1. CITES CONTROLS


- International agreement between “voluntary participating” States organized under the UN.

- An organization “without enforcement capabilities” that “checks compliance of international trade documents with declared export quotas”.

Enforcement is in the power of exporting-importing countries, this is if they have the political will to protect endangered species.
**CITES voluntary State declared export quota system**

There is “no specific requirement” in the text of the Convention to establish quotas to limit the trade in CITES-listed species.

Export quotas are established by each voluntary member State “unilaterally”.

Before any State may issue an export quota, its Scientific Authority must advise that the proposed export will not be detrimental to the survival of the species *(INTEREST IS ON THE SPECIES AND NOT ON THE FISHERY)*
CITES does not promulgate, advocate or suggest ways, methods or algorithms that should be used when estimating Queen Conch export quotas.

CITES assumes that Countries have the know-how and the resources (financially and scientifically) to define annual non detrimental export quotas for Queen Conch.

CITES assumes also that Governments and fishing industry are fair players.
Reasons to include Conch in Appendix II of the CITES

Internal fertilization imposes biological demands on minimum population density levels such that *individuals can find mates* or be properly *stimulated to mate*.

**CITES Queen Conch biological and trade criteria for inclusion in Appendix II are:**

1) Exported annual quotas should not be detrimental to reproductive (mating) success.

2) The minimum population density threshold for successful mating is defined as **56 individuals/ha**.
Mating success modeling

\[ PCRI = \alpha(D - \beta)(1 - \gamma\lambda(D - \beta))^\frac{1}{\lambda} \]

\[ \begin{align*}
\lambda & = -0.52741 \\
\gamma & = 0.11413 \\
\beta & = 37.3754 \\
\alpha & = 0.17992
\end{align*} \]

The Bahamas data from: Stoner and Ray-Clup 2000
Density dependent effect due to over crowding impacting mating rates

Density dependent effect due to mating failure

Per capita reproductive index (PCRI)

Density (#/ha)

Optimum Population Density Range
RESULTS OF USING NON STANDARDIZED PROCEDURES TO DEFINE QUEEN CONCH EXPORT QUOTAS UNDER A FAIR PLAY CONCEPT

There is no correlation between the non-detrimental export quotas and the sustainability criteria established for the species (population density).
1. Densities are higher in the exploited areas than in protected areas.
2. Issue: How do we estimate quotas based on population density only?
Density dependent effect due to over crowding impacting mating

Density dependent effect due to mating failure

Optimum Population Density Range

Paradox

Voluntary States suspended from exporting conch due to over exploitation

The Dominican Republic
Haiti
Honduras

Density dependent effect due to over crowding impacting mating

Average Density (#/ha)

Most recent export quotas (mt)

Per capita reproductive index (PCRI)
Density dependent effect due to over crowding impacting mating
density

Density dependent effect due to mating failure

Paradox
Voluntary Sates identified with proper conch management

Optimum Population Density Range

Most recent export quotas (mt)

Average Density (#/ha)

Per capita reproductive index (PCRI)

Voluntary Sates identified with proper conch management

Mexico
Belize
Jamaica

Voluntary Sates identified with proper conch management

Density dependent effect due to mating failure

Paradox
Voluntary Sates identified with proper conch management

Optimum Population Density Range

Most recent export quotas (mt)

Average Density (#/ha)

Per capita reproductive index (PCRI)
Technical Issues with CITES export quotas

**Condition 1**

*Voluntary* Countries *unilaterally* report the non detrimental export quotas.

**Issues with Condition 1:**

1) CITES does not perform a scientific review of the non detrimental quota “declared” by the countries. Reason: CITES does not have specialized personnel or handling power to carry out such reviews.

2) There are no Queen Conch stock assessment protocols adopted by the CITES; therefore, countries “declare” annual non detrimental quotas under different data and methods, usually following historic “intuitive” reasoning.
**Condition 2.**

The Government CITES Office (Management Authority) requests the Government Scientific Authority to review the status of the quota each time a CITES export certificate is requested. Scientific Authority checks if the exports are legally obtained, and certify that exports under CITES Certificates will not be detrimental to the survival of the species.

**Issues with Condition 2.**

1) Traceability of the products is impossible due to integration of several landings in the exported products. Most of the illegally caught Queen Conch cannot be retained once it is processed and packed.

2) There is no check on the non detrimental character of each export because it is implicit that if a quota is still open, such quota was already “declared non detrimental” to the survival of the species by the Management Authority to the CITES.

3) Countries do not have enforcement capabilities to prevent high seas product transfer.
Queen conch annual quota estimation

Quota = \( F_{\text{ref}} \times \text{Population Biomass} \)

Population Biomass = Average Density * Habitat Range * Average individual weight

\( F_{\text{ref}} \) = need population parameters (growth, natural mortality, fecundity, mating success as function of population density)
A SIMPLIFIED ANNUAL CONCH QUOTA DEFINITION

FISHERY MANAGEMENT OBJECTIVE OR STRATEGY REGARDING USE OF THE RESOURCE

POPULATION BIOMASS

VULNERABLE OR AVERAGE FISHABLE BIOMASS

STRATEGIC FISHING MORTALITY REFERENCE

ALLOWABLE BIOLOGICAL CATCH

FISHERY REGULATIONS OR CONTROLS: ANNUAL QUOTA

FISHING CAPACITY ADJUSTED TO ANNUAL QUOTA

ABC = F_{MDT} * Average Biomass
FISHABLE BIOMASS CAN BE ESTIMATED FROM:

1) POPULATION DENSITY (DIVING SURVEYS) EXPANDED TO EXPLOITED POPULATION HABITAT.

2) EXPLOITATION PATTERNS GENERATED BY STOCK ASSESSMENTS USING FISHERY DATA.
FISHING MORTALITY REFERENCE POINTS FRAME
FISHERY MANAGEMENT PROCESSES

FISHERY MANAGEMENT
STRATEGY REGARDING THE
RESOURCE

\( F_{\text{Density Threshold}} \)

\( F_{\text{Density Threshold}} \) NEW CONCEPT BASED ON POPULATION
DENSITY ESTIMATES AND THE
FISHERY-BASED ESTIMATES OF FISHING
MORTALITY THAT GENERATED SUCH DENSITIES
Paradox

Population density as biological criteria and quotas as trade criteria for CONTROL do not match.

Population density needs to be estimated for the habitat range of the species, including all fishing grounds; independently assessed due to habitat fidelity of conch.

Population density needs to be estimated “every year” under the requirement of annual export quotas.

Effective fishing grounds usually are a small fraction of the habitat range (where commercial densities are found).

“Unilaterally declared” quotas must be for an entire State with implicit spatial and temporal allocation.

Export quotas “declared” by States to the CITES cannot be estimated from existing data unless countries perform elaborated annual surveys to estimate population abundance. There is a time constraint to do this.

Models expressing the functional relationship between density, habitat range, and mating success at different density levels and quotas are still to be developed.
Survey approach to assess the resource and control fishing

1. Systematic replicated experimental sampling design to estimate:
   a. Population habitat range and fishing ground mapping
   b. Population density and size-sex structures
   c. Site fidelity regarding growth, mating success and spawning
   d. Overall population mortality rate and population abundance

2. Commercial population density surveys and monitoring to estimate:
   a. Fraction of habitat range used
   b. Population density on fishing grounds
   c. Exploited population mortality rate and abundance
1. Systematic replicated experimental sampling design to estimate and map population densities and dimension habitat range.
Systematic random sampling design

Sampling stations every 3 nm

45 belt transects per sampling station

Coral Reef
1) Conch density per belt transect

2) Average density and variance in sampling station

3) Statistics estimated per sampling station extrapolated to survey area.
Experimental density sampling survey results

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<tr>
<td>Brownish Red</td>
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Honduras

Nicaragua
2. Monitored commercial operations to define fishing grounds, exploitation rates, and commercial population densities.
Combined experimental sampling surveys and monitored commercial operations to estimate resource characteristics and stock utilization.
Oneida Bank
Average Density (#/ha)

2006        2009   2010
86.0       129.7   193.00
Monitoring commercial fleets by Electronic Satellite Logbook System

- Satellite Antenna
- Marine Sealed Microcomputer
- Marine Sealed Touch Screen for data entry
- Switch Box
Satellite tracking of vessel 1 operations in Rosalind bank

Satellite tracking of vessel 2 operations in Rosalind bank

Satellite tracking of vessel 3 operations in Rosalind bank

Satellite tracking of vessel 4 operations in Rosalind bank
Characteristics of the fisheries define options for data gathering.
Small scale fishers land whole queen conch

100% Clean  85% Clean  65% Clean  Whole
PROBLEM: Whole animals are not available to measure size frequencies, sex or maturity.

Industrial queen conch fishers land bulk clean frozen conch
Operational Fishing Characteristics that Affect Conch Stock Assessments

Fishing operations take place in areas with the highest densities; therefore, CPUE does not represent average stock abundance.

Each fishing ground portrays distinct conch biological properties associated with geographic identities. However, landings are a mix of catches from many different fishing grounds; therefore: Surplus production may not capture these distinct geographic identities.

In most fisheries only clean meat is landed. This mars the process of identifying maturity and size of the individuals landed.

Fishing intensity among the fishing grounds differs and it is difficult to assess. Such differences are significant to the CPUE standardization.
Stock assessment methods based on size structures of individuals in the landings

1) Growth as a function of clean meat size at age.
2) Empirical natural mortality rate formulation based on growth function.
3) Weight converted catch curves to estimate fishing mortality rates.
Regional Juvenile Conch Growth Functions

AVERAGE GROWTH PARAMETERS

<table>
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<tr>
<th>PARAMETER</th>
<th>Loo</th>
<th>K</th>
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<tbody>
<tr>
<td>MEAN</td>
<td>316.42 mm</td>
<td>0.385</td>
<td>-0.051</td>
</tr>
<tr>
<td>SD</td>
<td>61.25</td>
<td>0.113</td>
<td>0.28</td>
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CONCH GROWTH MODEL (based on clean foot meat weight)

\[ W_t = \frac{W_\infty}{W_\infty \exp(-A3*t)} \]

Relative Age is expressed as

\[ t = \frac{-\ln\left(\frac{\ln\left(\frac{W_\infty}{W_t}\right)}{\ln(W_\infty)}\right)}{A3} \]
Growth in meat weight for queen conch in the Martinique, Belize and Grand Bahama fisheries.
Natural mortality (M) estimation

\[ M = -0.0242 + \frac{4.33}{\text{Relative Age}} \]  \hspace{1cm} \text{(Appeldoorn 1988)}

\[ \text{Relative Age} = \frac{-\ln \left( \frac{W_{\infty}}{W_t} \right)}{A3} \]  \hspace{1cm} \text{(From growth in Ehrhardt’s weight at age equation)}

\[ M = -0.0242 + \frac{4.33 \times A3}{\ln \left( \frac{W_{\infty}}{W_t} \right)} - \ln \left[ \frac{-\ln \left( \frac{W_{\infty}}{W_t} \right)}{\ln(W_{\infty})} \right] \]
Honduras

Natural mortality rate

Average $M = 0.72$ for mature weight size

Clean foot meat size (grams)
Weight converted catch curve

RelativeAge = \frac{-\ln \left[ \frac{\ln \left( \frac{W_{\infty}}{W_t} \right)}{\ln (W_{\infty})} \right]}{A3}

From growth in weight of edible part at age

Size increment \Delta t_j = t_{j+1} - t_j = \frac{1}{A3} \ln \left[ \frac{\ln \left( \frac{W_{\infty}}{W_j} \right)}{\ln \left( \frac{W_{\infty}}{W_{j+1}} \right)} \right]

From growth in weight edible part

Slope of line total instantaneous mortality rate

\ln \left( \frac{C_t}{\Delta t_j} \right) = a + \dot{Z} t'
Relative age $t'$. Weight converted catch curve by fishing ground and year.

\[
\ln \left( \frac{C_t}{\Delta t_j} \right) = a + Zt'
\]

2009: Weight converted catch curve by fishing ground and year.

Rosalinda

Oneida

Gorda

2010
$F = Z - M$

2009

- Rosalinda: $F = 1.24$
- Oneida: $F = 1.27$
- Gorda: $F = 1.33$

2010

- $F = 1.16$
- $F = 0.86$
- $F = 1.01$
Mortality estimation from historic shell discards

5,500,000 Pre-Hispanic (1160–1540 A.D.) queen conch shells. Los Roques National Park, Venezuela.
600 AD and 1960 Discards. Dominican Republic

From Torres and Sullivan-Sealy (2002)
1960-Shell Discards Dominican Republic

From Torres and Sullivan-Sealy (2002)
Turks and Caicos Islands

1980-1990's  1450 to 1645 AD

- Midden
- Beachrock

Number of Shells

Shell Length in Centimeters

From Stager and Chen (1996)
PRODUCTION MODELING

Surplus Production Index

Fishing Effort Index

MSY

Density

MSY_{\text{Density}}

MSY_{\text{Logistic}}

Fish

Conch

Dynamic Biomass Production Models

PRODUCTION MODELING

B_{\text{unexploited}}

B_{\text{MSY}} = ?

B_{\text{MSY}} = B_{\text{unexpl}}/2

Population Biomass Index

Fishing Effort Index
Operational Impacts on Conch CPUE

Fundamental assumption: CPUE directly proportional to average population abundance.

CPUE affected by interactions among fishing units (e.g., divers).

CPUE related to operational processes and conch behavior.
Production modeling issues

There is a need to understand the Queen conch population generation function which must be subjected to recruitment success as function of population density.

There is a need to understand catchability dynamics when fishing effort is fundamentally by diving.

There is a need to assess surplus production by fishing grounds due to site fidelity of the Queen conch.

There is a need to understand stock connectivity due to nature of larval drift in strong ocean current systems and the nature of the *up-stream* exploitation effects.
Colored drawing by Louis Charles Kiener (1799-1881)

Thank you