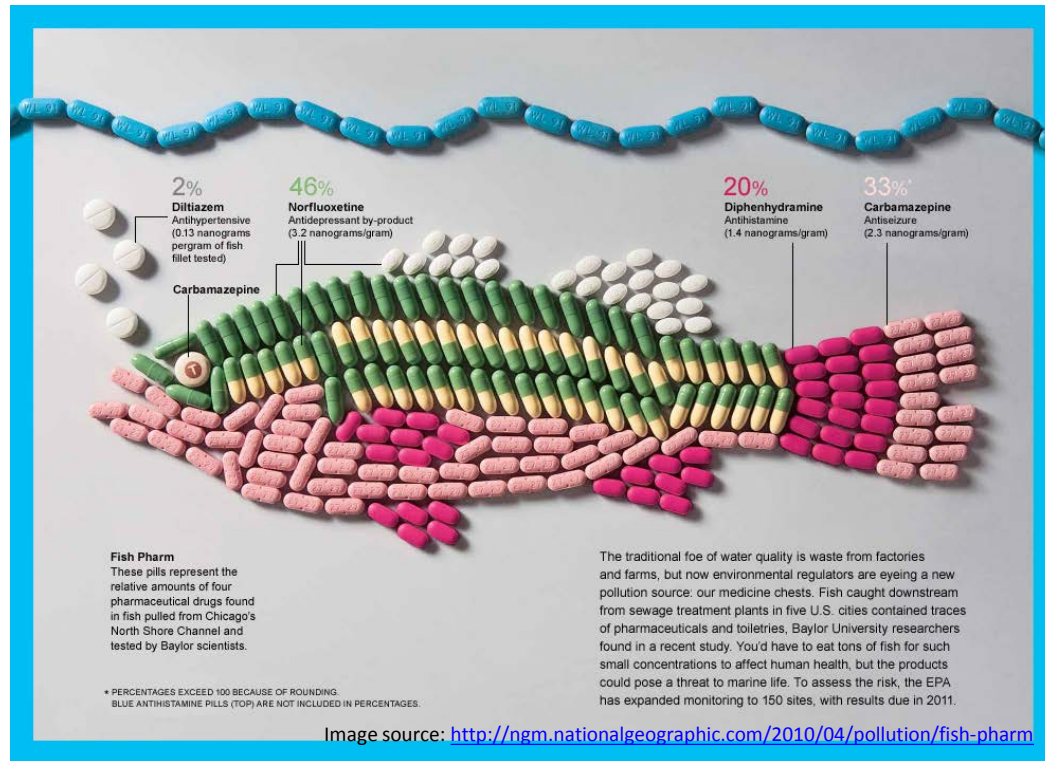


Pharmaceuticals in the Lake Champlain Basin: cause for concern?



Christine Vatovec, PhD

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cvatovec@uvm.edu

Trade-offs of pharmaceuticals: human health benefits and effects on social and ecological systems

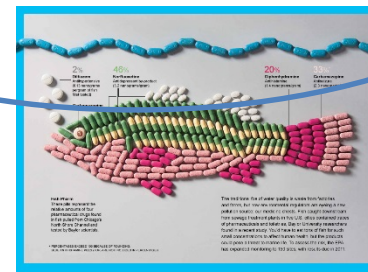
Benefits

- Individual health & well-being
 - Pain control
 - Symptom management
 - Birth control
 - Antibiotic/infection control
 - Sleep
 - Mental health



Harms

- Humans
 - Patients
 - Side-effects
 - Dependence/abuse
 - Out-of-pocket \$\$ costs
 - Society
 - Public health exposures
 - Financial burden
- Environment
 - Habitat degradation & biodiversity loss (biopiracy)
 - Aquatic ecological system impacts (pharmaceutical waste)



**PHARMACEUTICALS IN THE ENVIRONMENT:
WHAT WE KNOW**

Pharmaceuticals in the environment: why the concern?

- Over 131 million (66%) of U.S. adults use prescription drugs
 - 4 billion prescriptions each year
- Many medications are unused
 - 52% of over-the-counter
 - 45% of prescription drugs
 - 80% of antibiotics
- Unused drugs are discarded
 - Municipal waste (54%)
 - Flushed (35%)
 - Retained (7%)
 - Take-back programs (1%)

Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999–2000: A National Reconnaissance

DANA W. KOLPIN*

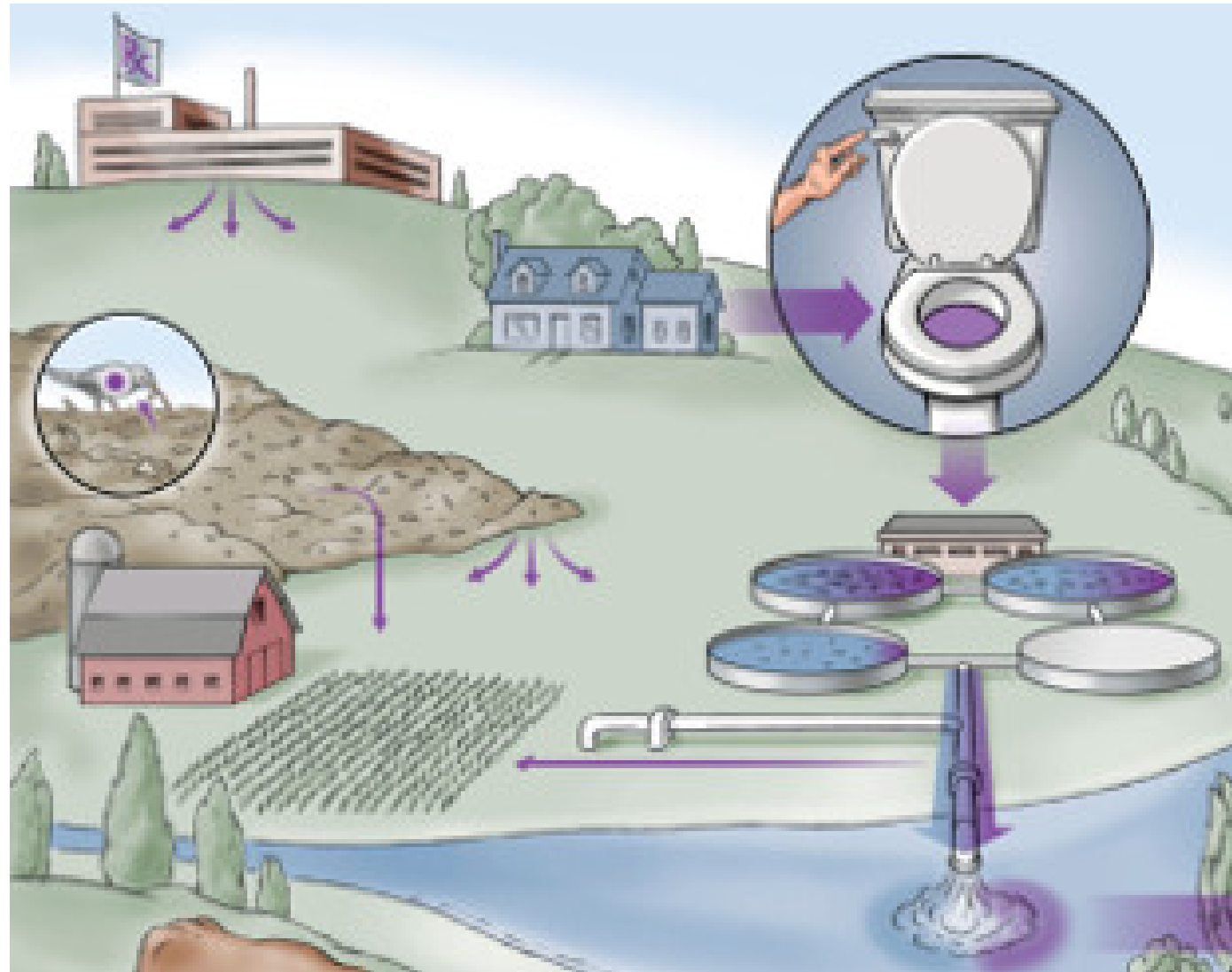
Critical Reviews in Toxicology, 34(4):335–350, 2004
Copyright © Taylor and Francis Inc.
ISSN: 1040-8371
DOI: 10.1080/10408440490464697



Potential Ecological and Human Health Risks Associated With the Presence of Pharmaceutically Active Compounds in the Aquatic Environment

O. A. H. Jones, N. Voulvoulis, and J. N. Lester

Sources of pharmaceuticals in the environment



**EPA CLASSIFIES PHARMACEUTICALS AS
CONTAMINANTS OF EMERGING CONCERN**

All pharmaceuticals, by design, are meant to elicit a biological response. We need to know what the environmental consequences are.

—Dana Kolpin, US Geological Survey

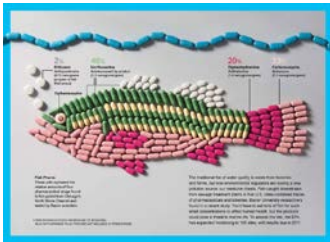
Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change?

Christian G. Daughton¹ and Thomas A. Ternes²



Flaherty & Dodson, 2005

- Individual and mixtures of pharmaceuticals affect normal development and reproduction of *Daphnia magna*
- Aquatic toxicity of pharmaceutical mixtures can be unpredictable and complex compared to individual pharmaceutical effects, and



Fish on Prozac (and Zoloft): Ten years later

Bryan W. Brooks*



Assessing Exposure and Health Consequences of Chemicals in Drinking Water: Current State of Knowledge and Research Needs

Cristina M. Villanueva,^{1,2,3} Manolis Kogevas,^{1,2,3,4} Sylvaine Cordier,⁵ Michael R. Templeton,⁶ Roel Vermeulen,⁷ John R. Nuckols,⁸ Mark J. Nieuwenhuijsen,^{1,2} and Patrick Levallois^{9,10,11}

PHARMACEUTICAL CONTAMINANTS IN LAKE CHAMPLAIN

Pharmaceuticals in Lake Champlain



Major Source: wastewater effluent

- Human excretion of medication
- Down-the-drain disposal

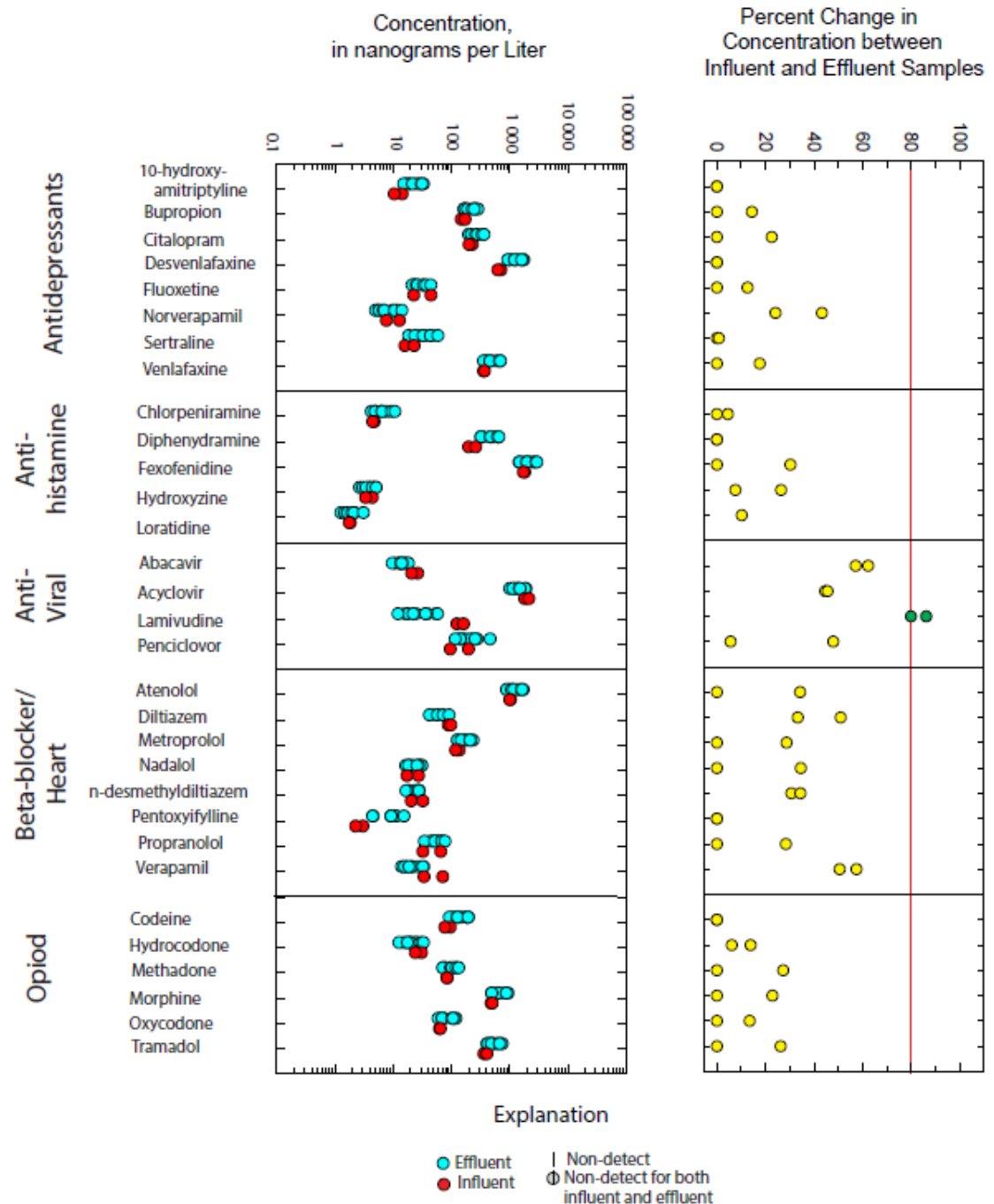
Levels: detection at Burlington WWTF (2014)

- 51 pharmaceuticals (110 tested)

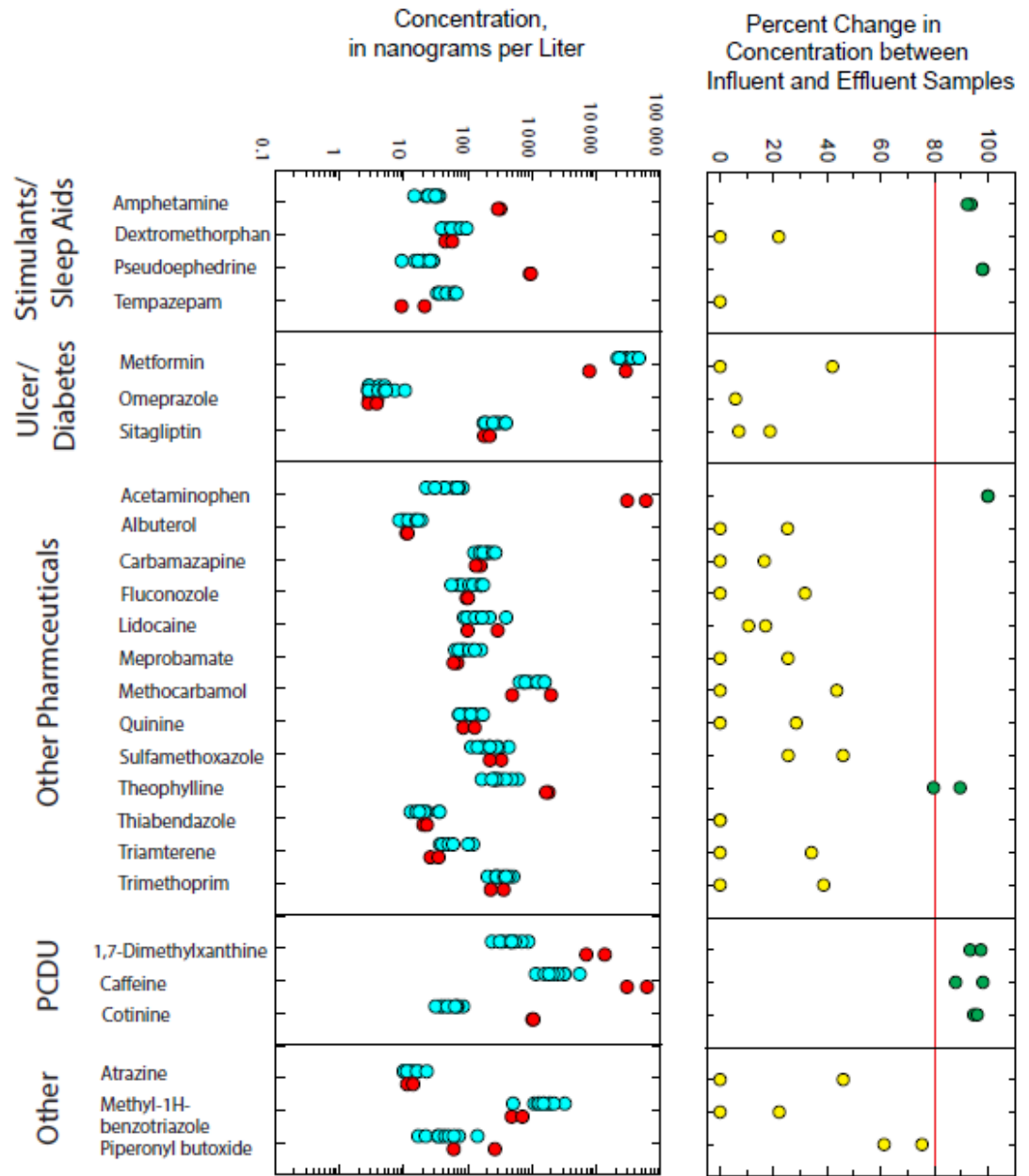
Effects

- Currently unknown

Concentrations of select SH2240 analytes for Burlington wastewater treatment plant influent and effluent samples, May 2014 (1 of 2)



Concentrations of select SH2240 analytes for Burlington wastewater treatment plant influent and effluent samples, May 2014 (2 of 2)

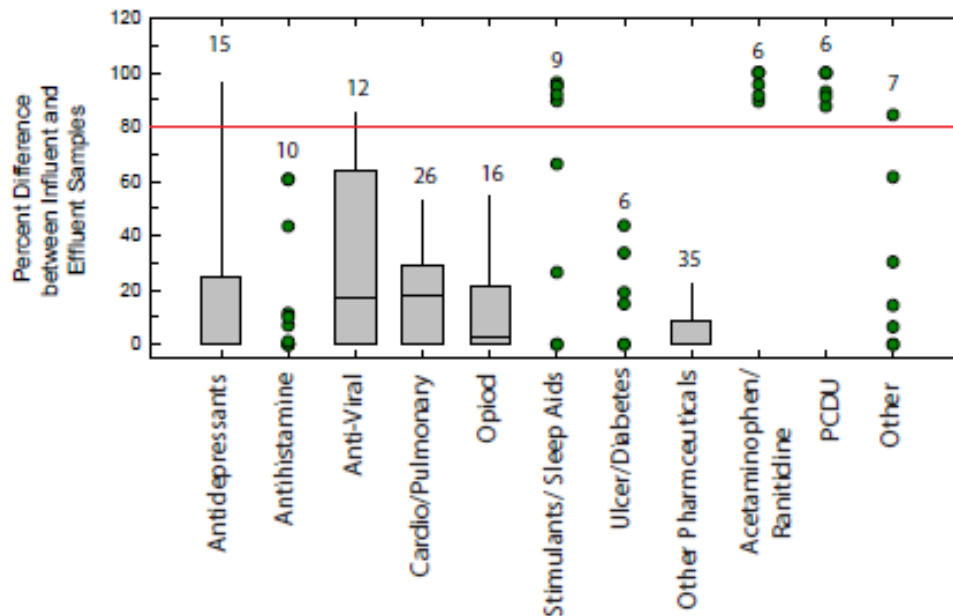


Explanation

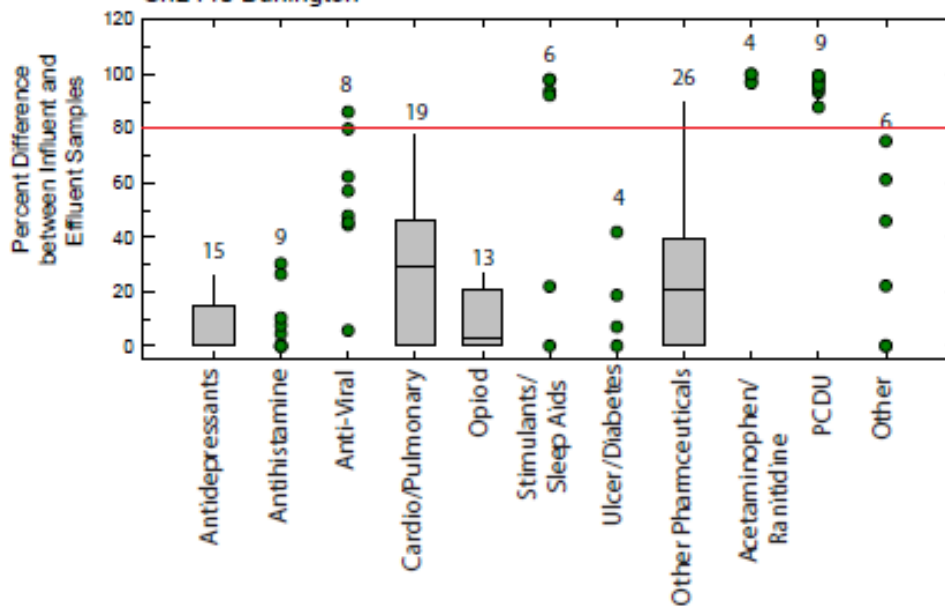
- Effluent
- Influent
- Non-detect
- ⊕ Non-detect for both influent and effluent

Percent removal by compound type for samples collected from Burlington, VT compared to Ithaca, NY (May 2014)

Sh2440 Ithaca



Sh2440 Burlington



Pharmaceuticals in Lake Champlain



Major Source: wastewater effluent

- Human excretion of medication
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Levels: detection at Burlington WWTF (2014)

- 51 pharmaceuticals (110 tested)

Effects

- Currently unknown

Surveys of Vermonters' pharmaceutical purchasing, use, and disposal

where will
your prescriptions
end up?

- UVM students (2014; n = 358)
- Vermont residents (2016; n = 412)



If you are a UVM student and are 18 or older,
please help a student research project
by answering a short survey
on pharmaceutical pollution
<http://go.uvm.edu/9gb>



UVM Students

Pharmaceutical purchasing, use, and disposal (n=358)

	Over-the-counter	Prescription
Did you purchased any medications in the past year?		
Yes	88%	77%
No	12%	23%
Did you use all of the medications that you purchased in the past year?		
Yes	22%	36%
No – still using it	38%	34%
No – some leftover	63%	33%
If some was leftover, why was there some leftover? (Check all that apply)		
More came in package than needed	44%	33%
Felt better so stopped using it	60%	43%
Didn't work, so stopped using it	9%	20%

UVM Students

Pharmaceutical purchasing, use, and disposal (n=358)

	Over-the-counter	Prescription
If there was some leftover, what did you do with it? (Check all that apply.)		
I still have it.	88%	65%
I gave it to a friend or family member.	10%	6%
I threw it away.	14%	33%
If you threw medication away in the past 12 months, how did you dispose of it? (% of total 358)		
Flushed down the drain	1%	1%
Threw in garbage	19%	14%
Took to National Take-Back Day	1%	1%

Vermonters

Pharmaceutical purchasing, use, and disposal (n=412)

Did you purchased any medications in the past year?	
Yes	98%
Have you ever had unused, leftover medication?	
Yes	61%
If some was leftover, why was there some leftover? (Check all that apply)	
Felt better so stopped using it	42%
More came in package than needed	41%
Didn't work, so stopped using it	22%
It expired	21%
Physician asked me to stop	17%

Vermonters

Pharmaceutical purchasing, use, and disposal (n=412)

If there was some leftover, what did you do with it? (Check all that apply.)

I still have it.	29%
------------------	-----

I threw it away.	32%
------------------	-----

If you threw medication away in the past 12 months, how did you dispose of it?
(% of total 358)

Flushed down the drain	13%
------------------------	-----

Threw in garbage	32%
------------------	-----

Returned to drug take-back program	38%
------------------------------------	-----

Opportunities for minimizing the sources of pharmaceuticals in the environment



Clinical pharmaceutical prescribing and dispensing practices

Currently collecting data



Alternatives to pharmaceuticals for managing pain and symptoms among cancer patients

Points of intervention for reducing the unintended consequences of pharmaceuticals



Wastewater treatment technology



Changes in consumer behavior

- purchasing
- disposal

Changes in policy and practice

- drug disposal guidelines
- prescribing?
- dispensing?



What questions do you have?

Christine Vatovec
cvatovec@uvm.edu

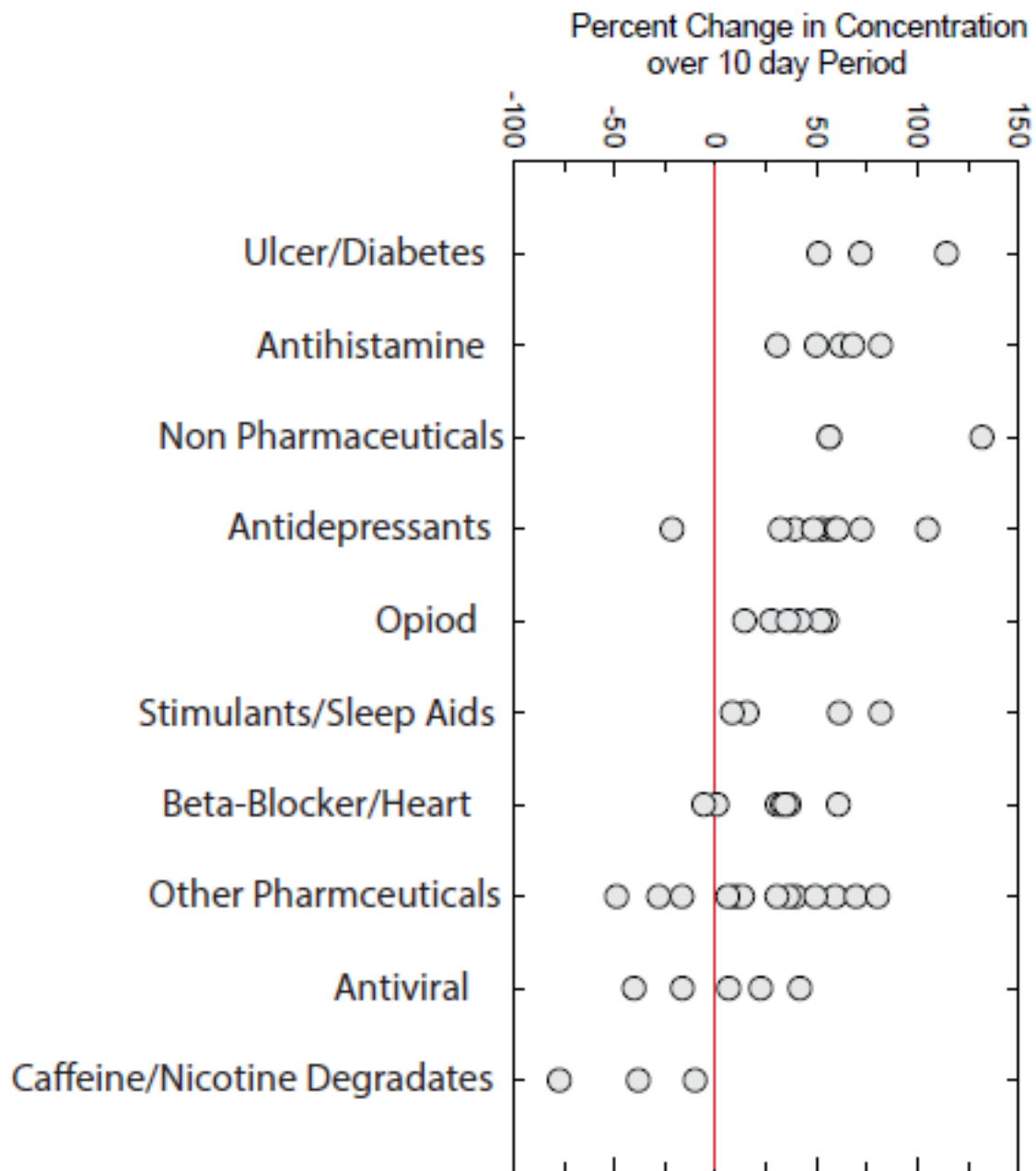
Supplementary material



Wastewater sampling during student move-out

- May 1 – May 10, 2014: UVM student move-out
 - Burlington WWTF
 - Sample collection method: 24-hour composite samples collected every 15 minutes
- USGS SH2440 method
 - 109 compounds tested (100 are pharmaceuticals)
 - LCMS/MS (liquid chromatography tandem mass spectrometry)
 - Reporting limits range: 0.45 ng/L – 145 ng/L

What change did we see over the ten-day sampling period?



	N (%)
Status	
First-year	48 (13%)
Sophomore	112 (31%)
Junior	94 (26%)
Senior	72 (20%)
Master's level	12 (3%)
Doctoral level	9 (3%)
Other	11 (3%)
Location	
In Burlington	325 (91%)
Outside of Burlington	25 (7%)
Campus	
On Campus	165 (46%)
Off campus	172 (48%)

Gender	
Male	81 (23%)
Female	275 (77%)
Race	
Black or African American	7 (2%)
Caucasian or White	339 (95%)
Asian or Pacific Islander	11 (3%)
American Indian or Alaska Native	3 (1%)
Ethnicity	
Hispanic or Latino/Latina	12 (3%)
Not Hispanic or Latino/Latina	333 (93%)
Family's Annual Income	
< \$15,000	22 (6%)
\$15,000 - \$64,999	85 (24%)
\$65,000-\$200,000	187 (52%)
> \$200,000	57 (16%)

UVM Survey Results
(n = 358)