



# Status of marine and coastal ecosystem-based management among the network of U.S. federal programs

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# Background



- Increased use of and pressure on natural marine resources
- Influence of human activities and their impacts to marine ecosystems condition and services
- Shortcomings of conventional (single user sector or single species) approaches to management

(Costanza et al. 1997; Jackson et al. 2001; Halpern et al. 2008)



# Ecosystem-based management



- Integrates across multiple sectors
- Considers the entire ecosystem, including humans

GOAL: collectively manage natural resources, habitat, and species in a sustainable manner while maintaining ecosystem services to humans on the long-term

(McLeod et al. 2005; Arkema et al. 2006; McLeod & Leslie 2009)

# Ecosystem-based management

## Key elements:

- Informed by science
- Connections and linkages between and within ecosystems as well as with social and economic systems
- Cumulative impacts of multiple activities
- Adaptive management strategies
- Multiple objectives among services or sectors
- Trade-off evaluations

Dynamic, adaptive, and iterative management approach that changes based on the spatial scale of the natural resource managed

(McLeod et al. 2005; 2009; McLeod & Leslie 2009; Link 2010)



# Ecosystem-based management

- Broad interest in applying marine and coastal EBM
- Limited systematic implementation of EBM in ocean and coastal ecosystem
- Lack of knowledge and understanding of EBM principles and practices

(UNEP 2011; Long et al. 2015)



# History of marine and coastal EBM in the U.S.

- PEW Ocean Commission (2003) and USCOP (2004)
  - Absence of an integrated holistic management approach for marine and coastal natural resources and call for comprehensive EBM
- Executive Order 13366 (2004)
  - Committee on Ocean Policy - Lacked legislative mandates and funding to advance ocean policies and programs
- OPTF (2009)
  - Charged with organizing a comprehensive policy approach by implementing EBM
- Executive Order 13547 (2010)
  - EBM has foundational approach to address conservation, economic activity, users' conflict, and sustainable use of ecosystem services across sectors
- NOP-IP (2013)
  - Describes specific actions that federal agencies will take to address key challenges for ocean, coasts, and Great Lakes by adopting EBM strategies
  - NOP EBM-Subgroup to provide policy advice on EBM strategies and technical representation from NOC federal agencies
- ORAP (2013)
  - Need for clarity and understanding of EBM's concepts, practices, and principles across participatory groups

(Fluharty 2012; NOC 2013; ORAP 2013)



# Objectives

- Provide an overview of the current state of practice among the many and varied U.S. federal programs employing EBM approaches in the ocean, coastal zone, and the Great Lakes
- Identify gaps in knowledge or implementation strategies to enhance EBM framework

# Material and methods

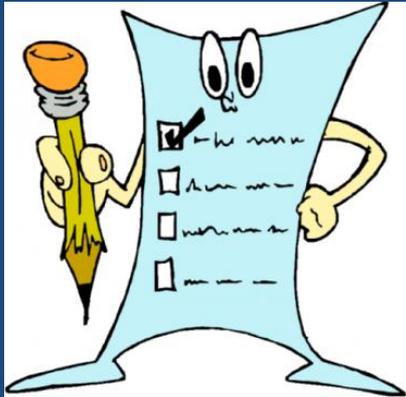
- Questionnaire

- 21 questions on key topic areas of EBM:

- Information on the program (e.g., name, federal agency, geographic location and spatial scope)

- Short description of program

- Audience, Partners, MoU, Training, Products, EBM-BMP, EBM principles



Subject Category	Breakdown Within Categories
Program	Science/Research; Resource Management/Extractive Uses; Resource Management/Non-extractive Uses; Mission Driven
Region	Nationwide; Alaska; Northeast; Pacific Islands; Southeast; West; Great Lakes; Gulf of Mexico and Caribbean; International
Audience	Internal to Agency; Federal Managers; Academia; Public; Private; Tribes; Non-Governmental Organizations; State Agencies; Foreign Governments; Inter-Governmental Organizations; Industries
Partners	Federal; State; Local; Non-Governmental Organizations; Academia; Community; Private; Tribes; Foreign Governments; Inter-Governmental Organizations; Industries
MoU	Federal; State; Local; Non-Governmental Organizations; Academia; Private; Tribes; International
Training	On-line tools; Handbooks; Workshop; Classes; Other Materials
Products	Peer-reviewed Publications; Other Publications; Guidance Documents; Forecasts; Websites; Workshops; Newsletters; Decision/Management Tools; Handbooks; Data; Other Products

# Program categories

**Management programs:** effort focused on management and stewardship of natural resources for the common-good

**Resource management/extractive uses (RMEU):** provide leadership and coordination for the management of natural resources, through activities with a primary emphasis on the extractive and/or consumptive use of the resource for the common-good

- Fishing and aquaculture
- Offshore energy development (oil, gas, and renewable)
- Mineral extraction
- Mitigation and planning for environmental impacts of other human uses of natural resources

**Resource management/non-extractive uses (RMNEU):** provide leadership and coordination for the management of natural resources, through activities with a primary emphasis on the protection of common-good resources for non-extractive uses

- Protection of marine, coastal and estuarine protected areas and national sanctuaries
- Protection of species
- Protection of coastal resources at risk of oil spills or other threats
- Restoration projects for coastal and estuarine species and habitats
- Development and implementation of adaptation

**Non-Management programs:** effort focused on providing information to advance the management and stewardship of natural resources, but primary goal is not the direct management of those resources

**Science/research (SR):** provide support for the stewardship of natural resources, through activities with a primary emphasis on advancing science and research of species, habitats, and ecosystems

- Assessment of species, population and stock abundance, distribution, ecology, and behavior
- Characterization of marine, coastal, and estuarine trophic webs and habitats
- Monitoring for the health of natural resources and habitats
- Ecosystem assessments, modeling and forecasting
- Improving understanding of the response of LMRS, habitats, and ecosystems to environmental variability and change
- Climate impact assessments
- Technological advancements

**Mission driven (MD):** provide stewardship for the program's own resources, through activities guided by specific challenges and project demands

- Marine, coastal, and estuarine infrastructure development and regulation
- Military operation and training
- Ballast water management systems
- Rulemaking regulating vessel technology and operations

- Program self-score on how well it aligns with working definition of EBM used by NOP (0-5 scale; 0 = program does not encompass the definition at all, 5 = program perfectly encompasses the definition)

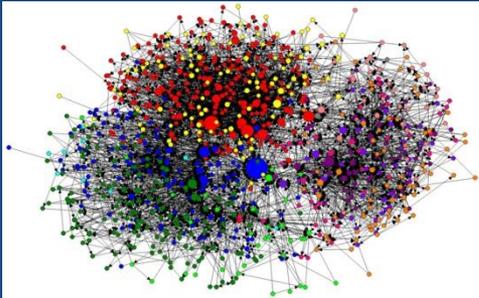
## Definition of EBM adopted by the NOP and included in the ORAP guidelines (2013)

*“ EBM is an integrated approach to resource management that considers the entire ecosystems, including humans. It requires managing ecosystems as a whole instead of separately managing their individual components or uses. EBM considers all the elements that are integral to ecosystem functions and accounts for economic and social benefits as well as environmental stewardship concerns. It also recognizes that ecosystems are not defined or constrained by political boundaries. The concept of EBM is underpinned by sound science and adaptive management as information or changing conditions present new challenges and opportunities ”*

# Data analysis



- Program self-scoring
  - Kruskal-Wallis single-factor ANOVA (R software)
  - Pairwise Wilcoxon test with Bonferroni correction (R software)
  - Permutation ( $n = 10,000$ ) t-test to test  $H_p$  of significant ( $P < 0.05$ ), non-random differences between program type and between national and regional programs (Ucinet)
- SNA techniques to explore relations and similarities among programs in different EBM topic areas (Ucinet and Netdraw)
  - Cohesion metrics from 1-mode matrix of Jaccard similarity index
    - Density
    - Fragmentation
  - Permutation tests ( $n = 10,000$ ) of QAP-correlations

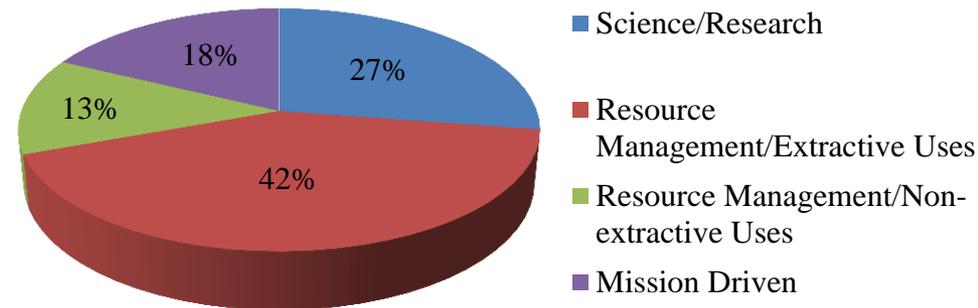
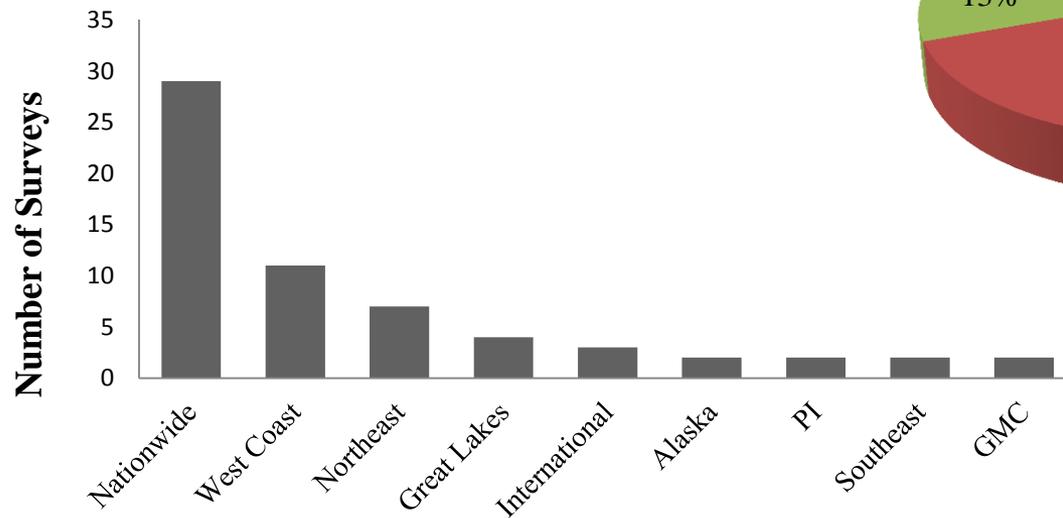


## Federal Agencies and Bureaus

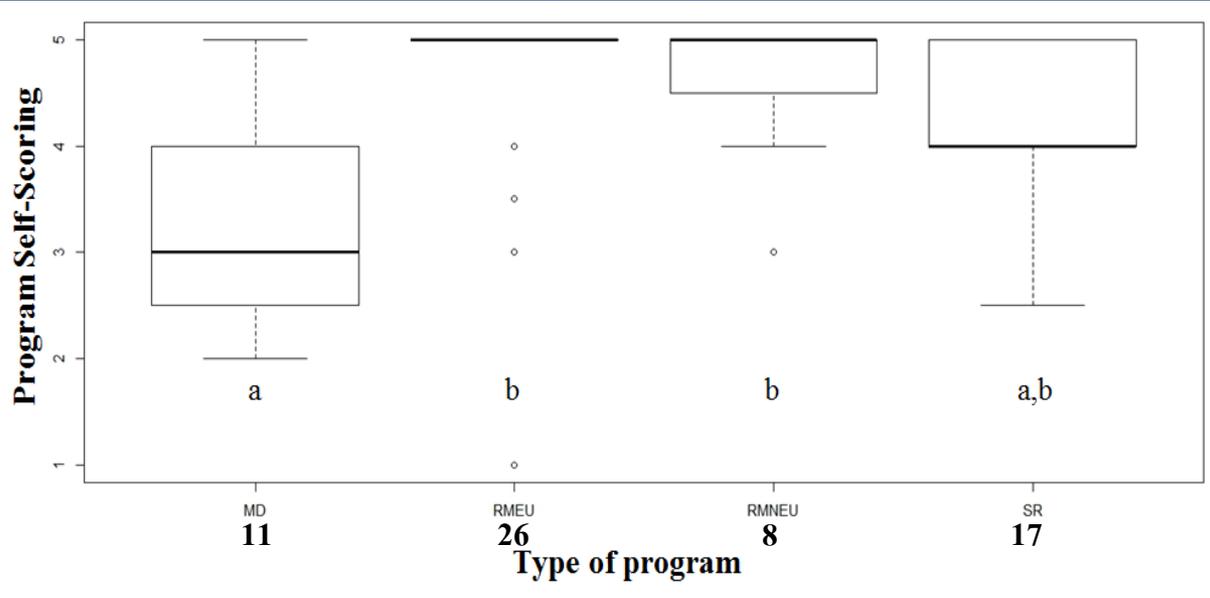
Bureau of Ocean Energy Management  
Bureau of Land Management  
National Aeronautics and Space Administration  
National Oceanic and Atmospheric Administration  
National Science Foundation  
US-Army Corps of Engineers  
US-Coast Guard  
US-Department of Transportation  
US-Environmental Protection Agency  
US-Fish and Wildlife Service  
US-Geological Survey  
US-National Park Services  
US-Navy

# Descriptive results

- 62 programs from 13 different NOC federal agencies and bureaus
- Not a complete census of all federal marine and coastal EBM programs



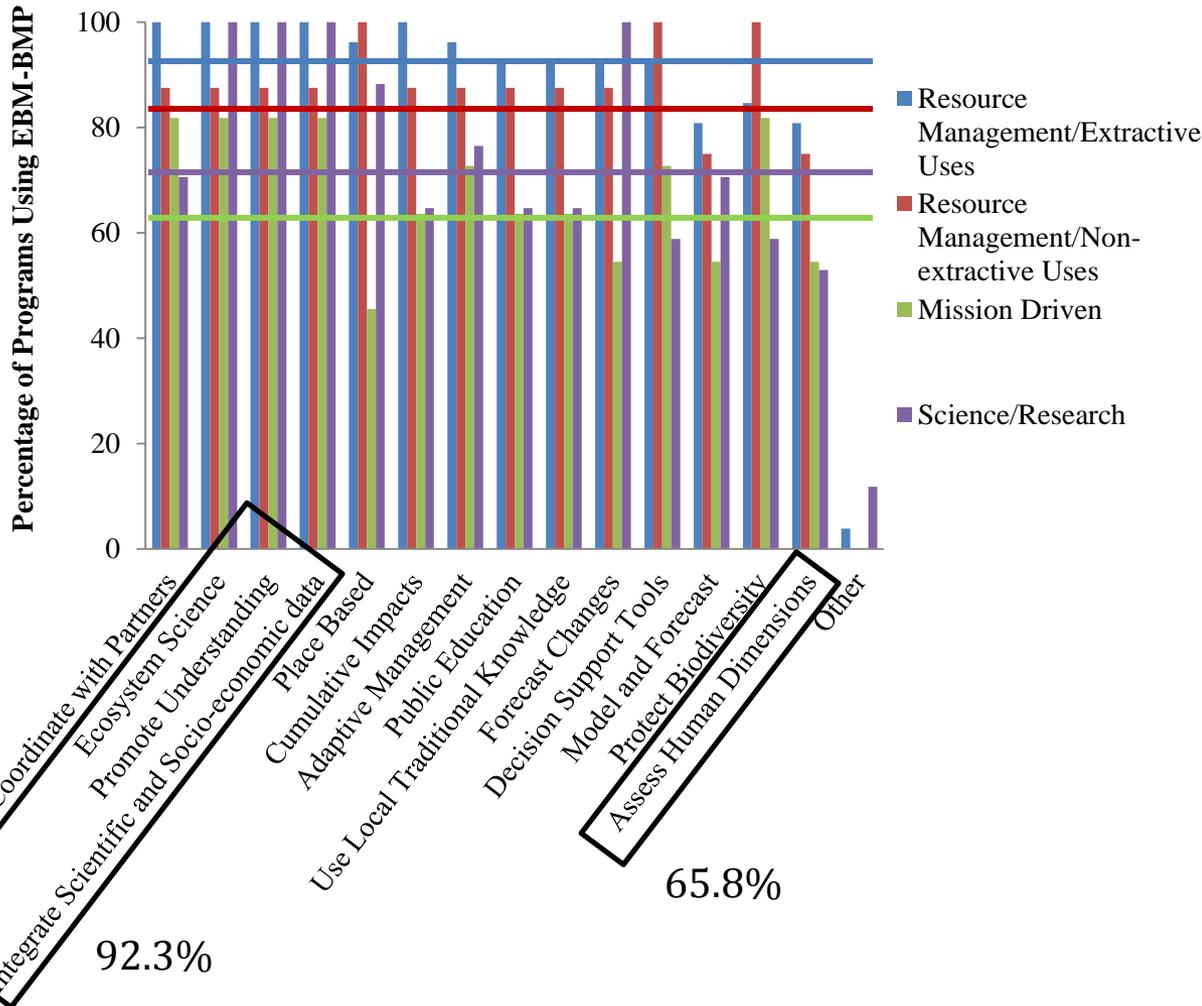
# Program self-scoring



ANOVA  $F_{0,05} = 17.9$ ,  $df = 3$ ,  $P < 0.01$

- Permutation t-test ( $n = 10,000$ ) with 2-mode matrices of programs similarities
  - $H_p$ : “Management” (RMEU and RMNEU) programs have a higher degree centrality than “Non-Management” (MD and SR) programs for each EBM topic area
    - Higher degree centrality ( $P < 0.001$ ) of “Management” programs for EBM-BMP and EBM principles

# EBM-BMP



Means:

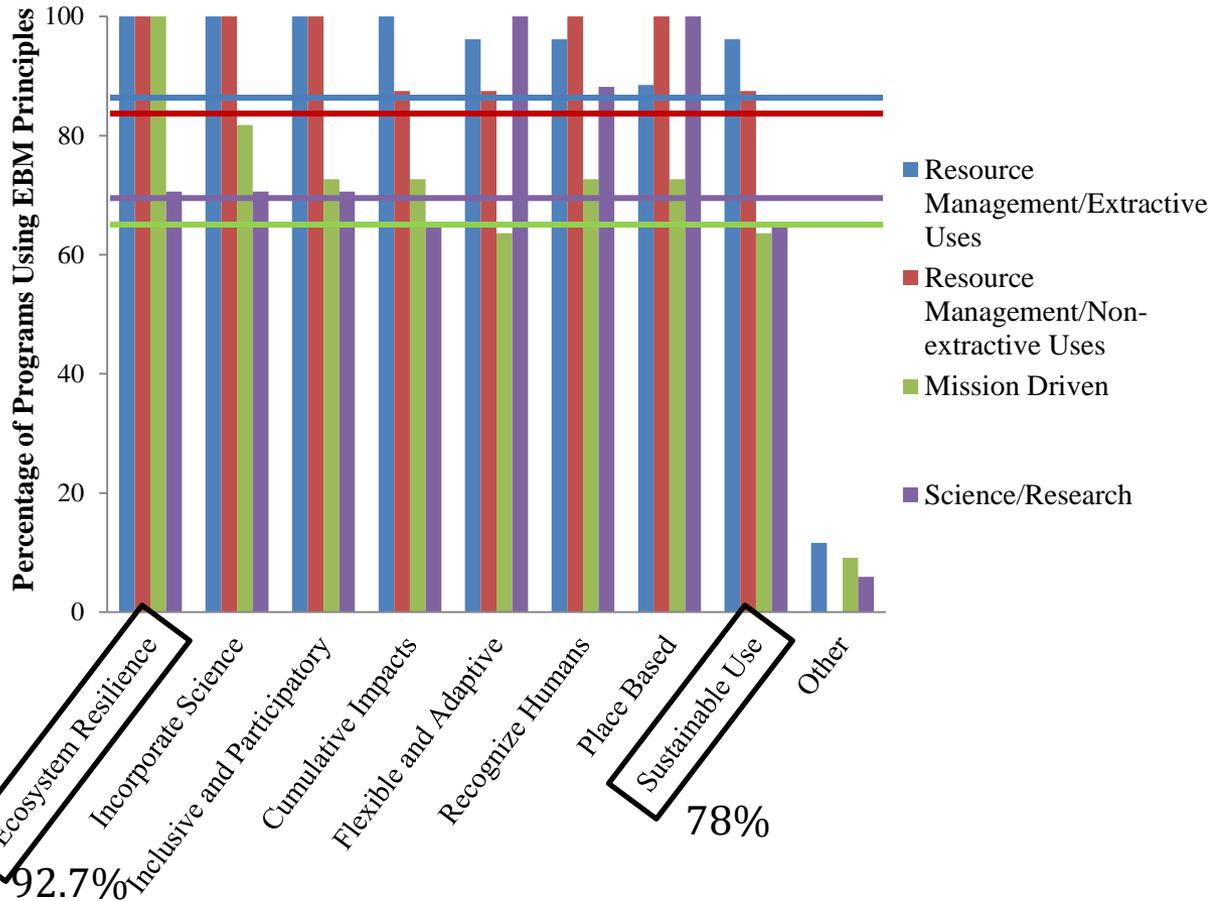
RMEU = 87.4%

RMNEU = 82.5%

SR = 72.2%

MD = 63.6%

# EBM Principles



Means:

RMEU = 87.6%

RMNEU = 84.7%

SR = 70.6%

MD = 67.7%

# Cohesion measures

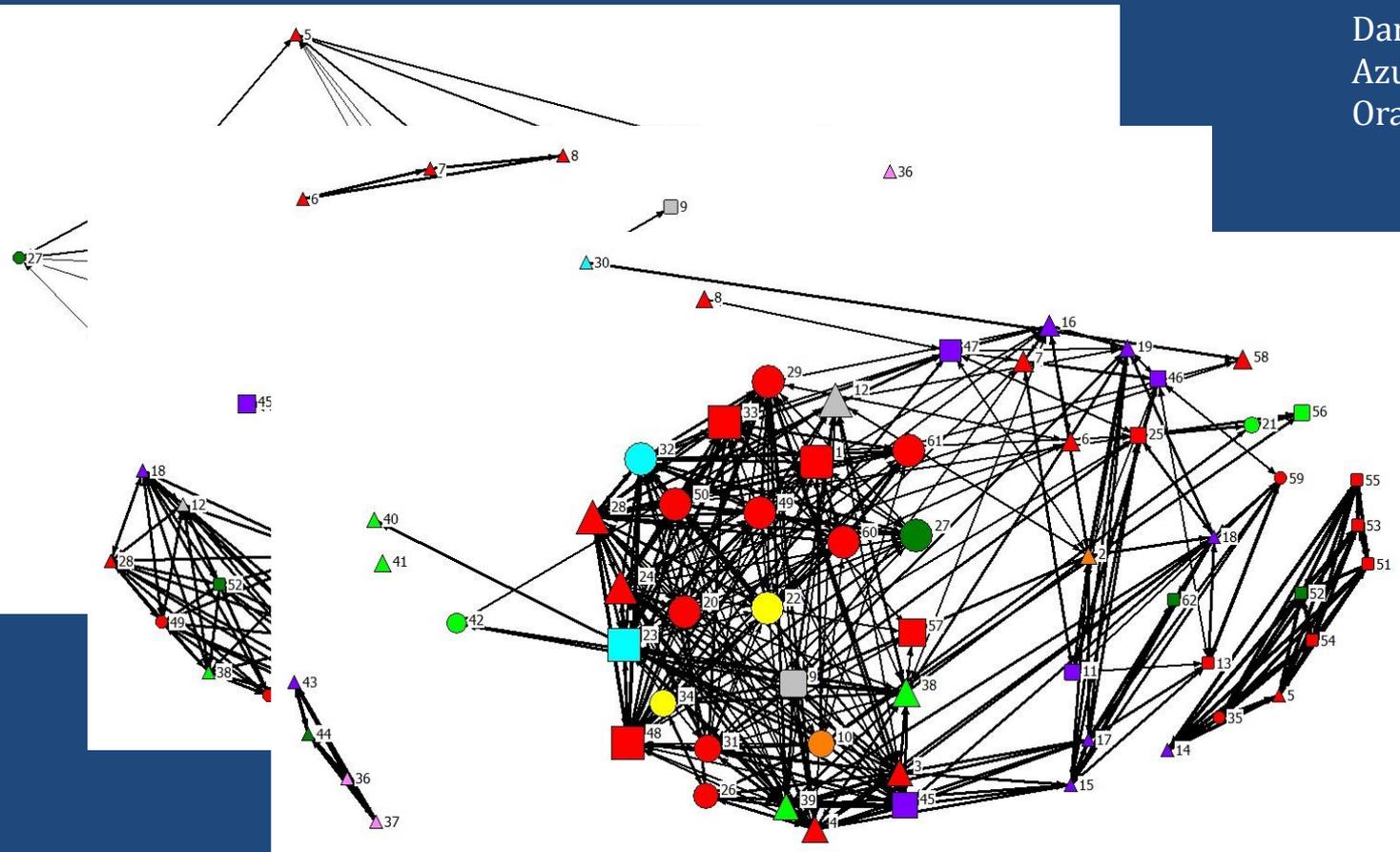
## Type of programs

- = SR
- ▲ = RMEU
- ◇ = RMNEU
- = MD

## Area/region of programs

- Yellow = Alaska
- Red = Nationwide
- Light-green = Northeast
- Grey = Pacific Islands
- Pink = Southeast
- Purple = West
- Dark-green = Great Lakes
- Azure = International
- Orange = GoM and Caribbean

Topical Areas	Network Size (# of nodes)	# of isolates	Density	Fragmentation
Audience	62	1	0.718	0.032
Partners	62	0	0.885	0
MoU	62	32	0.154	0.785
Training	62	19	0.323	0.522
Products	62	1	0.738	0.032
EBM-BMP	62	0	0.999	0
EBM Principles	62	0	0.994	0



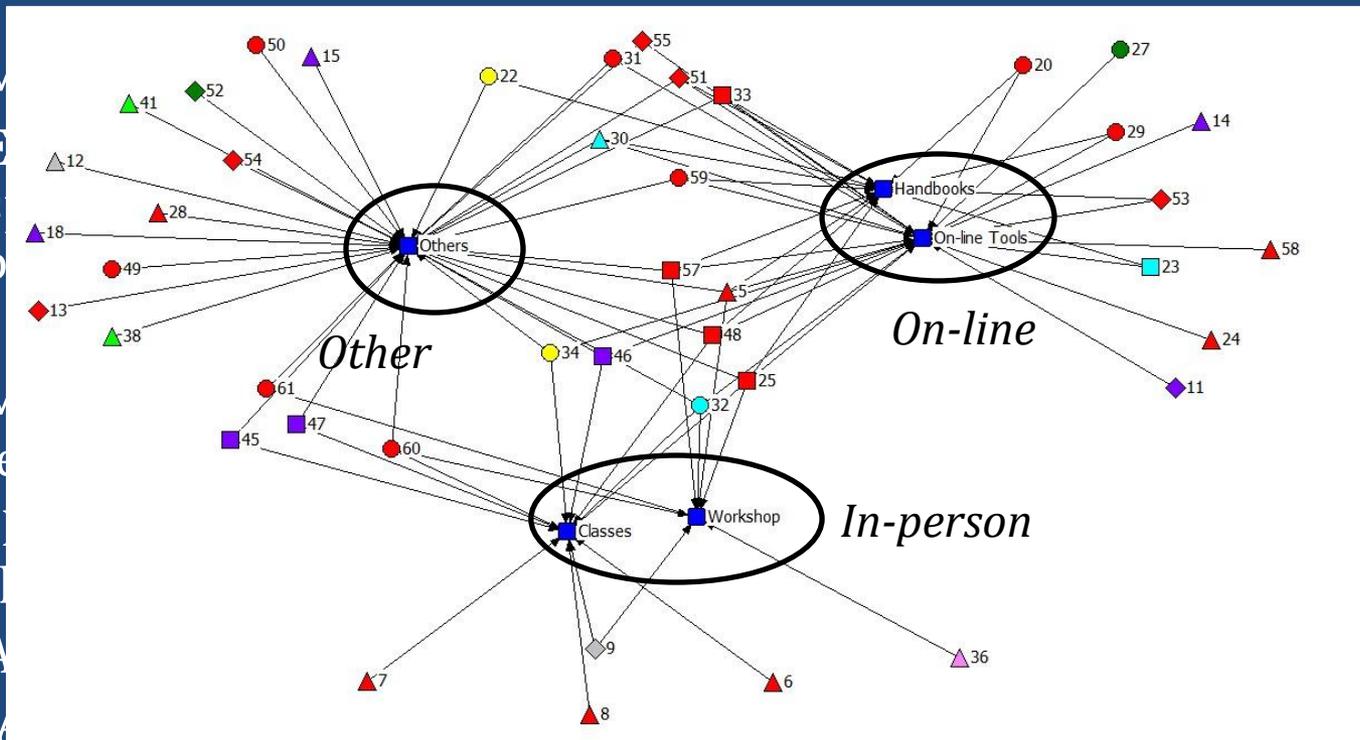
# Permutation test (QAP correlations)

<i>Pearson's correlations</i>	Audience	Partners	MoU	Training	Products	EBM-BMP	EBM Principles
Audience	-	0.07	0.12*	0.006	0.07*	0.14*	0.14*
Partners		-	0.18**	0.09*	0.19**	-0.06	-0.04
MoU			-	0.09*	0.11*	-0.08	-0.007
Training				-	0.15**	-0.007	0.02
Products					-	0.05	0.05
EBM-BMP						-	0.83**
EBM Principles							-

*\*P<0.05; \*\*P<0.001*

- Highest programs' matrix similarities between EBM-BMP and EBM principles
  - Programs that employ similar EBM-BMP also employ similar EBM principles
- Audience is main driver for which EBM-BMP and EBM principles is employed
- Similar Partners and Audience can potentially lead to more MoU, which can generate more similar Products
- Similar Products and Partners can potentially lead to similar Training

# Discussion



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- Need for more inter-agency and/or partner agreements
- Use of existing training material, mainly nationwide, can lead to more diversified products
- Increase cross-sectoral partnership, interdisciplinary collaborations, and communication

# Challenges and opportunities

- Improving EBM implementation among Federal agencies is a long-term iterative process
- In the long-term, EBM enhances collaboration, leverages opportunities, reduces chances for litigation, and improve decision making
- Working with partners and stakeholders key to effective and efficient EBM implementation
- Drawing from other programs experiences to increase education, partnerships, training, and involvement on EBM approaches
- Explore the understanding of less employed EBM-BMP and principles
- Look at regional examples of successful EBM implementation
- Understanding of actors' motivation and behavior
- Need to define metrics and performance measures to clarify what successful EBM looks like

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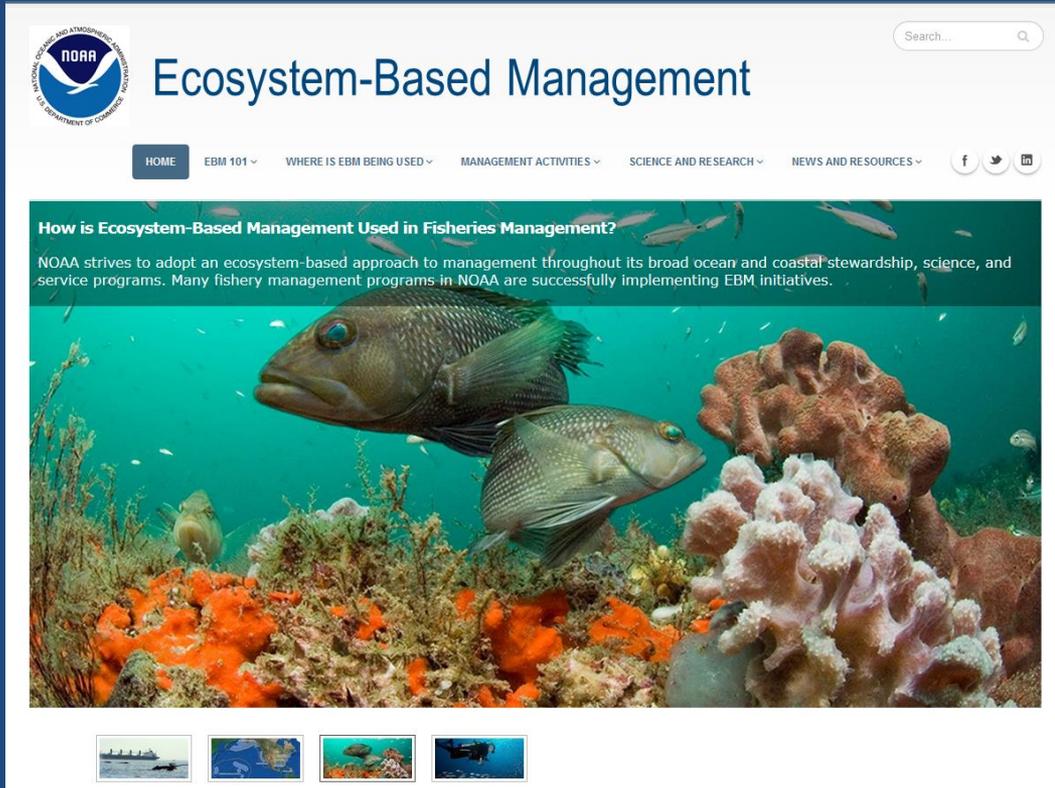
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# Questions?



 **Ecosystem-Based Management**

HOME EBM 101 WHERE IS EBM BEING USED MANAGEMENT ACTIVITIES SCIENCE AND RESEARCH NEWS AND RESOURCES

### How is Ecosystem-Based Management Used in Fisheries Management?

NOAA strives to adopt an ecosystem-based approach to management throughout its broad ocean and coastal stewardship, science, and service programs. Many fishery management programs in NOAA are successfully implementing EBM initiatives.



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