# Bacterial Production and Respiration in Sub-tropical Hong Kong Waters: Influence of Pearl River Discharge and Sewage Impacts

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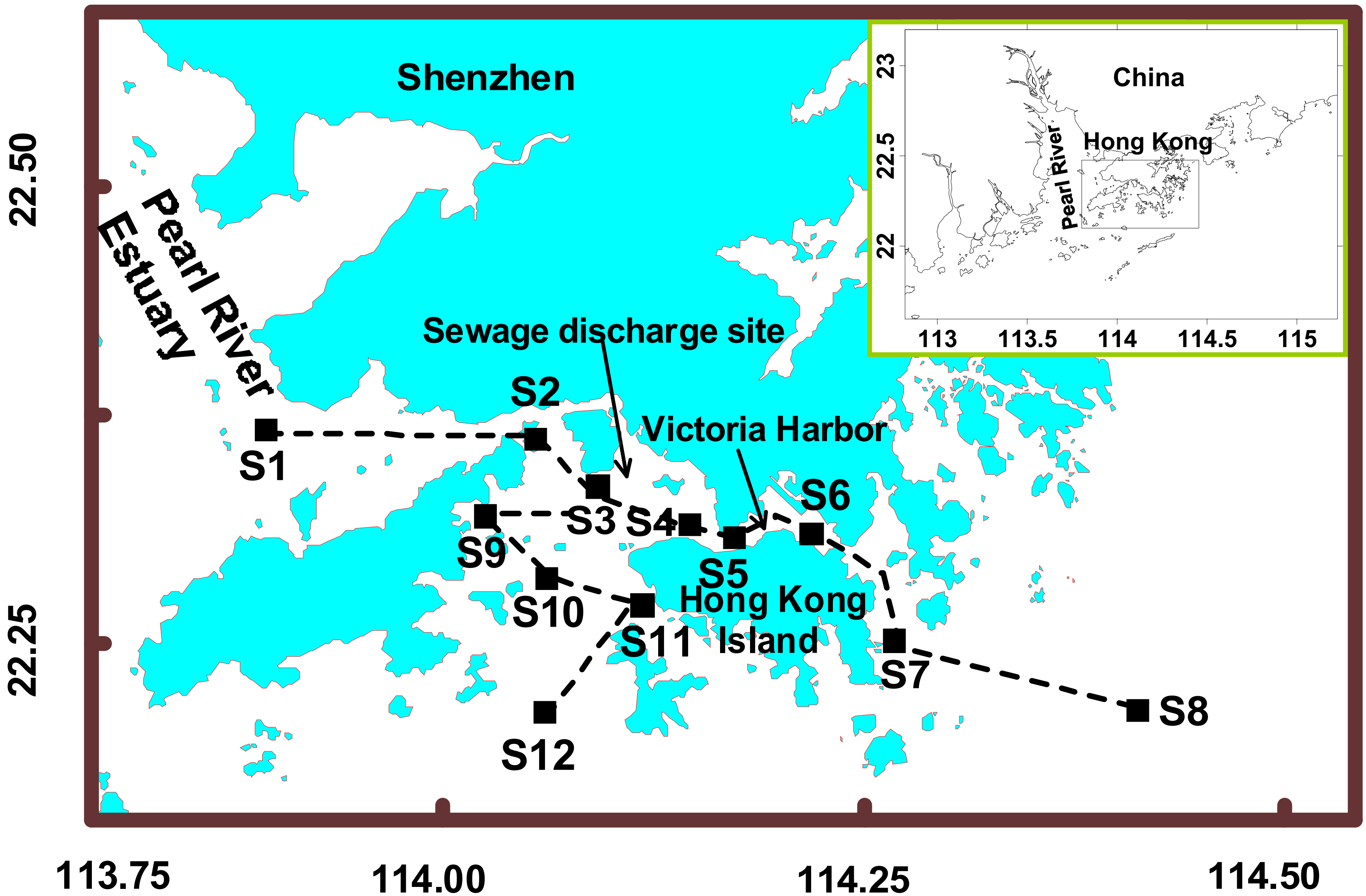
# Objectives:

1. Whether Hong Kong waters are heterotrophic

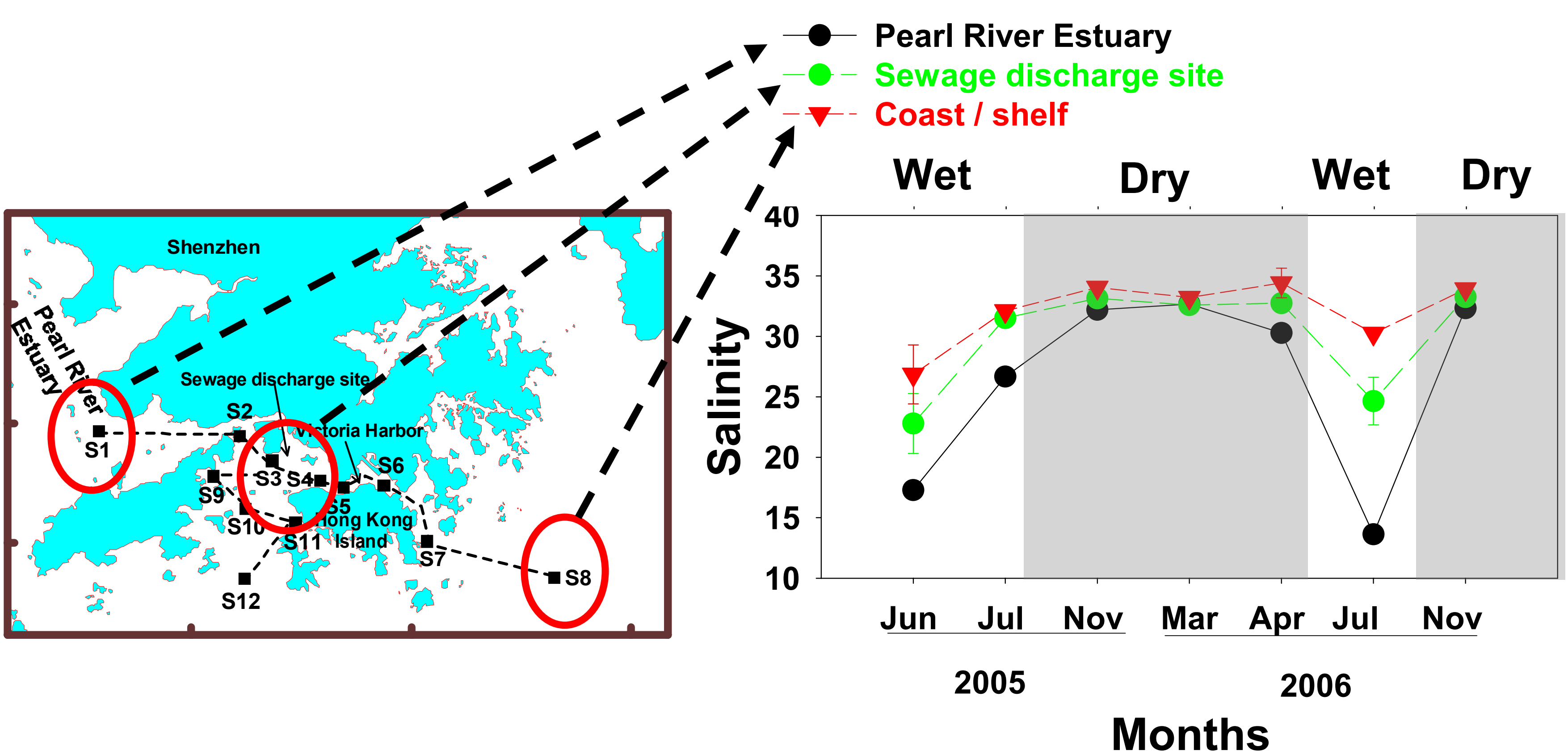
2. Influence of sewage discharge

3. Bacterial contribution to oxygen consumption and $CO_2$ release

# Monthly cruise tracks in Hong Kong

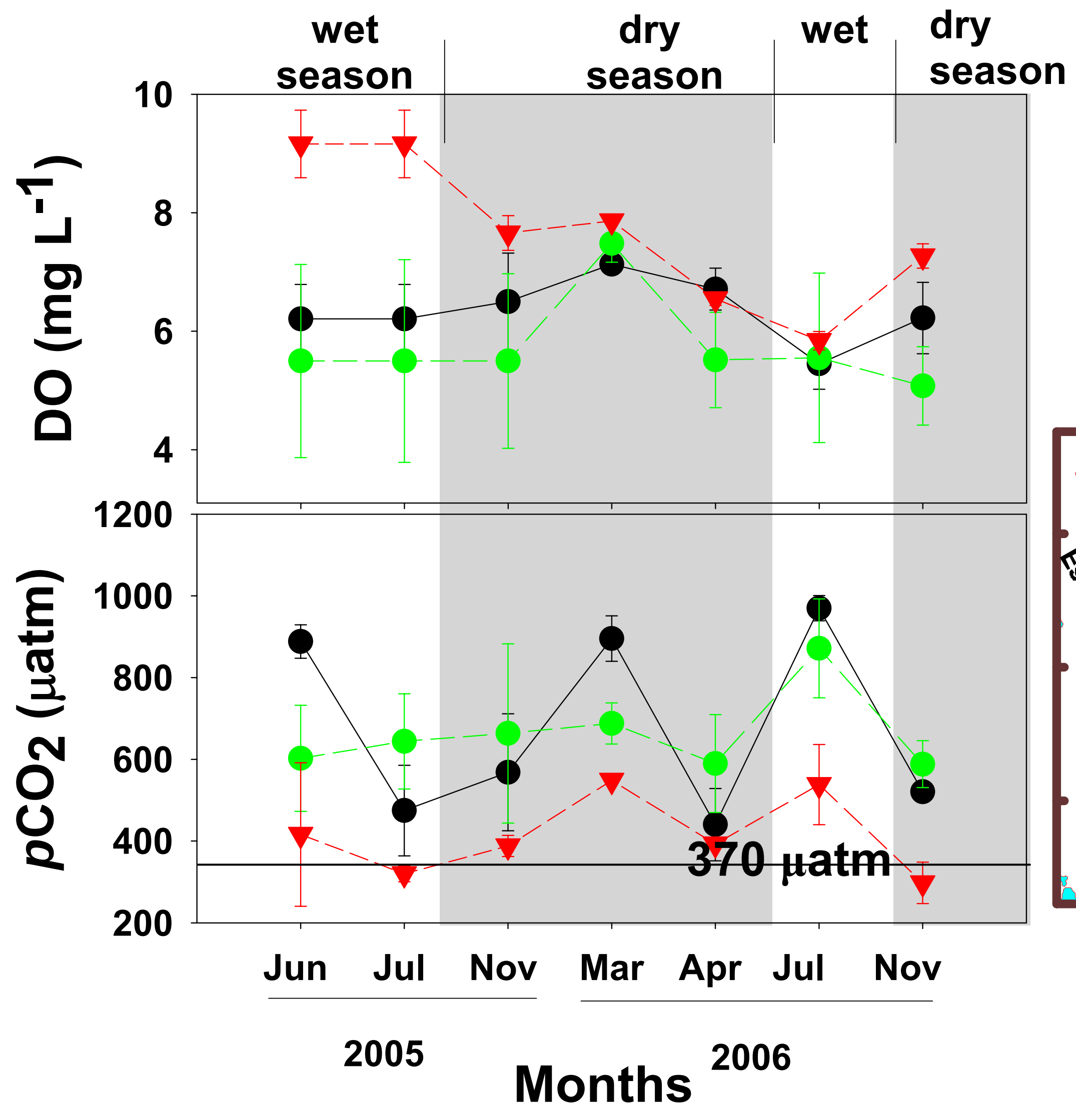


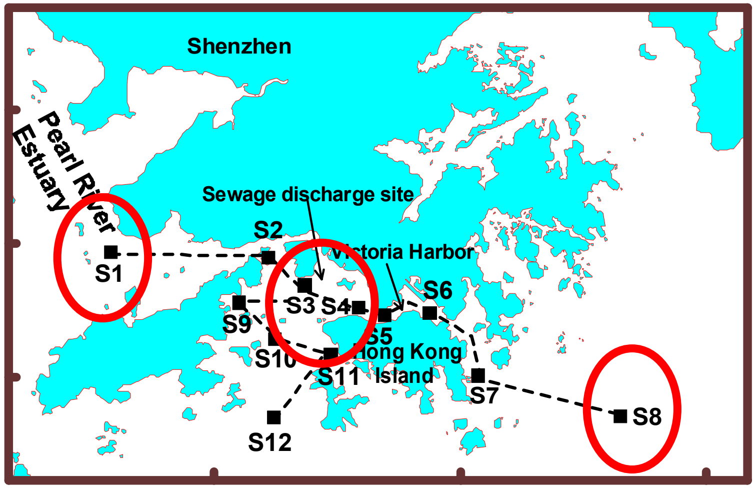
# Distribution of surface salinity and temperature (°C) in the wet and dry seasons




- Lower salinity at Stn 1 indicated estuarine influence
- There was strong mixing in the dry season

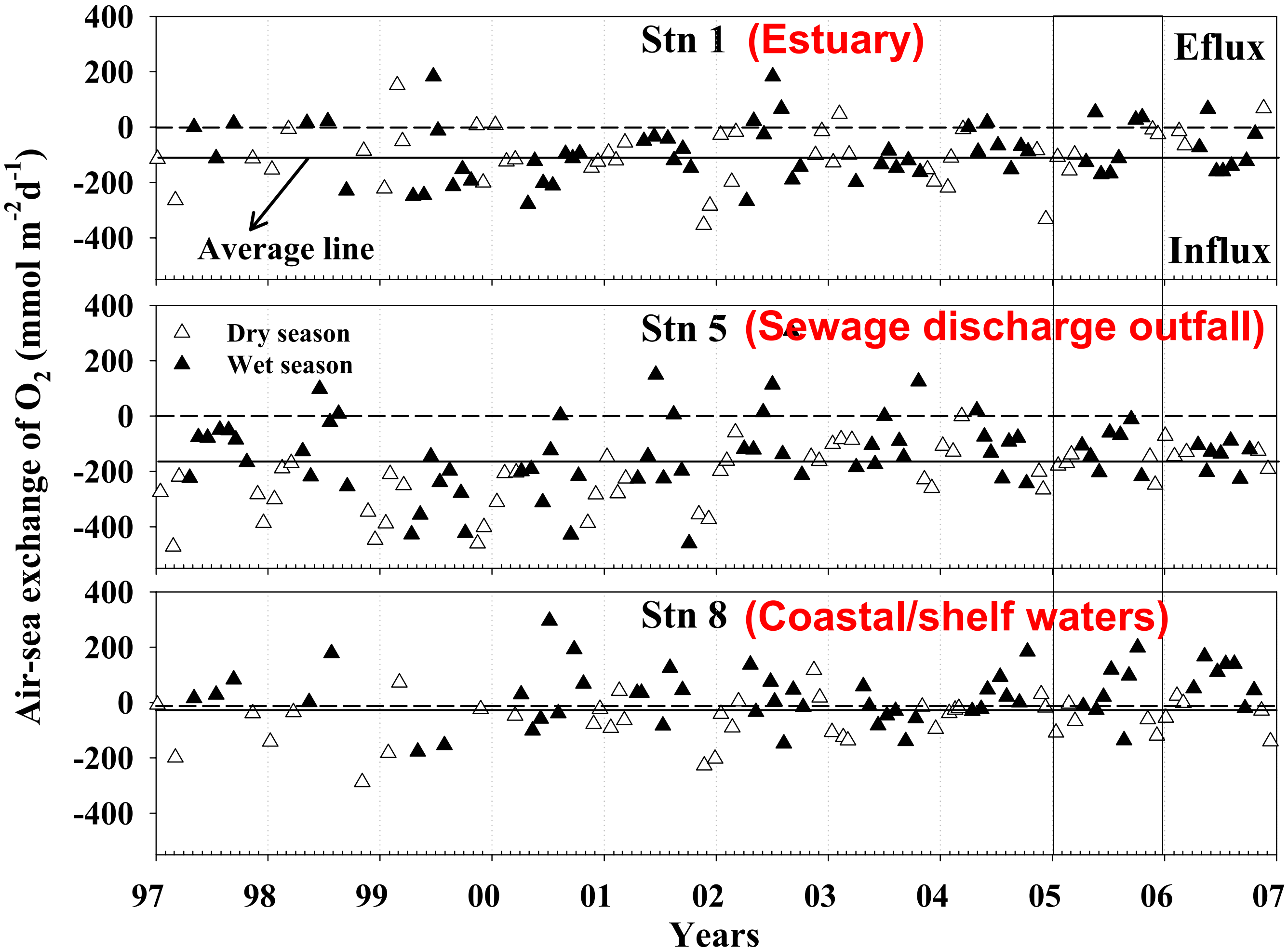
# Distribution of surface DO and $pCO_2$ variation in the wet and dry seasons




- $pCO_2$ was higher near the sewage discharge and Pearl River estuary
- DO was lower near the sewage discharge site

# Air-sea exchange of oxygen during past ten years




- Long term heterotrophy in Hong Kong waters
- Average influx of oxygen: sewage discharge outfall > estuary >coastal/shelf waters
- Air-sea exchange of oxygen can offset >50% of community respiration (~0.4 mg $O_2$ $l^{-1}$ $d^{-1}$) near sewage discharge outfall

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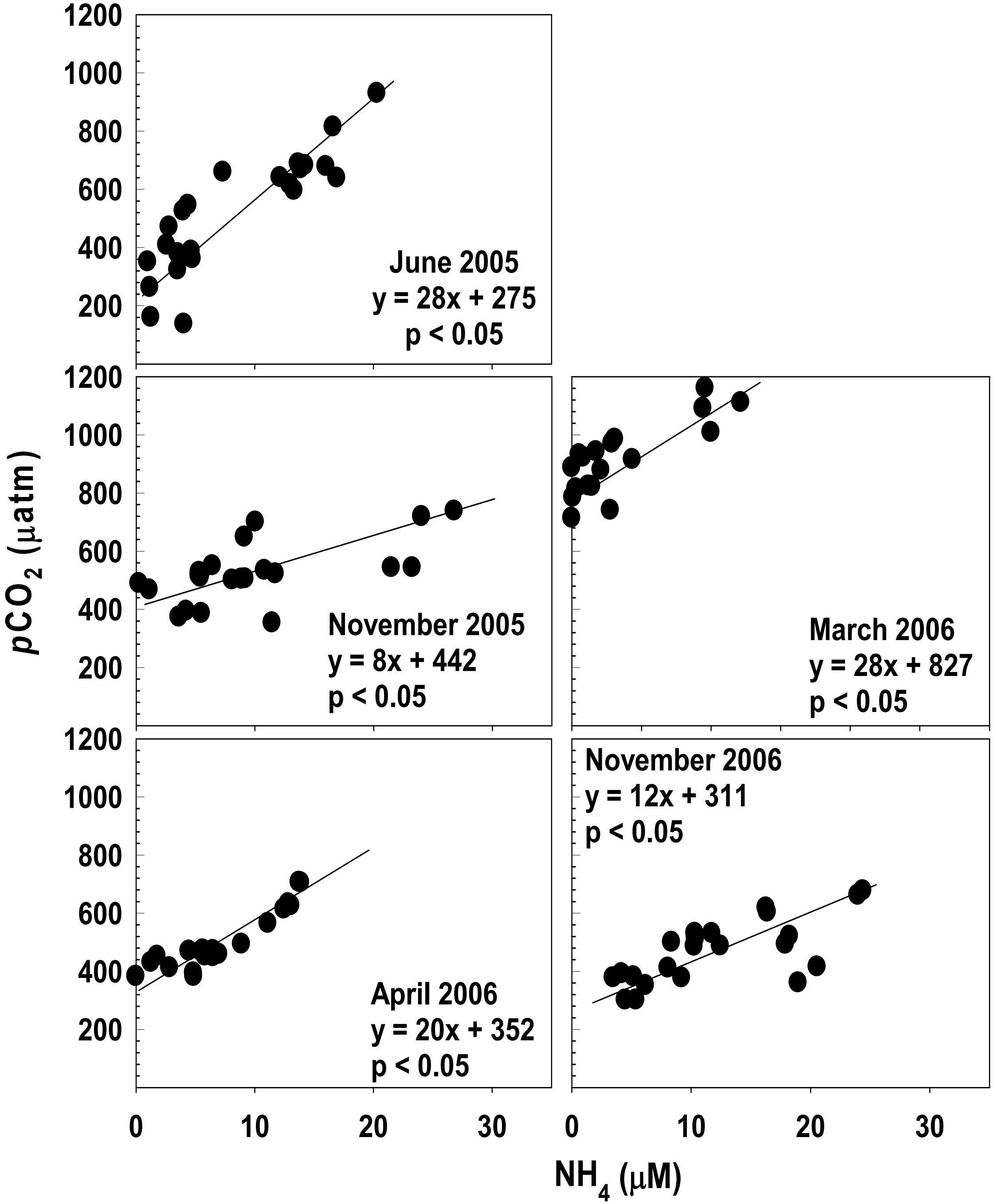
# Sewage effects

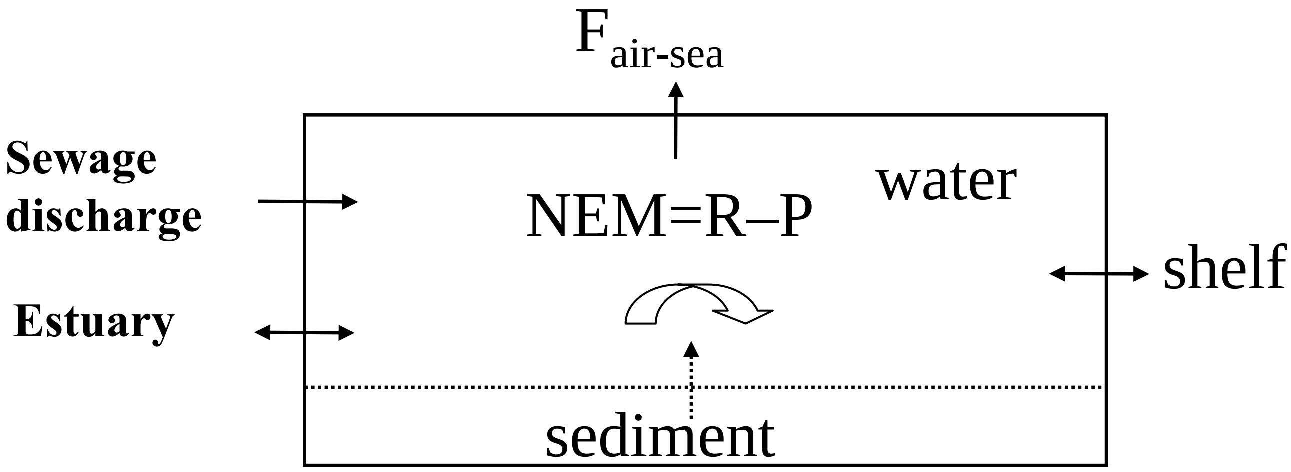
1) Significant correlation between $pCO_2$ and $NH_4$

2) $NH_4$ ($p < 0.05$), an indicator of sewage effluent discharges

3) Sewage effluent may exert a strong influence on $CO_2$ efflux.



# Increases in DIC due to sewage discharge




**Sediment respiration: 1 g $O_2$ $m^{-2}$ $d^{-1}$ (Guan et al. 2001)**

**Respiration (R) in water column : 3 to 5 g $m^{-2}$ $d^{-1}$,**
**Primary production (P) in water column: 1 to 19 g $m^{-2}$ $d^{-1}$**

**Increase due to sewage discharge —**
**DIC: ~70 μM $d^{-1}$ (6%),**
**TN: 7 μM $d^{-1}$(40%),**
**$pCO_2$: 100 μatm $d^{-1}$ (40%)**

# Estimate of carbon load per person

- Population (mid-2007): 6.92 million

Per capita nitrogen load in wastewaters: 3.3 to 4 kg N $yr^{-1}$ per person (Howarth et al. 1996, Diego-McGlone 2000)

Discharge: 2.1 to 2.8 x $10^7$ Kg N $yr^{-1}$

- TN in sewage before discharged : ~15 g $m^{-3}$ (EPD, 2008)

Annual flow: 9.7 x$10^8$ $m^3$ $yr^{-1}$ (EPD, 2008)

Discharge: 1.4 x $10^7$ Kg N $yr^{-1}$

Assumption: DIC/ TN= ~70 : 7

Discharge of DIC= 14 x $10^7$ Kg N $yr^{-1}$

Carbon load: ~20 kg C $yr^{-1}$ per person

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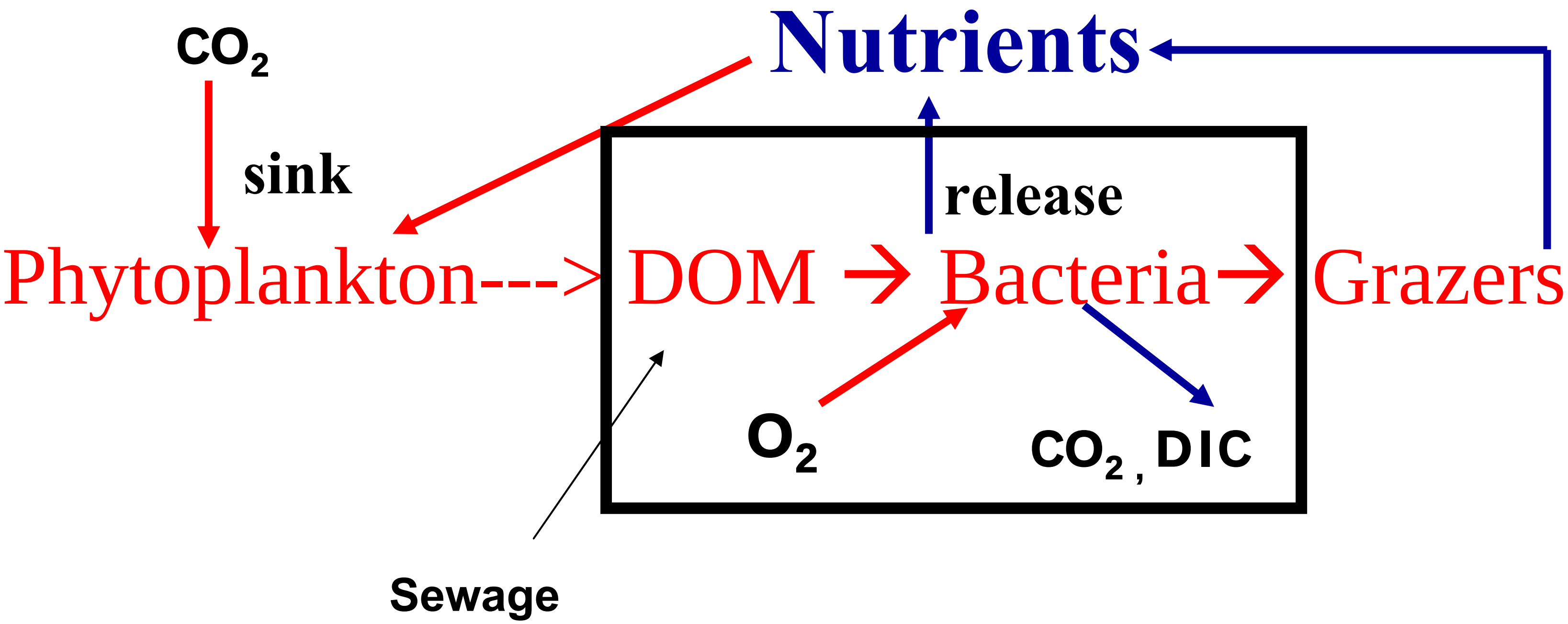
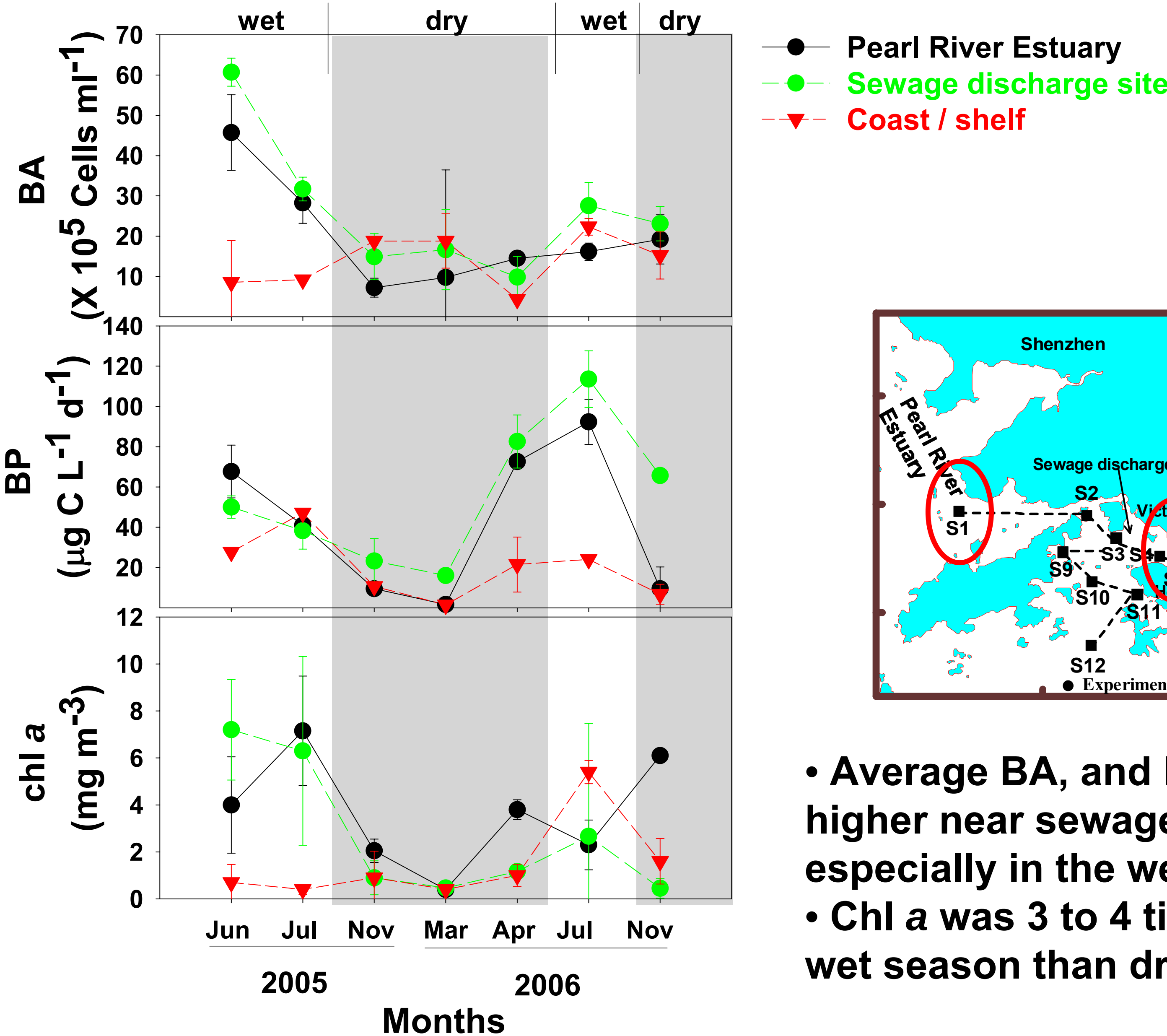
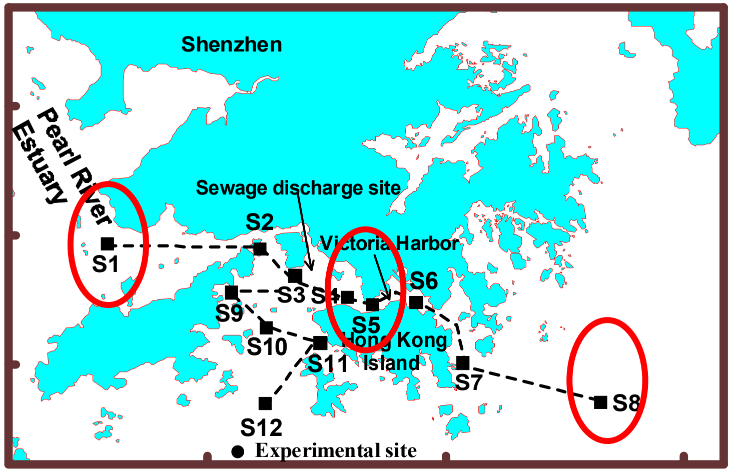
# Microbial loop




- **Bacteria play an important role in the food chain and biogeochemical cycling**

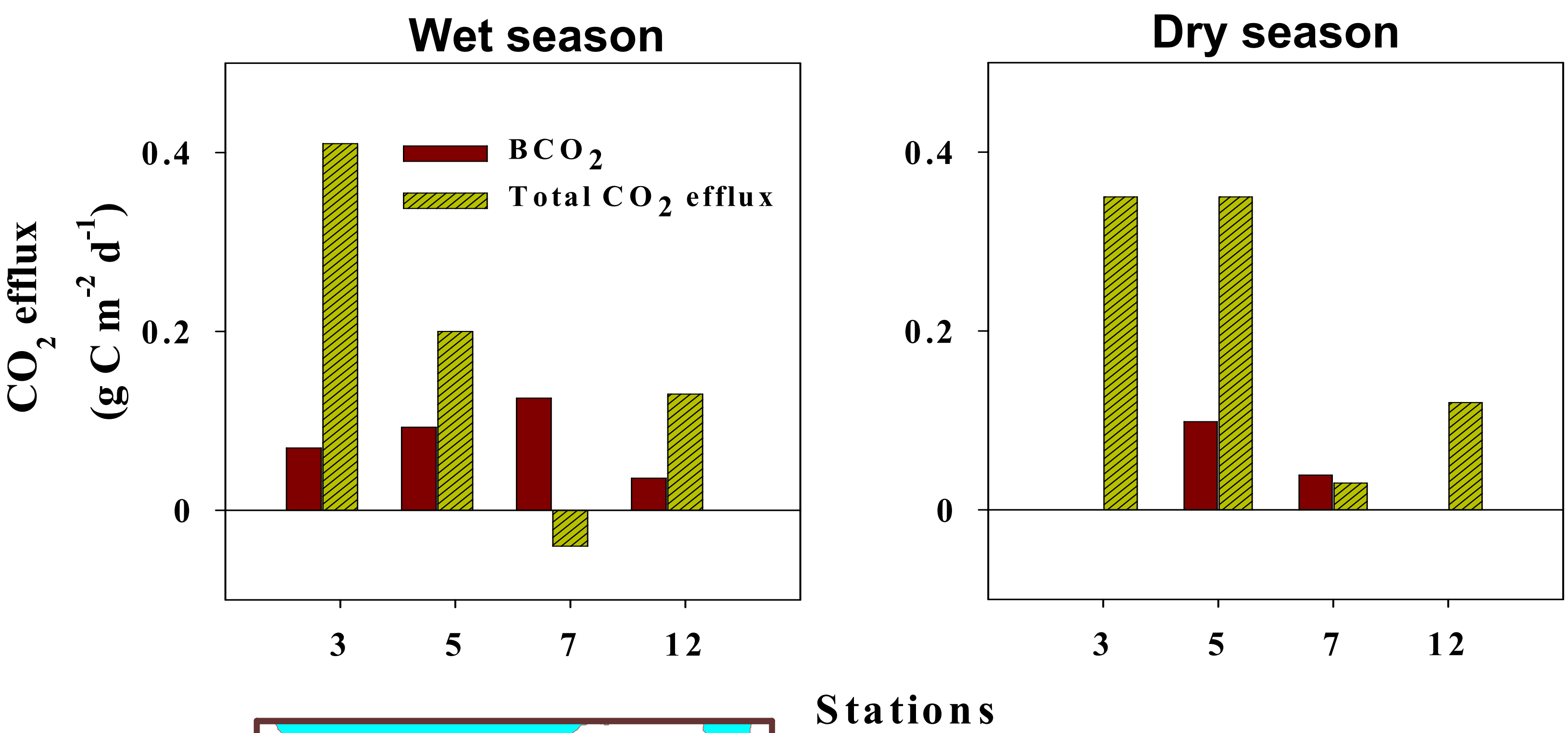
# Distribution of surface bacterial abundance (BA), production (BP) and chl *a* in the wet and dry seasons

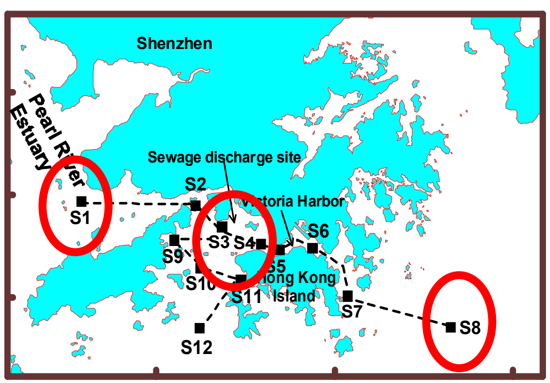



- Average BA, and BP were significantly higher near sewage discharge, especially in the wet season ($P < 0.05$)
- Chl *a* was 3 to 4 times higher in the wet season than dry season

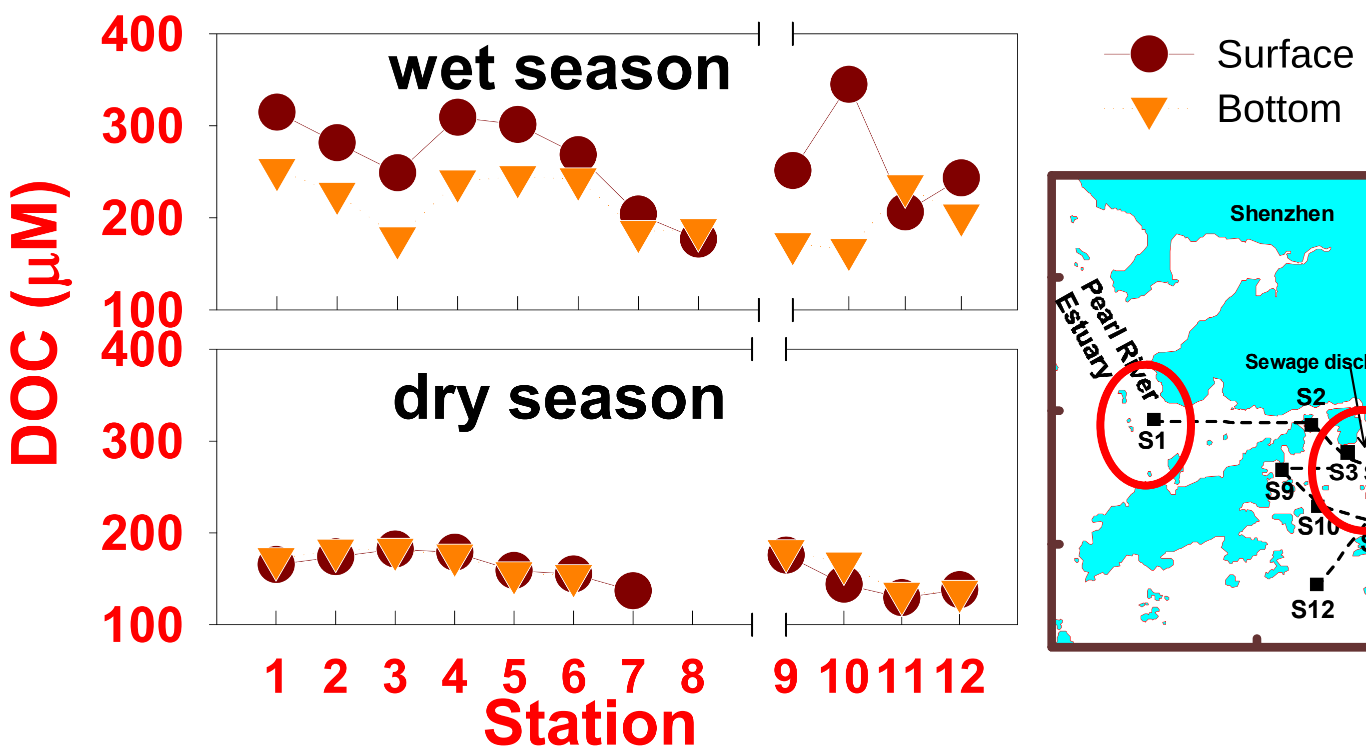
# Contribution of bacterial respiration to $CO_2$ release ($BCO_2$) and total $CO_2$ efflux

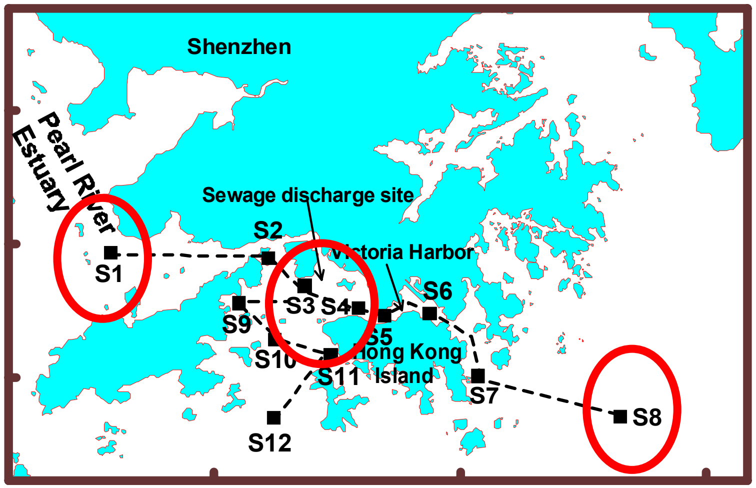



Bacterial respiration accounted for large proportion of total respiration near the sewage discharge site

# How much DOC can be respired by bacteria?




**Bacterial respiration rate was 0.1 to 0.4 mg C $L^{-1}$ $d^{-1}$ (i. e. ~10 to 30 μM C $d^{-1}$), and hence only ~10% DOC was respired by bacteria**
**Therefore large amount of DOC is exported offshore or sediment**

# Summary:

1. Estuarine and sewage inputs significantly enhanced the bacterial abundance, production and respiration ($p < 0.05$).

2. Pelagic bacteria contributed > 90% of total respiration in Victoria Harbor, and 35-90% at other stations.

3. Carbon load: ~20 kg C $yr^{-1}$ per person

4. Only ~10% of the ambient DOC (~200 µM) near the sewage discharge site was consumed by bacteria, and the remainder was most likely transported to the coastal waters.

# Thank you

**Prof. Paul J. Harrison**
**Prof. Ke-Dong Yin**
**Prof. Wei-Jun Cai**
**All my labmates**

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