Phytoplankton Fingerprinting

with the bbe FluoroProbe

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with
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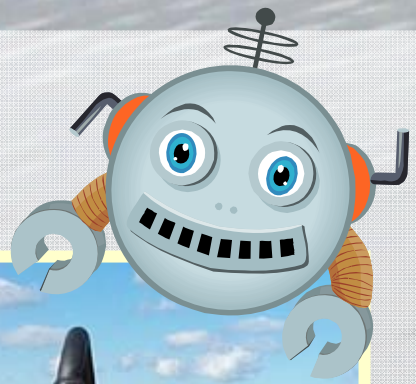
Also many thanks to Nick Sakata, Eric Santos, Jacob Fleck, Jackie Hagen, Samantha Pearson, Karen Gehrts, Gina Benigno, Rich Breuer, George Malyj, Geoff Schladow, Charles Goldman, and many others!



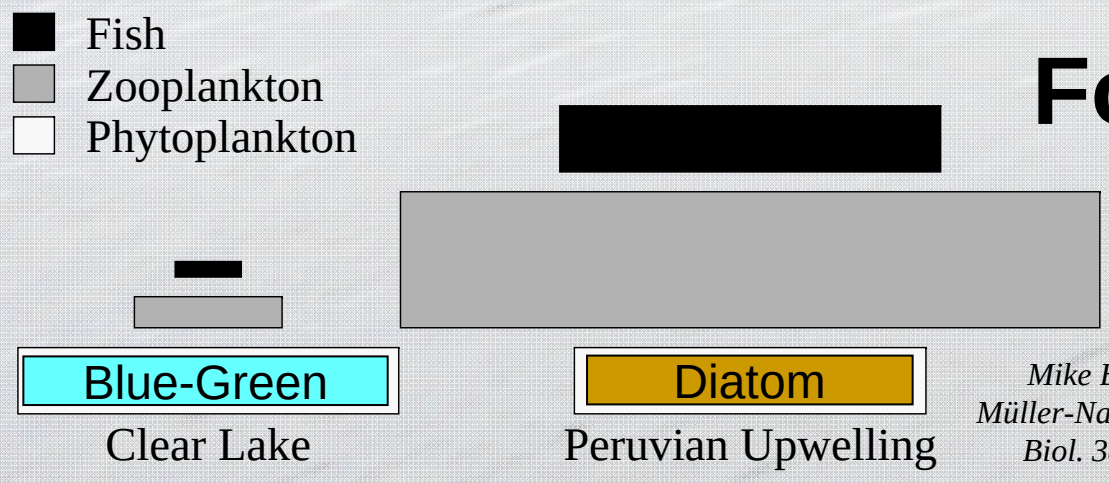
bbe FluoroProbe

http://www.bbe-moldaenke.de

What is it?

Submersible spectrofluorometer

- Fluorescence of algae in 4 taxonomic groups
- CDOM Fluorescence
- Water transmission (~turbidity)
- Water temperature
- Sample depth



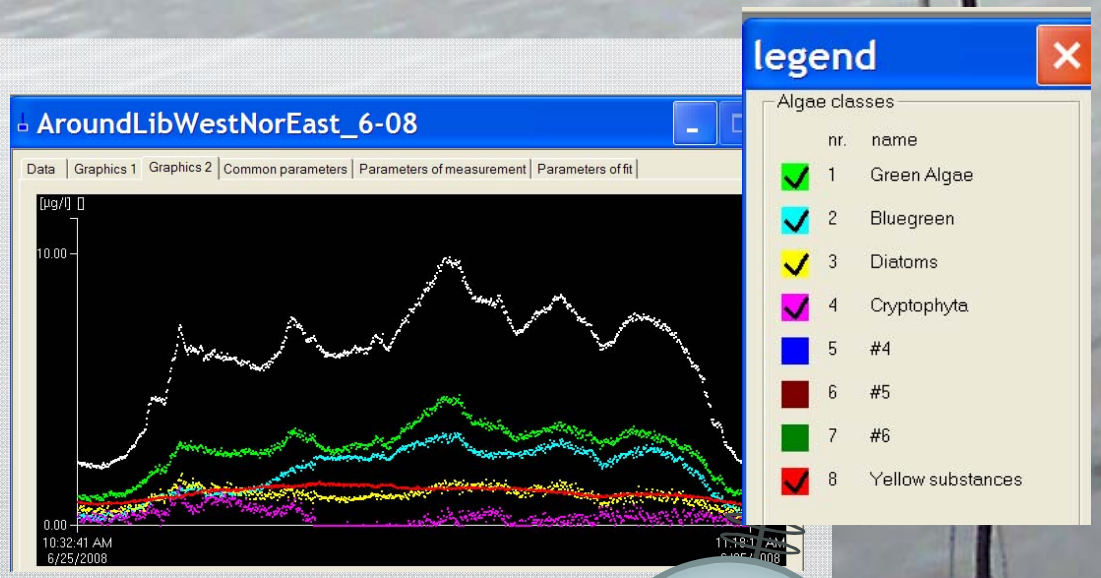
Food!

Mike Brett & Dörthe Müller-Navarra, Freshwater Biol. 38, 1997, p. 484

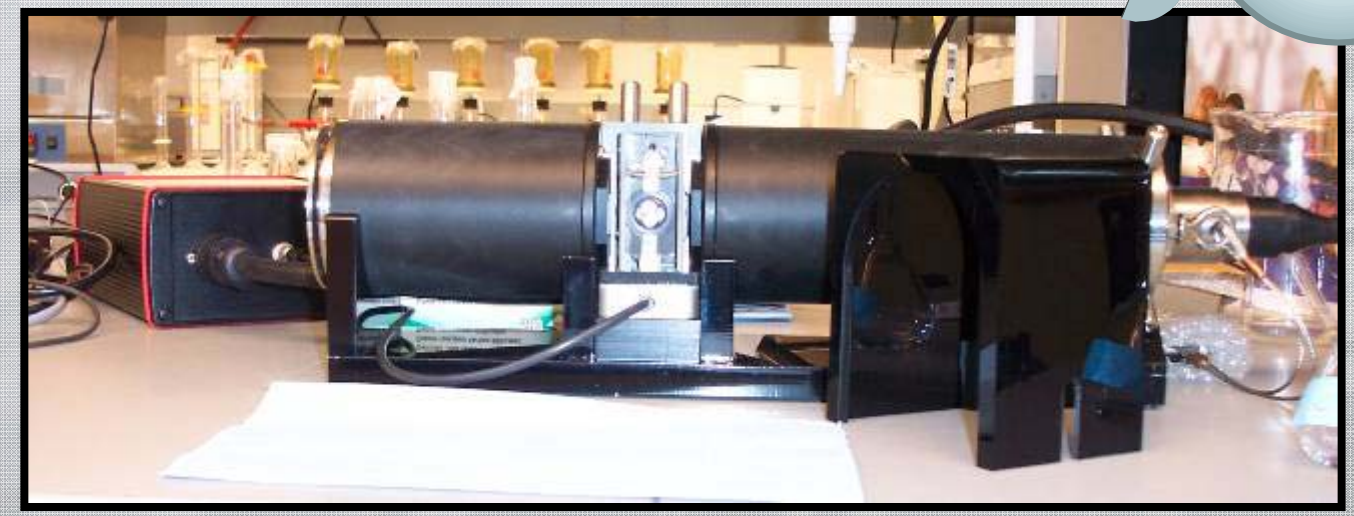
Harmful Blooms

Accessories

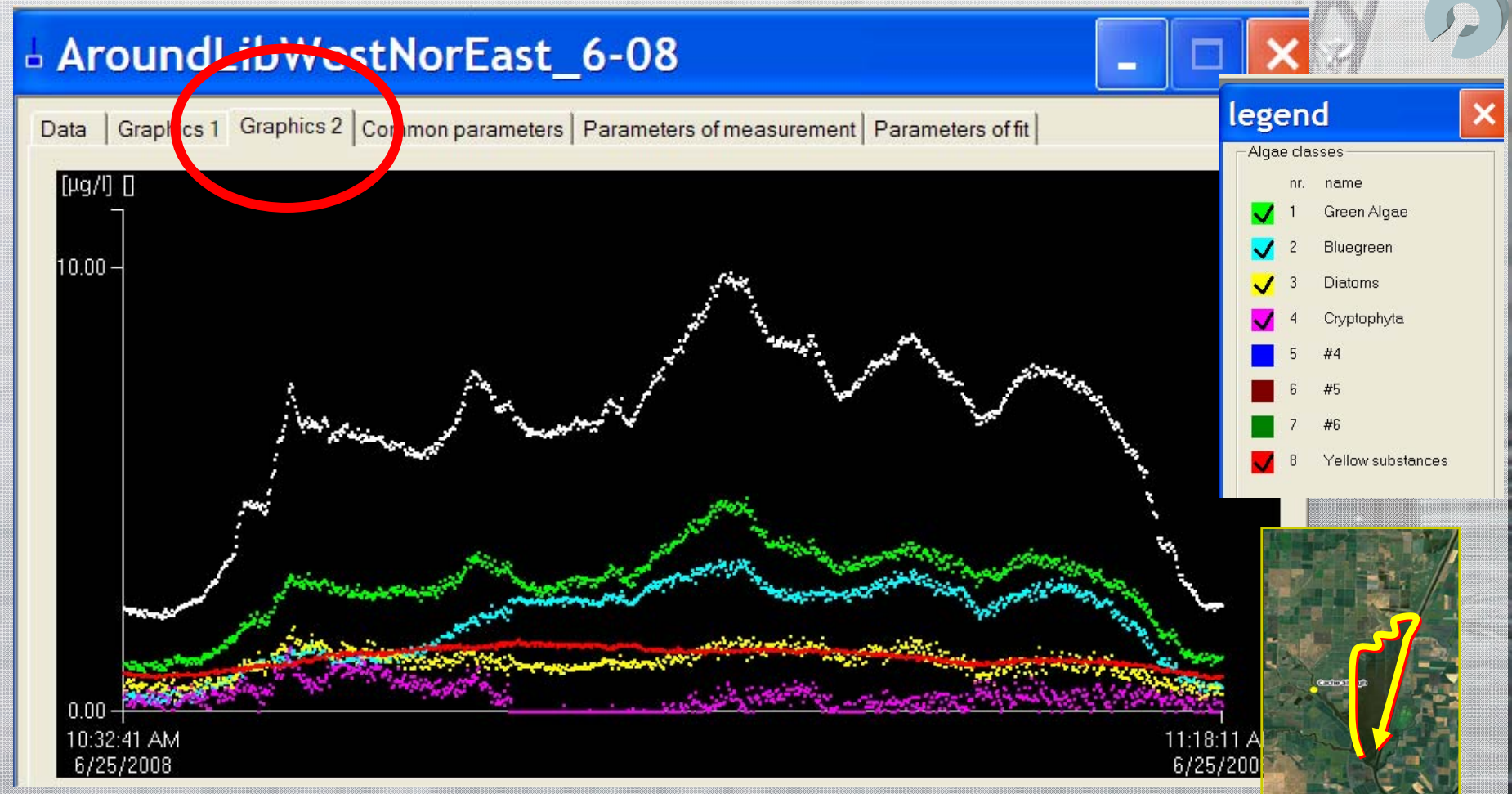
- Software
- Cuvette insert
- *No GPS*



- Benthic microalgae kit
- Wiper attachment
- Field flow-through housing
- Benchtop flow-through model



Big Plus: User-friendly software, “Learning curve” = 30 min



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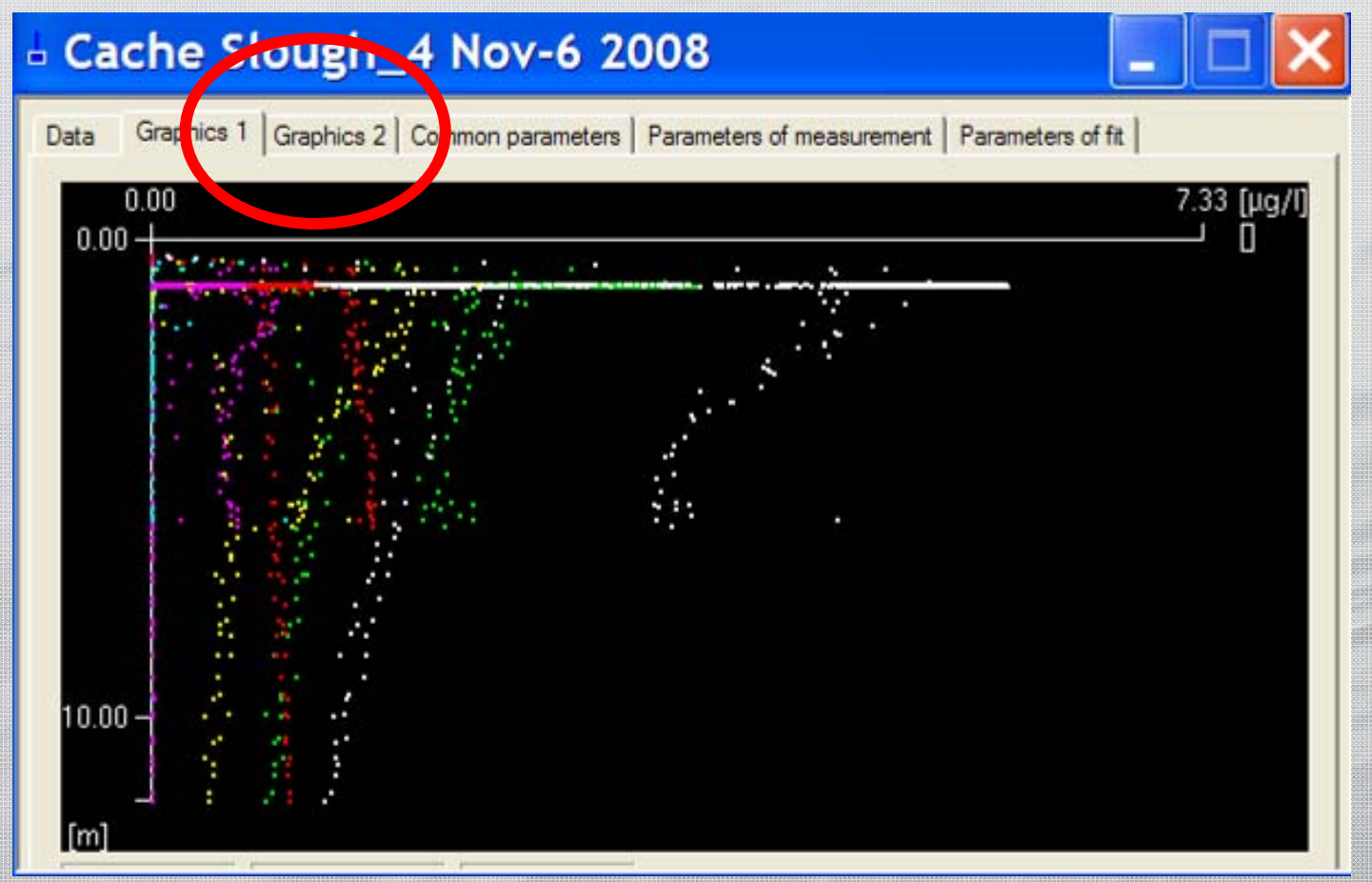
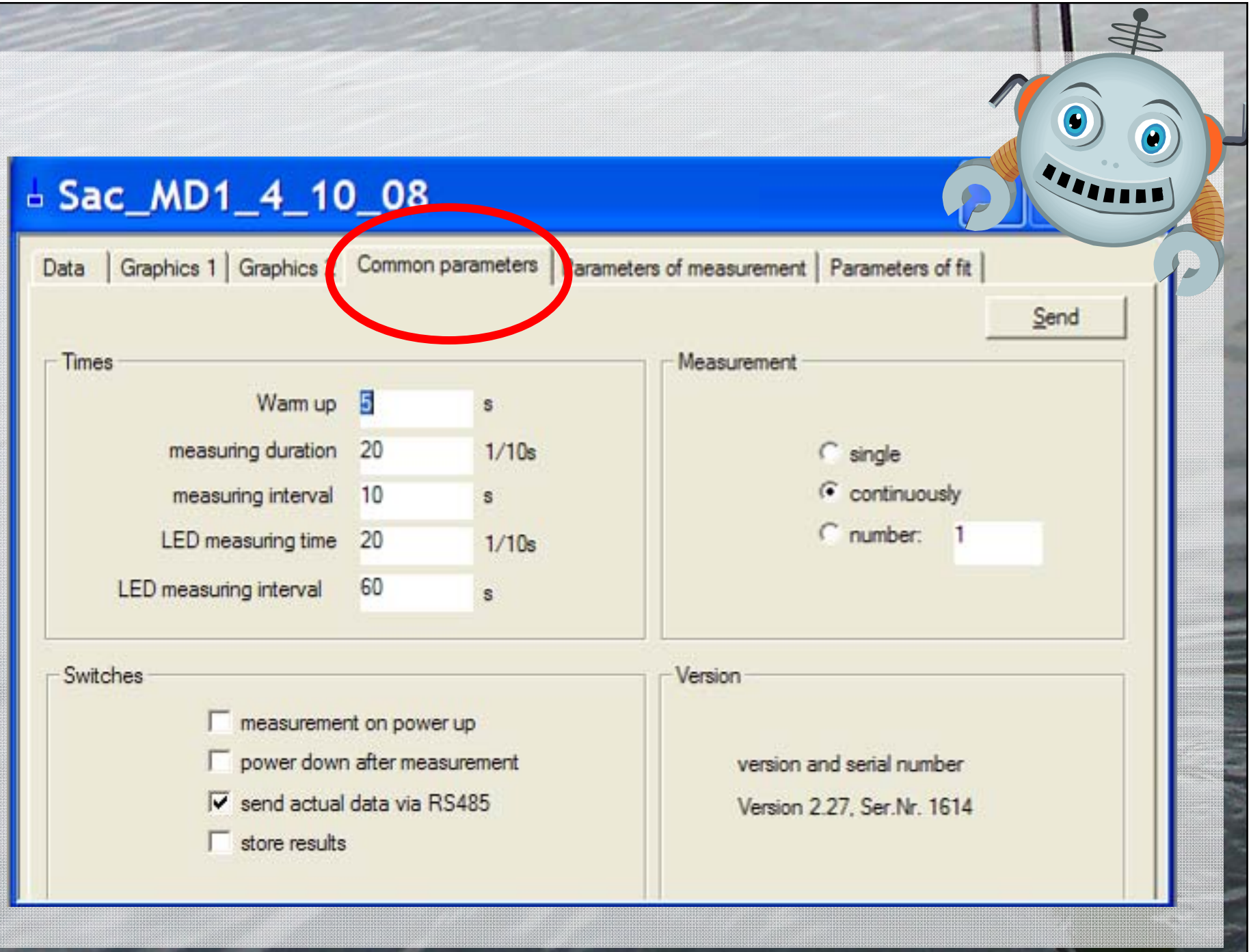
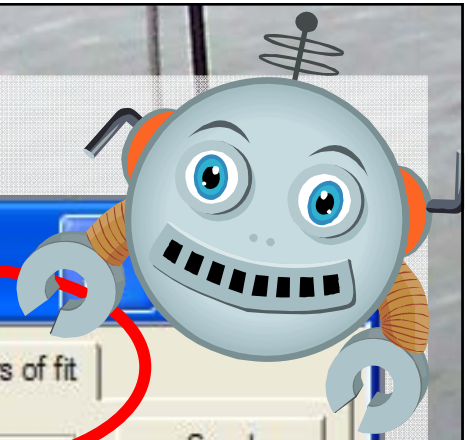



Sac_MD1_4_10_08
Data
Graphics 1
Graphics
Common parameters
arameters of measurement
Parameters of fit
Send
Times
Warm up 5 s
measuring duration 20 1/10s
measuring interval 10 s
LED measuring time 20 1/10s
LED measuring interval 60 s
Measurement
single
continuously
number: 1
Switches
measurement on power up
power down after measurement
send actual data via RS485
store results
Version
version and serial number
Version 2.27, Ser.Nr. 1614

Cache Slough_4 Nov-6 2008



Data | Graphics 1 | Graphics 2 | Common parameters | Parameters of measurement | Parameters of fit

Send

Offsets LEDs — filtrated water — distilled water

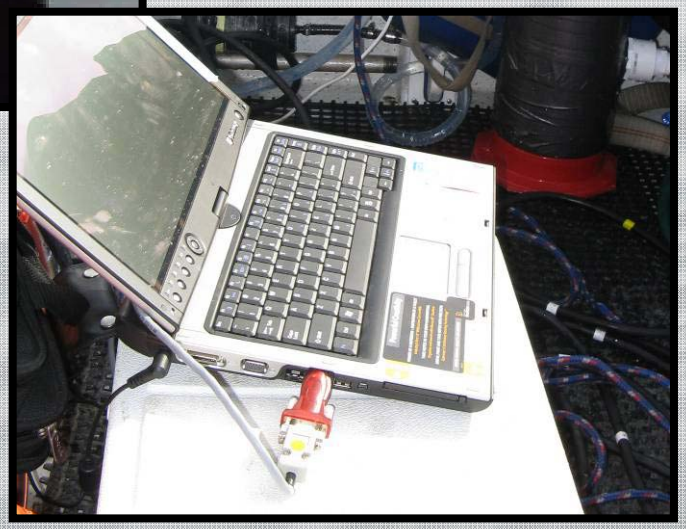
525	1.627	570	1.221	610	2.610	590	3.785	470	1.401	UV	1.328

Algae classes

fit	type	name	factor LEDs 525	570	610	590	470	UV	standard deviation of LEDs 525	570	610	590	470	UV
☑	A	Green Algae	1.007	0.305	1.112	1.359	4.988	2.24	0.1	0.1	0.1	0.1	0.1	0.1
☑	A	Bluegreen	0.849	0.749	3.232	3.805	0.36	0.677	0.1	0.1	0.1	0.1	0.1	0.1
☑	A	Diatoms	3.251	0.504	1.039	1.435	6.394	2.823	0.1	0.1	0.1	0.1	0.1	0.1
☑	A	Cryptophyta	2.495	1.151	1.806	3.014	3.538	1.488	0.1	0.1	0.1	0.1	0.1	0.1
☐	A	#4	1	1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1
☐	A	#5	1	1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1
☐	A	#6	1	1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1
☑	Y	Yellow substances	1.766	0.185	0.351	0.432	5.495	7.934	0.1	0.1	0.1	0.1	0.1	0.1

A home-made accessory: Trashcan/canister with lid = “flow-through chamber”

Communication trouble began March 2009



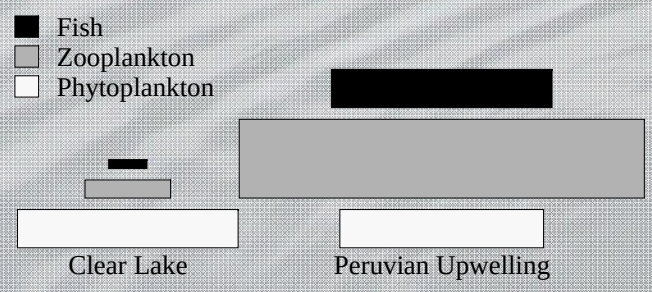
bbe FluoroProbe

So how does it work?

Does it work here?

- Lab tests
- Field tests

Is it useful?



4 algal groups: different pigments
➔ Different fluorescence maxima
➔ "Fluorescence fingerprints"

Green: Chl a & b
Brown: Chl a & c

Brown:
Fucoxanthin &
Peridinin

Cryptophyte &
Blue-Green:
Phycoerythrin

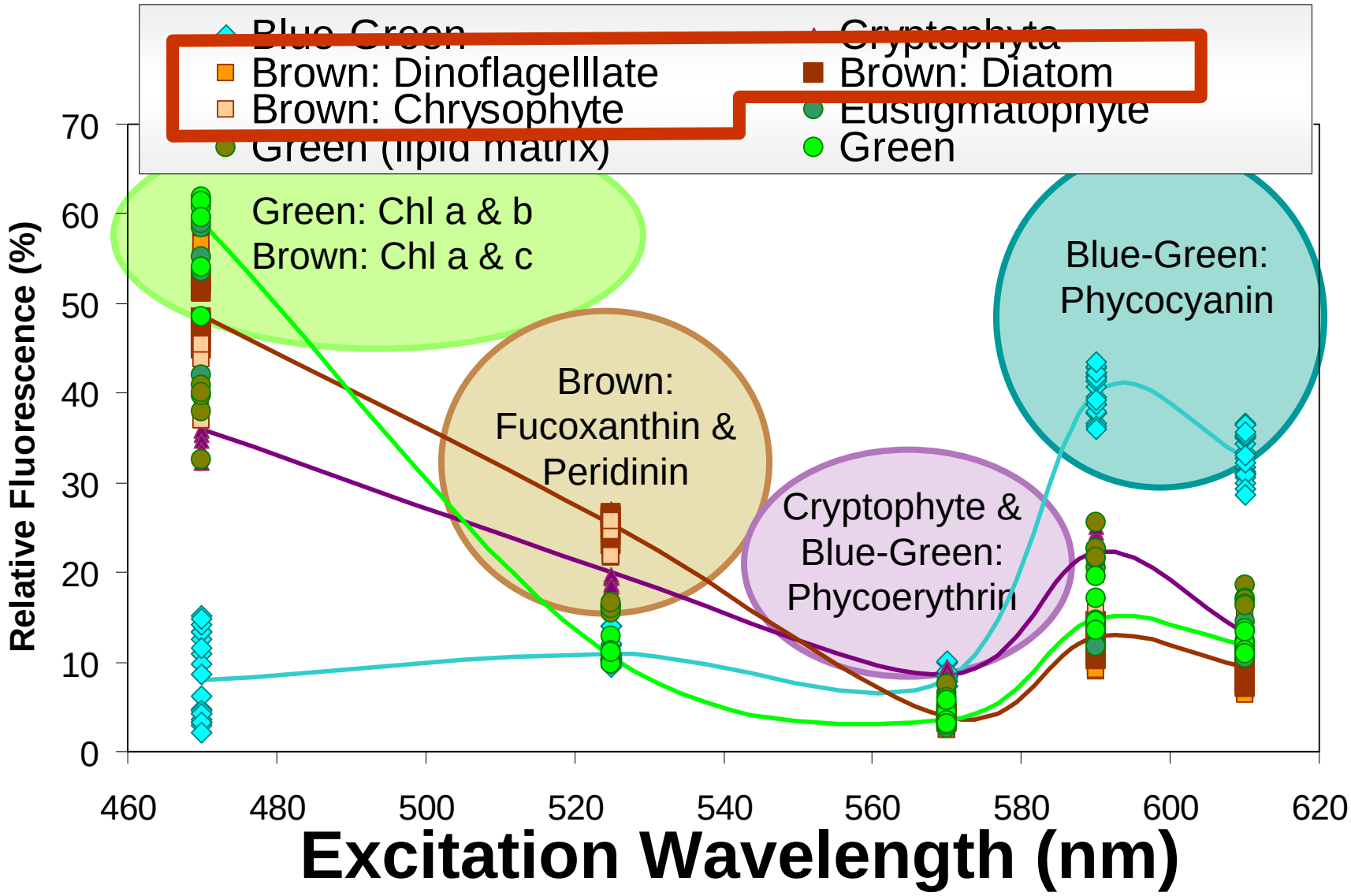
Blue-Green:
Phycocyanin

FluoroProbe:
5 LEDs: **470** **525** **570** **590** **610**

460 480 500 520 540 560 580 600 620

Excitation Wavelength (nm)

Algae culture tests: correct fluorescence maxima



Algae culture tests at UCD-TERC

19 species

3-5 concentrations

8000 measurements

Single species “fingerprints:”

Greens & Blue-Greens – “clean”

- > 90% (91-100%) correct group

Browns & Cryptophytes – a bit “smudged”

- < 90% (39-100%) correct group
- “Signal pollution,” esp. by Greens

➢ In Mixtures:

- Browns & Cryptophytes may be underestimated
- Greens overestimated
- Could adjust calibration factors

Mixture tests:

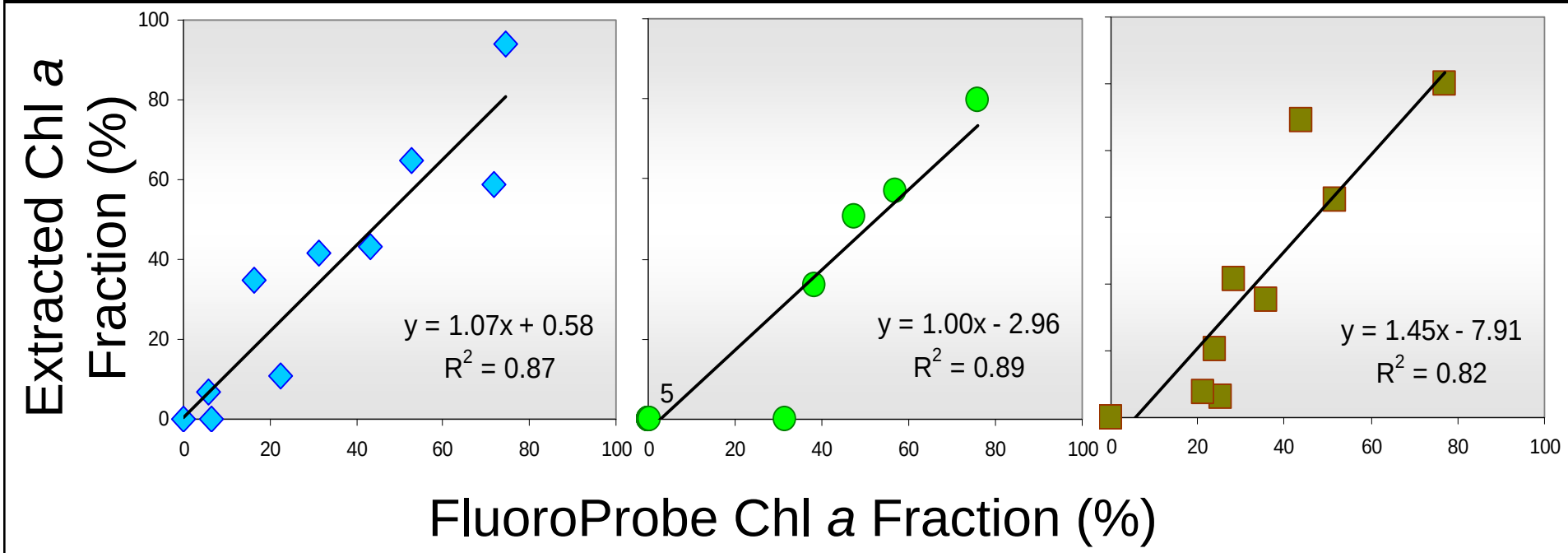
FluoroProbe resolves “fingerprints” quite well

10 test mixes with 2-4 species per mix

Blue-Green Fraction: Well estimated, Variable

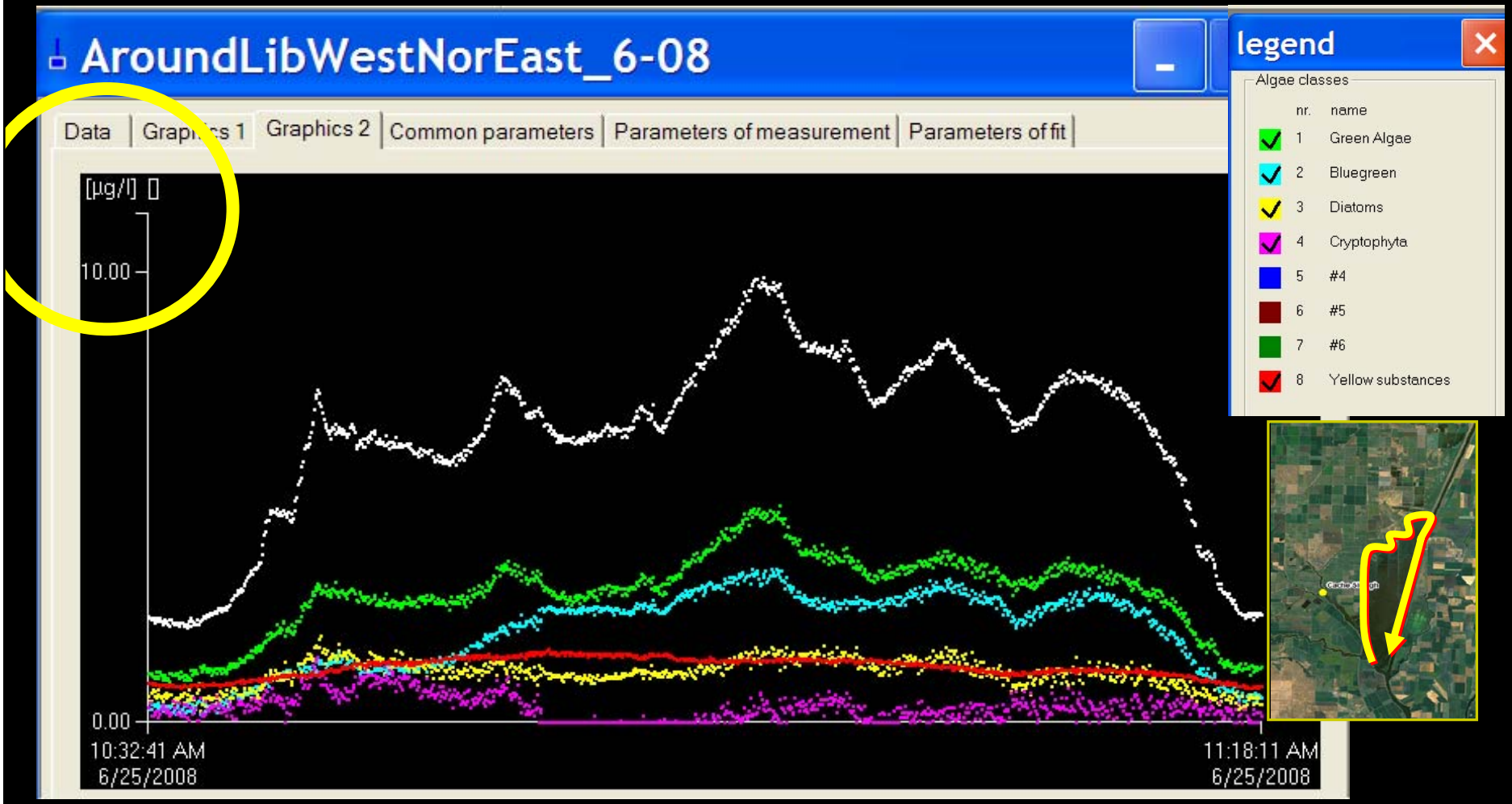
Green Fraction: Well-/ overestimated

Brown Fraction: Underestimated, Variable

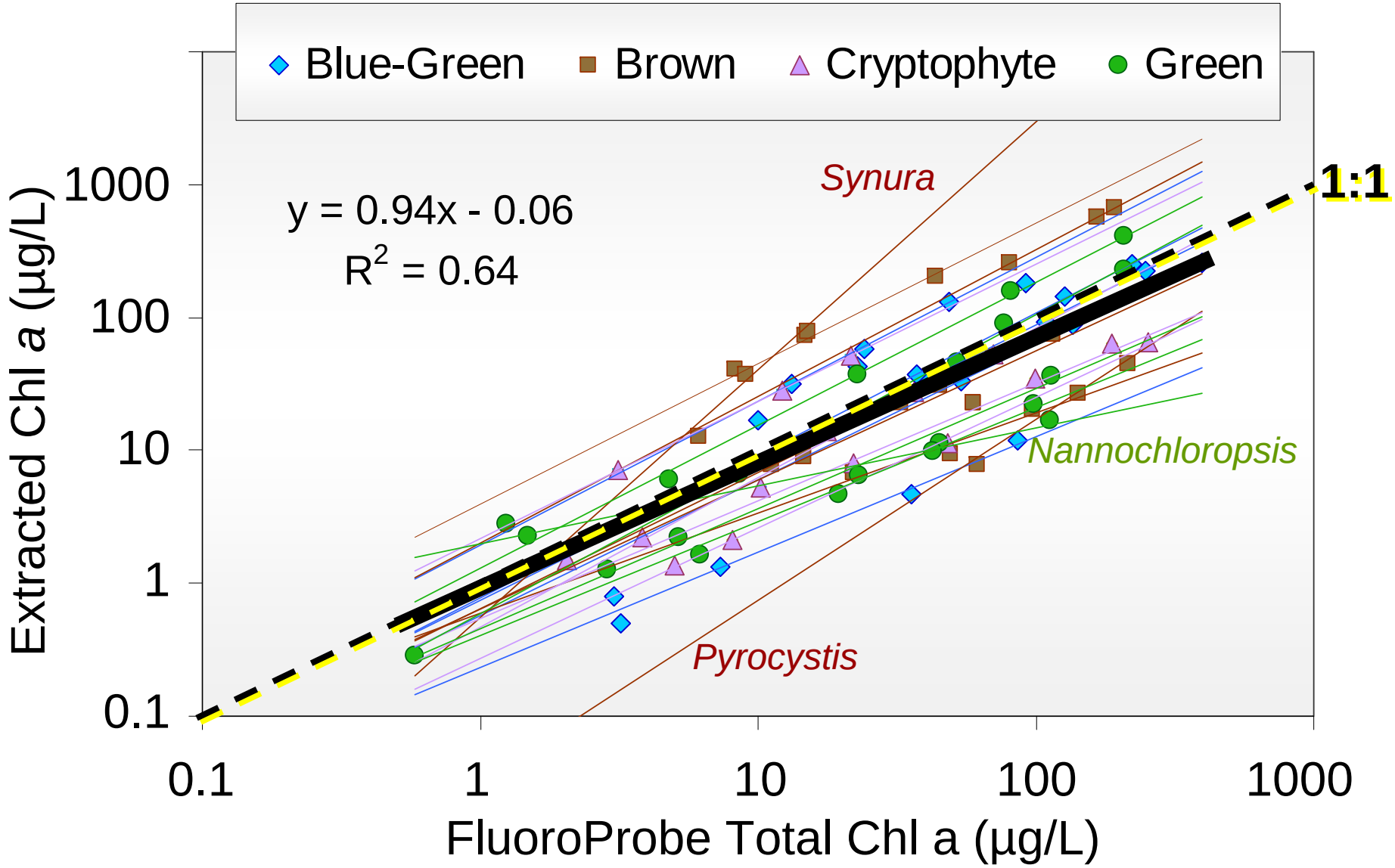


FluoroProbe output
Fingerprints and CONCENTRATIONS

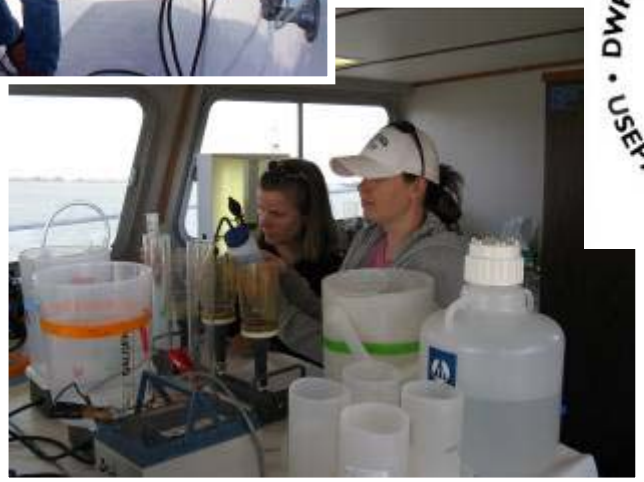
Fluorescence units and Chlorophyll *a* concentration (µg/L)



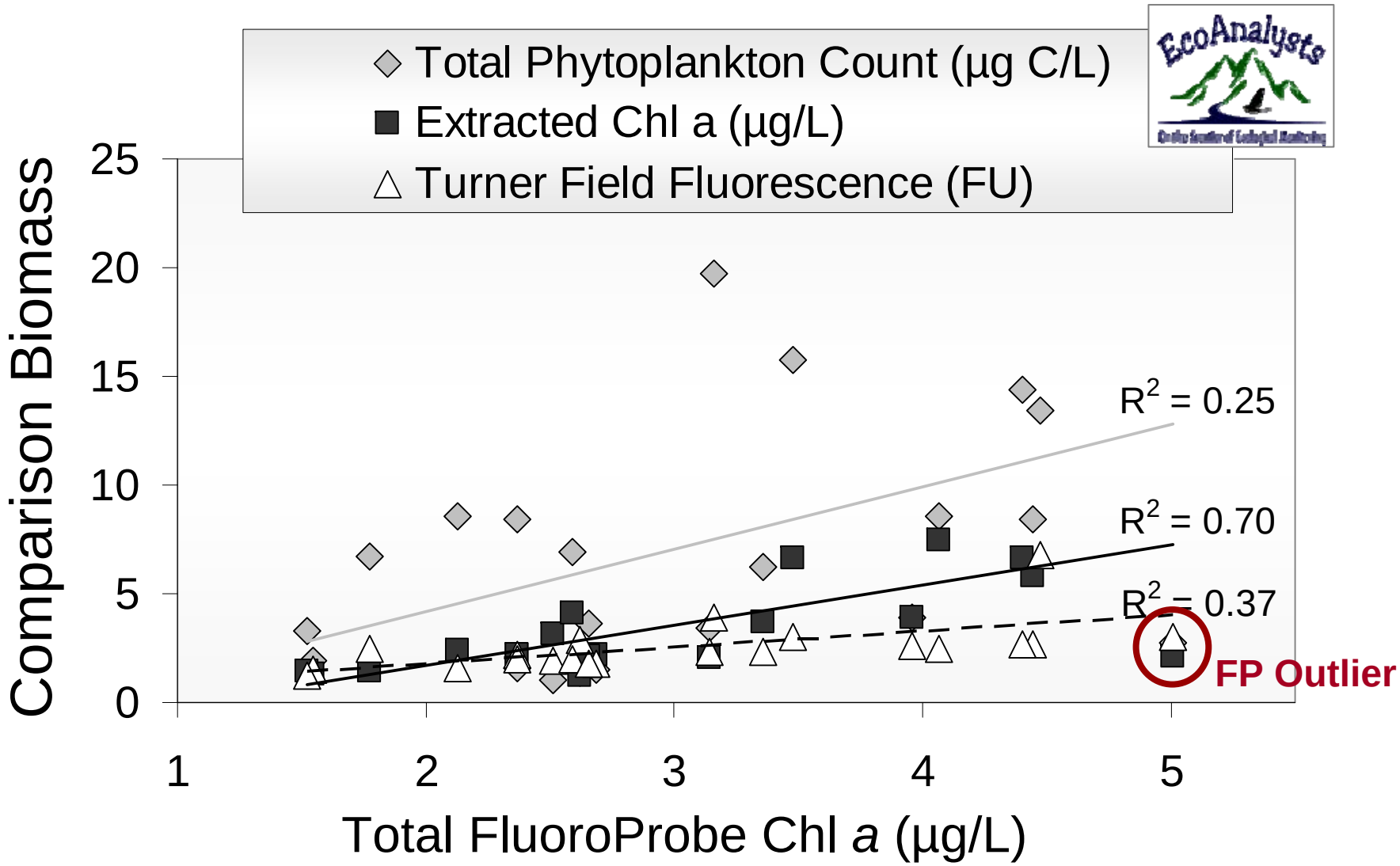
FluoroProbe predicts Chl *a* of **cultured** algae well (~1:1); But differences between species causes variability



Field Tests



Field phytoplankton biomass measurements with the FluoroProbe are comparable to other methods, but high variability



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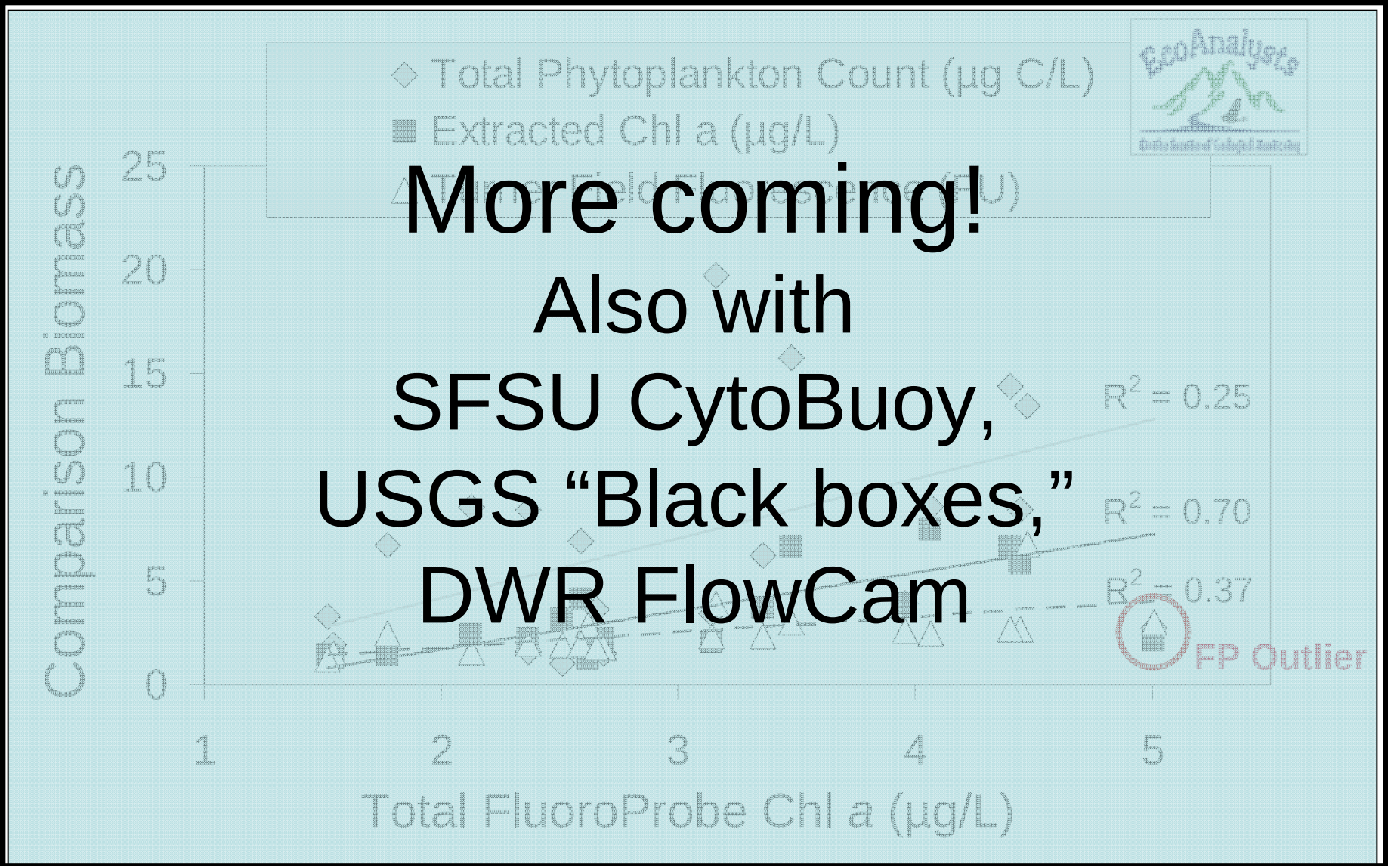


More coming!

Also with

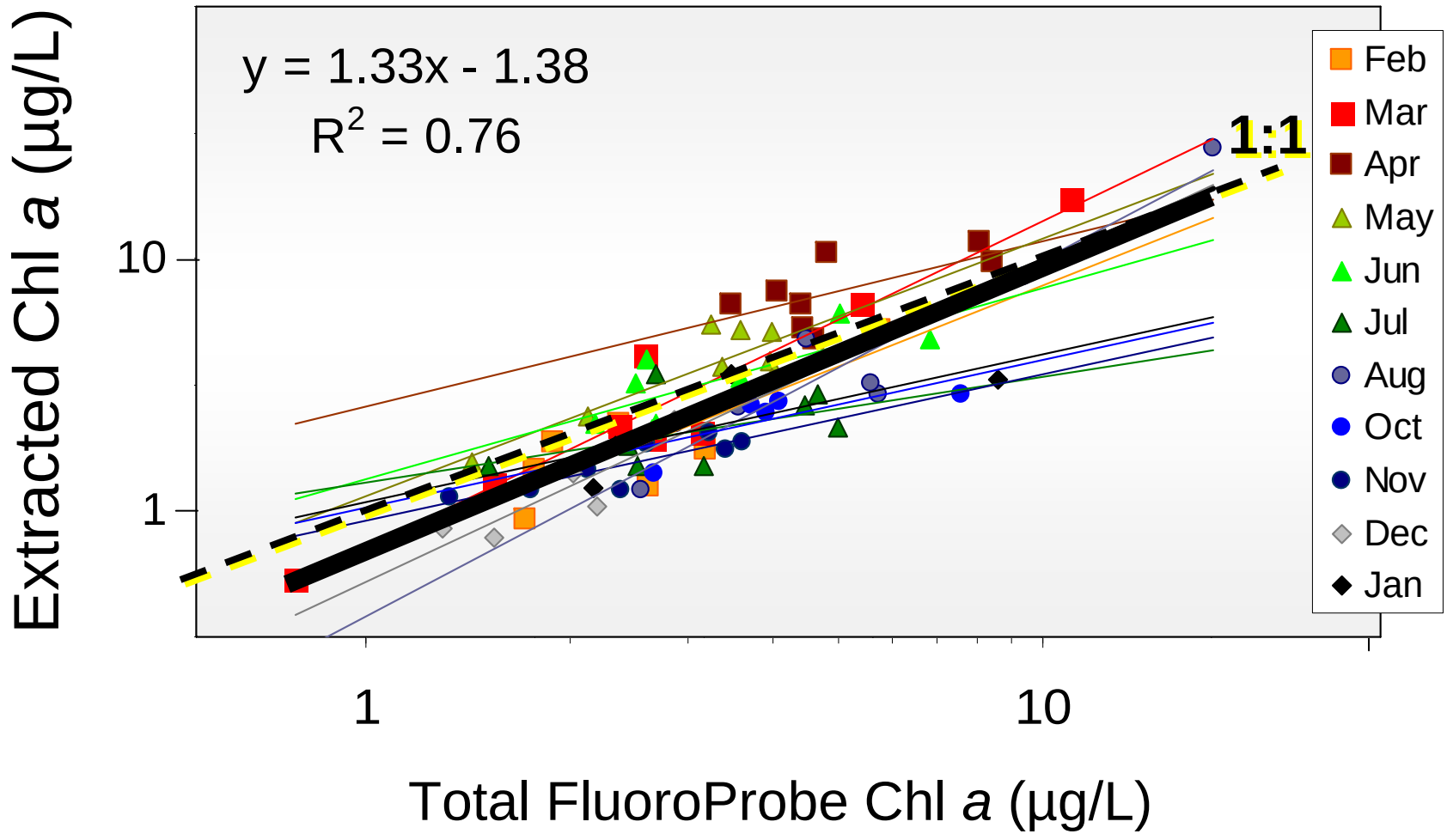
SFSU CytoBuoy,

USGS "Black boxes,"

DWR FlowCam

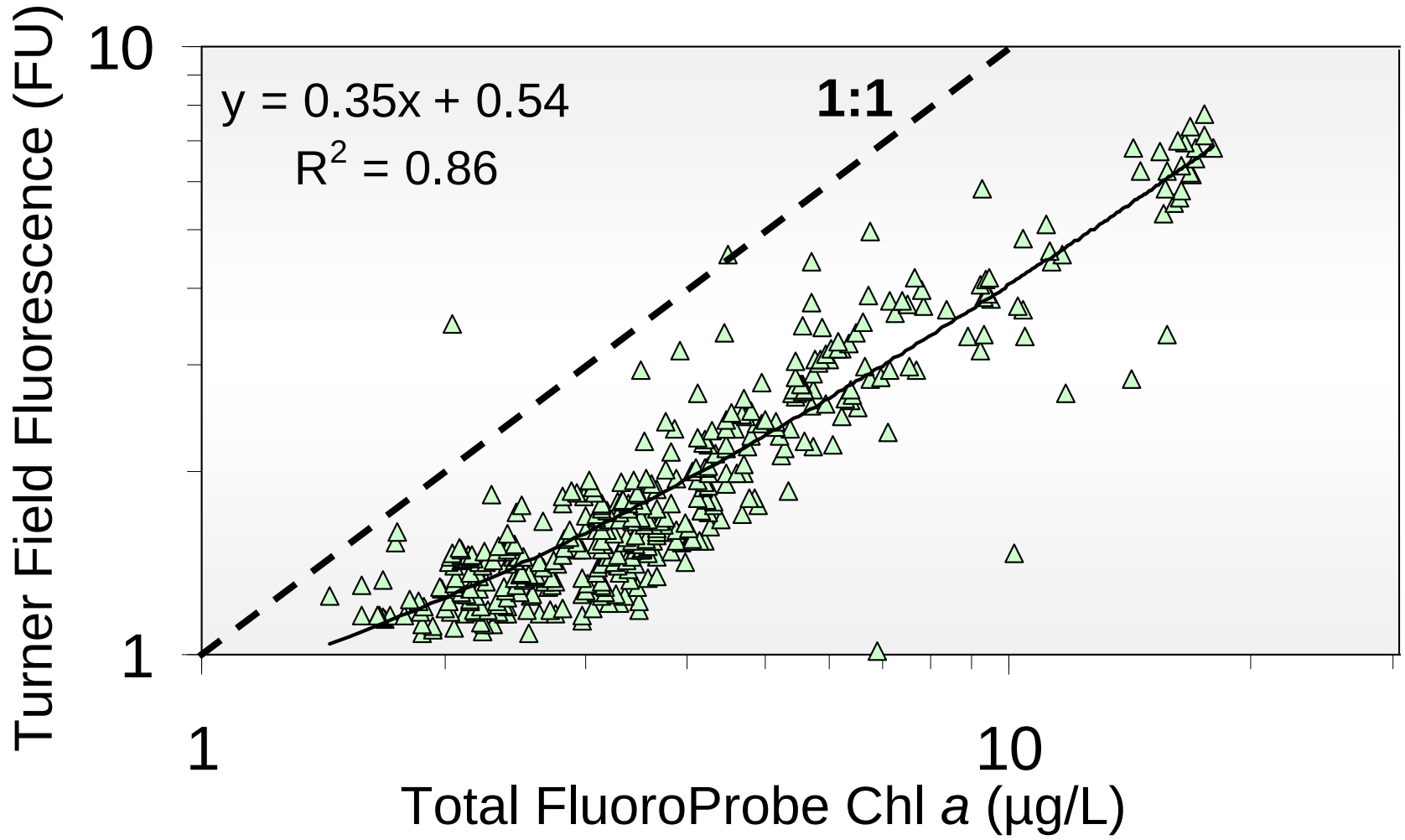
FluoroProbe predicts, but underestimates community Chl *a* in the field; monthly differences

(8 stations, n=77)

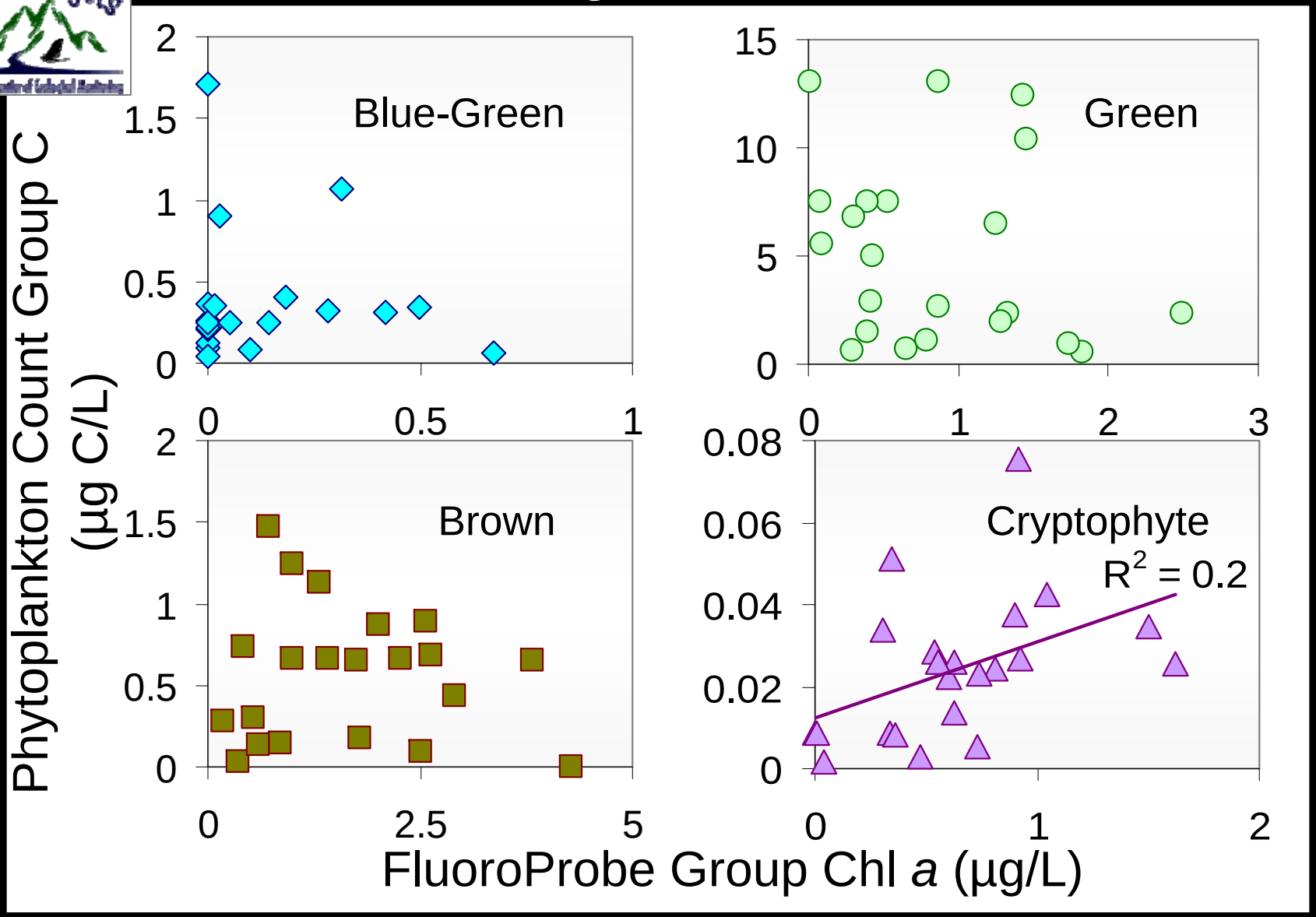


FluoroProbe *vs* Turner 10 AU Field Fluorometer: Good Agreement

August 2008, n=452



Phytoplankton group biomass comparisons: no agreement!



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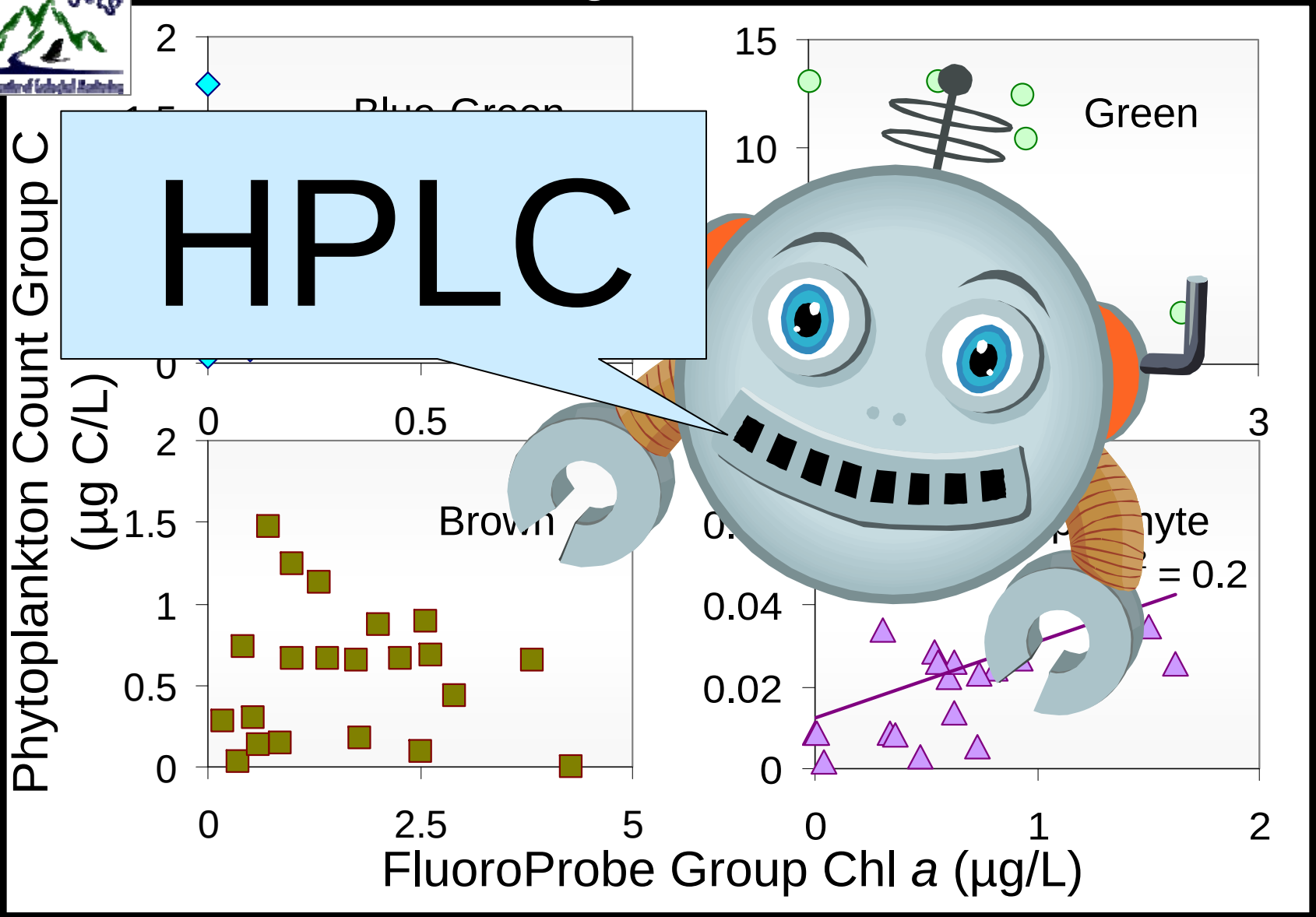

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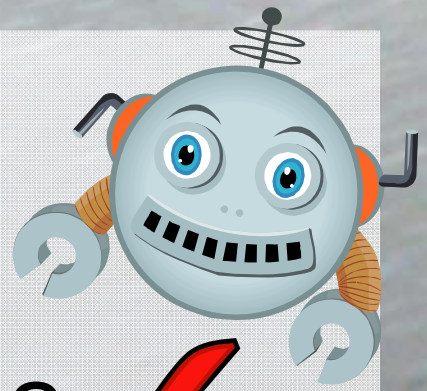
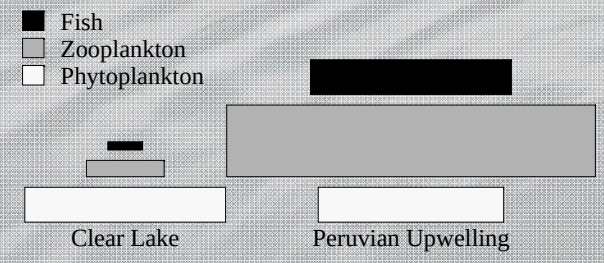


So how does it work?

Does it work here?

- Lab tests
- Field tests

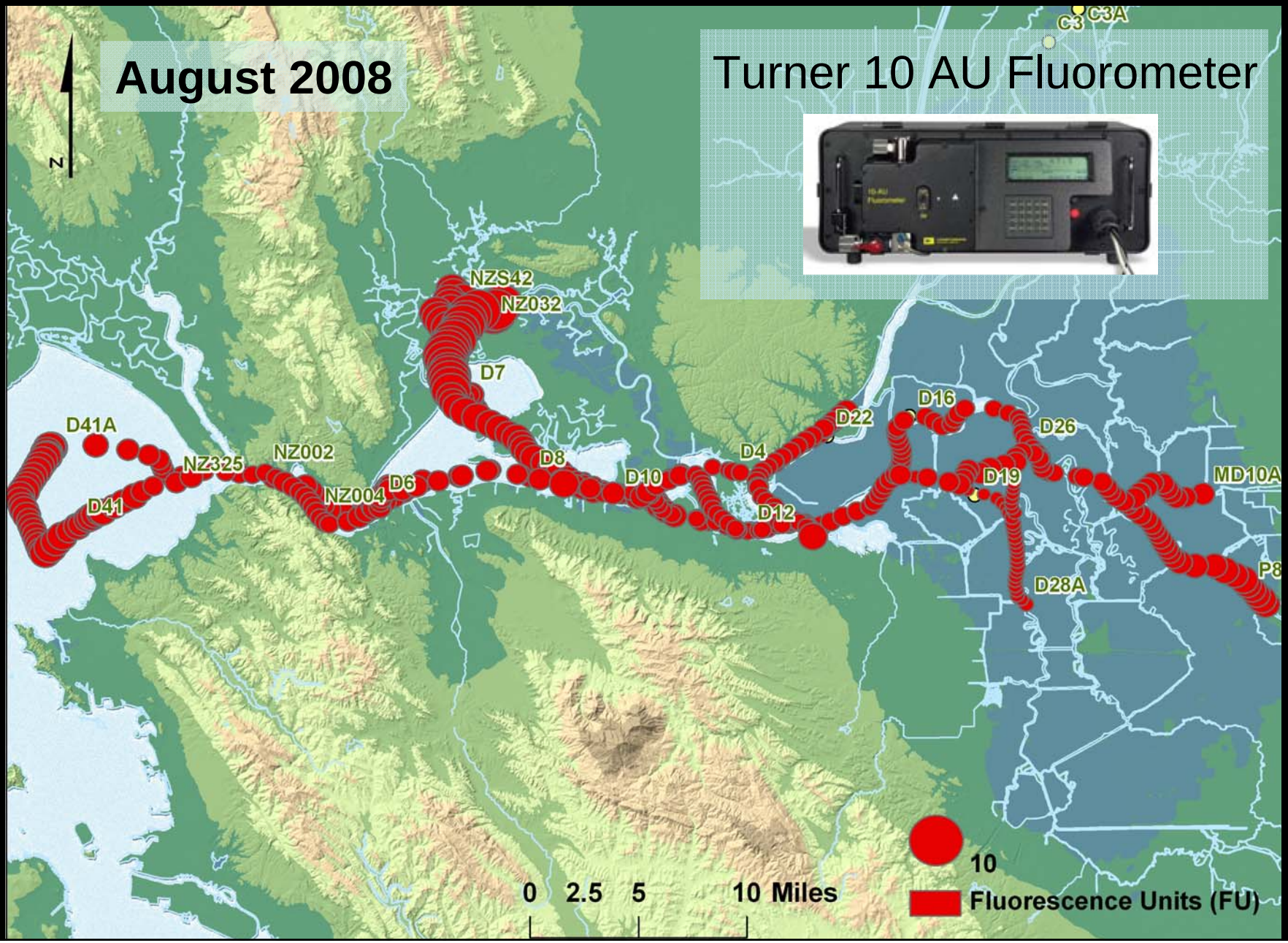
Is it useful?
(*Applications*)



Applications so far:

- Horizontal profiles
  - “Food” regions? Boundaries?
  - Seasonal succession?
  - Local hot spots?
- Vertical profiles - Stratification?
- Long-term deployments

1. Horizontal Profiles – Phytoplankton Regions?



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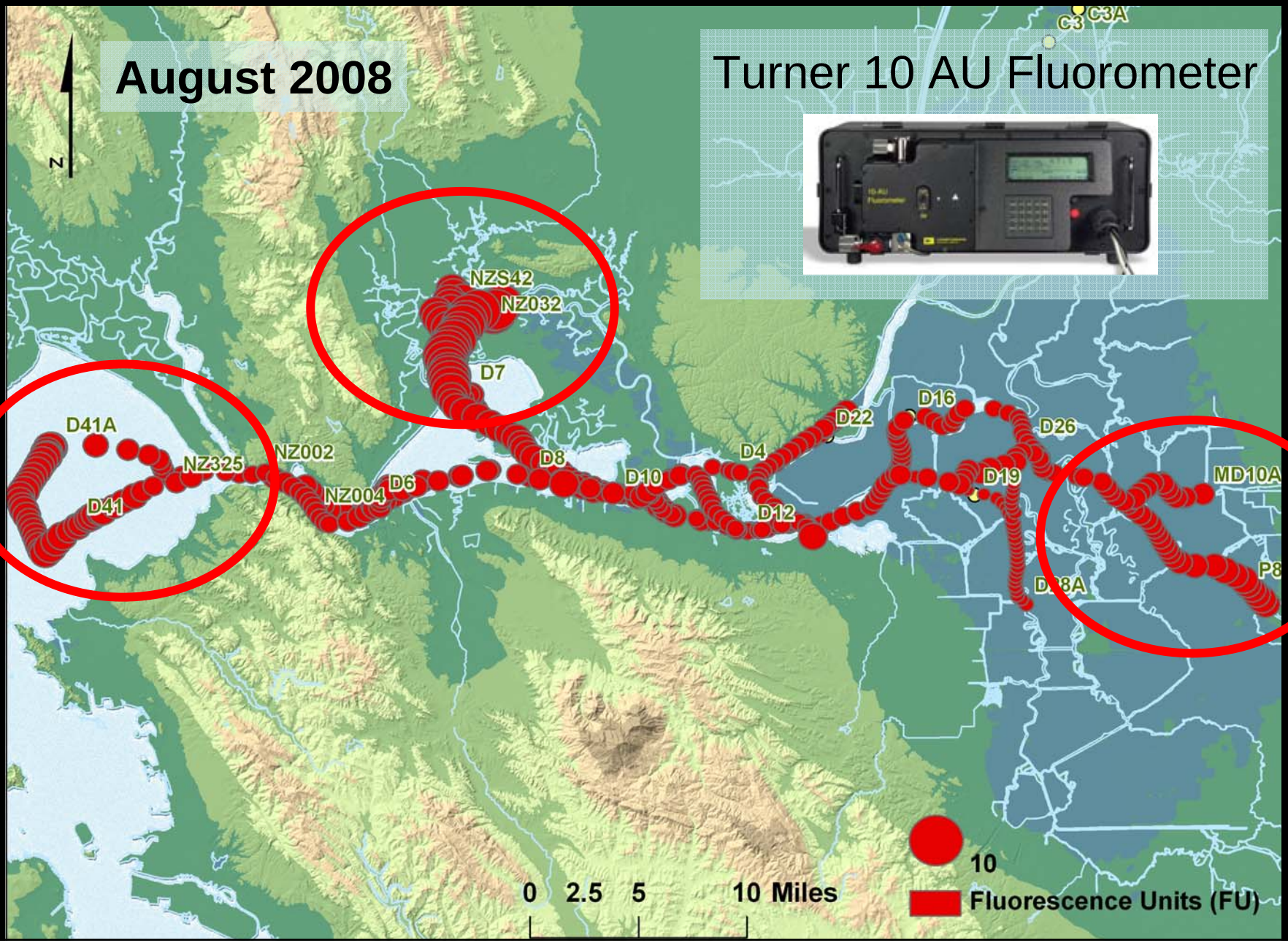

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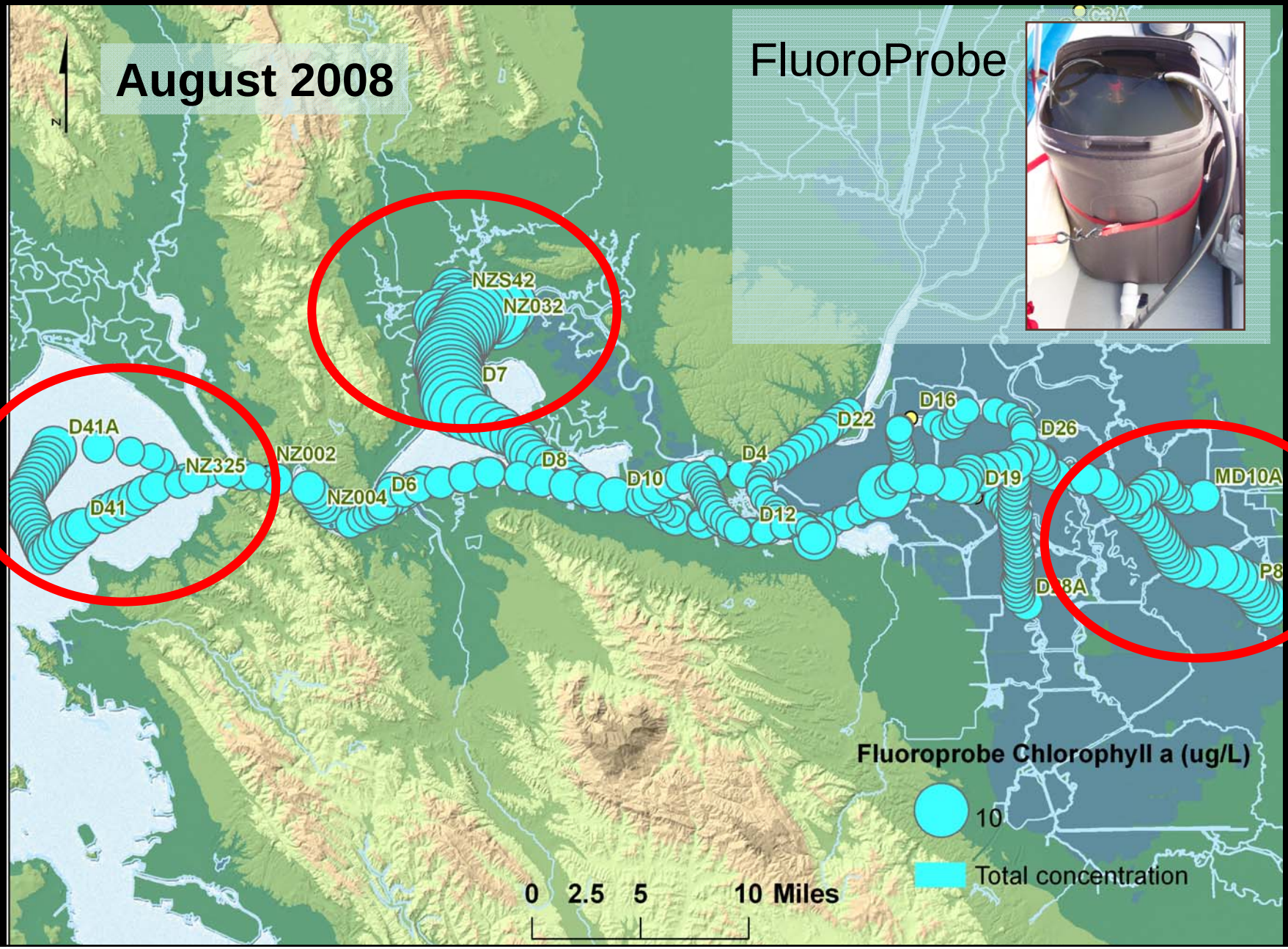

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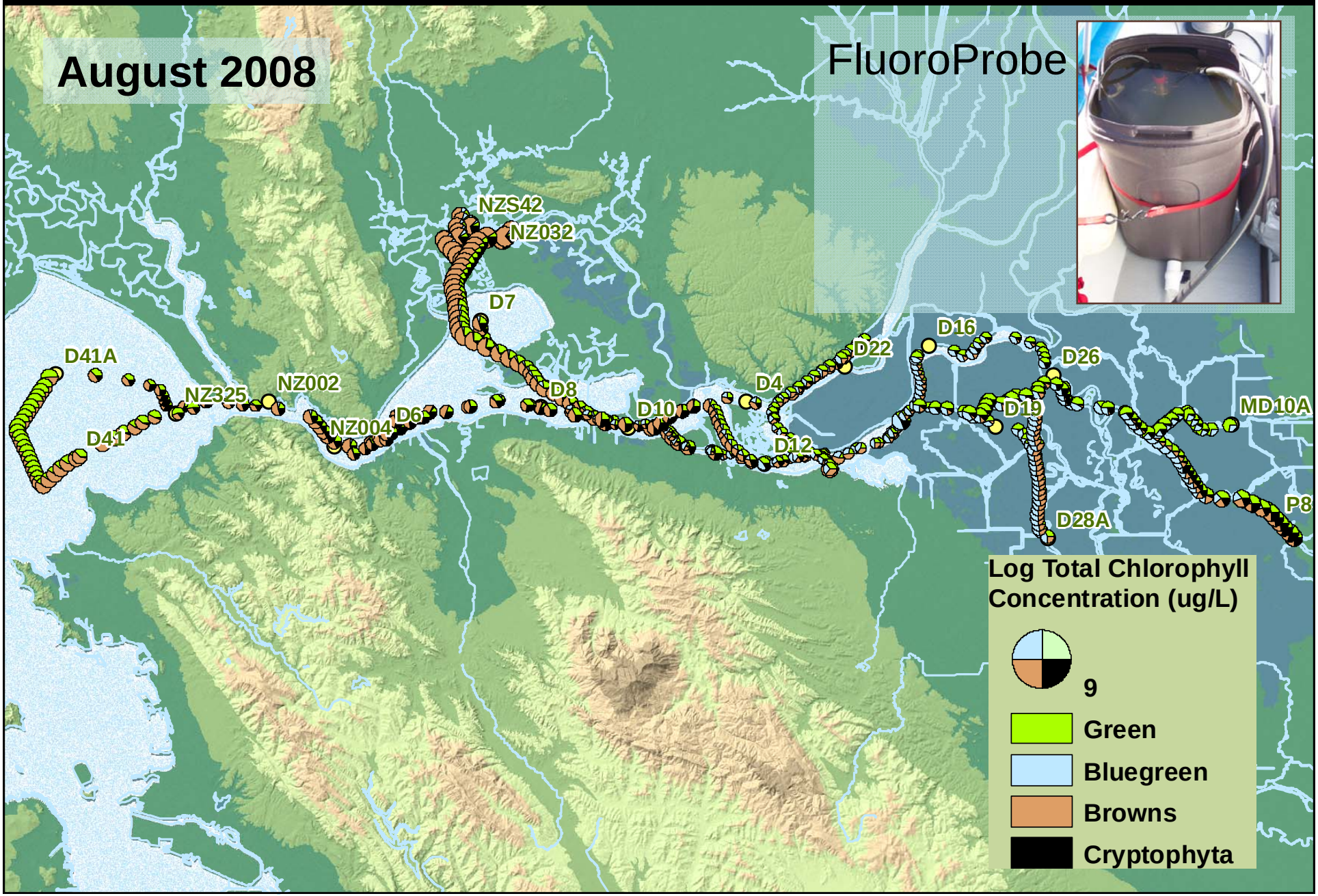
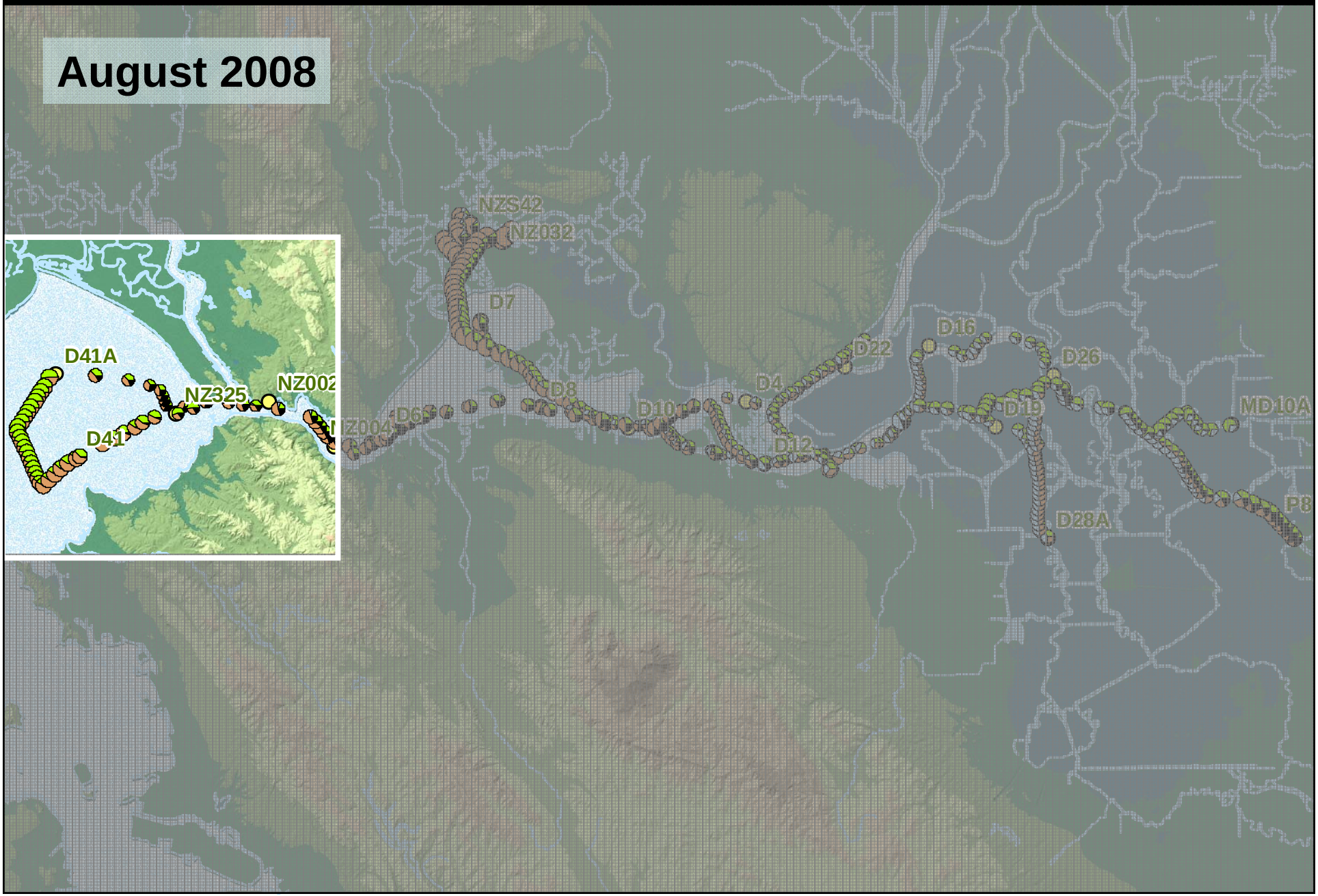
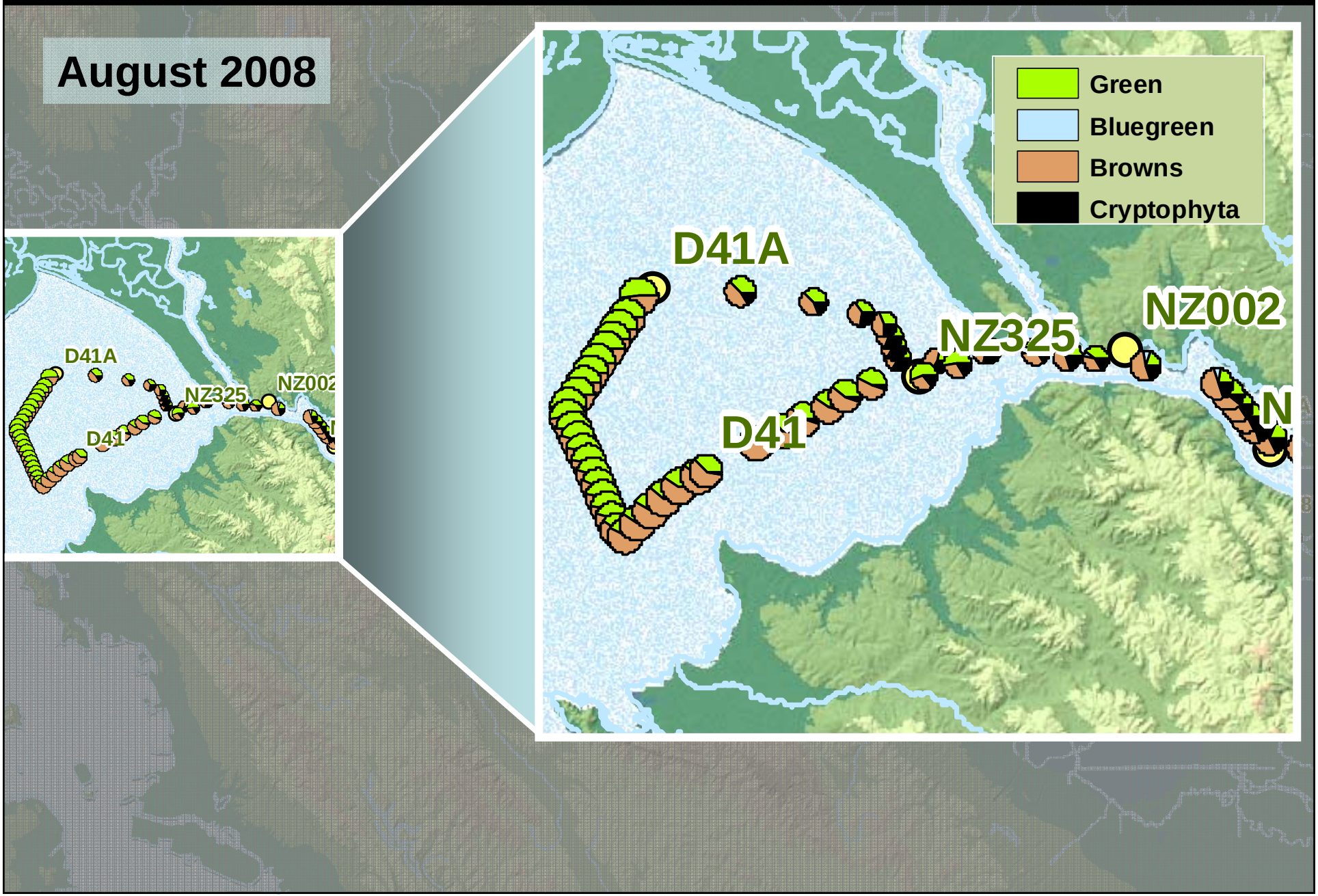


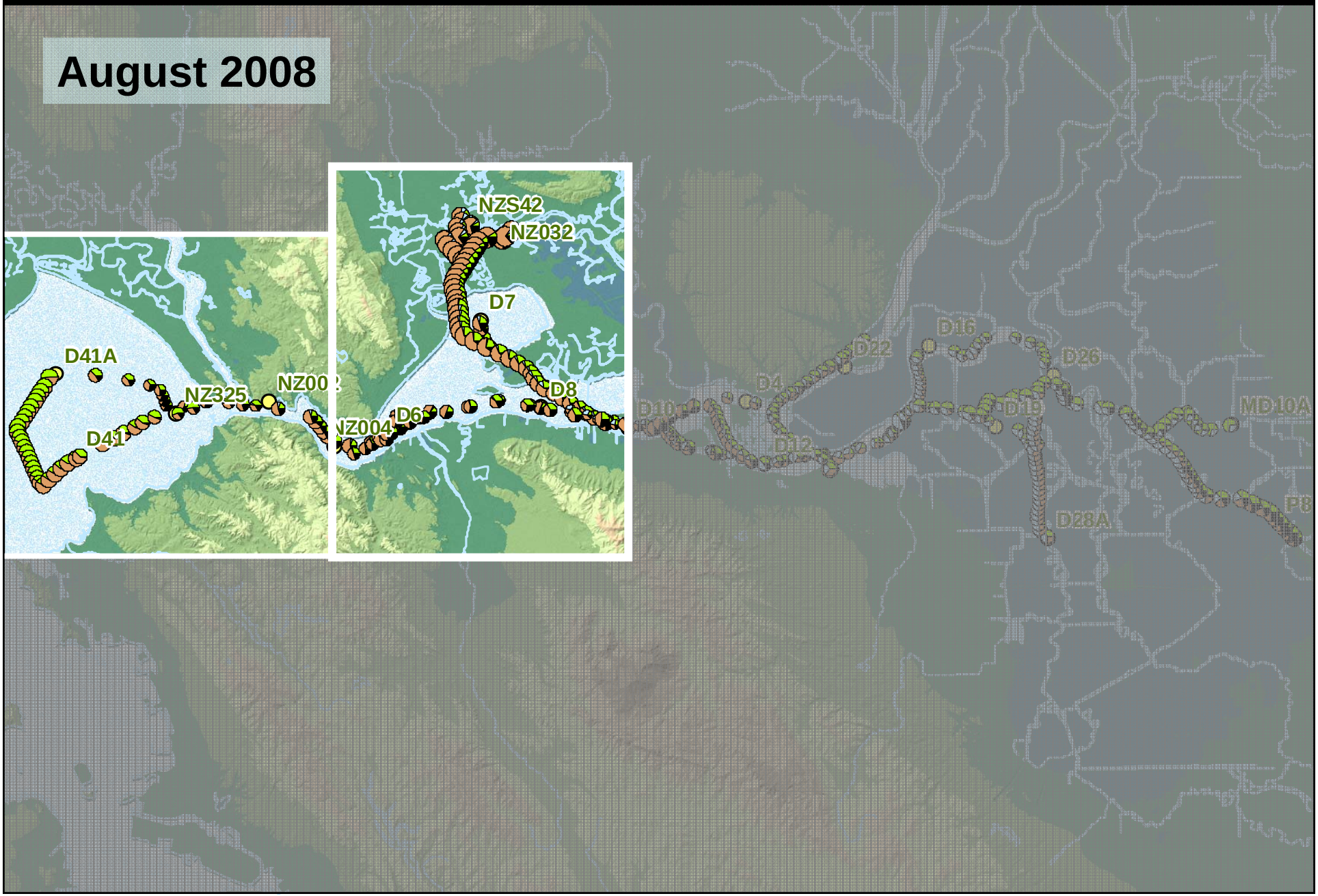
San Pablo Bay



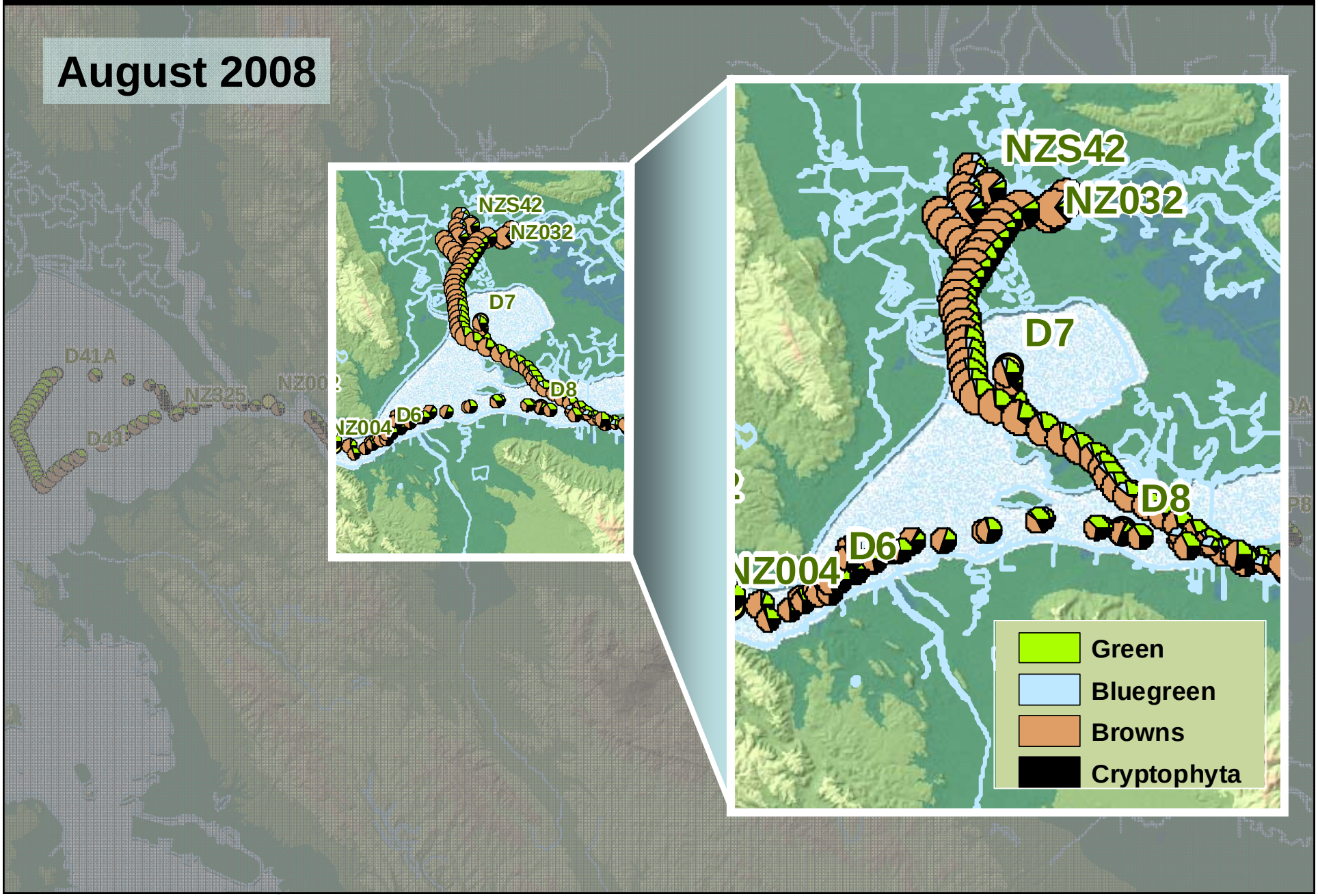
San Pablo Bay: Browns & Greens



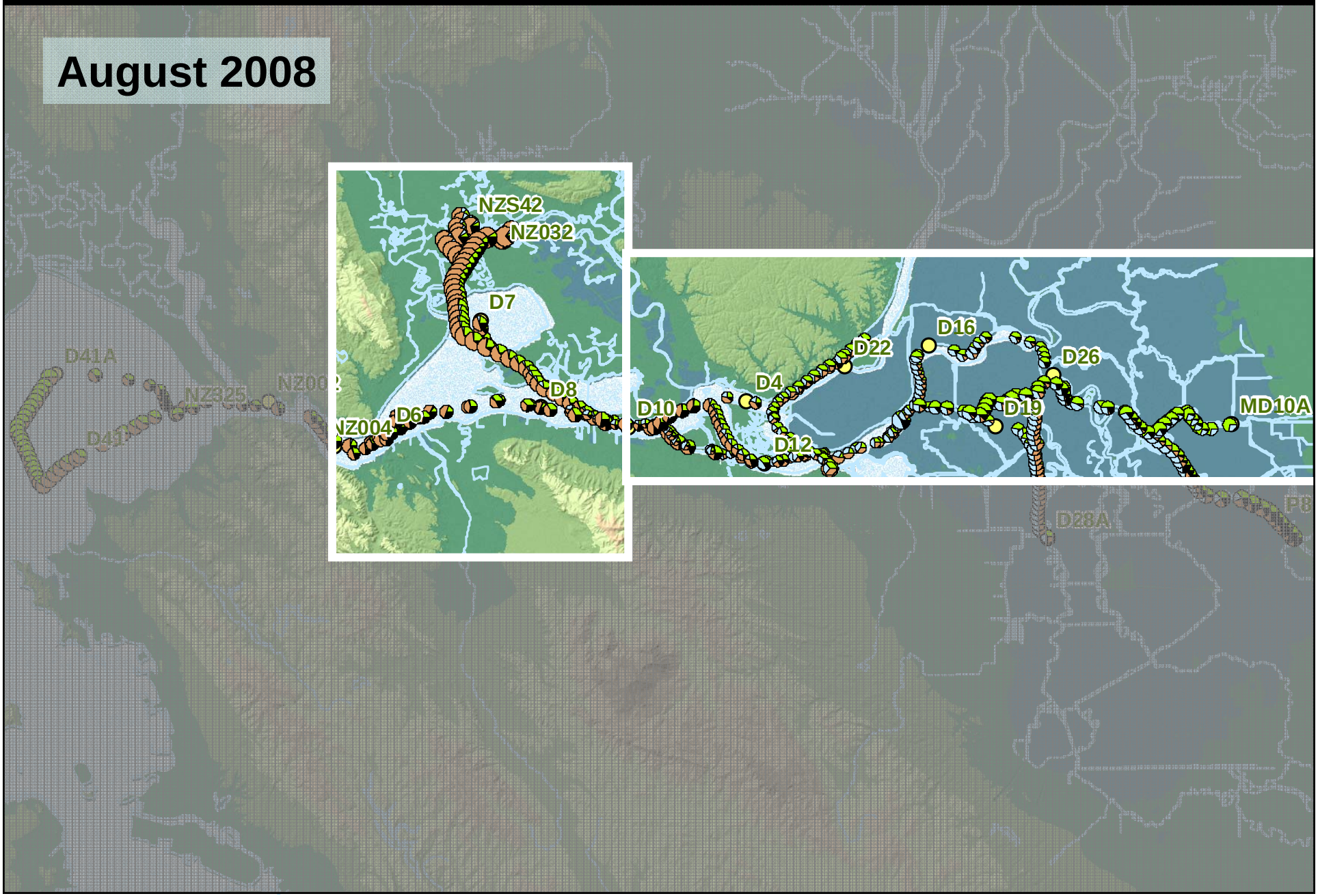
Suisun & Confluence



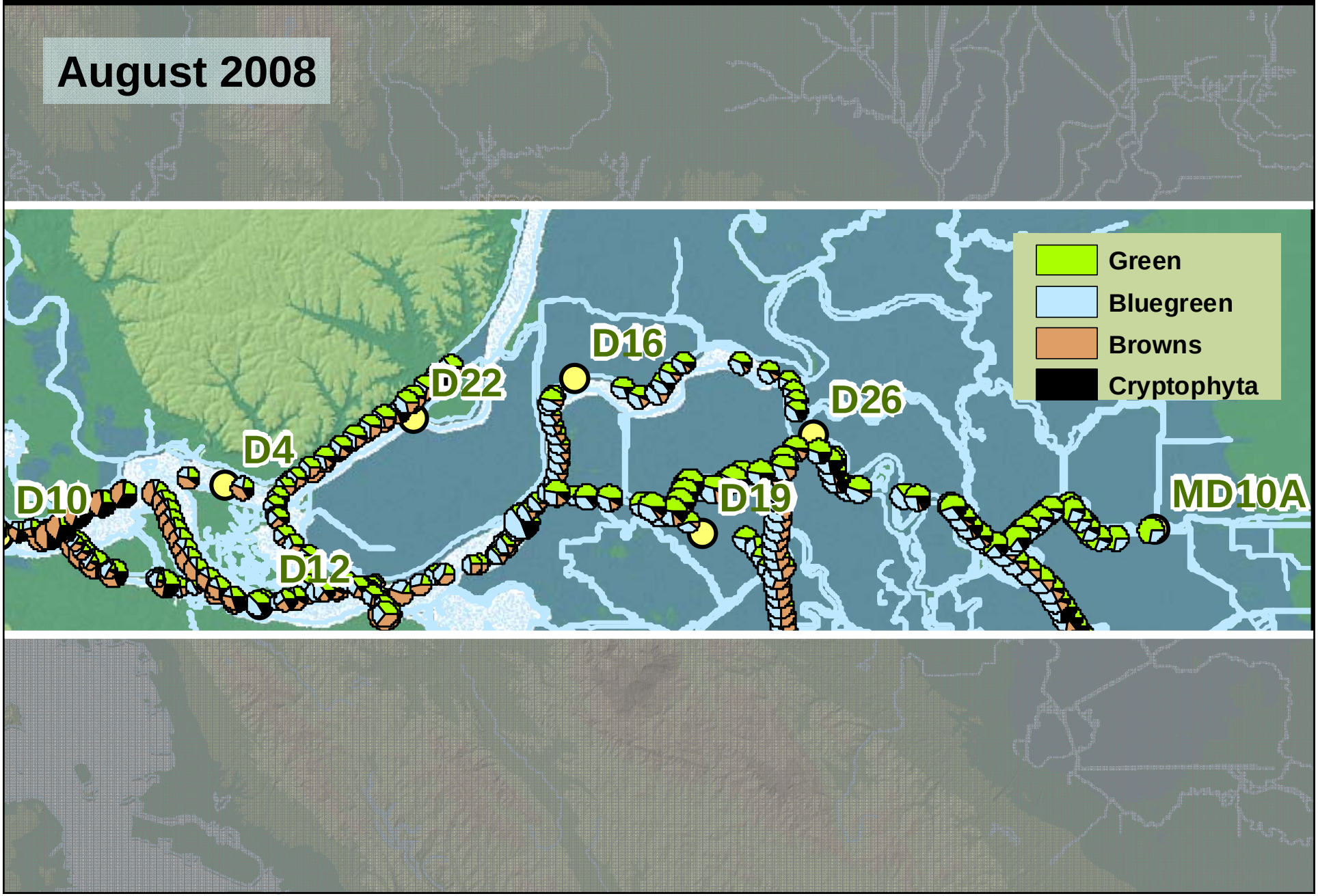
Suisun Bay & Marsh: Browns & Greens



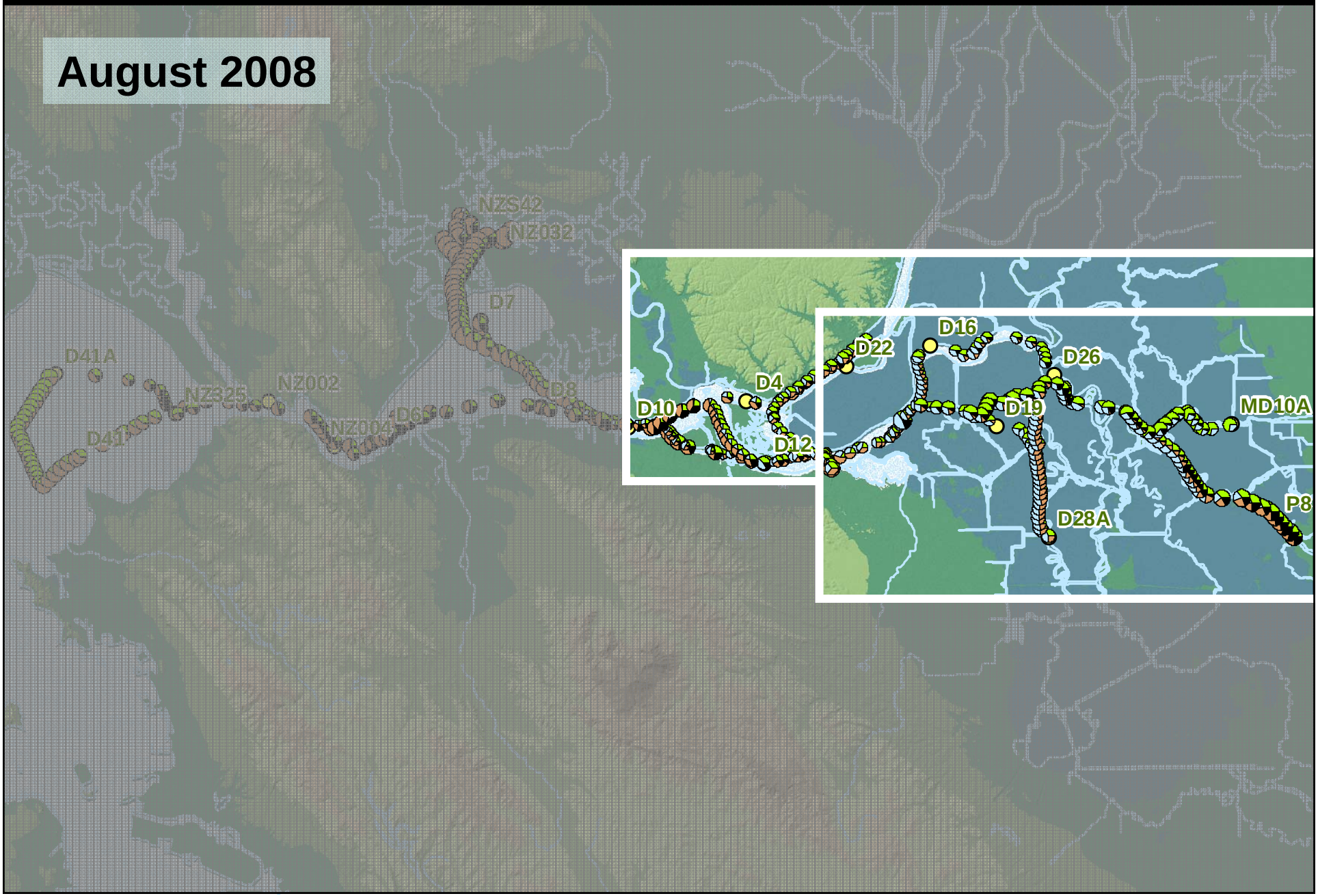
Confluence & Central Delta



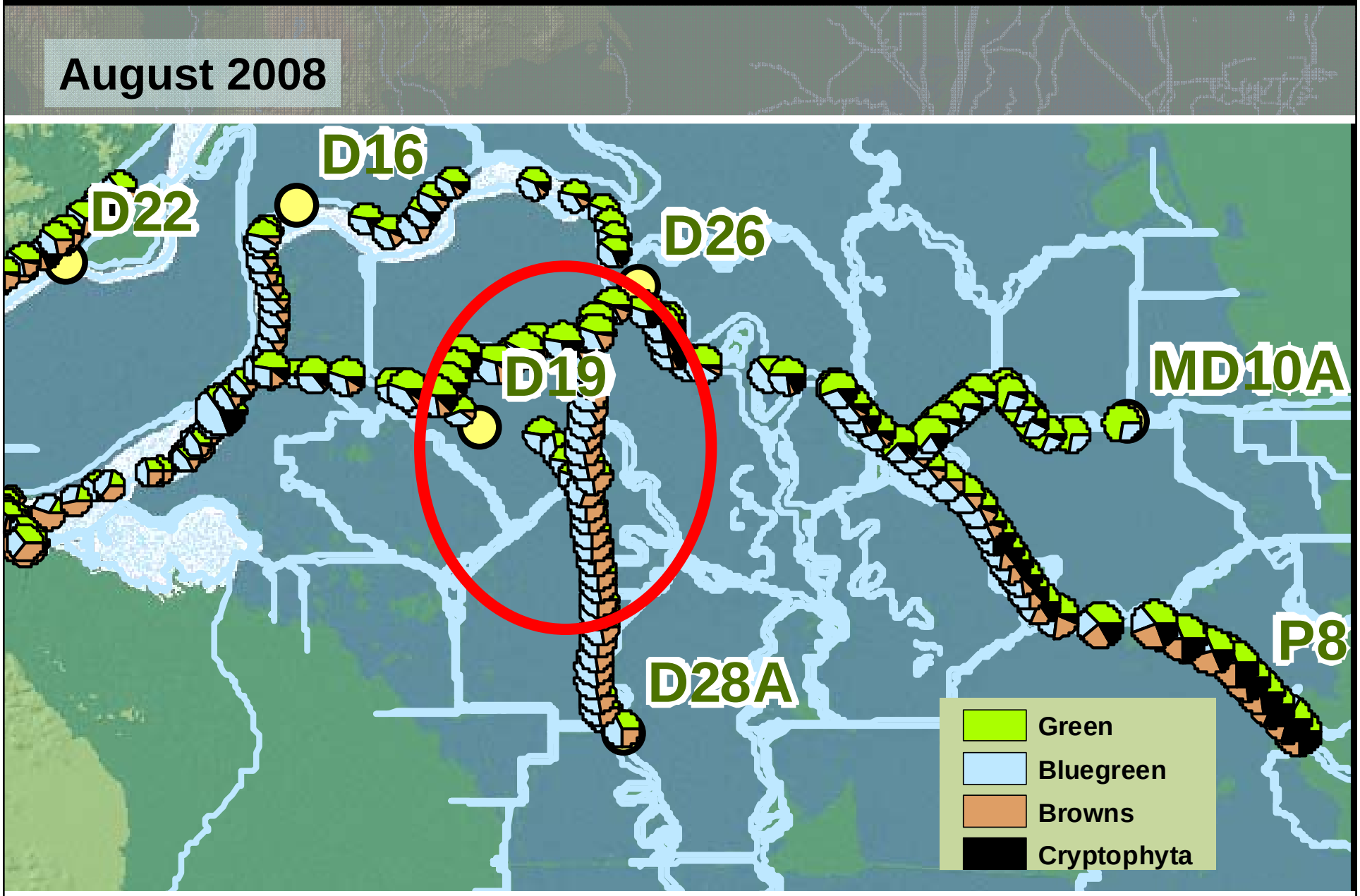
Confluence & Central Delta: The “Green belt”



South-Central Delta/San Joaquin

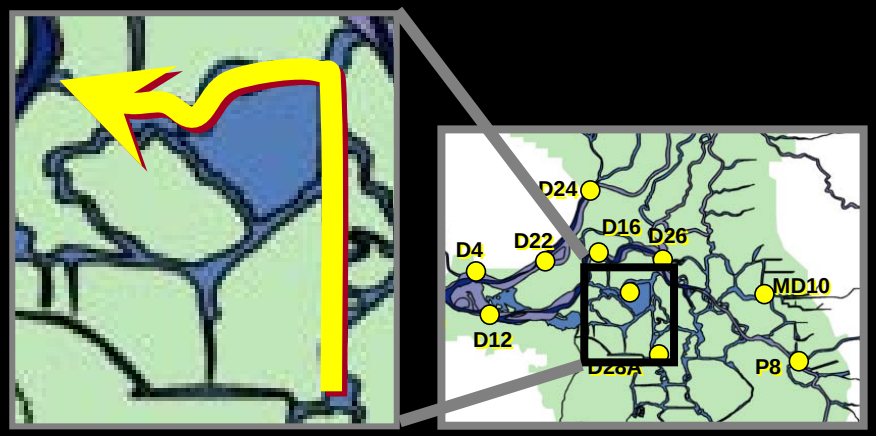


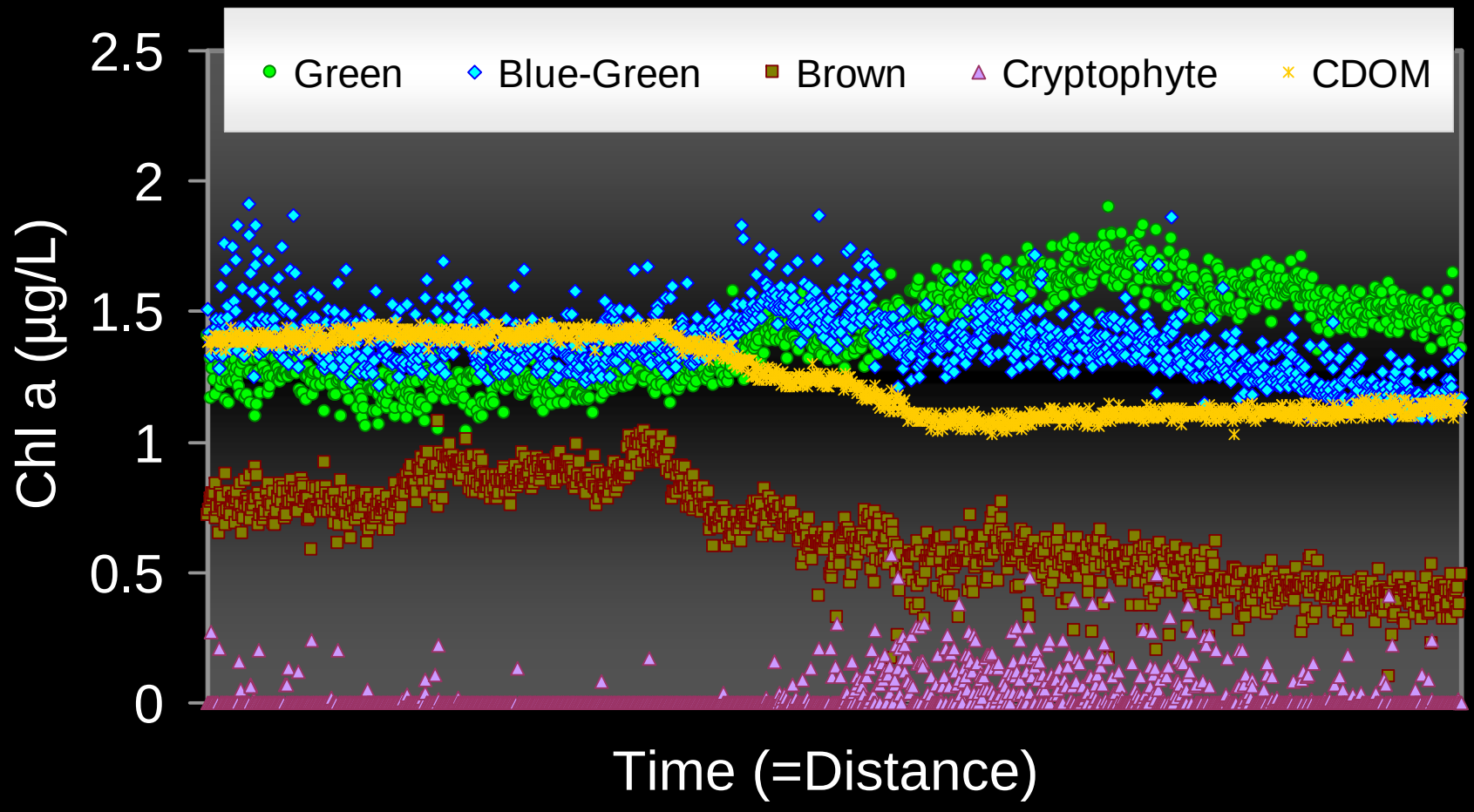
South-Central Delta/San Joaquin: Blue-Greens

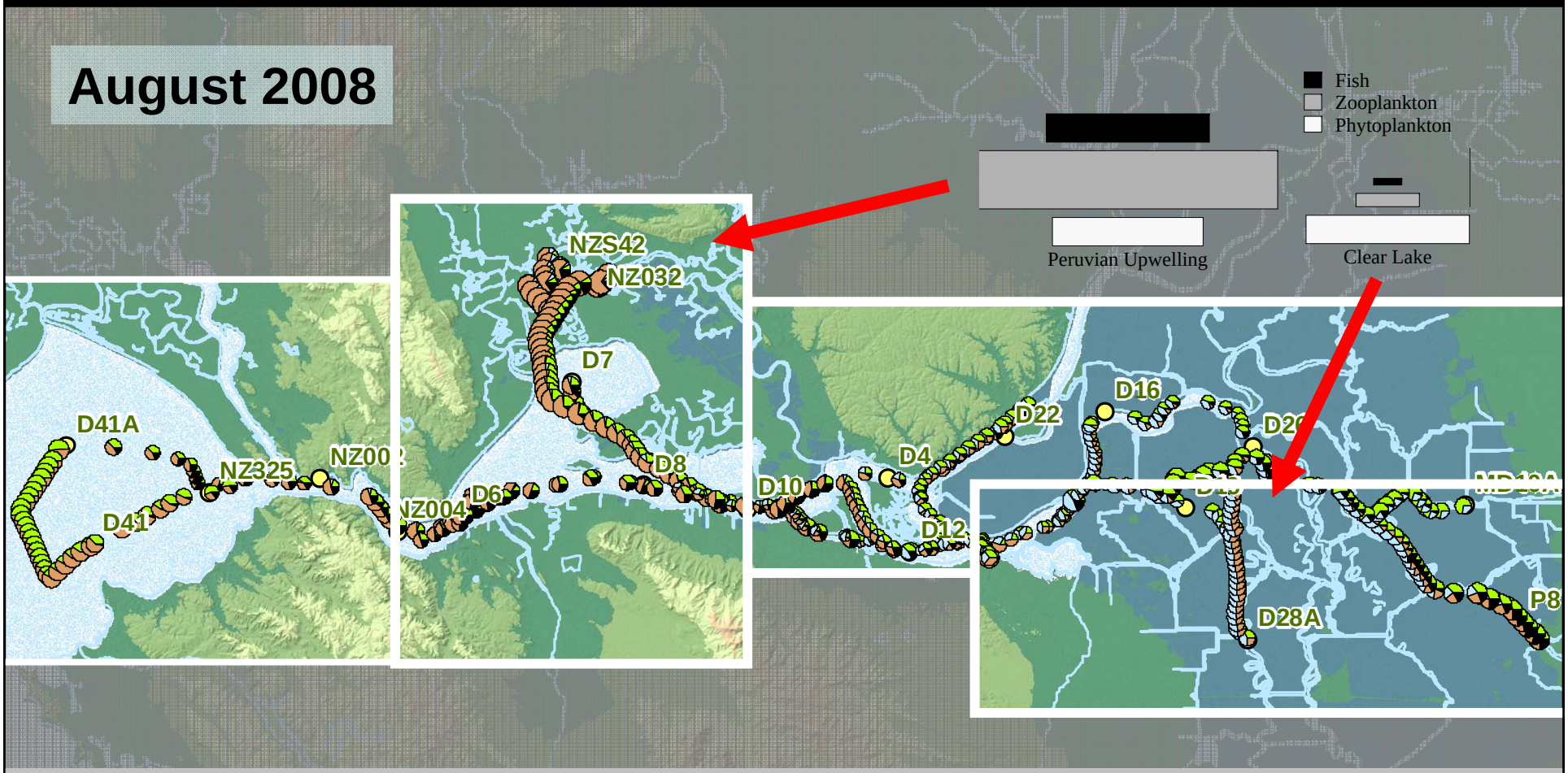


Old River to False River

August 08



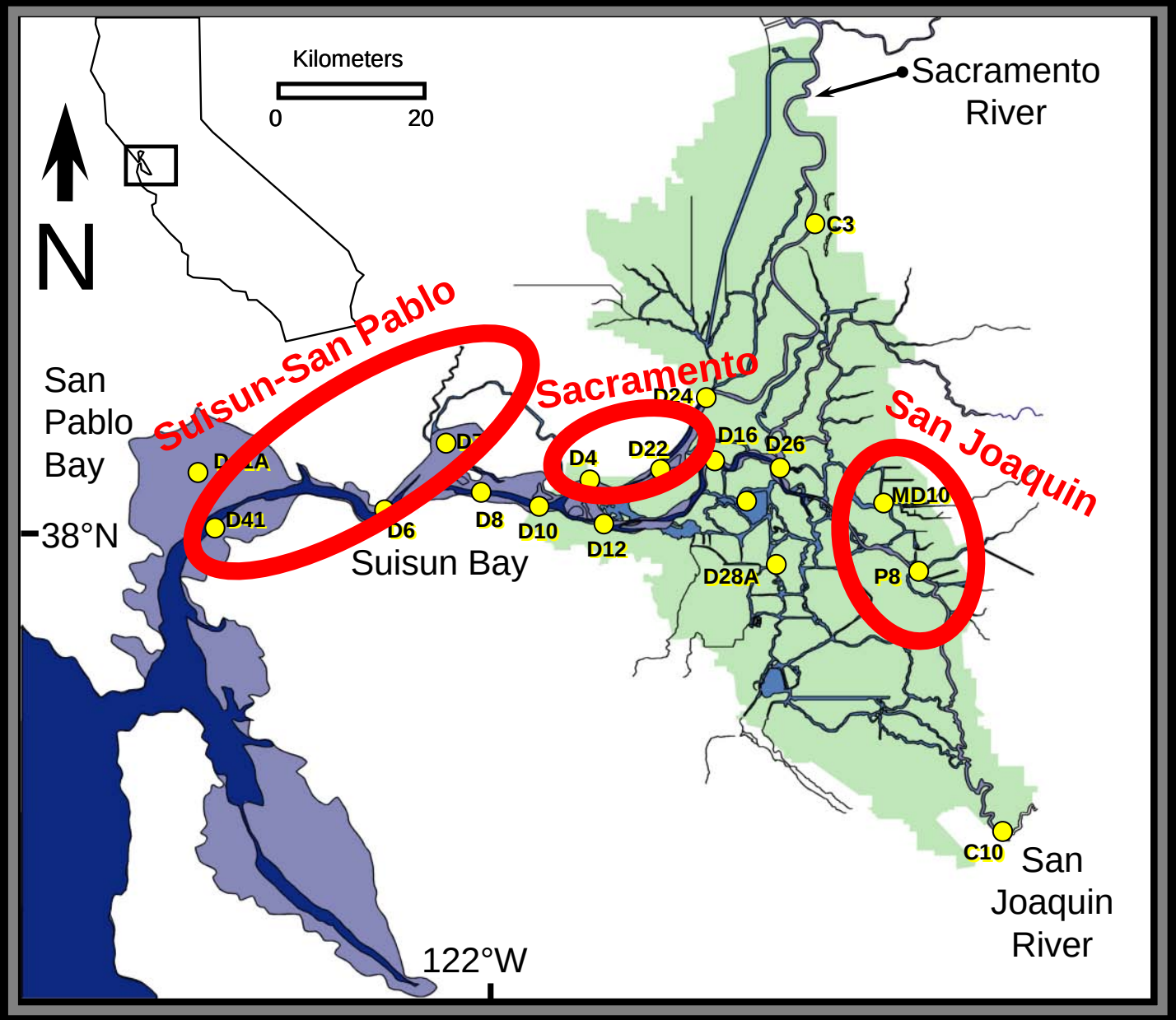




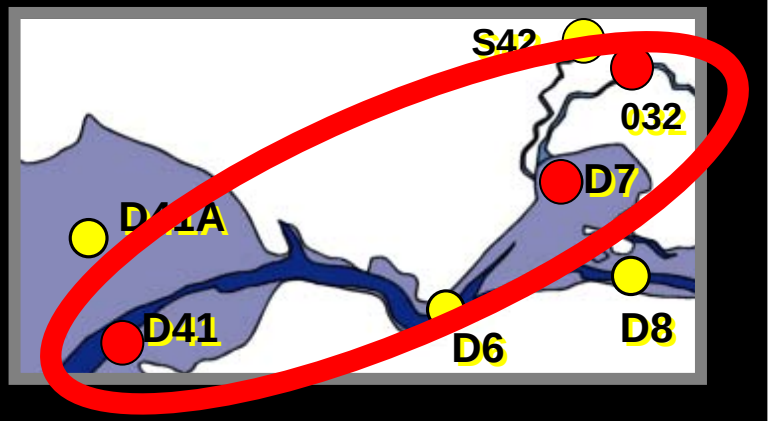
Greens & Browns Browns "Green-Belt"

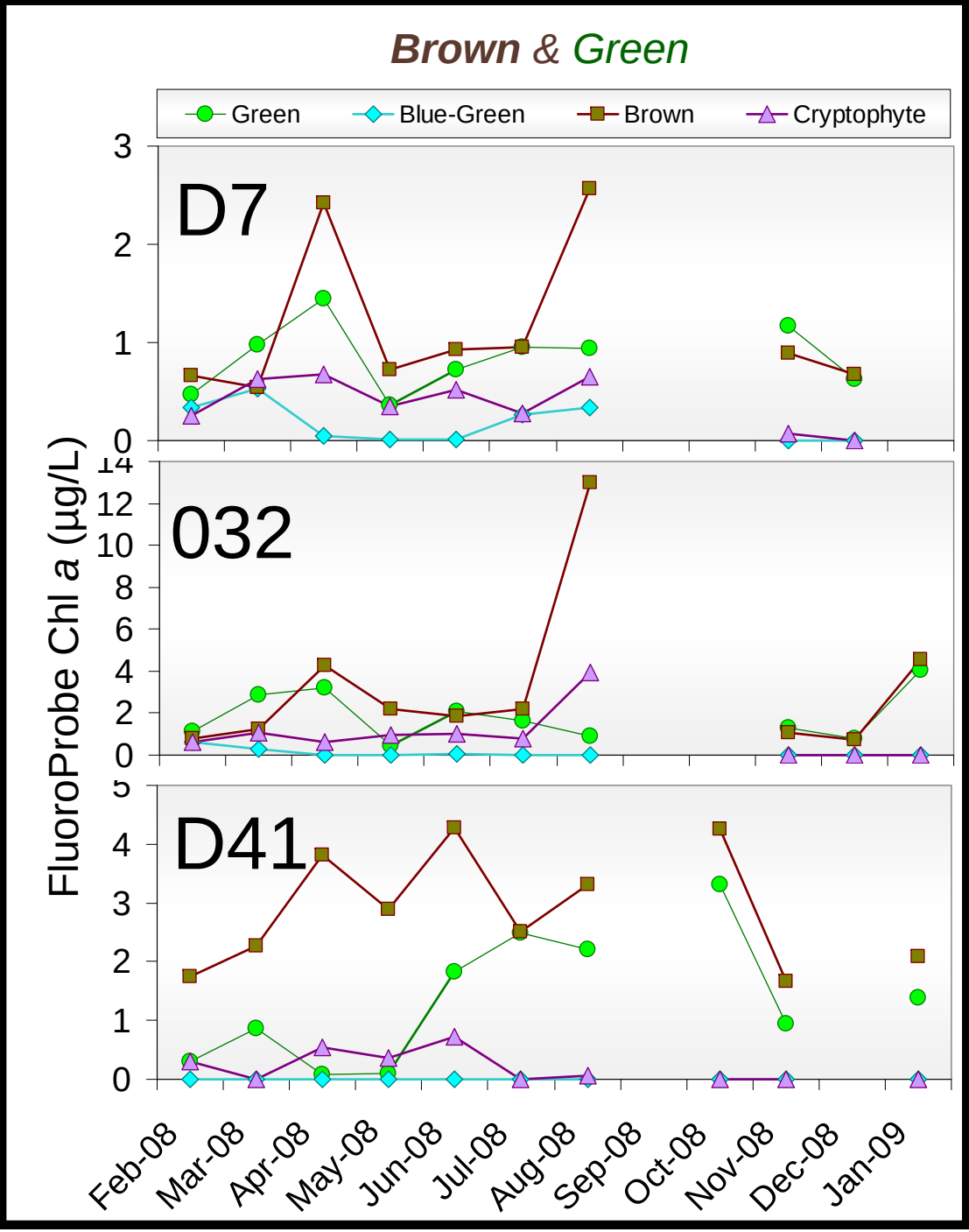
Blue-Greens

2. Phytoplankton seasonal succession (2008)

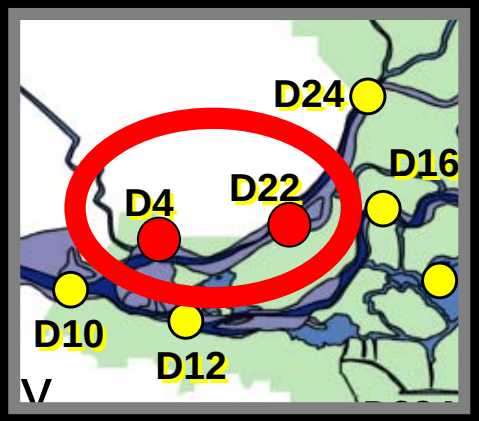


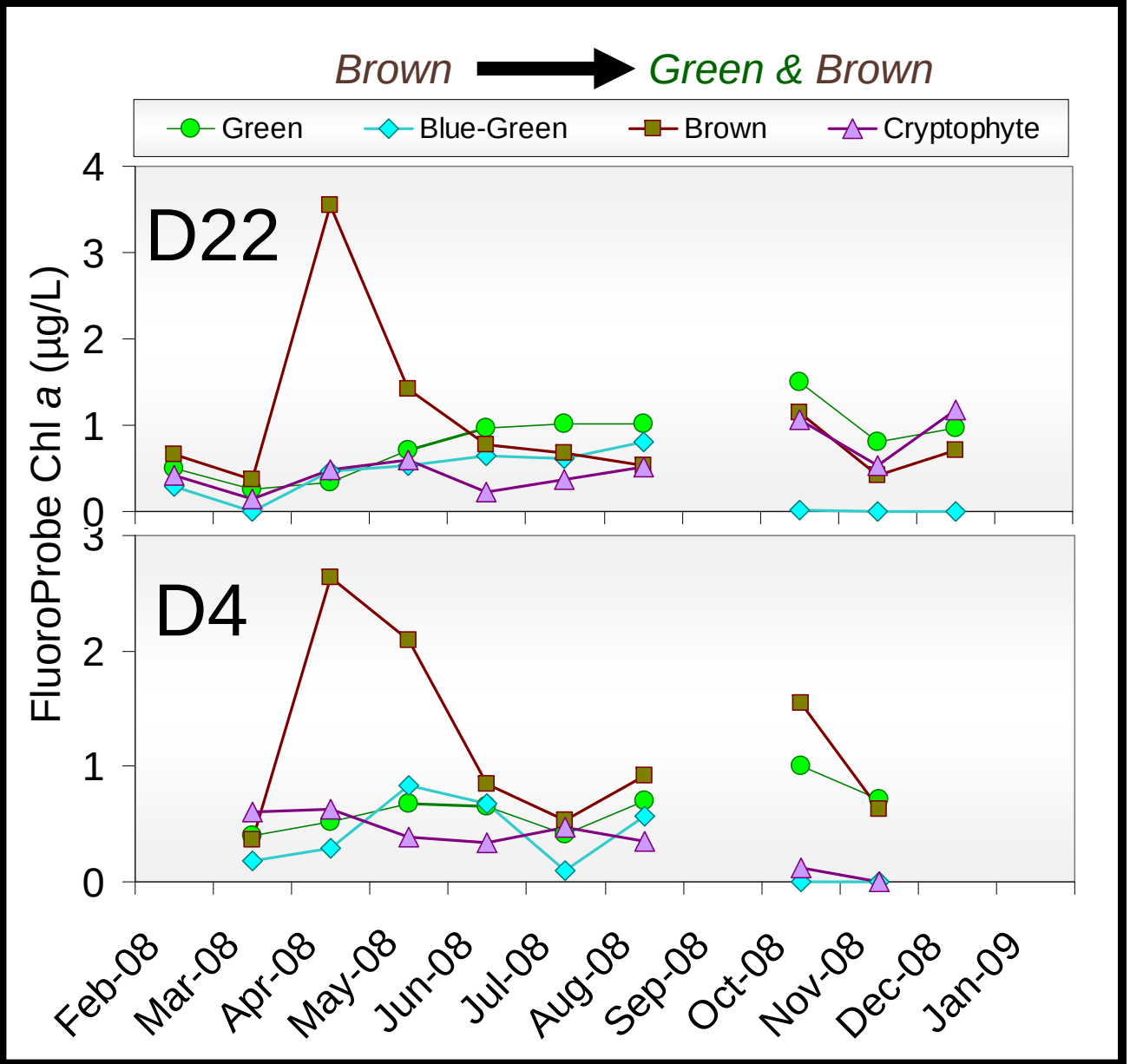
Suisun & San Pablo: Brown (& green)



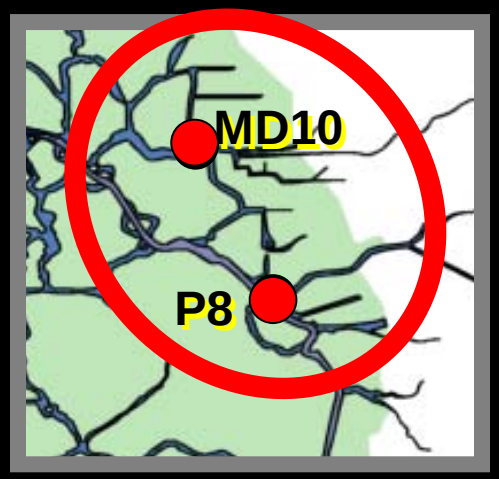


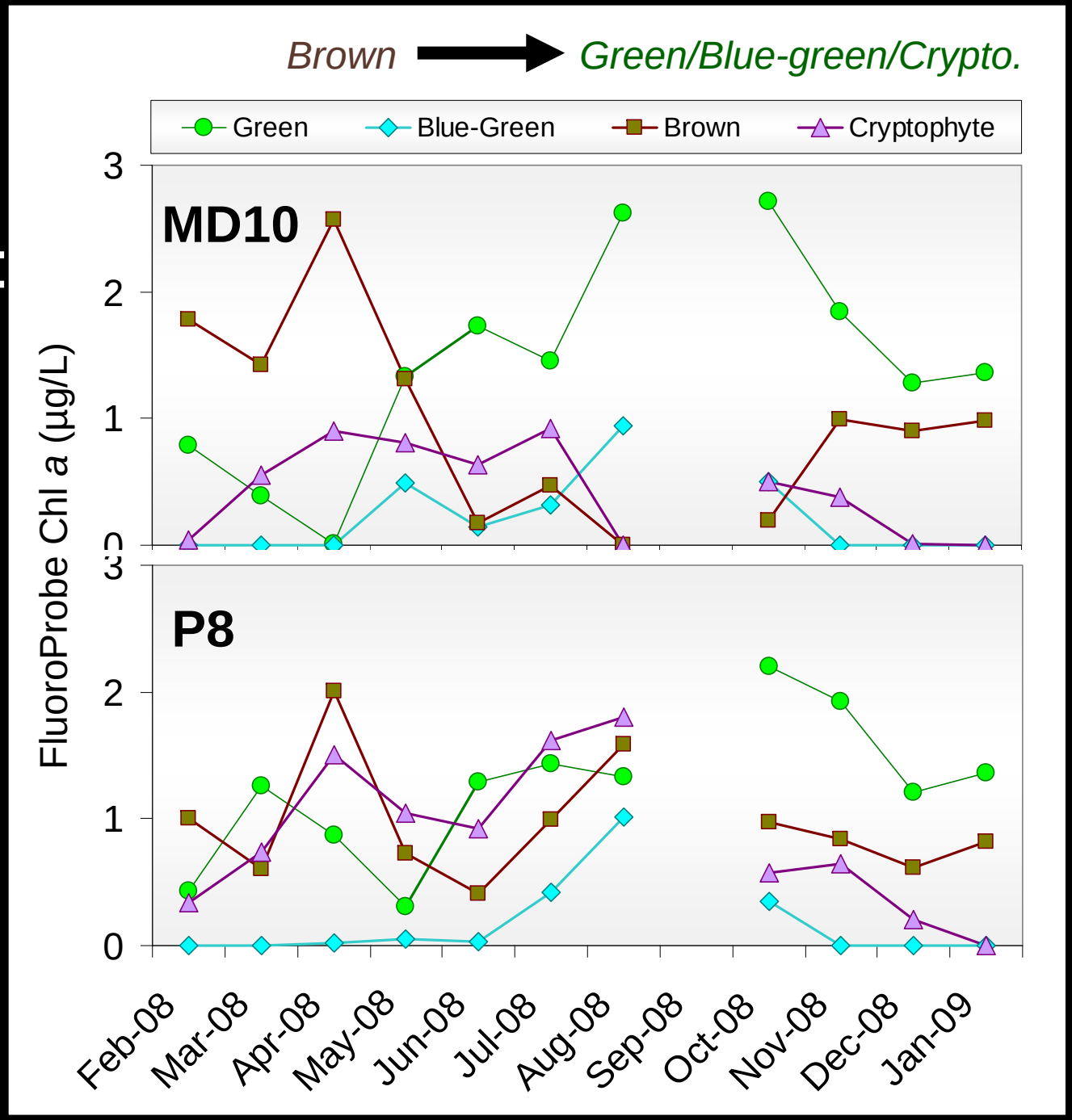
Lower Sacramento: Brown, then Green & Brown



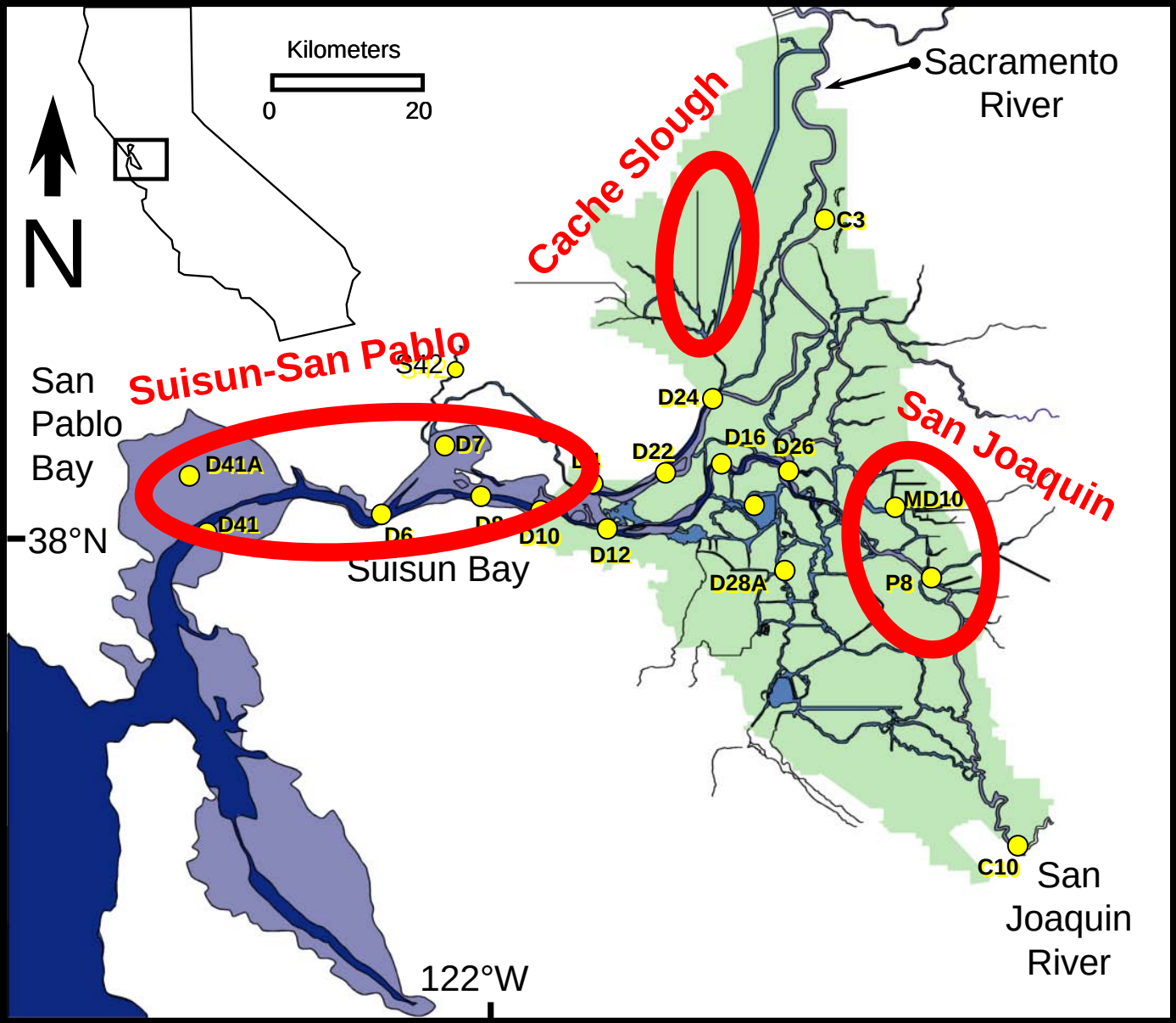


San Joaquin/ Eastern Delta: Brown, then Green

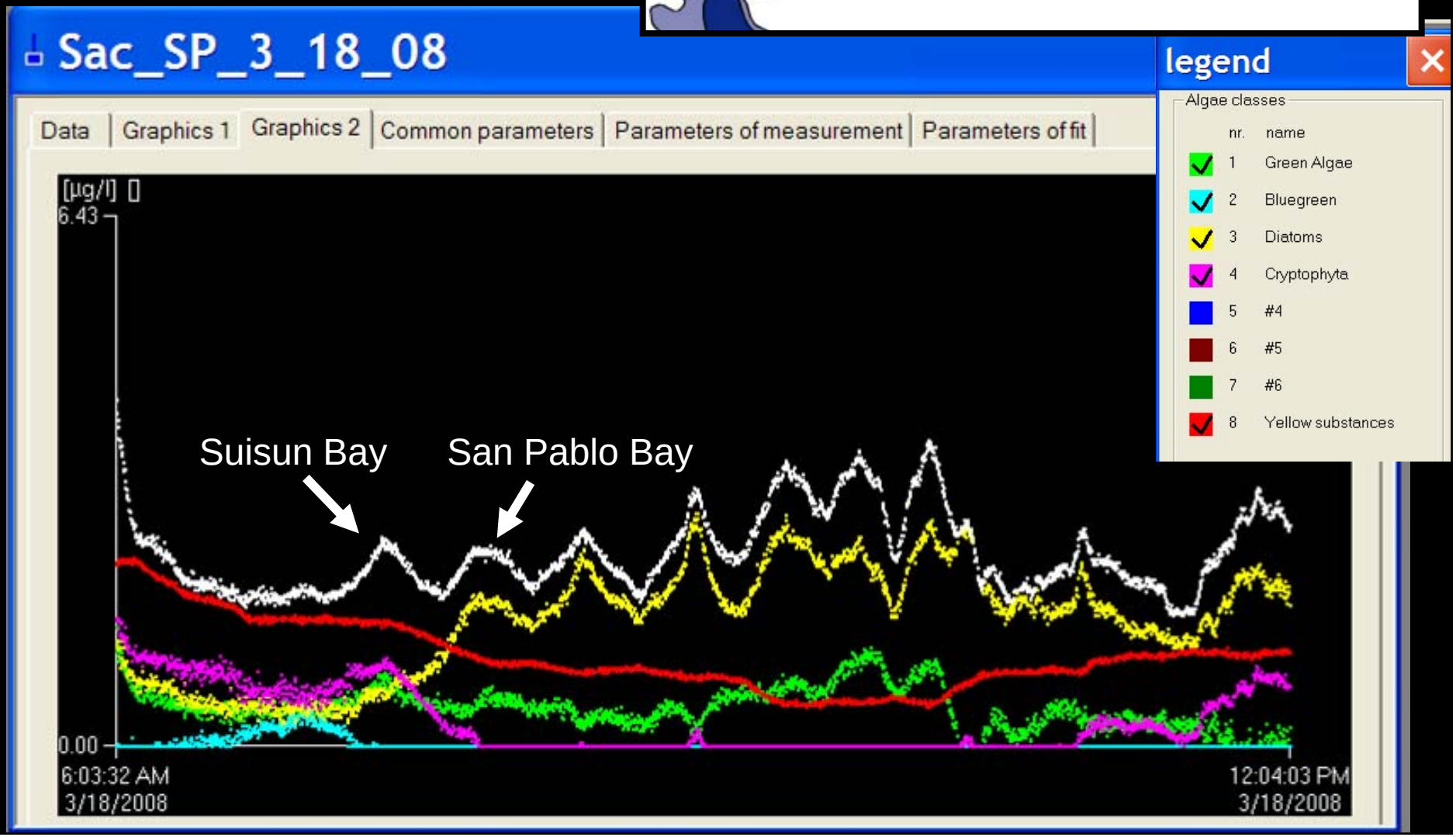




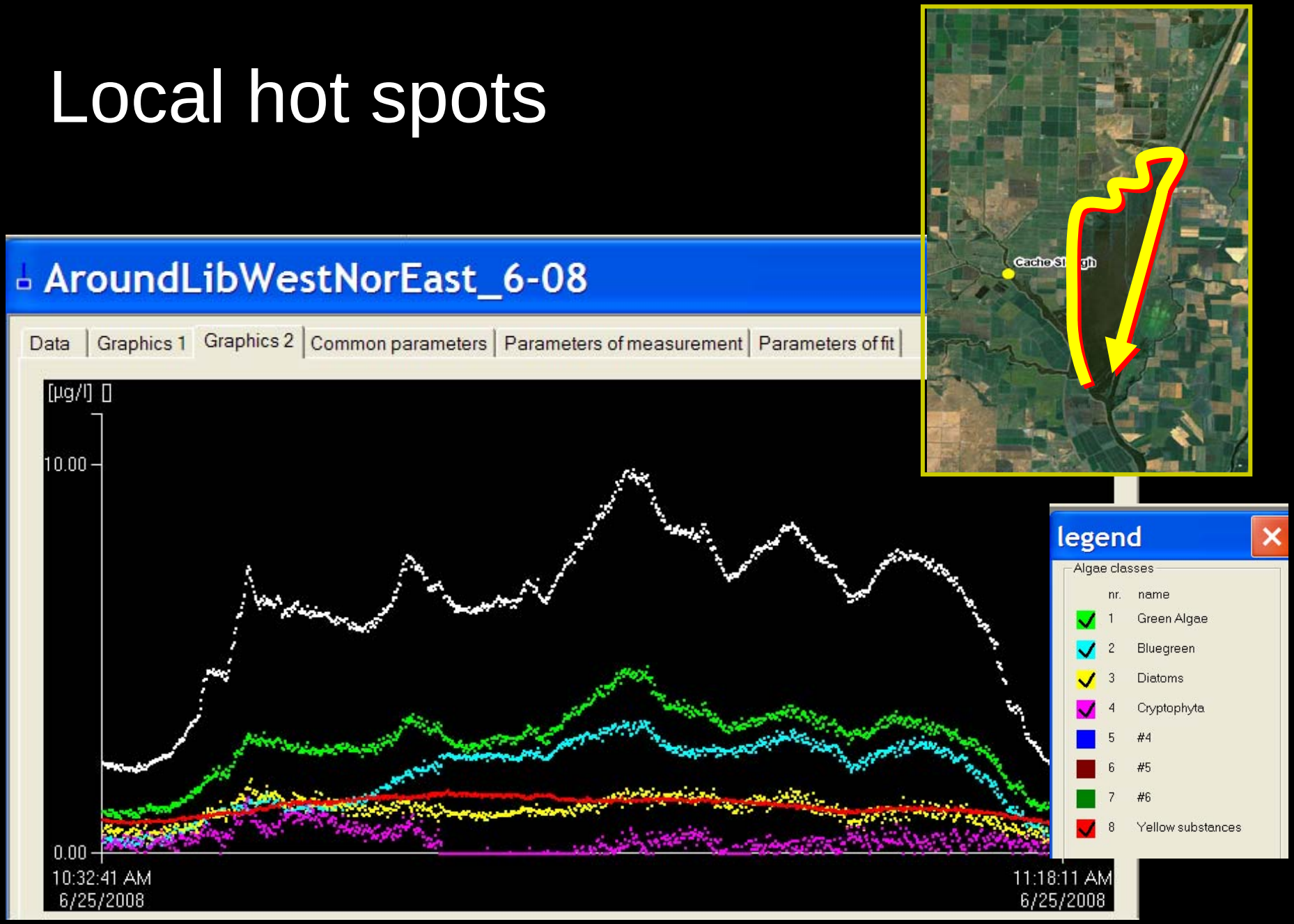
3. Local hot spots



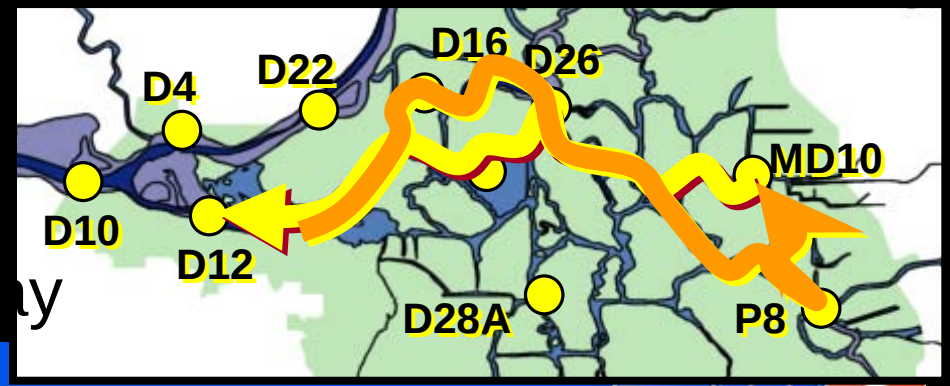
Local hot spots

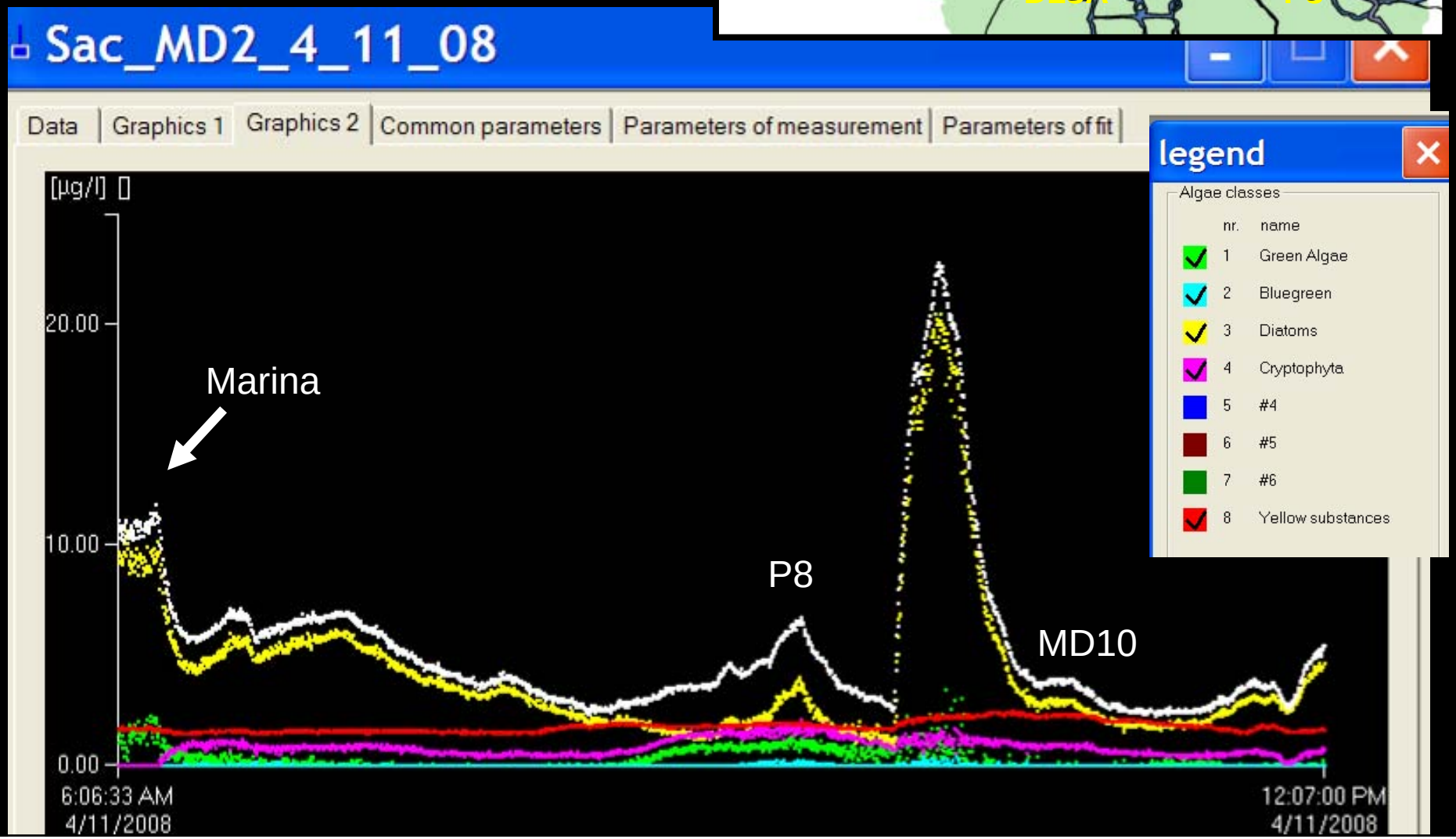


Local hot spots

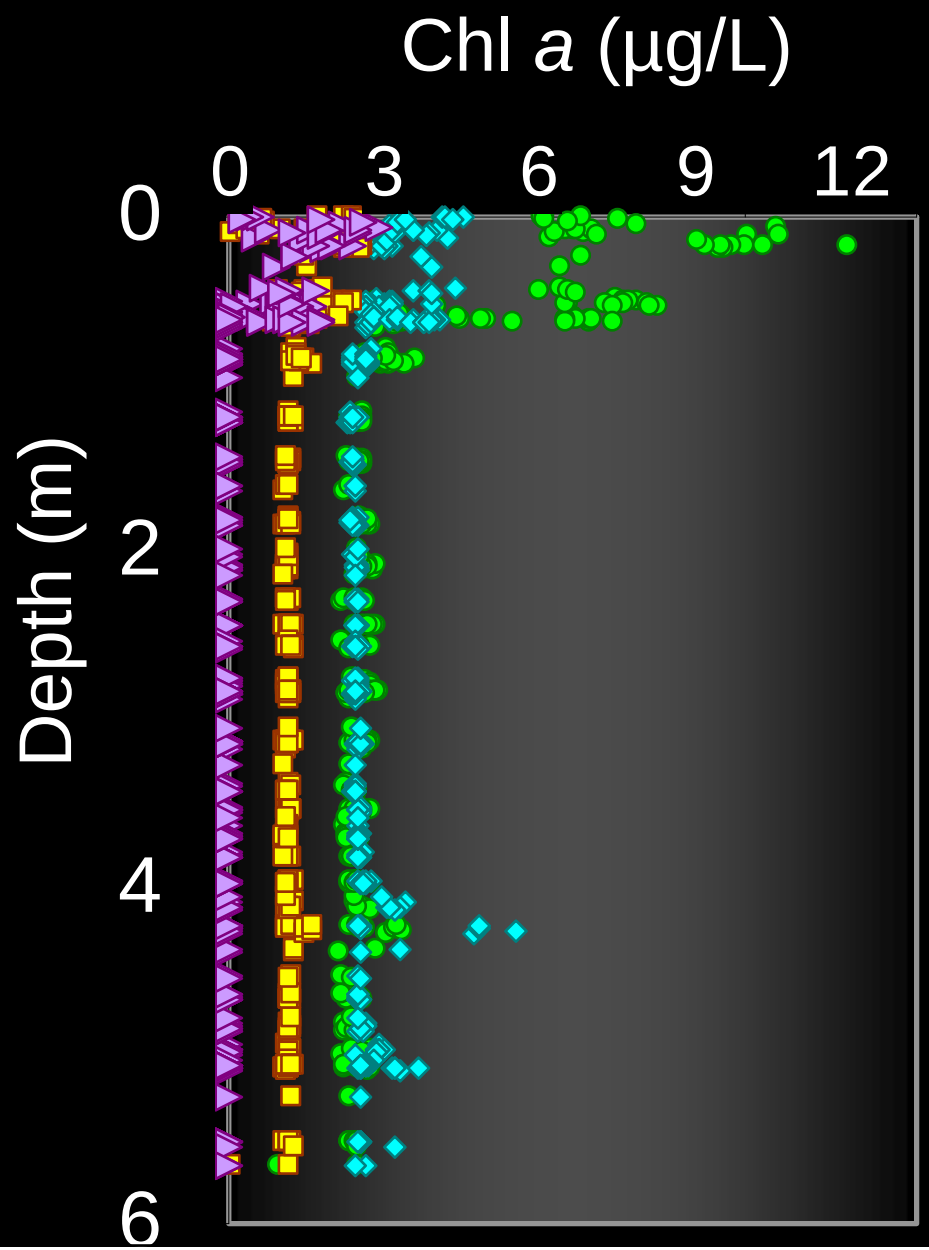


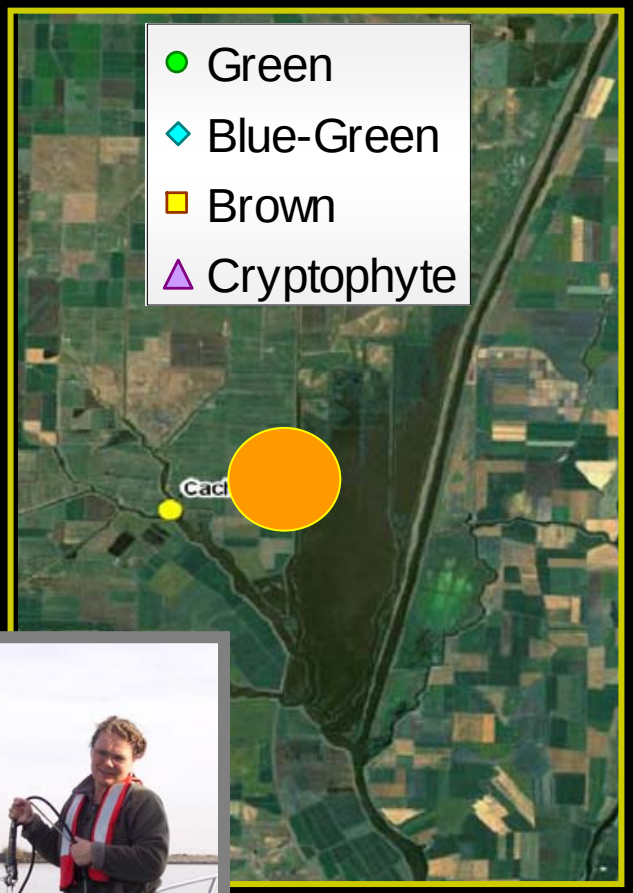
Local hot spots

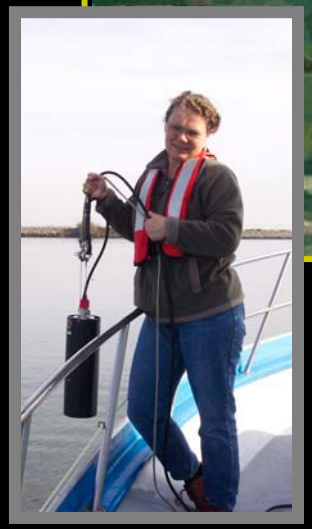




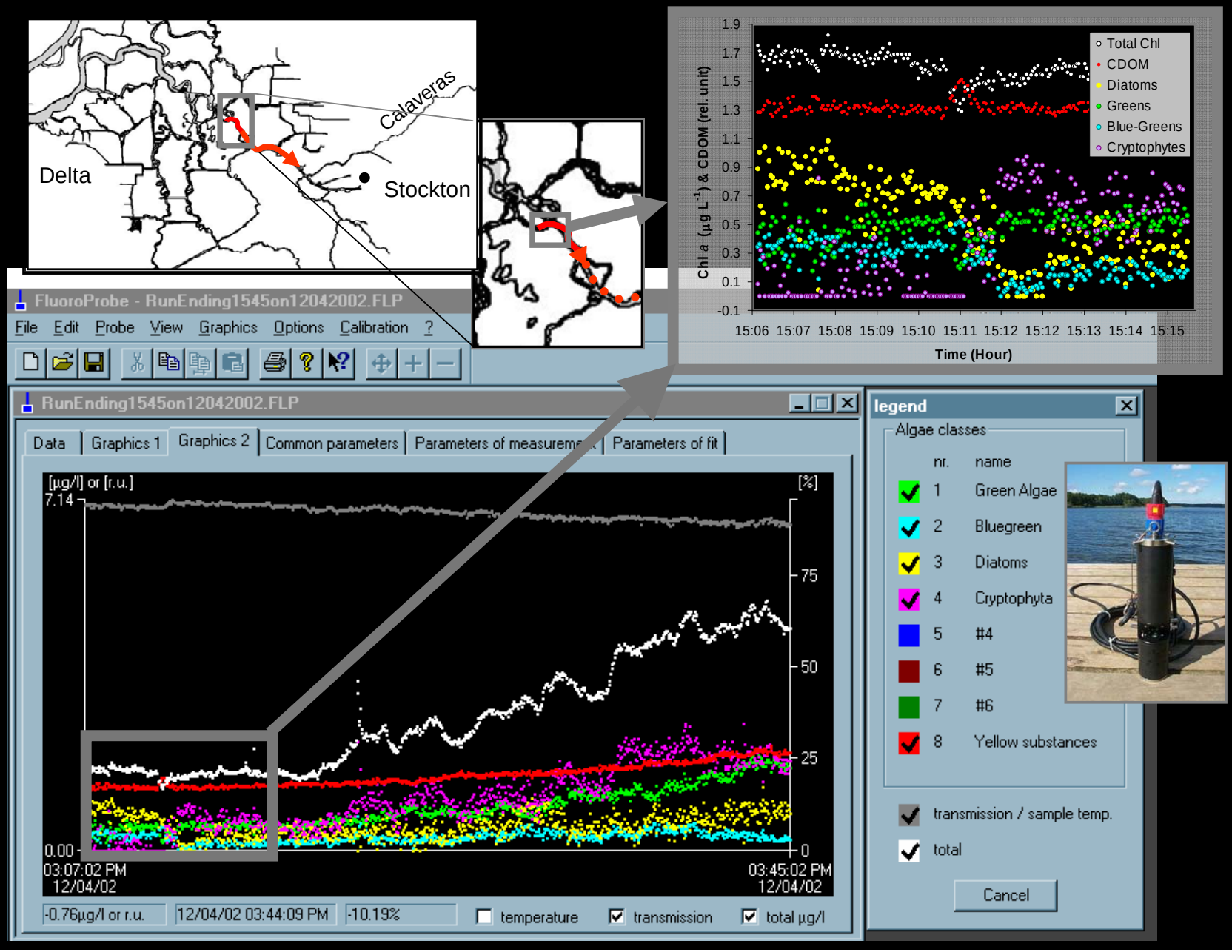
4. Vertical stratification



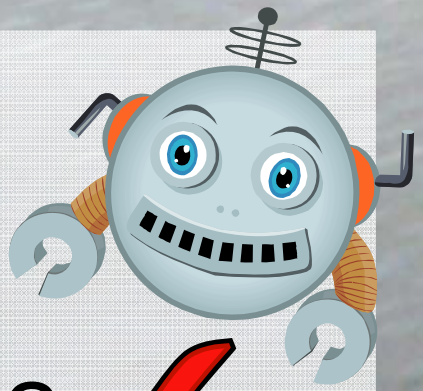




4. Fingerprint for water regions/sources



bbe FluoroProbe



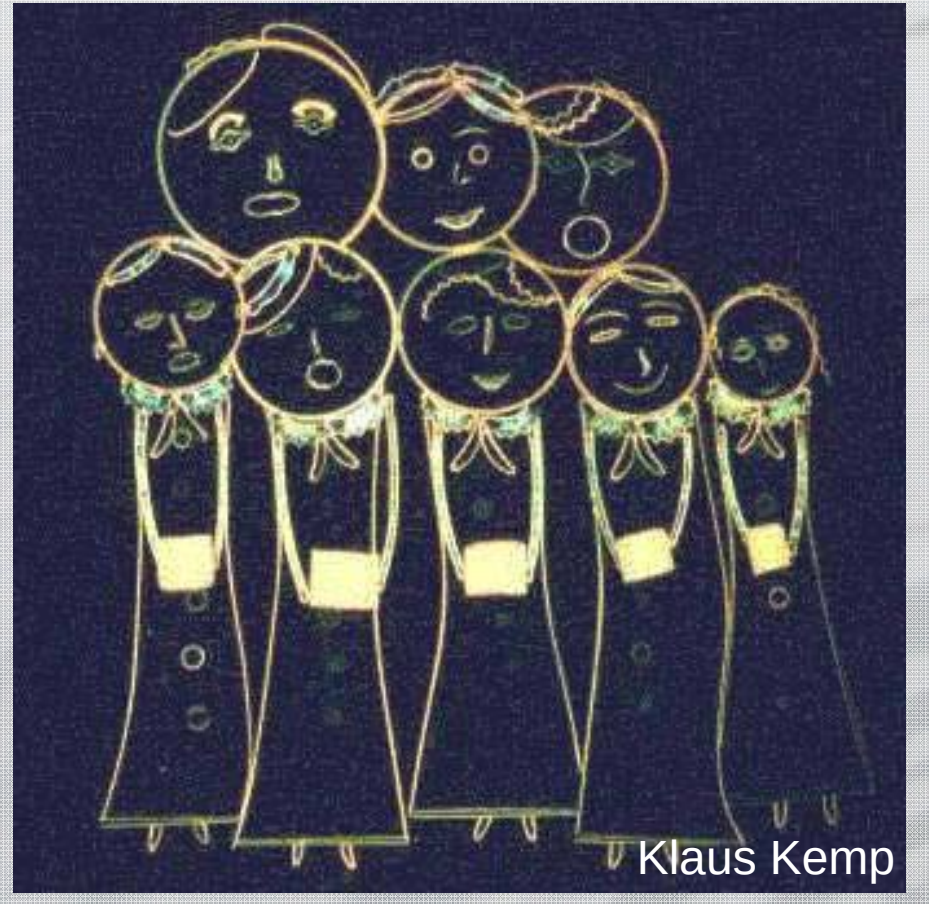
So how does it work?

Does it work here?

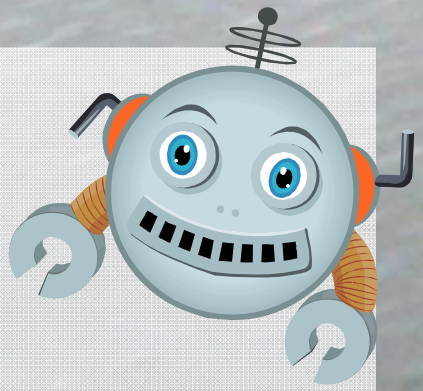
- Lab tests
- Field tests

Is it useful?

Questions?



Arachnoidiscus girdle bands,
Rhabdonema, Synedra and Eunotia



Thanks!