What do phytoplankton in the McMurdo Dry Valley lakes do when the sun sets?

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Introduction

The McMurdo Dry Valleys (MDV) is the largest ice-free area on the Antarctic continent, and is the study site of the Long Term Ecological Research (LTER) program. Research on ice-covered lakes in the Taylor Valley has been restricted to the austral spring and early summer (~October through January) when logistical support has allowed access to the area. The International Polar Year 2007-2008 (IPY) provided the first opportunity to study biological adaptation/acclimation by phytoplankton during the transition from 24h sun to the polar night. We present phytoplankton succession and diversity from West Lobe Bonney (WLB) and Lake Fryxell (FRX) (Fig 1).

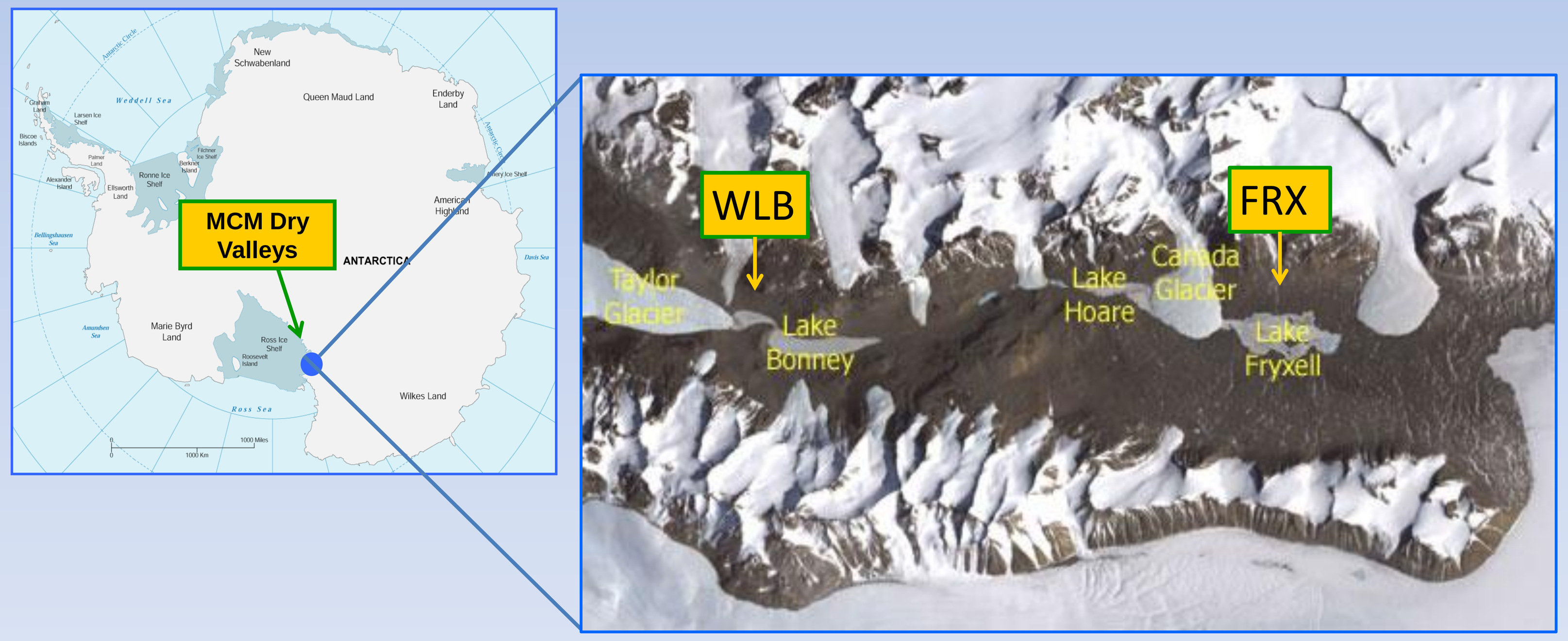

Fig 1. Location of the MCM Dry Valleys (77 °S, 163°E) and the study lakes in the Taylor Valley.

Study site

The MCM lakes contain stable water columns resulting from perennial ice covers, low advective stream inflow, and strong chemical gradients (Fig 2) which create distinct environments for phytoplankton populations.

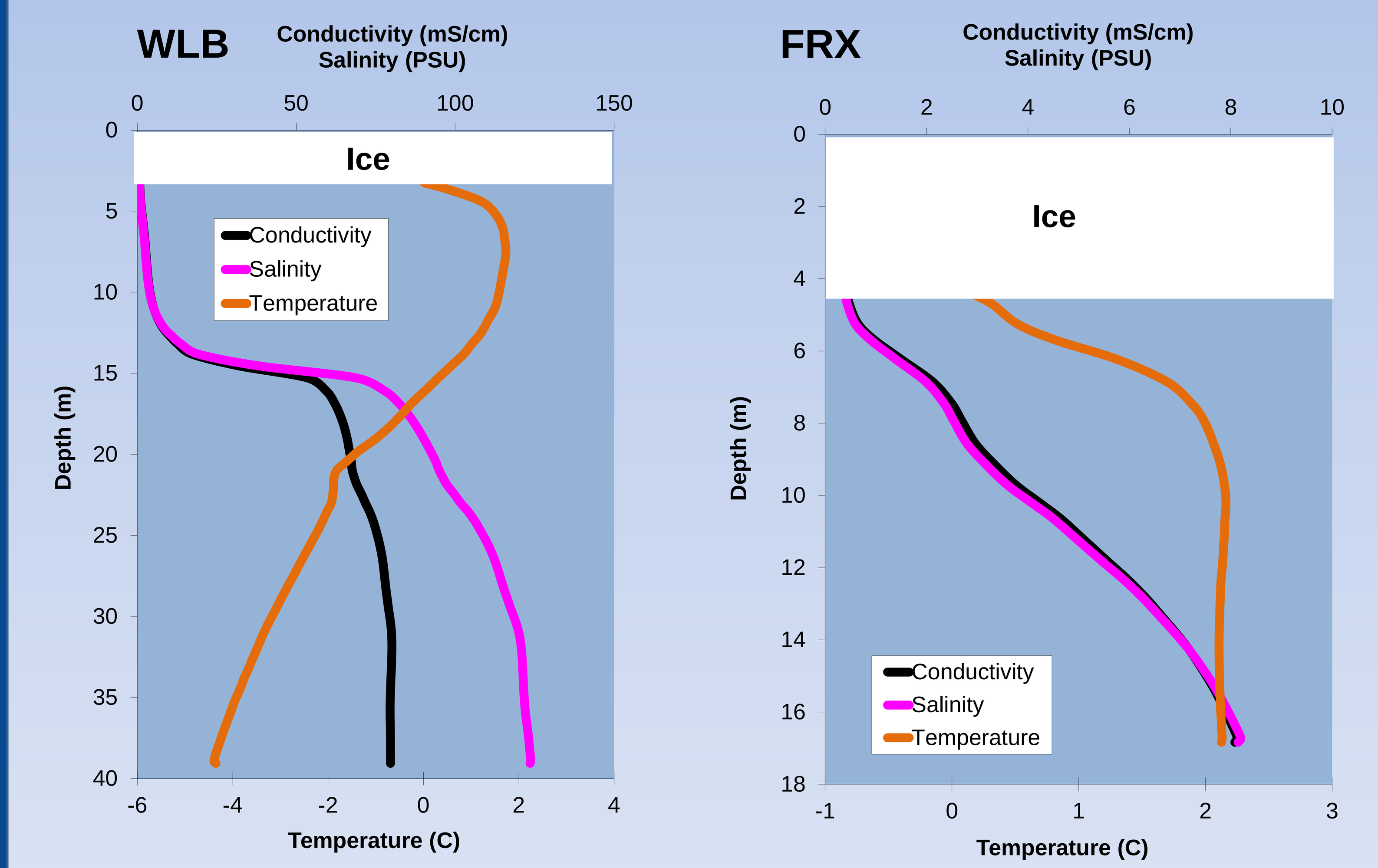

Fig 2. Temperature, salinity and conductivity profiles for each study lake.

Methods

Changes in under-ice photosynthetically active radiation (PAR) and primary production (PPR) were measured from early November through mid-April. During this same period, phytoplankton diversity was determined in-situ using a submersible spectrofluorometer (Fig 3) which differentiates the following groups: Cyanobacteria, Chlorophyta, Chrysophyta, Cryptophyta.

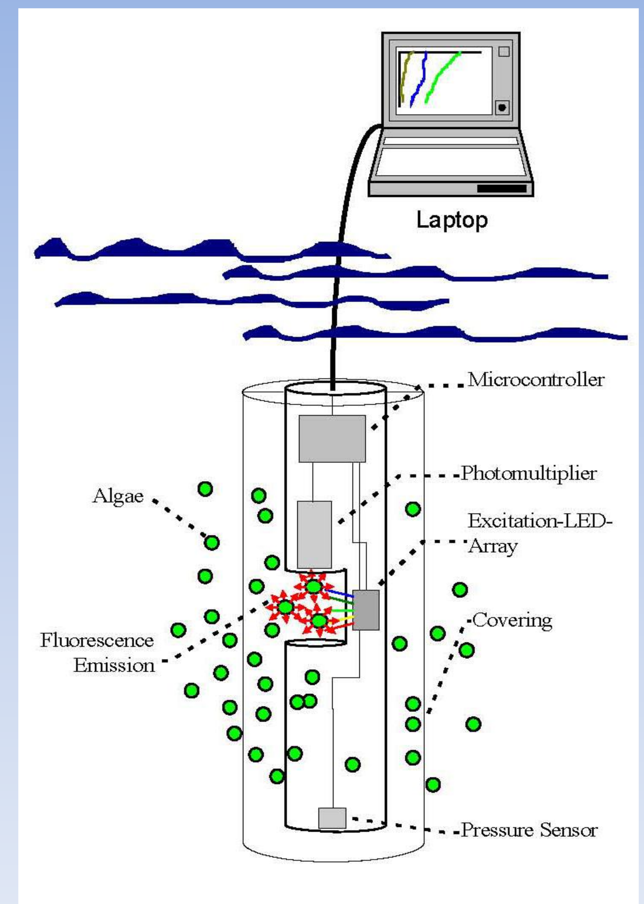

Fig 3. Schematic of the bbe Fluoroprobe. Cellular pigments are excited at 450, 525, 570, 590, and 610 nm and chl-a emission is measured at 683 nm. Algal groups are differentiated by light absorption by specific accessory pigment complexes.

Results I: PAR, PPR, total chl-a as the sun sets

Water column **PAR** decreased significantly in March and was no longer measureable by early April (Fig 4a). **PPR** reflected changes in PAR and ceased by mid-April (Fig 4b). **Total chl-a** did not decrease in direct response to diminished PPR (Fig 4c).

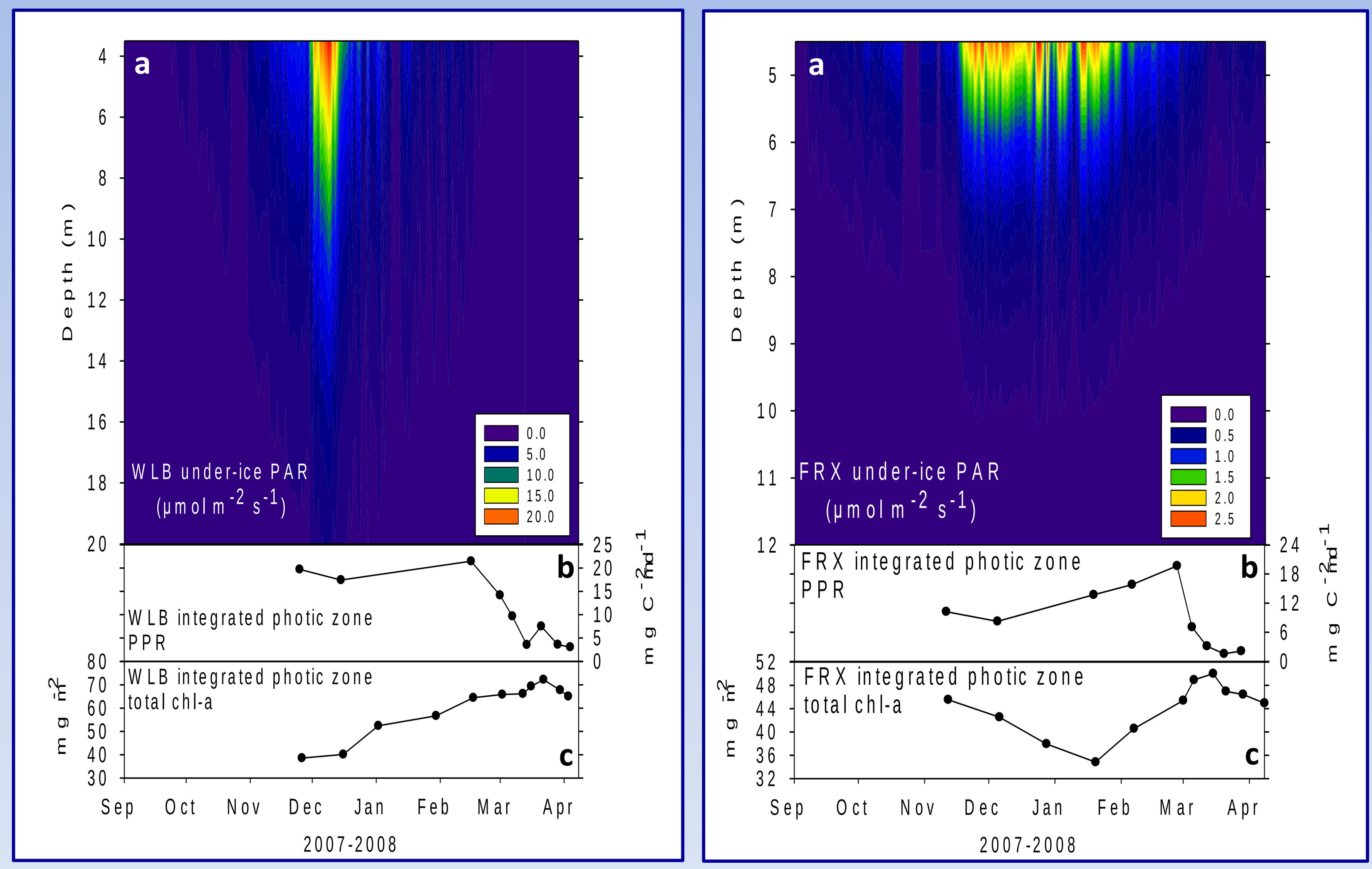

Fig 4. Contour plots of UW PAR (a) and PPR and total chl-a integrated over the photic zone (4-20m in WLB; 5-12m in FRX).

Conclusions

- Phytoplankton biomass does not respond to diminishing PAR despite diminished PPR
- Phytoplankton diversity shifted through the season and increased as the polar night approached
- These data indicate that phytoplankton may shift from photosynthesis to mixotrophy during the polar night as a mechanism for winter survival, and that fall-out from the ice cover can influence water column diversity.

Acknowledgements

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Results II: Phytoplankton group responses as the sun sets

WLB: All groups increased in March and April as PAR decreased, with Chlorophytes, Chrysophytes and Cryptophytes peaking at the chemocline, while the highest abundance of cyanobacteria occurred below the chemocline, which may be the result of fall-out from the permanent ice cover (Fig 5).
FRX: Chrysophyte and Chryptophyte biomass peaked during late Nov/Dec, and increased again during March/April as PAR started to decrease. The highest abundance of cyanobacteria occurred at and below the chl-a peak in early April, likely the result of fall-out from the permanent ice cover. Chlorophytes were the only group to show a decrease during April (Fig 5).

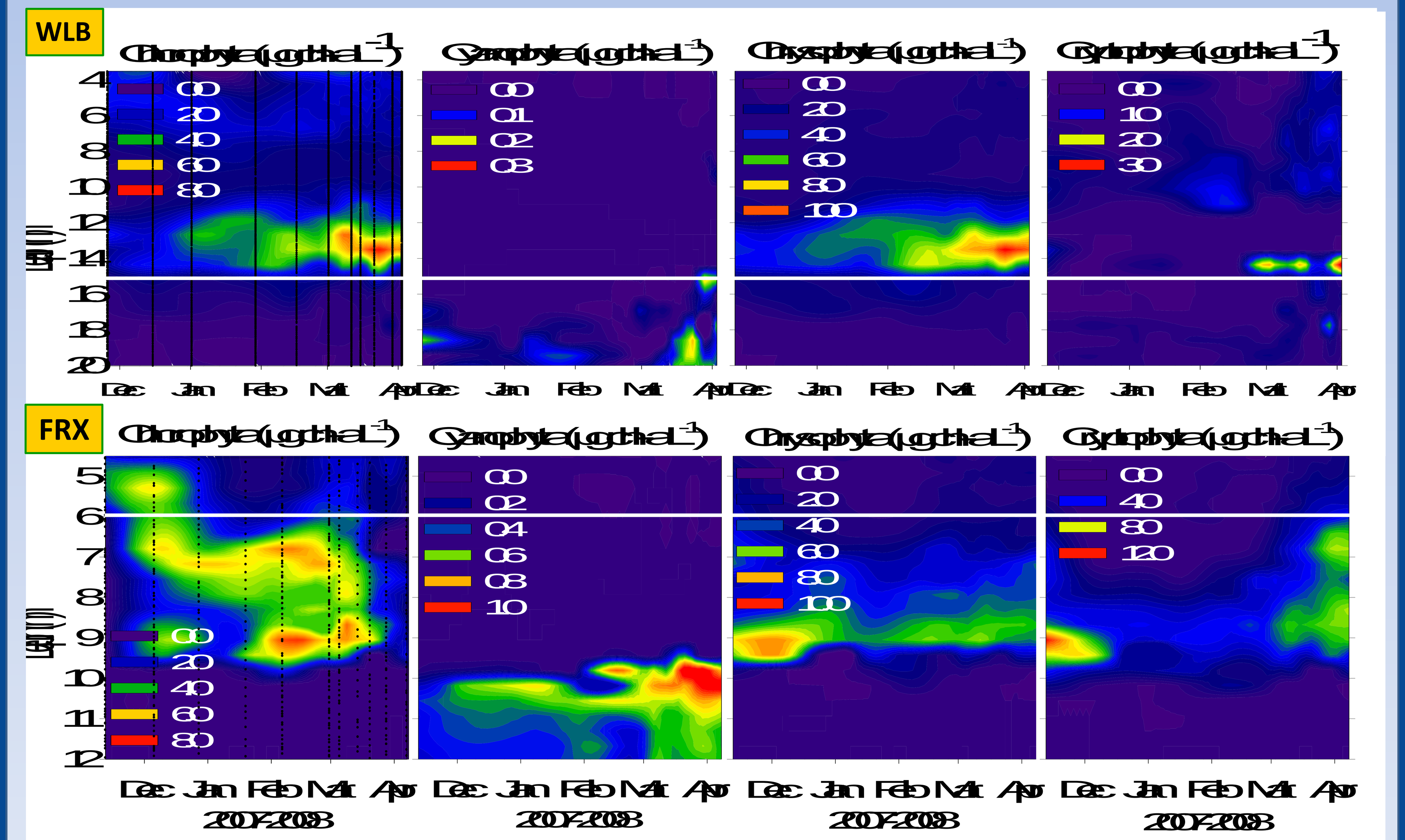

Fig 5. Phytoplankton concentration in the photic zones of WLB and FRX. Black dots represent data points; white line represents the chemocline.

Results III: Phytoplankton diversity as the sun sets

Phytoplankton diversity in **WLB** increased below the chemocline during March and April (Fig 6).

Phytoplankton diversity in **FRX** increased over time in the upper half of the water column, with the highest diversity found at the 10m chl peak between Feb and Mar (Fig 6).

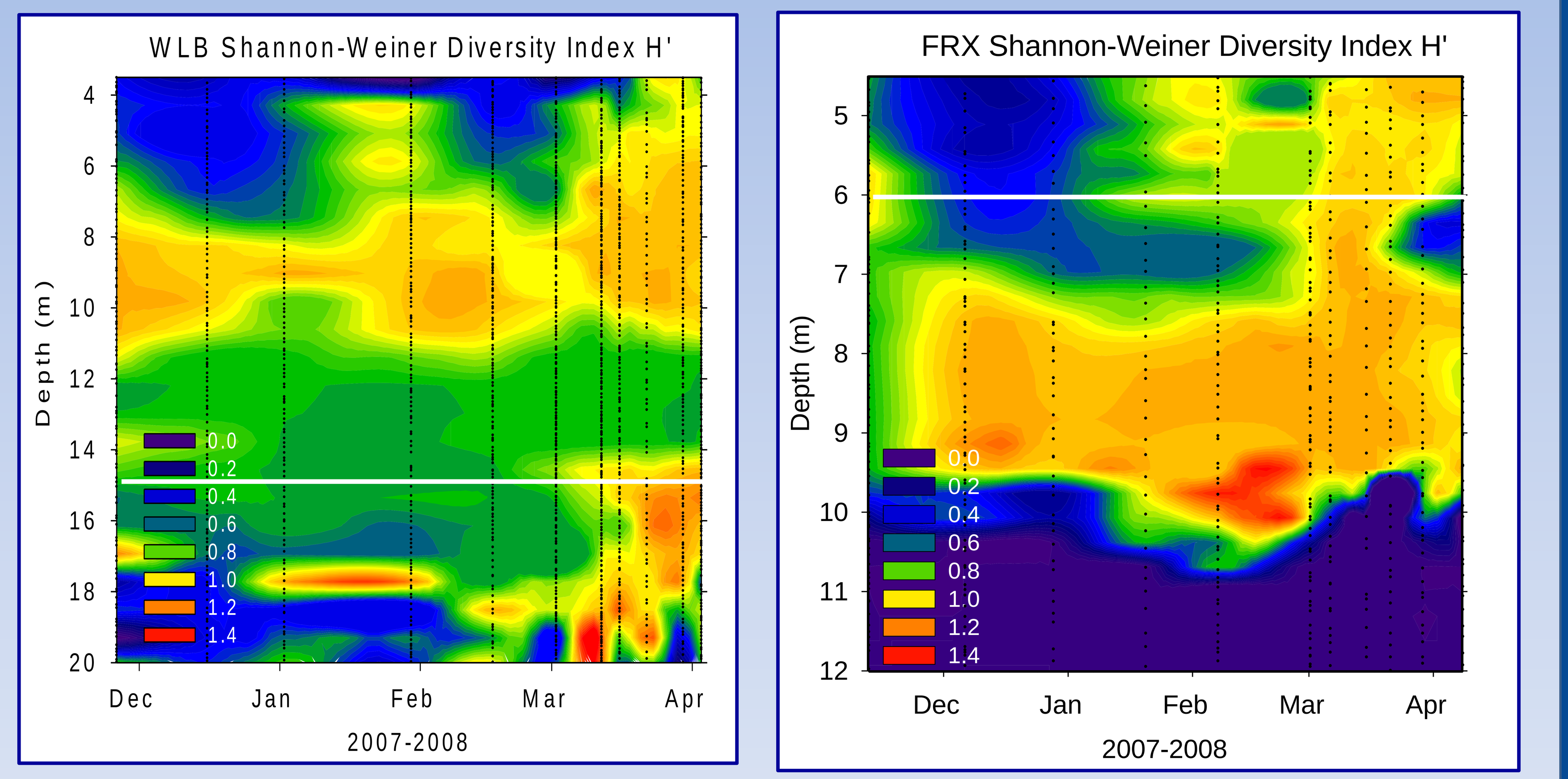

Fig 6. Photic zone phytoplankton diversity based on *in vivo* pigment fluorescence. Pi values for Shannon-Weiner Diversity Index H' were calculated using the proportion of fluorescence for each group to total chl-a. Black dots represent data points; white line represents the chemocline.