



Benthic video monitoring in Narragansett Bay – observations using the CMECS language

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Narragansett Bay Commission (NBC) Mission:
To maintain a leadership role in the protection and enhancement of water quality in Narragansett Bay and its tributaries by providing safe and reliable wastewater collection and treatment services to its customers at a reasonable cost.

The NBC conducts benthic video monitoring as part of a comprehensive receiving waters monitoring program evaluating potential impacts of wastewater discharge and improvements to water quality related to infrastructure investments and improvements, including CSO abatement and nutrient reductions.

CSO Abatement – Three-phase project to reduce discharges of combined sewage and stormwater, primarily through construction of deep storage tunnels.

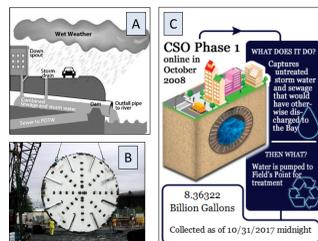


Figure 1. (A) Diagram of combined sewer system. (B) Tunnel boring head used in Phase 1 tunnel construction. (C) Online (narrabay.com) tracking of gallons stored by tunnel for advanced treatment.

Biological Nutrient Removal – Treatment system upgrades to drastically reduce nitrogen concentrations in wastewater effluent

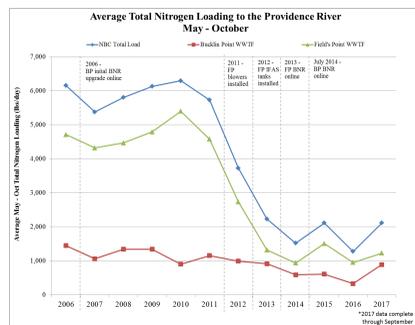


Figure 2. Reductions in total nitrogen loading from NBC wastewater facilities following initial upgrades in 2006 at Bucklin Point (target effluent total nitrogen <8.5 mg/L) and final upgrades at each facility going online in 2014 (target effluent total nitrogen <5 mg/L).

See poster - Comprehensive environmental monitoring in a rapidly changing estuary by Uva et al. in session Nutrient input declines and the restoration of urban coastal systems for more detail on NBC's Bay and River Monitoring

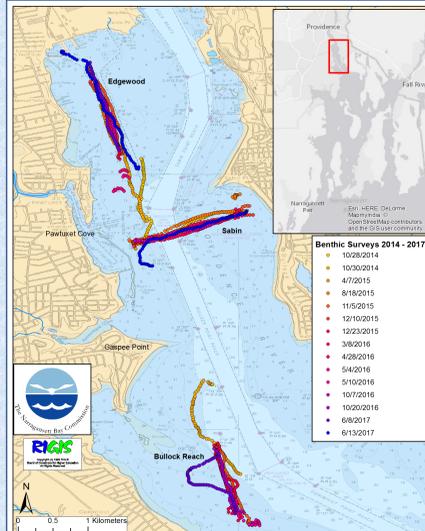


Figure 3. Benthic video survey tracks conducted and analyzed 2014 – 2017.

NBC's Benthic Video Monitoring - Methods

- Surveys target three regions (Edgewood, Sabin, Bullock Reach) in the Providence River estuary – all ~1.5 – 6 m depth.
- Note: Sabin transect crosses shipping channel, though typically visibility is poor.
- Regions selected for proximity to NBC wastewater outfall and other monitoring stations, and suitable underwater visibility.
- Additional surveys conducted as conditions allow.
- Analysis:
 - Sub-sampled every 5 minutes for species abundance counts.
 - Sub-sampled every minute for CMECS (see right).

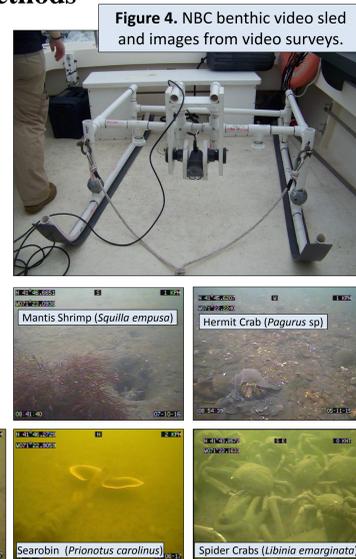


Figure 4. NBC benthic video sled and images from video surveys.

Coastal and Marine Ecological Classification Standard (CMECS)¹

- Standard classification scheme facilitates data comparison across global study locations and study scales/methods.
- NBC video analysis evaluates CMECS every 60 seconds.
- Substrate component and Biotic components evaluated, modifiers used as necessary.

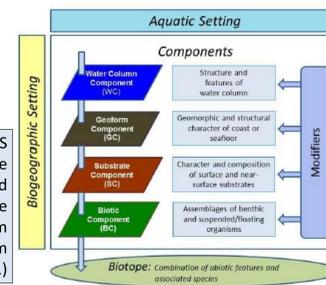


Figure 5. CMECS components can be modified and combined to form Biotope classifications. (Diagram reprinted from Reference 1)

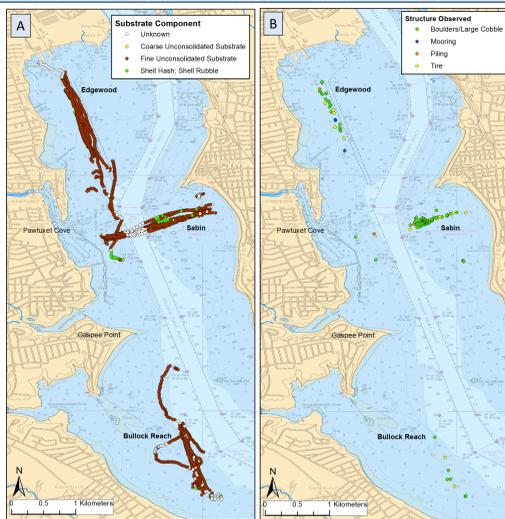


Figure 6. (A) CMECS Substrate Class of all transects, subsampled at 1-min increments. (B) Notable structure observations on transects.

CMECS Substrate Component

- The CMECS Substrate Component along each transect is typically:
 - Unconsolidated Fine Sediment (sands and mud)
 - Shell Rubble/Shell Hash
 - Occasional cobble/boulder patches observed.
 - Occasional anthropogenic structures observed.

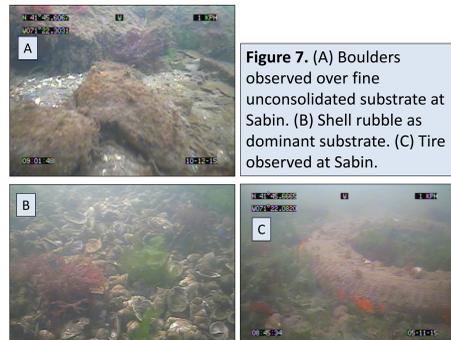


Figure 7. (A) Boulders observed over fine unconsolidated substrate at Sabin. (B) Shell rubble as dominant substrate. (C) Tire observed at Sabin.

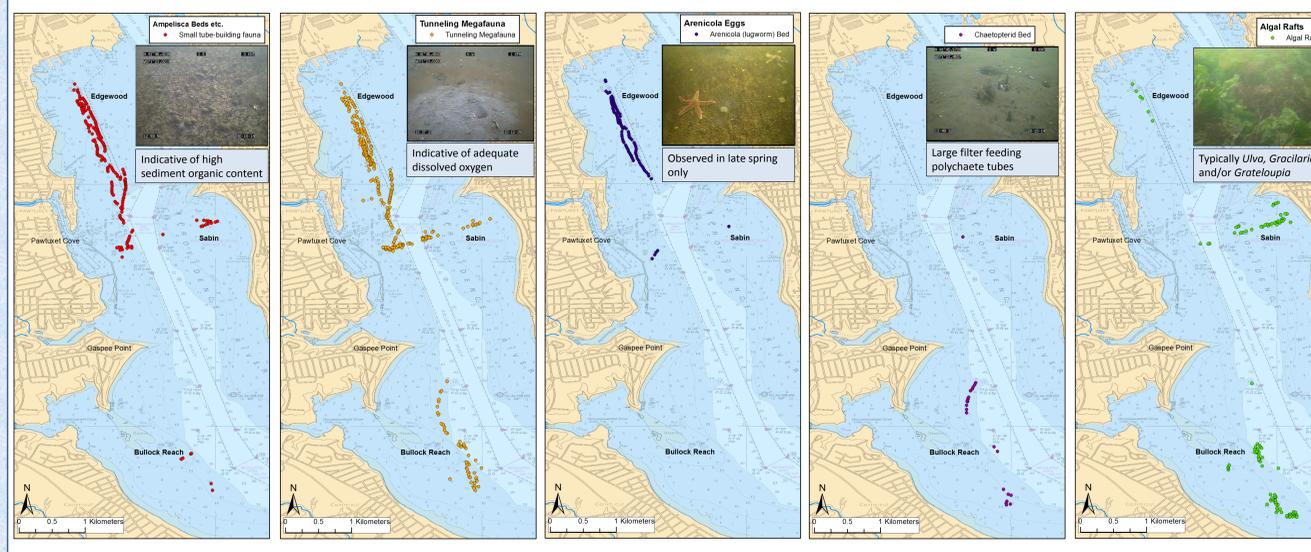


Figure 8. The maps at left highlight some typical biotic groups or communities observed in video transects. Points are mapped based on observations made while subsampling the video at 1-min increments.

CMECS Infaunal Stage Modifier

- Can be used as a loose proxy for successional stage using the general size or evidence of size of organisms utilizing benthic habitat.
- 0 - anoxia – Beggiatoa bacteria observed
- 1* - no burrows/siphons visible at surface, though Beggiatoa not evident.
- 1 - small surface burrows/tubes observed
- 2 - medium surface burrows/tubes observed
- 3 - large burrows observed
- 3* - active large burrow, evidenced by sediment disturbance.
- Changes through time confounded by spatial coverage differences – future efforts to cover greater area at each region.

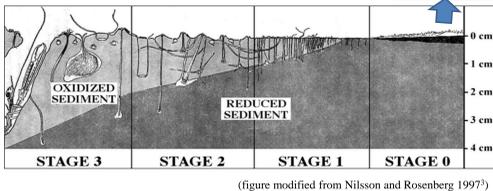
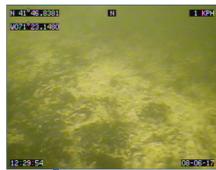


Figure 9. Successional stage diagram and image from benthic video showing extensive Beggiatoa bacteria growth, indicative of anoxic conditions in the turning basin at the north end of the Edgewood transect.

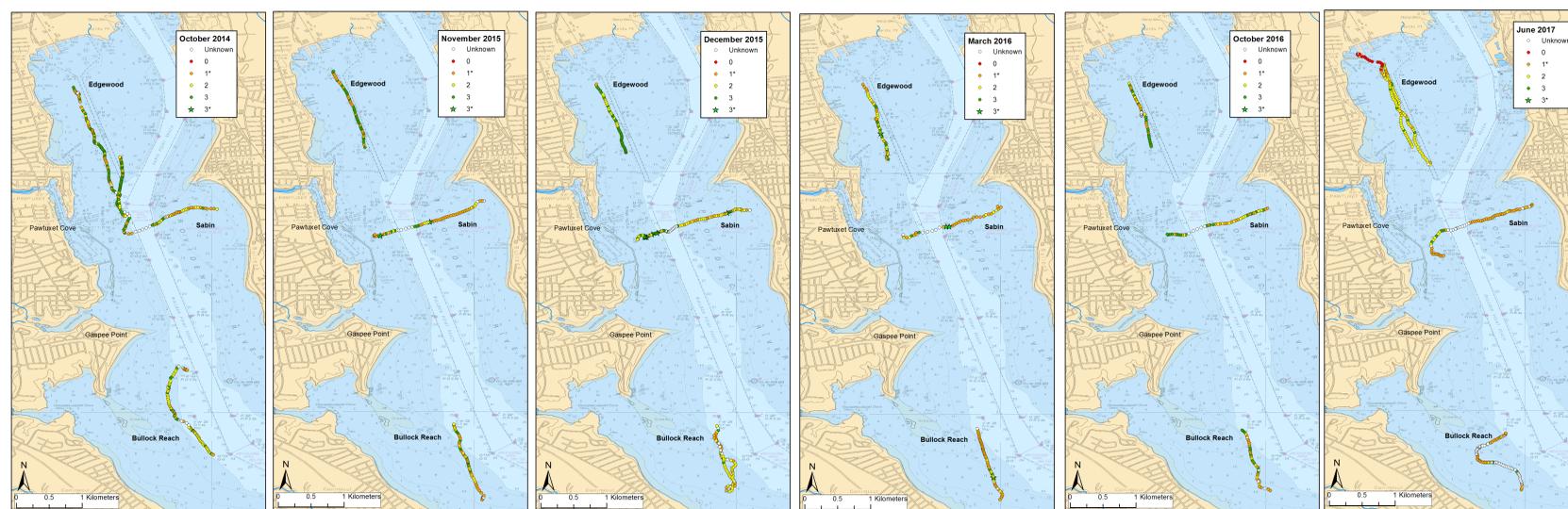


Figure 10. Maps of Infaunal Stage as measured during transect monitoring 2014 – 2017. Only a subset of surveys are shown for brevity. At this time, changes in Infaunal Stage cannot be attributed to temporal, seasonal, or spatial differences.

Future Directions

- Need to improve areal coverage - shorter transects, over more area? Randomized? Program continues to evolve.
- Adding lasers for more precise scale in video images.
- Active collaboration with USEPA, RI DEM, The Nature Conservancy, and others.
- Aiming to develop Biotope classification scheme to concisely summarize CMECS Substrate and Biotic Components through time in coming years.

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References: ¹Federal Geographic Data Committee. 2012. Coastal and Marine Ecological Classification Standard. FGDC-STD-018-2012. ²Nilson, H.C. and R. Rosenberg. 1997. Benthic habitat quality assessment of an oxygen stressed ford by surface and sediment profile images. Journal of Marine Systems. 11:249-264.