USING MULTIPLE TRACERS TO DETERMINE WASTEWATER CONTRIBUTIONS TO GROUNDWATER IN SPRINGS CONTRIBUTING AREAS

ANDY CANION [1], KATHERINE M. RANSOM [2]
BRIAN G. KATZ [3]

[1] ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, PALATKA, FL
[2] UNIVERSITY OF CALIFORNIA, DAVIS, CA
[3] FLORIDA DEPT. OF ENVIRONMENTAL PROTECTION, TALLAHASSEE, FL

2020 UF WATER INSTITUTE SYMPOSIUM

REDUCING NITROGEN LOADS TO SPRINGS

Numeric Nutrient Criteria of 0.35 mg L^{-1} NO_3 - N

Basin Management Action Plans (BMAPS)

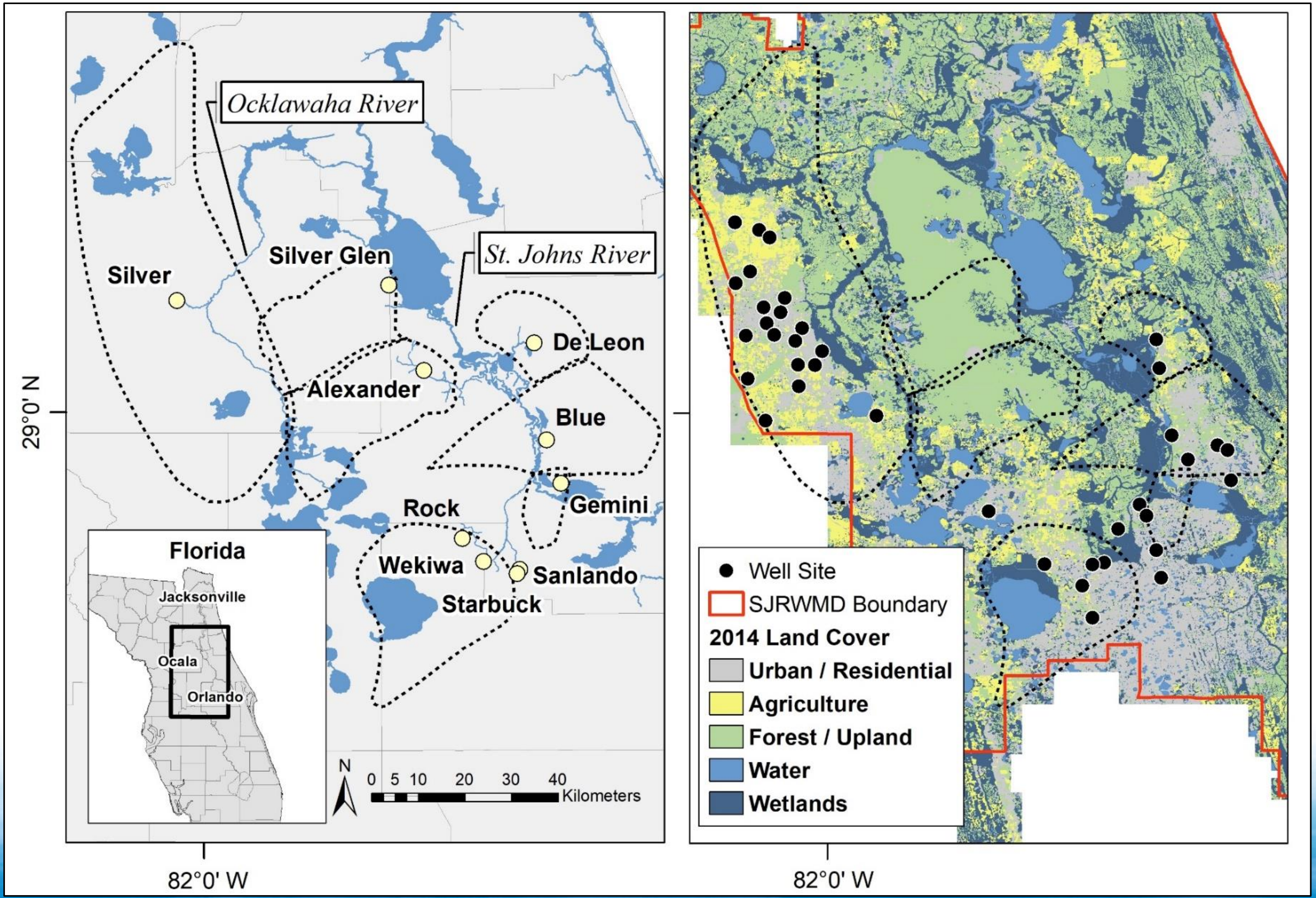
Develop projects to reduce aquifer N loads

<u>Assess sources of nitrogen</u>

Nitrogen Source Inventory and Loading Tool (NSILT)

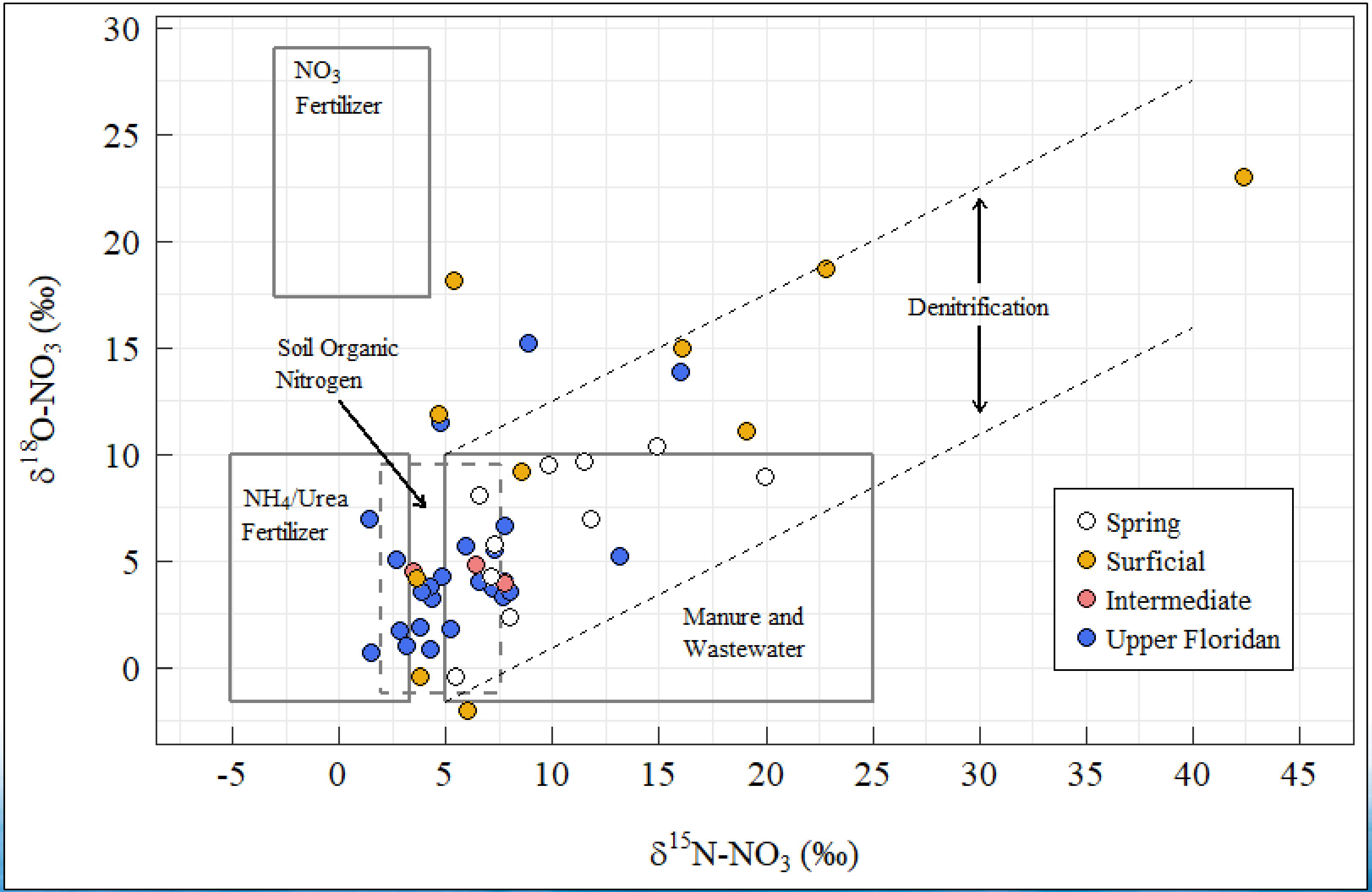
Groundwater monitoring

SAMPLING PROGRAM



- Standard water quality
- Nitrate isotopes
- Boron concentration and stable isotope
- Sucralose
- Iohexol

NITRATE STABLE ISOTOPES



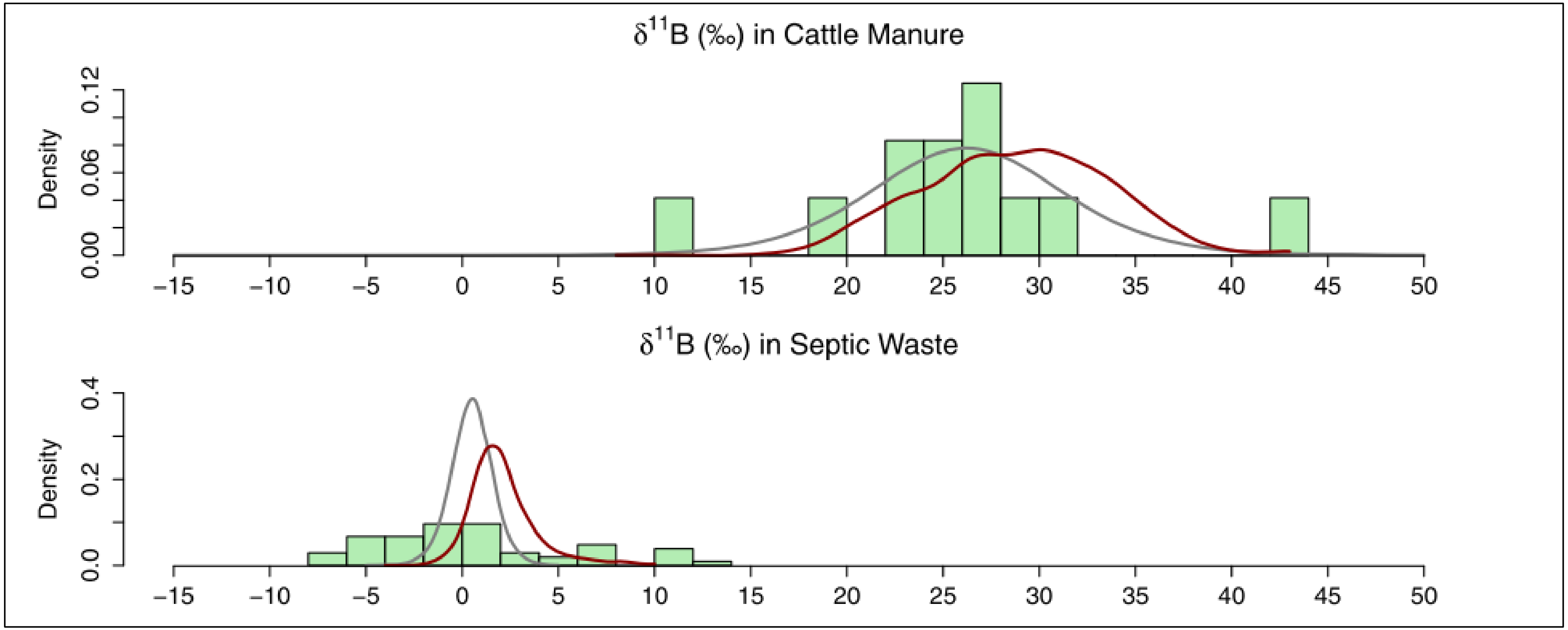
DENITRIFICATION INFLUENCE

Spring	NO_3-N (mg L^{-1})	Percent of Nitrogen Remaining †	$\delta^{15}N$-NO_3 (‰)	$\delta^{18}O$-NO_3 (‰)
Gemini Springs	1.40	50 - 65 %	7.09	4.28
Rock Springs	1.28	43 %	6.60	8.08
Silver Springs	1.24	50 - 93 %	7.30	5.74
Wekiwa Springs	1.12	30 %	11.49	9.67
Ponce De Leon Springs	0.81	21 - 31 %	9.80	9.54
Blue Spring	0.79	13 %	11.82	6.95
Sanlando Spring	0.62	10 %	14.88	10.39
Starbuck Spring	0.39	10 %	19.99	8.91
Silver Glen Springs	0.05	11 %	5.43	-0.39
Alexander Springs	0.04	12 %	8.01	2.34

† Data from Heffernan et al. (2012)

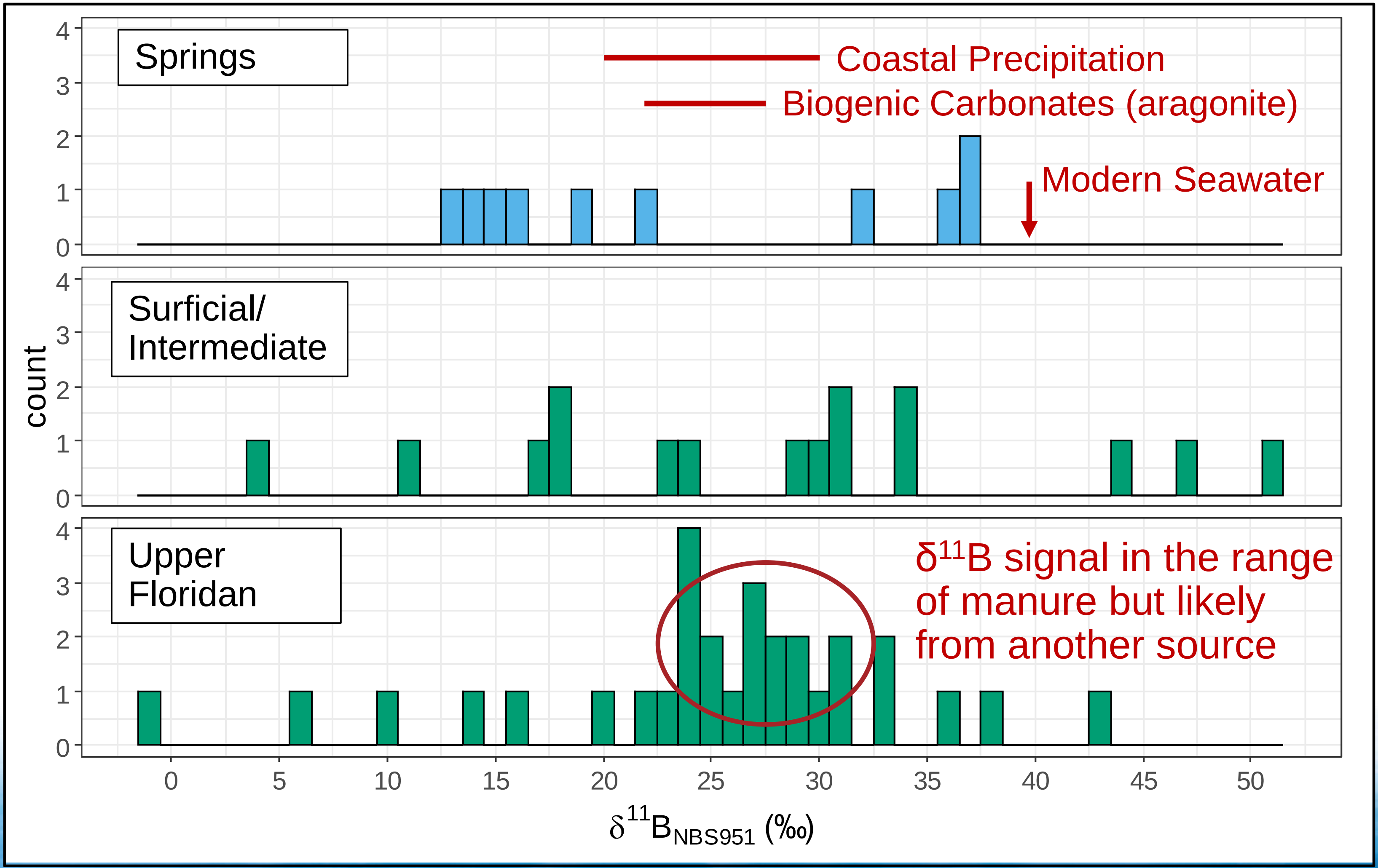
Denitrification limits interpretation of nutrient sources without associated N_2 gas measurements

BORON STABLE ISOTOPE

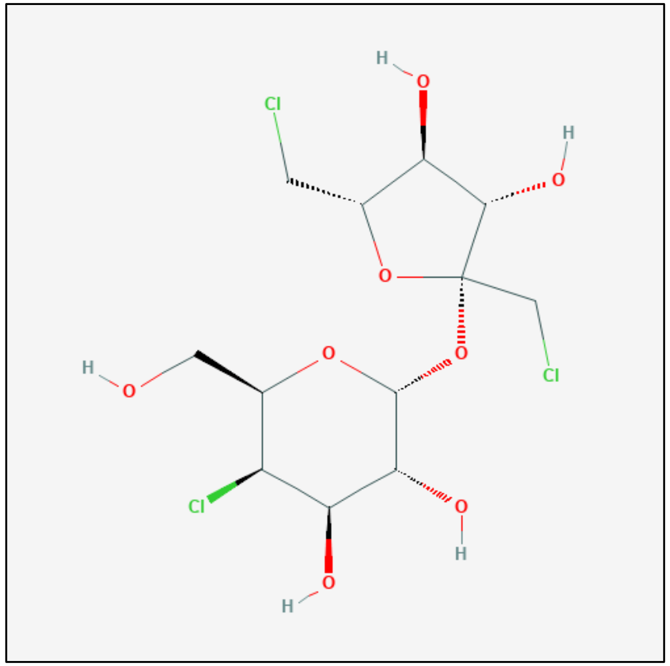


Modified after Ransom et al. 2016

BORON STABLE ISOTOPE



SUCRALOSE



- Artificial sweetener
- Half Life of ~1 year

Reuse systems: 18,000 – 79,000 ng L^{-1}

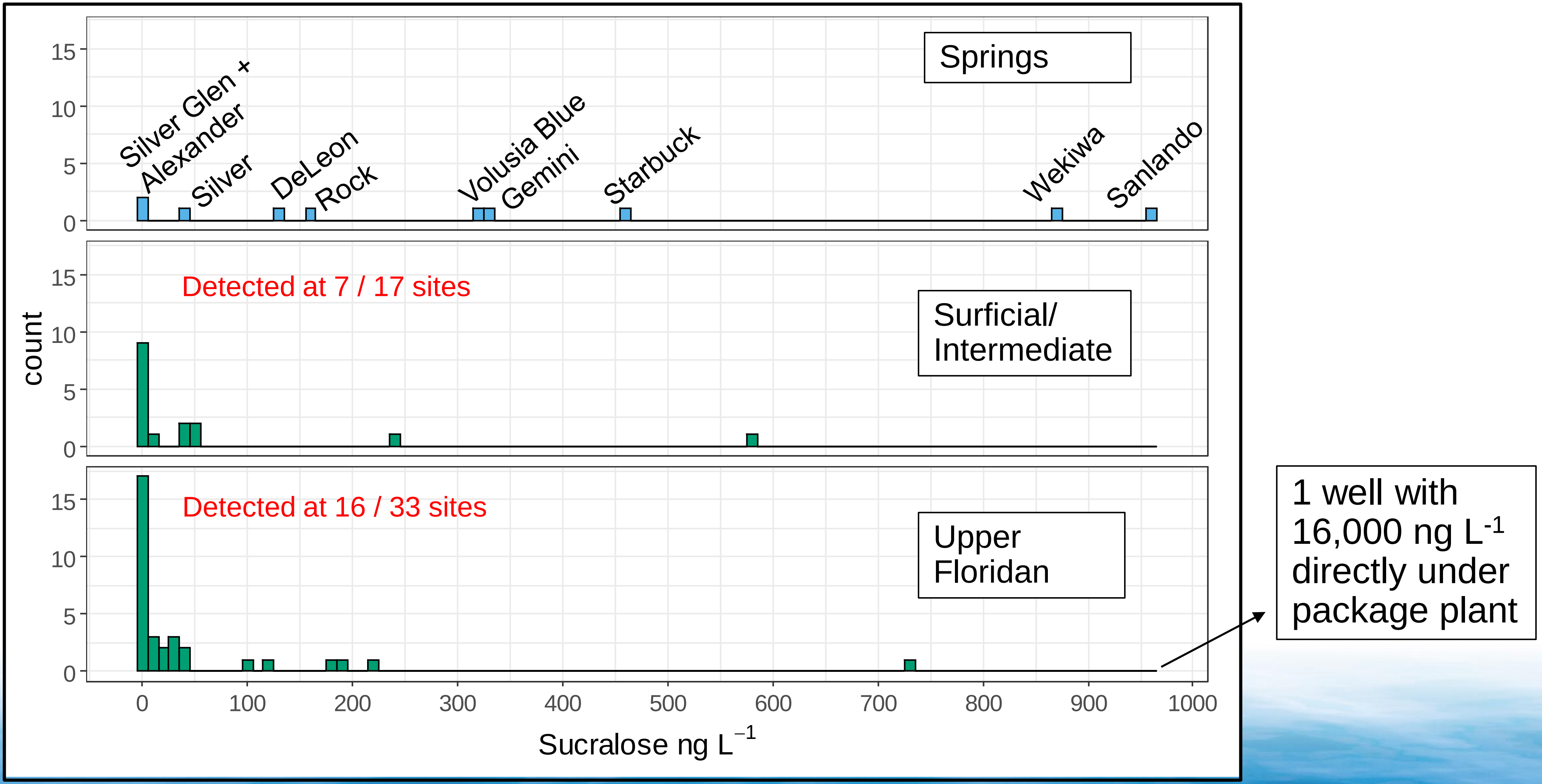
Septic Tanks: 12,000 – 80,000 ng L^{-1}

FL surface water: 0 – 27,000 ng L^{-1}

FL unconfined aquifers: 0 – 3,700 ng L^{-1}

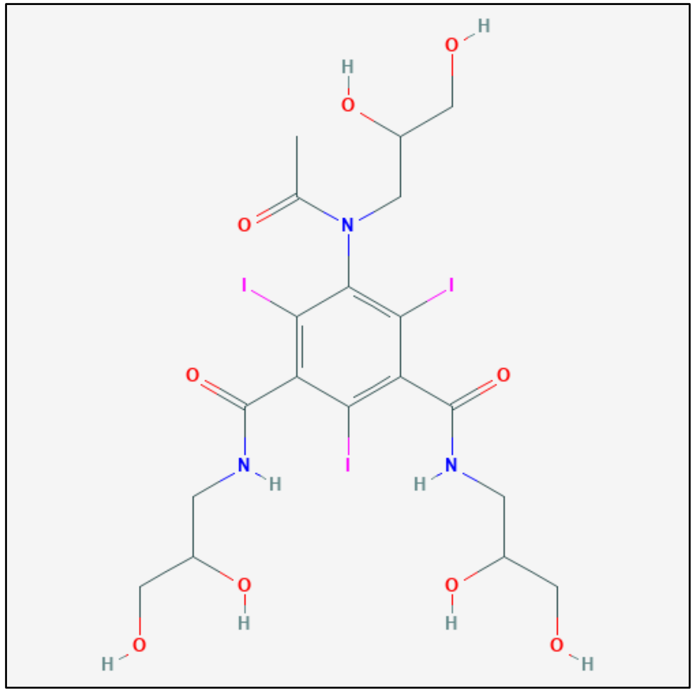
(Silvanima et al. 2018)

SUCRALOSE



Springs
Silver Glen +
Alexander
Silver
DeLeon
Rock
Volusia Blue
Gemini
Starbuck
Wekiwa
Sanlando
Detected at 7 / 17 sites
Surficial/
Intermediate
Detected at 16 / 33 sites
Upper
Floridan
count
0
5
10
15
0
100
200
300
400
500
600
700
800
900
1000
Sucralose ng L^{-1}
1 well with
16,000 ng L^{-1}
directly under
package plant

IOHEXOL



- X-ray contrast agent
- Photolabile
- May be readily biodegradable

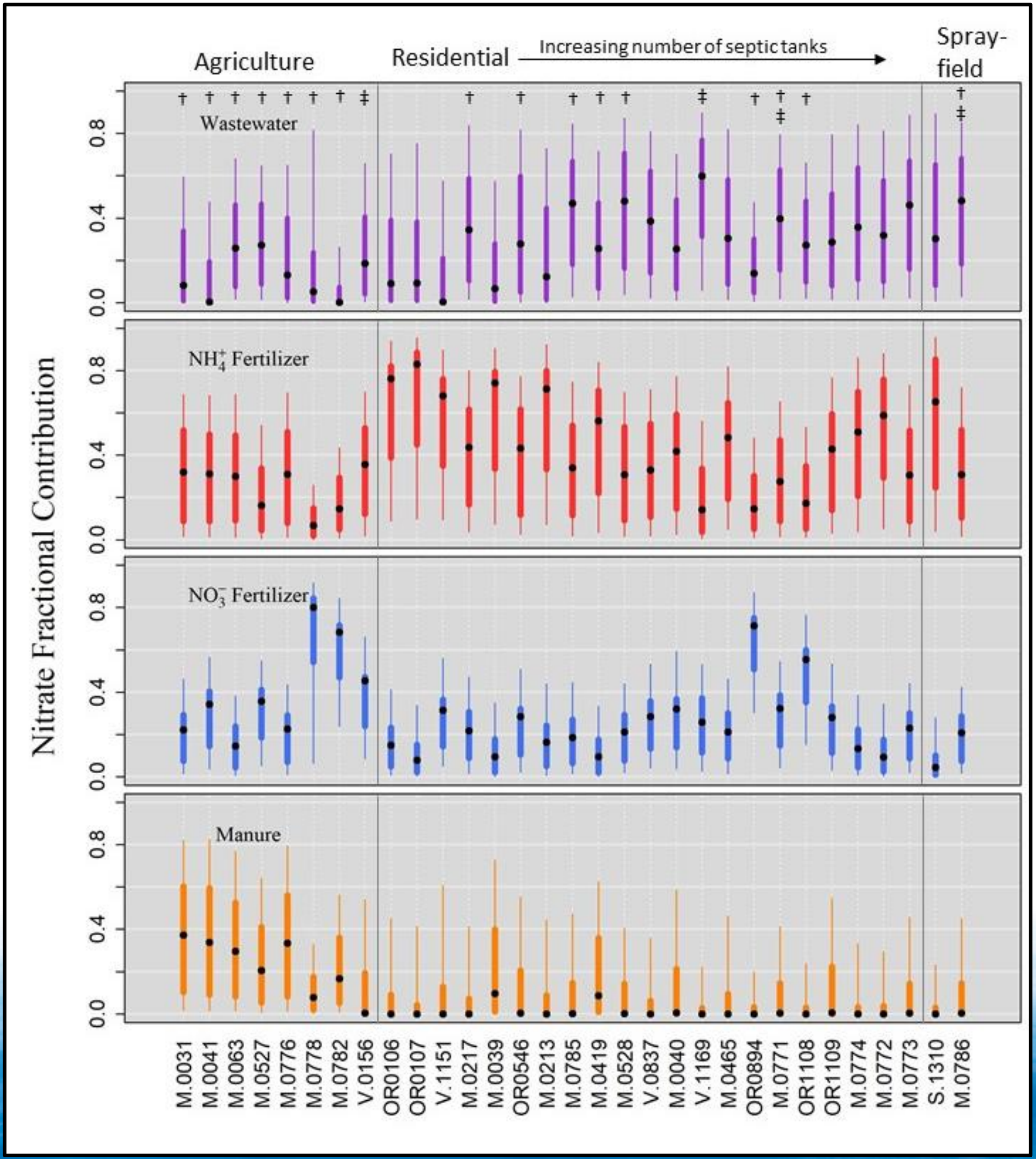
Reuse systems: 3,100 – 11,000 ng L^{-1}

Septic Tanks: <10 ng L^{-1}

Not detected in current study

BAYESIAN MIXING MODEL

- Accounts for distribution of source isotope values
- Prior contributions based on land use and septic tank density
- Use nitrate stable isotope data to update contributions



CONCLUSIONS

- Multiple tracers provide weight of evidence for wastewater contributions to groundwater and springs.
- Boron isotope may have limited application in FL
- Still difficult to discriminate between manure and septic/wastewater under mixed land use
- Absence of sucralose should not be used to rule-out wastewater sources
- Fertilizer sources still significant contribution in many areas – How much is from legacy loading?

REFERENCES

Badruzzaman, M., Pinzon, J., Oppenheimer, J., Jacangelo, J.G., 2012. Sources of nutrients impacting surface waters in Florida: A review. J. Environ. Mgmt. 109, 80–92.

Canion, A., Ransom, K.M., Katz, B.G., 2020. Discrimination of nitrogen sources in karst spring contributing areas using a Bayesian isotope mixing model and wastewater tracers. Environmental & Engineering Geoscience. *In press.*

Eller, K.T., Katz, B.G., 2017. Nitrogen Source Inventory and Loading Tool: An integrated approach toward restoration of water-quality impaired karst springs. J. Environ. Mgmt. 196, 702–709.

Heffernan, J.B., Albertin, A.R., Fork, M.L., Katz, B.G., Cohen, M.J., 2012. Denitrification and inference of nitrogen sources in the karstic Floridan Aquifer. Biogeosciences 9, 1671–1690.

Kendall, C., Doctor, D.H. and Young, M.B., 2014. Environmental Isotope Applications in Hydrologic Studies. In: Holland, H.D. and Turekian, K.K. (eds.) Treatise on Geochemistry, Second Edition, vol. 7, pp. 273-327. Oxford: Elsevier.

Ransom, K.M., Grote, M.N., Deinhart, A., Eppich, G., Kendall, C., Sanborn, M.E., Souders, A.K., Wimpenny, J., Yin, Q.Z., Young, M., Harter, T., 2016. Bayesian nitrate source apportionment to individual groundwater wells in the Central Valley by use of elemental and isotopic tracers. Water Resour. Res. 52, 5577–5597.

Schmidt, H., Waller, P., Oppenheimer, J., Badruzzaman, M., Pinzon, J., Jacangelo, J., 2013. No Sweetener in Your Stormwater, but What about Your Reclaimed Water? Florida Water Resour. J. Feb. 2013, 35–47.

Silvanima, J., Woeber, A., Sunderman-Barnes, S., Copeland, R., Sedlacek, C., Seal, T., 2018. A synoptic survey of select wastewater-tracer compounds and the pesticide imidacloprid in Florida’s ambient freshwaters. Environ. Monit. Assess. 190, 435.