progging" would appear to be responsible for most of the damage inflicted. Since beaches are one of the island's chief assets in attracting tourists, uncontrolled "progging" could have a serious economic impact upon the tourist sector. Policing alone will not prevent illegal beach removal. Public support is required, and could be increased by a publicity campaign via the existing media directed against the practice.

7. 4. 4. Soil Removal

For apparently several years, the removal of topsoil for sale from areas in the Southern Valley has been undertaken. The topsoil is bought locally for landscaping purposes by various hotels at approximately $16 to $18 per cubic yard. Soil resources of the island can only be described as scant, and should be conserved as much as possible. Such removal certainly preempts all agricultural activity in the affected areas, as well as destroying the previously existing vegetation.

7. 5. Petroleum Mining

7. 5. 1. Within the past two years several entrepreneurs have expressed interest in geo-magnetic/seismic surveys of the B. V. I. shelf area, with a view to locating possible sources of extractable oil. Legislation covering mineral and petroleum exploration was enacted in 1972. With regard to petroleum exploration the Government was provided with the services of an expert under the United Kingdom Technical Assistance Scheme to give advice on the granting of prospecting licenses and other related matters.

7.5.2 Since the principle forms of current economic activity, tourism, (including marina operation, yachting, scuba diving, sports fishing and water sports), plus commercial fishing would be adversely affected by ill-managed oil petroleum extraction, whatever its economic benefit, every effort should be made to establish appropriate, cost-effective environmental guidelines for any feature of petroleum mining which <u>might</u> affect Virgin Gorda (and this includes the "Horse Shoe" reef areas of Anegada).

7.6. Recommendations

7.6.1. Continue to develop the proposed quarry at Upper Soldier Bay.

7.6.2. Exercise caution in all dredging activity. See especially Annex B to this report for operating guidelines and suggested controls to protect coastal water quality.

7.6.3. Regulate all beach sand removal and move as rapidly as possible to an effective absolute prohibition against the removal of sand from all "protected" beaches, with heavy fines to be imposed upon offenders.

7.6.4. Regulate soil removal and limit the practice to pre-selected restricted isolated sites of limited value.

Chapter 8. Miscellaneous Factors

8.1. Energy - Electrical Power

8.1.1. Virgin Gorda is supplied by two undersea cables totalling 16 miles in length, connected to the East End (Tortola) feeder. One is laid via Beef Island to Spanish Town, and the other via Little and Great Camanoe to Colison Point. The total length of overhead transmission on the island is 12 miles, with an additional two miles laid underground.

In 1974, a total of 347 consumers were served (a 26% increase over the previous year). No analysis of trends over time is possible, since in 1974 the B.V.I. Electricity Board discovered "that all past annual reports omitted the consumer population of Virgin Gorda" (Electricity Board, Report for the Year 1974).

Also, no breakdown of electricity useage is available on an island basis. The following data have been calculated based on the percentage of Virgin Gorda consumers to total users in the Territory (11.4%). Since no adjustments have been made for hotels which are large consumers of power, the following calculations are probably extremely conservative. Additional research is needed.

Table 8.1. Power Consumption and Cost, Virgin Gorda, 1974

Total gallons (U.S.) used	10,452
Total cost of fuel (at 48.15¢ per gall.)	$50,330
Units sold, V.G.	1,703,076
Ave. number units used per consumer	4,908
Ave. cost to consumer p.a.	$505.92
Ave. cost of producing and delivering to consumer p.a.	$586.30
Total cost to consumers, V.G.	$175,554
Cost of producing 1 unit electricity and delivered to consumer	$.11946
Cost of producing and delivering to Virgin Gorda consumers p.a.	$203,446

The deficit of $181,000 incurred by the Electricity Board during 1974 is almost entirely attributable to the increase in cost of diesel fuel - from 18.92¢ per gallon in 1973 to 48.15¢ in 1974. The price undoubtedly will continue to rise.

8.1.2. The deficit for 1974 in table 8.1A was less than the previous year's deficit of $202,000 and principally resulted from a drop in consumption as a consequence of consumer resistance to higher prices, and in a few instances conservation practices. This would suggest that the total community outlay of funds for power costs could be further reduced (along with the government deficit) by a concerted educational campaign, and additionally by the development of alternative energy sources (wind and solar) for specialized uses, isolated locations, etc. (see below).

TABLE 8.1A

ELECTRICITY GENERATION AND CONSUMPTION, 1970-1974

	Unit	1970	1971	1972	1973	1974
Installed capacity	KW	3,321	4,504	4,380	4,380	3,784
System maximum demand	KW	1,320	2,000	2,290	2,330	2,500
Units generated	KWH'000	6,047	7,412	10,902	12,827	12,327
Annual load factor	%	52	42	54	63	56
Fuel delivered	US gal'000	441	545	807	959	929
Total cost of fuel	US $ 000	53	80	118	181	447
Average cost of fuel	US ¢/US gal	12	15	15	19	48
Consumers connected Dec 31st	No	1,829	2,170	2,408	2,624	2,703
Units metered	KWH'000	5,189	6,276	9,727	11,639	11,063
Average Units per consumer	KWH/month	284	289	404	444	409
Average Units per head of population	KWH/month	42	52	81	97	92
Total Revenue	US $000	384	482	796	866	1,213
Total Expenditure	US $000	446	735	911	1,068	1,394
Operating loss	US $000	62	253	115	202	181

Source: BVI Electricity Board Annual Report, 1974

TABLE 8.1B

Value of Fuel Imports into Virgin Gorda ($)

	1973	1974	1975
January	-	-	90
February	-	4224	6140
March	-	19844	150
April	9976	20139	
May	3070	-	
June	3669		
July	-	91	
August	16025	9931	
September	3640	121	
October	4601	33961	
November	8843	227	
December	20784	15338	

8.2. Energy - Wind Power Generation Possibilities

8.2.1. Introduction

For many years, there have been small numbers of advocates of certain "low level" technologies as being particularly appropriate for use in the less industrialized countries of the world. Meanwhile in the highly industrialized countries, a pattern of development has evolved based on the innovations of modern "high technology" supported by the cost-benefit analyses of modern economics. Application of this approach has generally been considered by most development experts to be the best solution to the problems of poorer countries if only these countries possessed the proper infrastructure.

But a growing series of crises in the industrialized countries --energy shortages, economic stagnation, environmental degradation, urban decay, increasing crime--seriously calls into question the appropriateness for rich or poor countries of a technology that is based on manipulation of poorly understood ecological and social systems and an economic analysis that exaggerates or invents economic benefits, while discounting or ignoring environmental or social costs.

As a result of these crises there is a reawakening of interest in the possibilities of adapting some of those nearly-forgotten "low level" technologies for use not just in poor countries but in the highly industrialized countries as well.

This is particularly true in the case of energy consumption, where much of modern technology is based on an extravagant and wasteful use of non-renewable resources. Now that the era of cheap and plentiful oil is rapidly drawing to a close, there is growing interest in obtaining renewable, non-polluting energy from sources such as the sun, the wind, and wastes.

TABLE 8.2

Virgin Islands Wind Resource Evaluation

The following listing was compiled from N.O. 16 charts (Pilot Charts of the North Atlantic Ocean) prepared by the Defense Mapping Agency Hydrographic Center, Department of Defense. The values listed represent monthly averages, with % calm indicating the percentage of the month that winds can be expected to be calm, very light or extremely variable.

MONTH	% CALM	DIRECTION	BEAUFORT VELOCITY	SURFACE MPH
January	1.0	ENE	4	15.5
February	2.0	ENE	4	15.5
March	2.5	ENE	+3	12.0
April	2.0	ENE	4	15.5
May	1.0	ENE	+3	12.0
June	.5	ENE	4	15.5
July	0	ENE	4	15.5
August	.5	ENE	4	15.5
September	2.5	ENE	3	10.5
October	3.5	ENE	3	10.5
November	2.0	ENE	+3	12.0
December	2.0	ENE	4	15.5

In addition, the probability of the occurence of one severe storm per year is .45.

Readers are cautioned against extrapolating from this table of general averages covering the Virgin Islands platform. Wind patterns will vary significantly from place to place, especially as a consequence of different land form configurations at various sites.

Economically and technically viable energy-getting systems have long existed but have been virtually ignored as long as petroleum has been predominant as an energy source. Solar and wind energy appear so obvious that people feel there must be something wrong with them.

8.2.2. General Feasibility and Advantages

While there is no indication that a major shift to solar and other related energy forms is imminent, the implications of such a shift reach far beyond a simple change in technologies. These forms of energy are available everywhere and their most efficient use in terms of energy costs is probably on a comparatively small scale at the local level thus avoiding the high cost of long distance transmission. This could result in significant alterations in the lifestyle that accompanies present patterns of energy consumption. For example, there would likely be a greater decentralization in the control and use of energy, and less highly concentrated forms of human settlement might become more common.

This does not imply a return to some nonexistent golden age of the past. Much valuable knowledge has been accumulated that did not exist in the past; it is a faulty perception of our relationship to nature that has led to its misapplication. The newly-evolving communities, whether they are in currently rich or poor countries, could continue the process of research and exchange of information, in effect decentralizing these functions as well and involving more "non-experts" in them.

But the important point is that nature is composed of complex, interrelated systems, and scientific research must help us to understand those systems and relationships more clearly. Our technology must be redirected to organize our productive activities and restructure our lifestyles so they are in harmony with those systems. In this respect, no societies are fully "developed" or "under-developed"; we are all in the process of developing human systems that are either moving closer to or farther away from a symbiotic relationship with other life systems in nature.

8.2.3. Potential for Virgin Islands Adaptation

There have been several preliminary inquiries made by interested persons into the possibilities of generating local primary, or, more often, supplementary power from wind in the Virgin Islands. Table 8.2. suggests that, in general, wind levels in the Virgin Islands are within what is considered an acceptable range (i.e., over 10 mph) for the introduction of currently available wind-driven generators. (Direct wind-driven pumps, i.e., for water, can function efficiently with lower wind levels.)

8.2.4. Numerous small, relatively inexpensive wind-generating systems, producing from 5 to 15kw are available at the present time. (See Annex 12D.) While kw hour costs are slightly higher than for presently available mains electricity for remote places, when the capital investment is amortized over a reasonable span of time the direct costs of the two sources are comparable but the added independence factor and exemption from anticipated fuel escalation cost increments lend justification to the use of wind energy sources.

8.2.5. Freezer plant operations, for example, are more reliable with wind-powered compressors (or back up compressors) or with alternative electrical power from a wind-driven generator (and battery bank).

8.2.6. The pumping of well water for domestic use or for livestock, the charging of electrical storage batteries, the operation of compressors, sewage system pumps, and the generation of moderate amounts of electricity are feasible and economically defensible with present levels of technology. It is our disinclination to think in these terms that prevents our development of a greater degree of self-sufficiency and a less polluting, possibly less costly, source of energy from the wind.

8.3. Energy - Solar Power

8.3.1. Introduction - Rising fuel costs and the consequent price per kilowatt hour of delivered electricity have, in combination with a rising social consciousness about "conservation" and the energy crisis, resulted in a new awareness about the concern for alternative, cheaper sources of energy. In the tropics and on islands, where traditional, petroleum based, energy production costs are proportionately high, and un-utilized solar energy levels are also high, there has emerged a growing interest in the possible utilization of solar heat sources, principally for heating water for domestic use. The same process could be used, if only in a supplementary way, to reduce costs in hotels, guest houses, restaurants, bars and marinas, where significant amounts of heated water are required.

8.3.2. Low cost, simple, practical systems for using solar energy to heat water (thereby saving on electrical costs), in virtually any situation, do exist and are both technologically and economically feasible, even if not generally viewed as "worth while or practical".

Any significant enhancement of public recognition of and acceptance of the use of "solar energy" for heating water could result in appreciable savings of more traditional, high cost, electrical energy and in an enhancement of the "local self sufficiency factor". With wind power energy utilization for pumping and solar energy power for heating, the average farm, household or

8. 3. 2.(cont.)

guest house/small hotel on Virgin Gorda could reduce its net energy costs by better than 30% - perhaps as much as twice this figure.

8. 3. 3. Experimental units are in operation in the BVI (see the Virgin Islander April, 1975, pp. 8-9) and widespread experiences elsewhere in the Caribbean suggest the cost-effectiveness of solar heating units can reduce consumer energy costs by a significant amount.

8. 3. 4. In Virgin Gorda, as elswhere in the Territory and in the Caribbean, no government-originated incentives exist as yet to encourage the "energy consumer" to consider and/or install solar powered units capable of reducing domestic demand on the public electrical utility system.

It is most perplexing to witness, on the one hand, expanding government subsidies of the existing central electric power generating systems (in 1974- nearly $200, 000),while at the same time no significant policy structure or strategy has been developed or implemented with a view to encouraging a greater degree of local self-sufficiency in the energy sector. When the petroleum stops flowing some day, whether because of strikes, embargoes, politics, cost - it makes no difference - small islands like Virgin Gorda should be prepared, with already developed alternatives.

8. 3. 5. Details on solar heating systems and related energy production, environmental considerations or community participation, can be obtained from the Island Resources Foundation. A twenty five percent reduction in electrical energy consumption, as a consequence of utilization of roof-type solar energy water heating systems, could save Virgin Gorda in excess of $50, 000/year and reduce the amount of the present government subsidy.

8. 4. Energy - Charcoal

8. 4. 1. Although charcoal for household cooking use has largely been replaced by gas and electricity, it is becoming increasingly sought after for barbecues by hotels. Within Virgin Gorda, Little Dix Bay Hotel alone buys three 100 pound bags each week, and many of the smaller hotels may take one bag a month. Its recent increased demand outside of the Territory is well shown by the figures in Table 8. 3.

8.4.1.(cont.)

TABLE 8.3

DOMESTIC EXPORTS OF CHARCOAL, BVI, 1960-1074 ($)

1960	2975	1965	2015	1970	361
1961	4016	1966	360	1971	1002
1962	3057	1967	704	1972	1642
1963	2527	1968	756	1973	1947
1964	2455	1969	207	1974	2224

8.4.2. Prior to the advent of tourism, the charcoal pits were worked communally and varied greatly in size, the larger pits yeilding up to 45 barrels of charcoal at a time. In the 1930's and 1940's, much was exported to St. Croix at 12-14¢ per bag (equivalent to 6 kerosene cans). Nowadays the prevailing price for a bag is $6.00.

8.4.3. For the making of charcoal, almost all hard woods can be used. On an island such as Virgin Gorda, which has few stands of hardwoods remaining, however, caution should be used against overcutting if the practice expands in the future. The white cedar, now protected as the national tree, was commonly used in the past. Unfortunately, mangrove - which is also ideally suited for charcoal making - is not presently protected. At the moment, however, only a few charcoal burners remain in practice.

8.5. Recommendations

Charcoal production for local assumption should be permitted but monitored locally. Charcoal production for export should be regulated and possibly curtailed after giving at least twenty four months advance notice and any future charcoal production activity should be licensed of export is the object. Should the domestic or export market increase significantly we recommend serious monitoring programs for vegetaion removal impact consideration.

Wind driven water pumps should be reintroduced to reduce the island's demand for mains power and local experimentation with solar energy utilization should be encouraged by government (i.e., rebates on or exemption from import duties, etc.).

CHAPTER 9. STATISTICAL TABLES

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CHAPTER 9. STATISTICAL TABLES (cont.)

9.1.1 Total Population

	Virgin Gorda	% Change
1881	832	
1891	593	- 28.7
1901	511	- 13.8
1911	417	- 18.4
1921	381	- 8.6
1946	504	32.3
1960	654	29.8
1970	904	38.2

9.1.2 Racial Origin, 1960, Virgin Gorda

	M	F
African	325	307
European	---	---
Mixed	5	8
Not stated	7	2
Total	337	317

9.1.3 Place of Birth, 1960, Virgin Gorda

	M	F	T
Tortola	39	44	83
Anegada	1	-	1
Virgin Gorda	280	259	539
Other islands (excl. JVD)	5	3	8
Elsewhere	12	11	23

9.1.4 Length of residence, 1960, Virgin Gorda

From birth & NS	478
< 1 year	13
1 - 5 years	32
> 6 years	131

9.1.5 de Jure & de Facto Populations, Virgin Gorda, 1960

	de jure	de facto
Total	654	562
Male	337	266
Female	317	296

9.1.6 Place of Temporary Absence, Virgin Gorda, 1960

Total absentees	99
In Territory	31
In U.S. Virgins	63
Elsewhere abroad	5

9.1.7 Number of Households, Virgin Gorda

1911	122
1921	99
1946	120
1970	226

9.1.8 Number of Persons in Household, Virgin Gorda, 1970

Number of Persons	Number of Households
1	70
2	53
3	38
4	30
5	19
6	19
7	10
8	4
9	10
10	3
11	2
13	1
Total	261

9.1.9 Population by Age Group, 1970, Virgin Gorda (also 1960 figures)

Age Group 1970	Age Group 1960	Male 1970	Male 1960	Female 1970	Female 1960
		479		425	
2	1	24	13	27	11
2 - 4	1 - 4	45	47	42	43
5 - 9		56	61	59	49
10 - 14		45	40	44	41
15 - 19		42	30	36	24
20 - 24		49	23	39	13
25 - 29		42	21	37	21
30 - 34		46	13	24	20
35 - 39		27	21	13	17
40 - 44		19	11	18	14
45 - 49		23	11	21	12
50 - 54		13	10	18	10
55 - 59		14	9	15	10
60 - 64		10	4	10	12
65 - 69		11	6	8	8
70 - 74		5	15	4	6
75 - 79	75+	5	2	3	6
80 - 84		3		1	
85+		--		1	

9.1.10 Population by enumeration district, 1970, Virgin Gorda

	M	F	T
North Valley, Little Dix Bay, St. Thomas Bay, Savannah Bay	151	124	275
South Valley, Spanish Town	181	158	339
North & South Sound	147	143	290

9.1.11 Projected Population, Virgin Gorda, 12% Growth Rate

1975	1508
1980	1748
1985	2588
1990	2716

9.2.1 Principal Occupations, 1946, Territory

	1946	1891
Farm labourers	321	1058
Farmers, stock raisers	700	--
Labourers	105	--
Carpenters	89	--
Fishermen	175	--
Seamen	112	--
Boot & shoe makers	11	--
Domestic servants	81	--

9.2.2 % Working Population by Sector, 1946

	Tortola	Other Islands
Agriculture	51.56	49.70
Quarrying	--	--
Fishing	5.23	27.88
Forestry	2.40	--
Manufacturing & Repair	9.98	4.55
Construction	4.27	3.03
Transport	6.79	6.36
Trade & Finance	1.92	0.60
Services:		
Professional & Public	10.22	4.22
Personal	5.59	3.64
Ill-defined	1.68	--

9.2.3 Labour Force, Virgin Gorda, 1960

Population 15+	349
Not classifiable	189
Classifiable	160
Agriculture	52
Other industries	108

9.2.4 External Movers in the Classifiable Labour Force, 1960, Virgin Gorda

Total external movers		51
Professional	--	
Supervisory	4	
Clerical	2	
Sales	1	
Craftsmen	5	
Technicians	--	
Cultivators	23	
Farm Labourers	4	
Other manual	10	
Domestic servants	2	

9.3.1 Type of Dwelling, Virgin Gorda, 1960

House	112
Flat (apartment)	--
Shared house	6
Room in shared house	3
Other rooms	7
Hut	6
Other & NS	--
	134

9.3.2 Year of Construction, Virgin Gorda, 1960

Pre-1940 & NS	99
1940 - 1955	16
1955 - 1960	19

9.3.3 Basis of Occupancy, Virgin Gorda, 1960

All households		134
House + land owned	98	
Land only rented	9	
Dwelling only rented	12	
Other bases & NS	15	

9.3.4 Type Water Supply, Virgin Gorda, 1960

Public tank	2
Private piped into dwelling	--
Own catchment	40
Stream	--
Pond	--
Well	91
N.S.	1

9.3.5 Type Toilet Facility, Virgin Gorda, 1960

Flush, exclusive use	1
Flush shared	--
Pit, exclusive use	58
Pit, shared	14
Other:	
Exclusive use	1
Shared	--
No facilities	59
NS	1

9.3.6 Projected Housing Needs, Virgin Gorda

1975	377
1980	437
1985	572
1990	679

9.4.1 Standard of Education, 1960, Virgin Gorda

Population 15+	349	
Primary (<6 years)		76
Primary (6+ years)		255
Post primary		8

9.4.2 Estimated Land Use Acreage Needed, 1990

	Acres
Tourism	2000
Agriculture	650
Industry	150
Housing	500
Shopping & Offices	28
National Parks	1100
Schools	20
Public amenity areas (including beaches)	600
Police & Health Centre	12
Total	5060

(Total area in Virgin Gorda = 5264 acres)

9.4.3 Value of Total Imports by Month, Virgin Gorda, 1973-1975

	1973	1974	1975
January	51027	2723	N.A.
February	24035	4706	
March	70906	20545	
April	10726	149184	
May	78381	4094	
June	45484	79050	
July	N.A.	81308	
August	111773	119389	
September	46844	62080	
October	90501	36027	
November	26462	134180	
December	70927	117466	

TABLE 9.5.1

Size of farms, V.G., 1946

Size in acres	# farms
1 - 1.9	8
2 - 2.9	13
3 - 4.9	17
5 - 6.9	15
7 - 9.9	14
10 - 14.9	12
15 - 19.9	6
20 - 29.9	5
30 - 59.9	5
50 - 99.9	4
100 -199.9	2
200 -499.9	1
500+	0

TABLE 9.5.2

Farms, Virgin Gorda, 1946

# 1 acre or more	104
# small plots < 1 acre	0

Acreage

Total area	1689
Cultivated land	61
Other cultivable	564
Pasture	879
Wood	55
Other	130

TABLE 9.5.3

	Number on farms
Citrus trees, bearing	18
" not bearing	53
Lemon trees (not bearing)	1
Lime trees, bearing	18
" not bearing	52
Bananas, stem	221
" plant	446
Plantains, stem	32
" plant	39
Coconut trees	796
green nut harvested	1959
dry " "	702
Total other fruit trees	632
avocado pear	88
breadfruit	4
guava	73
mangoes	279
pawpaw	179
Nut trees	308
Total cattle	402
Calves	143
heifers	153
dairy cows	96
beef cows	4
bulls	4
spaded	2
Mares	2
Donkeys	3

Swine & small stock	
All kinds	70
swine < 6 mos.	47
Boars	3
Other swine > 6 mos.	20
Sheep	123
Goats	368

Poultry	
All kinds	875
Hens & cocks	642
chickens < 6 mos.	233

Dairy Products

Cows' milk	129 g.p.d.
Eggs	243 p.d.

TABLE 9.5.4

Farm Produce Statistics, V.G., 1946

	Acres
Beans & peas	8
Maize	1
Sweet potatoes	7

TABLE 9.5.5

	Number declared
Fishermen	33
Boats	22
-- decked,	
sailing boats	1
planked,	
open, sailing, <20'	21
motor boats	0
Fish pots	96

TABLE 9.5.6

Total population, & persons living & working on farms, V. G., 1946

	Total	Male	Female
# farms	104		
Total population	504	236	268
Population on farms	449	218	231
Family workers on farms	226	140	86
Hired workers on farms	1	--	1

TABLE 9.5.7

Farms by principal product, V.G., 1946

Total farms	104
Cane	--
Grains, pulses, fodder	--
Roots	2
Other veges	--
Bananas	2
Coconuts	--
Other fruits and nuts	--
Cattle	69
Dairy produce	1
Horses, mules, donkeys	--
Small livestock	16
Poultry & eggs	3
Charcoal, timber, firewood	--
No product	8
Product not stated	3

TABLE 9.5.8

Tenancy Status

Owner-cultivators	50
Tenant-cultivators	51
Managers	1
Not stated	2

TABLE 9.5.9

Domestic Water Supply

Stream	--
Well	84
Roof catchment	1
Combination	19

TABLE 9.5.10

Land operating, V.G., 1960

Population 15+	349
Operating no land	279
1 acre	4
1-4 a.	30
5-9 a.	19
10+ a.	17

TABLE 9.5.11

LIVESTOCK, FISH AND FRUIT AND VEGETABLE EXPORTS, 1950-1974

U.S. $ 000

Year	Livestock	Fish	Fruit & Vegetable
1950	86	7	16
1951	266	7	9
1952	..	10	18
1953	196	15	6
1954	256	18	18
1955	225	10	13
1956	148	14	13
1957	187	15	13
1958	207	12	22
1959	175	14	18
1960*	128	13	21
1961	103	13	13
1962	91	14	18
1963	89	20	11
1964	74	11	7
1965	69	15	8
1966	19	31	22
1967	30	33	12
1968	45	78	9
1969	8	18	7
1970	6	22	9
1971	6	38	17
1972	–	29	19
1973	–	40	11
1974	–	29	14

*Adjusted to agree with Table 5.12

Sources: (i) Colonial Annual Reports.
(ii) Territorial Yearbooks.
(iii) Annual Trade Reports for the BVI, 1971-1974.

Published in <u>BVI General Abstract, 1974</u>

TABLE 9.5.12

COMPOSITION OF DOMESTIC EXPORTS, 1960-1974

B.V.I

Year	Live Animals	Coconuts	Fresh Fish	Bananas	Other Fresh Fruit	Fresh Vegetables
1960	127,760	2,102	13,378	8,731	3,412	9,238
1961	103,568	2,505	13,227	3,101	2,734	4,171
1962	91,600	2,651	14,361	2,521	4,527	8,016
1963	89,909	3,194	20,092	1,736	3,700	2,687
1964	73,861	3,398	11,322	323	2,068	1,887
1965	69,468	2,556	15,244	989	2,511	1,362
1966	18,782	6,885	2,919	1,648	10,447	2,815
1967	29,800	4,472	32,598	2,137	4,836	630
1968	45,505	2,978	78,017	1,345	3,497	1,173
1969	7,615	1,687	18,445	1,041	2,678	758
1970	5,955	1,995	21,607	3,386	1,225	1,922
1971	6,300	3,699	38,493	5,548	3,819	3,506
1972	-	4,281	28,987	6,856	3,024	4,675
1973	-	3,215	39,785	3,946	2,393	1,902
1974	-	2,284	28,524	-	7,583	4,511

Source: Trade Report for the BVI, 1974
Published in BVI General Abstract, 1974

Table 9.5.13

Domestic Exports, Virgin Gorda

Month/yr	Commodity	Value($)
Feb., 1973	fish	500
Mar., 1973	fish	525

Otherwise, no records available.

TABLE 9.5.14

Monthly Imports, Virgin Gorda, 1973 - 1975 ($)

Commodity	Min	Max	Mean	Median	# Mths. Recorded
Meats	384	33152	16399	16505	15
Dairy	46	11199	4505	4040	16
Fish	66	18748	5869	5910	16
Cereals	3	1970	816	794	16
Fruit & Vegetables	276	18451	8587	8012	17
Animal Foods	0	88	16	0	15
TOTAL FOODS	482	85279	33058	29286	20
Lumber	0	4162	457	204	15
Manufactured Fertiliser	0	420	59	0	11
Gems & Jewelry	0	632	112	0	11
Leather Manufactures	0	340	42	0	11

TABLE 9.5.15

RETAIL PRICES, ROAD TOWN, BVI, 1972 - 1974

ITEM	UNIT	December '72	December '74
Roasting Beef	lb.	1.74	2.68
Lamb-leg	lb.	1.14	1.98
Chicken, whole	lb.	.54	.82
Pork Chops	lb.	.98	1.49
Liver, Beef	lb.	.75	1.14
Bacon	lb.	1.11	1.69
Potatoes	lb.	.16	.18
Onions	lb.	.25	.26
Tomatoes	lb.	.54	.68
Cabbage	lb.	.23	.27
Lettuce	lb.	.50	.72
Cucumber	lb.	.32	.43
Carrots	lb.	.35	.39
Sweet potatoes	lb.	.28	.33
Peppers	lb.	.59	.59
Garlic	lb.	.96	1.29
Bananas	lb.	.20	.28
Pineapples	lb.	.16	.22
Plantains	lb.	.28	.30
Fresh milk	qt.	.50	.66
Butter	½ lb.	.56	.61
Eggs	doz.	.89	1.42
Fresh fish	lb.	.61	1.88
Frozen fish	lb.	1.43	2.78

TABLE 9.5.16

PRICE OF SELECTED FOODSTUFFS OF SUPERMARKETS IN VIRGIN GORDA WEEK ENDING NOV. 22, 1975

($ per pound unless stated otherwise)

Vegetables		Beef	
Cabbage	0.35	Boneless	1.20
Cabbage, red	0.43	Navel, trimmed	1.10
Carrots	0.43	Riblets	0.80
Celery	0.89	Ribs, short	1.05
Egg plant	0.49	Steak	2.75
Lettuce, Romaine	0.69 each	Stewing	1.99
Onions	0.40	Charcoal steak	3.35
Peppers, bell	2/0.69	Bull feet	1.00
Peppers, Italian	0.69		
Potatoes, sweet	0.45	Pork	
Potatoes, white	0.35	Chops	1.79
Pumpkin	0.45	Fat back	0.95
Tannias	0.60	Snouts	0.90
Tomatoes	0.89	Spare ribs	1.05
Turnips, white	0.59	Tails	0.80
Turnips, yellow	0.37	Pigs mouth	1.09
Fruits		Lamb	
Avocadoes	0.59 each	Legs	2.52
Bananas, open	0.30	Shoulder	1.60
Coconuts	0.59 each		
Limes	3/0.69	Chicken	
		Cornish game hens	2.70 each
Fish			
Kingfish	1.45	Poultry products	
Mackerel	1.00	Eggs	1.40 dozen

Table 9.6.1

–Estimated gross sales, production costs and returns above cost for a 15-acre vegetable-fruit farm, 1972–73 season, St. Croix, V.I.

Item	*Tomatoes*	*Peppers*	*Okra*	*Onions*	*Pine-apples*	*Total*
Acres (number)	3	2	2	3	3	13[1]
Production (tons)[2]	18.6	8.8	13.2	28.0	38.0	--
Price rec'd. ($/ton)[2]	500	500	500	600	160	--
			Dollars			
Gross value	9,300	4,400	6,600	16,800	6,080	43,180
Production costs[3]						
Labor	1,764	768	744	1,128	1,542	5,946
Materials	216	116	98	141	2,229	2,800
Other	699	408	474	762	282	2,625
Fixed items	120	80	80	120	621	1,021
Total	2,799	1,372	1,396	2,151	4,674	12,39[illegible]
Returns above costs						
Total	6,501	3,028	5,204	14,649	1,406	30,788
Per acre	2,167	1,514	2,602	4,883	467	----
Returns (prices rec'd at 80% of current level)						
Total	4,641	2,148	3,884	11,289	190	22,150
Per acre	1,547	1,074	1,942	3,763	33	----
Returns (labor at $2.75 per hr.)						
Total	5,839	2,740	4,925	14,226	828	28,558
Per acre	1,946	1,370	2,462	4,742	276	----
Returns (prices at 80% and labor at $2.75)						
Total	3,979	1,860	3,605	10,866	0	20,310
Per acre	1,326	930	1,802	3,622	0	----
Returns with onions at 67% and other items at 80% of current prices						
Total	4,641	2,148	3,884	9,049	190	19,912
Per acre	1,547	1,074	1,942	3,016	63	----
Returns with prices reduced to level of strongest competitor[4]						
Total	4,715	670	2,722	2,889	4,598	15,594
Per acre	1,572	335	1,361	963	1,533	----

[1] Two acres allowed for nursery, home garden, and to permit flexibility in cropping program.

[2] Per pound prices shown in Table 12.

[3] Per acre production and itemized costs shown in enterprise budget tables.

[4] Prices per pound for strongest competitor shown in Table 15.

Table 9.6.2

—Estimated cost per acre for growing mangoes, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		Dollars
Pruning (2 hours per tree)	100	200.00
Picking 2500 fruits per 8 hrs. times 50,000 fruits	160	320.00
	Sub-total	520.00
Material		
Boxes, ladders, poles, etc.		35.00
Other		
Spray—custom 4 hrs., including chemicals		80.00
Hauling		40.00
Fixed Cost		
Land charge		25.00
Bookkeeping and misc.		50.00
Amortization cost		110.00
Annual interest on investment		97.00
	Total	$957.00
Estimated production 44,167 [1] fruits		
Cost per fruit—cents		2.2

[1] Yield with average rainfall is 1000 fruits per tree, and in drought year about 650 fruits.

—Estimated cost per acre for establishing mangoes, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		Dollars
Dig and prepare holes	50 hrs.	100.00
Plant trees	15 hrs.	30.00
Mulch around trees	15 hrs.	30.00
Water and care for trees twice week	164 hrs.	328.00
Spray trees—2 times by hand	16 hrs.	32.00
	Sub-total	520.00
Second year		
Water trees	164 hrs.	328.00
Spray—hand	16 hrs.	32.00
Third thru fifth year		
Water and care (80 hrs. annually)	240	
Spray—custom ($10 per hour for 8 hours.)		160.00
	Sub-total	520.00
Materials		
Plants—$4 each		400.00
Spray (1st and 2nd years)		8.00
Mulch		60.00

Table 9.6.3

—Estimated cost per acre for establishing mangoes, St. Croix, U.S. Virgin Islands—Cont.

Item	Quantity and/or hours	Cost
Other		Dollars
Land preparation		34.00
Fixed Costs		
Land charge (5 seasons)		125.00
Misc. (5 seasons)		50.00
Interest charge at 8% on $1200 for 5 years		480.00
Total establishments costs		$2,197.00
Annual amortization charge -5%		110.00

Table 9.6.4

—Estimated cost per acre for growing pineapples, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		Dollars
Apply fertilizer, mulch, and fumigate	46 hrs.	92.00
Preparation of slips for planting	16 hrs.	32.00
Plant	35 hrs.	50.00
First Season		
Fertilizer, by hand—2 times	8 hrs.	16.00
Spray, by hand—2 times	6 hrs.	12.00
Harvest		
Cut and load (3 times over)	32 hrs.	64.00
Prepare fruit for market and haul	16 hrs.	32.00
Second Season		
Fertilizer and spray	14 hrs.	28.00
Harvest etc.	42 hrs.	84.00
Third Season		
Fertilizer and spray	14 hrs.	28.00
Harvest etc.	38 hrs.	76.00
	Sub-total	514.00
Materials		
Slips—5 cents per slip for 9,400		470.00
Mulch paper—5 rolls, $30 each		150.00
Sprays for 3 seasons		18.00
Fertilizer for 3 seasons—1500 lbs		90.00
Containers		15.00
	Sub-total	$743.00
Other		
Land preparation etc.		34.00
Truck operation (3 seasons)		60.00
Fixed Costs		
Land charge (3 seasons)		75.00

Table 9.6.4 (cont.)

—Estimated cost per acre for growing pineapples, St. Croix, U.S. Virgin Islands—Cont.

Item	Quantity and/or hours	Cost
		Dollars
Bookkeeping and Misc. (3 seasons)		50.00
Interest charge 8% on $1400 for 2 years		112.00
	Total	$1,588.00
Labor		
Estimated production 38 tons [1]		
Cost per ton		42.00
Cost per pound—cents		2.1

[1] Yield with average rainfall about 14 tons per acre and in drought year about 10 tons.

Table 9.6.5

—Estimated cost per acre for growing papayas, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		Dollars
Nursery	51 hrs.	102.00
Field		
Lay out hills and plant	25 hrs.	50.00
Mulch	20 hrs.	40.00
Screen and thin	10 hrs.	20.00
Hand Weed	45 hrs.	90.00
Harvest		
Picking	80 hrs.	160.00
Sort, cull, and size	40 hrs.	80.00
Haul	40 hrs.	80.00
	Sub-total	$622.00
Material		
Seed		6.00
Spray		33.00
Fertilizer		26.00
Mulching material		30.00
Containers		16.00
Other		
Land preparation		34.00
Truck operation		30.00
Grading and packing 5% of 3500 lbs.		84.00
Fixed Costs		
Land charge		80.00
Bookkeeping and misc.		20.00
Interest on prod. cost ($800)		64.00
	Total	$1,045.00
Estimated production—22,000 lbs. [1]		
Cost per pound—cents		4.75

[1] Yield with average rainfall is about 26,700 lbs. per acre and drought year about 13,000 lbs.

Table 9.6.6

Estimated cost per acre for producing okra, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		Dollars
Plant, by hand	20 hrs.	40.00
Apply Fertilizer by hand	12 hrs.	24.00
Hand weed—2 times	32 hrs.	64.00
Spray—6 times	12 hrs.	24.00
Harvest		
Pick	96 hrs.	192.00
Sort and haul	14 hrs.	28.00
	Sub-total	$372.00
Materials		
Seed 8 lbs at $1.25 per pound		10.00
Fertilizer		21.00
Spray		12.00
Containers		6.00
	Sub-total	$49.00
Other		
Land preparation		34.00
Truck operation—14 trips, 350 miles 8 cents per mile		28.00
Grading and packing		175.00
Fixed Costs		
Land Charge		25.00
Bookkeeping and misc		15.00
	Total	$698.00
Estimated production [1] 6.5 tons		
Cost per ton		107.00
Cost per pound—cents		5.4

[1] Estimated yield with average rainfall is 7.0 tons and for a drought year 5.6 tons.

Table 9.6.7

—Estimated cost per acre for producing tomatoes, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		Dollars
Nursery	9 hrs.	18.00
Field		
Plant	30 hrs	60.00
Water—2 times	15 hrs.	30.00
Hand Weed—3 times	48 hrs.	96 00
Apply fertilizer—3 times	24 hrs.	48.00
Spray—10 times	24 hrs.	48.00
Harvest		
Picking	120 hrs.	240.00
Sort and haul	24 hrs.	48.00
	Sub-total	$588.00
Materials		
Seed		2.00
Fertilizer (nursery)		5.00
Field—500 lbs		35.00

Table 9.6.7 (cont.)

—Estimated cost per acre for producing tomatoes, St Croix, U.S. Virgin Islands—Cont.

Item	Quantity and/or hours	Cost
		Dollars
Spray		20.00
Containers		10.00
	Sub-total	$72.00
Other		
Land preparation—custom		34.00
Truck operation—12 trips 300 miles at 8 cents		24.00
Grading and packing— 5% of gross value		175.00
Fixed Cost		
Land charge		25.00
Bookkeeping and misc.		15.00
	Total	$933.00
Estimated production[1] 6.2 tons		
Cost per ton		150.00
Cost per pound—cents		7.5

[1] Estimated yield with average rainfall is 7.0 tons and for a drought year is 4.6 tons.

Table 9.6.8

—Estimated cost per acre for producing peppers, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		*Dollars*
Nursery	9 hrs.	18.00
Field		
Plant	39 hrs.	60.00
Water—2 times	15 hrs.	30.00
Hand Weed—3 times	48 hrs.	96.00
Apply fertilizer	16 hrs.	32.00
Spray—10 times	24 hrs.	48.00
Harvest		
Pick and haul	50 hrs.	100.00
	Sub-total	$384.00
Materials		
Seed—¼ lbs at $10		2.00
Fertilizer		
Nursery		5.00
Field		25.00
Spray		20.00
Containers		6.00
	Sub-total	$58.00
Other		
Land preparation—custom		34.00

—Estimated cost per acre for producing peppers, St. Croix, U.S. Virgin Islands—Cont.

Item	Quantity and/or hours	Cost
Other—Cont.		*Dollars*
Truck operation		20.00
Grading and packing		150.00
Fixed Costs		
Land charge		25.00
Bookkeeping and misc.		15.00
	Total	$686.00
Estimated production[1] 4.4 tons		
Costs per ton		149.00
Cost per pound—cents		7.4

[1] Estimated yield with average rainfall is 5.0 tons and for a drought year is 3.8 tons.

Table 9.6.9

—Estimated cost per acre for producing cucumbers, St. Croix, U.S. Virgin Islands

Item	Quantity and/or hours	Cost
Labor		*Dollars*
Plant by hand	20 hrs.	40.00
Apply Fertilizer by hand	12 hrs.	24.00
Hand weed—3 times	48 hrs.	96.00
Spray—8 times	16 hrs.	32.00
Harvest		
Pick—3 times for 8 wks	120 hrs.	240.00
Sort and haul	24 hrs.	48.00
	Sub-total	$480.00
Materials		
Seed—3 lbs at $3.00		9.00
Fertilizer—350 lbs		21.00
Spray—$2 per time		16.00
Containers		6.00
	Sub-total	$52.00
Other		
Land Preparation		34.00
Truck operation—24 trips		20.00
Grading and packing		52.00
Fixed Costs		
Land Charge		25.00
Bookkeeping and misc.		15.00
	Total	$678.00
Estimated production[1] 2.9 tons		
Cost per ton		234.00
Cost per pound—cents		11.7

[1] Estimated yield with average rainfall is 3.5 tons and for a drought year is 1.8 tons.

Table 9.6.10

–Estimated cost per acre for producing onions, St. Croix, U.S. Virgin Islands

Item	*Quantity and/or hours*	*Cost*
Labor		*Dollars*
Nursery	9 hrs.	18.00
Field		
Plant	45 hrs.	90.00
Hand weed—2 times	32 hrs.	64.00
Apply fertilizer	12 hrs.	24.00
Spray—2 times	5 hrs.	10.00
Harvest		
Pull	45 hrs.	90.00
Remove top and haul	10 hrs.	20.00
Haul—10 trips	30 hrs.	60.00
	Sub-total	$376.00
Materials		
Seed—1 lb		5.00
Fertilizer—Nursery		5.00
Field		26.00
Spray—2 times		5.00
Containers		6.00

—Estimated cost per acre for producing onions, St. Croix, U.S. Virgin Islands—Cont.

Item	*Quantity and/or hours*	*Cost*
		Dollars
Other		
Land preparation—customs		34.00
Truck operation—10 trips 250 miles at 8 cents		20.00
Grading etc.— 5% of gross value		200.00
Fixed Costs		
Land charge		25.00
Bookkeeping, and misc.		15.00
	Total	$717.00
Estimated production 9.3 tons [1]		
Cost per ton		77.00
Cost per pound—cents		3.8

[1] Estimated yield with average rainfall is 10.0 tons and for a drought year 8.0 tons.

Table 9.6.11

–Potential margins for St. Croix producers: selected commodities

Commodity	*St. Croix grower price* [1]	*St. Croix import price from strongest competitor* [2]	*St. Croix production costs* [3]	*Potential profit* [4]	*Marketing costs* [5]	*Potential profit if marketing costs are incurred*	*Potential profit with 80% yields or 25% higher production costs*
			Cents per Pound				
Cucumbers	16.0	11.3 [6]	11.7	−0.4	3.8	−4.2	−6.9
Onions	30.0	9.0 [6]	3.8	5.2	3.0	2.2	1.2
Okra	25.0	15.3 [7]	5.4	9.9	5.1	4.5	3.1
Peppers	25.0	11.6 [6]	7.4	4.2	3.9	0.3	−1.6
Tomatoes	25.0	20.2 [7]	7.5	12.7	6.7	6.0	4.1
Mangoes	20.0	17.7 [8]	2.2	15.5	5.9	9.6	9.0
Papayas	15.0	NA	4.8	10.2	5.0	5.2	4.0
Pineapple	8.0	12.2 [6]	2.1	5.9	2.7	3.2	2.7

TABLE 9.6.12

Table A-1.—Per-capita consumption figures, 1971, and estimated consumption

Product	*Per-capita consumption for total population, U.S. Virgin Islands*	*Estimated per-capita consumption for resident population U.S. Virgin Islands*	*Estimated per-capita consumption for native population, U.S.V.I.*	*Per-capita consumption for Continental U.S.*
	Pounds			
Beef and veal	74.7	63.5	55.3	108
Pork	35.5	28.8	23	60.2
Poultry	108	112	124	50.1
Lamb and mutton	5.7	5.91	6.4	3.1
Edible offals	5.0	4.5	3.3	11.1
Eggs (doz.)	18.4	16.7	14.8	26.8
Fluid milk and cream	43.2	38.2	25.4	107.2
Other dairy products	34.2	27.6	10.6	120.5

Source: Stammer, 1974

TABLE 9.6.13

ESTIMATED TOTAL CONSUMPTION OF MEAT, V.G., 1975 (000 lb.)

Product	Total Consump. V.G. resident pop.[1]	Total Consp. Tourist [2]	Total Consump.	Estimated Value, 1975 [3] ($000)
Beef and veal	83.4	30.6	114.0	148.2
Pork	34.7	17.1	51.8	62.2
Poultry	157.0	14.2	201.2	161.0
Lambs & mutton	9.7	0.9	10.6	15.9
Edible offals	5.0	3.2	8.2	-
Eggs (doz.)	22.3	7.6	29.9	23.9
Fluid milk & cream	38.3	30.4	68.7	37.8
Other dairy prods.	16.0	34.2	50.2	-

1. Using a projected population estimate of 1,508 for 1975, and based on column 3 of Table 9.6.12

2. Using 1974 approximates, and based on column 4 of Table 9.6.12

3. Prices (per pound unless otherwise stated) used in column order were, respectively, \$1.30; \$1.20; 80¢; \$1.50; n.d.; 80¢ per dozen (lowest imported price quoted; local prices average \$1.30); 55¢; n.d.

Table 9.6.14

—Costs and returns, 1000-acre beef cow-calf operation, alternative models, St. Croix, 1973

Item	Ranch I (grazing)	Ranch II (grazing-silage)
	----Dollars----	
Expenses:		
Land taxes	2,000	2,000
Wages and salaries [1]	23,755	27,240
Buildings and facilities	3,425	3,206
Production inputs	1,560	10,172
Machinery and equipment	9,266	11,575
Interest on operating capital	1,217	1,665
Total	41,223	55,860
Income:		
Heifers and young bulls	19,635	35,722
Cull cows	14,025	23,111
Total	33,660	58,833
Gross loss or gain	−7,563	2,973
Interest on average non-land investment at 7.5%	−11,345	−18,336
Residual return to land	−18,908	−15,363
	----Percent----	
Return to land as a percent of average non-land investment [2]	−12.5	−6.3

[1] Includes a salary to management at the rate of $15,000 per year. Forty percent of the manager's time is charged to the beef enterprise.

[2] Land cost is not included as an expense.

Source: Park and Park, 1974

Table 9.6.15

—Summary of income and expenses of benchmark farms [1]

Item	50-cow herd	75-cow herd
	----Dollars----	
Gross income	58,025	86,390
Interest on aver. invest. @ 7.5%	7,527	9,751
Depreciation [2]	5,914	6,000
Land cost [3]	3,000	4,500
Cost of hired labor	9,935	13,246
Current production expenses	23,755	34,139
Total expenses	50,131	67,636
Returns to operator's labor and to management	7,894	18,754
Rate of return on aver. investment [4] (excluding land investment)	3.4%	12.7%
Net profit [5]	−$4,106	$6,754

[1] For cows yielding 11,500 pounds of milk.

[2] Assembled from Tables 4 and 5.

[3] Cost of land for agricultural use, including taxes, was assumed at $20 per acre.

[4] Capital is considered to be the residual claimant. The reward of capital was estimated by subtracting depreciation, land cost, cost of hired labor, current production expenses and operator's opportunity cost from the gross income. The opportunity cost of operator's labor and management was assumed to be $12,000 per year.

[5] Net profit is the reward of the entrepreneur. It was estimated by subtracting interest, depreciation, land cost, cost of hired labor, current production expenses and operator's opportunity cost from the gross income.

Source: Dhillon and Park, 1974

Table 9.6.16

—Machinery and equipment for sorghum silage

Item	*Initial cost*	*Annual depreciation*[1]	*Annual Repairs*[2]
	Dollars		
Tractor (⅓ of dairy tractor)	2,167	217	65
Small tractor	4,000	400	120
Plow	800	53	16
Disc harrow	1,000	67	20
Fertilizer spreader	850	57	17
Planter	900	60	18
Forage harvestor	4,500	300	90
Wagons (2)	2,000	200	60
Trench silo, 800 tons	1,200	60	--
Total	17,417	1,414	406
Additional investment	15,250	--	--
Average investment	8,708	--	--

[1] Tractor and wagons were assumed to last 10 years; because of small acreage of silage other machinery was assumed to last 15 years and silo was depreciated over 20 years.
[2] Repair costs of tractor and wagons were estimated at 3 percent of initial costs; on other machinery at 2 percent.

Table 9.6.17

—Cost of making and feeding silage from a 50-acre field of sorghum

Item	*Rate per acre*	*Cost per acre*	*Total cost*
Land cost		$20.00	$1,000
Seed	9 lbs. @ $.23	2.07	104
Fertilizer	400 lbs. @ $6.50/bag	26.00	1,300
Herbicide	3.5 lbs. @ $1.80	6.30	315
Insecticide	1 pint @ $2.25	2.25	113
Variable machinery costs[1]		8.24	400
Fixed costs[2]			2,473
Labor, ½ man @ $6,623			3,312
Total			$9,017
Total silage produced			750 tons
Cost per ton			$12.00
Cost per acre			$180.00
Total TDN produced			205,500 lbs.
Cost of TDN, per pound			4.4¢

[1] This includes cost of hiring a tractor
[2] Fixed costs include interest on average investment in machinery and silo, depreciation and machinery repair costs.

Source: Dhillon and Park, 1974

TABLE 9.6.18

–Specifications for benchmark goat and sheep operations, St. Croix, 1974

Item	*Benchmark farm*			
	Goats		*Sheep*	
	5 Acres	*20 Acres*	*5 Acres*	*20 Acres*
Carrying capacity at a point in time:[1]				
Brood females	7	29	8	30
Nursing young	4	17	4	15
Growing young	2	8	2	7
Sires	1	1	1	1
Total	14	55	15	53
Herd replacement rate:				
Culls at 7 yrs. of age (%)	14	14	14	14
Death and theft loss (%)	10	10	10	10
Annual birth rate (%)	350	350	300	300
Number of gestation periods	1.5–2	1.5–2	1.5–2	1.5–2
Age of young at time of sale (mos.)	3	3	3	3
Weight of animals (lbs.):				
Brood females	80	80	80	80
Young stock at time of sale	50	50	50	50
Sires	120	120	120	120
Number of young stock for sale annually	21	85	20	74
Sale prices (cents/lb.):				
Young stock, liveweight	60	60	60	60
Old stock, liveweight	50	50	50	50
Feed sources:[2]				
Concentrate per day (lbs.)	0.5	0.5	0.5	0.5
Pasture (lbs. TDN/acre/yr.)	1,500	1,475	1,500	1,475
Source of labor	Family	Family	Family	Family
Farm value of land/acre	$200	$200	$200	$200

[1] See Table 9.6.27 This is a composite of the herd. Since young stock are marketed at 3 months of age and females gestate up to two times a year, the total number of animals handled during the year is substantially greater than reported here. Carrying capacity is determined by dividing the total digestible nutrients (TDN) required by the herd composite into the TDN in the available feed.

[2] Grain concentrate is fed to adult animals for 180 days per year. The lbs. of TDN produced per acre is based on typical operating conditions on St. Croix. Well-managed pasture may yield substantially higher than that reported here. See Table 9.6.26-9.6.27.

Source of Tables 9.6.18-9.6.27: Park & Park (Report No. 7, 1974)

TABLE 9.6.19

-Investment and operating capital cost of a 20-acre goat or sheep operation, St. Croix, 1974

Item	Amount	Years to replacement	Replacement allowance
Investment capital:			
Land (20 acres @ $200/acre)[1]	$4,000	—	—
Fencing and gates (1.23 mi. @ $3,195/mi.)[2]	3,931	15	$262
Holding pens and feed bunks	100	20	5
Shelter	200	15	13
Miscellaneous equipment	25	5	5
Well and trough (25% of $1,660)[3]	415	20	21
Sub-total	$8,671		$306
Livestock:		*Goats*	*Sheep*
Brood females (30 lbs. @ 50¢)[4]		(29) $1,160	(30) $1,200
Sires (120 lbs. @ 50¢)		(1) 60	(1) 60
Young stock (25 lbs. Aug. @ 60¢)		(25) 375	(22) 330
Sub-total		$1,595	$1,590
Total investment capital		$10,266	$10,261
Investment capital per adult animal		342	331
Adjusted investment capital[5]		7,930	7,925
Interest on adjusted investment at 7.5%		595	594
Operating capital:			
Animal health		$ 33	$ 30
Repairs		93	93
Land taxes		40	40
Supplemental feed		170	176
Total operating capital		$336	$339
Interest on 25% of operating capital at 7.5%		$6	$6

[1] Any land value above $200 per acre is assumed to be development value and not chargeable to the enterprise.

[2] Fences consist of net wire plus 2 barbed wires on posts placed on 8 ft. centers and 6 gates for 6 pastures.

[3] Since this is a backyard operation, animals are to be watered at household well.

[4] Number in ( ) represents the number of head.

[5] Depreciable capital is included at 50 percent of original value.

TABLE 9.6.20

—Investment and operating capital cost of a 5-acre goat or sheep operation, St. Croix, 1974

Item	*Amount*	*Years to replacement*	*Replacement allowance*
Investment capital:			
Land (5 acres @ $200/acre)[1]	$1,000	--	—
Fencing and gates (0.44 mi. @ $3,195/mi.)[2]	1,406	15	94
Holding pens and bunks	50	20	2
Shelter	75	15	5
Miscellaneous equipment	25	5	5
Well and trough (.06 of $1,660)[3]	100	20	5
Sub-total	$2,656		$111
Livestock:		*Goats*	*Sheep*
Brood females (80 lbs. @ 50¢)[4]		(7) $280	(8) $320
Sires (120 lbs. @ 50¢)		(1) 60	(1) 60
Young stock (25 lb. avg. @ 60¢)		(6) 90	(6) 90
Sub-total		$430	$470
Total investment capital		$3,086	$3,126
Investment capital per adult animal		386	347
Adjusted investment capital[5]		$2,258	$2,298
Interest on adjusted investment at 7.5%		169	172
Operating capital:			
Animal health		$ 8	$ 8
Repairs		33	33
Land taxes		10	10
Supplemental feed		44	44
Total operating capital		$ 95	$ 95
Interest on 25% of operating capital at 7.5%		$2	$2

[1] Any land value above $200 per acre is assumed to be development value and not chargeable to the enterprise.
[2] Fences consist of net wire plus 2 barbed wires on posts placed on 8 ft. centers and 2 gates for 2 pastures.
[3] Since this is a backyard operation, animals are watered at the household well.
[4] Number in ( ) represents number of head.
[5] Depreciable capital is included at 50 percent of original value.

TABLE 9.6.21

—Costs and returns to a simulated 5- and 20-acre family operated goat or sheep enterprise, St. Croix, 1974

Item	Benchmark farm			
	Goats		Sheep	
	5 Acres	20 Acres	5 Acres	20 Acres
Expenses:				
Land taxes (2/acre)	$ 10	$ 40	$ 10	$ 40
Facilities cost (Replacement allowance)	111	306	111	306
Repairs (@ 2% of original value/year)	33	93	33	93
Animal health (25¢/head/year)	8	33	8	30
Supplemental grain concentrate Feed at $7/cwt.	44	170	44	176
Interest on operating capital	2	6	2	6
Total	$208	$648	$208	$651
Liveweight of stock sold (lbs.)	1,130	4,570	1,080	4,020
Cost per lb., liveweight ($)	0.18	0.14	0.19	0.16
Income:				
Young stock sales (50 lb. @ 60¢)	(21) $630	(85) $2,550	(20) $600	(74) $2,220
• Cull brood females (80 lb. @ 50¢)	(1) 40	(4) 160	(1) 40	(4) 160
Total	$670	$2,710	$640	$2,380
Returns:				
Return to labor and capital	$462	$2,062	$432	$1,729
Interest on invested capital at 7.5%	169	595	172	594
Family labor income	$293	$1,467	$260	$1,135
Estimated daily family labor required (hrs.)	0.5	2.0	0.5	2.0
Average hourly return to family labor	$1.61	$2.01	$1.42	$1.55

TABLE 9.6.22

—Estimated fencing cost for 20-acre goat or sheep operation, St. Croix, 1974

Item	Unit Price	No. units required	Value
Net wire, 150 ft./roll	$39.95	44	$1,757.80
Barbed wire, 480 ft./roll	12.50	27	337.50
Steel posts, 7 ft.	2.10	817	1,715.70
Gates	20.00	6	120.00
Total			$3,931.00

A square 20-acre field with 6 equal sized pastures would require 6,533 ft. of fence (1.237 miles)

Cost of fence per mile=$3,931/1.23=$3,195

The 5-acre operation with 2 pastures would require 0.44 miles of fence for a cost of

0.44×$3,195=$1,406

TABLE 9.6.23

Labor income per hour (LI) for a 20-acre goat or sheep operation at alternative sale prices and daily labor requirements, St. Croix, 1974

Liveweight saleprice [1] *($/lb)*	*Hours worked per day (H)*				
	1.0	*1.5*	*2.0*	*2.5*	*3.0*
Goats (P_g)			*Dollars*		
$ .45	2.27	1.52	1.14	0.91	0.76
.50	2.86	1.90	1.43	1.14	0.95
.55	3.44	2.29	1.72	1.37	1.15
.60	4.02	2.68	2.01	1.61	1.34
.65	4.60	3.07	2.30	1.84	1.53
.70	5.18	3.46	2.59	2.07	1.73
.75	5.77	3.84	2.88	2.31	1.92
Sheep (P_s)					
$ .45	1.59	1.06	0.79	0.64	0.53
.50	2.10	1.40	1.05	0.84	0.70
.55	2.60	1.73	1.30	1.04	0.87
.60	3.11	2.07	1.55	1.24	1.04
.65	3.62	2.41	1.81	1.45	1.21
.70	4.12	2.75	2.06	1.65	1.37
.75	4.63	3.09	2.31	1.85	1.54

[1] Priced at f.o.b. the farm. The prevailing practice on St. Croix is for buyers to pick up the livestock at the farm.

TABLE 9.6.24

—Labor income per hour (LI) for a 5-acre goat or sheep operation at alternative sale prices and daily labor requirements, St. Croix, 1974

Liveweight sale price [1] *($/lb.)*	*Hours worked per day (H)*				
	0.25	*0.375*	*0.5*	*0.625*	*0.75*
Goats (P_g)			*Dollars*		
$ .45	1.49	0.99	0.74	0.59	0,50
.50	2.06	1.37	1.03	0.82	0.69
.55	2.64	1.76	1.32	1.06	0.88
.60	3.22	2.14	1.61	1.29	1.07
.65	3.79	2.53	1.89	1.52	1.26
.70	4.36	2.91	2.18	1.75	1.45
.75	4.94	3.29	2.47	1.98	1.65
Sheep (P_s)					
$ .45	1.20	0.80	0.60	0.48	0.40
.50	1.75	1.17	0.88	0.70	0.58
.55	2.30	1.53	1.15	0.92	0.77
.60	2.85	1.90	1.42	1.14	0.95
.65	3.40	2.26	1.70	1.36	1.13
.70	3.94	2.63	1.97	1.58	1.31
.75	4.49	2.99	2.25	1.80	1.50

[1] Priced at f.o.b. the farm which is the prevailing sales point.

TABLE 9.6.25

—Determination of livestock sales for 5- and 20-acre goat or sheep operation, St. Croix, 1974

Item	*Benchmark farm*			
	Goats		*Sheep*	
	5 Acres	*20 Acres*	*5 Acres*	*20 Acres*
No. of brood females	7	29	8	30
Death and theft loss (10%)	1	3	1	3
Number culled from herd (14%)	1	4	1	4
Number of offspring	25	102	24	90
Less death and theft loss (10%)	2	10	2	9
Less herd replacements	2	7	2	7
Number of young stock for sale	21	85	20	74
Sales value per head ($):				
Young stock (50 lbs. @ 60¢)	30	30	30	30
Culls (80 lbs. @ 50¢)	40	40	40	40
Total sales ($):				
Young stock	630	2,550	600	2,220
Culls	40	160	40	160
Total sales value	670	2,710	640	2,380

TABLE 9.6.26

Annual TDN requirements per herd unit, 20-acre goat and sheep operations, St. Croix, 1974

Herd Component	Number of head per herd unit	Percent of total	lbs. TDN required per head per day	lbs. TDN required per HU	
				Daily	Annually
Goats:					
Brood females	10.0	52.6	2.2	22.0	8,030
Nursing kids [1]	5.8	30.5	0.5	2.9	1,058
Growing kids [2]	2.9	15.3	1.8	5.2	1,898
Sires	0.3	1.6	2.5	0.8	292
Total	19.0	100.0		30.9	11,278
Adjusted for death loss of 5% per year [4]					10,996
Sheep:					
Brood females	10.0	56.2	2.2	22.0	8,030
Nursing lambs [3]	5.0	38.1	0.5	2.5	912
Growing lambs [2]	2.5	14.0	1.8	4.5	1,642
Sires	0.3	1.7	2.5	0.8	292
Total	17.8	100.0		29.8	10,876
Adjusted for death loss of 5% per year [4]					10,604

[1] Two gestations and 350 percent annual kid crop. Young stock remain in the herd for 3 months at which time they are marketed.
[2] Weaning age is at 2 months.
[3] Two gestations and 300 percent annual lamb crop. Lambs are marketed at 3 months of age.
[4] If a 5-percent death loss occurs uniformly through the year, the feed requirement is reduced by only 2.5 percent.

TABLE 9.6.27

—Determination of carrying capacity for 5- and 20-acre goat or sheep operation, St. Croix, 1974

Item	Benchmark farm			
	Goats		Sheep	
	5 Acres	20 Acres	5 Acres	20 Acres
TDN Produced per acre (lbs.)	1,500	1,475	1,500	1,475
TDN Produced on pasture (lbs.)	7,500	29,500	7,500	29,500
TDN Required per herd unit (lbs.)[1]	10,996	10,996	10,604	10,604
No. of herd units supported by pasture feed	0.68	2.68	0.71	2.78
No. of brood females [2]	7	27	7	28
Grain concentrate fed (lbs.)[3]	630	2,430	630	2,520
TDN in grain concentrate (lbs.)	488	1,883	488	1,953
No. of herd units supported by concentrate feed	0.04	0.17	0.05	0.18
Total herd units supported by pasture and concentrate	0.72	2.85	0.76	2.96
No. animals supported by pasture and concentrate:				
Brood females	7	29	8	30
Nursing young	4	17	4	15
Growing young	2	8	2	8
Sires	1	1	1	1
Total animals	14	55	15	53

[1] See Table 5.43
[2] Computed at 10 brood females per Herd Unit times the number of HU's and rounded to the nearest whole animal.
[3] Feeding rate is assumed at 0.5 lbs. per day per brood female for 180 days per year or 90 lbs. per year.

TABLE 9.6.28

—Sensitivity analysis to measure impact of charges in variables on returns to owner's management and labor and net returns after all costs, hog enterprise, St. Croix, U.S. Virgin Islands, 1973

Price of hog and sow feed per cwt.	66-pound hogs Selling at a liveweight price per pound of:			132-pound hogs Selling at a liveweight price per pound of:			220-pound hogs Selling at a liveweight price per pound of:		
	.50	.60	.65	.50	.60	.65	.50	.60	.65
	Dollar returns to owner's management and labor								
$6.00	−610	88	437	1,380	2,776	3,474	3,396	5,723	6,886
7.50	−1,301	−603	−254	313	1,709[1]	2,407	1,670	3,997	5,160
9.00	−1,993	−1,295	−946	−754[1]	642[1]	1,340	−56	2,271	3,434
	Net dollar returns after all costs[1]								
6.00	−2,456	−1,758	−1,409	−773	623	1,321	935	3,262	4,425
7.50	−3,147	−2,449	−2,100	−1,840	−444	254	−791	1,536	2,699
9.00	−3,839	−3,141	−2,792	−2,907	−1,511	−813	−2,517	−190	973

[1] See Table 8 for total breakdown of sales and cost items.

TABLE 9.6.29

.—Returns to labor and management for hog enterprise, St. Croix, Virgin Islands, 1973

Item	Alternative A[1]	Alterantive B[2]	Alternative C[3]
Sales	Dollars		
Market hogs (132 pounds)	8,376	8,376	6,980
Cull sows	400	400	400
Gross sales	8,776	8,776	7,389
Variable costs			
Commercial feed	5,334	6,401	6,401
Hired labor	90	90	90
Veterinary, medication and sanitation	168	168	168
Building and fence repairs	32	32	32
Equipment repairs	12	12	12
Truck fuel, maintenance	104	104	104
Utilities	44	44	44
Marketing	84	84	84
Miscellaneous	56	56	56
Total variable costs	5,924	6,991	6,991
Fixed costs			
Depreciation on bldgs., fences, equipment	513	513	513
Property taxes	10	10	10
Insurance	120	120	120
Total fixed costs	643	643	643
Interest on investment	500	500	500
Total costs	7,067	8,134	8,134
Returns to labor and management	1,709	642	−754

[1] Based on assumption of feed price of $7.50 per cwt. and a market price of $.60 per pound liveweight.

[2] Based on assumption of feed price of $9.00 per cwt. and a market price of $.60 per pound liveweight. Most closely approximates present situation on island (June 1973).

[3] Based on assumption of feed price of $9.00 per cwt. and a market price of $.50 per pound liveweight.

TABLE 9.6.30 .—Annual returns to owner's labor and management for 12,000-bird flock, St. Croix, Virgin Islands, 1973

Item	*Alternative* [1] *A*	*Alternative* [2] *B*	*Alternative* [3] *C*
	Dollars		
Sales			
Eggs	140,028	160,072	180,036
Cull hens	4,440	4,440	4,440
TOTAL	144,468	164,472	184,476
Variable costs [4]			
Feed	94,605	94,605	94,605
Hen depreciation	32,252	32,252	32,252
Hired labor	12,099	12,099	12,099
Utilities	1,076	1,076	1,076
Medication and vaccination	489	489	489
Repairs	684	684	684
Truck fuel, tires and maintenance	210	210	210
Interest on operating capital	1,875	1,875	1,875
Supplies	6,675	6,675	6,675
Miscellaneous	500	500	500
Total variable costs	150,565	150,565	150,565
Fixed costs			
Property taxes	94	94	94
Insurance	958	958	958
Depreciation	4,381	4,381	4,381
Total Fixed costs	5,433	5,433	5,433
Interest on investment in land, building and equipment	2,100	2,100	2,100
Total costs	157,998	157,998	157,998
Returns to owner's labor and management	—13,530	6,474	26,468

[1] Based on $8.50/cwt. feed price, 5 pounds of feed per dozen eggs and a large egg price of $.70 per dozen.
[2] Based on $8.50/cwt. feed price, 5.0 pounds feed per dozen eggs, and a large egg price of $.80 per dozen.
[3] Based on $8.50/cwt. feed price, 5 pounds feed per dozen eggs and a large egg price of $.90 per dozen.

TABLE 9.6.31

Summary of per-unit costs and returns for a 12,000-bird flock, St. Croix, Virgin Islands, 1973

Item	*Alternative* *A*	*B*	*C*
	Dozens		
Eggs produced			
Per cycle	273,000	273,000	273,000
Per year	222,495	273,000	273,000
	Dollars		
Feed cost per dozen	$.425	$.425	$.425
Variable costs per dozen (Excluding owner's management and labor, but including feed and hen depreciation)	.676	.676	.676
Variable costs per dozen (Including owner's labor and management) [1]	.721	.721	.721
Fixed costs per dozen	.024	.024	.024
Total costs per dozen (Excluding owner's labor and management)	.710	.710	.710
Total costs per dozen (Including labor and management)	.755	.755	.755
Profits per dozen eggs (Excluding owner's labor and management)	[.060] [2]	.029	.119
Profits per dozen eggs (Including owner's labor and management)	[.106] [2]	[.016] [2]	.074

[1] Based on rate of $10,000 per year.
[2] Brackets indicate a loss.

TABLE 9.6.32

MONTHLY RAINFALL, VIRGIN GORDA, 1965-75

	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75
JAN	0.96	2.20	1.10	1.10	2.00	1.75	2.25	1.60	2.45	N.D.	N.D.
FEB	0.35	0.50	1.80	0.05	1.00	1.90	0.90	1.55	2.20	0.85	N.D.
MAR	0.35	NIL	0.85	2.35	0.65	0.40	1.90	3.00	0.95	0.85	1.00
APR	2.35	NIL	0.40	0.05	0.65	NIL	0.65	1.25	0.25	1.20	2.55
MAY	6.90	1.00	1.85	1.40	13.25	7.15	2.30	0.23	1.00	0.20	N.D.
JUN	0.03	1.25	0.90	1.75	2.15	1.65	0.10	3.15	2.40	1.30	0.55
JUL	5.85	1.05	2.85	2.00	1.60	NIL	0.25	0.95	2.20	2.75	N.D.
AUG	4.70	4.50	0.45	1.10	4.90	0.30	0.10	3.20	1.50	0.20	N.D.
SEP	1.60	4.95	0.40	0.75	2.58	1.75	0.45	2.35	1.75	7.55	11.40
OCT	3.70	2.40	3.80	0.90	3.80	12.50	2.15	4.55	2.45	8.55	4.85
NOV	3.50	3.55	3.65	1.75	6.28	4.35	4.90	2.40	N.D.	12.00	6.60
DEC	3.00	3.15	0.40	3.85	0.78	4.70	2.35	0.85	0.25	2.10	9.30
YRLY TOTAL	33.39	24.55	18.45	17.05	39.64	35.45	19.30	25.08	21.35*	39.15*	42.74*

* Median monthly values used where no existing data (see Table 9.6.33).

Underlined figures interpolated from irregular data.

Site of rainfall meter: East grounds, Little Dix Bay

(Source: Little Dix Bay Hotel Corporation)

TABLE 9.6.33

MONTHLY AVERAGE RAINFALL, VIRGIN GORDA, 1965-75

	Highest Recorded	Lowest Recorded	Mean	Median
JAN	2.45	0.96	1.71	1.60
FEB	2.20	0.35	1.11	0.88
MAR	2.35	NIL	1.12	0.85
APR	2.55	NIL	0.85	0.65
MAY	13.25	0.20	3.55	1.43
JUN	3.15	0.03	1.38	1.25
JUL	5.85	NIL	2.05	1.60
AUG	4.90	0.10	2.10	0.98
SEP	11.40	0.40	3.23	1.75
OCT	12.50	0.90	4.51	3.80
NOV	12.00	1.75	4.90	4.00
DEC	9.30	0.40	2.79	2.23
YRLY TOTAL	81.90	5.09	29.30	19.02

CHAPTER 10

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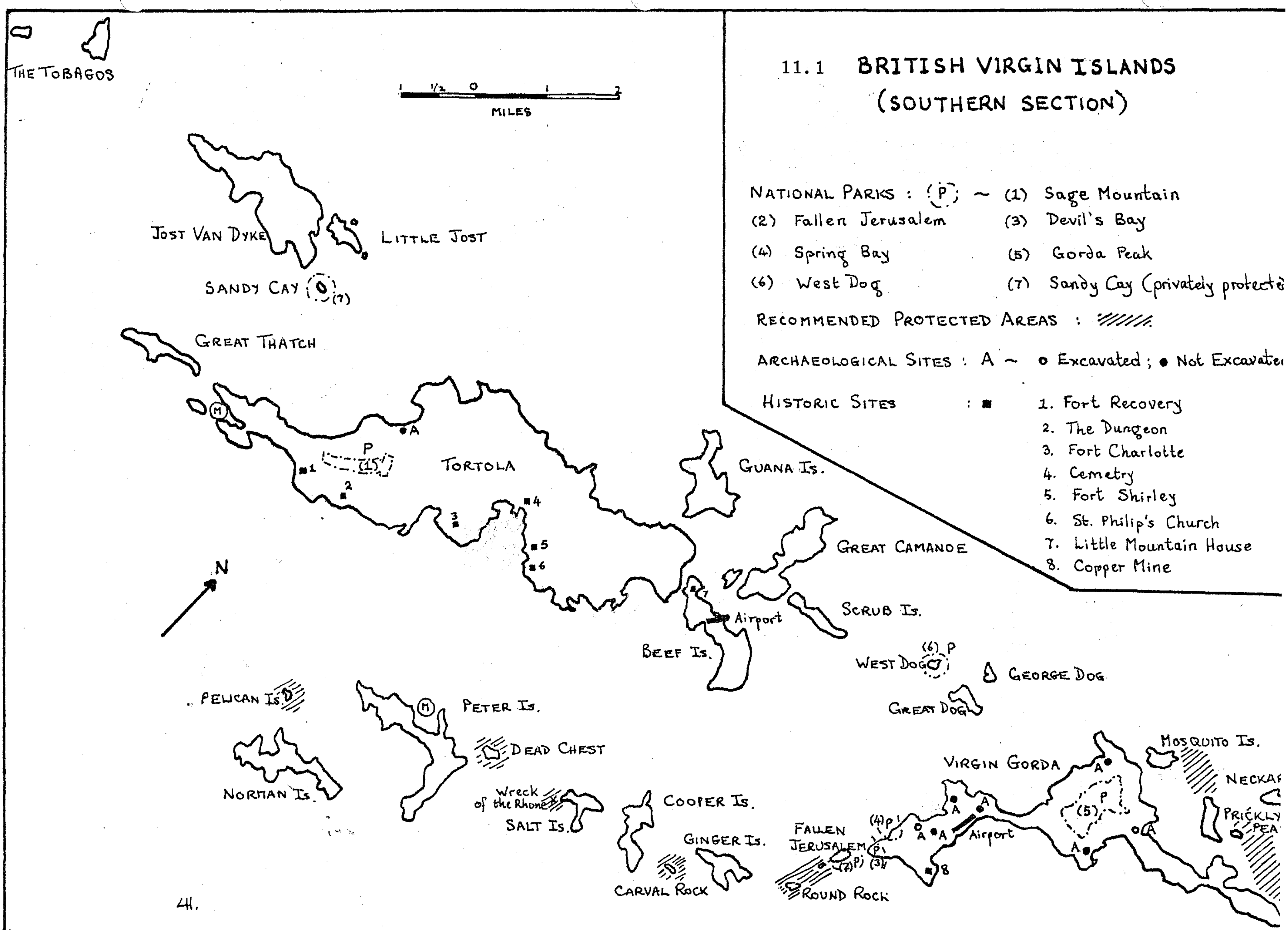
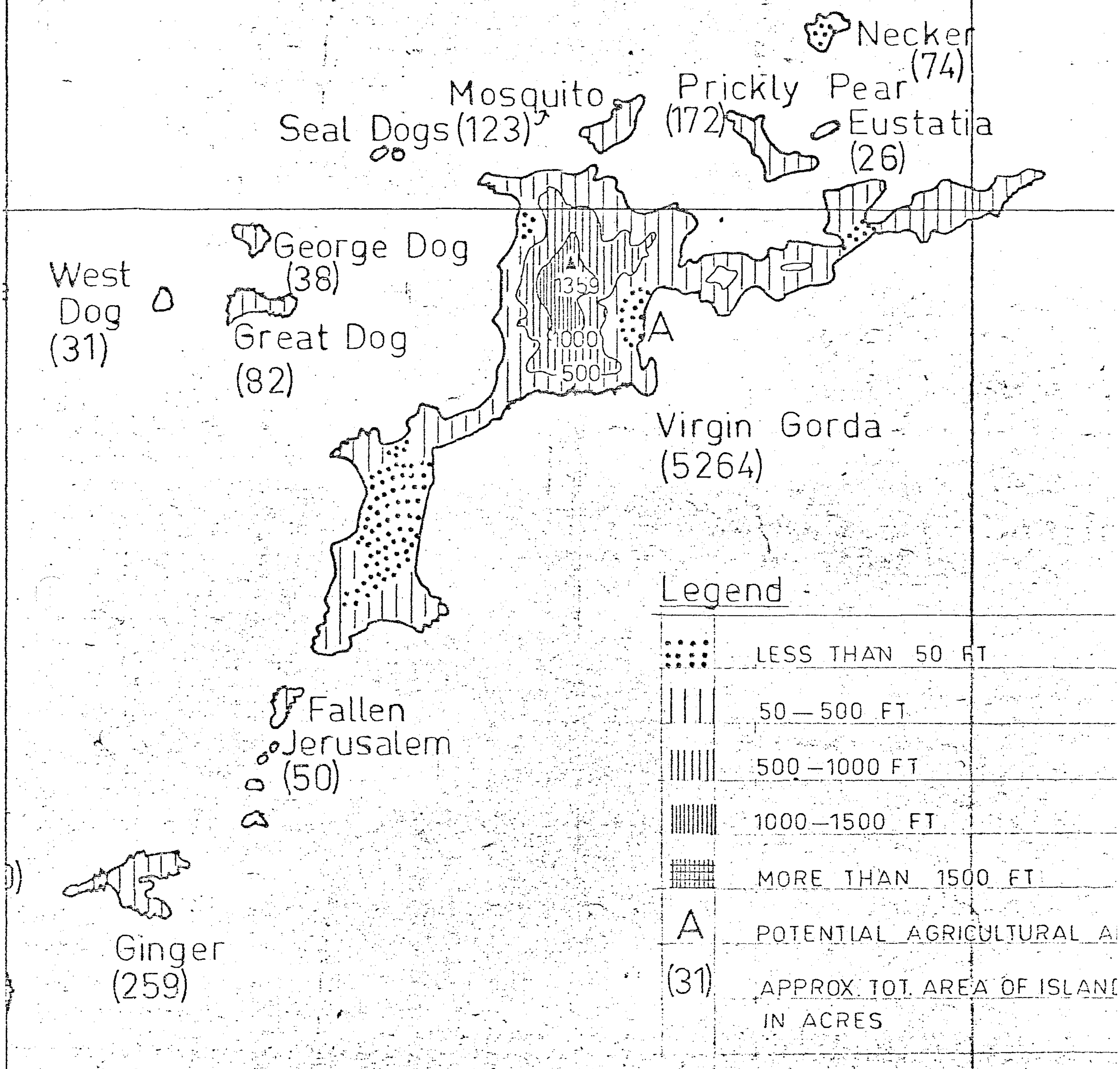
CHAPTER 11

MAPS


11.1 BRITISH VIRGIN ISLANDS
(SOUTHERN SECTION)
NATIONAL PARKS : (P) ~ (1) Sage Mountain
(2) Fallen Jerusalem
(3) Devil's Bay
(4) Spring Bay
(5) Gorda Peak
(6) West Dog
(7) Sandy Cay (privately protecte
RECOMMENDED PROTECTED AREAS :
ARCHAEOLOGICAL SITES : A ~ o Excavated ; • Not Excavate
HISTORIC SITES :
1. Fort Recovery
2. The Dungeon
3. Fort Charlotte
4. Cemetry
5. Fort Shirley
6. St. Philip's Church
7. Little Mountain House
8. Copper Mine
1 1/2 0 1 2
MILES
THE TOBAGOS
JOST VAN DYKE
LITTLE JOST
SANDY CAY
GREAT THATCH
TORTOLA
GUANA Is.
GREAT CAMANOE
SCRUB Is.
BEEF Is.
Airport
WEST DOG
GEORGE DOG
GREAT DOG
N
PELICAN Is.
NORMAN Is.
PETER Is.
DEAD CHEST
Wreck of the Rhone
SALT Is.
COOPER Is.
GINGER Is.
CARVAL ROCK
FALLEN JERUSALEM
ROUND ROCK
VIRGIN GORDA
MOSQUITO Is.
NECKAR
PRICKLY PEA
41.

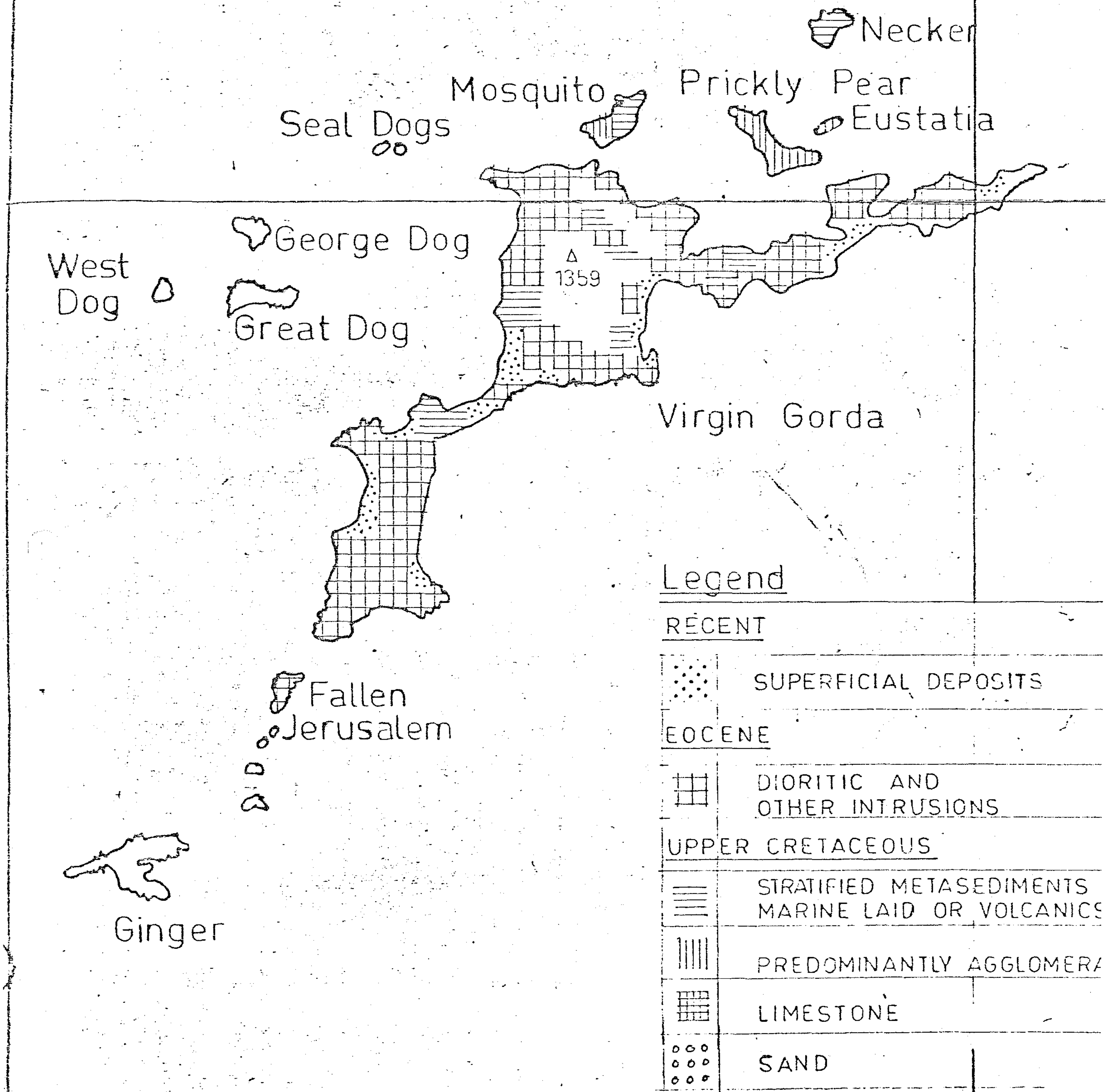


TOPOGRAPHY

FIGURE

Source and cartography: Town Planner's Office, Tortola

1:100,000

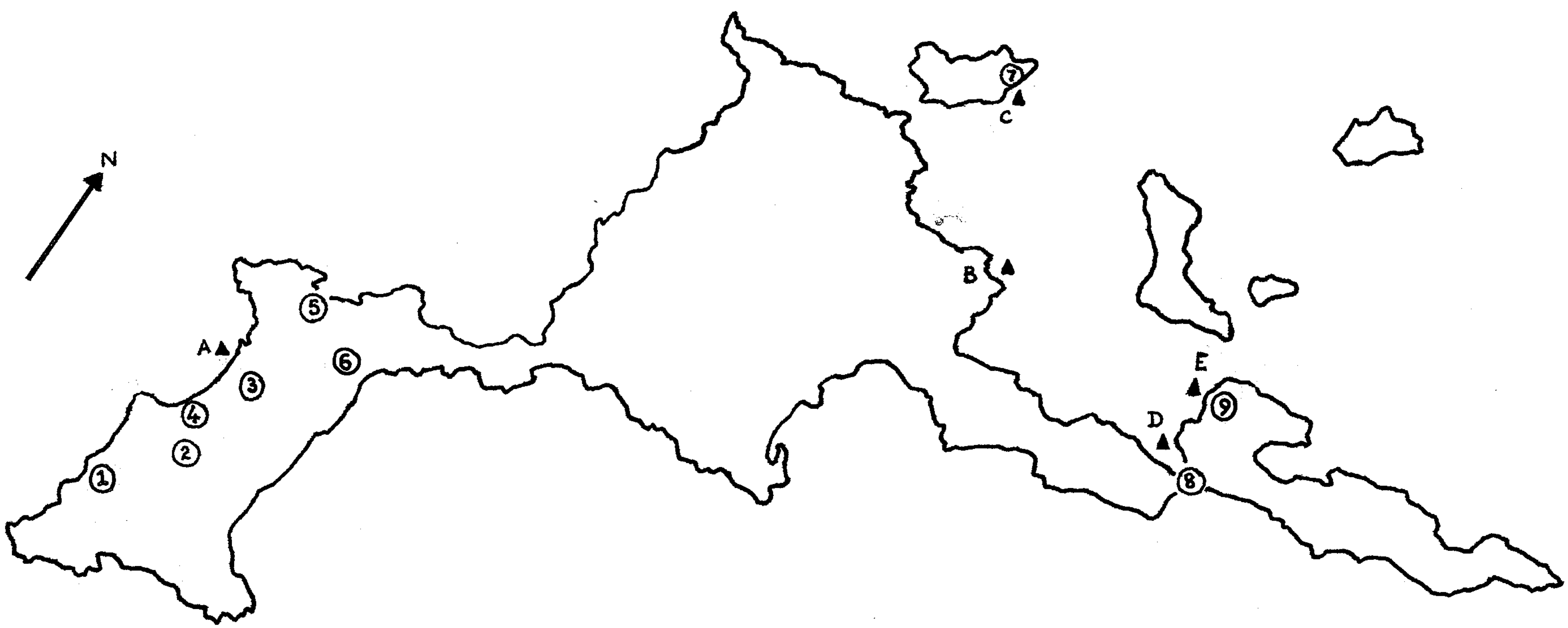


GEOLOGY

FIGUR

Source and cartography: Town Planner's Office, Tortola

VIRGIN GORDA -- TOURIST ACCOMMODATIONS



HOTELS	BEDS
1. Guavaberry Spring Bay	20
2. Lord Nelson Inn	10
3. Ocean View Hotel	24
4. Fischers Cove Beach	16
5. Little Dix Bay Hotel	132
6. Olde Yard Inn	18
7. Drakes Anchorage	24
8. Biras Creek	60
9. Bitter End Yacht Club	18
TOTAL:	322

MARINAS	BERTHS
A. Virgin Gorda Yacht Harbour	60
B. Leverick Bay Estates	20
C. Drakes Anchorage	20
D. Biras Creek	25+
E. Bitter End Yacht Club	20?
TOTAL:	140+

TOTAL BEDS AND BERTHS: 462+

IRF-HOWELL