

Integrated Source Apportionment Analysis of Atmospheric N-Deposition

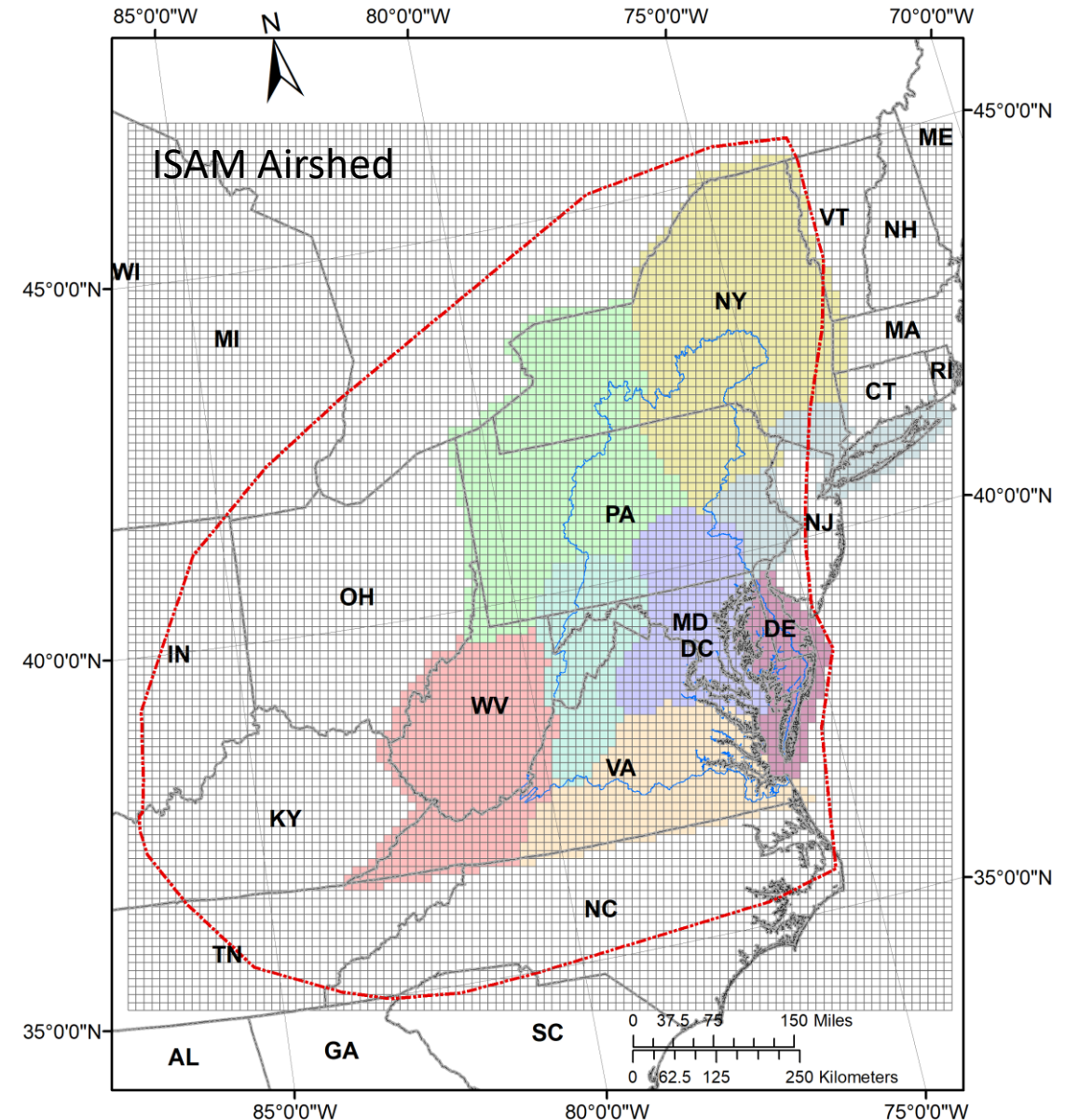
Modeling Workgroup Quarterly Meeting – October 2023

Gopal Bhatt¹, Jesse Bash², Gary Shenk³, Lewis Linker²

¹ Penn State, ² US EPA, ³ CBPO – Chesapeake Bay Program Office

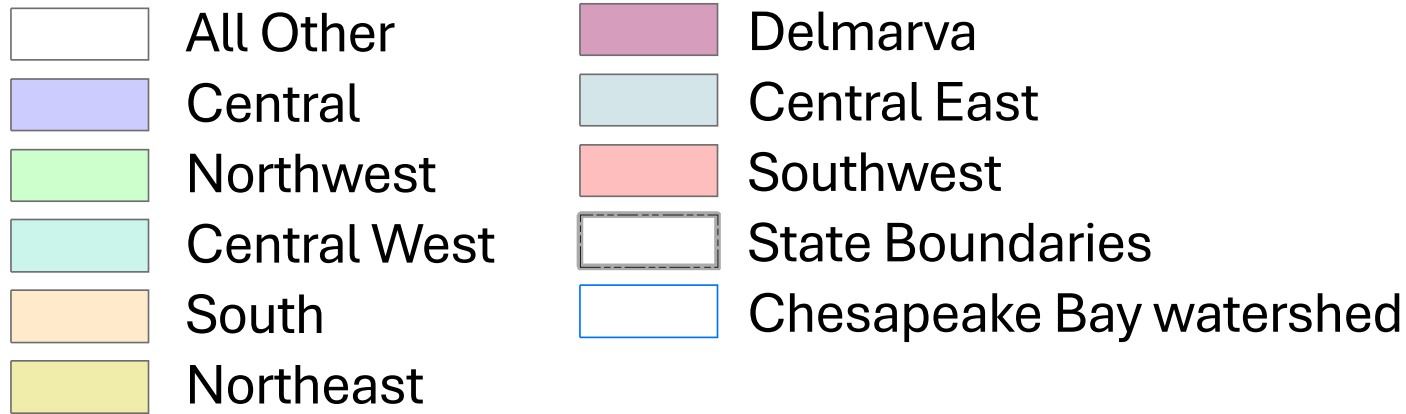
CMAQ-ISAM Domain

- Benish, Bash et al. developed estimates of emission source contributions to N deposition for the Chesapeake Bay airshed
- CMAQ model v5.3.2 with **I**ntegrated **S**ource **A**pportionment **M**ethod (ISAM)
- 12-km (111 x 103) grid cells for the Chesapeake Bay airshed
- ISAM used a reference average meteorological year of 2016

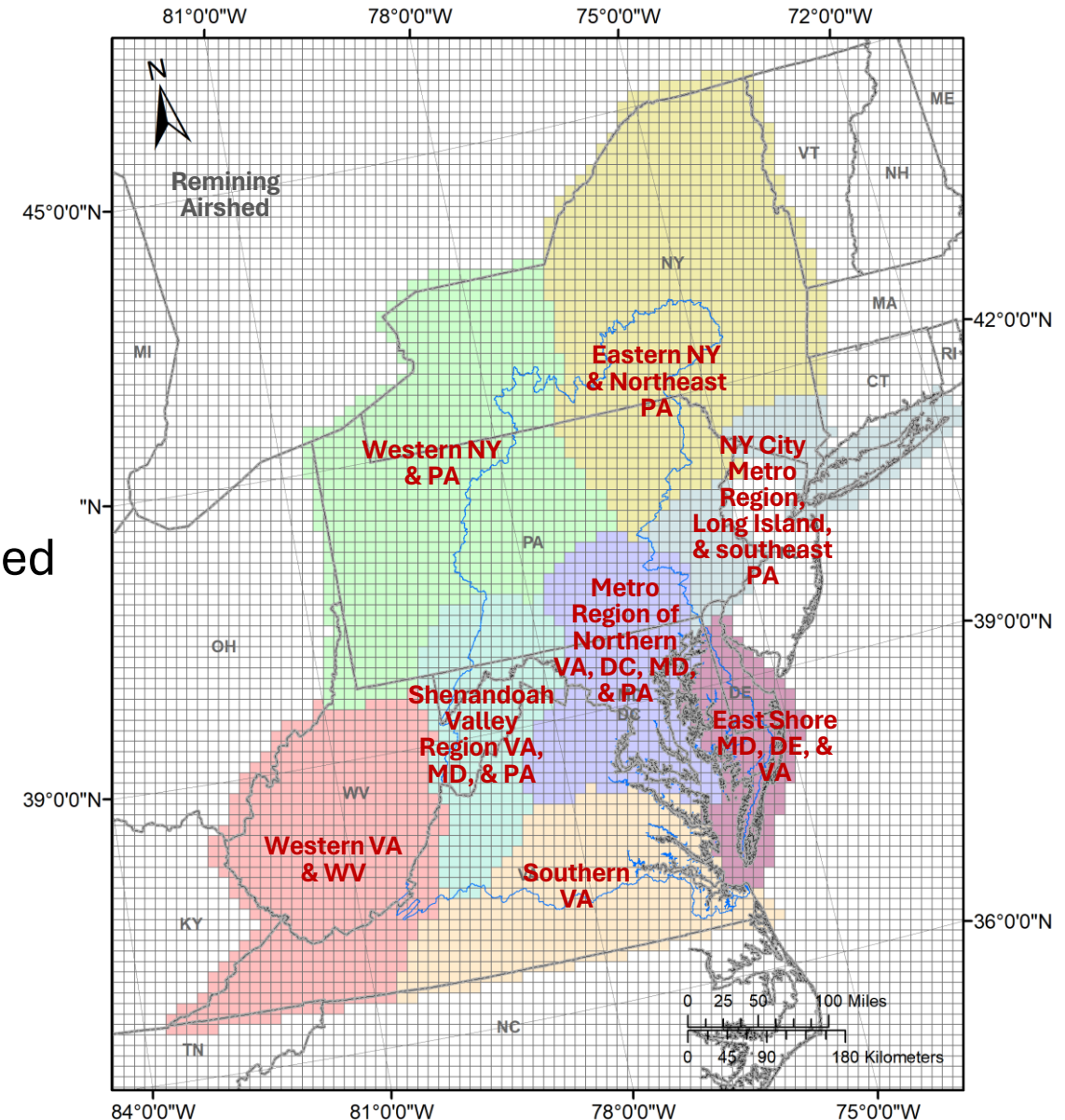


Chesapeake Regions and Sources

9 Regions

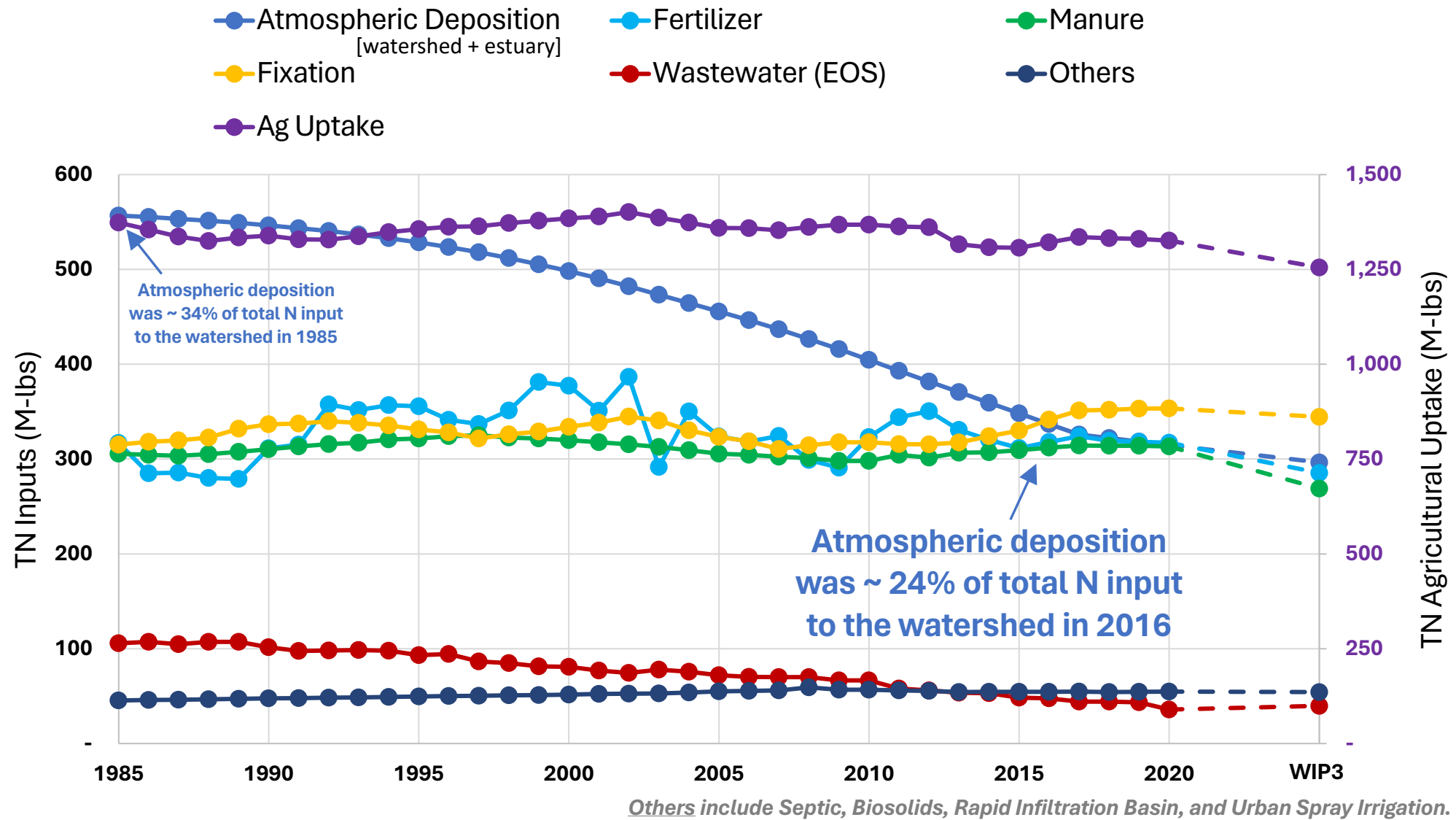


- 6 Sources: (0a) Boundary, (0b) Untracked, (1) On-road mobile, (2) Other manure, (3) Poultry manure, (4) Power plants (EGUs), (5) Offroad mobile, (0c) Fertilizers, (6) Ships (CMVs)



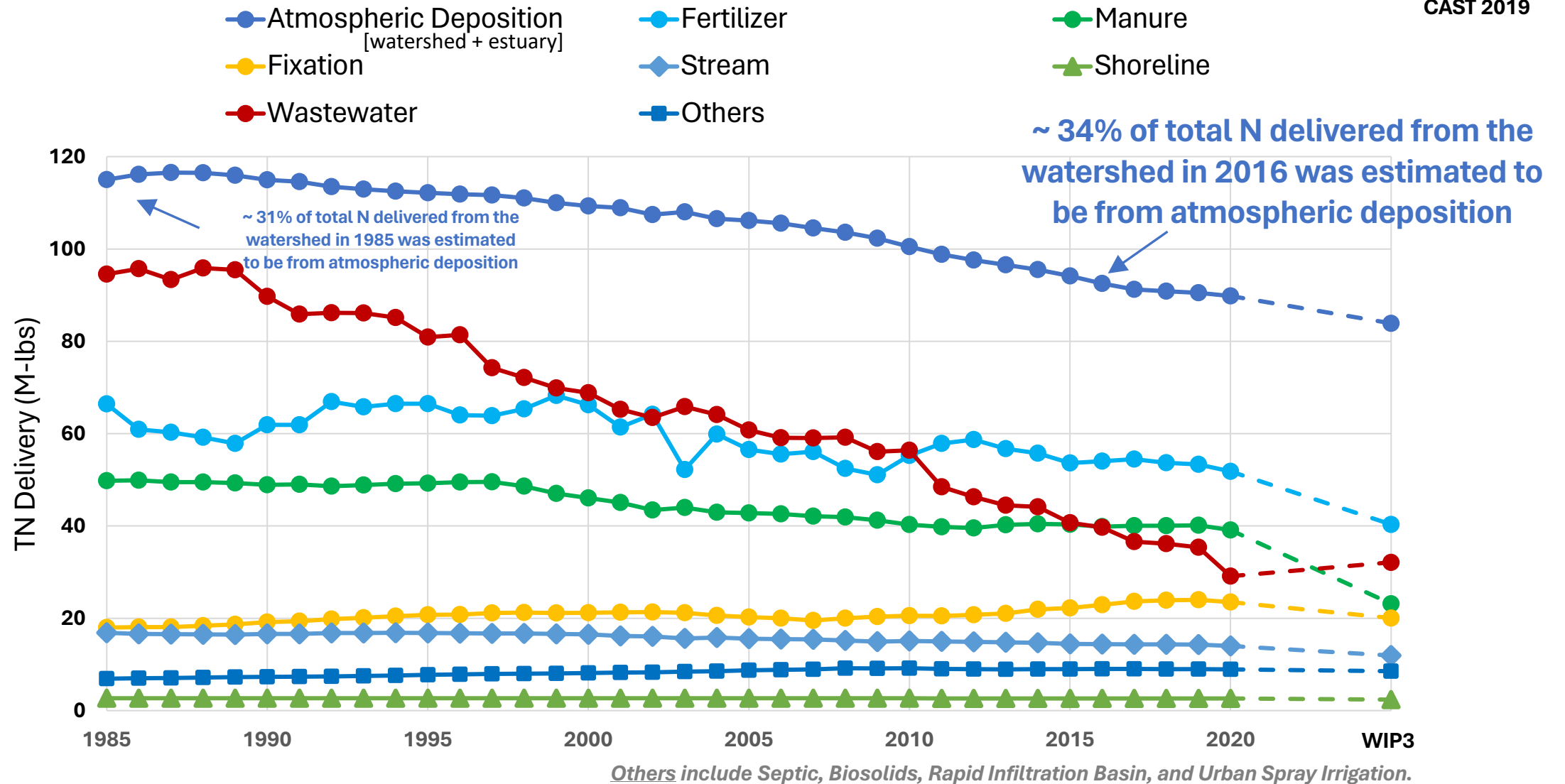
Phase 6 estimates of Total Nitrogen (TN) input to the Chesapeake Bay Watershed

CAST 2019



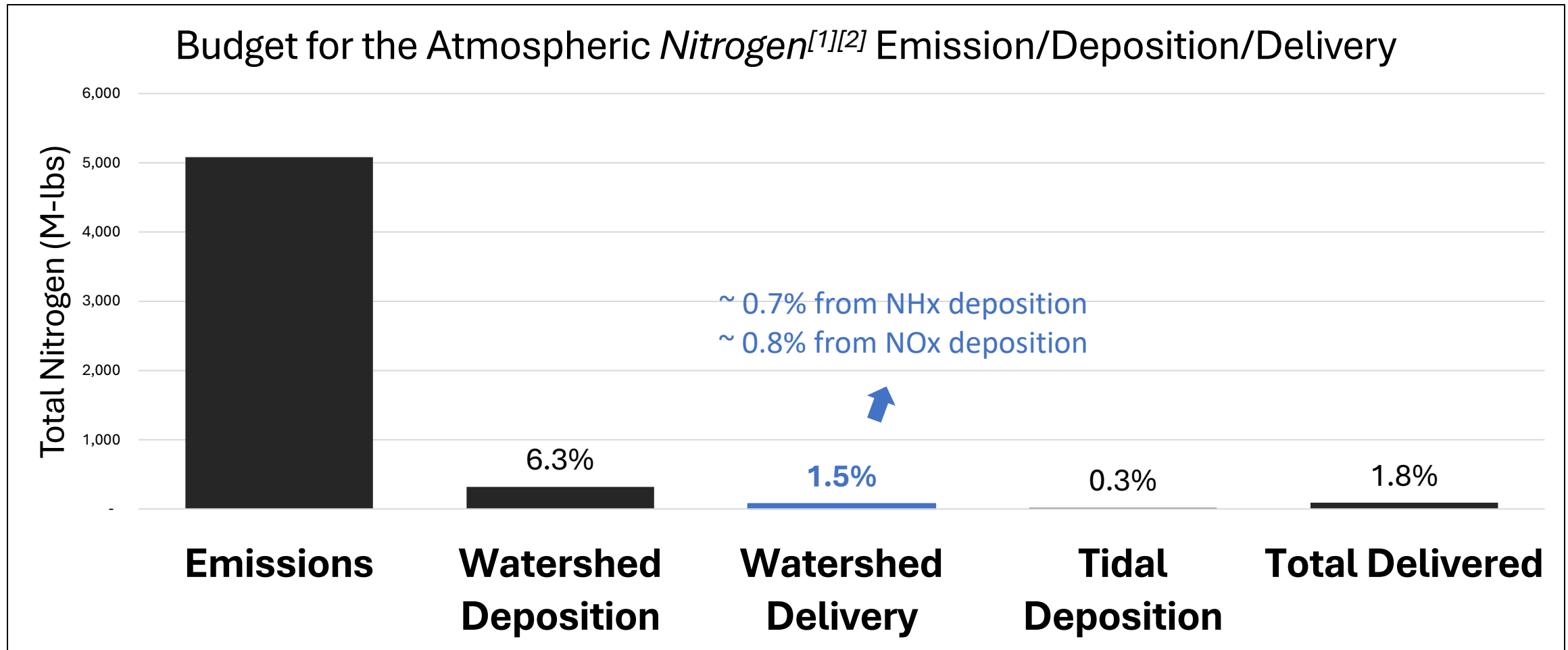
Phase 6 estimates of Total Nitrogen (TN) delivery to the Chesapeake Bay

CAST 2019



Estimated decreasing TN delivery is due to a combination of changes in inputs, BMPs, and management actions.

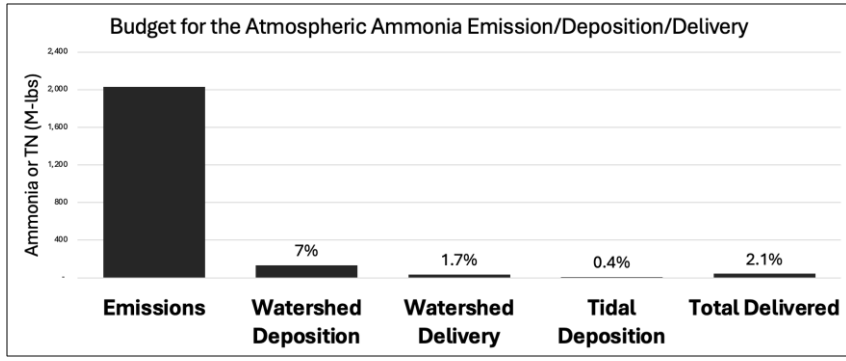
Integrated Analysis of CMAQ/ISAM and CAST



[1] Data are separately available for Ammonia (NHx) and Nitrate (NOx).

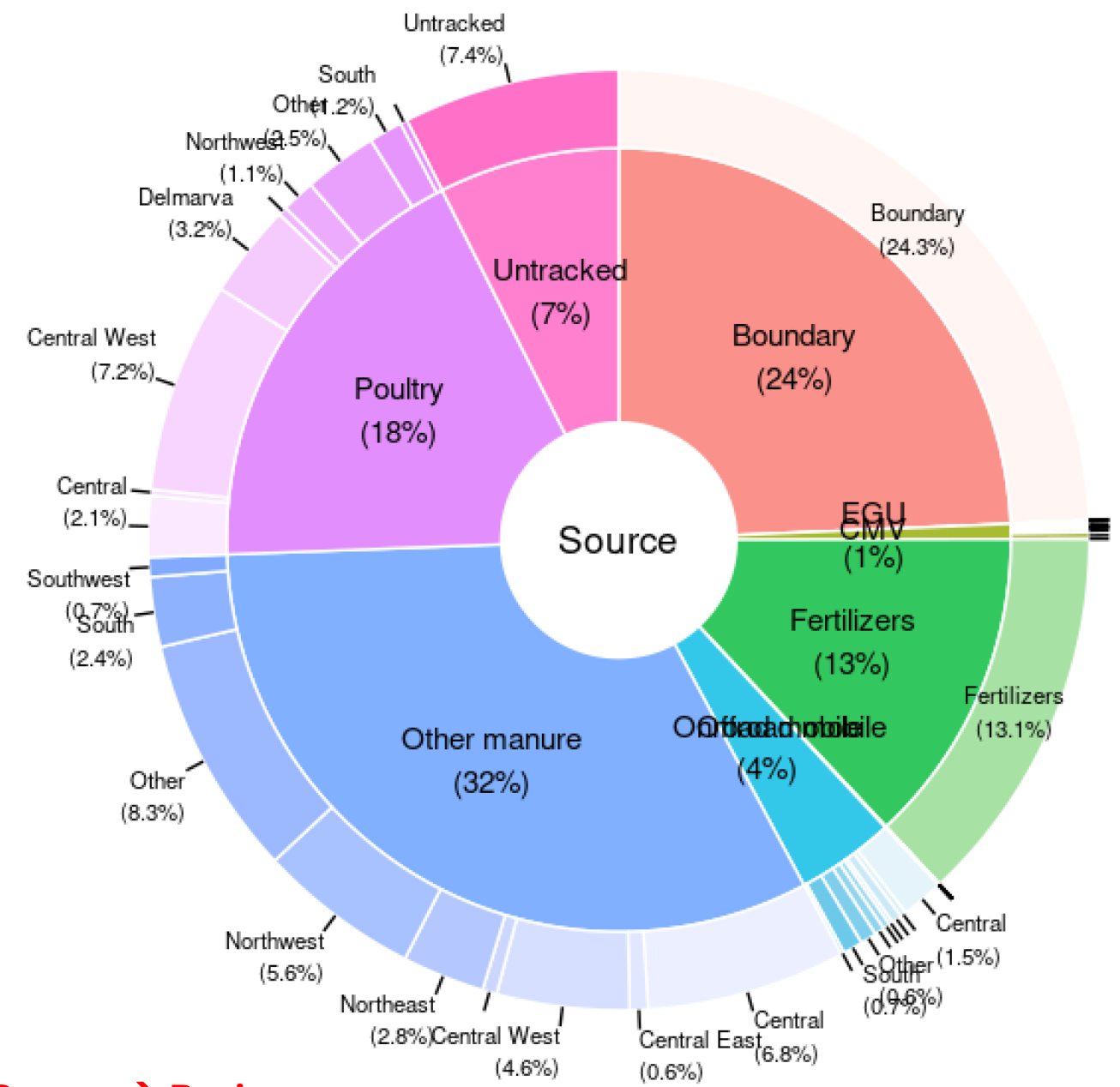
[2] Emissions bar include ~ 25% of total deposition (approx. 2% of the total airshed emissions) from outside the airshed boundary emissions.

NHx Deposition to the Chesapeake Bay Watershed



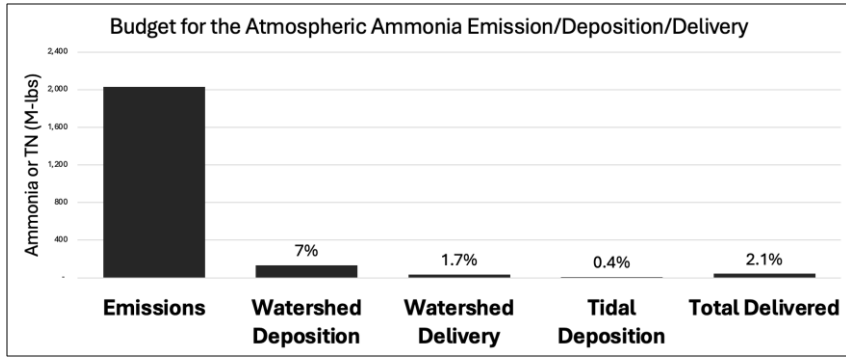
Ammonia

Region	Source	Emissions	Deposition	Watershed Deliv	Tidal Deposition	Total Delivered
Boundary	Boundary	32647850	32647850	7760383	2566045	10326428
South	CMV	8601	1546	702	988	1690
Central	CMV	4878	1533	535	623	1159
Delmarva	CMV	6240	834	259	684	943
All Other	CMV	38848	668	188	195	383
Central East	CMV	17820	492	144	49	193
Northwest	CMV	2532	150	38	5	43
Southwest	CMV	1824	103	24	3	27
Northeast	CMV	2654	11	3	0	3
Central West	CMV	0	0	0	0	0
South	EGU	1200365	294593	60517	27923	88439
Central	EGU	573495	147249	45220	9843	55063
All Other	EGU	5447428	143089	34575	9699	44274
Central East	EGU	2881549	132514	39389	13158	52548
Northwest	EGU	700309	62911	16144	2134	18278
Delmarva	EGU	231435	21218	6684	2478	9162
Southwest	EGU	120562	15141	3024	490	3514
Central West	EGU	51598	14704	3496	468	3964
Northeast	EGU	233653	11850	3126	312	3438
Fertilizers	Fertilizers	322589437	17562146	4451767	888622	5340389
Central	Offroad Mobile	75871	23975	8071	1924	9995
All Other	Offroad Mobile	603892	10804	2636	878	3515
South	Offroad Mobile	36997	9263	2518	1550	4068
Northwest	Offroad Mobile	71604	7887	2098	165	2263
Central West	Offroad Mobile	12956	4877	1194	77	1270
Northeast	Offroad Mobile	59324	4581	1205	66	1272
Central East	Offroad Mobile	135202	4451	1372	287	1659
Delmarva	Offroad Mobile	25278	3385	1033	1444	2477
Southwest	Offroad Mobile	21729	1686	327	73	400
Central	Onroad Mobile	5726877	1950172	649980	129023	779003
South	Onroad Mobile	3191000	905413	235061	83717	318778
All Other	Onroad Mobile	41688520	745188	178508	62681	241189
Central West	Onroad Mobile	1181862	462927	111536	7178	118774
Northwest	Onroad Mobile	4015239	452469	119723	9805	129528
Northeast	Onroad Mobile	3218635	316562	85459	4820	90279
Central East	Onroad Mobile	7553761	268275	81936	20631	102568
Delmarva	Onroad Mobile	1085522	181317	56375	23691	80067
Southwest	Onroad Mobile	2236087	156758	30404	6989	37393
All Other	Other Manure	549720159	11116998	2665134	1401589	4066723
Central	Other Manure	33427929	9170603	3381432	251813	3633245
Northwest	Other Manure	44585579	7445262	2021978	87232	2109210
Central West	Other Manure	17872490	6109211	1524290	102942	1627232
Northeast	Other Manure	38932083	3799071	923797	43909	967707
South	Other Manure	14940351	3215020	608831	258623	867455
Southwest	Other Manure	11339557	898595	171725	44733	216459
Central East	Other Manure	9011229	839839	308880	32268	341149
Delmarva	Other Manure	3682609	659451	207746	68840	276586
Central West	Poultry	26705203	9714537	1804555	151351	1955906
Delmarva	Poultry	23867407	4318803	1250594	451174	1701767
All Other	Poultry	161466189	3405744	791540	398310	1189850
Central	Poultry	10776977	2810063	1082099	73214	1155313
South	Poultry	5177438	1543905	245243	76794	322038
Northwest	Poultry	5286563	1541805	463022	14599	477621
Northeast	Poultry	3089917	407666	119871	6600	126471
Southwest	Poultry	2057115	311351	49778	10051	59829
Central East	Poultry	3082712	289398	105485	10488	115973
Untracked	Untracked	627669005	9980943	2623862	603536	3227398



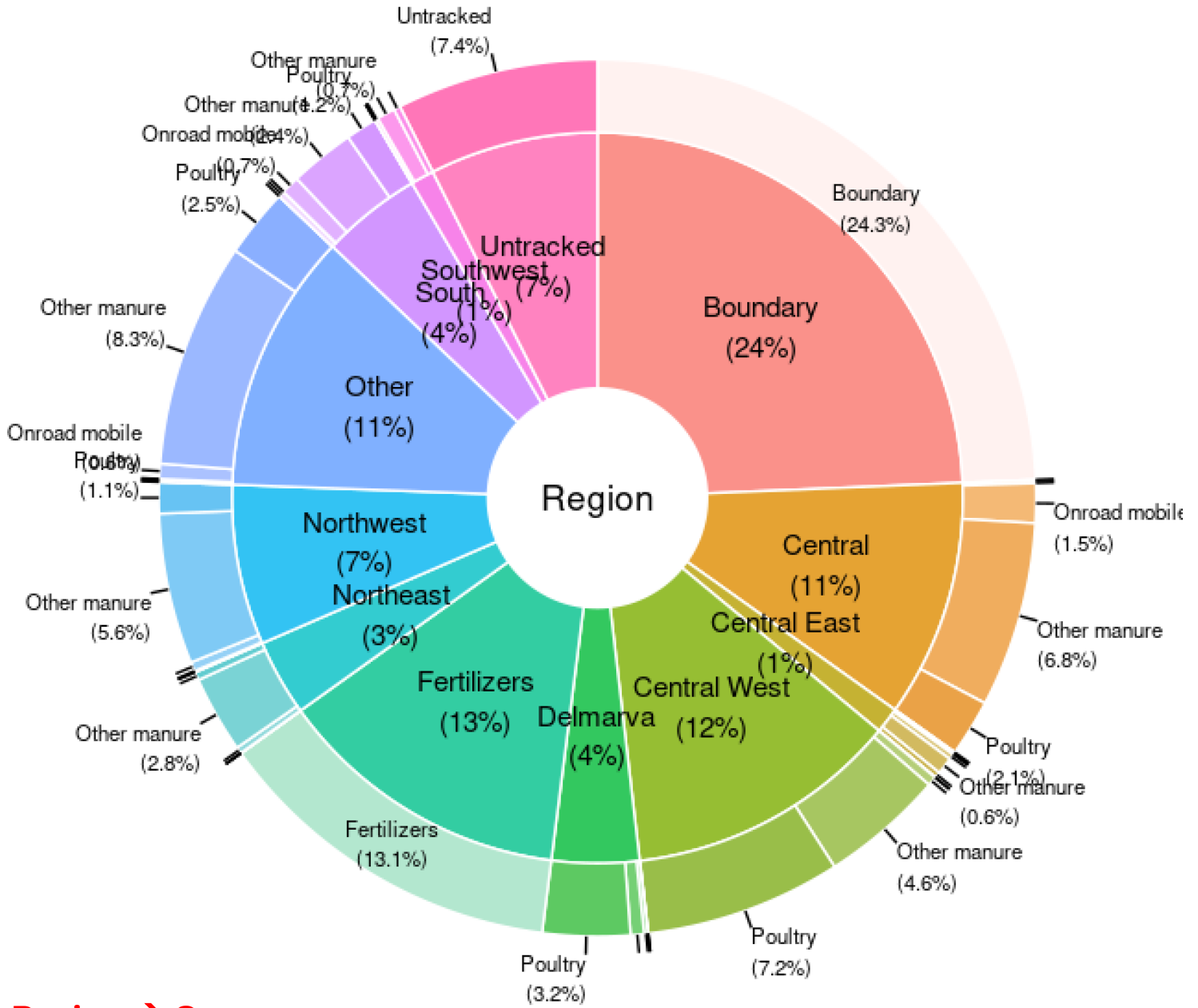
Source → Region

NHx Deposition to the Chesapeake Bay Watershed



Ammonia

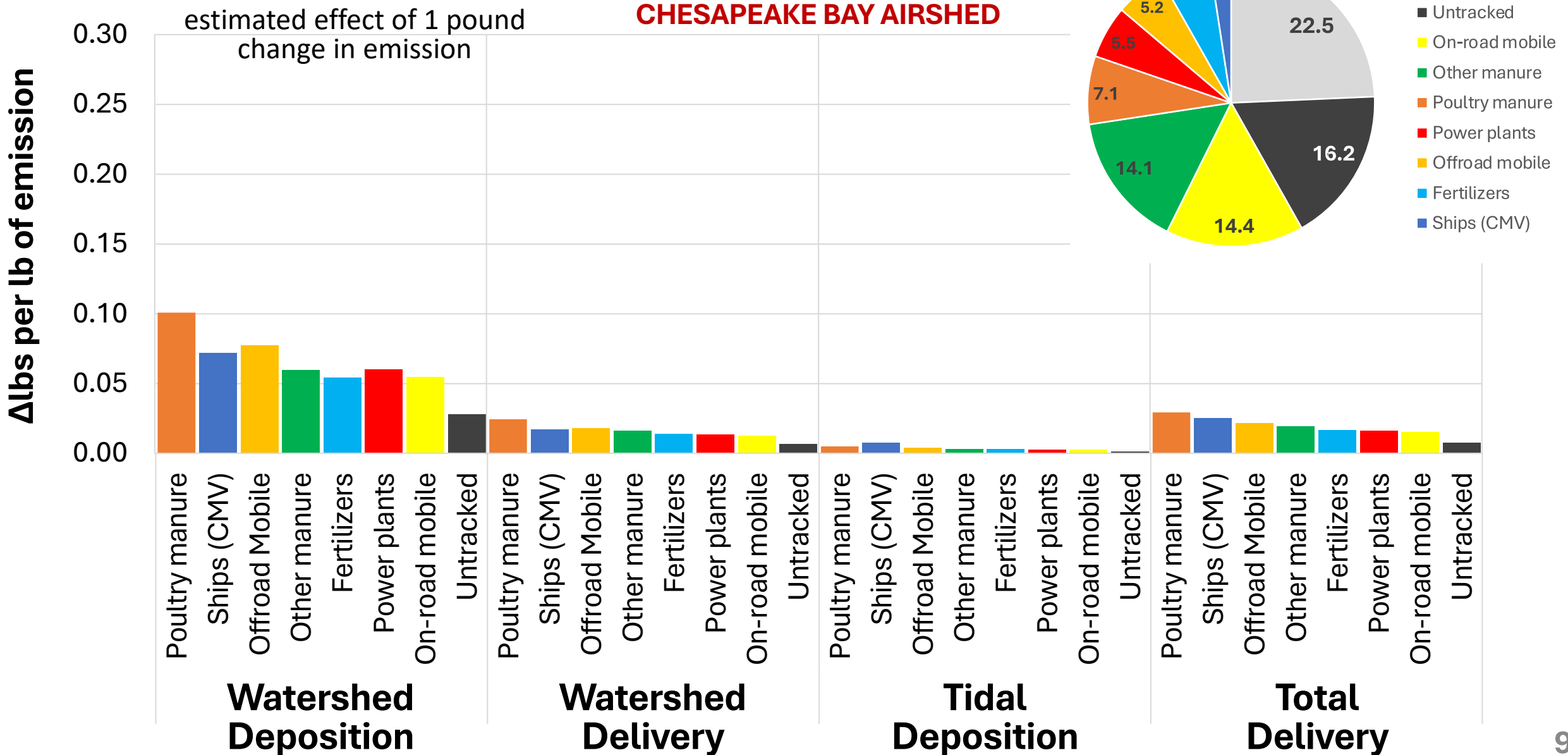
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Delmarva	Poultry	23867407	4318803	1250594	451174	1701767
Delmarva	Other Manure	3682609	659451	207746	68840	276586
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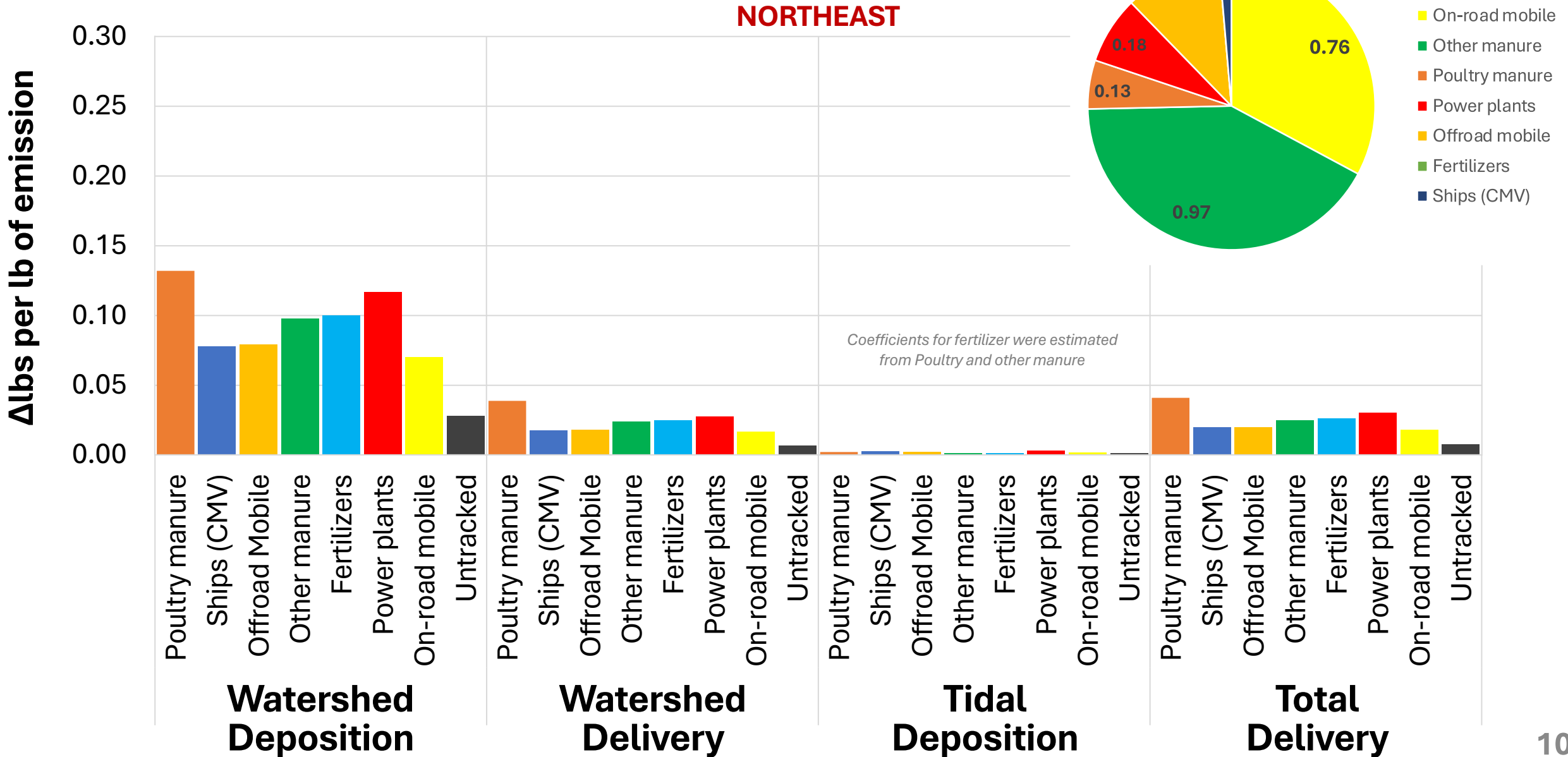
Region → Source

Sensitivity to changes in N-emissions

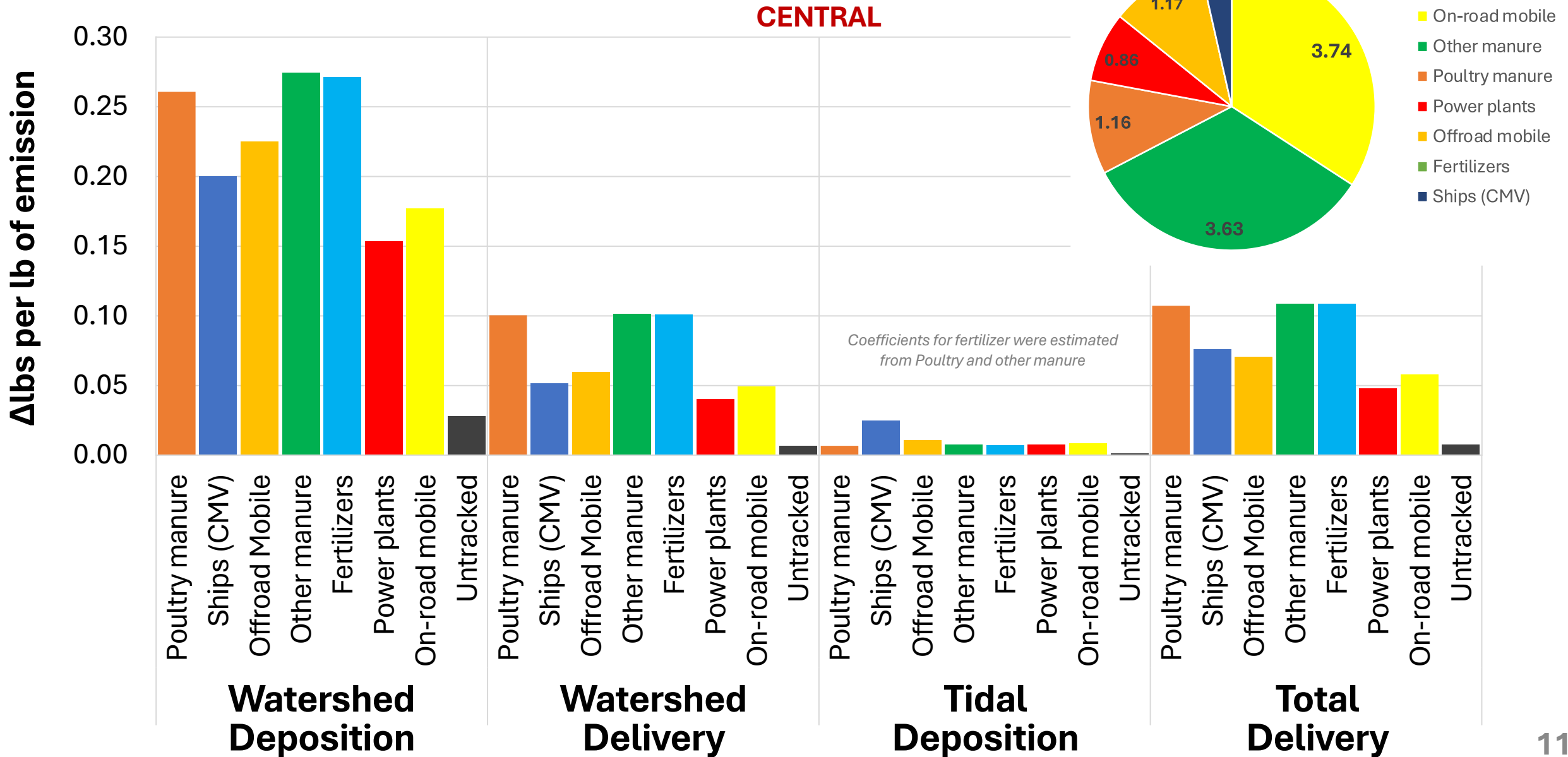
Total Delivered (M-lbs)



Sensitivity to changes in N-emissions



Sensitivity to changes in N-emissions

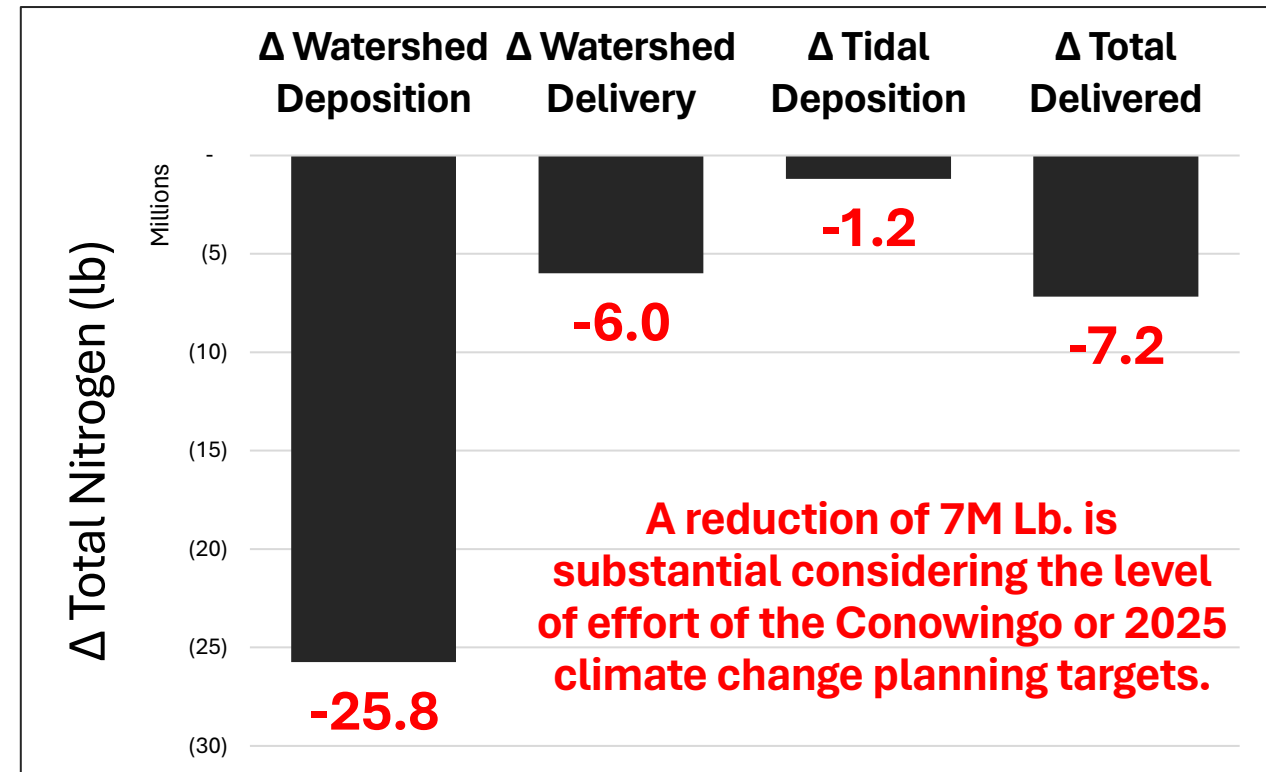


“what-if” scenarios

- We have developed delivery coefficients for the “*Region – Source*” scale.
- Let’s consider a scenario where **On Road N** emissions were cut in half.

Region	Δ Emissions	Δ Deposition	Δ Watershed Del	Δ Tidal Depositi	Δ Total Delivered
Central	2863439	975086	324990	64511	389501
Central West	590931	231463	55768	3589	59357
South	1595500	452707	117530	41858	159389
Delmarva	542761	90658	28188	11846	40033
Northwest	2007620	226234	59862	4903	64764
Northeast	1609317	158281	42729	2410	45140
Southwest	1118043	78379	15202	3494	18696
Central East	3776881	134137	40968	10316	51284
All Other	20844260	372594	89254	31340	120594
Total	34,948,751	2,719,540	774,491	174,268	948,759

Region	Δ Emissions	Δ Deposition	Δ Watershed Del	Δ Tidal Depositi	Δ Total Delivered
Central	29509537	4756140	1264709	214164	1478873
Central West	10574538	2145088	453300	48765	502065
Delmarva	6639259	765712	193619	70388	264007
South	20153594	2531180	489094	165129	654223
Northwest	26029910	2785770	632588	67375	699962
Northeast	19453870	1320283	304226	30438	334664
Southwest	16964667	1201101	223010	43831	266841
Central East	37649663	1540579	386349	77809	464158
All Other	267598428	5985989	1265359	296636	1561995
Total	434,573,468	23,031,842	5,212,254	1,014,535	6,226,790

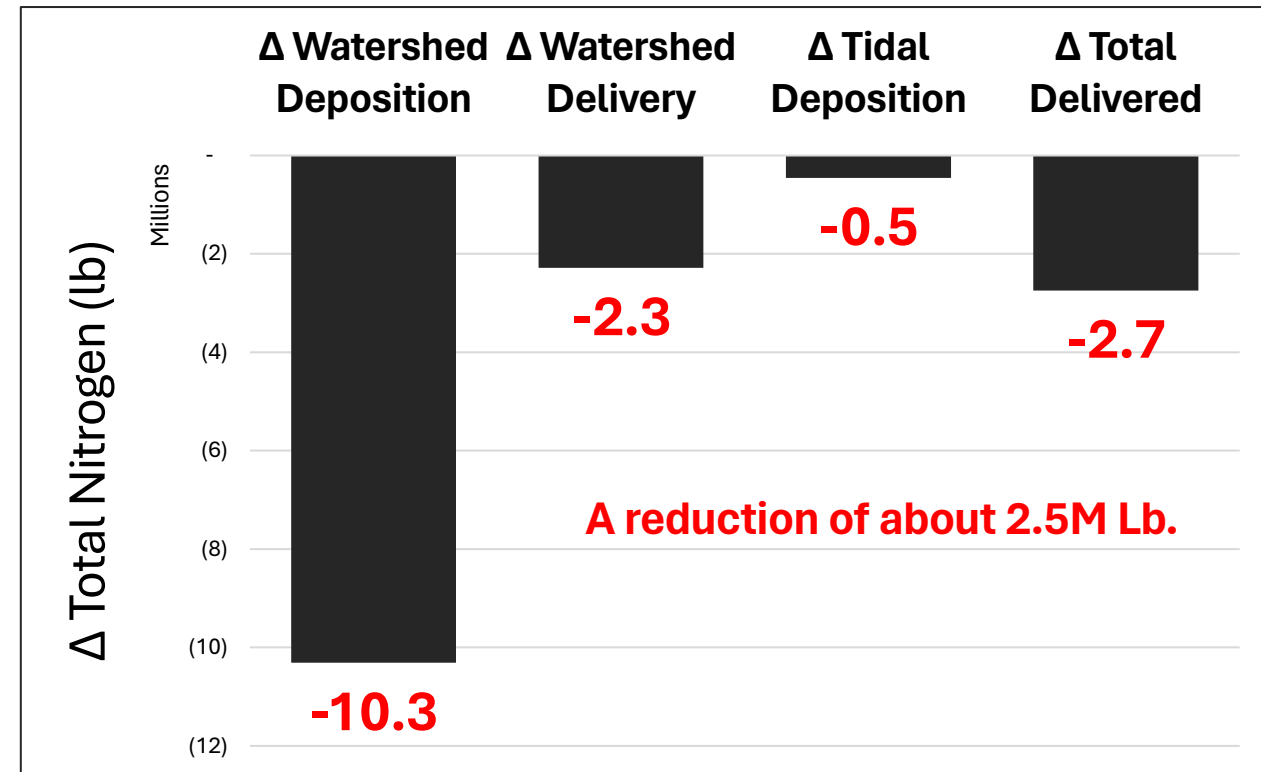


“what-if” scenarios

- We have developed delivery coefficients for the “*Region – Source*” scale.
- Let’s consider a scenario where **EGU** N emissions were cut in half.

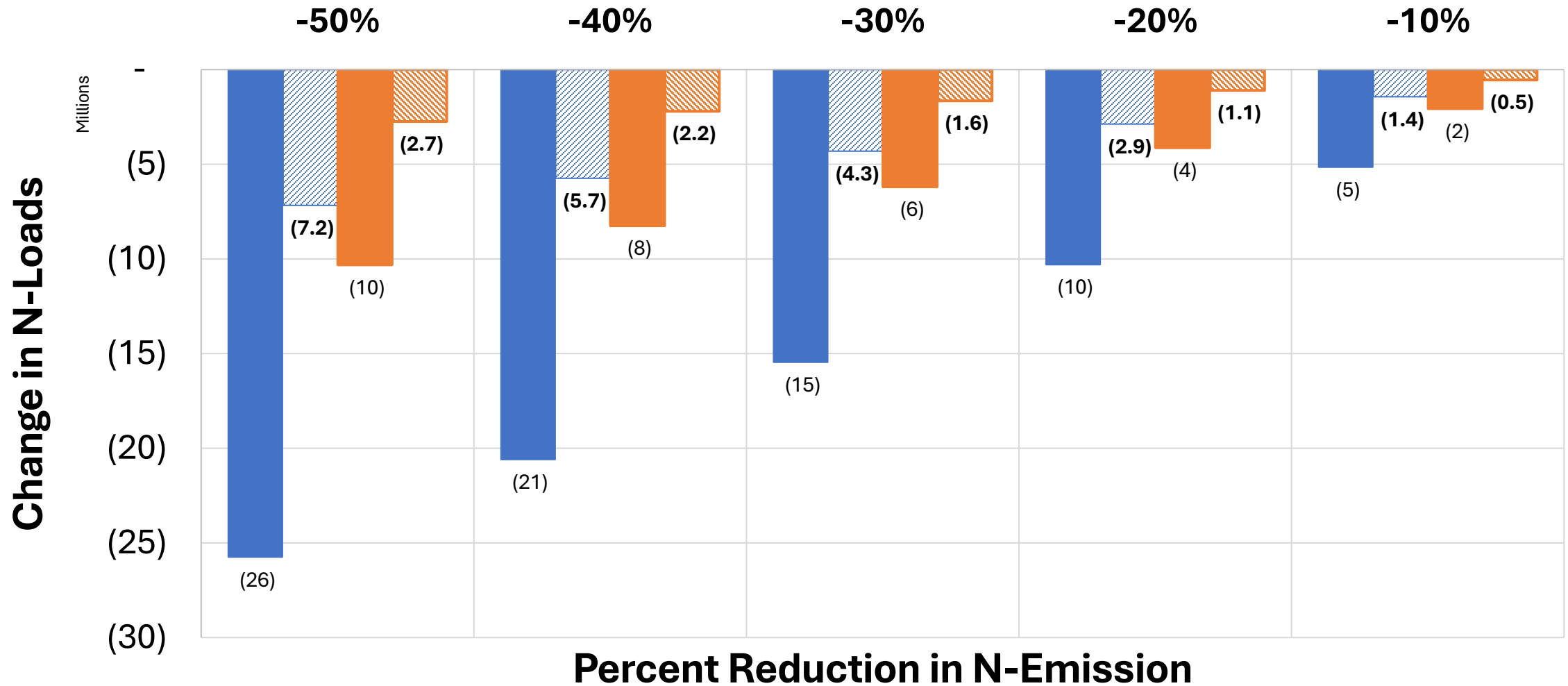
AMMONIA (NHx)	Region	Δ Emissions	Δ Deposition	Δ Watershed Del	Δ Tidal Depositi	Δ Total Delivered
	Central	286747	73624	22610	4922	27532
	Central West	25799	7352	1748	234	1982
	South	600182	147296	30258	13961	44220
	Delmarva	115718	10609	3342	1239	4581
	Northwest	350155	31455	8072	1067	9139
	Northeast	116826	5925	1563	156	1719
	Southwest	60281	7570	1512	245	1757
	Central East	1440775	66257	19695	6579	26274
	All Other	2723714	71544	17287	4849	22137
Total	5,720,197	421,634	106,087	33,253	139,340	

NITRATE (NOx)	Region	Δ Emissions	Δ Deposition	Δ Watershed Del	Δ Tidal Depositi	Δ Total Delivered
	Central	8677314	1300354	338280	63635	401914
	Central West	1760010	304370	66549	10840	77389
	Delmarva	972786	121054	29802	9943	39746
	South	9369259	925557	180297	71019	251316
	Northwest	31229150	2527183	572669	76875	649545
	Northeast	2770437	331739	77808	8213	86021
	Southwest	24273474	1495074	299537	50349	349885
	Central East	9921559	559601	135525	30806	166331
	All Other	76523005	2326082	480423	101966	582389
Total	165,496,995	9,891,014	2,180,890	423,646	2,604,536	



Percent reduction scenarios ...

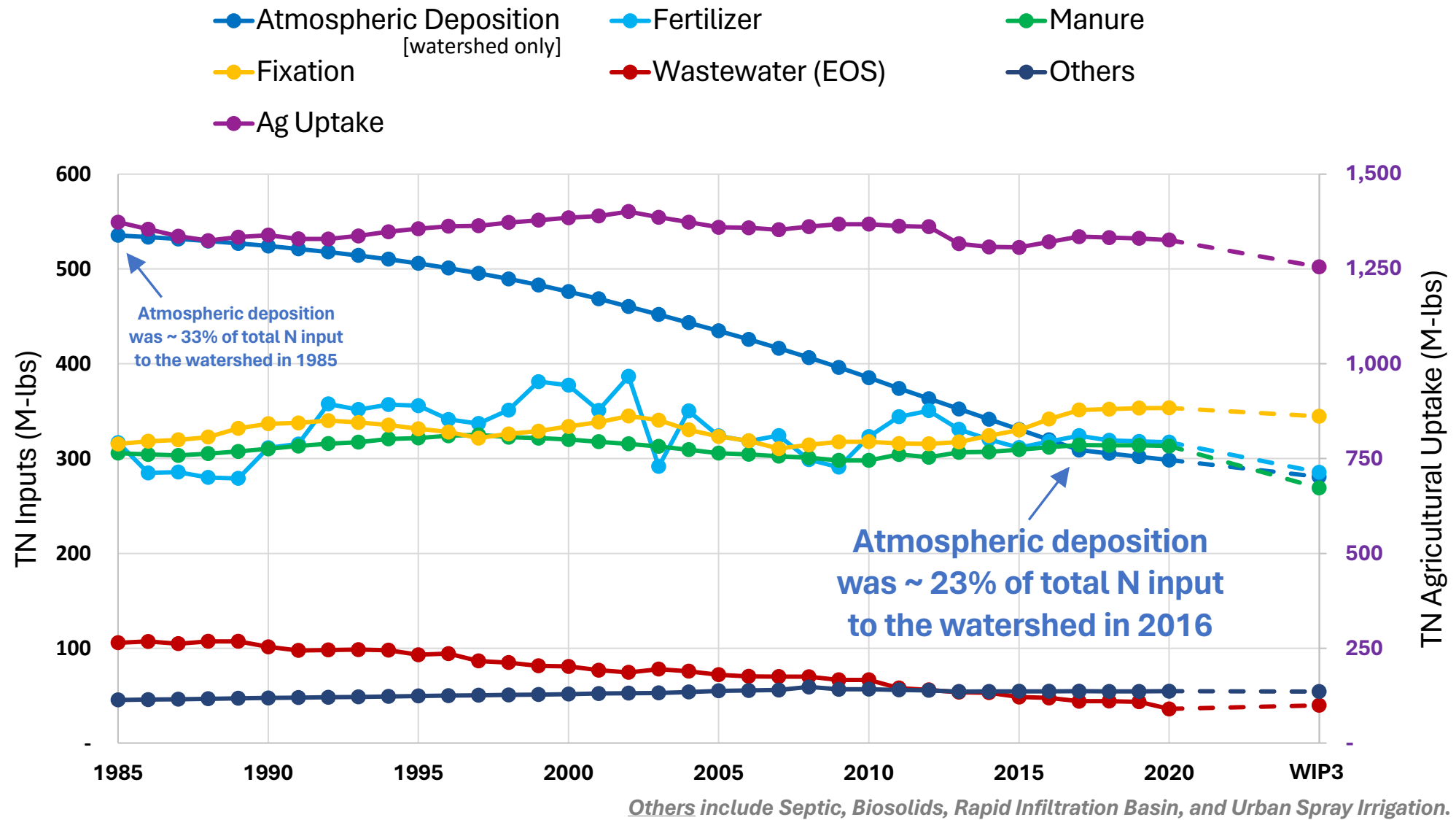
- Δ On-Road Watershed Deposition ▨ Δ On-Road Total Delivered
- Δ EGU Watershed Deposition ▨ Δ EGU Total Delivered



- The end.

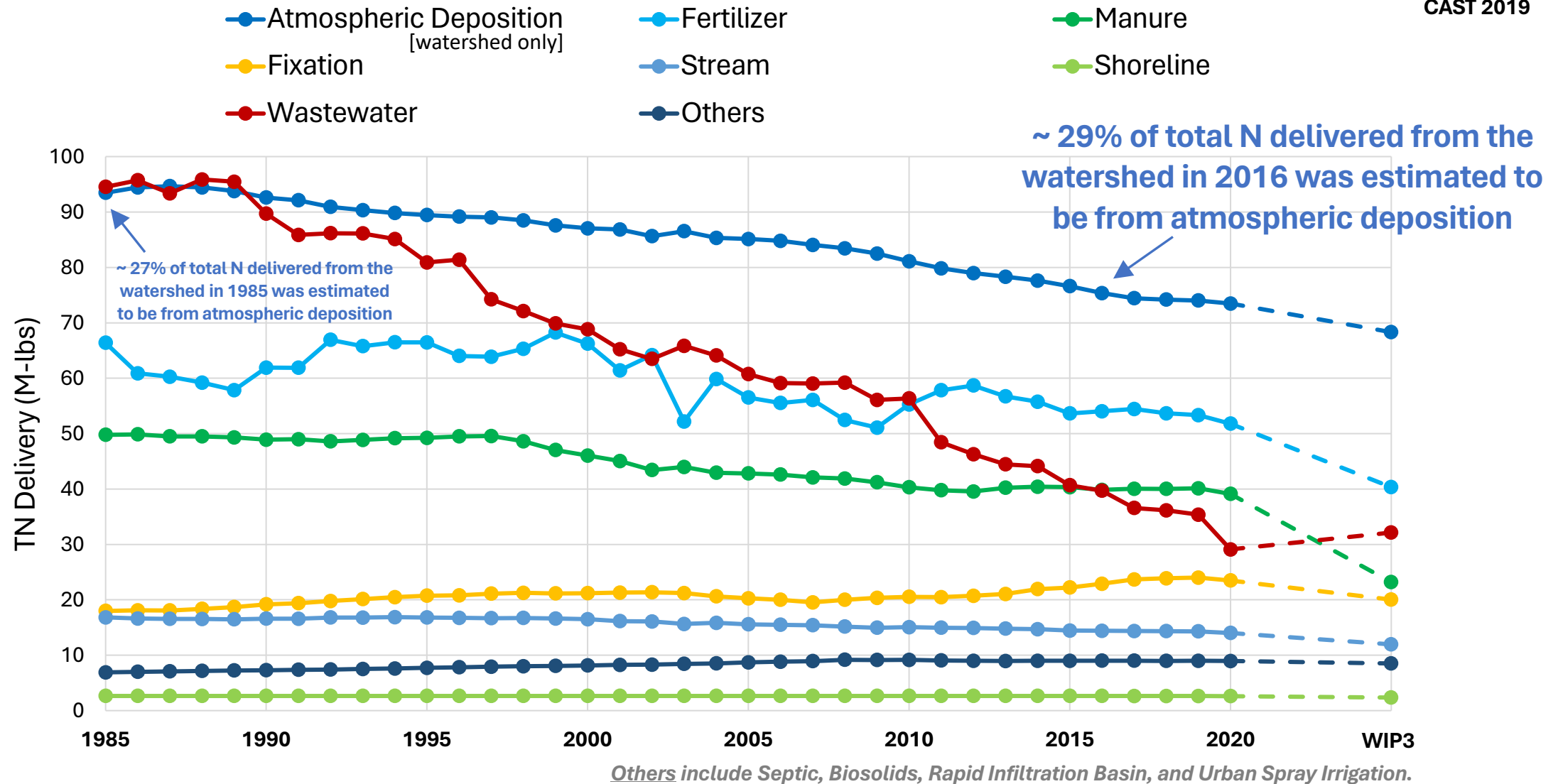
Phase 6 estimates of Total Nitrogen (TN) input to the Chesapeake Bay Watershed

CAST 2019

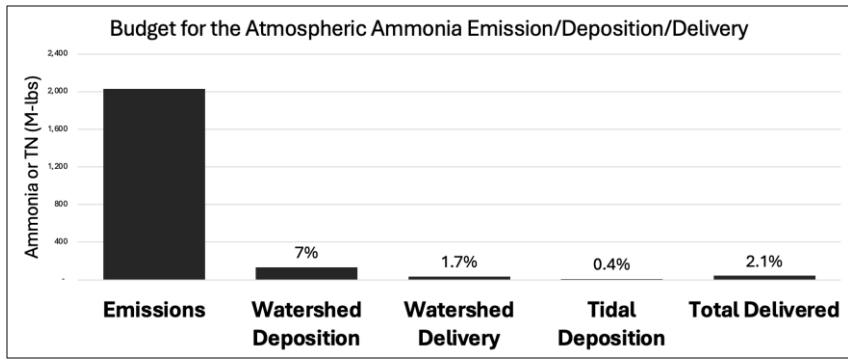


Phase 6 estimates of Total Nitrogen (TN) delivery to the Chesapeake Bay

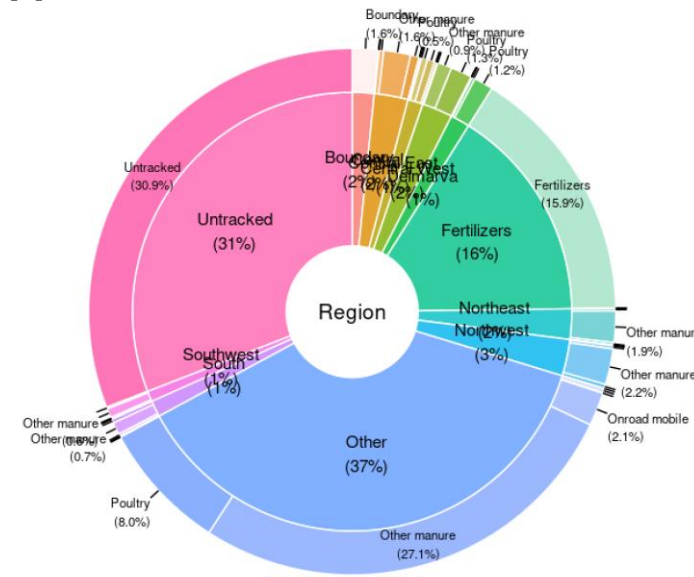
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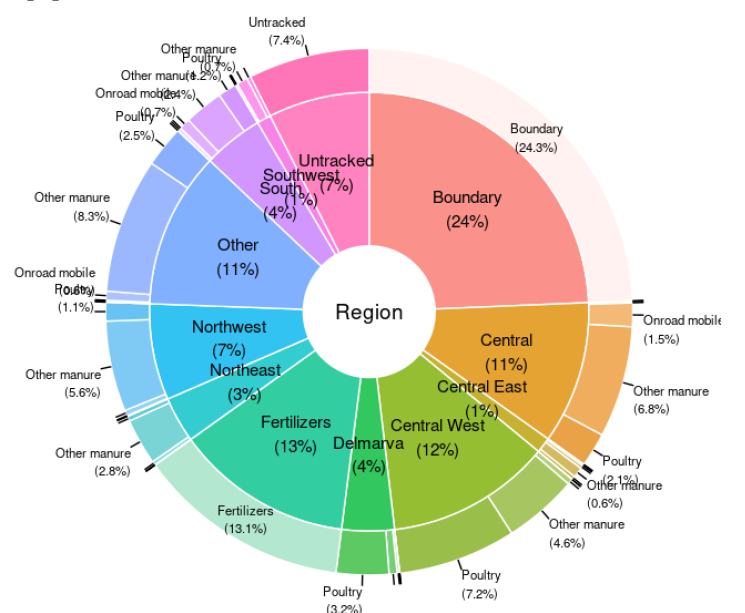
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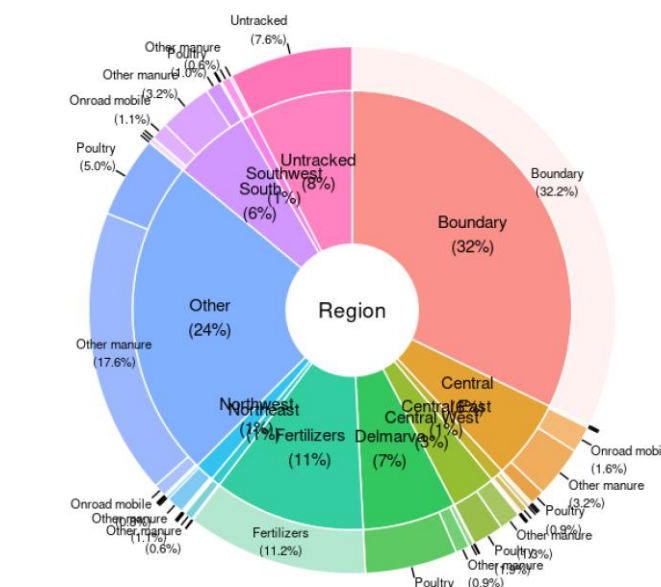
[1] NHx emissions for the Chesapeake Bay Airshed



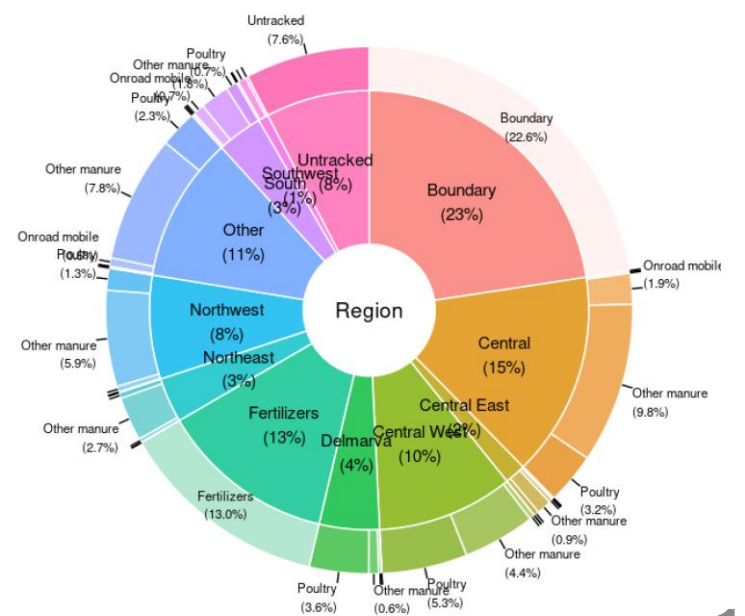
[3] NHx deposition to the Chesapeake Bay Watershed



[2] NHx deposition to the Chesapeake Bay Open Water



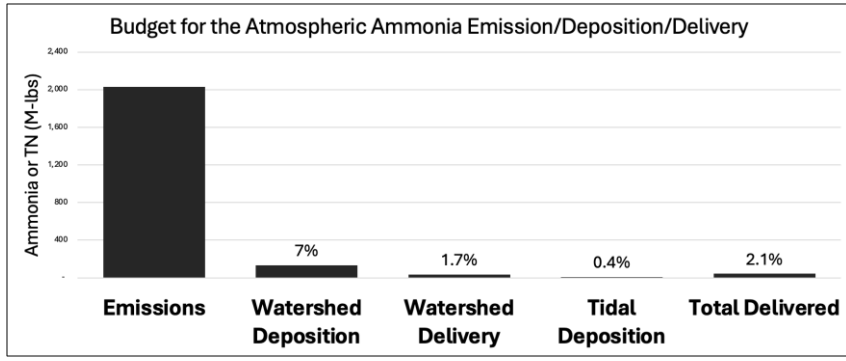
[4] NHx (TN) delivery from the Chesapeake Bay Watershed



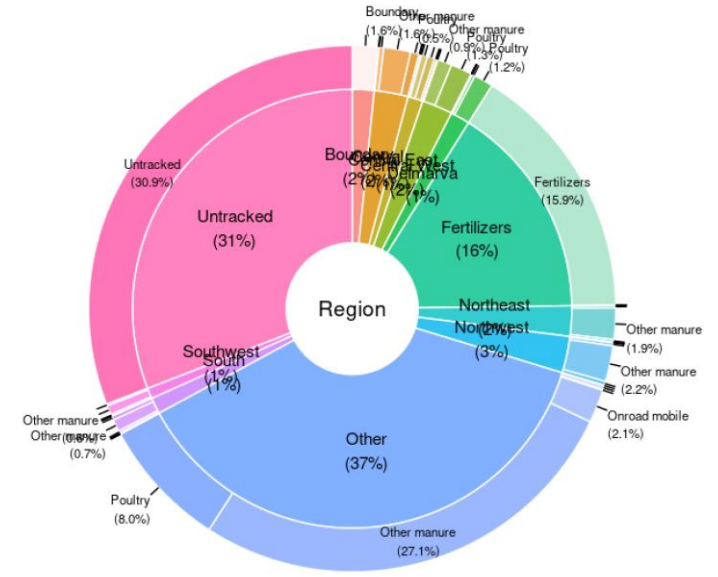
Ammonia

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Southwest	CMV	1824	103	24	3	27
Untracked	Untracked	627669005	9980943	2623862	603536	3227398

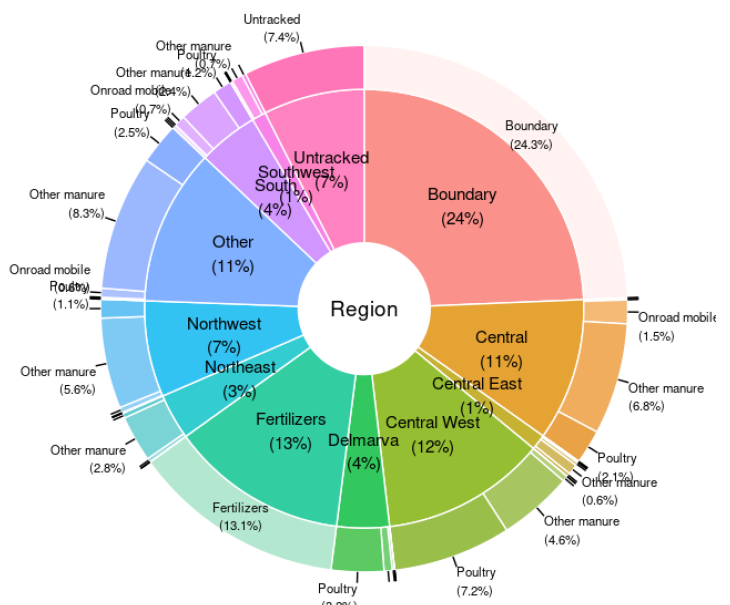
Region → Source



[1] NHx emissions for the Chesapeake Bay Airshed



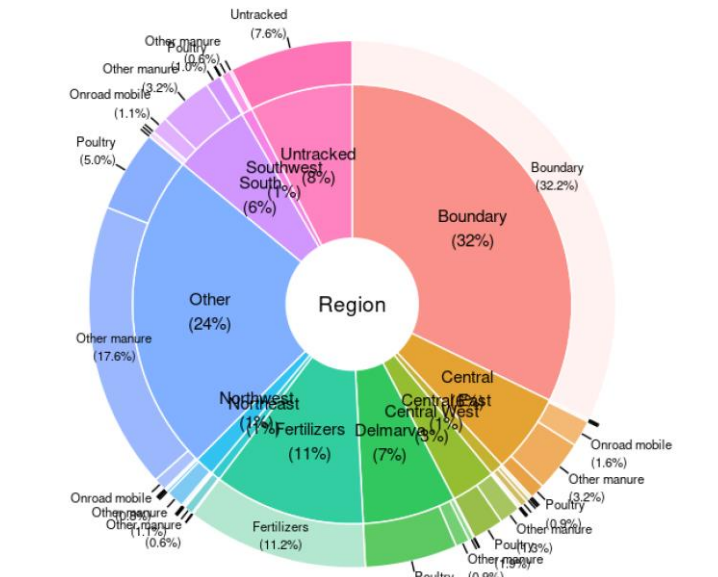
[3] NHx deposition to the Chesapeake Bay Watershed



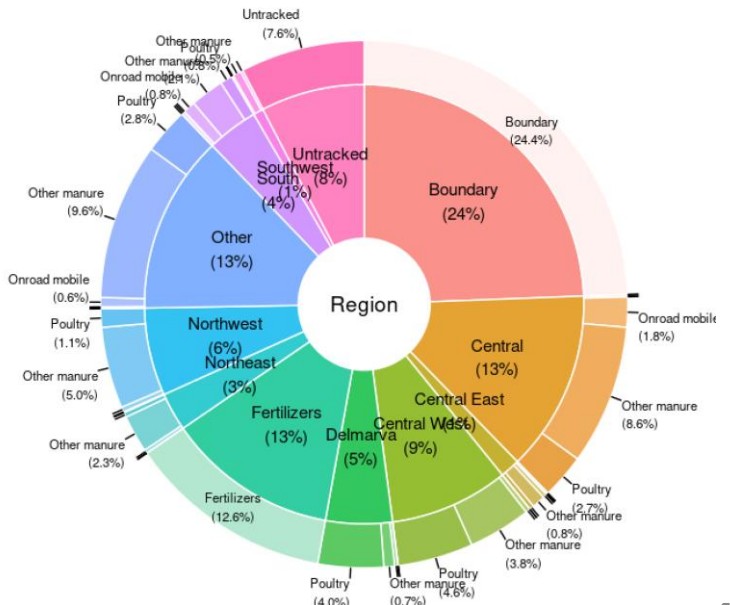
Ammonia

Region	Source	Emissions	Deposition	Watershed Deliv	Tidal Deposition	Total Delivered
Boundary	Boundary	32647850	32647850	7760383	2566045	10326428
Central	Other Manure	33427929	9170603	3381432	251813	3633245
Central	Poultry	10776977	2810063	1082099	73214	1155313
Central	Onroad Mobile	5726877	1950172	649980	129023	779003
Central	EGU	573495	147249	45220	9843	55063
Central	Offroad Mobile	75871	23975	8071	1924	9995
Central	CMV	4878	1533	535	623	1159
Central East	Other Manure	9011229	839839	308880	32268	341149
Central East	Poultry	3082712	289398	105485	10488	115973
Central East	Onroad Mobile	7553761	268275	81936	20631	102568
Central East	EGU	2881549	132514	39389	13158	52548
Central East	Offroad Mobile	135202	4451	1372	287	1659
Central East	CMV	17820	492	144	49	193
Central West	Poultry	26705203	9714537	1804555	151351	1955906
Central West	Other Manure	17872490	6109211	1524290	102942	1627232
Central West	Onroad Mobile	1181862	462927	111536	7178	118714
Central West	EGU	51598	14704	3496	468	3964
Central West	Offroad Mobile	12956	4877	1194	77	1270
Central West	CMV	0	0	0	0	0
Delmarva	Poultry	23867407	4318803	1250594	451174	1701767
Delmarva	Other Manure	3682609	659451	207746	68840	276586
Delmarva	Onroad Mobile	1085522	181317	56375	23691	80067
Delmarva	EGU	231435	21218	6684	2478	9162
Delmarva	Offroad Mobile	25278	3385	1033	1444	2477
Delmarva	CMV	6240	834	259	684	943
Fertilizers	Fertilizers	322589437	17562146	4451767	888622	5340389
Northeast	Other Manure	38932083	3799071	923797	43909	967707
Northeast	Poultry	3089917	407666	119871	6600	126471
Northeast	Onroad Mobile	3218635	316562	85459	4820	90279
Northeast	EGU	233653	11850	3126	312	3438
Northeast	Offroad Mobile	59324	4581	1205	66	1272
Northeast	CMV	2654	11	3	0	3
Northwest	Other Manure	44585579	7445262	2021978	87232	2109210
Northwest	Poultry	5286563	1541805	463022	14599	477621
Northwest	Onroad Mobile	4015239	452469	119723	9805	129528
Northwest	EGU	700309	62911	16144	2134	18278
Northwest	Offroad Mobile	71604	7887	2098	165	2263
Northwest	CMV	2532	150	38	5	43
All Other	Other Manure	549720159	11116998	2665134	1401589	4066723
All Other	Poultry	161466189	3405744	791540	398310	1189850
All Other	Onroad Mobile	41688520	745188	178508	62681	241189
All Other	EGU	5447428	143089	34575	9699	44274
All Other	Offroad Mobile	603892	10804	2636	878	3515
All Other	CMV	38848	668	188	195	383
South	Other Manure	14940351	3215020	608831	258623	867455
South	Poultry	5177438	1543905	245243	76794	322038
South	Onroad Mobile	3191000	905413	235061	83717	318778
South	EGU	1200365	294593	60517	27923	88439
South	Offroad Mobile	36997	9263	2518	1550	4068
South	CMV	8601	1546	702	988	1690
Southwest	Other Manure	11339557	898595	171725	44733	216459
Southwest	Poultry	2057115	311351	49778	10051	59829
Southwest	Onroad Mobile	2236087	156758	30404	6989	37393
Southwest	EGU	120562	15141	3024	490	3514
Southwest	Offroad Mobile	21729	1686	327	73	400
Southwest	CMV	1824	103	24	3	27
Untracked	Untracked	627669005	9980943	2623862	603536	3227398

[2] NHx deposition to the Chesapeake Bay Open Water

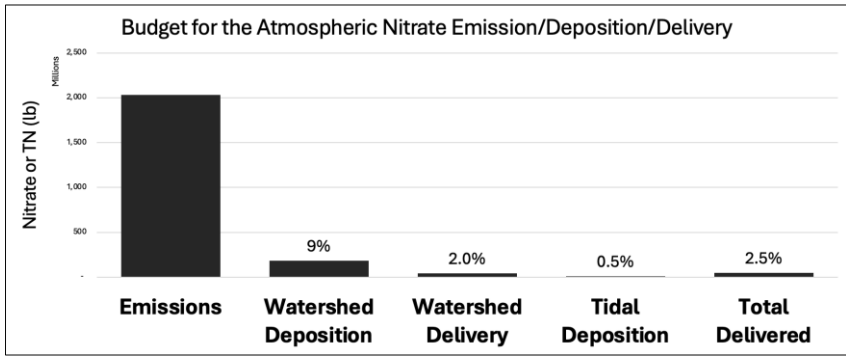


[4] NHx (TN) delivery to the Chesapeake Bay



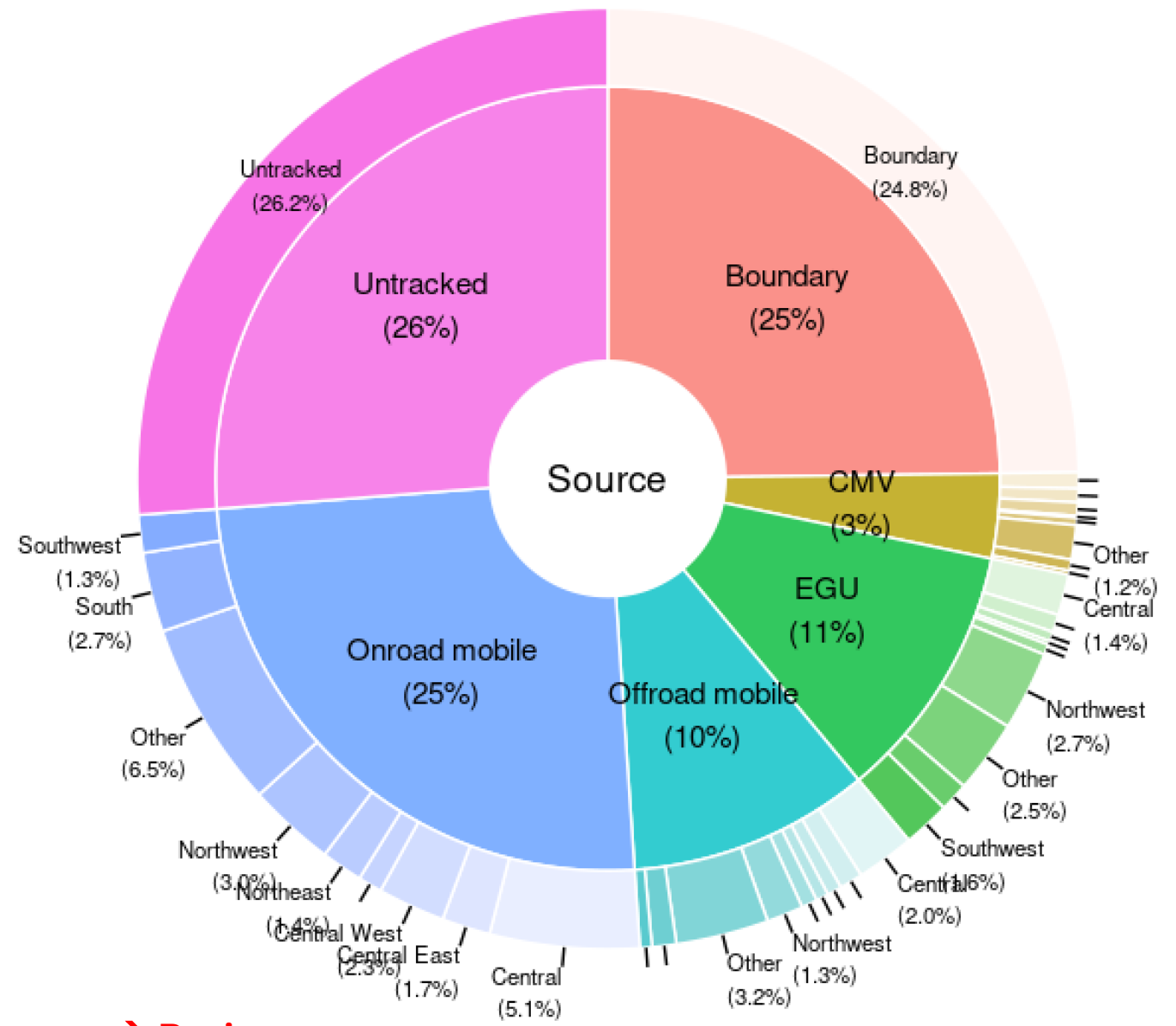
Region → Source

NOx Deposition to the Chesapeake Bay Watershed



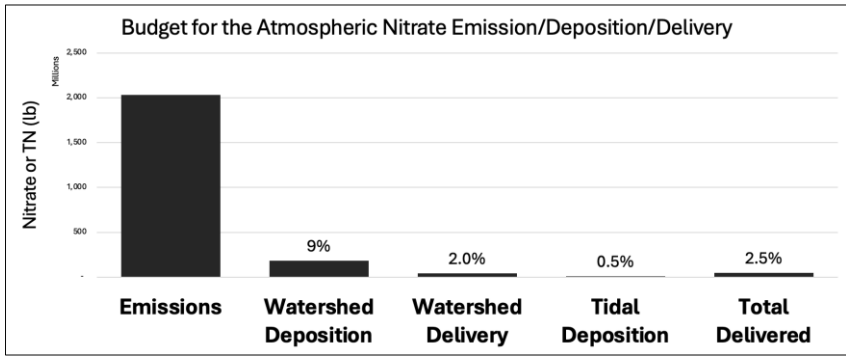
Nitrate

Region	Source	Emissions	Deposition	Watershed Deliv	Tidal Deposition	Total Delivered
Boundary	Boundary	45929040	45929040	9634052	2541148	12175201
Central	CMV	1737403	1021293	262154	125545	387699
Central	EGU	14659	2600708	676559	127270	803829
Central	Offroad_Mobile	16508263	3705572	978134	179428	1157562
Central	Onroad_Mobile	59019074	9512281	2529418	428327	2957745
Central	Other_Animal	0	0	0	0	0
Central	Poultry	0	0	0	0	0
Central East	CMV	6773926	871462	211039	47127	258166
Central East	EGU	139802	1119202	271051	61612	332663
Central East	Offroad_Mobile	28425853	1480929	367928	69980	437908
Central East	Onroad_Mobile	75299327	3081158	772698	155619	928317
Central East	Other_Animal	0	0	0	0	0
Central East	Poultry	0	0	0	0	0
Central West	CMV	2	0	0	0	0
Central West	EGU	7906	608739	133099	21680	154779
Central West	Offroad_Mobile	2962852	926761	202104	20379	224883
Central West	Onroad_Mobile	21149076	4290176	906600	97530	1004131
Central West	Other_Animal	0	0	0	0	0
Central West	Poultry	0	0	0	0	0
Delmarva	CMV	1377773	842242	207116	161663	368778
Delmarva	EGU	18954	242109	59605	19887	79491
Delmarva	Offroad_Mobile	6159735	792748	199311	132929	332240
Delmarva	Onroad_Mobile	13278518	1531423	387238	140776	528014
Delmarva	Other_Animal	0	0	0	0	0
Delmarva	Poultry	0	0	0	0	0
Fertilizers	Fertilizers	0	0	0	0	0
Northeast	CMV	336005	124396	27679	4063	31743
Northeast	EGU	18341	663478	155615	16426	172041
Northeast	Offroad_Mobile	12719457	1006162	226345	24657	251001
Northeast	Onroad_Mobile	38907741	2640565	608453	60876	669329
Northeast	Other_Animal	0	0	0	0	0
Northeast	Poultry	0	0	0	0	0
Northwest	CMV	993112	468548	103618	13454	117072
Northwest	EGU	1156	5054366	1145339	153751	1299089
Northwest	Offroad_Mobile	16116725	2327810	525331	55428	580759
Northwest	Onroad_Mobile	52059820	5571540	1265175	134750	1399925
Northwest	Other_Animal	0	0	0	0	0
Northwest	Poultry	0	0	0	0	0
All Other	CMV	9583497	2174295	485638	153817	639455
All Other	EGU	52603	4652164	960846	203932	1164778
All Other	Offroad_Mobile	141650426	5901498	1260865	272550	1533415
All Other	Onroad_Mobile	535196856	11971979	2530718	593273	3123991
All Other	Other_Animal	0	0	0	0	0
All Other	Poultry	0	0	0	0	0
South	CMV	3065315	711374	197326	179502	376828
South	EGU	83733	1851113	360594	142038	502632
South	Offroad_Mobile	8896925	1543977	320019	144865	464884
South	Onroad_Mobile	40307189	5062361	978188	330258	1308446
South	Other_Animal	0	0	0	0	0
South	Poultry	0	0	0	0	0
Southwest	CMV	896376	254895	53874	7998	61872
Southwest	EGU	463	2990148	599073	100697	699771
Southwest	Offroad_Mobile	5250288	759825	148601	28360	176961
Southwest	Onroad_Mobile	33929335	2402201	446020	87661	533682
Southwest	Other_Animal	0	0	0	0	0
Southwest	Poultry	0	0	0	0	0
Untracked	Untracked	855001455	48598802	10835027	2143115	12978142



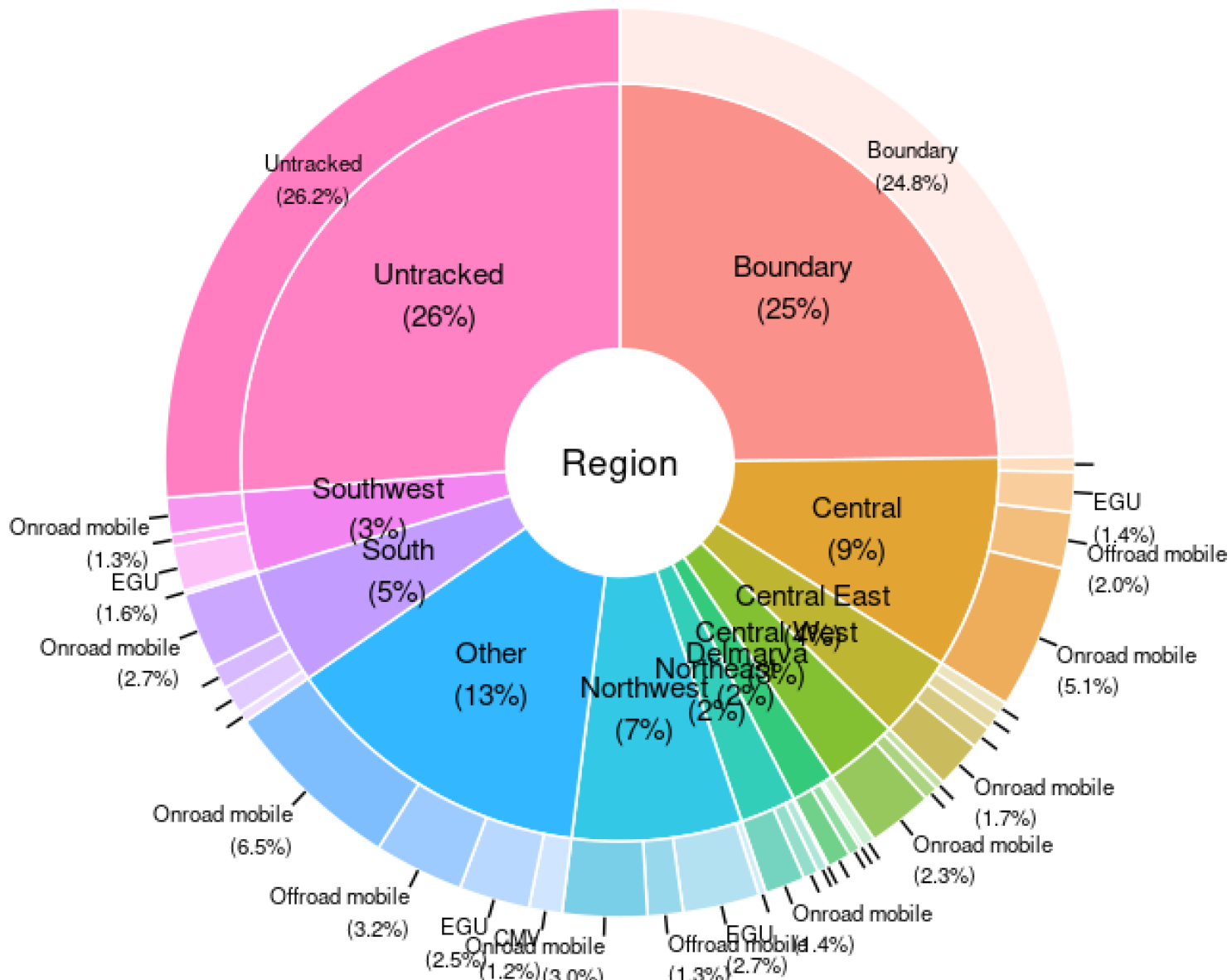
Source → Region

NOx Deposition to the Chesapeake Bay Watershed

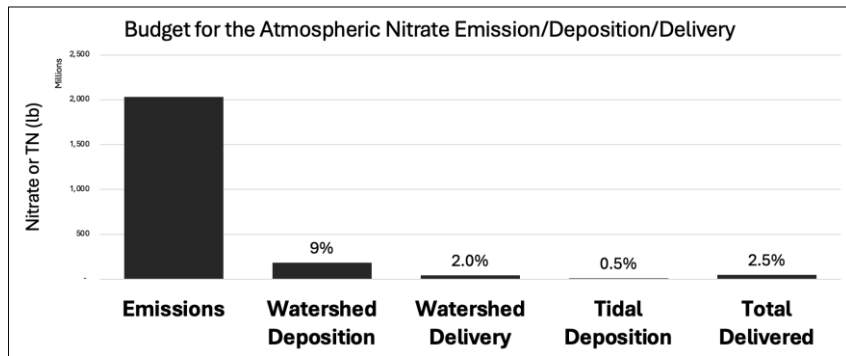


Nitrate

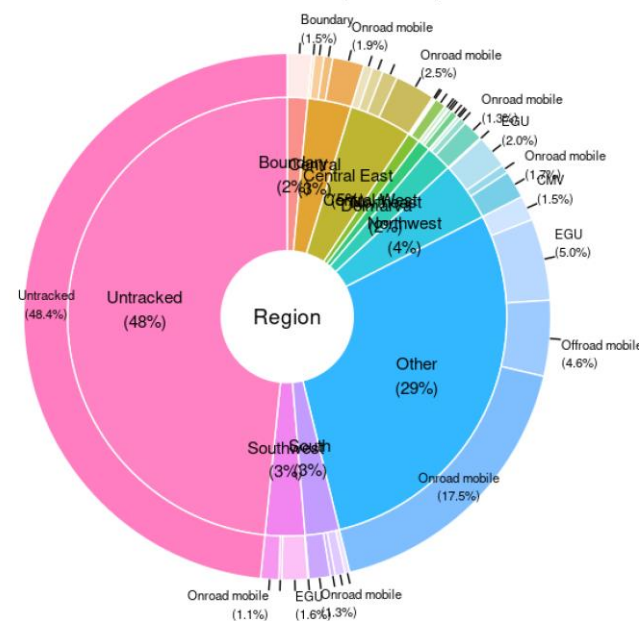
Region	Source	Emissions	Deposition	Watershed Deliv	Tidal Deposition	Total Delivered
Boundary	Boundary	45929040	45929040	9634052	2541148	12175201
Central	CMV	1737403	1021293	262154	125545	387699
Central	EGU	14659	2600708	676559	127270	803829
Central	Offroad_Mobile	16508263	3705572	978134	179428	1157562
Central	Onroad_Mobile	59019074	9512281	2529418	428327	2957745
Central	Other_Animal	0	0	0	0	0
Central	Poultry	0	0	0	0	0
Central East	CMV	6773926	871462	211039	47127	258166
Central East	EGU	139802	1119202	271051	61612	332663
Central East	Offroad_Mobile	28425853	1480929	367928	69980	437908
Central East	Onroad_Mobile	75299327	3081158	772698	155619	928317
Central East	Other_Animal	0	0	0	0	0
Central East	Poultry	0	0	0	0	0
Central West	CMV	2	0	0	0	0
Central West	EGU	7906	608739	133099	21680	154779
Central West	Offroad_Mobile	2962852	926761	202104	20379	224883
Central West	Onroad_Mobile	21149076	4290176	906600	97530	1004131
Central West	Other_Animal	0	0	0	0	0
Central West	Poultry	0	0	0	0	0
Delmarva	CMV	1377773	842242	207116	161663	368778
Delmarva	EGU	18954	242109	59605	19887	79491
Delmarva	Offroad_Mobile	6159735	792748	199311	132929	332240
Delmarva	Onroad_Mobile	13278518	1531423	387238	140776	528014
Delmarva	Other_Animal	0	0	0	0	0
Delmarva	Poultry	0	0	0	0	0
Fertilizers	Fertilizers	0	0	0	0	0
Northeast	CMV	336005	124396	27679	4063	31743
Northeast	EGU	18341	663478	156515	16426	172041
Northeast	Offroad_Mobile	12719457	1006162	226345	24657	251001
Northeast	Onroad_Mobile	38907741	2640565	608453	60876	669329
Northeast	Other_Animal	0	0	0	0	0
Northeast	Poultry	0	0	0	0	0
Northwest	CMV	993112	468548	103618	13454	117072
Northwest	EGU	1156	5054366	1145339	153751	1299089
Northwest	Offroad_Mobile	16116725	2327810	525331	55428	580759
Northwest	Onroad_Mobile	52059820	5571540	1265175	134750	1399925
Northwest	Other_Animal	0	0	0	0	0
Northwest	Poultry	0	0	0	0	0
All Other	CMV	9583497	2174295	485638	153817	639455
All Other	EGU	52603	4652164	960846	203932	1164778
All Other	Offroad_Mobile	141650426	5901498	1260865	272550	1533415
All Other	Onroad_Mobile	535196856	11971979	2530718	593273	3123991
All Other	Other_Animal	0	0	0	0	0
All Other	Poultry	0	0	0	0	0
South	CMV	3065315	711374	197326	179502	376828
South	EGU	83733	1851113	360594	142038	502632
South	Offroad_Mobile	8896925	1543977	320019	144865	464884
South	Onroad_Mobile	40307189	5062361	978188	330258	1308446
South	Other_Animal	0	0	0	0	0
South	Poultry	0	0	0	0	0
Southwest	CMV	896376	254895	53874	7998	61872
Southwest	EGU	463	2990148	599073	100697	699771
Southwest	Offroad_Mobile	5250288	759825	148601	28360	176961
Southwest	Onroad_Mobile	33929335	2402201	446020	87661	533682
Southwest	Other_Animal	0	0	0	0	0
Southwest	Poultry	0	0	0	0	0
Untracked	Untracked	855001455	48598802	10835027	2143115	12978142



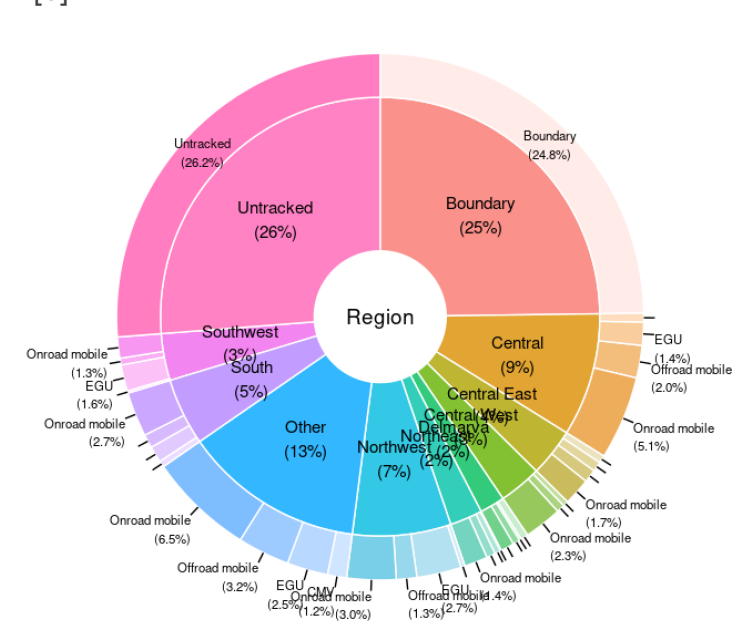
Region → Source



[1] NOx emissions from the Chesapeake Bay Airshed



[3] NOx deposition to the Chesapeake Bay Watershed

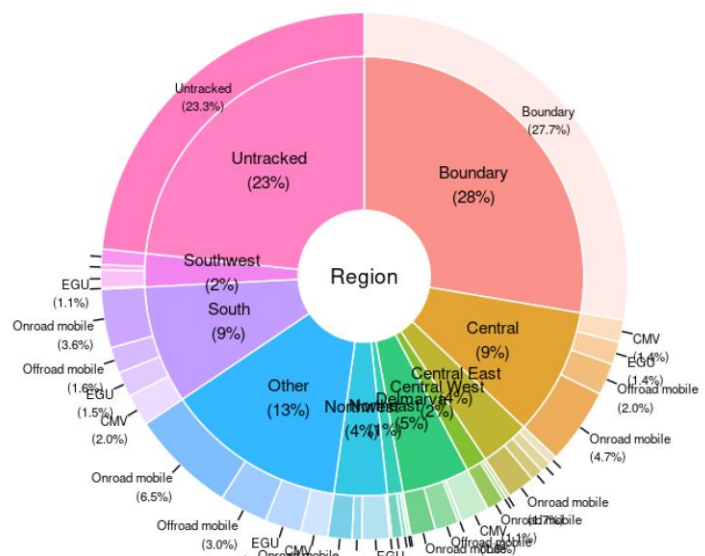


Nitrate

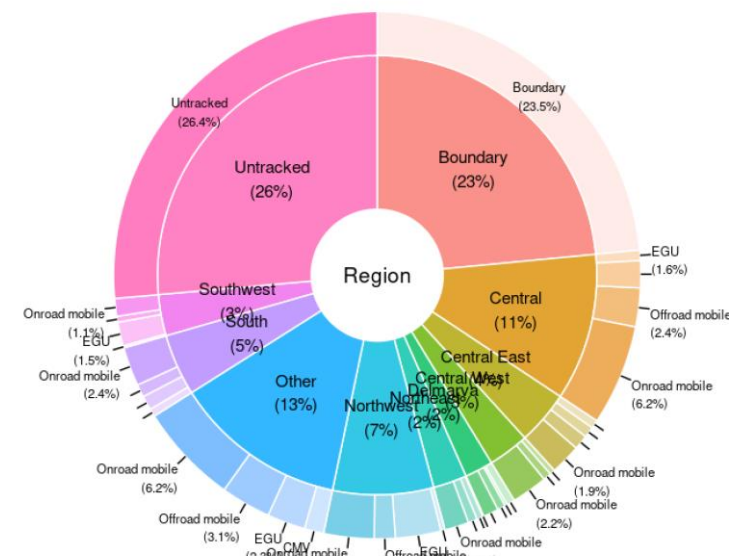
Region	Source	Emissions	Deposition	Watershed Deliv	Tidal Deposition	Total Delivered
Boundary	Boundary	45929040	45929040	9634052	2541148	12175201
Central	CMV	1737403	1021293	262154	125545	387699
Central	EGU	14659	2600708	676559	127270	803829
Central	Offroad_Mobile	16508263	3705572	978134	179428	1157562
Central	Onroad_Mobile	59019074	9512281	2529418	428327	2957745
Central	Other_Animal	0	0	0	0	0
Central	Poultry	0	0	0	0	0
Central East	CMV	6773926	871462	211039	47127	258166
Central East	EGU	139802	1119202	271051	61612	332663
Central East	Offroad_Mobile	28425853	1480929	367928	69980	437908
Central East	Onroad_Mobile	75299327	3081158	772698	155619	928317
Central East	Other_Animal	0	0	0	0	0
Central East	Poultry	0	0	0	0	0
Central West	CMV	2	0	0	0	0
Central West	EGU	7906	608739	133099	21680	154779
Central West	Offroad_Mobile	2962852	926761	202104	20379	222483
Central West	Onroad_Mobile	21149076	4290176	906600	97530	1004131
Central West	Other_Animal	0	0	0	0	0
Central West	Poultry	0	0	0	0	0
Delmarva	CMV	1377773	842242	207116	161663	368778
Delmarva	EGU	18954	242109	59605	19887	79491
Delmarva	Offroad_Mobile	6159735	792748	199311	132929	332240
Delmarva	Onroad_Mobile	13278518	1531423	387238	140776	528014
Delmarva	Other_Animal	0	0	0	0	0
Delmarva	Poultry	0	0	0	0	0
Fertilizers	Fertilizers	0	0	0	0	0
Northeast	CMV	336005	124396	27679	4063	31743
Northeast	EGU	18341	663478	155615	16426	172041
Northeast	Offroad_Mobile	12719457	1006162	226345	24657	251001
Northeast	Onroad_Mobile	38907741	2640565	608453	60876	669329
Northeast	Other_Animal	0	0	0	0	0
Northeast	Poultry	0	0	0	0	0
Northwest	CMV	993112	468548	103618	13454	117072
Northwest	EGU	1156	5054366	1145339	153751	1299089
Northwest	Offroad_Mobile	16116725	2327810	525331	55428	580759
Northwest	Onroad_Mobile	52059820	5571540	1265175	134750	1399925
Northwest	Other_Animal	0	0	0	0	0
Northwest	Poultry	0	0	0	0	0
All Other	CMV	9583497	2174295	485638	153817	639455
All Other	EGU	52603	4652164	960846	203932	1164778
All Other	Offroad_Mobile	141650426	5901498	1260865	272550	1533415
All Other	Onroad_Mobile	535196856	11971979	2530718	593273	3123991
All Other	Other_Animal	0	0	0	0	0
All Other	Poultry	0	0	0	0	0
South	CMV	3065315	711374	197326	179502	376828
South	EGU	83733	1851113	360594	142038	502632
South	Offroad_Mobile	8896925	1543977	320019	144865	464884
South	Onroad_Mobile	40307189	5062361	978188	330258	1308446
South	Other_Animal	0	0	0	0	0
South	Poultry	0	0	0	0	0
Southwest	CMV	896376	254895	53874	7998	61872
Southwest	EGU	463	2990148	599073	100697	699771
Southwest	Offroad_Mobile	5250288	759825	148601	28360	176961
Southwest	Onroad_Mobile	33929335	2402201	446020	87661	533682
Southwest	Other_Animal	0	0	0	0	0
Southwest	Poultry	0	0	0	0	0
Untracked	Untracked	855001455	48598802	10835027	2143115	12978142



[2] NOx deposition to the Chesapeake Bay Open Water



[4] NOx (TN) delivery from the Chesapeake Bay Watershed



Region → Source

