

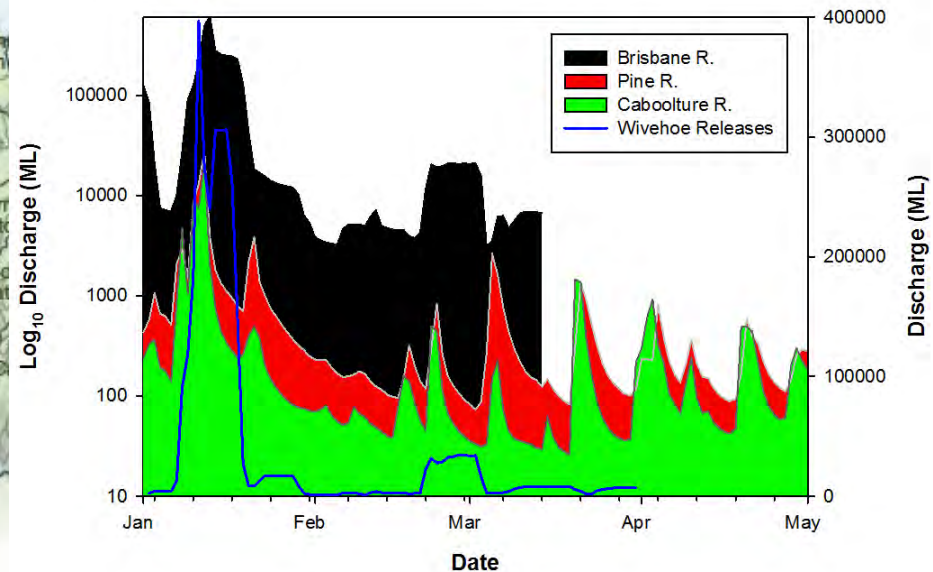
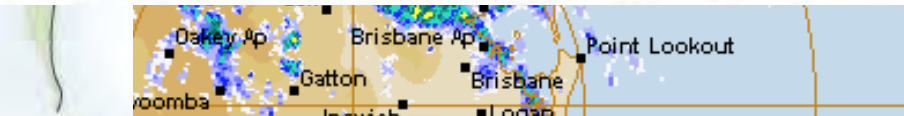
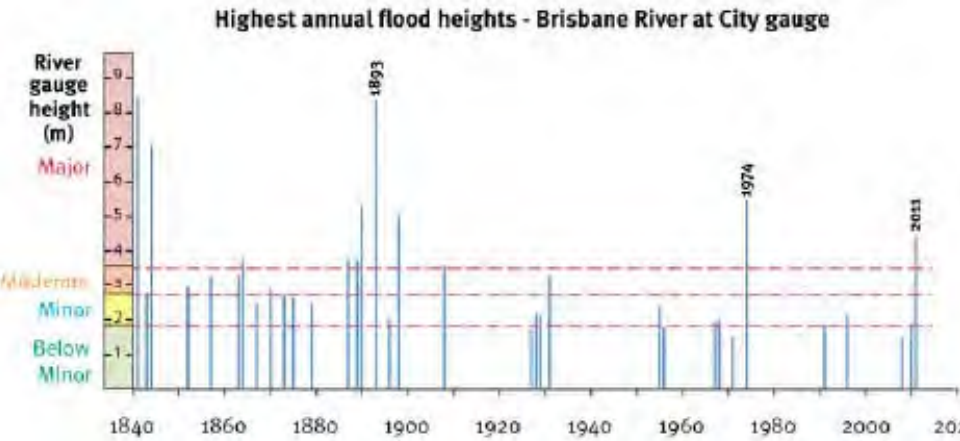
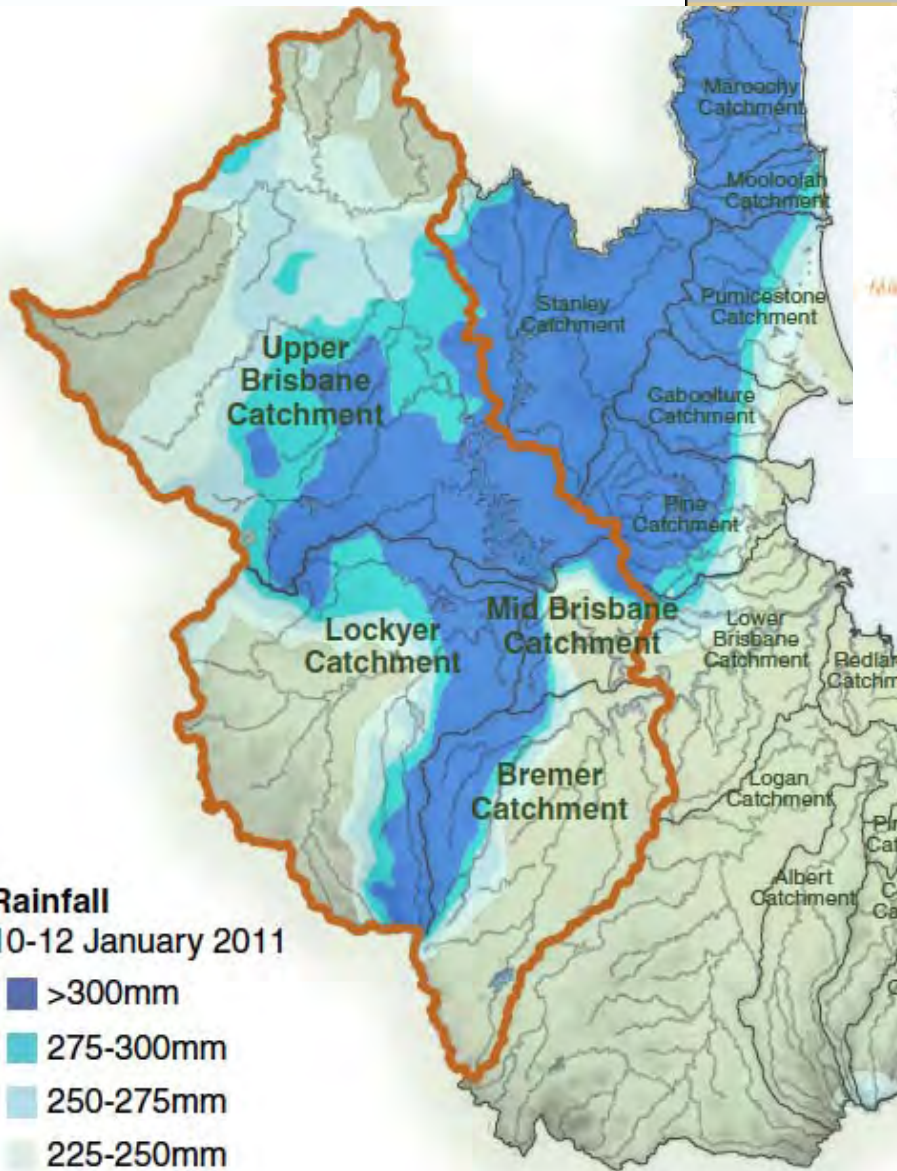


Biogeochemical and Bio-optical properties of the 2011 Floods in Moreton Bay

Andy Steven, Russ Babcock, Geoff Carlin, Nagur Cherukeru, Phillip Ford, Felipe Gusmao, Gary Fry and Kadija Oubelkheir

2010-11 : A Very Wet year!

Copyright: Image by Bureau of Meteorology. For related Warnings, see www.bom.gov.au



Brisbane Floods, 12 -14 January 2011



Rocklea Markets



Photos: ABC news online

Go to <http://www.abc.net.au/news/specials/qld-floods/>

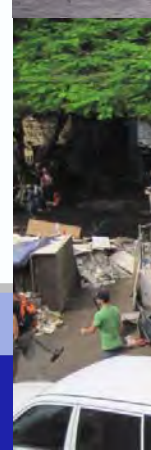
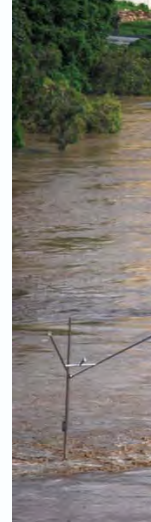


Bundamba



2011 SEQ Floods Damage

- 33 people died
- **Insurance claims**
 - 58 463 claims
- **State public infrastructure**
 - \$5 - 6 billion
- **State enquiry**
 - Flood proofing
 - prosecutions



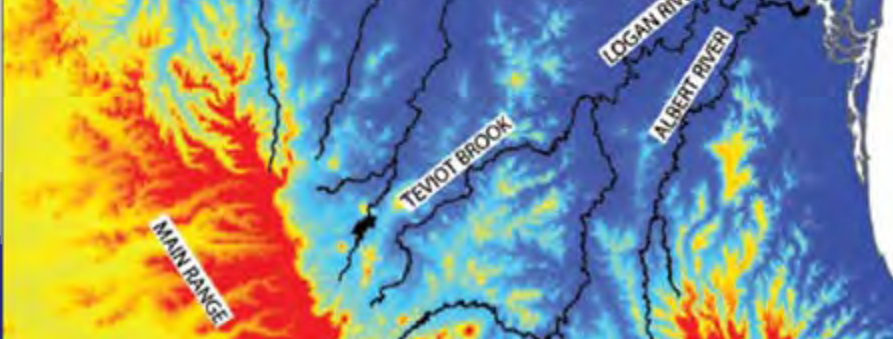
Changes to waterways



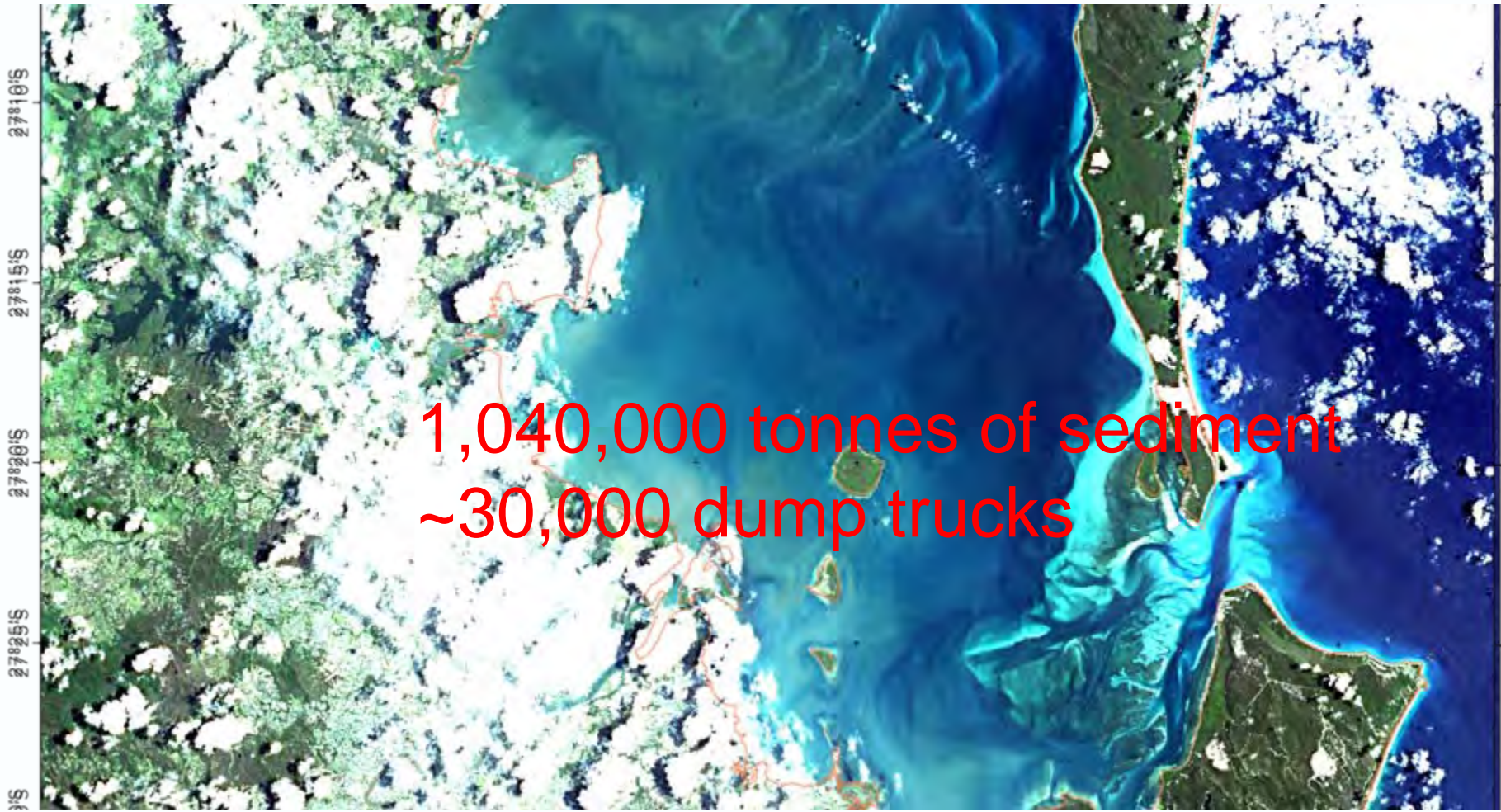
Moreton Bay and its Catchments



Max. length 125 km
Max. width 35 km
Surface area 1,523 km²
Average depth 6.8 m
Seagrass: 25,000 ha, 6 species
Mangroves: 15300 ha, 8 species
Dugongs: 960
Green sea turtles: 10,000
ShoreBirds: 43 species, 30 migratory



Moreton Bay – Before and After Flood



Key Questions

1. What was the extent of the plumes?
2. What was the 3D structure and biogeochemical composition of the flood plume ?
3. How does the structure and composition of the plumes change through time?
4. What were the bio-optical properties and how did they change ?
5. What are the ecological Impacts of the floods?



Sampling

Jan
12
Flood

Jan 26-
28 2
**Week
PF**

May 25-
28 19
W PF

Jan 19-
21
**1week
PF**

Feb 24-
26 6
week PF

**Dec 14-xx
44 W PF**

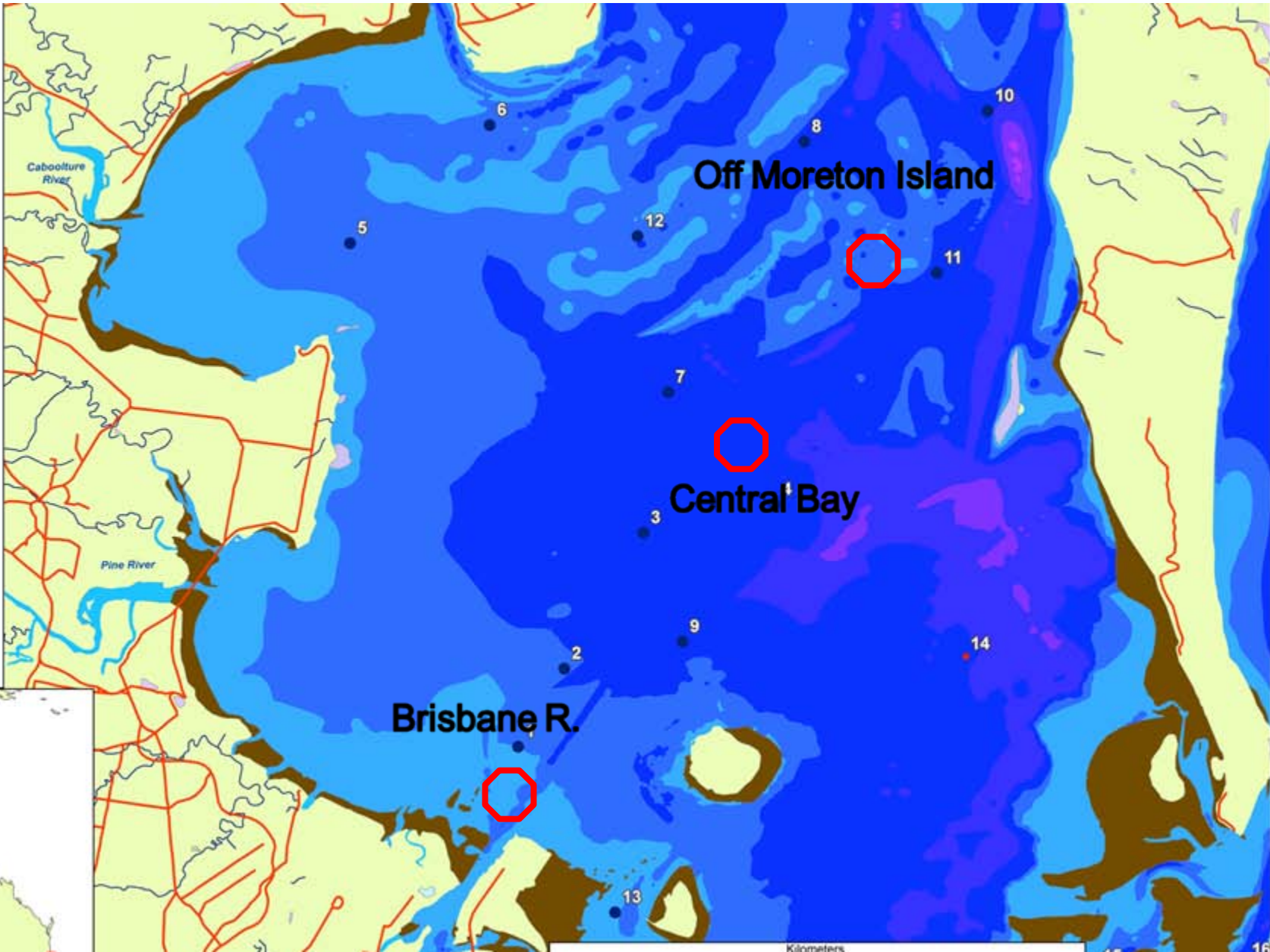
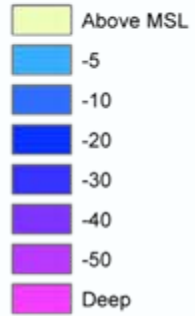
- 13 fixed repeated stations for biogeochemical parameters sampled on 5 cruises over 11 months
- Underway monitoring
- Glider Deployments
- Seagrass abundance and composition
- Sediment Composition and coring



Sampling

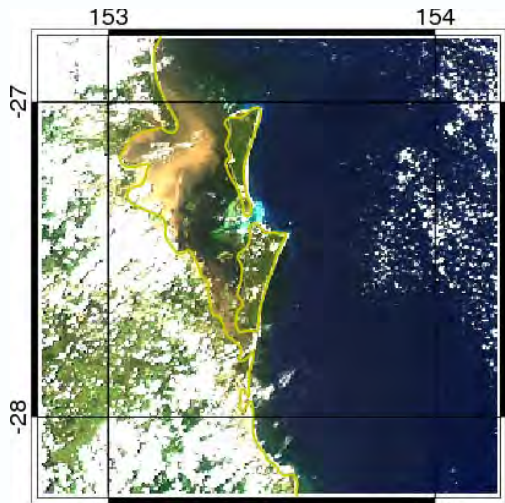
Moreton Bay
Flood
Sampling

DEPTH (MSL)

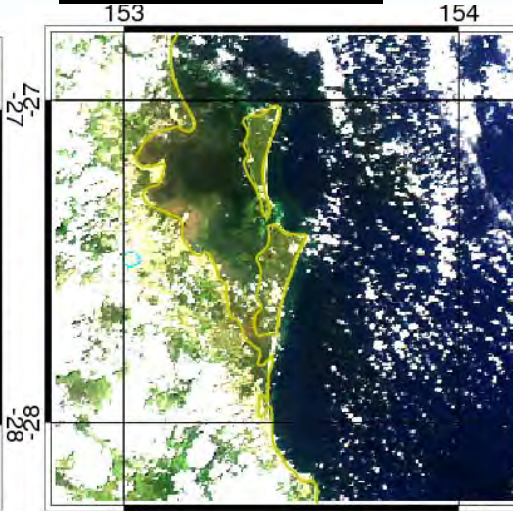


1. Extent of Plume

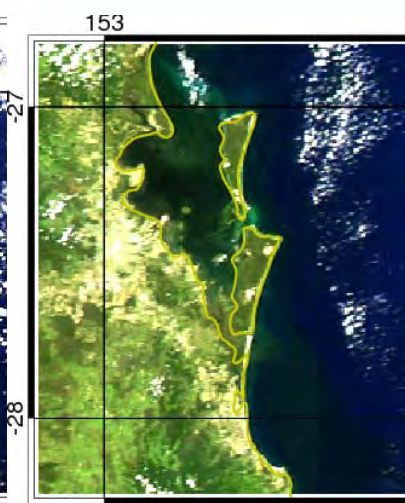
15 Jan 2011



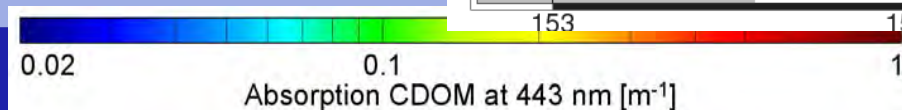
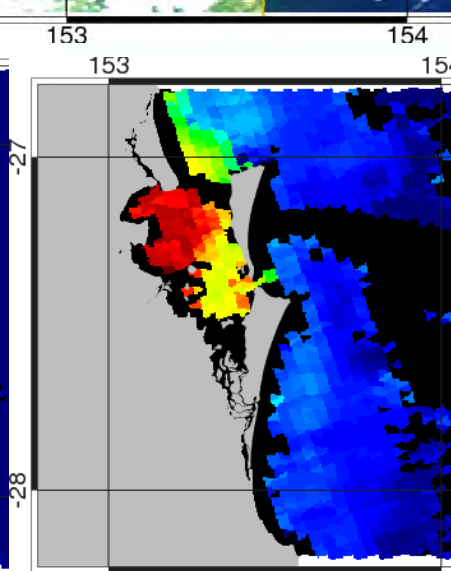
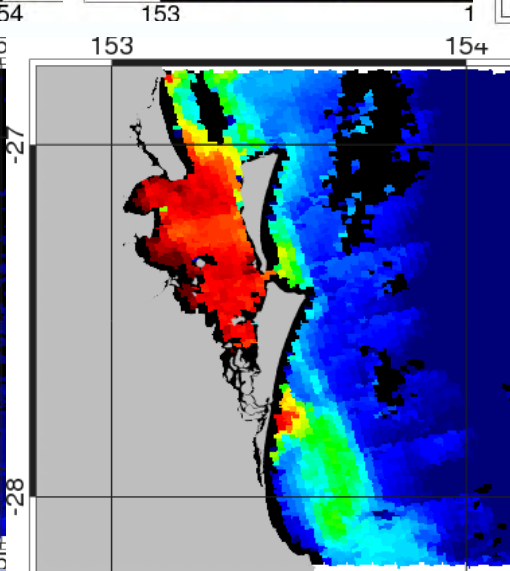
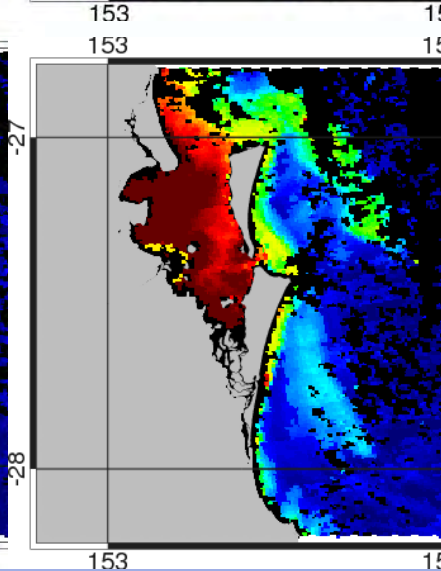
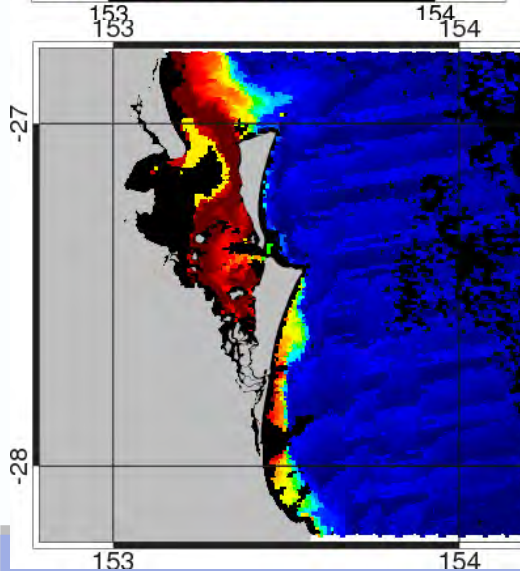
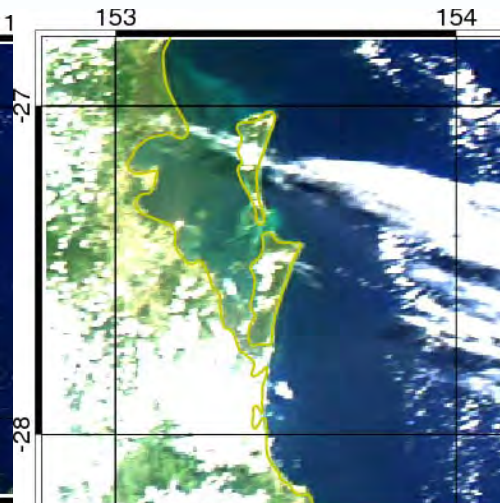
22 Jan 2011



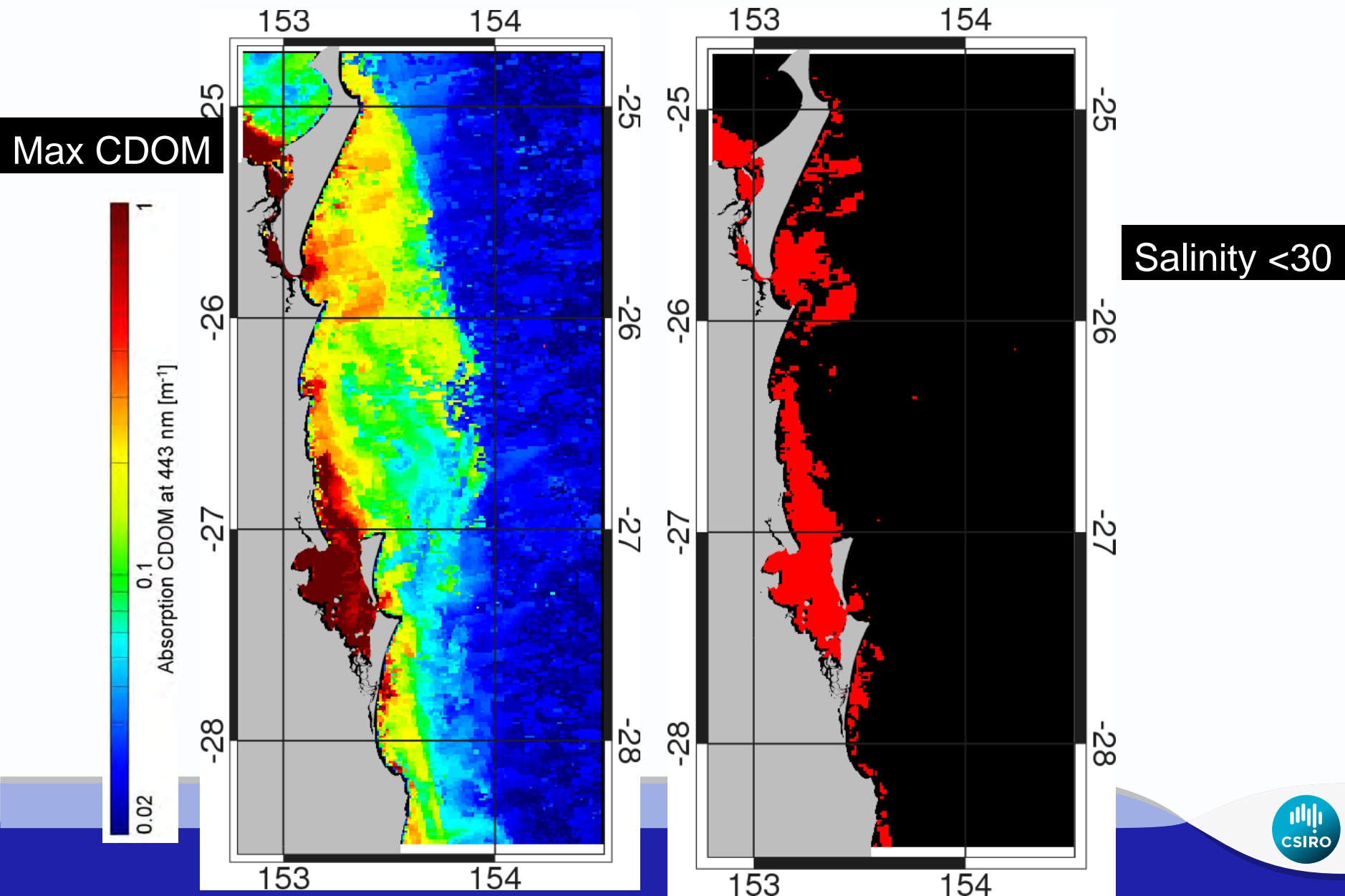
27 Jan 2011



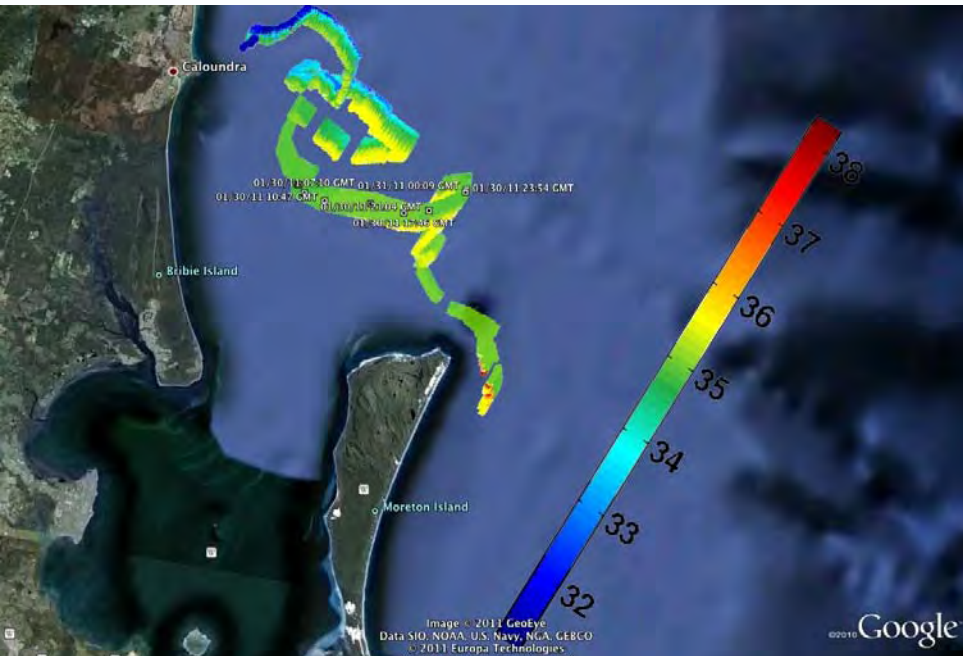
26 Feb 2011



Extent to flood Plumes in Moreton Bay 15 Jan - 28 Feb Composite

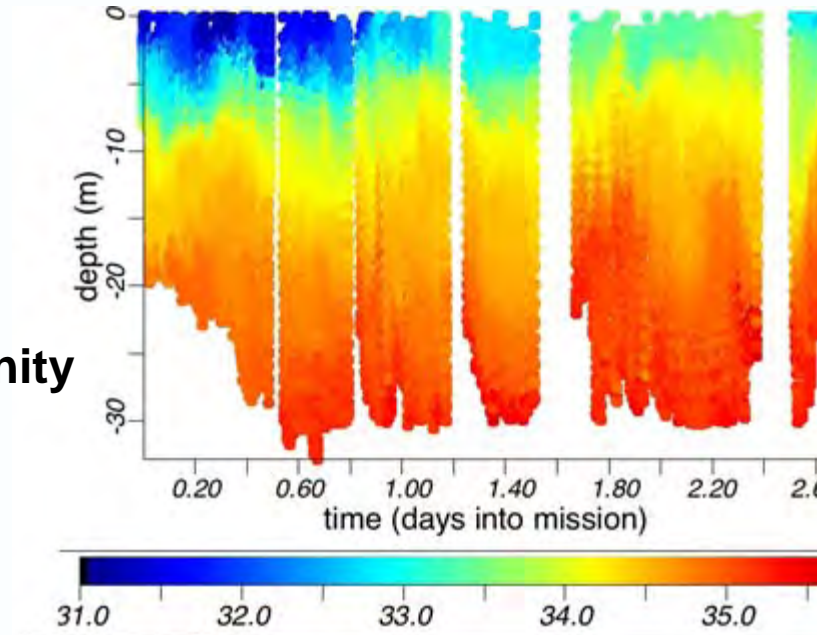


2. 3D Structure of Plume, 25-28 Feb

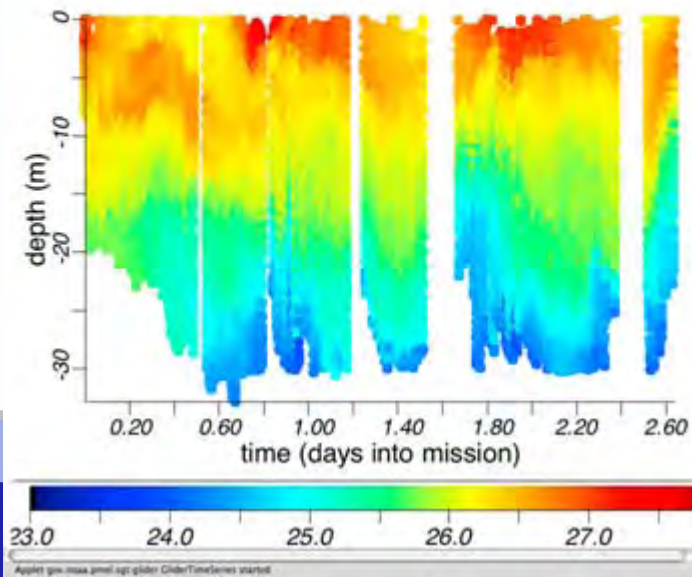


Salinity

a



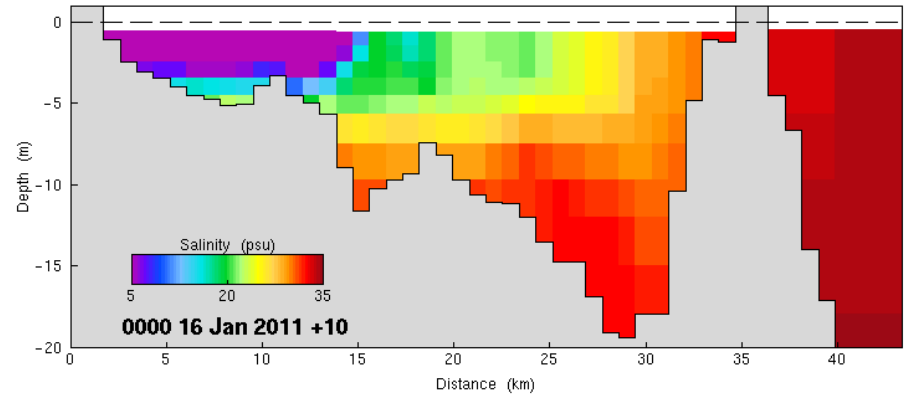
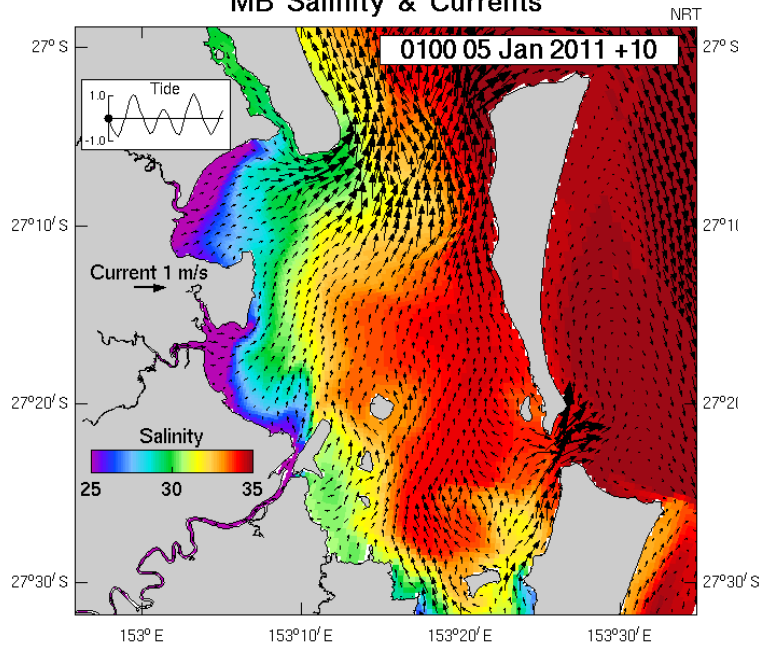
Temperature



2b. Salinity Structure inside Moreton Bay

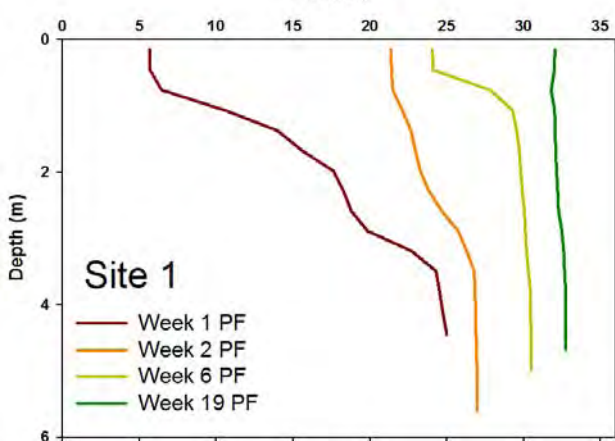
S.E. QUEENSLAND HYDRODYNAMIC MODELLING

MB Salinity & Currents

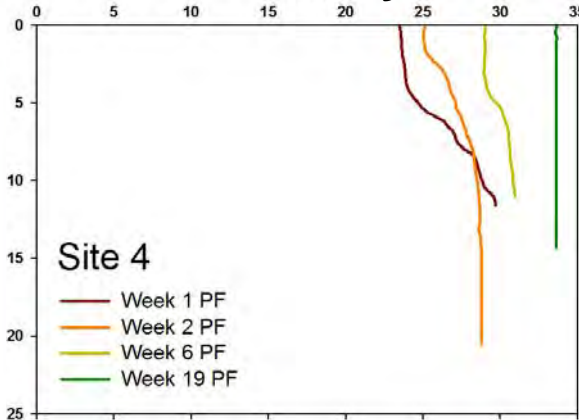


Last updated : 11-Jan-2011 00:05:40

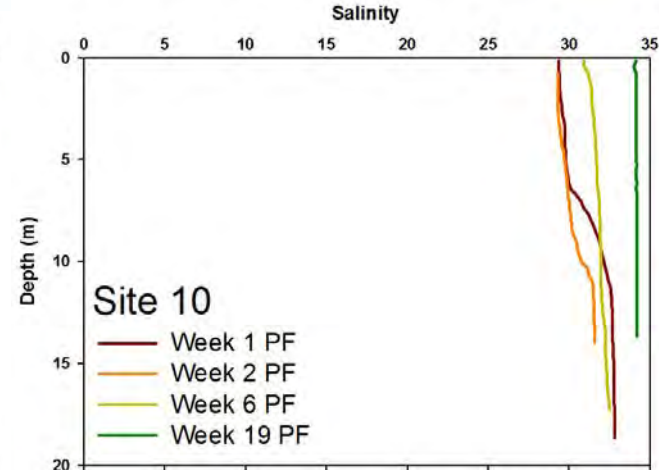
Brisbane R



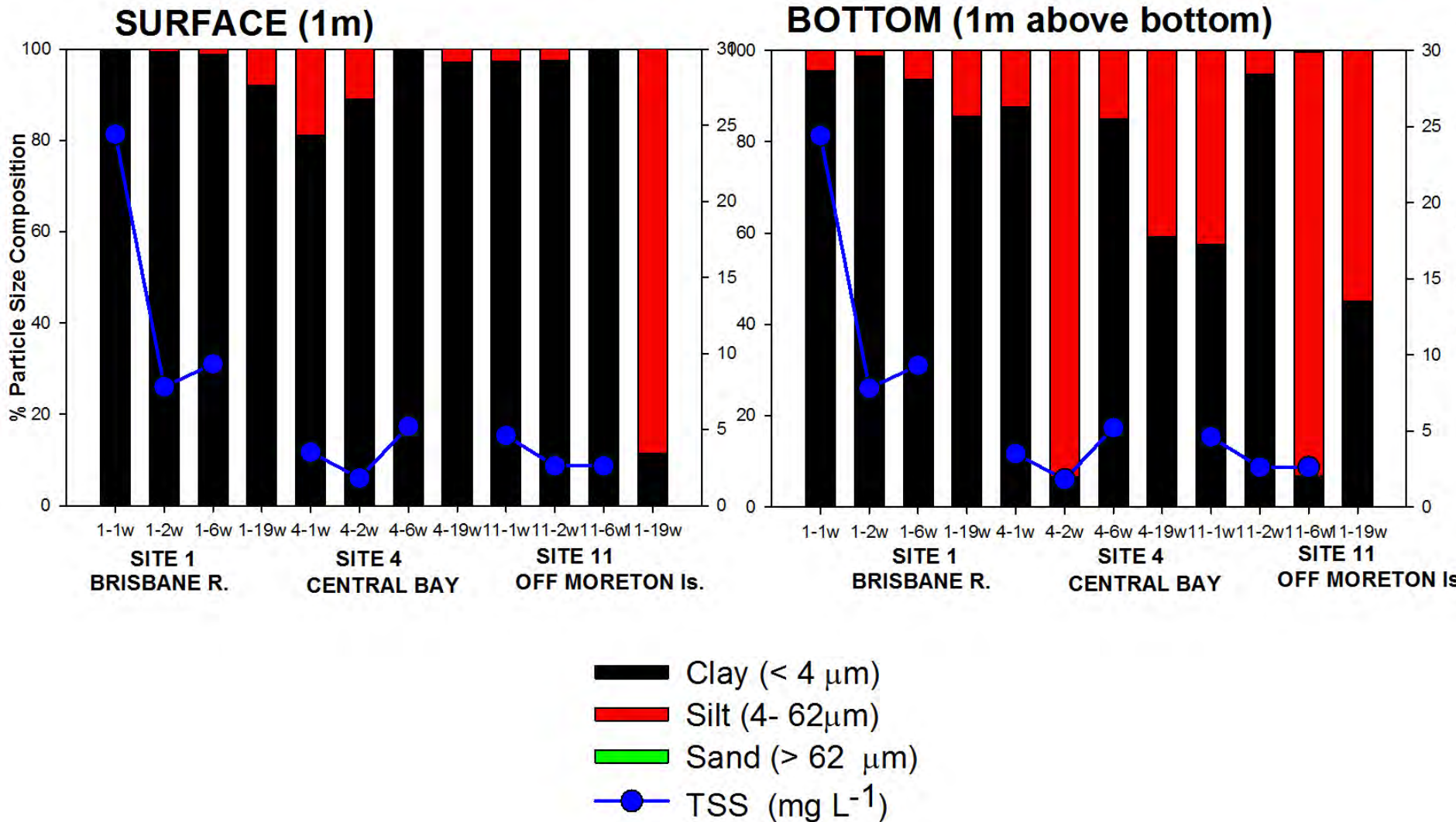
Central Bay



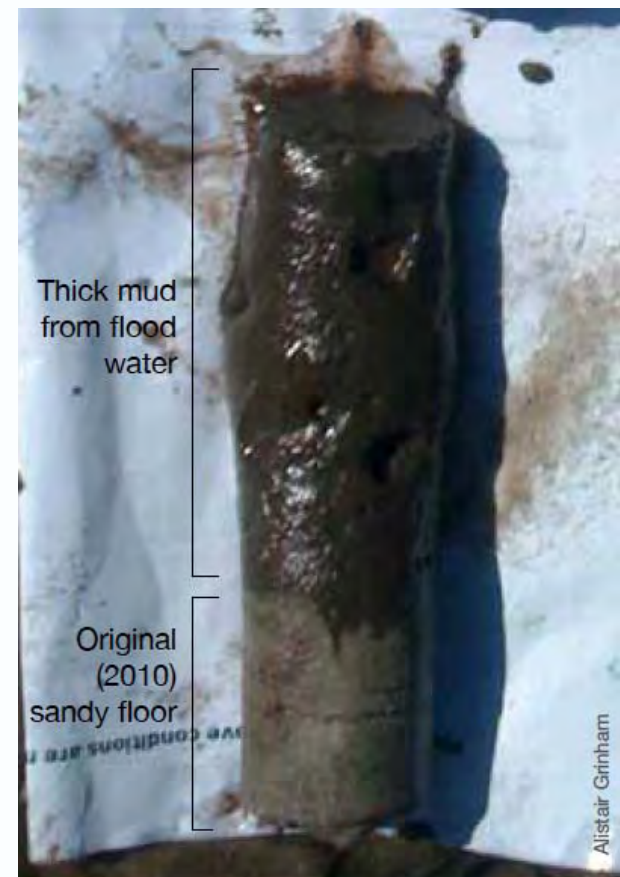
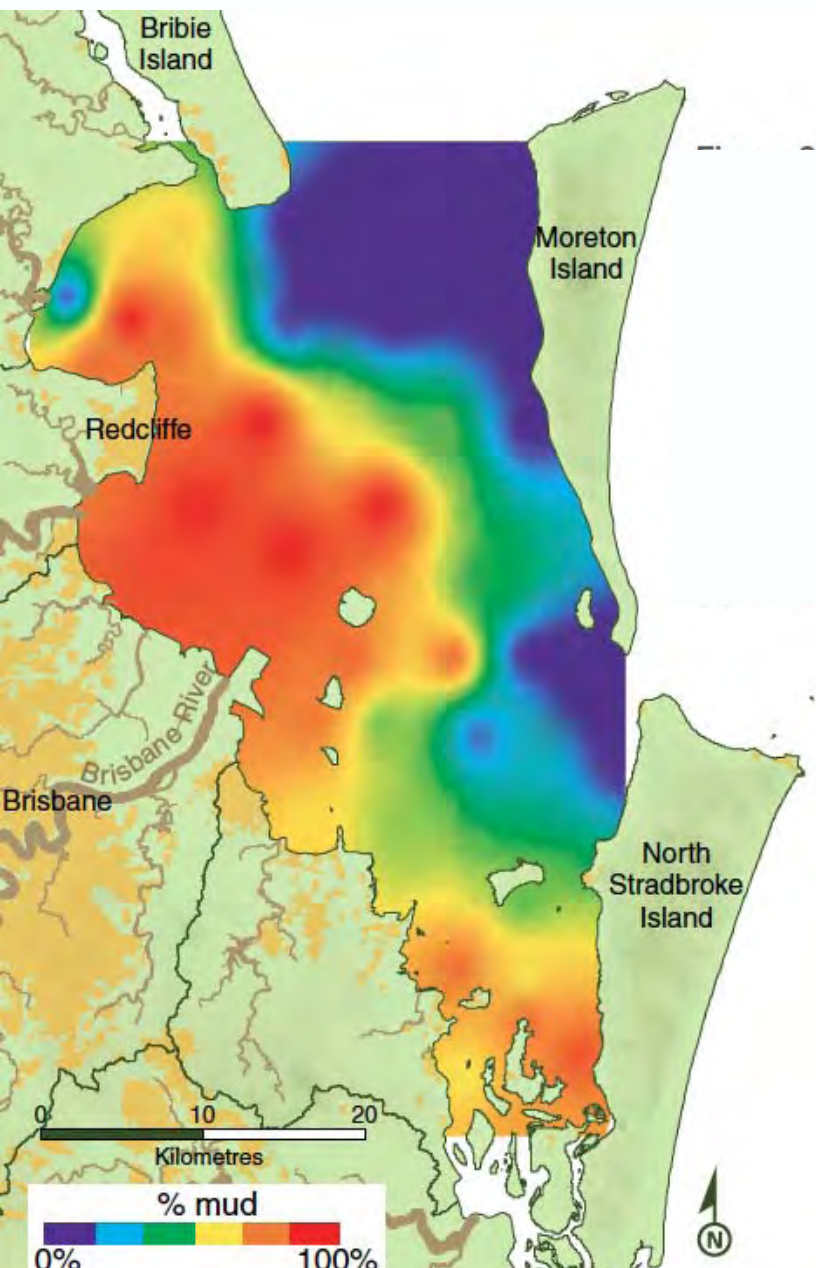
Off Moreton Island



Suspended sediment Distribution & Composition

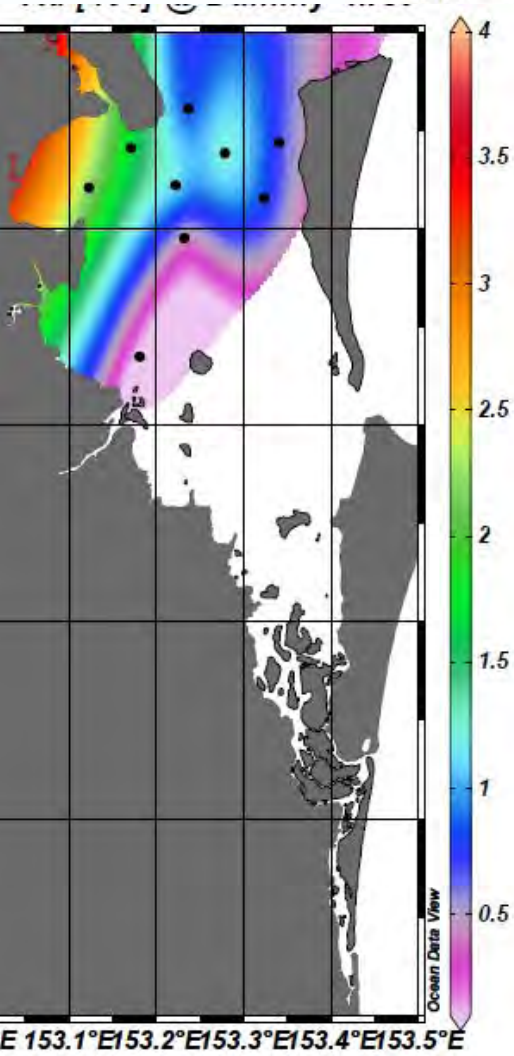


Sediment Distribution and composition

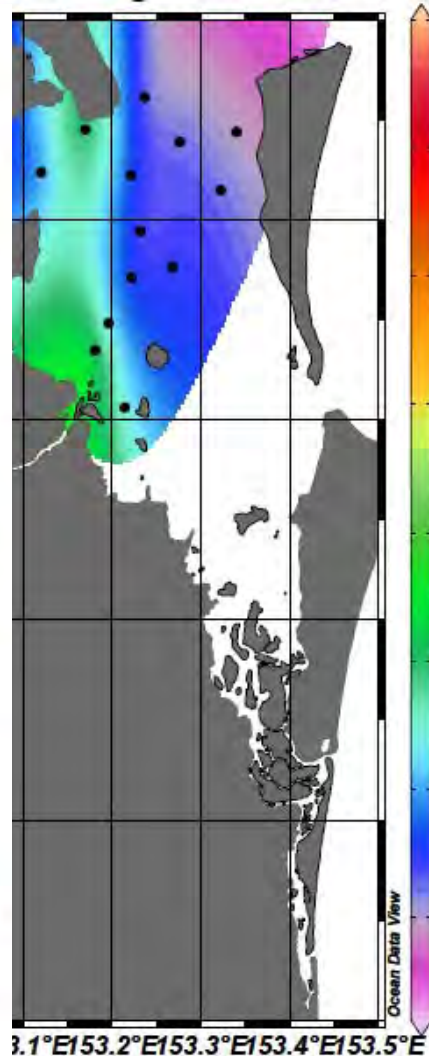


Light Attenuation : $K_d(490 \text{ nm})$ [m^{-1}]

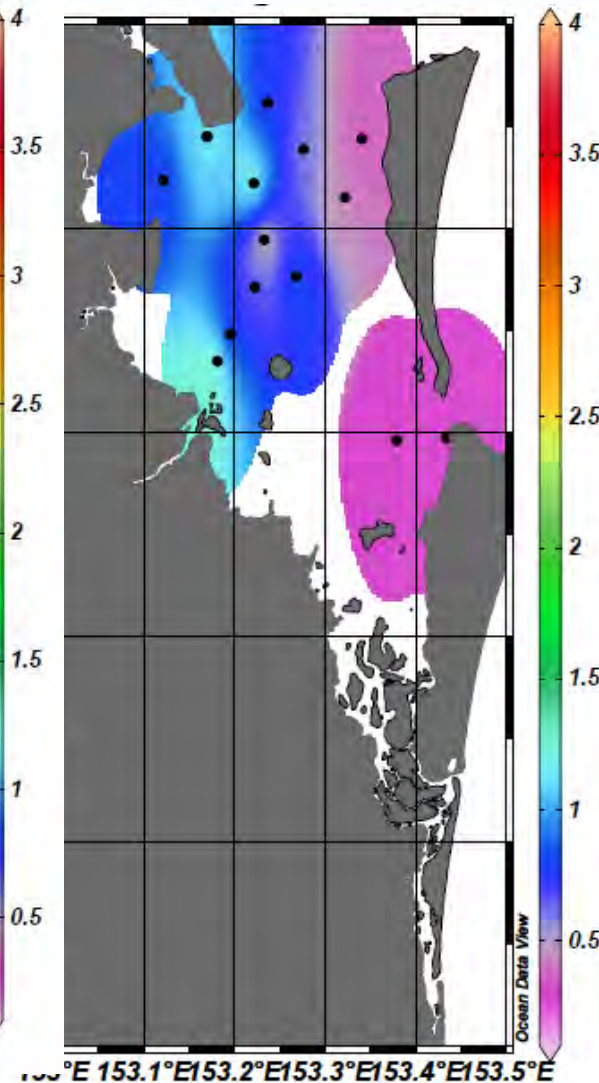
1 week



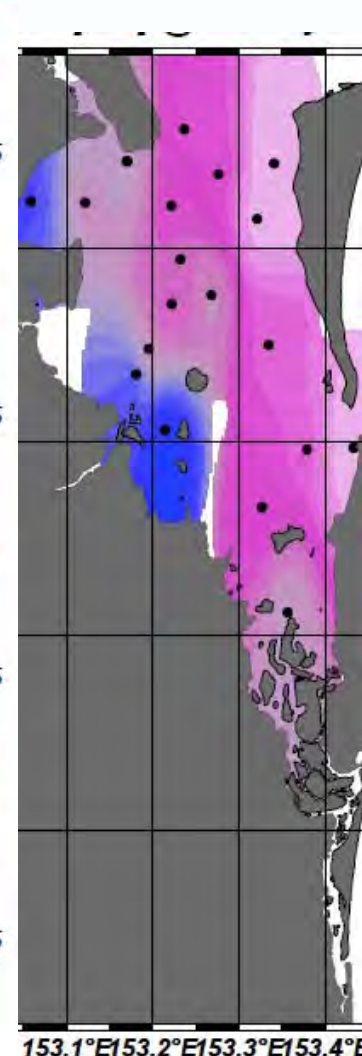
2 weeks



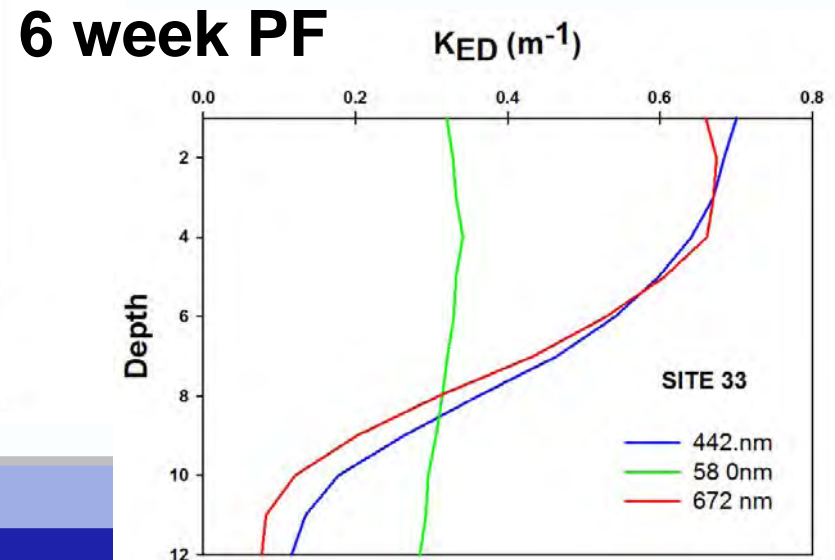
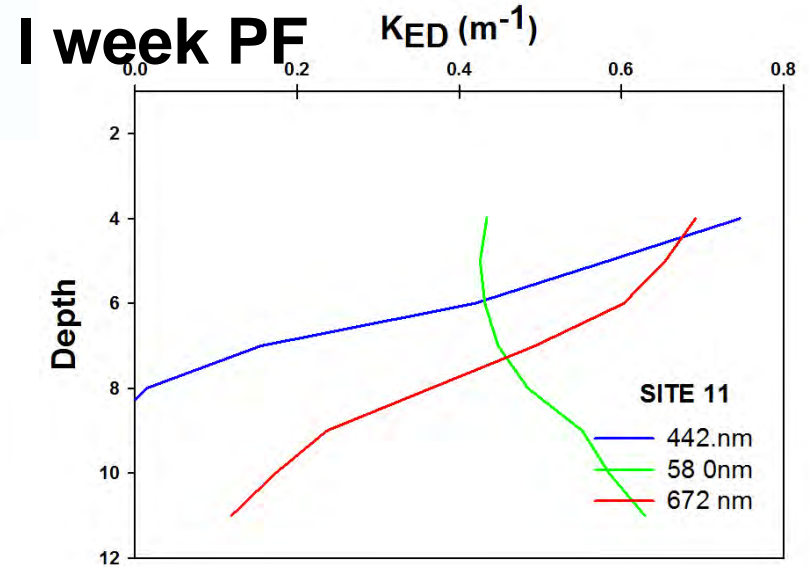
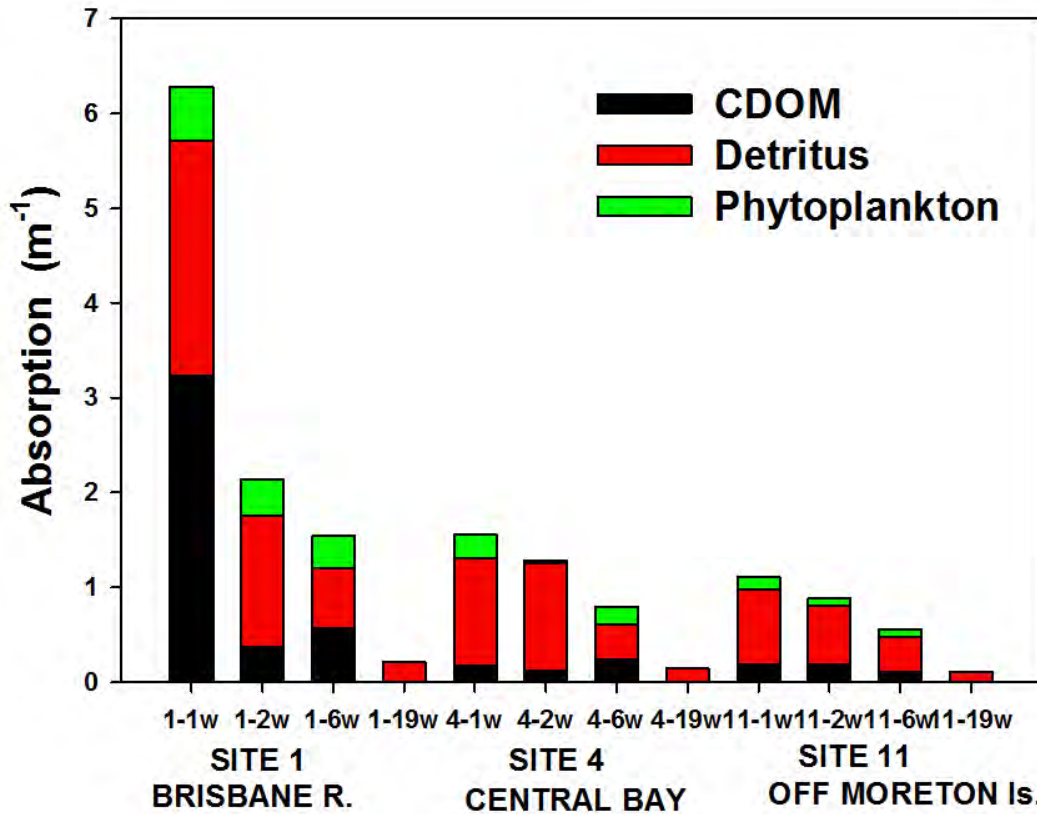
6 weeks



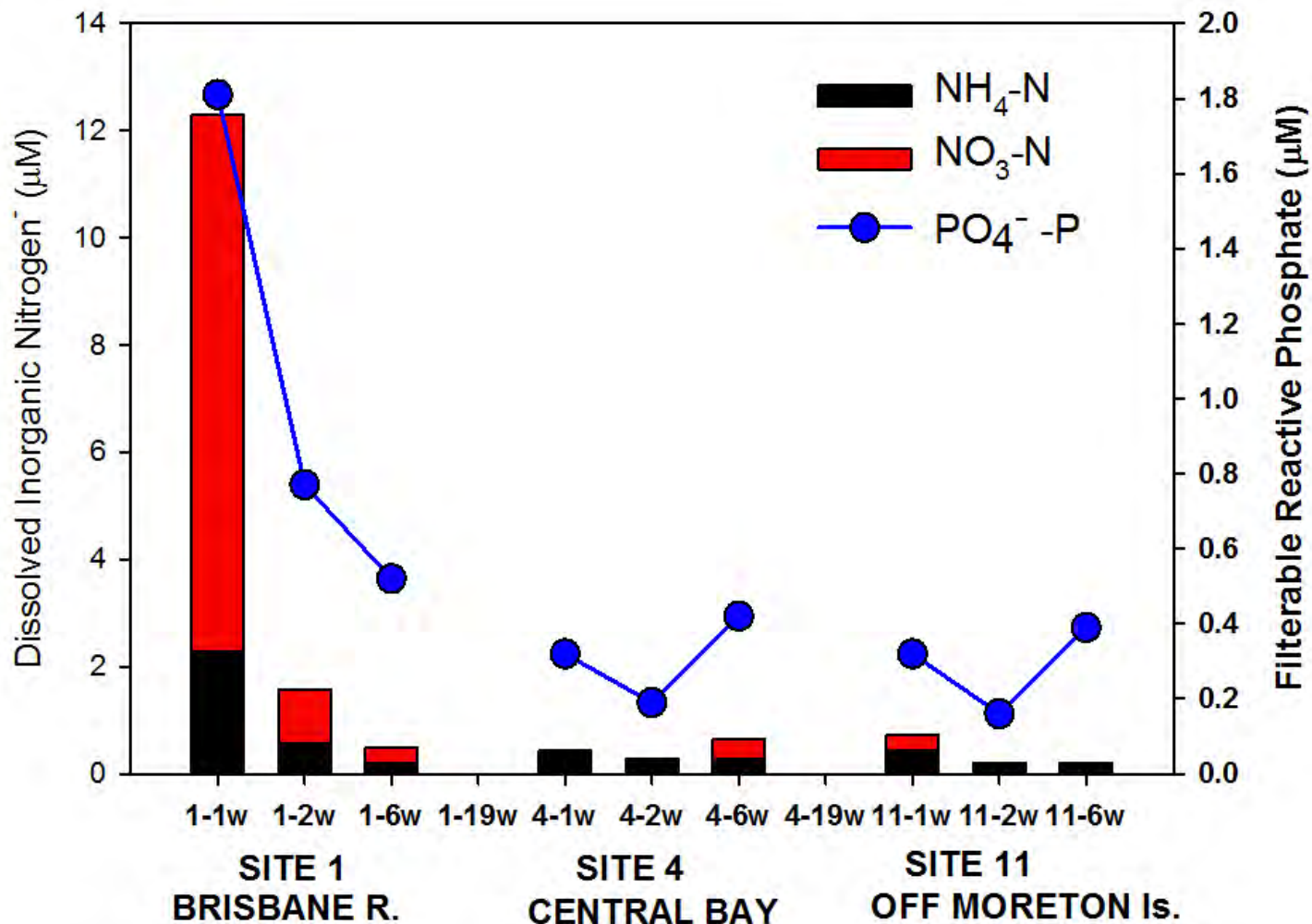
19 weeks



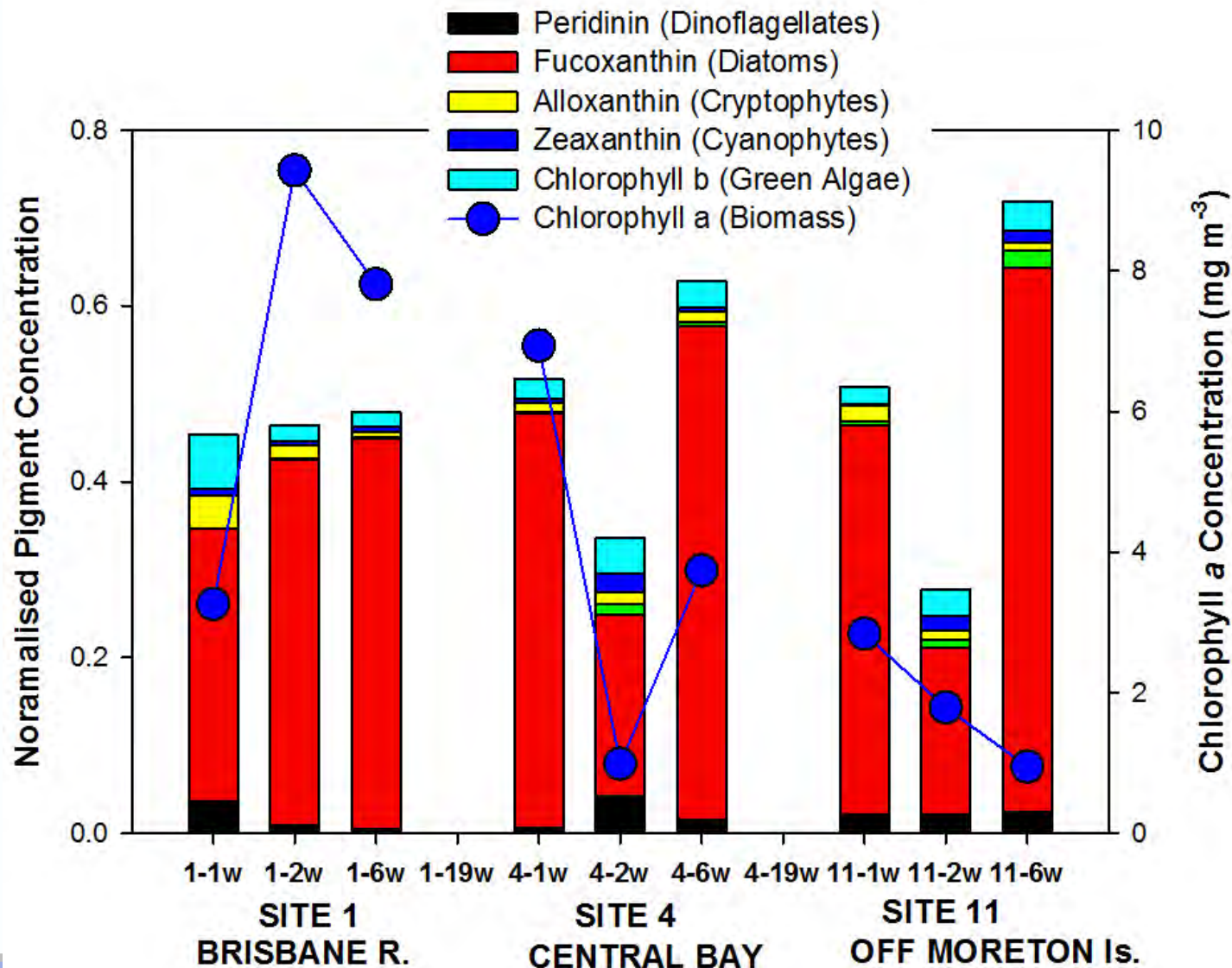
Light Absorption and spectral light quality coefficients (m^{-1})



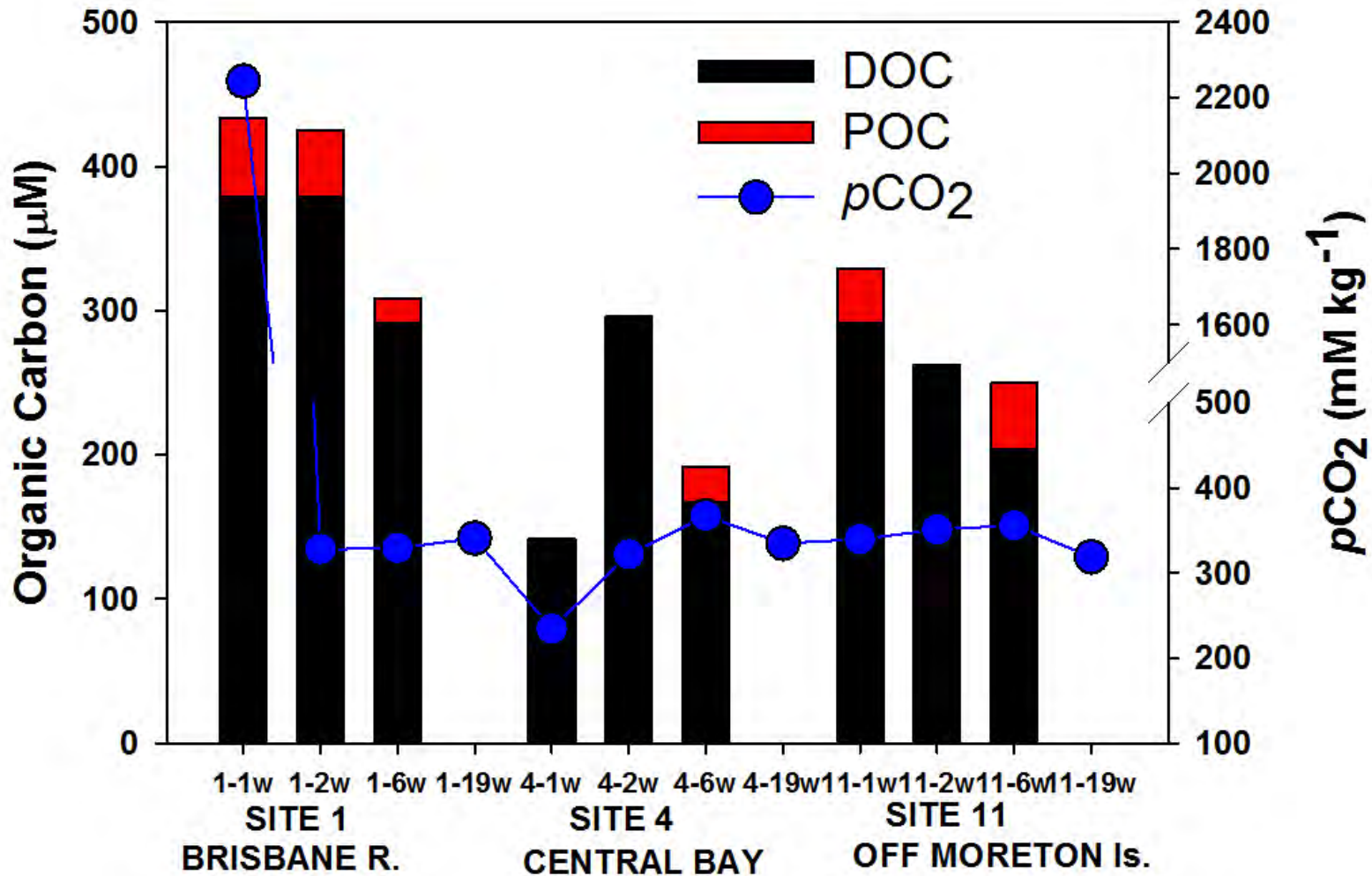
Dissolved Nutrients



Chlorophyll and Phytoplankton Composition

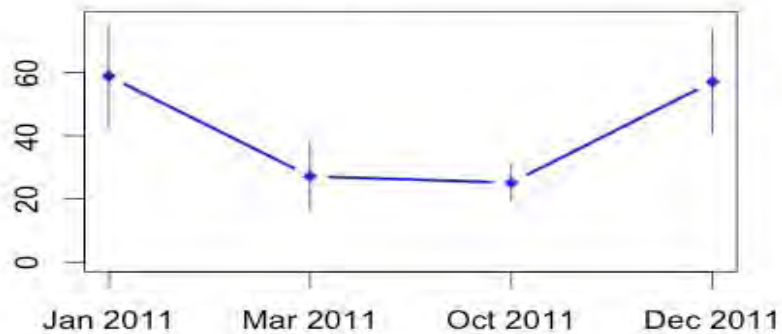


Carbon

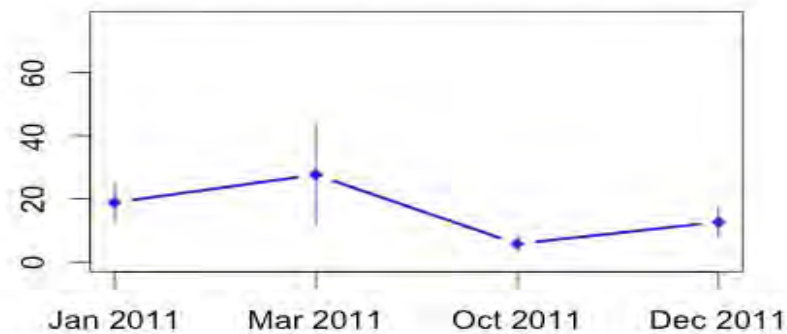


Seagrass Responses

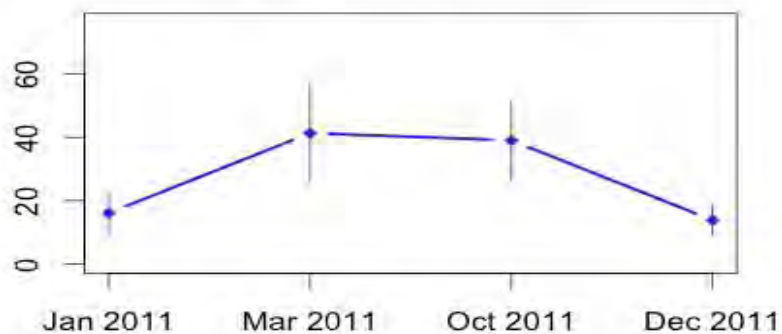
North of Brisbane River



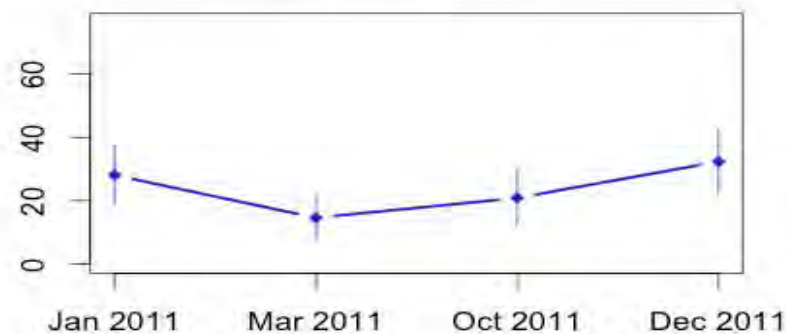
South of Brisbane River



Eastern Banks

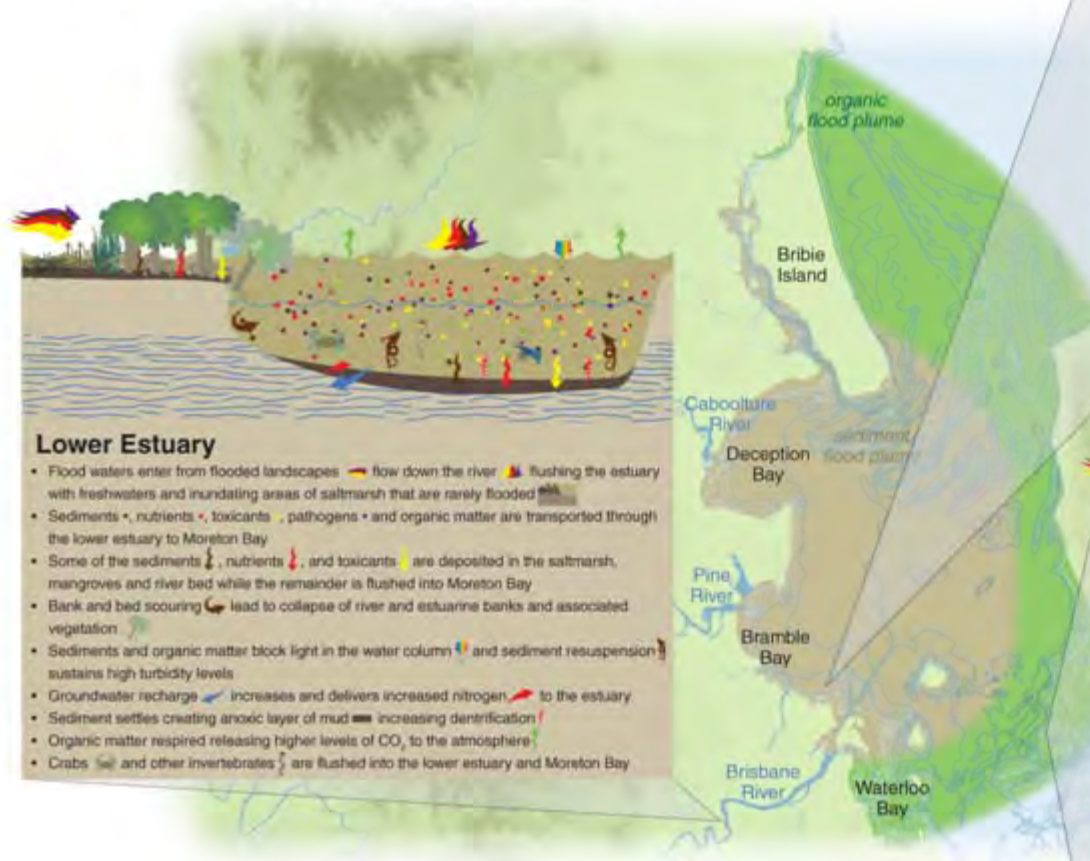


Southern Bay



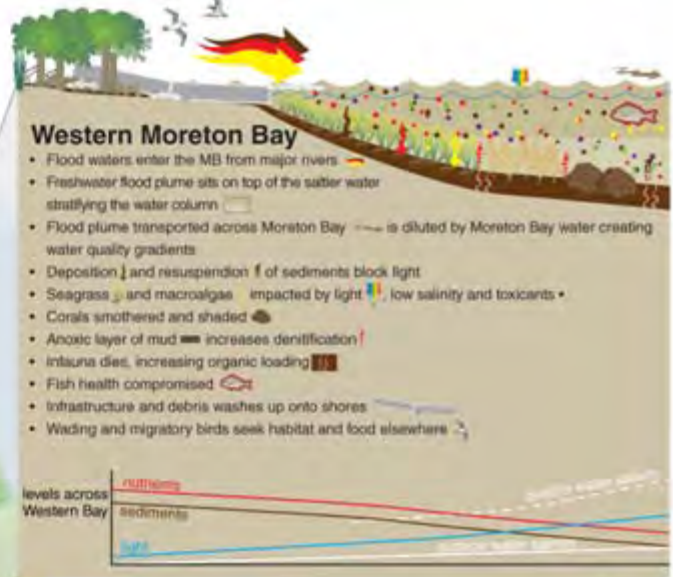
Spatial Effects of Floods (1-2 weeks PF)

Moreton Bay (MB) Immediate flood impacts (1-2 weeks)



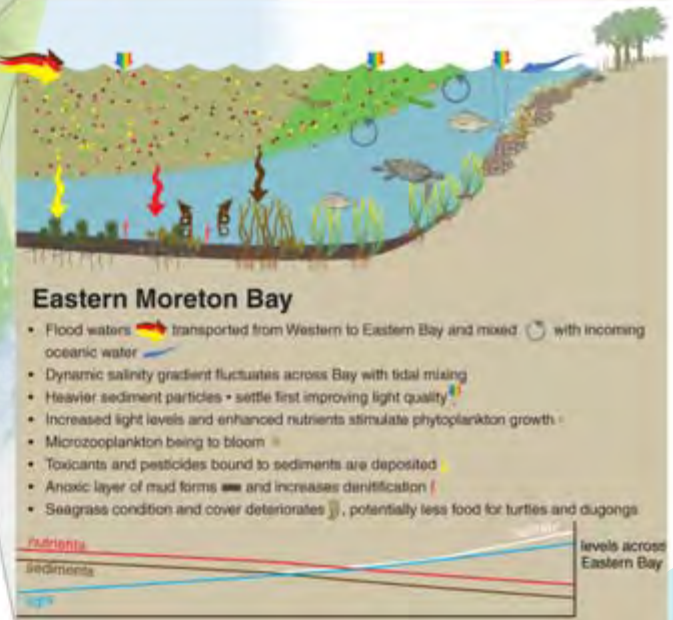
Lower Estuary

- Flood waters enter from flooded landscapes → flow down the river → flushing the estuary with freshwaters and inundating areas of saltmarsh that are rarely flooded
- Sediments, nutrients, toxicants, pathogens and organic matter are transported through the lower estuary to Moreton Bay
- Some of the sediments, nutrients, and toxicants are deposited in the saltmarsh, mangroves and river bed while the remainder is flushed into Moreton Bay
- Bank and bed scouring lead to collapse of river and estuarine banks and associated vegetation
- Sediments and organic matter block light in the water column and sediment resuspension sustains high turbidity levels
- Groundwater recharge increases and delivers increased nitrogen to the estuary
- Sediment settles creating anoxic layer of mud increasing denitrification
- Organic matter respired releasing higher levels of CO₂ to the atmosphere
- Crabs and other invertebrates are flushed into the lower estuary and Moreton Bay



Western Moreton Bay

- Flood waters enter the MB from major rivers
- Freshwater flood plume sits on top of the saltier water stratifying the water column
- Flood plume transported across Moreton Bay → is diluted by Moreton Bay water creating water quality gradients
- Deposition and resuspension of sediments block light
- Seagrass and macroalgae impacted by light, low salinity and toxicants
- Corals smothered and shaded
- Anoxic layer of mud increases denitrification
- Infauna die, increasing organic loading
- Fish health compromised
- Infrastructure and debris washes up onto shores
- Wading and migratory birds seek habitat and food elsewhere



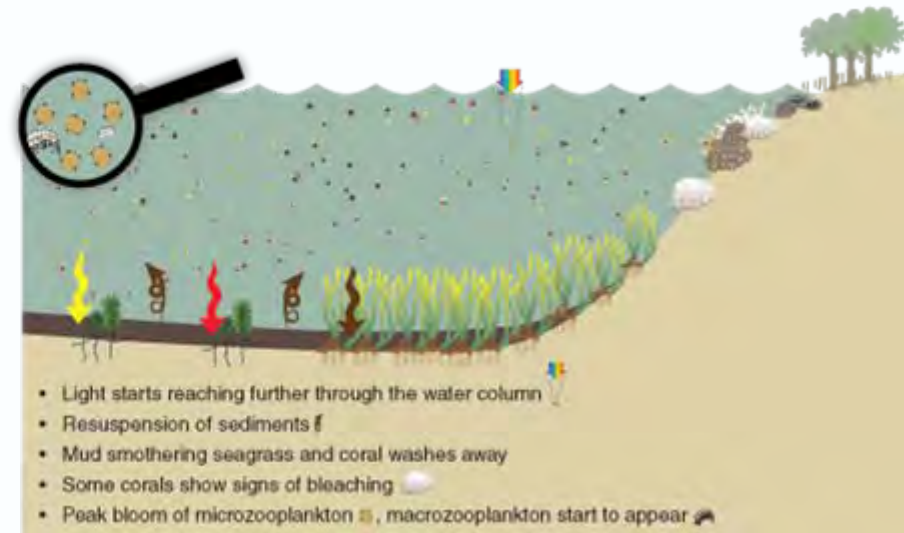
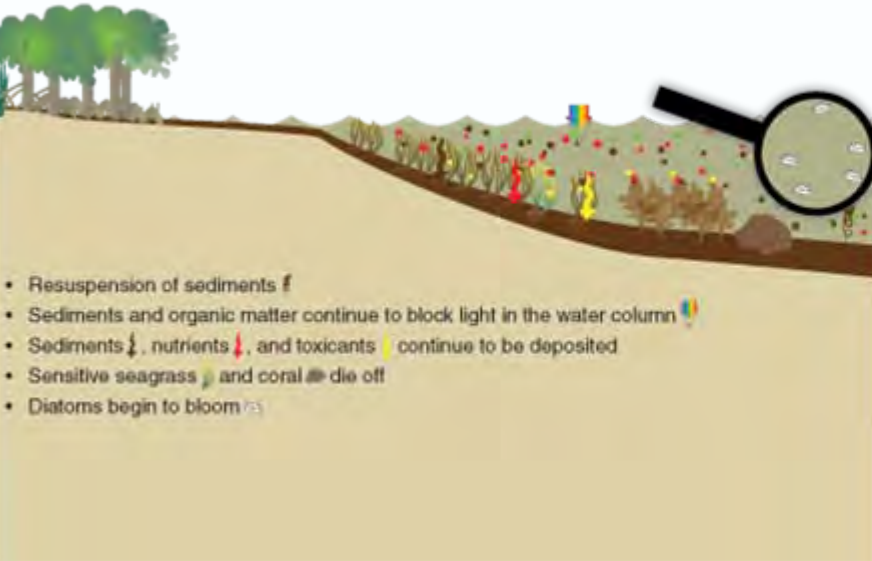
Eastern Moreton Bay

- Flood waters transported from Western to Eastern Bay and mixed with incoming oceanic water
- Dynamic salinity gradient fluctuates across Bay with tidal mixing
- Heavier sediment particles settle first improving light quality
- Increased light levels and enhanced nutrients stimulate phytoplankton growth
- Microzooplankton begin to bloom
- Toxicants and pesticides bound to sediments are deposited
- Anoxic layer of mud forms and increases denitrification
- Seagrass condition and cover deteriorates, potentially less food for turtles and dugongs

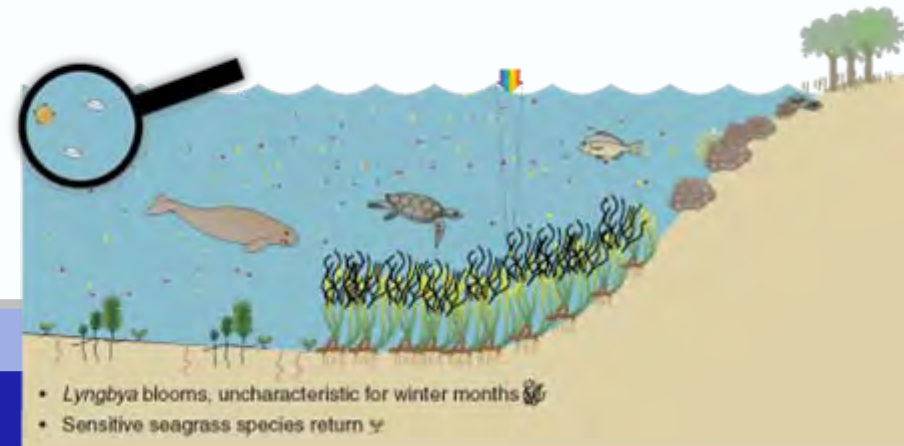
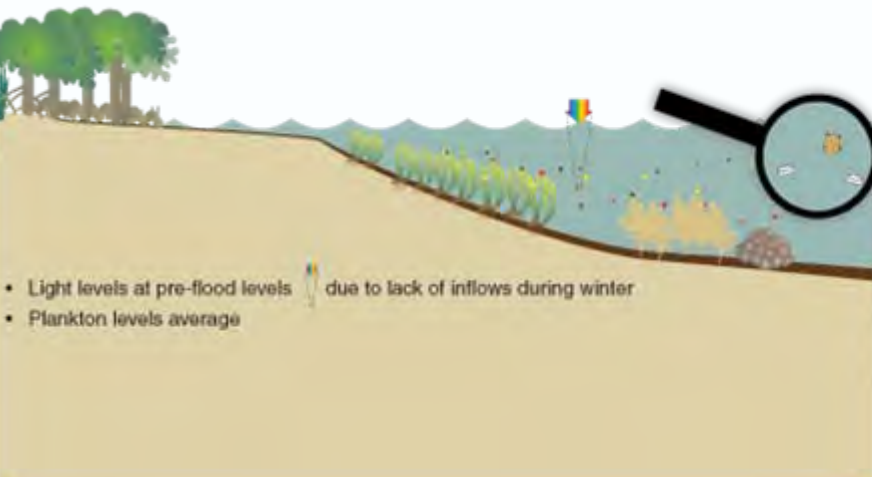


Post flood Effects, 1 and 3 months PF

Four weeks post flood



Six months post flood

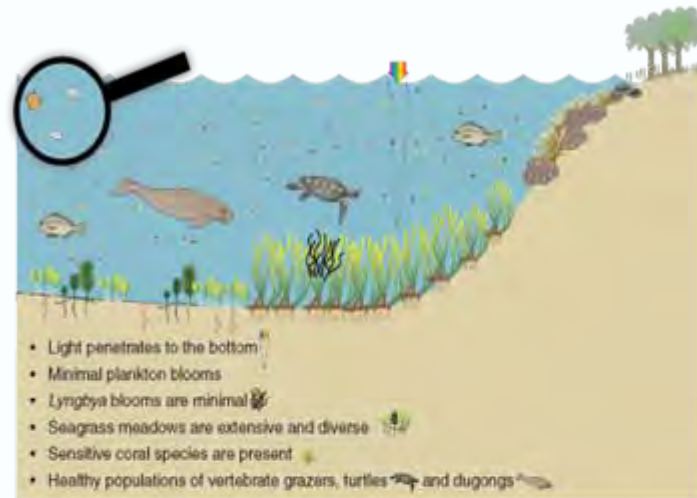
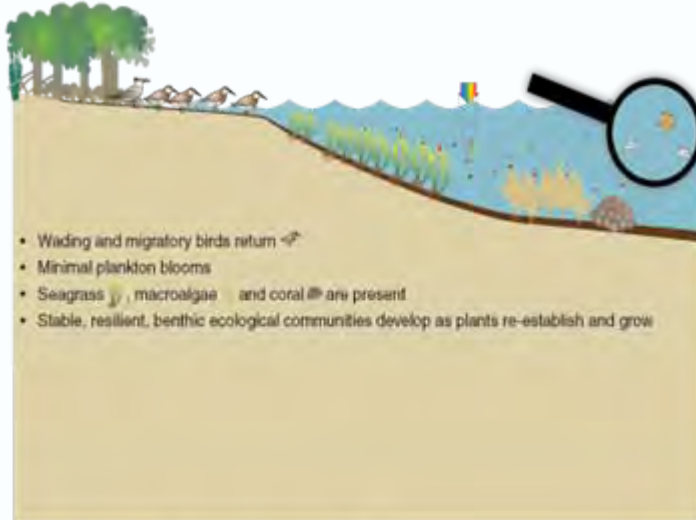


Future Scenarios of Flood Impacts

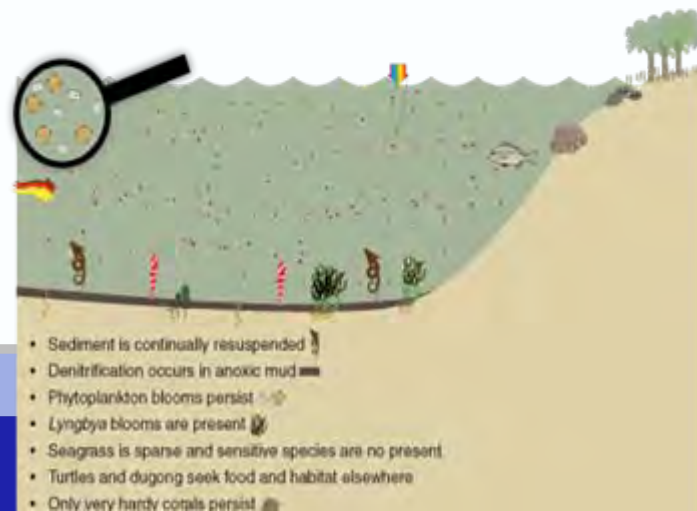
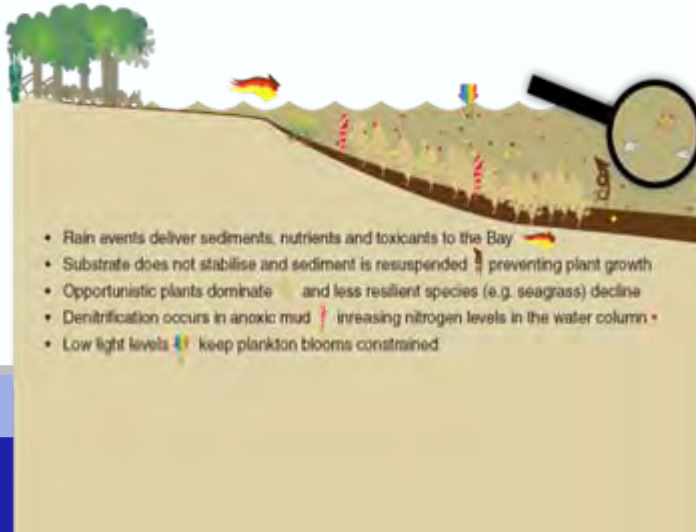
WESTERN MORETON Bay

EASTERN MORETON Bay

Future best case scenario



Future worst case scenario



Summary

- Plume extended beyond Moreton Bay and to a depth of 10 m
- Biochemical and bio-optical gradients in Moreton Bay persisted for more than 6 weeks
- After 19 weeks conditions similar to pre-flood
- 40% of seagrass area affected. Generally recovered after 12 months
- 10% of corals bleached and some species offshore more vulnerable



Acknowledgements

- Thomas Schroeder Heidi Franklin
- Karl Forcey, Brendan Dando
- Lynsay McDonald, Rizwi Farhan, Rob Gregor
- Jon Olley, Rod Conolly
- Paul Hough, Mike Holmes
- Stuart Phinn, Chris Rolfesma

Thank You

andy.steven@csiro.au