Urban Water Security Research Alliance

Photodegradation of Dissolved Organic Matter: The Impact on Monolayers

Nick Stuckey (NCEA, USQ)

Evaporation Loss

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Queensland Government

National Research FLAGSHIPS Water for a Healthy Country CSIRO

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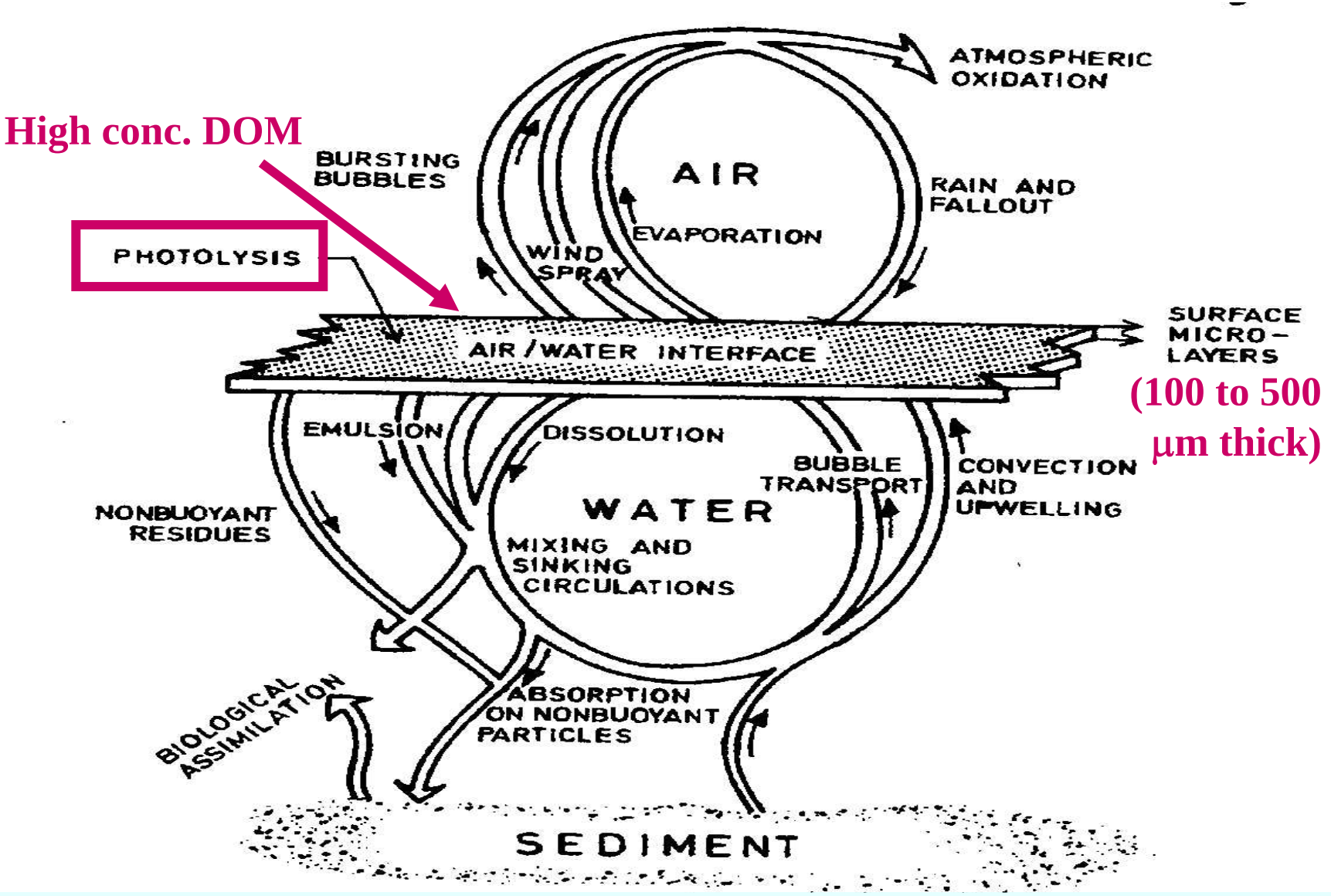
Varying Field Performance of Monolayers

- Monolayers reduce evaporation by ≤ 60%
- Some field trials 0% reduction
- Field results extreme day to day variability (10-40%)

Factors Affecting Field Performance of Monolayers

- Mechanical disruption of monolayer film
  - Wind
  - Waves
  - Beaching
  - Introduction of impurities
- Volatilization
- Dissolution into subsurface
- Microbial degradation
- Photodegradation
  - Direct
  - Indirect

Impact of the Microlayer on Monolayers?

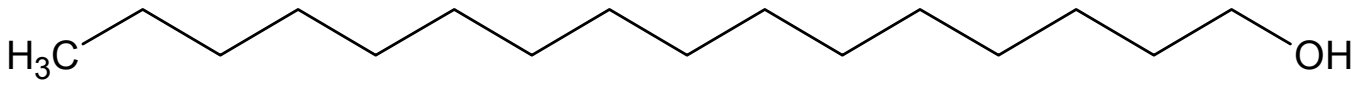


Norkrans 1980 Advances in Microbial Ecol 4 pp51-85

Photodegradation of Monolayers

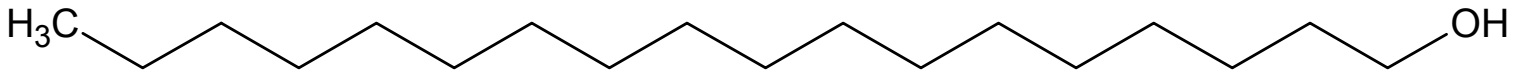
- Monolayer compounds may undergo photochemical reaction
  - Direct photolysis = chemical change due to photon absorption by chromophores in molecule
  - Indirect photolysis = reaction initiated by chromophore light absorption in other molecules

Structure of Monolayer Compounds Studied



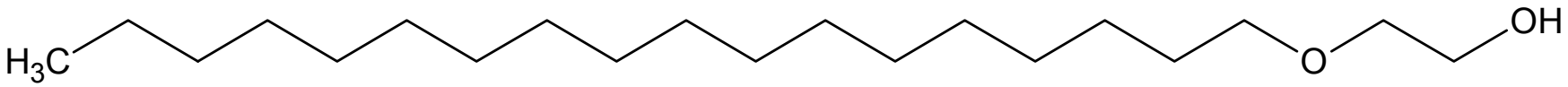
Hexadecanol – ($C_{16}OH$)

$C_{16}H_{34}O$



Octadecanol – ($C_{18}OH$)

$C_{18}H_{38}O$



2-octadecoxyethanol – ($C_{18}E_1$)

$C_{20}H_{42}O_2$

Direct Photodegradation of Monolayers

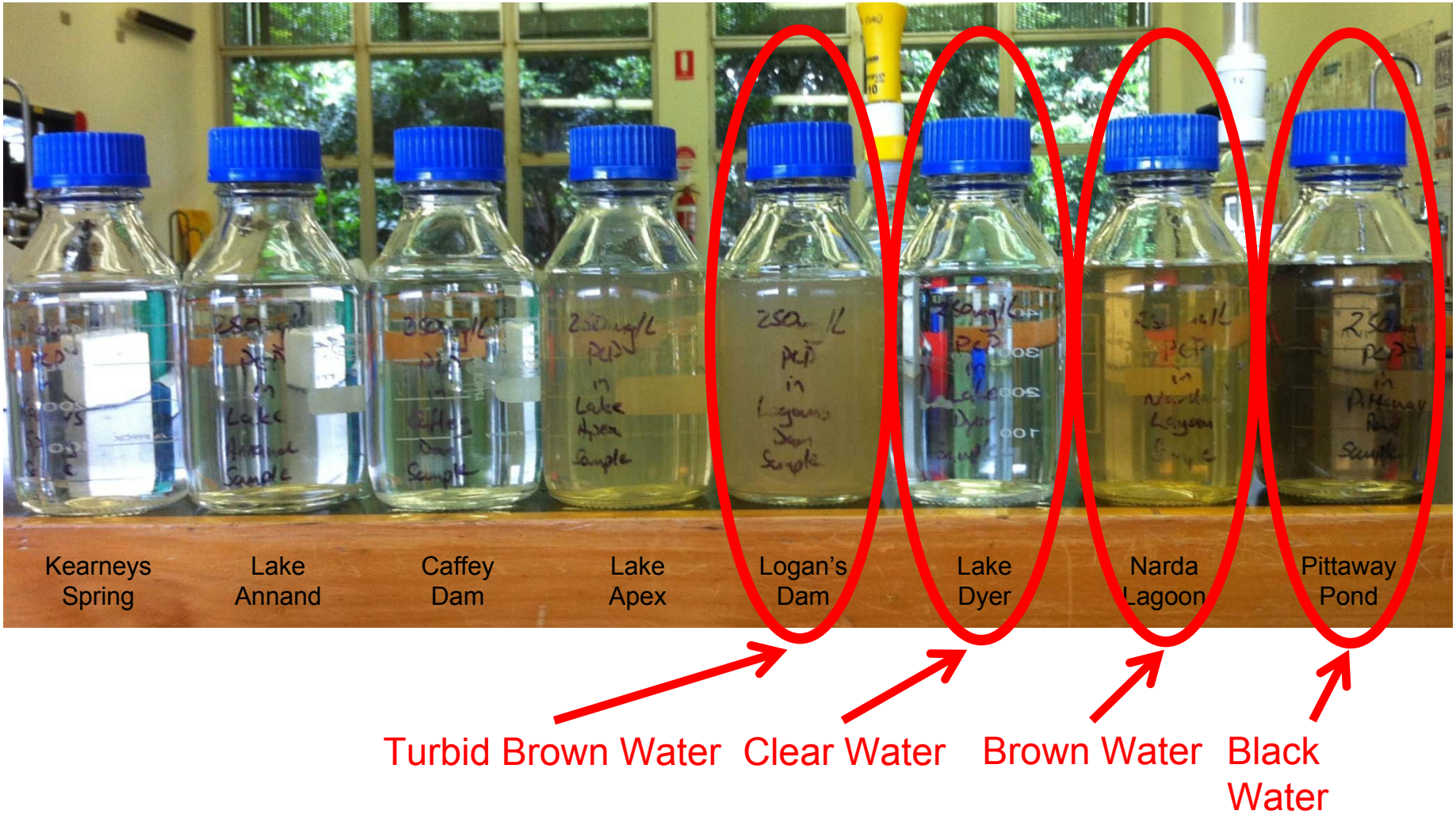
- Monolayer applied to distilled water
- Volatilization = samples placed in the dark
- Direct photodegradation = samples irradiated
- Monolayer loss measured as reduction in evaporative saving

	Volatilization	Direct Photodegradation
Hexadecanol ($C_{16}OH$)	22.8%	23%
Octadecanol ($C_{18}OH$)	18.6%	18.8%
2-Octadecoxyethanol ($C_{18}E_1$)	14.2%	14.3%

Water Bodies Monitored for this Study

a - Kearneys Spring, b - Lake Annand, c - Caffey Dam, d - Lake Apex, e – Logan's Dam, f – Lake Dyer, g - Narda Lagoon, h - Pittaway Pond

Water Bodies Selected for this Study



Indirect Photodegradation of Monolayers

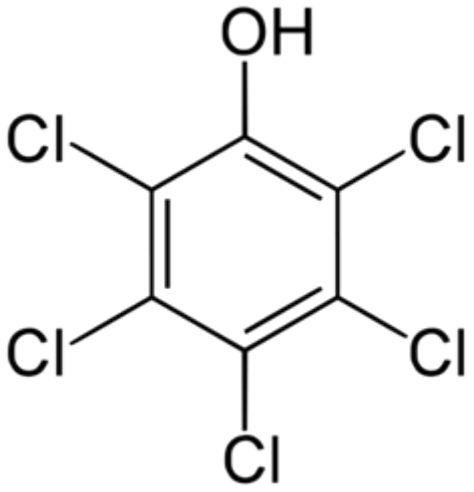
- Monolayers **DO NOT** undergo direct photodegradation
- Reactive species in water degrade monolayers
  - e.g. LMWC $^1O_2$, $^3O_2$, ·OH
- DOM photochemical reactions produce reactive species
- Photodegradation of monolayers **IS INDIRECT**

Photoreactivity of Water Bodies

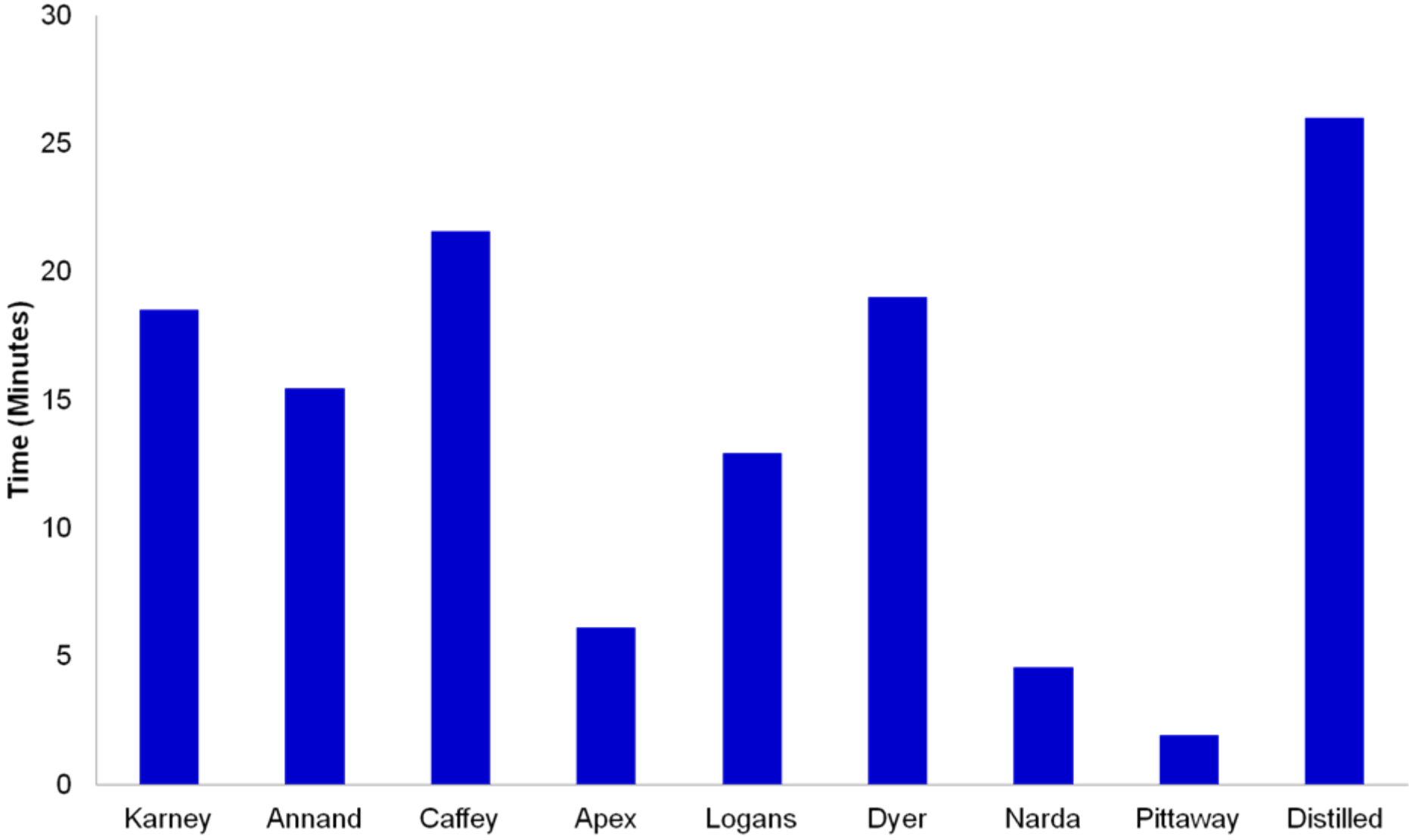
- > > photoreactive DOM produces > > reactive species
- > > reactive species produce higher rates of photodegradation of monolayers
- DOM quality and quantity varies within water bodies

Photoreactivity of Water Bodies

- Indirect photolysis > > in more reactive water bodies
- Pesticide degradation = index of indirect photolysis (natural cleansing)
- Pentachlorophenol for my study
- << half-life > > photoreactive the water body



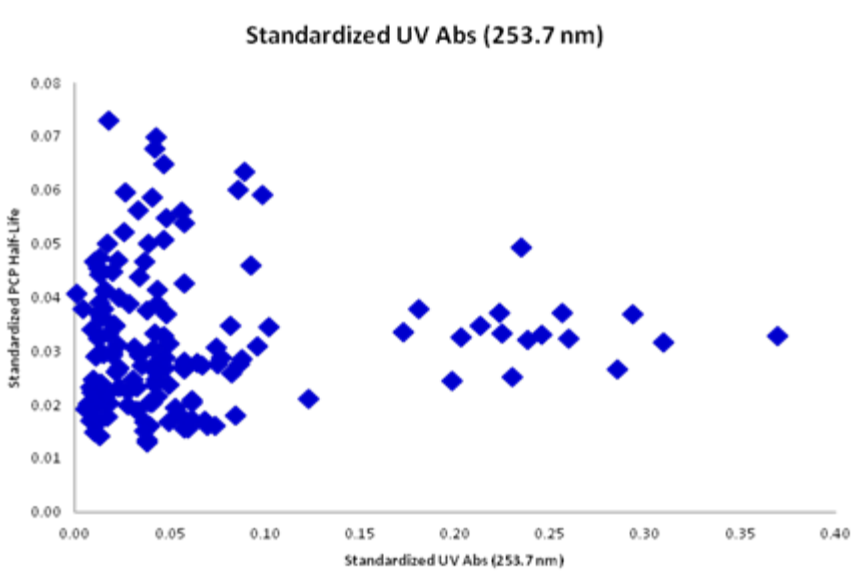
Photoreactivity of Water Bodies – PCP Half-lives

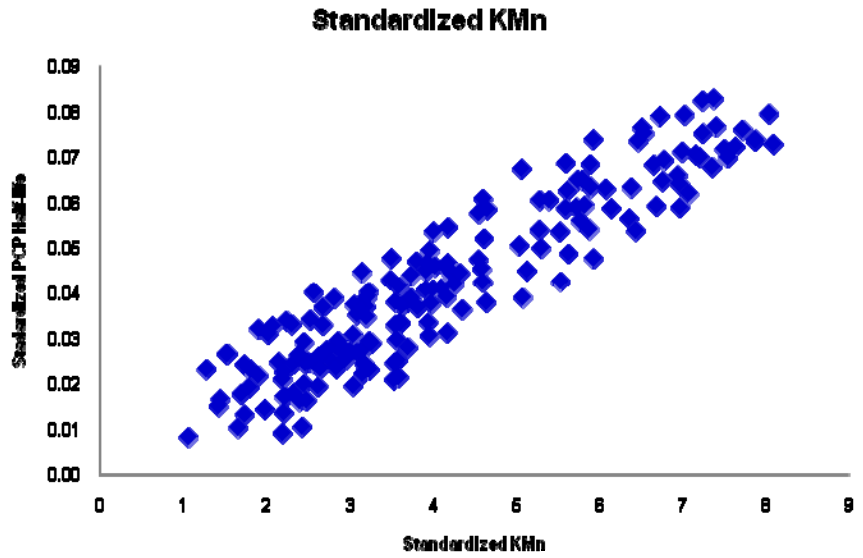


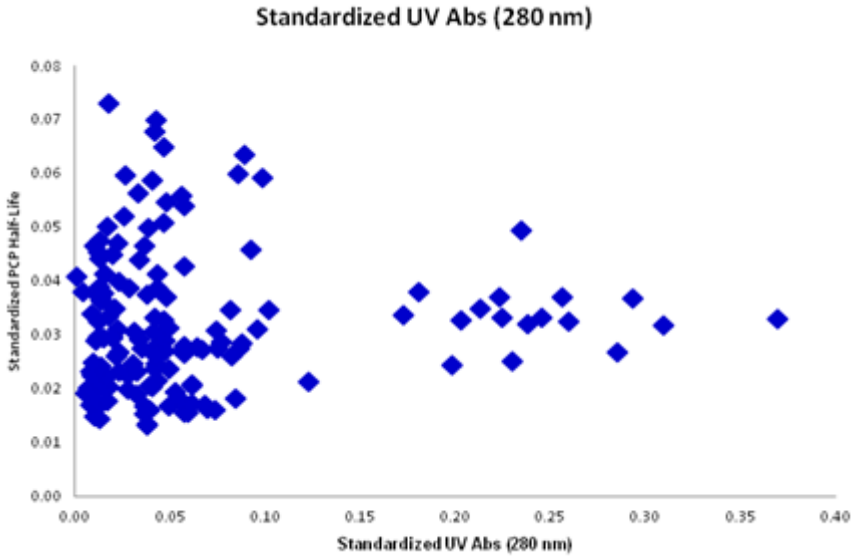
Photochemical Properties of DOM

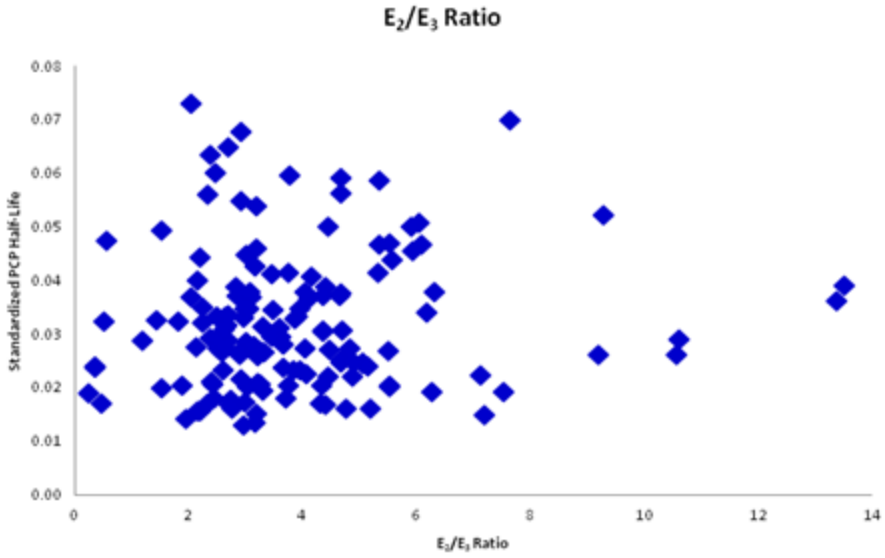
- Several tests investigated
  - DOC
  - UV Absorbance (253.7 nm)
  - Aromaticity (UV Abs 280 nm)
  - Permanganate Index
  - Molecular Size (E_2/E_3 Ratio)
  - IR spectroscopy
- Relationship with photoreactivity?

Relationship with Photodegradation

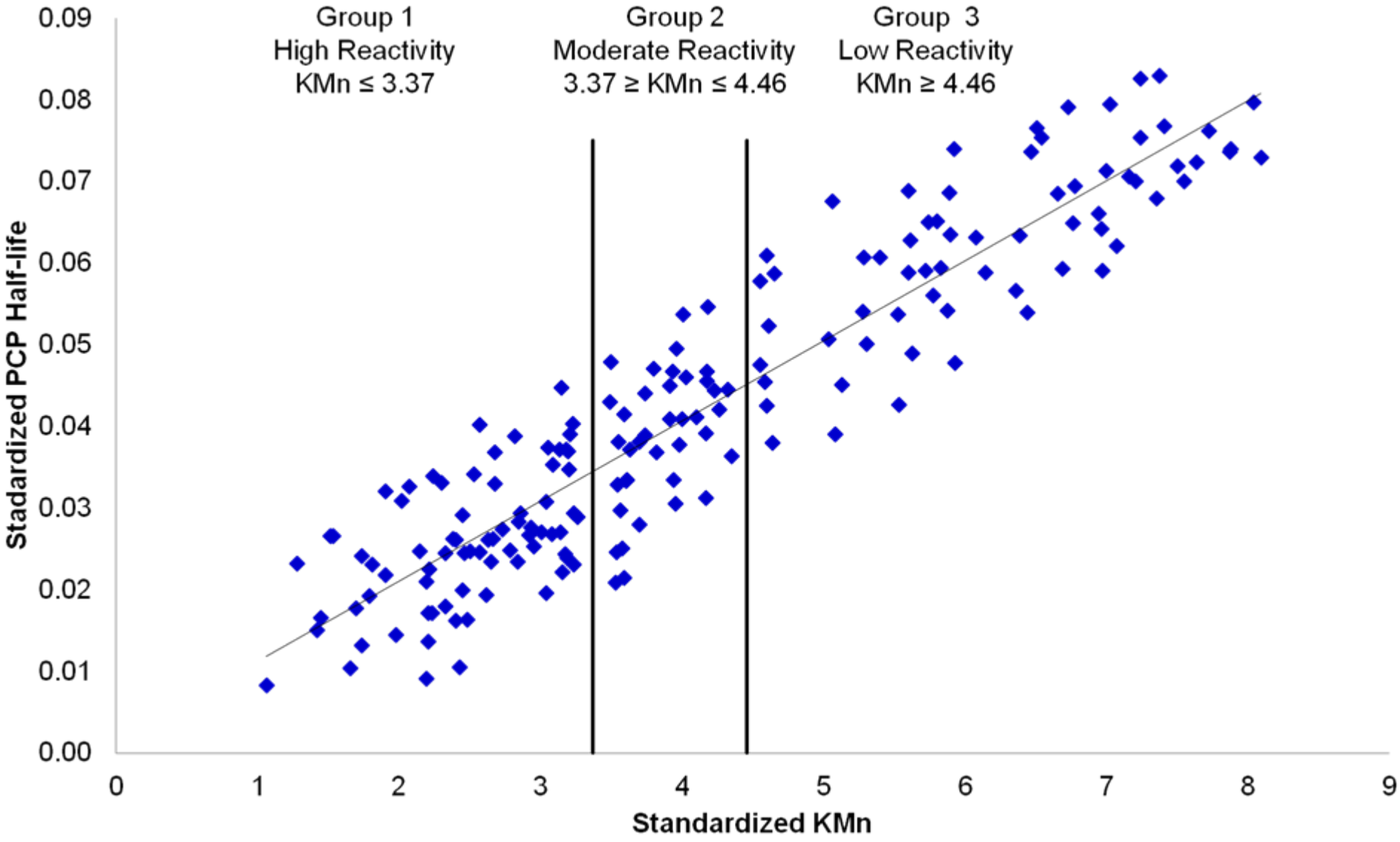




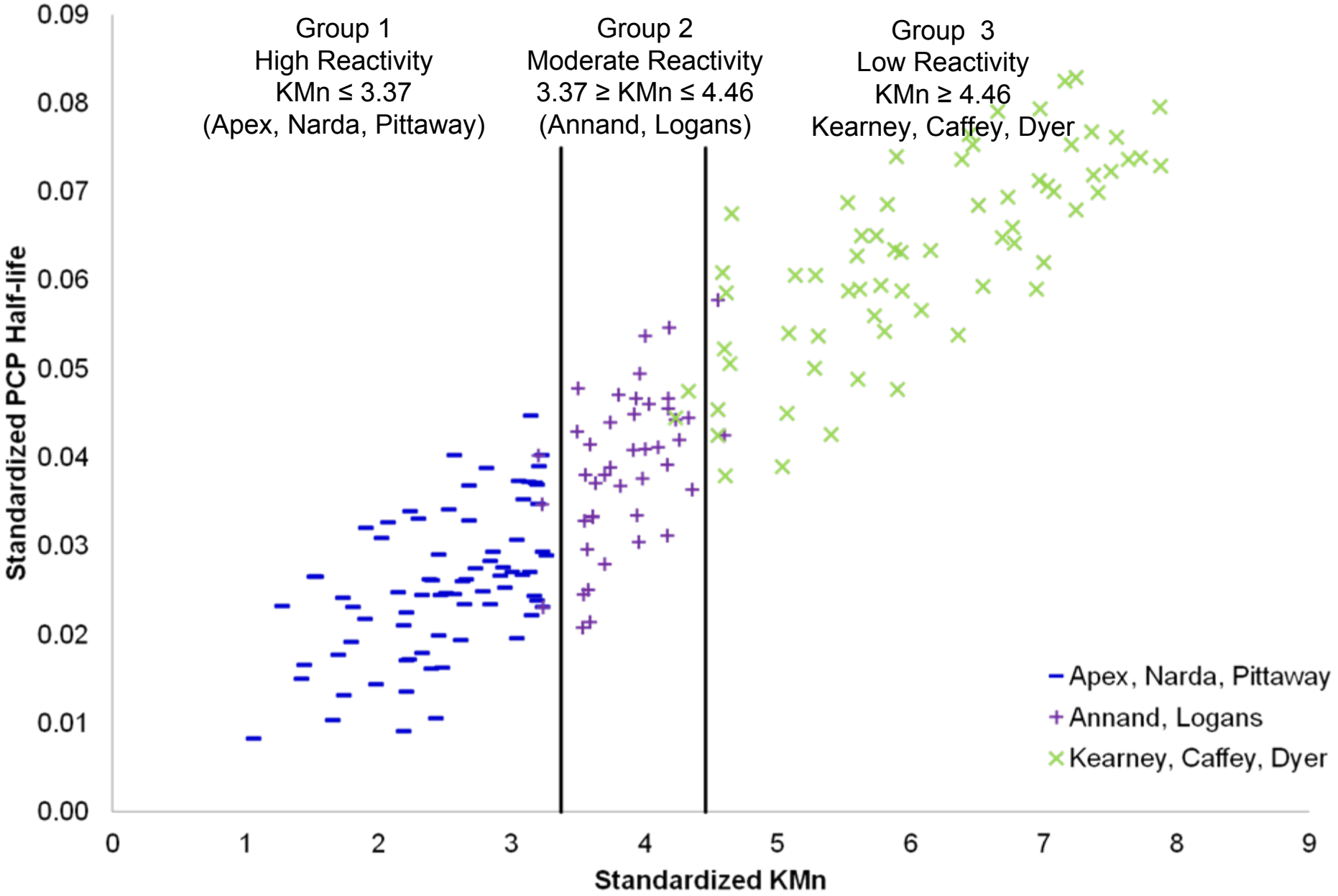




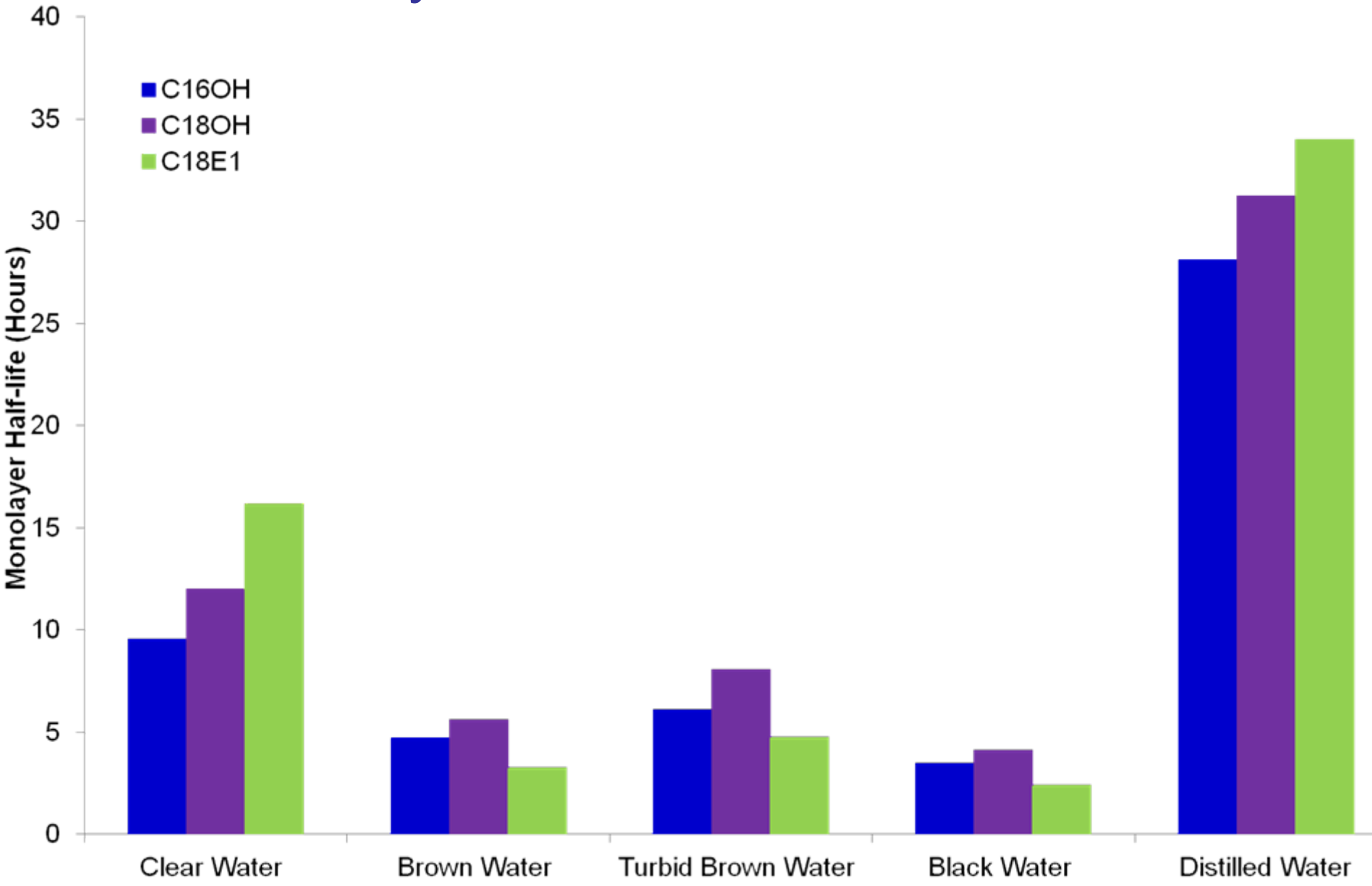
Grouping of Permanganate Index Results



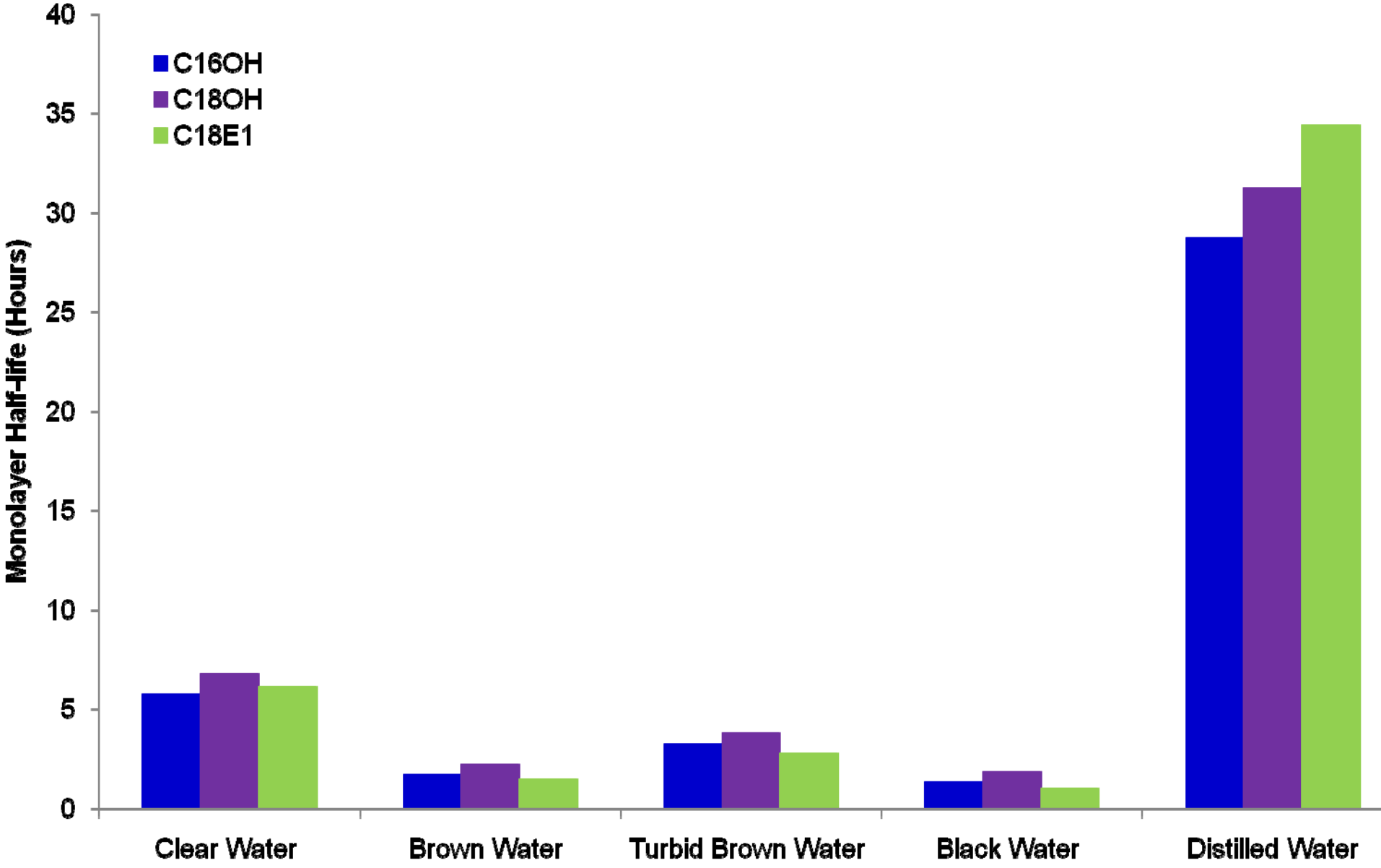
Photoreactivity of Water Bodies



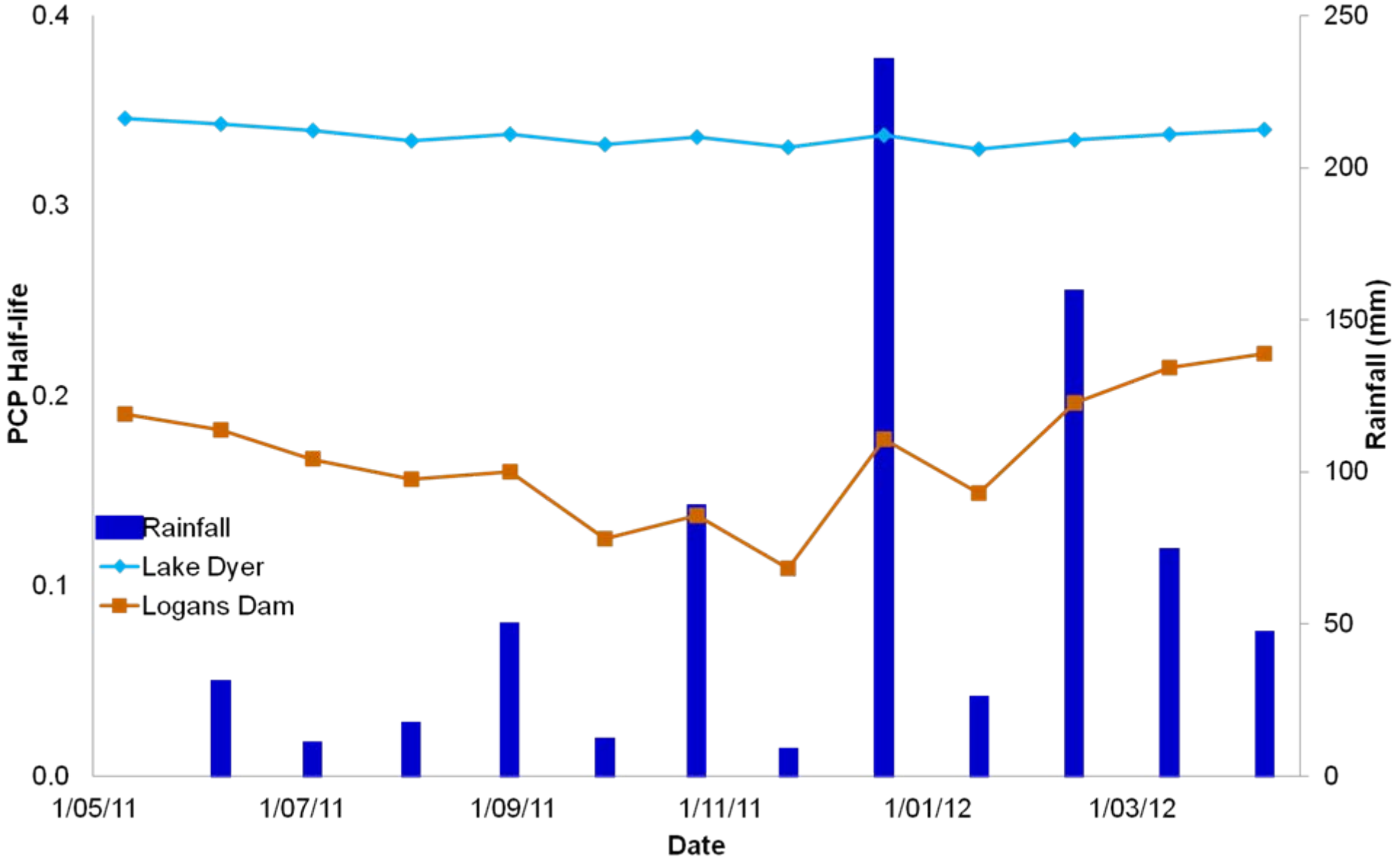
Monolayer Half-lives – Wet Season



Monolayer Half-lives – Dry Season



Seasonality of Photoreactivity



Monolayer Performance Specifications

- $C_{16}OH$ not suitable, volatilization too great
- $C_{18}OH$ – suitable for clear and coloured water (Annand, Apex, Logan's, Narda, Pittaway)
- $C_{18}E_1$ – restricted for use on clear water only (Kearney, Caffey, Dyer)
- Monolayer selection may change with season

Urban Water Security Research Alliance

THANK YOU

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