Case Study: Assessment and Management of the Queen Conch (*Strombus gigas*) Fishery of Antigua and Barbuda

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for

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Description of Conch Fishery

- In 2010, there were 11 full time conch-fishing vessels plus 8 part time vessels.
- Vessels range from small pirogues to large FRP launches, equipped with GPS and hydraulic hauler.
- Typical investment (vessel, gear, equipment, etc) range from EC$60,000 for a 22-foot FRP pirogue to EC$210,000 for a 40-foot FRP launch.


Photo: I. Horsford

Description of Conch Fishery

- Commercially conch is harvested using SCUBA and involves some 72 individuals (including 40 SCUBA divers).
- SCUBA is the gear of choice due in part to the mean depth of the Antigua and Barbuda Shelf (about 30 metres).
- On average, full time divers would use about two 80 cubic-feet tanks per day.
- Fishers who target conch in Antigua reside mainly in the southern villages of Urlings and Old Road and their home port is Urlings Fisheries Complex; vessels may operate from different ports depending on the dive area.
- In Barbuda, there is only one full time commercial conch vessel operating; the Caribbean spiny lobster is the principal species of commercial interest for divers there.
- In 2010, 102 metric tons of “dirty” conch meat (digestive gland removed) was landed with an ex-vessel value of EC$2.13 million; the live weight equivalent (including shell) was 764 tonnes.

Current Legislation

- The *Fisheries Act, No.14 of 1983* and the *Fisheries Regulations, No.10 of 1990*, are the primary legislative basis for fisheries management and development.
- Current legislation prohibit:
- harvest of conch with shell < 180 mm or no flared-lip shell; or
- conch whose meat weight is < 225 g without digestive gland.
- There are provisions for closed season, gear restrictions and protected areas.

Fisheries Governance Approach

- Over the past decades there has been a gradual shift in fisheries governance (including management) from one that is “top-down” and centralised to one that is “participatory” and devolved.
- This shift in governance by the Fisheries Division comes from a recognition that involvement of stakeholder in the decision-making process can lead to:
- increase understanding of management decisions;
- improve compliance by user groups;
- mitigate user conflicts;
- improve relationship with stakeholders; and
- increase effectiveness of fisheries governance.

Fisheries Governance Approach

Involvement of stakeholders has been at the following levels:

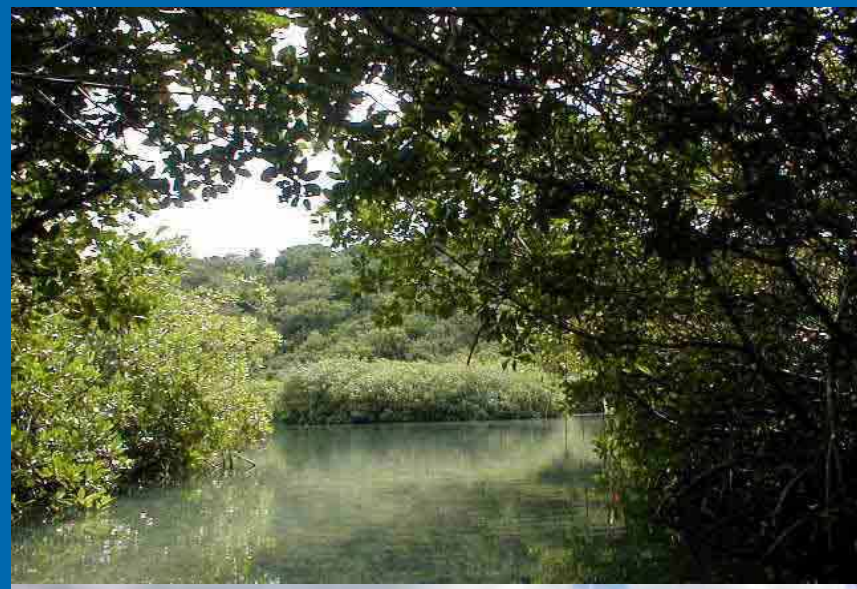
- consultation, where the views of individuals or organisations who are interested in or could be affected by management decision are solicited;
- formal representation of stakeholders on Fisheries Advisory Committee or fisheries focus group;
- devolution of governance to local council (e.g., Barbuda Council) or local fisheries management authority (as in the case of the North East Marine Management Area); and
- fisheries research / stock assessment (recognising the importance of fisheries traditional knowledge).

Previous Conch Assessments

- A morphometric study of two stocks from the western shelf of Antigua was conducted in1999.
- The main objective was to ascertain if conch stocks were significantly different in terms of morphology and the implications for management.
- While the results indicated spatial variability in term of conch morphology, the results could not be extrapolated to the entire shelf due to the limited area studied (Horsford 1999).
- In 1999, the Fisheries Division, with assistance from CFRAMP and local coast guard, conducted a conch abundance survey of the traditional area of commercial exploitation (the SW coast of Antigua).
- The results of the survey indicated that present overall densities of adults (3.7 conch/ha) were well below that which is required for effective reproductive encounters (Tewfik et al. 2001).

Previous Conch Assessments

- Due to financial constraints the conch abundance survey took a “worst-case scenario approach” where the survey was only limited to the heavily exploited fishing area.
- Hence MSY estimates for the area could not be extrapolated for the entire shelf.
- In response to fishing pressures and the need to protect critical habitats, the Cades Bay Marine Reserve was established in 1999 (approx. size: 1,943ha).
- The area includes Cades Reef and extends landward to include mangroves and wetlands as well as conch nursery areas (seagrass beds).



Previous Conch Assessments

- The main “lessons learned” from the two previous studies where:
- Fisheries research and management must be “cost-effective” to be sustainable; one option to improve cost-effectiveness is by having fishers provide support (manpower, logistics, etc).
- The participation of fishers in research allows for greater “buy-in” with respect to management decisions related to research.
- Traditional knowledge of fishers should be thoroughly researched and documented to ascertain their relevance to management and research.
- Fishers have “informal” management measures. For example, conch divers decide as a group to rotate or “rest” certain diving areas; this has implications when areas are declared permanent reserves.

2011 Conch Morphometic Study

- In light of the fore mentioned, the Fisheries Division in 2011 sought funding from JICA to purchase all the necessary equipment required to conduct a comprehensive conch morphometric study aimed at addressing all of the gaps in the earlier studies.

- A partnership was sought with the conch fishers in terms of their active participation in all aspects of the research and resulting management decisions.

- The remaining slides focus on the results and management decisions of the 2011 conch morphometric study; these results represent Fisheries Division's most successful research to-date and the approach will serve as a model for future fisheries research.

- The findings were presented in a paper entitled:

  "The Morphology of the Queen conch (*Strombus gigas*) from the Antigua and Barbuda Shelf – Implications for Fisheries Management",

  at the 64th Gulf and Caribbean Fisheries Institute Conference, held in Puerto Morelos, Mexico.

Objectives of Conch Morphometric Study

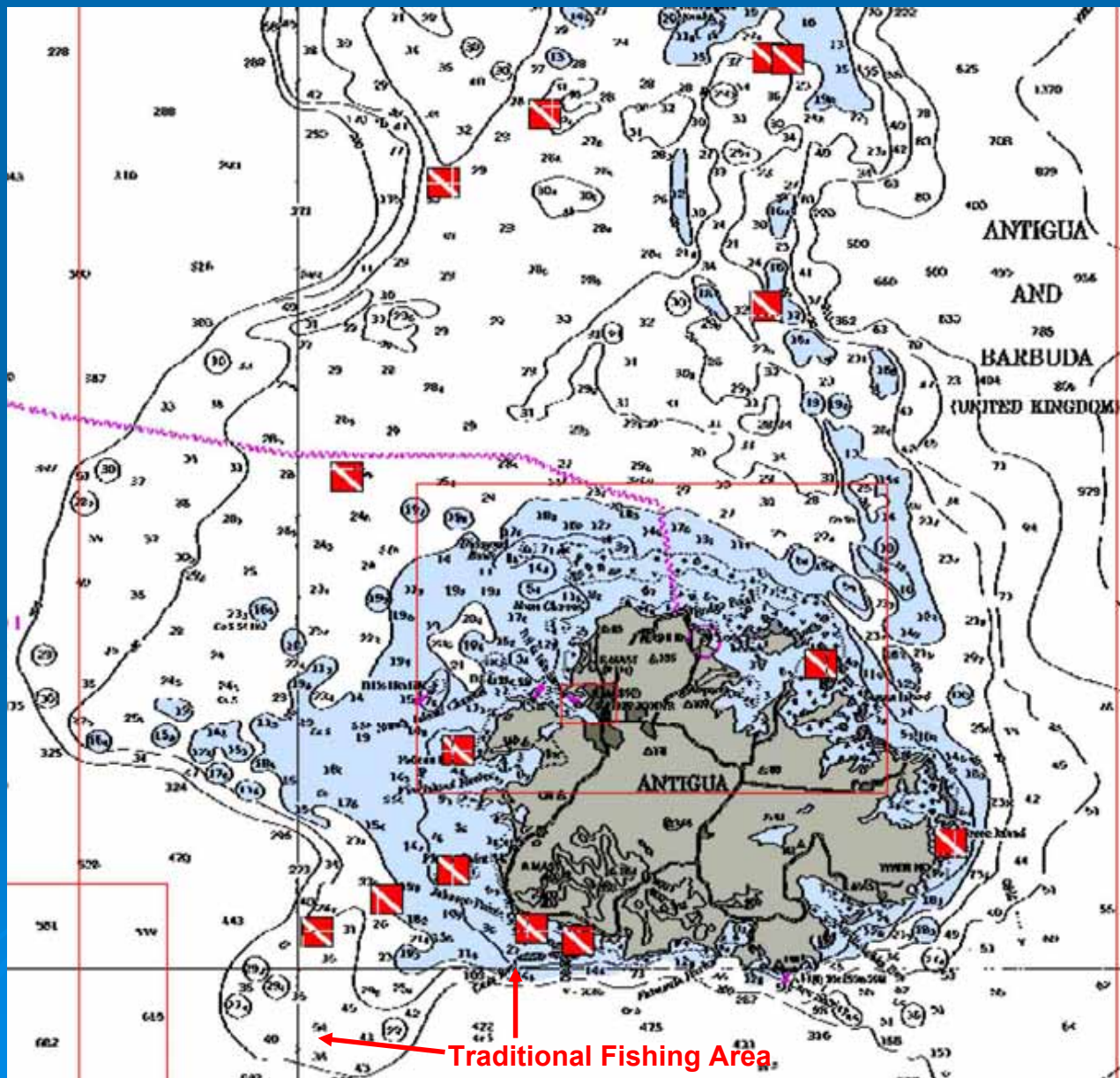
- Ascertain if there were spatial variability regarding conch morphology.
- Determine length-weight relationships for maturation stages.
- Develop locally derived conversion factors for different levels of processed conch meat.
- Assess current management regimes (e.g., minimum size / weight).
- Validate results of fisheries-dependent data programme.

Photo: I. Horsford

Photo: M. Ishida

Methods & Study Area

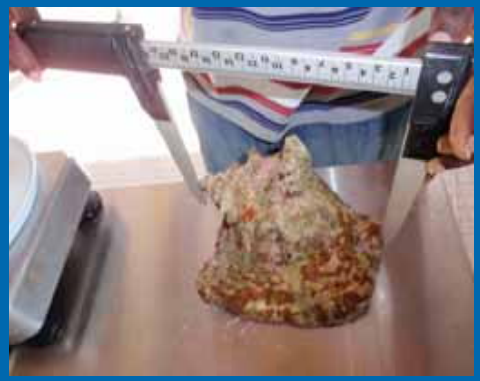
- Sites were sampled by research personnel and commercial conch divers.
- Type of trip (research vs. commercial fishing), habitat, depth and the following parameters records for maturation stages:
  - Shell length
  - Lip thickness
  - Nominal weight
  - Tissue weight: wt. after removal of shell
  - Dirty meat wt.: wt. after removal of shell & digestive gland
  - Clean meat wt.: wt. after removal of shell, digestive gland, mantle collar, operculum, radular & digestive tract.



The Process…

1. Clean the shell

2. Record shell length



3. Record lip thickness

4. Record nominal weight

5. "Knock" the shell & extract the soft tissue intact

6. Record the sex & maturation stage

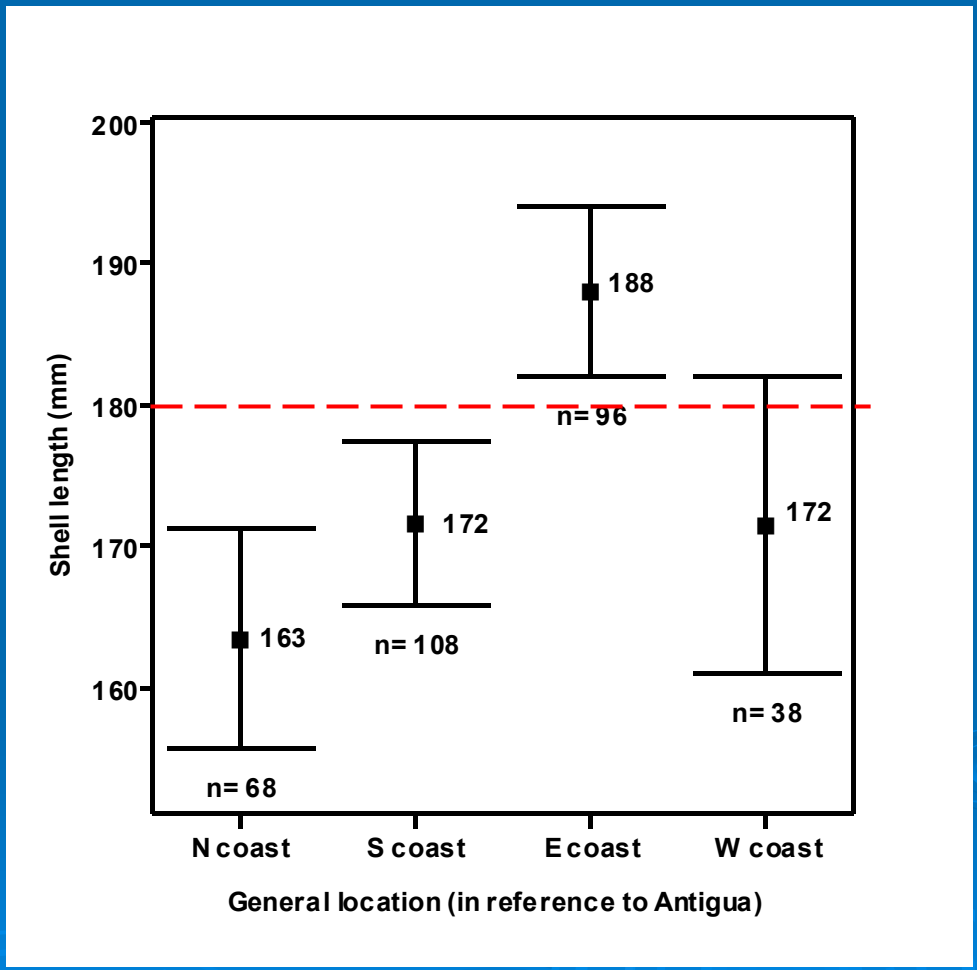
7. Record tissue wt. after removal of shell

8. Record "dirty" meat wt. after removal of digestive gland

9. Record "clean" meat wt. after removal of mantle collar, operculum, radular & digestive tract

Results & Discussion: Spatial Variability

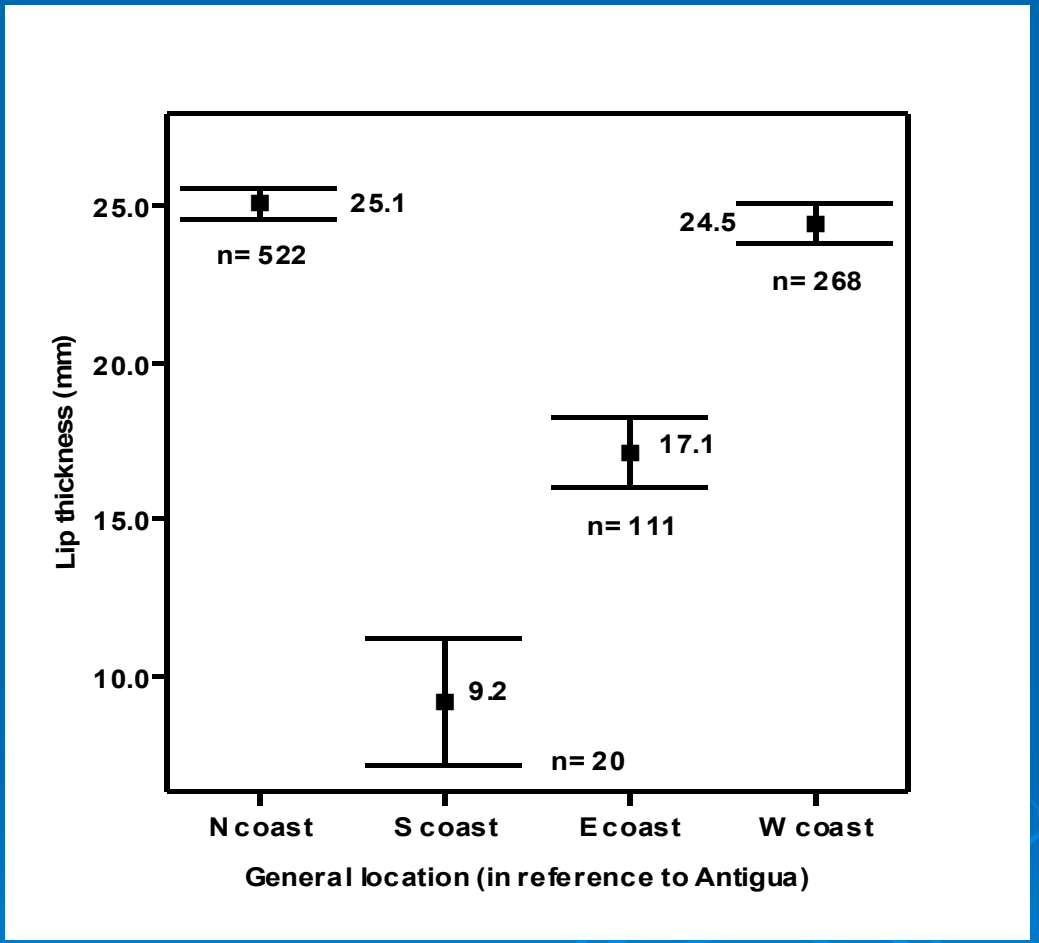
- Juveniles from the east were significantly larger than any other coast ($p < 0.05$).
- With this difference, regulations based solely on a uniform minimum shell length of 180 mm would be ineffective since large juveniles particularly from the east coast would not be protected.



Mean shell length of juvenile queen conch from the coast of Antigua. Error bar is 95% CI.

Results & Discussion: Spatial Variability & Age

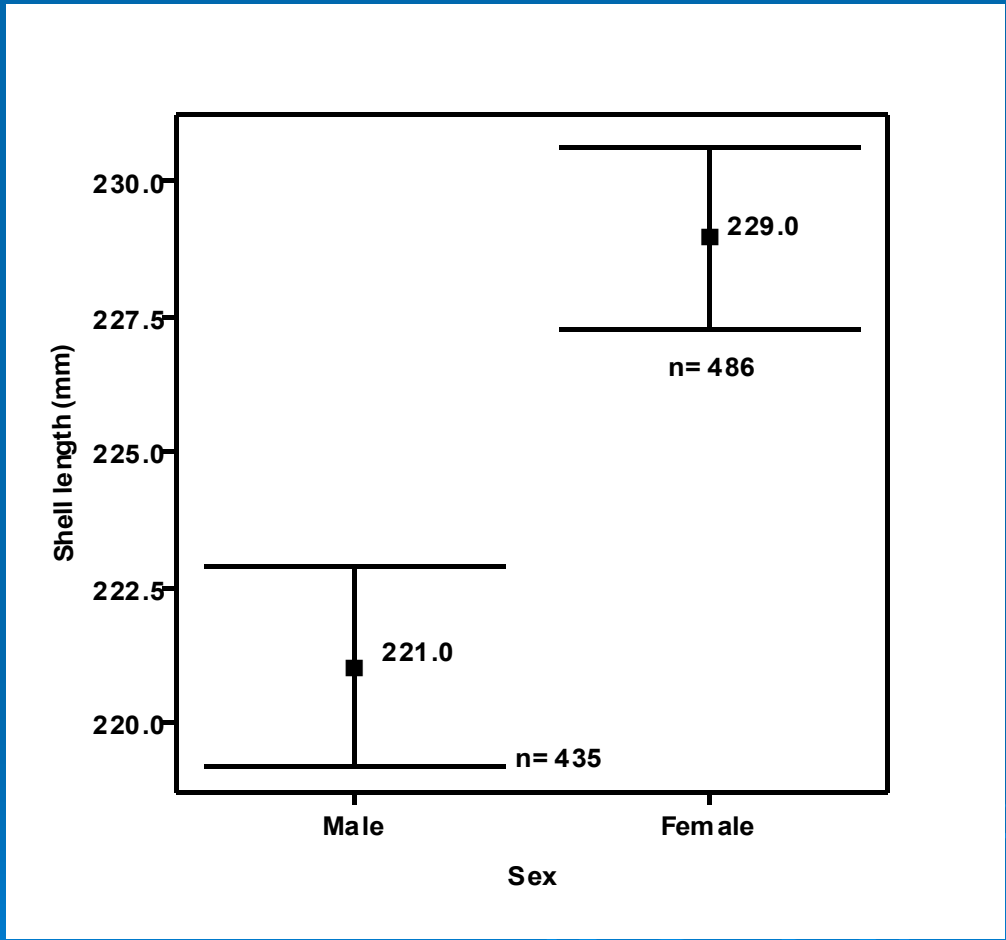
- Lip thickness, an indicator of the age, was significantly different among the coasts ($p < 0.001$), where conch from the north and west coast were significantly older than those from the east or south coast of Antigua ($p < 0.001$).
- Lip thickness of conch from the north and west coast 3-times that of those from the south (25.1 mm and 24.5 mm respectively vs. 9.2 mm); conch from the east were about 2-times that of those from the south.
- Results reflect the relative good health of conch in new fishing areas (N, E and W) vs. traditional area of exploitation (S coast).



Mean lip thickness of pooled adult queen conch (i.e., Sub adult, Adult & Old adult) from the coast of Antigua. Error bar is 95% CI.

Results & Discussion: Sexual Dimorphism

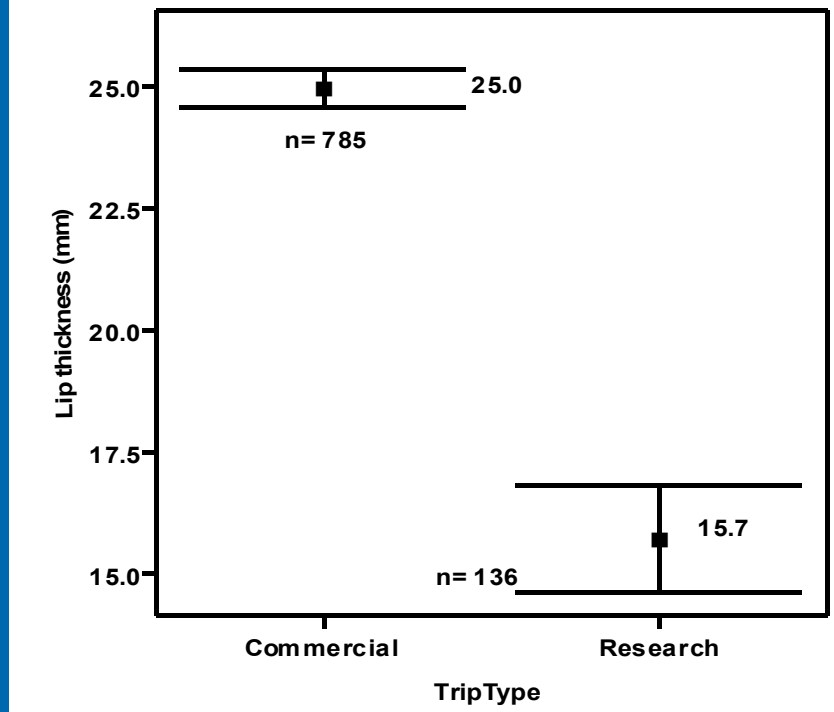
- Significant sexual dimorphism was only detected for adult conch ($p < 0.001$), with females being 4% larger than males.
- One possible consequence of sexual dimorphism is that regulations governing legal minimum size may result in a differential selection between the sexes.
- This was confirmed in the case of commercial fishing trips, when the sex ratio of the allowable catch (minimum meat weight of 225g), was favouring the harvesting of females [$X2$ (1, N = 711) = 4.26, $p < 0.05$].



Mean shell length by sex for pooled adult queen conch (i.e., Sub adult, Adult & Old adult) from the coast of Antigua. Error bar is 95% CI.

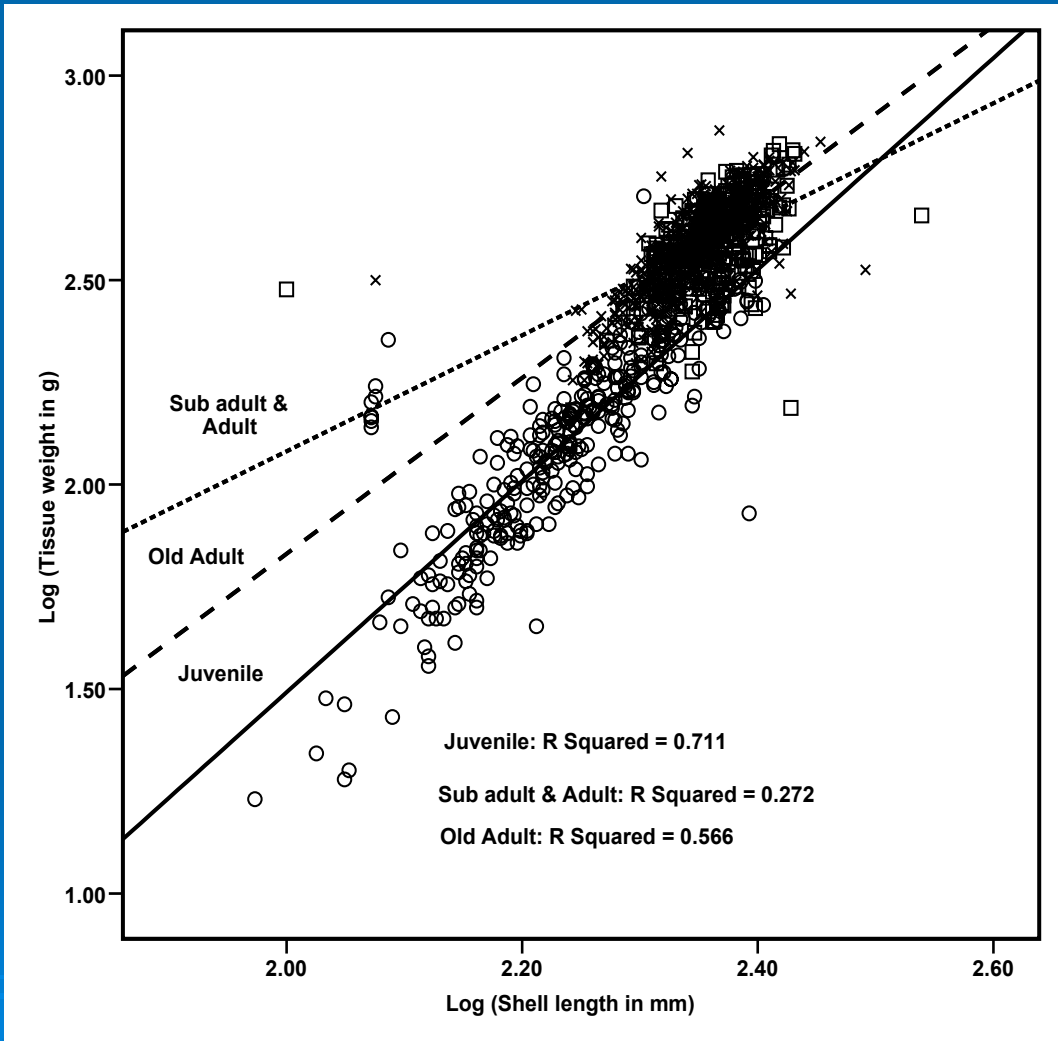
Resource Status

- The mean lip thickness for conch collected from commercial trips was 25.0 mm (*N* = 785, *S.D.* = 5.5 mm) indicating that commercial divers were targeting an old population (max. lip was 43.2 mm).
- In terms of level of compliance with fisheries regulations, 98.6% of the commercial sample (*N* = 796) had a flared-lip shell.
- Study validates compliance rates obtained from routine inspection and biological programme.
- The high level of compliance was attributed to the small, homogenous nature of the fishery, the participatory approach to management (including research) and conservation awareness programme.



Results & Discussion: L-W Relationship

- The relationship between shell length and tissue weight differed across maturation stage, with the regressions for the sub adult and adult group and old adults shifting above that for juveniles.
- With the cessation of shell length growth at maturity and bio-erosion of the shell with age, old adults growth are geared towards thickening the lip and shell, while losing soft tissue mass with age.



Shell Length-tissue weight relationship for juvenile (o), sub adult & adult (□) and old adult (x) queen conch from Antigua.

Results & Discussion: L-W Relationship

- Regressions were significant ($p < 0.001$), with regression models for juveniles accounting for more of the total variance than for sub adults / adults and old adults
- For all maturation stages, the goodness of fit of the models decreased marginally with processing from tissue to "dirty" meat weight.

Group	Regression Equation $Y = A + B(x)$	Adjusted Coefficient of Determination, R^2	Sample Size, N	Lower Bound for the 95% CI for B	Upper Bound for the 95% CI for B
Juvenile	Log(TW) = -3.68 + 2.59Log(SL)	0.71 ←	310	2.40	2.77
Juvenile	Log(DW) = -3.97 + 2.67Log(SL)	0.67 ←	310	2.46	2.88
Sub adult & Adult	Log(TW) = -0.76 + 1.42Log(SL)	0.27	324	1.16	1.67
Sub adult & Adult	Log(DW) = -0.80 + 1.40Log(SL)	0.25	324	1.14	1.67
Old adult	Log(TW) = -2.47 + 2.15Log(SL)	0.57	597	2.00	2.30
Old adult	Log(DW) = -2.48 + 2.12Log(SL)	0.54	597	1.96	2.28
Pooled Adult	Log(TW) = -1.81 + 1.87Log(SL)	0.46	921	1.74	2.00
Pooled Adult	Log(DW) = -1.87 + 1.86Log(SL)	0.43	921	1.72	1.99

Results & Discussion: W-W Relationship

- Regressions were significant ($p < 0.001$) and the slopes of the regressions shifted according to the maturation stage and the goodness of fit of the models decreased with age.
- Old adults yielded 20% less "dirty" meat for every 100 g increase in nominal weight when compared to sub adults and adults.

Regression equation for tissue weight (TW), shell weight (SW), dirty meat weight (DW) and clean meat weight (CW) as a function of nominal weight (NW) for queen conch from Antigua.

Group	Regression Equation $Y = A + B(x)$	Adjusted Coefficient of Determination, R^2	Sample Size, *N*	Lower Bound for the 95% CI for *B*	Upper Bound for the 95% CI for *B*
Juvenile	TW = 6.01 + 0.20NW	0.80	310	0.19	0.21
Juvenile	SW = -6.01 + 0.80NW	0.99	310	0.79	0.81
Juvenile	DW = 2.20 + 0.16NW	0.78	310	0.15	0.17
Juvenile	CW = -0.74 + 0.11NW	0.76	310	0.10	0.11
Sub adult & Adult	TW = 35.14 + 0.18NW	0.67	324	0.16	0.19
Sub adult & Adult	SW = -35.14 + 0.82NW	0.98	324	0.81	0.84
Sub adult & Adult	DW = 30.20 + 0.15NW	0.63	324	0.13	0.16
Sub adult & Adult	CW = 13.24 + 0.11NW	0.65	324	0.10	0.12
Old adult	TW = 57.21 + 0.15NW	0.53	597	0.14	0.16
Old adult	SW = -57.21 + 0.85NW	0.97	597	0.84	0.86
Old adult	DW = 43.86 + 0.12NW	0.52	597	0.11	0.13
Old adult	CW = 22.50 + 0.09NW	0.48	597	0.08	0.10

Results & Discussion: Conversion Factors

- Conch is typically landed commercially, in Antigua and Barbuda as "dirty" meat, where the shell and visceral mass are removed; however there are no locally derived conversion factors (currently using 7.5 from FAO to convert to nominal weight).
- Based on this study, 7.5 is outside the range of conversion factors for Antigua and Barbuda.
- Values ranging from 6.09 to 7.12 should be used depending on maturity of catch.

Conversion factors to nominal weight for queen conch from the Antigua and Barbuda shelf.

Level of Processing	Group	Sample Size, *N*	Mean Conversion Factor	Standard Deviation, *S.D.*	Lower Bound for the 95% CI for the Mean	Upper Bound for the 95% CI for the Mean
Tissue weight	Juvenile	310	5.08	0.99	4.97	5.19
	Sub adult	14	4.96	0.51	4.66	5.26
	Adult	310	5.25	0.92	5.14	5.35
	Old adult	597	5.82	0.99	5.74	5.90
	Total	1231	5.47	1.02	5.42	5.53
Shell weight	Juvenile	310	1.27	0.18	1.25	1.29
	Sub adult	14	1.26	0.03	1.24	1.28
	Adult	310	1.24	0.04	1.24	1.25
	Old adult	597	1.22	0.04	1.21	1.22
	Total	1231	1.24	0.10	1.23	1.24
"Dirty" meat weight	Juvenile	310	6.55	1.62	6.37	6.74
	Sub adult	14	6.09	0.79	5.64	6.55
	Adult	310	6.33	1.22	6.20	6.48
	Old adult	597	7.12	1.28	7.01	7.22
	Total	1231	6.77	1.40	6.69	6.85
"Clean" meat weight	Juvenile	310	9.79	2.52	9.50	10.07
	Sub adult	14	8.60	1.00	8.02	9.18
	Adult	310	9.09	1.67	8.91	9.28
	Old adult	597	10.59	2.07	10.43	10.76
	Total	1231	9.99	2.19	9.87	10.11

Results & Discussion: Conversion Factors

- Conversion factors differed significantly among maturation stages ($p < 0.001$), and the differences among the conversion factors for the various maturation stages increased with the level of processing.
- Hence the use of a single conversion factor to transform processed conch to nominal weight is problematic since conversion factor is dependent on the age structure of the population.
- Conversion factors should be monitored over time to ensure that the reference point has not shifted due to changes in demographics, from factors such as over-fishing.
- Conversion factors for Antigua and Barbuda were closer in value to the Central American countries as oppose to the Dominican Republic (i.e., Caribbean). Reason???

Conversion factors for tissue weight to nominal weight. Values for Nicaragua, Honduras and Dominican Republic are from Aspra et al. 2009.

Nicaragua	Honduras	Dominican Republic	Antigua & Barbuda
5.48	5.83	6.07	Juvenile: 5.08 Sub adult: 4.96 Adult: 5.25 Old adult: 5.82 Total: 5.47

Conclusions of Study

- The morphological differences with respect to location, sex and maturation stage require a multifaceted management approach to ensure the long term sustainability of the conch fishery.

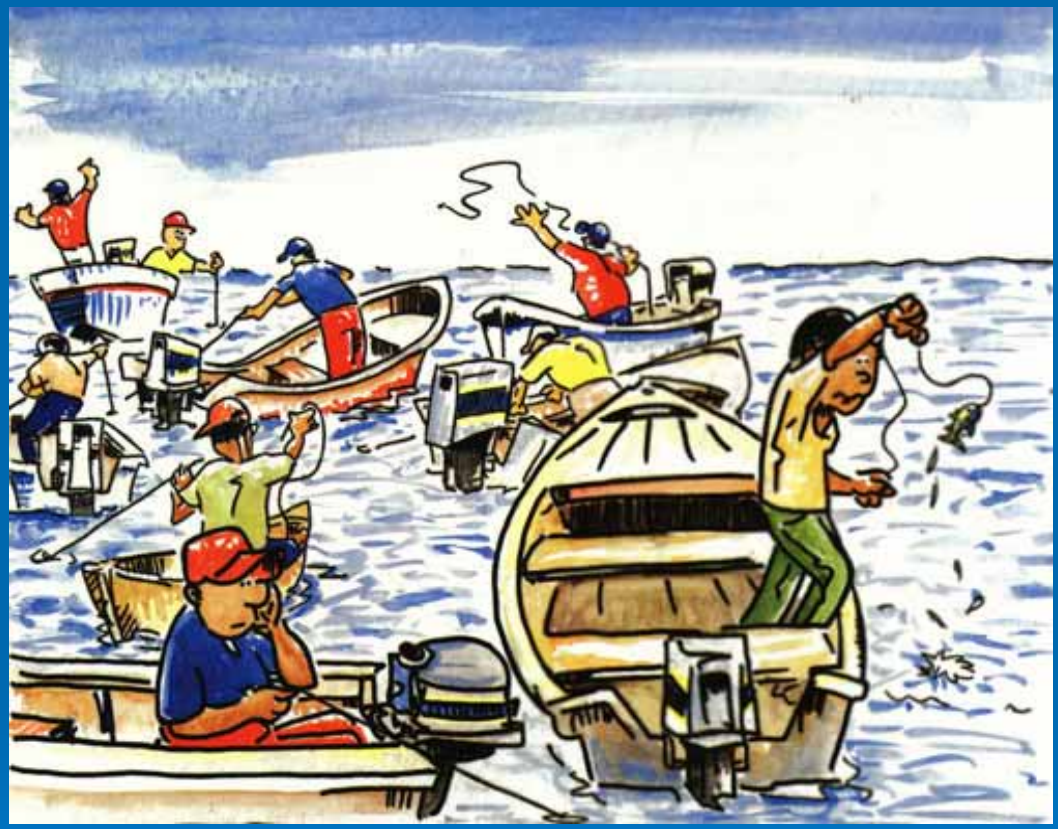
- Fisheries managers in Antigua and Barbuda, have opted for a combination of minimum size restrictions, protected areas, closed season, prohibited gears (e.g., hookah compressor diving rig), and “limited entry” through the use of special permits.

- The latter 3 options are expected to be implemented in August 2012 with the gazetting of the draft amended Fisheries Regulations; the substantive legislation, the *Fisheries Act, No. 22 of 2006*, has being passed by Parliament and is currently awaiting a date of enactment. The conch closed season would extend from 1st July to 31st August of every year and a 5 mm shell lip thickness would be incorporated into the regulations.

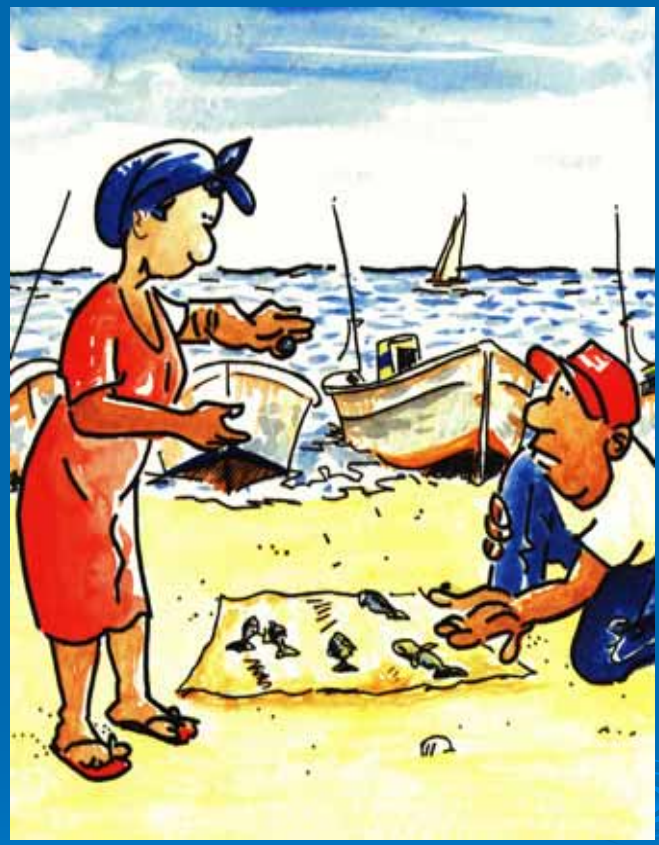
- In terms of future research, the study should be broadened to include the Barbuda portion of the Antigua and Barbuda shelf.

- Fishers are encouraged to standardise their method of processing as well as the terminologies used to describe the different levels of processed meat; this would improve compatibility of data and harmonise the trading of conch at the national and regional level.

- With the subsequent implication of the *Fisheries Act, No. 22 of 2006* and the accompanying regulations, conch fishery will move from an "open access" to a "limited entry" management regime.



Too many fishers and boats…



Smaller and smaller catch.

Source: CFRAMP

Acknowledgements

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Thank you!