Road Impacts on Aquatic Ecosystems

Robin Van Meter

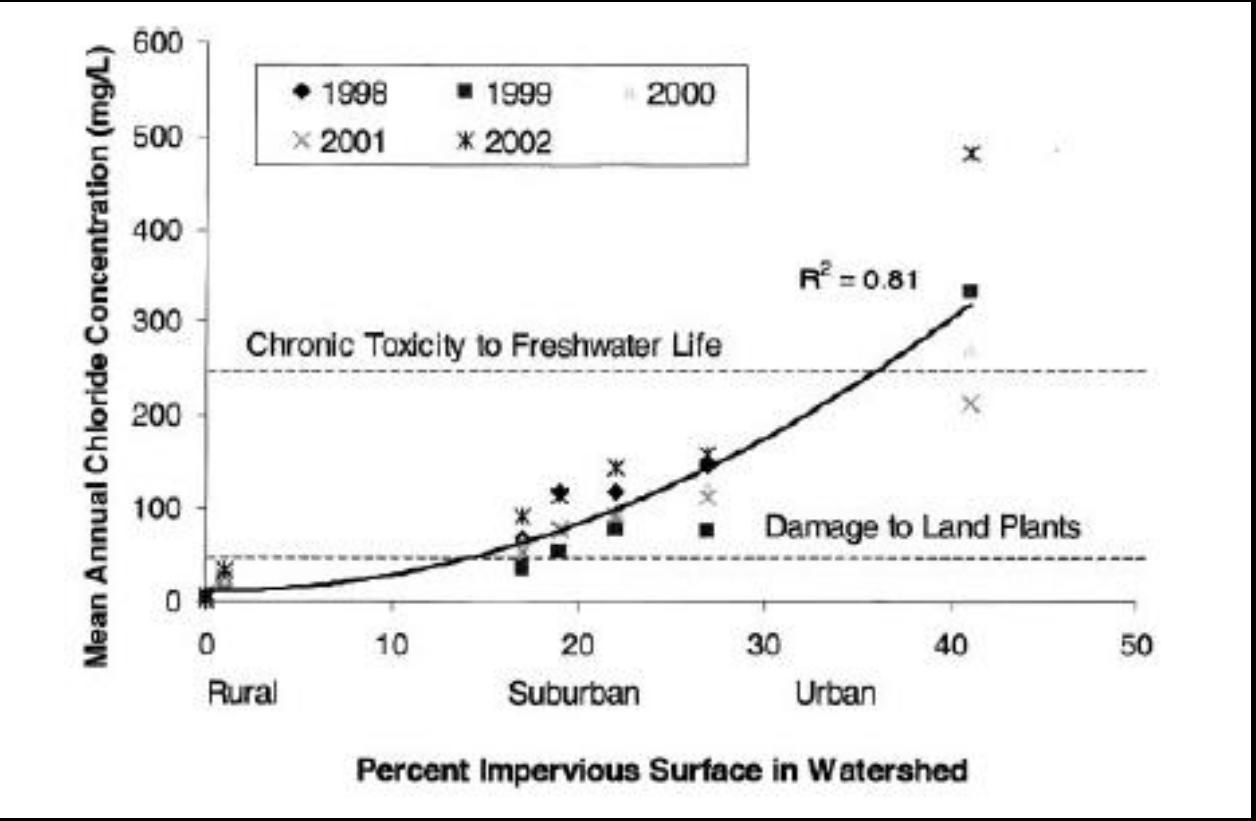
Assistant Professor, Biology & Environmental Science/Studies

Washington College, Chestertown, MD

Road Deicers:
Winter Road Maintenance

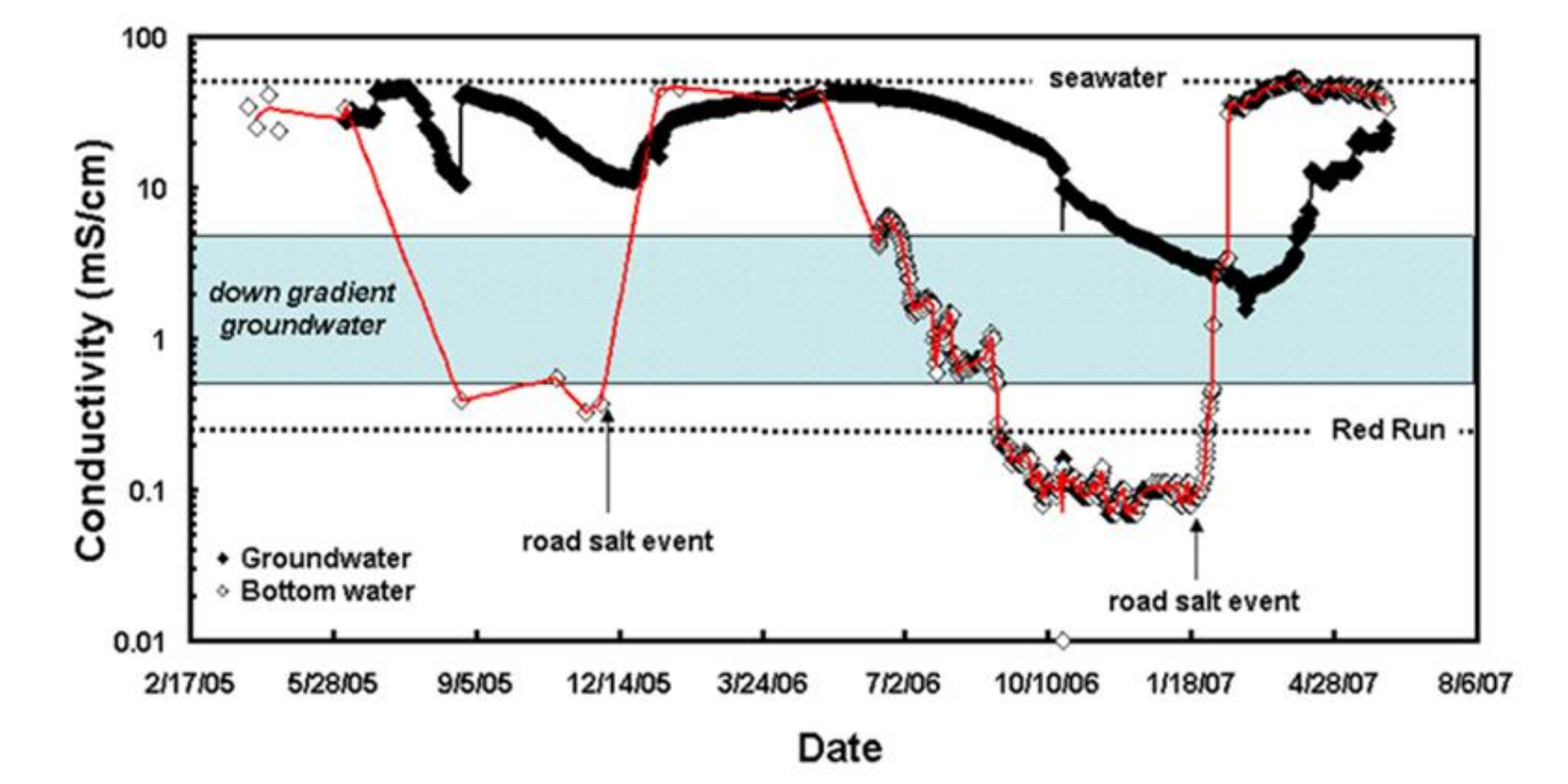
10,000,000-
20,000,000
tons/year

Salinization of Freshwater



Kaushal, SS, PM Groffman, GE Likens, KT Belt, WP Stack, VR Kelly, LE Band and GT Fisher. 2005. Increased salinization of fresh water in the northeastern United States. *Proceedings of the National Academy of Sciences* 102(38): 13517-13520.

Specific Conductance of Local Pond



Urban Biogeochemistry Laboratory – Towson University
Ryan Casey, PhD & Steve Lev, PhD

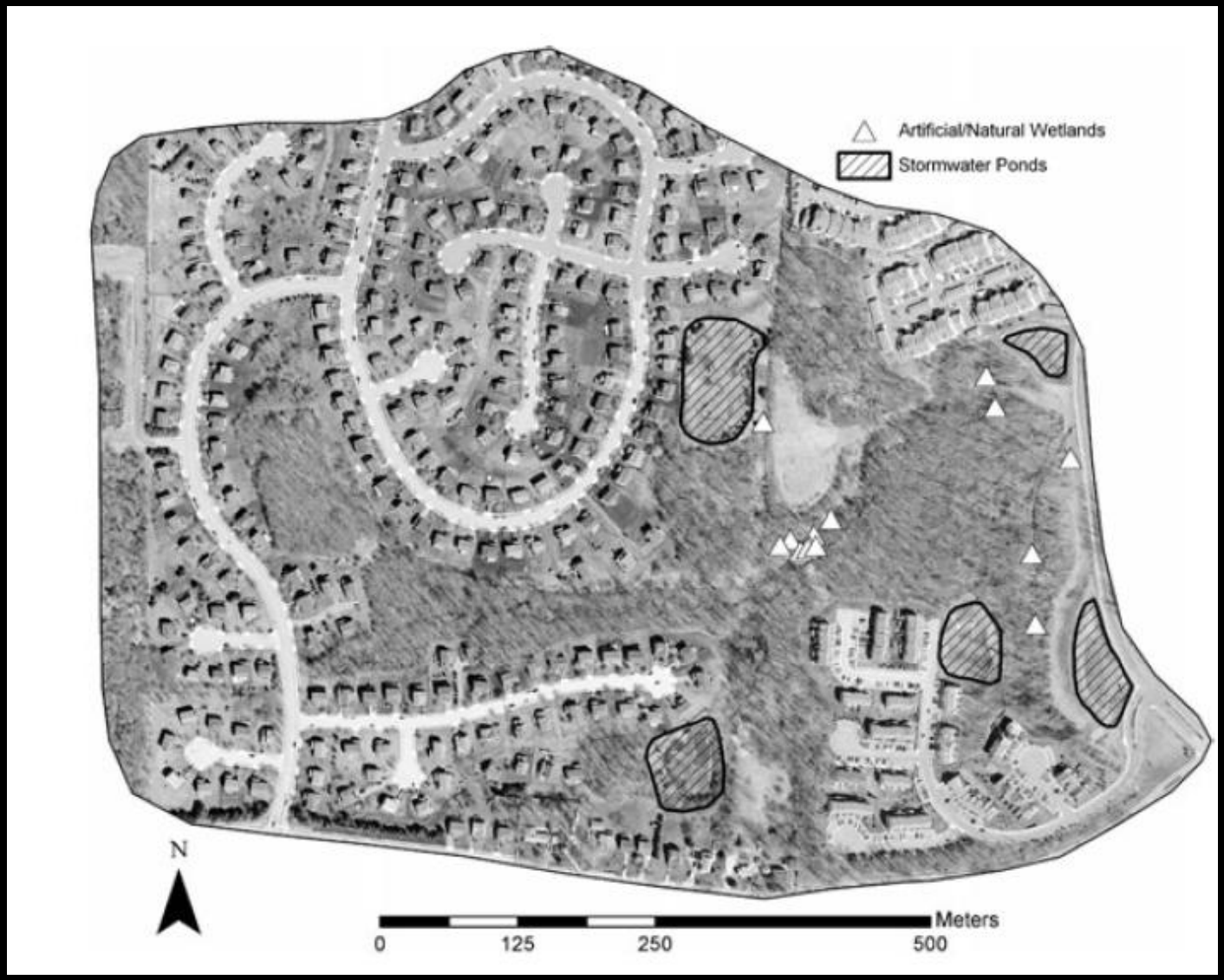
Urban Freshwater Habitats

Stormwater Ponds

Brand, A.B. & J.W. Snodgrass. 2009. Value of artificial habitats for amphibian reproduction in altered landscapes. *Conservation Biology* 24(1): 295-301.

Gallagher, M et al. 2014 . The role of pollutant accumulation in determining the use of stormwater ponds by amphibians. *Wetlands Ecology and Management* 22(5): 551-564.

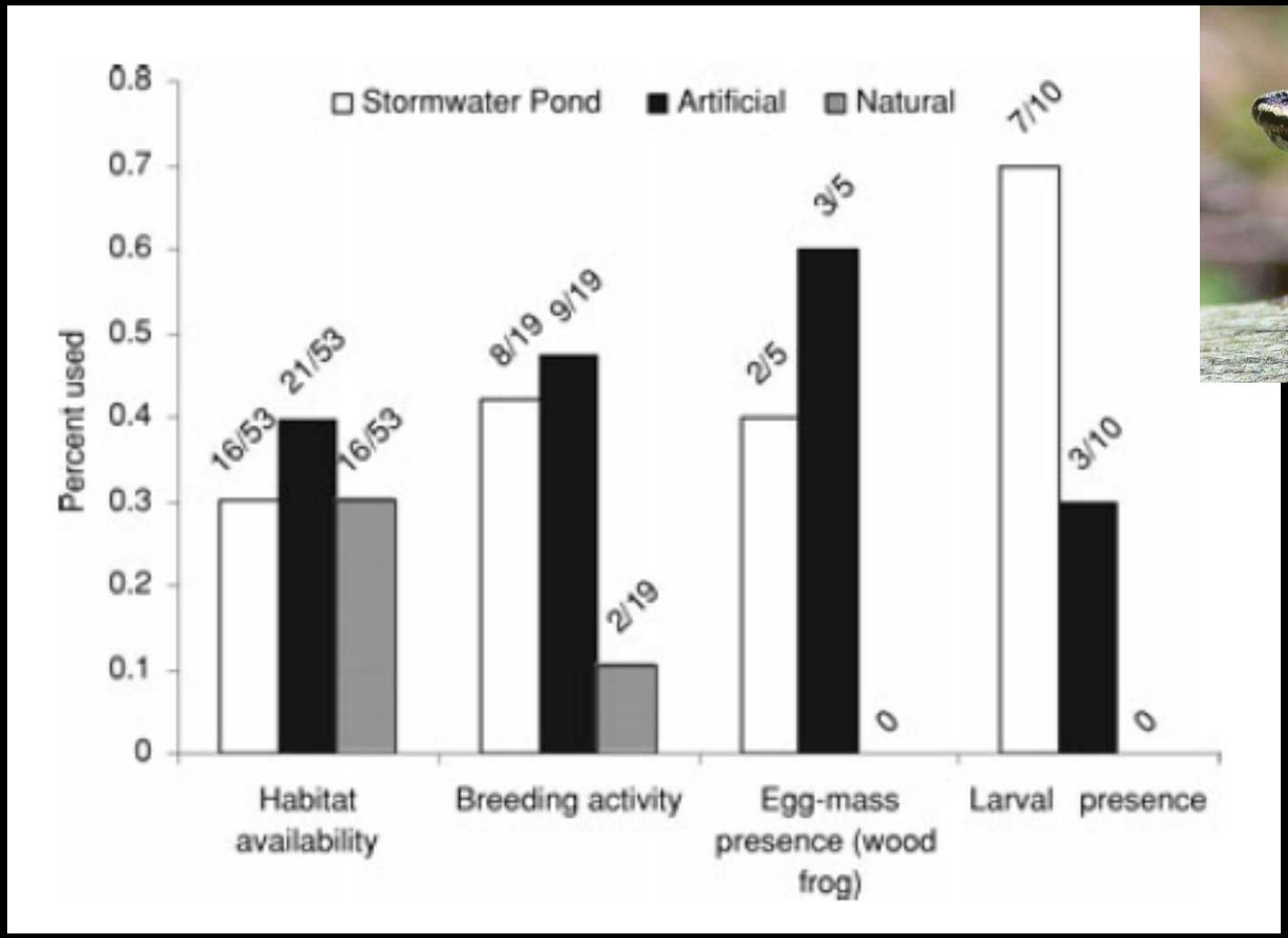
Stormwater Ponds & Amphibians



Red Run Watershed, Owings Mills, MD

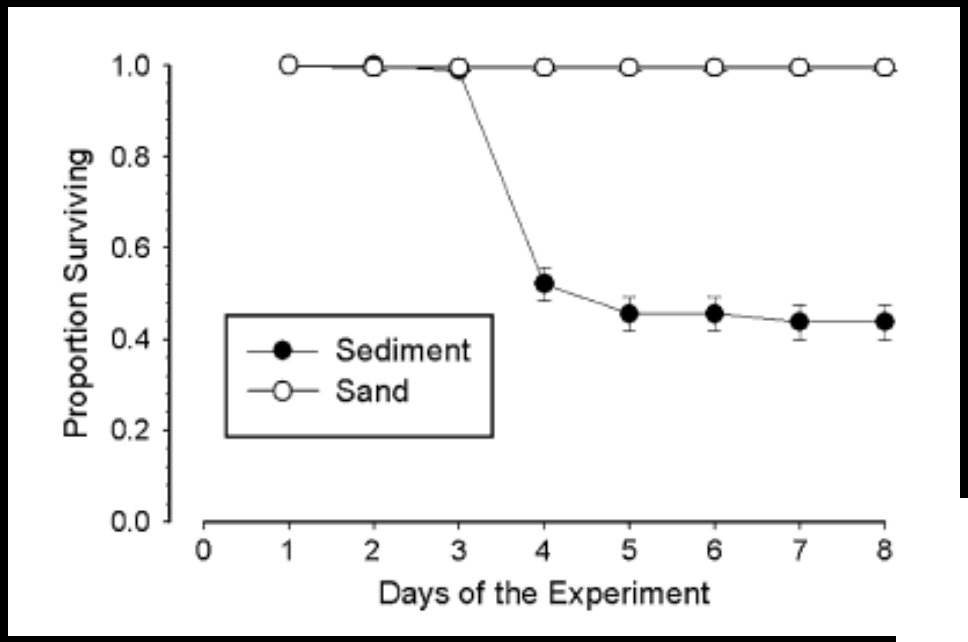
Brand & Snodgrass, 2009

Stormwater Ponds & Amphibians

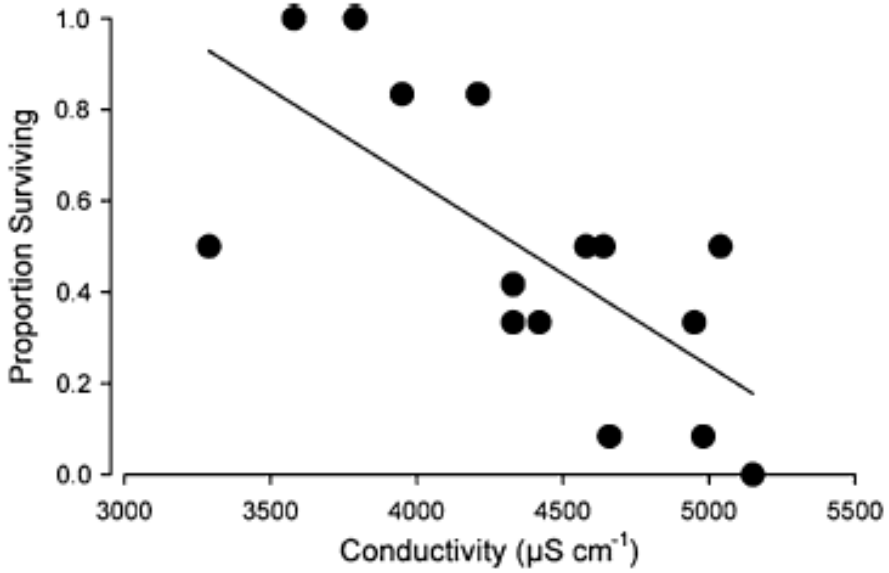


Brand & Snodgrass, 2009

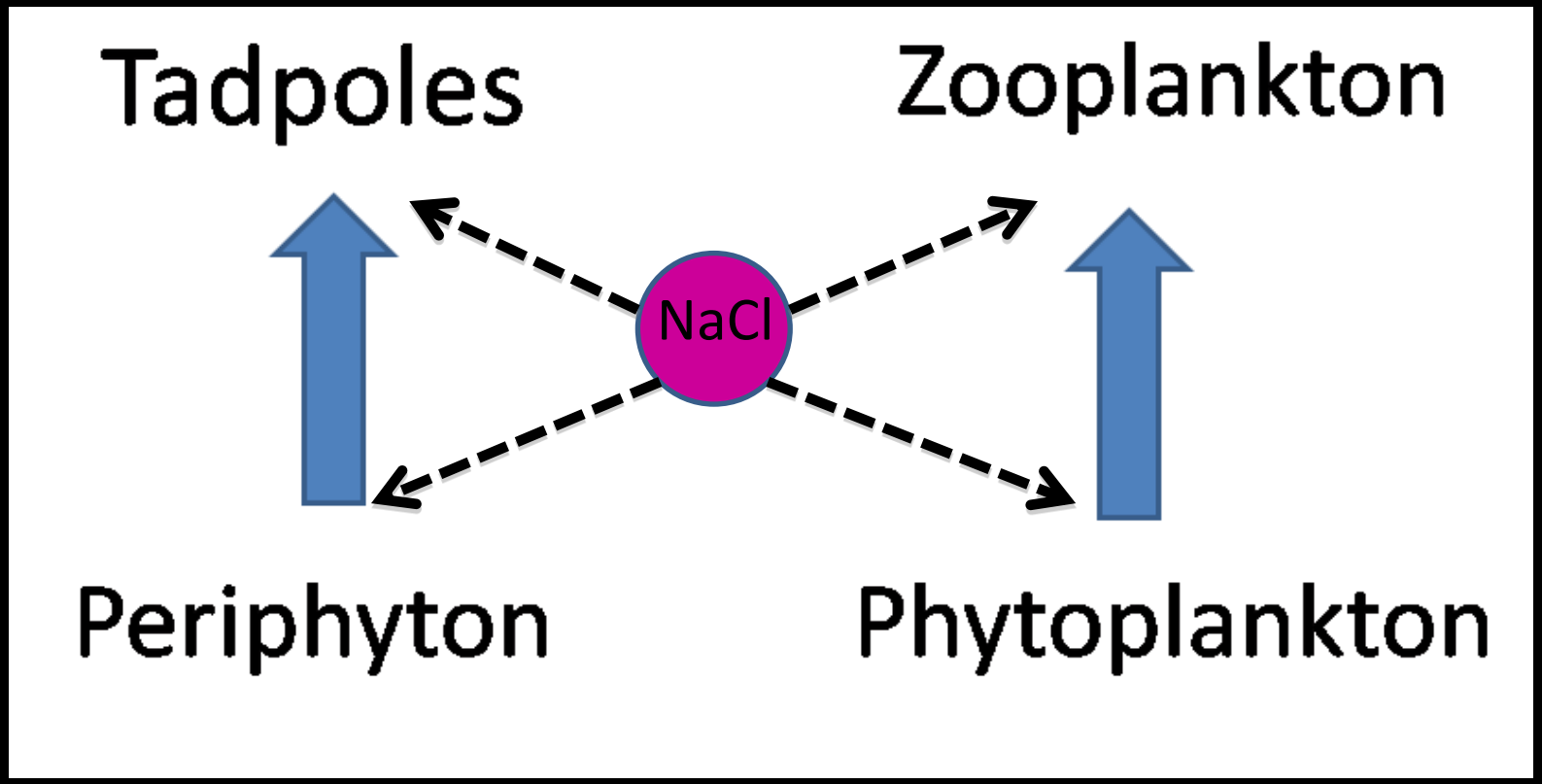
Road Salts & Amphibians



Brand et al. 2010 *Archives of Environmental Contamination & Toxicology*



Community structure in pond food webs

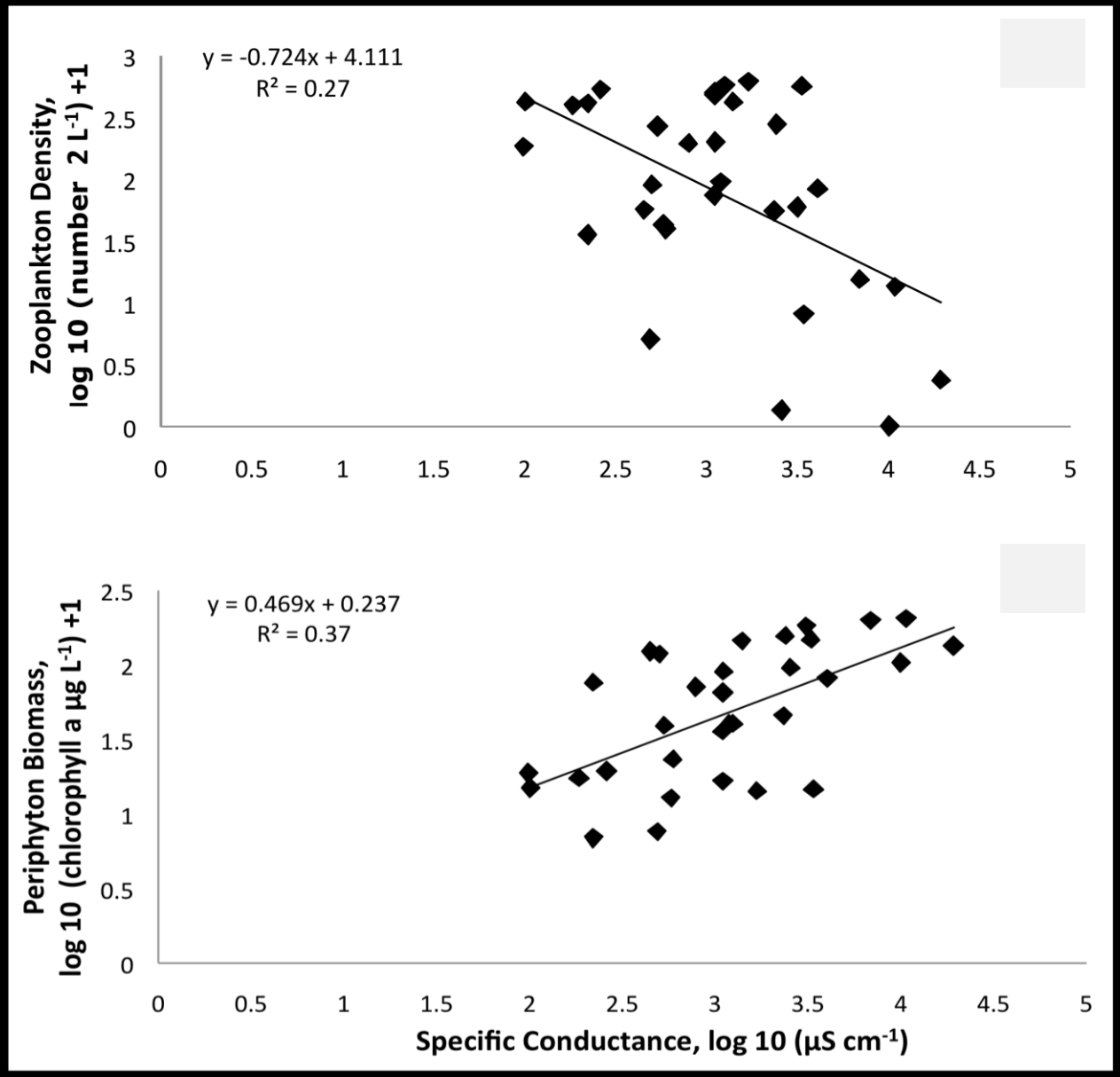


Stormwater Pond Specific Conductance (µS)

	Pond ID	2007 Average (Gallagher 2014)	2008 Average (Gallagher 2014)	Feb-09	Mar-09	Frogs in previous years?
Low	F7-7	231	234	589	780	Yes
	E9-4	245	293	102	100	Yes
	E7-5-2	725	2375	1027	1369	Yes
Medium	G6-13	1113	1409	1782	1970	Yes
	H8-5	4081	942	6270	11930	Yes
	H7-2	6290	8741	8750	16000	Yes
High	E4-1	14705	791	8720	15300	Yes
	E4-4	3756	24053	28800	49700	Yes

Chloride &hydroperiod have the largest effect on amphibian breeding use

Results – Food Web



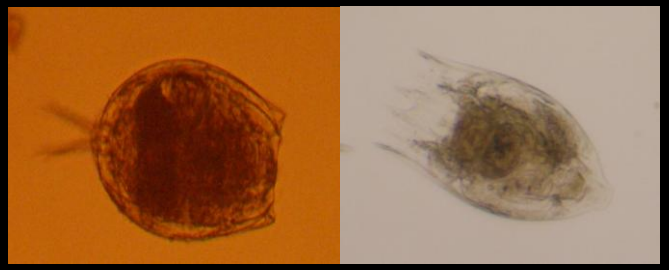
Results - Zooplankton

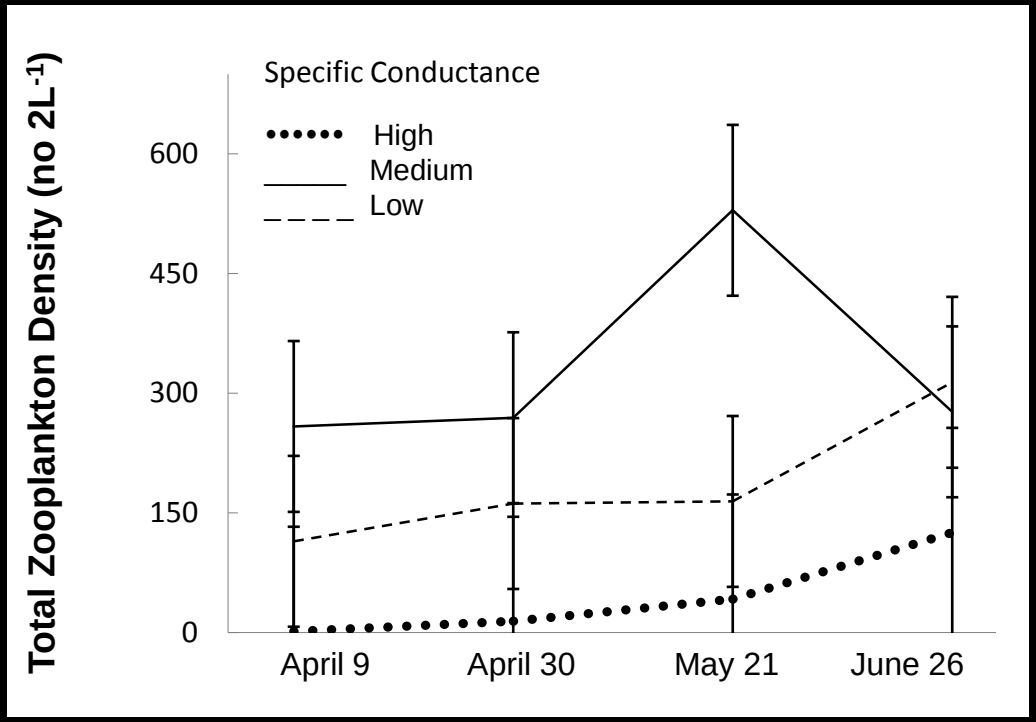
Copepods

Cladocerans

Ostracod

Rotifers





Van Meter et al. 2010 *Urban Ecosystems*

Stormwater Pond Trends

- An increasing specific conductance gradient:
  - ↓zooplankton density
  - ↑periphyton resources
  - shapes amphibian assemblages
  - long term effects poorly understood
  - additional pollutants also present

Vernal Pools

Katherine Wares

Figure 1. Life history stages of marbled salamander (McGarigal, Compton, & Gamble, 2008).

Marbled salamanders

Figure 2. Seasonal breeding pond (McGarigal, Compton, & Gamble, 2008).

Chino Farms, Queen Anne's County, MD

Vernal Pool Water Quality

Table 2. Water quality parameter values were found for six vernal pools, 3 roadside and 3 agricultural pools, in Kingstown, Maryland during the winter of 2014

Water quality parameter	R1	R2	R3	A1	A2	A3	Road Average	Ag Average
Dissolved oxygen (mg/L)	7.06	1.70	5.1	3.60	4.74	4.3	[illegible]	[illegible]
Conductivity (µS/cm)	137	389	97.9	71.1	30.9	52	207.97	51.33
Temperature (°Celcius)	8.45	9.35	5.2	7.85	10.2	7.35	[illegible]	8.47
pH	6.96	6.24	7.59	6.48	6.52	5.88	[illegible]	[illegible]
Chlorophyll (µg/L)	28.5	0.82	8.33	19.1	37.2	6.06	12.55	20.79
Nitrate (mg/L)	0.77	1.41	0.23	1.09	0.62	1.24	[illegible]	[illegible]
Total Nitrate (mg/L)	0.7	0	0	0.2	1.2	0	0.23	0.47
Phosphate (mg/L)	0	0	0	0	0.26	0	0	0.15
Total Phosphate (mg/L)	0.12	0.28	0.94	0.23	0.38	0.15	0.14	0.23

Vernal Pool Metals

Table 4. Metal concentrations in ppb found in sediment samples from six vernal pools and US EPA exceedance levels (ERL) and LC50 levels for metals.

Pool	27Al	52Cr	55Mn	56Fe	60Ni	65Cu	66Zn	75As	111Cd	208Pb
A1	6042.6	2.90	33.03	2152.22	7.47	9.92	49.43	0.305	1.07	35.82
A2	6931.5	3.29	162.28	4739.55	6.52	11.56	54.61	0.86	0.55	27.62
A3	4994.7	1.42	80.16	10262.84	7.17	9.70	41.46	1.38	0.27	42.25
R1	9256.7	7.89	111.21	9496.23	15.86	10.01	31.76	2.07	0.30	10.39
R2	9319.0	8.71	75.83	9223.44	18.02	8.24	46.76	1.63	0.23	14.49
R3	4893.3	6.16	365.01	6120.90	11.30	14.36	75.97	0.62	0.37	28.43
ERL	unknown	8.1	300	17000	21	34	150	8.2	1.2	47
LC50	50	30	142	unknown	50	40	10	40	40	40

Larval Salamanders In Vernal Pools

Table 11. The total number of salamanders caught at six vernal pools for either 100 dips or until the number of dips until 50 salamanders were caught.

Visit 1	R1	R2	R3	A1	A2	A3
Number of dips	19	100	16	100	15	100
Total larvae	50	48	50	2	50	5

Visit 2	R1	R2	R3	A1	A2	A3
Number of dips	22	100	100	100	90	100
Total larvae	50	0	0	1	50	3

Ag pools generally supported lower salamander abundance.

2 of 3 Roadside pools had 100% salamander mortality.

Considerations

Engineered BMPs or unplanned depressions?

Ditch Placement in the Landscape

Pollution Sources & Concentrations

Habitat Value

Habitat Goals

Ditches as habitats or ditches to sequester pollutants before entering adjacent habitats?

Know Your Target Species:

- Hydroperiod
- Water quality
- Life stages
- Vegetation
- Canopy cover
- Adjacent habitat