Dissolved organic matter (DOM) - microbe interactions

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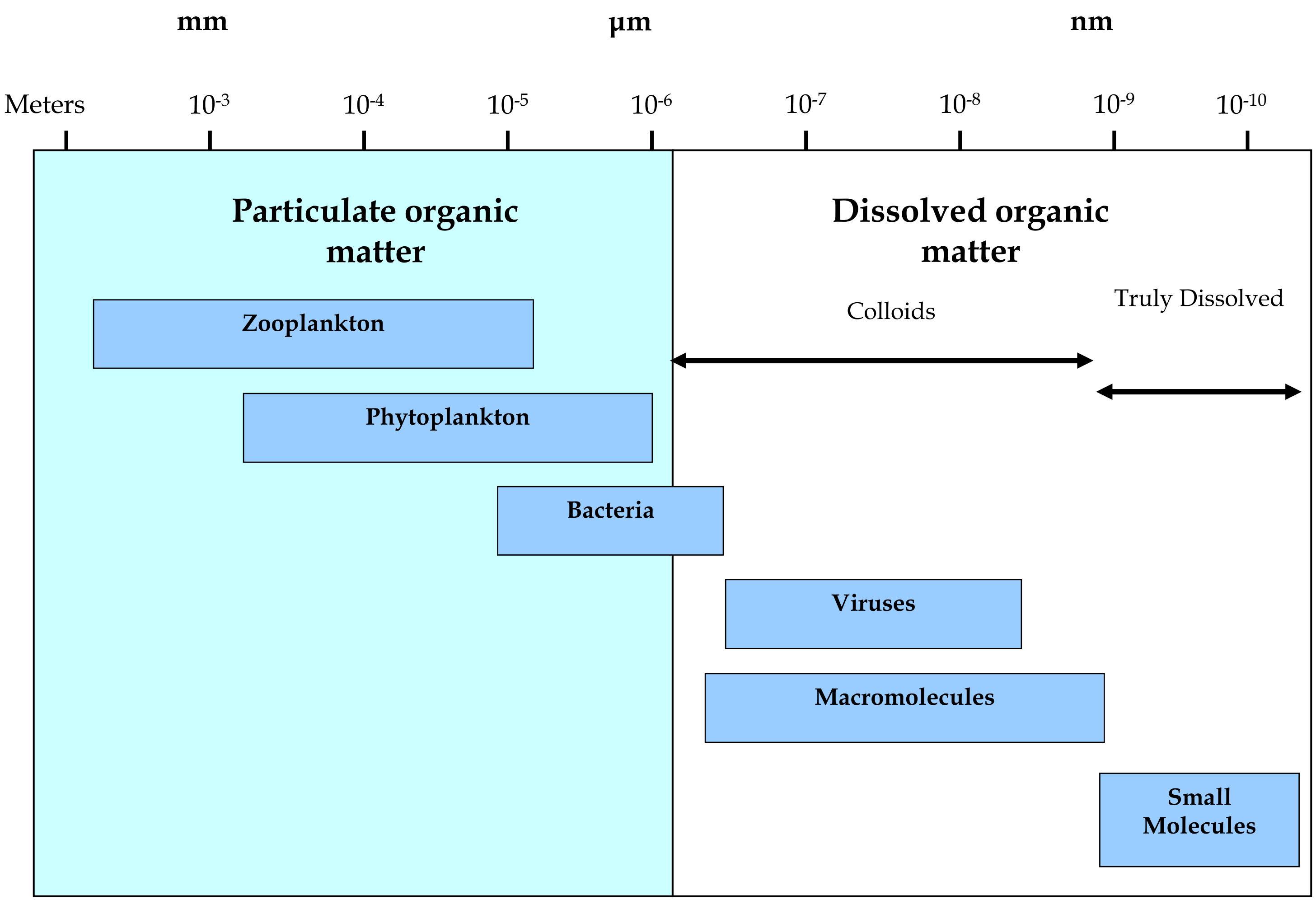
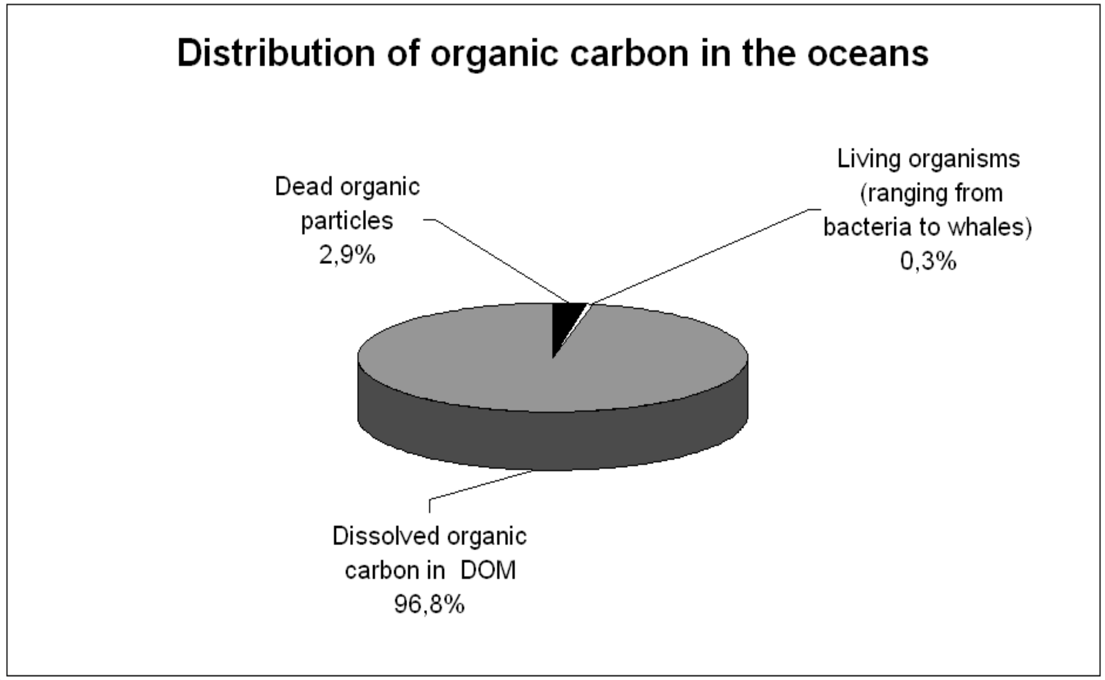
Overview

- DOM introduction and why do we care?
- Case studies: 1. Bacterial DOM degradation
  2. Bacterial and UV DOM degradation
- Research needs

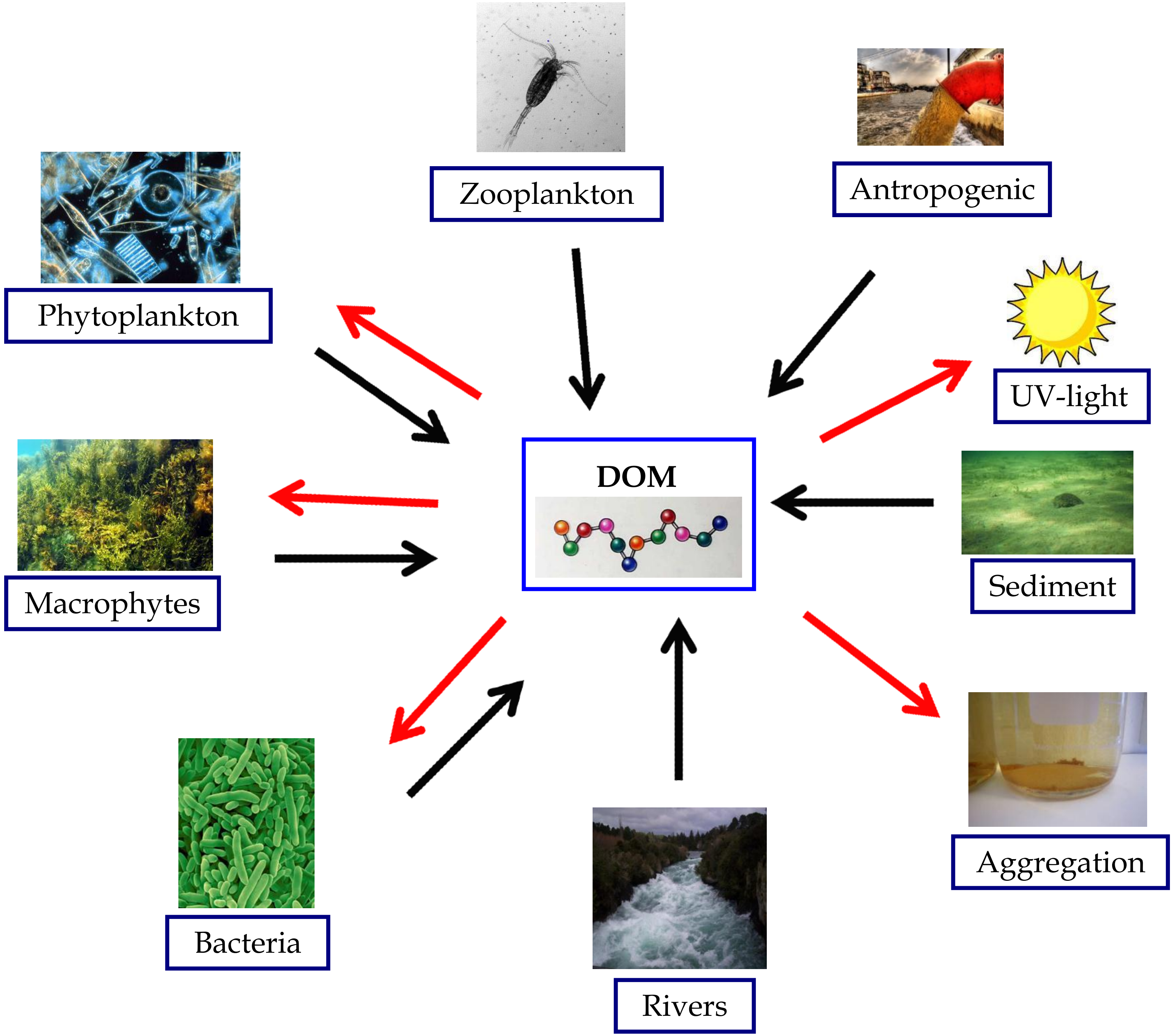
What is dissolved organic matter (DOM)?

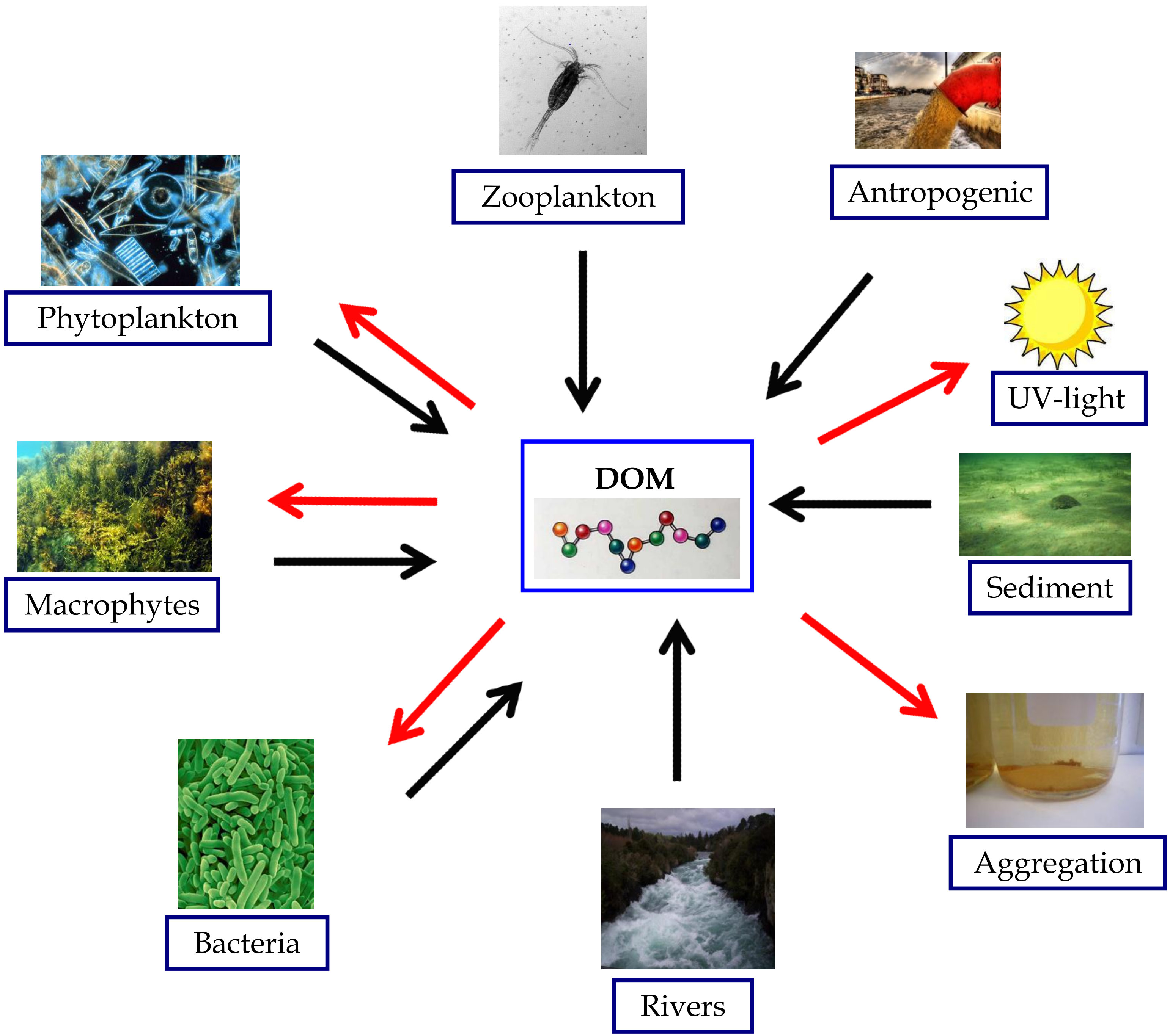


Why dissolved organics matter?



- 60% of nitrogen and phosphorus are in DOM


Zooplankton
Antropogenic
Phytoplankton
UV-light
DOM
Macrophytes
Sediment
Bacteria
Aggregation
Rivers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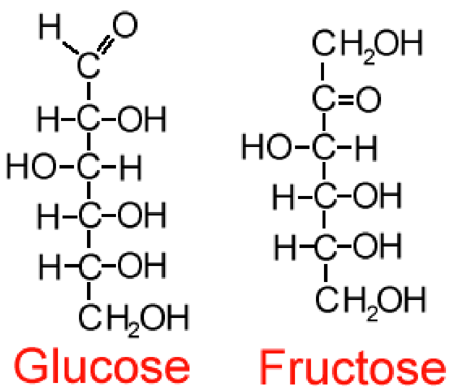
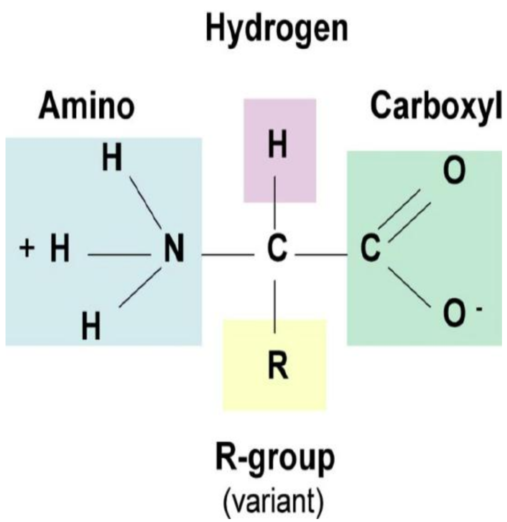
DOM composition





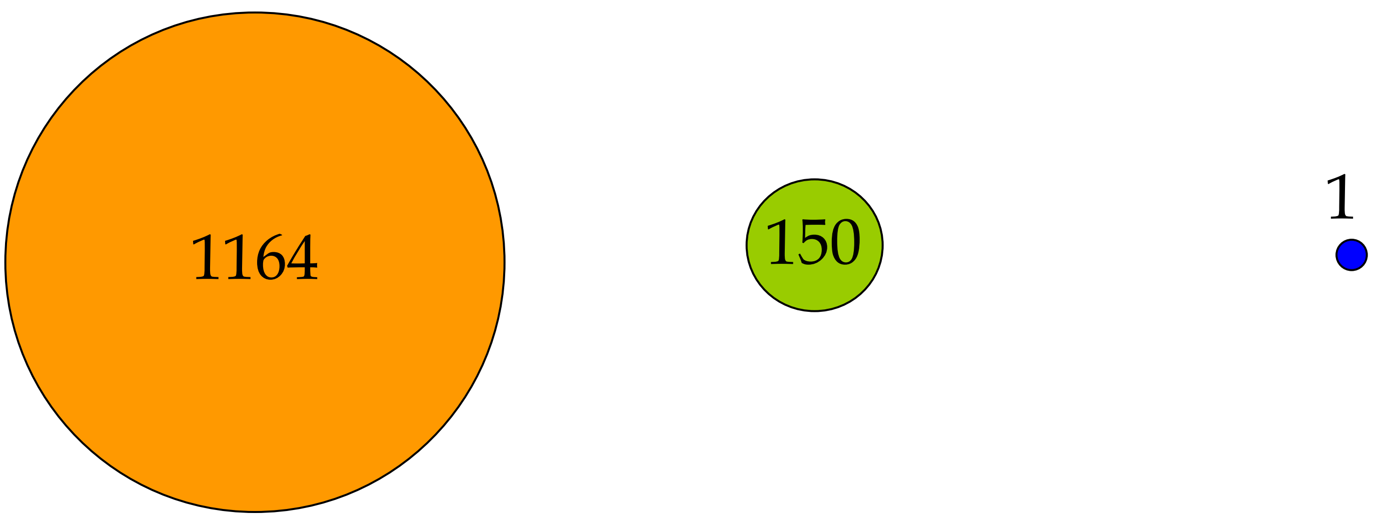
~15% of the bulk DOM pool in coastal ocean

DOM

Dissolved organic carbon (DOC) → e. g. Carbohydrates

Dissolved organic nitrogen (DON) → e. g. Proteins

Dissolved organic phosphorus (DOP) → e. g. DNA



DOM bioavailability

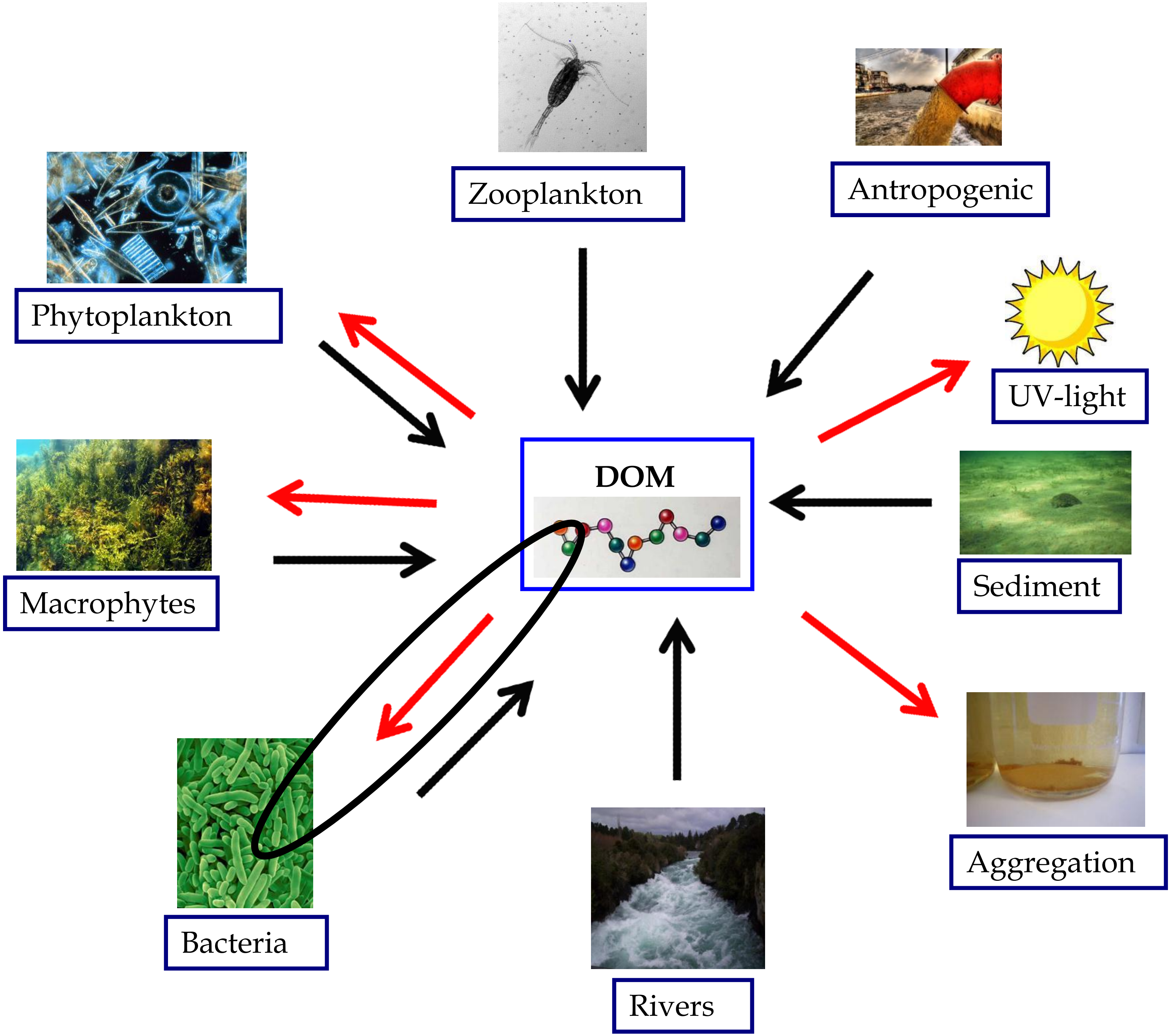
Degraded =

Bioavailable (BDOM)

Non-degraded =

Refractory (RDOM)

Case study 1: Bacterial DOM degradation



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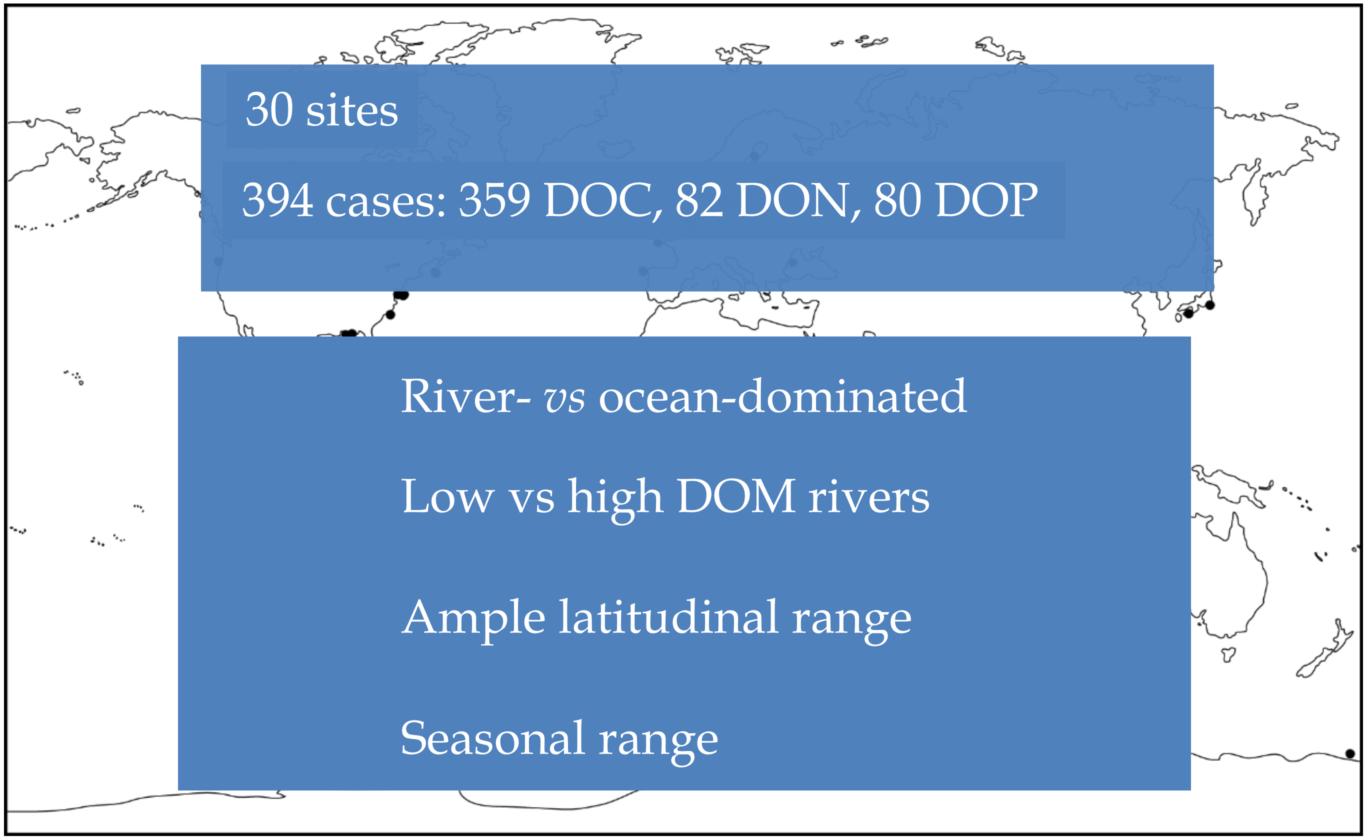
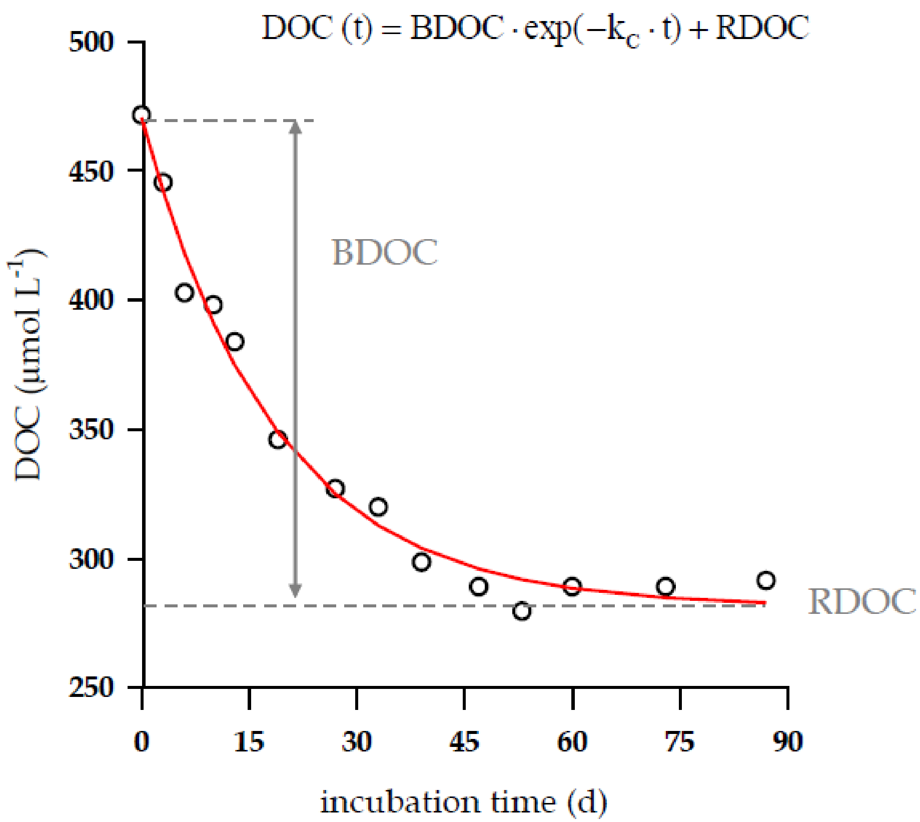
Coastal DOM database



Lønborg & Álvarez-Salgado (2012)

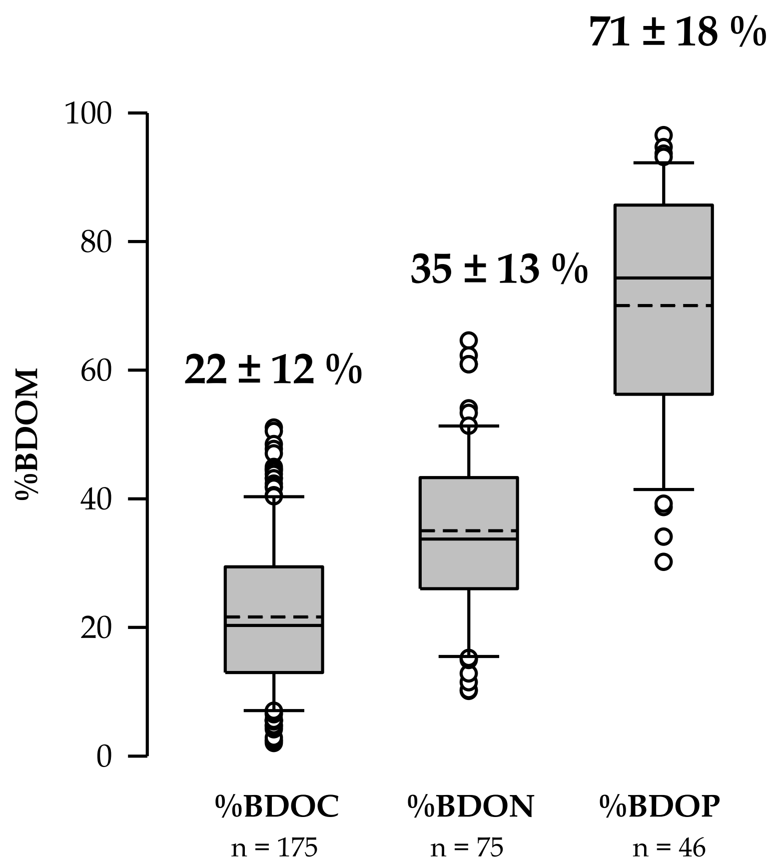
Microbial degradation of DOM



Included only incubations > 40 days

Pempkowiak (1985)

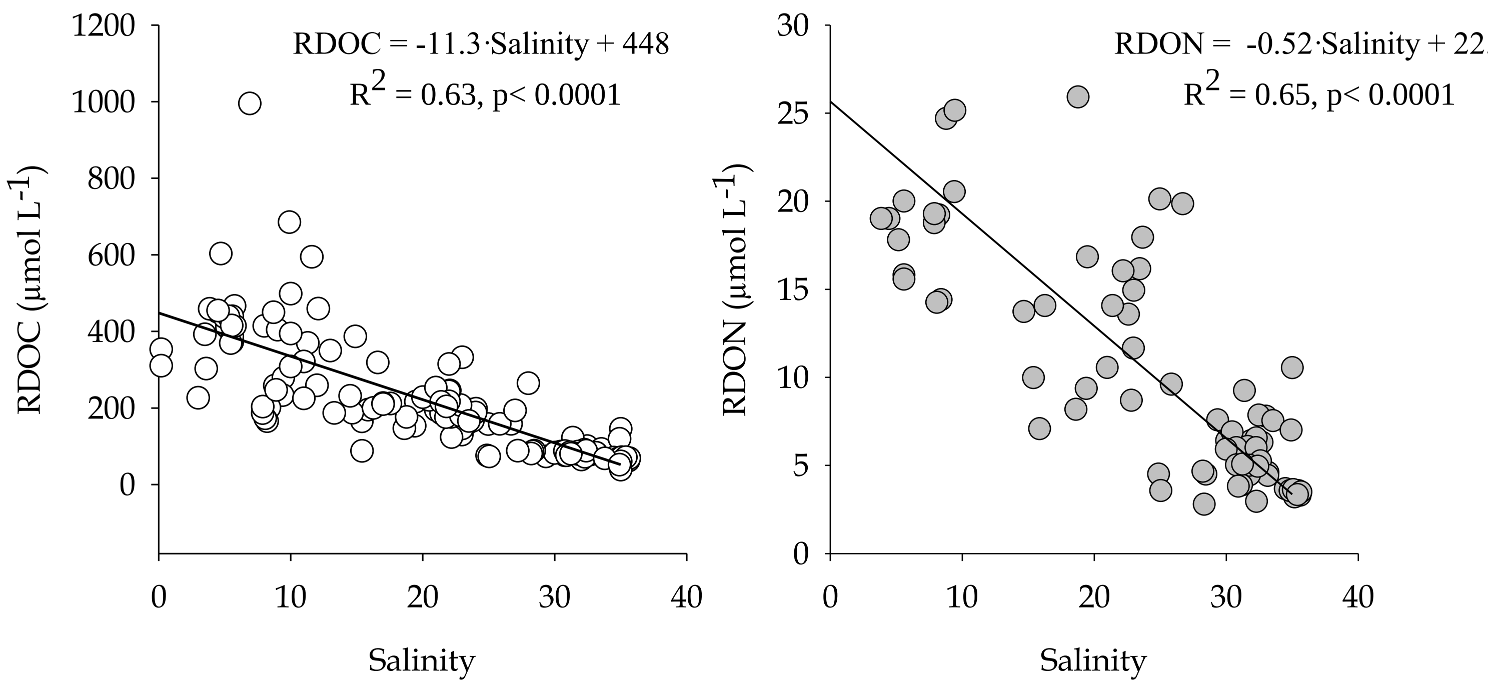
Bioavailability of DOM



Bioavailability gradient : P > N > C

Lønborg & Álvarez-Salgado (2012)

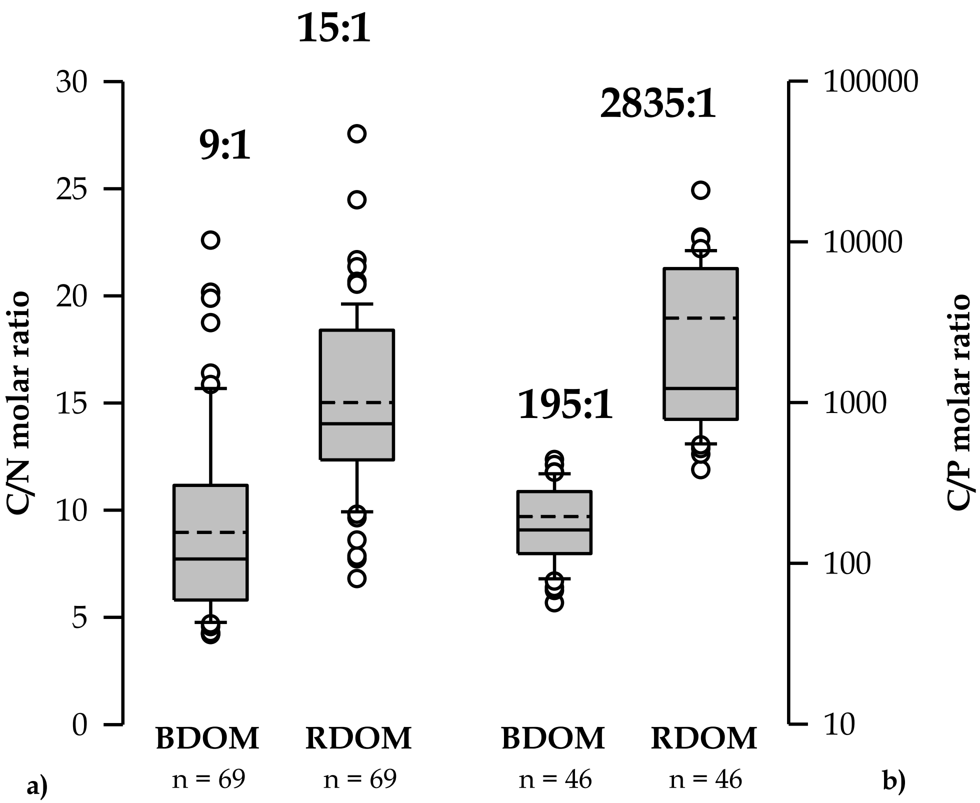
Refractory DOM



River DOM more refractory → moves conservatively

Lønborg & Álvarez-Salgado (2012)

C:N:P stoichiometry of DOM

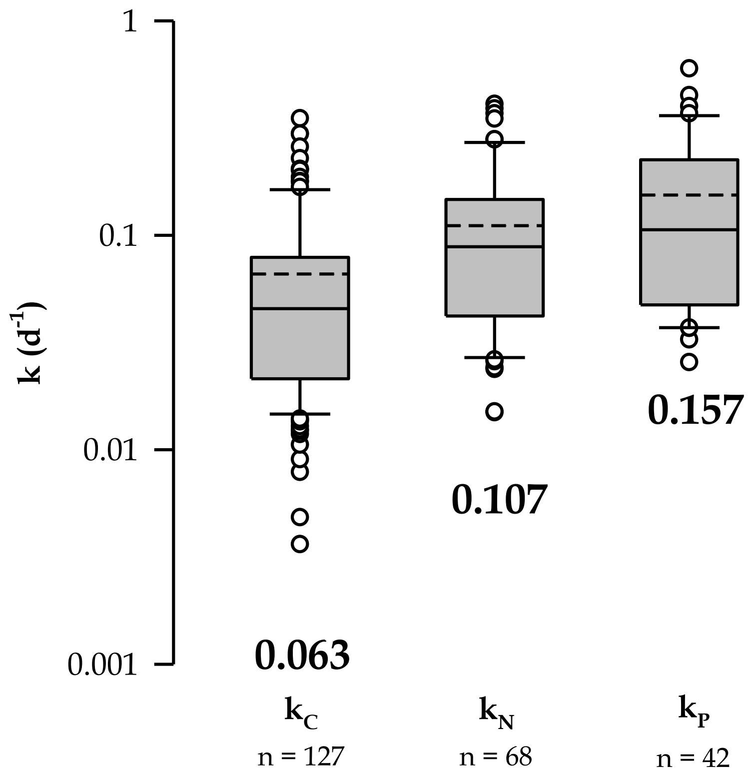


Ratio	C:	N:	P
Bioavailable DOM	195	26	1
Phyto. DOM	170	10	1
Refractory DOM	2835	159	1
River DOM	3495	118	1

River and plankton main contributor to DOM pool

Meybeck (1982); Lønborg&Álvarez-Salgado (2012)

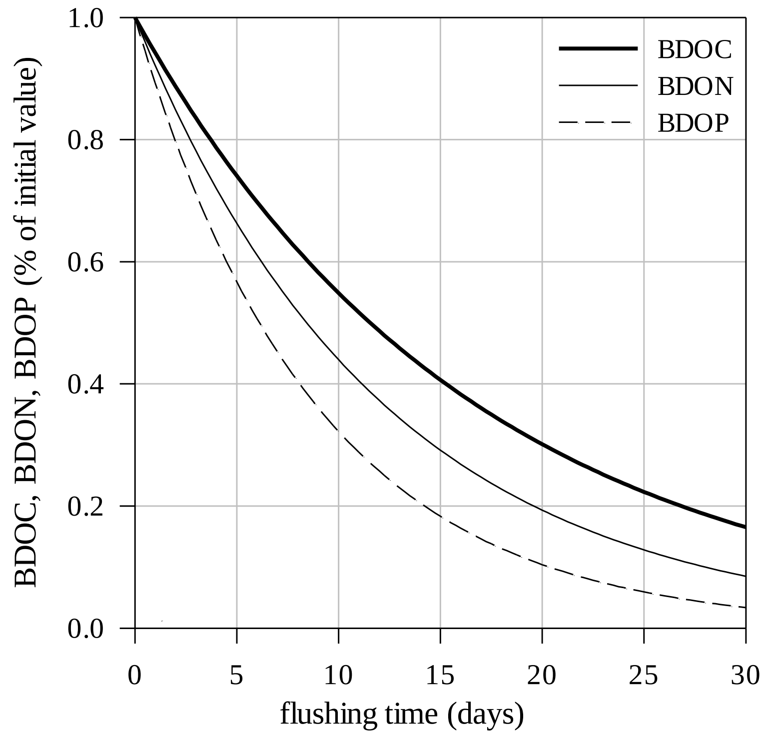
Kinetics of BDOM degradation



Reactivity gradient : P > N > C

Lønborg & Álvarez-Salgado (2012)

Modelling the BDOM degradation

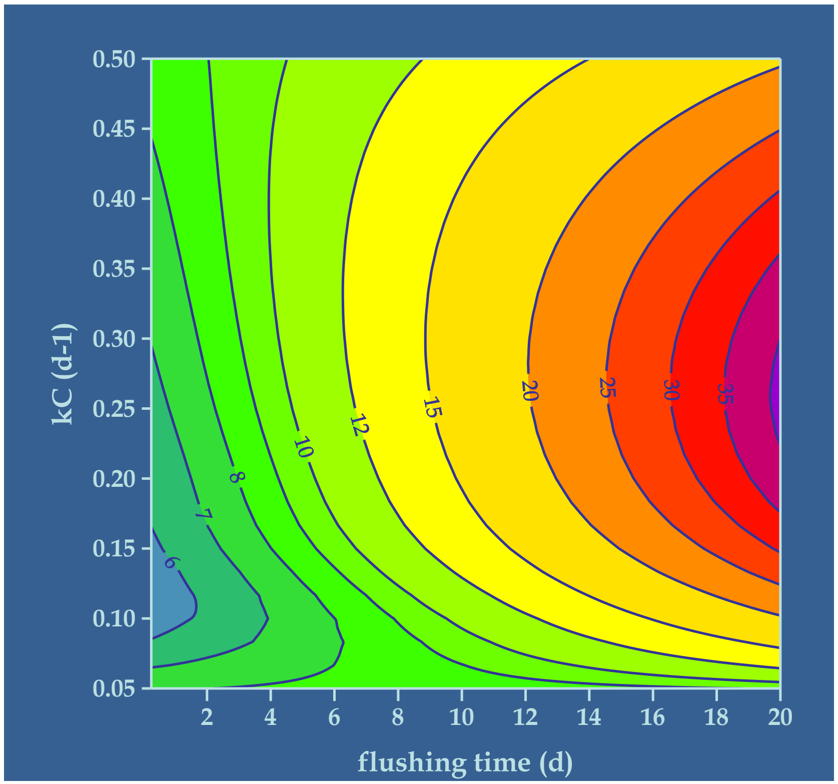


Longer flushing time less BDOM exported

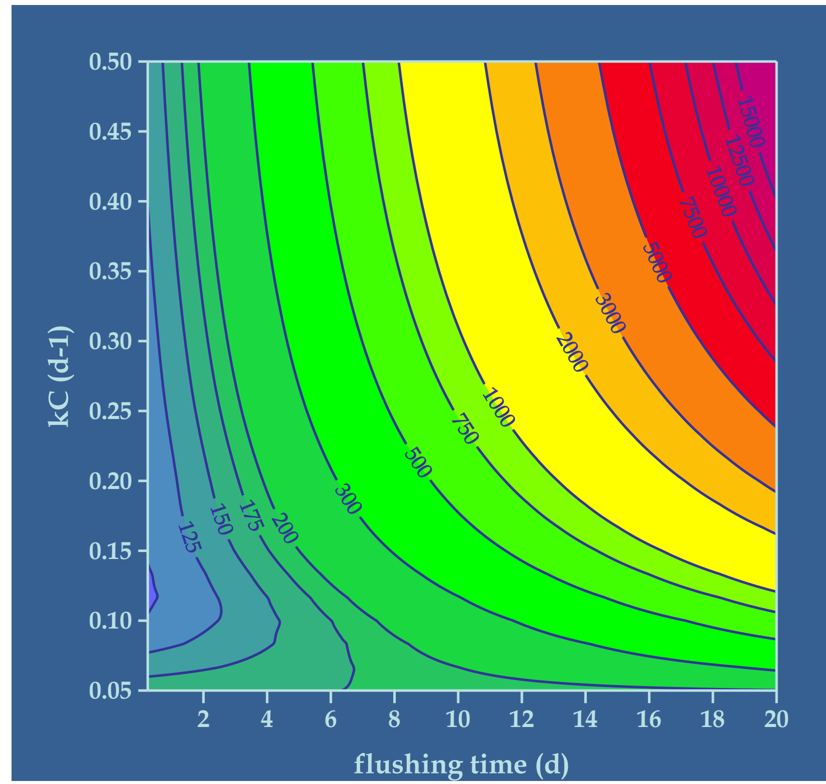
Lønborg & Álvarez-Salgado (2012)

Modelling the BDOM degradation

C/N of BDOM



C/P of BDOM



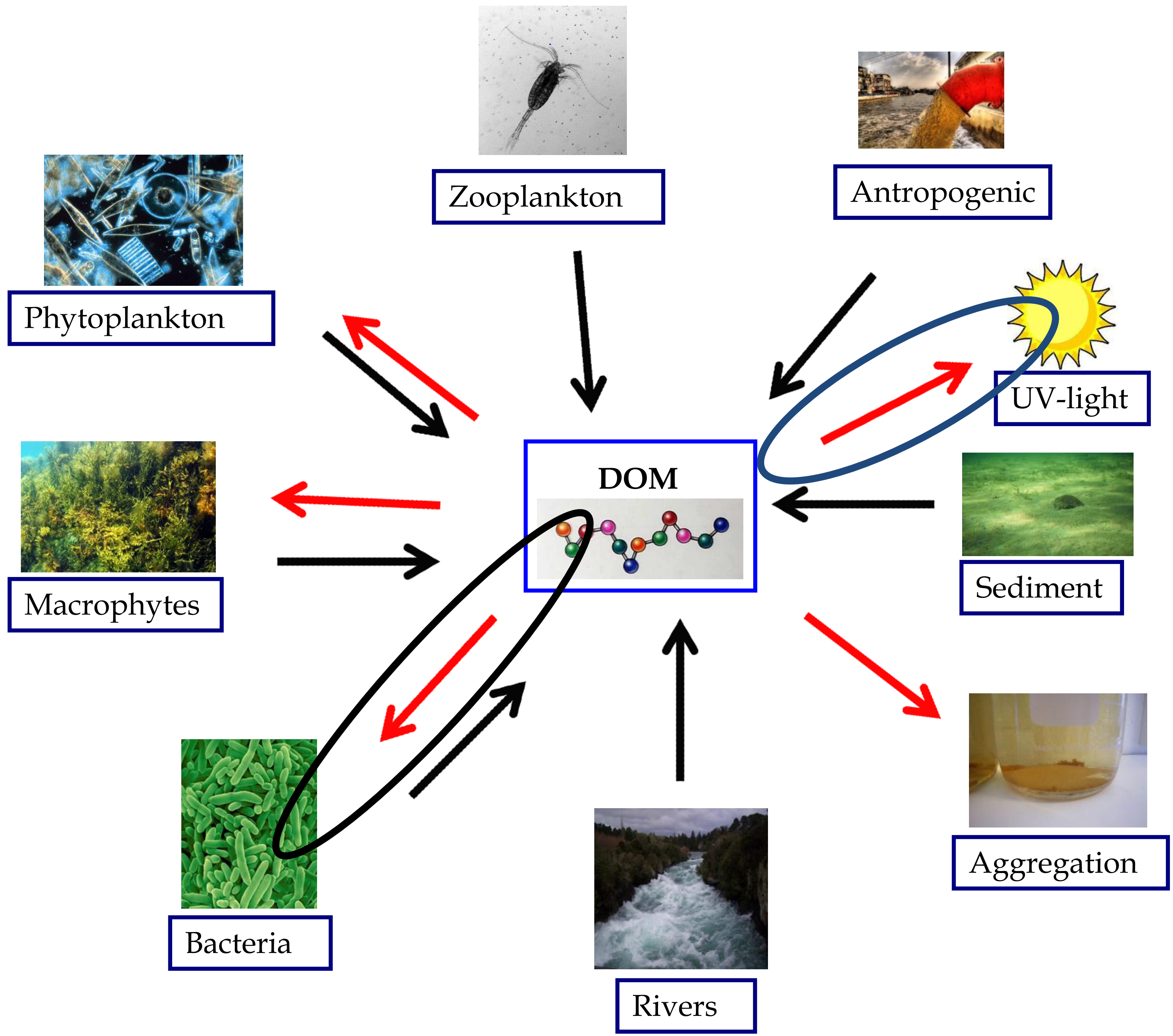
Longer flushing time - more carbon rich BDOM exported

Lønborg & Álvarez-Salgado (2012)

Conclusion

- DOM bioavailability and reactivity (P>N>C)
- Refractory DOM is conservatively mixed
- Plankton main contributor to BDOM
- Bioavailable DOM is exported

Case study 2: Bacterial and UV DOM degradation



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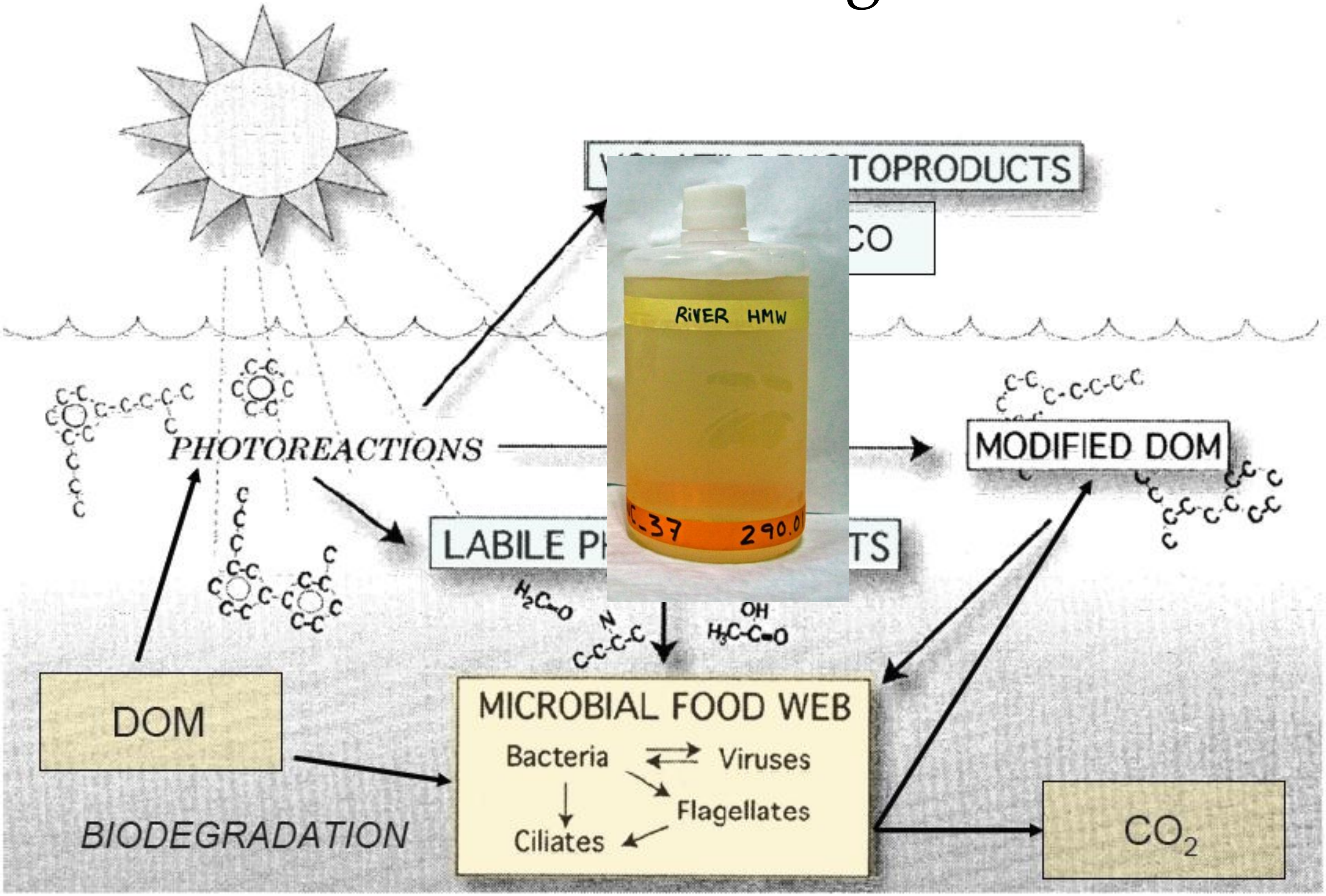
Photochemical DOM degradation

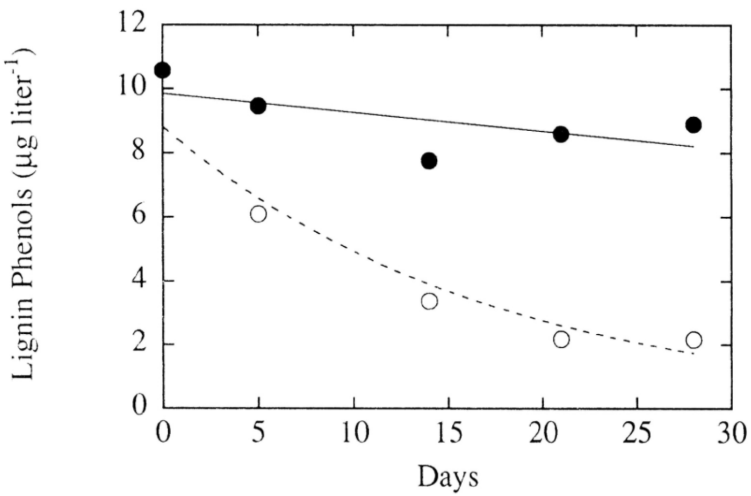


Moran& Covert (2003)

Microbes and photochemical processes

60% of river DOM is coloured (Aiken et al. 1985)

Sunlight - 96% of colour and 41% of DOC
(Vahatalo & Wetz 2004)

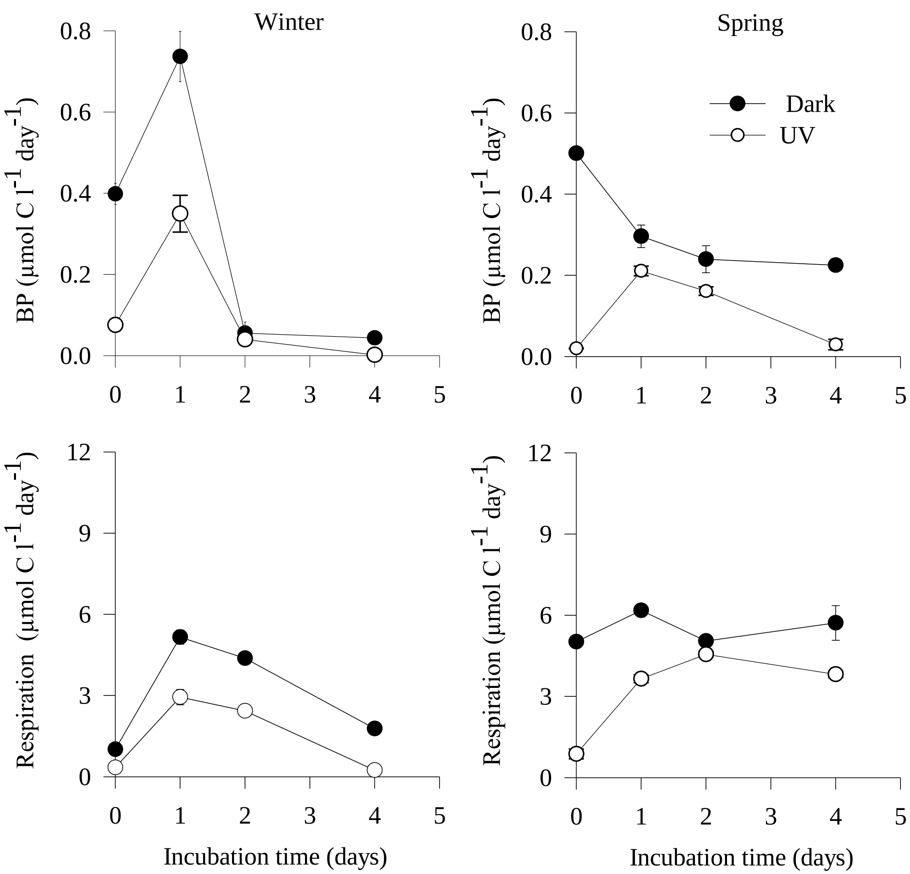


Photodegradation 5-fold greater (Opsahl & Benner 1998)

Combined microbial and photodegradation - 60% decrease in River DOM (Miller & Moran 1997)

Microbial and photodegradation together degrade DOM

Microbes and photochemical processes



DOC degradation also lower (Lønborg et al. 2013; Lønborg et al. in-prep)

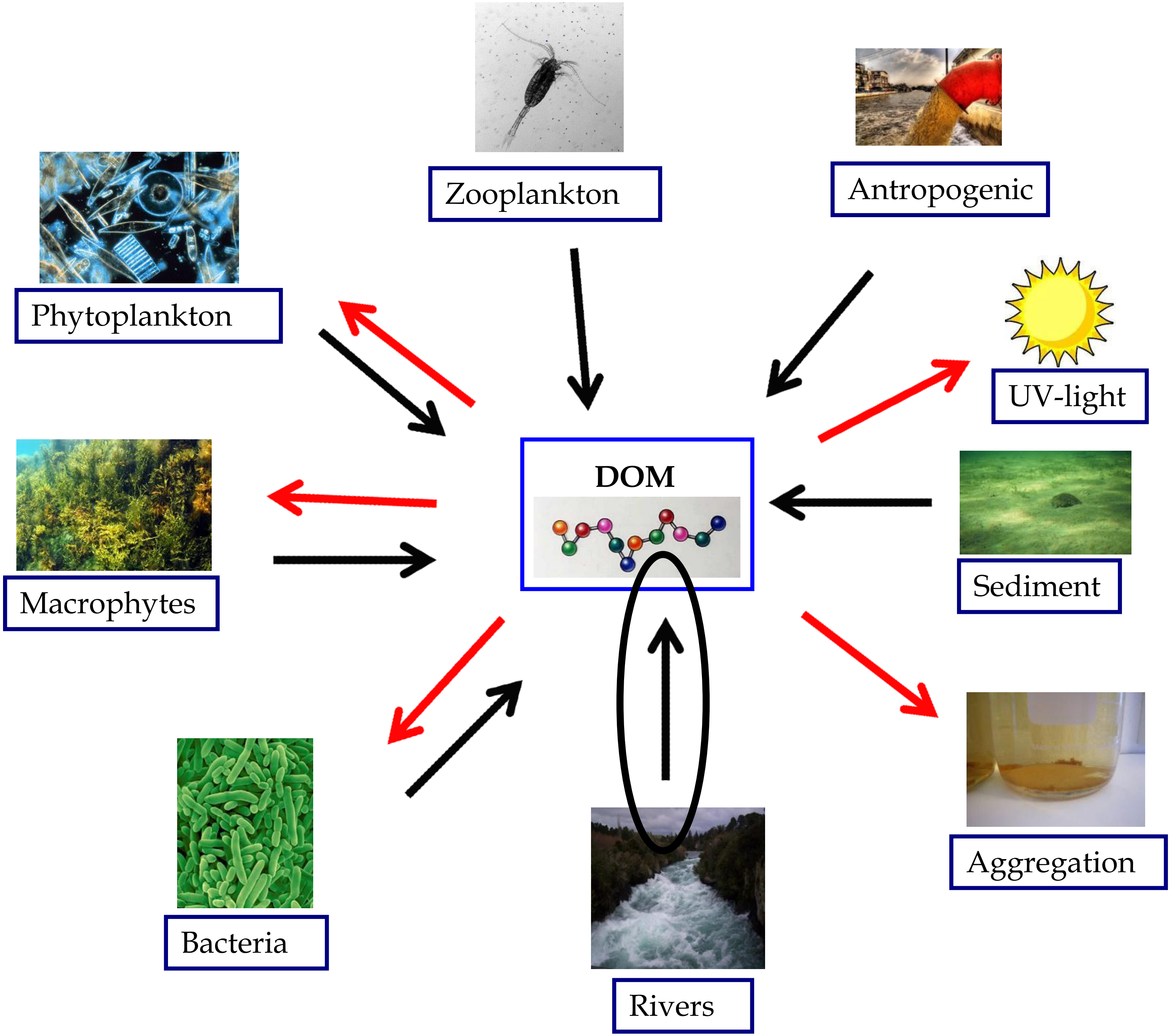
UV-light negative impact on DOM degradation (Lønborg et al. 2013; Lønborg et al. in-prep)

Plankton DOM → <u>negative</u> effect DOM degradation
River DOM → <u>positive</u> effect DOM degradation

Conclusions

- Sunlight exposure degradation of DOM
- Microbial and photodegradation more efficient
- UV-light:
- <u>negative</u> effect on plankton DOM degradation
- <u>positive</u> effect on river DOM degradation

Research needs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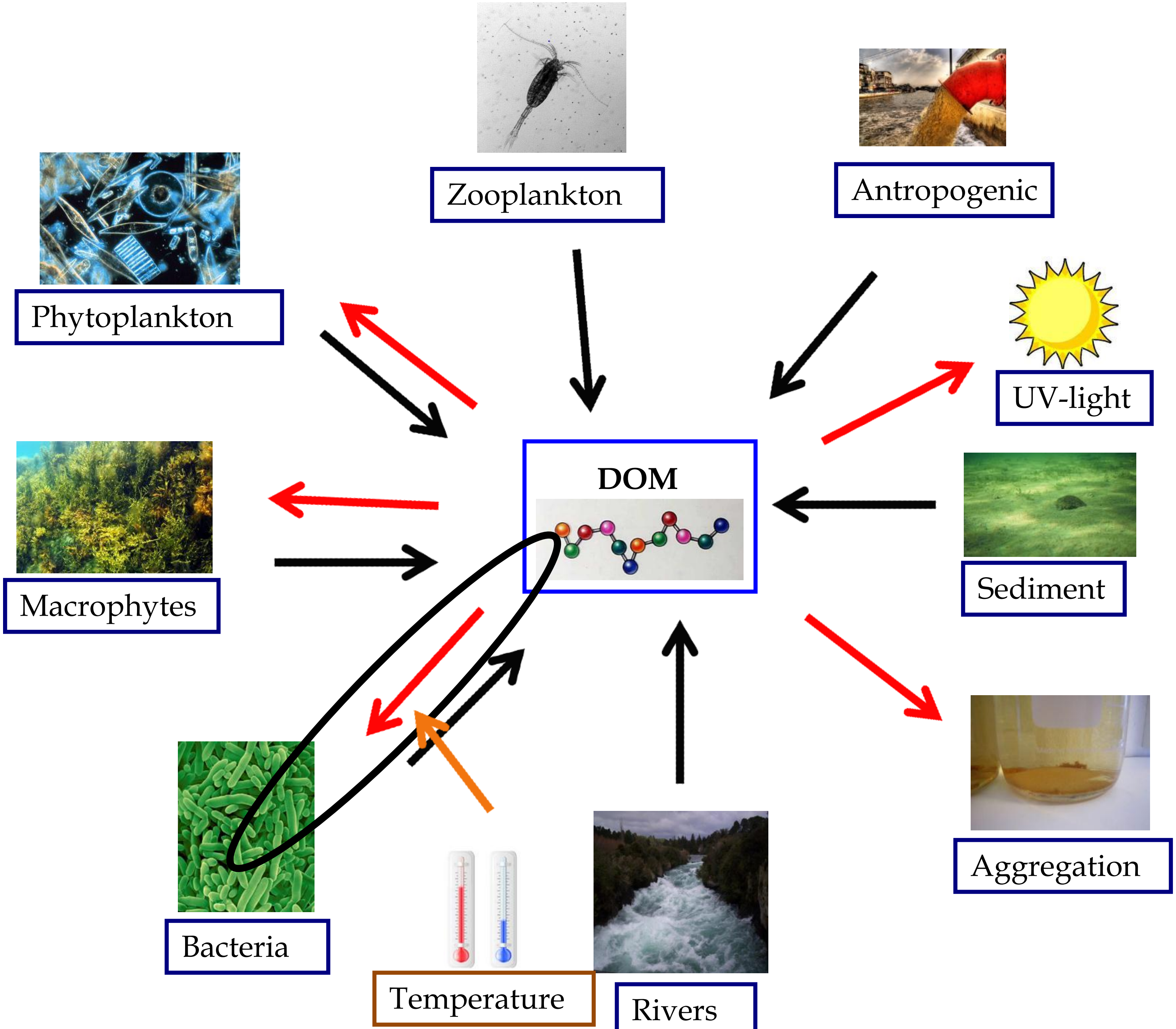
River DOM in marine systems

Rivers

0.3 Gt y^{-1} DOC to ocean (Bianchi 2011)

DOC in lakes and rivers has increased ~ 91% (Evans et al. 2006)

What is the effect for the coastal carbon cycle?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Temperature
Rivers

Temperature impacts

Global ocean warming – Impact on DOM degradation ?

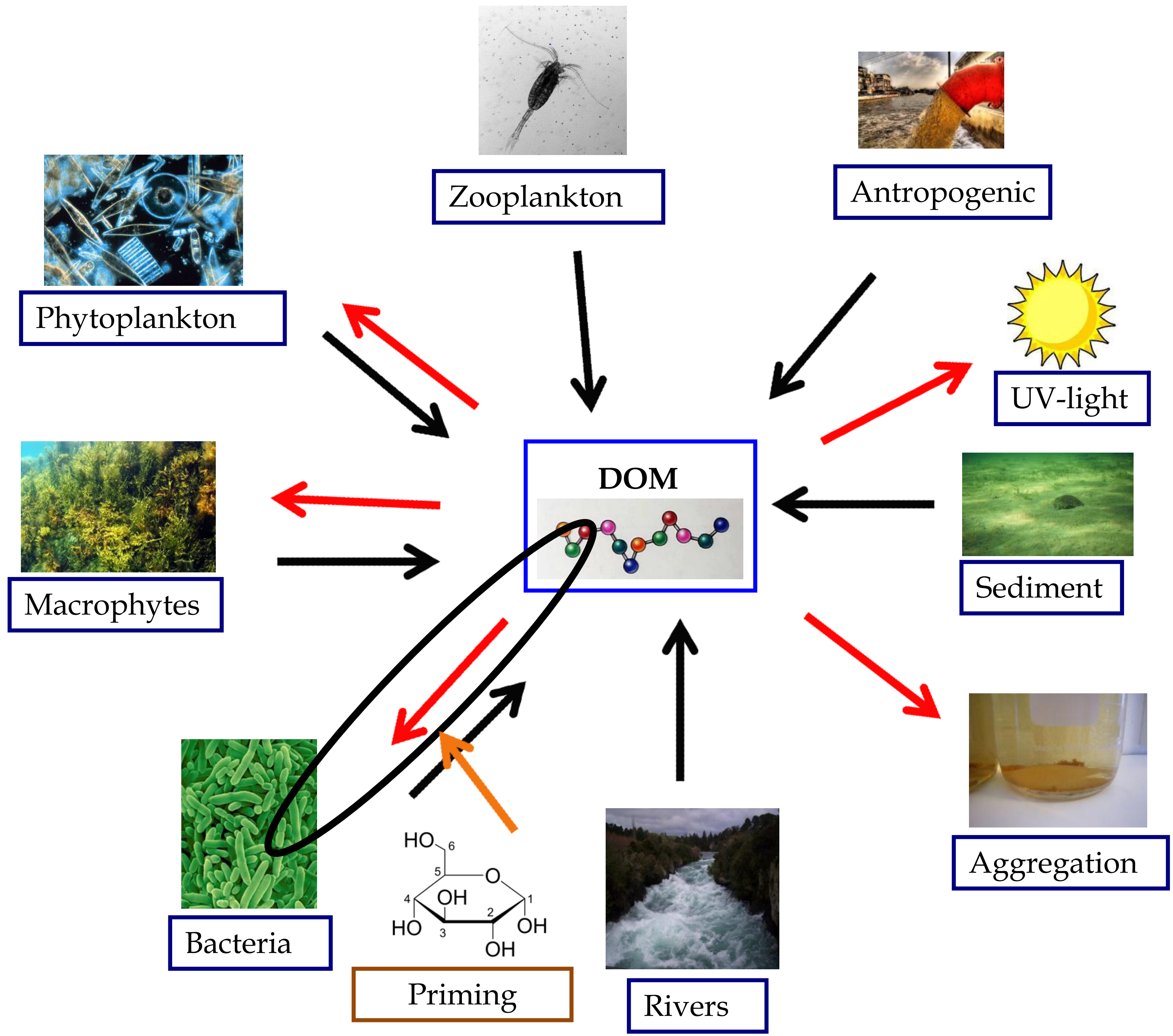
Q_{10} rate change with 10°C normally assumed to be 2

	Q_{10}	half-life (day)
Phytoplankton-derived DOC	1.7	6.3
Natural marine DOC (spring)	1.7	11
Natural marine DOC (summer)	1.8	6.9
Natural marine DOC (winter)	2.1	53
Humic DOC	2.7	152
Semirefractory DOC	3.8	3500
Semirefractory DOC	4.8	3500

- Q_{10} for DOM degradation varies between 1.7 – 4.8

What is the impact on foodweb and carbon cycle?

Lønborg et al. in-review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Priming
Rivers
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1
2
HO
3
OH
OH

Priming effects in marine systems

 +  = ?

• Refractory soil organic matter degradation – increase up to 600% when glucose added (Hamer et al. 2004)

• Some marine studies show effect on DOM degradation (Lønborg et al. unpubl. Results)

Does different DOM respond differently?

Summing up.....

- DOM bioavailability and reactivity (P>N>C)
- Bioavailable DOM is exported
- Microbial and photodegradation more efficient
- Plankton/river DOM respond differently

Research needs

- Increased flow of river DOM
- Temperature effects on DOM degradation
- Priming effects on DOM degradation

Acknowledgement

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Thank you for your attention!