COASTAL SCIENCE FUELING COASTAL ECONOMIES
Using Geoscience Research to Accelerate Innovation and the Coastal Economy

Sponsored by Senator Bill Nelson | Presented by the National Association of Marine Laboratories

November 20, 2015
Noon — 1:30 p.m.
Capitol Visitor Center, Room SVC 202

PAMELA YOCHEN
Aquaculture Reinvigorates the Coastal Community
Executive Vice President, Hubbs-SeaWorld Research Institute
San Diego, California

MEGAN DAVIS
Community Involvement for the Indian River Lagoon Leads to Water Project Investments
Interim Executive Director, FAU Harbor Branch
Fort Pierce, Florida

LISA AUERMULLER
Coastal Resilience—Reducing the Cost and Vulnerability To Future Storms and Flooding
Director, Coastal Training Program
Rutgers University
New Brunswick, New Jersey

ALAN D. STEINMAN
Ecosystem Restoration in the Great Lakes Yields Significant Return on Investment
Director, Annis Water Resources Institute
Grand Valley State University
Muskegon, Michigan

Copies of each presentation used at this briefing can be found at www.naml.org
Aquaculture Reinvigorates the Coastal Community

Coastal Science Fueling Coastal Economies
Capitol Visitor Center, Washington, D.C.
November 20, 2015

Pamela Yochem, D.V.M., Ph.D.
Executive Vice President
Hubbs-SeaWorld Research Institute
U.S. Economy Depends on a Healthy Coast

- 14% of coastal counties produce 45% of the GDP with 3 million jobs (one in 50)
- In 2011, the ocean economy’s 6 economic sectors contributed more than $282 billion to the GDP and over 2.8 million jobs.

Examples (major sectors):
- Tourism and Recreation:
  - 70% of ocean employment
  - 34% of ocean GDP
- Offshore Mineral Extraction:
  - 37% of ocean GDP

# Key Industry Diagnostics for the San Diego Maritime Industry

**September 2011**

<table>
<thead>
<tr>
<th>Total employment</th>
<th>45.8K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional maritime exclusive industries</td>
<td>8.2</td>
</tr>
<tr>
<td>Maritime technology industries</td>
<td>18.9</td>
</tr>
<tr>
<td>Other maritime</td>
<td>18.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total estimated revenue</th>
<th>$14 Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional maritime exclusive industries</td>
<td>$1.4</td>
</tr>
<tr>
<td>Maritime technology industries</td>
<td>$6.2</td>
</tr>
<tr>
<td>Other maritime</td>
<td>$6.5</td>
</tr>
</tbody>
</table>

The Economic Impact of San Diego’s Research Institutions

Driving San Diego’s Innovation Economy

RESEARCH INSTITUTIONS have a $4.6B ECONOMIC IMPACT and are at the center of SAN DIEGO’S $14.4B SCIENTIFIC R&D CLUSTER
$4.6 Billion equals the impact of:

33-U.S. Open Golf Championships

6-Aircraft carriers stationed in S.D.

4-San Diego Convention Centers

34-Comic-Con Conventions
Worldwide Seafood Supply Shortfall

Global Fish Shortages by 2030
Demand set to outstrip supplies in all regions

- Total
- Oceania
- North America
- Latin America
- Europe
- Asia
- Africa

Source: United Nations’ Food and Agriculture Organization.

50 million more metric tons

U.S. needs increased domestic supply of safe & sustainable seafood
- 91% of U.S. seafood is imported
- Annual seafood imports total over $16 billion
- 50% of global supply of seafood is farmed (80% in Asia)
- Domestic supply is 6.5% harvest and 2.5% farmed
For California Agriculture, Seafood Production is a Novelty

- 81,500 farms
- Over 400 commodities
- $43.5 billion total revenue
- #1 state with 11.3% of U.S. farm cash receipts
  - 11% for crops
  - 7.1% for livestock
- $12 billion in livestock sales
- <0.5% is aquaculture

<table>
<thead>
<tr>
<th>Source of Income</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture</td>
<td>$54</td>
</tr>
<tr>
<td>Chickens, All</td>
<td>$720</td>
</tr>
<tr>
<td>Cattle and Calves</td>
<td>$3,299</td>
</tr>
<tr>
<td>Eggs, Chicken</td>
<td>$393</td>
</tr>
<tr>
<td>Hogs and Pigs</td>
<td>$39</td>
</tr>
<tr>
<td>Honey</td>
<td>$23</td>
</tr>
<tr>
<td>Milk and Cream</td>
<td>$6,900</td>
</tr>
<tr>
<td>Turkeys</td>
<td>$311</td>
</tr>
<tr>
<td>Wool and Mohair</td>
<td>$5</td>
</tr>
<tr>
<td>Other Livestock</td>
<td>$412</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$12,155</strong></td>
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</tbody>
</table>
Reinvigorating a Coastal Community

Southern California’s history:

• By 1975 tuna fishing supported 16 canneries and employed 40,000 people.
• Southern California was known as the Tuna Capital of the World.

More recently:

• In 2013, California fisheries caught only 165K MT (worth $256 million)
• San Diego caught only 1K MT (worth $6 million)
Reinvigorating a Coastal Community

Southern California’s future?

- Proposed project: Rose Canyon Fisheries
- A commercial, state-of-the-art, aquaculture project off the coast of Southern California
  - Evaluate both economic and environmental sustainability
  - Scale up to 5,000 MT annual production
  - Annual sales in excess of $50 million with estimated 2:1 economic benefit to the region (Source: San Diego Regional Economic Development Corporation)
Potential Economic Benefits

- **Region**
  - Sales from $50 million annually
  - Supporting over 300 seafood jobs (wages ~ 2x regional average)
  - New spending in excess of $100 million annually (2:1 economic benefit)

- **State**
  - Represent a 31% increase in seafood ex-vessel sales

- **Nation**
  - Help to reduce the growing trade deficit in seafood imports

Source: San Diego Regional Economic Development Corporation
New Industry Precipitates the Need for Research

*NATIONAL STRATEGIC PLAN FOR FEDERAL AQUACULTURE RESEARCH (2014-2019)*

**Strategic Research Goals:**

1. Advance Understanding of the Interactions of Aquaculture and the Environment
2. Employ Genetics to Increase Productivity and Protect Natural Populations
3. Counter Disease in Aquatic Organisms and Improve Biosecurity
4. Improve Production Efficiency and Well-being
5. Improve Nutrition and Develop Novel Feeds
6. Increase Supply of Nutritious, Safe, High-quality Seafood and Aquatic Products
7. Improve Performance of Production Systems
8. Create a Skilled Workforce and Enhance Technology Transfer
9. Develop and Use Socioeconomic and Business Research to Advance Domestic Aquaculture

* National Science and Technology Council Committee on Science; Interagency Working Group on Aquaculture, 2014
Hubbs-SeaWorld Research Institute
50+ years experience in marine research
30+ years in aquaculture research (replenishment of depleted stocks, sustainable seafood)
Collaborators

Universities and research institutes, industry groups, eNGOs, community organizations

<table>
<thead>
<tr>
<th>Fish Health</th>
<th>Nutrition</th>
<th>Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Minnesota</td>
<td>NOAA Fisheries</td>
<td>Southern Illinois University Carbondale</td>
</tr>
<tr>
<td>Middle Tennessee State University</td>
<td>USDA</td>
<td>University Autónoma de Baja California</td>
</tr>
<tr>
<td>Washington State University</td>
<td>USDA ARS</td>
<td>Auburn University</td>
</tr>
<tr>
<td>Wisconsin University</td>
<td>Schilling Genetics</td>
<td>University of Idaho</td>
</tr>
<tr>
<td>NOAA Fisheries</td>
<td>UABC</td>
<td>Auburn University</td>
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<tr>
<td>UC Davis Veterinary Medicine</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Production</th>
<th>Environmental Effects</th>
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<tbody>
<tr>
<td>openblue</td>
<td>Ransel Associates Aquatic Science Consultants</td>
</tr>
<tr>
<td>OceanSpar</td>
<td>NOAA Fishery</td>
</tr>
<tr>
<td>Ocean Farm Technologies</td>
<td>California Department of Fish &amp; Wildlife</td>
</tr>
<tr>
<td>Baja Aquaculture, Inc.</td>
<td>NOAA National Ocean Service</td>
</tr>
<tr>
<td>Earth Ocean Farms</td>
<td></td>
</tr>
</tbody>
</table>
Sites Potentially Developable for Aquaculture

Almost 2K km² identified as suitable for marine farming

Classification of sites (depth, sediment/bottom characteristics, fishing conflicts)

Source:
Bren School of Environmental Science & Management, U.C. Santa Barbara
(Funded by Sea Grant)
Modeling Potential Impacts

- FARM: Fish metabolism
- Egestion: ~ 0.25 x Ingestion
- Assimilation = Ingestion x 0.75
- Growth = Assimilation - Respiration

Sea Surface
- Oxygen - Sulfides
- Advectic & Turbulent Flow

Feces
- Food Web Assimilation
- Resuspension
- Deposition

Phytoplankton
- Grazing
- Recycling

Zooplankton
- Egestion

Aerobic Respiration

Anaerobic Respiration
Aquaculture (and Science!)  
Reinvigorate the Coastal Community

With Earth’s burgeoning populations to feed, we must turn to the sea with new understanding and new technology. We must learn to farm the sea as we have farmed the land.

Capt. Jacques Cousteau

- Aquaculture **provides year-round, living wage jobs** centered in coastal and rural communities.
- Marine aquaculture operations **support working waterfronts** (docks, boat yards, and processing plants).
- We export advanced technology, feed, equipment, and other investments to producers around the world.
- **Let’s start using more of this U.S.-developed technology and expertise here**, and stop exporting jobs to other countries.

Dr. Kathryn Sullivan, NOAA Administrator  
SeaWeb Seafood Summit; New Orleans, LA; February 9, 2015
Community Involvement for the Indian River Lagoon Leads to Water Project Investments

MEGAN DAVIS, Ph.D.
INTERIM EXECUTIVE DIRECTOR

Photo courtesy of Indian River by Air
Many of the world’s largest cities are on the estuaries.
Land Connections to the Ocean

What percentage of the Earth’s land surface is connected to the ocean by rivers?

a. 35%
b. 73%
c. 87%
d. 100%
Estuaries are......

.....where rivers meet the sea

Photo courtesy of Indian River by Air
Enormous filter – most fertile ecosystems on earth

Fisheries nurseries and migration corridors

Stabilize shorelines & protect coastal areas
Historic and current flow of the Kissimmee, Okeechobee, Everglades watershed.

Graphic: U.S. Army Corps of Engineers, Jacksonville District
In the summer, 2013
“The Lost Summer”

Treasure Coast Photos

PHOTO BY ERIC HASERT

ERIC HASERT/TREASURE COAST NEWSPAPERS
The Derreenbacker family (from left) Stacey, Kyle, 9, Jenna, 14, Dave and Emily, 12, stand on their empty dock on the St. Lucie River behind their home on North Carolina Drive in Stuart.

“If you can’t go in the water, then there’s no reason to have a boat. We look at this as a lost summer,” Dave Derreenbacker said.
Community Involvement Caught the Attention of Lawmakers
RESULT: State Investment

$220+ million awarded
17 projects

• Infrastructure
• Water Quality Monitoring
• Water Studies
• Restoration
The importance of estuaries to local economies is the most effective lever for change.
Coastal Resilience - Reducing the Cost and Vulnerability for Future Storms and Flooding
Katrina 2005 $108 billion
Ike 2008 $29.5 billion
Sandy
2012
$50 billion
FEMA Disaster Declarations

Source: FEMA

Source: Federal Emergency Management Agency
National Flood Insurance Program
Losses Exceed Revenues

Source: FEMA
Highest Increases in Sea Level Rise

Source: Union of Concerned Scientists & NOAA
Spending on Disaster Recovery vs. Mitigation

<table>
<thead>
<tr>
<th>(in $ millions)</th>
<th>FY11</th>
<th>FY12</th>
<th>FY13</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disaster Recovery</td>
<td>$21,376</td>
<td>$32,412</td>
<td>$14,321</td>
<td>$68,109</td>
</tr>
<tr>
<td>Mitigation</td>
<td>$243</td>
<td>$197</td>
<td>$71</td>
<td>$510</td>
</tr>
</tbody>
</table>

Source: Center for American Progress (excludes supplemental appropriations)

$1.00 spent by FEMA on hazard mitigation provides the nation about $4.00 in future benefits.
Sandy: The Change in the Coastal Conversation
Assess
Evaluate Your Municipal Risks and Vulnerabilities

Plan
Utilize Getting to Resilience to Plan for the Future

Implement
Take Actions to Increase Municipal Preparedness
Assess

Evaluate Your Municipal Risks and Vulnerabilities

www.NJFloodMapper.org
Getting to Resilience

www.PrepareYourCommunityNJ.org

ASSESS 📚
Use the online map to visualize your community's current and future municipal hazards.

PLAN 🕐
Complete an online municipal preparedness public outreach activity for your community's future in the face of climate change.

IMPLEMENT 💡
Utilize the resilience plan to prioritize next steps in municipal actions. (http://www.prepareyourcommunitynj.org/linkages/)

www.PrepareYourCommunityNJ.org
Municipal Plans

- Master Plan
- All-Hazards Mitigation Plan
- Floodplain Management Plan
- Evacuation Plan
- Emergency Response Plan
- Continuity of Operations Plan
- Disaster Recovery Plan
- Open Space Plan
- Stormwater Management Plan
Municipal Members

- Land use Planners
- Hazard Mitigation Planners
- Floodplain Managers
- Emergency Managers
- Stormwater Managers
- Natural Resource Managers
- Municipal Engineers
- Town Administrators
- Construction Code Official
- Environmental Commissioners
- Clerks
Risk and Vulnerability Assessments
Public Engagement
Planning Integration
Disaster Preparedness and Recovery
Hazard Mitigation Implementation
Community Rating System

Hazard Mitigation Planning Actions

Municipal Certification
34 Communities have participated in “Getting to Resilience”.

New Jersey Success Stories

GTR Communities: recommendations report finalized, writing completed or in process
Brigantine: CRS Class 6 to 5
$1.00 spent to prevent damages provides the nation about $4.00 in future benefits.
Ecosystem Restoration in the Great Lakes Yields Significant Return on Investment

Alan Steinman
Annis Water Resources Institute, Grand Valley State University
Great Lakes

- ~ 90% of US surface fresh water
- ~ 35 million people reside in the Great Lakes basin
- Source of drinking water, transportation, recreation, manufacturing, aesthetics, wildlife habitat
<table>
<thead>
<tr>
<th>Improvement</th>
<th>Present Value Benefit (relative to baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased fish</td>
<td>$1.2-$6.0 billion</td>
</tr>
<tr>
<td>Reduced water pathogens</td>
<td>$2-$3 billion</td>
</tr>
<tr>
<td>Improved water clarity</td>
<td>$4.5 billion</td>
</tr>
<tr>
<td>Improved habitat: birds and waterfowl</td>
<td>$100-$300 million</td>
</tr>
<tr>
<td>Clean up AOCs</td>
<td>$12-$19 billion</td>
</tr>
<tr>
<td>Housing Values</td>
<td>$29-$41 billion</td>
</tr>
<tr>
<td><strong>Total Specific Benefits</strong></td>
<td><strong>$69-$81 billion</strong></td>
</tr>
</tbody>
</table>
Great Lakes Areas Of Concern
Muskegon Lake

- 17 km² drowned river mouth lake
- Direct connection to Lake Michigan
- Historical industrial activities caused habitat degradation
- 315 ha of nearshore habitat filled

Photo: From the Collection of the Muskegon County Museum

Present-day

Photo: Marge Beaver
- Over 16% of open water filled in
- 65% of the shoreline had been hardened
Muskegon Lake Water Quality Dashboard: 2014

Meeting Goal

Lower Phosphorus (Desirable)

Excess Phosphorus (Undesirable)

Total phosphorus concentration, $\mu$g/L

http://www.gvsu.edu/wri/director/muskegon-lake-water-quality-dashboard-78.htm
Habitat Restoration
Muskegon Lake Area of Concern
Habitat Restoration Project Partners

• $10 million project: American Recovery and Reinvestment Act (NOAA)
Muskegon Lake Habitat Restoration Project

• Restoration goals:
  – Soften ~3,050 m of hardened shoreline
  – Create or restore wetlands (11 ha)
  – Remove unnatural fill (10 ha): 135,000 yd$^3$

• Restoration design, construction, and monitoring
Before

After

Images: Kathy Evans
Monitoring

• 3 monitoring elements
  – Macrophytes
  – Fish
  – Socio-economics

• Used science to assess success and inform restoration design
Valuation of Remediation and Restoration in Muskegon L.

- Housing values
- Recreation values (CV)
- Use and non-use values
Results

• Housing value prediction: $11.9 million
• Contingent value prediction: $3.1 million
• Travel cost prediction: $6.06 million/yr
• Actual spending in Muskegon: $9.5 million
Return on Investment

Add hedonic value (real estate) to actual spending and the present value of travel cost predictions over 10 years:

$66.9 Million
($59.7 – $81.7 million)

Conservative estimate:
- No health benefits
- No effects counted outside Muskegon
- No multiplier effect
- Accounted for decreasing returns
Summary

- Created 80 jobs
- Retained 45 jobs
- Equal to 35,933 labor hours
- Economic impact: 6.6 ROI ($10 million investment resulted in $66 million)
- Enhanced civic pride