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Evaluation of a hand-held spectrophotometer for the proximal remote sensing of cyanobacterial abundance in water bodies

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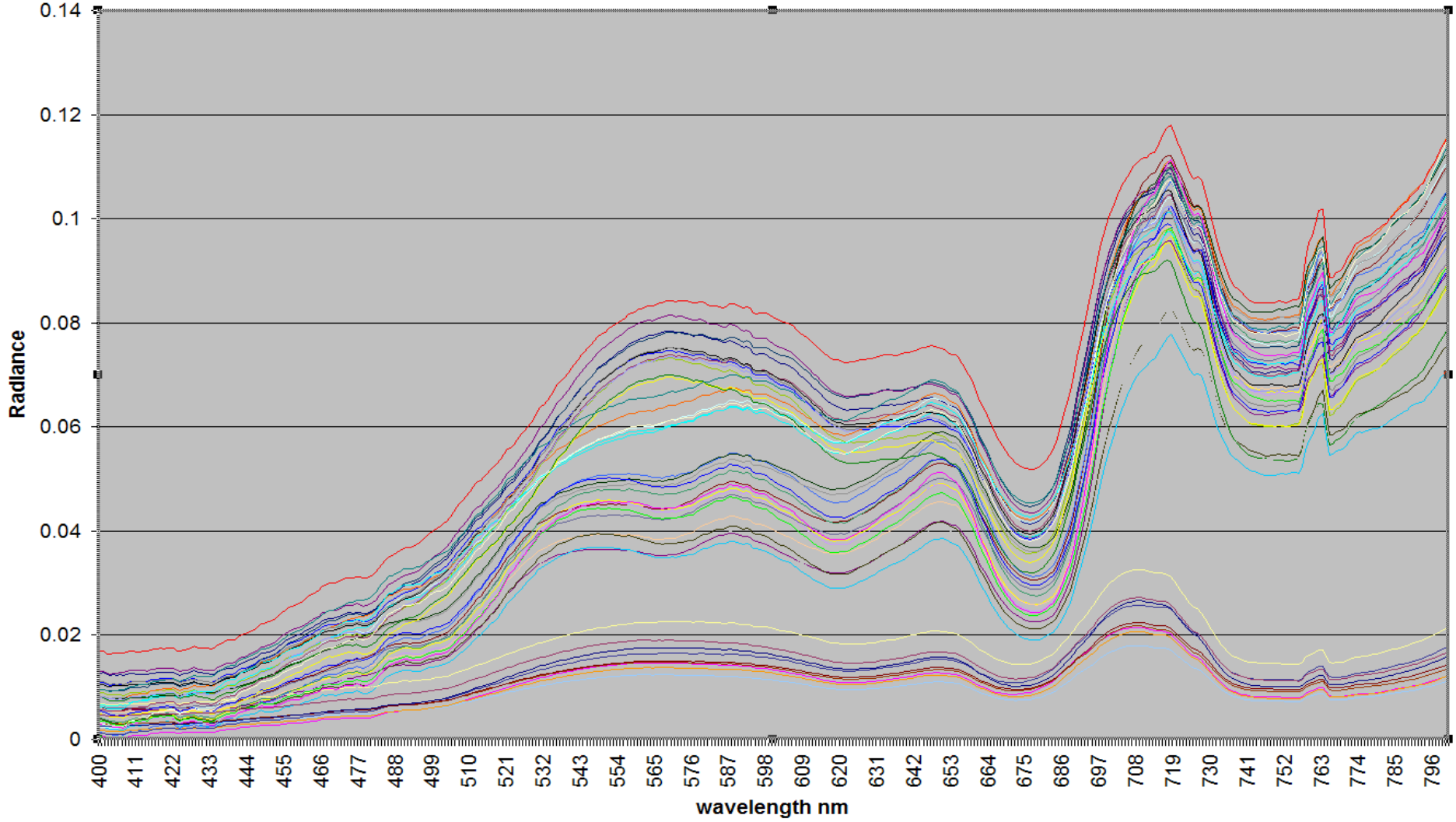
- Instant calculation
  - Chlorophyll-a (0-120µg/l)
  - Suspended matter TSM (0-100mg/l)
  - K_d and Phycocyanin
- Raw spectral measurement

Measurements

- Measurements were made at 3 urban ponds in the eastern suburbs of Sydney – SJBP at Botany and Kensington and Duck Ponds in Centennial Park
- Mostly weekly from September 2013 to May 2014
- In-situ measurements of phycocyanin and chlorophyll also made by fluorometery with a YSI EXO2 water quality sonde
- In-situ measurements of K_d at Duck Pond using a Licor underwater quanta sensor
- Samples collected for laboratory measurements –
  - Cyanobacterial identification, cell counts, biovolume estimation
  - Eukaryotic phytoplankton identification, cell counts
  - Chlorophyll-a, turbidity, TSM
- SJBP had generally had higher cyanobacterial biovolumes, eukaryotic algal counts and chlorophyll concentrations than the other 2 ponds. TSM and turbidity about the same in all 3 ponds.



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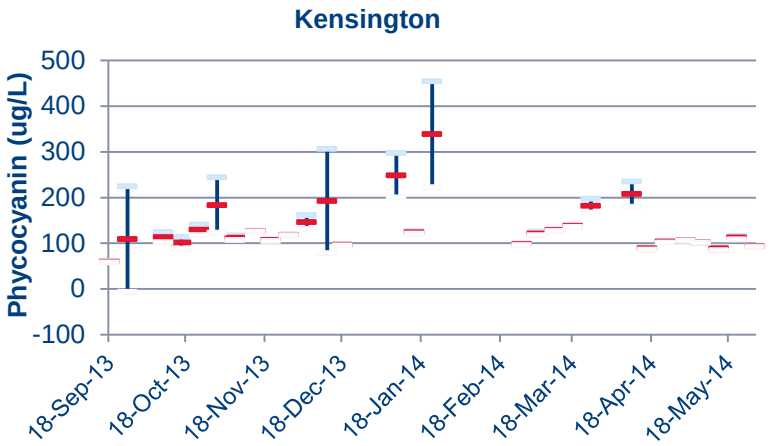
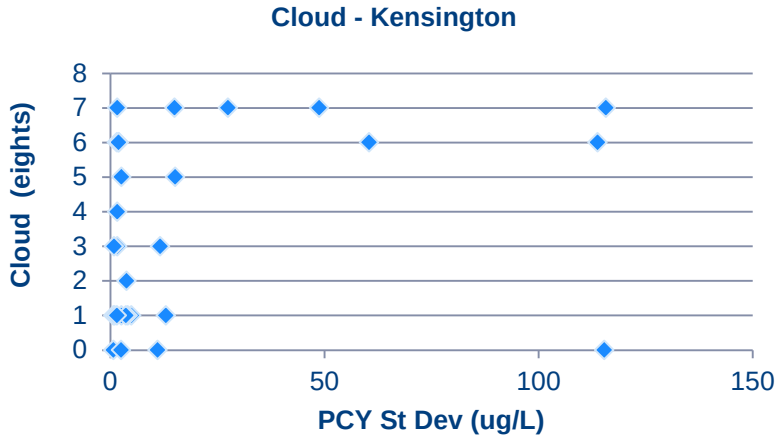
Variability between replicates





- Around 20 replicate measurements were made with the WISP per site per visit
- Sometimes considerable variation between replicates, other times very little
- High variation between replicates on cloudy days, but not always

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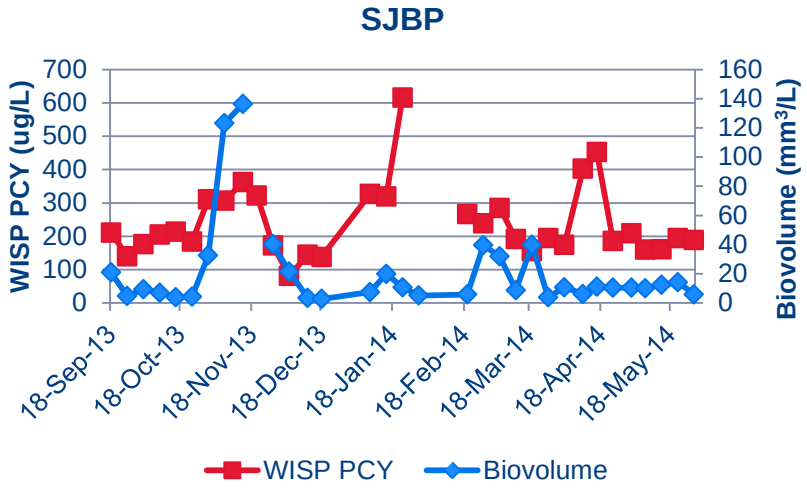
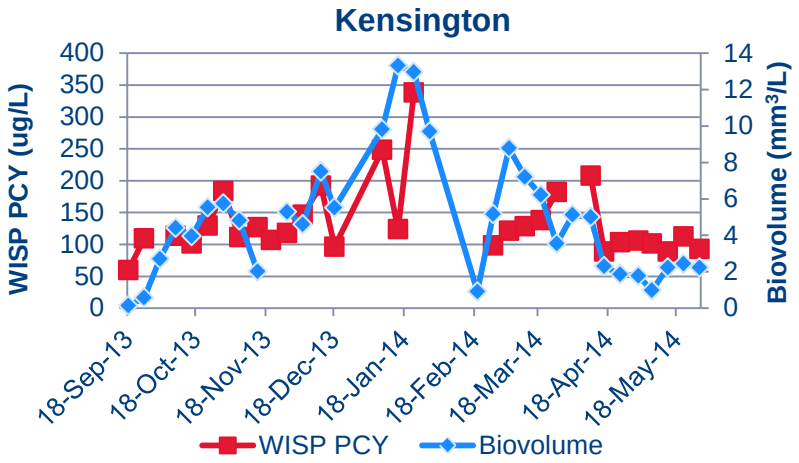
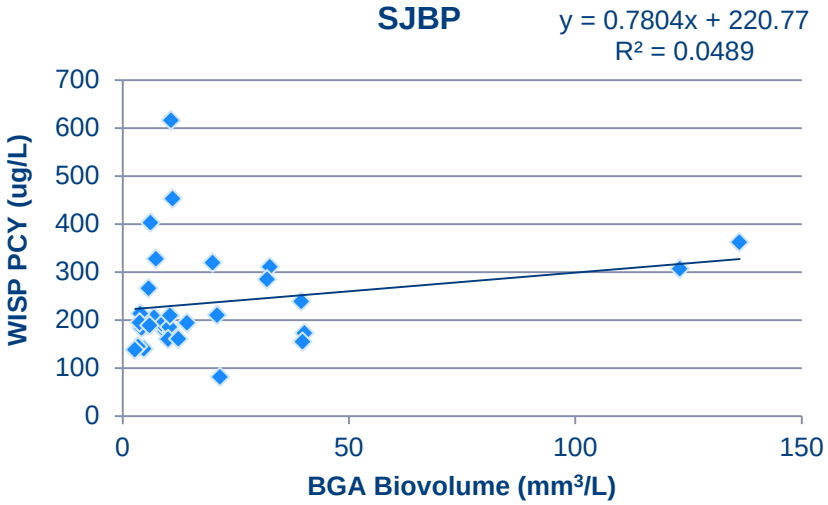
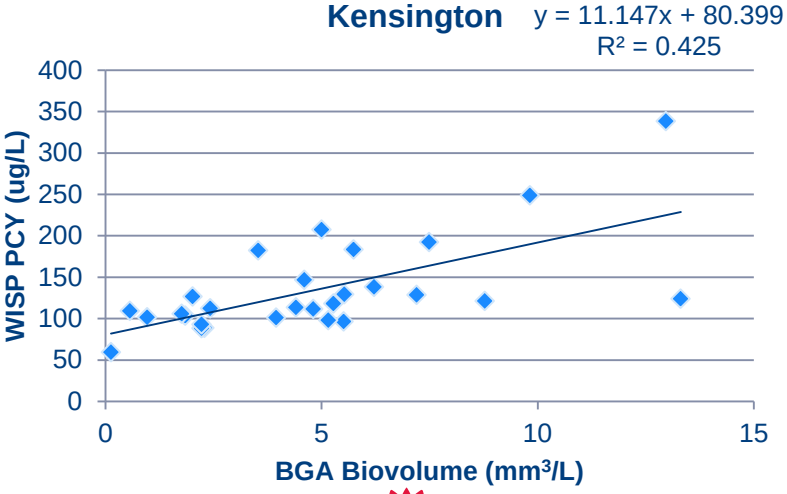
Phycocyanin at SJBP and Kensington









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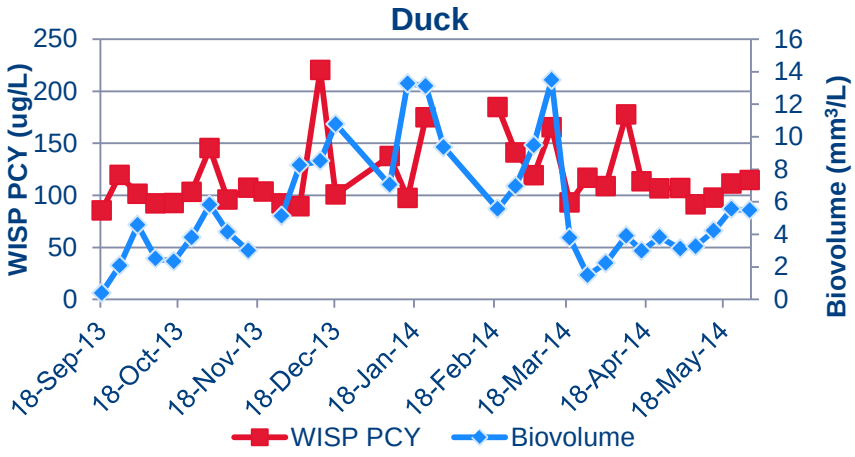
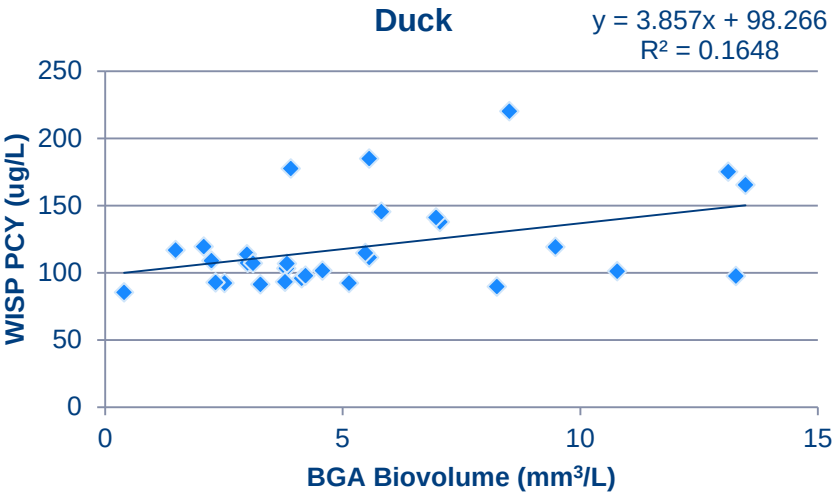
Phycocyanin at Duck





- Poor relationship between WISP phycocyanin and BGA biovolume at SJBP and Duck, best at Kensington
- Removal of WISP data for cloudy days improved R^2 at SJBP to 0.522, but decreased it at the 2 other ponds
- Using abundance (cells/mL) did not improve relationship between WISP phycocyanin and cyanobacterial presence
- WISP phycocyanin showed poor correlation with eukaryotic phytoplankton abundance

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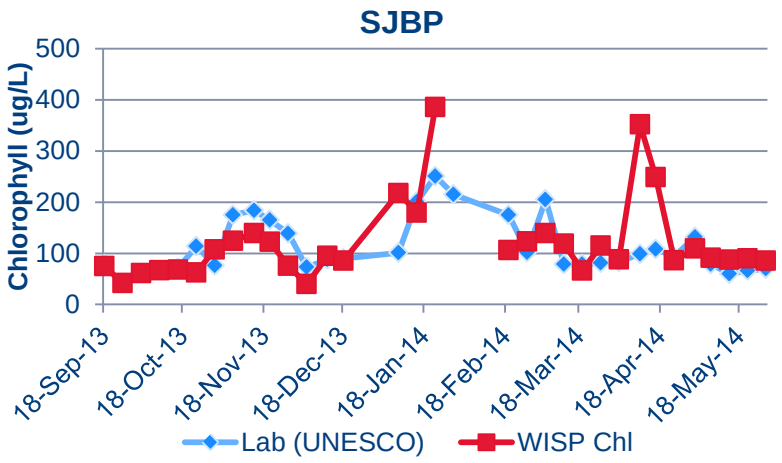
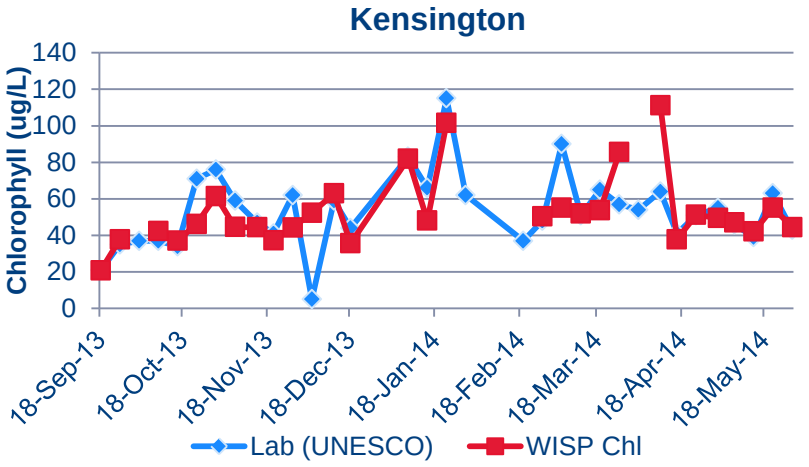
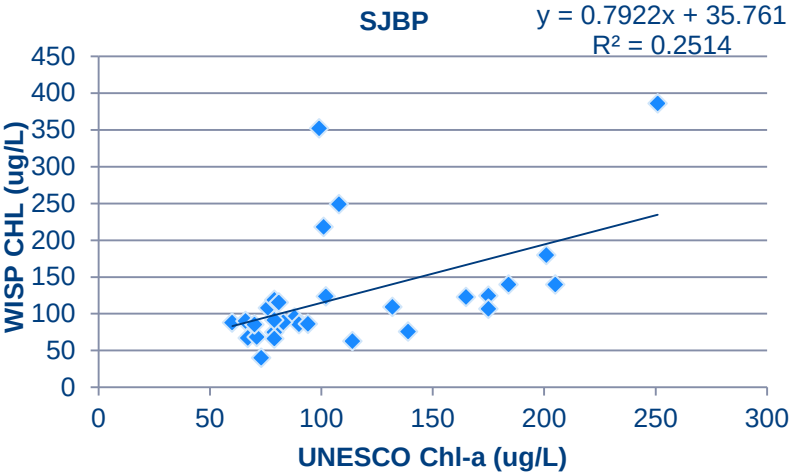
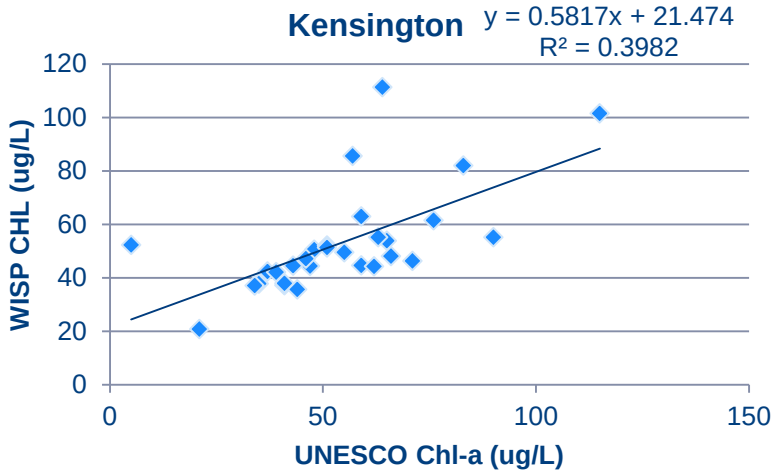
Chlorophyll at SJBP and Kensington









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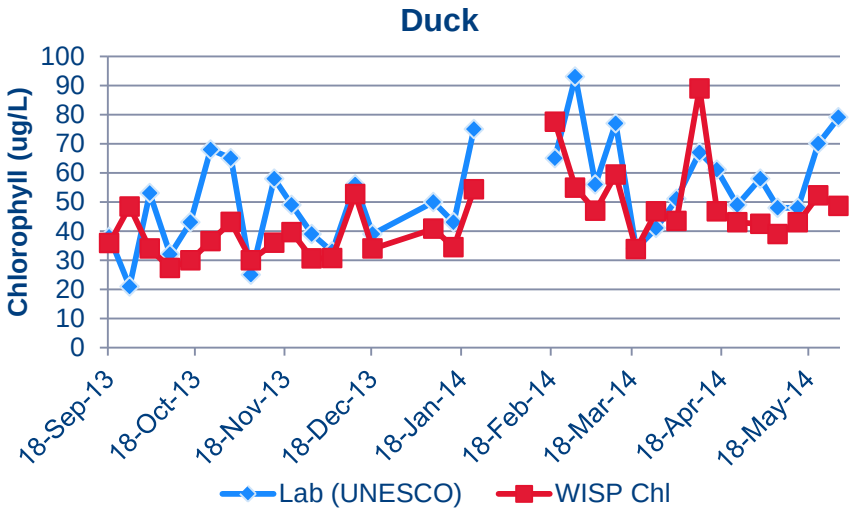
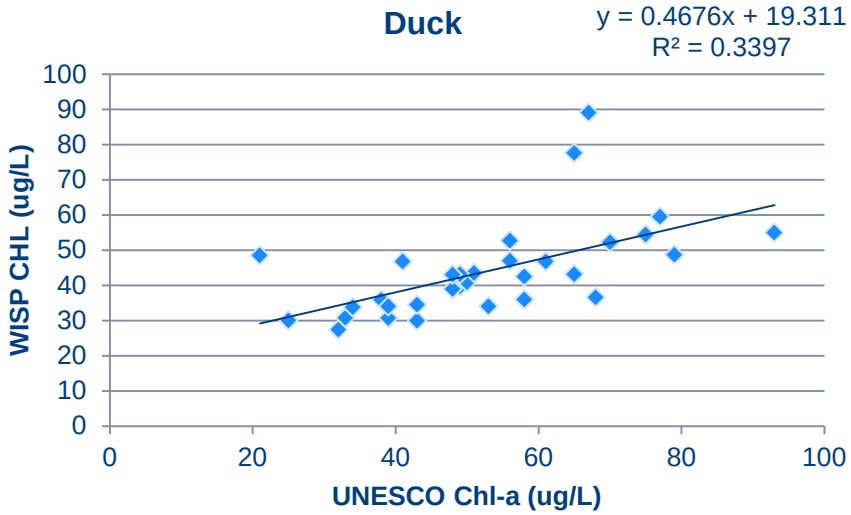
Chlorophyll at Duck





- Time series plots indicate that WISP and laboratory measured chlorophyll show similar patterns in each pond
- However correlation coefficients were still reasonably low (highest at Kensington, 0.40)
- Removal of cloudy day WISP data improved R^2 at SJBP (0.636) and Kensington (0.618), decrease at Duck (0.265).
- WISP chlorophyll poorly correlated with cyanobacterial biovolume, abundance and even eukaryotic phytoplankton cell count

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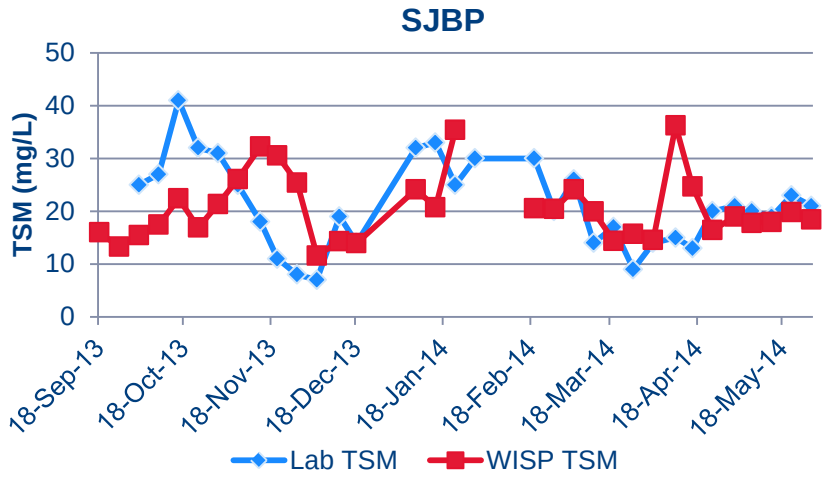
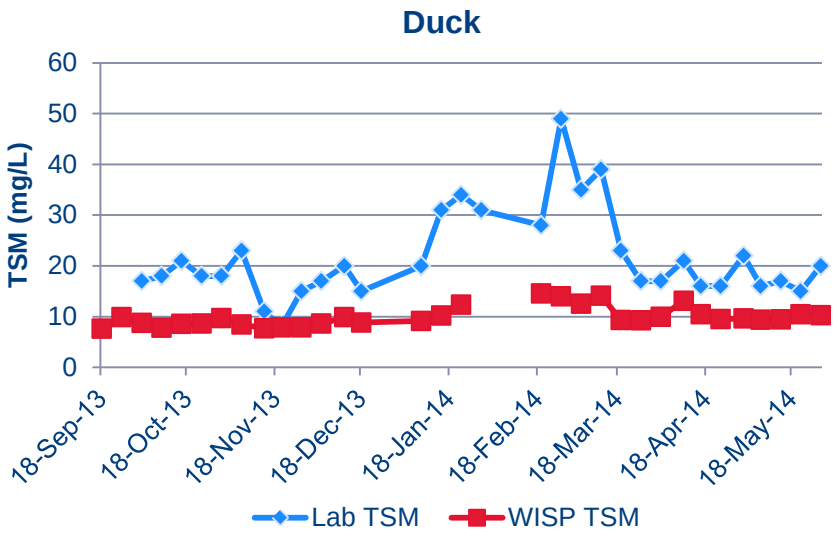
Total Suspended Material (TSM)





- Apart from SJBP, WISP TSM measurements were usually considerably less than laboratory TSM
- R^2 values were only 0.005 for SJBP, but higher at Kensington (0. 411) and best at Duck (0.606)
- Similar results were obtained when WISP TSM measurements were compared with laboratory turbidity measurements.
- Removal of cloudy day WISP data had little effect on R^2 results.

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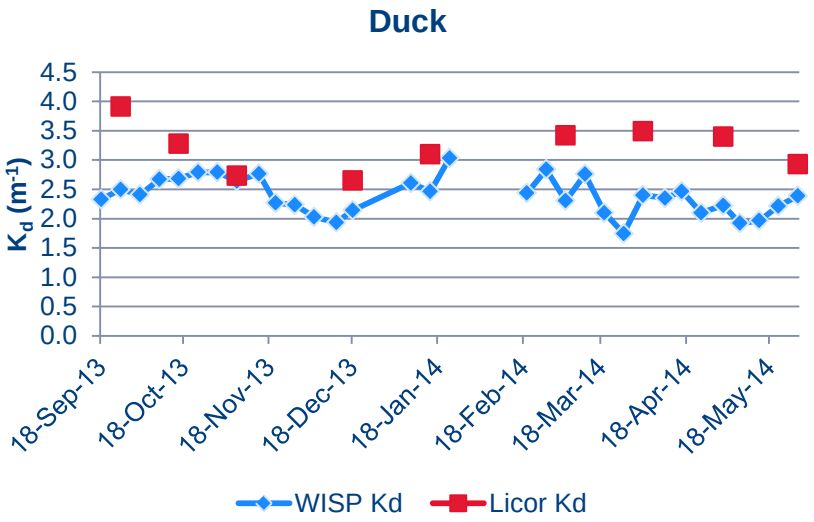
Downwelling vertical attenuation coefficient (K_d)



- WISP K_d measurements were only compared with in-situ K_d measurements at Duck Pond
- R^2 for the two sets of measurements was 0.012

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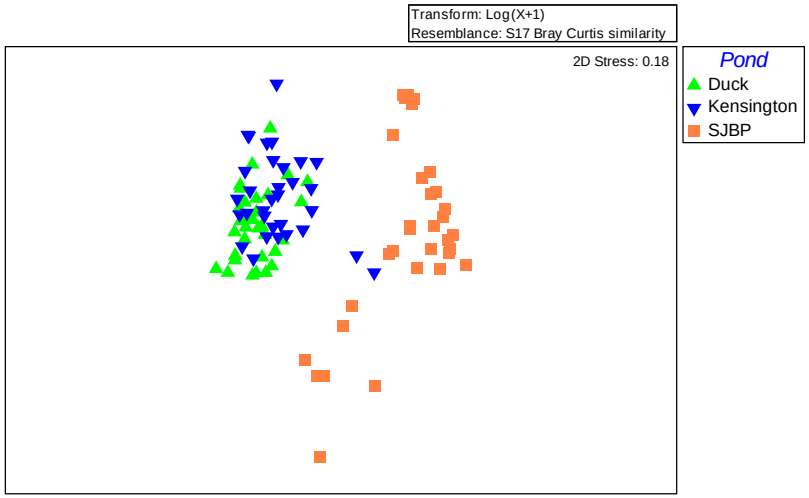
Comparisons – WISP and YSI

- SJBP– poor correlations between phycocyanin (0.142) and chlorophyll (0.093) measurements by these instruments, and also comparing WISP TSM with YSI turbidity (0.255). Correlations improved markedly once cloudy day WISP data was removed (0.80, 0.481 and 0.822 respectively)
- Kensington Pond – Good correlations – phycocyanin (0.818), chlorophyll (0.680), turbidity (0.423). Removing cloudy day data with little effect.
- Duck – R^2 for phycocyanin was 0.589, chlorophyll was 0.434, and TSM~turbidity was 0.476
- WISP and YSI supposedly both measure phycocyanin as µg/L, but WISP measurements sometimes 50 times or more greater than the simultaneously measured YSI measurements

Variation in phytoplankton community composition between ponds



- Common cyanobacteria in SJBP by biovolume were *Microcystis flos-aquae, Aphanocapsa*, *Raphidiopsis* and large *Merismopedia* sp.
  - Average similarity between samples was only 24.5%
  - Average similarity to other ponds was only 5%

- Dominant cyanobacteria in Kensington were *Anathece*, *Microcystis wesenbergi* and *Cyanodictyon*
  - Average similarity between samples was 35%

- Dominant cyanobacteria in Duck were *Cyanodictyon* and *Anathece*
  - Average similarity between samples was 44%

- Variation in eukaryotic phytoplankton between ponds less marked – dominants *Scenedesmus*, *Oocystis* and *Ankistrodesmus* in all 3, plus diatoms in Kensington and SJBP

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Conclusions

- These are initial investigations – indications are that the WISP may be suitable as a routine monitoring tool in NSW, but more evaluation is required
- WISP appears to give better results for chlorophyll, less so when phycocyanin is compared with laboratory biovolume
- Better correlations between WISP and YSI measurements – difficulties in making accurate laboratory measurements of biovolume on blooms of picoplanktonic species of cyanobacteria could introduce error in comparisons between WISP phycocyanin and laboratory biovolume
- Need to include laboratory measurements of phycocyanin to compare with WISP and YSI readings (are WISP phycocyanin values too high, YSI values too low ?)
- Need to determine causes of variability in replicate WISP data, especially on cloudy days
- Need to determine if phytoplankton community composition influences the measurements made with the WISP – trial the WISP on more water bodies than just the 3 in eastern Sydney

Acknowledgments

- Staff of the NSW Office of Water laboratory
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