Inaugural Research Webinar

Research Plan to Advance the Understanding of Potential Coastal Green Infrastructure Strategies in New York City

March 24, 2015

NEIWPCC
New England Interstate Water Pollution Control Commission

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NEIWPCC

- Established in 1947 by an Act of the U.S. Congress
- One of six congressionally authorized, nationally recognized interstate agencies
- 501(c)(3) Not-for-Profit Organization
- Compact member states and jurisdictional area include: New York, Rhode Island, Connecticut, Massachusetts, Maine, Vermont and New Hampshire

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NEIWPCC Mission

The New England Interstate Water Pollution Control Commission, a not-for-profit interstate agency established by an act of Congress, serves and assists its member states individually and collectively by providing coordination, public education, research, training, and leadership in water management and protection in the New England region and New York State.

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Hudson River Programs

NEIWPCC has administered program staffing and finances for 15 years!

Two multi-year contracts with NY for two distinct programs

Current combined-total: $14,000,000+ for efforts through 2020

- Hudson River Estuary Program
- Hudson River National Estuarine Research Reserve

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Hudson River Programs

Estuary

- 8 full-time staff
- 3 office locations
- ~$2M annual budget
- Resource management, climate change, green infrastructure, education, improving access

Research Reserve

- 3 full-time staff
- Norrie Point Env. Center. (Staatsburg)
- ~$300k annual budget
- Research, sustainable shoreline, stewardship and conservation, education, sea-level rise

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Select Project Partners

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NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

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NYC PLANNING DEPARTMENT OF CITY PLANNING CITY OF NEW YORK

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Today's Presenter

Hugh Roberts, PE

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ARCADIS Infrastructure · Water · Environment · Buildings

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Scape Landscape

- Kate Orff, Gena Wirth, Lauren Elachi

The Nature Conservancy

- George Schuler, Lauren Alleman, Andrew Peck, Rebecca Shirer

Matthews Nielsen

- Kim Mathews

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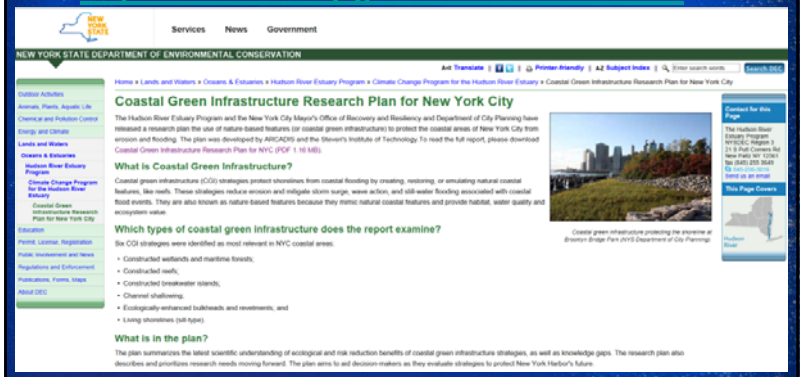
Online Access

- http://www.dec.ny.gov/lands/100057.html



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Project Goal

Develop a research plan that will advance the understanding of the benefits and costs of CGI strategies, ultimately facilitating the selection and implementation of projects which can most successfully improve resiliency in the New York City coastal environment

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CGI Strategies

- Constructed wetlands and maritime forests
- Constructed reefs
- Constructed breakwater islands
- Channel shallowing
- Ecologically enhanced bulkheads and revetments
- Living shorelines (sill-type)

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Methodology

- Literature review
- Team discussions
- Expert interviews
- Workshops
  - Project initiation
  - Existing Regulatory Framework
  - Review of Preliminary Research Agenda
    - Over 40 participants and 19 agencies
- Report reviews

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Focus Areas

- Hazard mitigation potential
- Potential ecological benefits
- Possible failure causes
- Data required to design, plan, and implement

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Report Structure

- Regulatory considerations
- Six CGI strategies
  - Constructed wetlands and maritime forests
  - Constructed reefs
  - Constructed breakwater islands
  - Channel shallowing
  - Ecologically enhanced bulkheads and revetments
  - Living shorelines (sill-type)
- Data, monitoring and integration
- Research Agendas

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Regulatory

- Success stories in other states
- No easy assessment of hazards mitigation and ecological benefits
- A thorough habitat evaluation tradeoff is necessary
- Pilot studies relieve some of the regulatory burden by simplifying the approval of CGI

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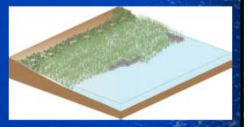
Wetlands and Maritime Forests

- Hazard Mitigation
  - Laboratory and numerical modeling experiments are most common
  - Field measurements during storm events are relatively rare
  - Vegetation resistance is dependent on internal factors (stem density) and external (water depth) factors



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Internal/External Factors

	Factors	Parameters	Impacts on Vegetative Resistance
Vegetation properties	Vegetation morphology	Height, stem/trunk diameter, branch, and foliage	Positively correlated
	Vegetation bio-mechanical properties	Stiffness of plant shoot (might vary seasonably)	Positively correlated
	Vegetation community	Stem density and communities arrangement	Positive correlated
Footprint	Wetland continuity	Distance to main coast, edge fractal dimension, and ratio of vegetated land area to non-vegetated area (water area, road area, swales, mudflats, etc.)	Intact wetland has the highest bulk resistance
	Horizontal extent	Distance in wave propagation or flooding direction	Positively correlated
	Vertical extent	Platform elevation	Positively correlated
	Topographic complexity	Arrangement of topographic features (hummocks, dunes, swales)	Unknown
Hydro-dynamics	Water surface elevation (surge height during a storm event)	Flow depth	Maximum resistance when flow depth is about the height of the vegetation (stem), i.e., near-emergent condition
	Wave climates	Wave height and wave period	Not in consensus

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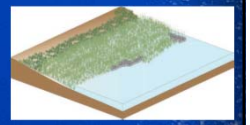
Wetlands and Maritime Forests

- Ecological Benefits
  - Quantification/comparison of habitat values to support effective policy-making and management is necessary
  - Review and improve existing habitat values evaluation tools, models and metrics
  - Pilot projects recommended to collect data, test hypotheses, and to support the permitting process



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Reefs

- Wave dissipation is not as standard as traditional breakwaters
- Ecosystem benefits should be better understood
- Some guidance exists for siting, designing and regular monitoring
- Along the north Atlantic coast, reefs are highly susceptible to damage from debris, ice, and/or longshore shifting sediment

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Breakwater Islands

- Benefits vary with project scale, structure, and habitat types
- Challenges associated with this strategy are planning, permitting, and constructing and maintaining a large in-water structure
- A large volume of sediment fill is required

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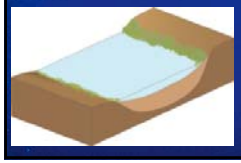
Channel Shallowing

- Potential for inundation reduction and ecosystem integrity improvement
- Knowledge on sediment transport and budget is essential
- Urban features and human activities (e.g. water quality and navigation) play important roles affecting the targeted performance



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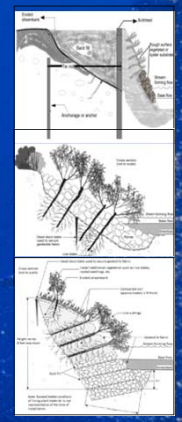
Ecological Enhancements

- Lowering PH and texturizing or increasing the complexity of the surface, results in a more diverse recruitment
- The timing of initiation and project implementation is important (e.g. ice and uprooting)
- No standard design guidelines



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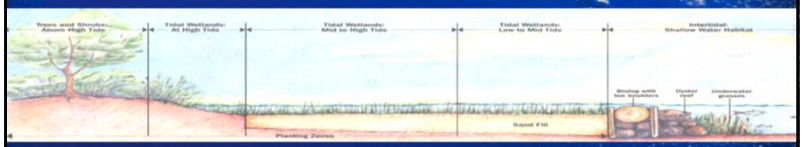
Living Shorelines (sill type)

- The feature is a combination of sill, sediment fill and vegetation planting
- Sills can be easily adjusted to accommodate changes in water level due to rising seas
- Ice and wake damages need be considered
- No standard design guidelines



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Data Management

- Effective data dissemination requires a cross-agencies platform to unify the data format, to avoid duplicate efforts, and improve data availability
- Baseline Data Needs
  - Currents and wave
  - Ice (floating and build-up)
  - Wakes
  - Vegetation biomechanics
  - Other ecosystem indicators (e.g. species abundance)

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Integration

- Conceptual models as non-quantitative planning tools are needed to synchronize science, data and policy across agencies.
- Monitoring programs for the regional baseline data and site-specific data collection are required

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Research Agenda

- Sorted into two groups
  - Meta strategy
  - Strategy Specific
- How were Research Agendas scored?
  - Fundamental Principles
  - Chronology
  - Regional Applicability, and
  - Affordability

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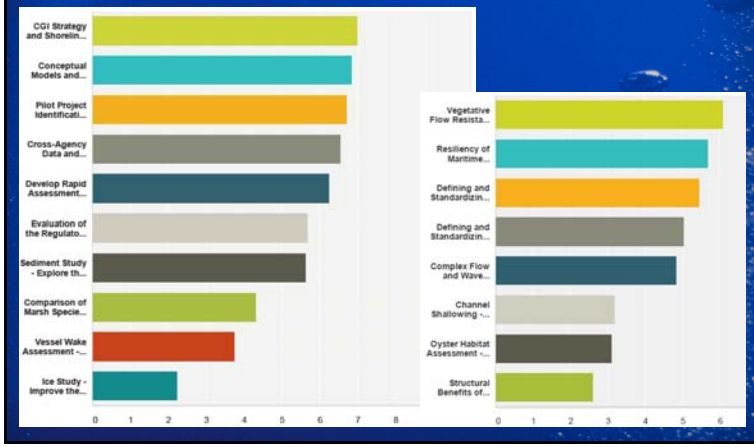
Workshop Rankings



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Agenda	Task	Brief Description	Prioritization				
			Fundamental principles	Chronology	Regional Applicability	Affordability	Overall weight
5.1 Ecological Conceptual Model and Monitoring Protocol Development	5.1.1	Develop conceptual model	0	3	3	2	7
	5.1.2	Identify/test metrics and control sites for habitat evaluation	0	3	3	3	9
	5.1.3	Develop ecosystem data monitoring protocol (coordinating with 5.1.2)	0	2	3	3	8
	5.1.4	Identify/test metrics to quantify hazard mitigation performance	0	3	3	3	9
	5.1.5	Develop environment data monitoring protocol (coordinating with 5.1.4)	0	2	3	3	8
5.2 Development of Ecosystem Models and CGI Projects Prioritization	5.2.1	Prioritize habitats and species	1	3	3	3	10
	5.2.2	Review and development of rapid assessment tools comparing net benefits across habitats	1	3	3	3	10
	5.2.3	Review and development of ecosystem models for landscape changes	1	1	3	2	7
	5.2.4	Review and improve eco-path models used to predict fish biomass changes (coordinating with 5.2.1)	1	1	3	2	7

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	5.1.4	Identify/test metrics to qu					
	5.1.5	Develop environment data					
5.2 Development of Ecosystem Models and CGI Projects Prioritization	5.2.1	Prioritize					
	5.2.2	Review and development o benef					
	5.2.3	Review and development					
	5.2.4	Review and improve eco-pa changes (c					

Conceptual Models

- Develop, refine, and document a common understanding of ecosystems and hazard mitigation.
- Identify important processes, key ecological attributes and indicators, and
- Integrate the current understanding of system dynamics across groups and agencies.

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Priority Habitats Coordination

- Identify critical species and habitats relevant to overall agency goals
- Standardize and prioritize screening criteria
- Apply NYC-specific research to modify or add to this list of critical species
- Create an overall, agency-coordinated ranking of priority habitats and sites that will allow for more efficient permitting and design along the shoreline

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Monitoring protocol

- Provide a framework coordinating monitoring efforts and uniting research forces.

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5.3 Sediment Study	5.3.1	Estimate an NYC area sediment budget	0	3	2	3	8
	5.3.2	Soil strength in NYC coast areas	0	3	1	2	6
	5.3.3	Identify sediment borrow sources and develop a regional sediment management plan	0	3	2	2	7
5.4 Ice Study	5.4.1	Ice volume mapping	0	3	2	3	8
	5.4.2	Assess the dynamic and static ice forces	1	2	2	2	7
	5.4.3	Explore the risk of freezing damage on structures and vegetation types	1	2	2	2	7
	5.4.4	Improve the capability to model ice in existing hydrodynamic models	1	2	2	2	7
5.5 Vessel Wake Assessment	5.5.1	Determine locations throughout NYC to deploy measurement devices and obtain wake wave height measurements (requires instrument deployment)	0	1	3	1	5
	5.5.2	Create a wake wave atlas	0	3	3	3	9

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Sediment Study

Understanding both the sediment budget and sediment longshore/cross-shore transport can provide important insight into the nature of the sedimentary system, landscape morphology, and the feasibility of particular CGI strategies.

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Ice Study

Improve the guidance for incorporating ice forces into the design of both traditional and CGI coastal protection works, including uprooting of vegetation.

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Vessel Wake Assessment

Accurately establish the wave climate including wakes. Wave height drives the design of many CGI projects.

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			Fundamental principles	Chronology	Regional Applicability	Affordability	Overall weight
5.6 Cross-Agency Data and Metadata Management	5.6.1	Develop the observational data dissemination portal and data management plan coordinating conceptual models development (5.1) and data collection (5.8)	0	1	2	3	6
	5.6.2	Develop a project library including project metadata and taxonomy	0	3	3	3	9
5.7 Comparison of Marsh Species -*Phragmites* and *Spartina*	5.7.1	Flow resistance of *Phragmites* vs. *Spartina* (Manning's coefficient)	1	2	3	2	8
	5.7.2	Evaluate species diversity, abundance, and population of birds and other wildlife in the presence of Phragmites	1	3	3	1	8
	5.7.3	Revise and recommend *Phragmites* management practices (coordinating with 5.7.1 and 5.7.2)	0	1	1	3	5
5.8 Pilot Project Identification, Implementation and Monitoring (Living Laboratory)	5.8.1	Pilot project identification	1	3	3	3	10
	5.8.2	Pilot project implementation and monitoring (coordinating with 5.1 and 5.6; time-demanding)	1	0	3	1	5
5.9 Evaluation of the Regulatory Process	5.9.1	Research the existing regulatory framework, SAP requirements, and coordinate regulatory agencies	0	1	1	3	5

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5.7 Comparison of Marsh Species -*Phragmites* and *Spartina*							8
							8
							5
5.8 Pilot Project Identification, Implementation and Monitoring (Living Laboratory)							10
							5
5.9 Evaluation of the Regulatory Process							5

Cross-Agency Data and Metadata Management

Abundant data can improve the understanding of NYC baseline conditions and can provide a better framework in which CGI projects will be designed and implemented. A cross-agency data management tool is recommended both to store and share available observational data and metadata for proposed and implemented projects in NYC to centralize updated project information including goals and objectives, strategy types, innovative design concepts, implementation challenges, performance evaluations, lessons learned, etc.

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Pilot Project Identification, Implementation, and Monitoring (Living Laboratory)

Many hypotheses related to the hazard mitigation potential and ecological benefits of CGI strategies require field observation data to further evaluate and refine. Pilot projects are critically important to systematically address hypothesis that require field observations and monitoring. Because pilot projects may be challenging to implement due to regulatory and cost considerations, it is recommended that pilot studies in the area be prioritized prior to implementation.

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5.10 Shoreline assessment for appropriateness of CGI Strategy	5.10.1	Develop a mapping tool displaying possibilities for CGI integration into the NYC shoreline	0	2	3	2	7
5.11 Coastal Resiliency Benefits Quantification	5.11.1	Develop a methodology for quantifying coastal resiliency benefits	1	2	3	2	8
6.1 Constructed Wetland Research Agendas	6.1.1.1	Flow resistance evaluation of coastal wetlands and coastal and maritime (coordinating with 5.7.1)	1	3	1	3	8
	6.1.1.2	Numerical model improvement for interactions between vegetation resistance, flow conditions and vegetation properties (coordinating with 5.7.1 and 6.1.1.1)	1	1	2	3	7
	6.1.1.3	Numerical study of wave and surge reduction potential and how are they affected by vegetation properties and storm dynamics (coordinating with 5.7.1, 6.1.1.1, and 6.1.1.2)	1	0	2	3	6
	6.1.2.1	Quantitatively assess resiliency of maritime forests and salt marshes (coordinating with 5.1.2)	0	2	2	3	7
	6.1.2.2	Quantitatively assess the impacts of the highly urban settings of NYC on resiliency (coordinating with 5.1.2 and 6.1.2.1)	1	1	2	3	7

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CGI Strategy and Shoreline Prioritization

- Mapping NYC shorelines with applicable, most beneficial CGI techniques using available data and metrics, including consideration of sea level rise impacts on critical at-risk ecosystems (e.g., evaluate which ecosystems and locations may shift quickly or disappear with sea level rise).
- Helping to prioritize projects throughout the region and to make robust and data-backed decision.

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Quantifying Coastal Resiliency Benefits

- CGI strategies generally have little to no impact on stillwater (storm tide) levels during storm events.
- The most significant hazard mitigation benefits are reductions in current velocity and wave energy.
- A systematic means to assess the economic impacts and damage reductions associated with these benefits has not been developed.

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Vegetative Flow Resistance and Storm Wave Attenuation Potential of Salt Marsh and Maritime Forest

- Test existing vegetative resistance formula and friction coefficients;
- Examine the potential of intact and fragmented (patchy) wetland and maritime forests for reducing storm surge and waves; and
- Explore surge/wave reduction capability and its relationship with internal and external factors.

6.1 Constructed Wetland Research Agendas	6.1.1.1	Flow resistance evaluation of coastal wetlands and coastal and maritime (coordinating with 5.7.1)	1	3	1	3	8
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6.2 Reef Research Agendas	6.2.1.1	Quantify three-dimensional flow through complex reef units and improve the parameterization of bulk flow and wave dissipation	1	3	1	3	8
	6.2.1.2	Optimize project attributes to maximize hazard mitigation and favor fish/shellfish abundance (coordinating with 5.1.4, and 6.2.2)	1	1	3	1	6
	6.2.2.1	Examine monitoring criteria, critical impact factors, and adaptive management of reefs	1	1	3	2	7
6.3 Dredged Channel Shallowing Research Agenda	6.3.1.1	Search potential channel shallowing site and conduct numerical studies	1	3	1	3	8
	6.3.1.2	Develop methods for valuing flood reductions	1	3	1	3	8
	6.3.2.1	Develop numerical models for circulation and transport	1	3	1	3	8
	6.3.2.2	Quantify the integrity of the restored habitats at a specific location	0	1	1	3	5
6.4 Ecologically-enhanced Bulkheads and Revetments Research Agendas	6.4.1	Define and standardize design rules for ecological enhancement	1	3	3	2	9
	6.4.2	Structural Benefits of Marine Growth on Marine Infrastructure	1	3	3	2	9
6.5 Living Shoreline Research Agendas	6.5.1.1	Develop a protocol for the monitoring and assessment of living shorelines	1	2	3	3	9
	6.5.1.2	Define and standardize design guidelines for living shorelines	1	3	3	3	10
	6.5.1.3	Evaluate the wave and current energy dissipation provided by various edge types using physical models and field studies	1	0	3	1	5

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Defining and Standardizing Design Guidelines for Living Shorelines and Ecologically Enhanced Bulkheads and Revetments

- Stone size,
- armoring depth,
- vegetation maintenance,
- window spacing, and
- distance of the sill from the shore edge.

6.4 Ecologically-enhanced Bulkheads and Revetments Research Agendas	6.4.1	Define and standardize design rules for ecological enhancement	1	3	3	2	9
	6.4.2	Structural Benefits of Marine Growth on Marine Infrastructure	1	3	3	2	9
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	6.5.1.3	Evaluate the wave and current energy dissipation provided by various edge types using physical models and field studies	1	0	3	1	5

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Next Steps

- Partnership: DEC Hudson River Estuary Program, NYC Department of City Planning, the New York-New Jersey Harbor & Estuary Program
- Consensus Building Institute will assist with strategic planning and stakeholder interviews to ID ways to move the plan forward in the years to come.
- Welcome ideas and suggestions!

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Questions & Answers

- **We will be posting this webinar and future research-related webinars at neiwpcc.org**
- **Follow @NEIWPCC to keep up-to-date**
- **THANK YOU!**