Annex 1 – **Agenda**

REGIONAL SHELLFISH HATCHERY FEASIBILITY WORKSHOP
Kingston, Jamaica, 18–21 October 2010

Sunday, 17 October 2010

19:00–21:00 Registration

Monday, 18 October 2010

09:00 Opening
Opening address – *M. Panton*, Chief Technical Director, Ministry of Agriculture and Fisheries, Jamaica
Host country representative – *R.A. Russell*, Fisheries, Chief Executive Officer, Fisheries Division, Ministry of Agriculture and Fisheries, Jamaica
Workshop objectives – *A. Lovatelli*, FAO, Aquaculture Service, Rome, Italy

CULTURING NATIVE SPECIES: A DREAM OR A REALITY?
Session moderator: A. Smikle (Jamaica)

09:45 Introduction to the regional hatchery concept: Interest and concerns raised by Caribbean countries – *A. Lovatelli*

10:00 Aquaculture candidate species and species of interest – *S. Sarkis*

10:15 Caribbean seafood market demand – *A. Lovatelli*

Break (10:30–11:00)

REGIONAL HATCHERY: POTENTIAL CULTURE CANDIDATES
Session moderator: J.J. Alió (Bolivarian Republic of Venezuela)

11:00 The cultivation of marine invertebrates indigenous to the Wider Caribbean Region: Established culture techniques and research needs for molluscs – *L. Creswell*

11:20 Oyster culture in Jamaica – *D. Brown*

11:40 Farming native scallop species – *S. Sarkis*

Lunch (12:00–13:30)

13:30 The cultivation of marine invertebrates indigenous to the Wider Caribbean Region: Established culture techniques and research needs for crustaceans – *L. Creswell*

13:50 Commercial molluscs and shellfish from the Colombian Caribbean: Current state of knowledge and culture – *L.A. Velasco*

14:10 Status of shellfish fisheries and farming in Panama – *N. Serrano*

14:40 Developing echinoderm culture for consumption and stock enhancement in the Caribbean – *L. Creswell*

15:00 Presentation of terms of reference and assignment of working groups for Round Table I – *S. Sarkis*

Break (15:00–15:30)

ROUND TABLE I

15:30 **Potential culture candidates** – Main questions: *How to prioritize species to be cultured for commercial production? Market demand; Culture know-how; Ease of transport of seed; Ease of adaptation of grow-out techniques to countries; Countries' needs for employment; Source of revenue and food; How to prioritize research for new culture candidates.*

16:30 Presentation by the working groups

Tuesday, 19 October 2010

REGIONAL HATCHERY: DEFINING GOALS AND OPERATIONAL PROTOCOLS

Session moderator: L. Velasco (Republic of Colombia)

09:00 Summary Round Table I – *S. Sarkis / A. Lovatelli*

09:25 Hatchery design considerations – *S. Sarkis*

09:45 Establishing operational protocols for a regional shellfish hatchery – *L. Creswell*

10:05 Presentation of terms of reference and assignment of working groups for Round Table II – *S. Sarkis*

ROUND TABLE II

10:10 **Pros and cons of a regional hatchery – Putting forward solutions** – Main questions: *How to ensure genetic diversity among Caribbean populations and ensure a disease/parasite-free operation? Broodstock management; Quality control of seed; Shipping and acclimatization protocols; Responsible party for environmental assessment for grow-out; Transfer of techniques; Discharge of waste waters; Introduction of invasive species and/or pathogens; Impact of increased populations to natural ecosystem.*

Break (11:00–11:20)

11:20 Presentation by the working groups

Lunch (12:15–13:45)

13:45 Summary Round Table II – *S. Sarkis / A. Lovatelli*

14:05 Cultivation of bivalve molluscs in Venezuela: diversity, potential and infrastructure for seed production – *J.J. Alió*

14:25 Considering Honduras as a potential site for the establishment of a Wider Caribbean regional hatchery to improve the quality of life for small-scale fishermen – *L. Morales*

14:45 Jamaica's potential as a regional shellfish hatchery site – *D. Brown*

15:05 Overview of aquaculture in Belize – *R. Quintana*

Wednesday, 20 October 2010

REGIONAL HATCHERY: SITE SELECTION PROCESS
Session moderator: A. Lovatelli (FAO)

09:00 Site selection criteria – *S. Sarkis*

09:20 Presentation of terms of reference and assignment of working groups for Round Table III – *S. Sarkis*

ROUND TABLE III

09:25 **Optimal site for a regional hatchery** – Main questions: *Ease of access; Infrastructure; Personnel available for training; Enforcement of protocols, Reliability; Exposure to natural disasters; Proposed list of countries; Availability of target species; Technical support (proximity of research institutes, university).*

Break (10:30–10:50)

10:50 Presentation by the working groups

Lunch (12:00–13:00)

13:00 Field trip

Thursday, 21 October 2010

IMPLEMENTING A REGIONAL HATCHERY: DEVELOPING A PLAN AND FUNDING
Session moderator: L. Creswell (United States of America)

09:00 Summary Round Table III – *S. Sarkis / A. Lovatelli*

09:20 Presentation of terms of reference and assignment of working groups for Round Table IV – *S. Sarkis*

ROUND TABLE IV

09:25 **Developing a 5-year plan** – Main questions: *How to ensure sustainability of a regional hatchery? Anticipated time frame of production; Selling of seed; Breakeven point; Training and continuity of skilled personnel; Reliable and continuous supply of seed; Balancing production and research.*

Break (10:20-10:40)

10:40 Presentation by the working groups

11:30 Funding opportunities for implementation of regional hatchery – *M. Haughton*

Lunch (12:00-13:30)

13:30 Presentation of terms of reference and assignment of working groups for Round Table V – *S. Sarkis*

ROUND TABLE V

13:35 **Funding implementation of a regional hatchery** – Main questions: *How to fund building of facility, training of personnel and initial operation? How to establish and maintain a cost-effective operation? Funding cost of production for the first five years; Cost effectiveness of purchasing seed for recipient countries; Inclusion of other agencies/ proposals in the Region; Inclusion of private sector in the regional hatchery operation; Involvement and funding of research centers; Assisting investigations of new culture candidates.*

14:45 Presentation by the working groups

Break (15:10-15:30)

15:30 Summary Round Table IV and V – *S. Sarkis / A. Lovatelli / L. Creswell*

16:00 Completion of working groups reports

17:00 Submission of working groups reports and preparation of workshop proceedings

17:15 Closing remarks – *A. Smikle*, Director, Aquaculture Branch, Fisheries Division, Ministry of Agriculture and Fisheries, Jamaica, and *A. Lovatelli* (FAO)

19:00 Closing dinner

Annex 2 – **List of participants**

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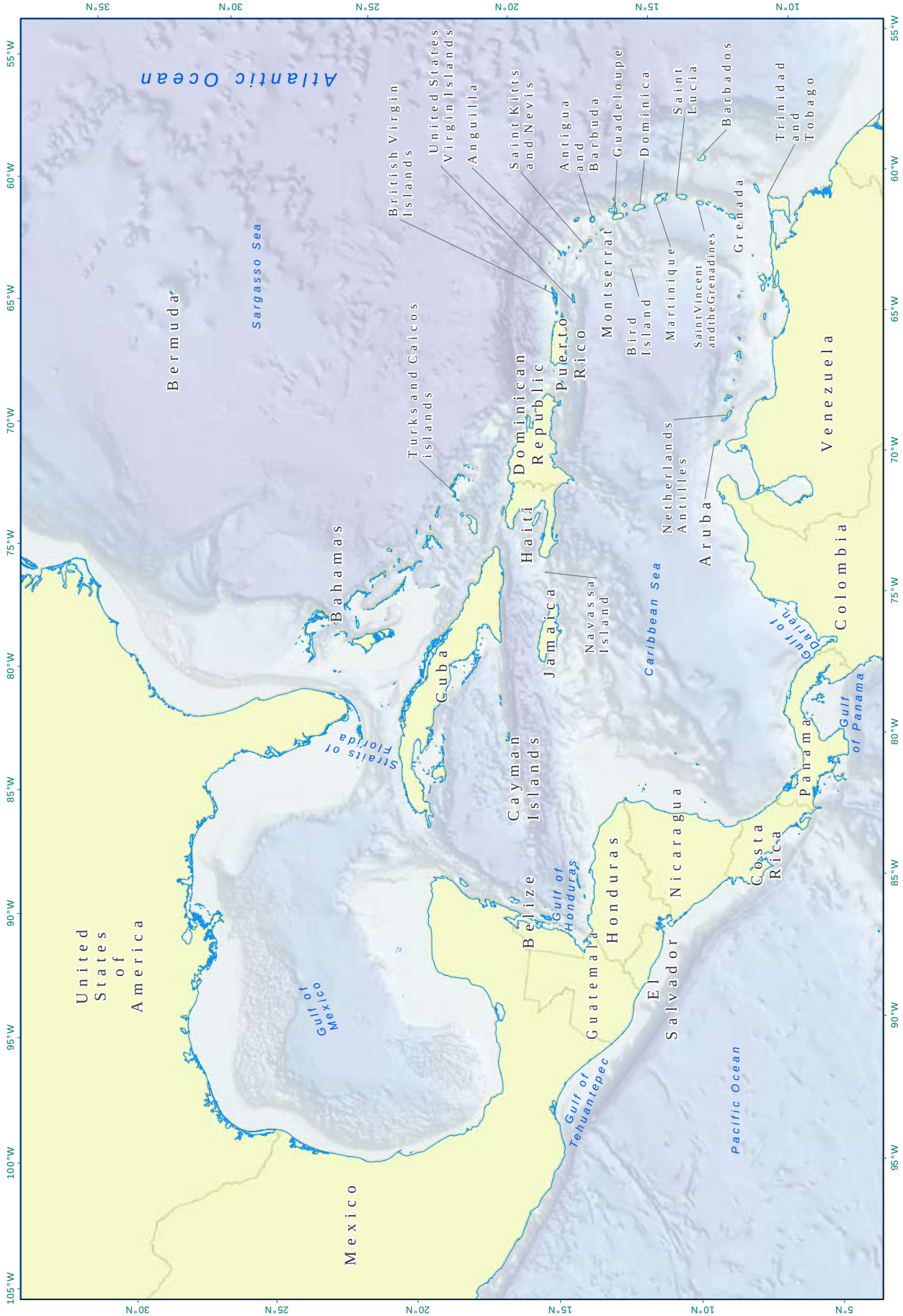
Annex 3 – **Map of the Caribbean**



Annex 4 – **Questionnaire and responses to the regional hatchery concept**

ANNEX 4.1 – CIRCULAR LETTER ATTACHED TO THE REGIONAL HATCHERY QUESTIONNAIRE

Note: *The explanatory letter below was attached to the Regional Hatchery Questionnaire, outlining in brief the background and concept of the investigation being conducted. The letters were sent in English or Spanish dependent on the official language of the recipient country. Both versions are given below.*

Dear Sir/Madam,

The establishment of a Regional Shellfish/Mollusc Hatchery for the Wider Caribbean was proposed at the Aquaculture Latin American and Caribbean Bivalve Aquaculture Workshop (ACUIBIVA)[1], held in the Republic of Chile in August 2007. This recommendation stemmed from previous assessments made through FAO workshops, where experts and government officials provided information on the status of aquaculture in the Caribbean (Bahamas, 1981; St Lucia, 2003; Panama, 2005). Based on these assessments, it was concluded at ACUIBIVA that although technology and scientific information is available for several shellfish species native to the Caribbean, one of the most constraining factors to aquaculture development is the limited seed supply. For this reason, hatchery production needs to be considered for a reliable production of juveniles. However, high initial capital investment for hatcheries and the requirements for basic infrastructure and skilled personnel are stumbling blocks within any one Caribbean country; this led to the Regional Hatchery Concept for the Wider Caribbean.

Given that not all countries of the Region were represented at ACUIBIVA 2007, the interest of all parties needs to be determined. Therefore, the Aquaculture Service (FIRA) of the FAO Fisheries and Aquaculture Department in collaboration with the FAO Subregional Office in Barbados is sending out a request to all Caribbean countries to express their interest in the development of a Regional Shellfish/Mollusc Hatchery. The establishment of such a facility would address one of the most constraining factors for aquaculture development in the Wider Caribbean Region – a lack of national and regional aquaculture plan – and focuses on the core requirement of seed supply.

[1] **Lovatelli, A.; Farías, A.; Uriarte, I. (eds).** Estado actual del cultivo y manejo de moluscos bivalvos y su proyección futura: factores que afectan su sustentabilidad en América Latina. Taller Técnico Regional de la FAO. 20–24 de agosto de 2007, Puerto Montt, Chile. *FAO Actas de Pesca y Acuicultura.* No. 12. Rome, FAO. 2008. 359p. Available at www.fao.org/docrep/011/i0444s/i0444s00.htm. Only available in Spanish.

There are several factors which favour the development of aquaculture in the Caribbean Region, including:

- The depletion of natural populations since the late 1980s.
- Local demand for fish and fisheries products associated with the tourism industry.
- The increased reliance on imported fish products, as increased demand exceeds the supply.

Native and endemic species are considered a priority for sustainable aquaculture in the Caribbean, eliminating the environmental and ecological impacts associated with exotic species. Shellfish/Molluscs are considered as first culture candidates for several reasons: 1) shellfish and especially bivalves, although not all a traditional element in the diet of the Caribbean people, are a well-appreciated seafood product by the tourists visiting the Region, and would potentially command a high price and a substantial market; 2) shellfish production requires no feed inputs into the natural environment, and hence results in a low impact activity, facilitating growth of the industry without adversely affecting the marine ecosystem; 3) the lack of necessary feed input for the grow-out of shellfish species also results in a lower production cost than that for finfish; 4) grow-out technology can be relatively simple, as are long-line systems used for bivalves, and can be easily transferred to small-scale farmers; and 5) long-line systems can additionally be submerged, making them adaptable to less protected areas and more open waters.

A Regional Shellfish/Mollusc Hatchery would:

1. Favour the development of aquaculture by centralizing efforts and resources.
2. Support a team skilled in the culture (and investigation) of native/endemic species.
3. Become responsible for the distribution of seed to interested parties.
4. Provide technical support for grow-out.

A successful operation would provide an opportunity for employment to small-scale displaced fishermen and/or entrepreneurs and potentially benefit natural resources. The development of such a project is complex, requiring the investigation of several key factors, namely site selection, management procedures, preservation of genetic diversity, etc. However, most importantly, the success of such an operation depends on the long-term commitment of beneficiary parties. For this reason, a short questionnaire is hereby attached to assess the interest and commitment of your country. Please return the filled form to Alessandro Lovatelli (see full contact details below) preferably by 31 August 2009.

Based on the responses of the countries, FAO will evaluate the interest and commitment of all Caribbean countries in a Regional Shellfish/Mollusc Hatchery and investigate its development. The results of the survey will be summarized and returned to you when completed.

Thank you for your interest and support.

Estimado Señor(a),

El establecimiento de un Laboratorio Regional de Producción de Semilla de Mariscos y/o Moluscos para el Caribe fue propuesto en el Taller Técnico Regional (Latinoamérica y Caribe) de Acuicultura de bivalvos (ACUIBIVA)[1] llevado a cabo en la República de Chile en agosto de 2007. Esta recomendación proviene de valoraciones realizadas a través de talleres FAO, donde expertos y oficiales gubernamentales entregaron información sobre el estatus de la acuicultura en el Caribe (Bahamas, 1981; Santa Lucía, 2003; Panamá, 2005). Basados en estos conceptos, se concluyó en ACUIBIVA que aunque la tecnología y la información científica está disponible para varias especies de mariscos nativos del Caribe, uno de los factores que más reprimen el desarrollo de la acuicultura es la limitada fuente de semilla. Por esta razón, la producción de juveniles en laboratorio necesita ser considerada para una producción confiable. Sin embargo, la alta inversión inicial en capital para los laboratorios y sus requerimientos básicos en infraestructura y personal experimentado son grandes impedimentos para cualquiera de los países del Caribe; esto ha llevado al concepto de Laboratorio Regional de Producción de Semilla de Mariscos y/o Moluscos para el Caribe.

Dado que no todos los países de la Región fueron representados en ACUIBIVA 2007, el interés de todas las partes necesita ser determinado. Así, el Servicio de Acuicultura (FIRA) del Departamento de Pesquería y Acuicultura de la FAO en colaboración con la oficina Subregional de la FAO en Barbados está enviando una solicitud a todos los países del Caribe para expresar sus intereses en el desarrollo de un Laboratorio Regional de Producción de Semilla de Mariscos y/o Moluscos. El establecimiento de tal laboratorio puede direccionar uno de los factores más importantes para el desarrollo de la acuicultura en la Región del Caribe – la falta de planes nacionales y regionales en la acuicultura – y enfocarse en el requerimiento central de un suministro de semilla.

Existen varios factores que favorecen el desarrollo de la acuicultura en la Región Caribe:

- La depleción de las poblaciones naturales desde los últimos 1980s.
- La demanda local de peces y productos pesqueros asociados con la industria del turismo.
- La incrementada confianza en los productos pesqueros importados, así como la alta demanda que excede la producción local.

Las especies nativas y endémicas son consideradas una prioridad para la acuicultura sostenible en el Caribe, eliminando los impactos ambientales y ecológicos asociados con las especies exóticas. Los mariscos y moluscos son considerados como los primeros candidatos de cultivo por varias razones: 1) los mariscos y especialmente los bivalvos, aunque no son un elemento tradicional en la dieta de la gente del Caribe, son productos de mar bien apreciados por los turistas que visitan la región, y podían potencialmente comandar un alto precio y un mercado sustancial; 2) la producción de mariscos no requiere la entrada de alimento exógeno dentro de los ambientes naturales, por lo que

[1] **Lovatelli, A.; Farías, A.; Uriarte, I. (eds).** Estado actual del cultivo y manejo de moluscos bivalvos y su proyección futura: factores que afectan su sustentabilidad en América Latina. Taller Técnico Regional de la FAO. 20–24 de agosto de 2007, Puerto Montt, Chile. *FAO Actas de Pesca y Acuicultura.* No. 12. Rome, FAO. 2008. 359pp. Disponible en http://www.fao.org/docrep/011/i0444s/i0444s00.htm

se considera una actividad de bajo impacto que permite el crecimiento de la industria sin afectar negativamente el sistema marino, 3) la falta de entradas de alimento exógeno para el crecimiento de las especies de mariscos además, resulta en un menor costo de producción que el de los peces y camarones; 4) la tecnología para el cultivo de los juveniles puede ser relativamente simple, como lo son los sistemas de líneas largas flotantes usadas para bivalvos, y puede ser fácilmente transferida a cultivadores en pequeña escala; y 5) los sistemas de líneas largas adicionalmente pueden ser sumergidos, siendo adaptables a áreas menos protegidas y aguas más abiertas.

Un Laboratorio Regional de Producción de Semilla de Mariscos y/o Moluscos podría:

1. Favorecer el desarrollo de la acuicultura mediante la centralización de esfuerzos y recursos.
2. Apoyar un equipo experimentado en el cultivo (e investigación) de especies nativas y/o endémicas.
3. Hacerse responsable de la distribución de semilla a las partes interesadas.
4. Proveer soporte técnico para el cultivo de los juveniles.

Una operación exitosa podría proveer una oportunidad de empleo para pescadores o emprendedores desplazados a pequeña escala y potencialmente beneficiar los recursos naturales. El desarrollo de tal proyecto es complejo, requiere la investigación de varios factores clave, como la selección del sitio, los procedimientos de manejo, la preservación de la diversidad genética, etc. Sin embargo, lo más importante para el éxito de tal operación depende del compromiso a largo plazo de las partes beneficiarias. Por esta razón, un corto cuestionario ha sido anexado para determinar el interés y compromiso de su país. Por favor devuelve el formulario rellenado a Alessandro Lovatelli (ver los detalles de contacto completos abajo) preferiblemente antes del 31 de agosto de 2009.

Basado en las respuestas, FAO evaluará el interés y compromiso de todos los países del Caribe en un Laboratorio Regional de Producción de Semilla de Mariscos y/o Moluscos e investigar su desarrollo. Los resultados de esta encuesta serán procesados y devuelto a ustedes cuando sean completados.

Gracias por su interés y apoyo.

ANNEX 4.2 – REGIONAL HATCHERY QUESTIONNAIRE

Note: *An English or Spanish version of the questionnaire was sent dependent on the recipient country's official language. Both versions are provided below.*

Regional Shellfish/Mollusc Hatchery Questionnaire

The information obtained in this form is to gather general information on the current aquaculture related projects in your country and to determine your need and/or interest in the development of a regional shellfish/mollusc hatchery. Species, such as queen conch, scallops, pearl oysters, West Indian top shell, as well as sea urchin, sea cucumber or any other native or endemic shellfish species which may be in demand are to be considered.

1. Ongoing aquaculture project(s) (*specify research or commercial*).
2. Are the cultured species exotic or native species? *Please list species*.
3. Are these governmental or private projects?
4. Is there interest or demand for species other than the one(s) currently cultured?
5. Is seed supply a limiting factor to the development of the project(s)?
6. Is your department interested in the prospect of a regional shellfish/mollusc hatchery in the Wider Caribbean?
7. Please give an indication (*on a scale from 1 to 3, where 1 is most important and 3 least important*) as to which regional hatchery activity would be most beneficial to your country:
   [ ] Reliable supply of seed
   [ ] Technical support in grow-out operations
   [ ] Investigating new culture candidate species
8. If you answered "Yes" to question 6, would you be willing to financially contribute to send one representative of your country to a feasibility workshop in the Caribbean Region, evaluating optimal hatchery site and candidate culture species?
9. If you are not willing to financially contribute, but willing to participate in the workshop, please indicate the reason from one of the choices below:
   [ ] Lack of funds
   [ ] Uncertain as to the importance of a feasibility workshop to develop the concept of a regional hatchery
   [ ] Uncertain as to country's contribution to workshop
   [ ] Would like to receive further information before committing
10. Any general comments or concerns regarding the development of a regional hatchery?

Please note that before the establishment of such a facility, all environmental factors will be thoroughly considered and strict management protocols established.

CUESTIONARIO CRIADERO REGIONAL DE PRODUCCIÓN DE SEMILLA DE MARISCOS Y/O MOLUSCOS

La información obtenida de este formulario es para generar una información general sobre los proyectos actuales relacionados con la acuicultura en su país, y para determinar sus necesidades y/o intereses en el desarrollo de un criadero regional. Especies como el caracol pala o rosado, los pectínidos o vieras, las ostras perlíferas, ostras del mangle, almejas, el caracol burgao o cigua, el erizo de mar, el pepino de mar y otras especies de mariscos endémicos o nativos que puedan tener una demanda son considerados.

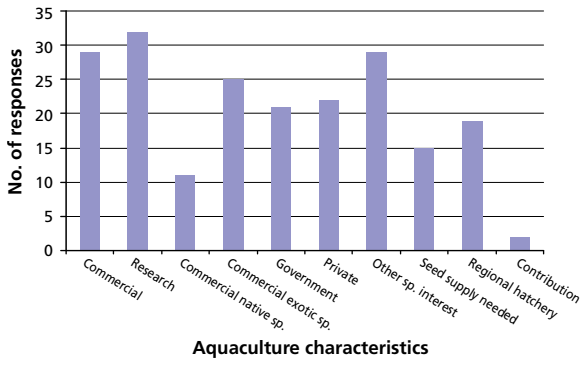
1. Proyecto(s) de acuicultura en curso (*especifique si son de investigación o de producción*).
2. ¿Las especies cultivadas son exóticas o nativas? *Por favor haga un listado de las especies*.
3. ¿Estos proyectos son gubernamentales o privados?
4. ¿Hay interés o demanda por especies diferentes a las que están cultivando actualmente?
5. ¿Es el suministro de semilla un factor limitante al desarrollo de los proyectos?
6. ¿Su departamento está interesado en el prospecto de un criadero regional de producción de semilla de mariscos y/o moluscos en el Caribe?
7. Por favor de un calificativo (en *una escala de 1 a 3, donde 1 es más importante y 3 menos importante*) sobre cómo la actividad de un criadero regional podría ser más beneficioso para su país:
   [ ] Confiable suministro de semilla.
   [ ] Apoyo técnico a las operaciones de cultivo de juveniles.
   [ ] Investigación de nuevas especies candidatas para cultivo.
8. Si usted ha contestado "Si" a la pregunta 6, ¿podría estar disponible para contribuir financieramente para el envío de un representante de su país a un taller de viabilidad en la Región Caribe, para evaluar el lugar óptimo para el criadero y las especies candidatas para cultivo?
9. Si usted no puede contribuir financieramente, pero le interesaría participar en el taller, por favor encierre en un círculo la razón entre las siguientes opciones:
   [ ] Falta de fondos.
   [ ] Incertidumbre sobre la importancia del taller de viabilidad para el desarrollo de un concepto de criadero regional.
   [ ] Incertidumbre sobre la contribución de los países al taller.
   [ ] Le gustaría recibir información adicional antes de comprometerse.
10. ¿Tiene algún comentario general o sugerencia respecto al desarrollo de un criadero regional?

Por favor note que antes del establecimiento de esta infraestructura, todos los factores ambientales serán ampliamente considerados y establecidos estrictos protocolos de manejo.

ANNEX 4.3 – SYNOPSIS OF AQUACULTURE ACTIVITY AND CONSTRAINTS IN THE REGION

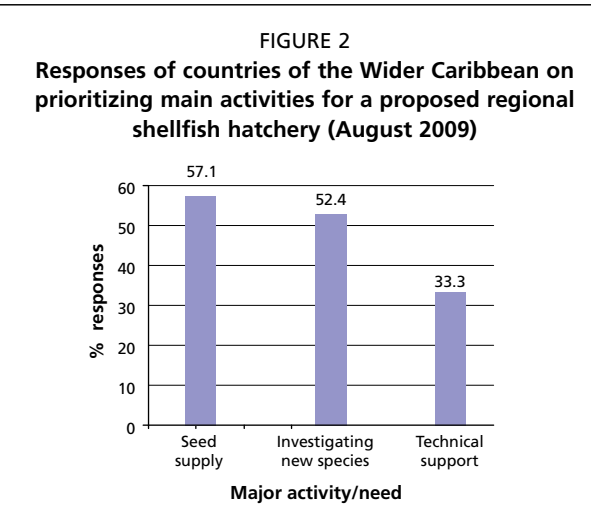
The FAO-designed questionnaire provides a first assessment on the engagement of the governments of the Region in the development of a regional shellfish/mollusc hatchery concept. This questionnaire was distributed to 33 countries in August 2009 (the original letter and questionnaire circulated in Spanish and English are appended above). Responses were received from 21 countries (63 percent). Of these, 11 are islands of the Caribbean, the other ten are continental countries bordering the Caribbean Sea. Of the total number of responses received, only two countries showed a lack of interest in the concept (9.5 percent), five were uncertain and required further information (23.8 percent) while the remaining 14 expressed a definite interest in the concept (66.7 percent). Furthermore, three governments offered their country as the site where to establish the future regional facility.

FIGURE 1
A summary of aquaculture activities in the Wider Caribbean Region, based on responses from government agencies to the FAO questionnaire sent in August 2009 (21 countries responded)



For the 21 countries responding to the FAO call of interest, a total of 61 aquaculture projects were reported. Of these, 29 are considered commercial and most are privately owned (20) (see Figure 1). Aquaculture research and production is conducted on both natives and exotic species with exotic species supporting more than 75 percent of commercial operations. A substantial number of investigations and experimental-scale culture (32 recorded) on native species are carried out by government departments of the Caribbean countries. There were no reports of endemic species culture.

FIGURE 2
Responses of countries of the Wider Caribbean on prioritizing main activities for a proposed regional shellfish hatchery (August 2009)



Seed supply was identified as the limiting factor to aquaculture development by 15 of the 21 respondents. The concept of a regional hatchery was endorsed by 19 of the 21 respondents (Figure 1). As shown in Figure 2, the top priority in the development of a regional facility is the reliable supply of seed for grow-out. In addition, 52 percent of regional governments who responded indicated their interest in the development of a more sustainable aquaculture, by the will to investigate new (native) species (Figure 2).

Several species are of interest as commercial culture candidates; all require further investigations into culture techniques and commercial feasibility. Species of common interest to countries who have responded are: queen conch, mangrove oyster, spiny lobster, pearl oyster, sea urchin, West Indian top shell and scallop species.

For a more comprehensive understanding of the molluscan species available for culture, Annex 5 provides an overview of Wider Caribbean species including target species.

Annex 5 – **Native Caribbean molluscan species**

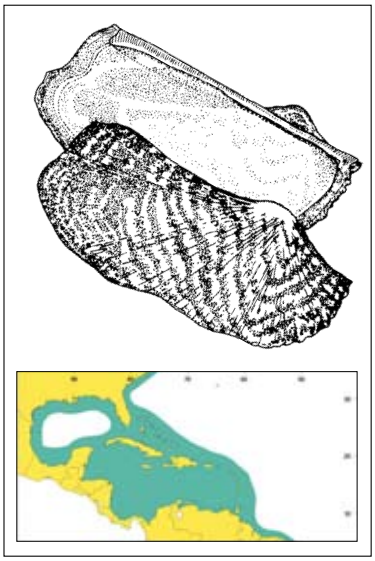
A compilation of the native molluscan/shellfish species of the Wider Caribbean Region indicates the occurrence of 37 species including gastropods, crustaceans, bivalves (scallops, clams, oysters and mussels), echinoderms and cephalopod (the common octopus). Of these, 22 species were identified by the Caribbean Governments as target species for aquaculture. Sea cucumber was added at a later date due to the strong interest expressed by a number of participants at the Jamaica Workshop. Information for all native species on population distribution, and what is referred to as the "culture potential" specifying level of knowledge on techniques, growth rate and market demand, is given for each species.

BIVALVE MOLLUSCS

ARCIDAE – Ark shells

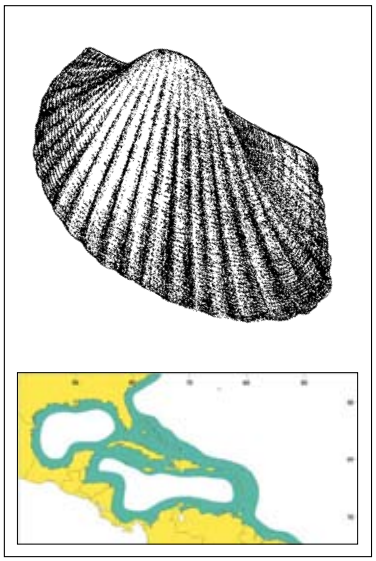
Arca zebra **Target species**

FAO names: **En**: Turkey wing; **Fr**: Arche zebra; **Sp**: Arca cebra
Size: to 100 mm
Distribution/habitat: North Carolina to Florida and Texas (United States of America), Caribbean, south to the Federative Republic of Brazil and Bermuda. Attached by byssus to the underside of rocks and coral heads. Supporting fishery of socio-economic importance to artisanal fishermen in southern part of its range (e.g. Bolivarian Republic of Venezuela).
Larviculture: Conducted experimentally. Relatively hardy even during early life stages, but slow growing.
Culture potential: Availability of broodstock in various locations, grows in high densities, attached to one another, tolerant species ranging from intertidal zone to depths of 15 m. Local demand.



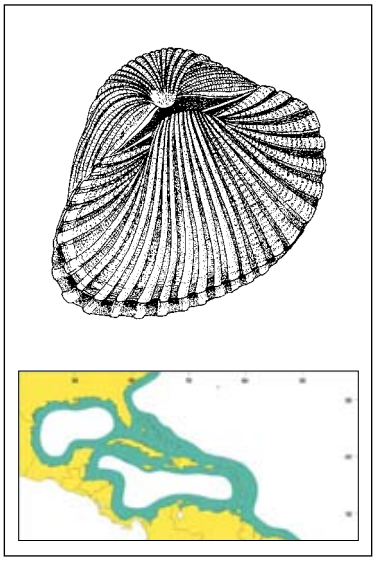
Anadara notabilis **Target species**

FAO names: **En**: Eared ark; **Fr**: Arche auriculée; **Sp**: Arca auriculada
Size: to 100 mm
Distribution/habitat: North Carolina to eastern Florida (United States of America), Caribbean, south to the Federative Republic of Brazil. Soft bottoms (mud or sand) at shallow intertidal depths. Exploited for local consumption.
Culture potential: Culture techniques tested for other species of same genus, which could be adapted to *A. notabilis.* Local demand.



Note: Distribution and some other information provided in this annex has been obtained from the following publication:

Carpenter, K.E. (ed.). The living marine resources of the Western Central Atlantic. Volume 1: Introduction, molluscs, crustaceans, hagfishes, sharks, batoid fishes, and chimaeras. *FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication* No. 5. Rome, FAO. 2002. pp. 1-600.



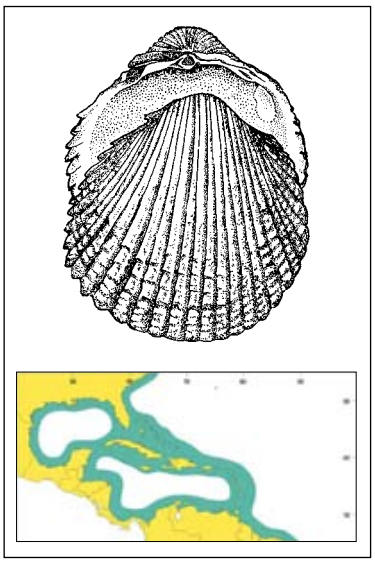
Scapharca brasiliana

FAO names: **En**: Incongruous ark; **Fr**: Arche incongrue; **Sp**: Arca pepitona

Size: to 78 mm

Distribution/habitat: North Carolina to Florida and Texas (United States of America), Caribbean and south to the Federative Republic of Brazil. Found at subtidal depths on sand, shell rubble and seagrass beds. Exploited for consumption in the southern portion of its range.

Larviculture: Arcid veligers typically reach metamorphosis in 23–35 days at a shell length approximately 250 µm shell length. They will attach to hard substrates with byssus threads and should be provided shell or fibrous materials for attachment.



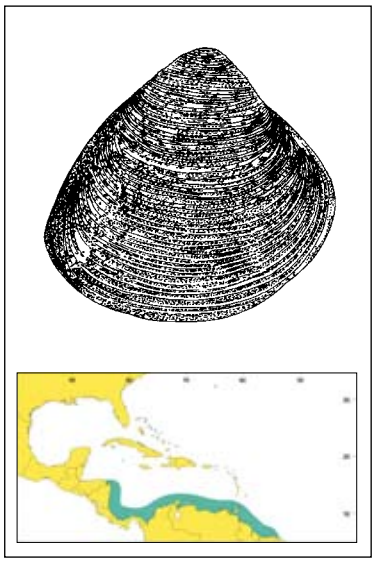
CARDIIDAE – Cockles

Trachycardium muricatum

FAO names: **En**: American yellow cockle (Yellow prickly cockle); **Fr**: Bucarde jaune; **Sp**: Berberecho Amarillo

Size: to 50 mm

Distribution/habitat: North Carolina to Florida and Texas (United States of America), the Caribbean to the Federative Republic of Brazil. Found in moderately shallow subtidal areas buried in sand and often associated with coral reefs. Collected by hand for local consumption.



CORBICULIDAE – Basket clams

Polymesoda artacta **Target species**

FAO names: **En**: Slender marsh clam, **Fr**: Cyrène elancée; **Sp:** Guacuco de marjal esbelto

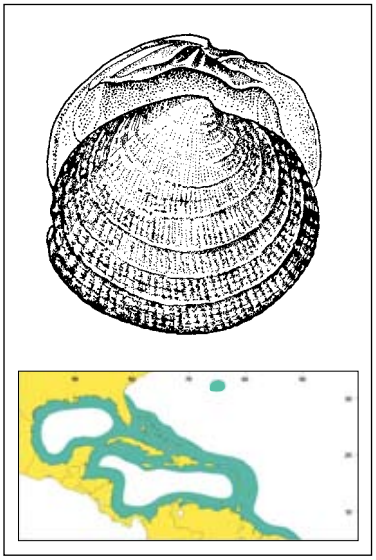
Size: to 40 mm

Distribution/habitat: Southern Caribbean Sea and northern shore of South America, from Belize to Gulf of Venezuela and Maracaibo Lake. Buried in mud in estuaries, mangrove swamps and coastal lagoons. Consumed locally.

Larviculture: Research studies on early life stages and documentation available.

Culture potential: Species of interest to Caribbean Governments.

LUCINIDAE – Lucinas



Codakia orbicularis

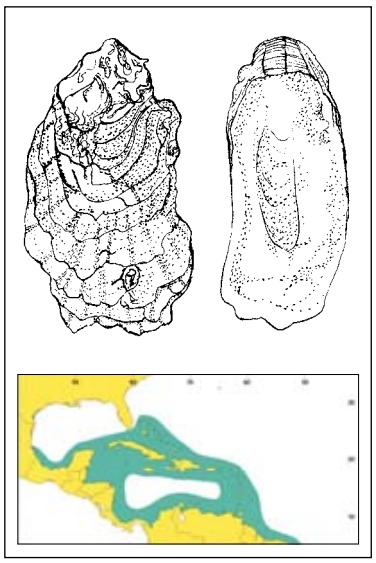
FAO names: **En**: Atlantic tiger lucine; **Fr**: Lucine tigrée américaine; **Sp**: Lucina tigre

Size: to 85 mm

Distribution/habitat: Bermuda, Florida to Texas (United States of America), the Caribbean south to the Federative Republic of Brazil, found deeply buried in sand at subtidal depths. Exploited locally for consumption.

Larviculture: *Codakia* sp. veligers have been reported to be lecithotrophic (not requiring algal food), reaching metamorphosis in 9–12 days at approximately 175 µm shell length. This species may be a detrital feeder or utilize chemoautotrophic bacteria in the gills for nutrition in waters with low phytoplankton production.

OSTREIDAE – Oysters



Crassostrea rhizophorae **Target species**

FAO names: **En**: Mangrove cupped oyster; **Fr**: Huître creuse des Caraïbes; **Sp**: Ostión de mangle

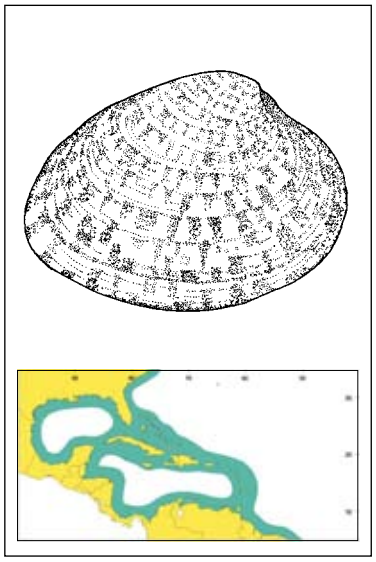
Size: to 120 mm

Distribution/habitat: Caribbean to the Federative Republic of Brazil. Attached to mangrove roots, rocks or other oyster shells. Heavily exploited species. Historically, there has been aquaculture development for this species in the Region, primarily based on wild spat.

Larviculture: Larvae become *eyed* pediveligers in 10–12 days at around 250 µm shell length at which time they attach to oyster shells, concrete, tires and other hard surfaces or plastic sheeting. The use of ground oyster shell provides individual, *cultchless*, spat.

Culture potential: Known techniques for larviculture and grow-out, broodstock availability in various locations, abundance of wild seed. Local demand.

VENERIDAE – Venus clams



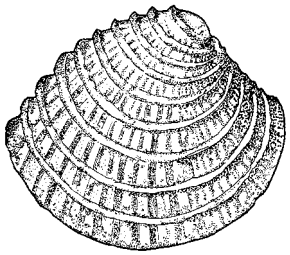
Macrocallista maculata

FAO names: **En**: Calico clam; **Fr**: Vénus calicot; **Sp**: Almeja calico

Size: to 70 mm

Distribution/habitat: Bermuda, North Carolina to Florida and Texas (United States of America), the Caribbean to the Federative Republic of Brazil. Lives in coarse sand at shallow subtidal depths, often associated with seagrass beds. Exploited for local consumption, primarily in southern half of its range.

Larviculture: *Macrocallista* sp. reach metamorphosis after one week at approximately 220 µm shell length. Survival through settlement is improved by providing a substrate (sand) to facilitate burrowing. Similarly, broodstock are best maintained in a substrate that allows the clams to burrow.



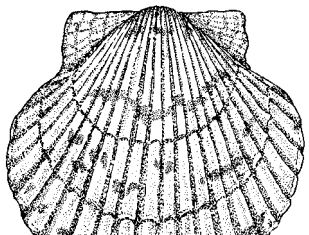
Chione cancellata

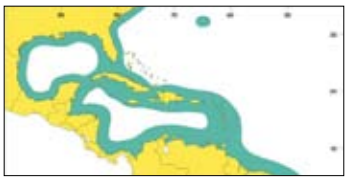
FAO names: **En**: Cross-barred venus; **Fr**: Vénusquadrillée; **Sp**: Venus cuadrilla

Size: to 45 mm

Distribution/habitat: From the Republic of Cuba throughout the Caribbean and from the Republic of Honduras to the southeastern Brazil (Federative Republic of). Sand in shallow subtidal environments, often associated with seagrass beds. Exploited for local consumption.

Larviculture: Cross-barred venus clams reproduce sexually. Sexes are separate and fertilization is external via broadcast spawning of gametes. *C. cancellata* larvae settled out of the water column when individuals reached a size of 170–196 µm. Larval duration as typically being around 11 days from hatching to settlement.





PECTINIDAE – Scallops

Argopecten gibbus **Target species**

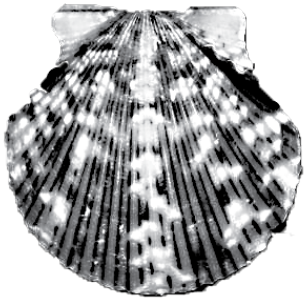
FAO names: **En**: Calico scallop; **Fr**: Peigne calicot; **Sp**: Peine percal

Size: to 65 mm

Distribution/habitat: Bermuda, Florida and Texas (United States of America), the Caribbean and northern Brazil (Federative Republic of). Found in beds in shallow to moderately deep water on sandy bottoms.

Larviculture: Larvae cultured in static and flow-through systems. Reach settlement in 10–14 days at 220 µm, high survival rate.

Culture potential: Tested culture techniques. Reach market size in 18 months at 55 mm shell height. Relatively hardy and easy to culture; rapid growth but to small market size. Small scallop needs to be sold and consumed whole. Potential market demand high. Limitations related to availability of broodstock.



Argopecten nucleus **Target species**

FAO names: Not recorded

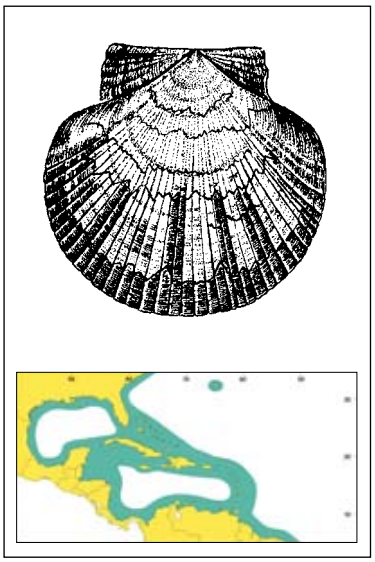
Size: to 65 mm

Distribution and habitat: South Florida (United States of America), southern Gulf of Mexico, Caribbean and the Republic of Suriname. Found in sandy bottoms, co-existing at times with *Nodipecten nodosus* at 10-50 m deep.

Larviculture: Early life stages culture researched and documented.

Culture potential: Natural spat collection and grow-out tested. High market value.

Euvola ziczac **Target species**



FAO names: **En**: Zigzag scallop; **Fr**: Peigne zigzag; **Sp**: Vieira zigzag
Size: to 120 mm
Distribution/habitat: Bermuda, North Carolina to Florida and Texas (United States of America), the Caribbean, south to the Federative Republic of Brazil. Gregarious subtidal species to depths of 50 m, usually buried in sand.
Larviculture: Pediveligers metamorphose approximately 10–12 days post fertilization (depending on rearing factors, larval density, food ration). The eyed-larvae settle at 200–220 µm shell length. Attain 10 mm shell height in three months under nursery conditions.
Culture potential: Well-tested culture techniques. Reach market size in 18–24 months. Rapid growth, but a delicate species during early life cycle to settlement. Grow-out on bottom, as species recesses in sand; labour intensive and needs to be optimized for commercial viability. High market value. Availability of broodstock low.

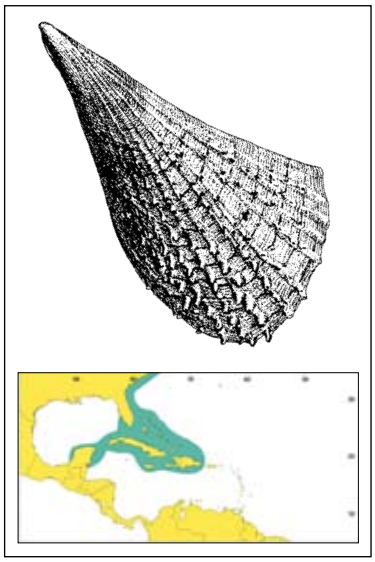
Nodipecten nodosus **Target species**

FAO names: Not recorded
Size: to 150 mm
Distribution and habitat: North Carolina (United States of America) to south to the Federative Republic of Brazil. Found in rocky hard and sandy bottoms. Lives attached to hard substrate, found up to 120 m depth. Consumed locally.
Larviculture: Pediveligers are competent to metamorphose approximately 10–15 days post fertilization. Attain 10 mm shell height in one month following transfer at sea.
Culture potential: Well-researched techniques for early life stages and grow-out. Large-scale culture conducted in the Federative Republic of Brazil. Fast-growing species. Recorded to reach market size 80 mm in 10–12 months. High market value.

PENNIDAE – Pen shells

Pinna carnea **Target species**

FAO names: Not recorded
Size: to 300 mm
Distribution/habitat: Bermuda, South Florida (United States of America) to the Federative Republic of Brazil. Buries vertically in sandy bottoms. Found subtidal to 25 m depth.
Larviculture: Research studies in early life stage culture.
Culture potential: Fast growing for first five months. Market size (160 mm) for meat consumption attained in 11–14 months. Grow-out techniques for pearl oysters and scallops can be adapted to species.

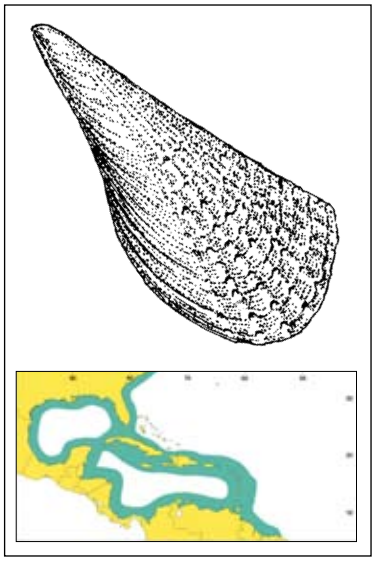


Atrina rigida

FAO names: **En**: Stiff pen shell; **Fr**: Jambonneau raide; **Sp**: Pina tiesa

Size: to 300 mm

Distribution/habitat: North Carolina to Florida (United States of America), northern Caribbean including the Commonwealth of Bahamas, Greater Antilles, the Republic of Cuba, and Yucatan (United Mexican States). Burrows in fine sands in shallow-water seagrass beds. Commercially exploited around Campeche (United Mexican States).



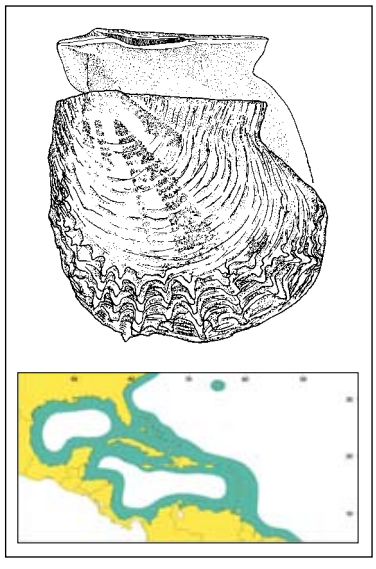
Atrina seminuda

FAO names: **En**: Half-naked pen shell; **Fr**: Jambonneau demi-lisse; **Sp**: Pina semislisa

Size: to 230 mm

Distribution/habitat: North Carolina to Florida and Texas (United States of America), and Caribbean to the Argentine Republic. Burrows in fine sands in shallow-water seagrass beds. Exploited for local markets.

Larviculture: Little is known about the larval biology of the pen shells, although it is reported that they are difficult to spawn relative to other bivalve species, and noted that the teloplanic larvae (long drifting), with some species reaching over 800 µm prior to settling, suggests significant constraints to hatchery production.



PTERIIDAE – Pearl oysters

Pinctada imbricata **Target species**

FAO names: **En**: Atlantic pearl oysters; **Fr**: Huître perlière de l'Atlantique; **Sp**: Ostra perlera Atlántica

Size: to 76 mm

Distribution/habitat: Bermuda, South Carolina to Florida and Texas (United States of America) and Caribbean. Lives subtidally attached to rocks and other hard substrates. Exploited by divers for local food consumption, and historically, for the pearl market.

Larviculture: Larvae are cultured in both static and flow-through culture systems. Larvae reach settlement at approximately 30–35 days at a size of 230–300 µm shell length.

Culture potential. Availability of broodstock. Can be cultured for consumption, half-pearl, or pearl. Relatively hardy and tolerant species. Commercial size reached in 9–12 months depending on type of culture. Local market for consumption.

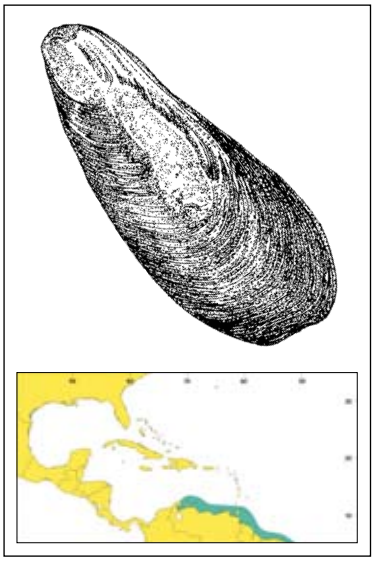
Pteria colymbus **Target species**

FAO names: Not recorded
Size: to 60 mm
Distribution/habitat: Bermuda, North Carolina (United States of America) to the south of the Federative Republic of Brazil. Lives subtidally attached to rocks and other hard substrates. Exploited by divers for local food consumption, and historically, for the pearl market.
Larviculture: Similar to *Pinctada imbricate*.
Culture potential. Availability of broodstock. Can be cultured for consumption, half-pearl, or pearl. Commercial size reached in 9–12 months depending on type of culture.

MYTILIDAE - Mussels

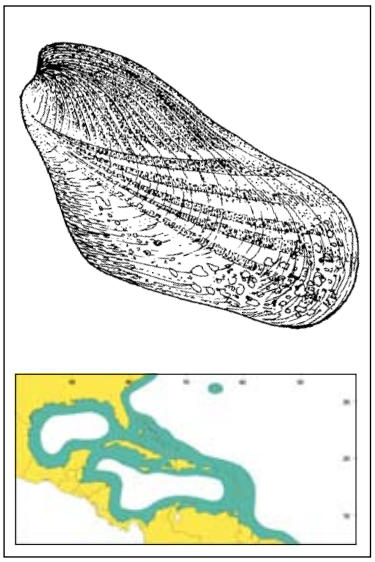
Perna perna **Target species**

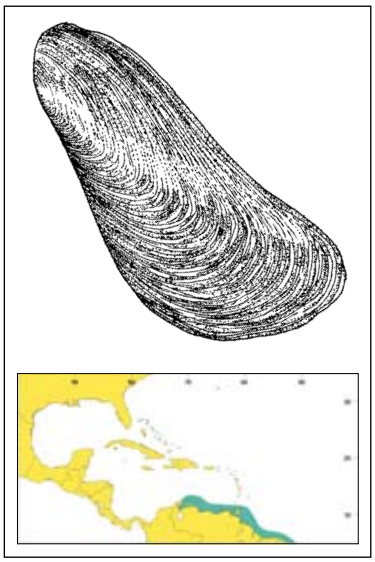
FAO names: **En**: South American rock mussel; **Fr**: Moule roche sudamériaine; **Sp**: Mejillón de roca sudamericano
Size: to 170 mm
Distribution/habitat: Southern Caribbean to the Federative Republic of Brazil. Lives on hard surfaces, common in high-energy rocky coasts. Species heavily exploited commercially, stocks are dwindling. Consumed cooked and canned industrially.
Larviculture: Spawning induction and larviculture of mytilids are similar to other bivalves, as are the species of phytoplankton and feeding regimes. Larvae metamorphose in 15–20 days at 250–300 µm shell length. They attached to surfaces using their byssus, and typically settled onto fibrous materials.
Culture potential: Local market demand and known culture techniques for early life stages. Relatively hardy.



Modiolus americanus

FAO names: **En**: Tulip mussel, American horse mussel; **Fr**: Modiole tulpe; **Sp**: Mejillón tulipán
Size: to 110 mm
Distribution/habitat: South Carolina to Florida (United States of America), Caribbean to the Federative Republic of Brazil, and Bermuda. Lives attached to hard substrates intertidally or shallow subtidal depths in coral reefs areas.





Mytella guyanensis **Target species**

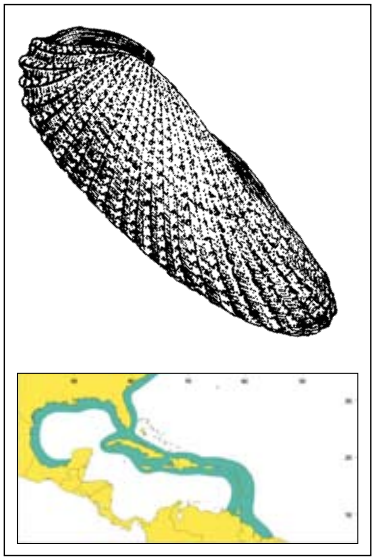
FAO names: **En**: Guyana swamp mussel; **Fr**: Moule de Guyane; **Sp**: Mejillón tulipán

Size: to 110 mm

Distribution/habitat: Southern Caribbean to the southeastern Brazil (Federative Republic of). Intertidal in bays and protected areas, forming clumps attached to mangrove prop roots or other hard substrates. Consumed locally (in southern part of area) in stews, boiled, grilled, or with rice.

Larviculture: Not well documented.

Culture potential: Local market demand for consumption.



PHOLADIDAE – Angel wings

Cyrtopleura costata

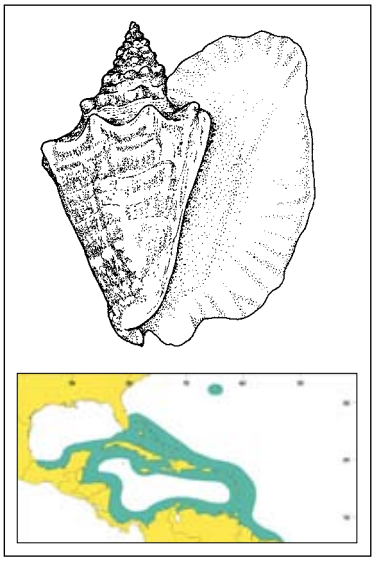
FAO names: **En**: Angel wing; **Fr**: Aîle d'ange; **Sp**: Ala de ángel

Size: to 180 mm

Distribution/habitat: Massachusetts to Texas (United States of America) and Caribbean to northeastern Brazil (Federative Republic of). Found in compact mud or sand from intertidal to shallow subtidal depths. This species supports an important fishery in the United Mexican States, the Republic of Cuba, Puerto Rico and the Republic of Chile.

Larviculture: Hatchery methods are well documented. Eggs have a limited amount of yolk, which requires that larvae begin to feed after the first day. Larvae remain free swimming for 16–21 days before metamorphosis. Pediveliger shell length averages approximately 317 um.

GASTROPOD MOLLUSCS



STROMBIDAE – Strombid conchs

Strombus gigas **Target species**

FAO names: **En**: Queen conch; **Fr**: Strombe rosé, lambi; **Sp**: Cobo Rosado, caracol

Size: to 300 mm

Distribution/habitat: Lives on sand near seagrass beds at depths of 2–30 m. Bermuda, southeastern Florida (United States of America), the Caribbean, the United Mexican States to the Federative Republic of Brazil. Due to exploitation, stocks are severely depleted throughout most of its range. Listed in Appendix 2 of CITES.

Larviculture: Very well documented and tested.

Culture potential: Broodstock maintenance, larviculture induction and nursery culture well established. Grow-out in land-based ponds and cage structures have reared queen conch to market size (18 cm SL) in 20 months. Limitations related to high hatchery costs, low survival and slow growth. High market value.

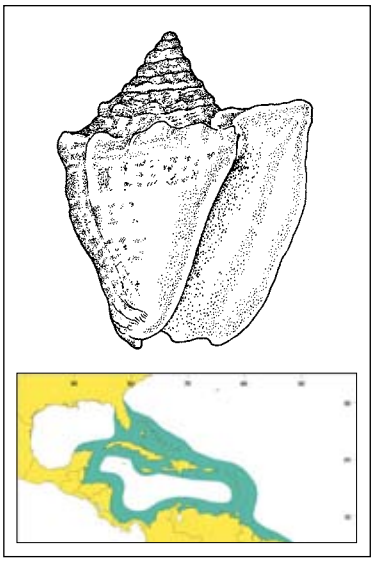
Strombus costatus **Target species**

FAO names: **En**: Milk conch; **Fr**: Strombe laiteus **Sp**: Cobo lechoso

Size: to 160 mm

Distribution/habitat: Lives on sand near seagrass beds between depths of 2–30 m. Bermuda, southern Florida (United States of America) and Gulf of Mexico, the Caribbean, the United Mexican States to the Federative Republic of Brazil. Consumed locally and exploited commercially in parts of its range.

Culture potential: Techniques for queen conch can most probably be adapted. Smaller species. Availability of broodstock. Market value not as high as *Strombus gigas*.



TROCHIDAE – Top shells

Cittarium pica **Target species**

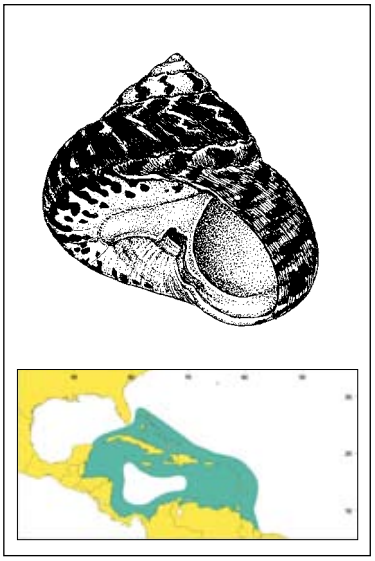
FAO names: **En**: West Indian top shell; **Fr**: Trochus des Antilles; **Sp**: Durgado antillano

Size: to 100 mm

Distribution/habitat: Shallow, subtidal on rocks and shell rubble. Collected by divers commercially throughout its range Bahamas, Caribbean and the United Mexican States to the Bolivarian Republic of Venezuela.

Larviculture: Spawning and larviculture techniques known. Conducted experimentally with purpose of restocking. Attains 2 mm in three months under controlled conditions.

Culture potential: Spawning in the laboratory and larval development described for several temperate and tropical species. Exploited for its meat and shell. High market value. Reduced broodstock availability and high production cost.



TURBINELLIDAE – Vase shells

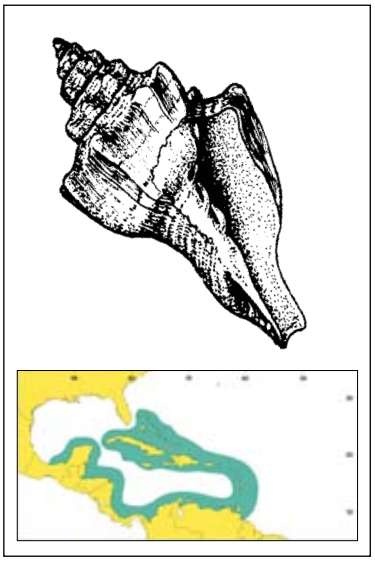
Turbinella angulata

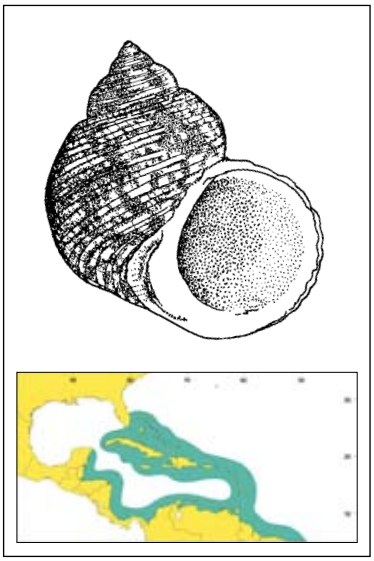
FAO names: **En**: West Indian shank; **Fr**: Chanque antillais; **Sp**: Chanque antillano

Size: to 350 mm

Distribution/habitat: Intertidal to shallow, subtidal on rocks and shell rubble. The Commonwealth of Bahamas, Caribbean and Yucatan (United Mexican States) to the Republic of Panama. Consumed locally, it is of the largest gastropods in the Atlantic.

Larval development: West Indian shanks produce a leathery egg capsule containing an average of 30–40 larvae/capsule. The larvae undergo direct development, emerging as juveniles. This means of reproduction could have potential for managed production. Growth rate is little known.





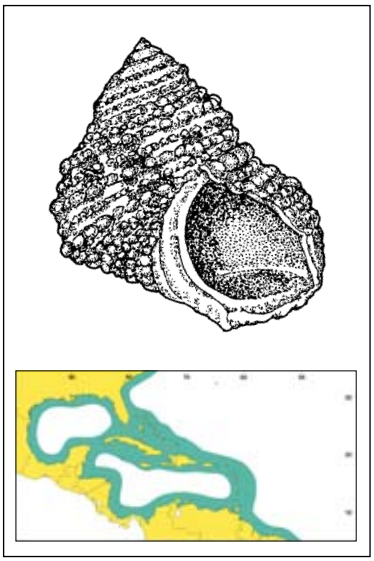
TURBINIDAE – Turban shells

Turbo canaliculatus

FAO names: **En**: Channelled turban; **Fr**: Turban canaliculé; **Sp**: Turbante acanalado

Size: to 75 mm

Distribution/habitat: Subtidal on rocks, usually associated with seaweeds, to 120 m. Southeastern Florida (United States of America), Caribbean and Yucatan (United Mexican States) to the Federative Republic of Brazil. Consumed locally with potential economic importance.



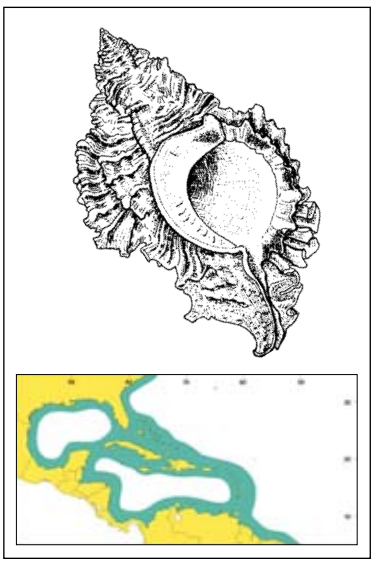
Turbo castanea

FAO names: **En**: Chestnut turban; **Fr**: Turban marron; **Sp**: Turbante castaña

Size: to 38 mm

Distribution/habitat: On sand, shell and coral rubble. North Carolina through Florida to Texas (United States of America), Caribbean and Yucatan (United Mexican States) to the Federative Republic of Brazil. Consumed locally with potential economic importance.

Larviculture: Turbinid gastropods are broadcast spawners; larval development have been documented for other species. Females release several million eggs (220 µm diameter) which metamorphosis in as little as four days, suggesting lecithotrophy. Little is known of the larval development and hatchery potential of the Caribbean species noted above.



MURICIDAE – Rock shells

Chicoreus pomum

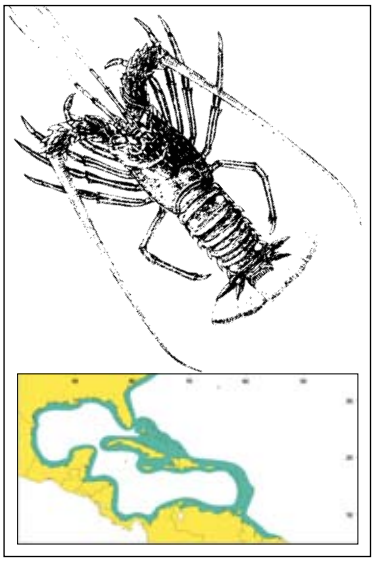
FAO names: **En**: Apple murex; **Fr**: Rocher pomme; **Sp**: Busano manzanero

Size: to 125 mm

Distribution/habitat: On soft and hard bottoms, shallow subtidal to 200 m. North Carolina through Florida (United States of America), Gulf of Mexico, the Caribbean and Yucatan (United Mexican States) to the Federative Republic of Brazil. Consumed locally, raw or boiled and spawns communally.

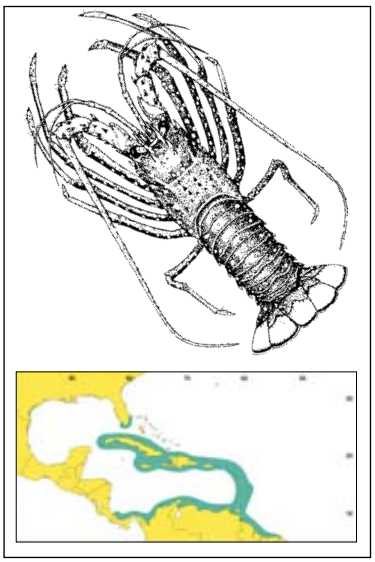
CRUSTACEANS

PALINURIDAE – Spiny lobsters



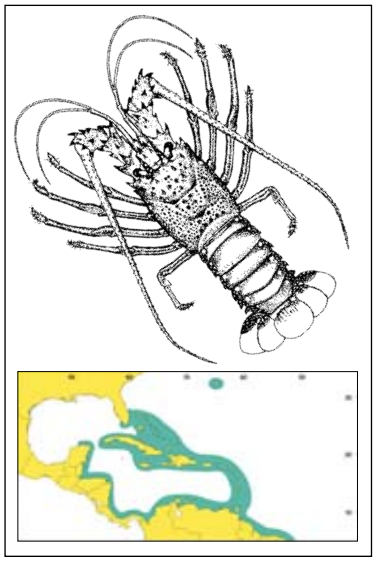
Panulirus argus **Target species**

FAO names: **En**: Caribbean spiny lobster; **Fr**: Langouste blanch; **Sp**: Langosta común del Caribe
Size: to 450 mm (commonly 250)
Distribution/habitat: Bermuda, North Carolina (United States of America), Caribbean to northern Brazil (Federative Republic of). Lives in shallow water to 90 m. Commercially and recreationally fished throughout its range. Considered overexploited in certain areas.
Larviculture: Reproduction and larval stages poorly understood.
Culture potential: Juvenile collection and grow-out researched. Limitations associated with lack of defined culture technology, aggressive behaviour, long larval life and grow-out period, and space requirements for culture. High demand and market value.



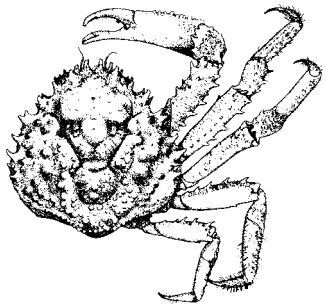
Panulirus guttatus

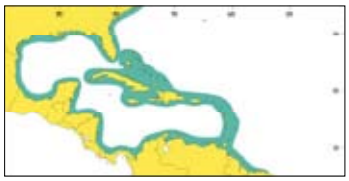
FAO names: **En**: Spotted spiny lobster; **Fr**: Langouste brésilienne; **Sp**: Langosta moteado
Size: to 150–200 mm
Distribution/habitat: Bermuda, Bahamas, southern Florida (United States of America), Belize, the Republic of Panama to the Republic of Suriname and the Federative Republic of Brazil, the Caribbean arc from the Republic of Cuba to the Republic of Trinidad and Tobago, Netherland Antilles and Los Roques (Bolivarian Republic of Venezuela). Lives in shallow rocky areas, found mainly in crevices.
Larviculture: No documented information available.
Culture potential: Not assessed for this species; knowledge on *Panulirus argus* culture may be applied.



Panulirus laevicauda

FAO names: **En**: Spotted spiny lobster; **Fr**: Langouste brésilienne; **Sp**: Langosta moteado
Size: to 200–300 mm
Distribution/habitat: Bermuda, southern Florida (United States of America), the Caribbean and the coasts of Central and South America from Yucatan (United Mexican States) to the Federative Republic of Brazil. Coastal waters to 50 m; on rock, gravel and coral substrates.
Larviculture: No documented information available.
Culture potential: Very little reported for this species; knowledge on *Panulirus argus* culture may be applied.





MAJIDAE - Spider crab

Mithrax spinosissimus **Target species**

FAO name: Not recorded

Size: to 133 mm

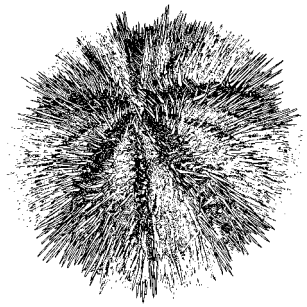
Distribution/habitat: Tropical Atlantic Ocean from the Carolinas, the Commonwealth of Bahamas, the Caribbean, as far south as Venezuela (Bolivarian Republic of). Inhabits rocky outcrop and man-made canals.

Larviculture: Experimental reproductive studies. Larvae hatch as swimming *first zoeae* and molt within 12 hours, again in 36–48 hours; during the zoeal stages the larvae are lecithotrophic. They metamorphose into feeding megalopa and within 3–4 days molt again to the first crab stage (6–8 days post hatch).

Culture potential: Tolerant to narrow range of environmental parameters. Aggressive and highly cannibalistic.

ECHINODERMS

ECHINOIDAE



Tripneustes ventricosus **Target species**

FAO names: Not recorded

Size: to 15 cm (spines up to 2 cm)

Distribution/habitat: Caribbean; inhabits seagrass beds and shallower reefs from 0–10 m.

Larviculture: Successfully developed for stock enhancement in Asia.

Culture potential: Species of interest by some Caribbean countries Hatchery and nursery techniques known. Widely harvested throughout Lesser Antilles to satisfy demand for local consumption.

Lytechinus variegates **Target species**

FAO names: Not recorded

Size: to 7 cm (spines up to 2 cm)

Distribution/habitat: Common in the Caribbean. Typically inhabits seagrass beds; found from 1 m to 17 m depth.

Larviculture: Successfully developed for stock enhancement in Asia.

Culture potential: Species of interest by some Caribbean countries. Hatchery and nursery techniques known. Harvested and exported to Japan and other Asian countries. Roe highly valued.

Diadema antillarum **Target species**

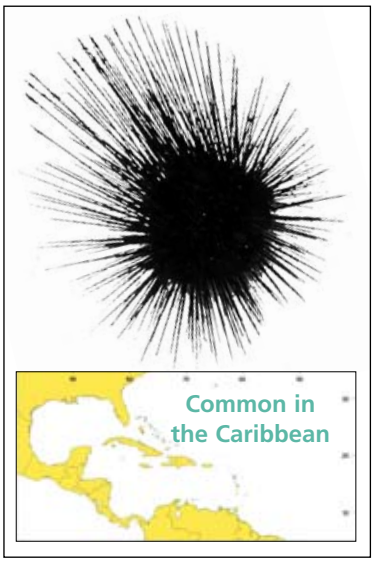
FAO names: Not recorded

Size: spines up to 30 cm

Distribution/habitat: Tropical oceans, including Indo-Pacific region and Western Atlantic and Caribbean basin, to South America. Inhabits coral reefs and found from 1–10 m depth.

Larviculture: Successfully developed for stock enhancement in Asia.

Culture potential: Species of interest by some Caribbean countries. Hatchery and nursery techniques documented. Record of mass mortality due to disease.



CEPHALOPODS

OCTOPODIDAE – Octopus

Octopus vulgaris **Target species**

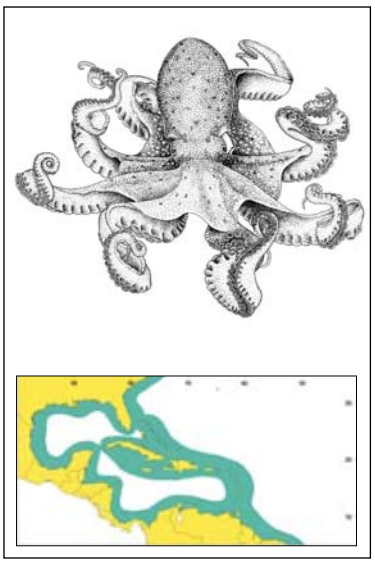
FAO names: **En:** Common octopus; **Fr:** Pieuvre; **Sp:** Pulpo común

Size: to 1.3 m

Distribution/habitat: Worldwide tropical and subtropical waters. Found in coastal waters and to outer edge of continental shelf (0–200 m depth). Inhabits rocky areas, coral reefs and sea grass beds. Known to migrate seasonally. Exploited for meat. Consumed locally with potential economic importance.

Larviculture: Experimental reproductive studies. Relatively long brooding period 25–65 days. Known to settle 40 days after hatching at minimum size of 12 mm.

Culture potential: Species of interest. Extended spawning period. More research required for optimal culture techniques.



Annex 6 – **Working group – terms of reference**

ROUND TABLE I – POTENTIAL CULTURE CANDIDATES

Main questions: *How to prioritize species to be cultured for commercial production? Market demand; culture know-how; ease of transport of seed; ease of adaptation of grow-out techniques to countries; countries' needs for employment; source of revenue and source of food; how to prioritize research for new culture candidates.*

A checklist of questions on culture candidate species – If the answer to the question is not known, identify possible information source, or data deficiency for species.

1. Make a list of four species which your group considers to be best candidates for a regional shellfish hatchery in a first instance. Choose from the target species outlined in red.
   a. For each species identify main reason for choice.
   b. List countries of the region which would benefit from culturing each of species listed.

2. List two more species outside of the target species and provided in the overview of native shellfish species as potential culture candidates.
   a. For each species identify main reason for choice.
   b. List countries of the region which would benefit from culturing each of species listed.

3. For each of species chosen, starting with target species, assess their suitability as culture candidates by considering the following:
   a. Distribution of species and availability of broodstock in Caribbean region.
   b. Natural growth rate, survival rate, reproductive cycle (continuous, well-defined spawning periods, etc.).
   c. Is species protected under international agreements or local legislation requiring permitting for culture? Specify.
   d. Is species known to be susceptible to diseases – any records of mass mortality in natural environment – specify or identify as data deficient.
   e. Any previous experience in the Region for culture of species – specify if experimental or commercial; specify if ongoing or stopped. If stopped, can limitations be overcome in future venture? (e.g. is limitation due to lack of funding, unsupportive government legislation, biological limitations).
   f. Any potential impact on environment during grow-out phase?

4. For each of the species chosen, starting with target species, further assess potential for culture by considering:
   a. Available information on known and tested culture techniques – for larvae, post-larvae, settlement, survival, grow-out. If not known for species, may be adapted from similar species? Which ones?
   b. More research required? If so, can production be initiated with already known techniques or need a few years of Research and Development?

   c. Known transport techniques – for broodstock, for spat? – if unknown, easily adaptable from others? Technical support available to develop adequate techniques?
   d. Ease of transfer of technology to growers.
   e. Costs (identify as: high, medium, low): spat production, and grow-out – specify if unknown or estimate based on culture requirements (does species require a lot of space – grown at low densities- methods used for grow-out expensive?).

5. For each species chosen, starting with target species, assess potential for sale considering:
   a. Market Demand – specify, local, export, tourism, potential increase in demand.
   b. Identify strategy for sale – high market/low volume, low market price/high volume – artisanal for local consumption/tourism product/potential export.

6. For each species, write up a short report summarizing all questions above, and identify top two culture candidates for commercial purpose, and two culture candidates with high potential but requiring further research.

7. Can one hatchery accommodate commercial culture for both of these candidates? Specify.

8. Finally, this question will be followed in Round Table IV (developing a 5-year plan), but in a first instance, can a Regional hatchery accommodate commercial production AND research of candidate species?

ROUND TABLE II – PROS AND CONS OF A REGIONAL HATCHERY. PUTTING FORWARD SOLUTIONS

Main questions: *How to ensure genetic diversity among Caribbean populations and ensure a disease/parasite-free operation? Broodstock management; quality control of seed; shipping and acclimatization protocols; responsible party for environmental assessment for grow-out; transfer of techniques; discharge of waste waters; introduction of invasive species and/or pathogens; impact of increased populations to natural ecosystem.*

Approach this exercise as if broodstock was imported in your country (your laboratory or hatchery), and introduction of pests, diseases, pathogens and exotics in your marine environment would be disastrous to the fishing industry of your country.

1. Each working group is given one group of target species to consider: bivalves, gastropods or echinoderms.

2. For each group of target species, determine process required to import broodstock to Regional Hatchery by considering the following:
   a. Determine current location of broodstock (country where found in abundant populations).
   b. Assess whether population level genetic information for the species is available.
   c. Is area of collection known for contaminants, and assess likelihood of broodstock carrying pathogens, diseases.
   d. Can collection be planned around disease outbreak or phytoplankton bloom? How does this affect health of broodstock, and how can it be addressed? – specify, known techniques for rapid assessment, monitoring of phytoplankton occurrence in collection site, etc.

e. Draw up collection protocol, preparation for shipment, and protocol for receiving broodstock – is there the need to check broodstock for pathogens upon arrival to facility? Be specific and consider both cases if broodstock genetically different, or similar to recipient Regional hatchery location.

3. Within hatchery, identify specific quarantine requirements for target species, by considering:
   a. Is there a need for a routine protocol to assess health of broodstock during quarantine and post-spawning?
   b. Can overflowing water be easily collected for treatment before discharge? How much discharge is generated? Where should it be discharged.
   c. How can decision be taken on method for treatment of discharge; what other experts are required for this? Where effluent should be discharged (into sea, land)?
   d. If there is a disease outbreak in broodstock area, draw up a contingency plan to avoid contaminating other parts of hatchery.
   e. How long does regional hatchery keep broodstock in quarantine? How can decision be made? What is done with broodstock once spawned?

4. For target species, identify protocols for shipping of spat to various countries by considering the following:
   a. Assessing health status of spat; routine examinations prior to shipping; which groups responsible for defining protocols and ensure that they are followed (government, scientists, and regional hatchery staff?).
   b. How to ensure adequate husbandry of spat upon arrival to enhance survival – training of growers, sending a regional hatchery staff for the first shipment?
   c. What documentation required for spat received, and spat exported, if any?
   d. Where does the responsibility of the regional hatchery stops – once sent, once received – once guaranteed to be disease-free?

ROUND TABLE III – OPTIMAL SITE FOR A REGIONAL HATCHERY

Main questions: *Ease of access; infrastructure; personnel available for training; enforcement of protocols, reliability, exposure to natural disasters, proposed list of countries, availability of target species, technical support (proximity of research institutes, university).*

A checklist of questions on site suitability.

1. Make a list of three countries which your group considers suitable for a regional shellfish/mollusc hatchery. Select from any countries in the Wider Caribbean (not restricting yourself to countries present at the workshop).

2. For each country, list the pros and cons by considering the following:
   a. Government support in venture – specify what kind of support if any (include permit requirement).
   b. Existing infrastructure – specify, roads, buildings, land.
   c. Ease of access – proximity of airport, shipping lines, central location to potential partners – specify.

3. Within each country, make a general assessment of available locations for a Regional Shellfish Hatchery by considering the following:
   a. Is it a known shellfish area – if yes, are shellfish consumed from the area-specify species, history.

b. Disease status of the area – known to have history of fish, shellfish kills, bacterial contamination – specify.
c. Any nearby industrial outfall, domestic wastes, agricultural land? – specify and consider potential for this in long-term.
d. Any harmful chemicals or pollutants known to exist in the water – specify.
e. Water quality of the area – any data available, possibility of doing surveys – is heavy fouling and disturbance of sediment (proximity to shipping channel) a potential problem?
f. Technical support available nearby – university, laboratory, etc. – specify.
g. Exposure to natural storms and hurricanes – specify.

4. For the location of the hatchery, assess its suitability by considering the following:
   a. Availability of Broodstock for target species – specify.
   b. Natural temperature and salinity within range of most target species – constant or fluctuating- specify for which target species most suitable.
   c. Are extremes in temperature and salinity within limits of target species – specify.
   d. Land availability provides scope for expansion in the long-term.

ROUND TABLE IV – DEVELOPING A 5-YEAR PLAN

Main questions: *How to ensure sustainability of Regional Hatchery? Anticipated time frame of production; selling of seed; breakeven point; training and continuity of skilled personnel; reliable and continuous supply of seed; balancing production and research.*

Base process on a 3-month production cycle (from spawning to spat) consider two scenarios:

Scenario 1 – No available infrastructure, i.e. virgin land and requirement for building of physical facility; and
Scenario 2 – Availability of basic infrastructure for housing of facility/nursery complex.

1. Develop a 5-year business plan for each scenario above by considering:
   a. Number of staff (hatchery, nursery, algae).
   b. Time required for construction, optimizing techniques, training staff, etc.
   c. Construction costs to (for Scenario 1) and range of operational costs (minimum to maximum); identify main costs of operation considering all culture stages (algae, larvae, nursery, shipping, importing broodstock), including personnel and facility.
   d. Threshold for cost of spat production to be commercially viable. Estimate using numbers provided throughout presentations and build an ideal situation. Consider spat cost needs to be acceptable to recipient countries.
   e. Threshold of spat production volume to be commercially viable (per year).
   f. Number of years before breaking even, and starting to make a profit; list factors on which this is dependent and main constraints – take into account poor production cycles, broodstock availability, etc.; identify first year of sale.
   g. Commercial potential of hatchery on a yearly basis without expansion of initial facility.

2. Balancing commercial production and research
   a. Assess staff requirements for research – taken within hatchery, external, part-time consultants, and students?

b. Identify extra costs – travel, accommodation, salary, etc.
c. Develop how to prioritize time and space allocated to research without jeopardizing production.

ROUND TABLE V – FUNDING IMPLEMENTATION OF REGIONAL HATCHERY

Main questions: *How to fund building of facility, training of personnel and initial operation? How to establish and maintain a cost-effective operation? Funding cost of production in first five years; cost effectiveness of purchasing seed for recipient countries; inclusion of other agencies/proposals in region; inclusion of private sector in the Regional Hatchery operation; involvement and funding of research centers; assisting investigations of new culture candidates.*

Note: All the participants at the Workshop took part in this round table. Part of these questions were addressed within the development of a 5-year plan in Round Table IV.

1. Assess grand total for regional shellfish hatchery
   a. Initial costs.
   b. Operational costs.
   c. Initial capital investment – initial construction costs plus operational costs until first sale.

2. Identify funding agencies in the region – List with specific interests of agencies.

3. Identify products of regional shellfish hatchery (spat, market size, trained staff, courses, etc.) – be specific.

4. Identify potential customers and level of involvement for Regional Shellfish Hatchery products:
   a. Private sector.
   b. Local and overseas.
   c. Governmental agencies.
   d. Tourism – direct sale.
   e. Any others.

5. Identify potential partners – University, laboratories, bringing in own funds, and degree of involvement in Regional shellfish hatchery.

6. Assess external funding requirements:
   a. Number of years relying on full funding.
   b. List operational aspects likely to require partial funding on a yearly basis.
   c. Identify operational costs that sale of spat will be able to cover.
   d. Identify need for other activities – training, technical support, grow-out to market size for sale.
   e. Identify costs and potential revenue for above activities.

7. Prioritize funding agencies to be approached – identify if dependent on funding type required, several need to be approached for specific needs.

Annex 7 – **Working groups – summary reports**

Working Groups (WG) were given 1–1.5 hours to discuss the subject according to the terms of reference outlined for each Round Table and indicated in the Agenda (see Annex 1). A short presentation of ten minutes was given to the rest of the participants by one working group representative, and a report submitted by the end of the Workshop, summarizing the working group discussion.

Two or three working groups were formed for each Round Table, with each having at least one representative from a bordering Latin American country, an island country and a host country representative (Jamaica).

ROUND TABLE I – POTENTIAL CULTURE CANDIDATES

Main questions: *How to prioritize species to be cultured for commercial production? Market demand; culture know-how; ease of transport of seed; ease of adaptation of grow-out techniques to countries; countries' needs for employment; source of revenue and source of food; how to prioritize research for new culture candidates.*

WG1: Aruba, Colombia, Belize, Jamaica
WG2: Haiti, Panama, Saint Kitts and Nevis, Jamaica
WG3: Honduras, Saint Vincent and the Grenadines, Venezuela (Bolivarian Republic of), Jamaica

Summary

All groups selected the mangrove oyster and the pearl oyster as optimal candidates for commercial production. Both gastropods (queen conch and West Indian top shell) were selected as commercial candidates by two out of three groups. Spiny lobster and Lion's paw scallop were considered by one of three groups as commercial candidate for culture. The latter scallop species was noted as top commercial candidate by this group.

This selection was based in great part on their local current and potential market demand, ease of culture, regional experience and wide distribution of the species in the region.

Mangrove oyster is the species for which technology is best available in the Region, easy to transfer to growers and for which there is a local demand; its major limitations are that its market size is relatively small, and is of a low market value (USD 0.10 a piece). Time to market size is six months, a rapid turnover from spawning and advantageous to hatchery production. Its cost of production is known to be relatively low and processing costs are minimal as it is served on the half shell on the local market. Larvae and spat of the species can be easily transported with minimal mortality rates among countries. Stock enhancement of natural populations is also considered as a side benefit of the commercial spat production for this species.

Pearl oyster can be grown for its meat and/or for pearl production (full pearls, half-pearls). The latter makes it a high value product. The constraints lie in the lack of tradition in pearl culture in the Region, and the need to develop and train a pearl producer sector, requiring a high level of skill. Time to pearl production from the spat phase is approximately two-and-half years. There has been experimental culture conducted on the species in the Region, and it is believed that culture techniques of other species of the same genus may be easily adapted. The species itself is relatively hardy and larvae and spat are thought to be easily transported.

Queen conch is another species with meat and shell as two end products. In addition, preliminary research on queen conch pearls indicates the potential for a third product form. It is a high market value species and one of the few shellfish traditionally consumed locally in the Region. Its culture has been conducted on a commercial-scale by a private company in the Region, and techniques are well known. Stock enhancement of natural populations is considered a side benefit to the commercial production of spat of this species. The constraints lie in its slow growth rate (two years to juveniles, and five years to adult size). A market has been successfully tested for the 2-year old product. Yet, it is questionable whether the species can be commercially cultured at profit. Additionally, the species is listed in Appendix II of CITES making trade among countries difficult and/or harvest. However, some countries have regulations which would allow the sale for 2-year old conch (namely, Jamaica).

West Indian top shell has a high local market demand in several of the islands of the Region and commands a relatively high price for its meat (reported as USD 40 for 5 lb (≈ 2.27 kg). of meat in Saint Vincent and the Grenadines). Its shell is highly prized in the Asian market (Belize reported sending two shipments to Asia in 2009). Experimental culture for spat has shown its ease of culture, however, little is known for grow-out to market size. It is thought that production costs would be high. However, it is a species worth investigating and because of its populations declining across its range due to overexploitation, stock enhancement of the species would be beneficial. Further research is required in order to complete the culture cycle.

Spiny lobster is a species of interest in the Region as it is heavily exploited for consumption across its range. Its major constraint is the long duration of its larval life (12 months), making hatchery production difficult. However, experimental culture has shown the ease of collection of pueruli juveniles, and grow-out in "casetas" in the natural environment. This enables stock enhancement of the exploited populations, which is of benefit to several governments of the Region; such work has been conducted in the Region in the past, but was discontinued due to lack of funding. Existing regulations on size limits for harvesting this species may limit product sale. This activity is slightly out of context with the goals of a regional hatchery.

Lion's paw scallop is one of the largest scallop species of the Region, although its range is more of a southern distribution, and grow-out would be confined to those waters. This would be its major constraint. Its culture techniques are well known and work has been conducted on an experimental and commercial scale in the Federative Republic of Brazil. It is a species of high market value and could be easily marketed to the tourist sector in the Region.

Other species mentioned as of interest but definitely requiring further research were the West Indian spider crab, *Mithrax Spinosissimus*, mainly because of its high market value, the long-spined sea urchin, *Diadema antillarum*, for its importance in the ecosystem and for the aquarium trade, the sea egg *Tripneustes ventricosus*, for its ease of culture demonstrated experimentally and market demand in the export market, the sea cucumber for its high market value and availability of farming techniques for other species in the Pacific, and the common octopus for its market demand and high market value.

The working groups felt that a regional hatchery could easily accommodate the production of several species, as long as culture techniques were similar, requiring similar equipment and/or that production cycles can be alternated. Similarly, research on other species should be considered and balanced with production requirements, as availability of skilled staff facilitates investigations, assisting visiting scientists/students in implementing applied studies.

Finally, each country was asked to list the top two candidates for commercial culture in a first instance. The following were listed (no. of listings in bracket): mangrove oyster (6), top shell (5), sea cucumber (2), queen conch (2), sea urchin (2), lion's paw scallop (2), and pearl oyster (2). One country did not answer.

Based on this working group session, it is recommended that a low market value, easily cultured species with well-tested techniques be selected as a first culture candidate for the regional hatchery – namely, the mangrove oyster. Its local market demand – both current and potential – needs to be assessed prior to its confirmed selection.

It is further recommended that a high value market species with well-tested techniques and an easily created high market demand be cultured commercially as a first instance – namely, the lion's paw scallop. In a second instance, the following species should be investigated for optimizing culture techniques to market size: top shell and sea urchin.

ROUND TABLE II – PROS AND CONS OF A REGIONAL HATCHERY. PUTTING FORWARD SOLUTIONS

Main questions: *How to ensure genetic diversity among Caribbean populations and ensure a disease/parasite-free operation? Broodstock management; quality control of seed; shipping and acclimatization protocols; responsible party for environmental assessment for grow-out; transfer of techniques; discharge of waste waters; introduction of invasive species and/or pathogens; impact of increased populations to natural ecosystem.*

WG1: Venezuela (Bolivarian Republic of), Colombia, Aruba, Jamaica
WG2: Haiti, Honduras, Saint Kitts and Nevis, Jamaica
WG3: Panama, Saint Vincent and the Grenadines, Belize, Jamaica

Each group was given a group of species to consider the requirements for culture on a regional basis.

WG1: Bivalves (namely mangrove oyster, lion's paw and pearl oyster)
WG2: Gastropods (namely West Indian top shell and queen conch)
WG3: Echinoderms

Summary

All groups noted that population level genetics are essential for adequate collection of broodstock and preservation of biodiversity among populations of the Region. Most species (aside from lion's paw scallop) are distributed throughout the Region and aside from queen conch, there is insufficient regional information available on the genetic make-up of the populations and their health status. The latter includes the assessment of pathogens and diseases in the broodstock by a veterinarian. Once this information is available, it is preferable that collection of broodstock is made from the population closest to or most accessible to the regional hatchery or from the "client" population.

The need for precautionary measures to avoid transfer of diseases and pathogens was stressed by all groups as was the collection for the broodstock deemed most "healthy". A second check on pathogens, as well as a physical inspection and record of mortality was recommended upon arrival to the Regional hatchery, and any contaminated or "unfit" individual to be discarded. These measures should follow standard EPA guidelines. Certification of shipment should, therefore, be made upon collection and reception of shipment. It was suggested by one group, that at least two collection sites should be identified in order to ensure availability of broodstock in the event of a problem at one of the sites.

Monitoring of broodstock should be conducted throughout the quarantine period. In addition, the quarantine area should be isolated from the remainder of the hatchery – receiving incoming water from the general seawater system, but treated separately with a separate discharge system; the treatment of effluent water and re-use of this water for the broodstock was recommended. Access to the quarantine area was recommended

to be for authorized staff only. A well-defined protocol for cleaning and discard was deemed necessary to avoid contamination of other parts of the hatchery. Quarantine time recommended varied among working groups, ranging from one to four weeks; this will be dependent on the species and needs to be determined within the regional hatchery protocol.

Some working groups recommended reusing the broodstock following spawning. Others suggested that this depends in part on the results of the population level genetics – should genetic make-up prove homogeneous, replenishing the broodstock would be easier. Conditioning the broodstock for spawning was recommended to enhance success. The question of limiting the gene pool within the hatchery by using the same broodstock for a number of production cycles was raised and needs to be addressed.

Most working groups felt that the government of the country hosting the regional hatchery should set the rules of the hatchery with respect to protocols followed, and certification of shipments should be made by an official authority – namely a specialized laboratory or veterinarian – according to the criteria set by the hatchery (hence, the government); should the hatchery criteria be higher than the national bodies, it is the former which will prevail.

Regarding the shipment of spat, and the allocated responsibilities, all working groups recommended that training be an important part of the package in the acclimation and reception of spat received by growers. There is the need for participating governments to commit at the onset and agree on spat transfer responsibilities and protocols. The accompaniment of a first shipment by a regional hatchery staff member was suggested, or by the previously trained "client" himself. This would come at a cost and the revenue used for the operation of the regional hatchery. The regional hatchery would be responsible for shipping pathogen-free and disease-free spat, certified by an authorized agency (e.g. the Fisheries Division), and that export documentation such as the certificate of origin, phytosanitary certification, etc., would be necessary for export. The responsibility of the regional hatchery was suggested to end upon delivery of the spat or once guaranteed to be disease-free. This latter point needs further discussion to be well-defined.

ROUND TABLE III – OPTIMAL SITE FOR A REGIONAL HATCHERY

Main questions: *Ease of access; infrastructure; personnel available for training; enforcement of protocols, reliability, exposure to natural disasters, proposed list of countries, availability of target species, technical support (proximity of research institutes, university).*

WG1: Jamaica, Venezuela (Bolivarian Republic of), Panama, Haiti
WG2: Jamaica, Colombia, Belize, Saint Vincent and the Grenadines
WG3: Jamaica, Honduras, Saint Kitts and Nevis, Aruba

Summary

Countries mentioned as potential sites for a regional hatchery were in no specific order of priority: Jamaica, the Republic of Colombia, Belize, Puerto Rico, Florida (Miami, United States of America), the Bolivarian Republic of Venezuela, the Republic of Panama, the Republic of Haiti, the Republic of Trinidad and Tobago. The two countries most favoured were Jamaica and the Republic of Colombia, followed by Belize and Trinidad and Tobago. Decisions were based on current and potential government support, existing infrastructure, ease of access, occurrence of targeted shellfish species, environmental health, technical support and protection from natural disasters. It should be noted that both Jamaica and the Republic of Colombia representatives were present at the workshop and gave a presentation on potential sites within their country.

Both countries have current legislation enabling activities within the scope of a regional hatchery, facilitating permitting. In addition, Jamaica has a site owned by the government which has the potential for hosting a regional hatchery facility. The Republic of Colombia has current local government support and external funds (Japan International Cooperation Agency – JICA) to conduct pilot investigations in the culture of shellfish species until 2013. Infrastructure between the two varies greatly in that Jamaica offers a virgin site with access to available utilities, with available land for further expansion; whereas the Republic of Colombia has recently built an extensive marine laboratory for shellfish culture within the boundaries of the University. Access to international airports for shipping is doable for both sites. The Colombian site is within a small city, which may be potentially an issue should development increase. The site in Jamaica is relatively remote, but there is the possibility of nearby residential developments which may impact on environmental parameters in the long-term.

Population occurrence of native shellfish species exists at both sites; in Jamaica, mangrove oyster and queen conch broodstock would be readily available, and further field surveys would be required to assess population distribution and occurrence of other species. Broodstock could be available for most target species near the Colombian site. The areas seems not to be prone to disease, and both benefit from local technical support (Jamaica hosts the University of West Indies and resident experts at the Department of Fisheries; the Republic of Colombia also has the benefit of a University). Water quality is routinely tested at both sites and there is the capacity to do further testing. Environmental parameters seem adequate, except for large salinity fluctuations recorded in the Jamaican site due to freshwater input following floods and heavy rainfall. The island itself is prone to hurricane exposure, whereas the Colombian coast is well protected from such natural disasters. Both countries have current aquaculture industry for both local and export sectors, facilitating the shipping of spat and market size individuals, encouraging the expansion of the industry.

The Republic of Trinidad and Tobago was mentioned as a potential site for the hatchery, although there were no representatives from this country at the workshop to provide further details. This site was selected based on its existing aquaculture activity, assuming an existing legislative framework and government support. Shipping lines and airport access provide ease of spat and broodstock transport between countries. Further information is required to assess the suitability of the Republic of Trinidad and Tobago as a regional hatchery site.

The Bolivarian Republic of Venezuela and the Republic of Haiti have some sites which would be suitable for culture; the Bolivarian Republic of Venezuela has local expertise on shellfish culture available from the University, as well as a site earmarked for shellfish culture, well protected from natural disasters; the Venezuelan coast harbours several of the targeted shellfish species implying adequate environmental parameters for these species. The Republic of Haiti has land, but with little local expertise and highly prone to natural disasters such as hurricanes. Access to other countries of the Region is not easy for both of these countries, and visa requirements to travel to-and-from the Bolivarian Republic of Venezuela are an additional obstacle to training of growers, etc.

Belize and the Republic of Panama are two central American countries mentioned as potential sites; they both have precedence in aquaculture, with existing legislative framework and government support. Technical support is available to a certain extent and shipping lines provide access to a great part of the Region. There is the potential for land becoming earmarked for a regional hatchery in both countries.

The concept of the regional hatchery as a business incubator of aquaculture development was put forward. More specifically, the regional hatchery would stimulate shellfish aquaculture in the Region by providing a pool of expertise and marketing packages of "solutions" customized for each potential client. In this way, a country's or sub-region individual needs may be better served; this may lead to a number of

small hatcheries, which would be part of a greater whole. The regional hatchery group thus, functions as a development agency to stimulate shellfish aquaculture. Marketing know-how, stimulus packages (venture capital, loans, incentives, R&D), training, etc., should form part of the whole catering to individual needs. In this way, the regional hatchery would not concentrate on the production of seed itself, but on distributing the know-how and the technical support for producing seed. This concept needs further discussion and approval by the interested parties to be better defined.

ROUND TABLE IV – DEVELOPING A 5-YEAR PLAN

Main questions: *How to ensure sustainability of regional hatchery? Anticipated time frame of production; selling of seed; breakeven point; training and continuity of skilled personnel; reliable and continuous supply of seed; balancing production and research.*

WG1: Aruba, Honduras, Haiti, Jamaica, Panama
WG2: Colombia, Saint Kitts and Nevis, Jamaica, Belize, Venezuela (Bolivarian Republic of), Saint Vincent and the Grenadines

Two scenarios were considered while attempting to develop a preliminary 5-year plan: **Scenario 1** based on the development of an undeveloped site, requiring the construction of the physical facility, as well as the installation of hatchery equipment and seawater system, **Scenario 2** based on the use of an existing infrastructure and requiring modification for the purpose of a hatchery.

The plan was based on the following:

- A 3-month production cycle from spawning to spat; and
- Four-fold objectives: commercial production, training of the private sector, research into new species and production for stock enhancement.

In order for the regional hatchery facility to be sustainable, the following were identified as key points:

- A strategic location of the facility itself (for ease of movement of seed and broodstock).
- Focus on a low market-value/high demand species and high market value/lower volume species.
- Identify markets and marketing required for sale of product.
- Need to balance commercial production and research. Research should only be initiated once production is stable and should be supported through grant funding. Funding for research from hatchery can only be allocated if all operating costs are covered by revenue.
- Financial contribution of participating countries required initially and for continued research.
- Government support at ministerial level is a must.

Summary

A general plan for the implementation of a regional hatchery was developed as as shown in the timeframe below, taking into consideration the input of both working groups and of the resource persons participating in the Workshop.

Breakeven point for the regional hatchery depends on whether Scenario 1 or 2 is followed. For Scenario 1, a minimum of five to six years was suggested as required for the hatchery to operate on its revenues from sales and training. For Scenario 2, where an existing infrastructure is used, a breakeven point of two to four years was given; this depends on the modifications required to the existing infrastructure and the availability of core staff.

Description of activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Inception phase – Details of actions required and promotion of facility, funding proposals, securing government support.						
Site acquisition (Scenario 1) – EIA, preparation of site (land clearing).						
Design and construction of facility – Approvals, permits, consultation and equipment purchase. Pump house has to be built to capacity. Hatchery in modular phases.						
Population level genetic for target species – Developing broodstock collection protocol and establishing partnerships for collection and shipping.						
Recruitment of core hatchery staff and project staff (project operations and technical staff – five in total) – Including administration, larval culture, microalgae culture, casual labour (grow-out, and general maintenance). Veterinary and water chemistry services can be provided by external support and not as core staff. Security staff may be required depending on site (two/three in total).						
Training of regional hatchery staff – Short training overseas for algal cultures/larvae. Two-way training/overseas and on-hatchery site.						
Engagement of all stakeholders.						
Pilot run in hatchery (focus on bivalves known techniques).						
Preliminary grow-out – Establishing seed transportation and farming protocols for interested countries. Two/three other sites in the Caribbean Region partnering in pilot grow-out.						
Developing grow-out package – Identify needs and time required for training growers of the Region.						
Initiating and exploring the market with products – Target restaurants, hotels, wholesalers (including specialized market considerations for export market requirements).						
Providing the package – Seed/growing to market size.						
Training – Full training programme of growers and selling of seed. On-site hatchery training/marketing of product.						
Scaling-up production – Increased production of seed.						
Research activities – Investigating additional species.						
Culture-based fisheries programme – Develop fishery of West Indian top shell via production of seed and grow-out for stock enhancement.						
Expanding hatchery facility – Adding production modules.						
Increased production – Increase bivalve hatchery seed production.						
Increased grow-out production – Both for training and sale of seed and market size individuals.						
Farming and shipment protocols – Completing all protocols.						
Development of coordinating office for growers and shipping.						
Legal status of hatchery defined and implemented.						
Funding Source	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
External agencies/partner governments.						
Technical services to growers.						
Sale of seed.						
Sale of market size product from grow-out component of hatchery.						
Government subsidies and grant proposals for aquaculture development (i.e. research and stock enhancement).						

Recommended size of the facility: 1 250 m^2. Hatchery (920 m^2): (tanks, pumps, filtration system, electrical, plumbing, accessories); office (28 m^2); training room (84 m^2); and dormitories to accommodate 15 persons (210 m^2).

Funds required for the establishment of a regional hatchery were estimated to range between USD 2 to 6 million for set-up and operation costs for a 5-year period. A detailed and comprehensive budget needs to be drawn for an accurate assessment. The amount of funding required is dependent on Scenario 1 or Scenario 2. Capital investment includes: land, buildings, equipment, boat (for grow-out component), vehicle for transport and a refrigerated truck. Capital investment for Scenario 1 (clean ground) is higher than for Scenario 2. Operational costs include staff salaries (five hatchery staff, two to three security), costs incurred through broodstock collection, shipping of seed, analyses, chemical supplies, utilities and fuel costs. Operational costs of the facility were estimated to be in the range of USD 500 000/year, for a commercial spat production of approximately 30 million (mangrove oyster and lion's paw). Operating costs will depend on the site of the regional hatchery, as well as on production volume and needs to be ascertained once a more definite plan is made.

Annex 8 – **Selected photos**

FIGURE 1
Adult specimen of lion's paw scallop, *Nodipecten nodosus*

PHOTO: G. RUPP

FIGURE 2
Open specimen of calico scallop, *Argopecten gibbus*, with muscle and gonads visible

PHOTO: S. SARKIS

FIGURE 3
Adult specimen of the West Indian top shell, *Cittarium pica*

PHOTO: L.A. VELASCO

FIGURE 4
Pearl oyster, *Pinctada imbricata*, seed ready for grow-out in Venezuela (Bolivarian Republic of)

PHOTO: FIDAES, VENEZUELA (BOLIVARIAN REPUBLIC OF)

FIGURE 5
Lion's paw scallop (*Nodipecten nodosus*) young spat

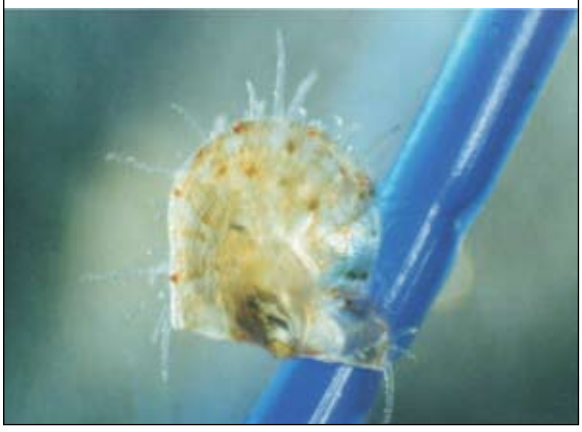


PHOTO: G. RUPP

FIGURE 6
Weighing bivalve spat in a shellfish hatchery

PHOTO: M.M. HELM

FIGURE 7
Oyster racks in Bowden Bay, Jamaica

PHOTO: S. SARKIS

FIGURE 8
Mangrove oysters, *Crassostrea rhizophorae*, farmed in Jamaica

PHOTO: S. SARKIS

FIGURE 9
Wild oysters spat collectors used in Jamaica

PHOTO: S. SARKIS

FIGURE 10
Growing Lion's paw scallops in lantern nets in Brazil

PHOTO: G. RUPP

FIGURE 11
Members of a fishing community preparing mussels socks in Venezuela (Bolivarian Republic of)

PHOTO: C. LODEIROS

FIGURE 12
Mussel stake farming in the Chacopata area northeast of Venezuela (Bolivarian Republic of)

PHOTO: C. LODEIROS

FIGURE 13
Artisanal mussel culture in Chacopata, Araya Peninsula, Venezuela (Bolivarian Republic of)

PHOTO: FIDAES, VENEZUELA (BOLIVARIAN REPUBLIC OF)

FIGURE 14
On-growing of pearl oyster, *Pinctada imbricata*, seed in Venezuela (Bolivarian Republic of)

PHOTO: C. LODEIROS

FIGURE 15
Group photo of selected workshop participants during field trip

PHOTO: L. MORALES

FIGURE 16
Group photo of selected workshop participants during a visit to the Oyster Culture Unit in Bowden, Jamaica

PHOTO: A. LOVATELLI