Tracer analysis for Virginia No-Discharge Zone development

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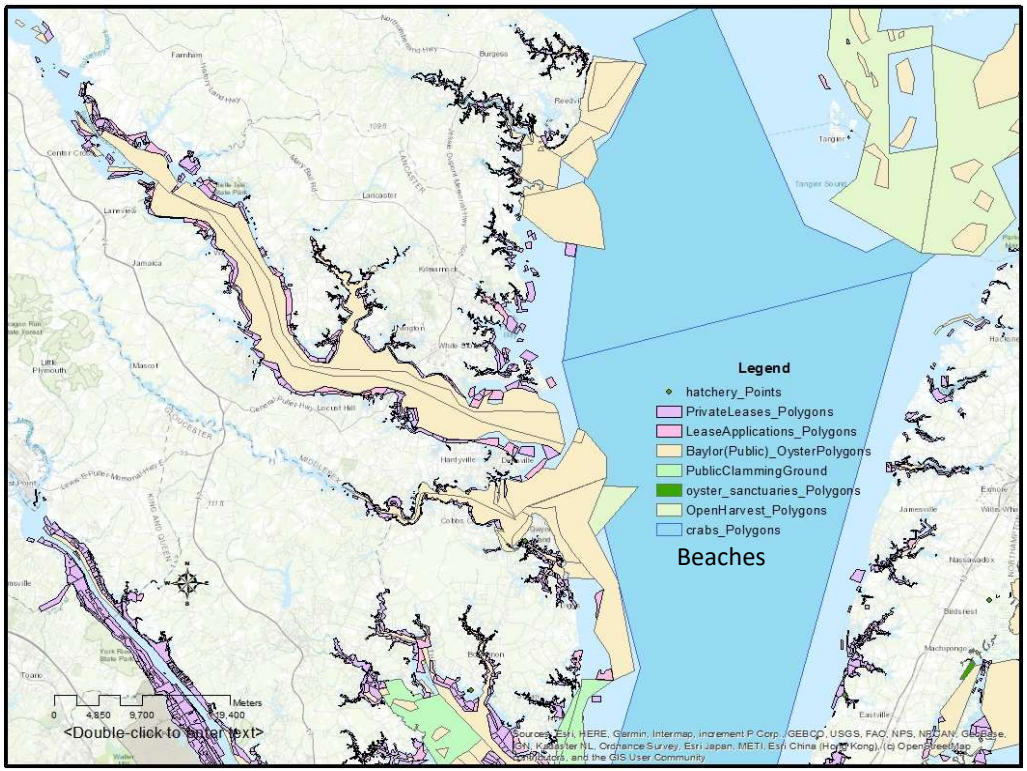
Modeling Quarterly Review Meeting

July 07, 2021

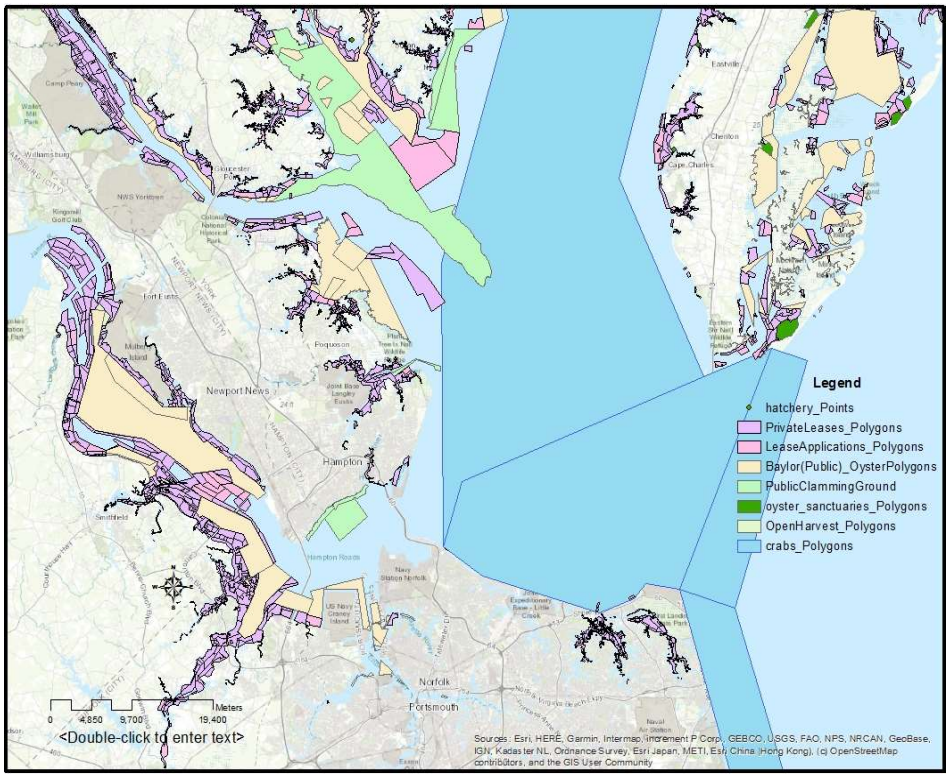
Objective

Provide tracer simulation information to VA DEQ for the development of No Discharge Zone in Chesapeake Bay and its tributaries to protect sensitive areas

Sensitive areas

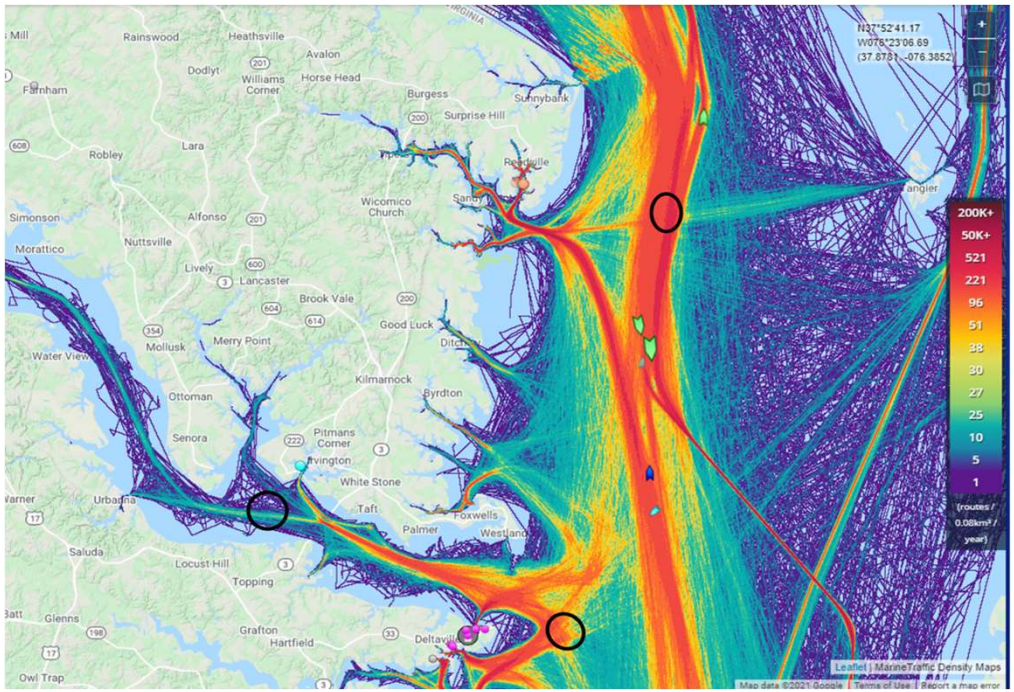


Northern Neck and northern half of middle peninsula.

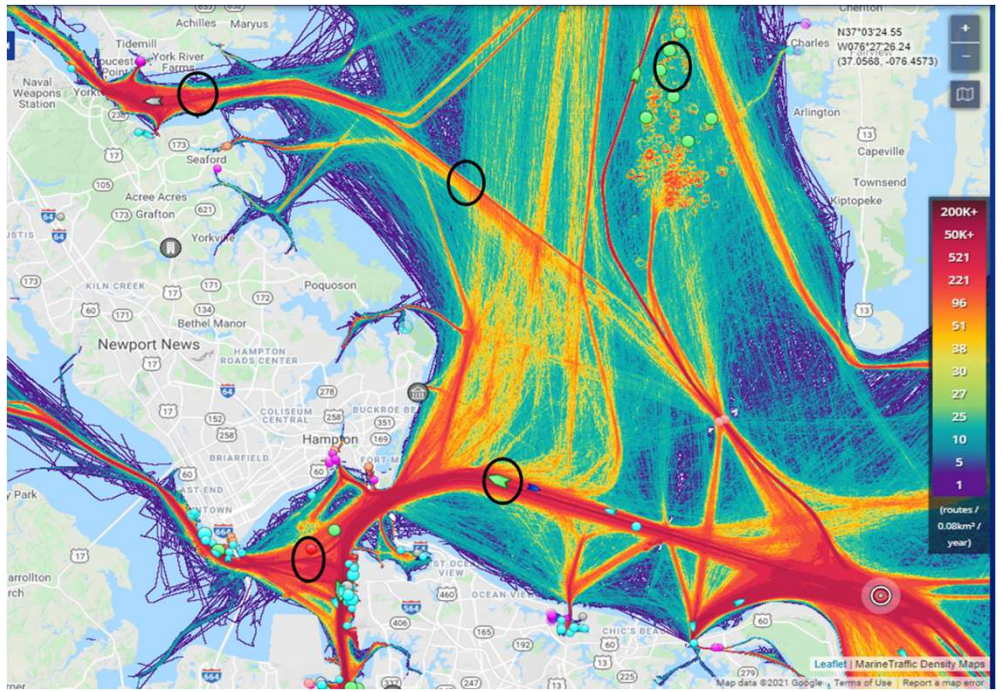


Southern middle peninsula and Southern Bay and tributaries

AIS vessel density



Northern Neck and northern half of middle peninsula.



Southern middle peninsula and Southern Bay and tributaries

Literature review on fecal coliforms simulation

Carl Cerco (03/29/2021):

- **Removal of Fecal coliforms mainly through mortality and settling.**
- **Mortality can be affected by T, S and light.**
- **Decay of 0.5 to 2 times per day are good starting values for model application.**
- **Settling of 0.5 to 1 m per day are recommended**

Jian Shen (04/06/2021):

- **Removal of fecal coliforms through light-dependent mortality and sinking.**
- **Observation in Lynnhaven River suggested a decay rate of 1 time per day.**
- **Model estimates range from 0.35 to 0.6 time per day.**
- **Suggesting 0.5 - 1 time per day.**
- **No suggestion for settling velocity given that it is lamped into the decay rate.**

Concerns of nutrient type contaminants from DEQ as well

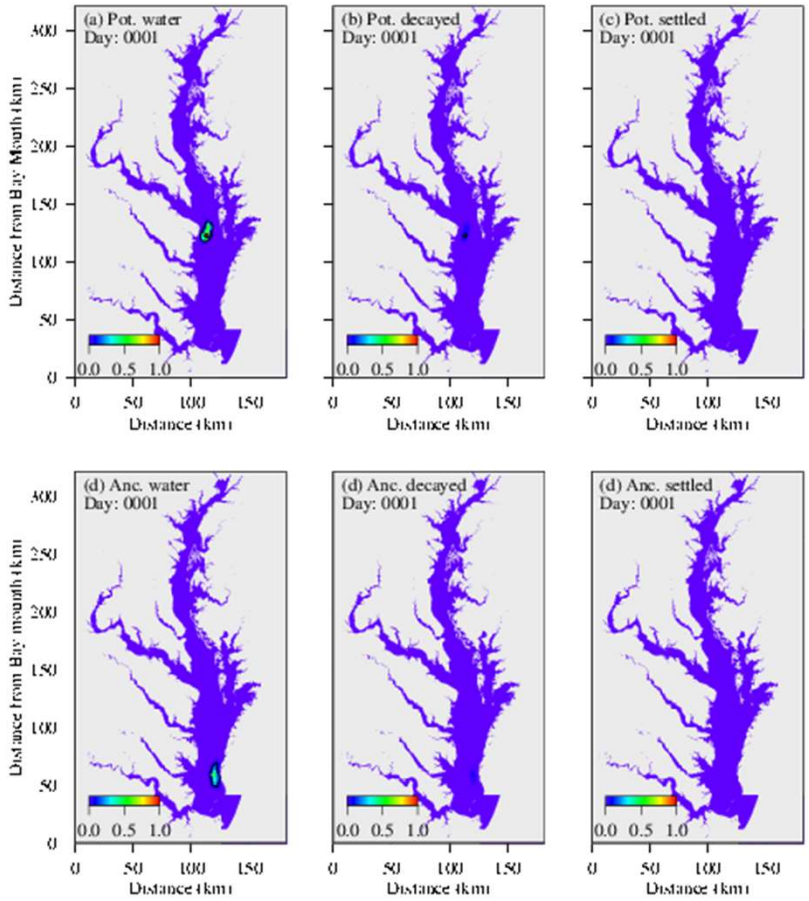
Work plan

Tracer	Dispersion	Decay (d^{-1})	Sinking (m d^{-1})	Daily release (kg per site)	Release duration (year)	Simulation period (year)
	Upper bound	0.1	0	50	1	2
Dissolved	Middle range	1.0	0	50	1	2
	Lower bound	2.0	0	50	1	2
	Upper bound	0.1	0.1	50	1	2
Particulate	Middle range	1.0	0.5	50	1	2
	Lower bound	2.0	1.0	50	1	2

The 0.1 d^{-1} decay scenario is designed to mimic nutrient-type contaminants

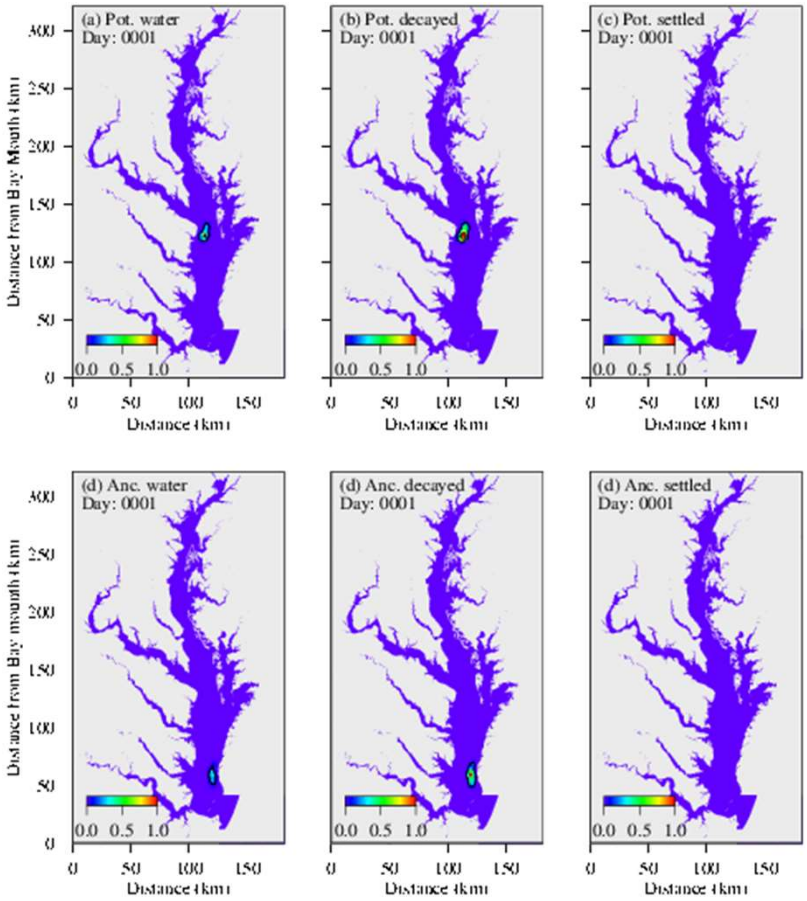
North neck and anchorage

- 0.1 d^{-1} decay.
- 0.1m d^{-1} settling.
- Unit: % of daily load.
- Logarithmic isobath (0.1, 1, 10 and 100%)

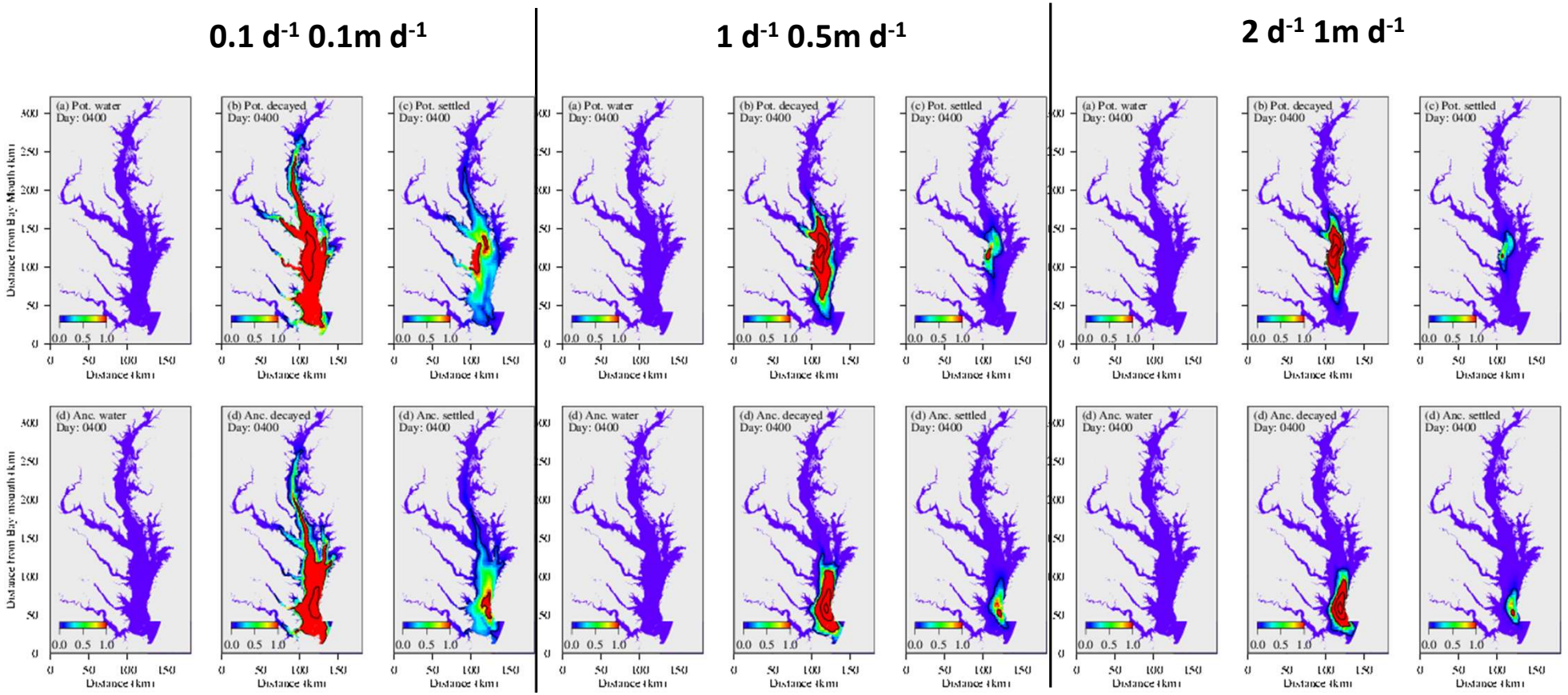


North neck and anchorage

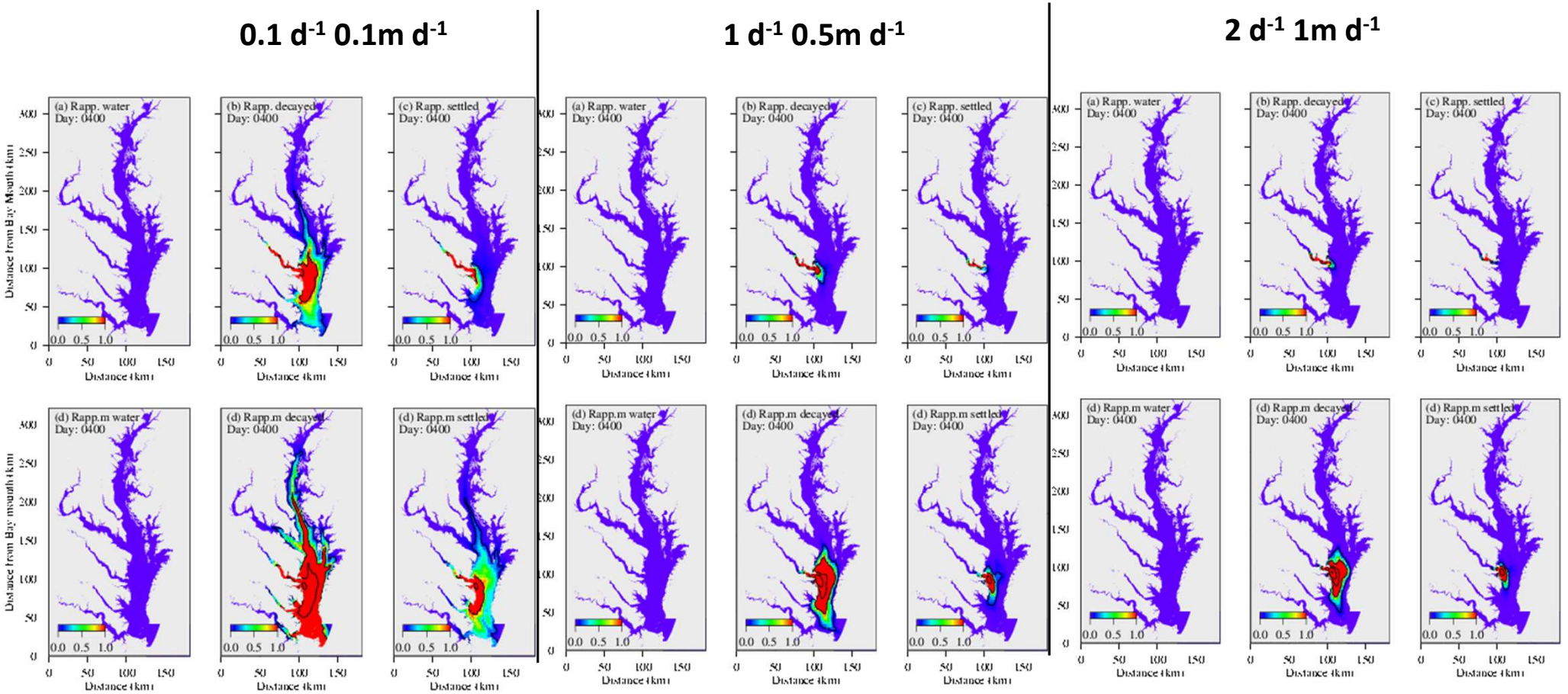
- 2 d^{-1} decay.
- 1 m d^{-1} settling.
- Unit: % of daily load.
- Logarithmic isobath (0.1, 1, 10 and 100%)



North neck and anchorage comparison between different decay and settling rates

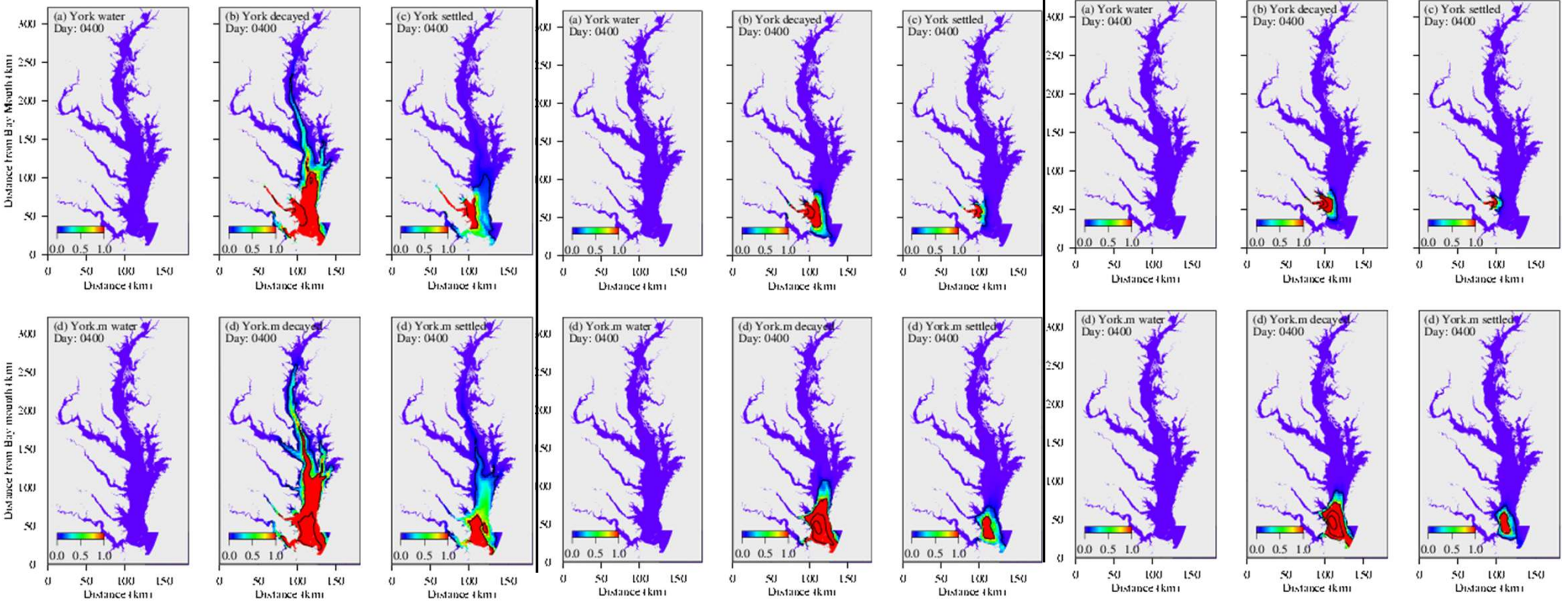


Rappahannock and mouth comparison between different decay and settling rates

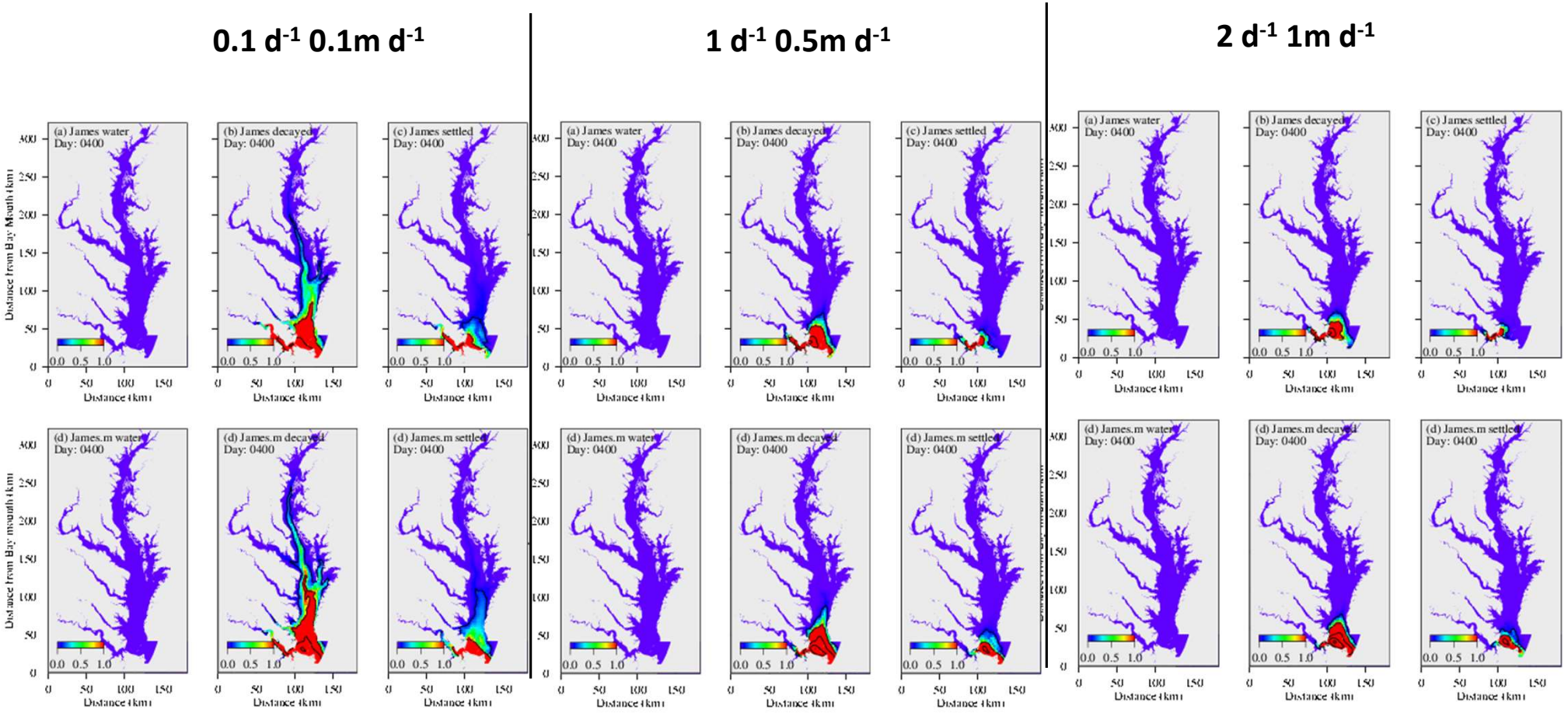


York and mouth comparison between different decay and settling rates

0.1 d^{-1} 0.1m d^{-1} | **1 d^{-1} 0.5m d^{-1}** | **2 d^{-1} 1m d^{-1}**



James and mouth comparison between different decay and settling rates



Extent of tracer dispersion (mi^2) demarcated by 1% of daily load

			Dissolved tracer									Particulate tracer				
scenario	North neck	Anchorage	Rappahannock	Rapp. Mouth	York	York mouth	James	James mouth	North neck	Anchorage	Rappahannock	Rapp. Mouth	York	York mouth	James	James mouth
Tracer01s	1742	1217	568	1563	983	1161	614	854	0	0	0	0	0	0	0	0
Tracer01p	1649	1150	469	1488	908	1111	576	789	164	90	111	271	218	272	167	202
Tracer1s	626	512	78	517	256	584	337	439	0	0	0	0	0	0	0	0
Tracer1p	603	493	73	493	234	569	322	428	30	34	24	80	68	113	68	132
Tracer2s	357	308	49	290	136	424	212	331	0	0	0	0	0	0	0	0
Tracer2p	343	299	48	278	127	407	198	321	10	18	14	56	41	87	51	92

1s: North neck>Rapp m>Anch>York m>James m>York>James>Rapp

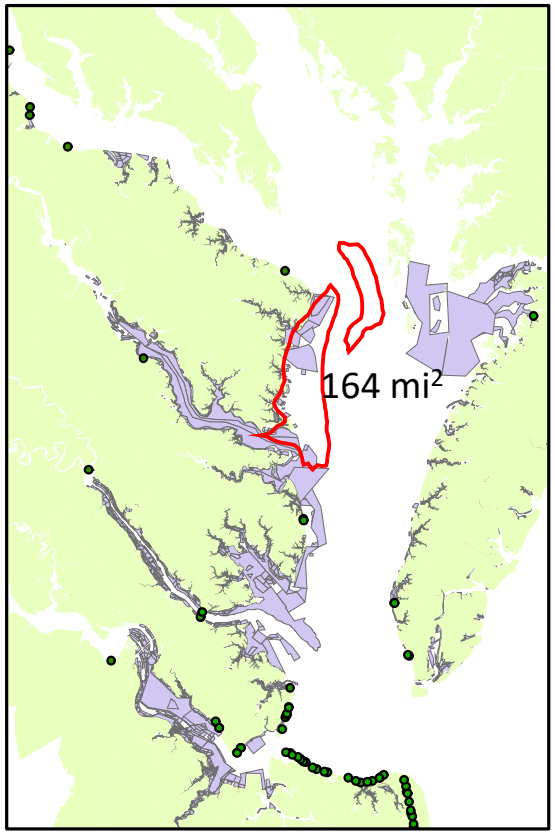
1p: James m>York m>Rapp m>James>York>Anch>North neck>Rapp

Order flips between scenarios.

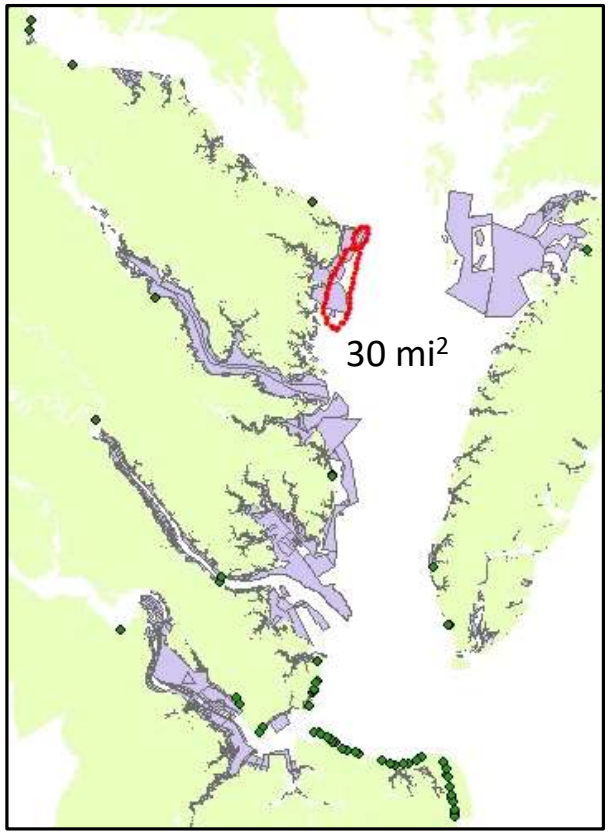
Total surface area of the Bay is: 4479 $mile^2$.

Extent of deposit particulate tracer and intersection with sensitive area: North neck

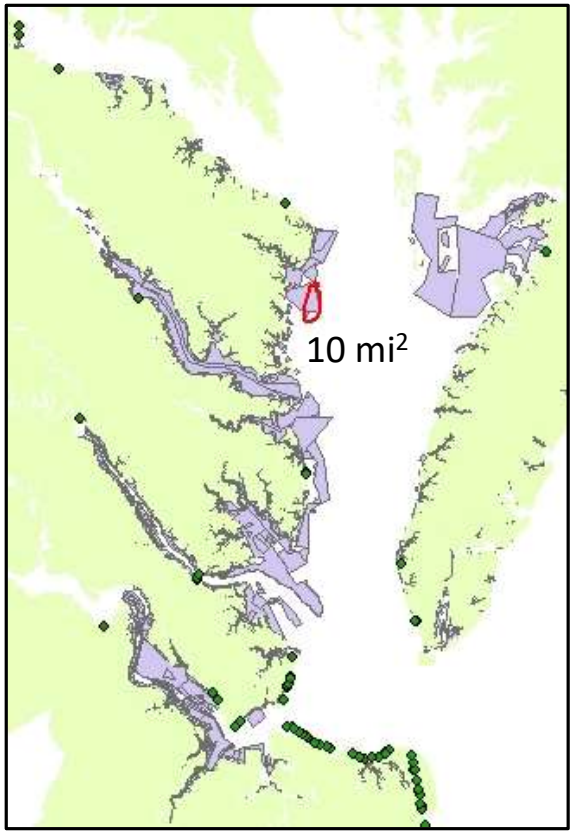
0.1 d^{-1} decay, 0.1m d^{-1} settling



1 d^{-1} decay, 0.5m d^{-1} settling

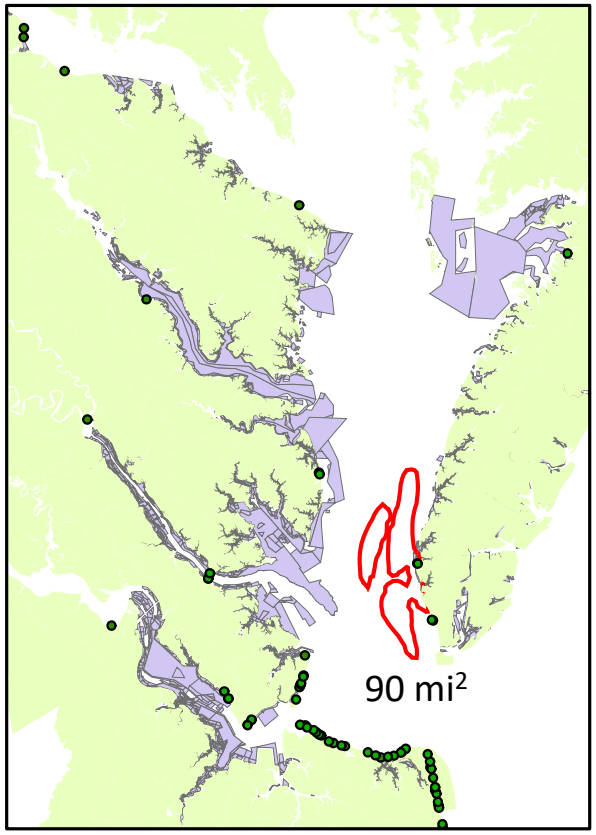


2 d^{-1} decay, 1m d^{-1} settling

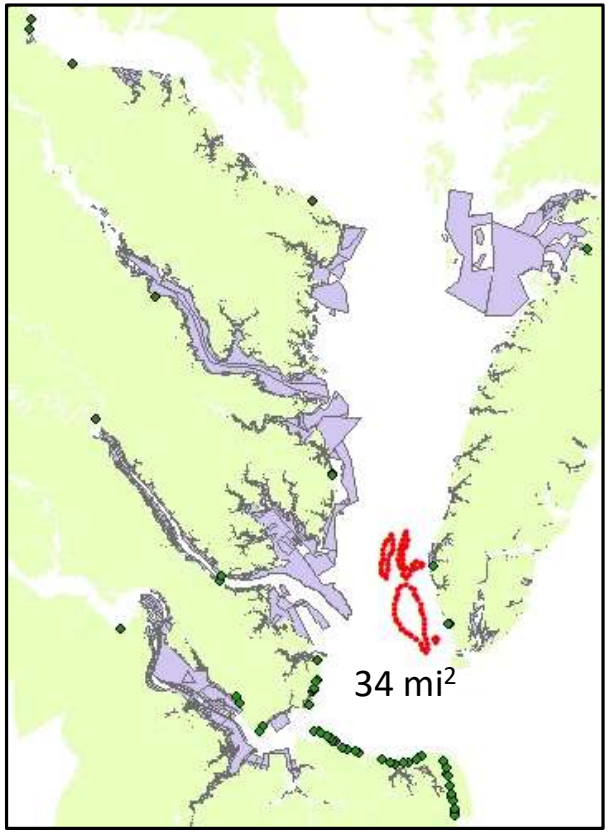


Extent of deposit particulate tracer and intersection with sensitive area: Anchorage

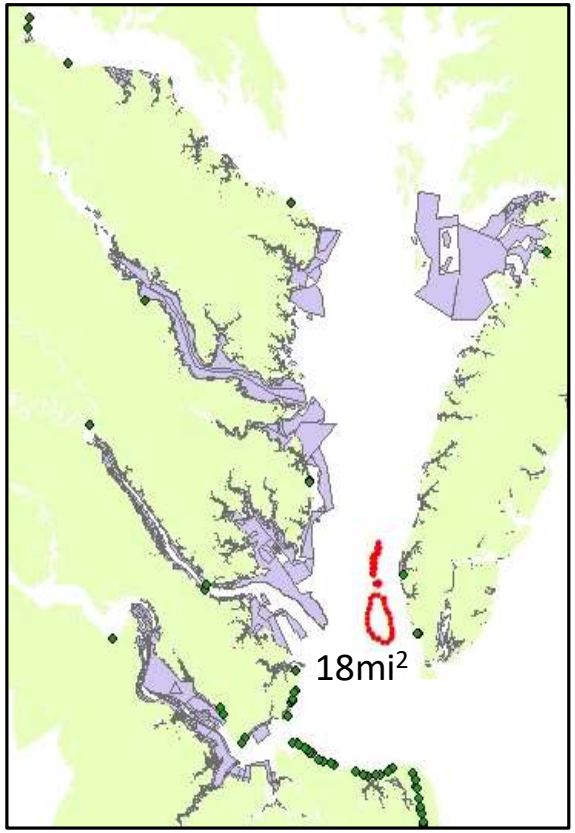
Anchorage 0.1 d-1 settling



Anchorage 0.5m d-1 settling

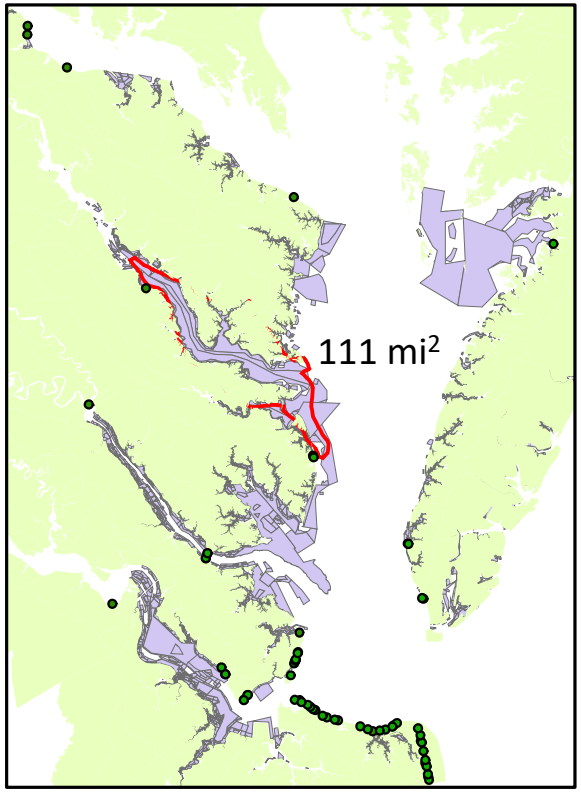


Anchorage 1m d-1 settling

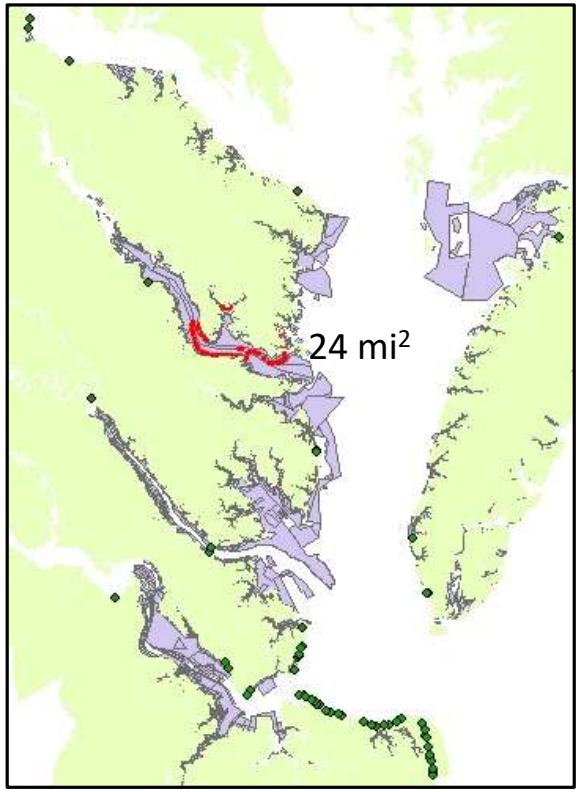


Extent of deposit particulate tracer and intersection with sensitive area: Rappahannock

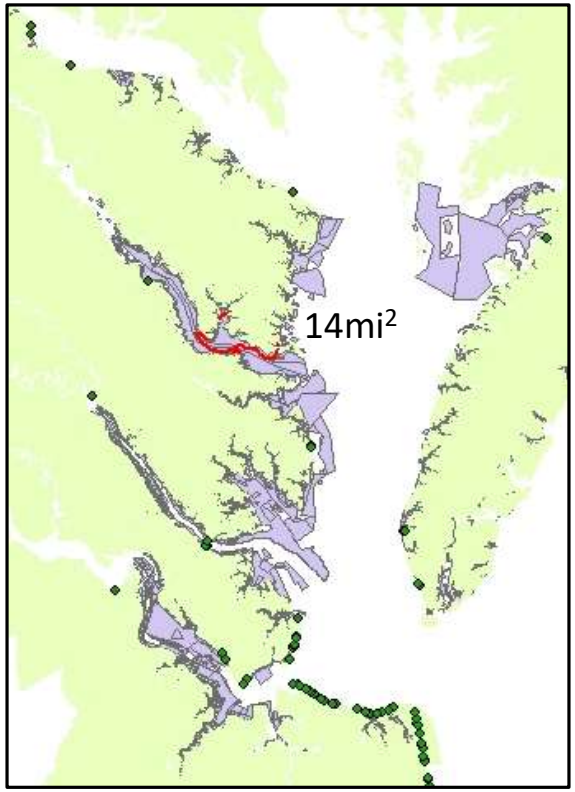
Rappahannock 0.1 d-1 settling



Rappahannock 0.5m d-1 settling

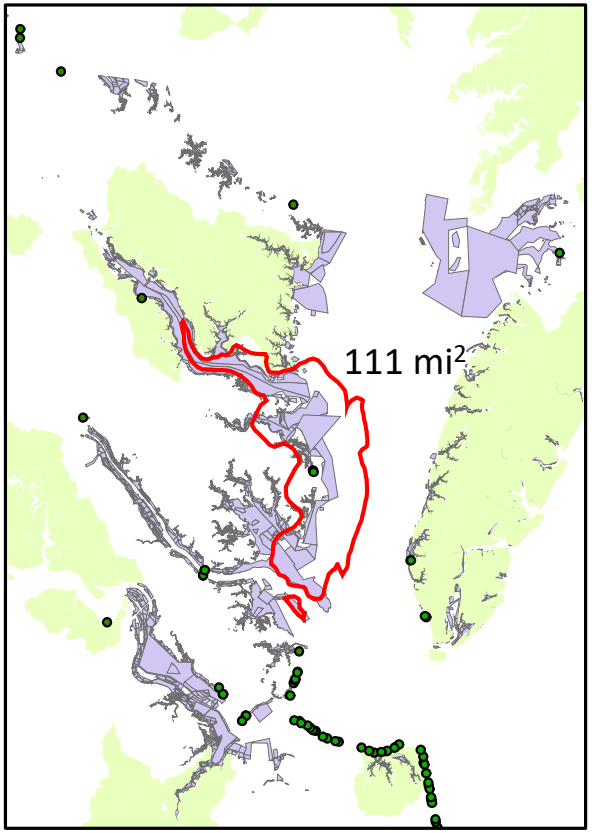


Rappahannock 1m d-1 settling

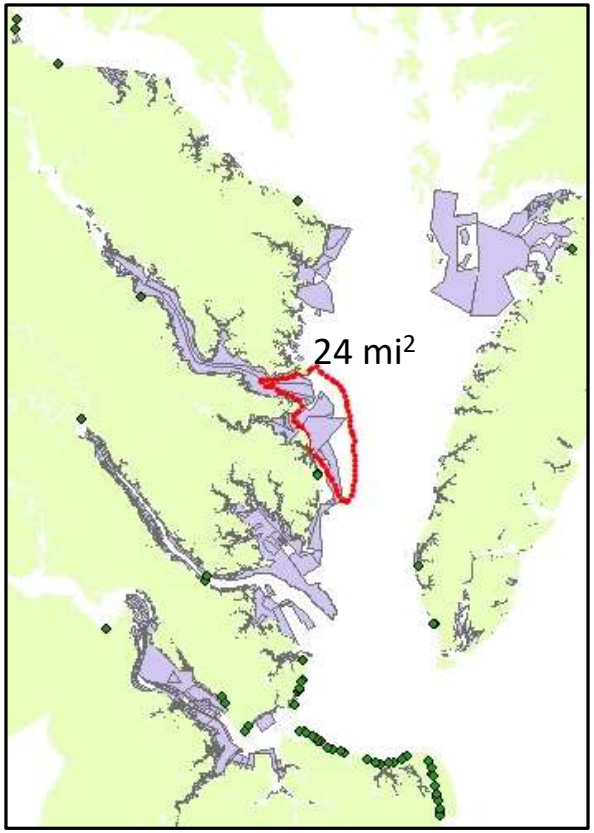


Extent of deposit particulate tracer and intersection with sensitive area: Rappahannock mouth

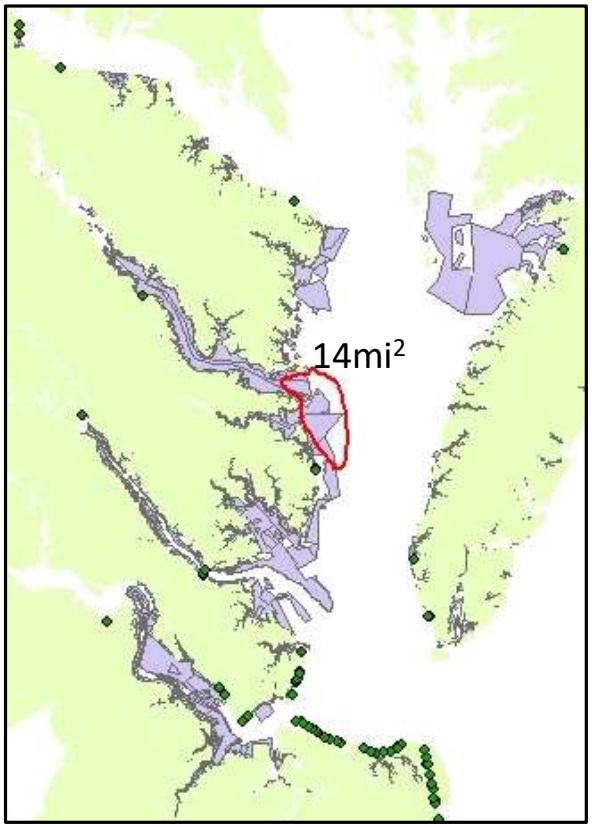
Rapp. mouth 0.1m d-1 d settled



Rapp. mouth 0.5m d-1 settling

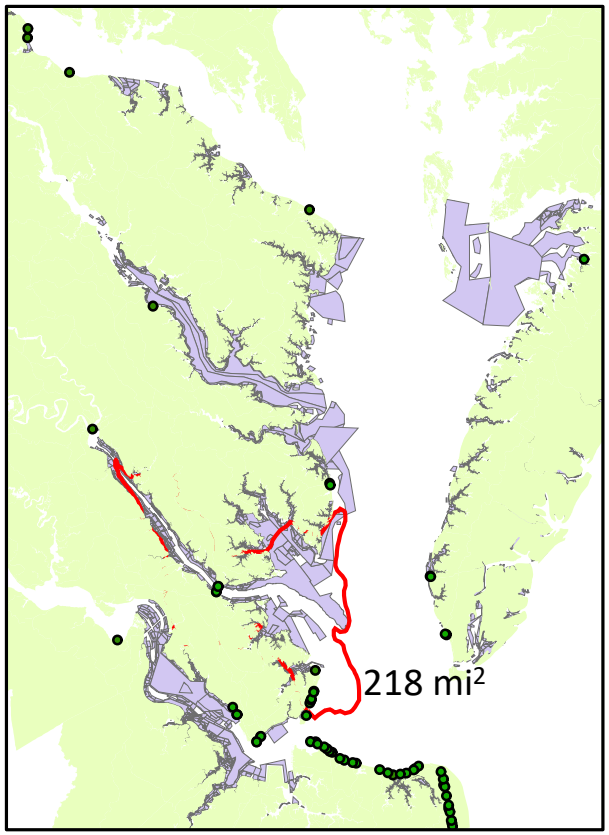


Rapp. mouth 1m d-1 settling

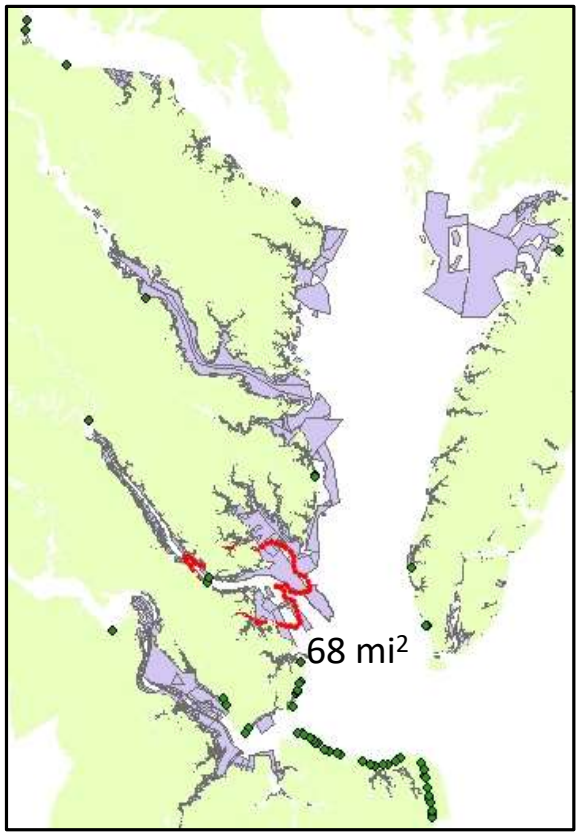


Extent of deposit particulate tracer and intersection with sensitive area: York

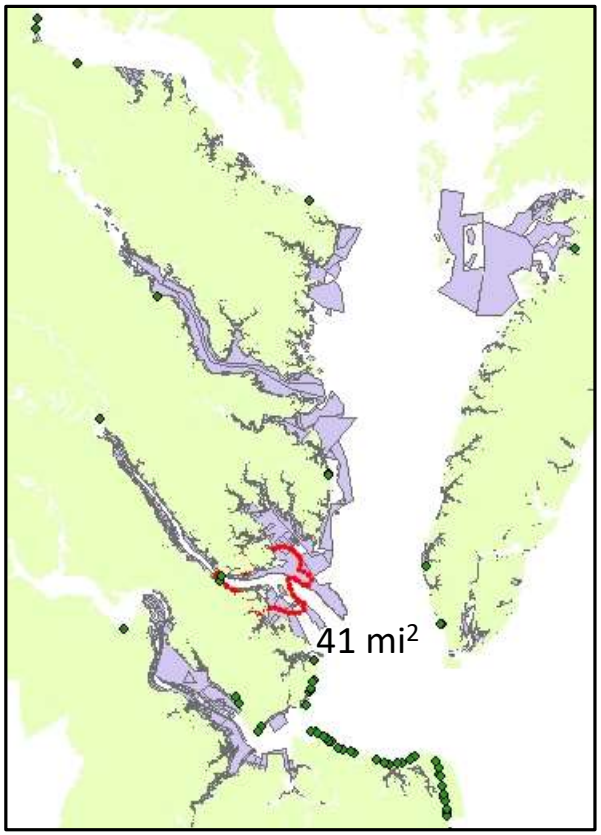
York 0.1m d-1 settled



York 0.5m d-1 settling

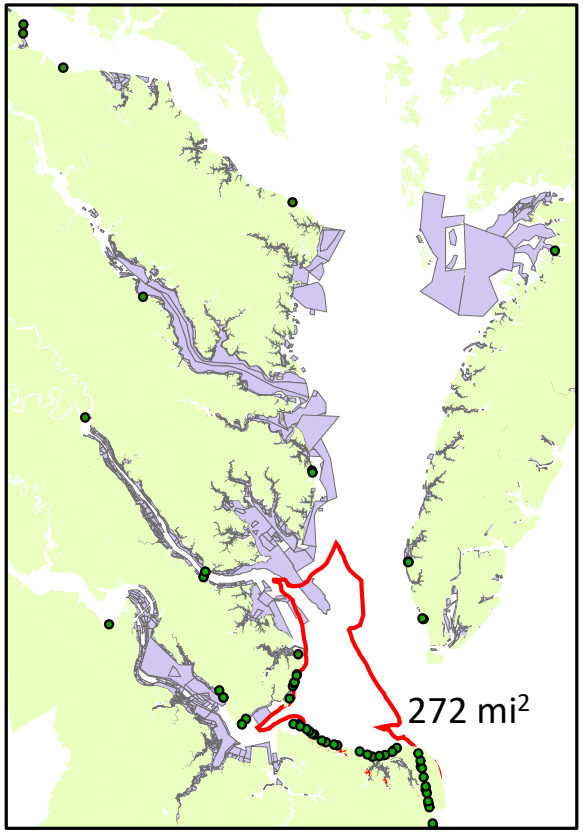


York 1m d-1 settling

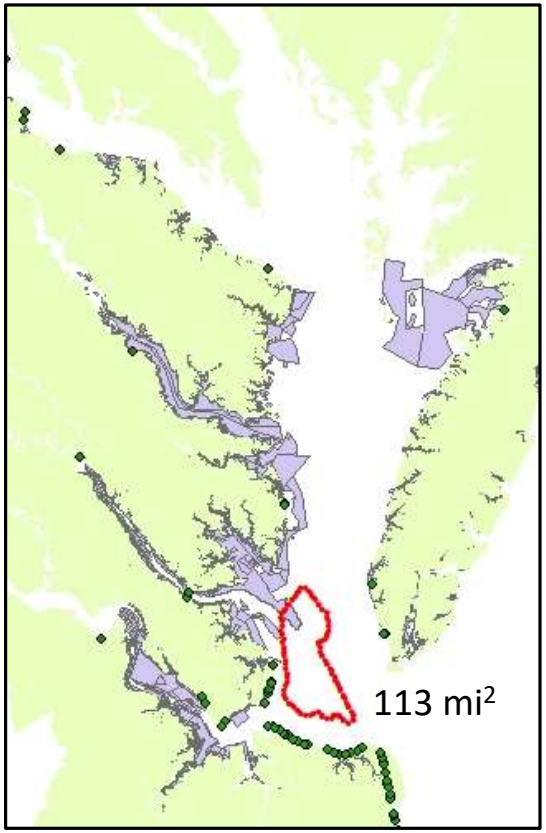


Extent of deposit particulate tracer and intersection with sensitive area: York mouth

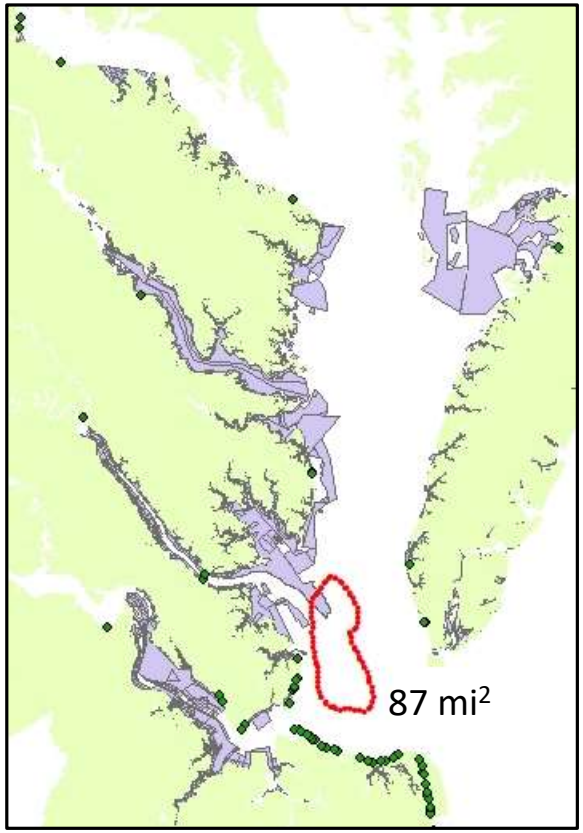
York month 0.m1 d^{-1} settled



York mouth 0.5m d-1 settling

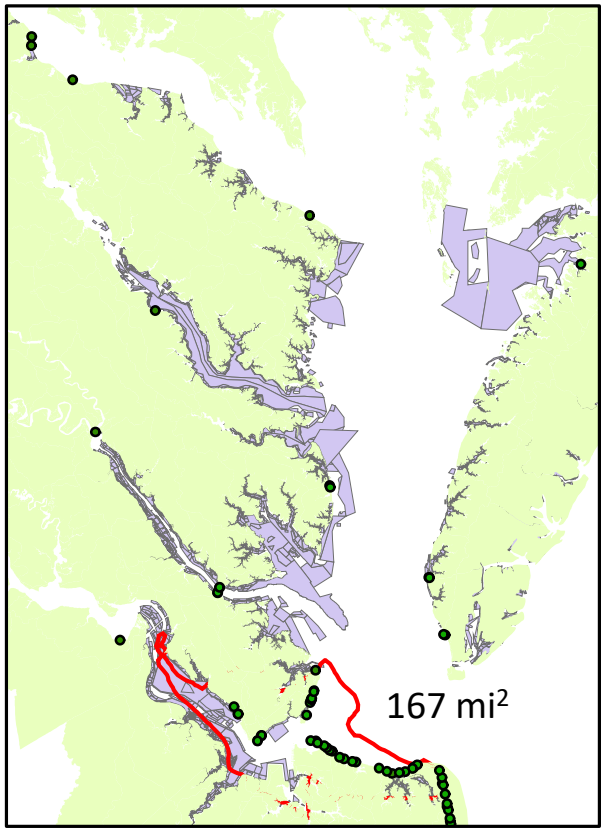


York mouth 1m d-1 settling

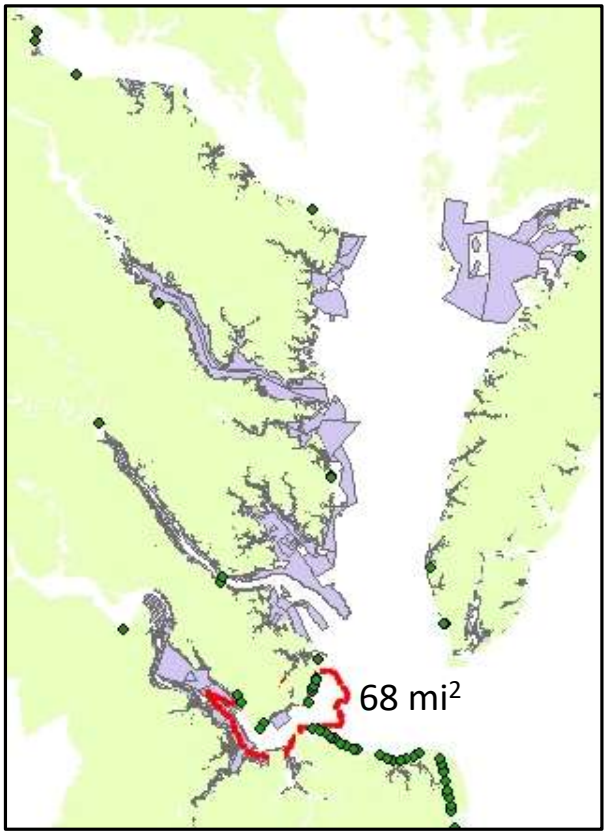


Extent of deposit particulate tracer and intersection with sensitive area: James

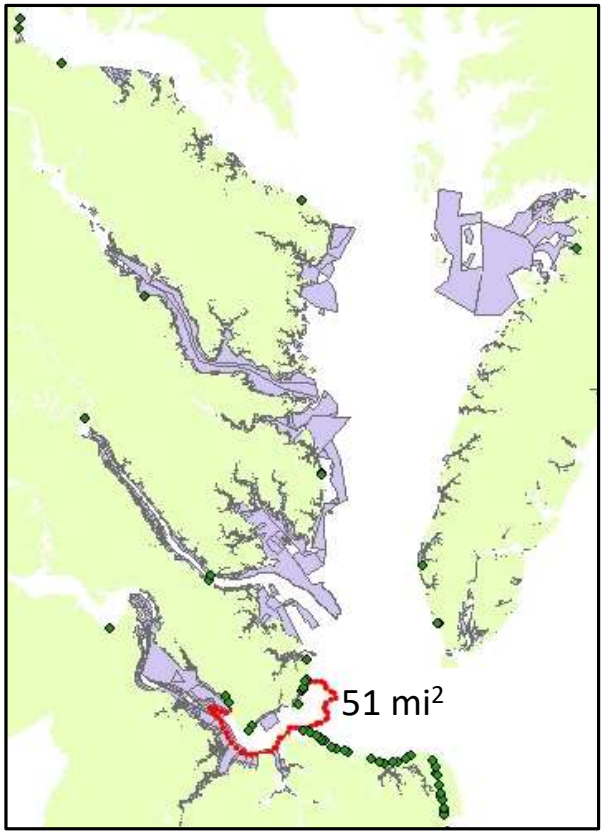
James 0.1 d-1 settled



James 0.5m d-1 settling

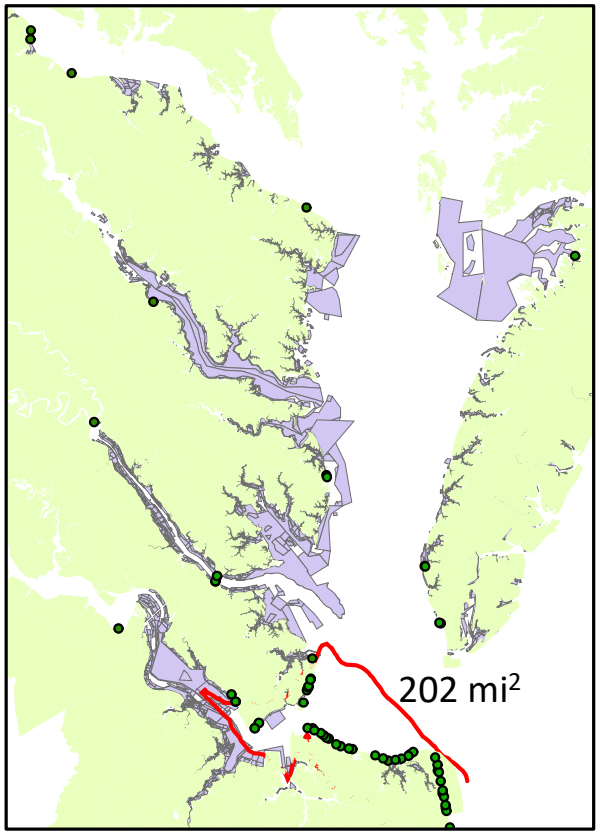


James 1 d-1 settling

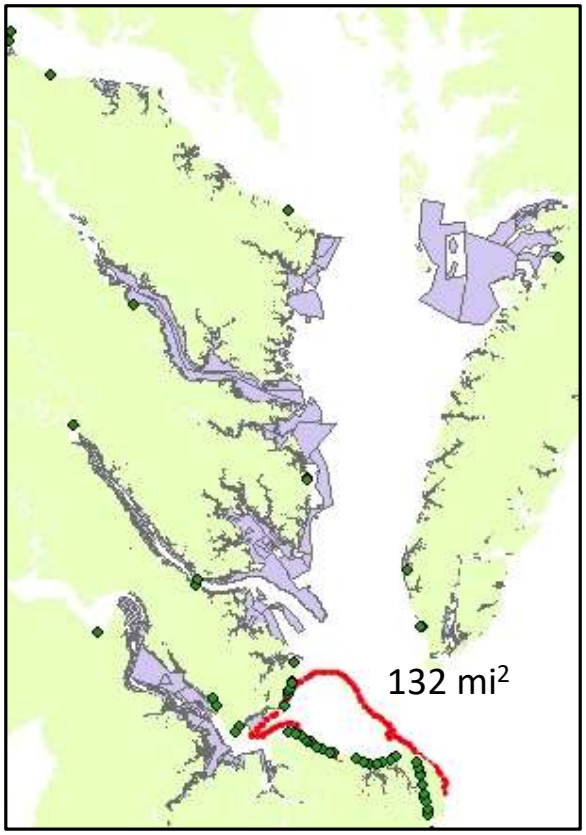


Extent of deposit particulate tracer and intersection with sensitive area: James mouth

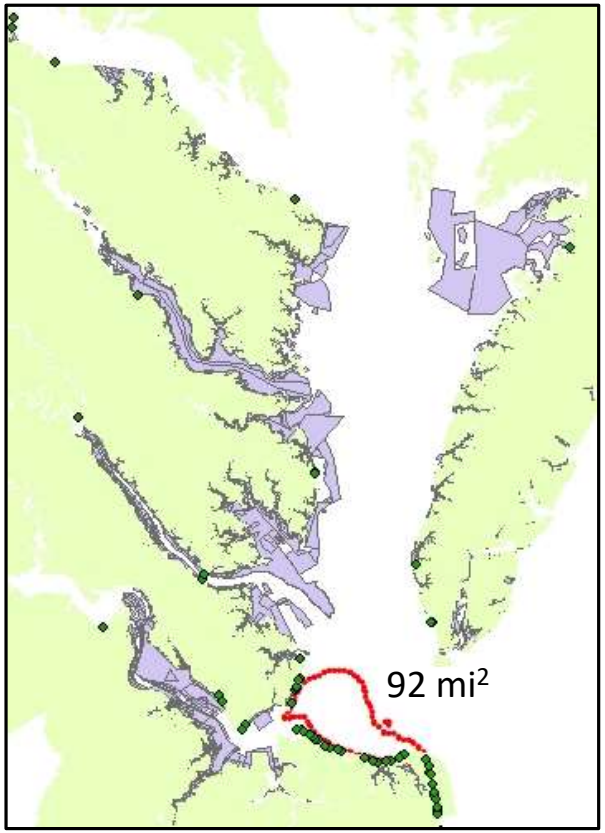
James mouth 0.1 d-1 settled



James mouth 0.5m d-1 settling

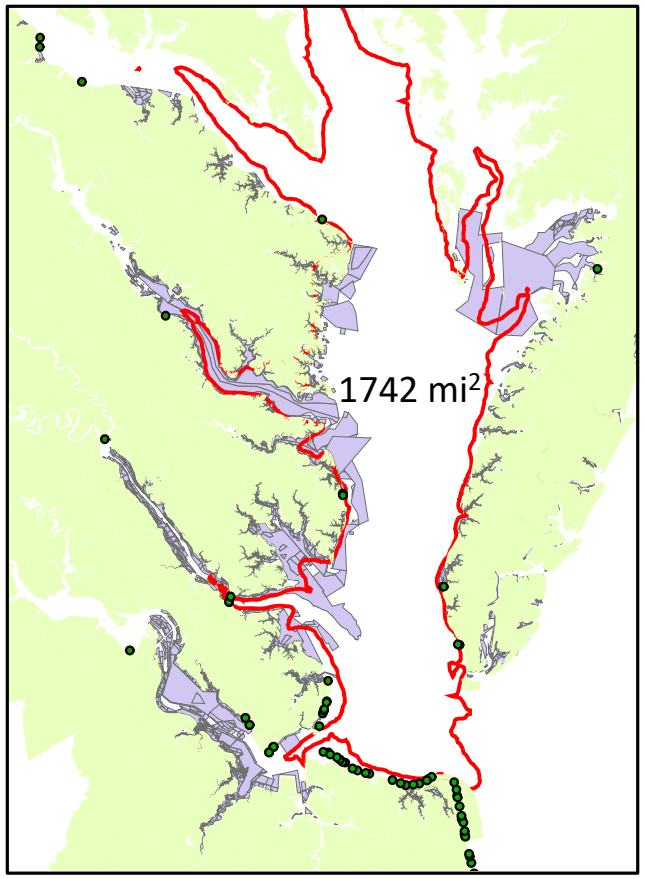


James mouth 1 d-1 settling

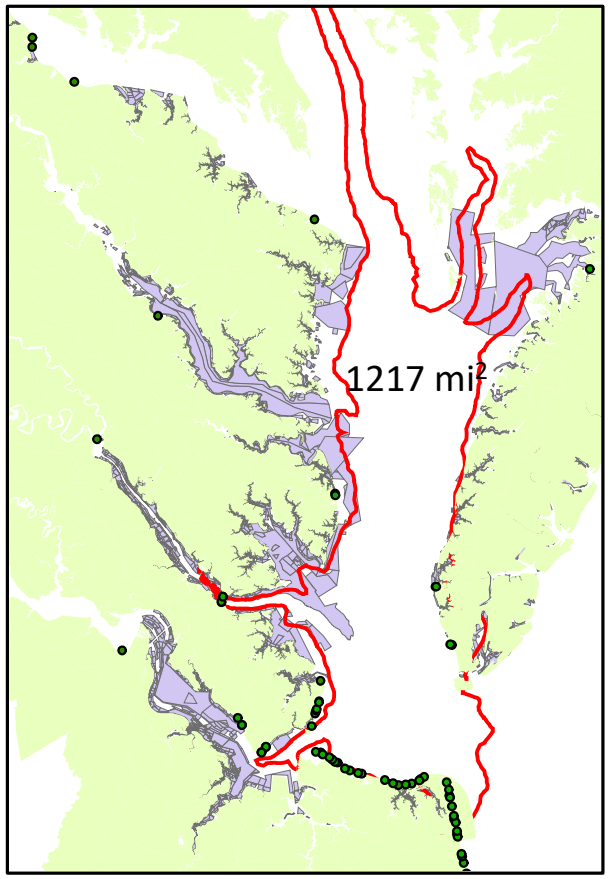


Extent of nutrient-type dissolved tracer and intersection with sensitive area

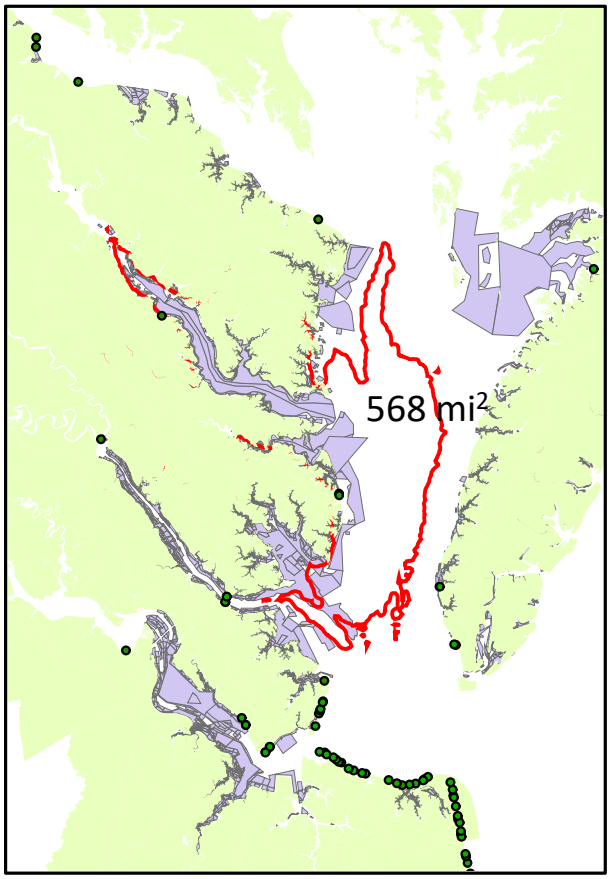
North neck 0.1 d-1 decay



Anchorage 0.1 d-1 decay

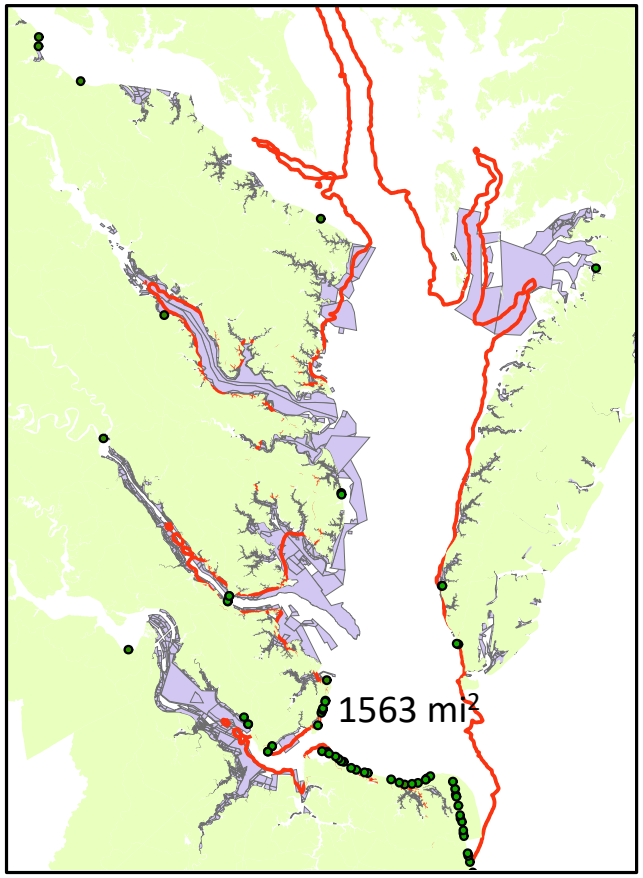


Rappahannock 0.1 d-1 decay

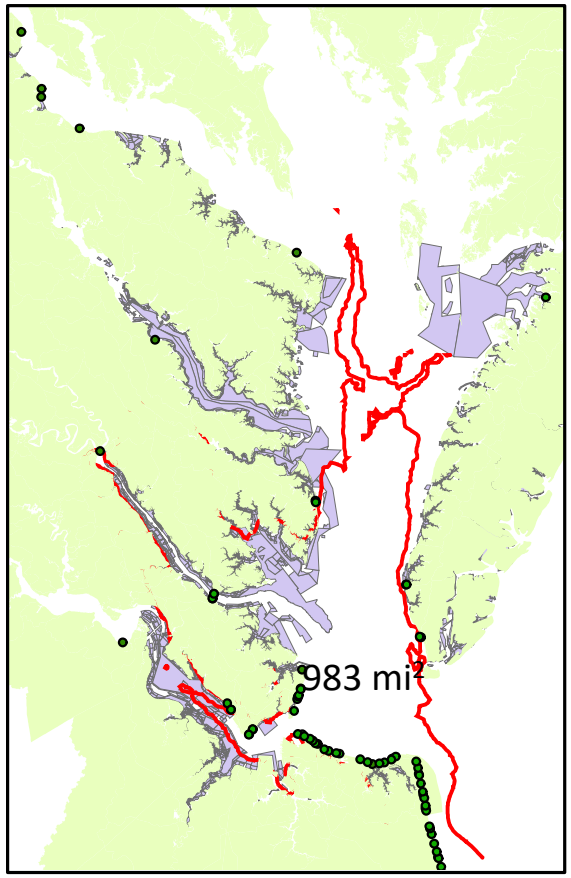


Extent of nutrient-type dissolved tracer and intersection with sensitive area

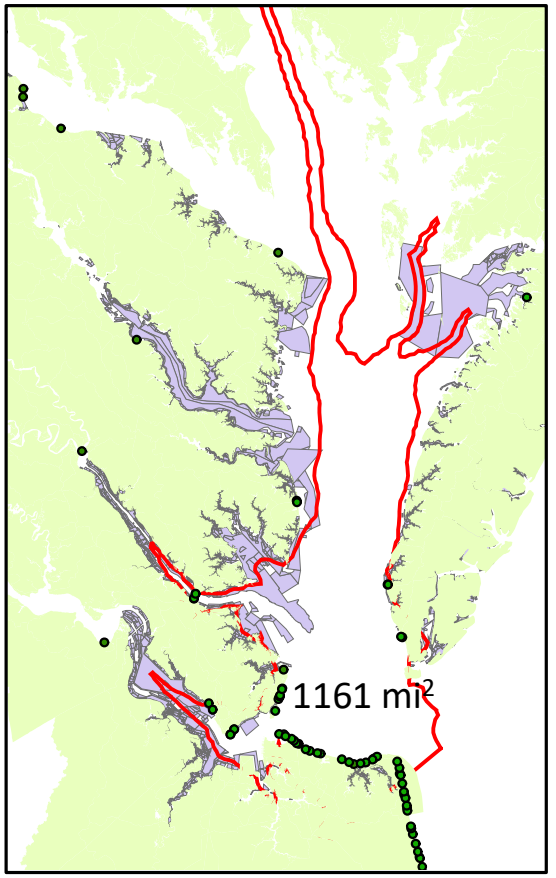
Rapp. mouth 0.1 d-1 decay



York 0.1 d-1 decay

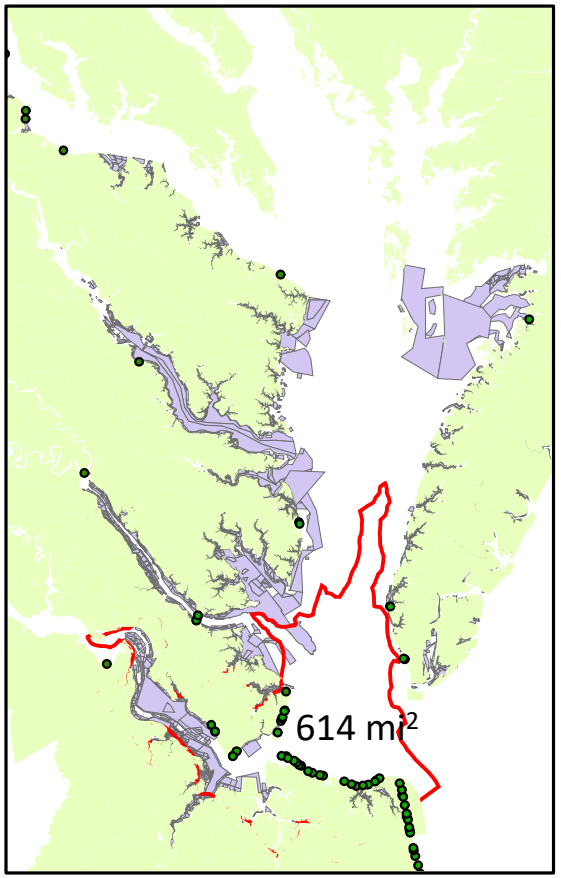


York month 0.1 d^{-1} decay

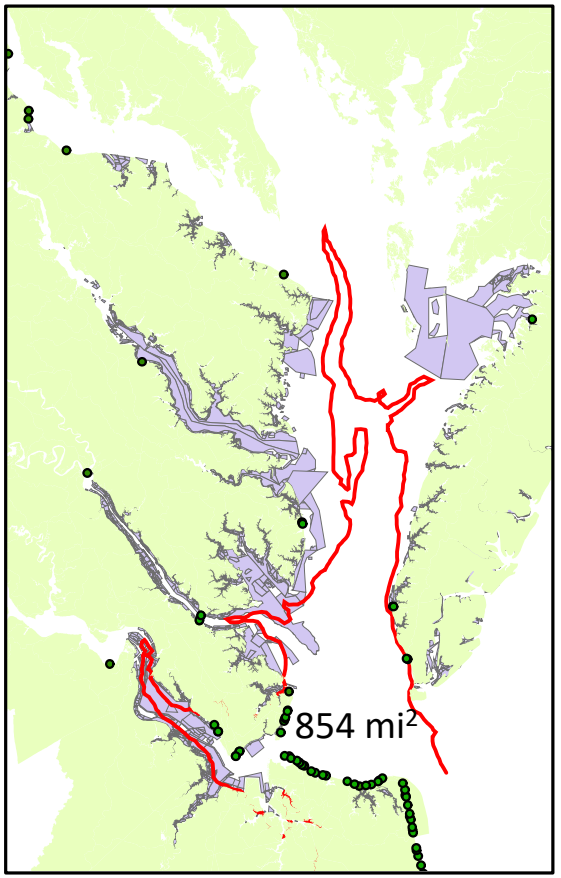


Extent of nutrient-type dissolved tracer and intersection with sensitive area

James 0.1 d-1 decay



James mouth 0.1 d-1 decay



Messages

- **All the tributary sites resulted in significant intersection with sensitive areas.**
- **Offshore sites have larger dispersion areas, but less intersection with sensitive areas than tributary sites.**
- **The anchorage site is the only one that did not result in intersection between settled tracers and sensitive areas.**
- **NDZ recommendation: Rappahannock mouth> York>Rappahannock> James>James mouth>York mouth> North neck>Anchorage**
- **Nutrient-type dissolved tracers demonstrate larger dispersion both in the tributaries and in the main stem of the Bay.**