2010

PEDRO BANK QUEEN CONCH FISHERY, ASSESSMENT & TAC RECOMMENDATION

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EXECUTIVE SUMMARY

For the upcoming 2010 queen conch fishing season, recommendations for total allowable catch (TAC) were based on the analyses of catch and effort data collected during the 2009 fishing season, as well as previously available information on the abundance and density of the conch stock on the Pedro Bank. This assessment went further than that of 2009 by incorporating all available data to determine total allowable catch for the 2010 fishing season as well as recommending future options for establishing catch limits for the Pedro Bank conch fishery

The conch operators continued to comply with their conditions of licence by providing catch and effort records throughout the fishing season. These data formed the basis for this report which among other things: i) validated key assumptions about the distribution of fishing effort and total allowable catch ii) identified any significant changes in catch per unit of effort (CPUE) that may indicate a reduction in available conch biomass and iii) examined the likely state of queen conch abundance on the Pedro Bank, to recommend an appropriate level for the 2010 national TAC (NTAC).

In summary the results showed that:

a) Fishing effort for the SF&T Dolphins, which resulted in approximately half of all catches for the 2009 season, was random and extensively spread across the bank. However, no fishing took place on the western end of the bank in the 20-30 metre depths which was equivalent to the export related conch production zone 5. The implications resulted in a reduction of TAC relating to the range of the fished areas for conch.
b) The fishing levels for conch during the 2009 season apparently did not significantly change available conch densities in the conch fishery zones of the Pedro Bank.
c) Further improvements are necessary for the conch fishery monitoring programme.

Based on the conclusions reached from the analyses of the catch and effort data and other related information the following recommendations were made:

1. **The Total Allowable Catch for queen conch for the 2010 conch fishing season be set at four hundred four forty five point four seven one metric tonnes (445.471 MT).**
2. The proposed Harvest Optimization Model should be considered for adoption.
3. A biomass survey should be conducted at the end of the 2010 conch fishing season to assess the current state of the conch population on the Pedro Bank.
4. The catch and effort data collection process should be improved for the upcoming seasons.
5. The use of more predictive analytical biomass dynamic models should be utilised with improved data sets.

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INTRODUCTION

The queen conch (*Strombus gigas*) is a large edible marine gastropod of the family *Strombidae,* and is found throughout the Caribbean but with greatest populations reported for the west, central and northern Caribbean (Ehrhardt and Valle-Esquivel 2008). The fishery for queen conch has a long tradition in the Caribbean region, with the species been valued, especially for its meat, for several centuries dating back to pre-columbian times (Brownell and Stevely 1981). By the end of the mid-nineties, harvest levels have been estimated to be around 6,000t of conch meat per year, not accounting for the conch meat that is harvested for local subsistence consumption and the unknown amount of conch that is taken by illegal fishing (Chakallal and Cochrane 1996). The wholesale value of these landings is estimated to be around 60 million USD per year, but may be multiplied several fold taking into account jobs created in the processing and marketing of *Strombus gigas* products, particularly in the ornamental, tourist and restaurant industry (Chakalall and Cochrane, 1996; Appeldoorn 1994).

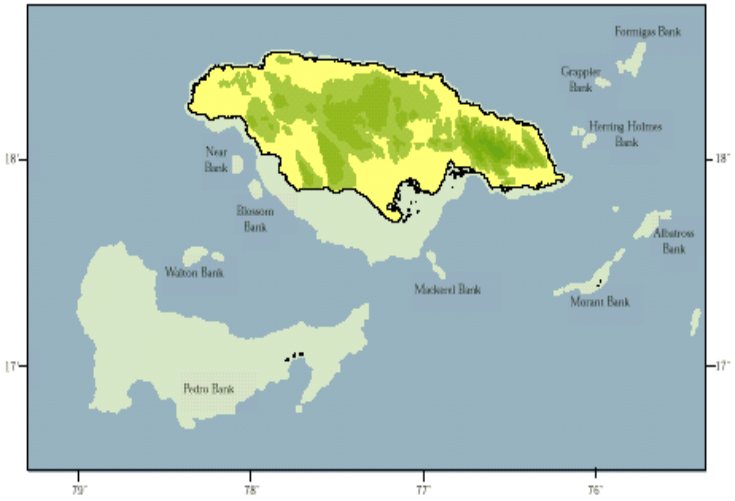


Figure 1. Mainland Jamaica and the offshore fishing grounds. The Pedro Bank to the south of the Island is the largest, and is the area where commercial fishing for conch takes place.

Jamaica has been recognised as a major conch producer regionally (Chakallal and Cochrane 1996) and continues to do so with exports averaging 500MT since 2005 (NEPA CITES export data, 2005 - 2007). The commercial fishery for queen conch is based on the Pedro Bank (Figure 1) and has been reported on by several authors (Aiken et al. 1999; Smikle 1997). The fishery is managed utilising annual total allowable catch limits and individual non-transferable quota systems (Aiken et al. 2006; Kong 1997). Total allowable catches are established based on scientific assessments of the status of the conch population on the Pedro Bank.

Since 1994, when the first quota system was introduced, all conch assessments have been based on biomass (stock abundance) surveys of the conch population on the Pedro Bank (Appeldoorn 1995; Tewfik and Appeldoorn 1998; Smikle and Appeldoorn 2002). This assessment follows the approach utilised in for the previous fishing season (Smikle 2009) where catch and effort data was analysed to recommend a catch quota for the 2009 fishing season as an alternative to unavailable conch abundance estimates. This assessment goes further by incorporating all available data to determine total allowable

catch for the 2010 fishing season as well as recommending future options for establishing catch limits for the Pedro Bank conch fishery.

OBJECTIVES

To determine an appropriate level of total allowable catch for queen conch fishery on the Pedro Bank based on analysis of available catch and effort data and other relevant information.

METHODS

1. Data from conch vessel log sheets were compiled into a spreadsheet (MS EXCEL) and made available by the Fisheries Division. The vessel log data included: Trip Date; Number of Divers; Dive time; latitude and longitude of vessel during fishing; total catch during trip
2. Computation of CPUE was done for each reported fishing trip for each vessel where possible. Total catch and average CPUE were reported for each vessel over the fishing season where possible.
3. Where available GPS location data were plotted for the fishing trips using electronic charting software (Garmin Mapsource, version 9.5)
4. Results from the most recent conch survey (2007) were reviewed to assist in determining the abundance of the conch population.
5. A decision rule method for harvest optimization was developed and TAC proposed;

RESULTS

Figure 2 shows a map of the geo-referenced (via Global Positioning Satellite system) location for each conch fishing vessel on a recorded fishing day. All the positions (excepting those of the SF&T Dolphins – see below) represent the average positions of the industrial vessels (larger Mother Fishing Boat) on a recorded fishing day. The Mother Boat deploys dories or works with artisanal fishing boats (28 – 32 feet Fibre Reinforced Plastic fishing canoes operated by small scale fishers) that fish an estimated maximum of a five miles radius around the Mother Boat.

The Sea Food and Ting (SF&T) Dolphins are several canoes named SF&T Dolphin 1, 2 etc. operated by artisanal fishers on behalf of Sea Food and Ting. Each canoe is equipped with Global Positioning Satellite (GPS) transponders. Their locations are recorded at one half hour to one hour intervals by the main operators in Kingston via satellite. The average daily positions are then provided to the Fisheries Division.

A breakdown of the total reported landings per fishing trip for each conch fishing vessel is provided in Table1. The daily catches from the SF&T Dolphins were added together so as to obtain one summary catch from all Dolphin boats fishing on a particular day. This reflects the operational strategy of the vessels operator as the catch from the Dolphin boats are taken to the mainland in daily trips from the Pedro Bank. The trip dates for the industrial vessels were not provided directly, but were estimated from the gaps between reported fishing days. Gaps of more than 5 days were considered to constitute separate trips.

Table 2 summarises the catch per unit of effort (CPUE) and total catches for all the conch vessels based on reported landings. CPUE was calculated at the level of catch of conch per diver hour (i.e. diver hour is unit representing the number of divers times the average dive time for each dive). The CPUE is shown in the table as catch in pounds, kilograms and corresponding numbers of whole live conch. The conversion factor used from meat weight to numbers of conch is 2.76 conchs per pound of unprocessed (no tissue loss, animal simply removed from shell) 'dirty' conch. The average CPUE for all vessels (where computation was possible) was 51.85 kg/Diver*Hour. However, given the uncertainty in how the catch and effort were distributed across the Pedro Bank and in how the data were reported for several of the larger vessels, the CPUE result for the SF&T Dolphins were used in the rest of the analyses.

Figures 3 shows plots of average CPUE across the fishing season (time) for those conch fishing vessels where both catch and effort data were available. Each point represents the average CPUE for each industrial fishing vessel or canoe – in the case of the SF&T Dolphins, on a reported fishing day. The trend line included is based on simple regression analysis, with the corresponding equations and R^2 values shown on the graphs. Attention should be paid to the slope of the regression lines and the level of significance for each line.

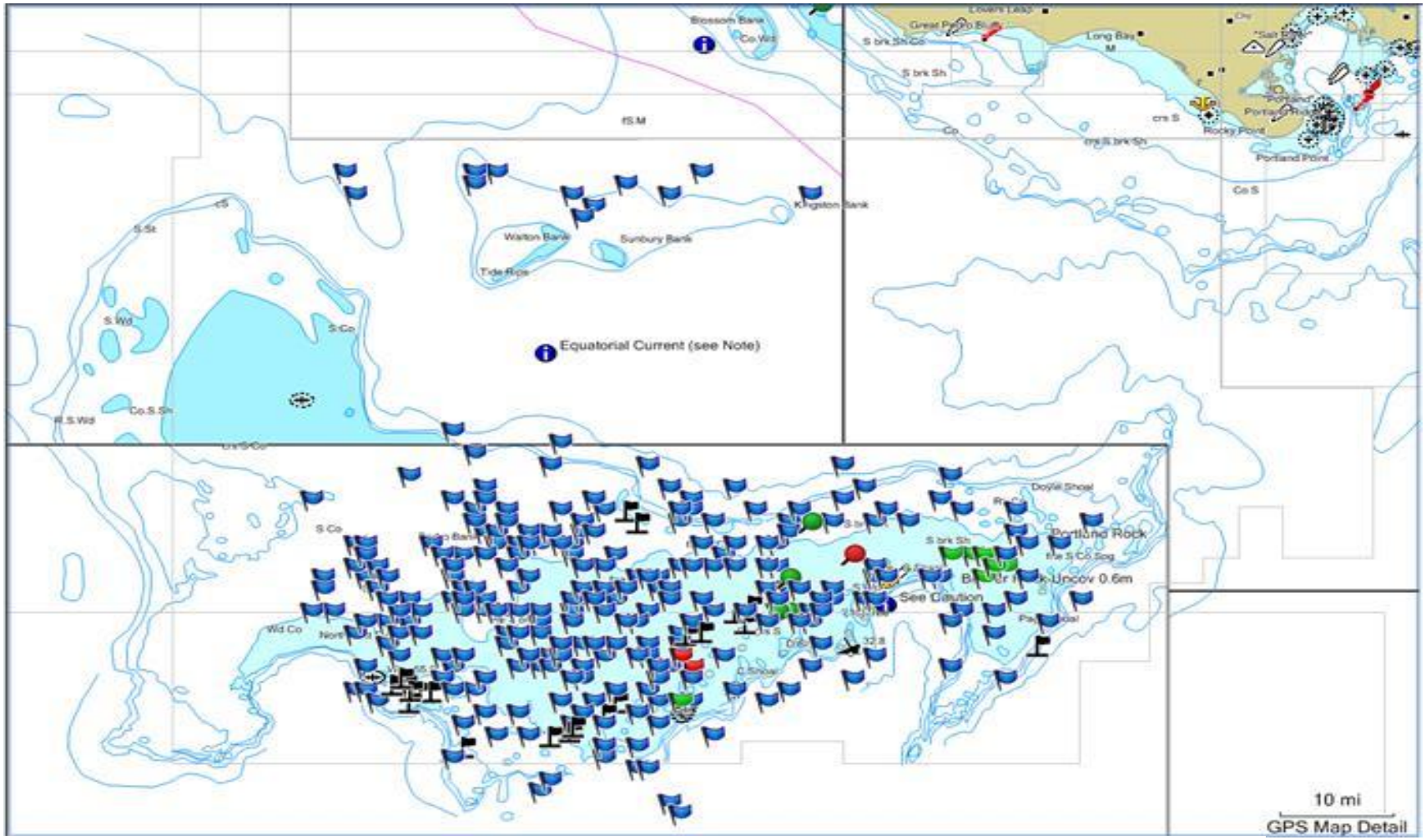


Figure 2. The Distribution of fishing effort for queen conch across the Pedro Bank. Each marker represents the average location of a fishing vessel or canoe on a reported fishing day.

Key

1. Blue Flag = SF&T Dolphins
2. Green Flag = Devin
3. Red Flag = Lady Kim
4. Black Flag = WindJammer
5. Red Lollipop = Captain Richard
6. Green Lollipop = Rajmilour

Table 1. Total Catch in metric tons (MT) per Fishing Trip for Commercial Conch Fishing Vessesls (each trip based on reported fishing days).

Vessels	Trip # 1			Trip # 2			Trip # 3			Trip # 4			Trip # 5			Average	Total
	Start Date	# of Days	Catch	Start Date	# of Days	Catch	Start Date	# of Days	Catch	Start Date	# of Days	Catch	Start Date	# of Days	Catch		
SF&T Dolphins †																5.0106	**175.3709**
Captain Richards	7/10/2009	2	**10.0871**													10.0871	**10.0871**
Devin	8/30/2009	1	**16.1450**													16.1450	**16.1450**
Lady Kim	8/6/2009	9	**21.8422**													21.8422	**21.8422**
Rajmilour	7/6/2009	4	**12.8446**	7/8/2009	3	**13.4125**	7/15/2009	3	**13.2487**	8/4/2009	3	**13.5544**	8/12/2009	2	**9.9211**	12.5963	**62.9813**
Wind Jammer	7/9/2009	9	**10.3067**	7/23/2009	8	**7.4554**	8/14/2009	14	**21.6217**							13.1279	**39.3837**

† Catches from each SF&T Dolphin canoes that fished on the same day, were summed and reported as catch for one trip. 35 trips were reported from an average of 8 fishing boats per day.

Table 2. Catch per Unit of Effort (CPUE) and Total Catch for all Conch Fishing Vessels

Conch Fishing Vessels	Average CPUE (Catch/Diver*Hour) lbs/hr	kgs/hr	conch/hr †	Total Catch lbs	MT
SF&T Dolphins	84.77	38.45	234	386,621.00	175.3683
Captain Richards	50.00	22.68	138	22,238.00	10.0870
Devin				35,593.00	16.1447
Lady Kim				48,153.00	21.8418
Rajmilour	89.03	40.38	246	138,848.00	62.9804
Wind Jammer ‡	233.40	105.87	644	86,825.00	39.3832
					-
Grand Average	**114.30**	**51.85**	**315.47**	119,713.00	46.5436
Total Catch				**718,278.00**	**325.8054**

(† Using conversion factor of 2.76 conch/lb of unprocessed conch meat)
(‡ Average CPUE withought Wind Jammer = 33.84 kgs/hr)

Given the extensive distribution of fishing effort across the Pedro Bank by the SF&T Dolphins, further summary and regression statistics were computed for the trend in CPUE over time. The results are shown below.

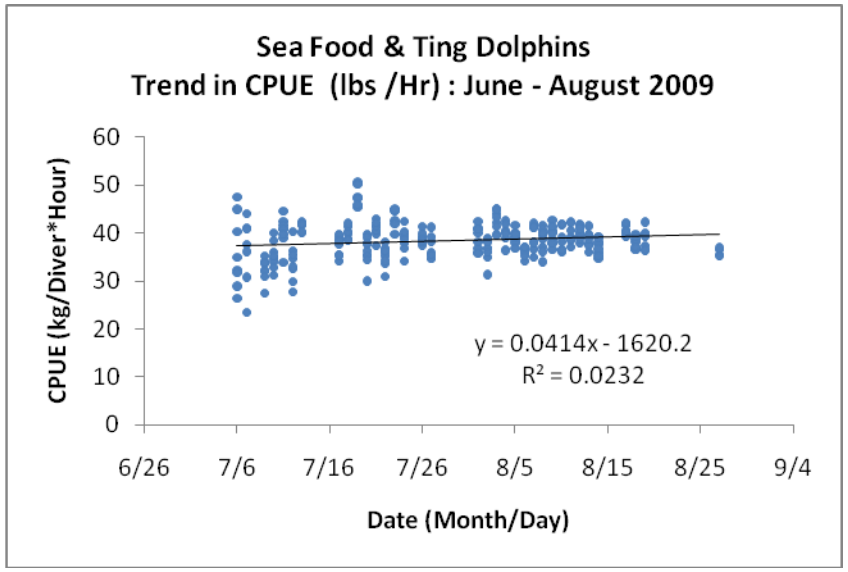
Regression Statistics	
Multiple R	0.152161383
R Square	0.023153086
Adjusted R Square	0.019587952
Standard Error	3.671022019
Observations	276

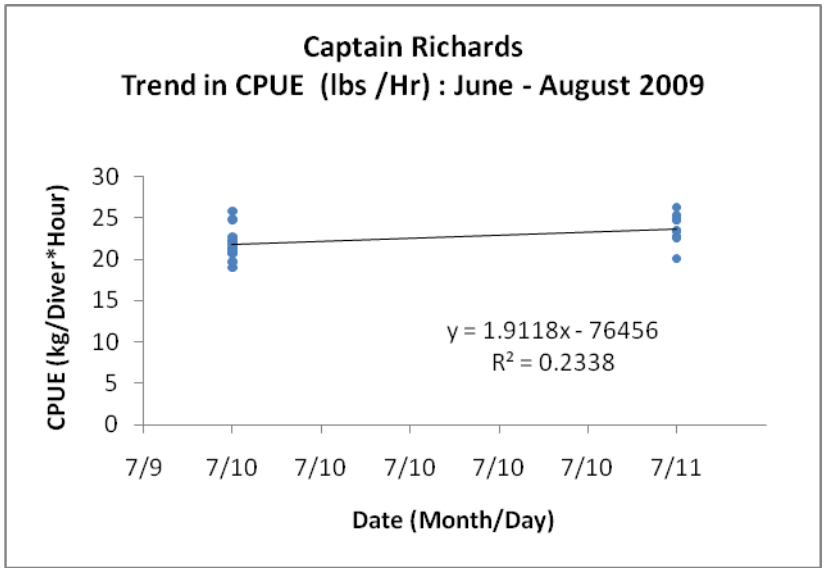
ANOVA

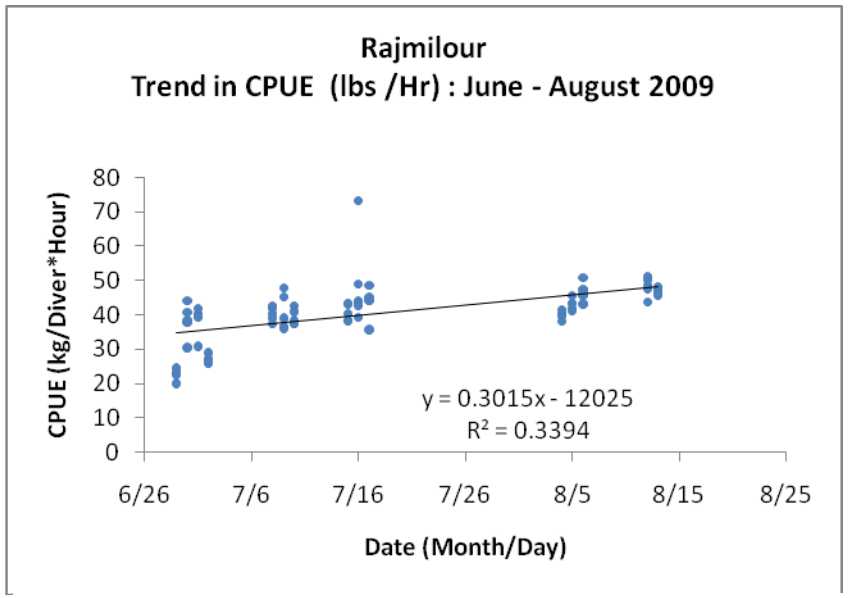
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	87.51992273	87.51992273	6.494308974	0.011368019
Residual	274	3692.534329	13.47640266		
Total	275	3780.054252			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1620.191738	650.8579005	-2.489317156	0.013392445	-2901.509371	-338.8741043
X Variable 1	0.041442222	0.016262097	2.54839341	0.011368019	0.009427688	0.073456755

Mean	38.45015138
Standard Deviation	3.707512889
Minimum	23.44391044
Maximum	50.60464758
Confidence Level(95.0%)	0.439330894







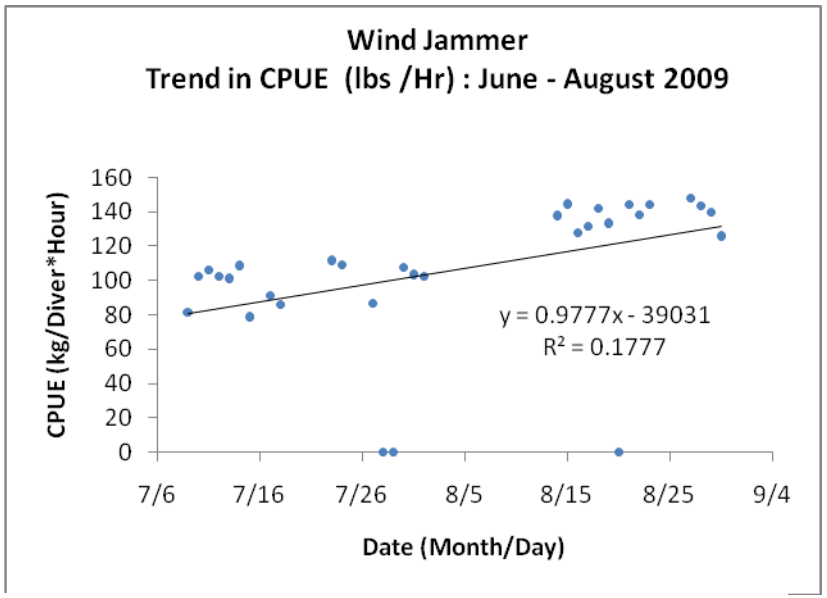


Figure 3. CPUE for each conch fishing vessel. Each point represents average CPUE for fishing vessel or canoe – in the case of the SF&T Dolphins, on a reported fishing day. The trend line included is based on simple regression analysis.

Table 3 presents the changes in CPUE and biomass since 1994, while Figure 4 further illustrates the CPUE trend in comparison to queen conch population densities on the Pedro Bank. Values for CPUE up until 2002 are as reported in Smikle and Appeldoorn (2002), while 2008 and 2009 values are based on computations from the vessel logs prepared by the conch fishers (Smikle 2009). The density and biomass estimates (Table 4) were computed from the conch abundance surveys completed to date.

Table 3. Estimated values for Average CPUE and Biomass for the queen conch fishery on the Pedro Bank 1994 - 2008

Year	Average CPUE	Biomass MT
1994	40	13,325.48
1995	32	
1996	22	
1997	16	12,203.27
1998	18	
2002	26	15,305.85
2007	—	7,421.78
2008	35	
2009	52 (38 ⌖)	

⌖ Average CPUE for SF&T Dolphins.

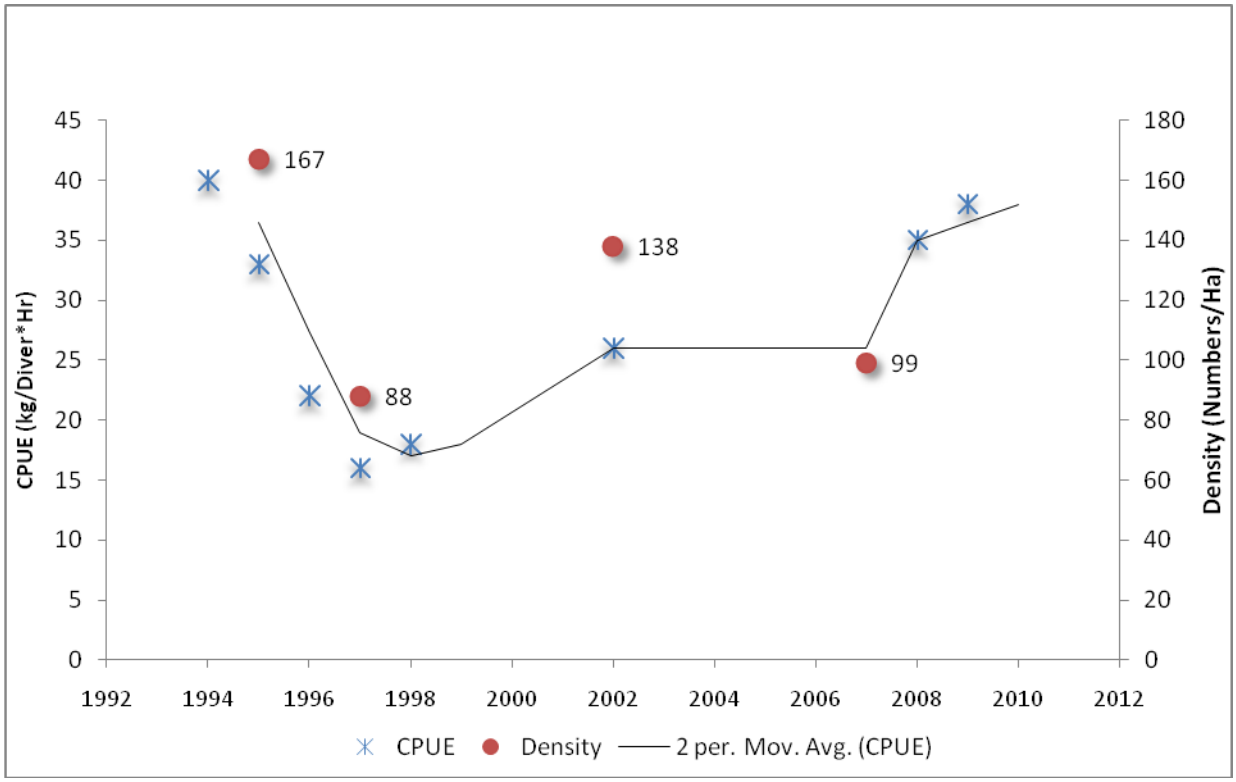


Figure 4. Trend in Catch per Unit Effort and Density for the Pedro Bank Queen Conch Stock (1993 - 2009)

Table 4. Estimates of Density and Biomass for the Queen Conch population on the Pedro Bank based on research surveys.

		Density (numbers / hectare)			
Zone Depth (metres)	Zone Area (hectares)	2007	2002	1997	1994
0 - 10	37,000	378	175 ②	175	73
10 - 20	201,700	49	138	88	152
20 - 30	370,000	50	244	203 ③	203
0 - 30		**99.25** ①			
		Biomass (metric tons) ④			
Zone Depth (metres)	Zone Area (hectares)	2007	2002	1997	1994
0 - 10	37,000	1,718.18	795.45	795.45	331.82
10 - 20	201,700	1,214.16	3,419.48	2,180.54	3,766.39
20 - 30	370,000	2,272.73	11,090.91	9,227.27	9,227.27
0 - 30	608,700	**7,421.78** ①	**15,305.85**	**12,203.27**	**13,325.48**

① Computed using the combined data from all depth zones. The Bootstrap method was used to derive mean and confidence limits.
② Assumed to be similar to results found in 1997. The 1997 result was used as this depth zone was not surveyed during the 2002 study.
③ Assumed to be similar to results found in 1994. The 1994 result was used as this depth zone was not surveyed during the 1997 study.
④ Computed using 8.14 individual whole conchs per kg of 50% cleaned conch

Estimates of total allowable catch (TAC) for a range of queen conch standing population biomass are shown in Table 5. Comparisons of TAC estimates were done using four different estimation methods namely: maximum sustainable yield (MSY) = 8% of current stock biomass (Medley 2008; Beddington and Cook 1983); The Fox (Fox 1970) surplus production model (Garcia, Sparre, and Csirke 1989); and the Cadima estimator for exploited stocks, (Cadima in Troadec 1977). The methods of Garcia and Cadima both require knowledge of fishing yield (Y) in the year of the biomass estimate. Yield was set at 400 MT representing the quota for the 2009 fishing season. This figure was also used for all levels of the range of biomass to illustrate the impact on the resulting estimate of MSY. Additionally the method of Cadima requires that the X multiplier (normally 0.5 in the original equation) be estimated to reflect current stock conditions. In the case of conch, X = 0.3 was used.

Table 5. Estimates of Total Allowable Catch for a range of total population biomass using four types of estimation criteria. Yield = 400 mt (2009 Quota) for Garcia and Cadima.

Biomass	MSY = 8%	Garcia (Fox)	Cadima
0	0	0.00	120.00
1,000.00	80.00	467.46	192.00
2,000.00	160.00	406.31	264.00
3,000.00	240.00	461.65	336.00
4,000.00	320.00	535.71	408.00
5,000.00	400.00	616.10	480.00
6,000.00	480.00	699.37	552.00
7,000.00	560.00	784.18	624.00
8,000.00	640.00	869.93	696.00
9,000.00	720.00	956.28	768.00
10,000.00	800.00	1,043.04	840.00
11,000.00	880.00	1,130.09	912.00
12,000.00	960.00	1,217.35	984.00
13,000.00	1,040.00	1,304.78	1,056.00
14,000.00	1,120.00	1,392.34	1,128.00
15,000.00	1,200.00	1,480.00	1,200.00
16,000.00	1,280.00	1,567.75	1,272.00
17,000.00	1,360.00	1,655.55	1,344.00
18,000.00	1,440.00	1,743.42	1,416.00
19,000.00	1,520.00	1,831.33	1,488.00
20,000.00	1,600.00	1,919.28	1,560.00

DISCUSSION

In order to determine an appropriate level of total allowable catch for the 2010 fishing season and in the absence of a conch population survey, the assessment relied on the following strategies:

1. Examine the catch and effort data to determine if CPUE was adversely affected by the level of fishing (or any adverse changes in CPUE).
2. Examine the spatial distribution of fishing effort to see if key assumptions were met. The most important being that TAC was fished from the entire 0 – 30m depth ranges across the bank. Secondly, the spatial plot of fishing effort should reveal any risks of localized depletions from overfishing a small range of the conch stock.
3. To determine a minimum level of conch population density on the Pedro Bank below which no fishing should take place. From this develop a harvest optimization model with decision rules for setting annual TACs.
4. Based on the harvest optimization model and the latest available information on the abundance of queen conch, determine and recommend an appropriate level of TAC.

The distribution of fishing effort shown in Figure 2 illustrates that the SF&T Dolphins fishing activity seem to be truly randomly and widely dispersed across the bank. All other vessels except Windjammer seemed to concentrate their efforts around a few positions on the bank. The number of fishing trips and total catch taken by the vessels were much less than that of the SF&T Dolphins (table 1).

Given that the larger industrial vessels are supported by smaller independent fishing boats (except Windjammer – which uses its own dories), it is not possible to discern exactly how fishing for these vessels was distributed. The supporting canoes do not carry GIS transponders. This is an area for improvement of the vessel and catch and effort monitoring systems.

Note that one key assumption – fishing is distributed across the entire range of the stock – was not met. For the second consecutive year for which GPS data is available, it is noted that no fishing takes place in a part of the 20 – 30 m depth zone on the western end of the bank. This corresponds to zone 5 of the Veterinary Services designation of conch production zones. It is possible that the Veterinary Services has not yet established its monitoring programme for this area and therefore conch for export cannot be taken from that zone. The implications are significant in that this and future TAC will have to be adjusted to reflect the smaller area of the bank from which the stock is fished, at least until the status of zone 5 changes.

Some uncertainties were revealed during the analysis of CPUE, particularly with respect to the M/V Windjammer. The effort data provided with the Wind Jammers log sheets shows the number of divers and dive times (2 divers per day on average) but no mention

is made of the number of dories displayed or if indeed the average of 2 divers represents the average daily total of the number of divers. The reported CPUE of 105.87 seems very high and as such it is suspected that the effort is under-reported. Without the estimates of CPUE for the Wind Jammer and the motor vessels Devin and Lady Kim (for which no effort data were available) the CPUE of 33.84kg/diver hour may be more reasonable, but again may be negatively influenced by unreliable reporting for the Captain Richard in particular.

The most reliable source of data came from SF&T Dolphins, and given their extensive fishing pattern, the CPUE of 38.45 kg/diver hour may be the best indicator of the status of queen conch abundance on the Pedro bank during 2009. The regression statistics for SF&T Dolphins CPUE shows that although the variability in CPUE across time is largely unexplained by the regression line ($r^2 = 0.023$), the positive slope of the regression line is significant ($F= 6.494$, sig. $F = 0.011$), indicating a positive upward trend in CPUE over the fishing period.

It is safe to conclude therefore that the average CPUE across the season was not adversely affected by fishing pressure, and that by extension the abundance of queen conch on the Bank was not significantly impacted.

The determination of annual catch quotas should be in keeping with the management objective of optimizing harvests for long term sustainable yields from the conch fishery (Conch fishery management plan). As such a harvest strategy or model should be utilised that establishes straightforward decision criteria regarding target and limit reference points, criteria for determining quotas (harvest rules) and feedback policies.

A target reference point (TRP) indicates a state of the resource which is considered to be desirable and at which management should aim while a limit reference point (LRP) indicates a state which is undesirable and which management action should avoid (Caddy and Mahon 1995). The Convention on International Trade in Endangered Species (CITES) proposes that a queen conch population density of 56 conchs per hectare is a minimum critical level below which the population would not be sustainable (Ehrhardt and Valle-Esquivel 2008). To err on the side of caution, it is proposed that the CITES recommendation of 56 conch per hectare be raised by 25% and that 70 conch per hectare be considered as the decision criteria for the LRP for queen conch density on the Pedro Bank.

Although several options for harvest rules are available (see Walters and Martel 2004 for further discussion on harvest rules) it is proposed that stock size-dependent rules are most relevant for the Pedro Bank conch fishery. Stock size-independent (or fixed quota) methods of determining TAC such as the Gulland (1973) formulae: $MSY = 0.5M*Bv$, where M is natural mortality and Bv is virgin Biomass, may lead to stock collapse due to progressively more severe depensatory increases in fishing impact should the conch stock fall below the level that could sustain the quota removal (Walters and Martel 2004).

The estimates of TAC presented in Table 5 are based on three stock size-depended methods of determining catch size. The fixed exploitation rate of 8% (Beddington and Cook 1983) is proposed by Medley (2008) as a more precautionary approach than traditional MSY approaches. Also of the three estimation methods the MSY = 8% rule is the most conservative at all levels of population biomass in the example used. The methods of Garcia and Cadima suffer from being heavily influenced by the levels of previous harvests and, in the case of Cadima, the level of the X factor which is in most cases a guestimate.

Figure 5 demonstrates the harvest optimization model proposed for the Pedro Bank queen conch fishery. The LRP of 5,000 metric tons is the biomass level corresponding to a density of 70 conch per hectare using a conversion factor of 8.14 individual conch per kg of 50% cleaned meat weight. The TRP is the line indicating the harvest rule MSY = 8% of total population biomass and is true up until where the population biomass is at carrying capacity. It is proposed that the TAC not be raised beyond the 1,040 metric tons even if the conch stock size is estimated to be higher than our current estimate of virgin biomass. This is to protect the stock from collapse that may result from natural fluctuations in recruitment or environmental impacts that may reduce the stock size in the ensuing fishing season.

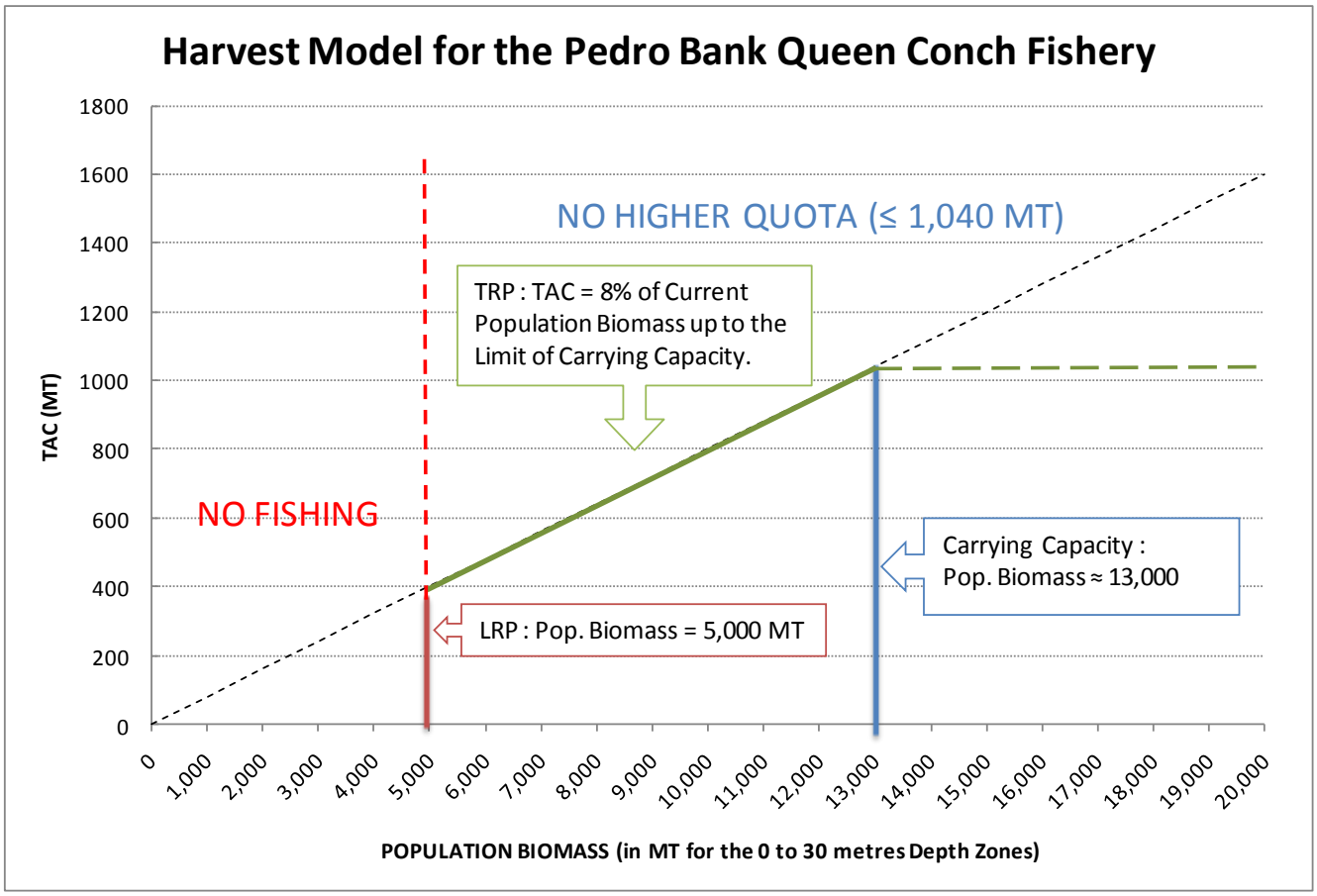
From Table 4 the most current estimate of conch biomass on the Pedro Bank is 7,421.78 metric tons. The corresponding TAC (Table 5) is 593.742 metric tonnes. However, this figure has to be adjusted to take into consideration two factors: the range of the stock currently being fished; and losses due to poaching.

1. The area of the bank in the 20-30 m depths equivalent to the Veterinary Services fishery production zone 5 is 111,000 hectares (approximately 30% of the entire 20-30 m depth strata). The total fished area becomes 497,700 hectares and the corresponding biomass is now 6,068.394 metric tonnes. The reduced TAC will now be = 485.471 metric tons.

2. In 2007 illegal unregulated and unreported (IUU) fishing was estimated to be up to 25 % of total reported catches. However recent improvements in enforcement and trade monitoring, as well as unfavourable market conditions has seen IUU fishing reduced to levels lower than 10% of reported landings (Kong pers. Comm..). A level of 10% of last year's reported catch (≈ 400 metric tonnes) was used to account for expected losses due to poaching. The adjusted TAC is now estimated to be = 445.471 metric tonnes.

As a final word, the method used above to estimate TAC is not predictive as catch limits are based on a stock size in a period antecedent to the actual stock in the season to be fished. Biomass dynamic models would provide some predictive power that may enable more accurate estimates of expected conch biomass levels. Alternatively, the frequency of conch abundance surveys or similar methods to empirically estimate the queen conch abundance may have to be increased (perhaps as much as annual surveys). Such monitoring of the conch population should form the basis for feedback mechanisms that

would improve on the reliability of the harvest optimization model (Walters and Martell 2004).


Harvest Model for the Pedro Bank Queen Conch Fishery
TAC (MT)
1800
1600
1400
1200
1000
800
600
400
200
0
NO HIGHER QUOTA (≤ 1,040 MT)
TRP : TAC = 8% of Current Population Biomass up to the Limit of Carrying Capacity.
NO FISHING
Carrying Capacity : Pop. Biomass ≈ 13,000
LRP : Pop. Biomass = 5,000 MT
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
POPULATION BIOMASS (in MT for the 0 to 30 metres Depth Zones)

RECOMMENDATIONS

1. Total Allowable Catch for the 2010 fishing season should be set at no more than 445.471 metric tonnes. This figure accounts for losses due to fishing a range less than that for which the total stock biomass was estimated, and for losses due to IUU fishing.

2. The proposed harvest optimization model should be considered as the strategy for setting future catch limits. Said model or any other superior model should be discussed with the conch industry stakeholders. The final acceptable model should then be incorporated in law as a fundamental part of the conch fishery management plan.

3. It is also recommended that a biomass survey be conducted at the end of the 2010 fishing season to assess the conch population on the Pedro Bank and to verify current CPUE trends.

4. The revised catch and effort data collection process although in its second year, need to be improved for the upcoming seasons. It is important that observations are recorded on the same day that fishing occurs. This would allow data to be recorded while it is still fresh. It is also important that the activities of all persons involved in catching conch (particularly all divers, including artisanal fishers contributing to a conch fishery operation) be accurately recorded. The Fisheries Division should make every effort to provide this training to the conch operators, captains and other related persons. It would help if the conch operators would use the same log forms for providing data to the Fisheries Division as they would use for their business documentation. The data collectors also need additional training that would allow increased recognition of data quality issues.

5. Finally, auxiliary research should be conducted to allow the development and application of more complex biomass dynamic models to predict biomass or expected catch rates for upcoming seasons (Medley 2005 and Medley and Ninnes 1999). Such models may prove more reliable in successive years rather than relying solely on biomass surveys conducted every 3 – 5 years.

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