The Future of Seafood Production
Why Aquaculture / Why Offshore?

Facts and trends:
- Fish consumption increasing, world population growing (FAO, 2003)
- Overfishing: 75% of ocean fisheries fully exploited (many stocks collapsed)
- US seafood trade déficit > $ 8 Billion /year and growing

Bottom line:
- Increases in seafood production are unlikely to come from fisheries
- Over 30% of total world fishery production from aquaculture
- World aquaculture production has been steadily increasing at >10% per year over the last decade
DANGER IN THE SEA

Threats to marine species listed as “vulnerable” on the World Conservation Union Red list

- Acoustic disturbance
- Aquaculture
- Disease
- Water diversion
- Vessel interactions
- Climate change
- Human disturbance
- Pollution
- Intrinsic factors
- Invasive species
- Habitat loss
- Over-exploitation

Percentage of species affected by over-exploitation

Direct harvest
Incidental & by-catch
Indirect effects
Aquaculture production

Landings of “bait” fish

Fishmeal production

Data from Tacon, A.G.J., 2003 and Allen, G. 2004
Currently, the global aquaculture industry employs over 100 million people.
By 2020, employment from aquaculture is predicted to grow substantially.

Aquaculture Production
International Food Policy Research Institute, 2003
“A new way to feed the world”
“The future of food”
“Aquaculture is a good thing, in spite of environmentalists concerns”
“… the inevitable..”
Firm-fleshed, farm-raised cobia are an environmentalist’s dream and a diner’s delight.

Cobia are fast-growing even in the wild, but put these jut-jawed, cigar-shaped fish in a pen deep in the ocean and they go totally alpha, reaching 6 to 10 pounds in less than a year. A muttn snapper raised in the same conditions wouldn’t even be a pound, making cobia enticing as a profitable fish to farm-raise.

That is just what Jimmy O’Halleran and Carlos Singularity of JC Seafood are doing, working with Daniel Benetti, director of the aquaculture program at the University of Miami, and his partner Evan O’Halleran (Jimmy’s nephew) and Joe Ayvazian of Sungirlfarm, an operation based on environmental sustainability.

Their “farm” is two galvanized steel-and-mesh pods, each large enough to hold 38 tractor trailers, moored several miles off the coast of Cuba, Puerto Rico. The pristine water is the perfect temperature and its fast flow acts as a natural filter.

One pod holds the cobia now being harvested; the other is home to the snapper that they expect will be big enough for market early next year. Hatched fingerlings are fed pellets made of fish and corn meal, soybean meal, vegetable fibers and yeast extracts, with no growth hormones, antibiotics or pigments added. There are no harmful pollutants or negative impact on the coastal mangrove swamps or coral reefs, UM’s Benetti says.

Best of all, these politically correct fish, related to dolphinfish and also called “black kingfish,” taste fantastic.

“We think it will be bigger than tilapia,” says Benetti, referring to the species that has until now cornered the farm-raised market.

Farm-raised cobia are whiter and have more fat, making them tastier with less granular flesh than their hard-swimming wild brethren.

In a tasting held at Pescado in the village of Merrick Park, executive chef Peter Hansen showcased its versatility. Starters included coconut tempura cobia and tempura fish (Peruvian-style sashimi). Cobia just might be the best raw. The sashimi’s raw are light and delicate but durable and not fishy tasting at all.

When cooked the flesh is gorgeous, too—pure white, muscular, mild and flaky, as in Hansen’s main course of pan-seared cobia fillets atop black-bean polenta with a salsa of chopped radicchio olives, sun-dried tomatoes, feta, fresh basil and red wine vinegar.

Cobia would also be great steamed, baked or broiled. Or mince the meat, form it into fish bulu bound with egg white and drop it into rice noodle soups. For an all-American treatment, grind it with chilies, fresh herbs and black pepper and make it into burgers, served with frilly ketchup.

With the environmental cloud surrounding Chilean sea bass, the timing couldn’t be better for a farm-raised fish that tastes even better than wild-caught.

Cobia is $4.95 a pound whole, $10.95 filleted at Captain Jim’s Seafood Market, 12590 W. Dixie Hwy., North Miami, 305-987-3929.

Restaurants serving cobia include Pescado, Village of Merrick Park, 620 Avenue San Lorenzo, Coral Gables, 305-443-3174; Normandy, 21 Almeria A Ave., Coral Gables, 305-444-6767; Nohu, 1901 Collins Ave., Miami Beach, 305-538-4259; and Cafe Ibarra, Village of Merrick Park, 370 Avenue San Lorenzo, Coral Gables, 305-443-8888.

PAN-SEARED COBIA

Peter Hansen, executive chef at Pescado, shared these directions for his spice-seared fish. (Black cod or wahoo can be substituted for cobia.) Serve it with couscous and a wedge of lemon.

1. Heat the oven to 400 degrees.
2. Rub a large cobia fillet with olive oil, a little salt and garam masala (a blend of cinnamon, cloves, coriander, cumin, black pepper, cumin, dried chilies, fennel, rice and mustard available at Indian markets).
3. Heat an oven-proof skillet over high heat; add oil and a little butter.
4. Carefully lay the fish in the pan and let it sear until the spice mixture forms a nice crust.
5. Remove the pan from the heat, turn the fish over carefully with a spatula and finish it in the oven for about 6 minutes. Makes 2 servings.

__________________________________________________________________________
At stake:

- Not whether, if or when but how and where it will expand:
  - Traditional or new technology?
  - Inland/Coastal/Open ocean/Offshore?
  - US or abroad?
- What can happen/What should happen (seafood/energy)
- Precautionary approach/sustainable development
- What ifs? California wine industry Napa; Silicone Valey
- Can “sustainable” aquaculture be economically feasible?
- Is the technology to move/expand aquaculture offshore (into the EEZ) in place?
CURRENT STATUS

- Technology limits move towards futuristic, fully automated, “self-sustained” farms offshore (EEZ)
- Oil/gas platforms hold promise but cost/liability prohibitive
WHERE ARE WE AT?

Exposed areas (adequate depth+current)
Near shore, within State waters
SeaStation 3000 - Ocean Spar, Net Systems (U.S.)

Culebra, Puerto Rico
Snapperfarm, Inc.

Cage volume = 3000 m³
Average current velocity = 0.5 knot
Depth = 25-30 m (90-100 ft)

H₂O flow > 2 billion liters/day
(>600 million gl/day)

Eleuthera, Bahamas
AquaSense Bahamas, Ltd.
OPEN OCEAN AQUAFARM - NOT JUST A CONCEPT ANYMORE…

CONCEPTUAL OFFSHORE SUSTAINABLE AQUAFARM

http://www.rsmas.miami.edu/groups/aquaculture
SPECIES

1) Native / endemic to the region (SE US, Gulf and the Caribbean)
2) High market demand and value
3) Technology developed/available from egg to market (hatchery produced)
4) High Aquaculture performance: growth, survival and feed conversion rate

Cobia (Rachycentron canadum)  Mutton Snapper (Lutjanus analis)
HATCHERY TECHNOLOGY DEVELOPED IN THE U.S.
COBIA *Rachycentron canadum*

- Yolk-sac larvae - 1 day old
- 2 days old
- 10 days old
- 20 days old
- 45 days old (4.5 in)
- 8 weeks (80 grams!)
Comparative Growth During Early Developmental Stages
45 DPH (Days Post Hatch) – 6 weeks

Cobia
5.5 g; 11.5 cm (4.5 in)

Snapper
0.2 g; 2.0 cm (1.0 in)
First trials carried out at the University of Miami Experimental Hatchery in May/June 2005 produced tens of thousands of healthy cobia fingerlings.
KONA BLUE
HAWAII

KAHALA
(a.k.a. Seriola rivoliana)
Snapperfarm and AquaSense cobia are produced without the use of any antibiotics, hormones, pigments, or pesticides. Grown offshore, far from pollution sources.

Organic Cobia!?
[Ethoxyquin, a synthetically-derived antioxidant (stabilizer) used to prevent oxidation, rancidity.]

Extraordinary Rates of Growth and Feed Conversion Efficiency (FCR) at Low Environmental Impact
Environmental and economic sustainability of operations?
Growth rate is inversely proportional to stocking density
Mortality rate is directly proportional to stocking density
Environmental Assessment

• **Physical factors**
  – Bathymetry (depth profile)
  – Bottom type (preferred sandy)
  – Coastal topography
  – Wind velocity/direction/fetch
  – Currents and tides
  – Wave height (max/min/average)
  – Air and water temperature
  – Turbidity

• **Biological factors**
  – Fouling
  – Chlorophyll
  – Productivity
  – HABs
  – Assemblage
  – Benthic studies

• **Chemical factors**
  – Total suspended solids
  – Ammonia
  – Nitrite
  – Nitrate
  – Phosphate
  – Dissolved oxygen
  – Organic matter
  – Nitrogen

• **Socio-economic factors**
  – Acceptance of project
  – Local communities
  – Partnership Fishermen Association

• **Educational factors**
  – Elementary / High School / Technical Level Curricula
  – Teachers’ Materials / Talks, etc.
Environmental Assessment
Summary of Results - Puerto Rico

Dissolved nutrients in the water column

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Snapper</th>
<th>Cobia</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Nitrite</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.002</td>
<td>0.002</td>
<td>0.003</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.003</td>
<td>0.004</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Organic matter in the sediments at the cages and control site

- Snapper: 4.76
- Cobia: 4.68
- Control: 4.75
Environmental Assessment
Summary of Results - Bahamas

Average Water Column Chlorophyll a
November 2003 - December 2004

Average Benthic Chlorophyll-a
November 2003 - December 2004
Summary of Environmental Studies (Puerto Rico, Bahamas, Hawaii, New Hampshire)

- Environmental data from Puerto Rico and the Bahamas indicate that there are no significant changes in the water column and benthic ecosystems near the area.

- There were no significant differences in any of the water quality parameters measured in the area surrounding and beneath the cages - except for small localized benthic impact just underneath the cages.

- No samples had values in excess of allowable values under the NPDES permits.

- Data are from small scale, demonstration projects.

- Need to continue environmental monitoring studies as operations expand to determine whether/when a threshold level may occur.

Benetti, Brand, Helsey, Langan, Alston, Cabarcas, Collins (in prep)
PROBLEMS:

HURRICANES

- In 2004, the cages were exposed to severe storms, including category 4 Hurricane Frances.

- WINDS ranging from 70-100 miles/hr prevailed in the area where one of the cages is deployed in South Eleuthera for almost 24 hours.

- No damage to the cage or fish mortality were observed.

SHARK PREDATION ESCAPEMENTS
HARVESTING/PROCESSING/SHIPPING
HIGH-QUALITY PRODUCT...
... FOR A HIGH-END MARKET
SUMMARY

• Objective is to produce high-quality fish for high-end market seeking profits and lowering US seafood trade deficit ($8B)

• New technology has been developed from egg to market: new species (moi, kahala, cobia) production has been added to market

• Results suggest that growing this species in exposed sites can produce high yields of fish with low environmental impact

• Results suggest that, properly sited and managed, aquaculture of high-value fish can be conducted responsibly

• Must be integral component of NOAA Ecosystem-Based Fishery Management Plan and Coastal Management Plans

• It will be difficult to compete with production from abroad; environmental and technological prospects seem great; economic prospects do not
SUMMARY - THE FUTURE

• Anti-predator systems including predator nets, shark pods, electromagnetic fields and chemical/electrical repellants (passive deterrent methods)

• Facilitate permits for demonstration projects and to expand currently permitted operations to reach economic feasibility

• Continue mandatory environmental monitoring studies to ensure sustainability and determine threshold to limit production/unit area

• Expansion of offshore aquaculture will be driven by economic and environmental concerns combining the needs from the industry, government agencies, NGO’s, press and the public at large

• Move/develop the industry abroad with great losses (e.g. quality control, employment, social/economic losses, dependence foreign production; seafood trade déficit)

• What can happen: to buy more seafood/energy abroad

• What should happen: to produce more seafood/energy at home
THANKS!

Aquaculture Research Council
Florida Department of Agriculture - Division of Aquaculture
Four cages are now on site: two nursery cages, and two submersible Sea Stations. Four more Sea Stations will be deployed over the next year.
Kona Blue’s submersible Sea Station cages, in waters over 200 ft deep, offshore from the Kona Coast, off the Big Island of Hawaii
Total of 90,000 fish stocked in offshore cages to date.
First harvest September 1st, 2005. Mean weight 3.5 lbs
Kona Blue’s **Kona Kampachi™** *(Seriola rivoliana)*