

How did DRBC address low dissolved oxygen in the Delaware Estuary - then and now?

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Science and Environmental Summit**

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Delaware River Basin Commission

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Delaware River Estuary

Water Quality Assessment Units:

Zone 1: Non-tidal (Upstream from Trenton)

Estuary:

Zone 2 - 5: Tidal Delaware River

Zone 6: Delaware Bay

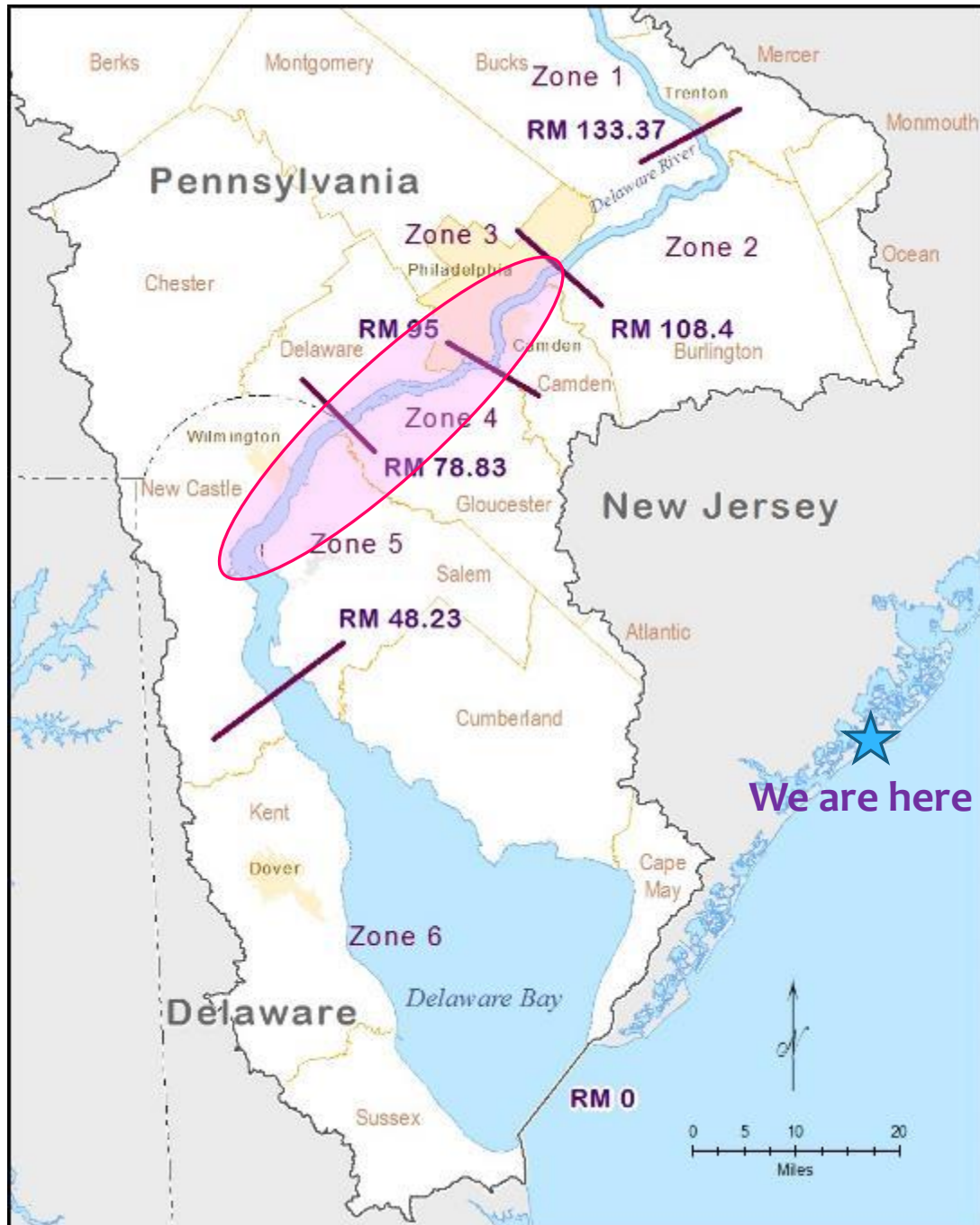
River Miles:

RM 0.0 = Atlantic Ocean

RM 70 = City of Wilmington

RM 100 = Ben Franklin Bridge, Philadelphia / Camden

RM 133 = "Head of Tide", Trenton, NJ



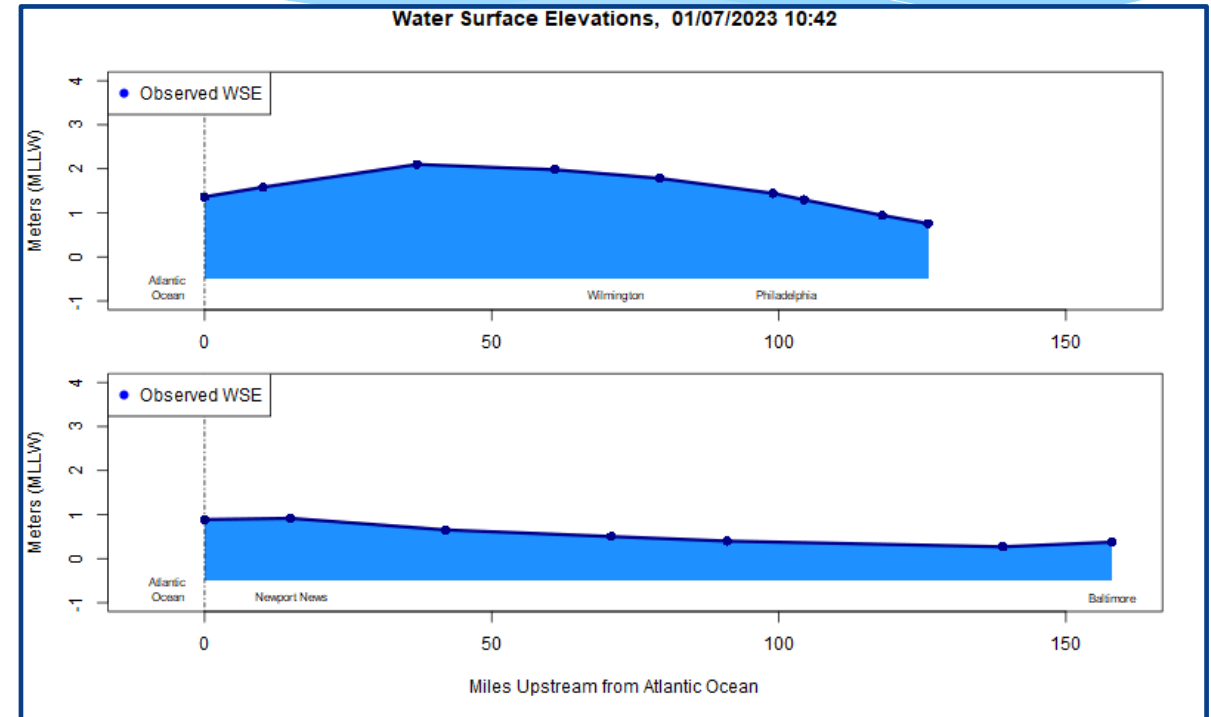
Delaware Estuary Characteristics

□ Tidal System

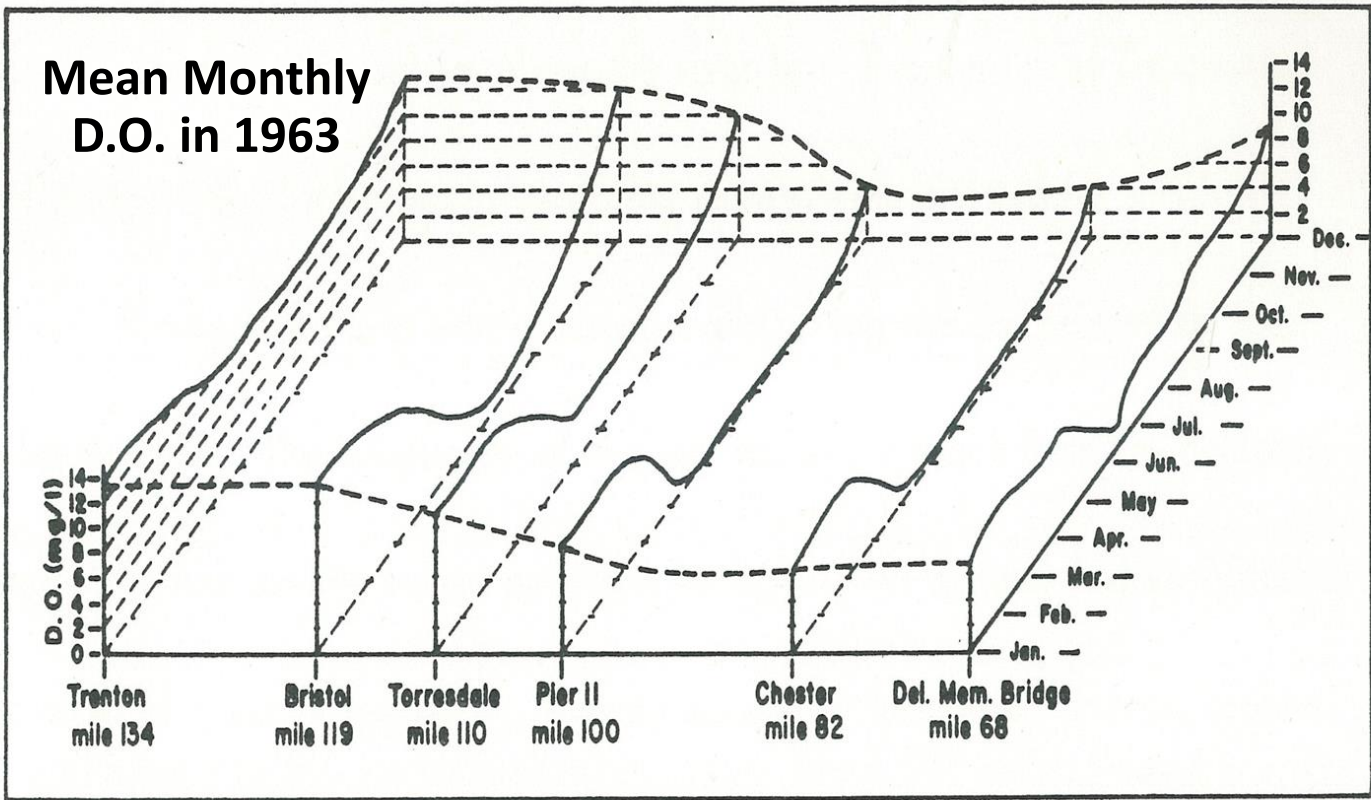
- Semi-diurnal tidal estuary
 - flow direction reversed twice a day
 - Tidal flow excursion ~13 miles/ tide
- Tidal amplitude increases upstream due to physical shape of the estuary (like a bellows)
 - Mean tidal range of ~4 feet at the mouth of bay and ~8 feet near the head of tide at Trenton, NJ
 - Delaware Estuary is highly energetic system
 - Stratified in bay but relatively well mixed in tidal river

□ Freshwater Inflows

- ~66% of freshwater flows from Delaware River at Trenton (51%) and Schuylkill River (15%)
- During the persistent low freshwater inflow condition, up to 30% of flow in the urban estuary is from treated wastewater

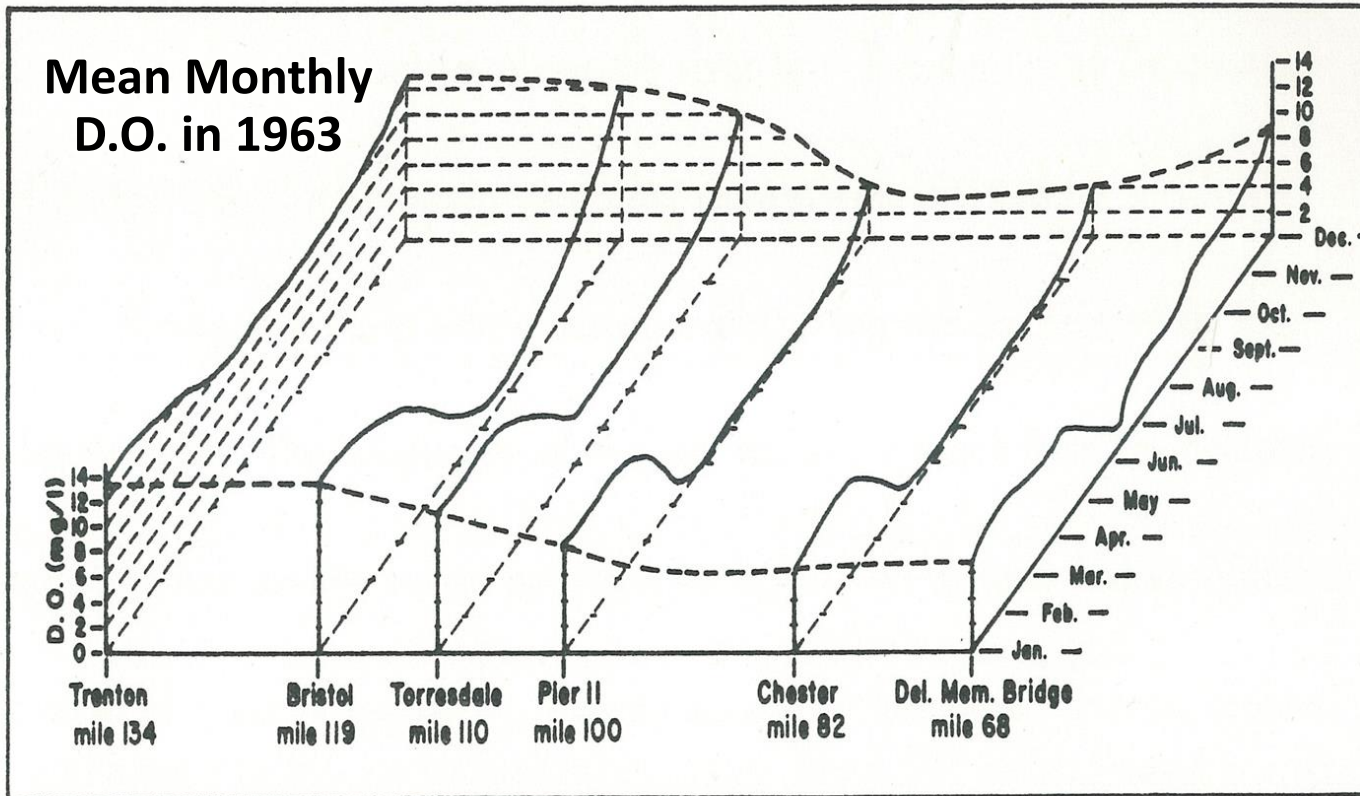


Water Quality in mid-1900s in Delaware Estuary



*Slaughterhouses discharging in 1928
 (PWD Historic Collection)*

Water Quality in mid-1900s in Delaware Estuary



Upstream



Downstream

- ❑ Historically, summer dissolved oxygen (DO) levels near urban portions of estuary were too low to support aquatic life
- ❑ Caused by human and industrial wastes:
 - Carbonaceous Biochemical Oxygen Demand (CBOD): Oxidation of organic materials
 - Nitrogenous Biochemical Oxygen Demand (NBOD): Oxidation of ammonium (NH_4) to nitrate (NO_3)
- ❑ DRBC adopted water quality standards in 1967
- ❑ DRBC established CBOD wasteload allocations for facilities in Zones 2-5 in 1968
 - Required 86.0 – 89.25 % treatment of CBOD

Aquatic Life Designated Uses in Current DRBC Regulations since 1967

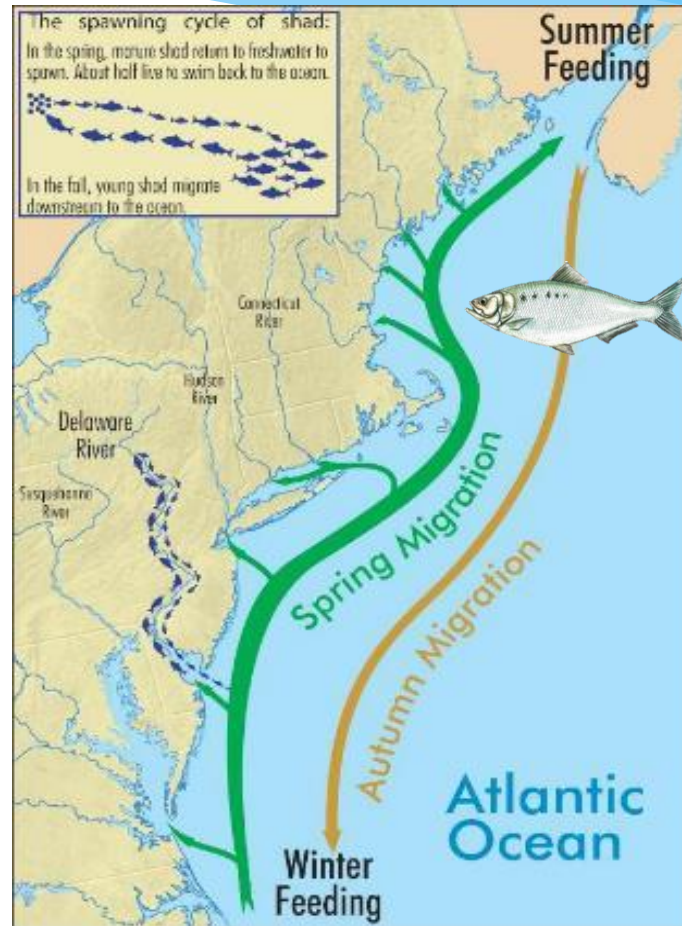
Urbanized portion of Delaware Estuary or Fish maintenance area (FMA)

The Delaware Bay

Zone	River Mile	Aquatic Life Use	Migratory Fishes	24-hour average D.O. Criteria
2	108.4 – 133.4	maintenance and propagation of resident fish and other aquatic life	passage of anadromous fish	5.0 mg/l
3	95 – 108.4	maintenance of resident fish and other aquatic life	passage of anadromous fish	3.5 mg/l
4	78.8 – 95	maintenance of resident fish and other aquatic life	passage of anadromous fish	3.5 mg/l
5	70 – 78.8	maintenance of resident fish and other aquatic life	passage of anadromous fish	3.5 mg/l
	48.2 – 70	maintenance and propagation of resident fish and other aquatic life	passage of anadromous fish	4.5 – 6.0 mg/l
6	0 – 48.2	maintenance and propagation of resident fish and other aquatic life maintenance and propagation of shellfish	passage of anadromous fish	6.0 mg/l

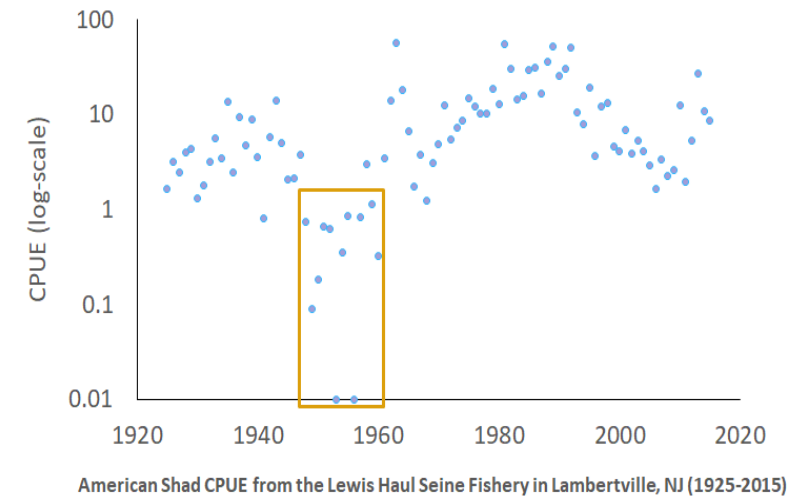
Dissolved Oxygen (DO) and Fisheries in Urbanized Delaware River Estuary

- ❑ Water quality goals established in 1967 have been met since 90s
 - Upgraded wastewater treatment
 - CWA funding
- ❑ Fisheries enhanced due to increased dissolved oxygen
- ❑ American Shad (example)
 - American shad are the largest member of the herring family
 - Historically American shad were abundant throughout the basin from the upper river to the Estuary



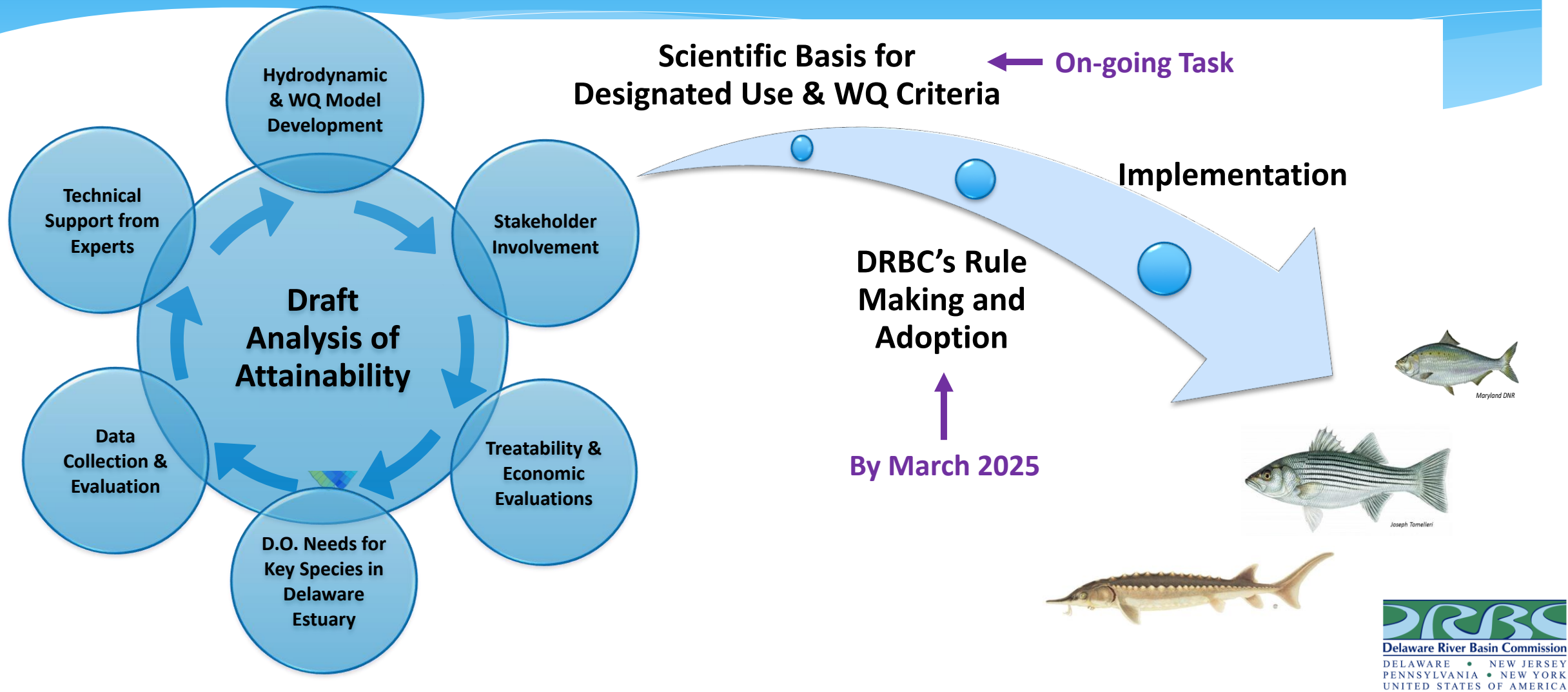
American shad migration. Photo Credit: DRBC

- ❑ Populations in the Delaware
 - Crashed in the 1950's



- Rebounded in the 1980's
- ❑ Still room for further improvement

Adopt new designated use and DO criteria to support fish propagation (DRBC Resolution No. 2017-4)



How did DRBC address low dissolved oxygen in the Delaware Estuary - then and now

- ❑ Significant water quality (DO) improvements have been achieved through CBOD control
- ❑ Aquatic life use is directly related to Dissolved Oxygen levels
- ❑ DRBC front-loaded scientific and technical studies prior to rule making
- ❑ Transparent processes for stakeholders through DRBC's Water Quality Advisory Committee
- ❑ The draft 'Analysis of Attainability' was completed in 2022 and Linkages developed for
 - DO levels and fisheries response;
 - Levels of ammonia (and other nutrients) reductions and achievable DO levels (models);
 - Ammonia reduction technologies for WWTPs, cost and affordability
- ❑ Development of water quality standards (aquatic life designated use and criteria) are underway.

Improving Dissolved Oxygen and Aquatic Life Uses in the Delaware River Estuary



Topic	Presenter
Why are we here?	Steve Tambini
How did DRBC address low dissolved oxygen in the Delaware Estuary - then and now?	Namsoo Suk
<u>Where do ammonia and other nutrients in the Delaware Estuary originate, and how do we know?</u>	<u>John Yagecic</u>
What is this estuary-wide eutrophication model and why do we need it?	Li Zheng
What matters and what doesn't with regard to low dissolved oxygen events in the Delaware Estuary?	Fanghui Chen
What combination of wastewater improvements will achieve the best dissolved oxygen outcome in the Delaware Estuary?	Sarah Beganskas
What is the highest attainable dissolved oxygen condition in the Delaware Estuary, and what will it mean for aquatic life uses?	Thomas Amidon
Q&A Panel: Enhancing support for aquatic life uses in the Delaware Estuary	All