Snapperfarm Experience in Puerto Rico with Comparisons

By

Jose A. Rivera

Workshop for Development of Sustainable Practices for Marine Cage Culture Operations in the U. S. Caribbean

NOAA Aquaculture Program
El San Juan Hotel and Casino
San Juan, Puerto Rico

November 2-3, 2010

ACKNOWLEDGMENTS:

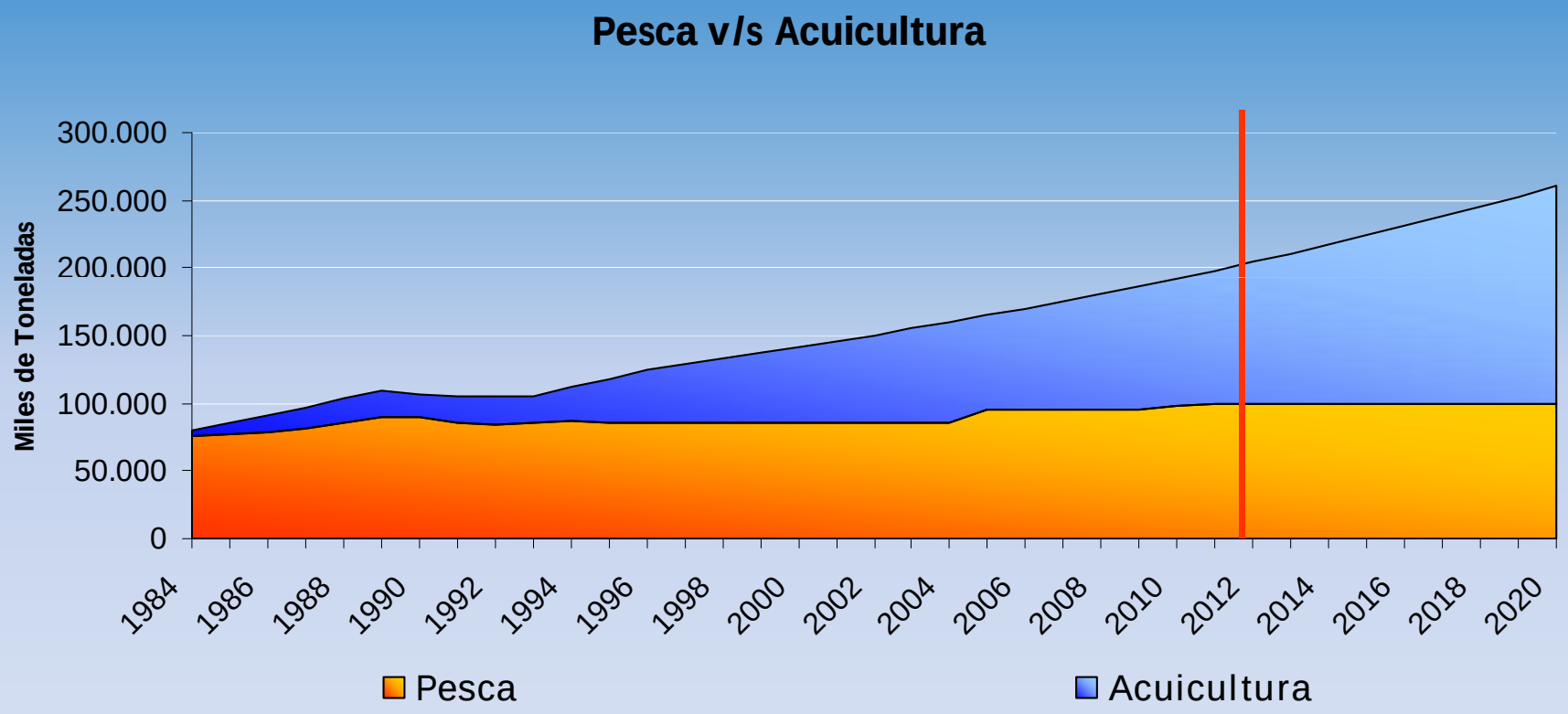
SNAPPERFARM
OPEN OCEAN AQUACULTURE

University of Puerto Rico at Mayagüez
Department of Marine Sciences

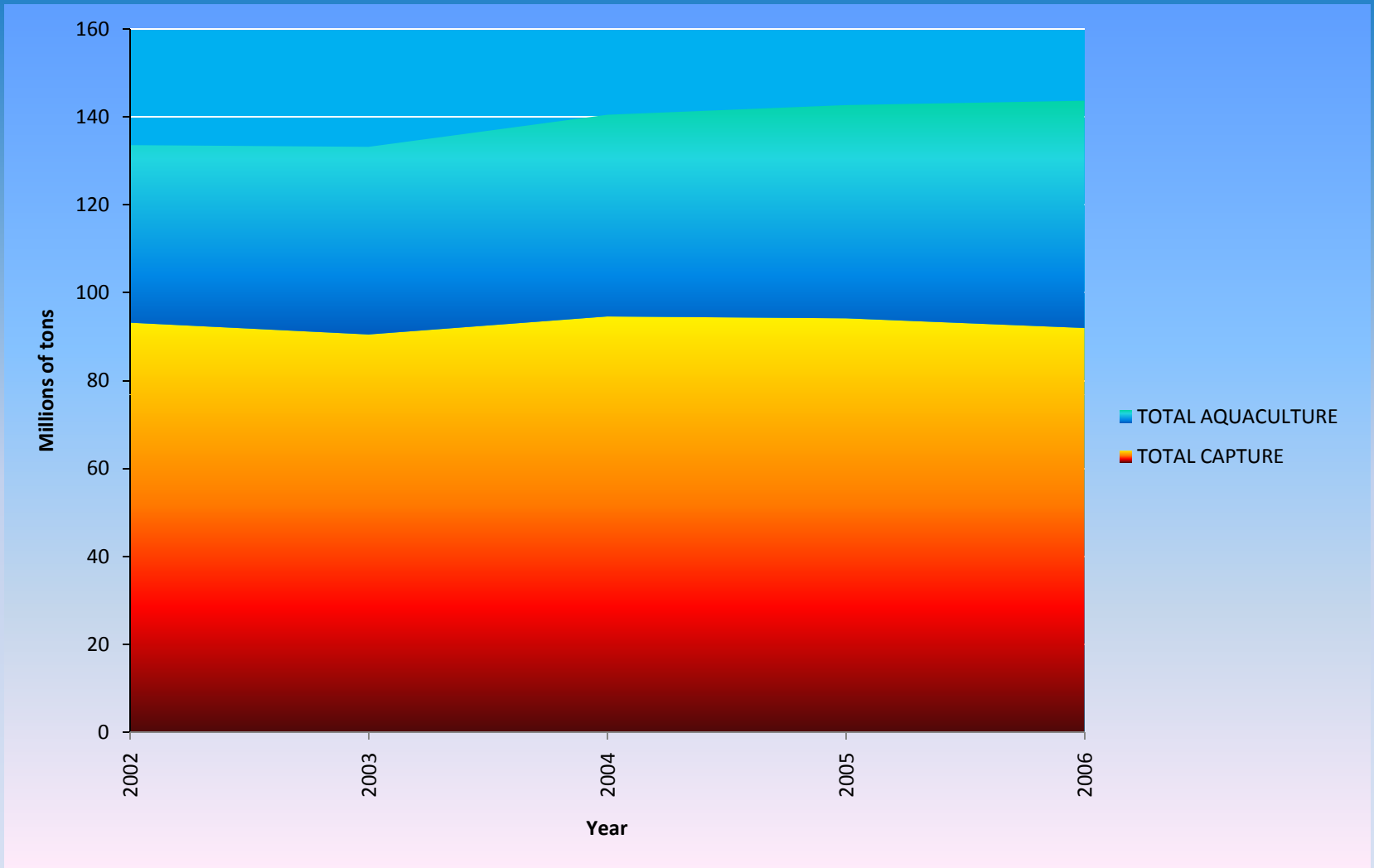
RSMAS
UNIVERSITY OF Miami
ROSENSTIEL SCHOOL
OF MARINE & ATMOSPHERIC SCIENCE

NOAA
NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

Acuicultura



Courtesy of Cristian Swett, OCEA, Chile



Data from FAO, SOFIA, 2006

Snapperfarm, Inc.

1998

- **Founded**

1999

2000

2001

Conducted site selection studies as the technology advanced for offshore aquaculture

2002

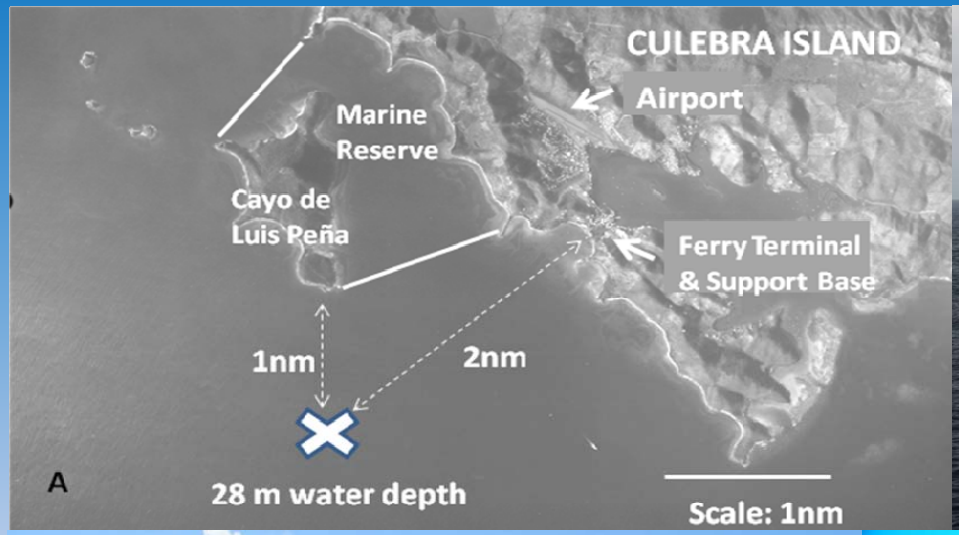
- **Obtained concession and permits for offshore demonstration farm**

2003

- **Initiated demonstration project**

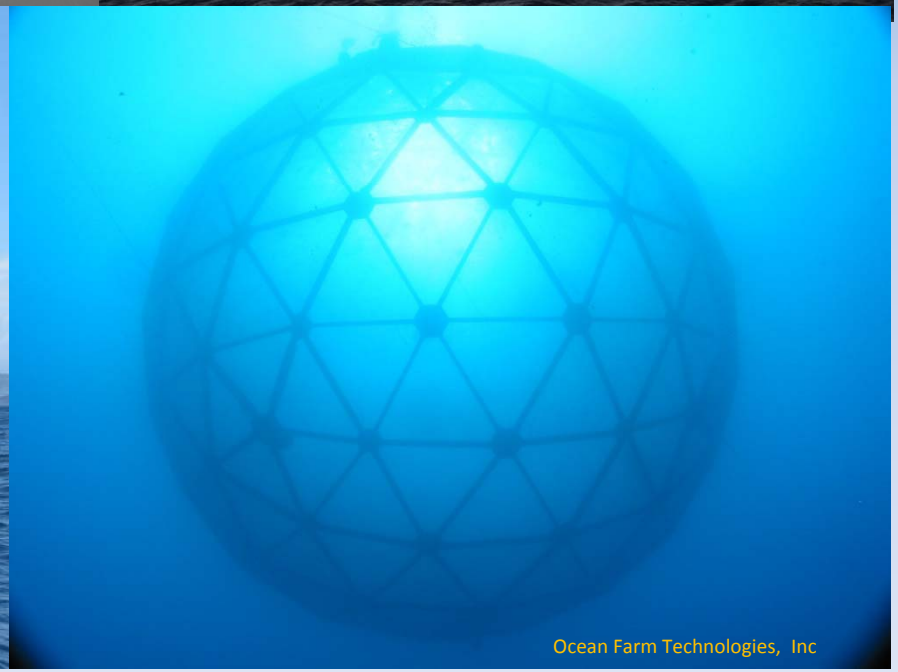
2004

- **Initial sales**



Open Blue Sea Farms, LLC

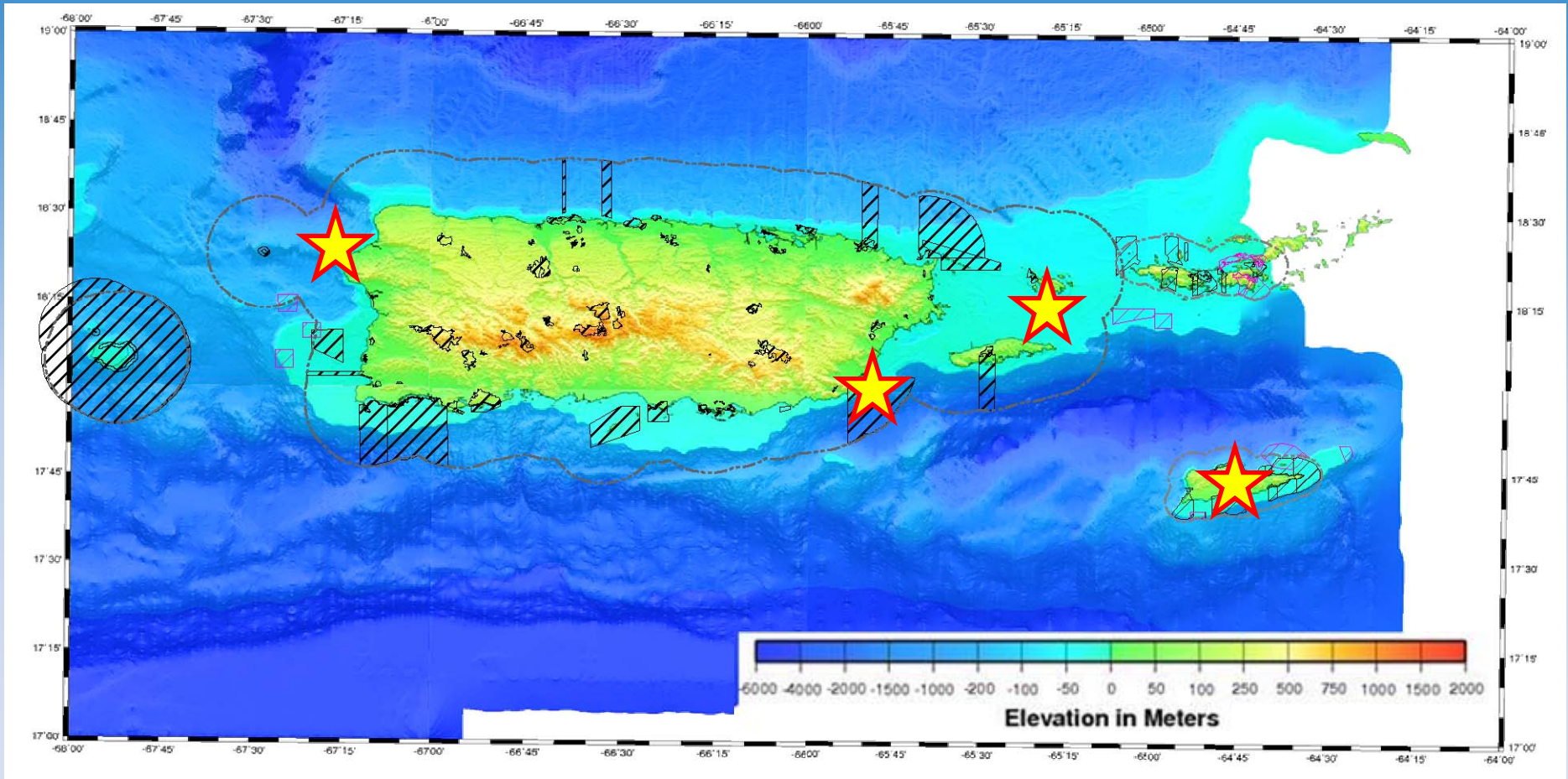
SnapperFarms, Inc


Ocean Farm Technologies, Inc

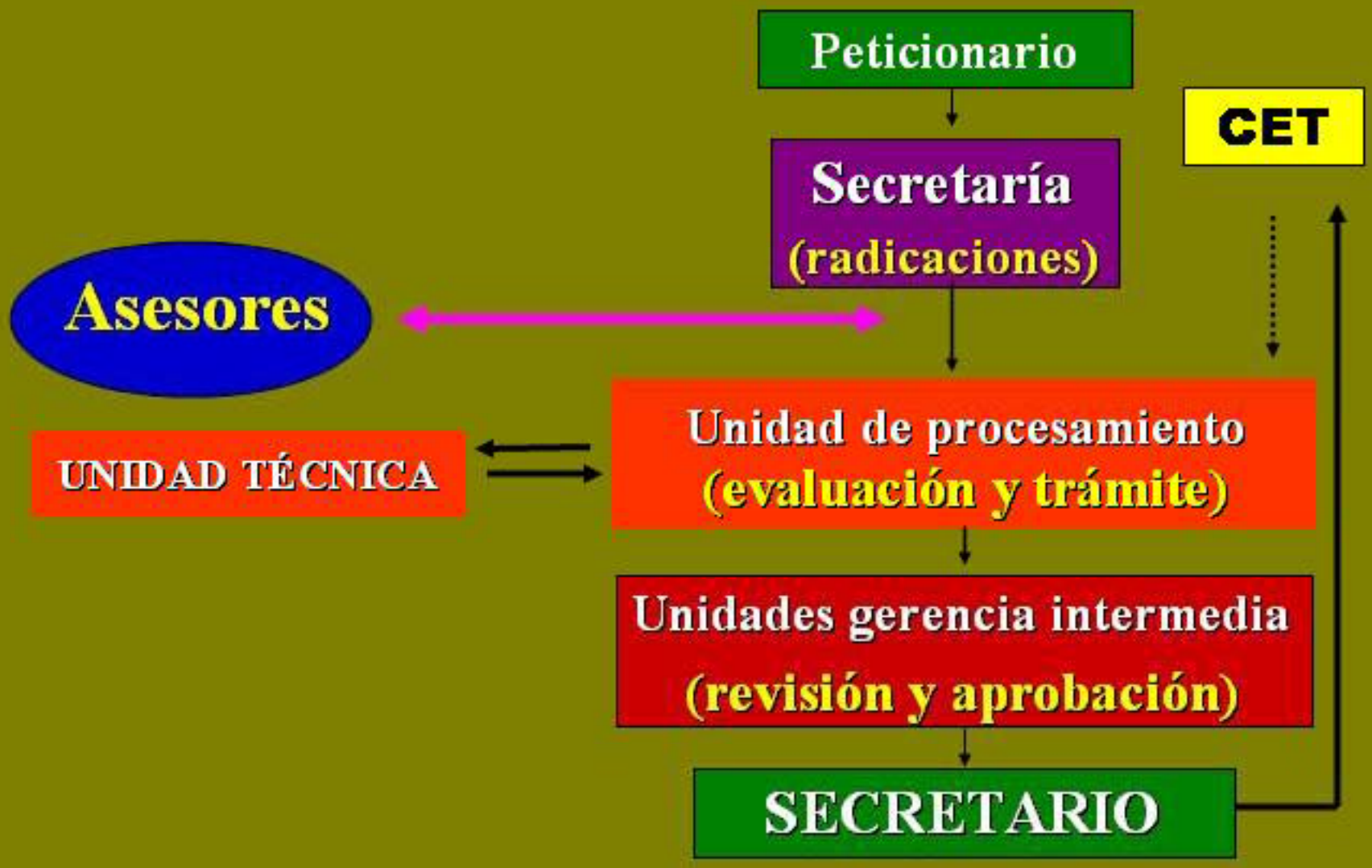
Snapperfarms, Inc

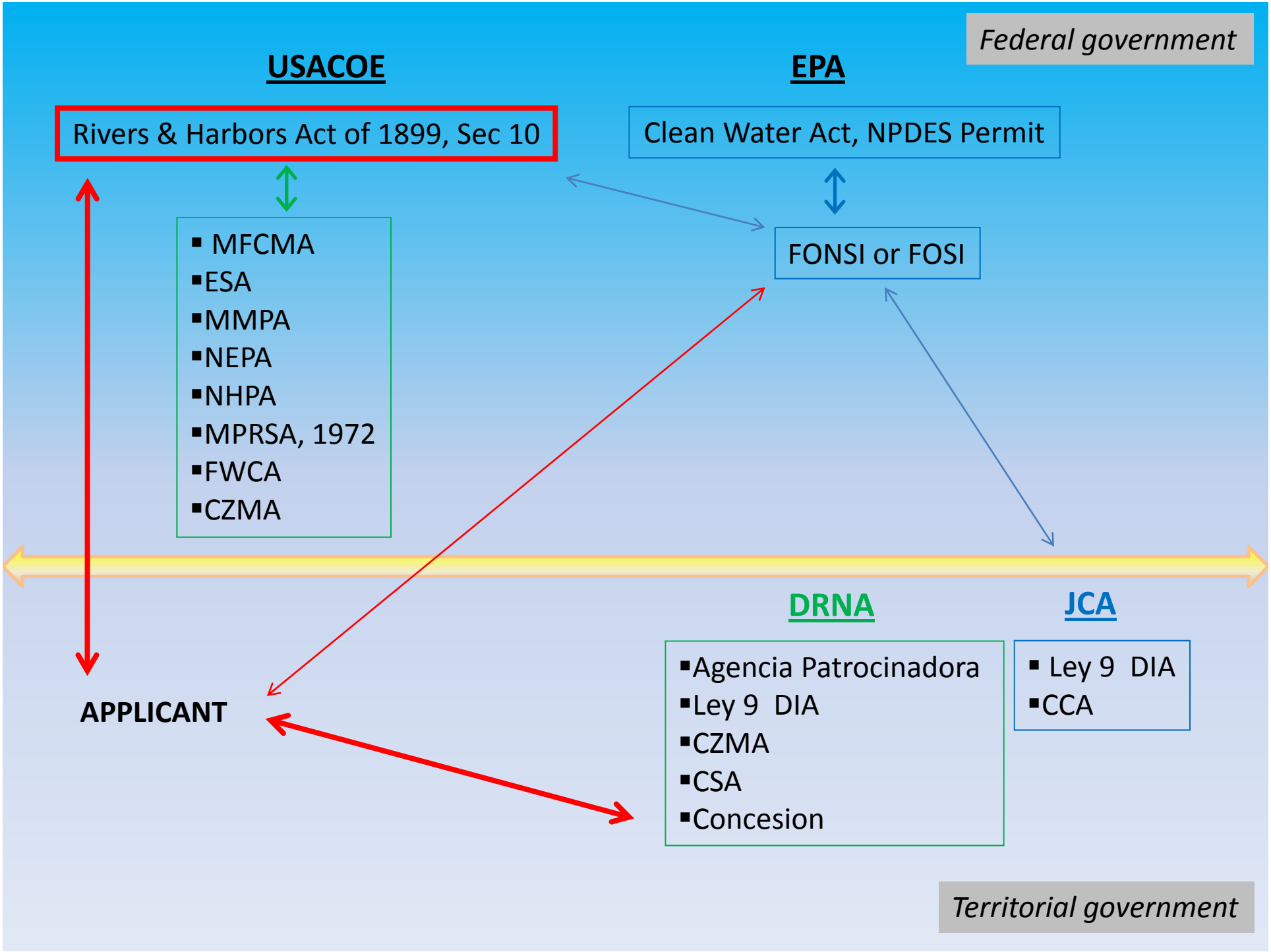
Snapperfarms, Inc

Brian O´Hanlon & Pesquera Delly, Guaymas, Mexico


-6000 -4000 -2000 -1500 -1000 -200 -100 -50 0 50 100 250 500 750 1000 1500 2000
Elevation in Meters

FLUJOGRAMA GENERAL DEL PROCESO DE PERMISOS Y ENDOSOS




Federal government
USACOE
EPA
Rivers & Harbors Act of 1899, Sec 10
Clean Water Act, NPDES Permit
MFCMA
ESA
MMPA
NEPA
NHPA
MPRSA, 1972
FWCA
CZMA
FONSI or FOSI
DRNA
JCA
Agencia Patrocinadora
Ley 9 DIA
CZMA
CSA
Concesion
Ley 9 DIA
CCA
APPLICANT
Territorial government

TERRITORIAL

- Junta de Calidad Ambiental-Law 9, Water Quality Certificate
- Junta de Planificacion-Coastal Zone Management Compliance Certificate
- Puerto Rico-State Historic Preservation Office
- Puerto Rico Port Authority
- Departamento de Recursos Naturales y Ambientales-Concession
- Consejo Subacuatico de Arquelogia, Underwater Archeology Council

FEDERAL

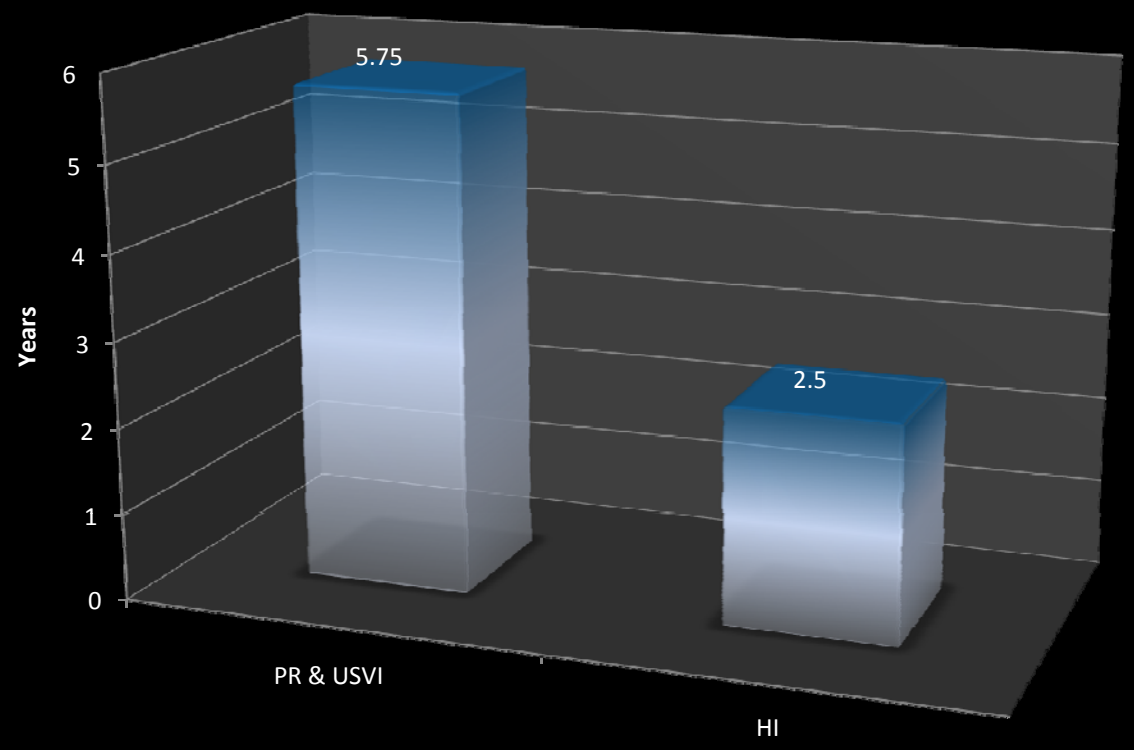
- American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.
- Archeological and Historic Preservation Act, as amended 16 U.S.C., 469-469c
- Archaeological Resources Protection Act of 1979, 16 U.S.C.
- Clean Water Act – Section 404, 33 U.S.C., 1251 et seq.
- Coastal Zone Management Act, 16 U.S.C., 1451 et seq.
- Endangered Species Act, 16 U.S.C., 1531 et seq.
- Fish and Wildlife Coordination Act, 16 U.S.C., 661 et seq.
- Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801
- Marine Mammal Protection Act of 1972, 16 U.S.C. 1361
- National Environmental Policy Act, 42 U.S.C.A., 4321
- National Historic Preservation Act, 16 U.S.C., 470 et seq.
- National Marine Sanctuaries Act
- Rivers and Harbors Act of 1899, 33 U.S.C. 403
- United States Coast Guard
- EO 11593 *Protection and Enhancement of the Cultural Environment*
- EO 11990, *Protection of Wetlands*
- EO 12898, *Environmental Justice*
- EO 13089, *Coral Reef Protection*
- EO 13112, *Invasive Species*
- EO 13158, *Marine Protected Areas*

Individual Permits Timetable

Company	Application	DRNA Concession	JCA CWC	JP CZMCC	NOAA ESA, EFH	USACOE Sec 10	EPA NPDES
PUERTO RICO & USVI							
Snapperfarms, Inc	2000(2)	2001	2001	2001	May-01	2001	NI
Snapperfarms, Inc	2006(8)	???	Sep-08	Sep-09	Jun-05	NI	Jan-10
Boriquen Aquaculture, Inc	2003(8)	Aug-06	Jan-07				Aug-08
Ocean Harvest, Inc	2004(8)	2006	2005/06	Jul-06	May-05	Mar-07	Jul-07
iii Associates, Inc	Jan-05	Sep-06					
HAWAII							
Cates International, Inc	Apr-00	Mar-01				Mar-01	
Kona Blue, Inc	Nov-02	Nov-03					

Elapsed Total Time

Company	1st Yr	2nd Yr	3rd Yr	4th Yr	5th Yr	6th Yr	→	10th Yr
PUERTO RICO & USVI								
Snapperfarms, Inc	2000							2010
Boriquen Aquaculture, Inc	2003					2008		
Ocean Harvest, Inc	2004			2007				
iii & Associates, Inc	2005		2007					
HAWAII								
Cates International, Inc	2000	2001(2)		2003(4)				
Kona Blue, Inc	2002		2004					
PUERTO RICO, Other								
Tourism project (Hotel)							7.8 yrs	
Urbanization					5.2			
Commercial					5.3			


Years
6
5
4
3
2
1
0
5.75
2.5
PR & USVI
HI

Federally Funded Research

2002-2006

- Environmental and Social Impacts of Sustainable Offshore Cage Culture Production in Puerto Rican Waters
  University of Puerto Rico - University of Miami
  NOAA Federal Grant Contract Number: NA16RG1611
- Measurement of the Benthic Loading and the Benthic Impact from an Open-Ocean Fish Farm in Tropical Waters
  University of Puerto Rico - University of Miami - NOAA Fisheries
  NOAA Federal Grant Contract Number: NA040AR4170
- Development of effective and low cost predator exclusion devices for offshore aquaculture facilities in the United States EEZ
  Snapperfarm, Inc. - Net Systems, Inc. - University of Miami – Cates International, Inc.
  NOAA/SBIR P1 Contract Number: DG133R05-CN-1200
- Refining Culture Technology for Growing Spiny Lobsters, *Panulirus argus*, from Pueruli to Market in Puerto Rico
  Snapperfarm, Inc. - Harbor Branch Oceanographic Institute - NOAA Fisheries - University of Miami - Florida Sea Grant
  NOAA/SBIR P1&2 Contract Number: DG133R-04-CN-0164

2006-2007

- Demonstrating Technological and Economic Feasibility of Cobia (*Rachycentron canadum*) Aquaculture from Hatchery to Market
  University of Miami - Snapperfarm, Inc.
  NOAA/NMAI-Approved Funding 2006-2007
- Assessment of Environmental Impact of Offshore Cage Culture
  University of Miami - Snapperfarm, Inc. - National Marine Fisheries Service
  NOAA/NMAI-Approved Funding 2006-2007
- NOAA Marine Aquaculture Program Pilot-scale Tests of Ocean Drifter
  MIT - Ocean Farm Technologies, Inc. - Snapperfarm, Inc. - University of Miami
  NOAA/NMAI-Approved Funding for 2007

New studies then, old studies now

Assessment of Environmental Impact of Offshore Cage Culture

Principal Investigator: Larry E. Brand [1]

Co-Principal Investigator: Jose A. Rivera [2]

Collaborators: Daniel D. Benetti [3], Brian O'Hanlon [4], Refik Orhun [5]

[1] University of Miami, Rosenstiel School of Marine and Atmospheric Science, 4600 Rickenbacker Causeway, Miami, FL 33149, phone: (305) 421-4138, fax: (305) 421-4600, e-mail: Lbrand@rsmas.miami.edu

[2] Under contract to: NOAA, National Marine Fisheries Service, HC-01, Box 1736, Boqueron, PR 00622-9704, phone: (787) 831-3426, fax: (787) 831-3427 email: jarivera@msn.com

[3] University of Miami, Rosenstiel School of Marine and Atmospheric Science – Aquaculture Program, 4600 Rickenbacker Causeway, Miami, FL 33149, phone: (305) 421-4889, fax: (305) 421-4675, e-mail: dbenetti@rsmas.miami.edu

[4] Snapperfarm, Inc., P.O. Box 685, Culebra, Puerto Rico 00775. Phone: (787) 548-6134, fax: (886) 829-4851, email: mail@snapperfarm.com

[5] University of Miami, Rosenstiel School of Marine and Atmospheric Science – Aquaculture Program, 4600 Rickenbacker Causeway, Miami, FL 33149, phone: (305) 421-4085, fax: (305) 421-4675, e-mail: refik@rsmas.miami.edu

Budget Period	**Federal Funds**
9-1-06 to 8-31-07	$ 100,000
9-1-07 to 8-31-08	$ 100,000
TOTAL	$ 200,000

Project Period: September 1, 2006 to August 31, 2008

Monitoring Studies for Open Cage Aquaculture in PR

➢ Alston, et al,	1 study (2yrs)	2002-04
➢ Rapp, et al,	1 study (1.4yrs)	2004-05
➢ Brand, et al,	1 study (2yrs)	2006-08
➢ Rentzel, et al,	1 model	2006

PAPER

Site Selection Criteria for Open Ocean Aquaculture

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Brian O'Hanlon
Open Blue Sea Farms LLC

ABSTRACT

With aquaculture steadily expanding, the need for suitable space has been followed by the development of more efficient, cost-effective, and environmentally sustainable methodologies. Avoiding possible conflicts between the development of commercial aquaculture operations and the environmental impact in coastal areas, utilizing the offshore environment offers the greatest potential for expansion of the industry in most regions throughout the world. Although currents and greater depths generally increase the assimilation capacity and energy of the offshore environment and offer many advantages for aquaculture, a number of challenges associated with developing any activity in the open ocean environment must be taken into consideration. This article summarizes these advantages and challenges, focusing on the first and most crucial step for project development: site selection criteria for open ocean aquaculture. Although most of the concepts and criteria are common to other marine net pen aquaculture operations, we review and present those conditions that are inherent to the open ocean environment and must be considered before developing any offshore aquaculture activity. These encompass basic premises; assumptions; logistics; infrastructure; availability of manpower, services, and materials; legal framework; socioeconomic and political issues; and oceanographic, biological, environmental, and technological criteria. There are no defined set of criteria, as most are interacting and not fixed but interdependent (e.g., depth vs. current velocity). However, suitable sites must meet basic crucial standards summarized here.

Site selection is one of the most important decisions for the establishment of a fish farm operation. Satellite images, hydrographic charts, maps, Google Earth, and Geographic Information Systems can all provide important information for preliminary work on site assessment; however, a very careful *in situ* survey is mandatory to evaluate the suitability of the area.

Keywords: Open ocean aquaculture, Offshore fish farming, Selection criteria for ocean fish farming

Introduction

Recent technological advances in offshore cage systems allow for the development of aquaculture operations in the open ocean. This offshore industry is rapidly expanding throughout the world. Indeed, during the past 20–30 years, the salmon industry has driven such technological advances, reaching a point where state-of-the-art aquaculture cages with 100 m of diameter or more, capital cost under US$7/m^3, and widespread applications have been extensively exposed to high-energy environments (Scott and Muir, 2000). The technology is in place, as over the past decade a variety of modern submersible, semisubmersible, and floating cages have been designed and built to "conform" with waves and strong currents associated with the high-energy environment generally associated to offshore areas.

In addition to the attainable benefit of higher potential profits, offshore aquaculture may provide the benefits of (1) overall reduction in conflicts with other users and in objections from adjacent landowners, (2) avoidance of the ecological carrying capacity limitations of inshore waters, (3) access to larger volumes of high-quality water for finfish or filter-feeding organisms, (4) reduction of overall ecological impacts, (5) possible reduction of regulatory and permit requirements, and (6) ability to culture high-value, open ocean species (Stickney and McVey, 2002). Although the economical feasibility of such operations is still being evaluated, the potential benefits described signal the feasibility of raising a variety of marine finfish species in offshore environments to increase production while

Aquaculture 302 (2010) 195–201

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Growth rates of cobia (*Rachycentron canadum*) cultured in open ocean submerged cages in the Caribbean

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[b] Snapperfarm, Inc., P.O. Box 685, Culebra, 00775 Puerto Rico
[c] Under contract to NOAA-Fisheries, HC-02, Box 1736, Boqueron, 00622 Puerto Rico
[d] The Island School, Cape Eleuthera Institute, P.O. Box 6008, Lawrenceville, NJ 08648, USA
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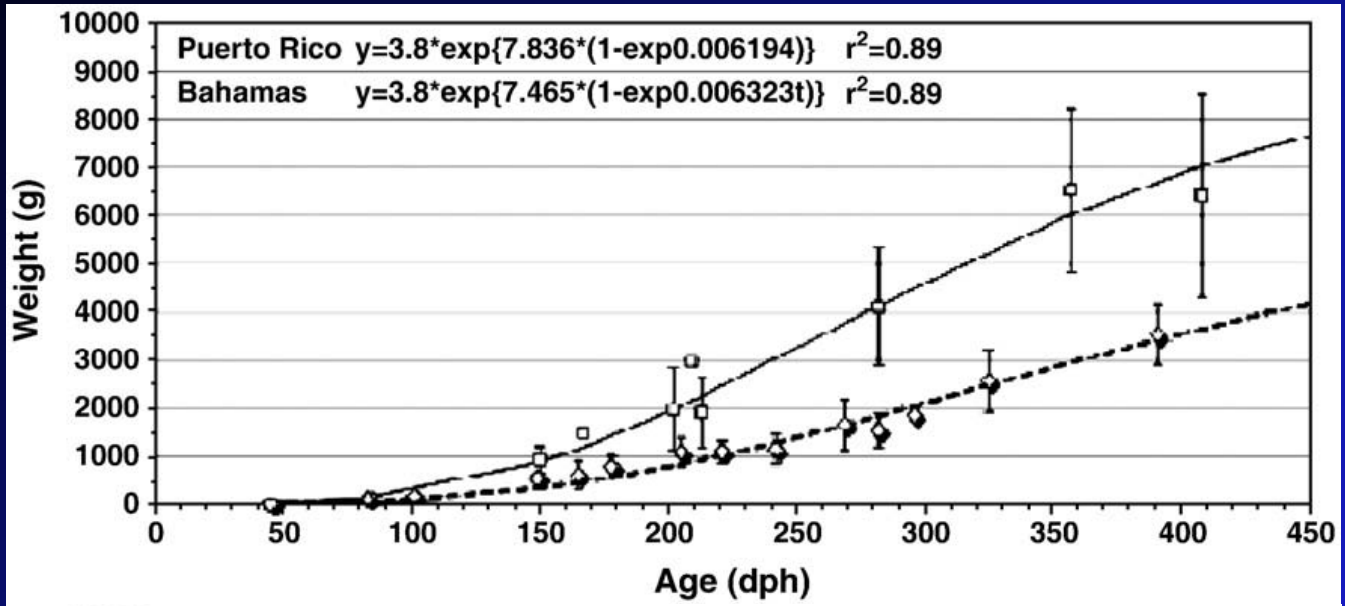
ARTICLE INFO

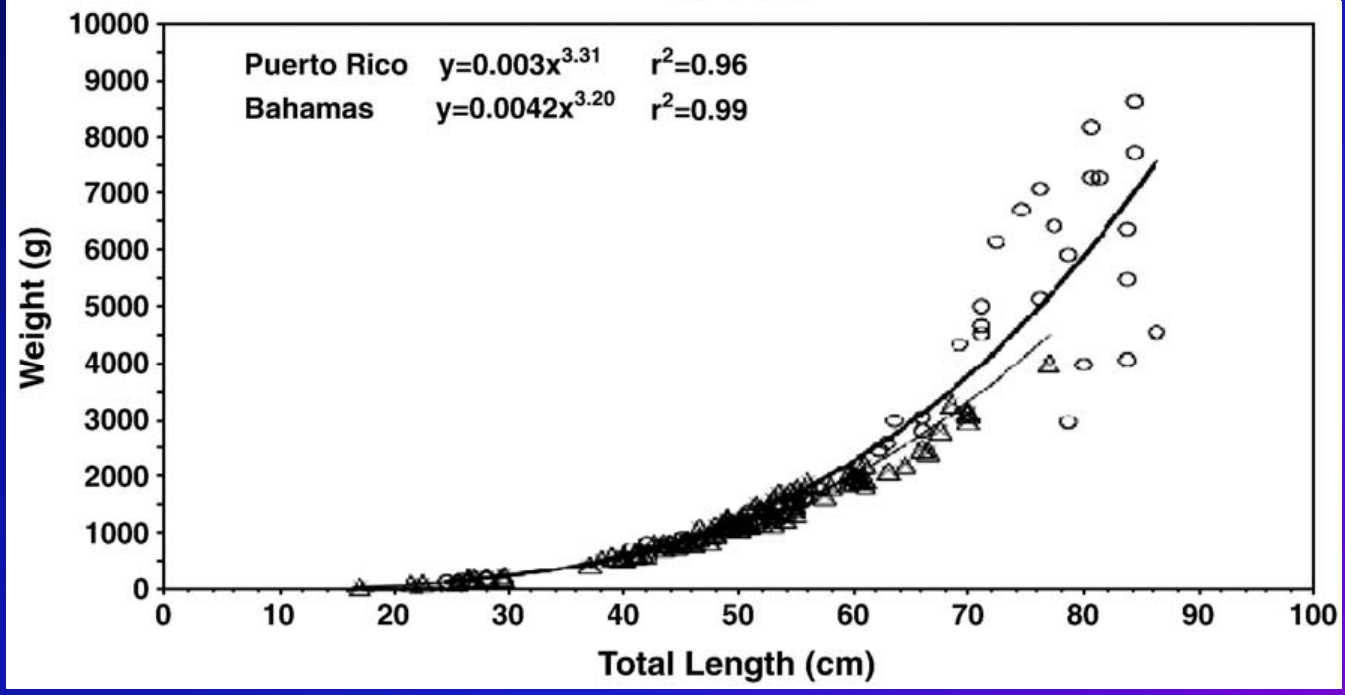
Article history:
Received 9 September 2009
Received in revised form 16 February 2010
Accepted 16 February 2010

Keywords:
Cobia
Growth
Condition factor
Open ocean aquaculture

ABSTRACT

Growth rates of hatchery-reared cobia *Rachycentron canadum* cultured in submersible cages off Puerto Rico and the Bahamas were comprehensively studied and are presented, discussed and compared to those of other teleosts. Cobia grew to averages of 6.035 kg (specific growth rate (SGR) = 2.10%/day) in 363 days at the Puerto Rico site (PR) and 3.545 kg (SGR = 2.04%/day) in 346 days at the Bahamas site (BA). Growth in length is best expressed by the equations: $y = 12 + 0.18x$; $r^2 = 0.59$ at PR and $y = 12 + 0.16x$; $r^2 = 0.86$ at BA. The Laird–Gompertz model was used to represent growth in weight to best express the rate of decline in growth rate with age ($\alpha = 0.006194$ PR and $\alpha = 0.006323$ BA), which occurred at the onset of precocious maturation for this species at 2.0–4.5 kg in 300 days post hatch (dph). The exponents (b) of length–weight relationships calculated (3.31 at PR and 3.20 at BA) demonstrate that cultured cobia exhibit greater condition factors than their wild counterparts ($b = 2.8$) and explain the morphological differences observed between wild and culture cobia. Final stocking densities of 5 and 15 kg/m^3 were estimated at PR and BA, respectively. Average water temperatures for the duration of the growout cycle were 27.8 °C at PR and 25.5 °C at BA. Results show that growth rates of cobia


Puerto Rico y=3.8*exp{7.836*(1-exp0.006194)} r2=0.89
Bahamas y=3.8*exp{7.465*(1-exp0.006323t)} r2=0.89
Weight (g)
Age (dph)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0
50
100
150
200
250
300
350
400
450


Puerto Rico y=0.003x3.31 r2=0.96
Bahamas y=0.0042x3.20 r2=0.99
Weight (g)
Total Length (cm)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0
10
20
30
40
50
60
70
80
90
100

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ISSN 0175–8659

Accepted: January 30, 2007
doi: 10.1111/j.1439-0426.2007.00900.x

Measurement of organic loading under an open-ocean aquaculture cage, using sediment traps on the bottom

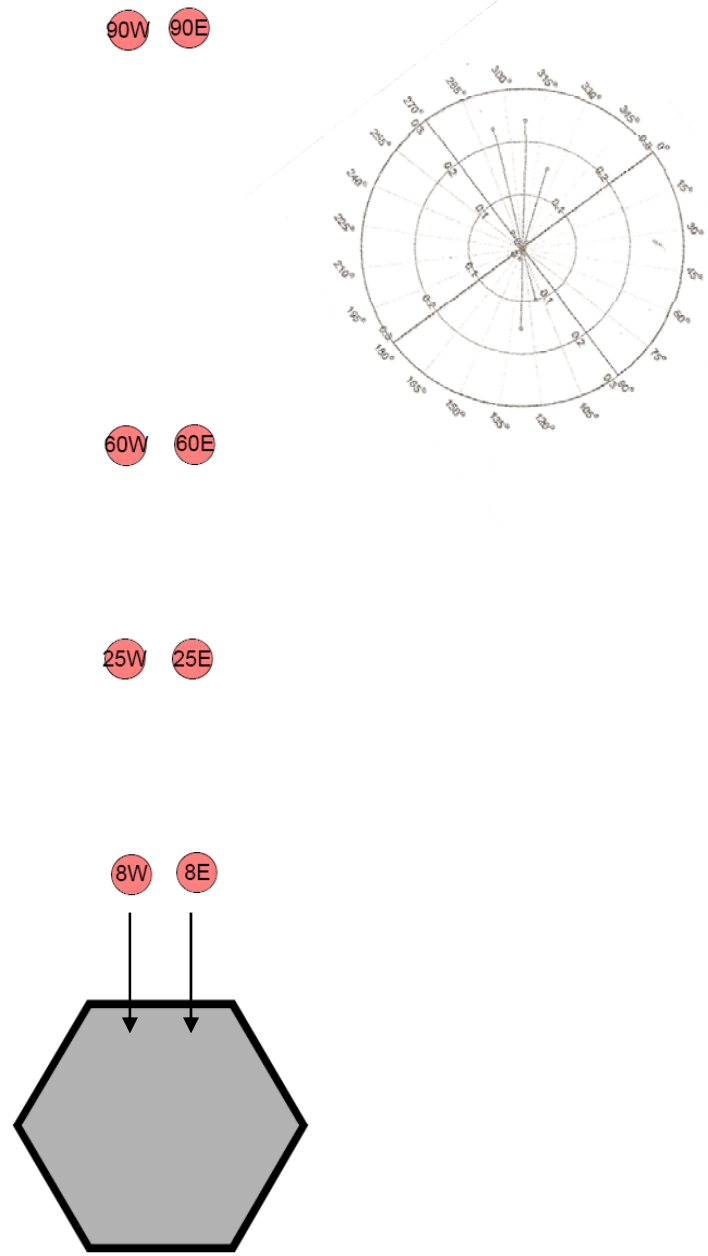
By P. Rapp[1], W. R. Ramírez[2], J. A. Rivera[3], M. Carlo[4] and R. Luciano[5]

[1]*Department of Physics, University of Puerto Rico, Mayagüez;* [2]*Department of Geology, University of Puerto Rico, Mayagüez;* [3]*under contract to: U. S. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Puerto Rico;* [4]*Department of Marine Sciences, University of Puerto Rico, Mayagüez;* [5]*Department of Crop Protection, University of Puerto Rico, Mayagüez*

OnlineOpen: This article is available free online at www.blackwell-synergy.com

Summary

Organic loading under a submerged fish cage in commercial operation has been quantified for the first time in the open ocean. Sediment traps out to 100 m sampled the loading catch the outfall in traps as it descends through the water. At near-shore sites with current amplitude < 10 cm s^{-1}, traps of almost any size will suffice. But at high current speeds, traps do not function as simple gravitational collectors. In fast current,


90W
90E
60W
60E
25W
25E
8W
8E

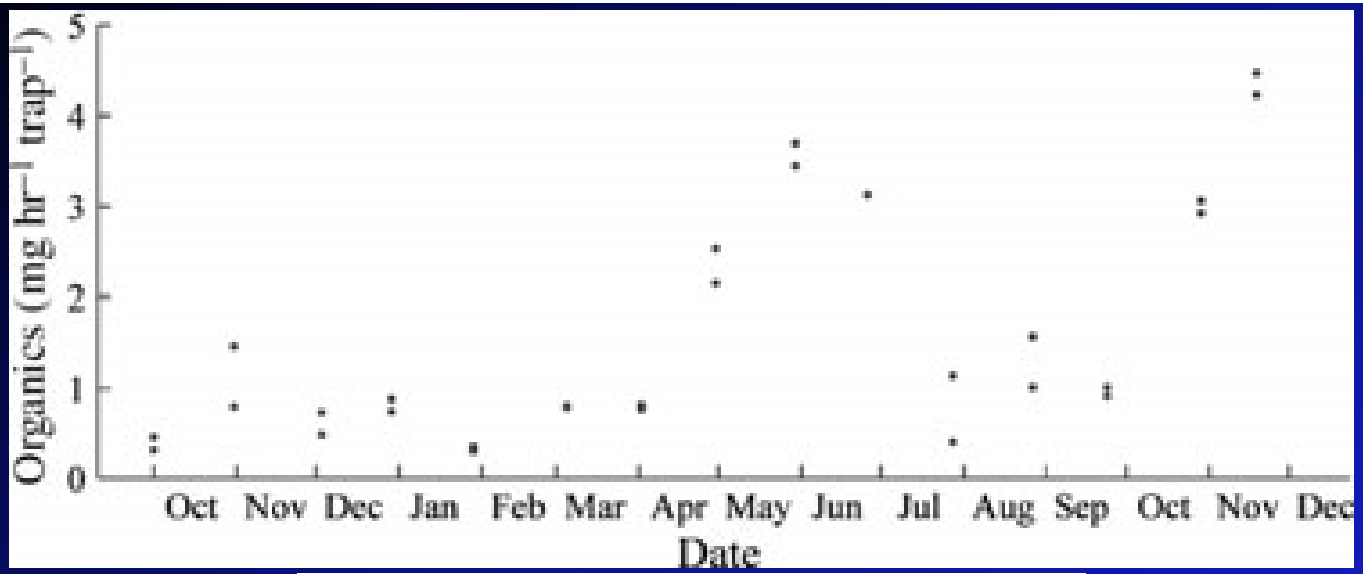


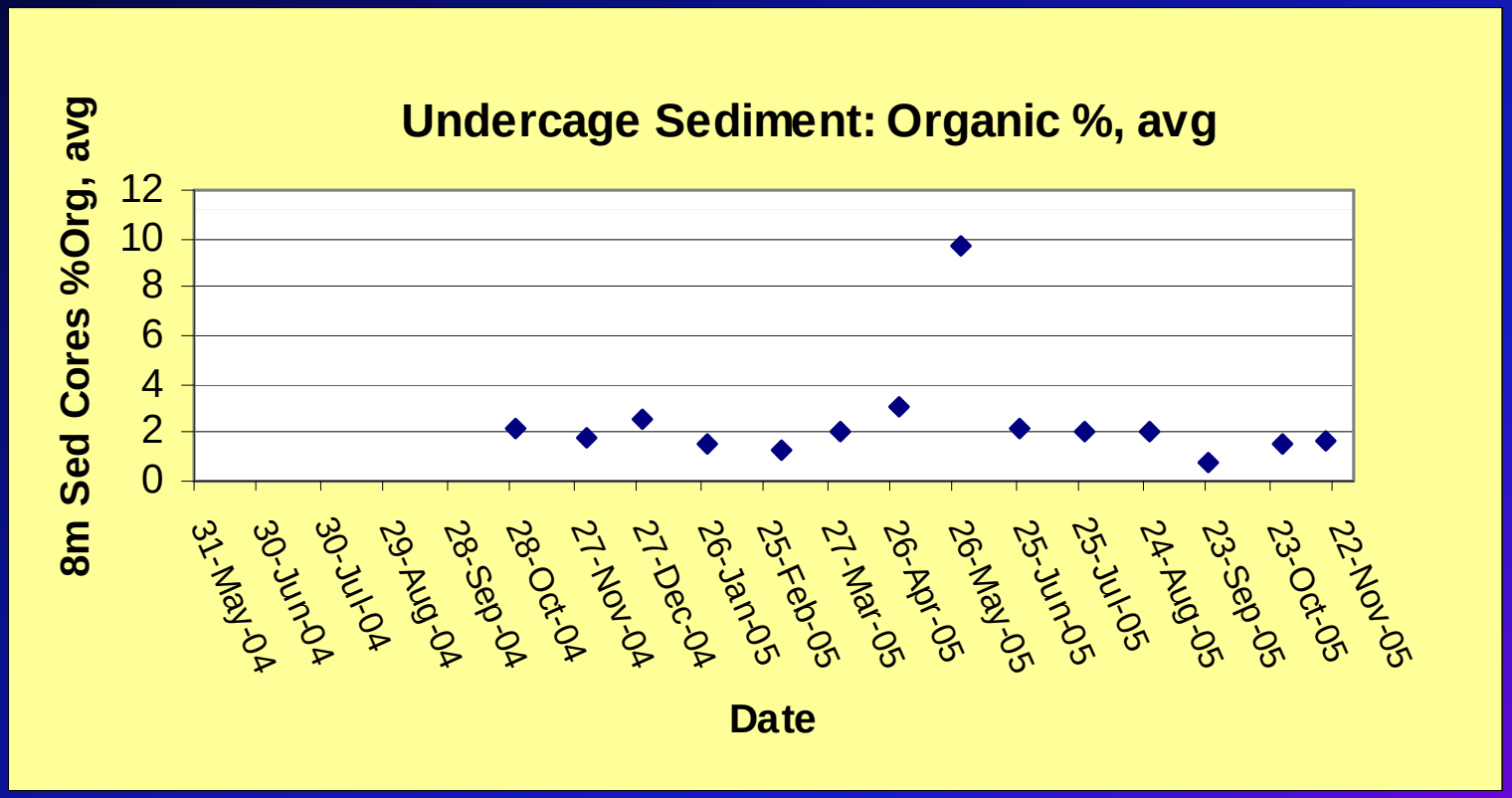
Table 1
Sampling dates, input feed, benthic percentage

Sampling date (day/month/year)	Input feed (metric tonnes)	Benthic percentage
1/10/04	0.07	–
31/10/04	1.56	–
3/12/04	4.76	–
29/12/04	4.67	–
29/1/05	6.45	–
5/3/05	8.96	–
2/4/05	8.65	–
30/4/05	11.74	5.1
30/5/05	12.92	7.1
26/6/05	11.85	5.9
28/7/05	12.43	1.8
27/8/05	11.06	4.6
24/9/05	8.37	2.9
29/10/05	7.89	16.0
19/11/05	3.45	25.0

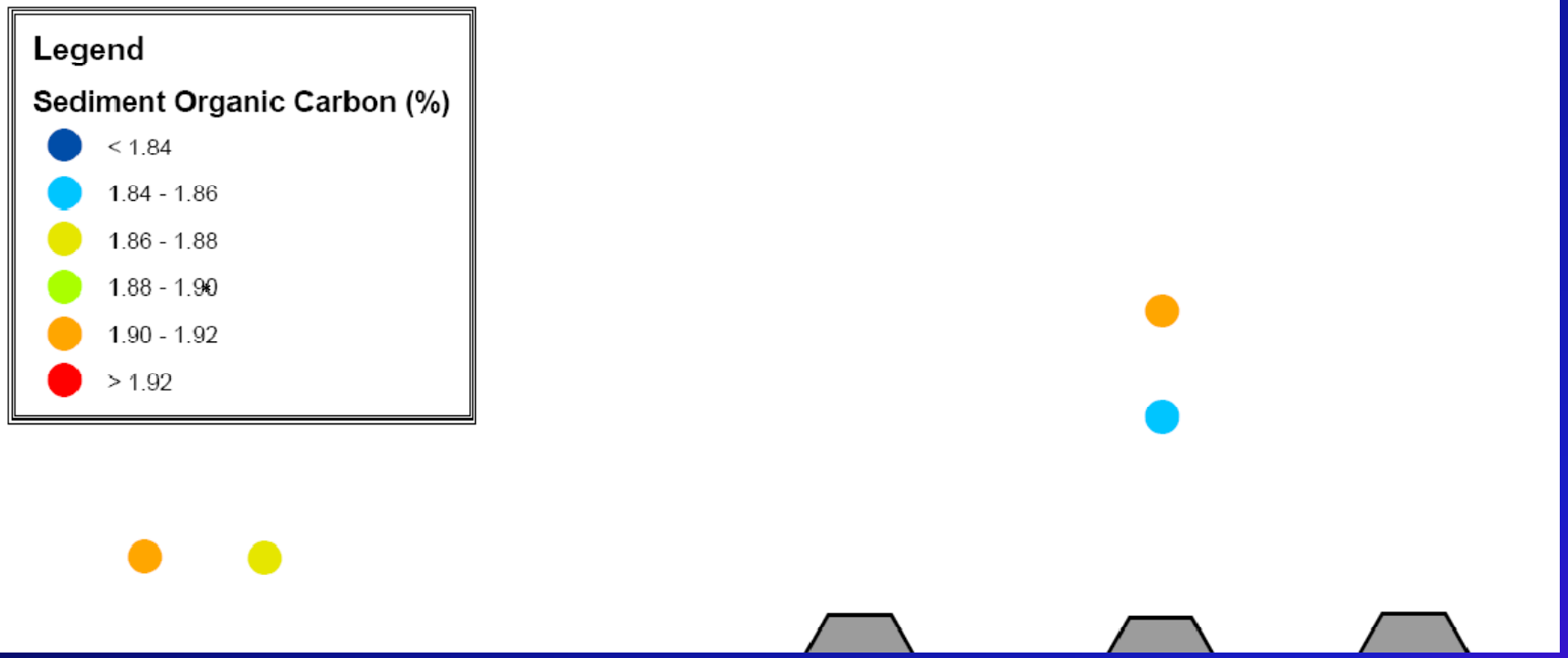
Sampling date = traps recovered from the bottom and replaced with fresh traps. Each trap sample was accumulated over an approximately 1-month period (dwell period) between consecutive sampling dates. Input feed = weight of feed pellets fed to fish in the dwell period between consecutive sampling dates. Benthic percentage = percentage of input feed that landed on the sediment during each dwell period. It is calculated by integrating the fitted Gaussian function over the entire benthos, and then dividing by the Input feed.

Benthic Sediment

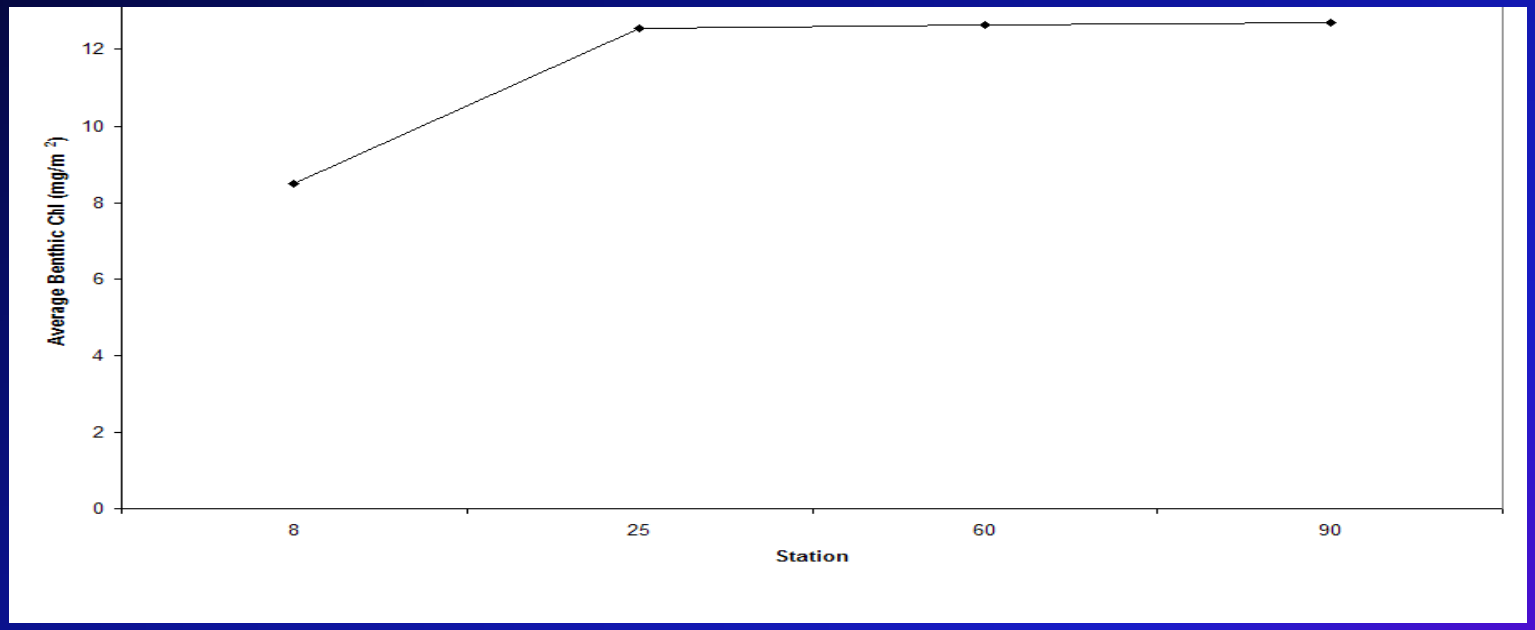
No Significant or Cumulative Environmental Impact

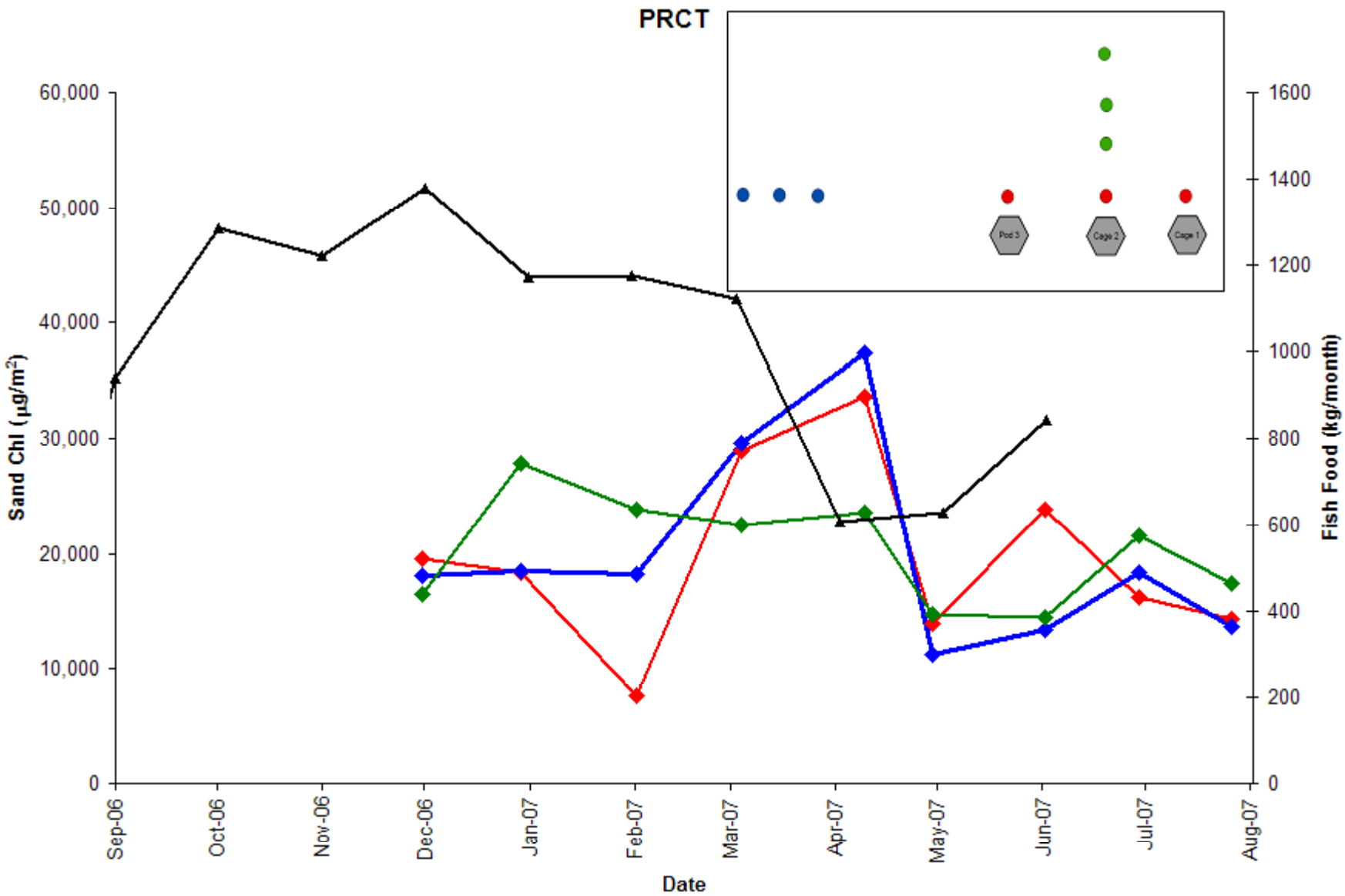


NOAA Contract #: NA040AR4170



• Organic carbon values did not exceed 2% under cages and at control stations.


Average Benthic Chl (mg/m 2)
0
2
4
6
8
10
12
8
25
60
90
Station


PRCT
Sand Chl (µg/m²)
Fish Food (kg/month)
Date
60,000
50,000
40,000
30,000
20,000
10,000
0
1600
1400
1200
1000
800
600
400
200
0
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Pod 3
Cage 2
Cage 1

Setbacks

- First time this kind of activity is requested on this island
- DRNA, JCA, USACOE, EPA unfamiliar with activity proposed
- Lack of knowledge and understanding; results in no action, no consulting
- DRNA permit evaluation technician accused of corruption ,

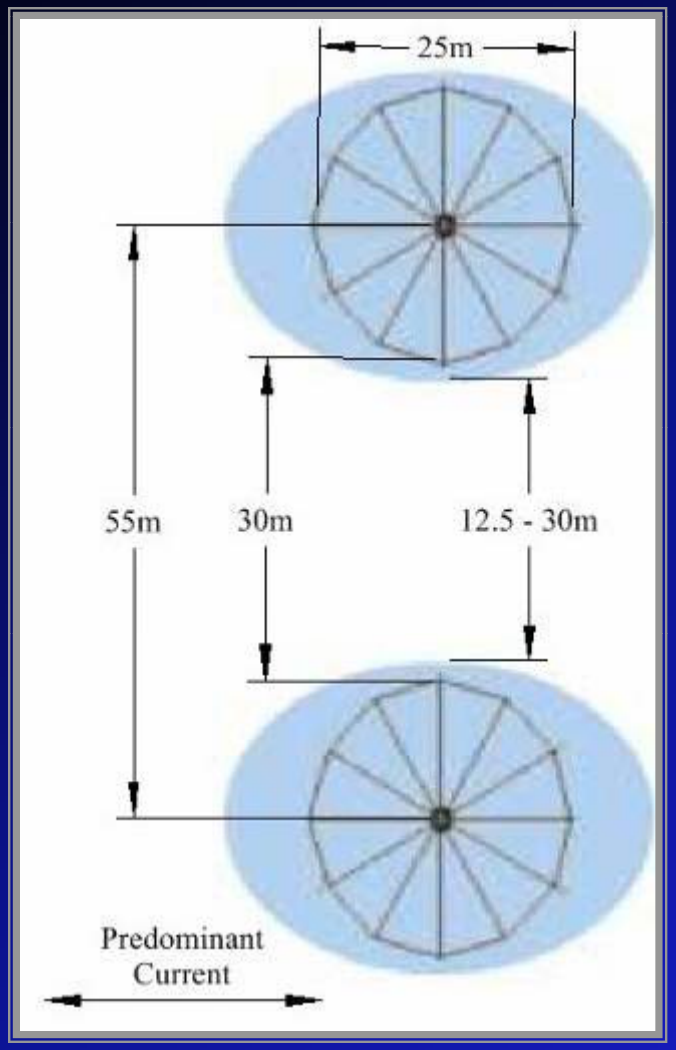
  – change of person – restart process all over
- PRIDCO reorganization
- Change of Government: From Rosello to Sila, then, from Sila to Acevedo
- Permitting uncertainty leads to investor uncertainty – **no funds**
- Delays, transfers project to another economic window ,

  (ie; > fuel increase, recession) further affecting project feasibility.

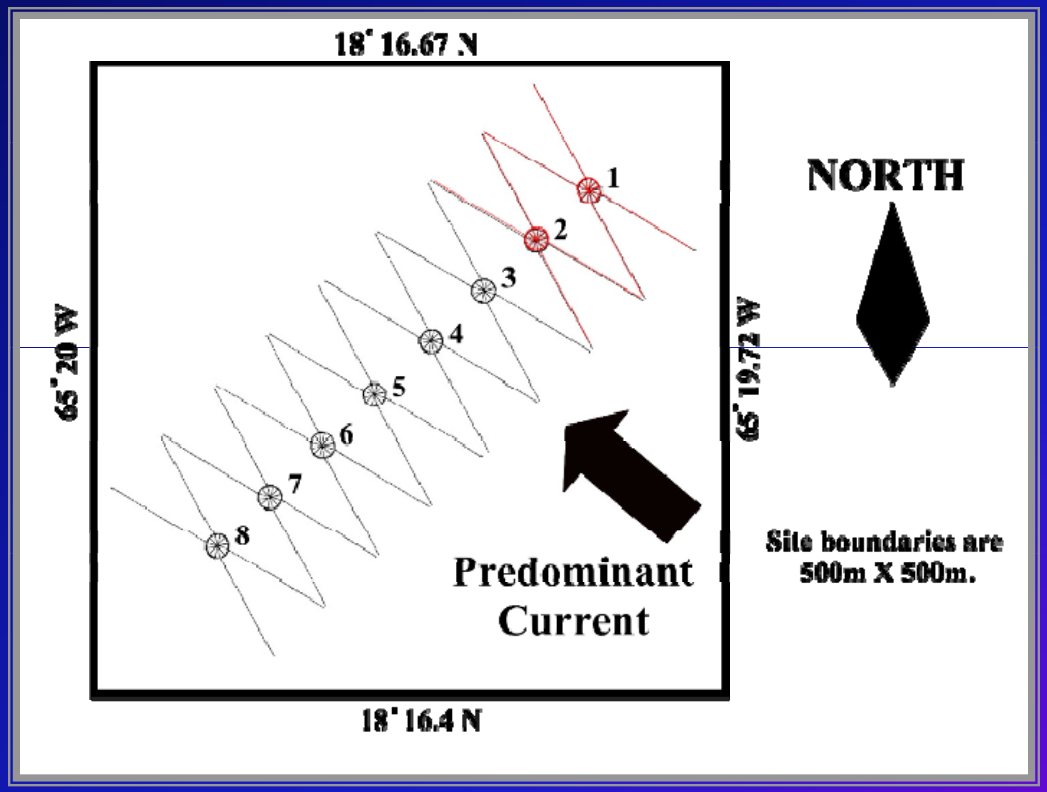
Suggested Best Management Practices

- Proper Site Selection and Layout

No Cumulative Loading



Buffer Zone



Prevent Cumulative Loading

Suggested Best Management Practices

- Proper Site Selection and Layout

➢ Adequate current

➢ Adequate benthic substrate

➢ Access to transport infrastructure

Suggested Best Management Practices

- Efficient Feed Management

➢ Feeding monitoring (video or divers)

➢ Correct current cycle

Suggested Best Management Practices

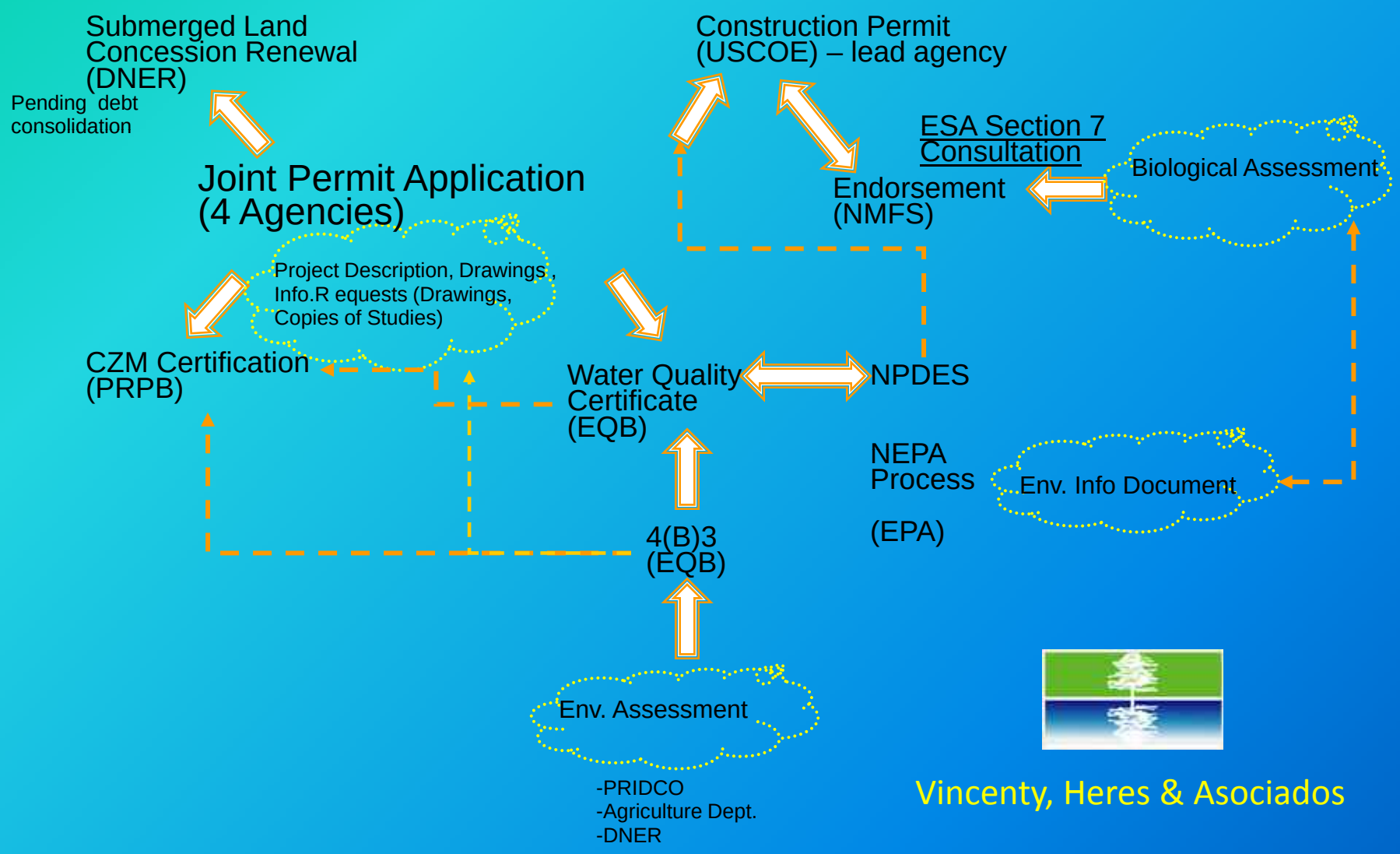
- Quality Feed and Healthy Fish

➢ Correct proportion of nutrients for species

➢ Correct buoyancy of pellets for current regime

➢ Feed should minimize dust-free dry pellets

Permit Web



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Permit Process – Frustrations

- Data gathered under federal grants programs (2002-2008) was not considered during the issuance of new permits

- Duplicity or redundancy evaluation for determining environmental impacts: PR Env. Policy Law 216 / NEPA process

- Changes in key staff in government agencies delayed procedure – knowledge was lost
  - PRIDCO
  - Agriculture
  - DNER

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Lessons Learned / Suggestions

- Identify areas in Puerto Rico which, according to currents, tides and benthic characteristics are ideal for Aquaculture to be established

- Establish the maximum mass loadings which will sustain the habitat in order to limit production activities in the area:
  - Control feeding practices
  - Monitor sediment and organic loading only

- EQB/EPA should not treat an Aquaculture farm in the same manner as a sanitary discharge… they are not the same

- Avoid redundancy in Environmental Impact evaluation – EQB / EPA should share the same document

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Lessons Learned / Suggestions

- State government should establish which agency will be proposing agency for this type of operation
- ESA Section 7 consultation was not a clearly defined process and, to date, has not been documented as completed
- Snapperfarm still has no Section 10 permit from the USCOE

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REMINDER

- Its still just fish in the water…

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