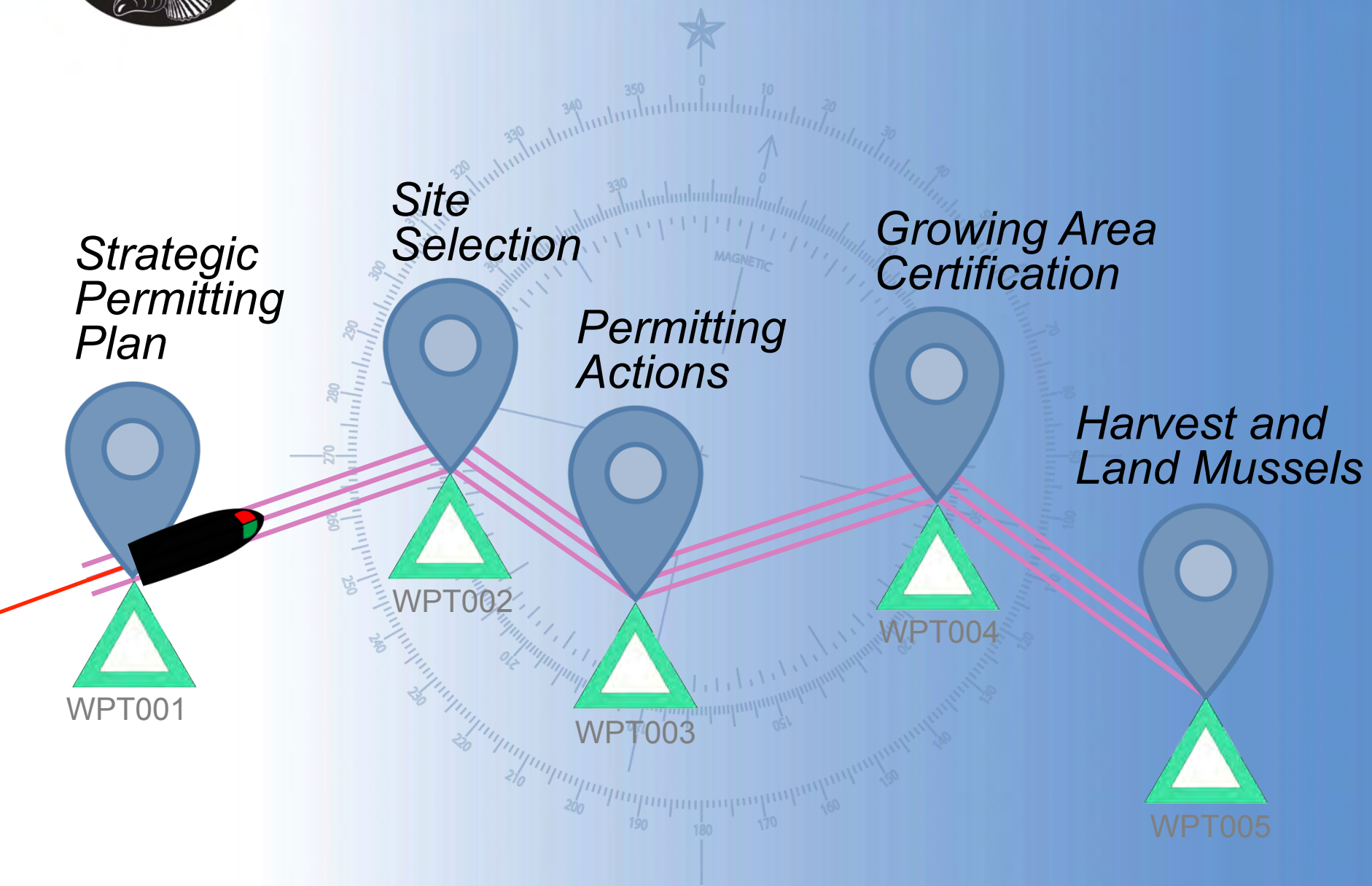

SUSTAINABLE
LOCAL
HEALTHY
VENTURA
SHELLFISH ENTERPRISE
Promoting healthy oceans with sustainable shellfish aquaculture
Aerial Photography Los Angeles

Current Project Focus

*The Ventura Shellfish Enterprise team is creating a permitting **blueprint** for offshore mussel farming operations in Ventura Harbor and other coastal California communities*

Charting a Course

Charting a Course



VSE Policy Partners

Diane Windham
Aquaculture Coordinator
NOAA Fisheries West Coast Region

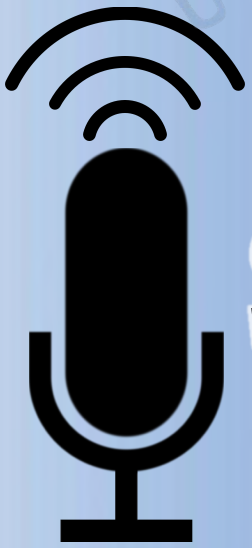
Randy Lovell
State Aquaculture Coordinator
California Department of Fish & Wildlife

Paul Olin
Aquaculture Specialist
California Sea Grant Extension Program
Scripps Institution of Oceanography/UCSD

We're Listening

Survey responses

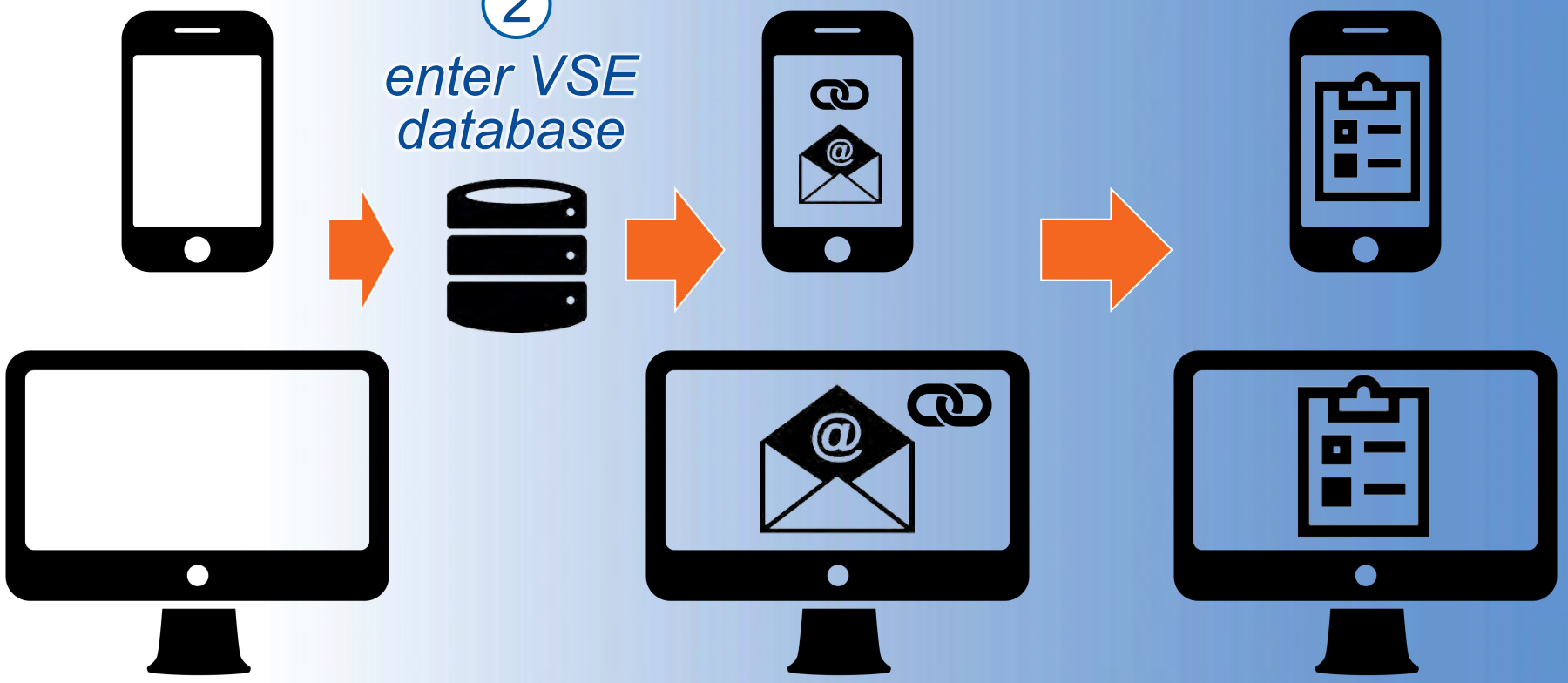
Comments from email subscribers



Q&A and feedback from workshop participants

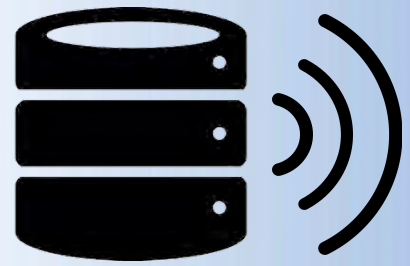
We're Listening

1. register
2. enter VSE database
3. receive email with survey link
4. complete online survey and make comments



We're Listening

VSE database



Workshop 4

Workshop 4

Environmental Effects & Best Management Practices (BMPs)

Shellfish Aquaculture and Environmental Interactions: Insights into BMPs, Siting, and Management

James Morris, Ecologist
NOAA National Ocean Service,
National Centers for Coastal Ocean Science





SHELLFISH AQUACULTURE AND ENVIRONMENTAL INTERACTIONS: INSIGHTS INTO BMPs, SITING, AND MANAGEMENT

James Morris, Jennica Hawkins, and Lisa Wickliffe

Coastal Aquaculture Siting and Sustainability Program

NOAA National Ocean Service
National Centers for Coastal Ocean Science



What's your AQUAVISION?

Aquaculture by the Numbers

Healthy Diets

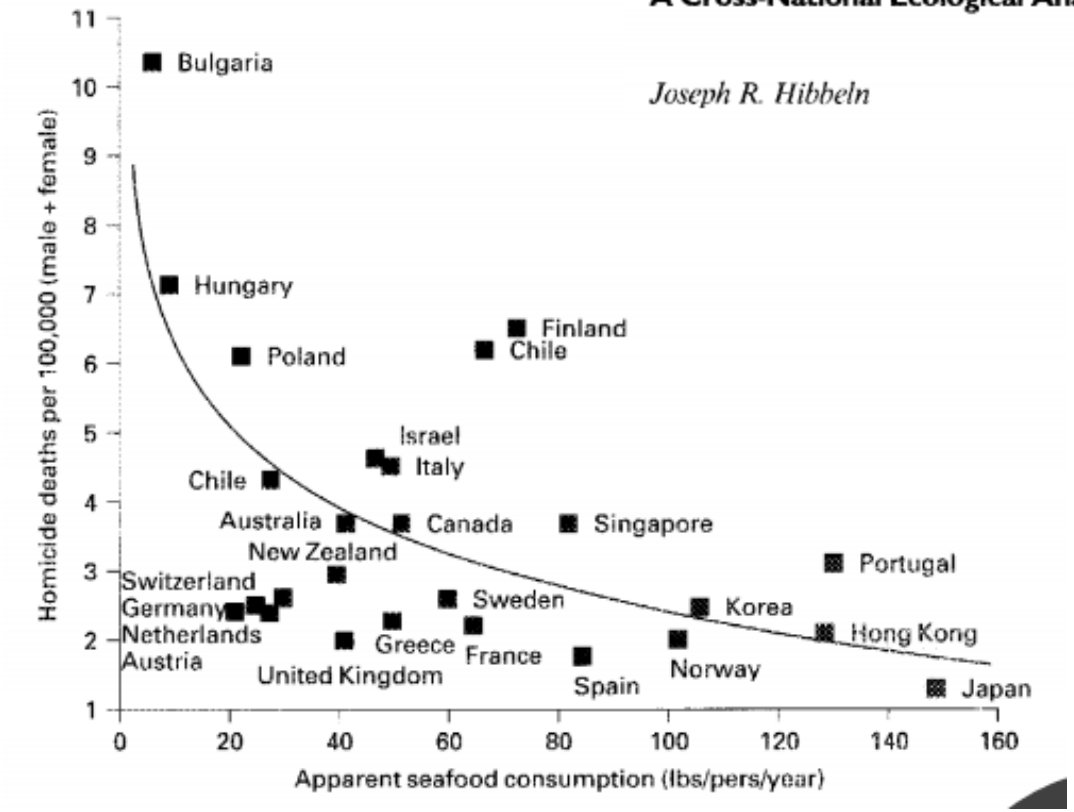
- We should consume 2 helpings of high Omega-3 food per week
- 17% reduction in death rate
- 37% reduction in cardiovascular disease
- Today, Americans consume 50% of this amount

Psychological Benefits of Seafood

Seafood Consumption and Homicide Mortality

A Cross-National Ecological Analysis

Joseph R. Hibbeln



Mussels and shellfish are brain food!

- **Brain essential nutrients (BEN) were identified by assessing assessed the literature on the treatment and prevention of depression.**
- **Key nutrients include long-chain omega 3 fatty acids, magnesium, calcium, fiber, and vitamins B1, B9, B12, D, and E.**
- **Top food sources of BEN were calculated from nutritional data of food composition from the Agricultural Research Service Nutrient Data Laboratory.**
- **A formula was used to calculate the Brain Food Scale score.**

Top 20 Brain Foods: Animals

	BFS
Oysters	51%
Clams	32%
Beef Spleen	31%
Chicken Liver	28%
Mussels	26%
Crab	24%
Poultry Giblets	23%
Octopus	22%
Fish Eggs (Caviar)	21%
Beef Kidney	20%
Seal	19%
Caribou	18%
Cuttlefish	18%
Whale	17%
Bluefin Tuna	17%
Rainbow Trout (wild)	17%
Bluefish	17%
Elk	16%
Smelts	16%
Herring	15%

BFS *Brain Food Score, Mean % daily value of brain essential nutrients / 100 calories **Drew Ramsey, J Hibbeln et al, ISNPR draft**

Dietary intake of n-3, n-6 fatty acids and fish: Relationship with hostility in young adults—the CARDIA study

C Iribarren[1]*, JH Markovitz[2,*], DR Jacobs Jr[3], PJ Schreiner[3], M Daviglus[4] and JR Hibbeln[5]

Reduction in behavior problems with omega-3 supplementation in children aged 8–16 years: a randomized, double-blind, placebo-controlled, stratified, parallel-group trial

Adrian Raine,[1] Jill Portnoy,[1] Jianghong Liu,[2] Tashneem Mahoomed,[3] and Joseph R. Hibbeln[4]

The effect of omega-3 fatty acids on aggression: A meta-analysis

Jamie M. Gajos[a,*], Kevin M. Beaver[a,b]

Associations between increases in plasma n-3 polyunsaturated fatty acids following supplementation and decreases in anger and anxiety in substance abusers

Laure Buydens-Branchey[a,*], Marc Branchey[a], Joseph R. Hibbeln[b]

NOAA's Aquaculture Goals

Competitive aquaculture businesses

Healthy aquatic environments

Aquaculture valued by the public

NOAA Aquaculture Strategic Plan 2012

Ross wants to eliminate seafood trade deficit

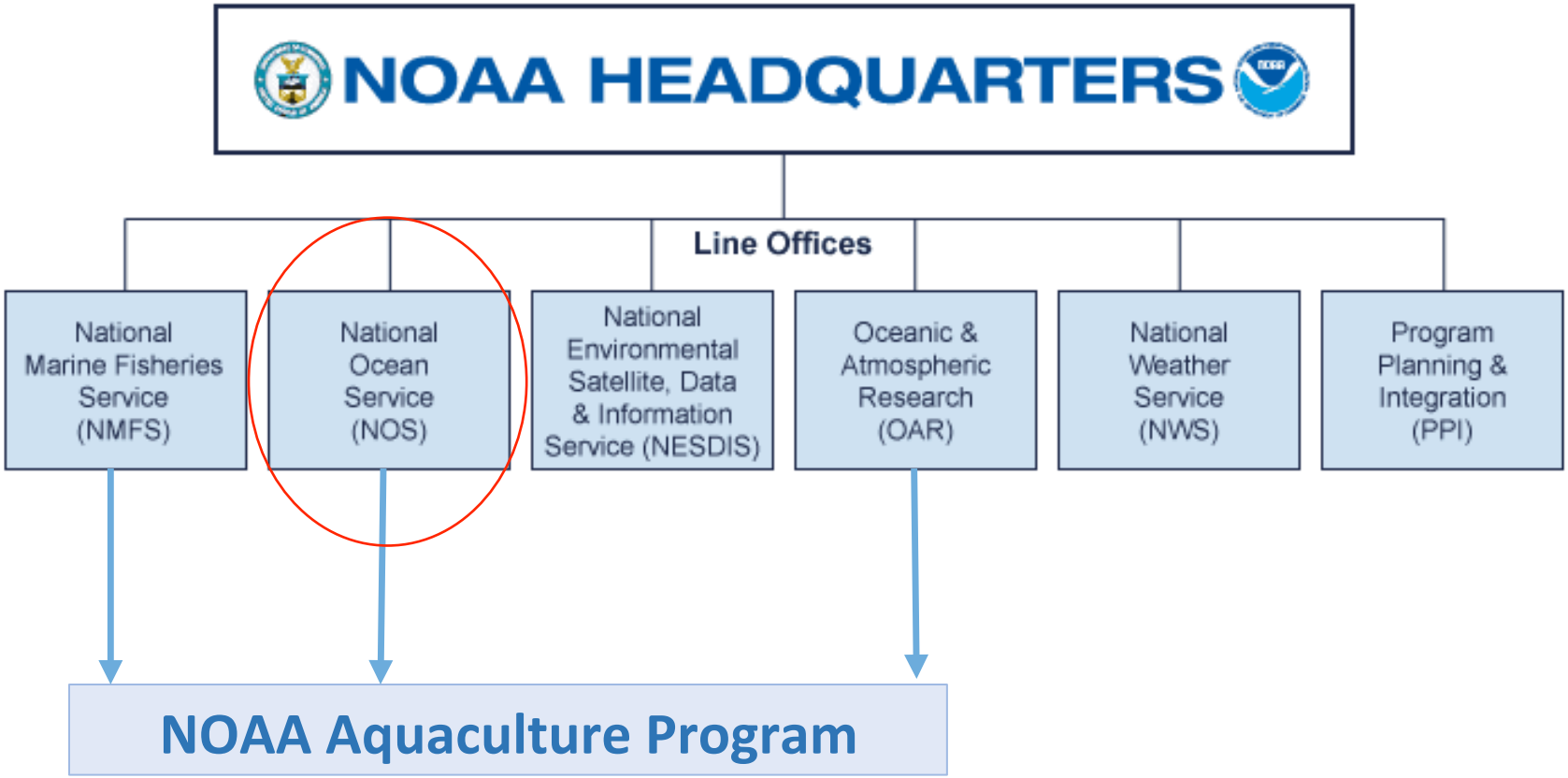
Emily Yehle, E&E News reporter

E&E Daily: Thursday, January 19, 2017

Wilbur Ross, President-elect Donald Trump's pick to lead the Commerce Department, at his confirmation hearing yesterday. Photo courtesy of C-SPAN.

Ross' side project: Make America first on seafood

By **MEGAN CASSELLA** | 02/27/17 10:06 AM EST


NOAA HEADQUARTERS
Line Offices
National Marine Fisheries Service (NMFS)
National Ocean Service (NOS)
National Environmental Satellite, Data & Information Service (NESDIS)
Oceanic & Atmospheric Research (OAR)
National Weather Service (NWS)
Program Planning & Integration (PPI)
NOAA Aquaculture Program

Coastal Aquaculture Siting and Sustainability

Our Mission

We develop decision support tools enabling *coastal managers* to safeguard the environment while supporting aquaculture development in the coastal zone.

Our Focus Areas

Environmental Interactions
Coastal Planning and Siting
Ecosystem Services

NCCOS Aquaculture Team Members

Dr. James Morris,
Marine ecologist

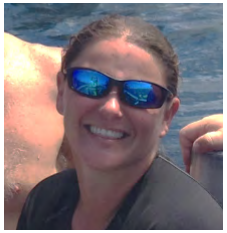
Dr. Lisa Wickliffe
JHT Biologist

Barry King, P.E.,
JHT Engineer/Modeler

Najat El Moutchou, Univ.
Abdelmalek Essadi,
JHT Biologist

Gary Fisher
Biological Tech

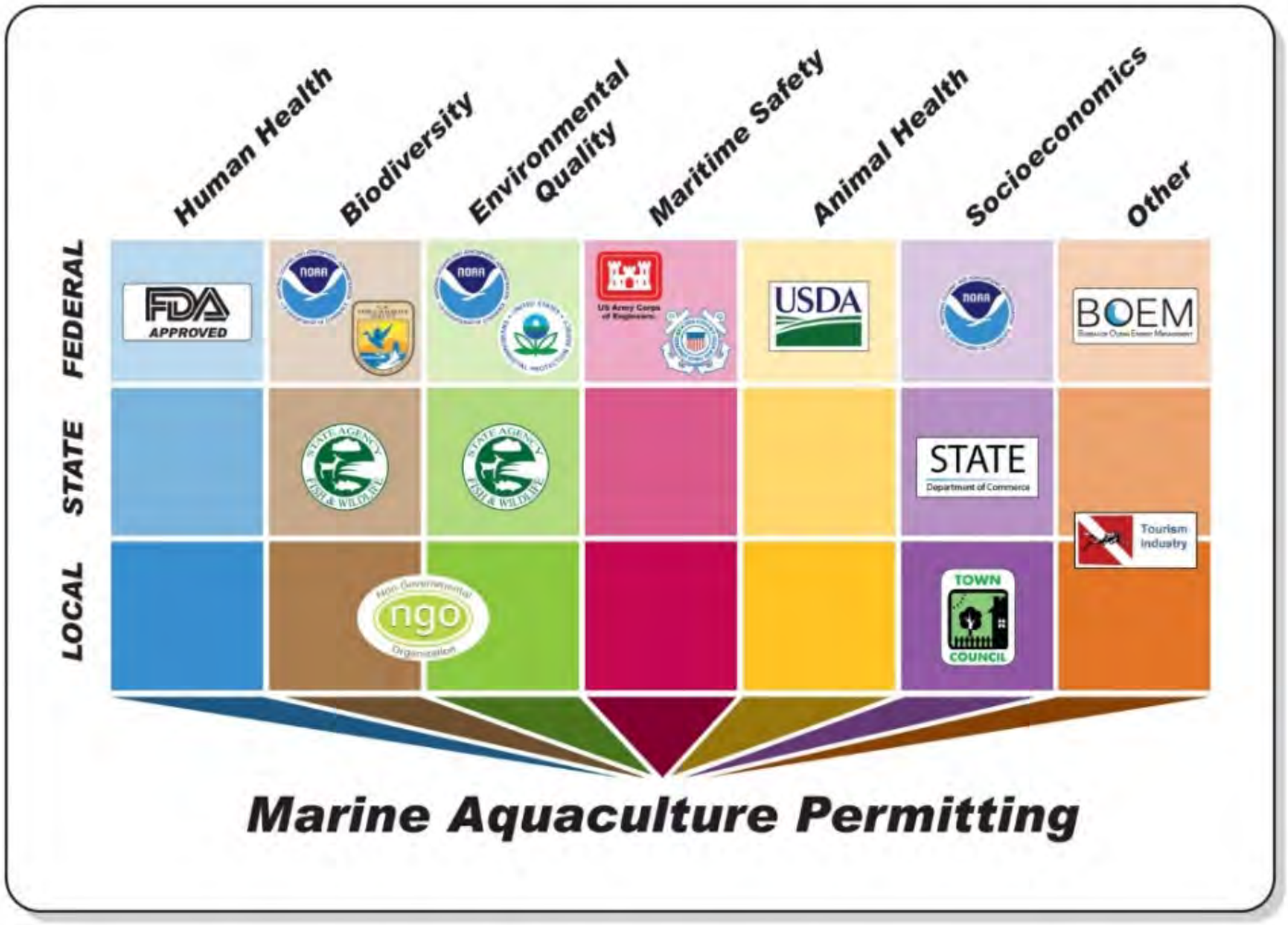
Troy Rezek,
JHT Biologist



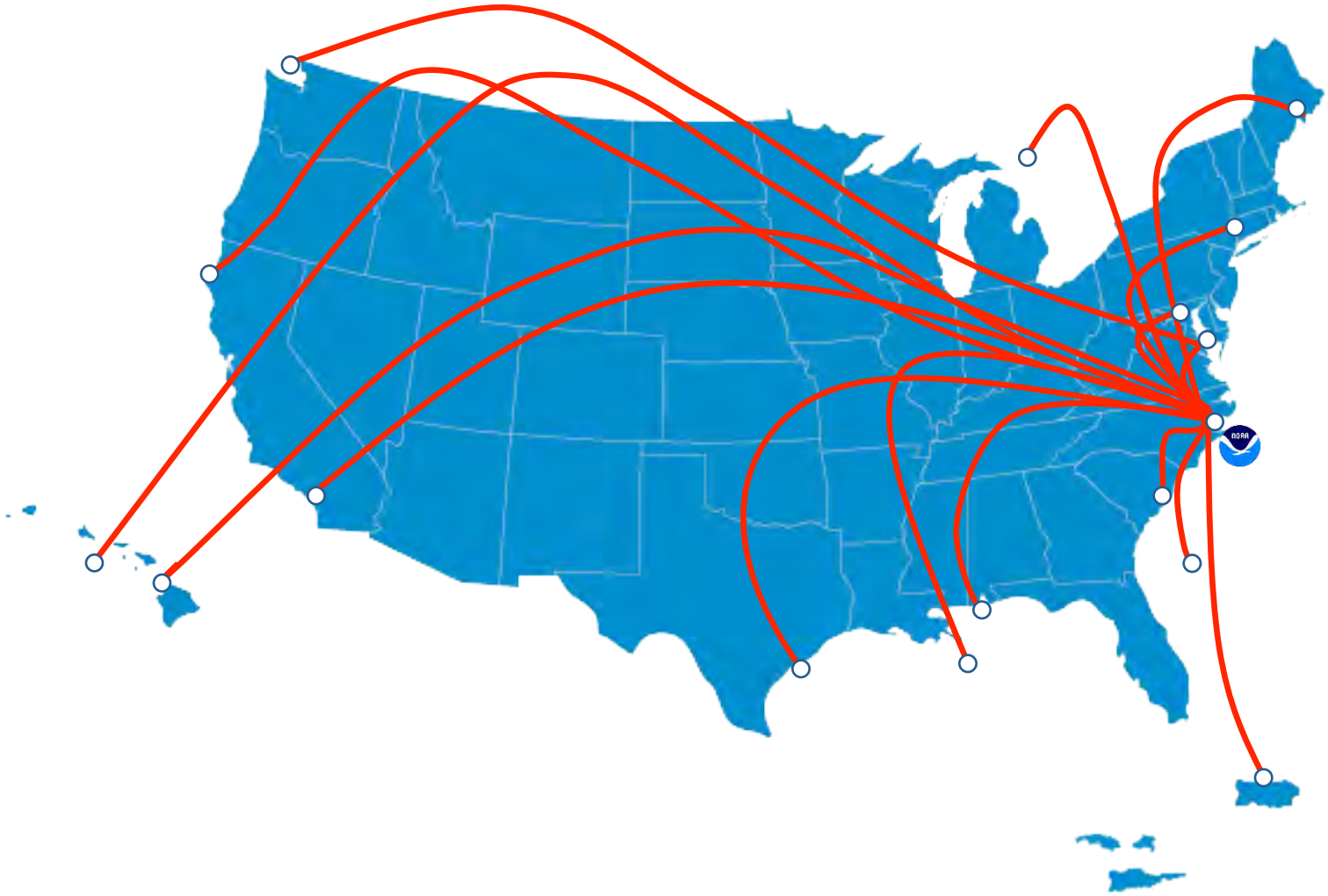
Jennica Hawkins
JHT Biologist

Consultants: Dr. Jud Kenworthy, Skip Kemp, Dr. Chris Voss, and James Hibbert

Our customers….



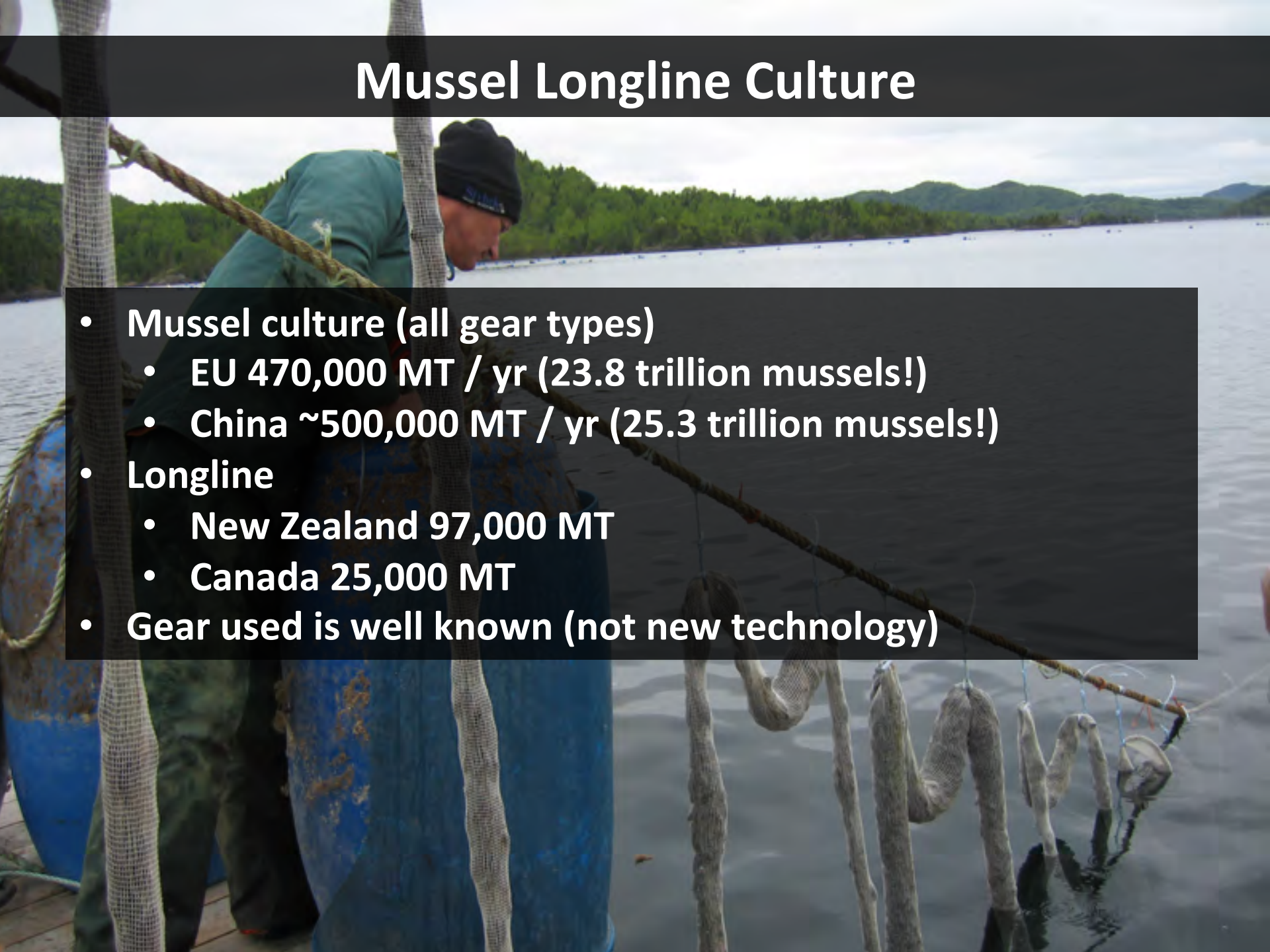
We work nationally…



Hot AquaHappenings in the U.S.

- Booming shellfish aquaculture industries
- Pacific Islands Programmatic EIS
- SAV and shellfish aquaculture assessment
- Gulf of Mexico Fishery Management Plan for Aquaculture
- California offshore aquaculture
- Ports are investing
- Offshore macroalgae aquaculture for biofuel

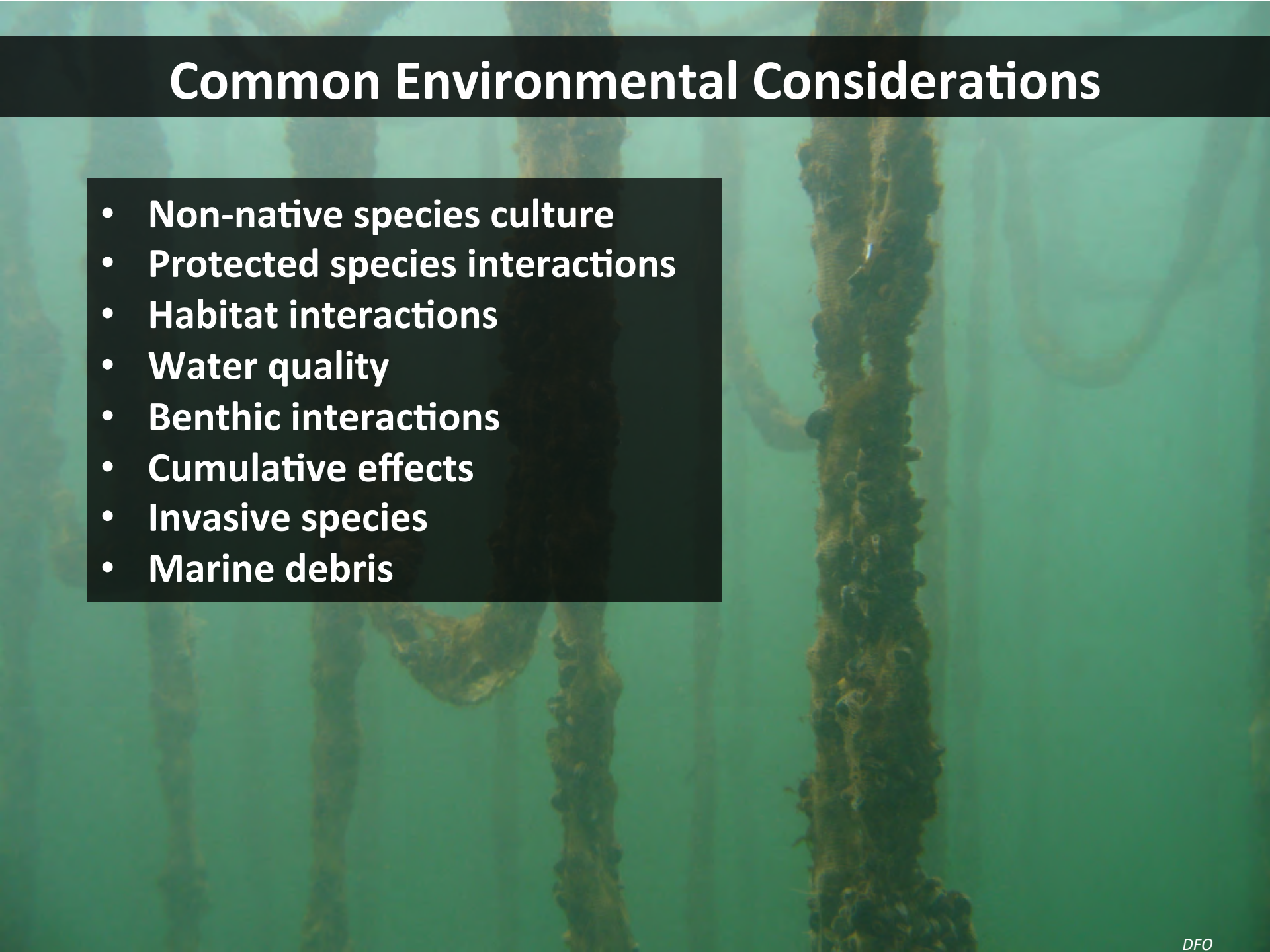
Mussel Longline Culture



- Mussel culture (all gear types)
  - EU 470,000 MT / yr (23.8 trillion mussels!)
  - China ~500,000 MT / yr (25.3 trillion mussels!)
- Longline
  - New Zealand 97,000 MT
  - Canada 25,000 MT
- Gear used is well known (not new technology)

Common Environmental Considerations

- Non-native species culture
- Protected species interactions
- Habitat interactions
- Water quality
- Benthic interactions
- Cumulative effects
- Invasive species
- Marine debris



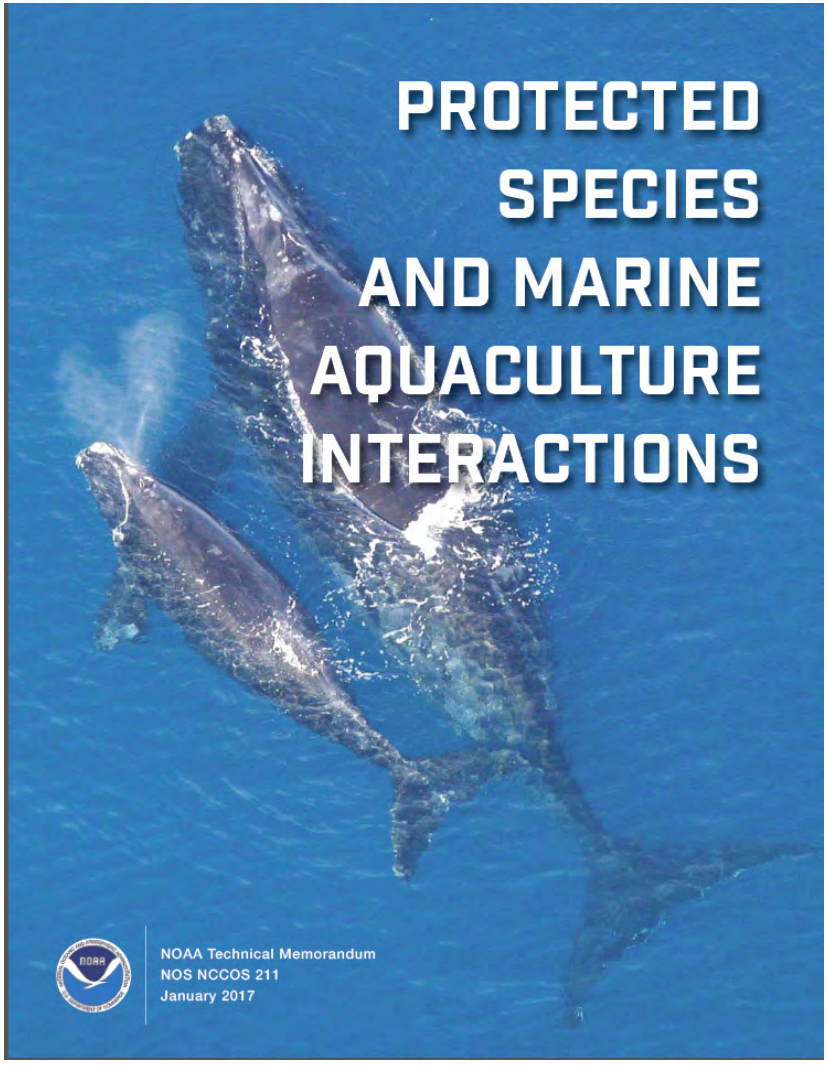
DFO

Non-native species culture

- Non-native species culture has led to introductions
- When non-native species is naturalized, aquaculture is typically allowed
- Med mussel is naturalized
- If aquaculture increases abundance of naturalized non-native, is this a problem?

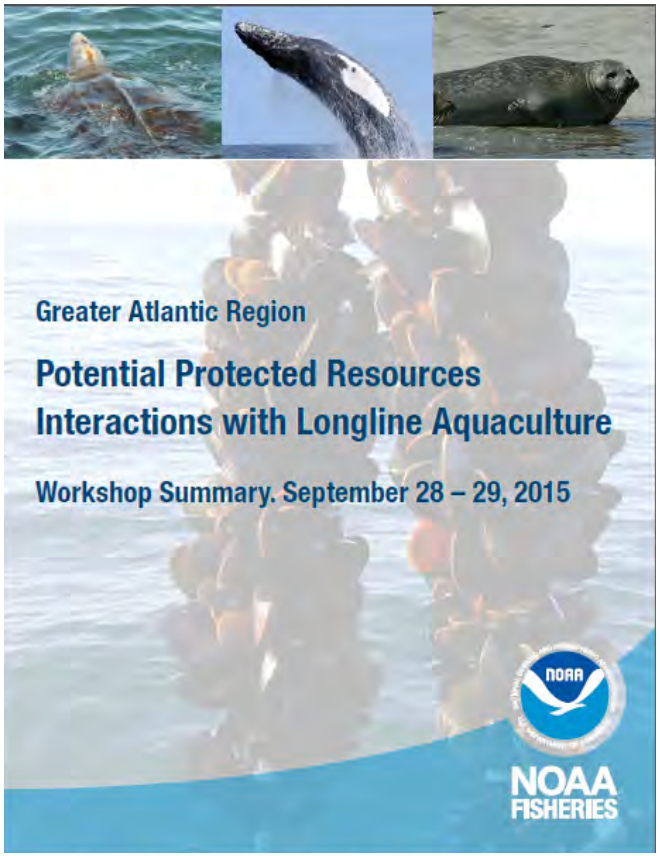
Albany Mussels, AU

Protected Species Interactions



Available at: http://venturashellfish.org/pdf/2017_Protected_Species_and_Marine_Aquaculture_Interactions.pdf

Workshop Report



Available at: https://www.greateratlantic.fisheries.noaa.gov/stories/2016/july/06_longline_aquaculture_workshop_summary.html

Assessment Includes

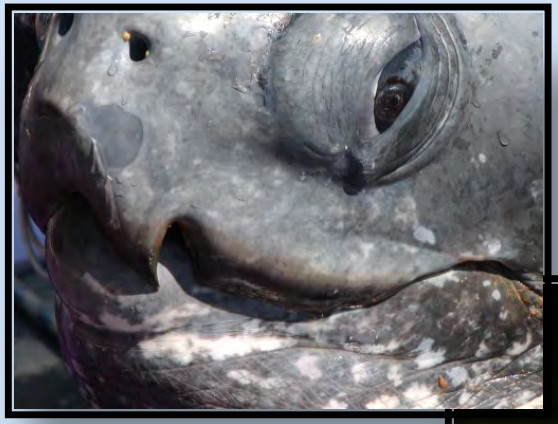
ESA-PROTECTED WHALES

North Atlantic Right
Humpback
Blue
Fin
Sei
Sperm

Assessment Includes

SEA TURTLES

Green
Hawksbill
Kemp's Ridley
Loggerhead
Leatherback

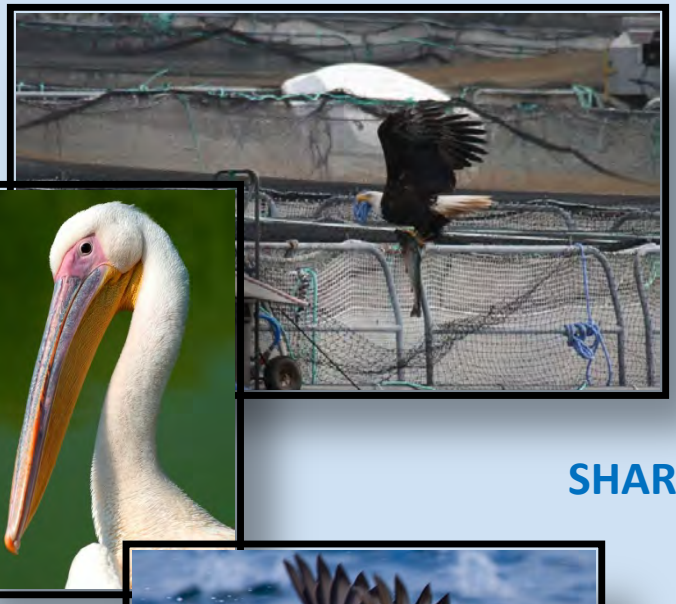


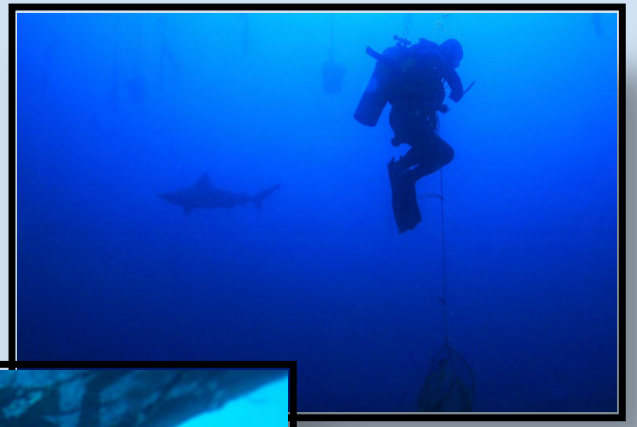
Assessment Includes

OTHER MARINE MAMMALS

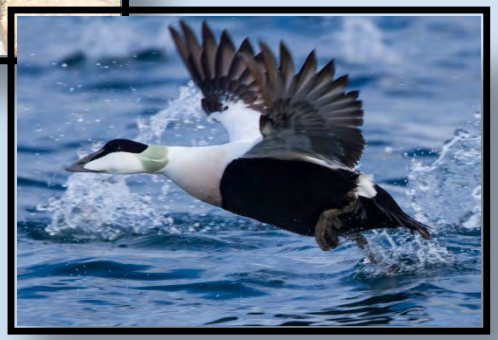
Dolphins
Porpoises
Seals
Sea Lions

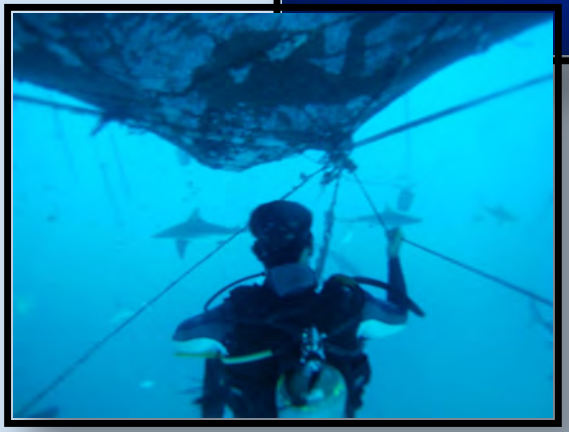
Assessment Includes





SHARKS & SEABIRDS





Assessment Includes

NOT INCLUDED

Atlantic Salmon
Atlantic Sturgeon
Shortnose Sturgeon

Assessment Outline

- Executive summary
- Introduction (background, regulations, methods)
- Protected species and mussel longlines
- Lessons learned from fisheries gear
  - Risk assessment, knowledge gaps and BMPs

Global cases of protected species interactions with aquaculture gear documented in this assessment.

Location	Species	Year	Gear Type	Outcome	Citation
Australia	Humpback Whale (calf)	2005	Mussel crop line	Released	Clement 2013
	Humpback Whale	1982 - 2010	Mussel (Possibly the same as reported by Clement 2013)	Unknown	Groom & Coughran 2012
	Humpback Whale		Abalone	Unknown	
	3 Humpback Whales		Pearl	Unknown	
New Zealand	Bryde's Whale	1996	Spat Line	Fatal	Lloyd 2003 Clement 2013
	Bryde's Whale	Unknown	Unknown	Unknown	Lloyd 2003 Clement 2013
South Korea	North Pacific Right Whale	2015	Mussel farm	Released	IWC 2015
Argentina	Southern Right Whale	2011	Unconfirmed aquaculture gear	Unknown	Bellazzi et al. 2012
Iceland	Humpback Whale (juvenile)	2010	Spat line	Fatal	Young 2015
	Harbor Porpoise	1998	Spat line	Fatal	Young 2015
North Atlantic Ocean	North Atlantic Right Whale	Unknown	Unspecified aquaculture	Unknown	Johnson 2005
California, USA (unconfirmed)	Grey Whale	Unknown	Unknown	Unknown	Lloyd 2003
Canada	Humpback Whale	2013	Fish Farm	Fatal	DFO Canada
	Leatherback Sea Turtle	2009	Mussel Farm	Fatal	Ledwell & Huntington 2010
	Leatherback Sea Turtle	2010	Spat line	Fatal	Scott Lindell
	Leatherback Sea Turtle	2013	Spat line	Released	Scott Lindell
	Humpback Whale	2016	Fish Farm	Fatal	Canada DFO

1982 - 2016

19 Interactions of Marine Mammals or Sea Turtles with Marine Aquaculture

Non-fatal Effects

- Ecological
  - Habitat Exclusion
  - Feeding Ecology
  - Population Dynamics
  - Behavioral Changes
- Injury
- Vessel Strike
- Marine Debris
- Positive and Negative

Habitat Interactions

- Habitats impacted are from bottom to surface
- Benthic biogeochemistry
- Water quality
- Foraging of protected species
- Gear can become habitat
- Protected species colonization of gear

Benthic Interactions

- **Shellfish farms can have benthic interactions**
- **Shellfish farm emissions include organics and shell primarily from the shellfish and fouling**
- **Important to site with adequate current to reduce pile up**
- **What is an impact? Some deposition may not be an impact**

What changes?

- Local infaunal community shifts from echinoderms/mollusks to polychaetes/ amphipods

- Biodeposits, zooplankton density, secondary production change (fish, crabs), etc.

Water Quality Interactions

- Shellfish farms can improve water quality
- But, sometimes shellfish can remove too much phytoplankton causing habitat concerns
- Likely not the case for offshore…?
- Other emissions (ammonia, nitrogen, phosphorus)
- Breakdown of feces, pseudofeces and epiphytes leading to increased levels of nitrogen and phosphorus

Cumulative ecosystem effects

- Cumulative effects is a growing concern
- Shellfish farms in estuaries can become concentrated
- How much is too much aquaculture?
- Water quality, entanglement, resource allocation, animal health (disease)
- Answers will come from observations and modeling
- We can learn a lot about this from other countries
- Knowing when cumulative effects can become a concern gives confidence to grow

Invasive Species

- Aquaculture gear provides habitat for fouling organisms
- Invasives can recruit (especially if they are opportunists)
- *Didemnum* sp. may be a local concern
- Fragmentation of *Didemnum* sp. presents a challenge

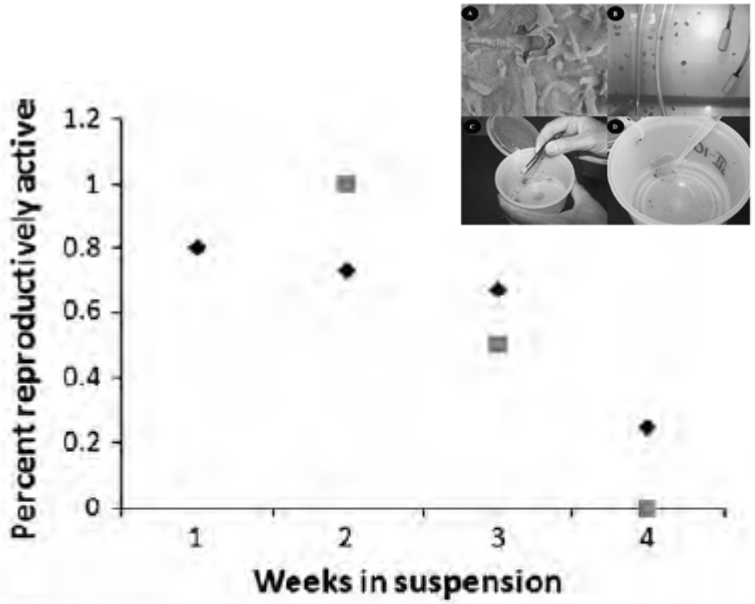
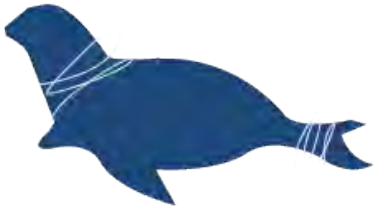


Fig. 2 Percent of reproductively active formerly suspended (*diamonds*) and control (*squares*) *D. vexillum* fragments as defined by the presence of larvae or eggs. Note that eggs and larvae were most often found in new growth regions

IMPACTS OF MARINE DEBRIS

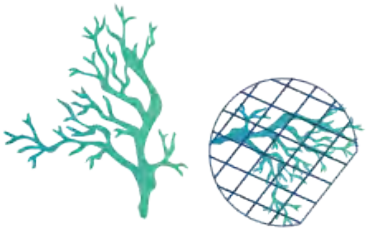
INGESTION

Animals mistakenly eat plastic and other debris.



ENTANGLEMENT & GHOSTFISHING

Marine life gets caught and killed in ghost nets, trapped in derelict gear, and entangled in plastic bands and other marine debris.



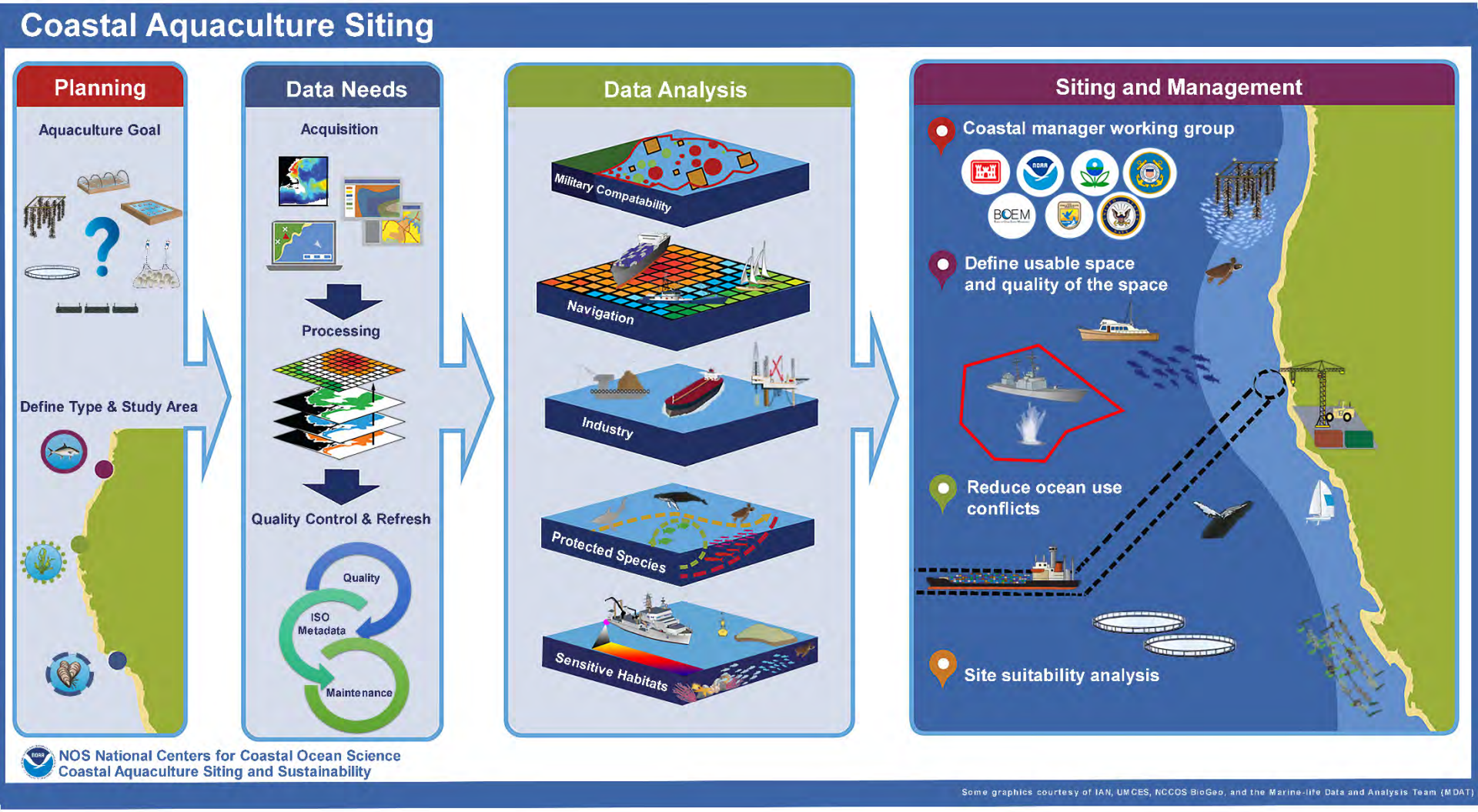
HABITAT DAMAGE

Heavy marine debris crushes sensitive habitat, such as coral reefs and sea grass.

NON-NATIVE SPECIES

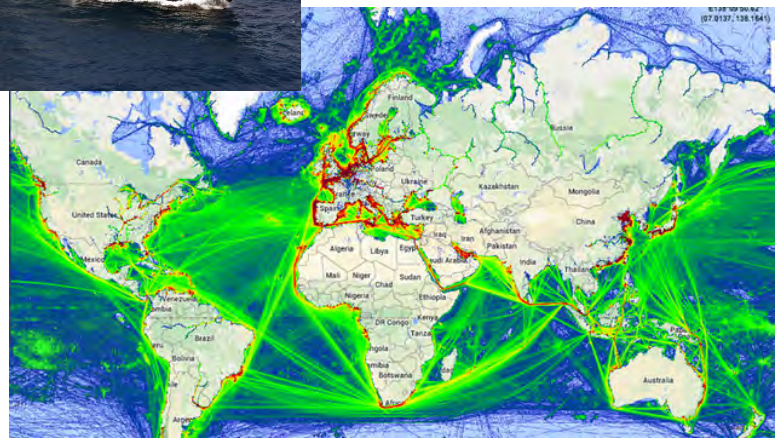
Marine debris transports alien and invasive species from one region to another.

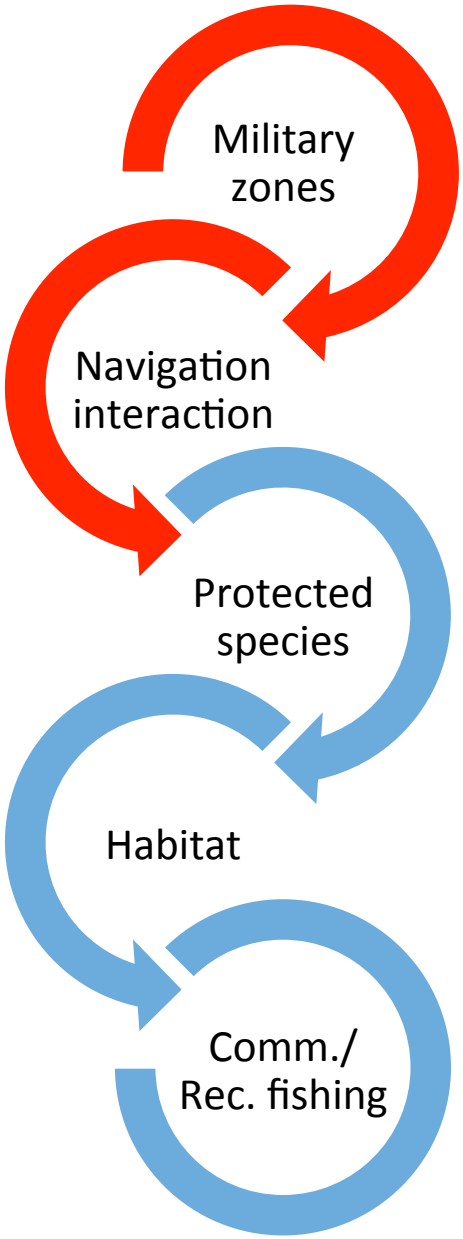
Aquaculture siting process and resources



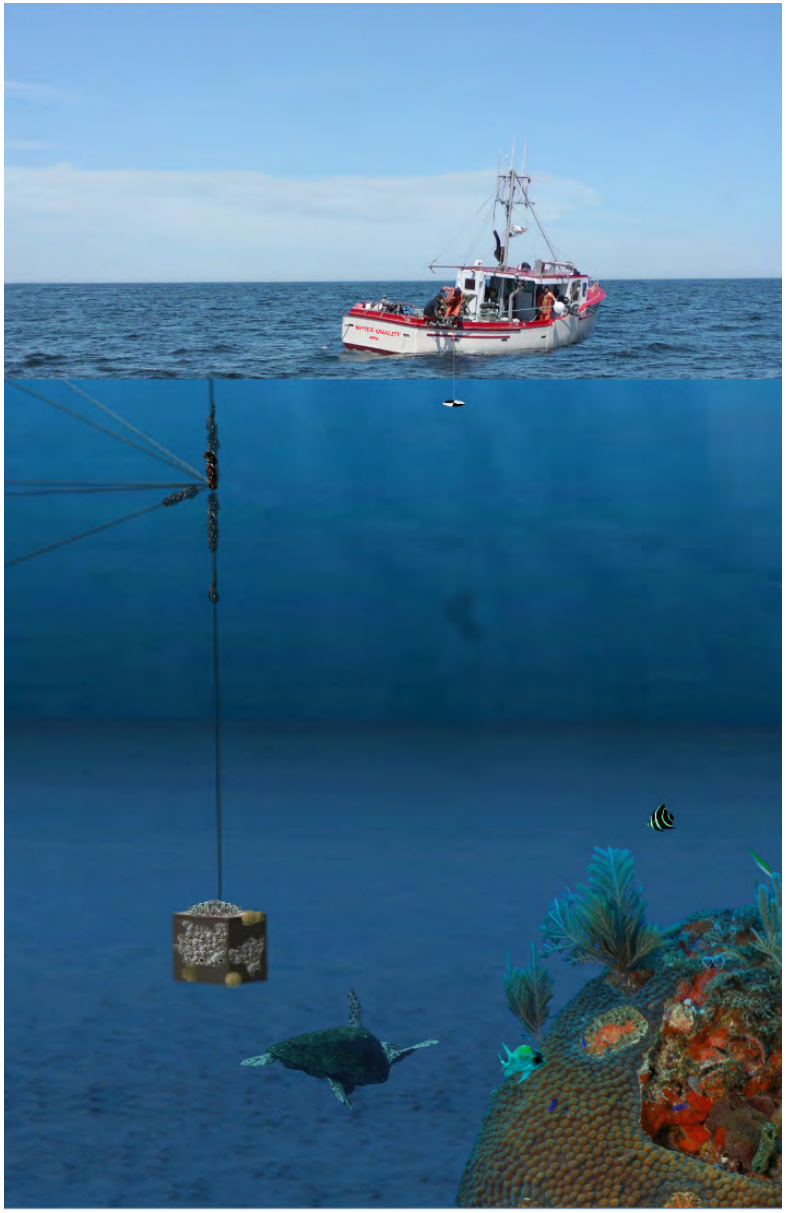
Primary Screening Parameters

Military zones and navigation interference are more difficult because they can't be mitigated



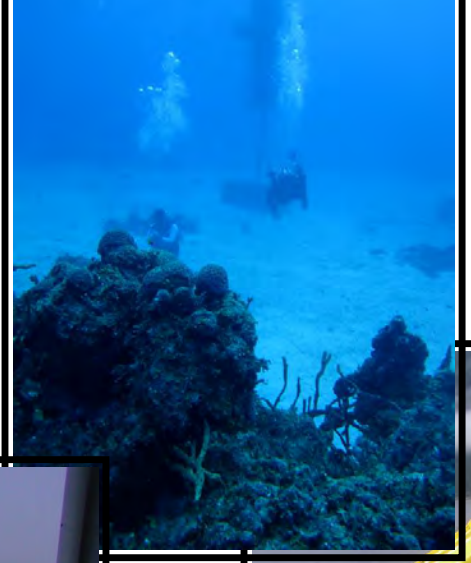


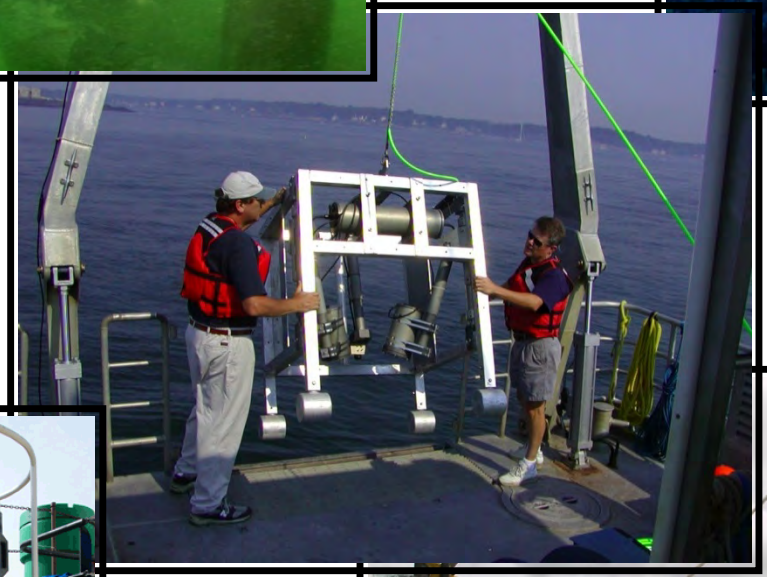
Monitoring plans

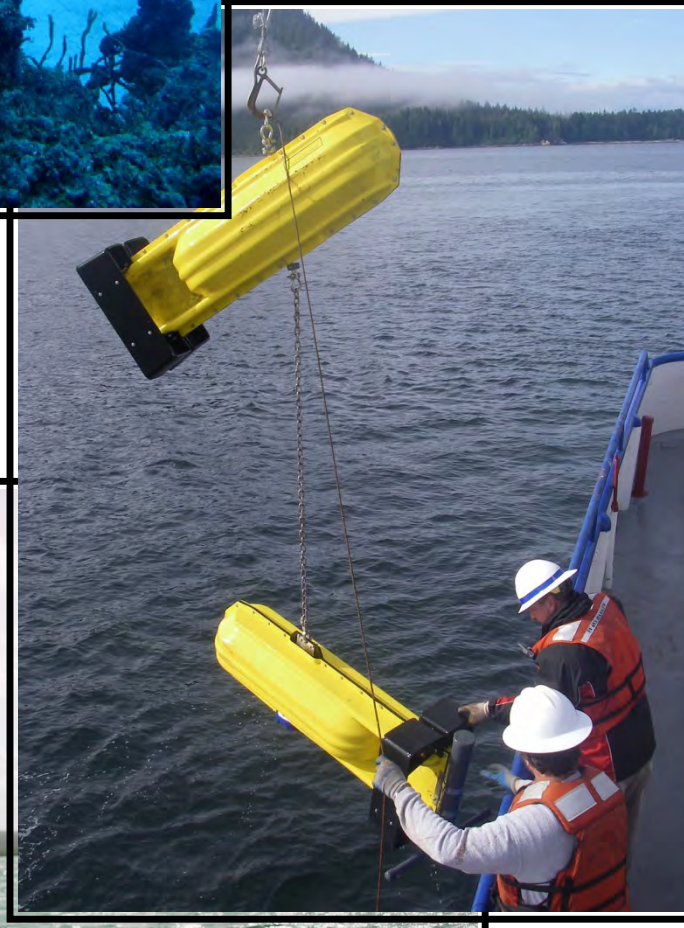


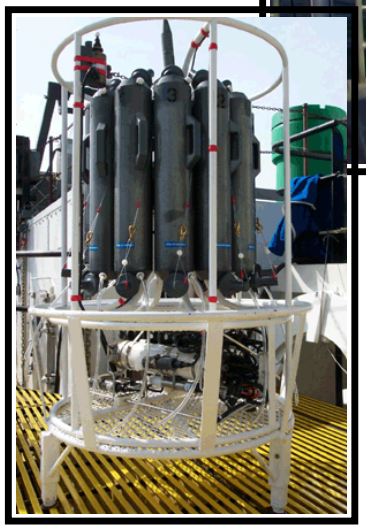
Monitoring best practices

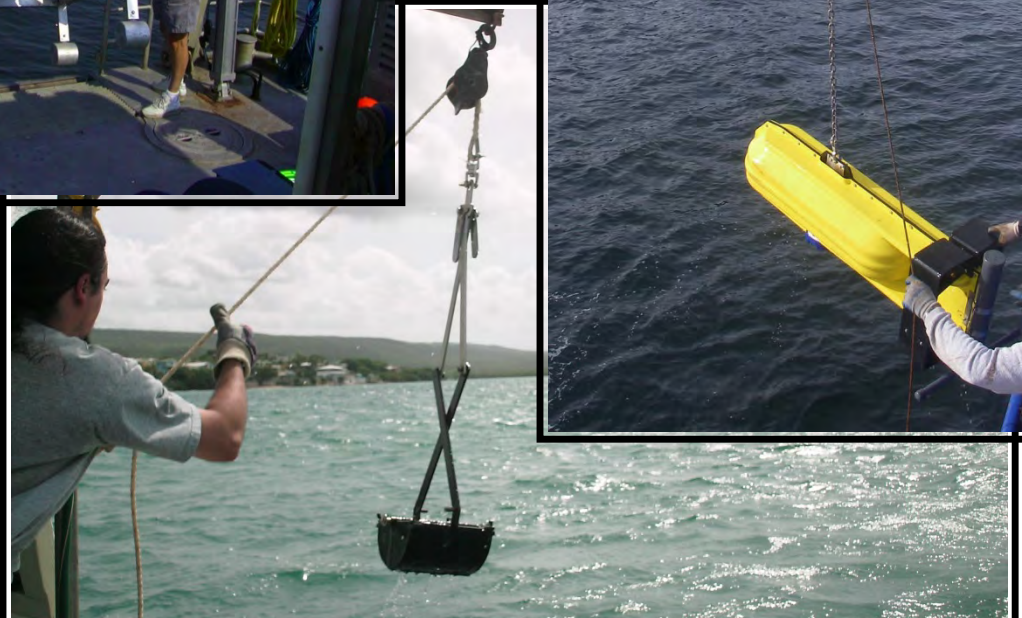
- **Monitoring plans build confidence**
- **Negative data is important**
- **Monitoring doesn't have to be costly**
- **Managers work with industry**
- **High monitoring requirement for new projects**
- **More experience results in less monitoring**
- **Local/regional specificity (larval monitoring)**











Environmental Monitoring

- Physical factors
  - Bathymetry (depth profile)
  - Bottom type (preferred sandy)
  - Coastal topography
  - Wind velocity/direction/fetch
  - Currents and tides
  - Wave height
  - Air and water temperature
  - Turbidity

- Chemical factors
  - Total suspended solids
  - Ammonia
  - Nitrite
  - Nitrate
  - Phosphate
  - Dissolved oxygen
  - Organic matter
  - Nitrogen

- Biological factors
  - Fouling
  - Chlorophyll
  - Productivity
  - Harmful Algal Blooms
  - Assemblage
  - Benthic studies

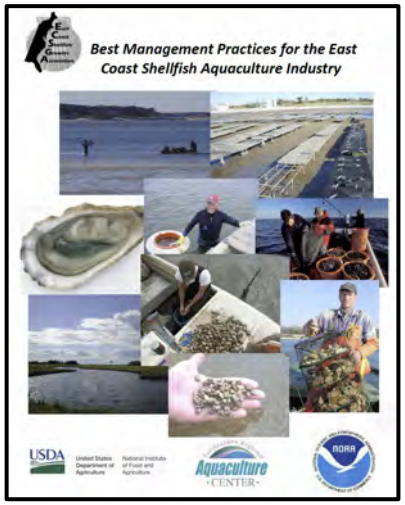
- Human dimensions
  - Acceptance of project
  - Local communities
  - Partnership with fishermen

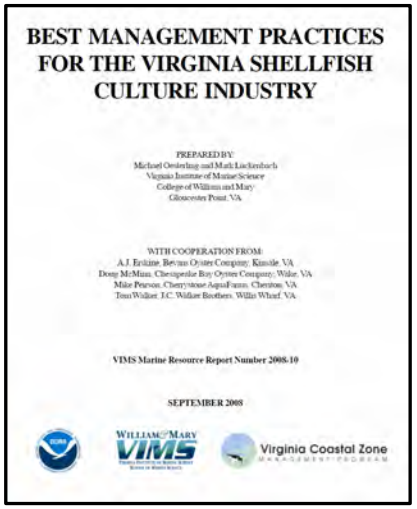
Adaptive management

- Adaptive management is necessary
- Adaptation is required by both industry and managers
- Some adapting likely to happen include:
  - Farming practices
  - Monitoring approaches
  - Environmental change
  - Farm ownership perspectives
  - Coastal manager turnover and perspective changes

Shellfish Aquaculture BMPs

- Florida
- Massachusetts
- Maine
- Virginia
- East Coast Shellfish Growers Association




BEST MANAGEMENT PRACTICES FOR THE VIRGINIA SHELLFISH CULTURE INDUSTRY

PREPARED BY:
Michael Oesterling and Mark Luckenbach
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA

WITH COOPERATION FROM:
A.J. Erikins, Bevans Oyster Company, Kinsale, VA
Doug McMinn, Chesapeake Bay Oysters Company, Wake, VA
Mike Pierson, Cherrystone AquaFarms, Cheriton, VA
Tom Walker, J.C. Walker Brothers, Willis Wharf, VA

VIMS Marine Resource Report Number 2008-10

SEPTEMBER 2008

William & Mary VIMS
Virginia Coastal Zone


Best Management Practices for the Shellfish Culture Industry in Southeastern Massachusetts

(Version 09-04a)

Developed by:
Massachusetts shellfish growers
in collaboration with
the Southeastern Massachusetts Aquaculture Center
with support provided by the Massachusetts
Department of Agricultural Resources and the
USDA Risk Management Agency

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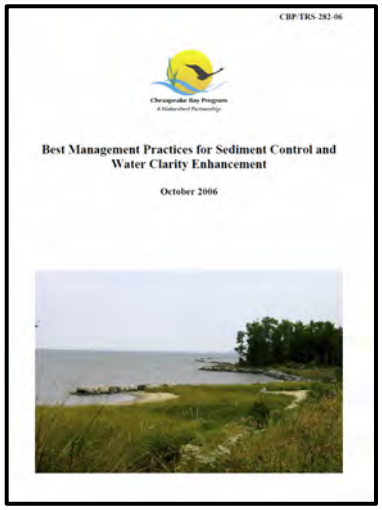
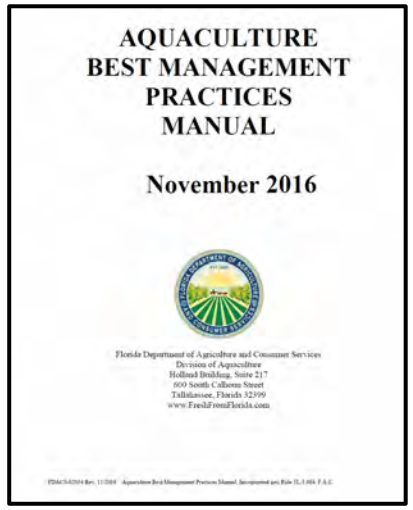
SEMAC


CBP/TRS-282-06

Chesapeake Bay Program
A Watershed Partnership

Best Management Practices for Sediment Control and Water Clarity Enhancement

October 2006


AQUACULTURE BEST MANAGEMENT PRACTICES MANUAL

November 2016

Florida Department of Agriculture and Consumer Services
Division of Aquaculture
Holland Building, Suite 217
600 South Calhoun Street
Tallahassee, Florida 32399
www.FreshFromFlorida.com

What's in BMPs?

Intro, permitting, stewardship, siting

- Introduction to shellfish aquaculture
- Permitting overview
  - Federal, State and local regulations
- Environmental Stewardship
  - Shared resources
  - Good neighbor policy
- Siting
  - Understanding required environmental conditions
  - Conflicting uses
  - Sensitive habitats
  - Marking the site

Image credit: Louise Murray/Getty

Operations and Maintenance

- **Operations and Maintenance**
  - **Layout and placement of gear**
  - **Gear cleaning and maintenance**
  - **Hours of operation**
  - **Equipment marking**
  - **Operating hours**
  - **Harvesting**
  - **Site access and transportation**

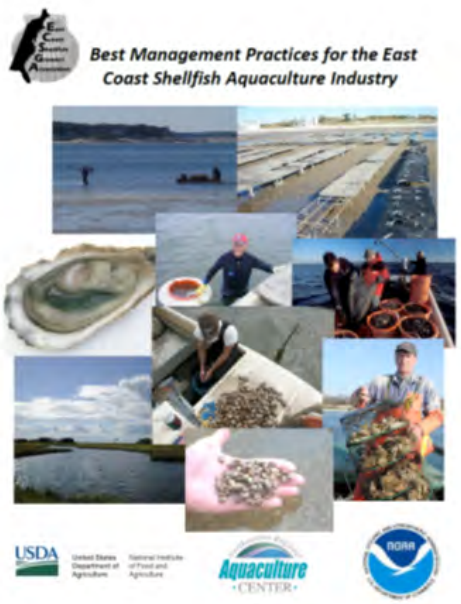
Image credit: New Zealand Geographic

Seed, animal health, human health, records…

- Seed Source
  - Genetics
  - Disease
- Animal Health Management
  - Disease free sources
  - Predator control
- Human Health, National Shellfish Sanitation Program
- Record Keeping
  - # years required to maintain records

Image credit: New Zealand Geographic

Examples of specific BMPs



BMPs

- Choose sites that provide the appropriate biological and physical factors for the species and gear chosen for culture.
- Choose sites from which harvest is allowed; factor in future water quality at the site.
- Choose sites with no SAV in the general vicinity.
- Choose sites away from navigational channels and ones that do not impede public access.
- Choose sites where adverse effects from gear or gear maintenance will be minimal.
- Attend scoping sessions, if offered, early in the permitting process and educate other stakeholders about your operation.
- Be a good neighbor.

BMPs

- Follow regulations regarding marking.
- If using stakes, ensure that they are visible and can be seen by other boaters.
- Replace broken stakes immediately to ensure that passing boats will not be damaged.
- Use appropriate buoy colors for the situation – dark colors near shore and brighter colors that may be appropriate further offshore.

Other Resources

- **Certification Programs**
  - **Aquaculture Stewardship Council Bivalve Standards**
  - **Best Aquaculture Practices (Global Aquaculture Alliance)**
    - **Mussel Standards**

- **Pacific Shellfish Growers Environmental Policy**

- **State Shellfish Initiatives**


CALIFORNIA SHELLFISH INITIATIVE

CALIFORNIA SHELLFISH INITIATIVE

A Strategy to Enhance the Marine Environment and Economy of Key Coastal Communities

INTRODUCTION

A POSITION PAPER OF THE PACIFIC COAST SHELLFISH GROWERS ASSOCIATION

Coastal Aquaculture Planning Portal (CAPP)

New!

A Toolbox for Sustainable Aquaculture Coastal Planning and Siting

The Coastal Aquaculture Planning Portal (CAPP) is a toolbox of coastal planning tools designed to assist managers, planners, and industry with sustainable aquaculture development. This toolbox was developed in partnership with Digital Coast, a product of the *NOAA* National Ocean Service Office of Coastal Management.

Choose one of the subportals below.

~40 aquaculture tools!

EPA's National Stormwater Calculator

A desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States (including Puerto Rico). Estimates are based on local soil conditions, land cover, and historic rainfall records.

Aquaculture application:
This map will allow shellfish farmers to analyze local rainwater runoff in their area in efforts to site shellfish leases with a decreased risk of closure after heavy rain events.

Contributing Partners: EPA

Essential Fish Habitat Mapper

Display essential fish habitat boundaries and associated areas protected from fishing.

Aquaculture application:
Identify potential species interactions with aquaculture siting.

Contributing Partners: NOAA Office of Habitat Conservation


What's on our horizon?
Grow here and sell there?
Questions/discussion