



Monitoring the Saba Bank Fishery

**Department of
Public Health and
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Preface

This document was prepared by the Environmental Division of the Department of Public Health and Environmental Hygiene of the Government of the Netherlands Antilles in Curaçao, which initiated the monitoring of the Saba Bank fishery as part of a biodiversity survey program to formulate an integrated management plan for the Saba Bank. This project (BOM Project N5) was carried out as part of the implementation of the policy paper “Contours of Nature and Environmental Policy of the Netherlands Antilles”, which is supported by the cooperative funding made available by the Dutch Department of the Interior and Kingdom Affairs.

The data collection took place from April, 1999 to May, 2000 in Saba and St. Maarten, Netherlands Antilles.

This document includes a brief summary on the general characteristics of the Saba Bank, a review of the fishery, the results and the conclusions of the monitoring. Furthermore recommendations are given for future management of the Saba Bank fishery, which will enable sustainable exploitation of the fisheries resources of the Saba Bank.

Willemstad, October 2000

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We thank all the Saba Bank fishermen for their excellent cooperation in the monitoring program.

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Executive summary

From April 23, 1999 to May 30, 2000 a comprehensive survey was undertaken of the fishery of the Saba Bank. This catch assessment and monitoring program was initiated by the Environmental Division of the Department of Public Health and Environment of the Government of the Netherlands Antilles in Willemstad to determine the degree of exploitation of the fisheries resources of the Saba Bank. The objective of the program was to collect fishery dependent data on the different target species of the Saba Bank.

The survey found that the Saba Bank fishermen engage in two types of fisheries: a spiny lobster (*Panulirus argus*) fishery, and a snapper fishery targeting mainly: silk snapper (*Lutjanus vivanus*) and blackfin snapper (*Lutjanus buccanella*). The main fishery activity on the Saba Bank was the lobster fishery; snappers were targeted less frequently.

The total lobster catch per year amounted to about 90 tons and the total red snapper catch came to 12 tons per year. During the study it became clear that a high percentage of lobsters landed were under the legal size limit and a substantial percentage of berried lobsters were landed. Furthermore a considerable number of traps were lost, due to ship traffic and hurricanes. None of these traps were fitted with a biodegradable panel, so the lost traps may be extremely damaging to the ecology and consequently the fish stock of the Saba Bank.

Snapper catches were considered fairly good, although the targeted specimens were relatively small in size.

About 50 fishermen were active in the fishery and the Saba Bank fishery sector generated a gross economical value of 2 million Guilders (1.1 million US\$) over 1999.

As result of the program the following regulations are now being strictly enforced:

- Presence of a biodegradable panel in each trap;
- Legal mesh size of 1.5" or 3.8 mm;
- Legal size limit for lobsters;
- Prohibition to land berried lobsters;
- Prohibition to land lobsters in ecdysis;
- Prohibition to fish without a license in both the Saban territorial waters and the Economic Fishery Zone (EFZ) of the Netherlands Antilles.

As average length of the main snapper species of the Saba Bank is relatively small, it is recommended not to increase the total fishing effort for snappers, until more data are available.

Despite the fact that catches and average lengths of the lobsters seem to be good, the maximum sustainable yield calculations available in literature dealing with the Saba Bank, although admittedly very rough, seem to indicate that the present day fishing effort may be close to the limit of sustainable levels of exploitation. Until further research is completed and maximum sustainable yield can be calculated no further fishing permits should be issued.

It is urgently recommended that either the Central or Saba Island Government appoint a body to follow up on this study and collect the necessary fishery dependent data.

1. Introduction

The Saba Bank is a large, totally submerged shallow, marine area off the island of Saba. The Bank is important as a fishery resource for fishermen from Saba, St. Eustatius and St. Maarten.

Frequent reports of decreasing fish stocks, destructive fishing activities of foreign vessels, anchoring of oil tankers and tank cleaning, has raised concerns about the environmental state of the Bank. Meesters *et al*, (1996), commissioned by the Environmental Section reviewed the Saba Bank in 1996 in combination with a short study on location. He concluded that the habitat of the Saba Bank is particularly important for several reasons:

- The significance of the sea-current patterns suggest that the reefs are potentially an important source of fish and shellfish larval dispersal to the islands of Saba, St Maarten and to the islands in the eastern Greater Antilles;
- The coral reefs of the Saba Bank are relatively remote from intense human impact and may not only provide important scientific information on the status of reefs in relatively unspoiled condition, but are also a reserve of biodiversity for the region;
- The reefs of the Saba Bank are potentially a resource for dive-tourism and an essential resource for fishing.

Meesters's study also recommended that a management plan should be developed in order to preserve this unique marine habitat. The National Policy paper "Contours of Environmental & Nature Conservation Policy for the Netherlands Antilles" incorporated this recommendation, and again in the National Nature Policy Plan of 2000 the development of a management plan for the Saba bank is stated as an important objective. As a first step to realize such a management plan, the Environmental Section initiated a comprehensive fishery catch assessment survey in order to get an impression of the fisheries resources of the Saba Bank.

During the time of the assessment (from April 23rd, 1999 to May 30th, 2000) an abundance of fishery dependent data was collected, which will contribute to formulation of an adequate management plan for sustainable exploitation of the fishery resources of the Saba Bank.

2. Background

2.1 The Saba Bank

The Saba Bank (17° 25' N, 63 ° 30' W) is a roughly rectangular undersea elevation with a flattened top, located 3 – 5 km Southwest of the island of Saba and 25 km West of St. Eustatius. With a length of 60 to 65 km and a width of 30 to 40 km, the total surface area is approximately 2,200 km², as measured from 11-200 meter depth. Water depth is 20-40 meter over most of the Bank. The Bank's surface slopes gradually from the shallower southeastern part to the deeper northwestern part.

The Saba Bank shows all the characteristics of a typical atoll and as such ranks among the largest atolls in the world (van der Land, 1977), its surface area being of the same order as that of the Suvadiva Atoll in the Maldives (2,240 km²)(Stoddart, 1971) and Kwajelein in the Marshalls (1,683 km²)(Wiens, 1962). Actively growing coral reefs are located on the eastern windward edges, while the leeward reefs do not appear to be actively growing and should be considered a drowned fringing reef (van der Land, 1977).

The natural resources of the Saba Bank include living organisms such as coral reefs, fish, lobster, conch, invertebrates, turtles, and mammals.

The geological history of the Saba Bank indicates that the Saba Bank may store commercially exploitable stocks of oil and gas. Despite two explorations in 1977 and 1982, no significant amount of oil or gas was detected. The extensive seismological research however, produced an abundance of geological and paleontological data that have regrettably never been published. The only mineral identified so far is sand, which was only detected in the more central parts of the Bank (van der Land, 1977).

The Saba Bank appears to be an important spawning ground for several fish species, particularly queen triggerfish, locally called moonfish, and squirrelfish, locally called redman. Queen triggerfish (*Balistes vetula*) congregate on one specific area of the Bank, locally called the Moonfish Bank (Figure I), during the winter months (December till the end of February), and can be caught in large numbers around full moon (Boeke, 1907, Meesters *et al*, 1996). Squirrelfish (*Holocentrus adscensionis*) congregate on a specific area of the Bank locally called the Redman Bank, from November to April, and can be caught in large numbers during this period, particularly around full moon (Boeke, 1907, Meesters *et al*, 1996). It is believed that there are more such areas on the Saba Bank.

In one section of the Saba Bank, locally called the Poison Bank (8-10 miles/SSE of Saba), no fishing takes place, because the fish are affected by ciguatera, a toxin (ciguatoxin) that accumulates through the food web and originates from a dinoflagellate (*Gambierdiscus toxicus*). The toxin first affects the algae-grazing fish and is then passed up through the food chain to the piscivorous fish (i.e. snapper, grouper, jack, barracuda) and finally to man. In size-age distribution, larger older fish of a species are more likely to be poisonous than smaller and younger individuals of the same species.

Fishermen do not fish on this section of the Bank and its vicinity since it has been known for generations that in the past many instances of fish poisoning have occurred, by eating fish caught in this area (Boeke, 1907). The relative frequency of ciguatera poisoning by fish from the Saba Bank is not known.

About one third of the Saba Bank falls within the Saban territorial waters, while two thirds are outside, but fall within the limits of the Economic Fisheries Zone (EFZ) of the Netherlands Antilles. The jurisdiction in fisheries matters in the territorial waters, (which according to the ERNA which forms part of the Netherlands Antilles constitution), resides with the Island Governments. Consequently the island of Saba has the fisheries jurisdiction in the territorial waters of Saba (12 nautical miles zone) (Figure I.).

The area beyond the territorial waters, the Economic Fisheries Zone, falls within the jurisdiction of the Netherlands Antilles.

An important characteristic of tropical fisheries resources is the limited supply of an individual stock of a targeted organism. Fisheries yields from tropical ecosystems are inherently low compared to temperate

environments. The catch from a specific population increases with increasing fishing effort up to a certain point (i.e. defined as maximum sustainable yield), however, additional fishing effort beyond this level will lead to reduced catch, as well as declines in catch per unit of effort (CPUE) and economic efficiency.

In the past the main objective of fisheries management has been the conservation of the stock. In recent times this rather limited objective of fisheries management has been extended to address also economic, sociological, political and environmental objectives, which can be used to suggest management strategies for the fisheries,

The aim of the Saba Bank fish stock assessment project was to collect data on the condition of the fisheries resources of the Saba Bank, and the level at which this resource can be exploited in a sustainable manner.

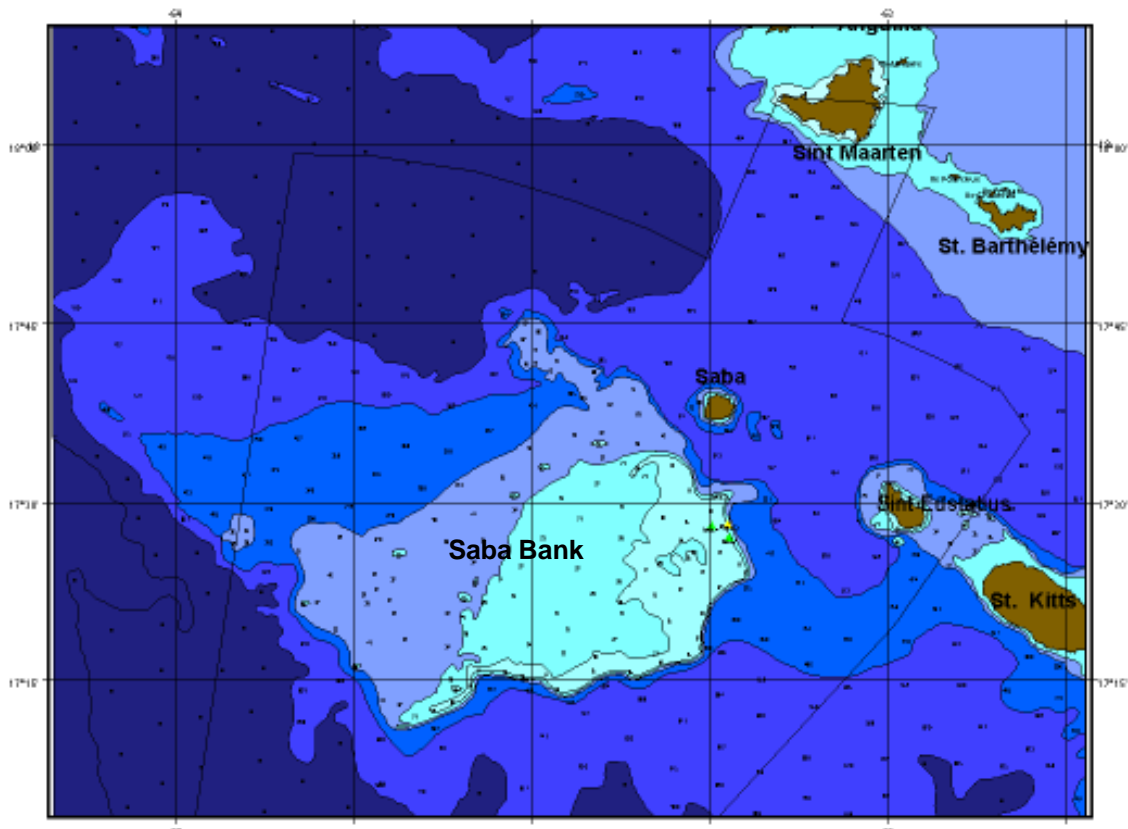


Figure 1. Map of the Saba Bank (Scale 1:550,000).

2.2 The Saba Bank Fishery

For generations Sabans have been fishing the Saba Bank, and written documentation goes back at least to 1907 (Boeke, 1907). Fishing used to be one of the main means of existence for the Saban population; the fish were consumed locally, and exported to the surrounding islands.

In 1971 the “M/V Calamar” an exploratory fishing vessel of the FAO Caribbean fisheries development project fished the northwestern edge of the Saba Bank, and catches were considered fairly good in comparison with the other explored locations in the Caribbean (Cruise report Number 35, M/V Calamar, 1971).

In 1980 total catch by the Saban fishermen was estimated at 50 tons of fish per year (van Buurt, 1980). Fishing was mostly done at the northern and northwestern parts of the Saba Bank. There were 21 small fishing boats on the island. Besides the Saban fishermen several other parties were also fishing the Saba Bank. There were three sixty foot boats operating from St. Croix each utilizing about 200 traps, and one Venezuelan sixty foot vessel, utilizing 200 traps as well (van Buurt, 1980). A number of smaller boats from Anguilla and St. Kitts were doing mostly hand line fishing. In 1980 the total fish extraction by foreign parties was roughly estimated at 500-700 ton (van Buurt, 1980).

In the seventies most of the Caribbean nations declared an Exclusive Economic Zone (EEZ), and started to control their fishery, the Saba Bank became a refuge for foreign fishing vessels, since any form of control in the Netherlands Antillean waters was absent. Not until 1993 did the fishery law of the Netherlands Antilles become effective, and in 1995 the Coast Guard of the Netherlands Antilles was founded. In 1996 the Coast Guard of the Netherlands Antilles started to patrol the Saba Bank. The number of patrols at the time was modest, since the range of the patrol boat available at the time was limited. In 1999 the Coast Guard was equipped with a larger patrol boat, and consequently started to patrol the Saba Bank on a more regular basis.

In the eighties and nineties the fisheries resources of the Saba Bank were being over-exploited by foreign fishing vessels from i.e. the French islands, Venezuela, Puerto Rico, St. Kitts and Nevis, Anguilla and Montserrat (Proplan Consultants Group N.V., 1992, Meesters *et al*, 1996). As a result the Saban people were not motivated to get involved in the fishery, since they felt that catches had dropped considerably due to over-fishing. In 1996 only 4 fishing boats and 8 professional fishermen remained (Meesters *et al*, 1996).

After the Coast Guard of the Netherlands Antilles commenced patrolling the EFZ in 1996, numerous foreign illegal fishing vessels were expelled from the Antillean waters. This encouraged the Saban people to expand their fishing industry; which during the last 3 years has made a significant comeback.

The Saba Bank fishery is currently of great significance to the small-scale island economy of Saba (total population approximately 1600, GDP 15.7 million US\$ (CBS, 1996)). The Saba Bank fishery sector has developed into a viable semi-industrial fishery and the means of production used in the fishery are among the most advanced utilized in the Netherlands Antilles. About 20 people generate a living from the fishery, while a relatively large group of approximately 30 persons obtains an additional income from the fishery sector.

2.3 Fishing effort: boats and gears

There are currently 14 vessels fishing the Saba Bank. Twelve of these vessels are operating from Saba, and two from St. Maarten. One of the two operating from St. Maarten landed its catch directly there, and the other vessel used the Saba harbor between its daily trips.

Eleven fishing vessels are currently operating in the lobster fishery; all vessels (L.O.A. 22-47 feet) are made of fiberglass and powered by inboard Diesel engines of approximately 280 hp, cruising speed 10-20 knots. The boats are operated by 2-3 fishermen; trip duration is commonly one day. All boats are equipped with either a hydraulic or electric winch and most vessels are fitted with a built-in live well. There were 3 fishing vessels that only targeted snappers. At the end of the project almost all lobster boats were also targeting snappers.

All vessels are equipped with a Global Positioning System (GPS) and a deepwater echo sounder. All the Saban fishing vessels are well maintained and relatively new, and operate from the Saban territorial waters till the outer edges of the Saba Bank. The price of a lobster boat ranges between 35,000-135,000 US\$ depending on size and age. A lobster vessel uses approximately 130 liters of diesel per day and the sailors make 70 US\$ per day on average, while practically all harbor facilities are free of charge for the fishermen.

Each boat has between 100-300 lobster traps and approximately 20 fish traps (Chevron type). The main difference between a fish trap and a lobster trap is the funnel entrance and the mesh material. The funnel entrance of a fish trap is much narrower than the funnel opening of a lobster trap (Figure II.). Fish traps are constructed from uncoated chicken wire, while for the lobster traps plastic coated wire-mesh is used. A welded iron frame holds the wire together. An anode is attached to the wire-mesh in order to slow down corrosion. As long as the anodes are changed regularly a lobster trap can last at least 5 years. The color of the plastic coating is either black or green, and some fishermen believe that the catch rate is being influenced by the color of the coating. The length of a lobster trap is either 3, 4, or 5 feet, the 4 feet (122 cm.) trap is preferred by most fishermen. The lobster traps are 60 cm. high, and the funnel entrance is 22.5 cm. wide and 20 cm. high. The funnel has a parabolic shape and has a total length of 125 cm.

According to the fishermen a new lobster trap including rope and buoys, costs approximately 100 US\$ in materials and labor.

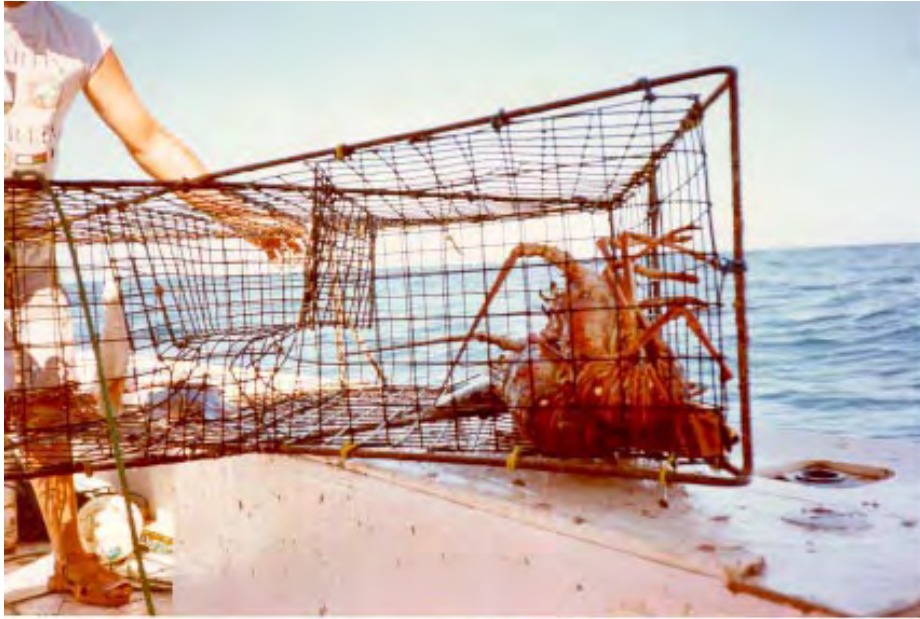


Figure II. Lobster trap.

One fisherman uses wooden traps, which have the advantage that they are biodegradable and cheaper to construct. The disadvantage is that the live span of a wooden lobster trap is much shorter.

Lobster traps are set on the Saba Bank between 11-50 meter depth. Fish traps are set on the drop-off at the edges of the Saba Bank in water of 70-180 meter depth. The soak time for a lobster trap is commonly 7 days, while a fish trap can be hauled every day or more commonly every two days. Lobster traps are baited with pieces of cowhide, while the fish traps in contrast are baited with mackerel and the so-called Japanese bait, which is purchased at the Japanese fish firm Nicherei in St. Maarten, and normally used to bait the hooks of the long-line fleet.

Most of the traps used in the lobster fishery are fitted with a mesh size of 1,5” but none of the traps are fitted with a biodegradable panel, as required by law. During the 1999 hurricane season close to 1000 lobster traps were lost. Since it will take several years for the wire to disintegrate and form an escape opening, the lost traps keep on fishing and are extremely damaging to the ecology and consequently the fish stock of the Saba Bank. Fish traps are even more likely to get lost since they lie on ledges on the steep drop-off and can easily slide off the slope with the current. In addition a considerable number of these non-biodegradable traps are lost every year due to ship traffic (especially tankers coming from or going to Statia Oil Terminal).

According to article 2 of the National Fishery Ordinance (Official Bulletin 1992, no 108) anyone fishing in the Economic Fishery Zone and license holders fishing in the territorial waters are forbidden to use:

- Traps with a mesh size of less than 1.5” or 3,8 cm;
- Traps not fitted with a biodegradable escape opening.

Despite various fishery meetings where the importance of using traps fitted with a biodegradable escape opening was emphasized and a press release stating that the Coast Guard would enforce these regulations, none of the fishermen has complied as yet.

Snappers are, other than with fish traps, also targeted by using hand lines, hydraulic or electric snapper reels and vertical bottom long lines. The monofilament hand lines of approximately 180-280 lbs. breaking strength are fitted with 6-8 hooks (Mustad #1, #2, #3) An 1 lbs. sinker is attached to the end of the line in order to rapidly reach the bottom. The long-lines are fitted with approximately 20 self-setting hooks; 3 to 4 sets are commonly used.

Occasionally trolling lines and rod and reels are used to target pelagic species.

2.4 Target species and by-catch

The Saba Bank fishermen engage in two types of fishery: spiny lobster (*Panulirus argus*) fishery, and snapper fishery, targeting mainly: silk snapper (*Lutjanus vivanus*) and blackfin snapper (*Lutjanus buccanella*). During this study the main fishery activity on the Saba Bank was the lobster fishery. A significant portion of the lobster catch however did not meet the legal requirements, as will be further explained in the next chapter.

During the first 9 months of the project it became apparent that the fishermen were concerned about the state of the snapper stock. As was explained by the fishermen, snappers caught were small in size, and in areas where snapper species used to be abundant in the past, catches were low. However after the Coast Guard of the Netherlands Antilles started to enforce the fishery regulations on March 21, 2000, particularly the lobster regulations, and consequently the lobster catch dropped, the fishermen started to set fish traps for snappers.

Grouper species, other than hinds and coney, used to be targeted by the fishermen in the past, and an area Northwest of the Saba Bank is locally called the Grouper Bank, but during the time of this study, groupers were only sporadically landed, either by hand lines or traps. It can be concluded that their stock is practically non-existent, presumably due to over-fishing, and they are now no longer a target species, but only an occasional by-catch.

From the lobster traps a by catch of demersal fish is landed consisting mostly of white grunts, queen triggerfish and red hinds. Part of the by-catch is used as extra bait for the traps. Species that are preferably used as additional bait in the lobster pots are e.g. nurse sharks, parrotfish, jacks, doctor-fish, cowfish, angelfish and coney's. White grunts, queen triggerfish and red hinds are preferably landed and sold, but also commonly used to bait the lobster traps.

The by-catch composition of the fish trap catches varied considerably according to the fishing depth. Generally speaking, the by-catch species composition became less complex and the proportion of snappers increased as the fishing depth increased. During the project fish trap fishing was limited to the shallower edges of the northwestern parts of the Saba Bank.

Traditionally the Saban fishermen only targeted fish. Lobsters were an occasional by-catch and according to more than one fisherman in those days lobsters caught were frequently used to bait the fish traps. The

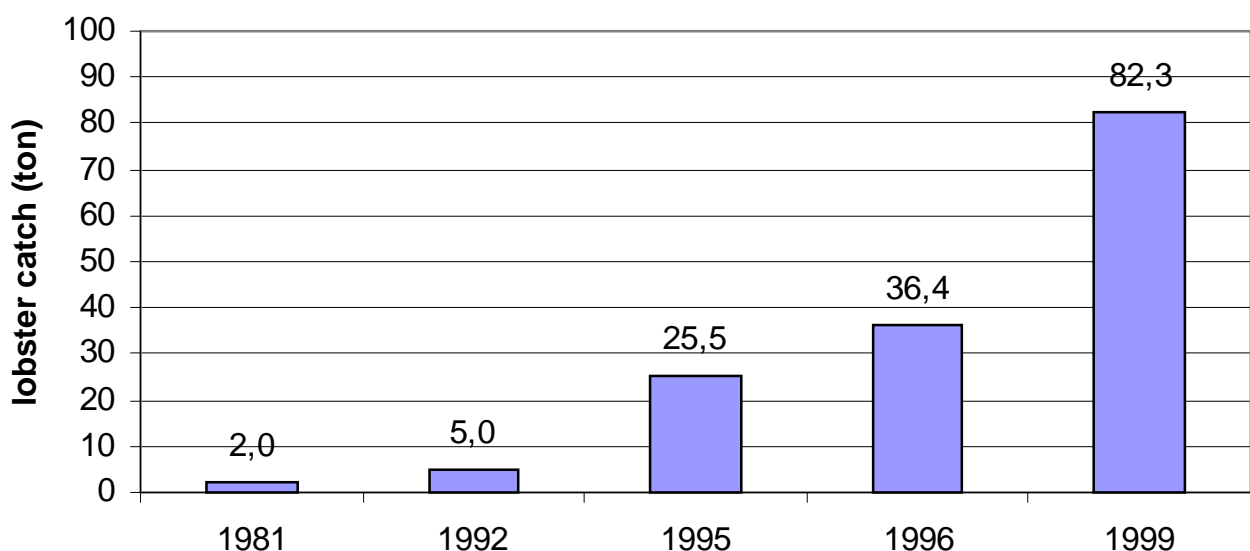


Figure III. Estimates of total lobster catch on the Saba Bank per year from vessels fishing from Saba, St. Eustatius and St. Maarten, lobster catches from foreign vessels are not included (see Appendix I. for source).

growth of the tourist industry on the neighboring islands however, raised the demand for lobsters and the lobster price. Consequently fishermen shifted from targeting fish to targeting lobsters, and converted most of their fish traps to lobster traps.

According to the Saban fishermen, commercial exploitation of spiny lobsters began on the North-North-western part of the Saba bank, the area closest to Saba, but presently lobster traps are set all over the Saba bank. Quantitative estimates on the lobster catch are shown in Figure III. (see Appendix I. for the source).

In 1981 M. Guidicelli and L. Villegas of the Food and Agricultural Organization (FAO) of the United Nations estimated the Maximum Sustainable Yield for lobsters of the Saba Bank to be 30 tons per year. Their estimate is based on comparison of the Saba bank with other Banks in the Caribbean, which are located at similar latitude, where comprehensive research had been done, Cuba in particular. Assuming the fauna in the center of the Saba Bank, especially its Western parts, to be fairly poor (van der Land, 1977), and the limited size of its potential nursery ground, Guidicelli and Villegas only used half of the total area as an indication of the lobster region. The methods used by Guidicelli and Villegas were the only methods that could be applied at the time, given the almost total absence of data. Of course such methods give very rough estimates at best, nevertheless they do provide a rough frame of reference.

3. Monitoring of the Saba Bank fishery

3.1 Monitoring program

The Saba Bank Fish Stock Assessment Project has collected fishery-dependent data of the Saba Bank fishery from April 23, 1999 to May 30, 2000 commissioned by the Environmental Division of the Department of Public Health and Environmental Hygiene of the Netherlands Antilles, which is located in Curaçao.

In an exploited fishery, assessment involves determining the current state of the resource, including the degree of exploitation. Extensive data had to be collected from the Saba Bank fishery in order to estimate population parameters. The monitoring program required several different types of information from the fisheries survey.

Before the program started a schedule was prepared, outlining all activities for the coming period, and establishing the standard way of measuring.

Data were collected in the Saba harbor on length-frequency of the catch, collected during daily sampling from the stock, as well as data on total catch and effort. The lobsters and fishes were measured as consistently and accurately as possible. In Saba harbor total length (TL) and fork length (FL) of the fish were measured to the nearest centimeter. The carapace length (CL) of lobsters was measured to the nearest millimeter and 150 male and female lobsters were measured and weighed in order to obtain a reliable length-weight relationship. A kitchen-scale was used for this purpose. The length of the carapace of the lobsters was measured with a caliper, and a measuring board was used to measure the fish.

During sampling, data were collected to obtain specific biological parameters useful in either estimating yield, or providing a basis for fisheries management strategies. In addition to the catch and effort data of the lobster fishery, biological data, such as, length frequency, length-weight relationship, sex, number of females carrying eggs, and the number of molting lobsters (lobsters in ecdysis), were collected.

Catch and effort data were collected on a daily basis in Saba harbor, including also the fishing grounds and species composition of the catch.

The data were entered on a data form, and later entered into Microsoft Excel, and/or MS-Access. Catch and effort data of landings on Saba and St. Maarten were stored in a central database (MS-Access) located in Saba, while length-frequency data were stored in MS-Excel files.

The required information included date, boat name, fishing hours, number of gear hauled, soak time, weight of catch and by-catch.

Furthermore the monitoring program included a frame survey. The frame survey was conducted to detect the landing practices and to count the number of boats, the number of gear types, and the number of fishermen. The fishermen were interviewed in order to obtain this information.

An important part of the monitoring program consisted of giving feedback to all parties involved. At regular intervals the preliminary results and progress of the program were presented, which resulted in an excellent participation of the fishermen in the monitoring program.

The collected fishery dependent data are now available at the Department of Public Health and Environment in Curaçao.

3.2 Lobster fishery

3.2.1 Catch and effort data

During the project a lobster catch of 89,235 kilograms was recorded. Although this is the great majority of the catch, not all lobsters caught were recorded. In order to obtain the approximate total lobster catch a raising factor is used to correct the recorded catch. An estimated 11.5 % of the lobster catch was not in-

	# Lobsters	Recorded catch (kg)	Calculated total catch	Effort (trapdays)	# trips	CPUE
May	5,576	7,125	7,944	24,447	58	291
June	6,532	7,95	8,864	33,113	75	240
July	5,075	6,045	6,74	25,413	62	238
August	8,578	9,889	11,026	39,711	97	249
September	5,057	5,706	6,362	16,316	45	350
October	4,434	5,219	5,819	17,337	43	301
November	1,735	2,111	2,354	9,973	28	212
December	2,114	2,573	2,869	10,267	33	251
January	5,475	6,758	7,535	35,669	55	189
February	7,711	9,405	10,487	29,743	68	316
March	8,846	11,81	13,168	43,538	98	271
April	4,021	6,12	6,824	28,941	69	211
May	3,977	6,042	6,737	42,051	91	144
Total:	70,914	89,235	99,497	356,519	822	250

Table I. Monthly recorded catch of lobsters, fishing effort, number of trips and CPUE for all fishing vessels exploiting the Saba Bank from April 23, 1999 to May 30, 2000.

cluded in the records. This percentage is based on the number of days no data was collected. Total catch then comes to about 100 tons. The following table (Table I.) shows the recorded catch of lobsters per month for all fishing vessels exploiting the Saba Bank, and the estimated actual catch using the raising factor of 11,5%.

The next figure (Figure IV) displays the total lobster catch and effort distributed over the time of the project. Both catch and effort fluctuate considerably over the year. The hurricane season (from July till December) had a great impact on the lobster catch and effort. Lobster catch and sale were fairly good from May, 1999 till August, 1999. September is considered the month most hurricanes occur, and consequently tourism decreases during this month. September, October and November are considered low season months for tourism and as a result there is only limited sale for lobsters. On October 20, 1999 hurricane José passed over the Windward islands, followed by hurricane Lenny on November 18-19. These hurricanes had a

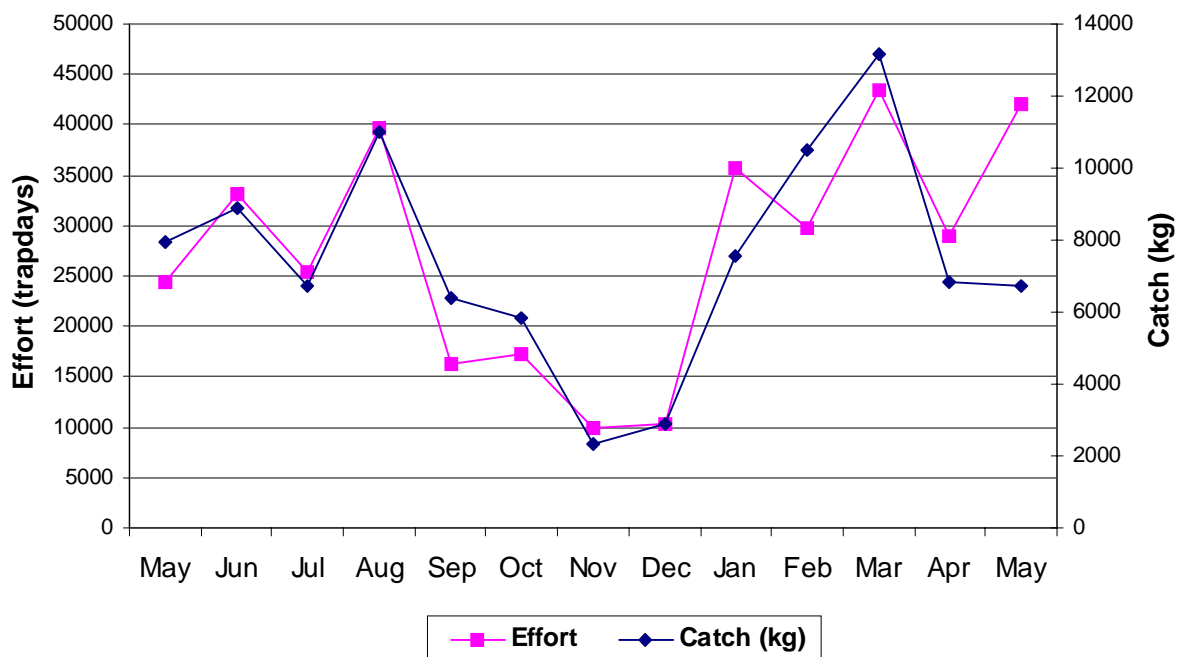


Figure IV. Distribution of the monthly lobster catches and effort from May, 1999 to April, 2000.

negative influence on the lobster catch and fishing effort, since most fishermen took their boats out of the water before the hurricanes, and lost a considerable number of gear. Although the fishermen suffered great losses i.e. gear, boats, etc., the lobster catch increased substantially within two months after the hurricane season, in an attempt to meet the demand for lobsters, since the months of December to May are considered high season months for tourism.

In general the effectiveness of a lobster trap does not improve after 5-12 days in the water. Long soak times caused by i.e. boat repairs, maintenance, bad weather conditions, no sale, no availability of bait etc., result in a relatively high fishing effort that is not representative for the actual fishing effort, since the effectiveness of the trap does not further improve. Since the maximum soak time intentionally used by the fishermen is 7 days, all records with soak times of 8 or more (hence due to unintentional delays, not a directed effort) were adjusted to 7 days. To compare the catch per unit of effort (CPUE) for lobsters on different parts of the Saba Bank, the Bank was divided in 12 quadrants, whereby each quadrant is 12 by 12 nautical miles (Figure V).

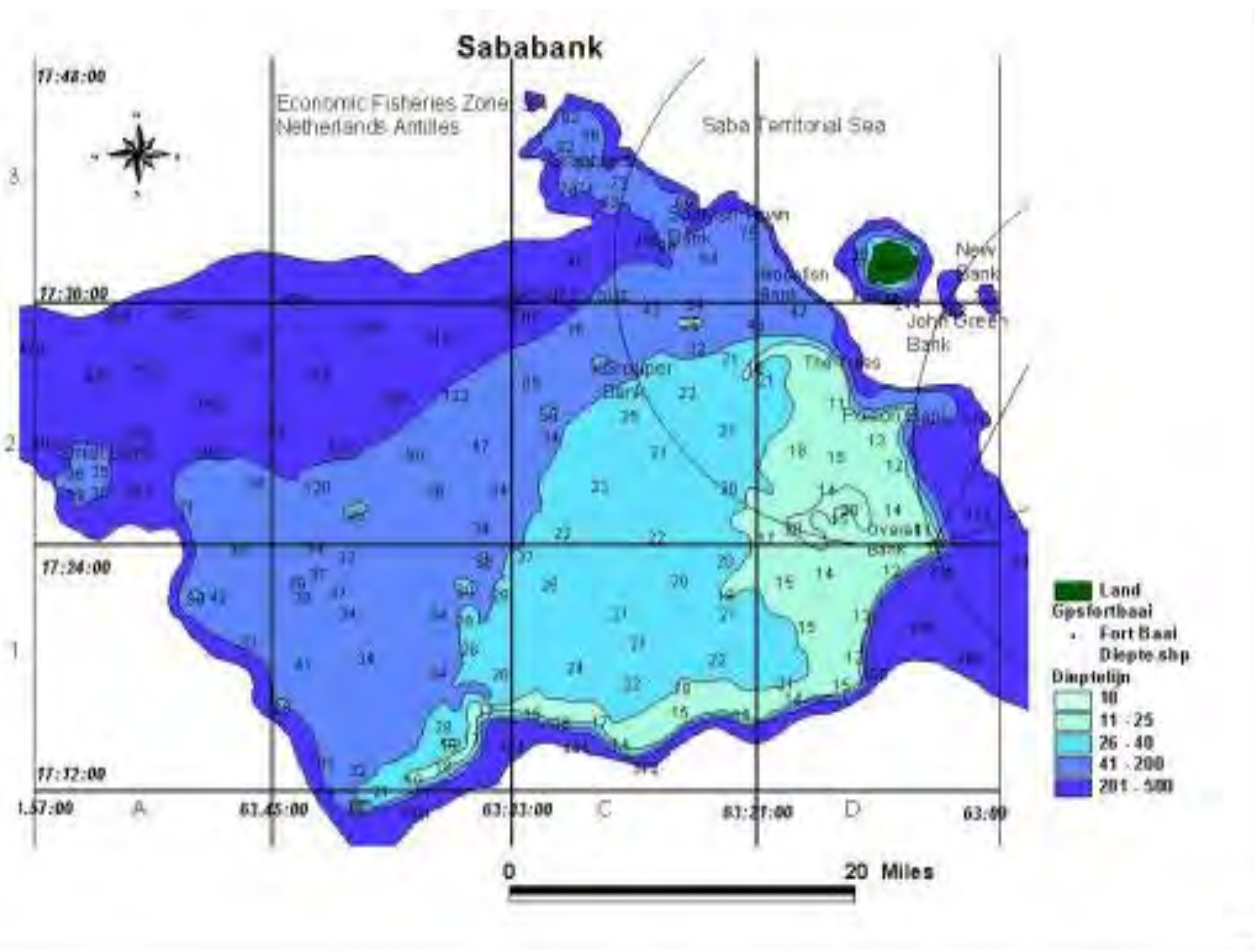


Figure V. Map of the Saba Bank (scale 1:550,000), and quadrants (fishing grounds).

To calculate the CPUE of lobsters caught per trap per day, the catch per fishing ground is divided by the unit of effort used in the fishery, as expressed in number of traps multiplied by soak time (trap days). CPUE in grams/trap/day calculated for each fishing ground, is shown in Table II.

The largest fishing effort takes place in fishing grounds D2, C2, C1 and B1, with D2 having a substantially smaller CPUE than other main fishing grounds. Fishing ground C1 shows the highest CPUE among the quadrants.

Comparing the CPUE of the Saba Bank lobster fishery with CPUE of other lobster fisheries in the region is complicated due to the fact that each country uses other units to calculate CPUE. Within the timeframe of the assessment project this was not possible. It would however be a valuable exercise if somehow the man-hours could be made available.

Fishing ground	Catch (kg)	Effort (Trap days)	CPUE (g/trap/d)
A1	166	534	311
A2	504	2,136	236
B1	11,959	41,458	288
B2	4,393	13,937	315
C1	17,637	52,237	338
C2	20,289	77,921	260
C3	1,614	7,61	212
D1	9,397	44,865	209
D2	22,52	104,896	215
D3	599	3,13	191
Total:	89,078	348,724	255

Table II. Lobster catch per unit of effort per quadrant (fishing ground).

3.2.2 Biological data

3.2.2.1 Size

The carapace length (i.e. the distance from the base of the supraorbital horns to the posterior edge of the carapace) is the usual measure of body length in spiny lobster (Cobb & Wang, 1985). The fishery law of the Netherlands Antilles forbids catching of lobsters with a carapace length smaller than 9.5 cm. This carapace length is approximately equivalent to a total body length of 25 cm, and a weight of 680 gram. This minimum length originated from the Harmonized Fisheries Legislation Project, guided by the FAO, which had the objective to match the fisheries legislations of the islands of the Lesser Antilles.

From April 23, 1999 to, May 30, 2000 53,522 lobster traps were hauled and 70,914 spiny lobsters, (*Panulirus argus*) with a corresponding weight of 89,235 kilograms were recorded caught. The carapace length (CL) of 29,802 lobsters was measured. The total amount of lobsters sampled, the percentage of lobsters with a CL of less than 9.5, the average length and average weight of the sampled lobsters are shown in Table III. The monthly fluctuation of the average CL is shown in Figure VI.

The average CL displays a fall in the months of April to September. Length-frequency analysis of the

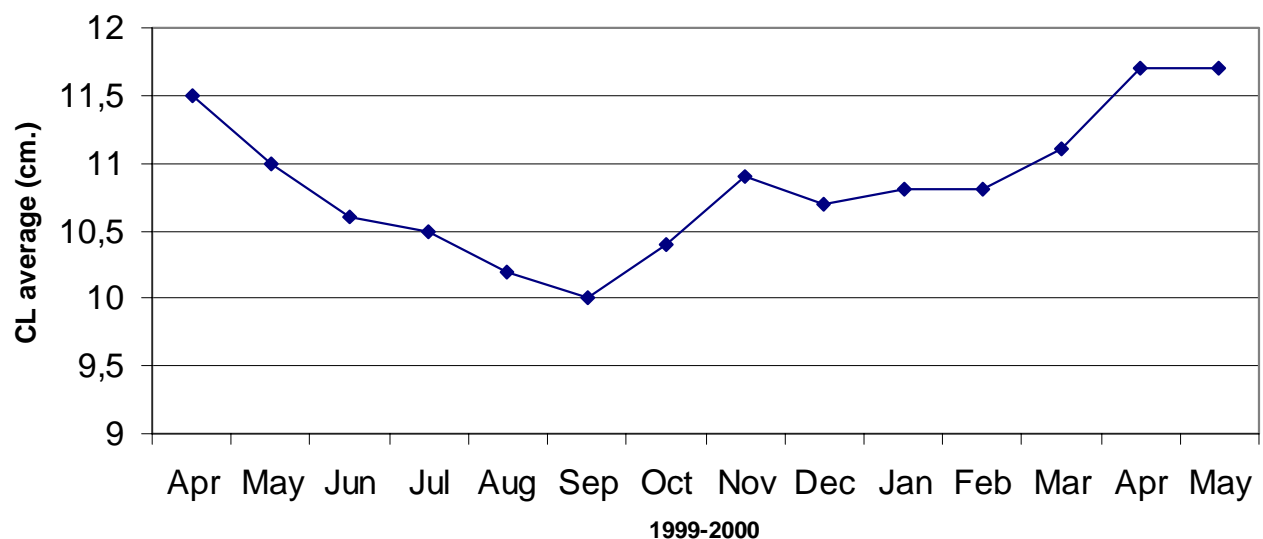


Figure VI. Average CL for lobsters on the Saba Bank from April 23, 1999 to May 30, 2000.

	# Measured	W (kg.)	# CL < 9.5 cm	% CL < 9.5 cm	CL avg. (cm)	W avg. (g)
April	1,377	1,992	203	14.7	11.5	1,447
May	2,562	3,404	607	23.7	11.0	1,329
June	3,518	4,266	1109	31.5	10.6	1,213
July	2,245	2,541	830	37.0	10.5	1,132
August	3,468	3,881	1420	40.9	10.2	1,119
September	2,191	2,327	924	42.2	10.0	1,062
October	1,857	2,159	598	32.2	10.4	1,163
November	681	858	180	26.4	10.9	1,26
December	1,655	2,029	468	28.3	10.7	1,226
January	2,93	3,628	750	25.6	10.8	1,238
February	1,892	2,335	480	25.4	10.8	1,234
March	3,23	4,36	540	16.7	11.1	1,35
April	1,146	1,784	76	6.6	11.7	1,557
May	1,05	1,615	81	7.7	11.7	1,538
Total:	29,802	37,179	8,266	28.0	10.7	1,248

Table III. Number of lobsters measured per month, number of lobsters with a carapace length (CL) less than 9.5 cm, and average CL of lobsters sampled.

lobster catch shows that this maybe due to recruitment of small lobsters.

As shown in the table, 28.0 percent of the lobsters sampled over the past 12 months had a CL of less than 9.5 cm. The high percentage of under-sized lobsters has been reason for serious concern, because it indicated that the lobster stock of the Saba Bank was being over-harvested. The latter was reason for the Government to take action to halt the high percentages of under-sized lobsters. The Coast Guard of the Netherlands Antilles has started to enforce the fishery regulations. After the first control on 21st of March one could notice that the fishermen practically stopped landing illegal size lobsters. Consequently, the average CL increased as the number of under-sized lobsters landed decreased.

The amount of under-sized lobsters landed (an illegal act) is influenced by market pressure (higher risk taking by the fishermen if there is potential gain due to large market demand) and thus might not be a reliable indicator of population fluctuations. Therefore the avg. CL was corrected, i.e. by subtracting all

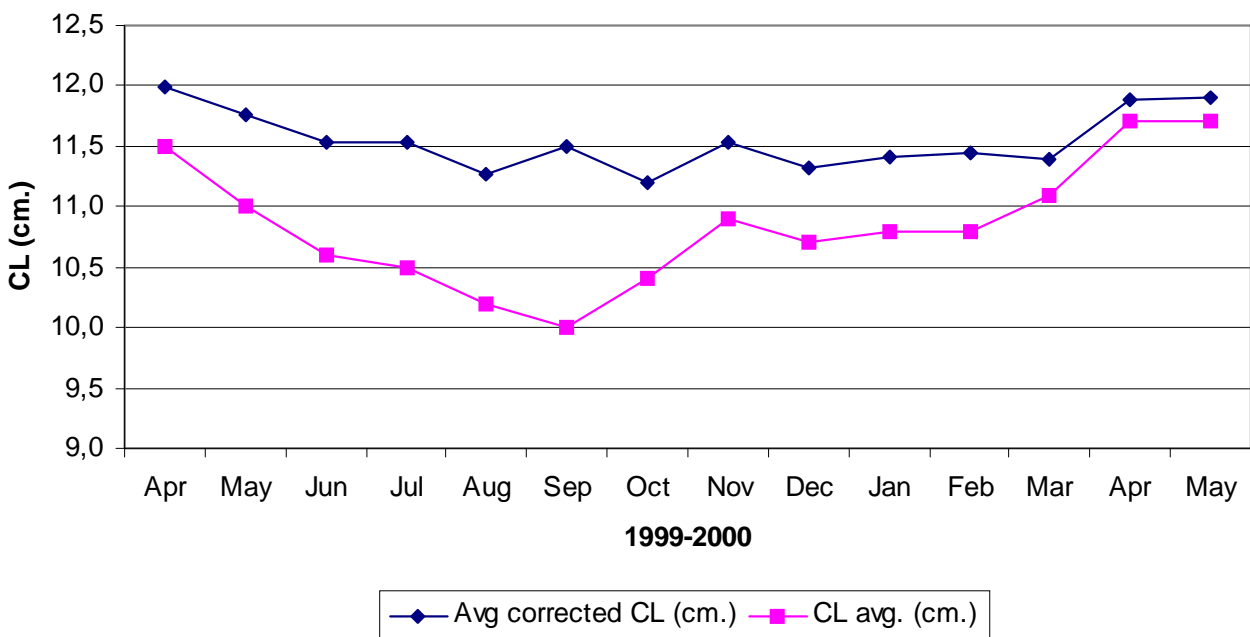


Figure VII. Average CL and corrected avg. CL of lobsters sampled from April 23, 1999 to May 30, 2000.

lobsters smaller than 9.5 cm CL. In Figure VII both avg. CL and corrected CL are shown. It is apparent that the greatest number of under-sized lobsters are taken in the months June to October. This does not correlate with a larger market demand, which in fact is lower during these months. It can be concluded then that the drop in uncorrected avg. CL is in fact a reflection of the natural lobster population. The drop may indicate that there is an influx of small lobsters during these months.

In the size composition of the catches, length-frequencies of male lobsters exceed those of female lobsters. The tables IV and V show the Mean CL of male (Table IV) and female lobsters (Table V) per quadrant and the Mean CL for the whole Saba Bank. Furthermore the tables show that both absolutely and relatively more under-sized females than under-sized males are captured.

A length-converted catch curve (assuming $L_{\infty}=19.00$ and $k=0.3$) for males and female lobsters gives a Z (total mortality) males=0.97 and a Z females =1.9. This indicates a much higher fishing mortality of female lobsters with an equal natural mortality ($M=0.4-0.5$). In other words female lobsters are much more liable to enter the traps than males.

In Florida males attain the size of 7.6 mm CL in an average of 23 months, whereas females require an average of 30 months (Muller *et al*, 1997). Catches on the Saba Bank consist for a large part of lobsters of 3 -5 years of age (Figure VIII). Legal sized lobsters (9.5 mm CL) have the approximate age of 4-5 years, whereas 3 years old lobsters are predominantly under-sized.

The percentages of under-sized lobsters captured are particularly high in fishing grounds C2 and D2 (50%). The next figure (Figure VIII) displays the length-frequency distribution of male and female lobsters captured on the Saba Bank during the time of the monitoring program. Analysis of the monthly length-frequency graphs per quadrant (Appendix V) shows that on fishing grounds C2, D2 and D1 in particular the smaller lobsters were more frequently being captured than on the other fishing grounds (Figure IX, X) it is

Quadrant:	n	Mean CL	Totals under-sized	% under-sized	Ranking order
B1	536	11,57	67	12,5	4
B2	313	11,06	57	11*	5
C1	502	11,6	63	12,5	4
C2	747	10,42	226	30,3	1
D1	439	11,52	47	10,7	3
D2	591	10,46	150	25,4	2
Total:	3128	11,03	610	19,5	

Table IV. Mean CL of male lobsters per quadrant and for the Saba Bank as a whole, captured from April, 1999 to May, 2000.

Quadrant:	n	Mean CL	Totals under-sized	% under-sized	Ranking order
B1	326	10,41	80	24,5	6
B2	201	9,69	84	32*	4
C1	318	10,11	98	30,8	5
C2	466	9,56	238	51,1	1
D1	253	9,98	93	36,8	3
D2	400	9,68	194	48,5	2
Total:	1964	9,88	787	40,1	

Table V. Mean CL of female lobsters per quadrant and for the Saba Bank as a whole, captured from April, 1999 to May, 2000.

* These are estimates because no samples could be taken of quadrant B2 from October, 1999 to May, 2000 so the percentages had to be extrapolated over the whole monitoring period.

Totals males/females

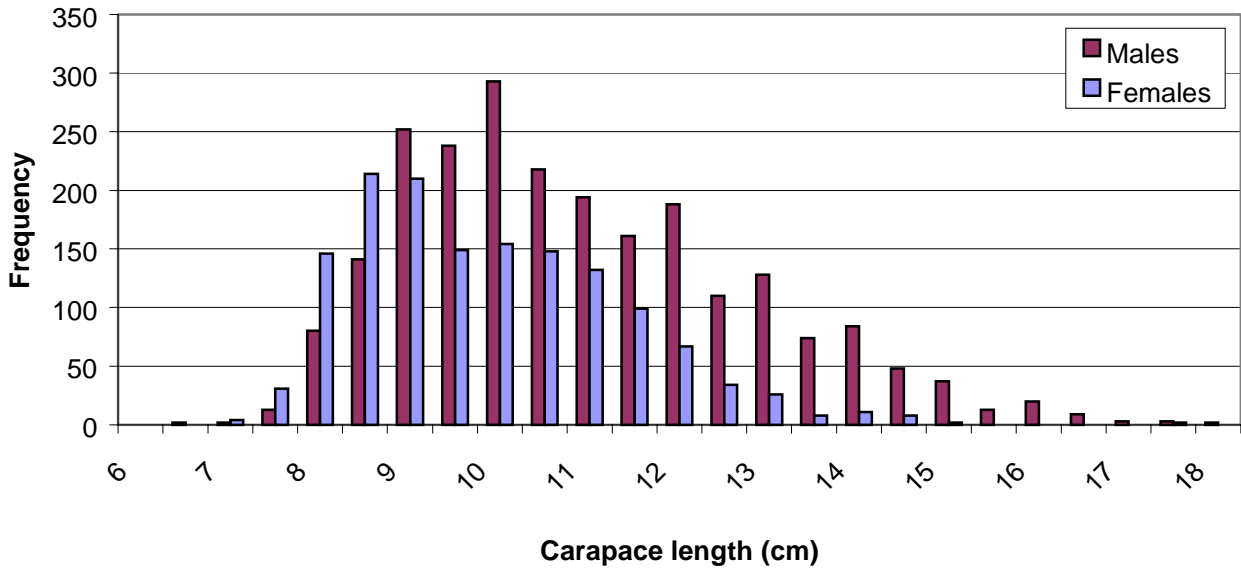


Figure VIII. Length frequency distribution of male (n= 3128) and female (n=1964) lobsters captured on the Saba Bank from April, 1999 to May, 2000.

possible that fishing grounds C2, D2 and D1 (shallower than B1, B2, and C1) are the habitat of the sub-adults (7.0-9.0 mm CL), which migrate to the deeper parts of the Saba Bank as they grow bigger.

Recruitment is visible particularly in fishing grounds C2 and D2 in the months June-September/ October and less in the other fishing grounds.

3.2.2.2 Reproduction Male/Female ratio

Figure XI shows the percentage of female lobsters and the percentage of male lobsters among the lobsters sampled during the project.

In general the percentage of male lobsters exceeds the percentage of female lobsters. During the winter months however the percentage of female lobsters among the lobsters sampled increased substantially, and

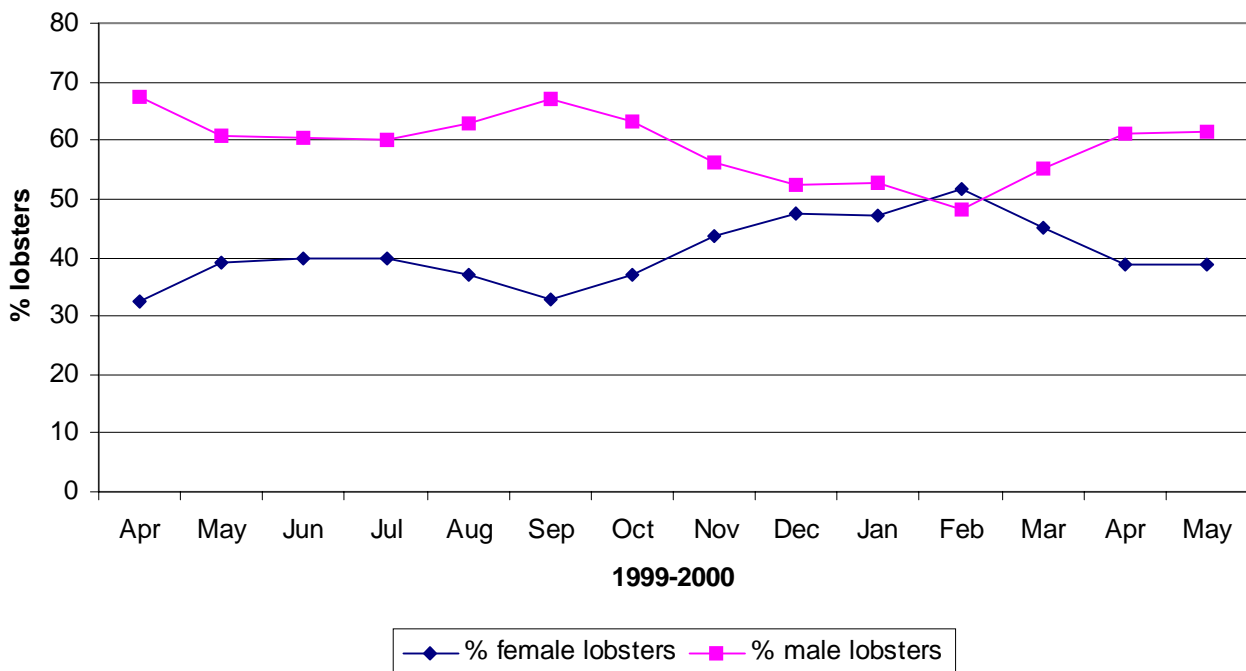


Figure XI. Percentage of female lobsters and percentage of male lobsters among the lobsters sampled from April 23, 1999 to May 30, 2000.

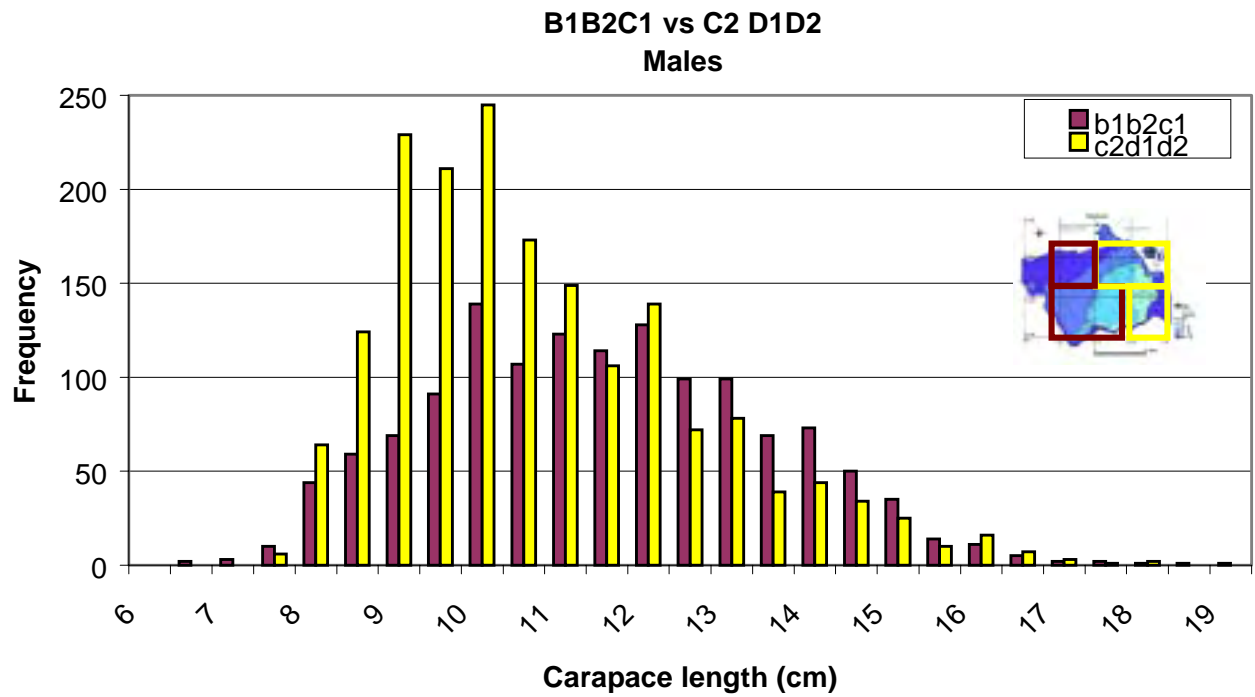


Figure IX. Length-frequency distribution of male lobsters of fishing grounds C2, D2 and D1 vs. B1, B2 and C1 from April, 1999 to May, 2000.

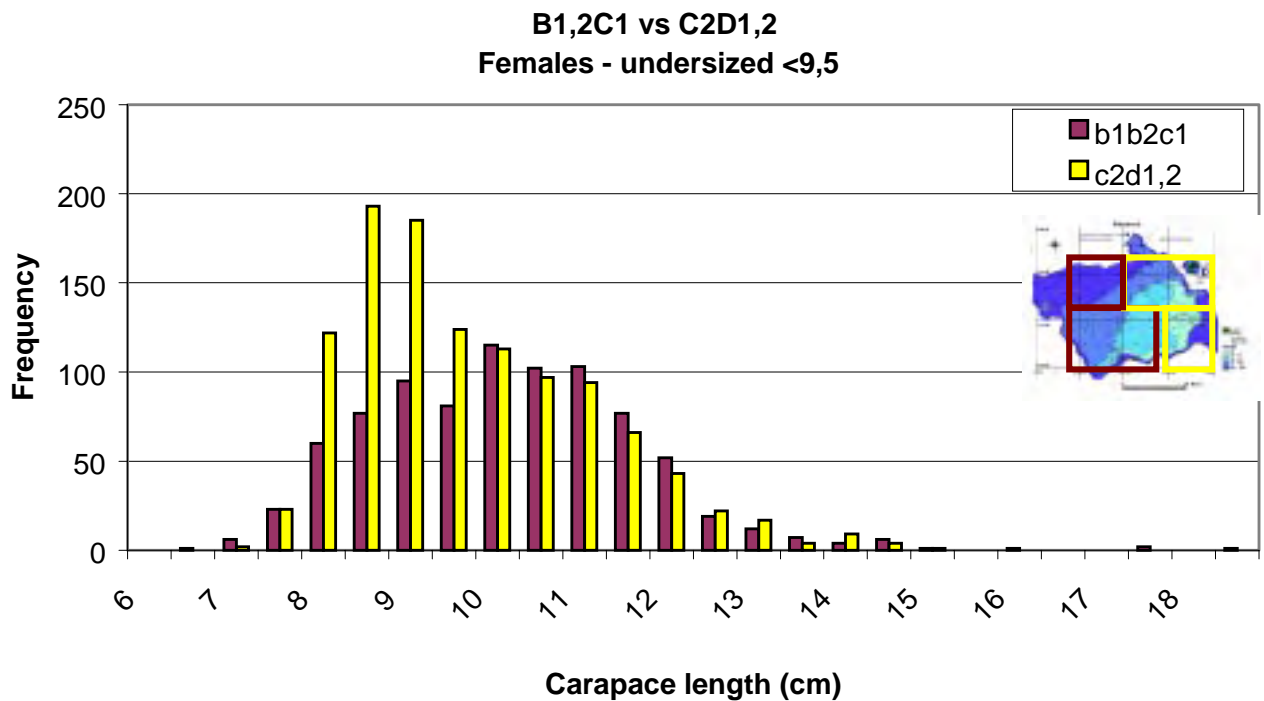


Figure X. Length-frequency distribution of female lobsters of fishing grounds C2, D2 and D1 vs. B1, B2 and C1 from April, 1999 to May, 2000.

in the month of February even surpassed the percentage of male lobsters.

Berried lobsters and lobsters in ecdysis

Size of first maturity was found to be in the range 2.8-8.3 cm CL for all countries in the Western Central

	# measured	females sampled	# berried lobsters	% berried lobsters	# lobsters in ecdysis	% lobsters in ecdysis
August	3,468	1,282	59	4.6	0	0.00
September	2,191	814	49	6.0	1	0.05
October	1,857	685	32	4.7	2	0.11
November	681	298	5	1.7	1	0.15
December	1,655	786	9	1.1	3	0.18
January	2,93	1,381	19	1.4	12	0.41
February	1,892	981	17	1.7	4	0.21
March	3,23	1,45	162	11.2	6	0.19
April	1,262	489	1	0.20	0	0.00
May	1,047	405	2	0.49	2	0.19
Total:	20,213	8,571	353	4.1	29	0.14

Table VI. Number of female lobsters sampled, percentage of berried lobsters, and percentage of lobsters in ecdysis from April 23, 1999 to May 30, 2000.

Atlantic Fishery (WECAF) region. In Brazil, the size at first maturity was estimated at 201 mm total length by Soares and Cavalcante (1985). For Cuba, the smallest size that a berried lobster was captured was 6.7 cm CL (Cruz and León, 1991) and the estimated sizes at 50% and 100% maturity were 8.1 and 9.7 cm CL respectively. In the Turks and Caicos Islands, tar spot data were recorded from sampled landings. A logit model was used to separate seasons and size (Medley and Ninnes, 1997). The results largely agree with other assessments, size at first maturity was 8.3 cm CL, 50% fecundity occurred at 9.3 cm CL and full fecundity at approximately 10.8 cm. CL. The smallest size that a berried lobster was captured on the Saba Bank during the time of the monitoring was 7.6 cm CL.

Besides legal size limits for lobsters the Fishery Law of the Netherlands Antilles also prohibits landing female lobsters carrying eggs, and lobsters in ecdysis (molting lobsters). Female lobsters carrying eggs and

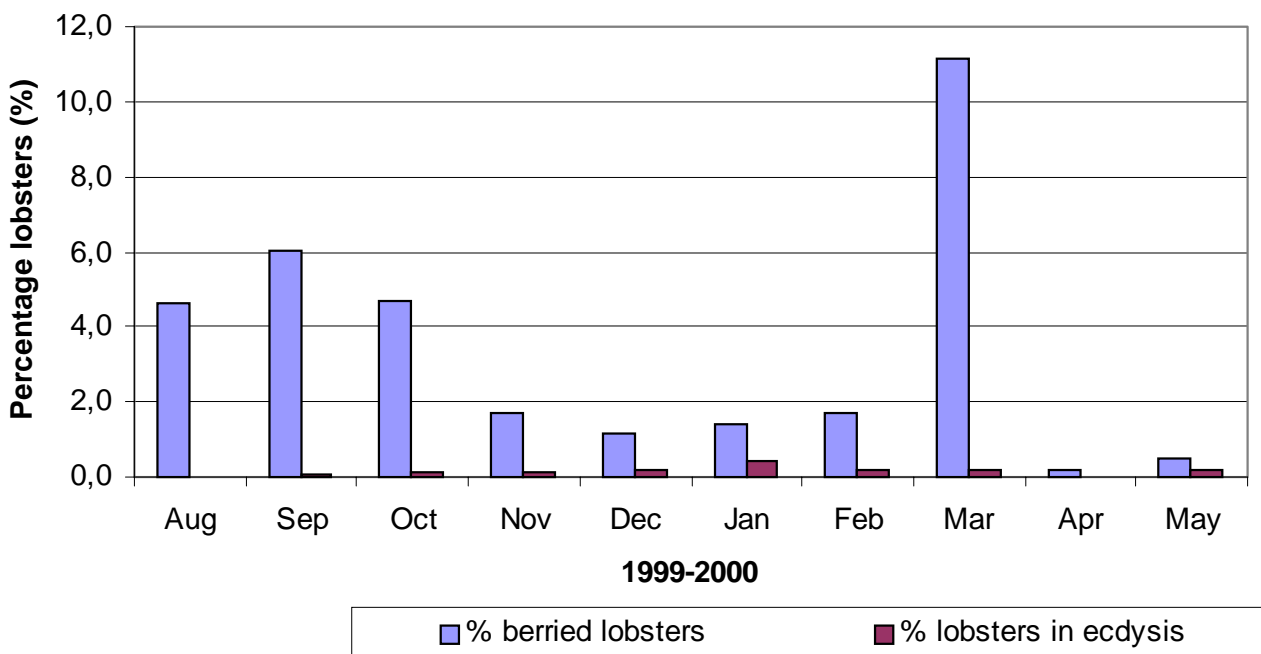


Figure XII. Percentage of berried lobsters and percentage of lobsters in ecdysis from August, 1999 to May, 2000 (The percentages in April and May, 2000 are no indication of the population because of the Coast Guard controls).

spermatophoric mass on the female's sternum (tar spot) were however, observed during the whole period of the project. Table VI shows the number of female lobsters carrying eggs and the number of lobsters in ecdysis among the lobsters sampled from August, 1999 to May, 2000. As is very clear from the table, the fishermen practically discontinued landing female lobsters carrying eggs and lobsters in ecdysis after the Coastguard started to enforce the fishery regulations on March 21, 2000.

Figure XII displays the percentage of berried lobsters and the percentage of lobsters in ecdysis. During the first 3 months of the project no data were collected on berried lobsters and lobsters in ecdysis, because the emphasis at that time was obtaining catch/effort and length-frequency data.

During the month of March, 2000 an excessive percentage of egg-bearing females were landed, possibly caused by the high demand for lobsters on the market and the high percentage of berried lobsters among the female lobsters caught in the lobster traps.

3.2.3 By-catch of lobster traps

From the lobster traps a by-catch of demersal fish was landed, of which mostly white grunts, queen triggerfish, Caesar grunts, and red hinds were brought in. Other species were preferably used to bait the traps. No length-weight relationship was established for the by-catch species, because fishermen had the habit of gutting the fish on the sea.

The following table (Table VII.) shows the number of fish sampled, the average length, average weight and the a and b value used for the length-weight relationship (length was measured, weight calculated). The a and the b value were obtained from recent scientific literature (Fish Base CDROM, FOA/ICLARM-electronic file. The average length is shown as either total length (TL) or fork length (FL).

Latin name	English name	# sampled	length type	L(cm.) Avg.	W(g.) Avg.	a	b
<i>Epinephelus guttatus</i>	Red hind	321	TL	32.9	733	0.0360	2.84
<i>Balistes vetula</i>	Queen triggerfish	200	FL	32.4	1,237	0.0657	2.83
<i>Haemulon plumieri</i>	White grunt	771	TL	27.3	527	0.0259	3.00
<i>Haemulon carbonarium</i>	Caesar grunt	140	TL	24.4	256	0.0404	2.74

Table VII. The main species caught as by-catch in the lobster traps, the number of fish sampled, average length, average weight and the a and b value for the length-weight (L-W) relationship (where $W=a \times L^b$).

3.3 Snapper fishery

During the project different snapper species were targeted with a wide variety of fishing gear. The gear types used by the fishermen were fish traps, hydraulic or electric snapper reels, bottom long lines and hand lines. The recorded catch of various snapper species (all marketed as red snapper) landed during the project from the Saba Bank was 9,565 kilogram. However, the catch of a relatively large number of boats was not included in the records, because landings took place at night. Hand line fishing for snappers mainly took place during periods of relatively calm weather, while the fishermen only started targeting snappers by fish traps during the last three months of the program.

Fishing for snappers mainly took place on the eastern and northern edges of the Saba Bank and on the northwestern undersea peninsula, locally called the Grabblers (see Figure II).

In order to obtain the approximately total catch the recorded catch was multiplied by a factor of 1.5. An estimated 33% of the snapper catch was not recorded. The following tables describe the total recorded catch, the estimated total catch (Table VIII), and the average length, average weight, the corresponding a and b values for the L-W relationship (length was measured, weight calculated), and the number of snappers sampled per species (Table IX.). The a and the b value were obtained from recent scientific literature (Fish Base CDROM, FAO/ICLARM-electronic file). Snapper species are arranged in order of importance.

Latin name	# sampled	Length Type	Avg L (cm)	W (g)	a	b
<i>Lutjanus vivanus</i>	1,514	TL	29.4	745	0.0617	2.78
<i>Lutjanus buccanella</i>	344	TL	31.3	936	0.0747	2.74
<i>Rhomboplites aurorubens</i>	181	TL	28.6	501	0.0214	2.95
<i>Etelis oculatus</i>	77	FL	40.0	1,732	0.0632	2.77
<i>Apsilus dentatus</i>	3	TL	43.7	1,252	0.0150	3.00
<i>Pristipomoides aquilonaris</i>	20	TL	41.2	1,79	0.0464	2.84

Table VIII. Total recorded catch and total calculated catch for snapper species caught on the Saba Bank from April 24, 1999 to May 30, 2000.

Latin name	English name	Recorded catch (kg.)	Calculated total catch
<i>Lutjanus vivanus</i>	Silk snapper	6,706	8,919
<i>Lutjanus buccanella</i>	Blackfin snapper	2,158	2,87
<i>Rhomboplites aurorubens</i>	Vermilion snapper	345	458
<i>Etelis oculatus</i>	Queen snapper	255	339
<i>Apsilus dentatus</i>	Black snapper	46	61
<i>Pristipomoides aquilonaris</i>	Wenchman	55	73
Total:		9,565	12,721

Table IX. Number of snappers sampled, average length, average weight, and the a and b values for the L-W relationship (where $W=a \times L^b$).

Figures XIII and XV show length-frequency distributions of total landings of *Lutjanus vivanus* and *Lutjanus buccanella* caught by fish traps, figure XIV and XVI show the same for hand lines on the Saba Bank. It can be concluded that fish trap catches consist of individuals with a smaller average total length than individuals caught by hand lines. This is most likely a combined result of gear selectivity and the fishing depth, as hand line fishing in general took place at greater depth than trap fishing.

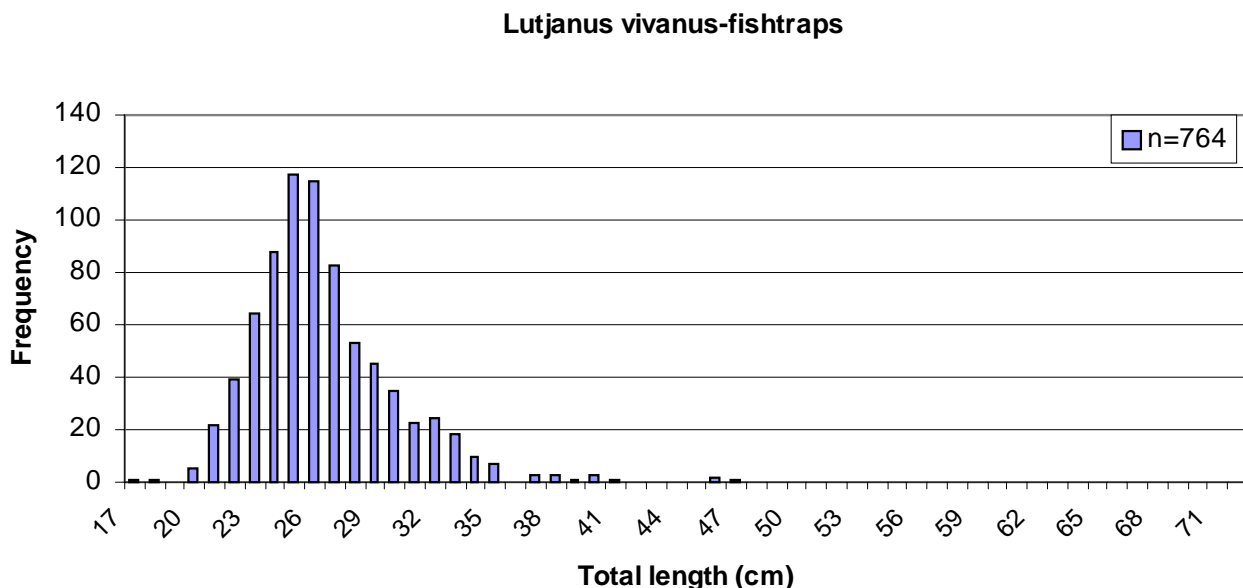


Figure XIII. Length-frequency distribution of *Lutjanus vivanus* caught by fish traps from April, 1999 to May, 2000.

Lutjanus vivanus-handline

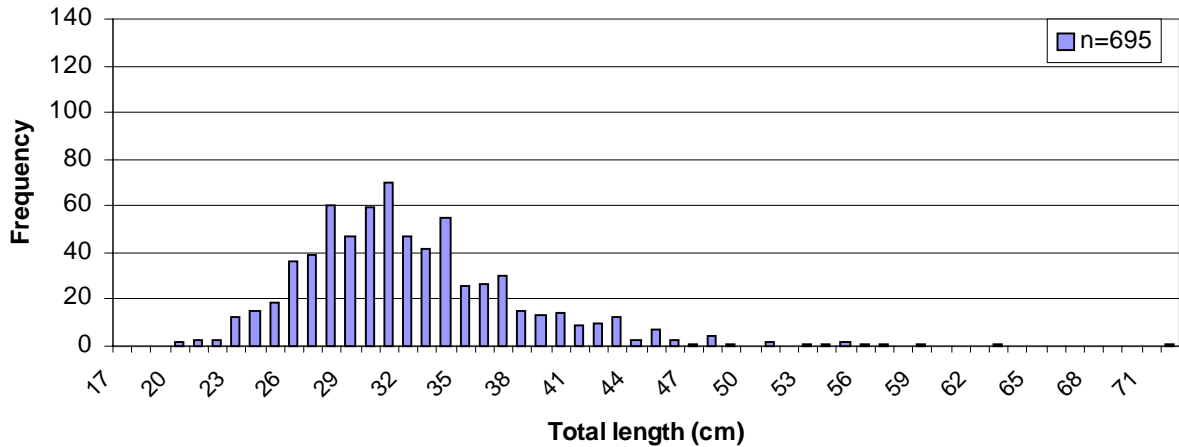


Figure XIV. Length-frequency distribution of *Lutjanus vivanus* caught by hand lines from April, 1999 to May, 2000.

Lutjanus buccanella-fishtraps

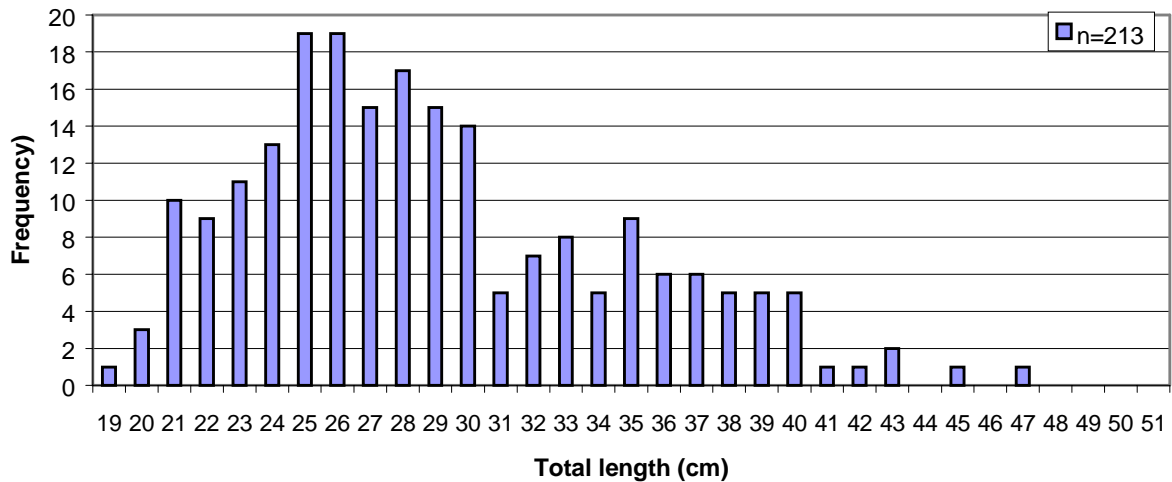


Figure XV. Length-frequency distribution of *Lutjanus buccanella* caught by fish traps from April, 1999 to May, 2000.

Lutjanus buccanella-handline

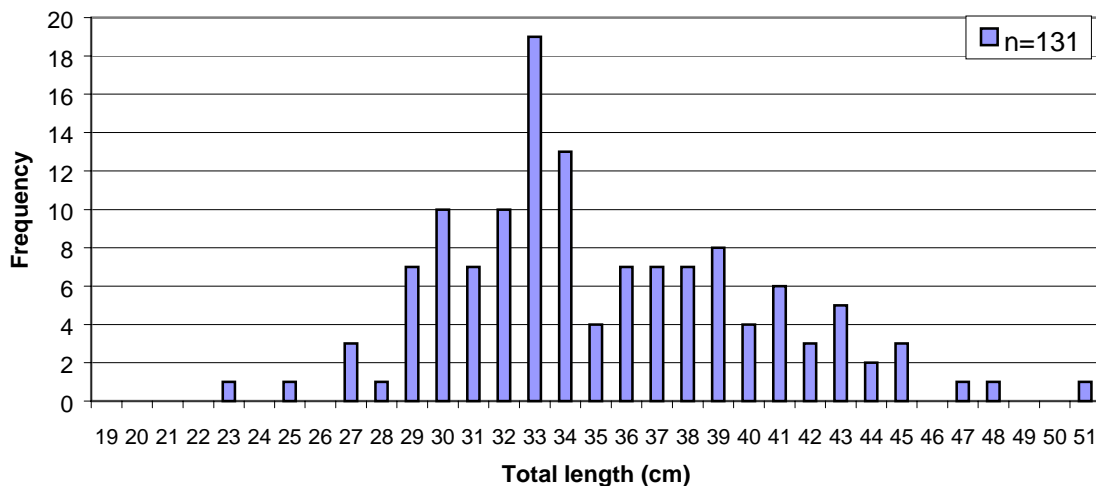


Figure XVI. Length-frequency distribution of *Lutjanus buccanella* caught by hand lines from April, 1999 to May, 2000.

Gear type:	<i>L. vivanus</i> # sampled	TL (cm) Avg	s.d.	<i>L. buccanella</i> # sampled	TL (cm) Avg	s.d.
Fish traps (FT)	764	26.5	3.7	213	28.6	5.6
Snapper reels (SR)	46	32.1	3.3	0	0	
Long line (LL)	9	41.3	9.8	0	0	
Hand line (HL)	695	32.3	6.1	131	35.2	5.0
Total:	1,514	29.4		344	31.3	

Table X. Average length, and number of *Lutjanus vivanus* and *Lutjanus buccanella* sampled per gear type from April 24, 1999 to May 30, 2000.

Table X shows the average length of silk snappers and blackfin snappers per gear type, sampled during the time of the project. The average length of specimens caught by fish traps is relatively small. The average length of silk snappers caught by bottom long-line fishing is the highest among the gear types used. This is most likely the result of gear selectivity and the fishing depth. Bottom long-lines and snapper reels are used at great depths (200-300 meter) where commonly no hand line fishing or trap fishing takes place. It can be expected that the catch consist of relative large individuals. Blackfin snappers were not being targeted by bottom long-lines and snapper reels, because the adults of this species prefer relatively shallow rocky ledges, in 60-91 meter (Robbins, 1986) and can be caught with less effort by fish traps.

Figure XVII shows the average length of *Lutjanus vivanus* and *Lutjanus buccanella* caught by different gear types. No *Lutjanus buccanella* were caught by either long-lines or snapper reels.

The common length (defined as the length of the fish commonly caught or marketed) of the above snapper species in the Caribbean was obtained from recent scientific literature (Fish Base CDROM, FAO/ICLARM-electronic file). These values are compared to the average length of the snapper species caught on the Saba Bank (Table XI) Although the average length of the Saba Bank snappers cannot strictly be compared to common lengths for other areas, the data nevertheless indicate that the lengths of the main snapper species targeted on the Saba bank is most likely below average and that is indicative of heavy over-fishing up to the recent past.

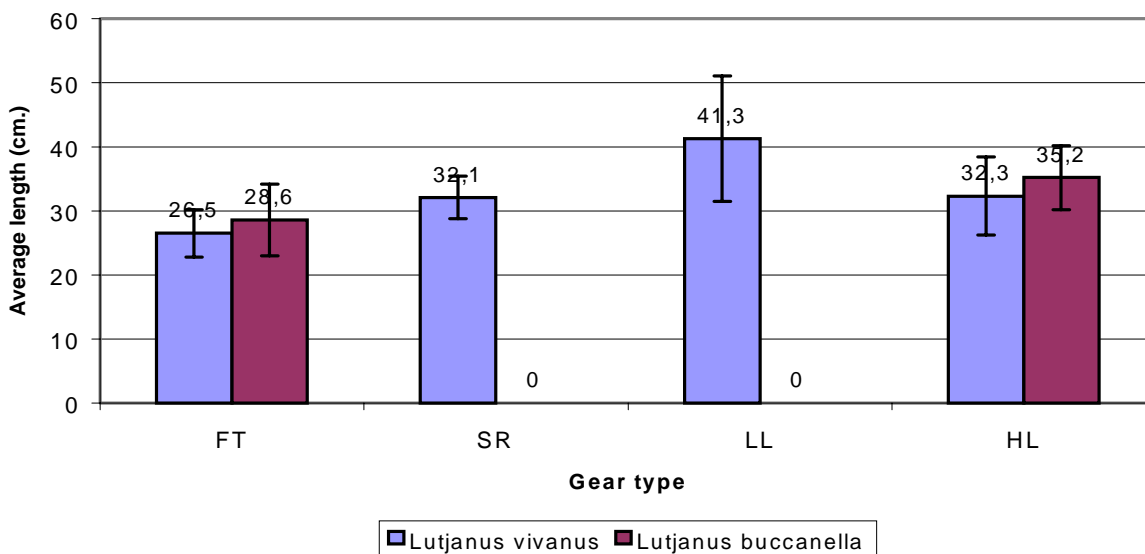


Figure XVII. Average length of *Lutjanus vivanus* and *Lutjanus buccanella* caught by FT= fish traps, SR= snapper reels, LL= bottom drop long line and HL= hand lines.

Latin name	English name	Common Length FAO/ICLARM	Length Type	Average Length Saba Bank	Length Type
<i>Lutjanus vivanus</i>	Silk snapper	45	TL	29	TL
<i>Lutjanus buccanella</i>	Blackfin snapper	50	TL	32	TL
<i>Rhomboplites aurorubens</i>	Vermilion snapper	35	TL	29	TL
<i>Etelis oculatus</i>	Queen snapper	64	TL	40	FL
<i>Apsilus dentatus</i>	Black snapper	40	TL	44	TL
<i>Pristipomoides aquilonaris</i>	Wenchman	20	TL	41	TL

Table XI. Average length of the following snapper species obtained from literature and average length for snapper species caught on the Saba bank from April 1999 to May,2000.

4. Conclusions and recommendations

4.1 Conclusions

4.1.1 Economic importance

During the monitoring program it became evident that the Saba Bank fishery sector is of great importance to the island economy of Saba. Table XII shows the total catch during the survey of the target species and the predominant species encountered in the by-catch, the market price and the gross economical value. The Saba Bank fishery sector has developed into a viable semi-industrial fishery, and the means of production used in the fishery are among the most advanced utilized in the Netherlands Antilles. The contribution of the Saba Bank fishery sector, which generated approximately 1.1 million US\$ in 1999, is substantial to the island economy of Saba (GDP 15.7 million US\$, CBS 1996);

	Catch (kg)	Catch (lbs.)	Price per lbs (ANG)	Economical value (ANG)
Lobsters	99,497	221,082	9.00	1,989,741
Snappers	12,721	28,267	6.00	169,6
Moonfish	2,75	6,111	3.00	18,332
Red Hinds	1,685	3,744	3.00	11,233
Grunts	2,339	5198	3.00	15,593
Others	2,109	4,687	3.00	10,415
Total:				2,214,914

Table XII. Total catch of the target species and the predominant species encountered in the by-catch and the corresponding gross economical value from April 23, 1999 to May 30, 2000.

- The sector provides employment to a relatively large number of people (8% of the economically active population). About 20 people generate a living exclusively from the fishery, while a relatively large group of approximately 30 people find part-time employment in it and so generate additional income in the fishery sector;
- The added value and the generation of foreign exchange to the island economy of Saba are high.

The growth of the tourist industry on the neighboring islands raised the demand for lobsters, large groupers, and snappers, and consequently the prices. Usually only a small portion of the lobsters and fish caught is consumed locally. The main export market for live lobsters and frozen fish or iced fish from the Saba Bank is St. Maarten, St Barthélemy, Guadeloupe, St. Eustatius and Martinique. About 60 percent of the lobster catch is sold to both Dutch and French St. Maarten, while approximately 40% is sold to the other French islands in the region. Practically all fish was sold in St. Maarten.

4.1.2 Enforcement

It became apparent that a substantial part of the landings of lobsters consisted of illegal lobster catch. High percentages of under-sized lobsters and berried lobsters in the catch are a serious concern.

Of all lobsters sampled during the study, 28 percent were under-sized. Practically all fishermen were landing large numbers of under-sized lobsters, which was encouraged by the restaurants, since small lobsters sell faster than large lobsters.

Throughout the survey also relatively large amounts of berried lobsters were landed. It became apparent that certain fishermen were consistently landing berried lobsters, while others did not, unless there was a high demand for lobsters on the market. Most fishermen were willing to adhere to the regulations, but as others were repeatedly landing berried lobsters they felt the “obligation” to do the same.

Although several fishery regulations have been in existence for quite some time, until recently they were not adequately enforced. The effectiveness of management measures is directly related to the extent they are accepted by the fishermen, and to the level of enforcement by the authorities. Most of the Saba Bank fishermen have the environmental awareness to exploit the resources of the Saba Bank in a sustainable manner. They are willing to adhere to the regulations, as long as they are consistently and without exception enforced by the Government.

Enforcement is a key factor to create sustainable fisheries. The benefit to the resource users will only increase if the resource is effectively protected.

As a direct result of this catch assessment survey the Coast Guard of the Netherlands Antilles has commenced to strictly enforce the fishery regulations. The following regulations are currently being enforced:

- Legal mesh size;
- Use of the biodegradable panel;
- Legal size limits for lobsters;
- No landing of berried lobsters;
- No landing of soft-shell lobsters (lobsters in ecdysis);
- Requirement of Fishing License for both Saban Territorial Waters and Economic Fishery Zone (EFZ) of the Netherlands Antilles.

The implementation of the fishery regulations by the Coast Guard of the Netherlands Antilles resulted in a substantial decline in illegal fishery activities:

- The number of under-sized lobsters decreased, and practically no berried lobsters and lobsters in ecdysis were brought in;
- Illegal (non-licensed) fishing activities from both foreign and domestic vessels have practically stopped.

4.1.3 By-catch

From the traps a by-catch of demersal fish was landed consisting mostly of grunts, hinds and triggerfish. Since part of the by-catch was used as bait for the traps, only a rough estimate of the total catch of these species could be given. Furthermore in the traps mortality occurred in both, by-catch species and target species (usually lobsters). On one occasion even a dead turtle was encountered in the traps. It would be completely speculative to give an estimate on the mortality occurring in the traps. Besides data collection of the by-catch species is difficult due to the vast diversity of species encountered in a by-catch.

4.1.4 Lobster

The mean CL of the main lobster producing countries in the region (Cuba, USA) ranges from 8.3 to 9.5 cm CL. One can conclude that the mean CL of lobsters from the Saba Bank (10.7 cm CL) is still on a level whereby future harvesting is not endangered as long as the legal size regulation is strictly enforced.

It is evident that Guidicelli and Villegas (1981) underestimated the full potential of the Saba Bank lobster fishery. Guidicelli and Villegas estimated the maximum sustainable yield for lobsters of the Saba Bank to be 30 tons per year. The present annual lobster catch is over 80 tons/year and the average CL of lobsters of the Saba Bank is still relatively high compared to the average CL of sustainable exploited lobster fisheries in the region (Cuba, USA).

Regulation practices in the Netherlands Antillean lobster fishery differ slightly from those in the region. Regulations in the region rest on three main bases; minimum legal size, limited entry, and closed season.

Legal Size

The minimum legal size regulation in the Netherlands Antilles (minimum CL of 9.5 cm) is intended to allow the lobsters to achieve sexual maturity and to have the opportunity to spawn at least once, in order to preserve the stock's reproductive capacity. Other regional minimum legal sizes include: Cuba, 6.9 cm CL, (Estela de León, Puga, 1997), Mexico, 7.4 cm CL, (Sosa-Cordero *et al*, 1997), USA, 7.62 cm CL, (Muller, 1998), Jamaica, 7.62 cm CL, (Grant, 1997), Bahamas, 8.25 cm CL, (Deleveaux *et al*, 1998), Bermuda, 9.2 cm CL, (Luckhurst, 1998), St Lucia, 9.5 cm CL, (Joseph, 1997), and Venezuela 12.0 cm CL, (Fernandez, 1997).

Clearly the legal size in the Netherlands Antilles is among the highest, thus most restrictive, in the region. For countries with a high level of management and research, and large stocks the legal size can be smaller, because they can adjust total fishing effort whenever necessary; for countries such as the Netherlands Antilles that do not at present possess the mechanisms to quickly adjust total fishing effort when necessary, a more restrictive legal size is needed.

Limited entry

Most of the WECAF-nations such as Bermuda, Cuba, the USA, Mexico, Colombia, Honduras, Jamaica, Nicaragua, Brazil, and Venezuela have some system of limited entry in place, where either the number of fishermen and/or the number of fishing units is restricted. In both the Saba island territorial waters as the Netherlands Antillean waters (EFZ) no lobster fishing can take place without a fishing license, but there are no restrictions to the number of fishing units per vessel. However within the framework of the National Fishery Law it is possible to introduce such restrictions quite easily via a National Decree.

Closed season

The main lobster producing countries in the region have a closed season in place (Appendix III). The closed season regulation has three main objectives:

- Ensure reproduction during the peak spawning period;
- Protect the molting period;
- Allow growth and thus increase in weight, of a major part of the population (Cruz, 1998).

The Netherlands Antilles has no closed season regulation in place as yet, but it might consider either closing the lobster fishery during the spring months in order to ensure reproduction during the peak spawning period or closing the lobster fishery during the hurricane season. During the hurricane season lobster sale and consequently fishing effort are traditionally low. Closing the lobster fishery during the hurricane season would have the following advantages, it would:

- Prevent loss of fishing gear;
- Allow precise counting and tagging of the lobster traps;
- Allow growth and thus increase in weight, of a major part of the population (Cruz, 1998).

Other restrictions

The fishery regulations in all countries include a permanent prohibition to catch or land lobsters in ecdysis and female lobsters in reproductive condition. This is also the case in the Netherlands Antilles.

4.1.5 Snappers

In 1971 the "M/V Calamar" an exploratory fishing vessel of the FAO Caribbean fisheries development project fished the northwestern edge of the Saba Bank, and catches were considered fairly good (Cruise report Number 35, M/V Calamar, cruise 71-6, 1971). Fish traps were set on the northwestern edge of the Saba Bank and the optimum soak time was determined for fish traps (Appendix IV.). After one day in the water an average catch of 49.6 lbs. was realized per fish trap hauled. During the time of this project the Saba

Bank fishermen averaged 1.85 kg. (4.1 lbs.) per fish trap hauled per soak day, i.e. 8.3% of the CPUE 30 years ago.

In one fisherman's hand line catch off Saba, Nagelkerken (1981) found 47 specimens of *Lutjanus vivanus* with a mean fork length (FL) of 34.7 cm. and a range of 25 cm. to 57 cm. During this study 695 specimens of *Lutjanus vivanus*, caught by hand line were sampled with a mean TL of 32.3 cm. and a range of 20 cm. to 72 cm. The relationship between fork length and total length for *Lutjanus vivanus* can be calculated by the formula $TL = 0.3 + 1.09 FL$ (Munro, 1980), and a FL of 34.7 corresponds to a TL of 38.1 cm. This is a drop of 15.2% in average size.

Comparing the average length of the targeted snapper species of the Saba Bank to the length of these snapper species, commonly caught or marketed in the region (common length), one can conclude that the main snapper species from the Saba Bank are relatively small.

The comparison between different gear types and average lengths of the snapper species caught, shows that certain gear types select larger fish. In general fish traps selected relative smaller individuals compared to hand lines. This difference was most likely the combined result of gear selectivity and the fishing depth.

During the first 9 months of the project, the fishermen were strictly targeting lobsters; snappers were only targeted sporadically. Only during the last 3 months of the project, snappers were regularly targeted by the fishermen. Consequently insufficient data were obtained on snappers for final conclusions.

There are no specific regulations for the snapper fishery as of yet.

4.1.6 Export

The French Coast Guard has recently stopped export of all fish products (including lobsters) from Saba to the French islands. To import fish products into the European Union a health certificate from the Netherlands Antillean Central Government is required. This health certificate has to be issued according to European Commission (EC) standards. In Saba the inspection procedures do not yet conform to these standards. The Central Government is working to comply with the new EC regulations, but for the time being fish products cannot legally be exported from Saba to the French islands.

4.2 Recommendations

The following recommendations are indispensable to successful management of the Saba Bank fishery:

- Restrictions on catch and effort through size limits (lobsters), restrictions on landing berried lobsters and lobsters in ecdysis;
- Strict enforcement of fishery regulations;
- Further research and accurate catch and effort and length-frequency data are required to formulate sound regulations;
- The need for a communication network involving fishermen, Central and Island Governments, Coast Guard and research community.

Substantial and immediate benefits to the conservation of the fish stock would be realized through strict implementation of the existing fishery regulations i.e. legal size limits for lobsters, the prohibition to land berried lobster, lobsters in ecdysis, and the use of biodegradable panels and legal mesh size for gear.

By combining effective fishery management and comprehensive monitoring, the fishery of the Saba Bank can be optimally exploited at sustainable levels in the future.

Continued fishing by lost traps has become the focus of increasing concern for both the Saba Island Government and the Central Government. The recent trend that the fishermen construct their traps from longer lasting material has increased the problem of ghost fishing by the lost traps. Ghost fishing has been defined as the continued fishing by irretrievable gear (Smolowitz, 1978). Mortality will occur in the lost traps, which can have a severe negative impact on the fish stock of the targeted species.

Considering the large amount of ghost traps on the Saba Bank and the certainty that the Saba Bank will be repeatedly exposed to hurricane conditions, resulting in lost traps, it is urgently recommended that both the Saba island Government and the Central Government strictly enforce the regulations concerning the legal mesh size and the biodegradable hatch for traps.

It is recommended not to expand the lobster fishery. Despite the fact that catches and average lengths of the lobsters seem to be fairly good, the available literature dealing with the Saba Bank does raise concerns that the fishing effort might already be at or beyond sustainable levels of exploitation.

In the Netherlands Antilles there is a shortage of funds and capacity both for management and for monitoring. Furthermore the lobster fishery of the Saba Bank is targeting an isolated stock. It is therefore urgently recommended that both the Saba island Government and the Central Government adopt a precautionary approach:

- Not to expand the lobster fishery;
- Strict enforcement of the legal size regulation.

If the legal size is strictly enforced there should not be any sudden crashes of the stock, however no definite conclusions can be made until continued monitoring of the fishery show clear trends on the exploitation level.

It is recommended that the total fishing effort for snappers should not expand, until more data are available in order to calculate sustainable levels of exploitation.

The collection of fishery dependent data is of great importance in order to enable successful management of the fisheries resources of the Saba Bank. If extensive data have been collected and population parameters have been estimated, it is possible to estimate the maximum sustainable yield and corresponding optimum fishing effort for the target species. The present study was only a preliminary step to produce some baseline data. These data however, are not sufficient to draw definite conclusions about the state of exploitation of the fisheries, although some definite recommendations especially regarding enforcement can be drawn.

It is therefore urgently recommended that the Central and/or Saba Island Government take steps to ensure the continuation of the data collection and data interpretation. It should be pointed out that a Central Government fisheries officer would also be invaluable for monitoring of other fish stocks such as pelagic stocks (longlining), as well as be helpful to optimization of fisheries of other islands.

As the Saba Bank fishery sector is of great importance to the island economy of Saba, it is urgently recommended that both the Central and the Saba Island Government encourage the fishermen to exploit the fisheries resources of the Saba Bank in a sustainable manner.

It is recommended that both the Central Government and the Saba island Government conform to the inspection procedures and standards required by the EC, so fish products can once more be legally exported to the French islands.

Additional management options for both the Saba Island territorial waters and the Economic Fishery Zone of the Netherlands Antilles could include:

- Permanent closures of areas identified as nurseries for juveniles;
- Restrict the total number of lobster and /or fish traps;
- Specify the nature of the fishing license per target species (lobster license/snapper license) or per gear type (trap license/long-line license etc);
- Charge a fee for fishing licenses possibly correlating to the number of gear to be used.

It is recommended to both the Central Government and the Saba island Government to specify the nature of the fishing licenses per target species. The resource users should pay a fee for these licenses according to regional standards. The income generated from the fishing licenses fee can be used for management and monitoring of the fishery, whereby the resource users contribute to the management and monitoring of the stock.

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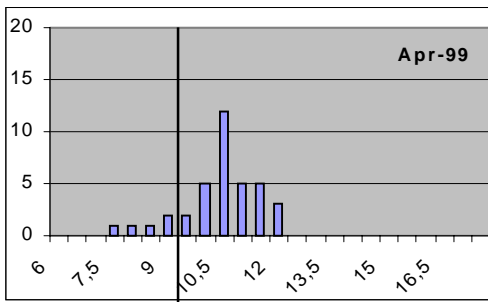
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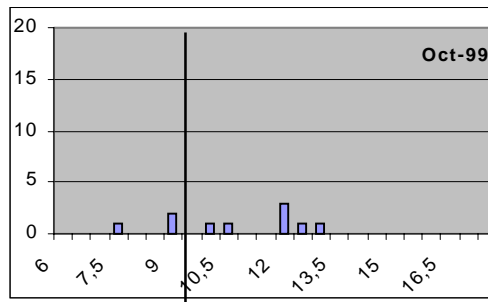
Appendix I.
Quantitative estimates on the lobster catch and their source.

Fishermen from:	Lobster catch (ton)	Source
Saba and St. Eustatius	2.0	Guidicelli and Villegas, 1981
Saba	5.0	Proplan Consultans Group N.V., 1992
Saba	25.5	Framhein, 1995
Saba	36.4	Meesters, Nijkamp, Blijvoet, 1996
Saba and St. Maarten	82.3	Vomil, 1999

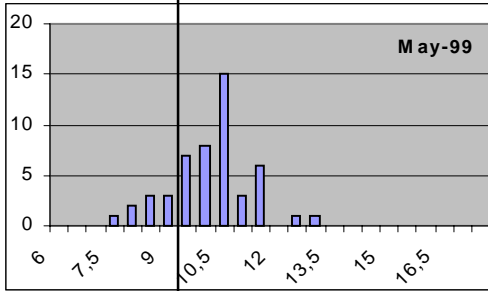
Appendix II.
Length-Frequency graphs of *Panulirus argus*
for fishing quadrants B1, B2, C1, C2, D1 and D2



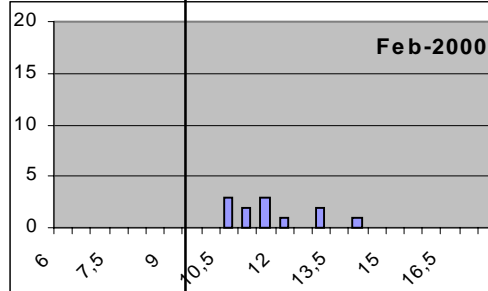
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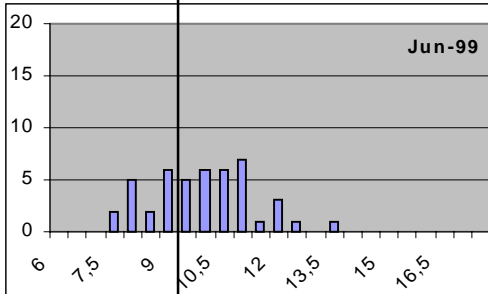
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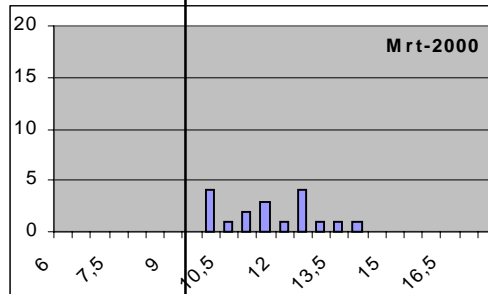
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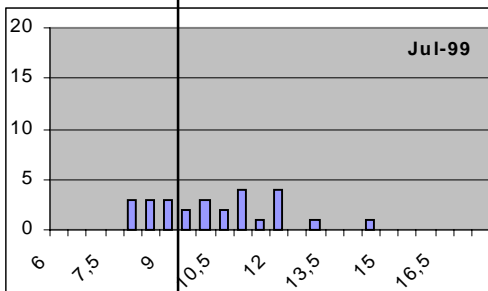
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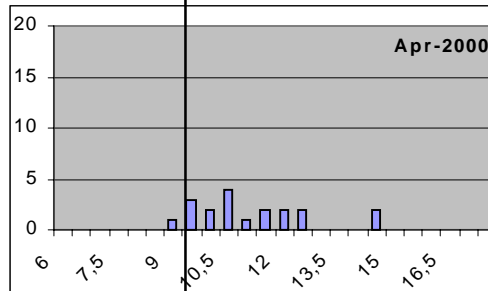
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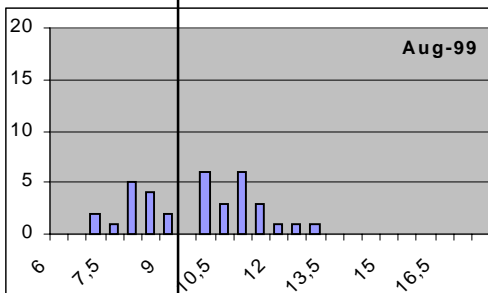
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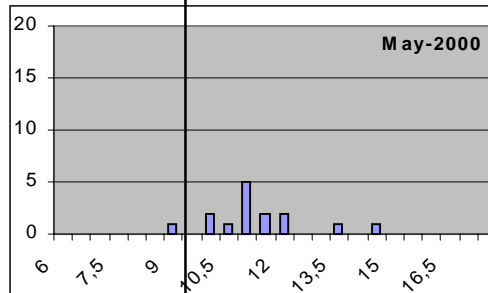
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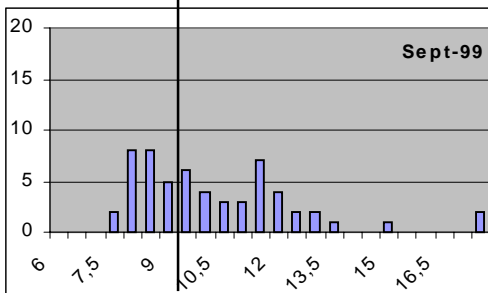
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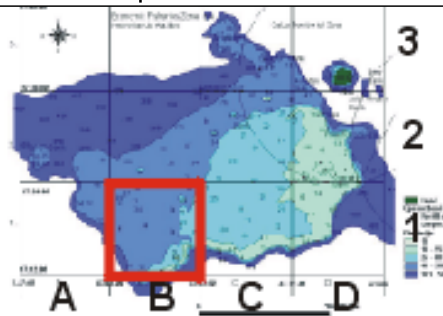
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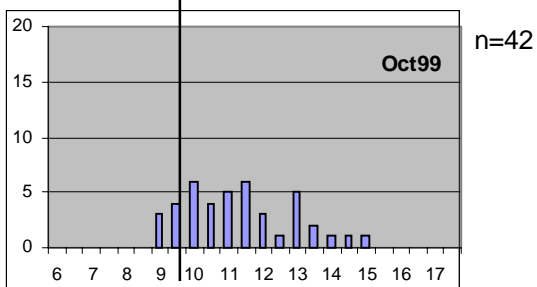
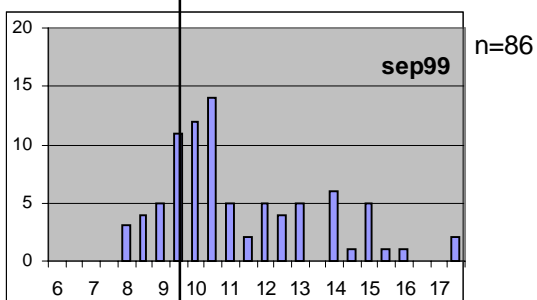
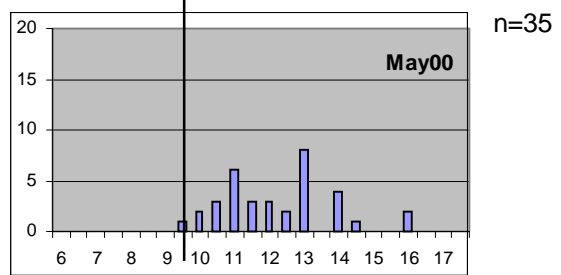
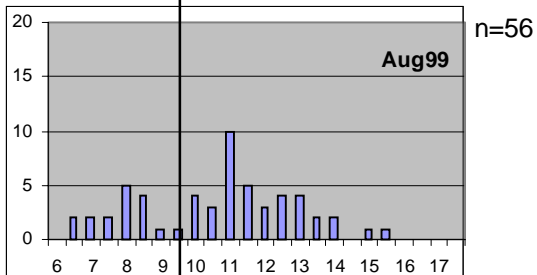
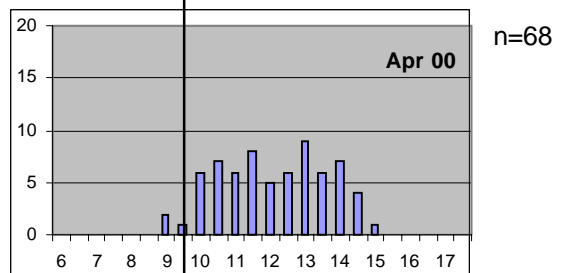
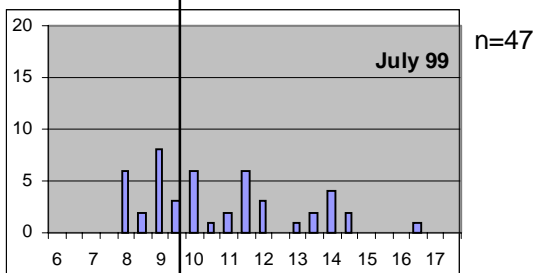
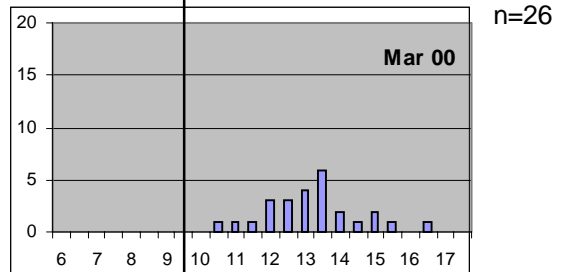
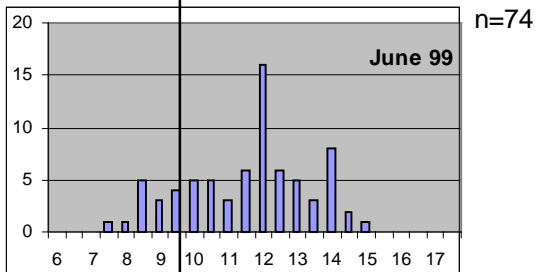
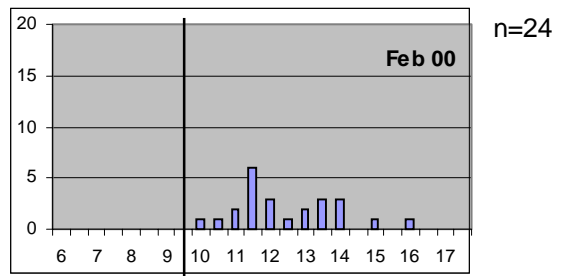
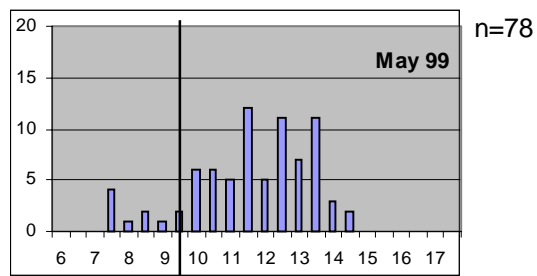
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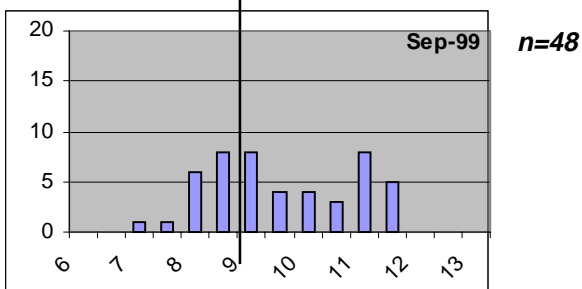
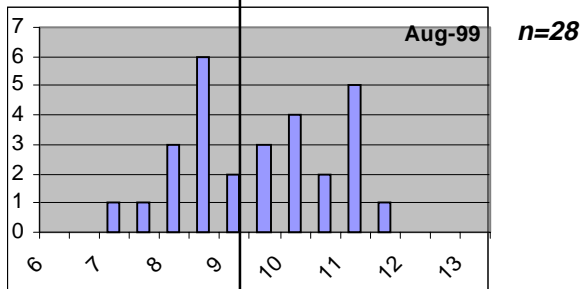
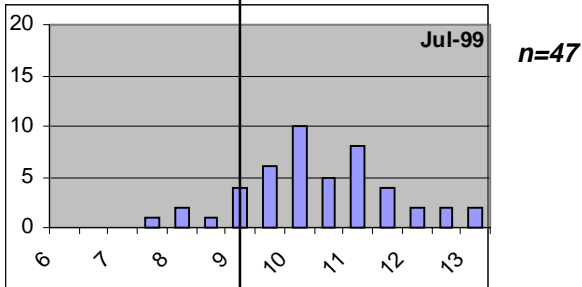
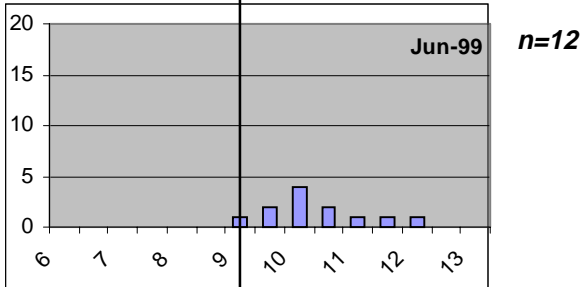
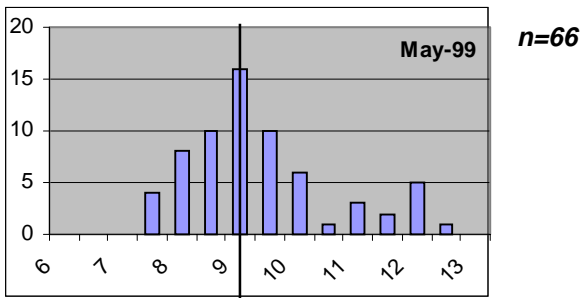
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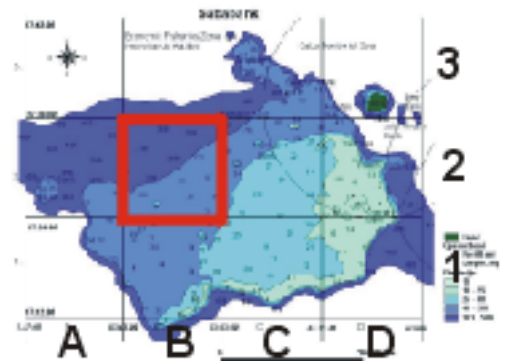
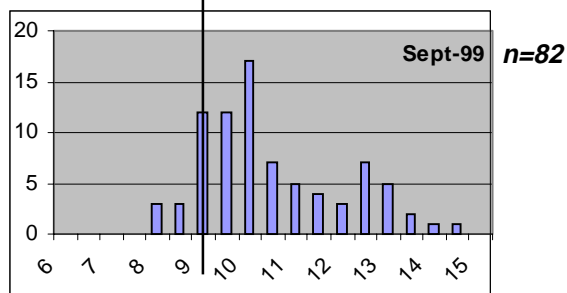
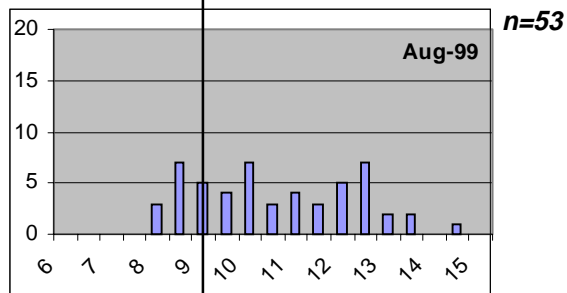
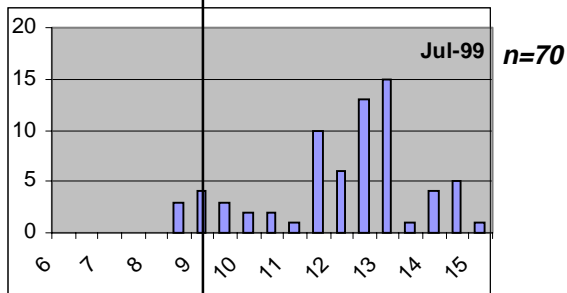
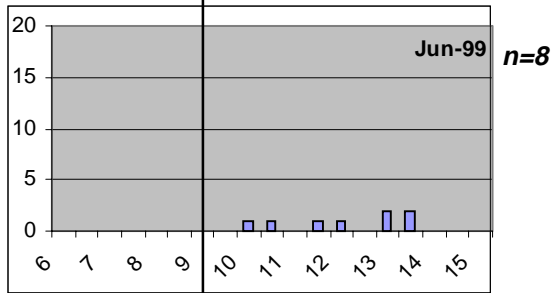
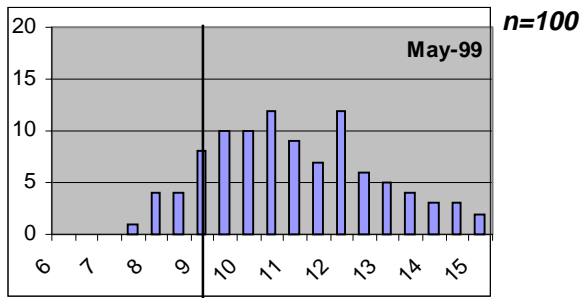
**LF Female lobsters, Sababank B1
April 1999 - May 2000**



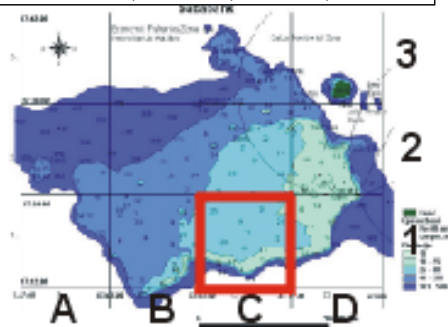
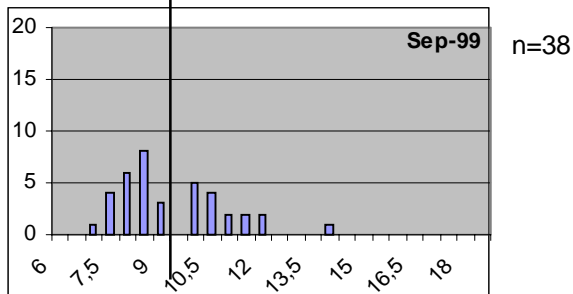
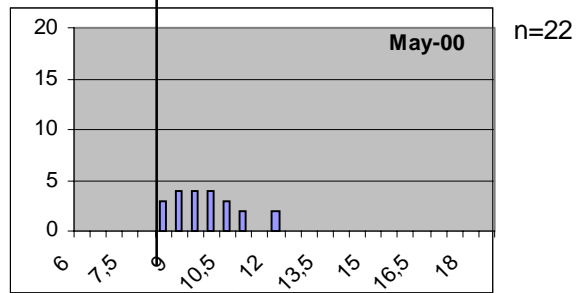
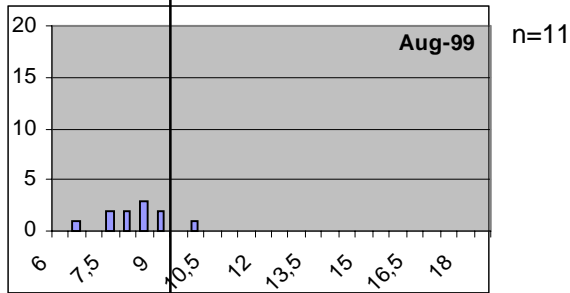
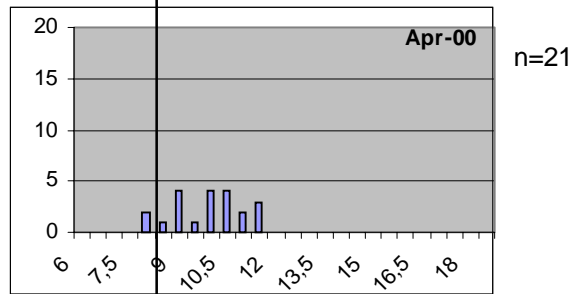
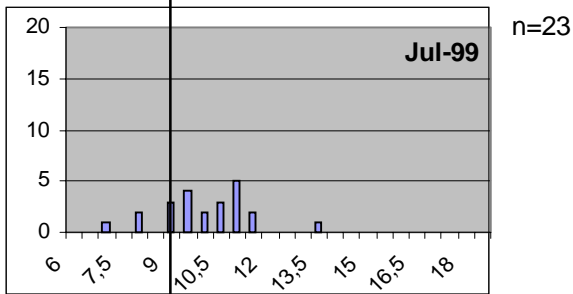
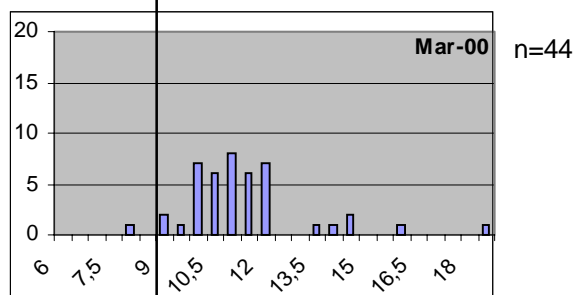
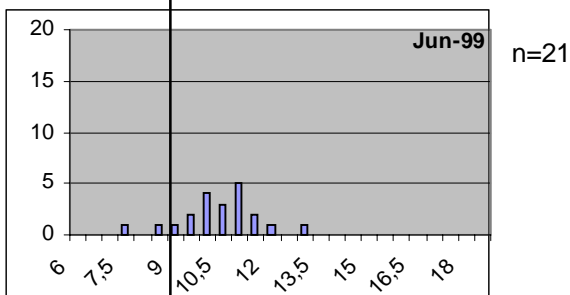
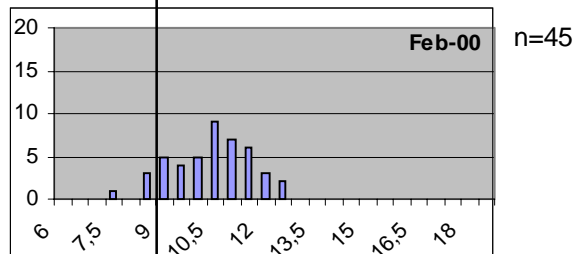
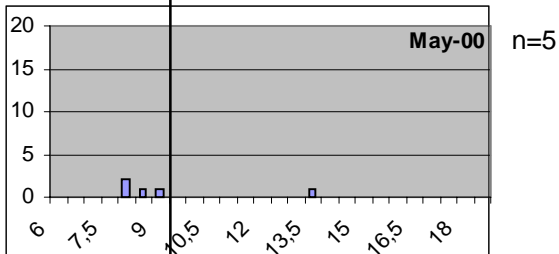
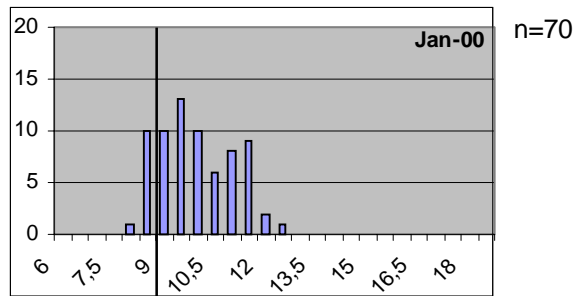
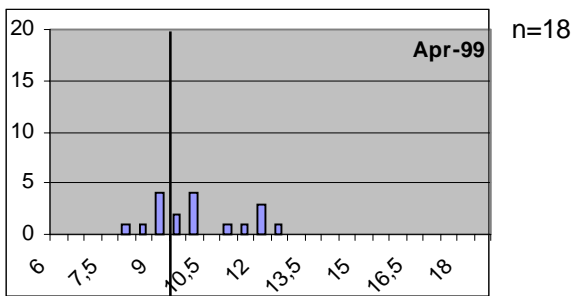
**LF Male lobsters, Sababank B1
May 1999 - May 2000;**



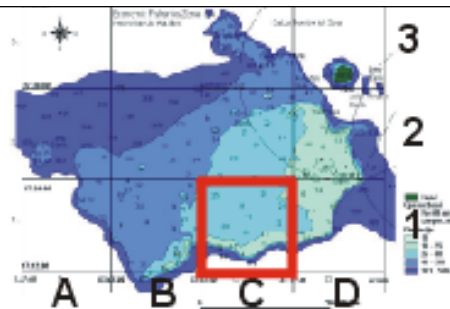
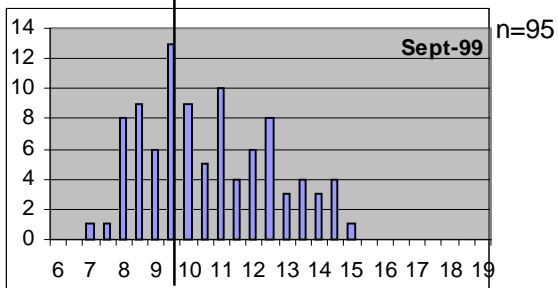
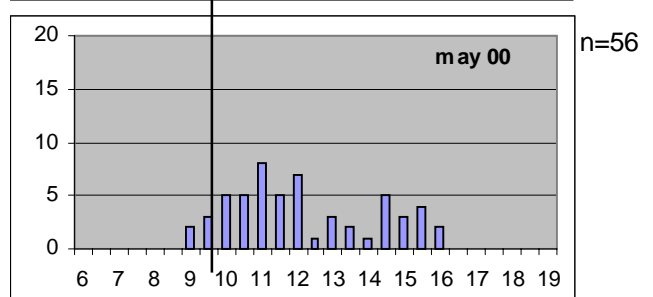
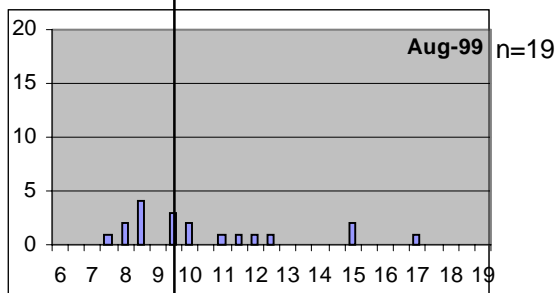
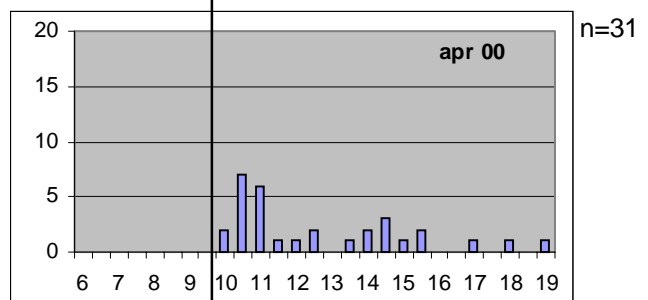
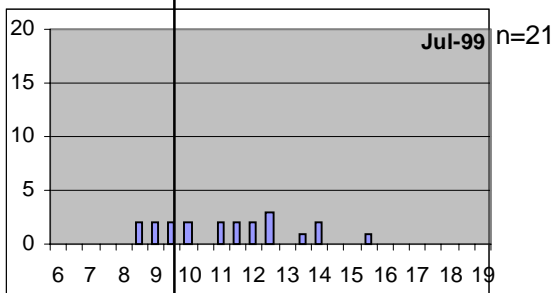
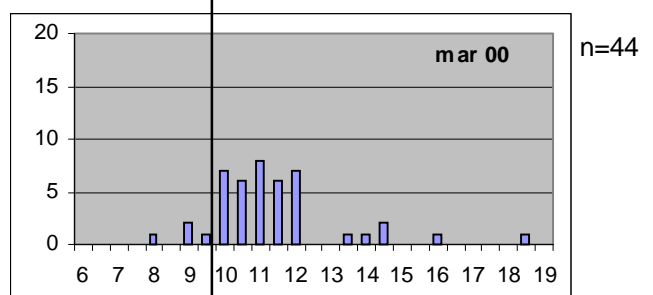
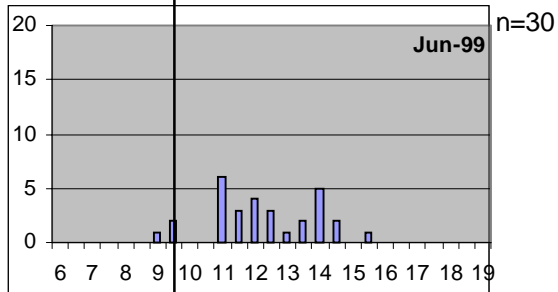
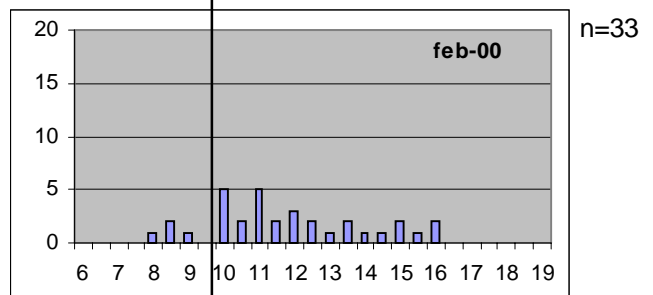
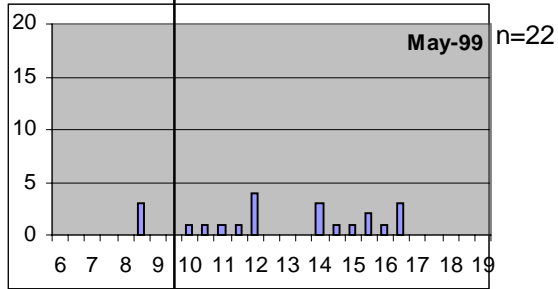
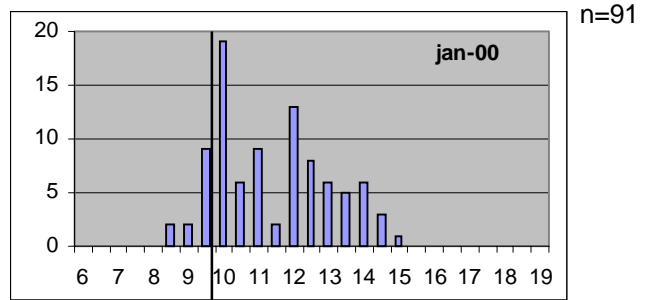
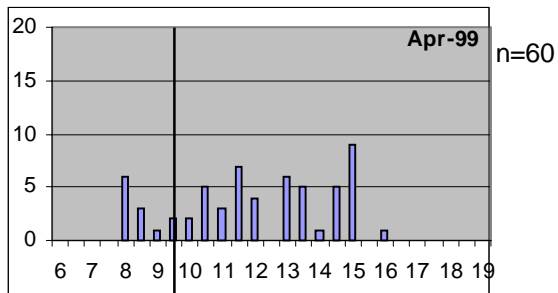
**LF Female lobsters, Sababank B2
May 1999 - September 1999**



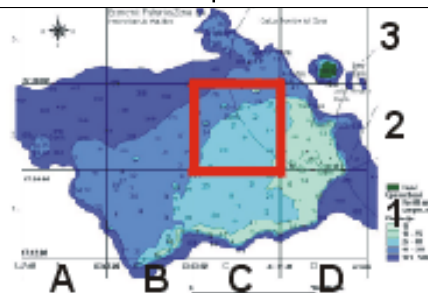
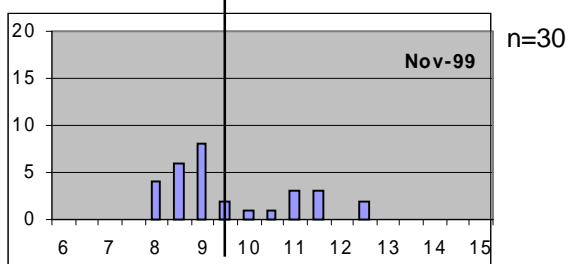
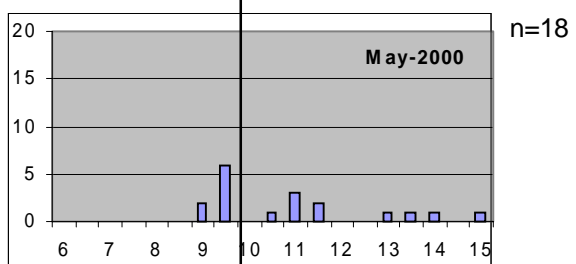
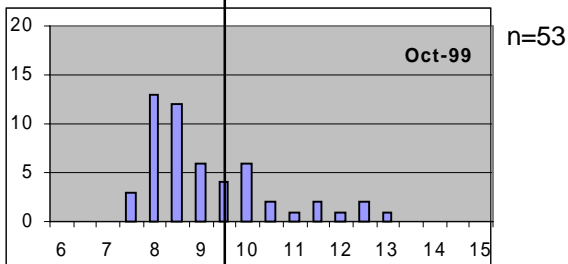
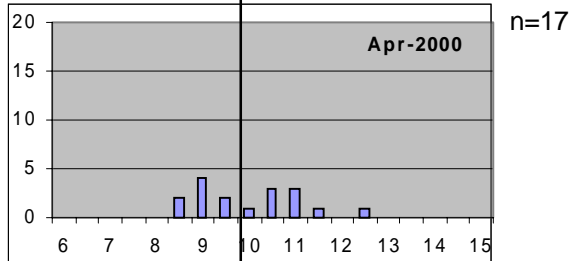
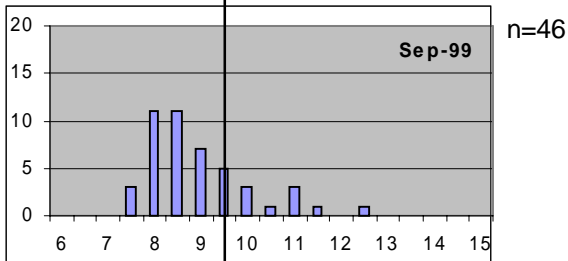
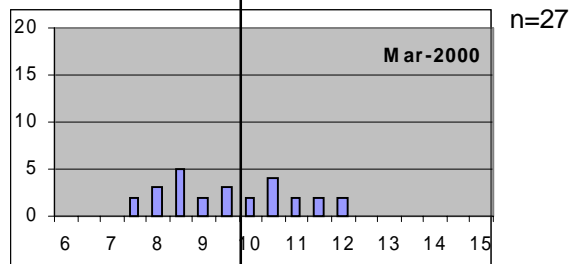
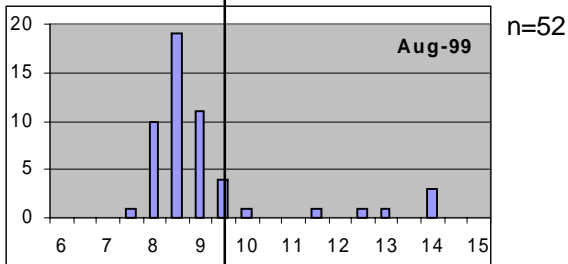
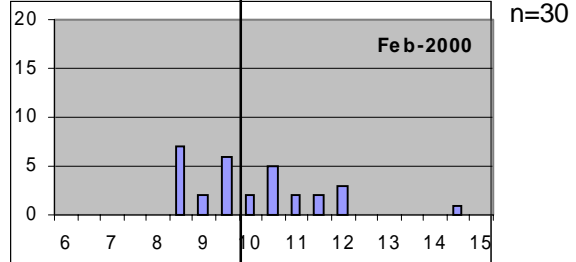
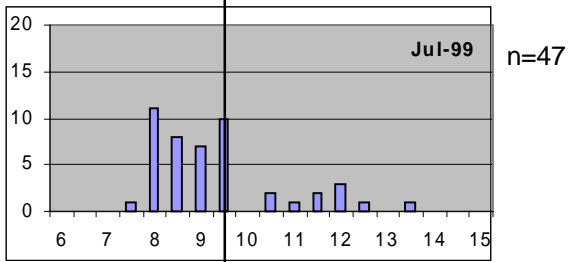
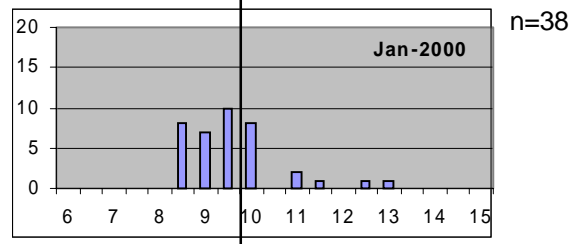
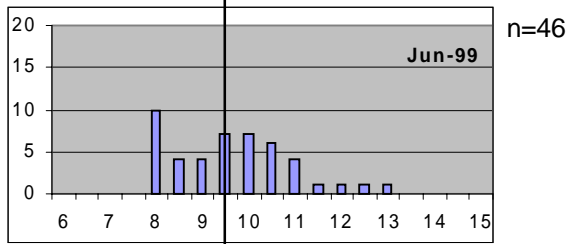
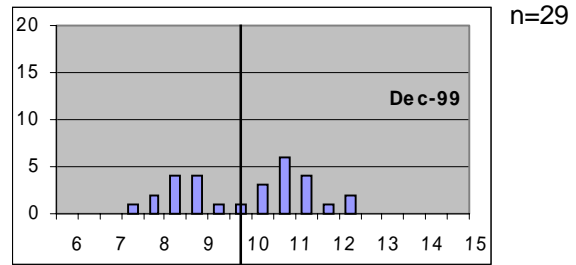
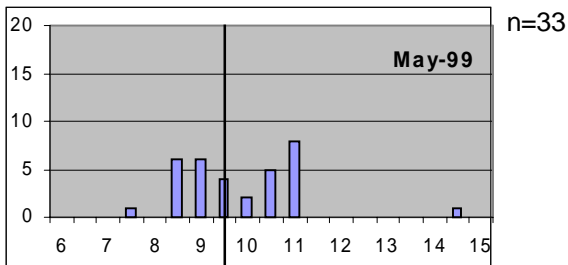
**LF Male lobsters, Sababank B2
May 1999 - September 1999**



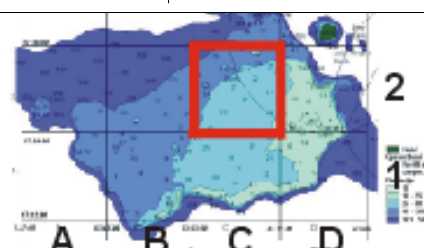
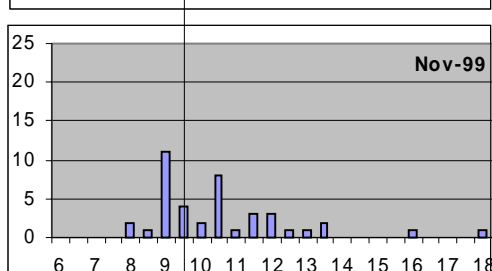
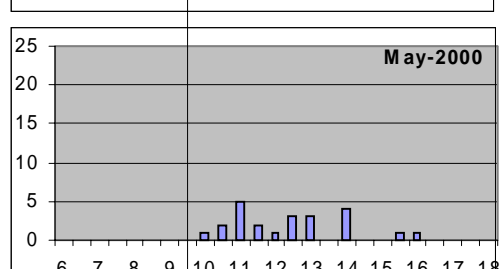
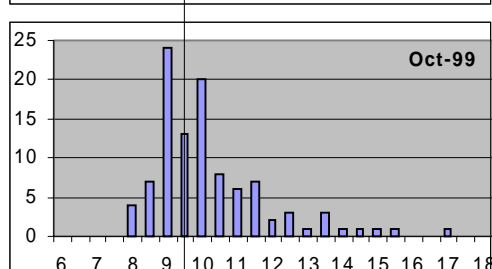
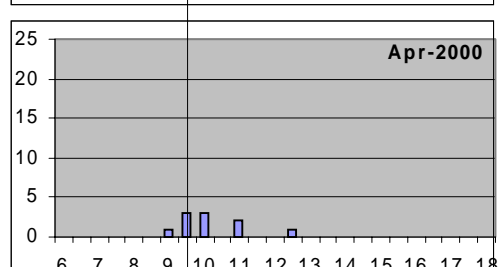
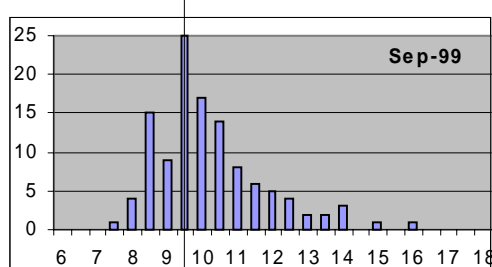
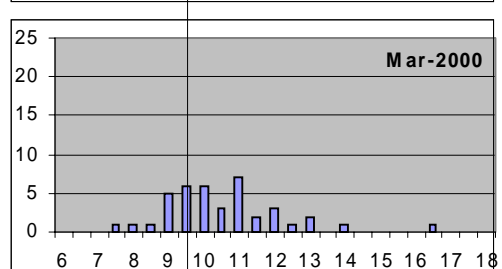
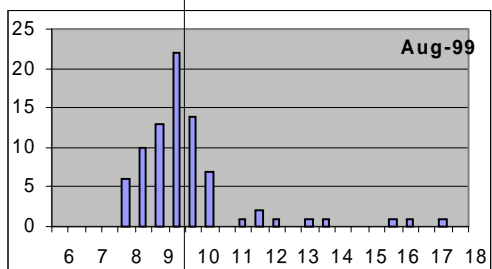
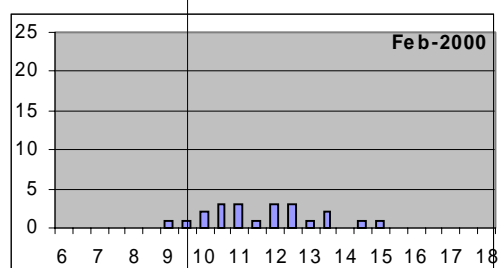
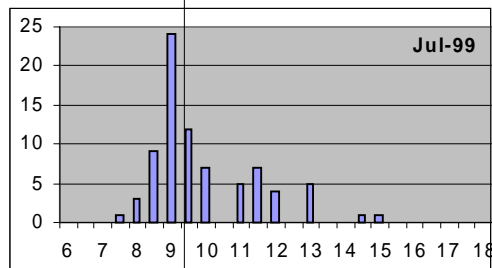
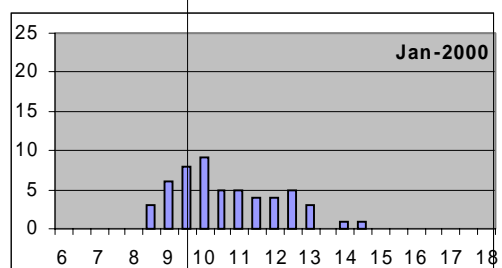
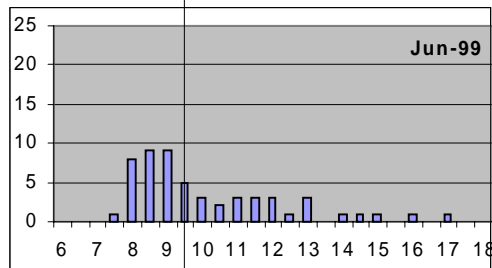
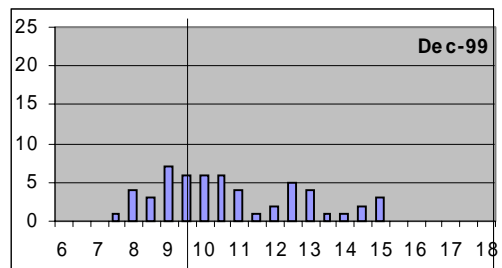
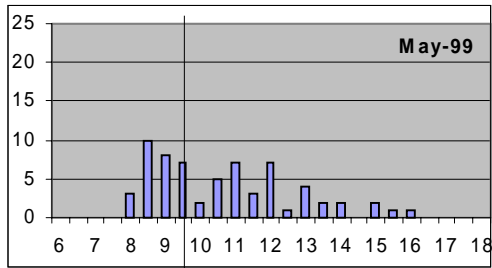
**LF Female lobsters, Sababank C1
April 1999 - May 2000;**



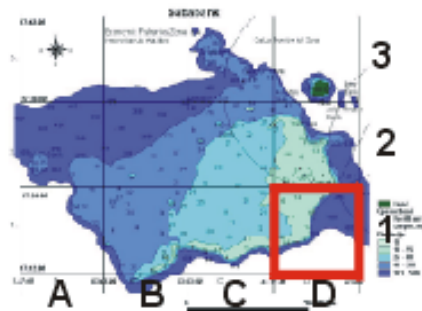
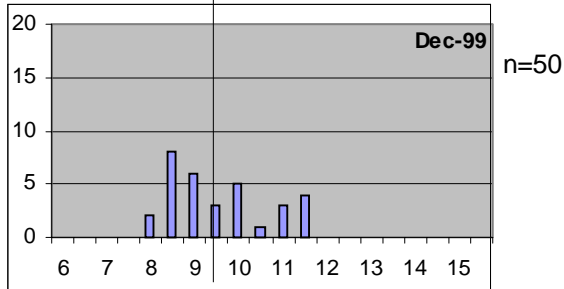
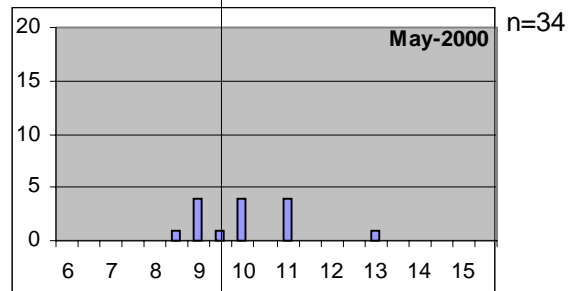
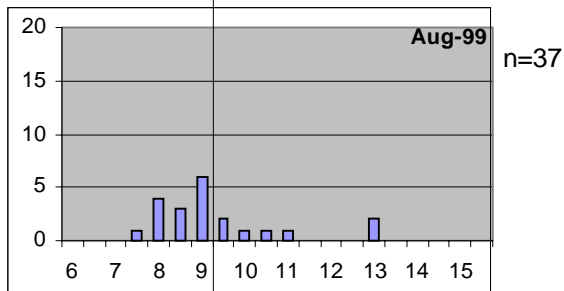
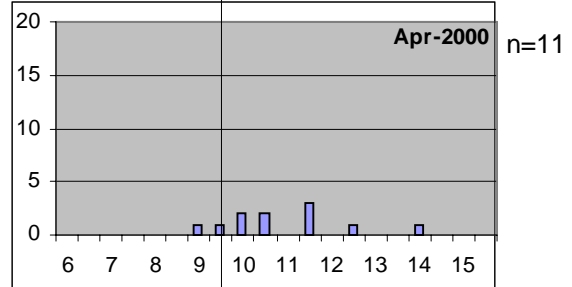
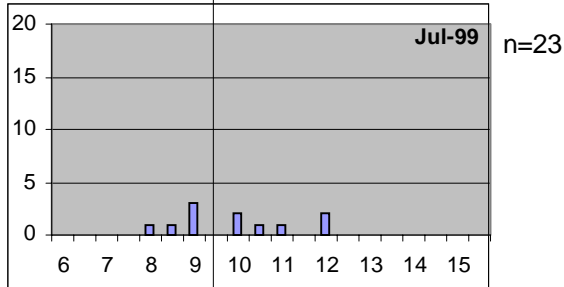
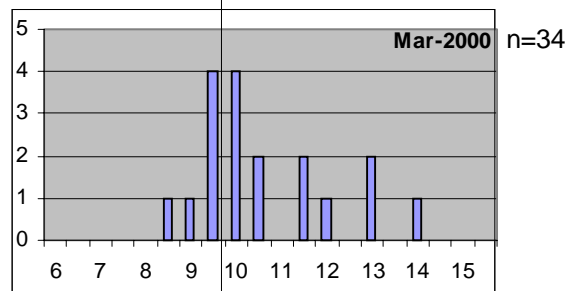
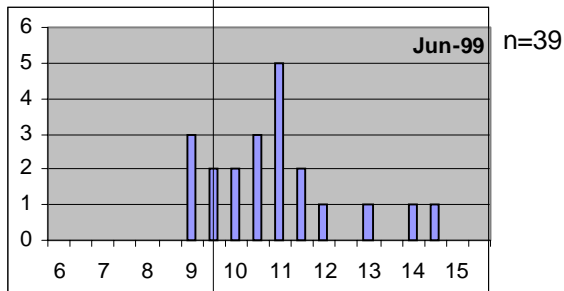
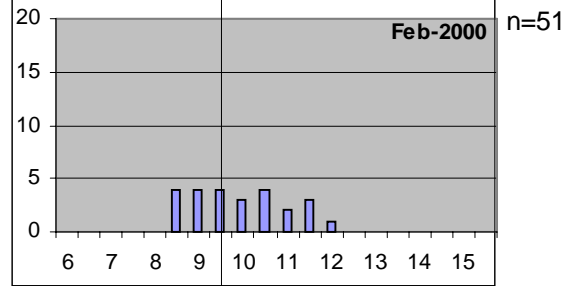
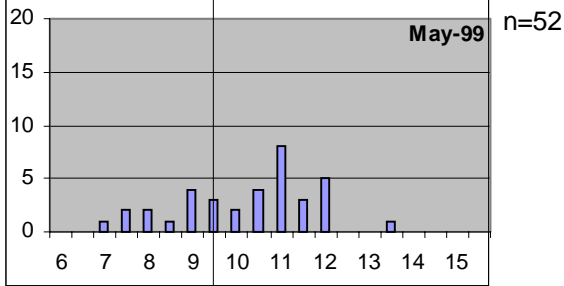
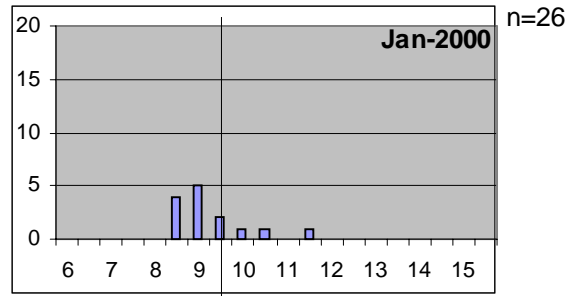
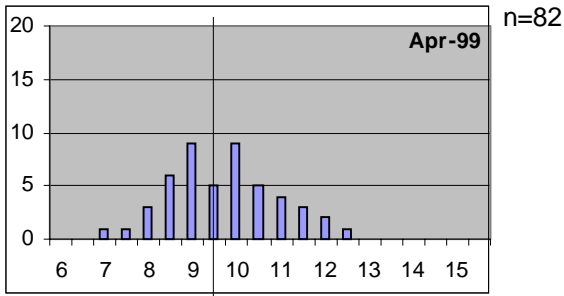
**LF Male lobsters, Sababank C1
April 1999 - May 2000;**



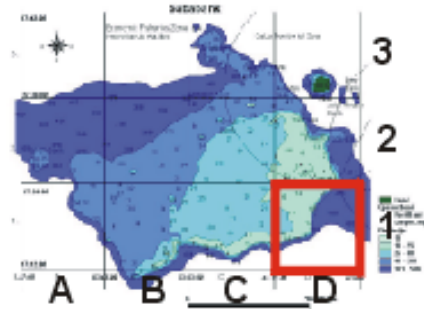
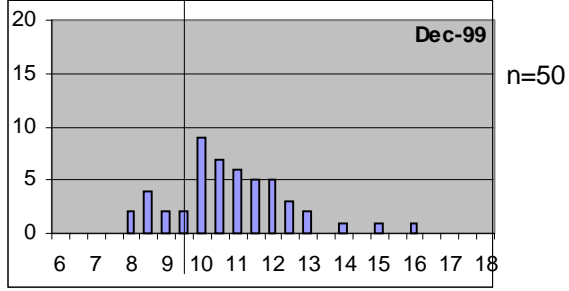
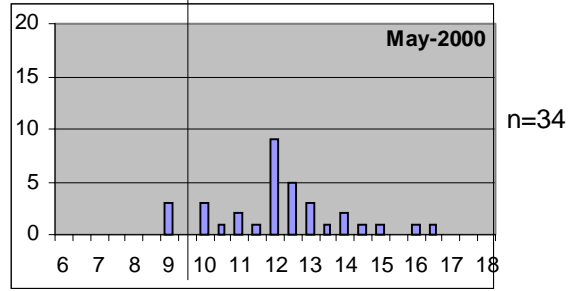
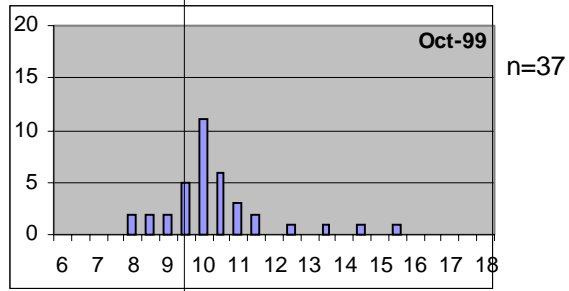
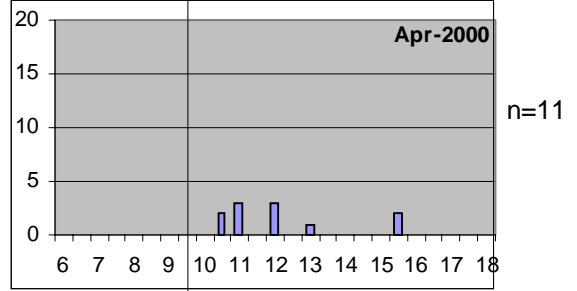
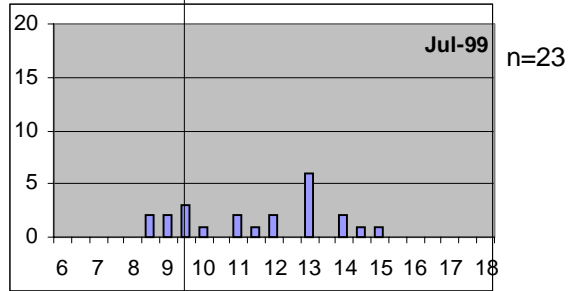
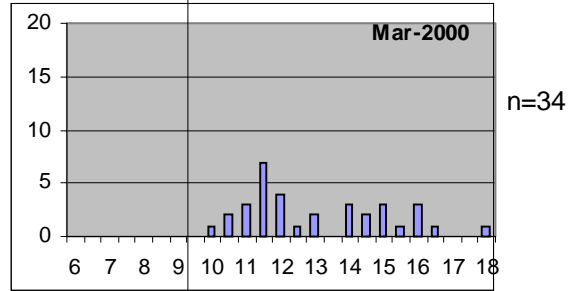
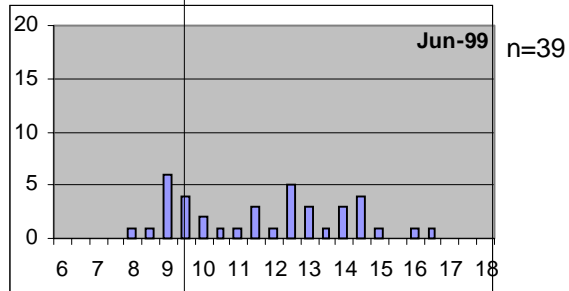
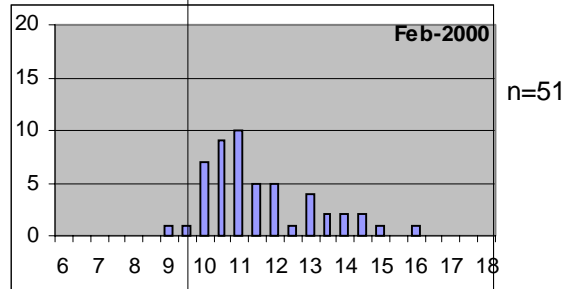
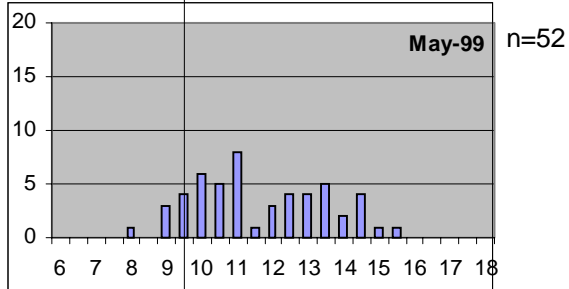
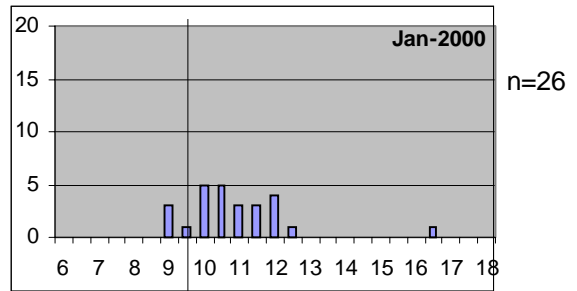
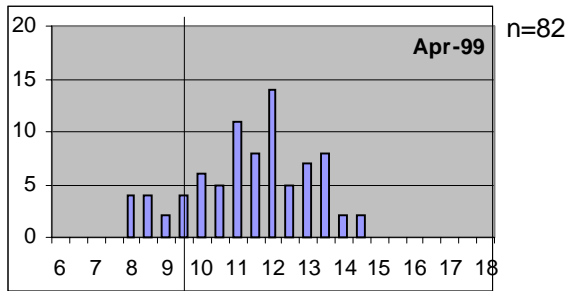
**LF Female lobsters, Sababank C2
April 1999 - May 2000;**



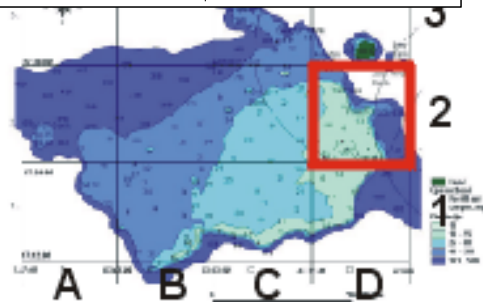
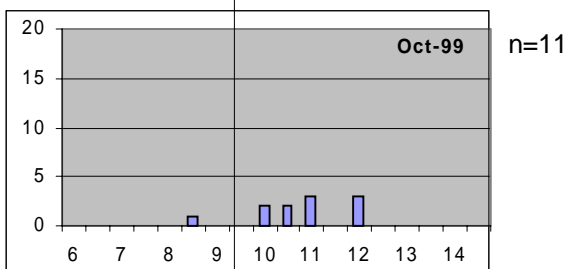
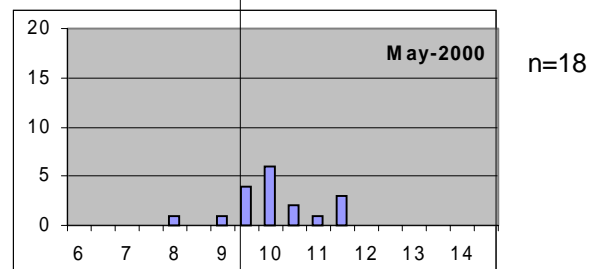
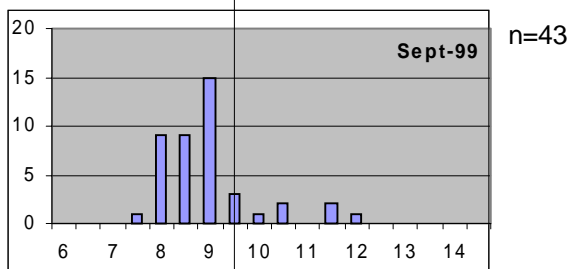
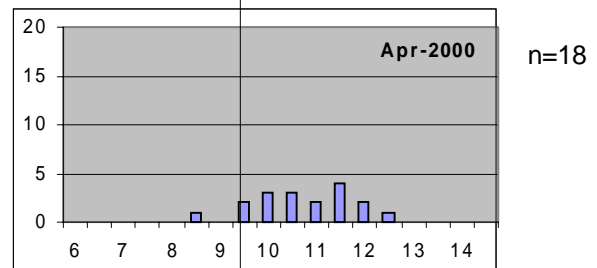
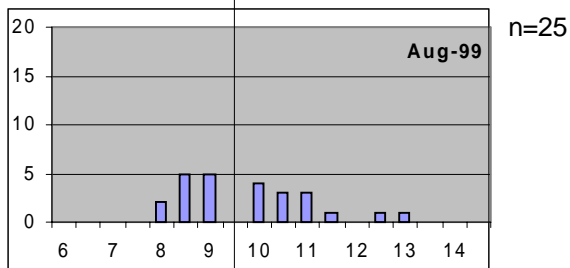
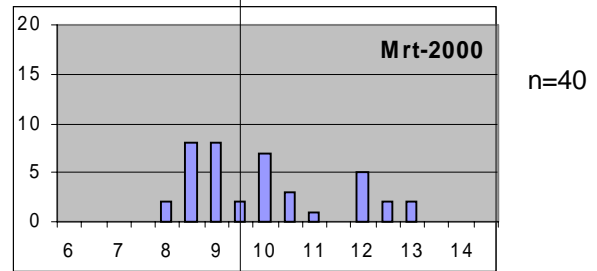
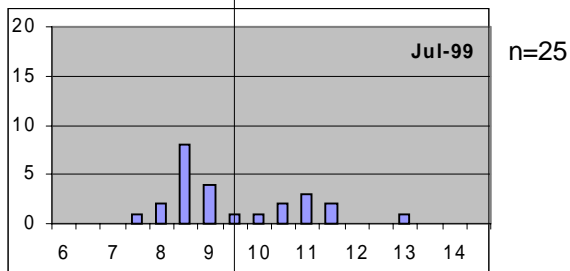
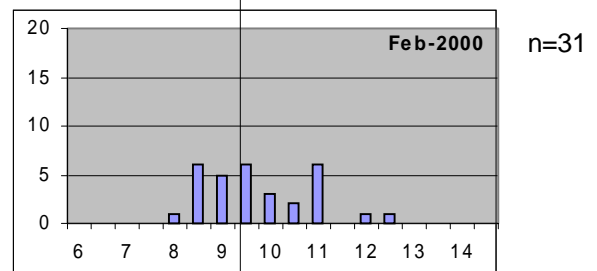
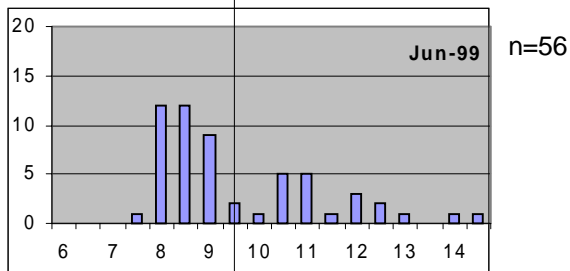
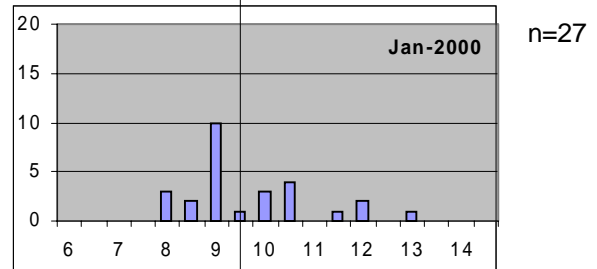
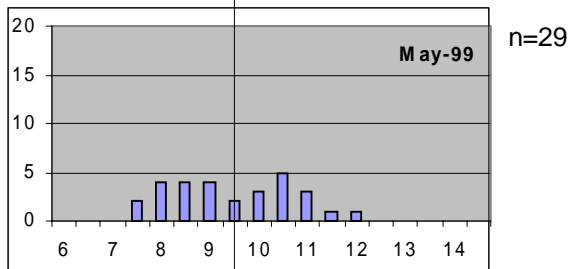
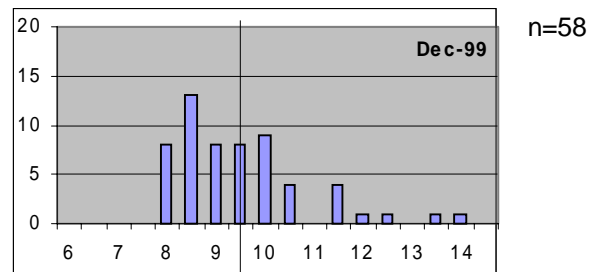
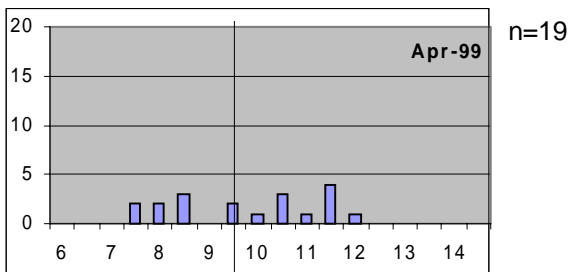
**LF Male lobsters, Sababank C2
April 1999 - May 2000;**



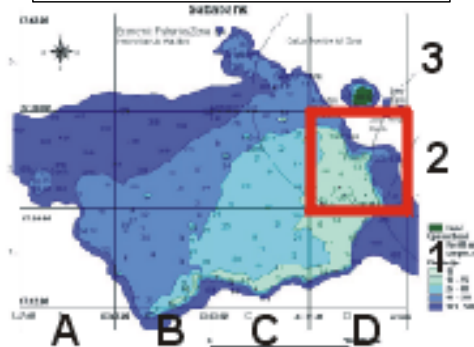
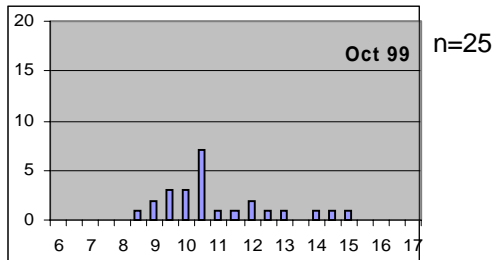
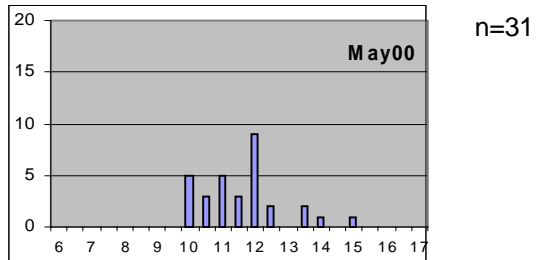
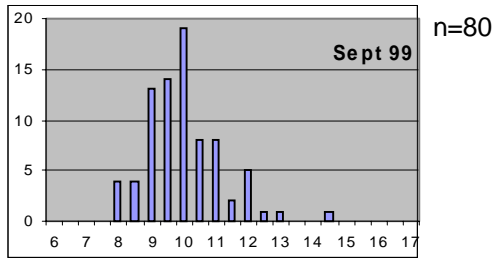
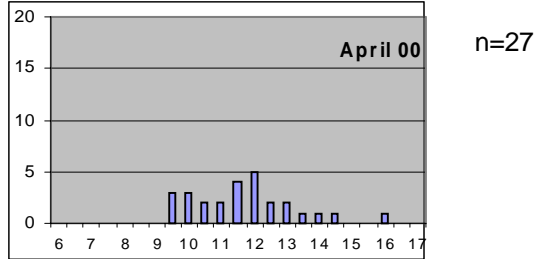
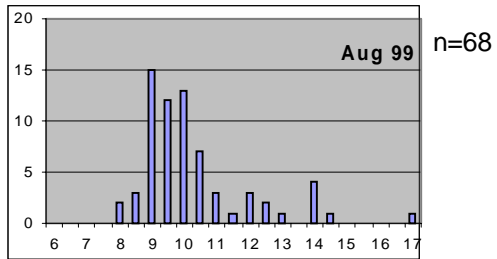
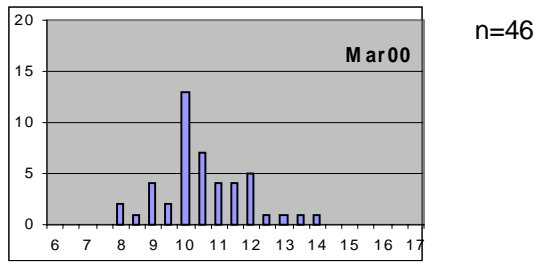
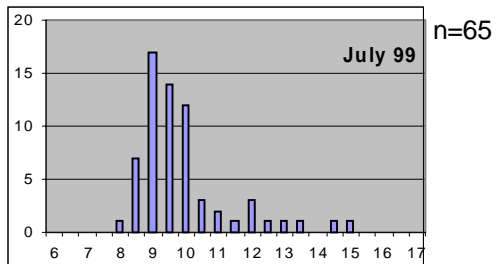
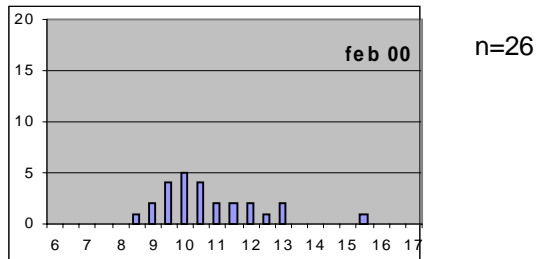
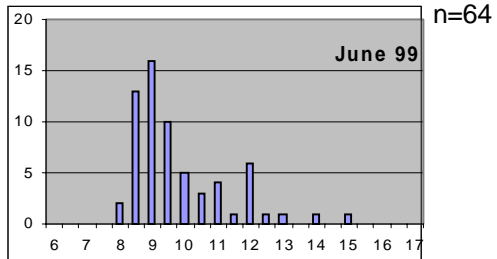
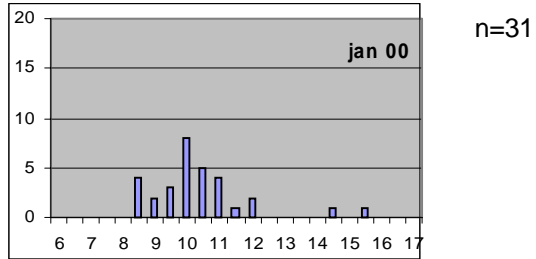
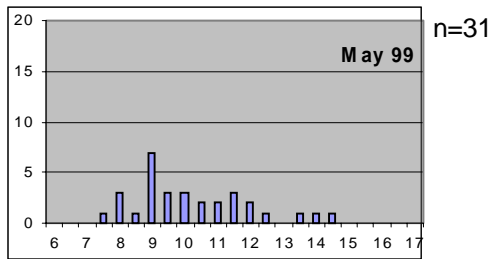
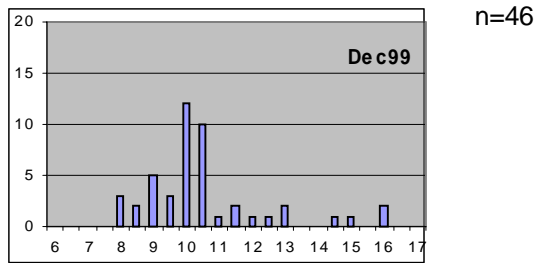
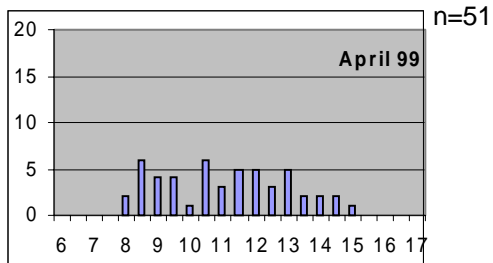
LF Female lobsters, Sababank D1 April 1999 - May 2000



**LF Male lobsters, Sababank D1
April 1999 - May 2000**



LF Female lobsters, Sababank D2; April 1999 - May 2000



LF Male lobsters, Sababank D2; April 1999 - May 2000

Appendix III.

Closed seasons for spiny lobster fisheries in the WECAF region.

SUMARIO DE LAS MEDIDAS REGULATORIAS QUE GOBIERNAN EL MANEJO DE LA PESQUERIA DE LA LANGOSTA <i>Panulirus argus</i> EN LA REGION.												
PERIODO DE VEDA	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
CUBA												
BRASIL												
BAHAMAS												
FLORIDA												
NICARAGUA (Flota extranjera)												
HONDURAS												
MEXICO												
BELICE												
COLOMBIA												
VENEZUELA												
JAMAICA												
TURCOS Y CAICOS												
PUERTO RICO												
COSTA RICA												
REPUBLICA DOMINICANA												
HAITI												
BERMUDAS												
PANAMA												
MARTINICA												
SANTA LUCIA												
ISLAS VIRGENES												
GUADALUPE												
GRANADA												
SAN KITS												
ISLA CAIMAN												
ANTIGUA Y BARBUDA												
DOMINICA												
SI VICENTE Y LAS GRANADINAS												

Tabla 1. Sumario de las medidas regulatorias de *Panulirus argus* en la región del Atlántico Centro Occidental (Según FAO, 1998)

Appendix IV.

Cruise report 71-6 M/V Calamar.

Location	Month-Year	Night (N) Set	Mesh size	Range (fms)	No. of fish	Lbs per lift
Jamaica Banks						
S.W. Pedro Bank (30 mi. S.W. Blower Rocks)	Feb. 70	N	"0" 2"	20 - 22	25	24.4
Salmon Bank (on center ridge)	Feb. 70	N	"0" 2"	20 - 54	12	28.3
Albatross Bank (East and Southeast edges)	Feb. 70	N	"0" 2"	18 - 22	18	32.8
S.E. Pedro Bank (Southeast Peak)	Apr. 70	N	"2" 1 1/2"	18 - 30	14	40.0
S-mile Bank (13 mi. West of Morant Cay)	July 70	N	"2" 1 1/2"	22 - 27	76	22.4
S.E. Pedro Bank (Southeast Peak)	Nov. 70	N	"2" 1 1/2"	18 - 27	42	20.4
North of Hispaniola						
Silver Bank (Southeast edge)	Jan. 70	N	"2" 1 1/2"	10 - 20	12	36.8
	Jan. 70	D	"0" 2"	10 - 20	10	29.3
Nevidad Bank (Southeast tip)	Jan. 70	N	"0" 2"	21 - 30	20	22.6
Mouthor Bank (Southeast tip)	Jan. 70	N	"0" 2"	10 - 15	20	21.9
Northern Leeward Islands						
Barbuda Bank (N.W. slope)	Nov. 69	N	"0" 2"	43 - 52	11	21.7
Saba Bank (N. tip to N.W. slope)	Mar. 70	N	"2" 1 1/2"	50 - 75	25	55.8
	Mar. 70	N	"0" 2"	50 - 75	38	34.0
Anguilla Bank (Northern slope)	Mar. 70	N	"2" 1 1/2"	44 - 60	12	35.1
Barbuda Bank (N. and W. slopes)	Mar. 70	N	"0" 2"	50 - 85	17	30.6
Small Bank (11 mi. E. of Sombrero Bank)	Jun. 70	N	"2" 1 1/2"	52 - 88	21	20.6
Saba Bank (Northwest slope)	Sept. 70	D	"2" 1 1/2"	60 - 82	41	32.6
	Sept. 70	N	"2" 1 1/2"	60 - 82	48	54.7
	Sept. 70	D	"2" 2"	60 - 82	40	33.6
	Sept. 70	N	"2" 2"	60 - 82	50	37.9
Barbuda Bank (North and Northwest slope)	Sept. 70	D	"2" 1 1/2"	80 - 80	19	29.1
	Sept. 70	N	"2" 1 1/2"	80 - 80	31	61.3
	Sept. 70	D	"2" 2"	80 - 80	19	63.7
	Sept. 70	N	"2" 2"	80 - 80	32	38.8
Saba Bank (Northwest slope)	Dec. 70	D	"2" 1 1/2"	60 - 115	43	33.8
	Dec. 70	N	"2" 1 1/2"	60 - 115	38	37.2
Anguilla Bank (East edge)	Dec. 70	N	"2" 1 1/2"	30 - 55	37	31.2
Barbuda Bank (N. and N.W. slope)	Dec. 70	D	"2" 1 1/2"	60 - 100	12	45.9
	Dec. 70	N	"2" 1 1/2"	60 - 100	35	33.1
Saba Bank (Northwest slope)	Apr. 71	N	"2" 1 1/2"	85 - 80	27	54.5
South American continental shelf						
Guyana Shelf (43 mi. E. Waini Point)	Feb. 71	N	"2" 1 1/2"	41	11	41.5
Venezuela (50 mi. N.E. X E. Orinoco Delta)	Apr. 71	D	"2" 1 1/2"	55 - 63	19	24.5
	Apr. 71	N	"2" 1 1/2"	45 - 63	29	20.3
Surinam (70 mi. N.E. Georgetown, Guyana)	Apr. 71	N	"2" 1 1/2"	49 - 56	10	49.5
French Guiana (60 mi. N. Cayenne)	Apr. 71	D	"2" 1 1/2"	45 - 65	38	33.0
	Apr. 71	N	"2" 1 1/2"	45 - 65	38	64.3

¹All traps in water 22 hours.

Soaking period

Calamar cruise 71-6 was planned as a specific experiment to observe the change in pot catch rate during soak periods varying from 1 to 5 days. Twenty "Z" pots and five "D" pots were set on a 1 1/2 mile line in random order in 70 to 80 fathoms on the west side of the north peak of Saba Bank. All pots were of 1 1/2-inch mesh and were baited identically with about 5 pounds of robins. All pots were set in 1 day. Five pots (4 "Z", 1 "D") were hauled and reset the next day. The following day those same five pots were again hauled and reset the next day. The following day those same five pots were again hauled and a new group of five pots were also hauled. This latter sequence was continued for an additional 3 days. On the sixth day all pots were hauled and the experiment completed. Results were as follows:

Days in water	No. pots lifted	Total no. fish	Total lbs. fish	Average	
				no fish/ pot	lbs. fish/ pot
1	34	1509	1688	44.4	49.6
2	10	506	540	50.6	54.0
3	10	569	595	56.9	59.5
4	8	279	369	34.9	46.1
5	5	216	231	43.2	46.2

There is an increase of about 5 pounds per lift between 1 and 2 and between 2 and 3 days soaking, after which the catch rate declined back to about 46 pounds/lift. From the appearance of bait strings observed during the experiment, the rise and fall of catch rates was closely coupled to the time during which bait stayed available to the fish before falling off the wires and out of the trap.

DISCUSSION

The species composition of trap catches varied considerably throughout the region. A number of factors, including geographic area, fishing depth, mesh size, and to some extent, bait, affect the variation of species. The most important of these is felt to be the depth. Generally speaking, the species composition available to the pots will become less complex and the proportion of snapper will increase as the depth increases. Where it is not yet physically possible to fish pots on the precipitous bank peripheral slopes, fishing will be limited to the usually shallower edges and the species composition of the catch will be so affected and be more complex. It was found

during our explorations that only the slopes of the banks in the northern Leeward Islands, and then only on the slopes facing away from the prevailing current (usually north and northwest), are gradual enough to permit pot fishing down to 100 fathoms and below. Consequently, in this area, catches were overwhelmingly dominated by silk snapper. This was most fortunate as this particular area appears to hold a high level of ciguatera type fish poisoning (Halstead 1970) which was not reported from any of the nearly 20,000 pounds of silk snapper caught from this area and sold by the project.

Because species composition is related to the sizes of fish retained by the pot, it will also vary with a change in mesh size. This is because a larger mesh size will allow small fish to escape from the trap, but will retain the larger (and usually more desirable) ones.

Mesh size can be applied as a fishery management tool also. During *Calamar* cruise 70-8 on Saba Bank, at one station 545 silk snappers were caught and measured. Twelve 2-inch mesh "Z" pots caught 223 of these, while

Appendix V. Trap positions Saba Bank

