

**New York & New Jersey Harbor
Contaminant Assessment and Reduction
Project (CARP)**

**Model Evaluation Group Final Peer-Review
Report**

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Outline

- Initial Challenges
- Role of the CARP Model Evaluation Group
- Model Evaluation
- Future Directions
- Acknowledgements

The Beginning: Challenges

- The NY/NJ Harbor is extremely complex, with large spatial and temporal gradients.
- The transport of most targeted analytes is tightly coupled to the production, movement, and burial of organic matter.
- Deterministic modeling of mercury dynamics (methylation) requires linkage to carbon and sulfur cycling.
- Prior to the CARP program, consistent estimates of source loadings were not available.

No existing model was suitable for the Port Authority's needs

Role of the CARP Model Evaluation Group

- Developing complex models requires a large number of decisions and interpretations, each of which impacts the final model performance and capability.
- The MEG provided technical review and guidance to the field assessment groups and to modelers throughout the process to insure that each component of CARP was thoroughly evaluated and understood before the linked model was assembled.
- The MEG reviewed each component of the field program (ambient monitoring, loadings calculations) and model as they were completed.

Role of the CARP Model Evaluation Group

Overarching Questions for the Final Review

- Does each component of the CARP model reflect the best available science?
- Are all available field data appropriately used in model development and calibration?
- Does the model structure and complexity, especially spatial and temporal resolution, match the intended uses and the available data from the study area?
- How accurate are the model results, and what tools are available to evaluate and communicate model uncertainty?

Role of the CARP Model Evaluation Group

MEG Members

- **Joel Baker**, University of Maryland
- **Frank Bohlen**, University of Connecticut
- **Richard Bopp**, RPI
- **Joe DePinto**, LimnoTech, Inc.
- **Joe DiLorenzo**, Najarian and Associates
- **William Fitzgerald**, University of Connecticut
- **W. Rockwell Geyer**, Woods Hole Oceanographic Institution
- **Lawrence Sanford**, University of Maryland
- **Jay Taft**, Harvard University

CARP MEG Overall Findings

Temporal and spatial resolution

- The overall CARP objective is to predict contaminant concentrations in water, sediments, and biota throughout the Harbor over time scales of years to decades.
- These spatial and temporal scales, coupled with the available field observations for calibration, dictated to some extent the model resolution.
- The model is designed to explore spatial trends across the entire Harbor, rather than detailed analysis within specific tributaries, berthings, or embayments.
 - The fairly coarse model grid in many tributaries is likely suitable for predicting transport of chemicals on the scale of the entire Harbor, but insufficient to predict detailed behavior within these tributaries.

CARP MEG Overall Findings

1. The CARP model provides an important framework to organize and interpret field data and to identify gaps in data and knowledge.
2. The CARP model is technically sound and represents the best and latest science available at the time of model development.
3. The CARP model development utilizes available data to the greatest extent possible in terms of its complexity (*i.e.*, the spatial and temporal resolution and the process kinetics).

CARP MEG Overall Findings

4. The CARP model is suitable for use in predicting relationships between external contaminant loadings and concentrations in water and sediment throughout the NY/NJ Harbor. Predictions of concentrations in biota are less certain due to, among other things, relatively few calibration data.
5. Of the chemical classes modeled, mercury is the most difficult due to its complex geochemistry in the estuary, especially the processes controlling conversion of inorganic mercury to methylmercury.
6. The relationships between current loadings and ambient chemical concentrations are fairly well characterized, but it is more difficult to predict the long-term rate of change in concentrations.

CARP MEG Overall Findings

7. The response time of the system is long due to storage in sediments, and the projections are sensitive to the sediment initial conditions and especially to the model parameterization of net sedimentation rates in various parts of the system.
8. Uncertainties increase with time in the projections. This is a characteristic of all models.
9. The model is based on six years of observations. Extreme events for all parts of the system are not included in the projections.

CARP MEG Overall Findings

A Shortcoming

The initial desire to explicitly model sediment toxicity was a 'bridge too far'

The current scientific understanding of the underlying causes of toxicity does not allow reliable modeling of sediment toxicity in NJ/NJ Harbor

The CARP model framework is a suitable framework for such toxicity calculations once approaches such as critical body residue reach maturity.

CARP MEG Recommendations

1. The influence of the Hudson River on Newark Bay is uncertain. The CARP model shows a relatively high amount of sediment entering Newark Bay from the Hudson River, which might have important management implications. This behavior needs to be verified by further field studies.
2. The CARP Program has advanced the understanding of contaminant behavior in the Harbor. This increase in understanding should continue to evolve by further field investigations and model refinement.

A unique opportunity (obligation) to conduct a validation exercise

CARP MEG Recommendations

3. The model should be continually maintained and improved. Findings from the CARP model should drive these studies, i.e., investigate transport of sediments into Newark Bay.
4. A particular research need identified by the CARP model development is to improve the empirical relationships and mechanistic understanding of contaminant levels in biota, sediment, and water. A quantitative formulation of food web bioenergetics and trophic transfer processes, especially as modified by nutrient reductions, introduction of exotics, etc. is needed.

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