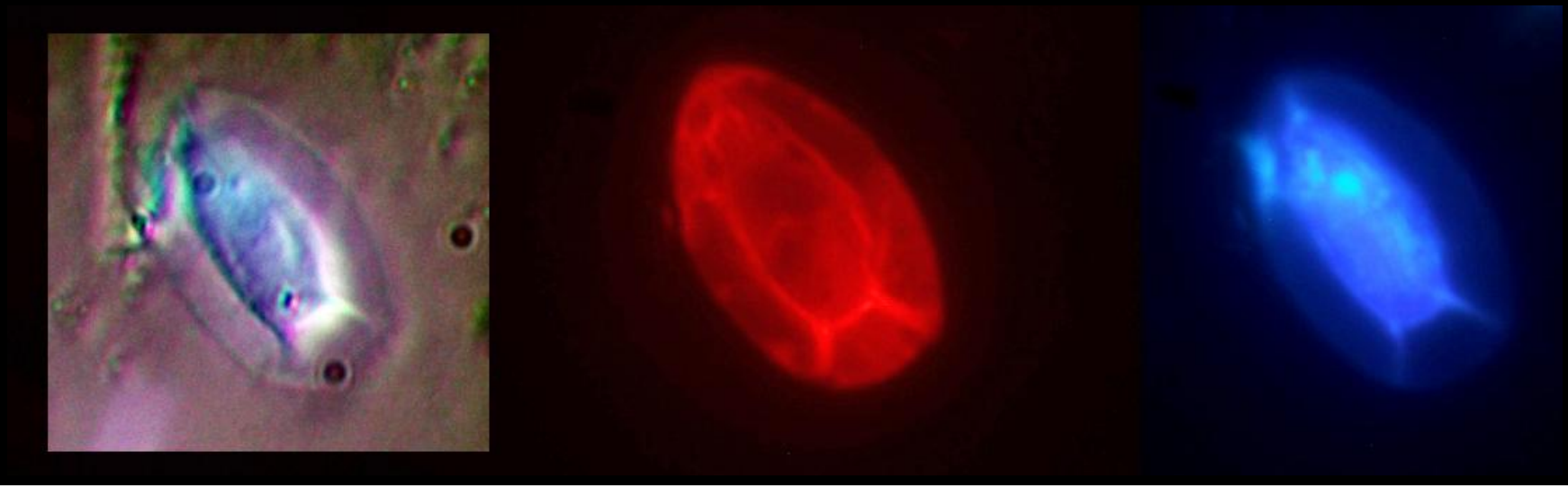
A Simplified Microscopic Particulate Analysis for use in GARP Determination



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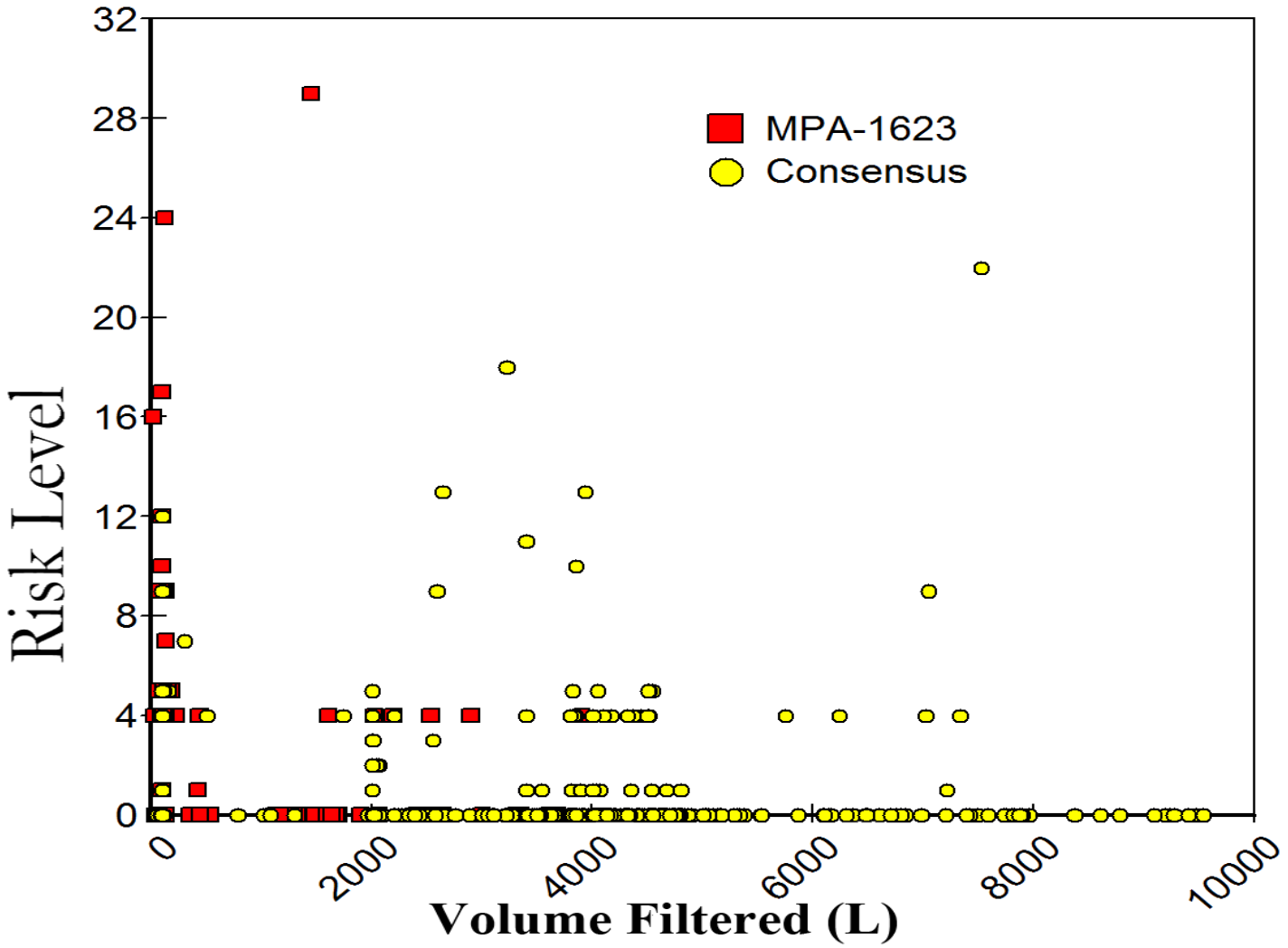
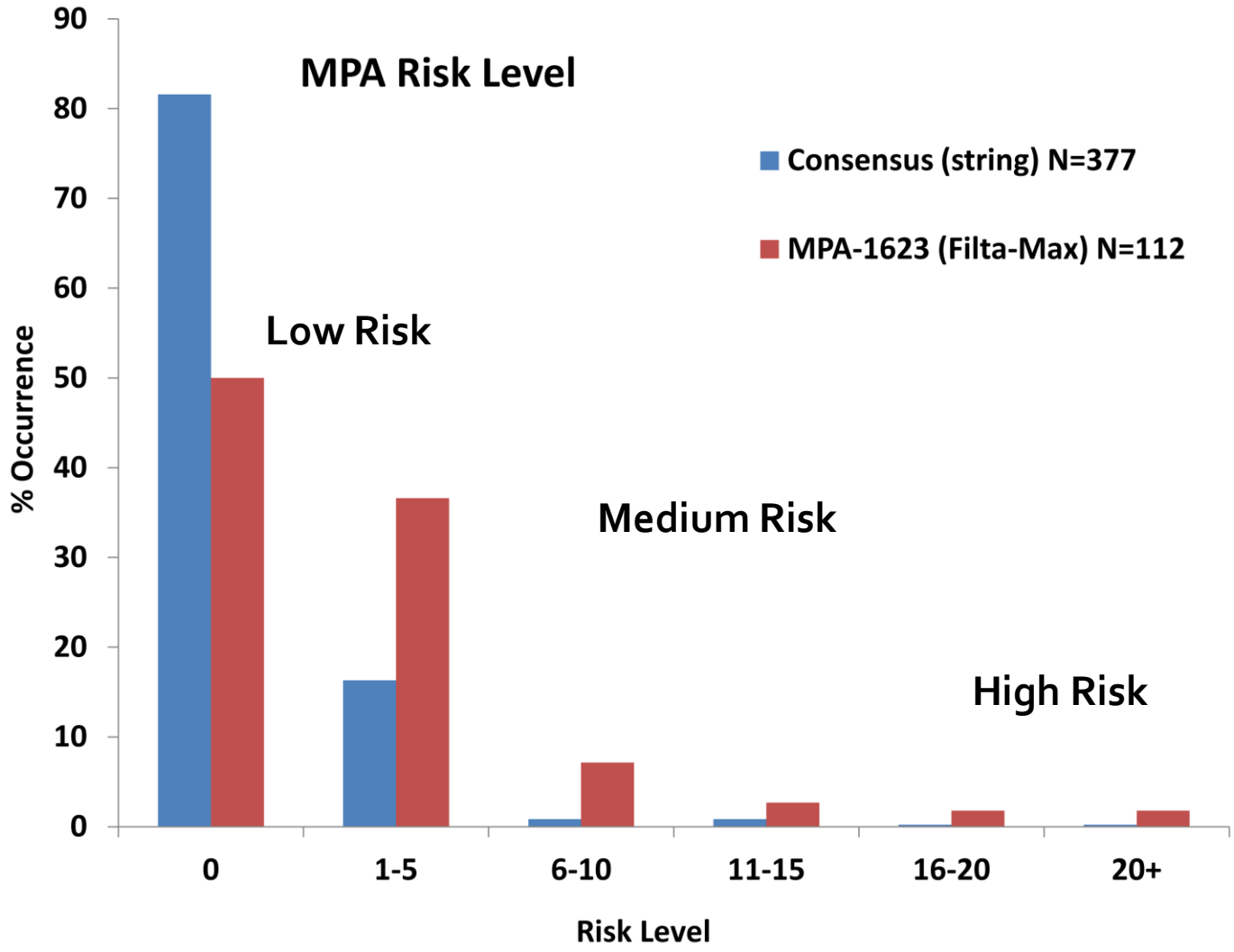
BACKGROUND: Filtering more water does not improve risk prediction



MPA-1623: Better filtration & elution technology saves field time and improves results



Project Objectives

- Test the idea that MPA risk can be estimated from a small, grab sample at Level 2 in a GARP determination
- Evaluate the contribution of turbidity to risk
- Ask, can MPA risk be correlated with geochemical measurements in the field or bacteriology that could be collected at Level 1 (GARP screening)?

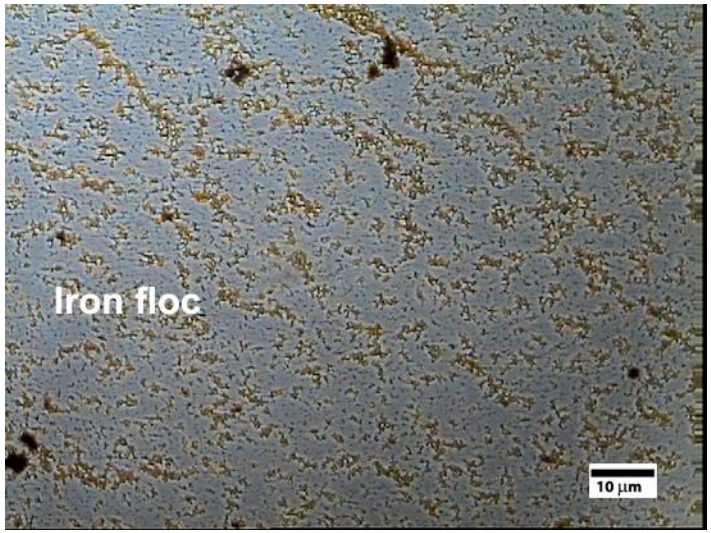
Samples were collected from 113 wells and springs. 2 L grab samples were examined by microscopy as a screening tool for risk ("mini"-MPA).

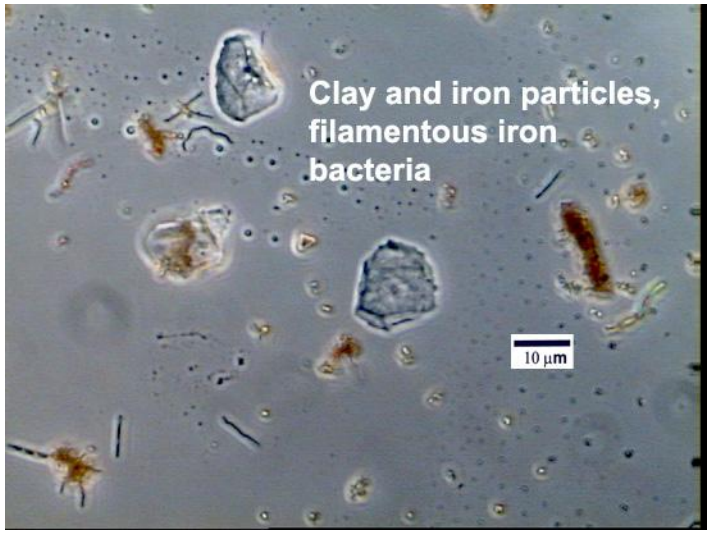
RESULTS

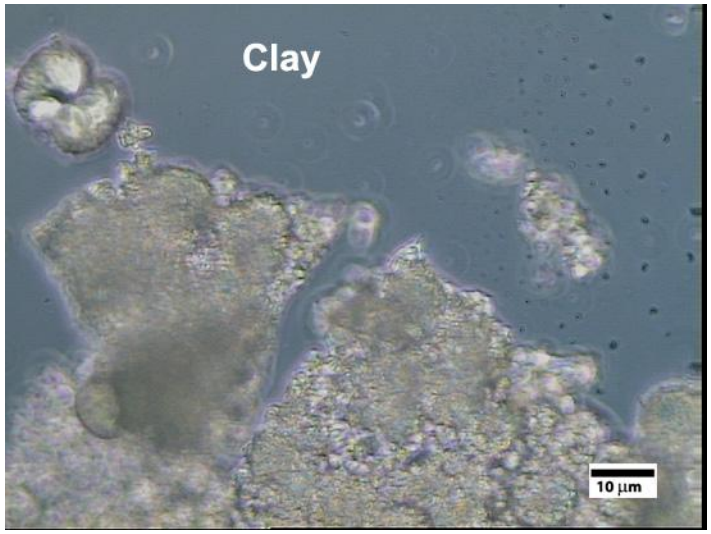
	Springs		Wells	
Predicted Risk	**Developed**	**Undeveloped**	**Drilled**	**Dug**
High	5	9	1*	0
Medium	6	4	8	0
Low	9	2	66	2

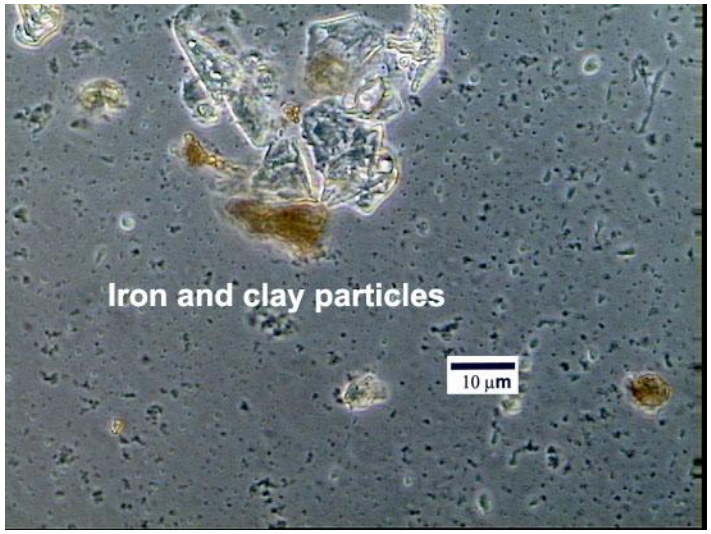
*** Hair, probably rodent, was found in this well!**

What we saw under the microscope:
- Lots of iron, silica and clay Minerals

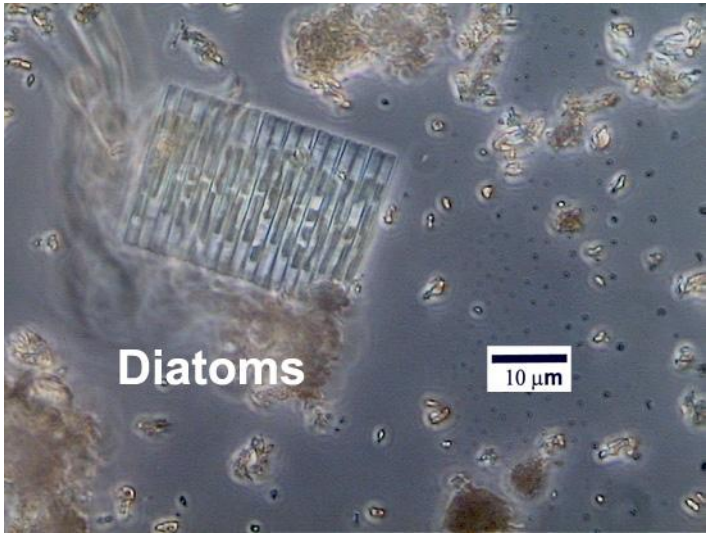


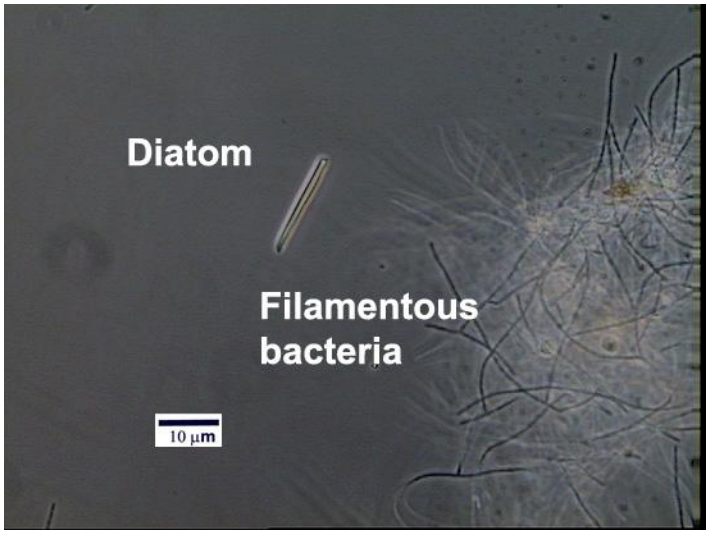


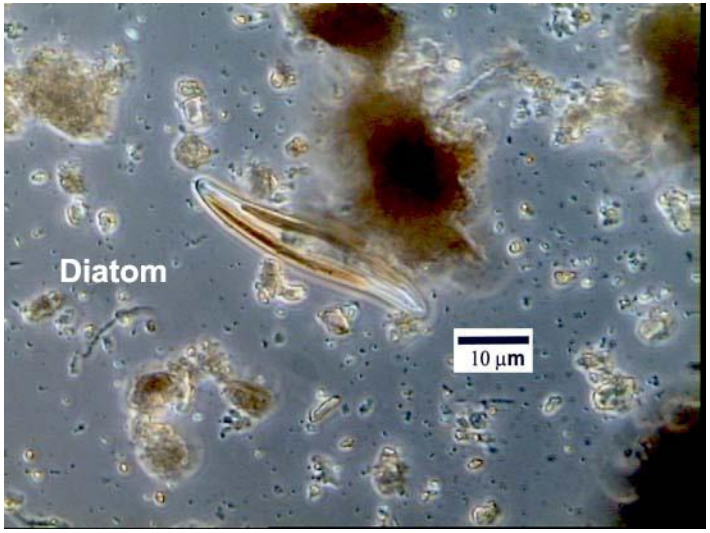


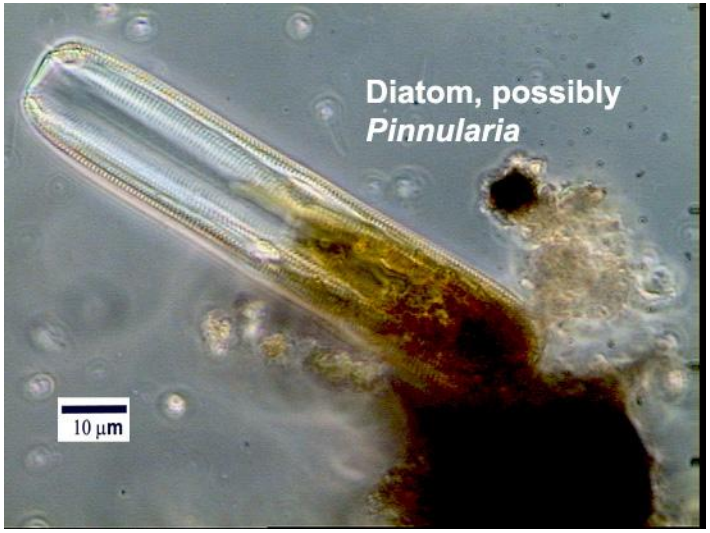


- Sometimes diatoms

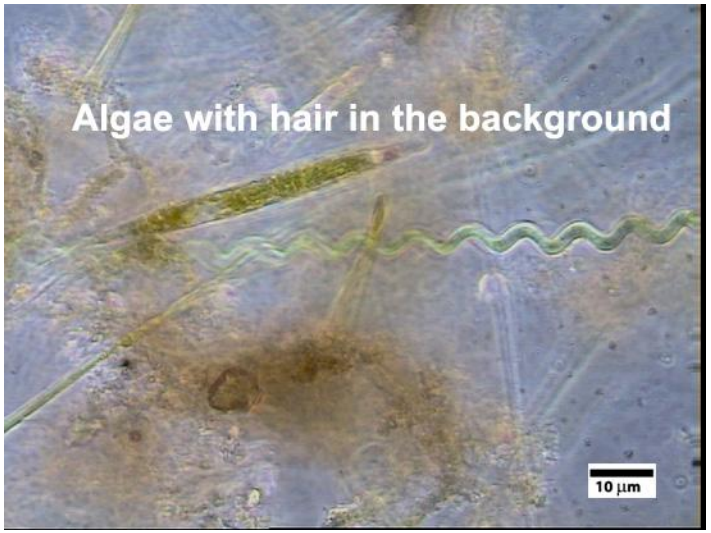


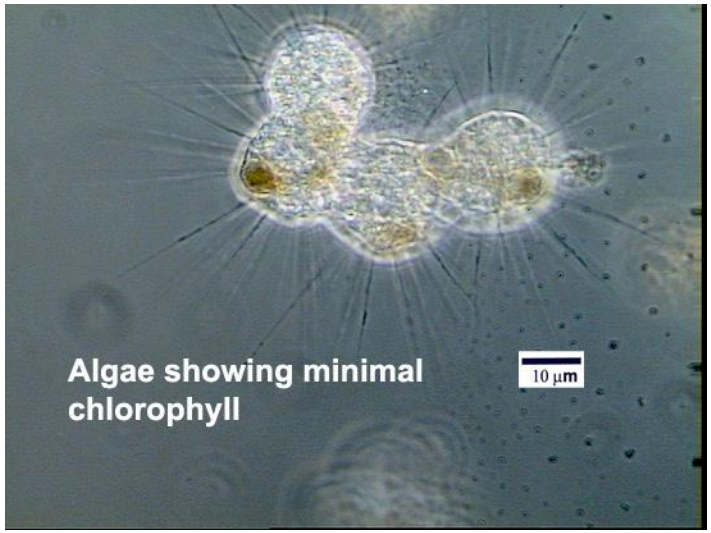


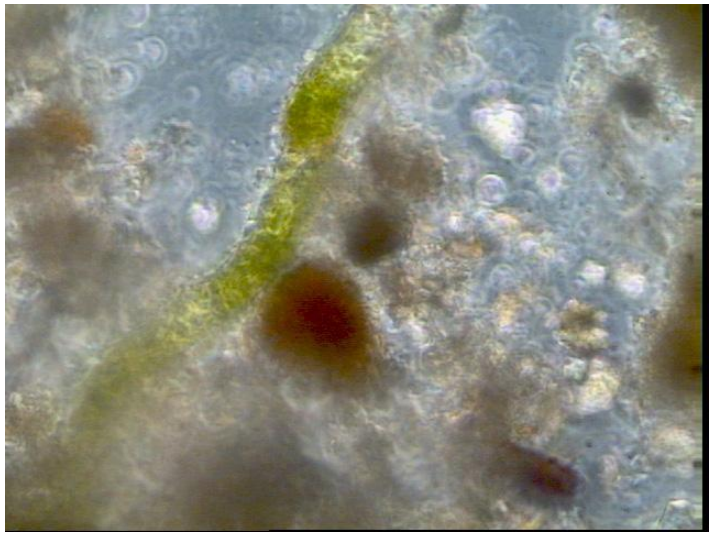




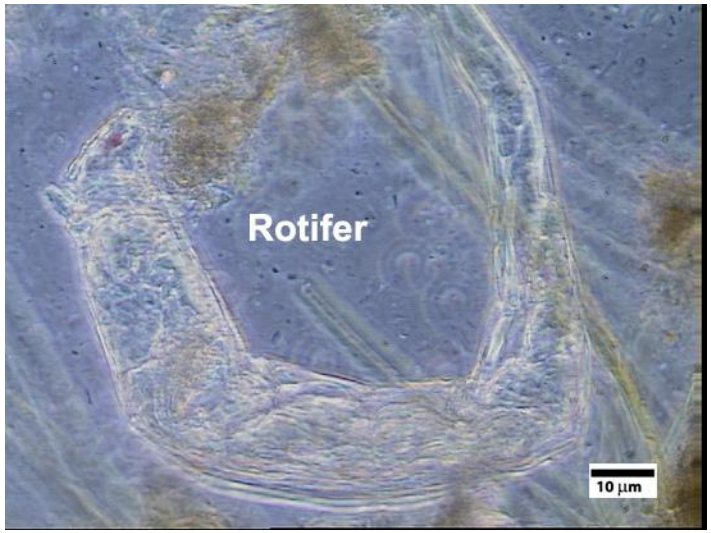
- And other algae

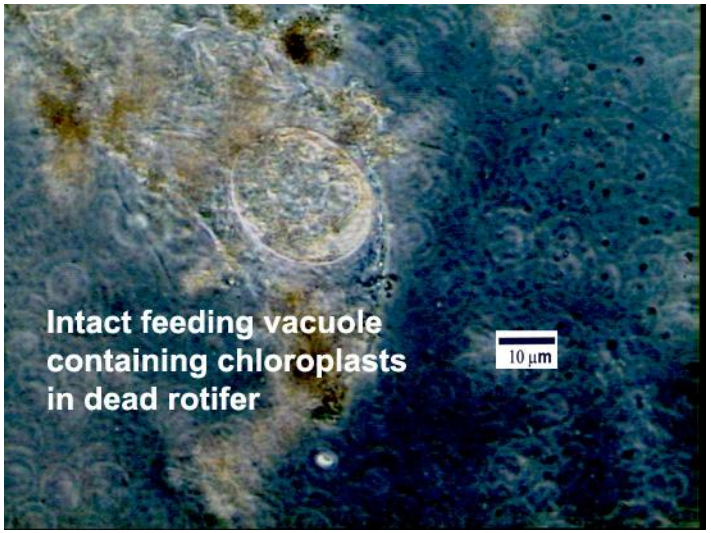


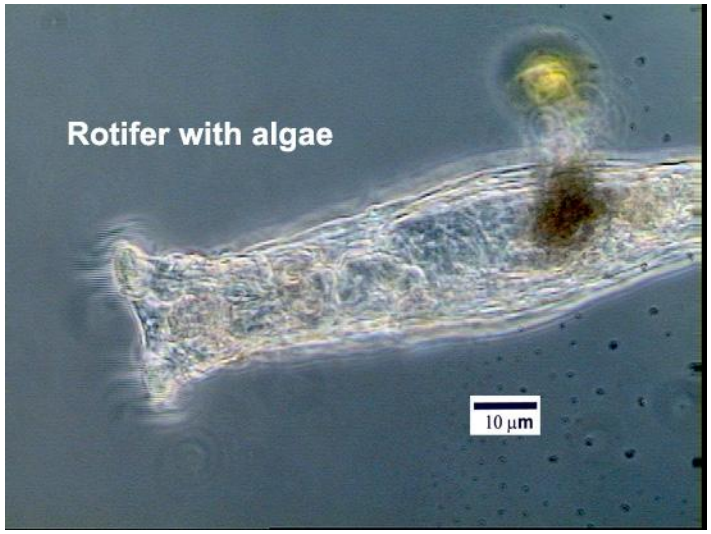




- Rotifers

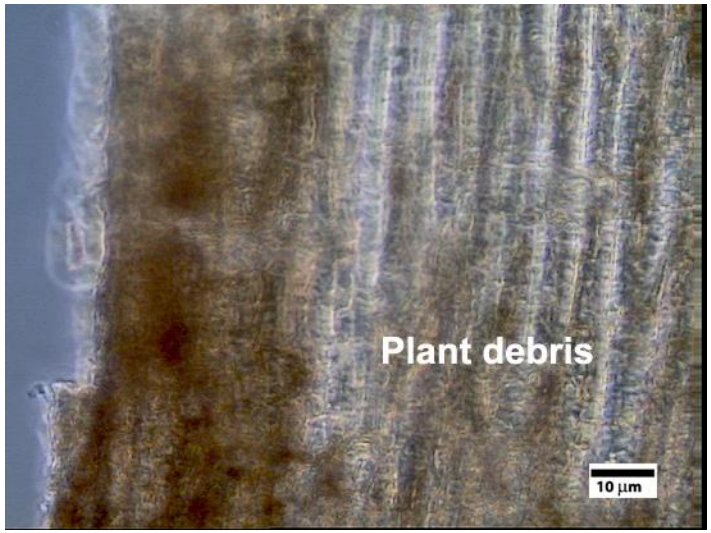


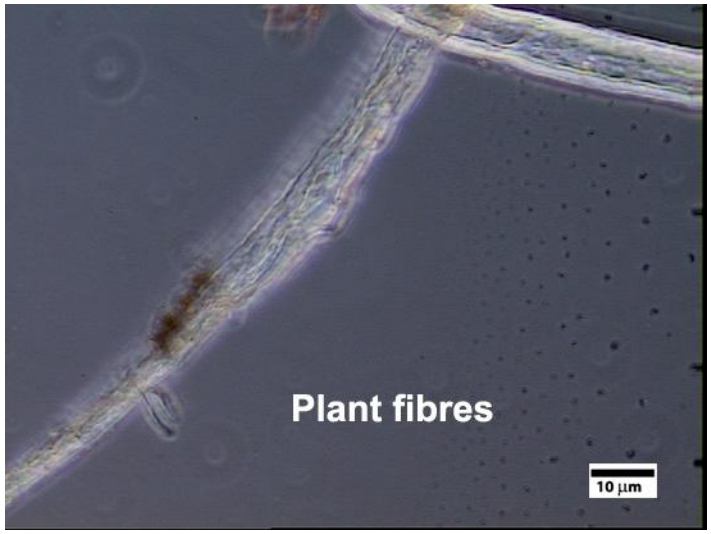


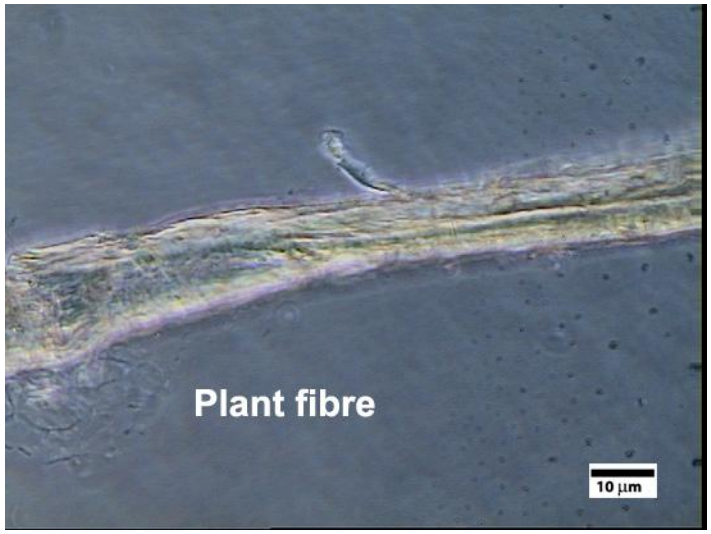


Rotifer https://youtu.be/eVyTJdFifEI

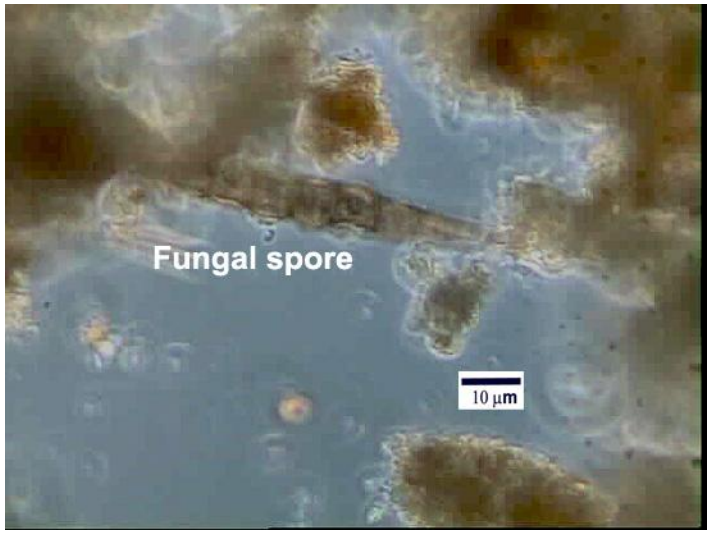
- Plant debris was common



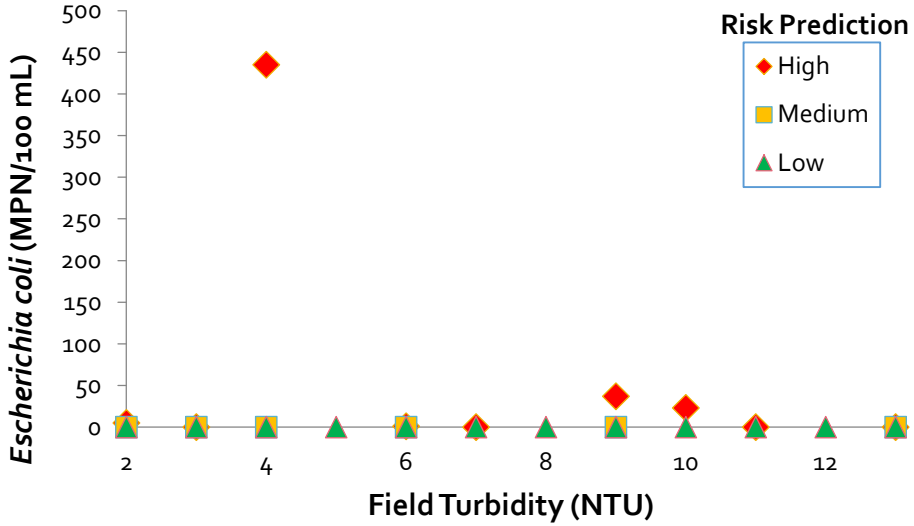


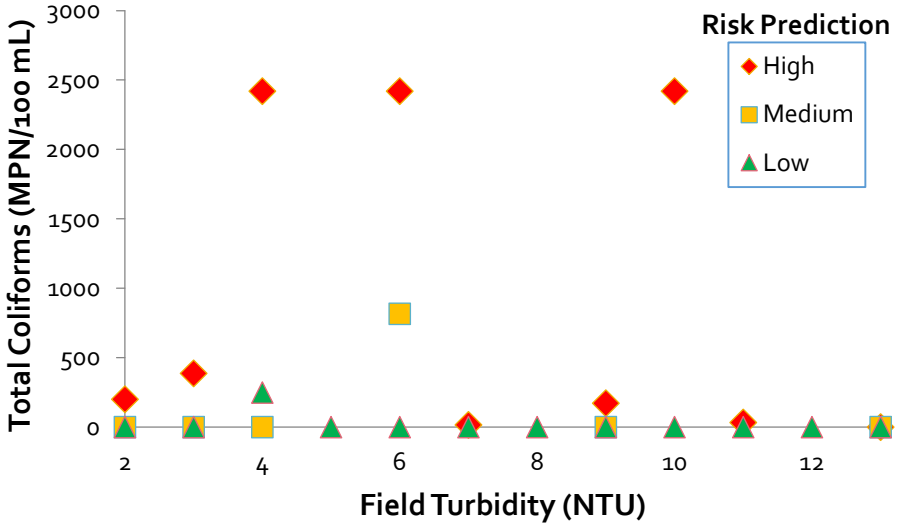


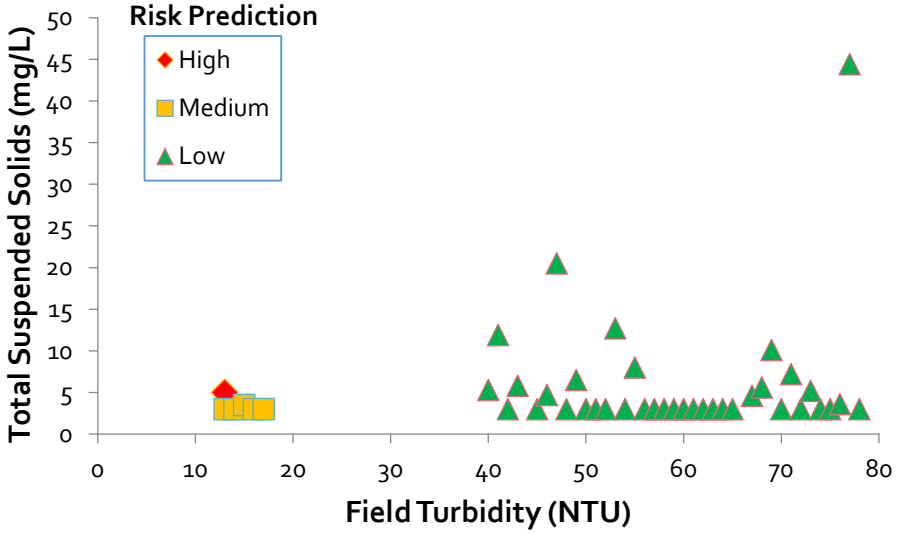
- Other interesting objects

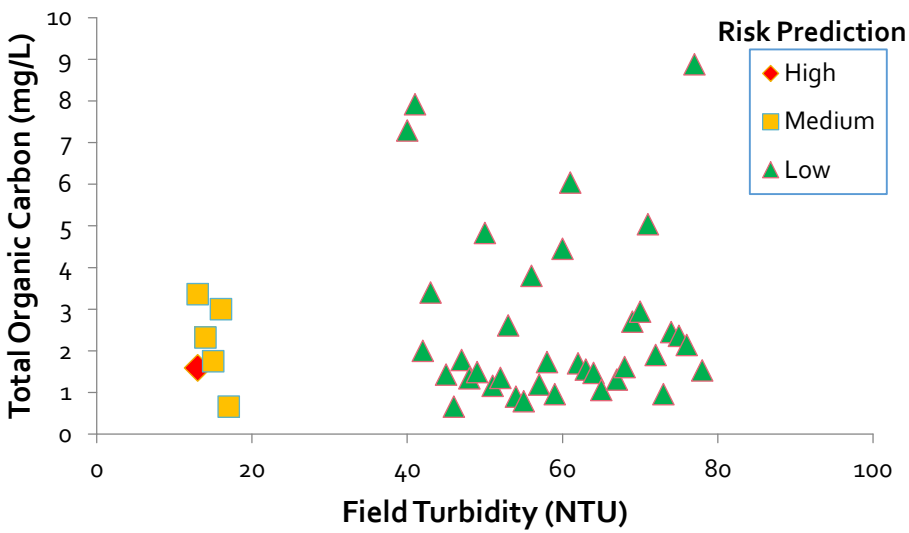


Turbidity alone was not closely related to Total Coliforms, *E. coli*, TOC or TSS

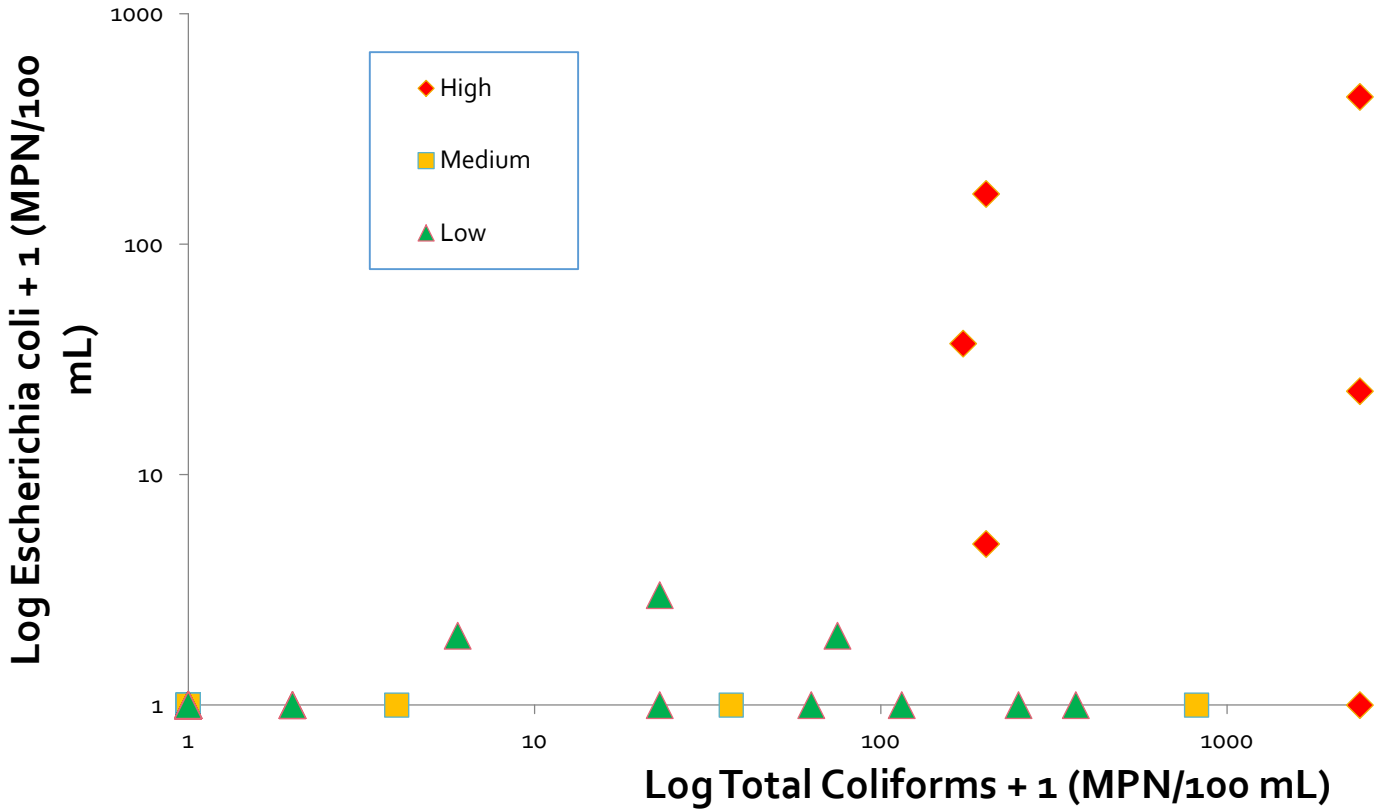








But all samples that scored high risk contained either *E. coli* or Total Coliforms



Low Risk: 12 positive out of 68

Medium Risk 3 positive out of 12

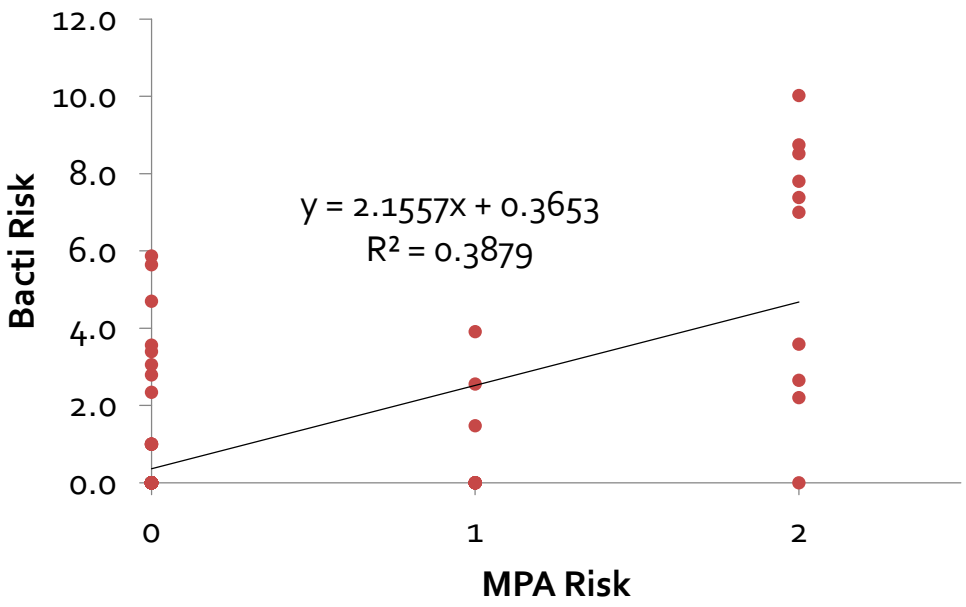
High Risk 10 positive out of 11

And so did some that scored low to medium

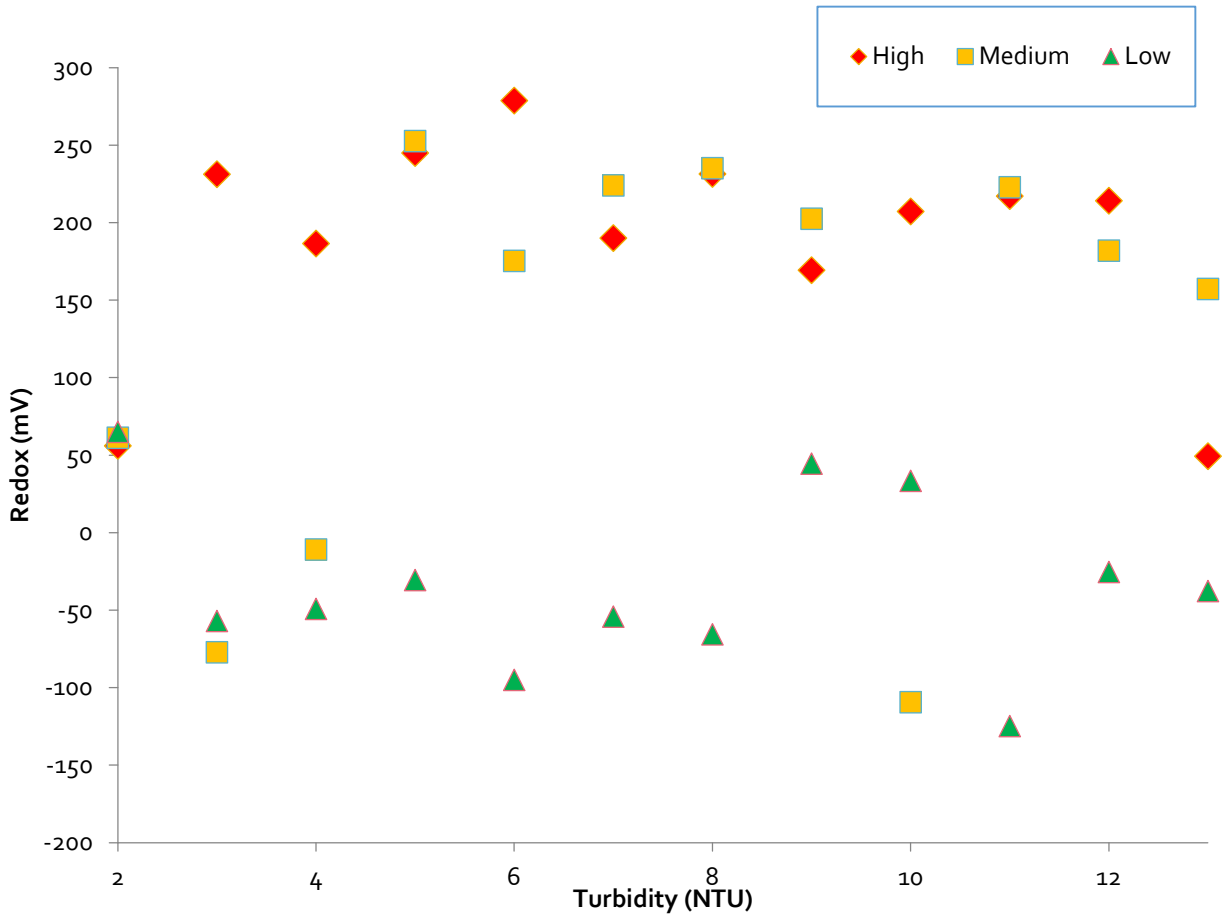
N = 91

But, does simplified MPA duplicate standard coliform bacteria testing?

- **NO, because sewage contamination may not contain algae etc.**
- Simplified MPA is barely correlated with coliform testing:
  - Pearson correlation coefficient (r)
  - r (SMPA,Ecoli) = -0.07 (N=45) **… negative!**
  - r (SMPA,Total coliform) = + 0.13 (N=45)



Positive ORP seems to be related to risk but higher turbidity is NOT.



So, can any analytical parameters predict pathogen risk (GARP)?

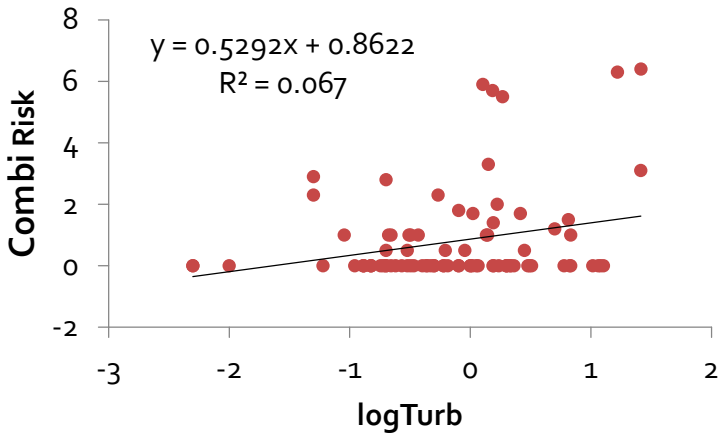
- GARP guideline suggests that Turbidity and Total Organic Carbon are risk factors
  - suggests differentiating *organic* turbidity from *inorganic* turbidity … how?
- Risk modelled as a function of
  - Simplified MPA score (low=0, med=1, high=2)
  - *E.coli*, Total Coliforms (MPN/dL)
- definitions:
  - BactiRisk = f ($\log_{10}$ E.coli, $\log_{10}$ TC)
  - CombiRisk = BactiRisk + Simplified MPA score
  - Suspended Organic Carbon (SOC) = Total (TOC) – Dissolved (DOC)

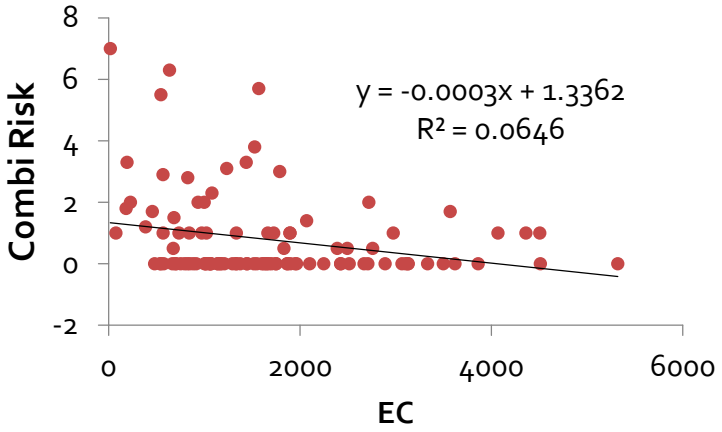
Number crunching looking for association

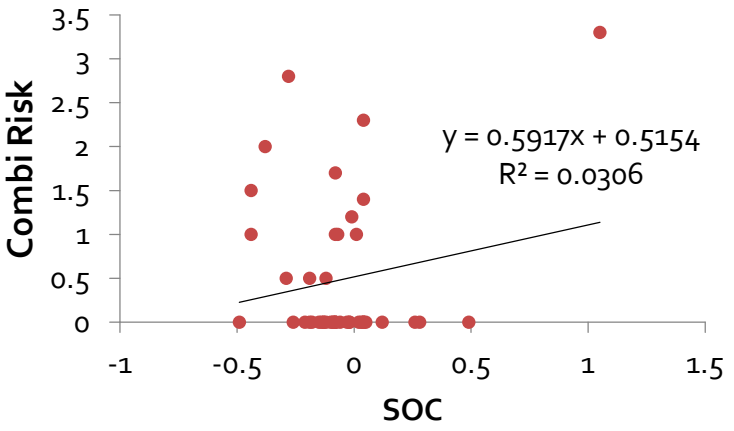
Statistic	logTurb	EC/1000	SOC	Temp	DOC	Redox	logDO	TOC	TSS	pH
Slope (m_i)	0.53	-0.27	0.59	0.117	-0.06	0.0015	0.2159	-0.05	-0.009	0.07
SE(m_i)	0.21	0.12	0.51	0.119	0.066	0.0016	0.2424	0.065	0.0187	0.18
t	2.49	2.23	1.17	0.99	0.92	0.90	0.89	0.75	0.48	0.37
r^2	0.067	0.057	0.031	0.011	0.019	0.009	0.009	0.013	0.005	0.002
df	86	82	43	86	43	86	86	43	43	86
P-value	0.01	0.01	0.12	0.16	0.18	0.18	0.19	0.23	0.32	0.36

- Single variable linear regression
  - CombiRisk = mX + b + ε
- Most significant factors:
  - Turbidity
  - Electrical conductivity
  - Suspended organic carbon

Not Very Good by Themselves



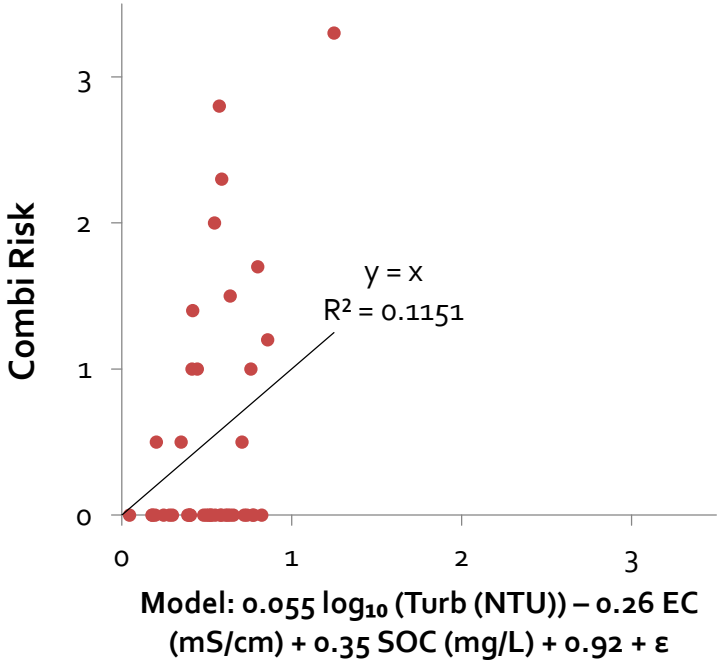




- high Turbidity
- low Electrical Conductivity
  - or TDS
- high Suspended Organic Carbon
  - not TOC or DOC alone

How About Turbidity, EC, and SOC Together?

- 3-variable linear regression
- CombiRisk = m_1 logTurb + m_2 EC + m_3 SOC + b + ε
- BETTER BUT STILL NOT VERY CONVINCING
- the best model based on analytical chemistry cannot predict (Simplified) MPA and bacti testing.

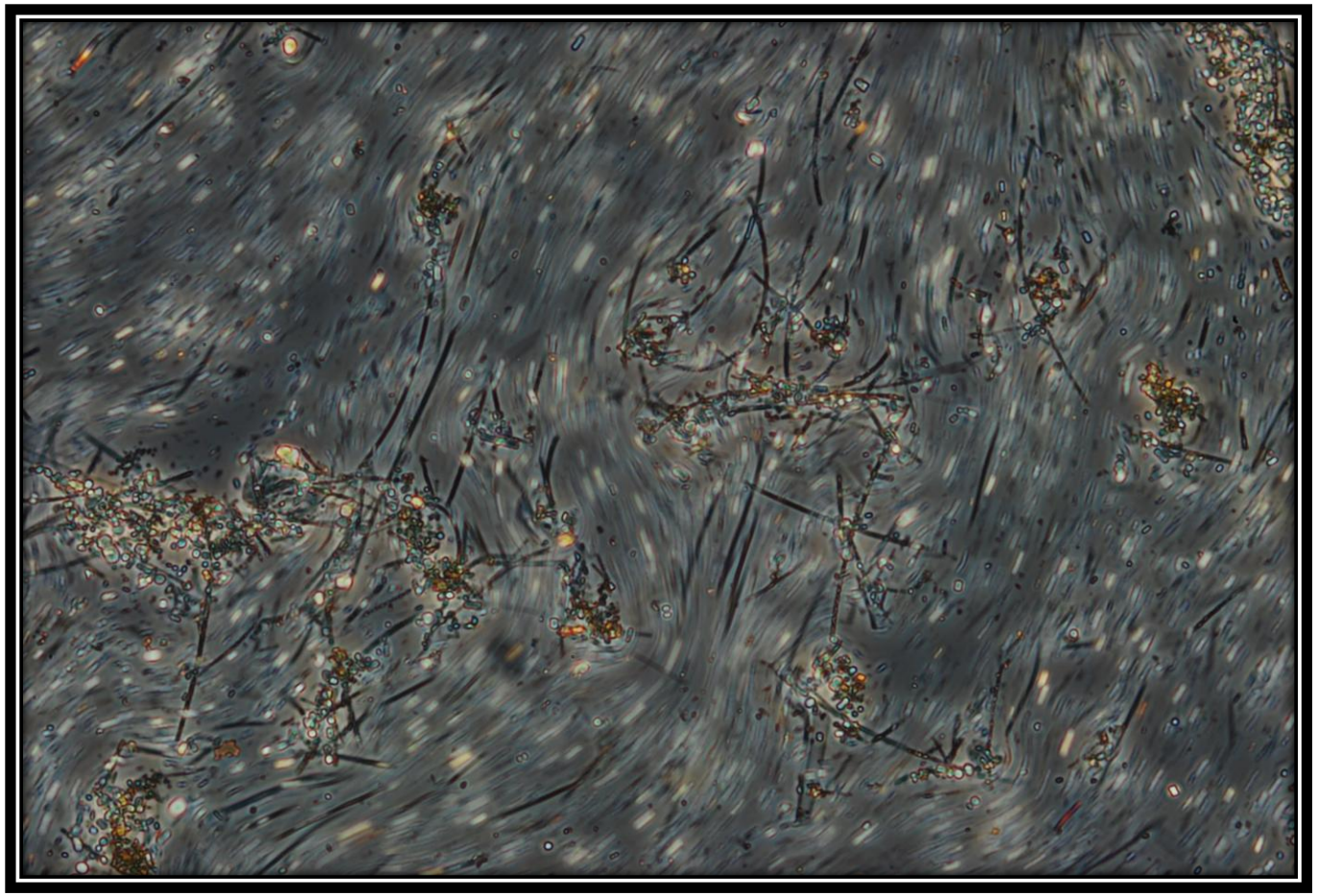


Conclusions

- Filtering large volumes of water does not make an MPA test more sensitive
- If surface water organisms or coliforms can be detected in 2L of water, it's GARP
- Wells with positive ORP, especially springs, are more likely to contain surface water organisms
- Suspended organic carbon (SOC = TOC – DOC) better GARP predictor than either TOC or DOC
- Even the best *field parameters* (Turbidity, Electrical conductivity, ORP) and *analytical parameters* (SOC, TSS) may not be reliable GARP predictors
- DRAFT Best Available Technology:

  => hydrogeology, microscopy, and bacteriological monitoring

Questions?



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