

UNDERWATER FISHERIES INDEPENDENT APPROACHES FOR QUEEN CONCH POPULATION ESTIMATION – A REVIEW



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Prepared by:

SOFRECO, under contract to the ACP Fish II Project, on behalf of the Caribbean Regional Fisheries Mechanism (CRFM) Secretariat

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FOREWORD

In 2013, the EU-sponsored ACP Fish II Programme commissioned a study titled ‘Training in underwater visual survey methods for evaluating the status of *Strombus gigas* queen conch stocks’. The study was executed by SOFRECO on behalf of the CRFM Secretariat, and upon completion, a Final Technical Report was submitted to the ACP Fish II Programme that contained 4 major outputs of direct interest to the CRFM: a review of underwater fisheries independent approaches to queen conch population estimation; a manual for conducting underwater visual surveys for queen conch; report of a mock survey of a sea area in the southern Grenadines of St. Vincent; and country-specific queen conch survey plans.

To make the 4 major outputs more readily identifiable as CRFM-approved, and also more easily available to the various CRFM publics, they have been extracted from the original Final Technical Report submitted to the ACP Fish II Programme, and reproduced as CRFM Technical and Advisory Documents 2013/14 (regional review), 2013/15 (manual) and 2013/16 (mock survey report and country-specific queen conch survey plans).

The CRFM Secretariat acknowledges the contribution of the EU-sponsored ACP Fish II Programme in this endeavour.

ACRONYMS

AUV	Autonomous Underwater Vehicle
CARICOM	Caribbean Community
CFMC	Caribbean Fisheries Management Council
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CRFM	Caribbean Regional Fisheries Mechanism
EBM	Eco-system Based Management
FAO	Food and Agriculture Organization of the United Nations
FIM	Fisheries Independent Monitoring
FKNMS	Florida Keys National Marine Sanctuary
GCFI	Gulf and Caribbean Fisheries Institute
GIS	Geographical Information System
GPS	Global Positioning System
IUU	Illegal, Unreported and Unregulated fishing
LORAN	Long Range Navigation
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
ROV	Remotely Operated underwater Vehicle
UNDP	United Nations Development Programme

TABLE OF CONTENTS

INTRODUCTION	1
FISHERIES INDEPENDENT APPROACHES USED FOR CONCH SURVEYS	3
SURVEY METHODS THAT SAMPLE LARGE AREAS	4
STRIP TRANSECTS USING TOWED-DIVERS (MANTA TOWS) AND SCOOTERS	4
VIDEO TRANSECTS	5
SURVEY METHODS THAT SAMPLE SMALL AREAS	6
BELT TRANSECTS	6
QUADRAT SAMPLING	7
LITERATURE CITED	12

Introduction

Fisheries independent monitoring (FIM) approaches are often used to evaluate fish and invertebrate populations either alone or in conjunction with fisheries data. Because FIM sampling is based on techniques that do not require catch data, they are often conducted using sampling designs that address the specific habitat-based population distribution. For this reason, these studies are often considered to be ecosystem-based. Specifically, FIM approaches may allow for methodologies to determine population attributes in a more holistic and ecosystem-based assessment regime by stratifying sampling based on habitats and water depths.

Queen Conch have a number of attributes that makes them desirable for ecosystem-based approaches for sampling and management [1]. For example, conch have very specific habitat requirements, especially for reproduction, that are quantifiable and easily incorporated into sampling protocols.



Figure 1. A diver measures siphonal length of a conch in a fisheries independent conch survey.

Conch also have a number of specific attributes that are directly related to developing strategies that ensure the sustainability of populations and which cannot be assessed using traditional capture data. For example, conch exhibit density-dependent reproduction with very well-defined density thresholds below which reproduction will not occur. Ascertaining the density of a population using methods other than direct enumeration is, therefore, problematic.

Furthermore, FIM methods facilitate sampling conch ‘in the shell’ (Figure 1) which provides more accurate age and growth information when compared with fisheries-dependent methods. Conch exhibit determinate growth; at the onset of the flared lip (approximately 3.5 years) the shell growth represented by siphonal length (i.e., the length from the notch on the anterior part of the shell to the tip of the spire) ceases and all further shell deposition inside the flared lip thus increasing the lip thickness. As the lip thickens, the meat weight may actually decline. The problem arises in estimating the age of the conch. In most conch fisheries, the animal is not landed in the shell; rather, the animal is cleaned at sea, the shell is discarded, and only the meat is landed. Because of the poor relationship between meat weight and age, it is very difficult to

determine population demography (age of the population) using fisheries data. FIM methods overcome this deficiency because an observer is able to directly measure shell morphology in situ and thus a better estimate of population demography may be obtained.

There are other problems with using fisheries catch data to assess conch populations. Size-based harvest restrictions prevent sampling a full range of sizes in a population. In many locations in the Caribbean region, regulations prohibit the harvest of juvenile conch. FIM methods overcome this sampling deficiency by permitting sampling of both juveniles and adults thus providing more robust recruitment estimations and identification of population structure.

FIM methods allow for sampling where fisheries based methods are not available such as in inaccessible locations related to deep water, areas far from shore, or within the boundaries of protected areas. These surveys may provide an understanding of the demography and reproductive output of unfished population. In the same vein, these methods facilitate comparisons between fished and unfished populations [2, 3] that can provide a baseline for evaluating different management strategies.

Finally, FIM sampling permits managers to target specific locations to determine stock status that may be underrepresented in fisheries capture data. This is especially problematic because catch data may not be comprehensive or representative of the overall population. Throughout the Caribbean region, conch have been used for local consumption and these catches are often not reported in traditional fisheries landings data thus resulting in underreporting of catch.

Nevertheless, fisheries dependent monitoring approaches have been widely used to estimate the abundance of queen conch populations, to estimate harvestable biomass, and to set catch quotas. In these more data-rich cases, fisheries independent monitoring approaches can complement these programs by providing information on spatial and depth distribution, population density, habitat associations, reproductive behavior and output, and other variables that would not otherwise be collected using fisheries-based approaches (e.g., reproductive activity, habitat associations, indices of recruitment, spatial distribution). Results from a FIM program within an existing data-rich fishery can provide an independent index that may corroborate results, elucidate deficiencies, or complement fisheries-based approaches. For this reason, incorporating FIM methods is often cited as a desirable step in developing quotas and sustainable yield estimates as well as understanding the status of conch stocks [4, 5, 6, 7, 8, 9].

Even in locations where there are good capture data, FIM sampling may be used to set quotas. For example, in Belize populations are surveyed using transects surveyed by divers. Harvestable biomass is estimated from these surveys and the catch quotas are developed from these estimates [10, 11, 12]. Jamaica [13, 14], Honduras [15, 16, 17] and Nicaragua [18] have also used FIM methods to set fisheries quotas. The latter two studies used FIM methods by employing the commercial industry to conduct the surveys in association with their ongoing fishing activities.

For all the reasons detailed above, a large number of studies have examined queen conch populations and ecological associations using surveys conducted using divers. These studies are detailed in the included summary table (*Table 1*.)

This review is meant to provide an overview of how fisheries-independent approaches have been used for conch surveys, the types of survey approaches that have been used, the advantages of each method, and the difficulties or deficiencies provided by each methodology. The various methods are presented with a brief overview of their use. The specific studies and countries where the approaches were used, along with the advantages and disadvantages are them detailed in more depth in the associated table. It has been our intent to be as comprehensive as possible but it is likely that we may have missed one or more studies due to the extensive literature based in peer-reviewed, gray, and unpublished literature. The data was collected through an extensive literature review as well as in-person contacts during conch workshops conducted in St. Vincent and the Grenadines in June 2013. Additional literature was collected from personal contacts. Finally, we present an extensive bibliography of references that are cited in the text and the table.

As we discovered, some countries have been conducting studies for a long period of time and have extensive datasets (e.g., Florida, The Bahamas, Jamaica, Belize). Others have relatively poor knowledge

of their conch populations. With the inclusion of *Strombus gigas* within Appendix II of CITES, more countries have become interested in understanding the status of their population and the exploitable biomass their resources may present.

It was not our intention to provide critical analyses of specific programs or projects; rather, our intention was to review the use of these techniques and provide an evaluation of their efficacy under different conditions. In that spirit, we hope to point out when the techniques are most appropriate and when they are inappropriate, inefficient, or unsafe. It is up to individual countries or territories to determine the usefulness of each approach based upon their specific case with regard to the area under consideration, the distribution of the conch population (e.g., depth distribution, habitat associations, the aggregated nature of the population), the resources available (including financial and human), the level of training of the individuals conducting the surveys, and the capacity of the organization conducting the surveys.

The references that are included refer to studies where specific techniques are described rather than reporting solely on the results of the surveys. We also do not report studies within which the methodologies are not sufficiently detailed to determine what method was used to collect the data even though it may be apparent that it was collected using fisheries-independent approaches.

Fisheries Independent Approaches Used for Conch Surveys

FIM methods for conch surveys have been used to sample either entire populations or representative samples of the populations. Standard sampling methods have been applied and modified for the specific biological attributes of conch, habitats occupied, and the constraints related to underwater sampling. Similarly, statistical analyses use standard approaches adjusted for the distributions associated with conch populations.

In this review, we have subdivided the survey techniques into those methods that are designed to rapidly survey large areas represented the entire cross-shelf area are surveyed (i.e., surveys using towed divers, scooters, and towed video systems) and those where smaller, representative areas are surveyed (e.g., belt transects and quadrats). Each approach has its advantage. However, these categories are not exclusive and both can be used to derive cross-shelf density and abundance estimations. For example, in some cases, belt-transects (The Bahamas [22, 39, 70], Belize [12], Colombia [26, 27]) and quadrat sampling (Barbados [19, 20, 21]) were used to estimate entire, cross-shelf populations.

In some cases, a number of methodologies were used together. For example, in The Bahamas [22] and St. Eustatius [23], both quadrats and belt transects were used to estimate conch densities. Areas to be surveyed often are determined using habitat maps developed from aerial imagery [23], satellite imagery [24, 25] or pre-developed GIS maps [26, 27].

In a number of cases, fishermen were used to determine the location of the areas to be surveyed [23, 26, 27, 28, 29, 30]. In Honduras [15, 16, 17] Jamaica [13], and Nicaragua [18] fishermen conducted the surveys in conjunction with ongoing commercial fishing activities. In some cases fisheries dependent and fisheries independent approaches were used together to estimate conch abundance (e.g., Honduras [15, 16], Nicaragua [18], Jamaica [14], and St. Lucia [29]).

FIM studies have been conducted in numerous countries (Table 1.) Generally, each study used one methodology although there are a few studies in which a broader approach (e.g., surveys using towed divers) was used to determine the extent and general distribution of conch populations, and higher resolution studies were used to determine more precise population parameters. For example, manta tows were combined with belt transects in the Turks and Caicos to examine the habitat requirements of conch within a marine reserve [25]. In the Dominican Republic, towed divers were used to conduct a coarse evaluation of conch distribution and then the areas where conch were found were sampled more intensively [31]. In Florida, surveys using towed-divers were conducted to first establish the distribution of the conch population in the region [32] and, subsequently, more focused studies were used to estimate recovery of the spawning stock [36].

There are a number of techniques that have not been used much in estimating conch populations. In rare cases, line transect methods were used [34]. In this approach, all conch visible perpendicular to a transect line are noted and used in the data analyses. These types of approaches suffer from a ‘sightability’ bias which refers to the decaying ability to identify an individual the further it is from the line. In conch surveys, especially those which use towed divers, sightability can be a significant issue due to changing conditions (e.g., visibility) within one transect thus resulting in changing sightability values.

Some techniques have been used rarely but have value in certain circumstances (e.g., mixed-gas diving [35].) Other techniques have not been used as far as our research has uncovered but may have value in certain circumstances (e.g. AUVs, surveys from submersible platforms, ROVs.)

Survey Methods That Sample Large Areas

Strip transects using Towed-Divers (Manta tows) and Scooters

These approaches have found favorable use where large amounts of area need to be surveyed and the need is to cover as much area as possible. In that spirit, towed-divers (Figure 2) and scooters have been used to establish cross-shelf densities and abundance usually in units of number of individual per hectare. This method has been used in Florida [32, 37, 86], Bermuda [38], the Turks and Caicos [25], The Bahamas [3, 39, 40, 41, 42, 43, 44], the U.S. Virgin Islands [45, 64] and St. Lucia [46, 47].



Figure 2. A diver towed by a vessel to estimate conch densities.

In some cases, the beginning and end points were delineated with deployed marker buoys [48]. In other cases, GPS [28] or LORAN systems [32] were used. Land-based features were also used to estimate distance traversed [49].

In general, this approach can cover vast distances with little effort. Densities (generally reported as individuals per hectare or individuals per square meter) may follow the negative binomial (clustering) distribution which presents difficulties from an analytical perspective.

The status of live versus dead conch is often difficult to establish. If line transects are conducted (rather than strip transects), sightability can be an issue and correctly calibrating for this variable can be difficult. Furthermore, sightability may change within one transect.

Other data may be difficult to ascertain. Specific reproductive behavior may be difficult to categorize when towed. Intra-aggregation densities may be difficult to establish because in general spatial distribution of the conch within the transect (i.e., where along the transect an individual was found) are not reported.

Video transects

In general, video transects have been used to sample areas that are beyond the limits of safe-diving. The

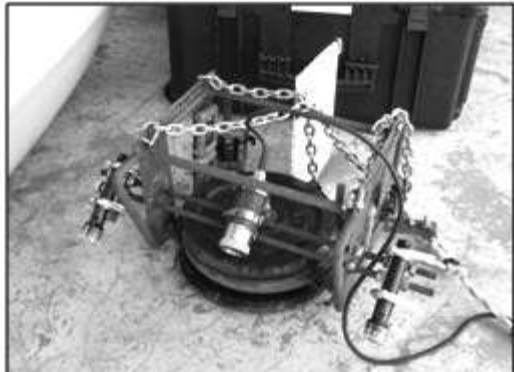


Figure 3 Underwater video equipment used in the French West Indies [14,86].

location where it has been used most extensively for surveying conch is in the French West Indies [50, 51] (Figure 3). In Florida (Figure 4), these methods have begun to be used to assess deepwater conch populations (from 15m – 70m)[Glazer personal observation]. In both cases, only 3 people are needed to run the video equipment. These include a boat driver, a camera operator, and a navigator.

This method provides the benefit of accessing deep water conch aggregations that are at or below the limits of safe diving. Virtually unlimited time can be spent at depth.

There are a number of issues that make this approach potentially problematic. First, a great deal of funding is necessary to purchase the equipment. In 2013, approximately \$3,500 was required to purchase the system which acquires the video. A second issue is the amount of post-processing that is required to examine the video. A third issue is that it may be difficult to determine if the conch are living, laying eggs, or the precise size of the individuals that are identified in the surveys. Finally, highly rugose environments are difficult to survey due to the potential for the equipment to entangle within three-dimensional structure. In order to identify conch within these surveys, the camera must be positioned close to the bottom. New, high definition systems are available, and these may provide better resolution at higher elevation, however, they suffer from requiring even more storage capacity and equipment expense.



Figure 4. Underwater video camera manufactured by SeaViewer and used in Florida surveys. Equipment in the left pane is self-contained data acquisition equipment with integrated screen, GPS (for overlay on the video, and Bluetooth glasses to visualize the video while traversing the bottom. Pane on the right is the camera and cable. Data is saved to an SD card which is read using standard video editing software.

Perhaps the most comprehensive evaluation of video transect methods was conducted in Statia [100]. In this study, researchers calibrated a towed-camera array (Figure 5) versus diver observations and concluded that using the camera system underestimated the total number of conch. Furthermore, distinguishing between *S. gigas* and *S. costatus* was problematic, although the researchers suggested that



queen conch aggregations. The array uses a GoPro camera angled slightly forward

this could be overcome with more practice. They also concluded that the maximum speed that could be used was 1 kt. In shallow areas, divers were more effective. The researchers using this system measured the width of the transect by attaching laser pointers to the frame. The laser pointers delineated the width of the swath that was sampled.

Towed-video transects are effective for examining a number of critical ecosystem-based parameters. For example, habitat is easily identified and quantified. Copulation is easily quantified; however, as mentioned,

identifying individuals who are spawning (i.e. egg-laying) is very difficult. For those studies where quantification of Allee effects (i.e., depensatory reproduction) is a priority, this approach may be challenging.

Survey Methods That Sample Small Areas

Belt Transects

By far, the most FIM studies that were identified used belt-transects. This method consists of a measured transect length and conch within a pre-defined width either side of the transect are sampled (Figure 6).



Figure 6. Diver surveying along a belt transect.

There are often a replicated number of belts and the mean density is used to estimate the overall density of the area under consideration.

Belt transects have been used in a variety of habitats and at a variety of depths. They are often used in stratified sampling approaches. They have been used to categorize habitat associations, examine reproduction, estimate

densities, and as a basis for calculating harvestable biomass. By far the majority of countries that have conducted FIM studies have used belt-transects.

Belt transects are a popular way of estimating densities [36, 53]. The approach is well-suited for measuring densities either within well-defined, discrete aggregations or for larger, cross-shelf densities

[22, 26, 27, 39, 70]. In general, the densities are reported as the number of individuals/hectare or the number of individuals/square meter.

Belt transects can only cover a limited area because of the labor required to deploy the sampling grid and the minimum amount of area that can be examined by a diver. In Florida, this method has been used together with a surface snorkeler to deploy the grid as well as measure the perimeter of the aggregation to arrive at both densities and overall estimates of abundance. Because of the relationship of the diver with the habitat, data related to environment and habitat associations are easy to collect. This approach provides a standard sampling unit and thus facilitates easy statistical evaluation in a replicated sampling design.

Length and width of belt transects are usually predetermined. In general, widths were determined using measuring sticks [53] or tethers [53, 54, 55, 56] of predetermined lengths.

For transects with lengths that were not predetermined, divers sometimes used compass courses and flow-meters to estimate distance surveyed [53, 54, 57]. The number of kicks was also used as a method to quantify and standardize area sampled [23]. Timed-surveys were used in the Dominican Republic [31] and Venezuela [58].

This method has been used to examine attributes of protected areas [59, 22, 25] as well as recovery within protected areas [63].

Quadrat sampling

For the purposes of this review, quadrat sampling is used to describe a method in which all conch within a plot are sampled. This approach can be used for estimating critical population parameters (growth, mortality, abundance, recruitment) as well as movements and migration [60].

Quadrat sampling is useful when it is desirable to sample the entire contents of the quadrat; however, with high population densities such as juvenile aggregations, this approach may require too much effort with respect to sub-sampling representative random or stratified

Quadrat sampling was also used in The Bahamas to examine ecological associations [61, 62]. For example, studies which examined Allee effects to identify densities below which no reproduction occurs were examined using these methods [87].

In both The Bahamas [3] and Venezuela [82], these approaches were used to examine densities in fished versus unfished areas. In Barbados, this method was used to estimate total abundance for their conch population [19, 20, 21]. In some cases, quadrat sampling was used to recover tagged conch; however, tag-recapture surveys are beyond the scope of this review. In most cases, data used to examine ecological associations were collected as a bi-product to population sampling.

Circle Transects

Circle transects are a type of quadrat sampling in which a centroid is identified and a radius is either predetermined or the area is surveyed based on the bottom time available to divers. Circle transects been used in The Bahamas [43], Barbados [20], and Jamaica [13] to estimate densities and abundance. All conch were counted within these plots.

Table 1. Studies in which fisheries independent methods were used. Only studies in which the methods were described are included here.

Approach	Pros	Cons	Countries where the survey techniques were used (references are within brackets)
Strip or line transects using Towed-Divers (Manta tows)	<ul style="list-style-type: none"> • Good for cross-shelf densities • Can cover vast distances • Little effort required 	<ul style="list-style-type: none"> • Poor for aggregation densities • Relatively unsafe • Limited to safe diving depths • Difficult analyzing • Difficult to determine live versus dead conch • Specific reproductive behavior may be difficult to identify (spawning, mating) • If line transects are conducted, ‘sightability’ can be an issue when towed. • Size distribution is difficult to determine • Limited to safe-diving depth • Difficult to determine width of transect in situ 	<ul style="list-style-type: none"> • Florida [32, 36, 37] • Bermuda [38] • Turks and Caicos [25] • The Bahamas [33, 53¹, 39², 40, 41, 42, 43, 44] • U.S. Virgin Islands [45] • St. Lucia [46³, 47] • Dominican Republic [31]
Strip transects using Scooters	<ul style="list-style-type: none"> • Good for cross-shelf densities • Can cover vast 	<ul style="list-style-type: none"> • Equipment intensive • Limited to safe- 	<ul style="list-style-type: none"> • Puerto Rico [28, 48] • US Virgin Islands [64]

¹ Snorkeling
² Snorkeling
³ Abstract only

	<p>distances</p> <ul style="list-style-type: none"> • Little effort required • Able to determine live vs. dead conch • Divers can leave scooters to take specific measurements • Divers can leave scooters to take specific measurements 	<p>diving depth</p> <ul style="list-style-type: none"> • Difficult to determine width of transect in situ 	
Belt transects	<ul style="list-style-type: none"> • Good for intra-aggregation densities • Good for nursery densities • Inexpensive • Easy to train technicians • Able to collect wide range of ecological and environmental parameters 	<ul style="list-style-type: none"> • Limited to safe diving depths • Limited distance (area) can be covered so large shelves require large efforts 	<ul style="list-style-type: none"> • Antigua and Barbuda [65] • Belize [2, 10, 12, 52] • Cuba [53, 66, 67, 68, 69] • Florida [32, 63, 37] • Puerto Rico [6, 54, 55, 56] • Turks and Caicos Islands [24, 25, 59] • The Bahamas [22, 39, 70] • Colombia [26, 27] • Honduras [34⁴, 71, 72] • Dominican Republic [31, 73, 74, 98] • Mexico (Alacranes)[75, 76, 77, 78] • Mexico (Chinchorro) [79] • Mexico (Q roo) [80] • Nicaragua [81] • St. Lucia [29] • Venezuela [58, 82] • US Virgin Islands [83] • Panama [84]
Circle and Quadrat sampling	<ul style="list-style-type: none"> • Good for intra-aggregation densities 	<ul style="list-style-type: none"> • Limited to safe-diving depth • Limited are can be 	<ul style="list-style-type: none"> • Barbados [19, 20, 21] • The Bahamas [22, 61, 62, 85, 86,

⁴ Line transect method

	<ul style="list-style-type: none"> • Good for nursery densities • Inexpensive • Easy to train technicians • Able to collect wide range of ecological and environmental parameters 	<p>surveyed</p> <ul style="list-style-type: none"> • Requires extreme amount of time for surveying extensive areas 	<p>87, 88, 89]</p> <ul style="list-style-type: none"> • Mexico (Chinchorro) [90, 91] • Mexico (Q. roo) [90, 92] • Mexico (Cozumel) [93⁵] • Nicaragua [18⁶] • Turks and Caicos Islands [60] • Honduras [15, 16⁷] • Jamaica [13⁸] • Venezuela [94] • Cayman Islands [95, 96]
Towed-Video Transects	<ul style="list-style-type: none"> • Good for cross-shelf densities • Can cover large distances • Unlimited bottom time • Safe • Can examine habitats and locations inaccessible to divers due to safe diving depth limitations 	<ul style="list-style-type: none"> • Equipment intensive • Expensive • Requires investment in training • Requires extensive post-processing • Difficult to calibrate (e.g. distance from bottom) • Difficult to determine live versus dead conch 	<ul style="list-style-type: none"> • Guadeloupe [50,51] • Florida [97] • Mexico (Chinchorro) [98] • Statia [100]
Mixed-gas diving	<ul style="list-style-type: none"> • Good for intra-aggregation densities • Able to sample very deep areas • Unlimited bottom time • Safe 	<ul style="list-style-type: none"> • Expensive – high equipment expenses • Requires extensive investment in training 	<ul style="list-style-type: none"> • Puerto Rico [35]

⁵ Used hookah to collect all conch in swath

⁶ Surveys conducted by commercial fishers

⁷ Surveys conducted by commercial fishers

⁸ Surveys conducted by commercial fishers

	<ul style="list-style-type: none">• Can examine habitats and locations inaccessible to divers due to safe diving depth limitations		
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Literature Cited

- [1] Appeldoorn RS, Castro Gonzalez E, Glazer R, Prada M. 2011. Applying EBM to Queen Conch Fisheries in the Caribbean. Pages 177 - 186 *In*: Fanning L, Mahon R, McConney P. (eds) Towards Marine Ecosystem-based Management in the wider Caribbean. Amsterdam University Press.
- [2] Appeldoorn RS, Rolke W. 1996. Stock Abundance and Potential Yield of the Queen Conch Resource in Belize. CARICOM Fisheries Research Assessment and Management Program (CFRAMP) and Belize Fisheries Department Princess Margaret Dr. Belize City, Belize. 31p.
- [3] Stoner AW, Ray M. 1996. Queen conch, *Strombus gigas*, in fished and unfished locations of The Bahamas: Effects of a Marine Fishery Reserve on adults, juveniles, and larval production. *Fish Bull.* 94 : 551 – 565p.
- [4] Anonymous. 1999. Queen conch Stock Assessment and Management Workshop. Belize City, Belize, 15 - 22 March 1999 CFMC. 105p.
- [5] Ehrhardt NM, Valle-Esquivel M. 2008. Conch (*Strombus gigas*) Stock Assessment Manual. Caribbean Fishery Management Council. 128p.
- [6] Medley P. 2005. Manual for the Monitoring and Management of Queen conch. FAO Fisheries Circular No. 1012. FIRM/C1012. 68p.
- [6] Appeldoorn RS, Ballantine DL. 1986. Assessment of Fisheries of Queen conch, *Strombus gigas* in Puerto Rico. Completion Report submitted to the National Marine Fisheries Service. Contract No. NA81-GA-C-00015. 62p.
- [7] Medley P. 2008. Monitoring and Managing Queen conch Fisheries – A Manual. FAO Fisheries Technical Paper 514. 90p.
- [8] SEDAR. 2007. Stock Assessment Report. Caribbean Queen conch. SEDAR 14, Stock Assessment Report 3. Southeast Data, Assessment, and Review, North Charleston, SC, USA
- [9] FAO. Regional Workshop on the Monitoring and Management of Queen conch, *Strombus gigas*. Kingston, Jamaica, 1 – 5 May 2006. FAO Fisheries Report. No. 832. Rome, FAO. 2007. 174p.
- [10] Singh-Renton S, Appeldoorn R, & Gongora M. 2006. Report of Workshop to Analyse Data Collected during Visual Abundance Survey of Queen conch Conducted in Belize. CRFM Technical & Advisory Document, Number 2008 / 1. 20p.
- [11] Acosta CA. Impending Trade Suspensions of Caribbean Queen conch under CITES: A Case Study on Fishery Impacts and Potential for Stock Recovery.
- [12] Gibson J, Stradine S, Gonzalez K. 1983. The Status of the Conch Industry in Belize. *Proc Gulf Carib Fisheries Institute* 35 : 99 - 107.

- [13] Tewfik A. 1997. An Assessment of the Biological Characteristics, Abundance, and Potential Yield of the Queen conch (*Strombus gigas* L.) Fishery on the Pedro Bank off Jamaica. MSc. Thesis. Acadia University. 151p.
- [14] Aiken K, Kong A, Smikle S, Appeldoorn R, Warner G. 2006. Managing Jamaica's Queen conch Resources. *Ocean Coastal Management*. 49 : 332 - 341.
- [15] Ehrhardt N, Galo M. 2005. Informe Sobre los Resultados de las Investigaciones Relacionadas con el Caracol *Strombus gigas* y su Pesquería en Honduras. Informe Presentado a la 53ava Reunión del Comité Permanente de la CITES Ginebra, 27 Junio - 1 Julio 2005. 37p.
- [16] Ehrhardt N, Romero JA [Date unknown] Informe Sobre los Trabajos de Realizados en 2011 Destinados a Conseguir Información Científica para el Desarrollo de Metodologías para la Evaluación de los Efectivos de Caracol, *Strombus gigas*, en Honduras 46p.
- [17] Espinoza E. 2009. Queen conch Management Strategies and Use of CITES as a Control Instrument, the Honduras Case. Pages 37 - 42 *In*: Prada MC and ER Castro. Proceedings of the Regional Workshop for the Improvement of the Queen conch Collaborative Management and Enforcement in the Southwestern Caribbean Sea. San Andres Island, Colombia.
- [18] Sanchez Baquero R. 2009. National Report of Queen conch (*Strombus gigas*) in the Republic of Nicaragua. Pages 33 - 36 *In*: Prada MC and ER Castro. Proceedings of the Regional Workshop for the Improvement of the Queen conch Collaborative Management and Enforcement in the Southwestern Caribbean Sea. San Andres Island, Colombia.
- [19] Oxenford H.A., Parker C. 2009. A Preliminary Management Plan for the Queen conch (*Strombus gigas*) Fishery in Barbados. Prepared for the Fisheries Division, Government of Barbados, 27p.
- [20] Oxenford H.A., Walcott J., Staskiewicz T. 2008. Preliminary Assessment of the Abundance of Queen conch, *Strombus gigas*, along the Southeast and Southwest Coasts of Barbados. Report prepared for the Natural Heritage Department and the Environmental Unit, Ministry of Family, Youth, Sports and Environment (Environment Division), Government of Barbados, 39p.
- [21] Oxenford H.A., Gooding C., Walcott J., Staskiewicz T., Valles H. 2010. Assessment of the Queen conch, *Strombus gigas*, in Barbados. Report prepared for the Natural Heritage Department and the Environmental Unit, Ministry of Environment, Water Resources and Drainage, Government of Barbados, 49p.
- [22] Clark S.A., Danylchuk A.J., Freeman B.T. 2005. The Harvest of Juvenile Queen conch (*Strombus gigas*) off Cape Eleuthera, Bahamas: Implications for the Effectiveness of a Marine Reserve. *Proc Gulf Carib Fisheries Institute*. 56 : 705 - 714.
- [23] Davis J.E. 2003. Population Assessment of Queen conch, *Strombus gigas*, in the St. Eustatius Marine Park, Netherlands Antilles. Report prepared for St. Eustatius Marine Park. 15p.
- [24] Clerveaux W., Danylchuk A.J., Clerveaux V. 2005. Variation in Queen Conch Morphology: Management Implications in the Turks and Caicos Islands. *Proc. Gulf Carib Fisheries Institute*. 56 : 715 - 724.

- [25] Danylchuk A.J., Rudd M.A., Giles I., Baldwin K. 2003. Size-dependent Habitat Use of Juvenile Queen conch (*Strombus gigas*) in East Harbour Lobster and Conch Reserve, Turks and Caicos Islands, BWI. Proc Gulf Carib Fisheries Institute. 54 : 241 - 249.
- [26] Castro E., Ballesteros C., Rojas A., Forbes T., Bent H., Prada M. 2010. Estado Actual del Caracol *Strombus gigas* en la Reserva de Biosfera Seaflower, Colombia 19p.
- [27] Appeldoorn R., Aaang L., Cabeza F., Castro-Gonzalez E., Glazer R., Marshak T., Peñaloza G. 2003. Queen conch Distribution and Population Assessment of the Northern Banks of the San Andrés Archipelago, Colombia. 37p.
- [28] Jiménez N. 2007. Caribbean / NMFS Cooperative SEAMAP Program - Queen conch, *Strombus gigas*, Assessment 2006. Department of Natural and Environmental Resources, Report to National Marine Fisheries Service, NOAA. 30p.
- [29] King-Joseph A., Lendor-Gabriel G., Serieux N., St. Omer A. 2008. Conch Resource Assessment Study. Ministry of Economic Affairs, Economic Planning, Investment & National Development, Office of the National Authorising Officer. 124p.
- [30] Baldwin K., Punnett S. 2008. A Preliminary Investigation of the Queen conch Fishery in St. Vincent and the Grenadines. Proc. Gulf Carib. Fisheries Institute. 61 : 560 (abstract only).
- [31] Posada J., Mateo I., and Nemeth M. Unpublished Manuscript. Distribution of Queen conch, *Strombus gigas*, (Gastropoda: Strombidae) on the Shallow Waters of the Jaragua National. Park, Dominican Republic. 14p.
- [32] Berg C.J. Jr., Glazer R.A. 1995. Stock Assessment of a Large Marine Gastropod (*Strombus gigas*) using Randomized and Stratified Towed Diver Censusing. ICES mar. Sci Symp. 199 : 247 - 258.
- [33] Ray M., Stoner A.W. 1994. Experimental Analysis of Growth and Survivorship in a Marine Gastropod Aggregation: Balancing Growth with Safety in Numbers. Mar Ecology Prog Series. 105 : 47 - 59.
- [34] Green S., Bicknella J., Saunders J., Curtis A., Jinda S., Logan M. 2011. Conch Ecology and Research Group pages 30 - 32 *In*: Cayos Cochinos Marine Science Report – 2011. Report prepared by Operation Wallacea on Behalf of the Honduran Coral Reef Foundation. 57p.
- [35] García-Sais J.R., Sabater-Clavell J., Esteves R., Carlo M. 2012. Fishery Independent Survey of Commercially Exploited Fish and Shellfish Populations from Mesophotic Reefs within the Puerto Rican EEZ. Report submitted to Caribbean Fishery Management Council, San Juan, Puerto Rico 91p.
- [36] Glazer R.A. 1999. Manual for Surveying Queen conch Aggregations. Unpublished.
- [37] Glazer R.A., Berg C.J. 1994. Queen conch Research in Florida: An Overview. Pages 79 - 95 *In*: Appeldoorn R.S., Rodriguez B. (eds) Queen conch Biology, Fisheries and Mariculture. Fundación Científica Los Roques, Caracas, Venezuela. 338p.

- [38] Berg C.J., Cooper F., Nisbet K., Ward J. 1992. Stock Assessment of Queen conch, *Strombus gigas*, and Harbour conch, *S. costatus*, in Bermuda. 41: 433 - 438.
- [39] Ray M., Stoner A.W., Jones R. 1994. Adult Queen conch Distribution in the Exuma Cays Land and Sea Park near Wardrick Wells. A Report to The Bahamas National Trust. Caribbean Marine Research Center, Vero Beach, FL . 15p.
- [40] Stoner, A.W., Davis M.H., Booker C.J. 2012, Surveys of Queen conch Populations and Reproductive Biology at Sandy Point and More's Island, Bight of Abaco, The Bahamas. Report produced by Community Conch for The Bahamas Department of Marine Resources Bahamas National Trust. www.communityconch.org.
- [41] Stoner A.W., M. Davis M.H. 2010, Queen conch Stock Assessment Historical Fishing Grounds Andros Island, The Bahamas. Report produced by Community Conch for The Nature Conservancy, Northern Caribbean Office. Nassau, The Bahamas. www.communityconch.org.
- [42] Jones R.L. 1996. Spatial Analysis of Biological and Physical Features Associated with the Distribution of Queen conch, *Strombus gigas*, Nursery Habitats. Thesis. Florida Institute of Technology. 107p.
- [43] Stoner A.W., Sandt V., Boidron-Metairon I.F. 1992. Seasonality in Reproductive Activity and Larval Abundance of Queen conch *Strombus gigas* Fish Bull. 90 : 161 - 170.
- [44] Stoner A.W., Sandt V. 1992. Population Structure, Seasonal Movements and Feeding of Queen conch, *Strombus gigas*, in Deep-water Habitats of The Bahamas. Bull Mar Sci. 287 - 300.
- [45] Wood R.S. Olsen D.A. 1983. Application of Biological Knowledge to the Management of the Virgin Islands conch Fishery. Proc Gul Carib. Fisheries Institute. 35 : 112 - 121.
- [46] Nichols K.E. 1987. Conch Management Program St. Lucia. Proc Gulf Carib Fisheries Institute 38 : 379 - 379.
- [47] Nichols K., Jennings-Clark S. 1994. An Overview of the Conch Industry in St. Lucia, West Indies. Pages 25 - 28 In: Appeldoorn R.S., Rodriguez B. (eds) Queen conch Biology, Fisheries and Mariculture. Fundación Científica Los Roques, Caracas, Venezuela. 338p.
- [48] Mateo I.R., Appeldoorn R.S., Rolke W. Unpublished. Spatial Variations in Stock Abundance of Queen conch, *Strombus gigas*, (Gastropoda: Strombidae) in the West and East coast of Puerto Rico. 20p.
- [49] Stoner A.W., Pitts P.A., Armstrong R.A. 1996. Interaction of Physical and Biological Factors in Queen conch in Seagrass Meadows the Large-scale Distribution of Juvenile Queen conch in Seagrass Meadows. Bull. Mar Sci. 58 : 217 - 233.
- [50] Chalifour J. 2009. Development of an Evaluation Method of the Queen conch (*Strombus gigas*) Resources in Guadeloupe and Application to Eight Marine Sites in the Archipelago. Proc Gulf and Carib. Fish Institute. 61 : 509 - 513.

- [51] Chalifour J. 2010. First Implementation of Queen conch Stocks Monitoring in Guadeloupe on Six Marine Sites in its Archipelago. Proc. Gulf Carib. Fisheries Inst. 62 : 390 - 393.
- [52] Stoner A.W. 1989. Winter Mass Migration of Juvenile Queen conch *Strombus gigas* and their Influence on the Benthic Environment. Mar Ecology Progress. Ser. 56 : 99 - 104.
- [53] Alcalado P.M. 1976. Growth, Morphological Variations of the Shell and some Biological Data of the conch ("Cobo") *Strombus gigas* L. (Mollusca, Mesogastropoda). Academia de Ciencias de Cuba Instituto de Oceanologia. No. 34 La Habana. 27p.
- [54] Stoner, A.W., Davis M.H., Booker C.J. 2009, Queen conch Stock Assessment proposed MPA and Fishing Grounds Berry Islands, The Bahamas. Report produced by Community Conch for The Bahamas Department of Marine Resources, The Bahamas National Trust. www.communityconch.org.
- [55] Torres Rosado Z.A., Appeldoorn R.S. Unpublished manuscript. Distribution and Association between the Queen conch, *Strombus gigas* Linneus, and Milk conch, *S. costatus* Gmelin, in La Parguee, Puerto Rico. 23p.
- [56] Torres Rosado Z.A. 1987. Distribution of two Mesogastropods, the Queen conch, *Strombus gigas* Linnaeus, and the Milk conch, *Strombus costatus* Gmelin, in La Parguera, Lajas, Puerto Rico. Thesis. University of Puerto Rico. 58p.
- [57] Stoner A.W., Schwarte K.C. 1993. Queen conch, *Strombus gigas*, Reproductive Stocks in the Central Bahamas: Distribution and Probable Sources. Fish Bull. 92 : 171 - 179.
- [58] Schweizer D., Posada J. 2002. Distribution, Density and Abundance of Queen conch, *Strombus gigas*, in the Los Roques Archipelago National Park, Venezuela. Proc Gulf Carib Fisheries Institute. 53 : 129 - 142.
- [59] Béne C. Tewfik A. 2003. Biological Evaluation of Marine Protected Area: Evidence of Crowding Effect on a Protected Population of Queen conch in the Caribbean. Marine Ecology. 24: 45 - 58.
- [60] Hesse K.O. 1979. Movement and Migration of the Queen conch, *Strombus gigas*, in the Turks and Caicos Islands. Bull Mar Sci. 29 : 305 - 311.
- [61] Stoner A.W., Lally J. 1994. High-density Aggregation in Queen conch *Strombus gigas*: Formation, Patterns, and Ecological Significance. Mar Ecology Progress. Series. 106 : 73 - 84.
- [62] Stoner A.W., Lin J, Hannisak D. 1995. Relationships between Seagrass Bed Characteristics and Juvenile Queen conch (*Strombus gigas* Linne) Abundance in The Bahamas. J Shellfish Res. 14 : 315 - 323.
- [63] Glazer R. 2002. Queen conch Population Monitoring in the FKNMS fully-protected zones. Pages 44 - 45 In: U.S. Department of Commerce Sanctuary Monitoring Report 2000. Florida Keys National Marine Sanctuary. Marathon, Florida, USA [www.fknms.nos.noaa.gov/research_monitoring/welcome.html]
- [64] Friedlander A., Appeldoorn R.S., Beets J. 1994. Spatial and Temporal Variations in Stock Abundance of Queen conch in the U.S. Virgin Islands. Pages 51 - 60 In: Appeldoorn R.S., Rodriguez B.

(eds) Queen conch Biology, Fisheries and Mariculture. Fundación Científica Los Roques, Caracas, Venezuela. 338p.

[65] Tewfik A., Archibald S., James P., Horsford I. 2001. Antigua and Barbuda Queen conch Abundance survey (1999). CARICOM Fishery Report No. 7: 30 p.

[66] Formosa M. Unpublished Manuscript. El Manejo integral de las Poblaciones de Cobo (*Strombus gigas*) en los Ambientes Costeros de la Plataforma Cubana

[67] Formoso M. Unpublished. Stock Assessment and Fishery Management of Queen conch (*Strombus gigas*) in Major Fishing Grounds of the Cuban Shelf.

[68] Grua P, Alcolado P. 1984. Evaluacion de las Poblaciones de Cobo en Nueve Zonas de la Costa Nore y sur de Cuba. Archivo Centro Invest. Pesq. Cuba. 8p.

[69] Formosa M. Unpublished. Evaluacion y Estrategia de Manejo de la Pesqueria del Cobo (*Strombus gigas*) en Nuevitas, Cayería Norte de Camaguey, Cuba.

[70] Smith G.B., van Nierop M. 1984. Distribution, Abundance and Potential Yield of Shallow-water Fishery Resources of the Little and Great Bahama Banks. UNDP / FAO Fish. Dev. Proj. BHA / 82 / 002 : 1 - 78.

[71] Tewfik A., Guzmán H.M., Gabriel J. 1998. Assessment of the Queen conch *Strombus gigas* (Gastropoda: Strombidae) Population in Cayos Cochinos, Honduras. Rev. Biol. Trop.

[72] de Arias G.P., Ehrhardt N.M. 2009. The Honduras conch Research and Management Program in Support of the CITES Requirements for Species in Appendix II. Pages 111 - 115 *In*: Prada MC and ER Castro. Proceedings of the Regional Workshop for the Improvement of the Queen Conch Collaborative Management and Enforcement in the Southwestern Caribbean Sea. San Andres Island, Colombia.

[73] Torres R., Sullivan-Sealey K.M. 2002. Abundance, Size Frequency, and Spatial Distribution of Queen conch (*Strombus gigas*) in Southeastern Dominican Republic: a Four year Population Study in Parque Nacional del Este. Proc Gulf Carib Fisheries Institute. 53 : 120 - 128.

[74] Delgado G.A.1999. Influence of Habitat on Queen conch Abundance and Size Distribution in Soft-sediment Marine Communities in Parque Nacional del Este, Dominican Republic. MS Thesis. RSMAS - University of Miami, Florida, USA.

[75] Pérez-Pérez M., Aldana-Aranda D. 1998. Análisis Preliminar de la Densidad del Caracol Rosado (*Strombus gigas*) en el Arrecife Alacranes, Yucatan, Mexico. Proc. Gulf Carib. Fisheries Institute. 50 : 49 - 65.

[76] Pérez-Pérez M. Aldana-Aranda D. 2002. *Strombus gigas* L. 1758 (Mesogasteropoda, Strombidae) y su Periodo de Desove en el Arrecife Alacranes, Yucatán. Proc. Gulf Carib. Fisheries Institute. 53 : 108 - 119 2002.

[77] de Jesus Navarette A. 2013. Evaluacion Poblacional del Caracol Rosado (*Strombus gigas*) en el Parque Nacional Arrecife Alacranes, Yucatan, Mexico – Proposal to GCFI.

- [78] Ríos-Lara G.V.K., Cervera J.C., Espinoza M., Pérez C., Zetina-Moguel, Chable E.K. 2000. Densidad Poblacional de Langosta (*Panulirus argus*) y Caracol Rosado (*Strombus gigas*) en el área Central del Arrecife Alacranes, Yucatán, México, del 14 al 21 de Febrero de 1997. Ciencia Pesquera No. 14 : 47 - 55.
- [79] Chávez E.A. 1995. An Assessment of the Queen conch Stock of Banco Chinchorro, Mexico. Proc. Gulf Carib. Fisheries Institute. 43 : 487 - 497.
- [80] Basurto M., Martinez D., Cadena P. Unpublished manuscript) Evaluacion de la Poblacion de Caracol Rosado *Strombus gigas* (Linne0, 1758) en la Plataforma Marina de Isla Mujeres y Cozumel, Quintan Roo.
- [81] CIPA. Unpublished. Investigación de la Distribución y Abundancia del Caracol *Strombus gigas* en el Caribe Nicaragüense. 11p.
- [82] Schweizer D. and Posada J.M. 2006. Distribution, Density and Abundance of the Queen conch, *Strombus gigas*, in Los Roques Archipelago, Venezuela. Bulletin of Marine Science. 79 : 243 - 258.
- [83] Tobias W., Mateo I., Valiulis J., O'Sullivan C. 2005. Assessment of conch Densities in Backreef Embayments on the Northeast and Southeast Coast of St. Croix, U.S. Virgin Islands. Report to the Southeast Area Monitoring and Assessment Program – Caribbean (SEAMAP-C), Project Number: NA03NMF4350100. 34p.
- [84] Tewfik A., Guzman H.M. 2003. Shallow-water Distribution and Population Characteristics of *Strombus gigas* and *S. costatus* (Gastropoda Strombidae) in Bocas Del Toro, Panamá. Journal of Shellfish Research, 3: 789 - 794.
- [85] Stoner A.W., Ray M. 1993. Aggregation Dynamics in Juvenile Queen conch (*Strombus gigas*): Population Structure, Mortality, Growth, and Migration. Marine Biology 116 : 571 - 582.
- [86] Berg C.J., Glazer, R.A., Carr J., Krieger J., and Acton S. 1992. Status of Queen conch in Florida Waters: a Progress Report. Proc Gulf Carib Fisheries Instit. 41 : 439 - 443.
- [87] Stoner A.W., Ray M. 2000. Evidence for Allee Effects in an Over-harvested Marine Gastropod: Density-dependent Mating and Egg Production.
- [88] Sandt V.J., Stoner A.W. 1993. Ontogenetic Shift in Habitat by Early Juvenile Queen conch, *Strombus gigas* Patterns and Potential Mechanisms. Fish Bull. 91 : 516 - 525.
- [89] Wicklund R.I., Hepp L.J., Wenz G.A. 1988. Preliminary Studies on the Early Life History of the Queen conch *Strombus gigas* in the Exuma Cays, The Bahamas. National Underseas Research Program Research Report 88 – 4 : 347 - 363.
- [90] Pelaya, A.A. 1994. Distribucion y Densidad del Caracol Rosado *Strombus gigas* (Linnaeus, 1758) en el sure de Quintana Roo. Tesis. Instituto Tecnológico de Chetumal. 55p.
- [91] Basurto M., Martinez D., Cadena P. 2000. Comparación de Metodologías para la Evaluación de Caracol Rosado *Strombus gigas* en Banco Chinchorro. Report to World Wildlife Fund.

- [92] de Jesus Navarette A.J., Oliva Rivera J. 1997. Densidad, Crecimiento y Reclutamiento del Caracol Rosado *Strombus gigas* L. (Gastropoda: Strombidae) en Quintana Roo, Mexico. Rev. Biol. Trop. 45 : 797 - 801.
- [93] Martinez D. 1998. Distribución y Abundancia de las Poblaciones del Caracol Rosado *Strombus gigas* en la isla de Cozumel, Quintana Roo. Tesis. Universidad Nacional Autonoma de Mexico. 53p.
- [94] Weil M.E., Laughlin R. 1984. Biology, Population Dynamics, and Reproduction of the Queen conch *Strombus gigas* Linne in the Archipiélago de Los Roques National Park. J Shellfish Res. 4 : 45 - 62.
- [95] Anonymous. Conch surveys. From <http://www.doe.ky/marine/conch/conch-survey/>.
- [96] Bothwell J. 2009. Conch in the Cayman Islands: CITES, IUU and fishery status. Pages 43 - 45 In: Prada MC and ER Castro. Proceedings of the Regional Workshop for the Improvement of the Queen Conch Collaborative Management and Enforcement in the Southwestern Caribbean Sea. San Andres Island, Colombia.
- [97] Glazer RA. 2013. Deepwater Queen conch Surveys in Florida – A Proposal.
- [98] Tejada Soto JC. 1995. Evaluacion de la Pesqueria de Lambi (*Strombus gigas*) en el Parque Nacional Jaragua, 1992 - 1993. Republica Dominicana. Tesis. Universidad Autonoma de Santo Domingo. 96p.
- [99] Wood, E.M. 2010. Status and Management of Queen conch in Haiti. Marine Conservation Society, Ross-on-Wye, UK.
- [100] Van Rijn J. 2013. Population Assessment of the Queen conch, *Strombus gigas*. University of Applied Sciences. Van Hall Larenstein.

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