Assessing the Effects of Storm Surge Barriers on the Hudson River Estuary

Final Project Workshop

Philip Orton (PI), Ziyu Chen, Stevens Institute of Technology, philip.orton@stevens.edu
Bennett Brooks (Coordination Lead), Consensus Building Institute, bbrooks@cbi.org
Kristin Marcell, New York State DEC, Hudson River Estuary Program, and Cornell University Water Resources Institute
Sarah Fernald, NOAA Hudson River National Estuarine Research Reserve and New York State Department of Environmental Conservation (NYS DEC)

Funding: NOAA National Estuarine Research Reserve Science Collaborative
New York State Energy Research and Development Authority

Workshop Purpose

- Share, discuss and confirm results from September 2019 Surge Barrier Environmental Effects and Empirical Experience Workshop
- Present recent research results, including work from the Harbor and Tributaries Focus Area Feasibility (HAT) Study, NERRS- and NYSERDA-funded efforts, HRF and other related work
- Develop future research agenda priorities related to the potential environmental effects of storm surge barriers on the region's estuaries
- Identify potential future funding needs and sources and opportunities for broader research collaboration

Workshop Agenda

Morning Session

- Introduction/Welcome/Project Overview
- Project-Related Updates
- Update on Research Results and Ongoing Studies

Lunch

Afternoon Session

- Identifying Future Research Needs and Priorities
- Research Funding Needs and Opportunities
- Wrap-up and Next Steps

Informal no-host happy hour to follow – Yonkers Brewing Company

Workshop Ground Rules

- **What we ask of each other**
  - Contribute, but share time
  - Learn from each other, integrate across ideas, explain scientific basis for concerns
  - Be mindful of session purpose
    - Informed feedback, not decision-making
    - Seeking to understand potential effects, not debating merits of surge barriers
- **Session mechanics**
  - Planning team to support discussion, keep us on track
  - Mix of plenary and small group conversations
  - Cell phones off, placards up
  - Lunch provided; afternoon break

Project Overview

Project team:

Philip Orton, Bennett Brooks (Coordination Lead), Kristin Marcell, Sarah Fernald

Funding:

NOAA National Estuarine Research Reserve System (NERRS) Science Collaborative

→ Collaborative and End-User driven from start-to-finish

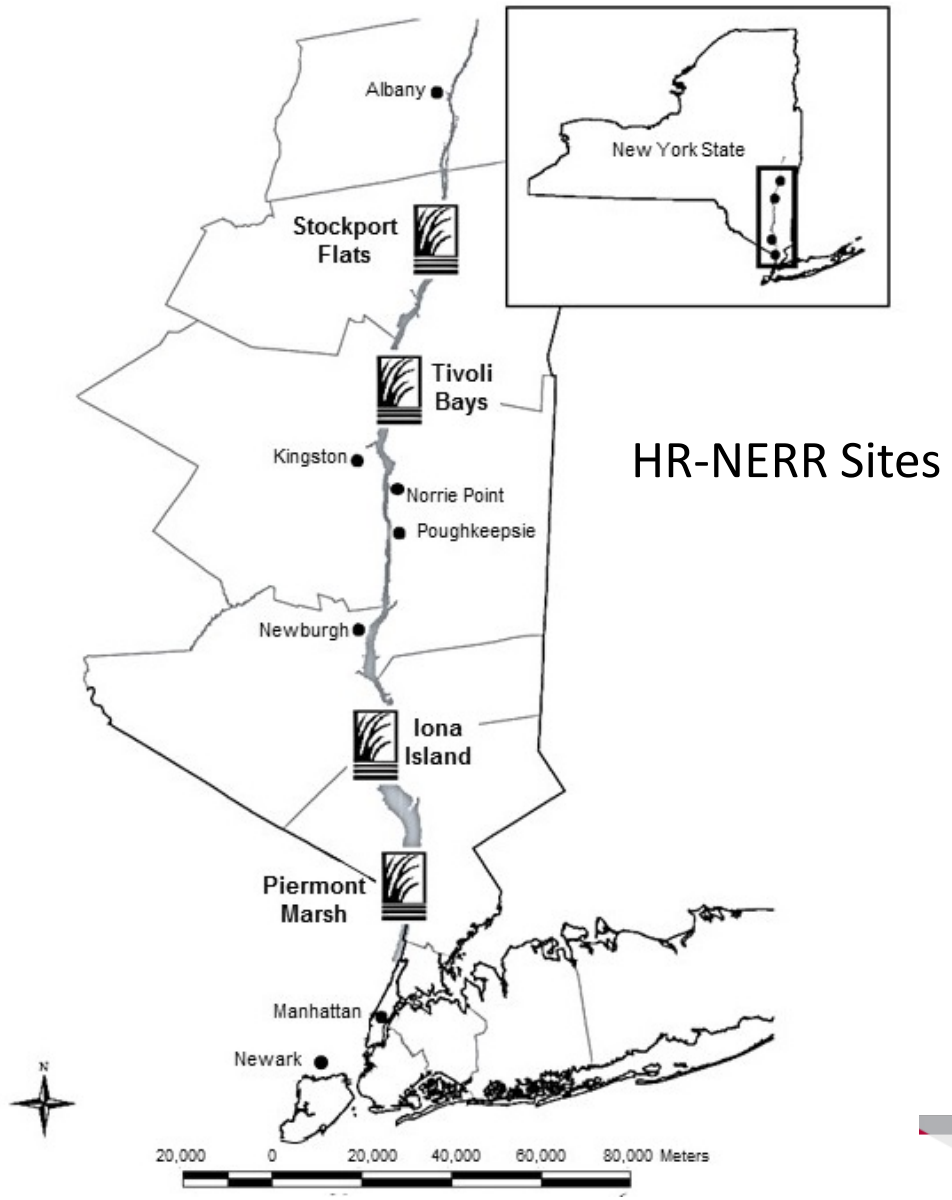
Project Type:

One-year "Catalyst" – Targeted investment for advancing collaborative science

Goals:

- (1) To facilitate development of a collaborative research agenda that can help interested parties better understand potential barrier effects on nearby estuaries
- (2) To undertake targeted research in close collaboration and with information-sharing among scientists and key end-users such as the U.S. Army Corps of Engineers and its partners NY State, NYC and NJ

Assessing the Effects of Storm Surge Barriers on the Hudson River Estuary



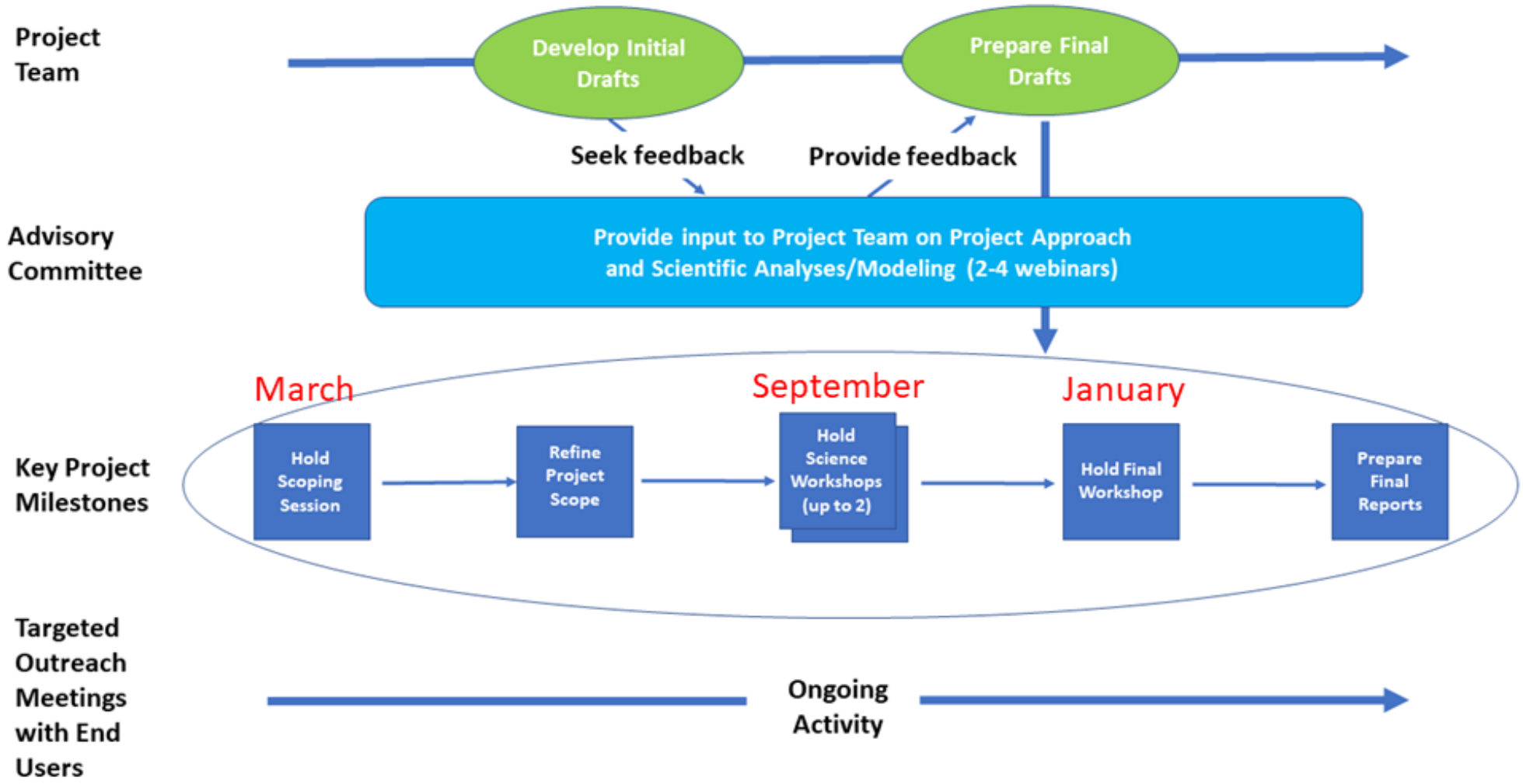
HR-NERR Sites

FOCUS:

The project was originally intended to focus on the physical and ecological effects of gated storm surge barriers on the Hudson River estuary and its habitats and ecosystems (NY/NJ Harbor up to Troy).

As we look ahead to future research needs and opportunities, this workshop's focus can be broader, including NJ Back Bays, Jamaica Bay and other area estuaries with proposed surge barriers.

Project Overview



Deliverables and Due Dates

Deliverable	Due Date
Revised Scope of Work	Finalized in April
Scientific workshop report	Finalized in December
Technical report on analyses + modeling	Draft February, final April
Proposals for additional funding	Ongoing
Scope of Future Work	Draft February, final March
Project final report to NOAA	April

Project-Related Updates

Updates on relevant projects to provide context for workshop discussions

- NY/NJ Harbor and Tributary Study (Bryce Wisemiller; separate slide deck)
- September 2019 Surge Barrier Environmental Effects and Empirical Experience Workshop (P. Orton; Kristin Marcell, Sarah Fernald)

Surge Barrier Environmental Effects and Empirical Experience Workshop

Goals of the workshop were to:

- Build collaboration among people involved in the topic around the world, including empirical data and experience from past surge barrier projects, as well as approaches for evaluating environmental effects in present studies
- Identify the present scientific understanding regarding surge barrier environmental effects, highlighting both areas of consensus and divergent views, and identify key additional data, research and models
- Improve the scientific foundation for Decisionmaker End Users within the HAT Study

Focus Areas

- The workshop was attended by 30+ researchers (US, UK, Netherlands) and PAC members
- Three main focus topics for the workshop were developed during a prior Scoping Session workshop attended by 35 people and the Estuary Effects study's 14-member Project Advisory Committee.
- These topics were
  - (1) empirical experience from constructed gated storm surge barriers,
  - (2) potential surge barrier effects on migrating organisms, and
  - (3) potential surge barrier effects on tidal wetlands.

Philip Orton presented an overview of the Estuary Effects Study's research, including demonstrations of how sea level rise could affect barrier closures and their effects.

Bram van Prooijen of Delft University of Technology reviewed Dutch experiences on the impact of storm surge barriers:

- The degree of environmental impacts (post-construction) scales with the degree of obstruction of tidal flows
  - suggests that by minimizing flow obstruction, it is possible to avoid severe environmental degradation.
- The Eastern Scheldt is a healthy ecosystem compared to other, fully dammed estuaries, but pre-construction biological monitoring data are very limited.
- It has clear water and contains many species (also invasive species), and supports aquaculture.
- A well-understood negative ecological impact of the barrier is that it reduced sediment supply to intertidal zones in the estuary, inducing erosion and loss of intertidal areas.

Charles Schelpe of Jacobs Engineering Group reviewed his experiences with United Kingdom surge barriers:

He recommended that we all:

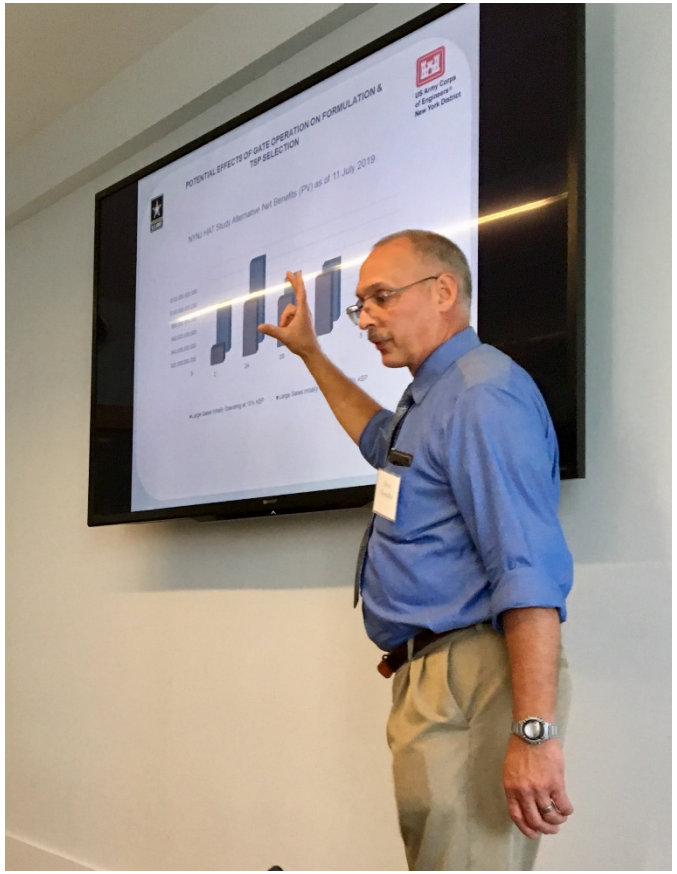
- Ensure there is a baseline understanding of the physical and biological system, and consider the limits of deviation for the environmental assessment
- Consider the adequacy/veracity of baseline environmental data
- Recognize that management of effects is invariably an iterative process, and invariably involves compromise
- Think of the opportunities, not just the negatives, associated with barrier development – e.g. there can be some opportunities in habitat creation
- With barriers large or small, the potential effects are often the same, except for their scale

Presentations by the USACE

Harbor and Tributaries Focus Area Feasibility Study (HATS) Overview – Bryce Wisemiller

HATS physical and management aspects of surge barriers relating to wetlands or migrating organisms – Maarten Kluyver

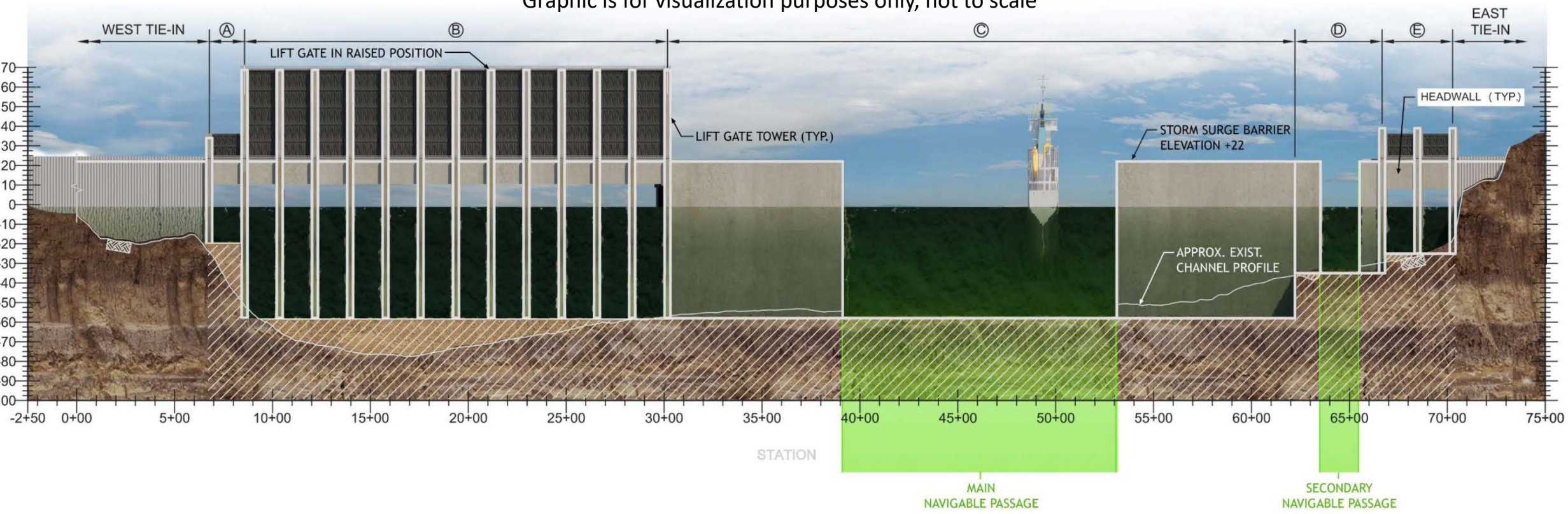
HATS evaluation of environmental effects of gated surge barriers – Peter Weppler and S. Kyle McKay



Surge Barrier Geometrical Characteristics and Considerations

Verrazano Narrows Storm Surge Barrier (looking north, gates in open position)

Graphic is for visualization purposes only, not to scale



LEGEND :

Ⓐ GATE SERIES (PER TABLE XX)

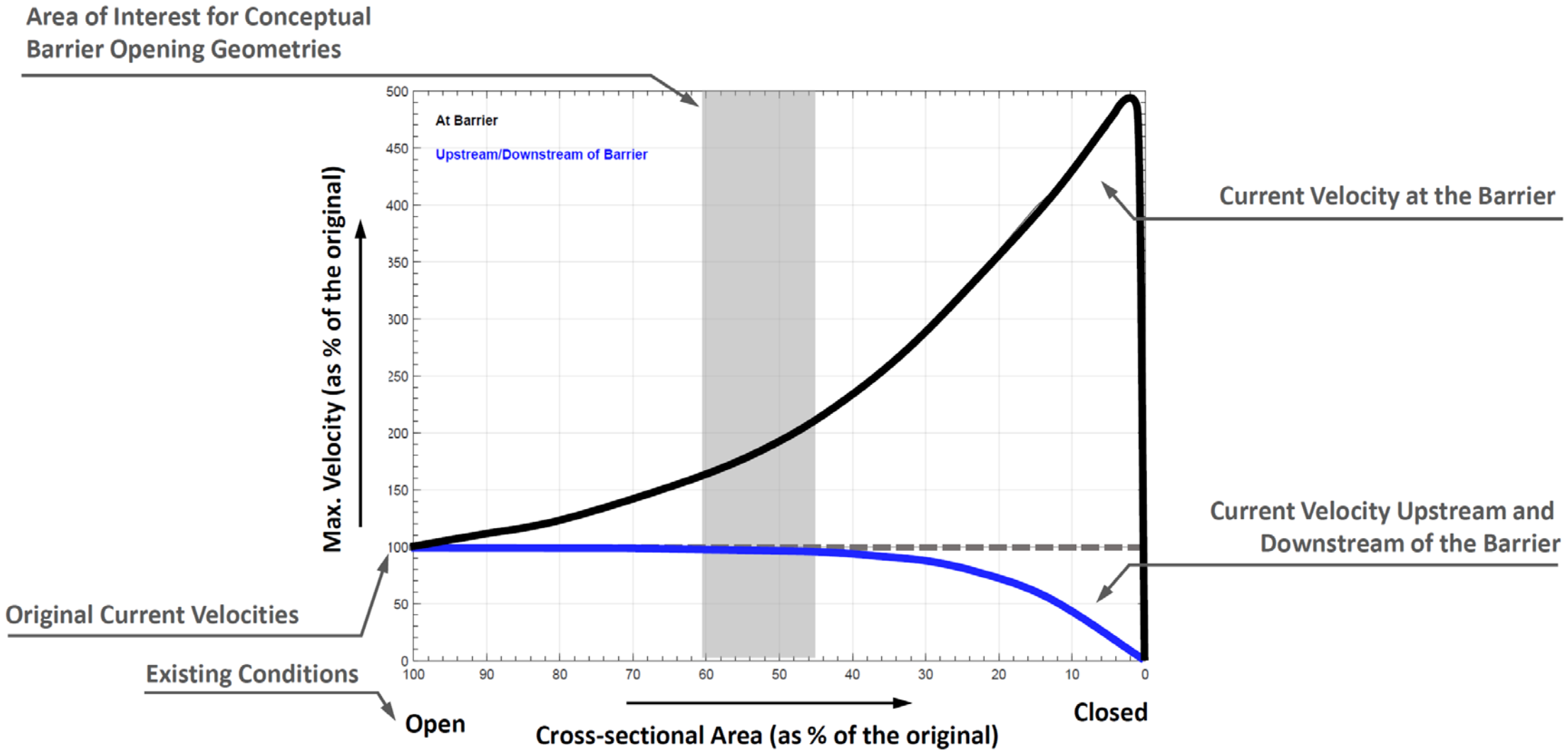
▨ GATE SILL AND FOUNDATION (TBD)

NOTE HORIZONTAL SCALE AND VERTICAL SCALE ARE DISTORTED

NOTES:

THIS ELEVATION VIEW SHOWS A CONCEPTUAL GEOMETRIC DESIGN. THIS PRELIMINARY DEPICTION OF THE GEOMETRY OF THE NAVIGABLE PASSAGES, AUXILIARY FLOW GATES AND STORM SURGE BARRIER CONFIGURATION SHALL NOT BE CONSTRUED AS RECOMMENDATIONS OR REQUIREMENTS FOR ACTUAL DESIGN FOR IMPLEMENTATION. SIGNIFICANT ADDITIONAL STUDY IS REQUIRED TO SUBSTANTIATE THE CONCEPTUAL DESIGN OF THIS STORM SURGE BARRIER.

HATS Preliminary Result – Effects on Flow Speeds



David Secor, Professor at the University of Maryland Center for Environmental Science, presented on “New York Harbor: High Stakes Ecological Corridor."

Suggested key questions were:

(1) Are the NY Bight, NY/NJ Harbor Estuary, and Hudson River discrete ecological provinces?
(2) Can impoundments make these provinces increasingly discrete?
(3) Could barriers work against faunal adaptations to climate change by curtailing connectivity across these provinces?

David Ralston, Associate Scientist at WHOI, explained estuarine and wetland processes to set up the discussion of potential surge barrier effects on salinity, sediment, and tidal wetlands.

Neil Ganju, Research Oceanographer at USGS, presented several points to consider for evaluating possible effects of surge barriers:

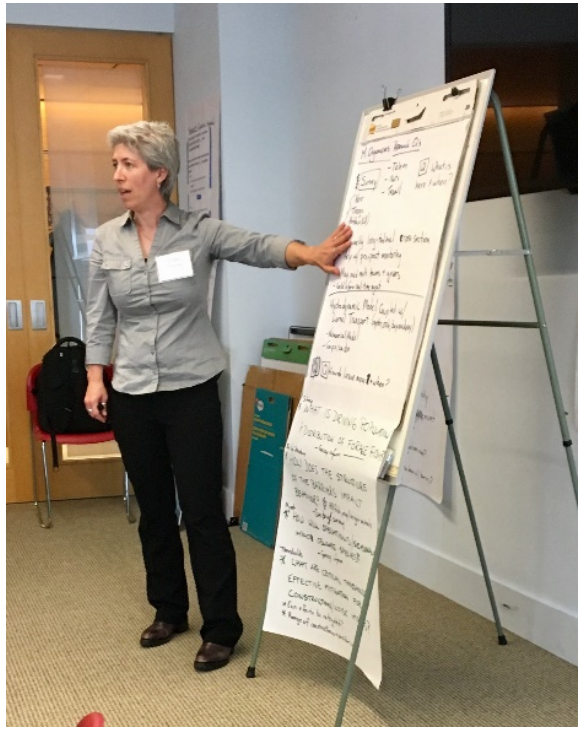
- Any reduction in tidal amplitude will decrease accretion through reduced biomass production and sediment deposition
- Any reduction in high water levels will decrease inundation time and sediment deposition
- Any reduction in water level in severe storms will modify edge erosion processes, depending on relative elevation of marsh
- Changes to harbor/estuary salinity or its extremes could cause an evolution of marsh species
- The barrier influence on sediment supply will depend on location relative to riverine and marine sediment loading
- Conceptual models for individual marsh complexes are helpful to diagnose future trajectory

Breakout Sessions

Migrating Organisms and Tidal Wetlands

The goal of both breakout sessions was to take in broad inputs and perspectives on the most important drivers and their potential effects on the system, and what information about drivers and their effects is available or could be sought.

We aimed to finish with a list of potentially important drivers, a catalog of what is known, a list of knowledge gaps and how they can be addressed.



Effects on Migrating Organisms

Organized organisms into 5 guilds to consider effects

- Marine mammals
- Obligate migrators (e.g., diadromous fishes - eels, sturgeon and shad)
- Marine fishes and other facultative migrators (e.g., bluefish, flounders and weakfish) and forage/bait fishes (e.g., menhaden, bay anchovy, Atlantic silversides)
- Invertebrate resource species (e.g., crabs, oysters)
- Drifting organisms (larvae, plankton)

Top voted drivers affecting migrating organisms across all guilds

- Seasonality – need to travel at specific times of year
- Flow/velocity
- Salinity
- Forage/food

Key themes - Migrating Organisms

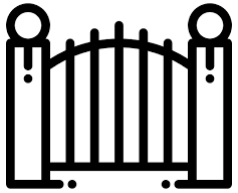
- Critical: What species use the regions where barriers are proposed. When? Where - in water or shoreline? What is driving population and distribution of forage fish?
- Limited knowledge of life cycle use of Harbor Estuary below Battery compared to Hudson north of Battery for most species
  - Some data exist from historical projects. Not well documented at proposed barrier locations. Limited in scope, scale, duration
- Could conduct bi-weekly census (telemetry, trawls, plankton nets) at proposed sites
  - Need experienced team in this highly trafficked area
  - Valuable as pre- and post-construction monitoring and for real-time management of the barrier

Key Themes – Migrating Organisms

- Larval species
  - How do they use or move through this area?
  - Use hydrodynamic model coupled with larval transport model to model different barrier locations. Corps Adaptive Hydraulics (ADH) model could be used with a Particle Tracking Model.
- Barrier construction and operation
  - Limited understanding of how the structure and operation of a barrier might affect animal behavior
  - What are critical thresholds for mitigation of construction and noise impacts?
- General agreement: Need for regular census, larval transport model
- Feasible: Can be done near-term – won't take decades to complete

Tidal Wetland Breakout Key Themes

- There is a need to study how wetlands would respond to the loss of storm-deposited sediment, as a result of barrier closure during storms, coupled with a diminished tidal range.
- Tidal range was discussed as a key driver for tidal wetlands, with priority research including what magnitude of tides and surge impact tidal wetlands and how tidal range amplifies sediment transport.
- There is a need to study the position of the Estuarine Turbidity Maximum (ETM), the location of sediment pools in proximity to individual wetlands and how fast they turn over.
- Detailed models may be a challenge to develop and may have biases, but may still be useful for understanding trends or processes. Conceptual modeling was also determined to be useful.



Update on Research Results and Ongoing Studies

Opportunity for updates on related research efforts – recently undertaken work and planned future studies

- NERRS- and NYSERDA-funded research (P. Orton and Ziyu Chen)
- USACE NY/NJ Harbor and Tributary Study – Recent and future environmental studies and needs (Kyle McKay; separate slide deck)
- Hudson River Foundation-funded studies (Jim Lodge; separate slide deck)

Stevens Surge Barrier Research Overview

- (2018) Preliminary evaluation of the physical influences of storm surge barriers on the estuary
  - Used pre-existing models to study how barriers with open gates influence estuary physical conditions
- (NERR-SC) Quantifying gate closures, given case of constant trigger water level (NERR-SC funding)
  - Management strategy #1: Rise in gate closure frequency, duration with sea level rise
  - Management strategy #2: Rise in waterfront elevations with SLR (raising the trigger water level)
- (NERR-SC) Inter-comparisons of existing model results – do models agree?
- (NYSERDA) Quantifying trapped water levels and how they change with SLR
- (NYSERDA) Modeling the influence of various closure durations and frequencies on estuary physical conditions

Storm Surge Barrier Closure Frequency, Duration and Trapped River Flooding Analysis

Ziyu Chen, Stevens Institute of Technology
Philip Orton, Stevens Institute of Technology
Thomas Wahl, University of South Florida

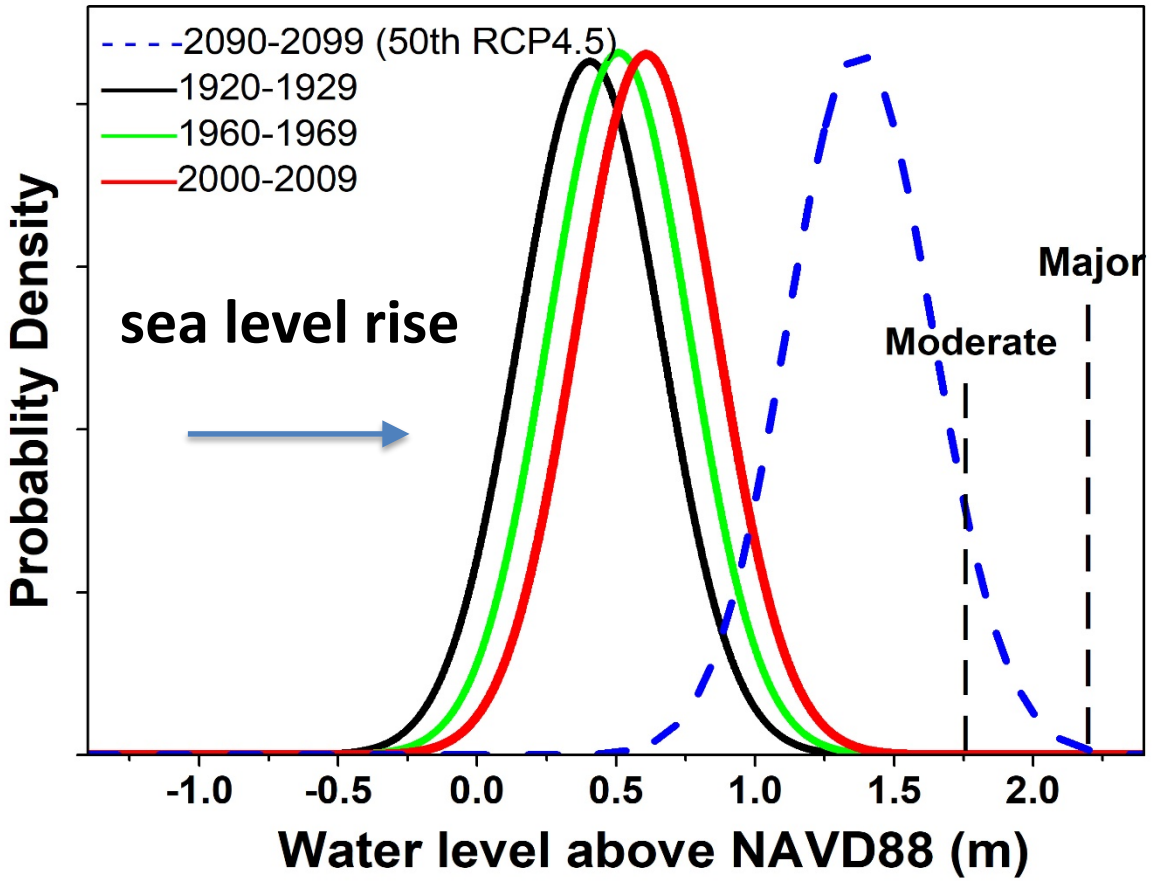
Primary Funding:
NOAA National Estuarine Research Reserve Science Collaborative

Gate closure “trigger” water level

NWS “**moderate flood**” level of 1.74 m: some inundation of structures and roads near the stream.
NWS “**major flood**” level of 2.20 m: extensive inundation; significant threats to life and property.

Closure frequency and duration

Sea level rise will **increase the frequency** of trigger water level exceedances and lengthen the closure duration.

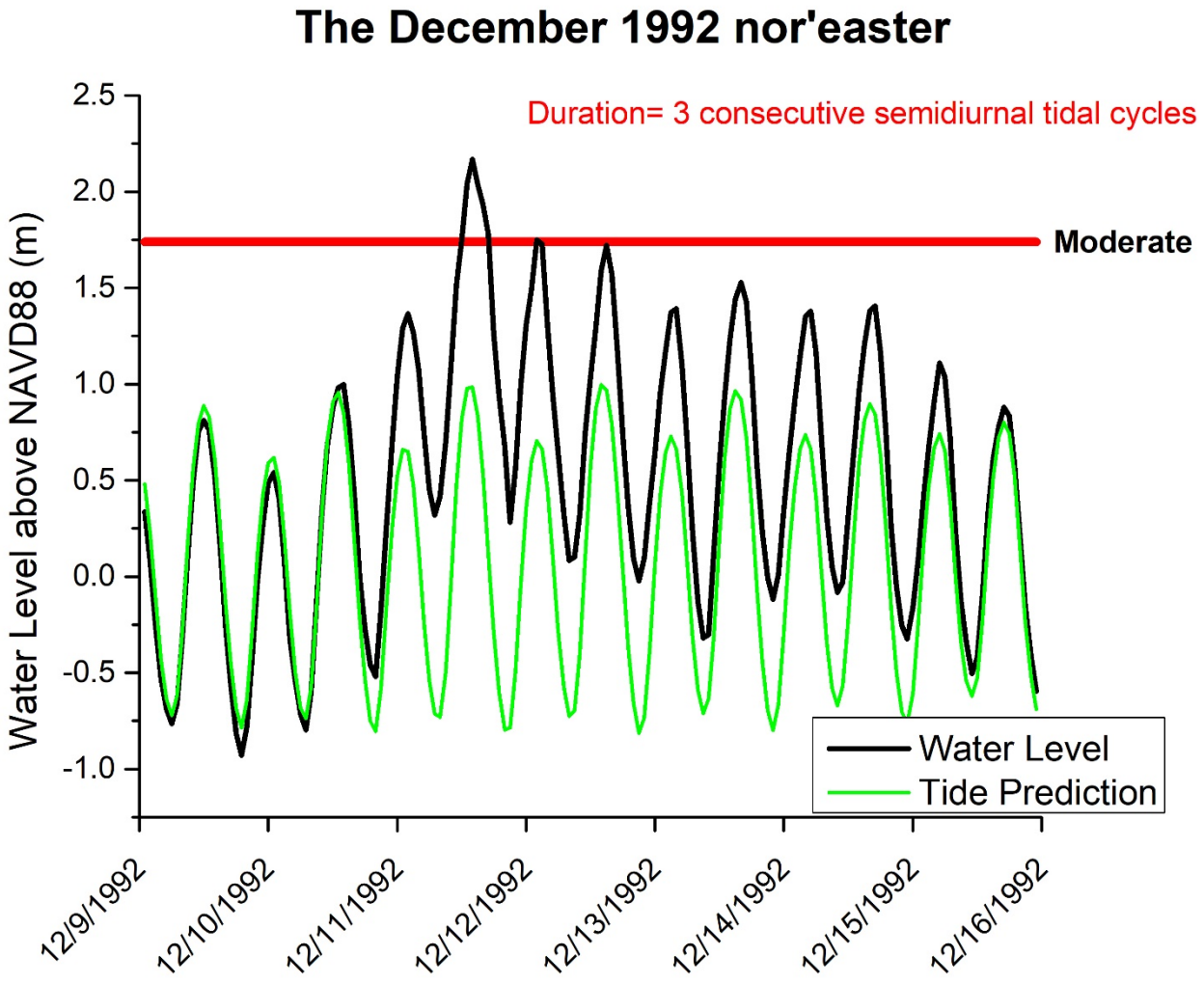


Gate closure “trigger” water level

NWS “**moderate flood**” level of 1.74 m: some inundation of structures and roads near the stream.
NWS “**major flood**” level of 2.20 m: extensive inundation; significant threats to life and property.

Closure frequency and duration

Sea level rise will increase the frequency of trigger water level exceedances and **lengthen the closure duration**.



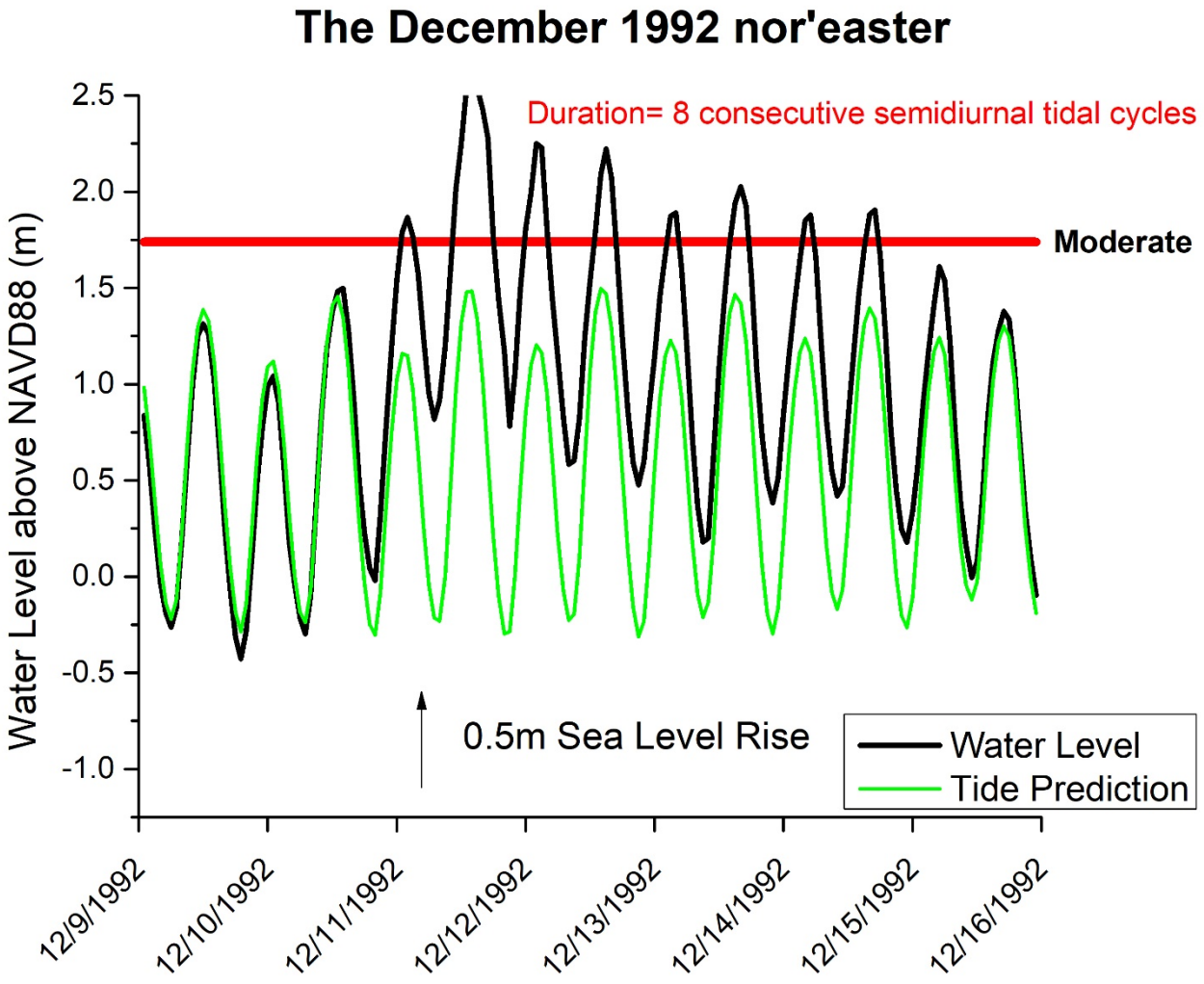
Gate closure “trigger” water level

NWS “**moderate flood**” level of 1.74 m: some inundation of structures and roads near the stream.
NWS “**major flood**” level of 2.20 m: extensive inundation; significant threats to life and property.

Closure frequency and duration

Sea level rise will increase the frequency of trigger water level exceedances and **lengthen the closure duration**.

Potential long closure duration may cause **trapped river flooding** behind the surge barrier.



Observed water level data

Stochastic storm-driven and tide-driven variability

Impacts of forecast uncertainty

Synthesized forecast peak water level values by incorporating forecast uncertainty

Local sea-level rise projections

water level future evolution with sea level rise

NWS trigger water level

SLR superimposition

Gate Closure Frequency Analysis
Gate Closure Frequency-Duration Analysis

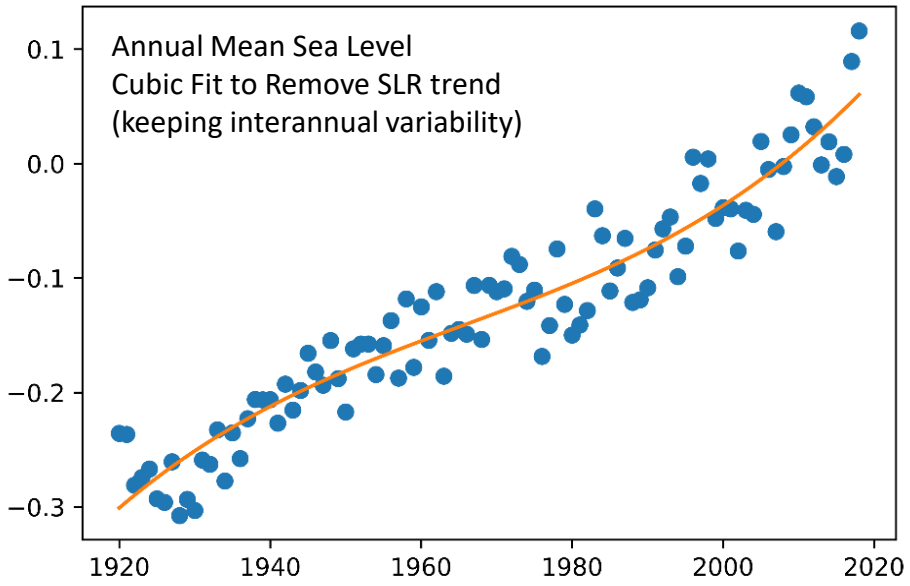
Observed stream flow data
NYHOPS hydrodynamic model

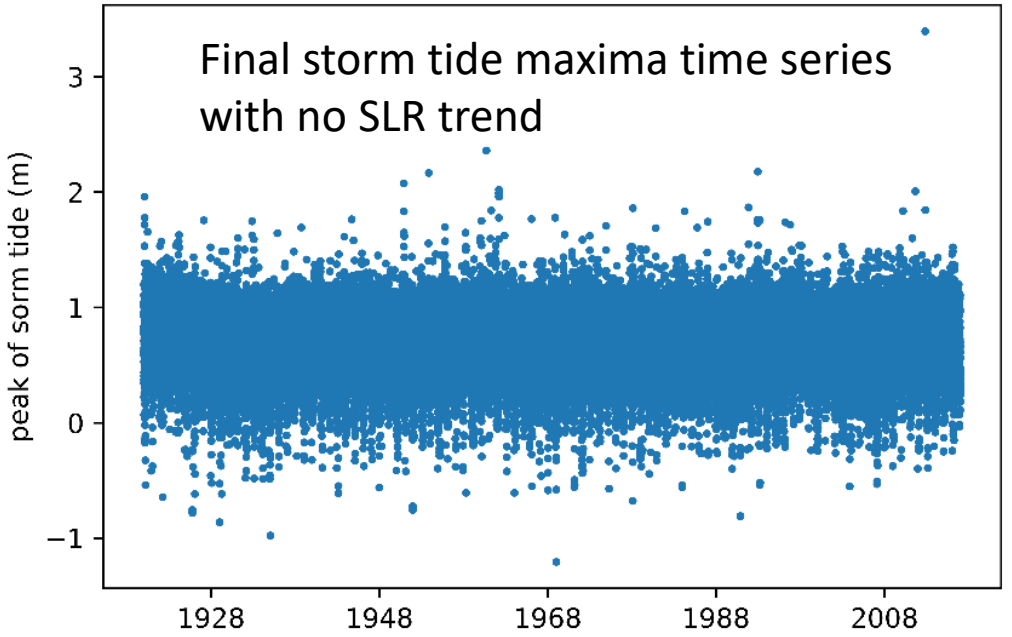
Compare with no forecast uncertainty

Trapped River Flooding Risk Analysis

Observed water level data

- Start with 1920-2019 water level data at Battery and remove SLR trend
- Compute semidiurnal maxima
- Use the detrend data to empirically represent stochastic storm-driven and tide-driven variability in harbor extreme water levels





Observed water level data

Stochastic storm-driven and tide-driven variability

Impacts of forecast uncertainty

Synthesized forecast peak water level values by incorporating forecast uncertainty

Local sea-level rise projections

water level future evolution with sea level rise

NWS trigger water level

SLR superimposition

Gate Closure Frequency Analysis
Gate Closure Frequency-Duration Analysis

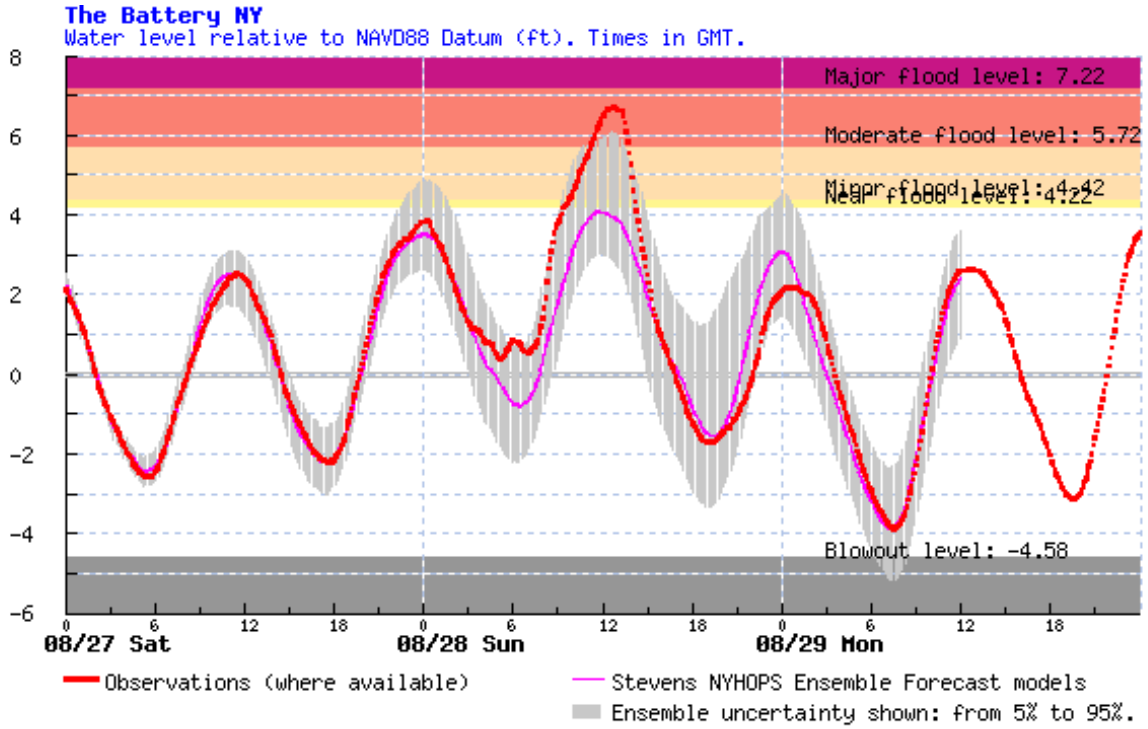
Observed stream flow data
NYHOPS hydrodynamic model

Compare with no forecast uncertainty

Trapped River Flooding Risk Analysis

Impacts of forecast uncertainty

- In the practical operation of the surge barrier system, the gate closure criterion is based on the forecast of water levels;
- For a risk-averse purpose, barrier will close even if there is a small chance of flooding



- Quantify typical uncertainty in water level forecasts and its dependence on storm surge from an established operational forecast system. (24h Forecasts "High-end uncertainty" = 0.186*Surge+0.107)
- Incorporate forecast uncertainty to the historical data to synthesize 95th percentile forecasted values

Observed water level data

Stochastic storm-driven and tide-driven variability

Impacts of forecast uncertainty

Synthesized forecast peak water level values by incorporating forecast uncertainty

Local sea-level rise projections

water level future evolution with sea level rise

NWS trigger water level

SLR superimposition

Gate Closure Frequency Analysis
Gate Closure Frequency-Duration Analysis

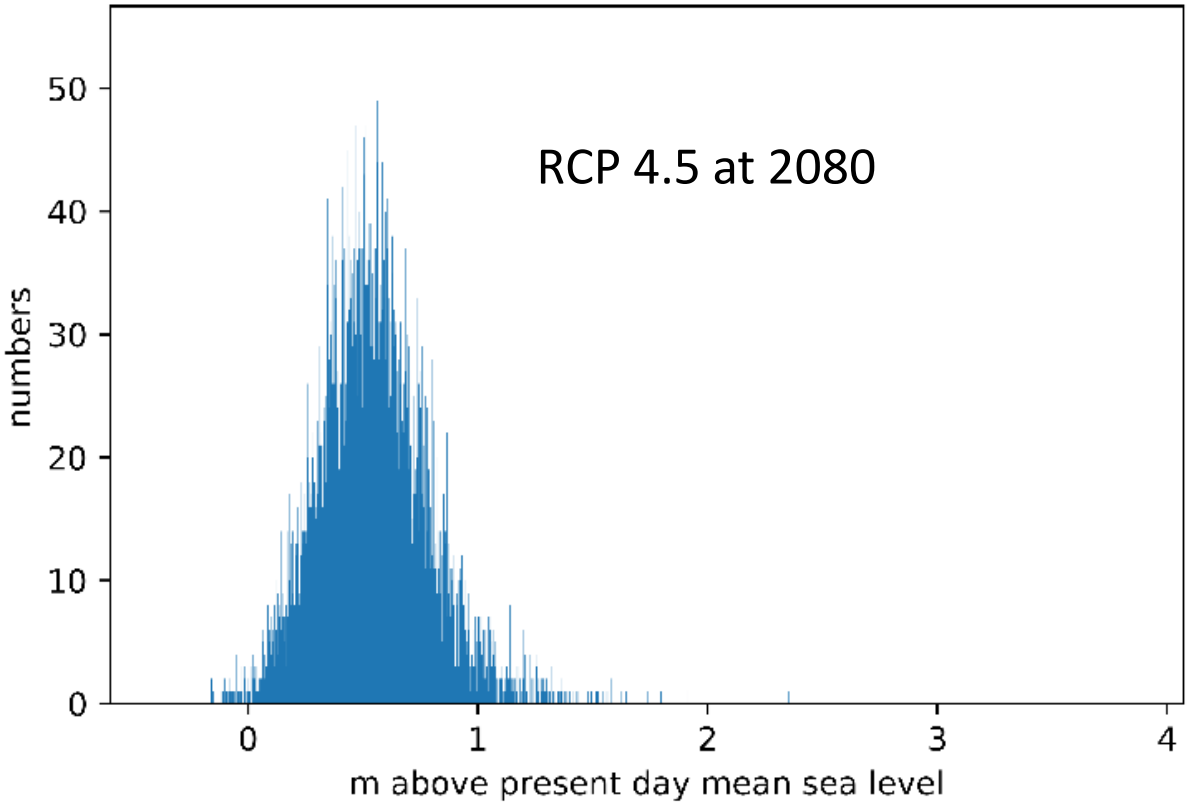
Observed stream flow data
NYHOPS hydrodynamic model

Compare with no forecast uncertainty

Trapped River Flooding Risk Analysis

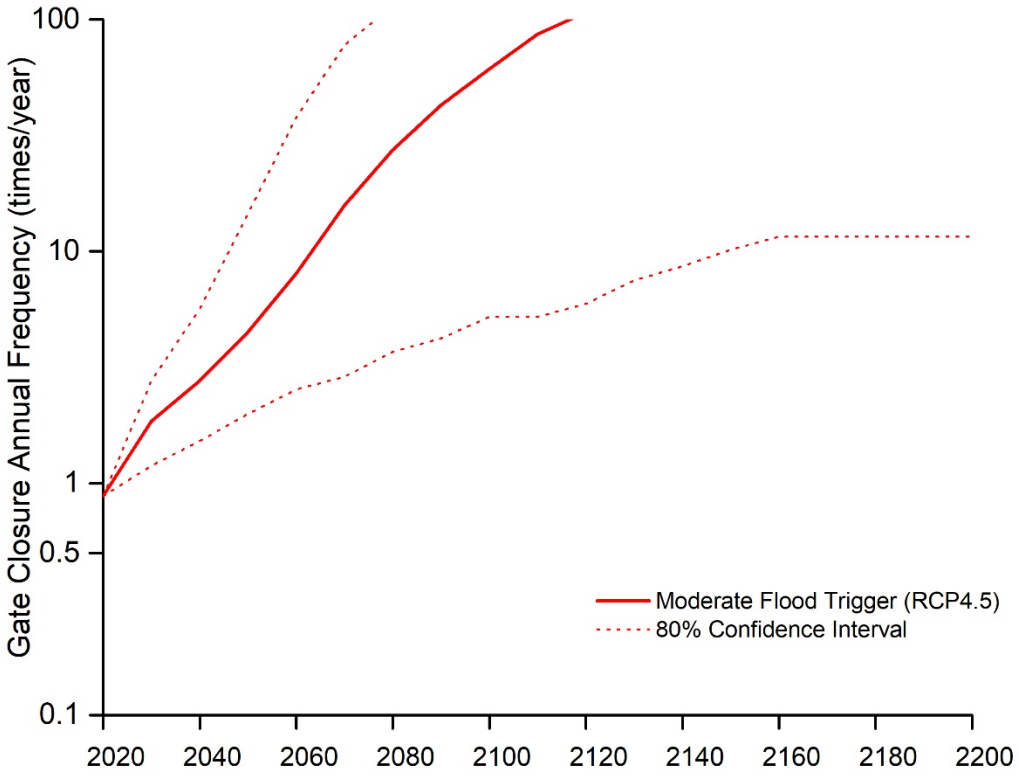
Local sea-level rise projections

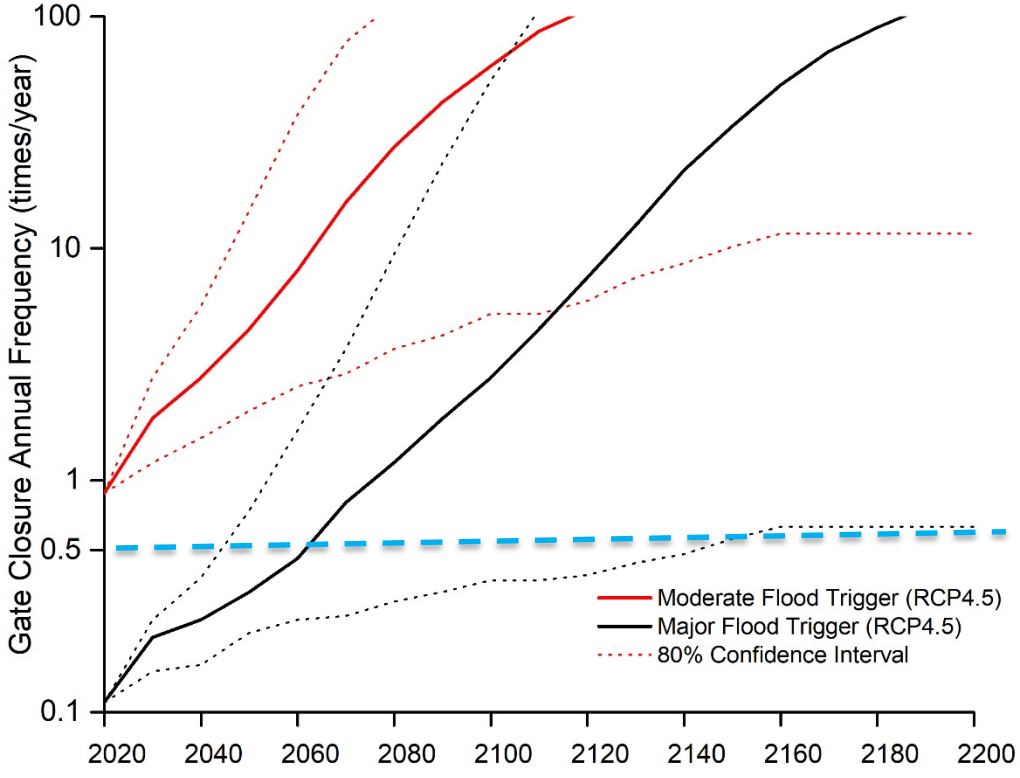
- Use probabilistic SLR distribution at each decadal time points from 2020 to 2200 (Kopp et al. 2014; Sweet et al. 2017)
  - RCP4.5 IPCC moderate emissions pathway
  - RCP8.5 IPCC high emissions pathway



- Superimpose the 10th 50th, 90th percentile SLR data on the water level to simulate their future evolution with sea level rise

Result: **Surge barrier closure management strategy 1**

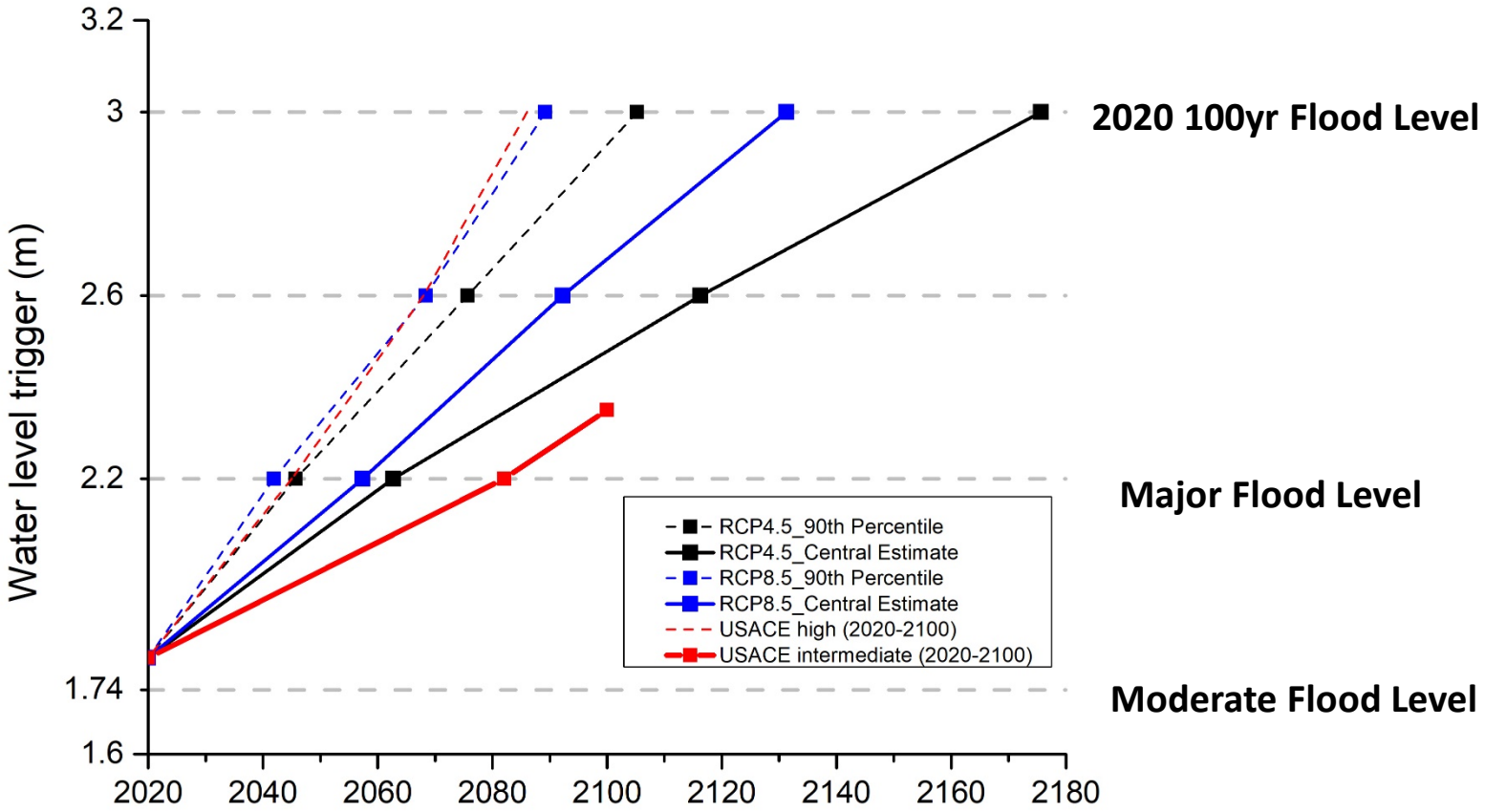




- The trigger water level (moderate vs major flood) has a strong influence on the number of closures
- The annual gate closures frequency has a high uncertainty due to sea level rise

Result: Surge barrier closure management strategy 2

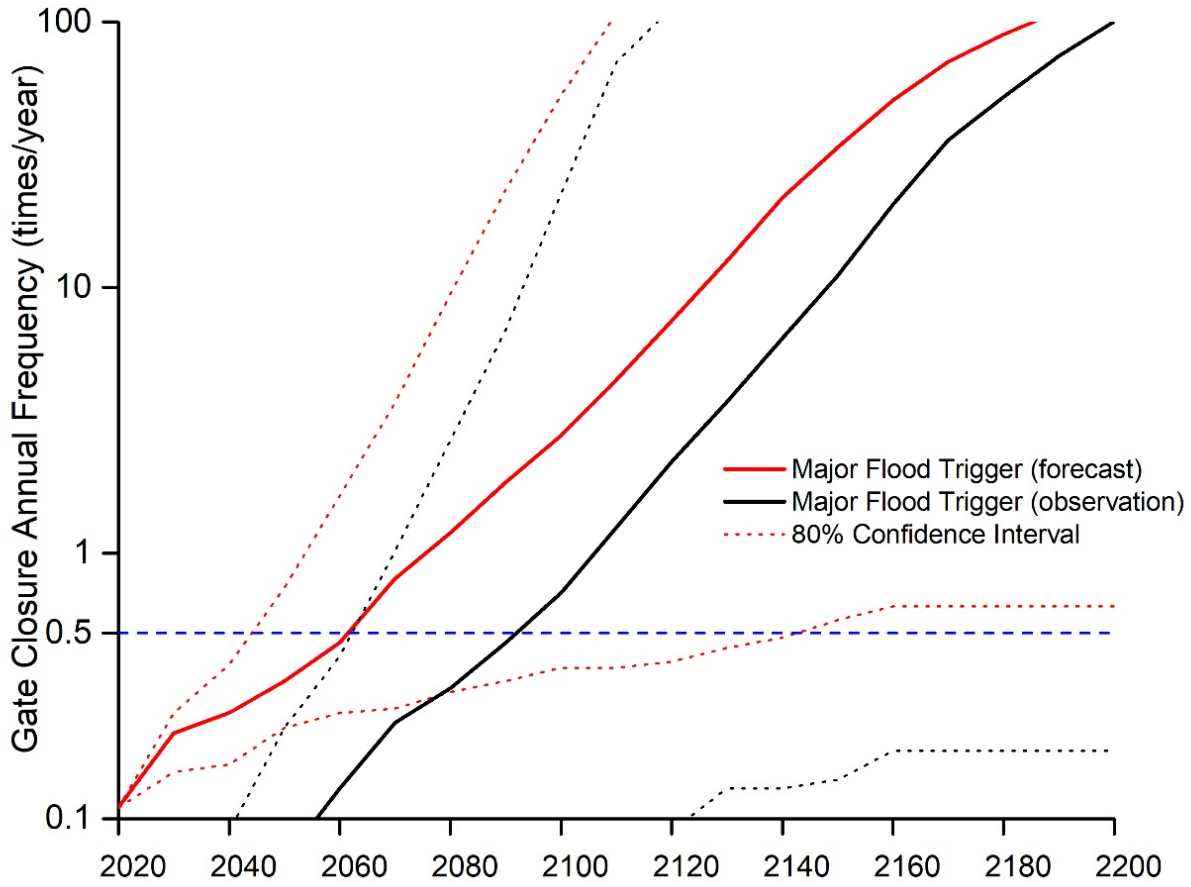
(Allowing for closures up to average 0.5/year)

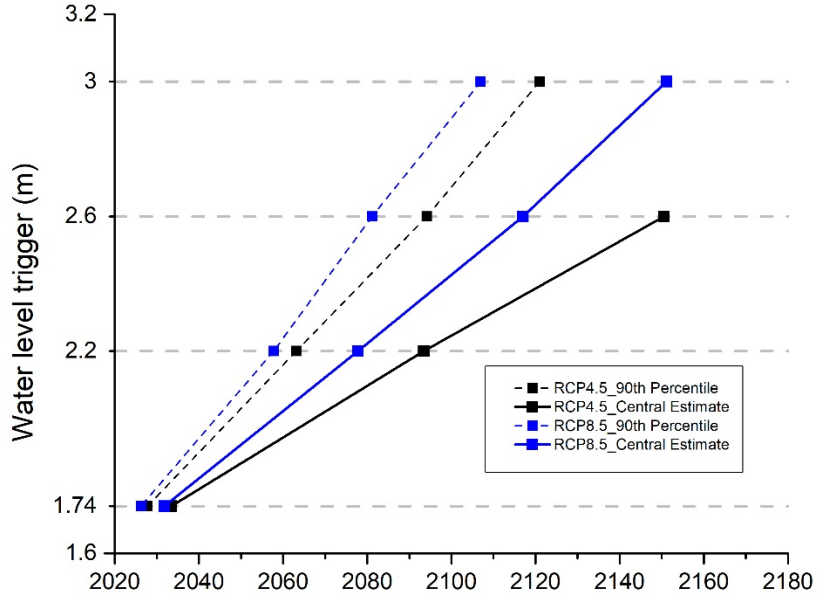


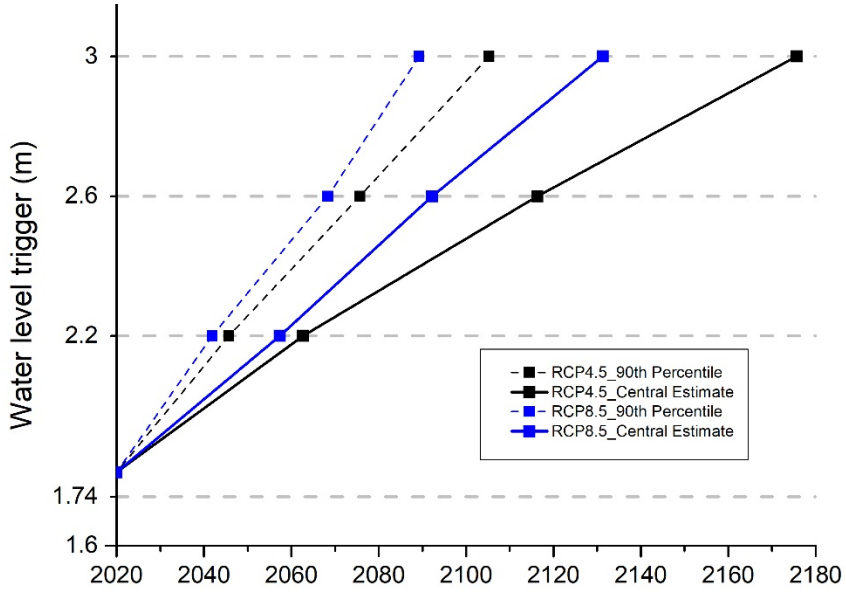
Note: we only have USACE SLR projection to 2100
http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html

- A higher water level trigger requires higher waterfront seawalls (etc) to stop flooding
- This can lead to a longer system Useful-Time-Horizon
- The Barrier/Seawall system's Useful-Time-Horizon has great uncertainty
- The waterfront elevation calculated by USACE intermediate SLR(used for cost benefit analysis) is below the RCP4.5 central estimate and far below the RCP8.5

The Importance of the forecast uncertainty

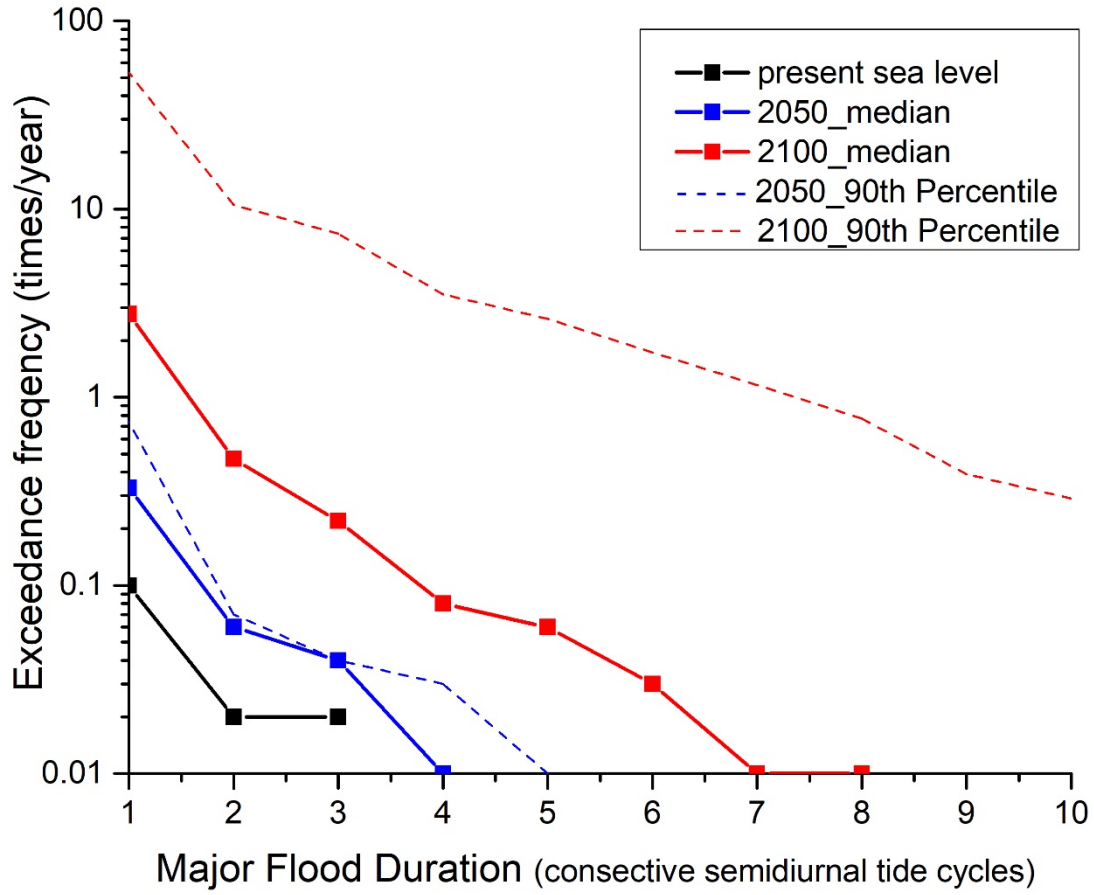






Result: Gate Closure Frequency-Duration Analysis

Assumed trigger – NWS Major Flood level (2.20m) RCP4.5

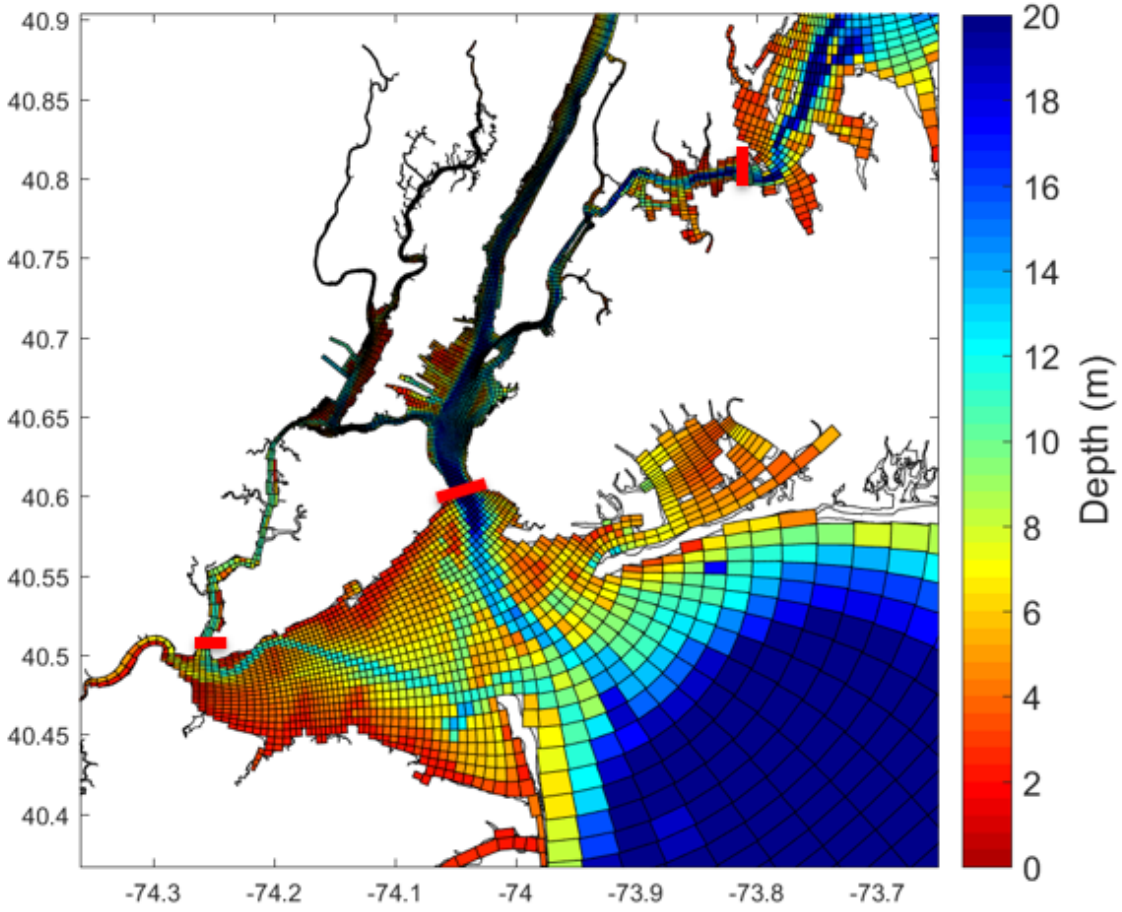


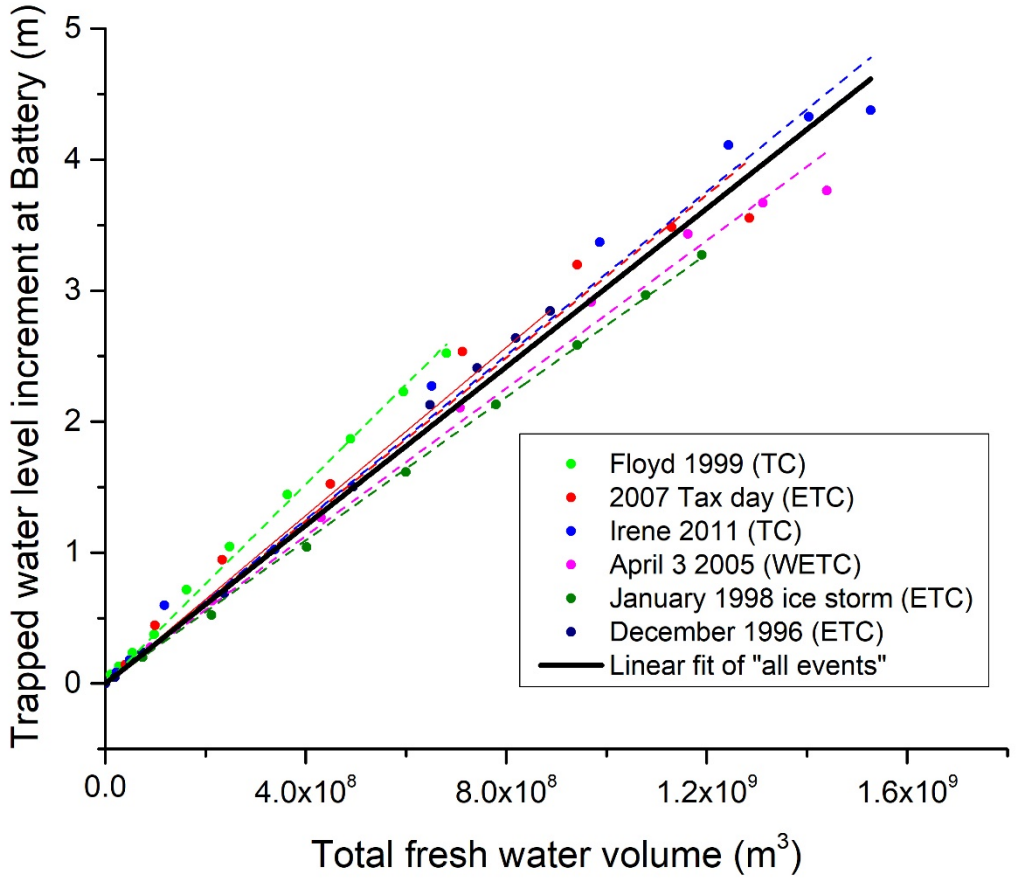
- If using a constant trigger water level, SLR causes increasing closure frequency and closure duration

Trapped River Flooding Analysis

Hydrodynamic modeling: Model historical flood to obtain a simple relationship between trapped water volume and water level at Battery.

Historical streamflow data: Use nearby available 16 USGS gauges and fill gaps by empirical method.



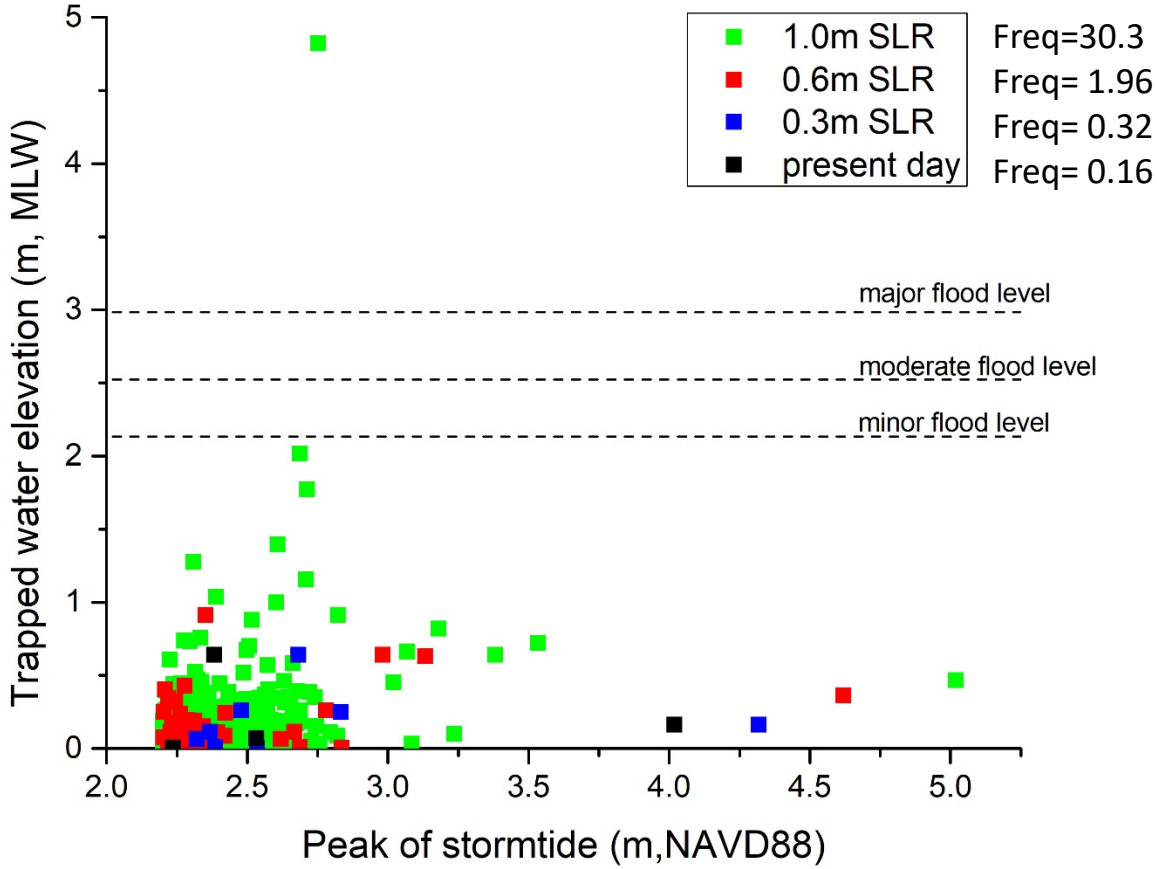


Trapped River Flooding Analysis

Temporally matching all hourly historical streamflow data(1990-2014) with water level data

Assume constant “Major flood” trigger water level

Assume close the gate at MLW



- There is small risk of trapped river flood under a 0.6m sea level rise

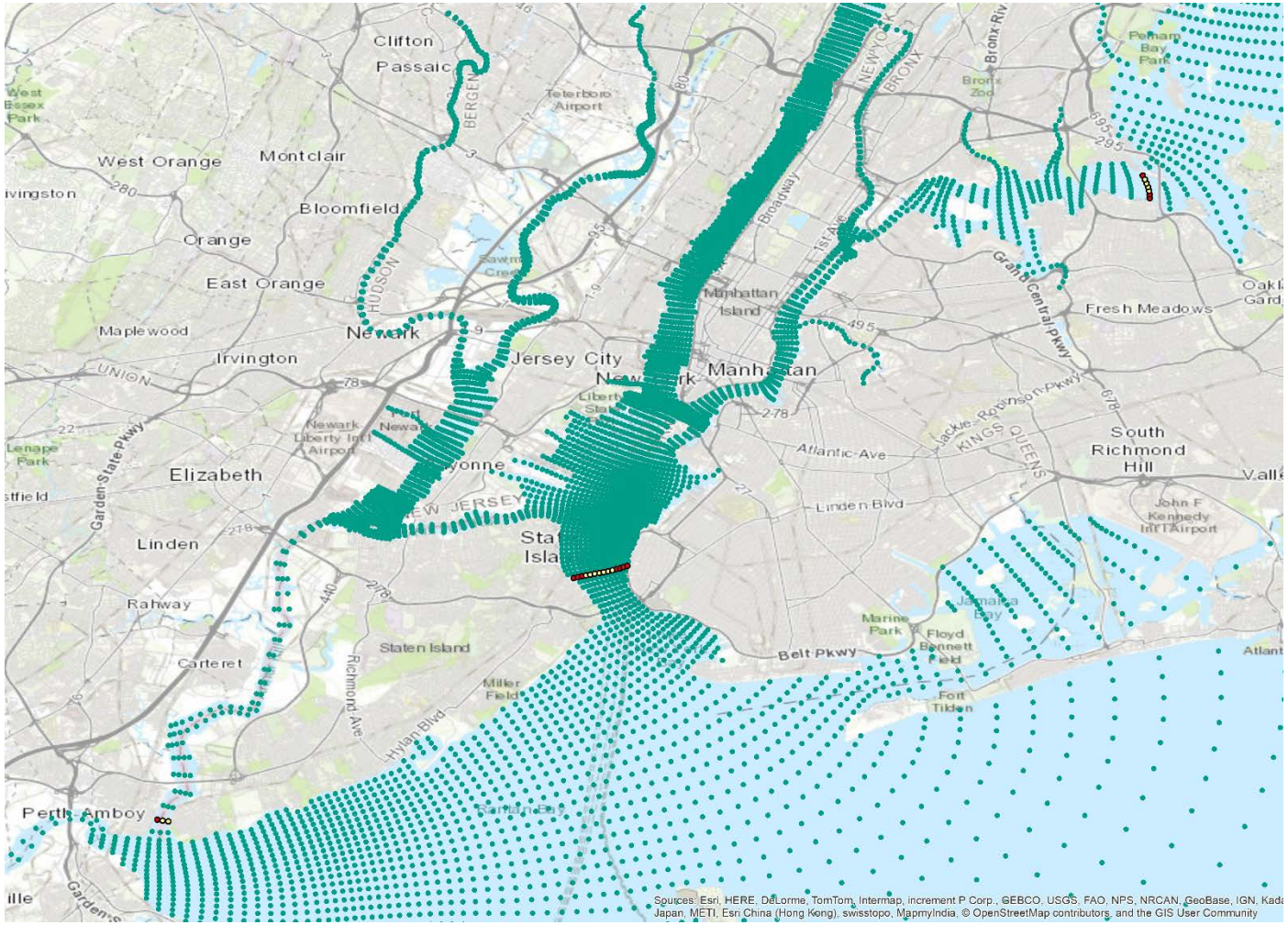
Conclusions

- Taking account of forecast uncertainty results in a substantially greater number of barrier gate closures than using the observed water level
- The time of arrival of a 0.5/year closure frequency has high uncertainty due to sea level rise, even if emissions trajectory uncertainty is ignored.
- If closures are managed by a constant water level trigger:
  - Sea level rise causes both increasing closure frequency and duration
  - The probability of trapped river water flooding is presently very low. Increasing sea levels leads to an increase in this probability, but closure frequency is a much bigger challenge.
- If closures are managed by a maximum gate closure frequency (e.g. 0.5/year):
  - Seawalls will need to be raised higher up front and again in future decades.
  - The USACE intermediate SLR is below the RCP4.5 central estimate and well below the RCP4.5 90% percentile. Therefore, HATS may underestimate the cost of seawalls (and the benefit of reduced flood damage) for their cost-benefit analysis.

Barrier Closure Effects on Estuary Physical Conditions

Methods: Closed Surge Barrier Influences on Estuary Physical Conditions

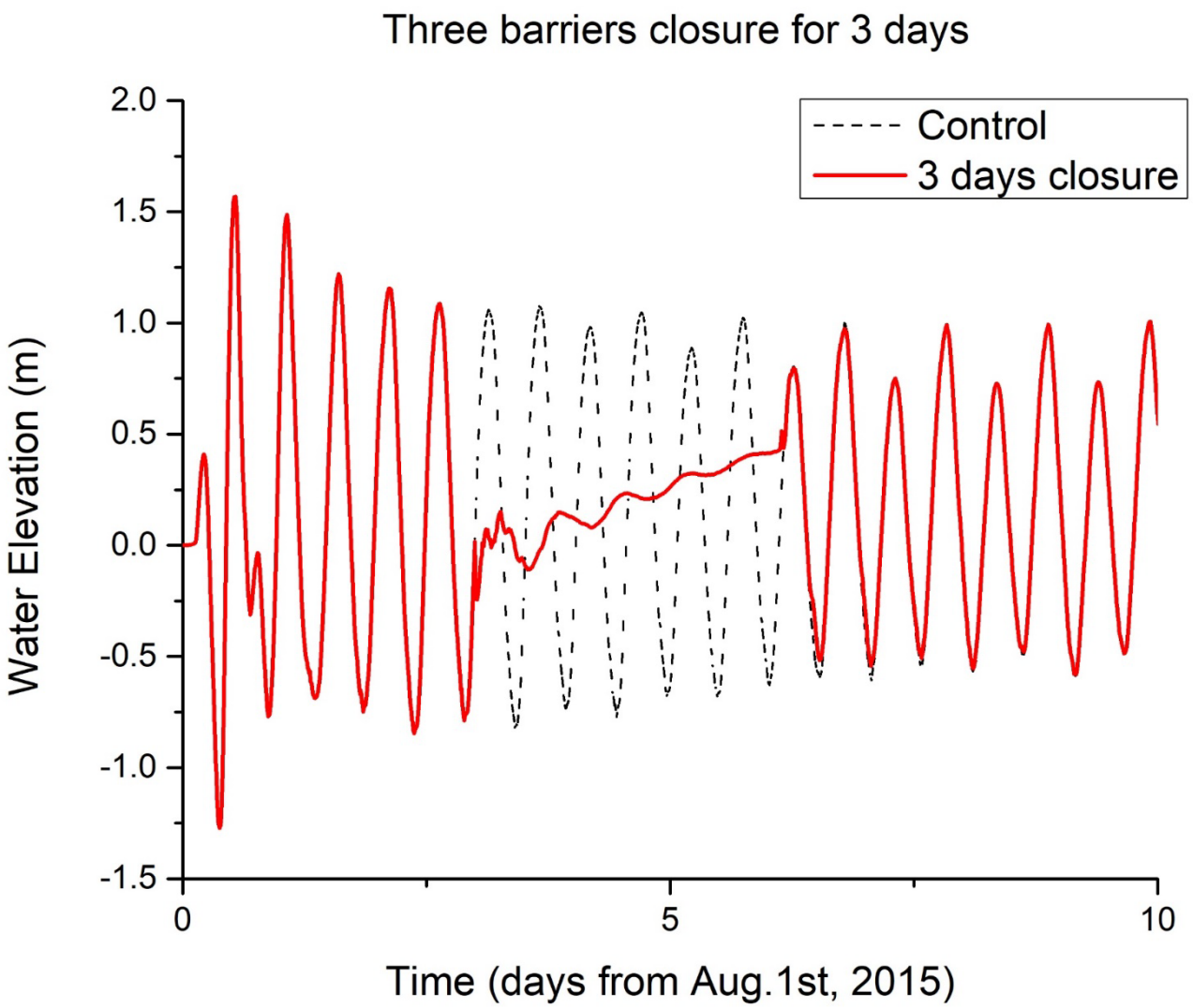
- GOAL: study effects of barrier closures on estuary physical conditions
- Again using the sECOM model, NYHOPS domain
- Modifying the model bathymetry to represent fixed surge barrier components (red dots on map)
- Using model code edits from HDR Inc to enable open/close capability for gates (white dots)
- Plan to use at least 10 tide and storm simulations with different closure duration, closure frequency



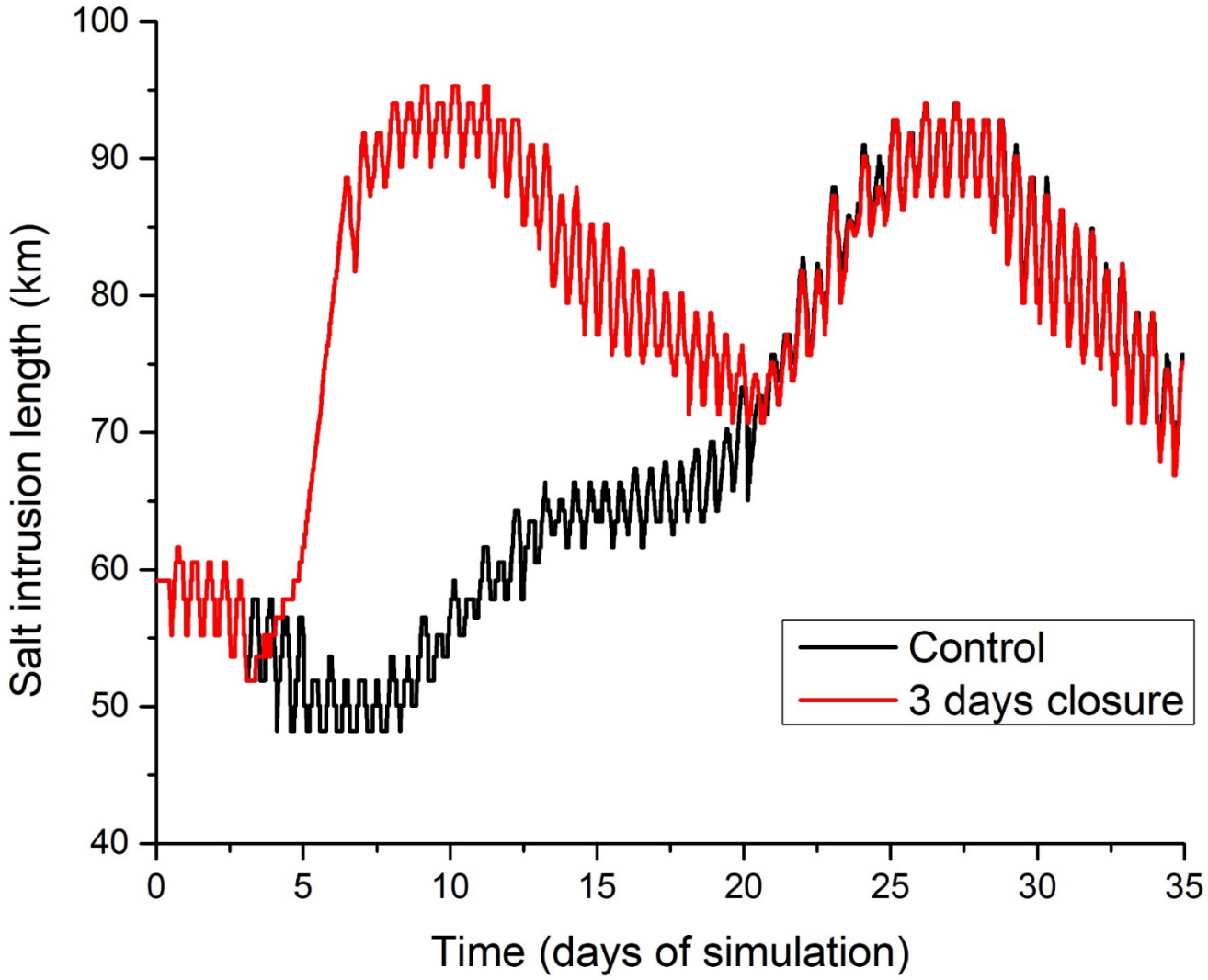
Methods: Closed Surge Barrier Influences on Estuary Physical Conditions

- GOAL: study effects of barrier closures on estuary physical conditions
- Again using the sECOM model, NYHOPS domain
- Modifying the model bathymetry to represent fixed surge barrier components (red dots on map)
- Using model code edits from HDR Inc to enable open/close capability for gates (white dots)
- Plan to use at least 10 tide and storm simulations with different closure duration, closure frequency

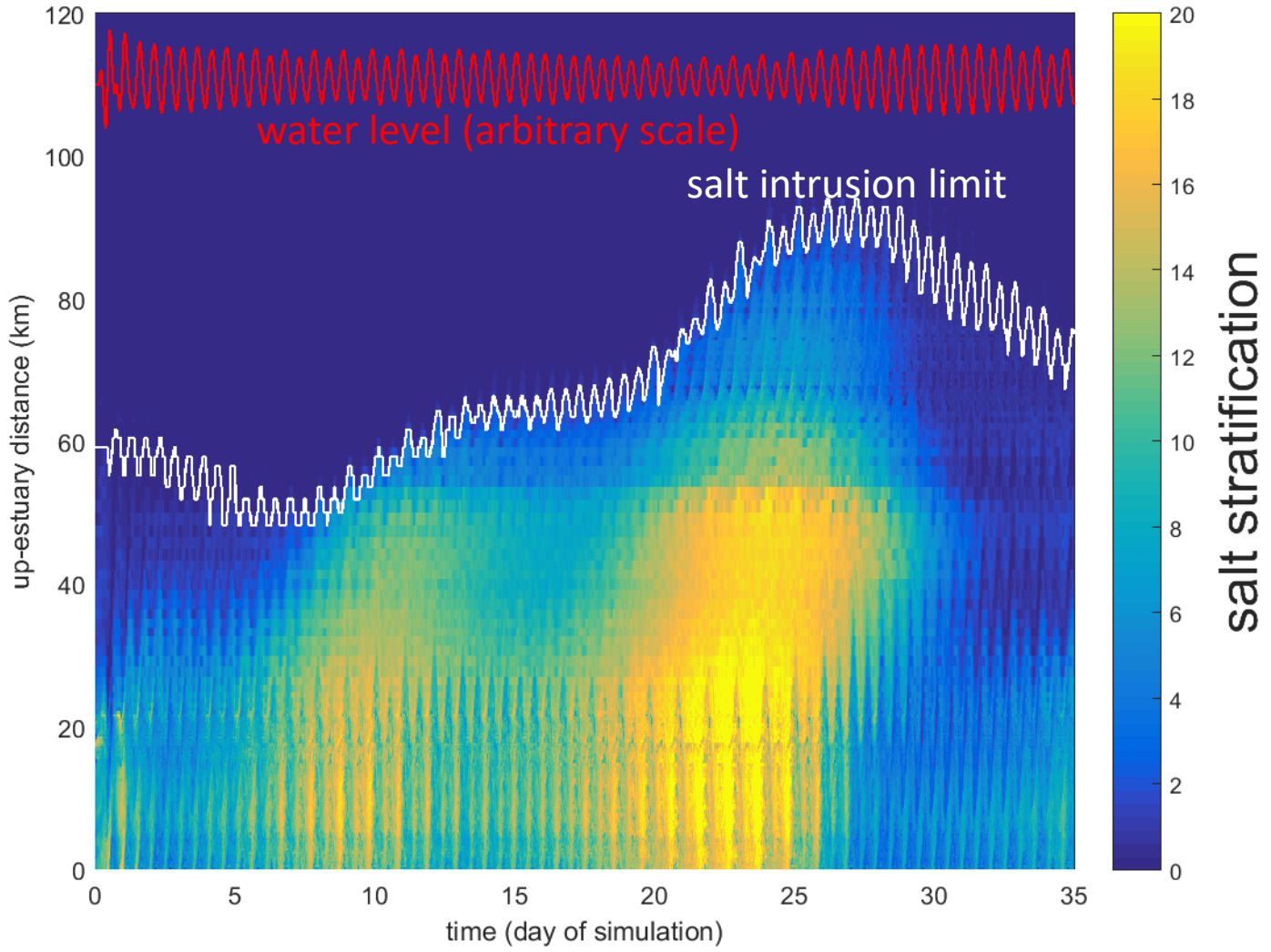
Preliminary Results: Simulation of Gate Closure



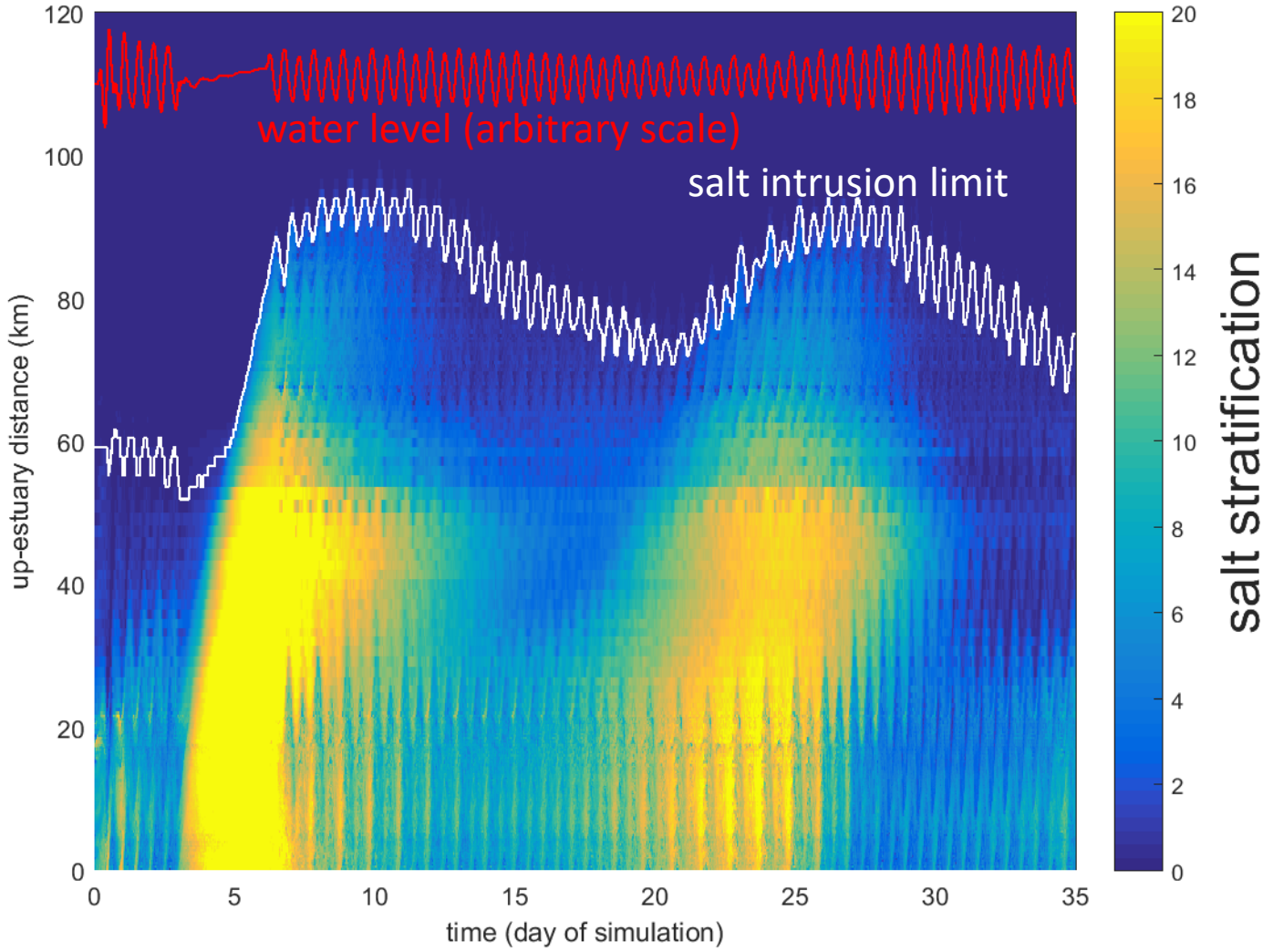
Preliminary Results: Simulation of Gate Closure



Preliminary Results: Simulation of Gate Closure



Preliminary Results: Simulation of Gate Closure



Future Work: Model Simulation Grid

Table 1: Set of model experiments

Storm event	Number of closures	Simulation duration	Model DEM(s)	Streamflows
Tides only – no flood	0	3 months	open gates	Mean
Tides only- no flood	0	3 months	control (NYHOPS)	Mean
Tides only- no flood	1	3 months	open/closed gates	Mean
Tides only- no flood	3	3 months	open/closed gates	Mean
1-day flood	0	3 months	control	Storm
1-day flood	1	3 months	open/closed gates	Storm
1-day flood	3	3 months	open/closed gates	Storm
3-day flood	0	3 months	control	Storm
3-day flood	1	3 months	open/closed gates	Storm
3-day flood	3	3 months	open/closed gates	Storm

Research Schedule

Deliverable	Expected Completion
Publication submission for barrier closure frequency, duration + analysis tools and data posted on GitHub	March 1
Technical report on NERR-funded research – closure frequency, duration, and model intercomparisons	March 15
Technical Report on Closed Barrier Analyses (NYSERDA) – estuary physical changes, trapped water levels	March 28
Chen Dissertation	ongoing

McKay / USACE Presentation (separate)

Lodge / HRF Presentation (separate slide deck)

Identifying Future Research Needs and Priorities

Discussion among workshop participants to identify top research priorities related to the environmental effects of surge barriers

- Presentation and discussion on Priority #1: Effects on tidal wetland sediment supply (P. Orton)
- Presentation and discussion of Priority #2: Comprehensive survey of migrating organisms (K. Marcell)
- Open discussion on other priority research needs

Identifying Future Research Needs

Wetlands and Sediment

What we know:

- Tides, low-frequency water level, salinity and sediment are primary factors in wetland stability and evolution
- Estuaries are excellent sediment traps, focusing sediment deposition and resuspension in the region around the salt front
- Coastal storm events provide a large source of sediment to the NYNJ Harbor region and its wetlands
- Location of a tidal wetland is a critical factor in how estuary physical changes would affect any given wetland
- Low tide range and lack of sediment can lead to ponding and collapse
- Storm erosion occurs primarily in high-frequency events via wave energy. In larger storms low frequency storms the water is too deep to cause edge erosion.

Identifying Future Research Needs

Wetlands and Sediment

Needs Identified in report

- What is the spatial relationship of existing wetlands to sediment reservoirs and their variability?
- Geomorphically-relevant events for tidal wetlands – How do tides and surges affect accretion?
- How accurately do current hydrodynamic models capture effects of gate structures on estuary spring or king tides?

Pre-Proposal to NERR Science Collaborative:

"*Effects of Surge Barriers and Climate Change on Hudson River Tidal Marshes and Ecosystems*"

- Three years: October 1, 2020 to September 30, 2023
- Two main objectives:
  - (1) continue our collaborative process among scientists and end-users to broadly assess surge barrier effects, and
  - (2) conduct field measurements, analyses and modeling to assess how climate change and possible surge barriers will influence sediment delivery to tidal wetlands.
- Project team: Orton, Brooks, Fernald, Marcell, + new members:
  - Emilie Hauser – HR-NERR, NY-DEC
  - Jon Miller, Reza Marsooli – Stevens
  - Brian Yellen, Jon Woodruff – University of Massachusetts Amherst

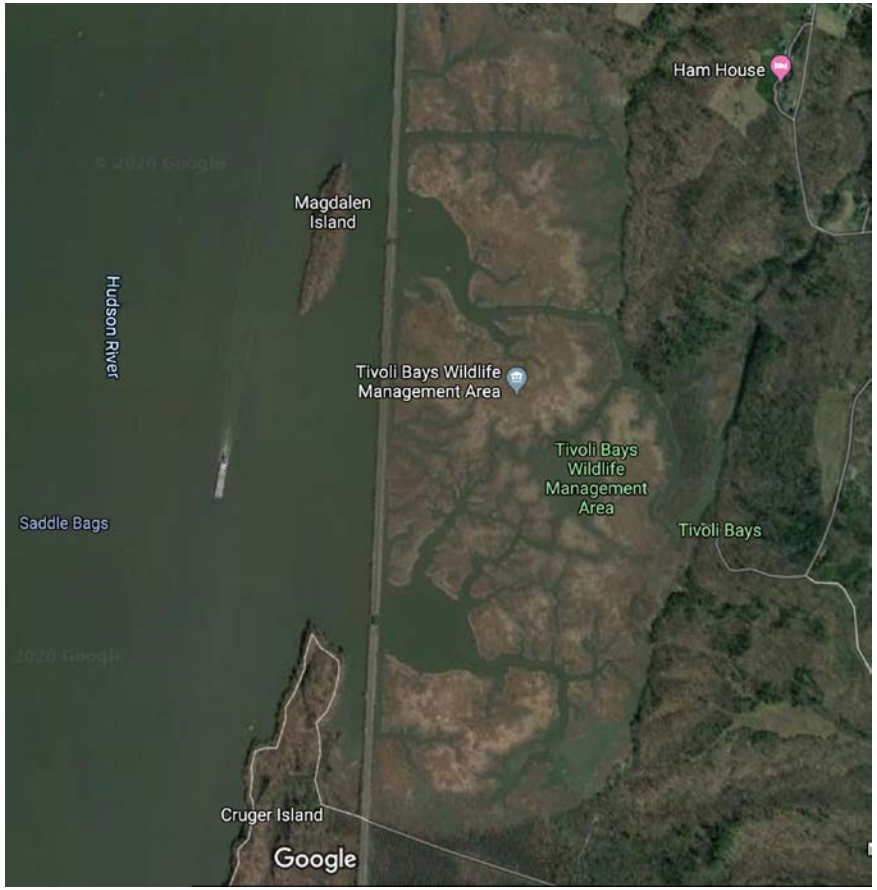
Central Scientific Questions

- Surge barrier related changes include reductions in high-tide levels and elimination of extreme storm surge events. Climate-related changes include changes to mean sea level, salt intrusion and streamflow.
- Three sub-questions include:
  - What magnitude of tides and surges are important for long-term accretion on the Hudson's tidal wetlands?
  - How will climate change and possible surge barriers affect sediment delivery to tidal marshes?
  - How do these answers vary with distance from the marsh edge or distance up the estuary?

Study Sites

Piermont (river km 38, a brackish river reach)

Tivoli North (river km 158, a freshwater river reach)



Technical Approach

1) Analysis of existing turbidity and water level data
2) Full water column monitoring at Piermont Marsh and Tivoli North Bay
3) Sediment coring and surveys
4) Detailed estuary-marsh modeling of storms and tides

Collaborative Process

1) A sustained cycle of annual surge barrier environmental effects workshops
2) Project Advisory Committee guidance
3) A network of external researchers and co-collaborators

Requested External Partners

- Dave Ralston (WHOI) will provide estuary-scale modeling of sediment reservoirs in relation to tidal wetlands under his Hudson River Foundation-funded project.
- Neil Ganju (USGS) will help guide development of conceptual models for tidal marsh sedimentary systems, as well as hosting the PhD student as a visiting collaborator at USGS/WHOI in May 2021.
- Gregg Kenney is the head of NYSDEC's Hudson River Fisheries Unit, and can contribute regarding the use of tidal marshes as fish habitat.
- David Secor (University of Maryland Center for Environmental Science) will continue to work on conceptual modeling of fish migration.
- Kyle McKay (USACE) is a primary end user in charge of developing and refining conceptual environmental models for the HAT Study.
- Bryce Wisemiller (USACE and project director for the HAT Study) is a primary end user.

Outputs and Outcomes

- Outputs:
  - Decision-support conceptual models and detailed models, webinars, conference presentations, reports and publications.

- Outcomes:
  - Continued expansion of the collaborating research community,
  - an improved scientific basis for decision-making for the HAT Study,
  - and broader communication of surge barrier assessment knowledge to other researchers and NERRS sites.

- If we're invited to submit a full proposal, they are due in April

Identifying Future Research Needs

Wetlands and Sediment

Discussion Questions

- Did we miss anything?
- What else could be studied related to this topic ?
- Are there researchers, other than those we have contacted, who could add their expertise to answering these questions?

Migrating Organisms

Kristin Marcell

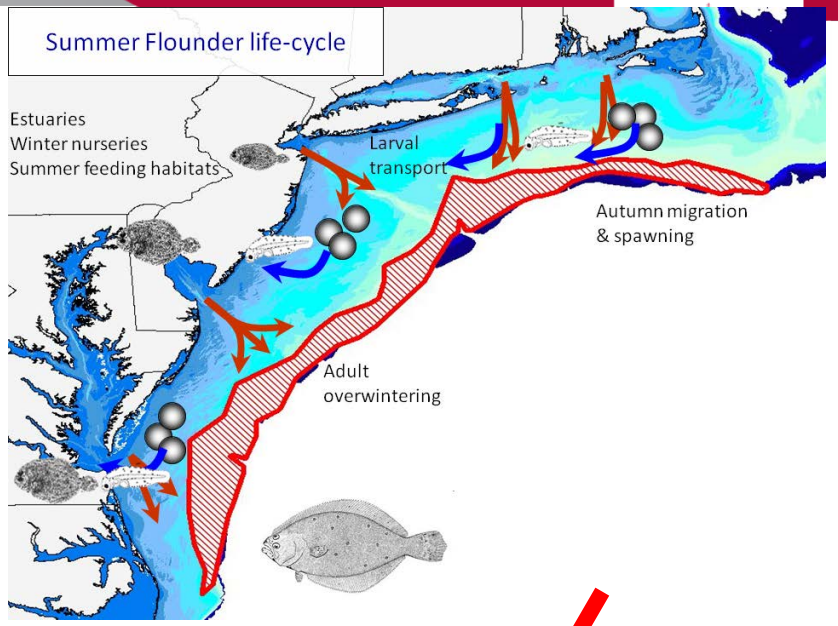
Identifying Future Research Needs

Migrating Organisms

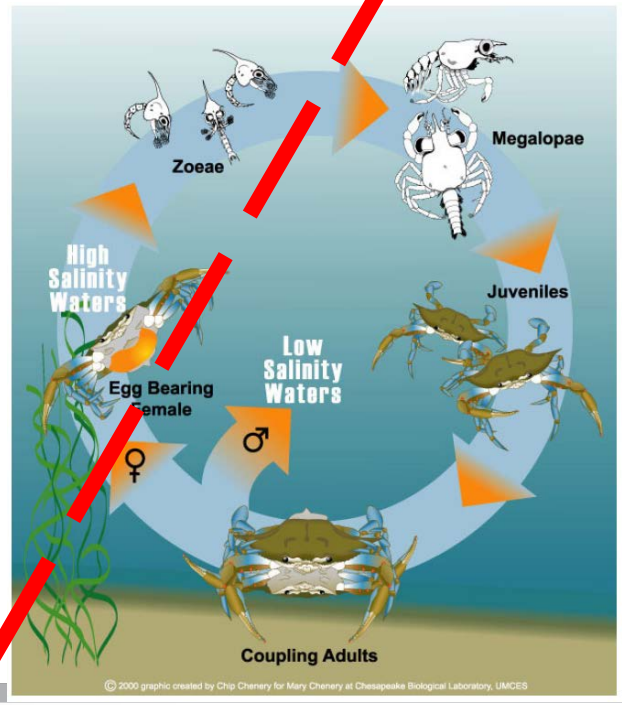
What we know…

- Hudson one of principal nurseries on Atlantic coast
- Key corridor for a variety of resident and migratory species
- Unclear how other barrier systems in the world have affected aquatic populations (lack of data). There are very large uncertainties for ecological effects.
- Limited knowledge of species life cycle use of Harbor Estuary below Battery compared to Hudson north

MAB Estuaries: Catcher mitts for marine fishes/crabs



NY Blue Crabs:
150 000 tons,
$0.5 Million



Identifying Future Research Needs

Migrating Organisms

Needs Identified in Report

- More complete set of baseline measurements – What species use the areas where barriers have been proposed? Where in the water column? How do they use it?
- Hydrodynamic modeling of larval transport
- Research on how construction, structure and operation of barrier will affect animals

Identifying Future Research Needs

Migrating Organisms

Other Possible questions

- What is relative importance of the Hudson vs. other regional habitats?
- How could obstructions change species assemblages, phenology, migration behavior?
- Could gate structures make populations increasingly discrete?
- Will the effects of obstructions work against species adaptations to climate change by curtailing connectivity?

Identifying Future Research Needs

Migrating Organisms

Discussion Questions

- What questions have we missed?
- What other data is available in the Harbor region?
- Who should lead this work?
- Are there researchers here today that are interested in organizing discussion or pursuing funding to answer these questions?
- Are there additional researchers who could add their expertise to answering these questions?

Identifying Future Research Needs

Other priority research needs

Small group discussion:

- What other ideas do you have for future research related to this topic?
- Consider beyond just the Hudson - Jamaica Bay, Barnegat Bay, Delaware Estuary, Chesapeake Bay? Other regions?

Research Funding Needs and Opportunities

Identify needs and opportunities for leveraging or finding additional funding for conducting near-term or long-term priority research on estuary effects of surge barriers

Wrap-up and Next Steps

Review key discussion points and next steps