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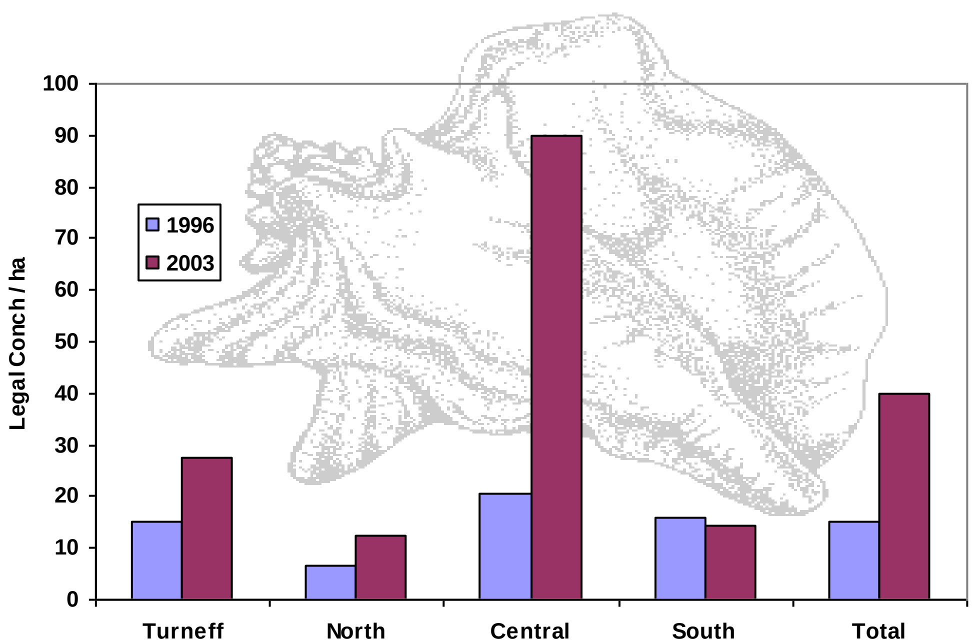
Workshop of 23-26 February 2004
Fisheries Department, Belize City, Belize



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ANALYSIS OF DATA COLLECTED DURING THE QUEEN CONCH (*STROMBUS GIGAS*) VISUAL SURVEYS OF NOVEMBER 2003 IN BELIZE

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TABLE OF CONTENTS

EEXCUTIVE SUMMARY

The queen conch (*Strombus gigas*) has been Belize's second largest marine export commodity for more than three decades. In 1992 the queen conch was placed on the CITES (Convention for International Trade in Endangered Species) Appendix II list. In August 2003, CITES concluded that Belize's conch population was showing evidence of severe decline. As a result, Belize was placed in the Category (ii) list of countries, which were recommended to undertake certain actions in order to avoid a suspension of trade in conch.

In response to the CITES review and recommendations, the Belize Fisheries Department carried out a field survey in November 2003 to: (i) assess the status of the queen conch stock in Belize's shallow coastal waters, and (ii) develop recommendations for managing this important resource. Following completion of this survey, the government of Belize, with assistance from the CRFM and CFMC (Caribbean Fishery Management Council), held a workshop during 23-26 February 2004 to analyse the survey data. This document is a report of the data analyses conducted during that workshop.

The results of the data analysis indicated a threefold increase in the density of the exploitable queen conch stock, since the last survey analysis conducted in 1996, with the greatest increases observed in central and northern areas. Additionally, adult conch in deeper water were found to be significantly older and larger than adult conch found in shallow areas. These observations suggest that some young conch settle in deeper water and so contribute to the creation of deeper water populations. Such populations probably serve as reserves for the spawning adults that supply young conch for settlement in both shallow and deep areas in Belize.

Though sampling was limited during the 2003 survey, there was some evidence showing that marine reserves help to sustain an increased abundance, as well an increased size of adult conch. This result demonstrates the potential of marine reserves as an effective tool for managing the queen conch resource in Belize.

Based on the survey data analysis results, the workshop concluded that the current ban on scuba should be maintained, as it appears to be effective in protecting the deeper water adult conch of spawning size. It was also concluded that the fishery should be managed to maximize yield per recruit. By controlling fishing pressure in key areas, the results showed that the network of marine reserves serves both to enhance yield per recruit and to facilitate spawning in shallow areas. Both an increase in the minimum size and strengthening the system of marine reserves were therefore recommended for ensuring an increase in the yield per recruit and hence overall fishery yield.

1. INTRODUCTION

The Queen Conch (*Strombus gigas*) has been one of the most important fishery resources in the Caribbean region. This species has been Belize's second largest marine export commodity for more than three decades. It is fished for local consumption and for the export market, which had a value of BZ $2.8 million in 2001.

In 1992 the Queen Conch was placed on the CITES (Convention for International Trade in Endangered Species) Appendix II list. Species listed in Appendix II are not believed to be in immediate danger of extinction, but which could become so unless trade of such species was strictly regulated so as to ensure that usage did not threaten the survival of the species. Trade in Appendix II species is controlled through the allocation of permits.

In August 2003, a CITES review of significant trade in specimens of Appendix II species (Resolution Conf.12.8 and Decision 12.75) reported that Belize's conch population was considered to be overfished and was showing evidence of severe decline. Belize was placed in the Category (ii) list of countries, which were recommended to undertake certain actions in order to avoid a suspension of trade in conch. Given certain data and evidence, CITES is considering including queen conch in its Appendix I list. This action would prohibit trade in queen conch, except for very special circumstances. Given the importance of the queen conch fishery in Belize, a trade restriction in respect of queen conch will present major socio-economic difficulties for almost 2,000 active Belizean artisanal fishermen.

In response to the CITES review and recommendations, the Belize Fisheries Department carried out a field survey in November 2003 to: (i) assess the status of the queen conch (*Strombus gigas*) stock in Belize's shallow coastal waters, and (ii) develop recommendations for managing this important resource. By this means, Belize also hopes to alleviate CITES' concerns about the status and management of queen conch in Belize.

The government of Belize, with assistance from the CRFM (Caribbean Regional Fisheries Mechanism) and CFMC (Caribbean Fishery Management Council), held a workshop to analyze the 2003 survey data. During this workshop, which was held 23-26 February 2004, several staff of the Fisheries Department in Belize, with assistance from CRFM and CFMC staff, compiled, cleaned and analyzed the 2003 queen conch survey data. The 2003 trends were also compared with the results obtained from a similar survey of queen conch conducted in Belize in 1996, and management recommendations were developed for the queen conch fishery. The workshop format also provided the opportunity for Department staff to be trained in the manipulation and analysis of visual survey data.

2. METHODOLOGY

2.1. Sampling strategy

The Belize coastal area and atolls were divided into 6 major zones in which 70 transects were set and sampled (Figure 1). The methodology consisted of setting and sampling line transects: these were either 1180 m or 590 m long, with divers surveying up to 2 m on both sides of the transect line to give an overall width of 4 m. The transects were aligned perpendicular to the reef crest. These transects began at the 15 m depth contour along the main barrier reef as well as the atolls. The distance between adjacent transects were five (5) km where possible. Most of the Marine Reserves were not included in the 2003 survey, as these have ongoing monitoring programmes for conch. Some data, collected during surveys of the Hol Chan Marine Reserve were also examined, and these trends were compared with other survey area observations. Data from the Glovers Reef Marine Reserve were not included in the present analysis, as sampling in this area was not random, but focused only in areas where conch were known to be abundant (Gongora, pers comm.).

On the atolls, divers began transects from the 15 m depth mark at the eastern end of each transect (seaward), and swam due west (towards the mainland of Belize) until they encounter the 15 m depth mark on that side. Sometimes, if 15 m depths were encountered during the course of the transect within the atoll, the diver(s) determined the feasibility of continuing to sample the transect along the same line until 15 m depth mark at the west side close to the mainland.

Sampling of the Barrier Reef transects occurred at the 15 m depth mark on the landward side (i.e. within the barrier reef or shelf lagoon), and continued eastward, i.e. seaward, until the reef crest was reached.

Fishermen were interviewed to determine the location of some of the deep-water stocks of Queen Conch along the Barrier Reef system and on the atolls. These sites were also surveyed using the line transect method.

2.2 Data collected

As the diver swam along each transect, the following types of data were recorded.

- i) Numbers of queen conch, by size category (see section 2.3, and Table 1) and the distances at which these occurred along each transect.
- ii) Shell length and lip thickness of sampled conch were recorded and measured. Shell length was measured to the nearest 0.1 cm and lip thickness was measured to the nearest mm.
- iii) Data on habitat and water depth were recorded only when queen conch was observed, and not the distances at which these parameters changed along the transect.

2.3 Data Preparation and Analysis

In order to facilitate comparison with the 1996 survey analysis results, the size categories of queen conch were the same as used in the 1996 survey (see Table 1). Conch shell length data were placed into these size categories to facilitate estimation of the frequency of occurrence of each size category within transects and hence by areas, by depth and also by habitat. The raw data were entered into an Excel spreadsheet that facilitated calculation of the total numbers of conch occurring in each size category within each transect.

2.3.1 Estimation of conch density

Data on transect lengths and widths were used to estimate transect areas and hence sampled sea areas. Density estimates were not normally distributed, and could not be made so with any data transformation (see Appeldoorn and Rolke, 1996). Hence estimates of variance and hence the confidence limits of the density estimates were obtained by applying a bootstrapping technique (Efron, 1982).

Habitat and depth composition and distribution in the sampled areas were assumed to be representative of the habitat and depth composition and distribution of the larger area of interest. Using the same values for the larger areas as the 1996 study, the density of conch in the sampled transect areas was raised to give the total conch density for the larger area.

In view of the fact that habitat and depth were not recorded whenever these parameters changed, it was not possible to estimate density of conch per unit of area of habitat, or per unit of area for the various depth categories. Instead, it was only possible to estimate the frequency of observed occurrence in each habitat and at each depth category.

2.3.2 *Estimation of exploited biomass*

The minimum legal shell length of queen conch in Belize is 7 in or 17.8 cm and minimum legal meat weight is 3 oz or 85 g. However, Appeldoorn and Rolke (1996) noted that the minimum meat weight of 85 g would be associated with a shell length less than 17.8 cm, and concluded that it was more reasonable to assume that 15 cm was the legal minimum shell length in practice. Given that this regulation is still in effect, the present study also utilized 15 cm as the effective minimum legal shell length.

The total number of conch of legal shell length, and hence which could be taken by the fishery, was multiplied by the average meat weight of individual conch in order to estimate total exploited biomass, i.e.

Exploited Biomass = No. legal conch x Average individual meat weight……………. 1.

The average meat weight of individual conch was assumed to be 6 oz or 170 g, as this was the figure used in the 1996 analysis and was considered to be still reasonable in 2003-04 (Gongora, pers comm.).

2.3.3. *Estimation of MSY*

Having obtained the value of the average biomass, approximate estimates of MSY was then acquired using the following MSY estimators that assumed surplus production followed the Schaefer (linear) and Fox (exponential) models (Garcia *et al*., 1989).

$MSY = (MB_c)2 / (2MB)-Y_c$ …...Schaefer model estimator……………………………. 2

$MSY = MB_c\exp\{Y_c/(MB_c)-1\}$ ……Fox model estimator………………….………….. 3

where,

M is natural mortality, B_c is average biomass, and Y_c is the current yield from the fishery. For the present study, M was assumed to be 0.6 (see explanation in Appeldoorn and Rolke, 1996), and the 2003 yield value, which was 285,062.8 kg, was used as the value of the current yield. Garcia *et al*. (1989) provides a detailed explanation of the derivations of the two MSY estimators noted above.

3. RESULTS AND DISCUSSIONS

A total of 70 transects were set and sampled within the 6 zones (Figure1). The stations found in each zone, together with their classifications in terms of fishing pressure and water depth are shown in table 2. The total number of legal sized conch included conch classified as J4, sub-adult, adult and samba individuals. Using equation 1, it was possible to calculate the density of legal sized conch observed in each transect (also given in table 2). Table 3 provides a summary of the average densities of legal sized conch obtained in transects classified by zone, depth, and level of protection. These data show that conch densities in 'shallow water' transects were much notably lower than those in 'deep water' transects. Similarly, conch densities in 'fished area' transects were much less than those observed in 'marine reserve' transects (see table 3). Given though that the number of 'deep water' and 'marine reserve' transects was few compared to the number of 'fished area' transects (table 3), these results are preliminary and additional data are needed to warrant these conclusions.

In general, the density of legal-sized conch appeared to have increased by a factor of 3 since 1996, and this was statistically significant. The increases were observed mostly in the north and central areas, with highest increases recorded in the central areas (Figure 2). The gradual increase in landings observed during the past decade and particularly in the most recent 6-year period, coupled with reports that juvenile conch are more abundant, are in accord with these observations.

In zone 4 that lies in the north, data were available for both 'fished area' and 'marine reserve' transects. Comparison of the relative frequencies of the various size categories of conch occurring in these transects indicated a higher abundance of both very young as well as adult conch in reserves than in fished areas (Figure 3). This implies that the reserve areas provide effective protection to these two stages of conch.

Similar studies in the northern areas were carried out in September 2003, and support the observation that more conch are able to reach the adult stage in reserves areas than in fished areas. The available data from the September 2003 study revealed that average conch shell length was higher in the fully protected Hol Chan Marine Reserve than in the partially protected area of Mexico Rocks. Similarly, conch density was highest within the Hol Chan Marine Reserve, decreasing with distance from the areas of full protection (Figure 4).

Comparison of shell lip thickness data from 'shallow water' and 'deep water' transects indicated a higher lip thickness in adults found in deep water (Figure 5a). Moreover, there was limited overlap in the distributions observed. These observations suggest that 'deep-water' adult conch are significantly older than adults found in the shallow areas, and that the 'deep water' resource may be separate from the 'shallow water' resource. If so, and considering the mobile larval stage of conch, it is not unreasonable to assume that the deep-water resource serves as a reserve for replenishing the supply of conch settling in shallow areas and recruiting to the fishery. This would also explain why the fishery, which is based in shallow water areas and which tends to harvest a large portion of juveniles, has been able to maintain landings at a relatively stable level.

A similar result was obtained for the comparison of adult shell length between 'shallow water' and 'deep water' transects (Figure 5b). Again, the average shell length of adult conch in 'deep water' areas was found to be higher than the average shell length of adult conch inhabiting 'shallow water' areas. These data suggest that adult conch in 'deep water' areas tend to be larger than adults found in 'shallow water' areas. The 'deep water' resource therefore appears to have at least some separation from the resource occurring in shallow water areas. Additionally, given the overlapping shell lengths observed in fig. 5b, it is likely that there may be direct larval settlement in 'deep water' areas. Further sampling research are needed to determine the extent of the 'deep water' resource and the possibility of direct larval recruitment in these areas. If larval settlement can take place in 'deep water' areas, then the healthier 'deep water' resource is able to supply new larvae to both 'shallow water' and 'deep water' areas.

The relative frequencies of occurrence of the different size categories of conch in different habitats are shown in Figure 6. These data showed that the smallest sizes of conch (J1 category) were only observed in habitats containing sand, grass, or dictyota components. J1 sizes were not observed in habitats containing algae or reef habitats. The J2-sizes tended to occur in habitats having seagrass, sand, and reef components, but with no algae and rubble present. On the other hand, the J3 and J4 sizes appeared to be less selective. The adults were observed in habitats containing components of coral, reef, seagrass, algae, or sand components, but were not observed in habitats with rubble and dictyota components present. Additionally, no adults were observed in habitats composed of a combination of brown algae and sand only. The juvenile stages, as well as the adults, therefore appear to have more specific habitats preferences than the middle size categories of conch.

Annual estimated queen conch production for the period 1977-2003 fluctuated from year to year, but showed a gradual overall increase since the early 1990s, with more obvious increases recorded in the most recent 6-year period (Figure 7). The number of legal-sized conch available to the fishery in Belize was estimated to be 6,019,652, with the 95% confidence interval for this estimate being 3,582,241-9,560,211 (Table 3). Using the figure of 6,019,652 individuals, the exploitable biomass was estimated to be 726,804.5 kg. This gave MSY estimates of 323,910 kg {95% C.I.= [287,854 – 436,019] and 308,438 kg {95% C.I.= [286,363 - 384,526], using the Schaefer and Fox estimators respectively. The sensitivity of the two estimators to the value of M used is shown in figs. 8 and 9. The range of possible MSY values generated by the Fox estimator for different M values was comparatively smaller to that obtained by the Schaefer estimator, showing it to be less sensitive to the value of M used. If two-thirds of the MSY value is considered to be a suitable management limit reference point as it usually lies close to the point of Maximum Economic Yield (MEY), this limit would be 213,780 kg and 203,569 kg, using the MSY value generated by the Schaefer and Fox estimator respectively. While the current yield of 285,062.8 kg is lower than both the MSY estimates, it is higher than the more precautionary limits of 2/3 MSY noted previously.

The fishery has always harvested a notable portion of juvenile conch, but landings have continued to increase since 1997. It is possible that the fishery, which is conducted in the ‘shallow water’ areas of Belize, is being sustained by the nearby ‘deep water’ resource that is not currently accessible to the fishery and which is capable of serving as a reserve supply of recruiting individuals for the ‘shallow water’ fishery. If so, it may be more suitable for management to attain optimal fishery performance by maximising the yield per recruit, and this can be achieved by increasing the current minimum size limit. It would also maximise spawning possibilities in the ‘shallow water’ areas. In addition, management should also continue to protect the ‘deep water’ reserve by maintaining the present ban on the use of scuba gear.

4. CONCLUSIONS

The fishery harvests a notable portion of juvenile conch, but the ‘shallow water’ production appears to be sustained by recruitment from the ‘deep water’ resource. The current ban on scuba should therefore be maintained, as it appears to be effective in protecting the ‘deep water’ adult conch of spawning size.

The fishery should be managed to maximize yield per recruit, which would also enhance spawning in the ‘shallow water’ areas. This can be achieved by increasing the minimum landing size of conch.

By controlling fishing pressure in key areas, the results showed that the network of marine reserves serves both to enhance yield per recruit through spillover, and to facilitate spawning in shallow areas. Both an increase in the minimum size and strengthening the system of marine reserves should therefore ensure an increase in the yield per recruit and hence overall fishery yield.

5. RECOMMENDATIONS

Future work

1) Future surveys should include more samples to quantify the effect of the 'shallow water' reserves. Sampling should be conducted within the reserve, near the reserve, and outside the reserve.
2) Future surveys should try to collect data to confirm the occurrence of reproduction in 'shallow water' and 'deep water' areas.
3) Future surveys should conduct more sampling in 'deep water' areas to determine the extent of this resource, as well as the presence of juvenile conch in these areas.
4) Smaller-scale surveys can be carried out annually, to monitor changes in recruitment, size structure, and spawning activities.
5) Studies should be conducted to compare the morphologies of 'deep water' and 'shallow water' conch to determine their connectivity.
6) There is a need to establish length-weight(s) relationship(s).

Management

1) The current gear and area restrictions that prevent 'deep water' fishing should be maintained.
2) An increase in yield per recruit will be achieved if the minimum size limit (s) are (shell length and meat weight) increased. The current minimum meat weight of 3 oz (85 g) is equivalent to a conch with shell length less than 18 cm.
3) The protection afforded by the marine reserves was measurable in the results obtained during the 2003 survey. Hence consideration should be given to strengthening and expanding the current system of marine reserves. Reserve areas should be strategically positioned so as to allow adequate escapement of maturing conch to the 'deep water' areas.

6. REFERENCE

Appeldoorn, R. S. and W. Rolke. (1996). Stock abundance and potential yield of the queen conch resource in Belize. *CARICOM Fishery Report*, 2. 30 pp.

Efron, B. (1982). *The Jacknife, the Bootstrap and Other Resampling Plans*. CBMS-NSF Regional Conference Series in Applied Mathematics, Monograph 38, Society for Industrial and Applied Mathematics, Philadelphia.

Garcia, S., P. Sparre and J. Csirke. (1989). Estimating Surplus Production and Maximum Sustainable Yield from Biomass data when catch and effort time series are not available. *Fisheries Research*, **8**, p13-23.

Table 1. Definitions of the various size categories of queen conch observed during the survey. These size categories were identical to the ones used to analyse the 1996 survey data (see Table 2 of Appeldoorn and Rolke, 1996)

Size code	**Definition**
J1	Juvenile with shell length < 5 cm
J2	Juvenile with shell length 5-10 cm

J3	Juvenile with shell length 10-15 cm
J4	Juvenile with shell length >15 cm
Subadults	Flared shell lip present but not fully formed
Adults	Flared shell lip fully formed and showing minimal to moderate erosion
Samba	Thick worn shell lip and showing heavy erosion and epizootic fouling

Table 2. List of stations and zones in which transects were set, together with their classification in terms of: (i) level of protection against fishing, i.e. Reserve (R) vs Fished (F) station; and (ii) water depth, i.e. shallow (S) or Deep (D) station, and density of legal conch (n/ha) estimated for each transect. Data for Glover's Reef (GRMR) were not available for analysis during the workshop. The GRMR data were not included afterwards, as the sampling strategy was found to be non-random (Gongora, pers. comm.)

Location of transects	Zone	Reserve	DepthClass	Density of Legal conch (n/ha)
CockroachCaye	1	F	D	84.75
Grass Caye (Turneffe)	1	F	D	84.75
Turneffe Island caye bockel	1	F	S	23.31
Turneffe Island calabash caye	1	F	S	50.85
Turneffe Island flats	1	F	S	8.47
Average density of station/zone class				27.54
Half moon caye (east)	2	R	D	21.19
Halfmoon Caye (West, near mooring buoys)	2	R	S	118.64
GRMR – 1	3	F	S	
GRMR – 2	3	F	S	
GRMR – 3	3	F	S	
GRMR – 4	3	F	S	
GRMR (by:North East Caye) – 5	3	F	S	
GRMR – 6	3	F	S	
GRMR – transect 7	3	F	S	
GRMR – transect 8	3	F	S	
GRMR – transect 9	3	F	S	
Bachalar Chico robles point	4	P	D	77.87
Bachalar Chico sandy valley	4	R	D	27.17
Bachalar Chico rocky point –1	4	R	D	24.39
Bachalar Chico rocky point –2	4	R	D	141.67

Average density of station/zone class				67.77
Northern area - 1	4	F	S	28.85
Northern area - 2	4	F	S	9.87
Nothern area - 3	4	F	S	2.27
Northern area - 4	4	F	S	18.66
Northern areas - 5	4	F	S	16.67
Northern areas - 6	4	F	S	7.81
Northern areas - 8	4	F	S	6.82
Northern areas - 9	4	F	S	40.00
Northern areas - 10	4	F	S	17.00
Northern areas - 11	4	F	S	21.90
Northern areas - 12	4	F	S	0.00
Northern areas - 13	4	F	S	2.40
Northern areas - 14	4	F	S	2.07
Northern areas - 15	4	F	S	0.00
Average density of station/zone class				12.45
Northern areas - 7	4	R	S	500.00
Gallows Points – 1	5	F	S	21.19
Gallows Points – 2	5	F	S	8.47
Gallows Points – 3	5	F	S	4.24
Gallows Points – 4	5	F	S	194.92
Goffs Caye	5	F	S	29.66
English Caye	5	F	S	118.64
Rendeuz Caye	5	F	S	33.90
Rendeuz Caye	5	F	S	309.32
Cregg Caye	5	F	S	21.19
Tobacco Caye –1	5	F	S	16.95
Tobacco Caye – 2	5	F	S	8.47
South Water Caye	5	F	S	148.31
Caribo	5	F	S	93.22
Grand Channel	5	F	S	288.14
Pass Grand Channel	5	F	S	226.69
button wood caye – 1	5	F	S	0.00
button wood caye – 2	5	F	S	4.24
Average density of station/zone class				89.86
pampion caye – 1	6	F	S	12.71
pampion caye – 2	6	F	S	0.00
Hatchet caye	6	F	S	8.47
silk caye	6	F	S	12.71
pampion caye – 3	6	F	S	50.85
Ranguanna	6	F	S	0.00
tomowing area – 1	6	F	S	16.95
tomowing area – 2	6	F	S	0.00
tomowing area – 3	6	F	S	0.00
tomowing area – 4	6	F	S	0.00

Ragged Caye South	6	F	S	53.33
Nicholas Caye West	6	F	S	46.67
Tom Owens – 1	6	F	S	29.66
Tom Owens – 2	6	F	S	0.00
Coco Solo – 1	6	F	S	12.71
Coco Solo – 2	6	F	S	0.00
Coco Solo – 3	6	F	S	0.00
Average density of station/zone class				14.36

Table 3. The average density of conch by zone, depth nd level of protection. The number of transects and zone areas are also given. Zone areas were the same as used by Appeldoorn and Rolke (1996).

Zone Number	Name of Zone	Shallow - Fished	N	Lower 95%CL	Upper 95%CL	Shallow - Reserve	N	Deep - Fished	N	Deep - Reserve	N	Area (ha)
1	Turneffe	27.54	3					84.75	2			18,997.7
2	Lighthouse					118.64	1			21.19	1	21,522.6
3	Glovers											20,161.4
4	North	12.45	14	8.71	20.76	500.00	1			67.77	4	13,339.7
5	Central	89.86	17	55.58	152.29							66,178.9
6	South	14.36	17	7.73	25.82							11,140.7
	Total number of transects		51				2		2		5	
	Average Density	39.78		23.67	63.17	309.32		84.75		58.46		151,341.0
	Weighted	36.05										
	Total number of legal conch	6,019,652		3,582,241	9,560,211							

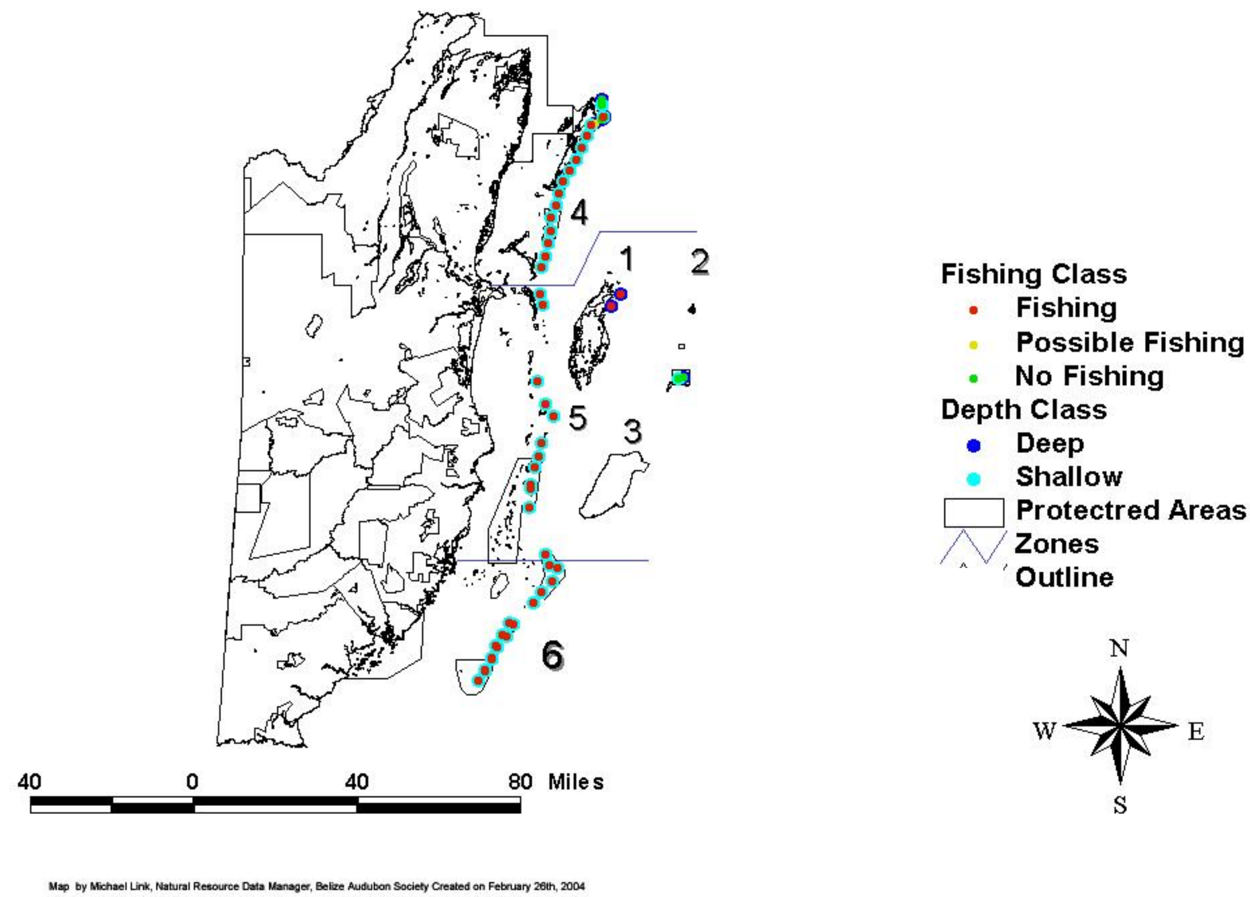


Figure 1. Chart of Belize showing the six major zones and the stations in which 70 transects were sampled.

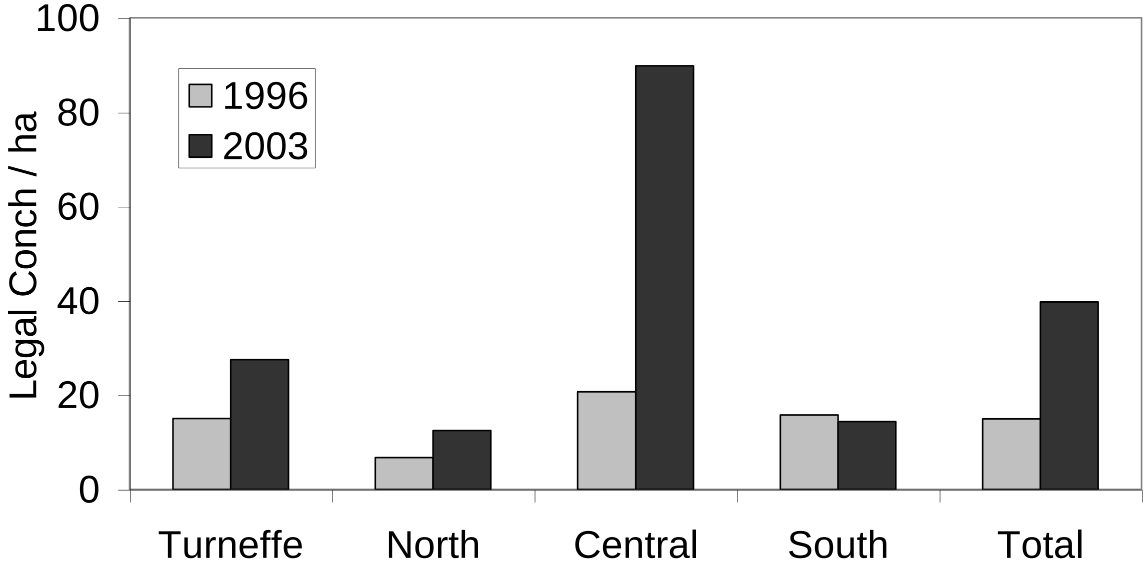


Figure 2. Average densities of legal sized queen conch in the different zones, based on data collected during 1996 and 2003.

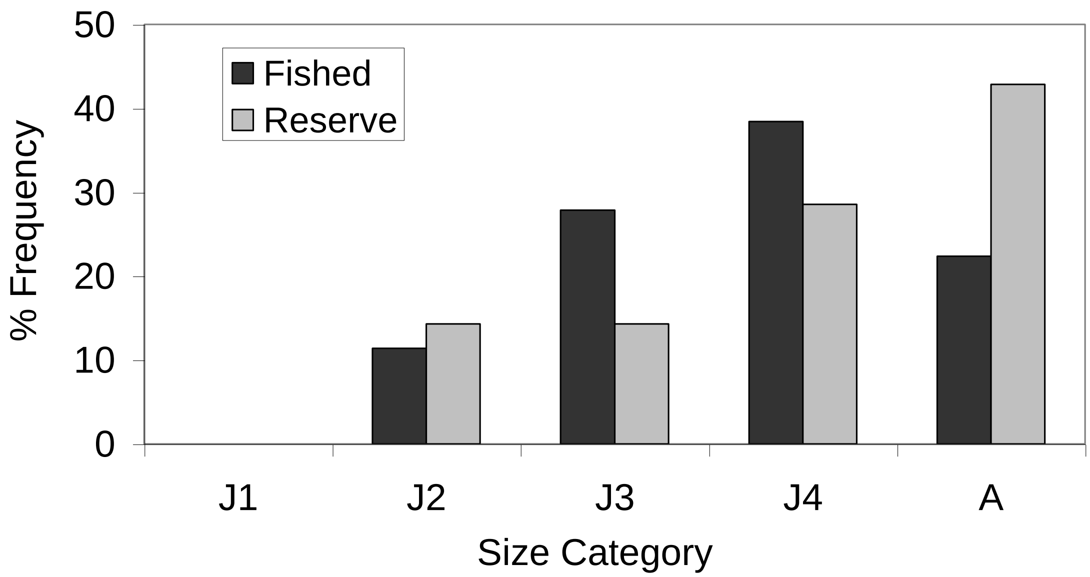
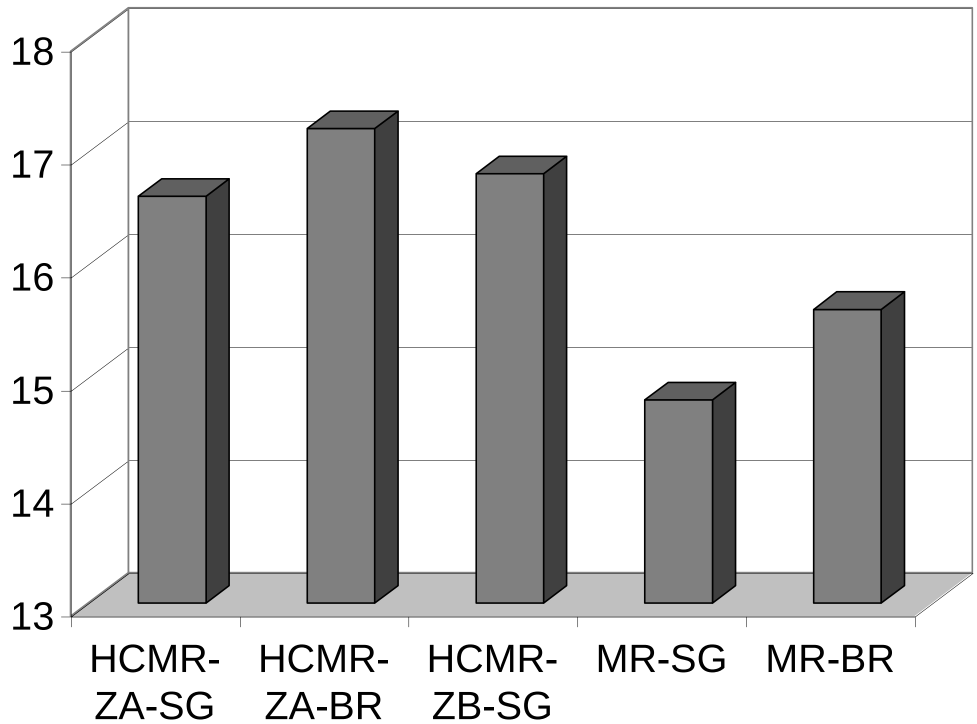
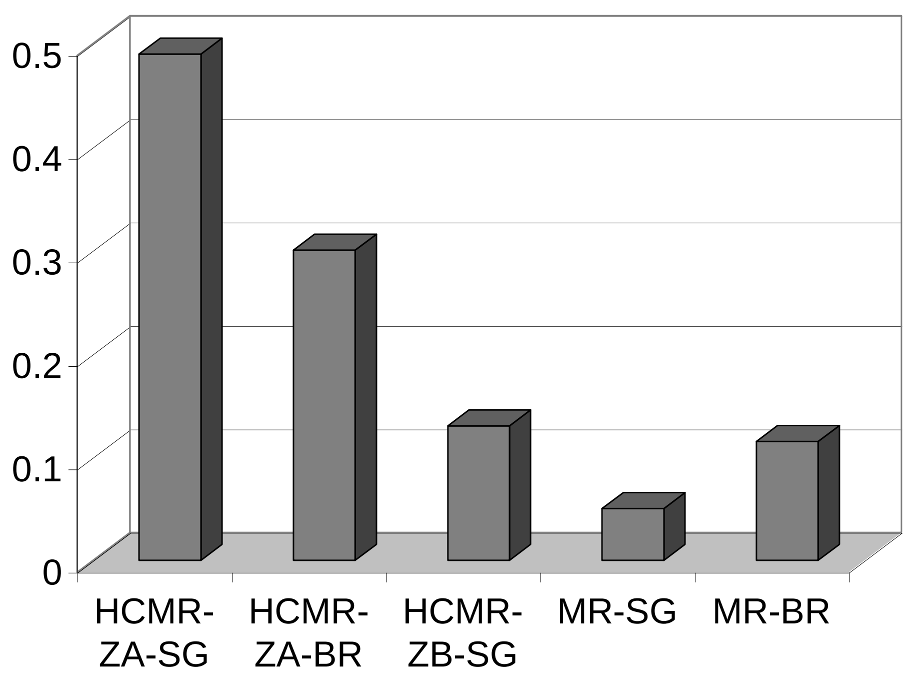


Figure 3. Percentage frequency of occurrence of the various size categories of queen conch in fished areas and Marine Reserves located within zone 4.

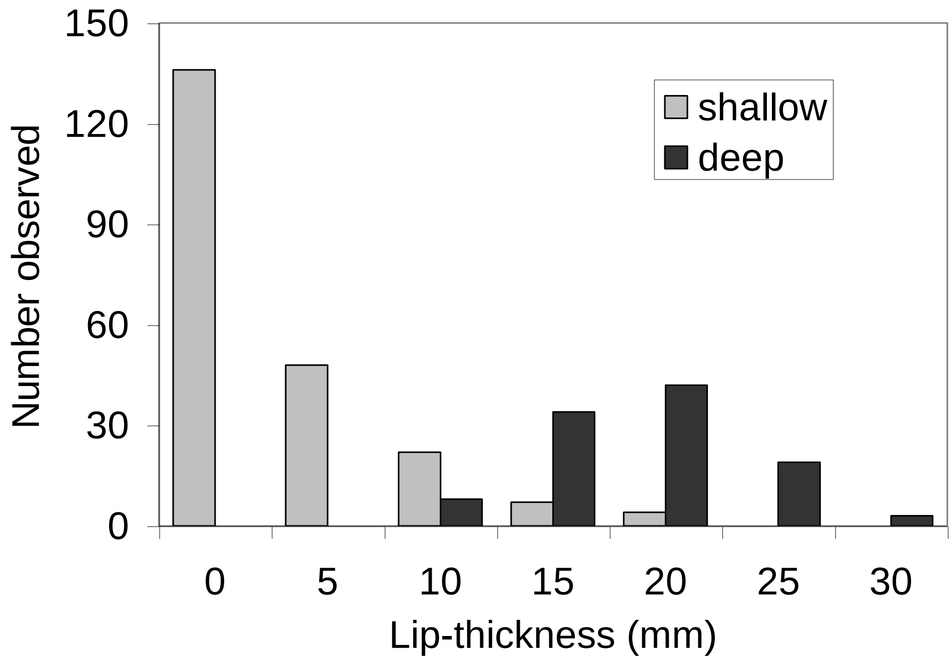


(a)

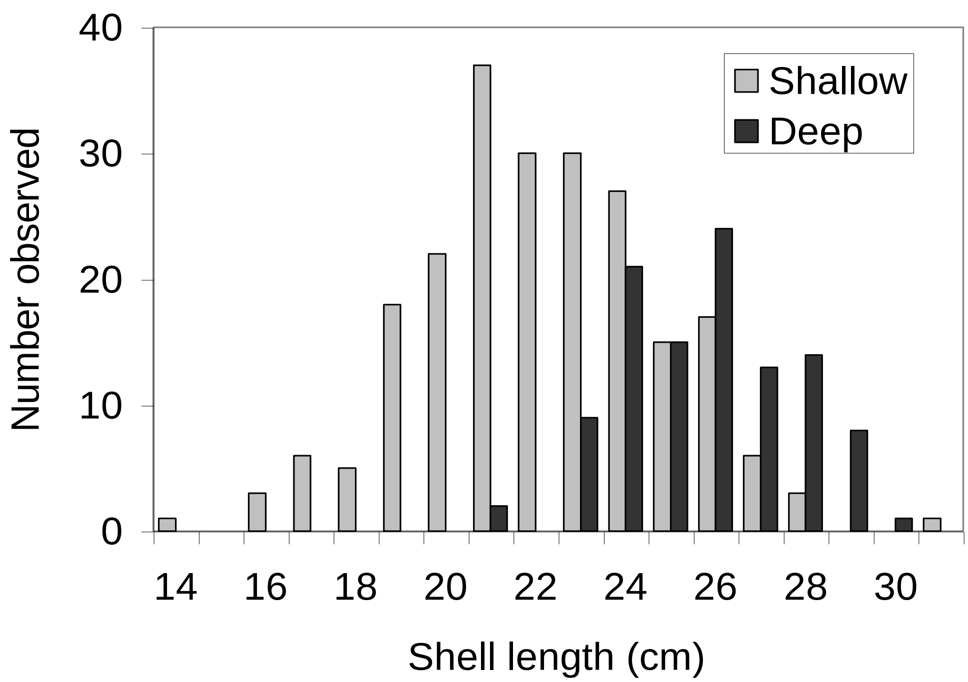


(b)

Figure 4. Results of visual survey conducted in September 2003 in sea grass (SG) and back Reef (BR) areas of the Hol Chan Marine Reserve (HCMR) and Mexico Rocks (MR) showing: (a) average shell length of queen conch and (b) average density of queen conch.



(a)



(b)

Figure 5. Frequencies of (a) adult lip thickness and (b) adult shell length in shallow and deep water stations.

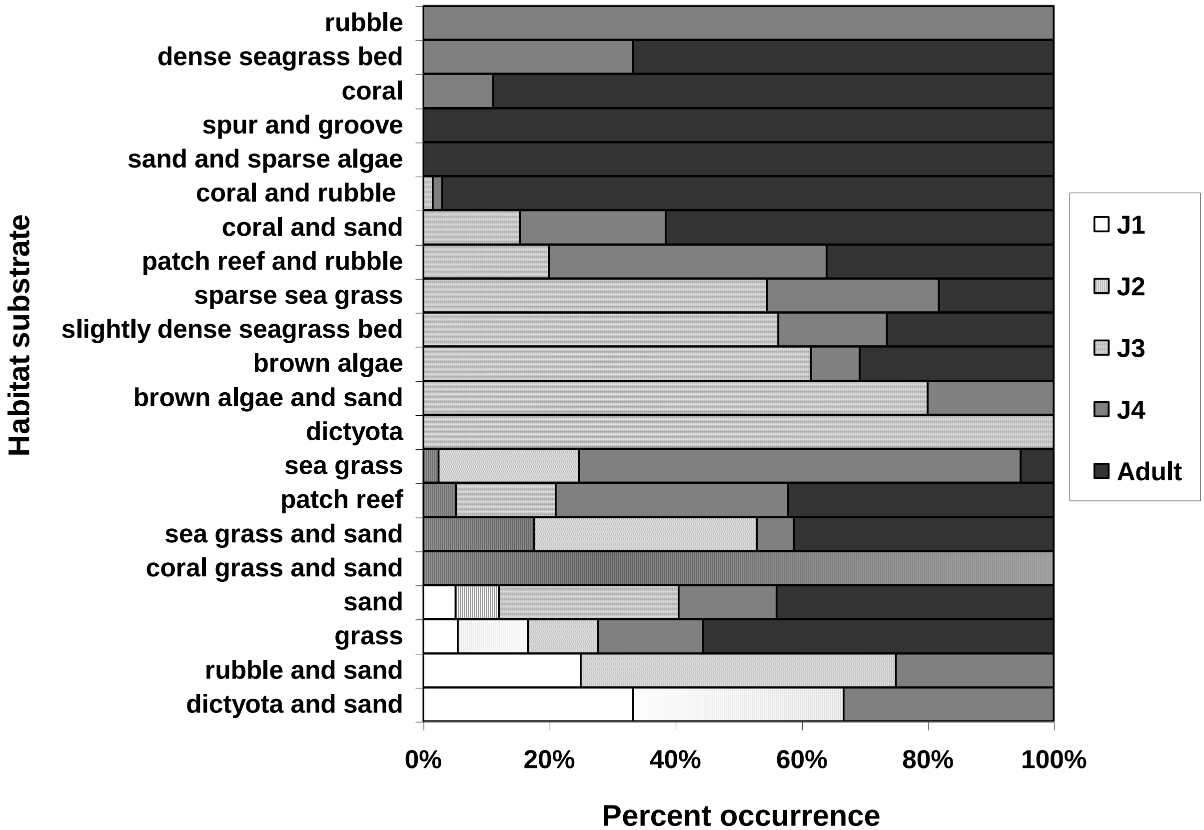


Figure 6. Relative percentage occurrence of various size categories of conch in the different habitats observed and recorded.

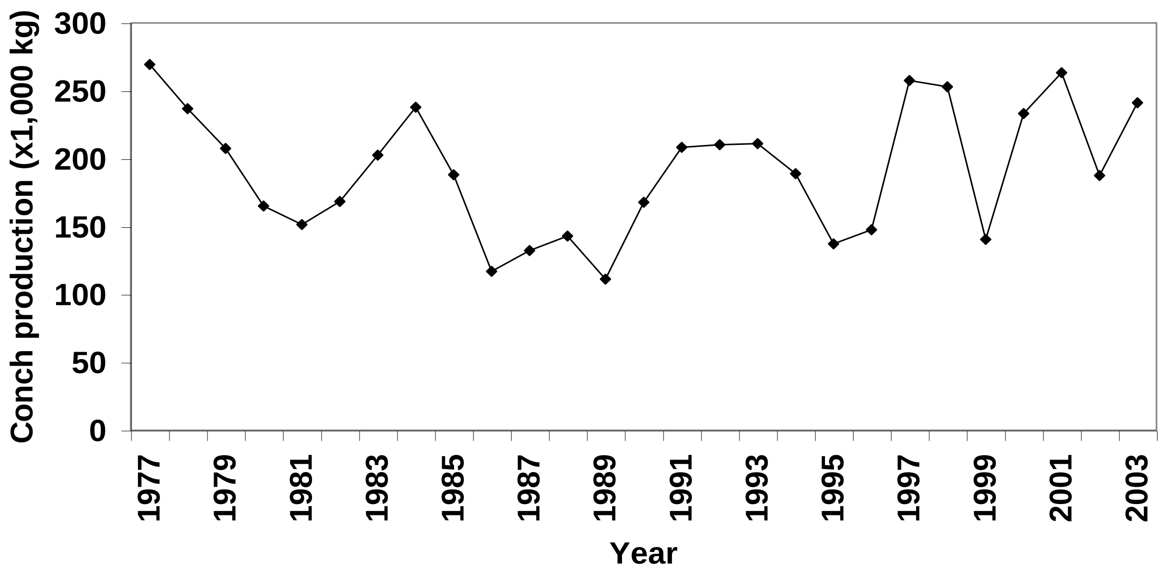


Figure 7. Conch production (lb) in Belize during 1977-2003.

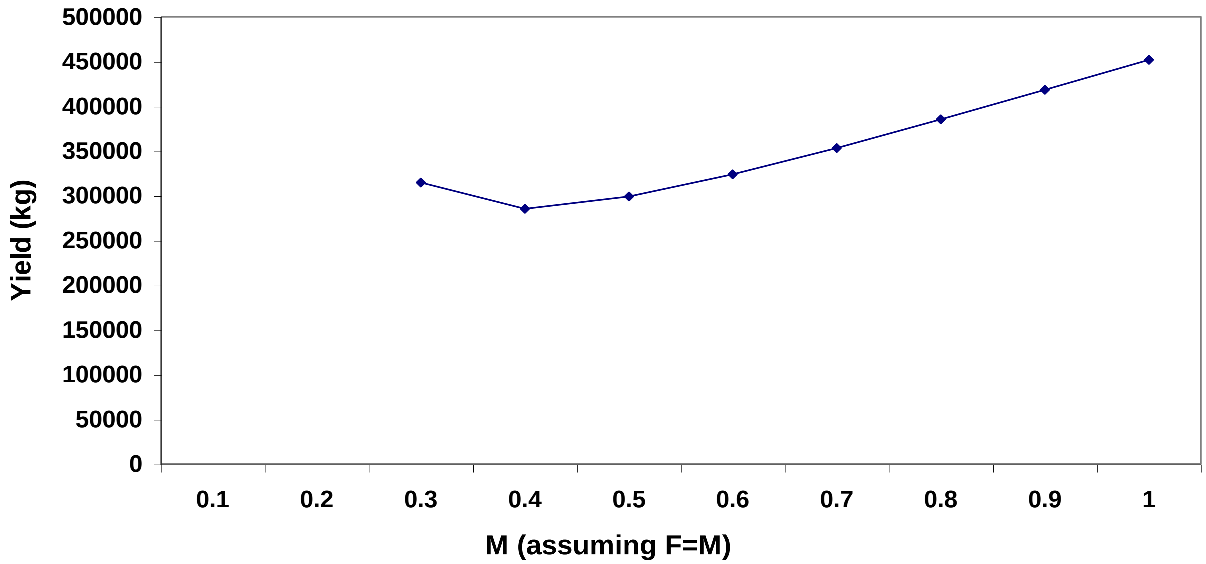


Figure 8. Sensitivity of the Schaefer estimator for MSY.

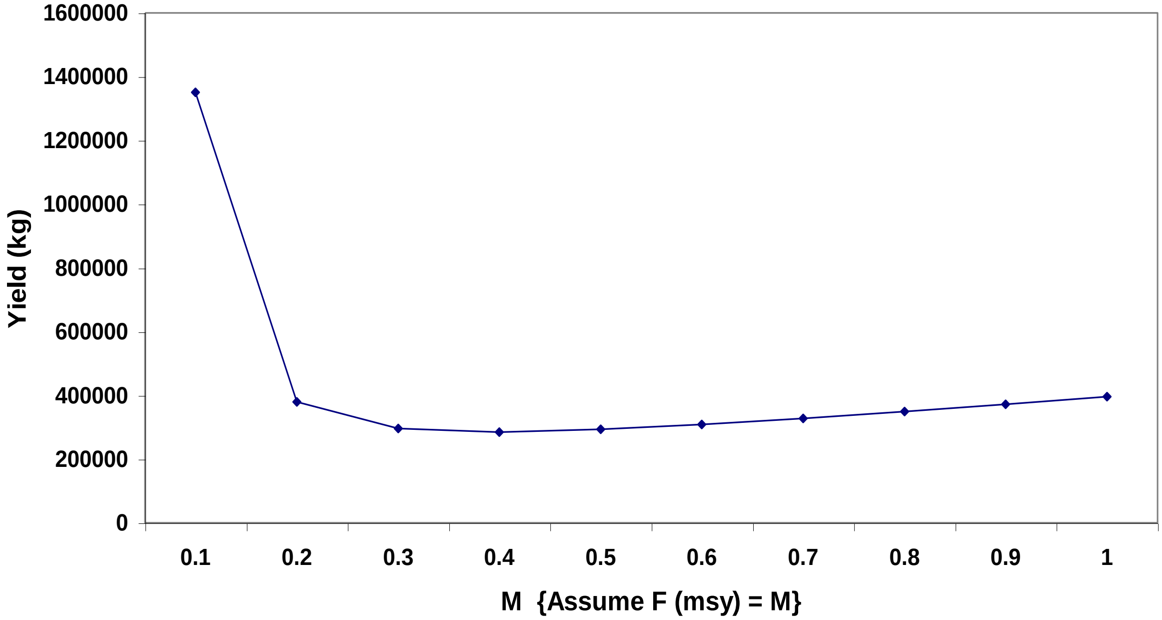


Figure 9. Sensitivity of the Fox estimator for MSY.