Ecosystem Processes in a Piped Stream

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Defining a Piped Stream

- For this study, **culverts** and **longer**:

- Run **underground** (under parking lots, roads, buildings, etc.)
- **Fully enclosed** within a **pipe** (6')
- **No light** source

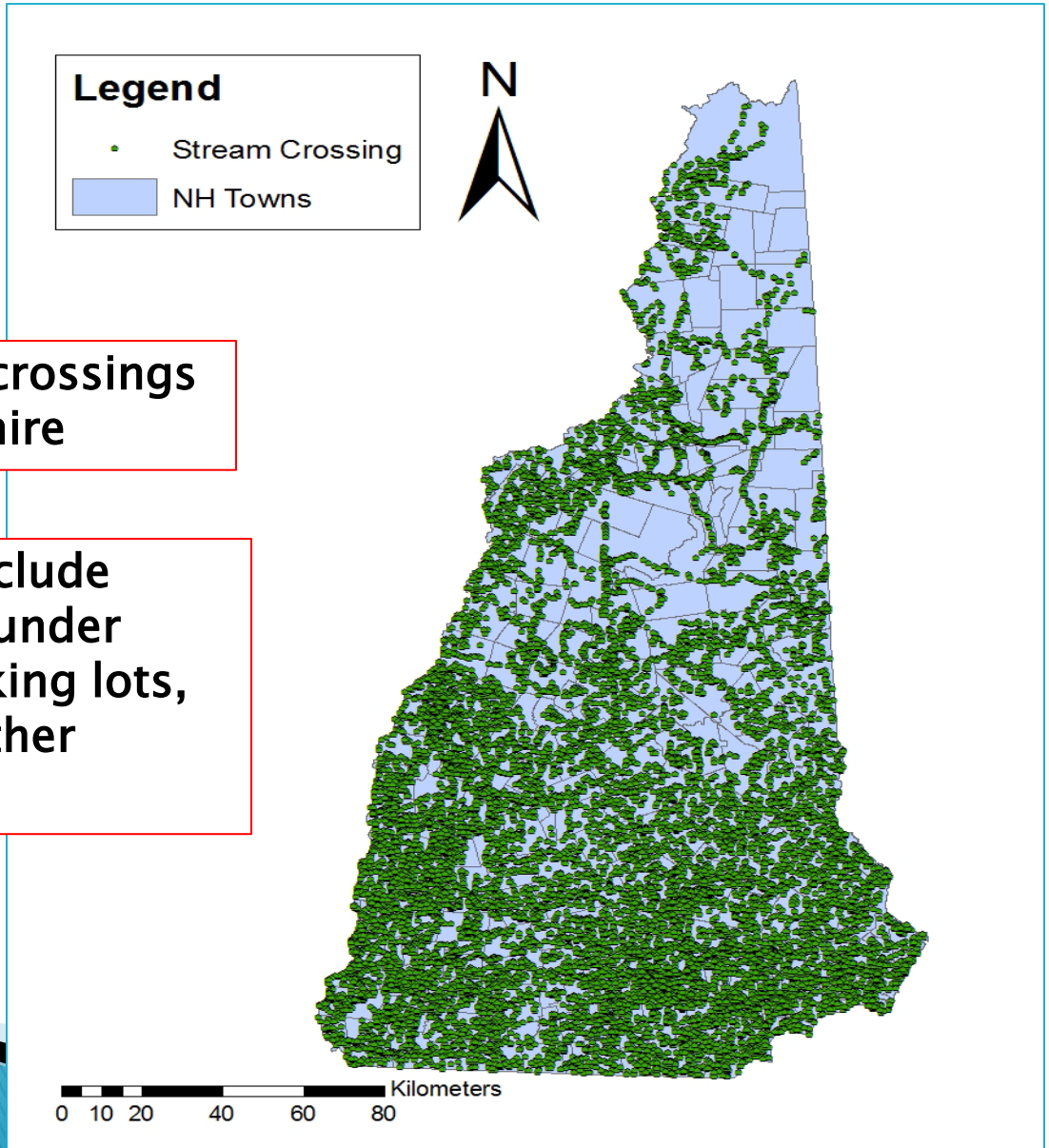
Different from a Ditch

PIPED STREAM

Streams that flow in concrete/ asphalt ditches but are exposed to light and the surrounding landscape are called “ditches” in this study

DITCH

Potential Importance of Piped Streams



>17,000 road crossings in New Hampshire

Map doesn't include piped streams under driveways, parking lots, buildings, or other surfaces

Lemay 2008 (personal comm.)

Why Study Piped Streams?

- Prevalence may increase with urbanization
- Little empirical evidence regarding biogeochemical processes in piped streams
- Restoration/management efforts

Elmore and Kaushal 2008, Walsh et al. 2005

Study Objectives

- **Characterize ecosystem processes in a piped stream**
  - **Measure NH_4^+ and PO_4^{3-} Uptake**
  - **Measure Ecosystem Metabolism**
  - **Other characteristics**

- **Compare results from piped reaches to non-piped reaches**

Pettee Brook, UNH Campus

Open (Reference) Reach

Pipe 1 (Concrete)

Downstream 1

Ditch (Stone)

Pipe 2 (Metal)

Downstream 2

250 m

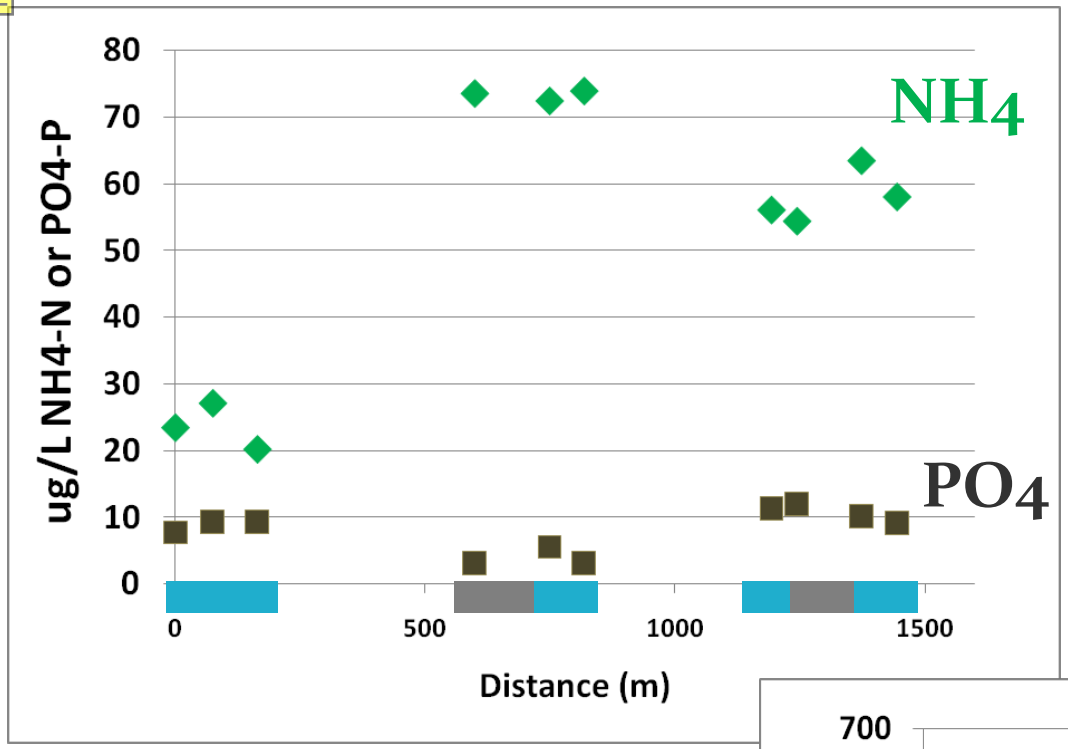
Methods

Methods

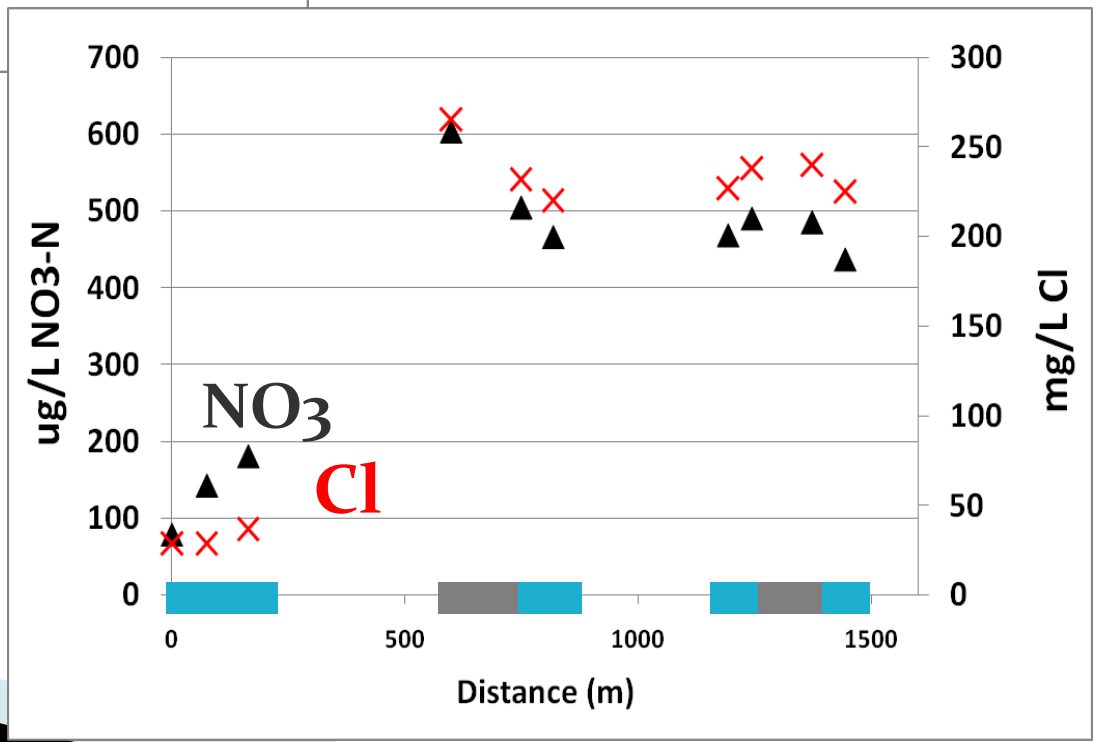
- Combined NH_4^+/PO_4^{3-} solute addition using Br^- and Rhodamine as tracers
- Upstream–Downstream O_2 change w/reaeration determined using SF_6

Hauer & Lamberti 2007,
LINX Protocol (Potter, pers. comm.)

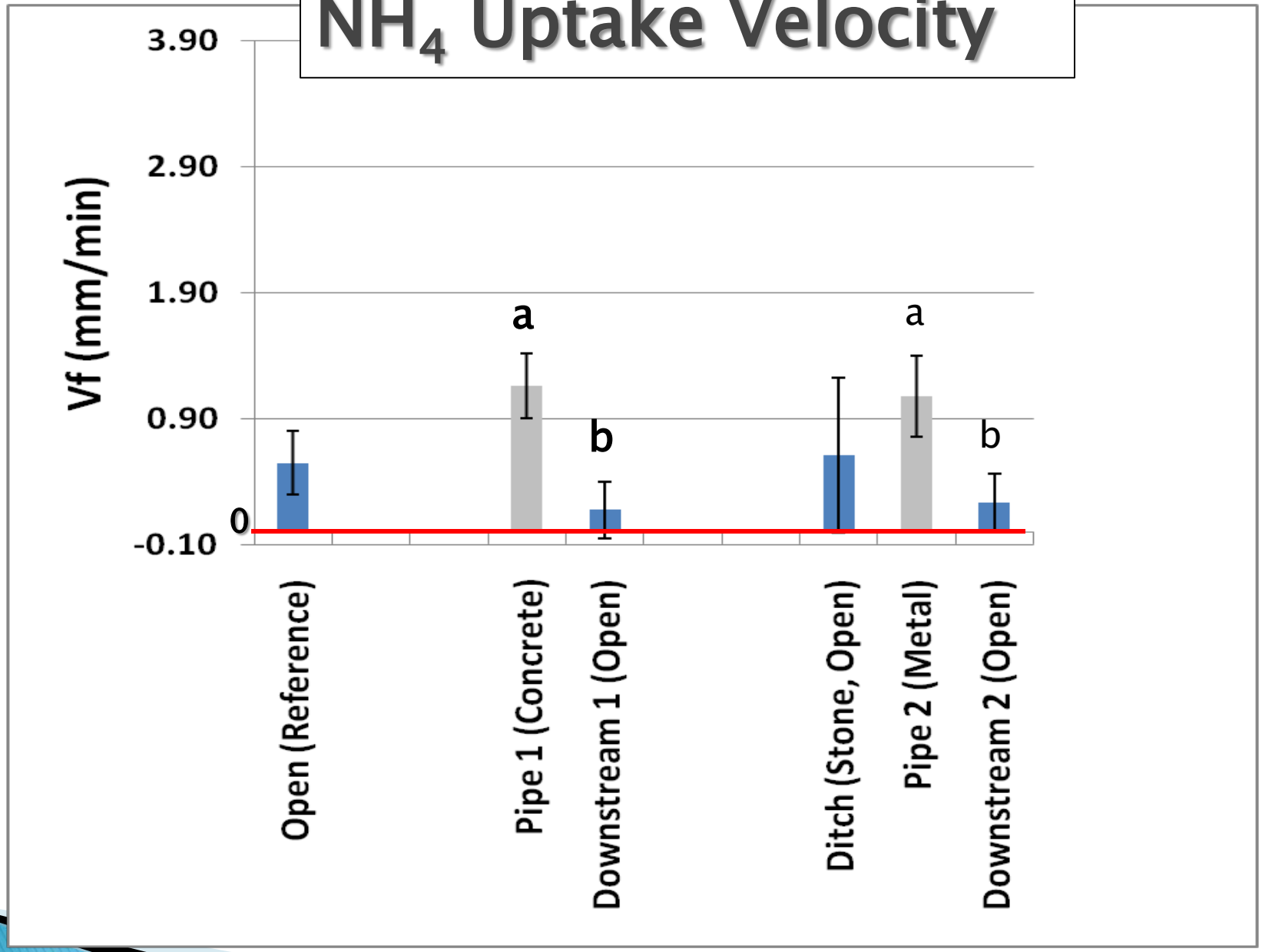
Ambient Concentrations



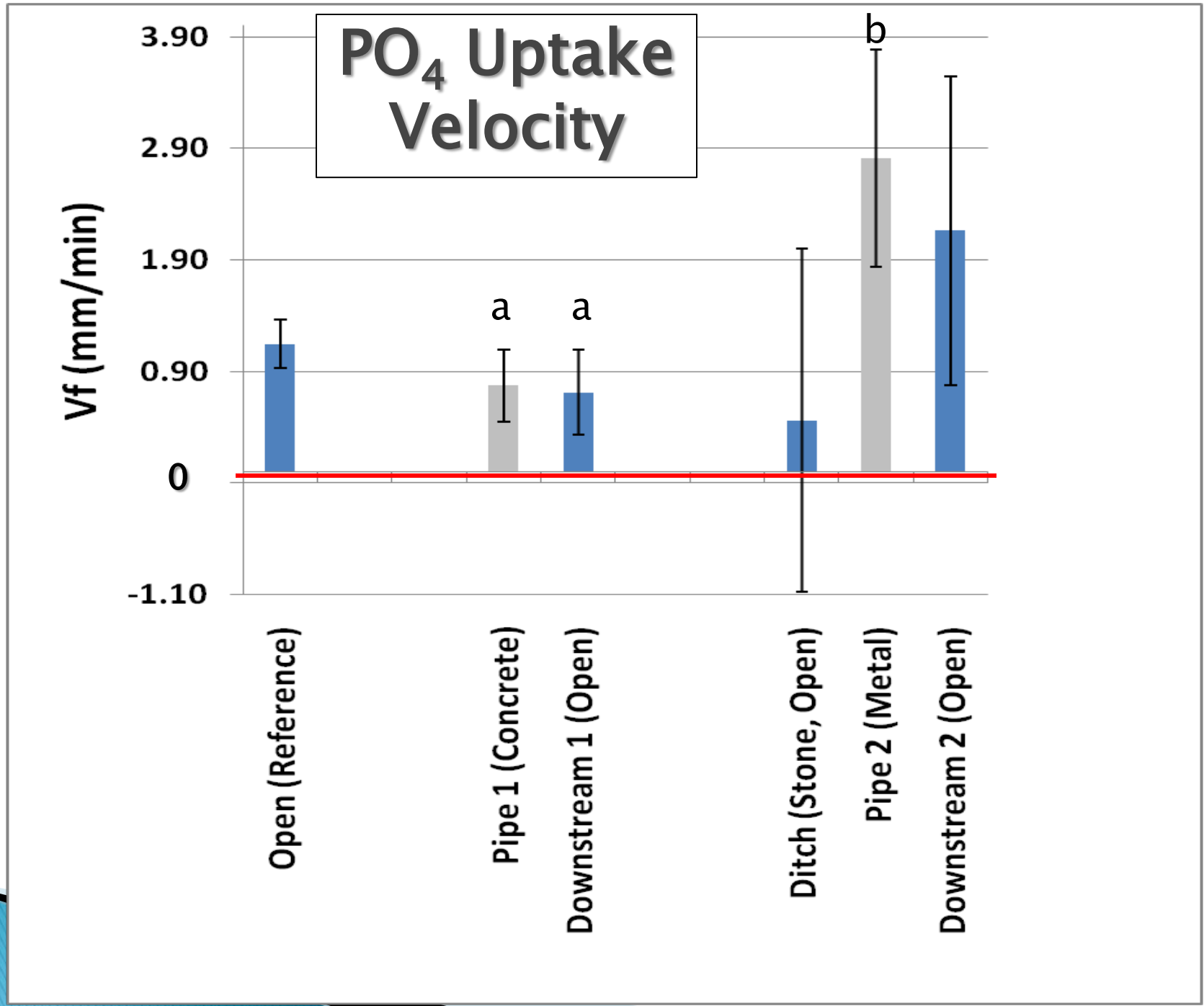
- NH4-N: 20-75 ug/L
- PO4-P : 3-12 ug/L
- NO3-N: 70-600 ug/L
- Cl: 25-270 mg/L



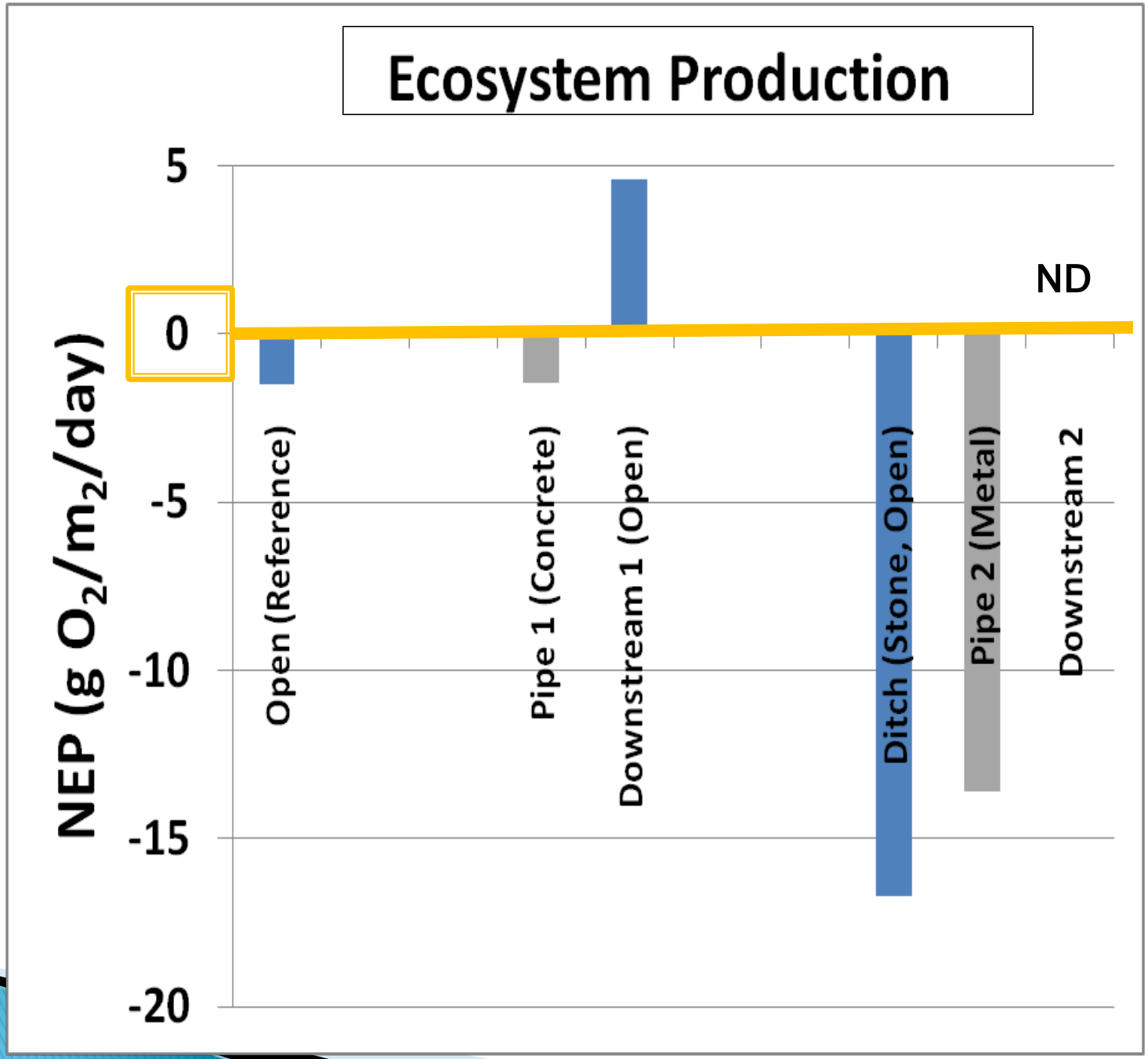
NH_4 Uptake Velocity



Results


PO4 Uptake Velocity
Vf (mm/min)
3.90
2.90
1.90
0.90
0
-1.10
a
a
b
Open (Reference)
Pipe 1 (Concrete)
Downstream 1 (Open)
Ditch (Stone, Open)
Pipe 2 (Metal)
Downstream 2 (Open)

Results


Ecosystem Production
NEP (g O_2/m_2/day)
5
0
-5
-10
-15
-20
ND
Open (Reference)
Pipe 1 (Concrete)
Downstream 1 (Open)
Ditch (Stone, Open)
Pipe 2 (Metal)
Downstream 2

Results

Additional Reach Characteristics

Reach	Peak Light (lum/ft^2)	Peak H_2O Temp. (C)	k O_2 (1/min)	Q (L/s)	Velocity (m/min)
Open (Reference)	3000	17	0	5	1.06
Pipe 1 (Concrete)	0	22	0.015	5.2	5.91
Downstream 1 (Open)	17000	22	0.015	5.2	3.53
Ditch (Stone, Open)	11000	22	0.015	27.4	7.5
Pipe 2 (Metal)	0	22	0.012	27.4	6.14

Discussion

- NH_4^+ and PO_4^{3-} V_f values within range found in literature, although on low end (Hall *et al*. 2002, Ensign & Doyle 2006)
- Uptake was measured in piped stream reaches
- In some cases, uptake velocities in piped stream reaches were significantly higher than nearby open reaches
- Related to Energy Limitation? Sediments? Pools? Other characteristics???

- Ecosystem metabolism results similar to Mulholland *et al.* 2001
- Most reaches were heterotrophic
- Related to Light? Temp? Nutrients? Other?
- First look at biogeochemical processes in piped stream reaches
- Additional study needed

Additional Research Questions (2010 Field Season)

- What are NH_4^+ and PO_4^{3-} uptake velocities during Open Canopy?
- Is there NO_3 uptake at summer baseflow?
- Is there DOC uptake at summer baseflow?
- Will my Ecosystem Metabolism results be supported by additional measurements?
- What are FBOM, Chl. *a,* and TSS/sediment amounts?

Acknowledgements

- Thank you! to my committee: Dr. Bill McDowell, Dr. Wil Wollheim, and Dr. Gretchen Gettel

- Jody Potter, Jeff Merriam, Adam Baumann, Michelle Daley, and Jeff Schloss for field/lab assistance, advice, and materials

- NH Water Resources Research Center for funding

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