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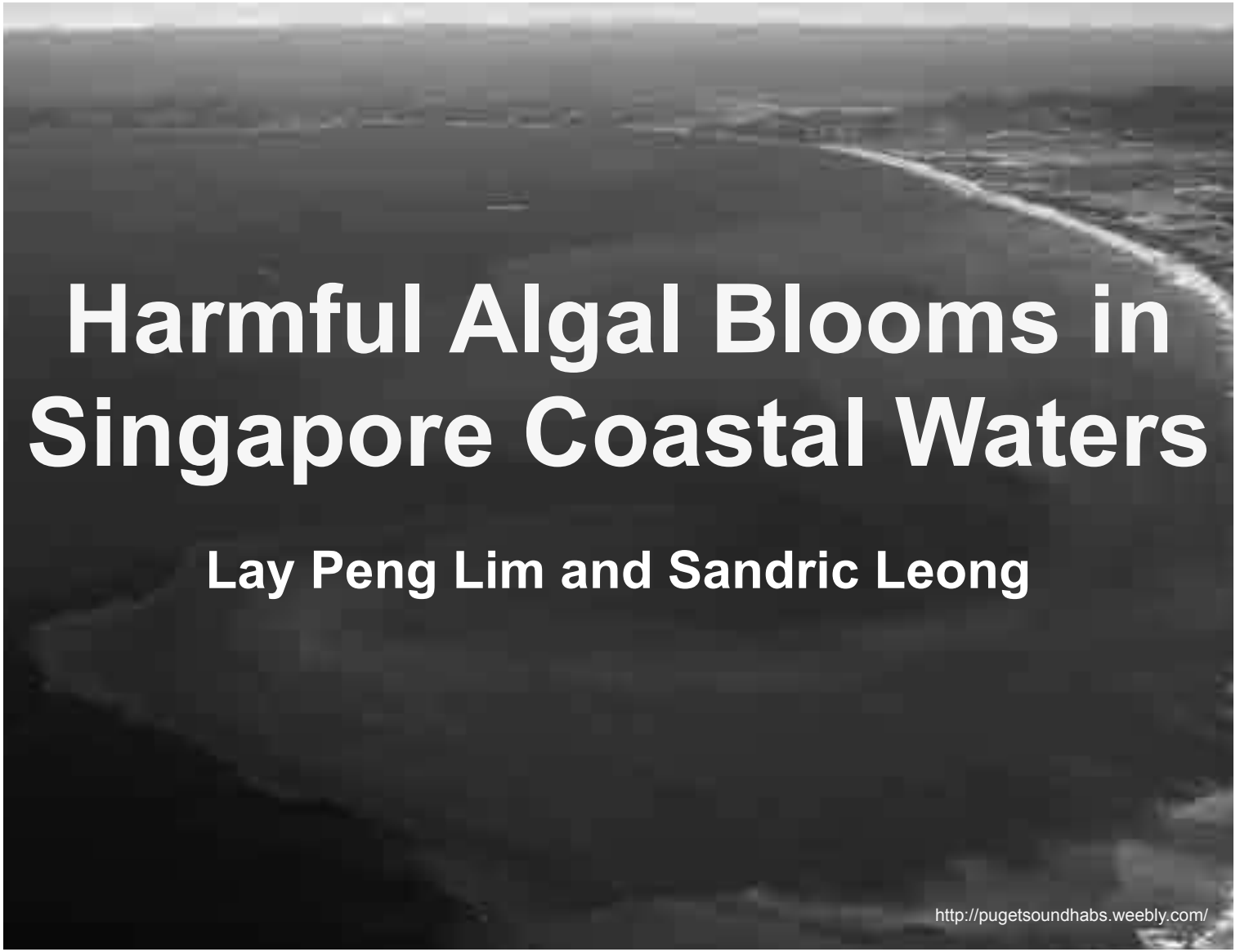
Harmful Algal Blooms in Singapore Coastal Waters

Lay Peng Lim and Sandric Leong



http://pugetsoundhabs.weebly.com/

Team HABs

Marine Biology & Ecology Lab (based on St. John's Island)

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Outline

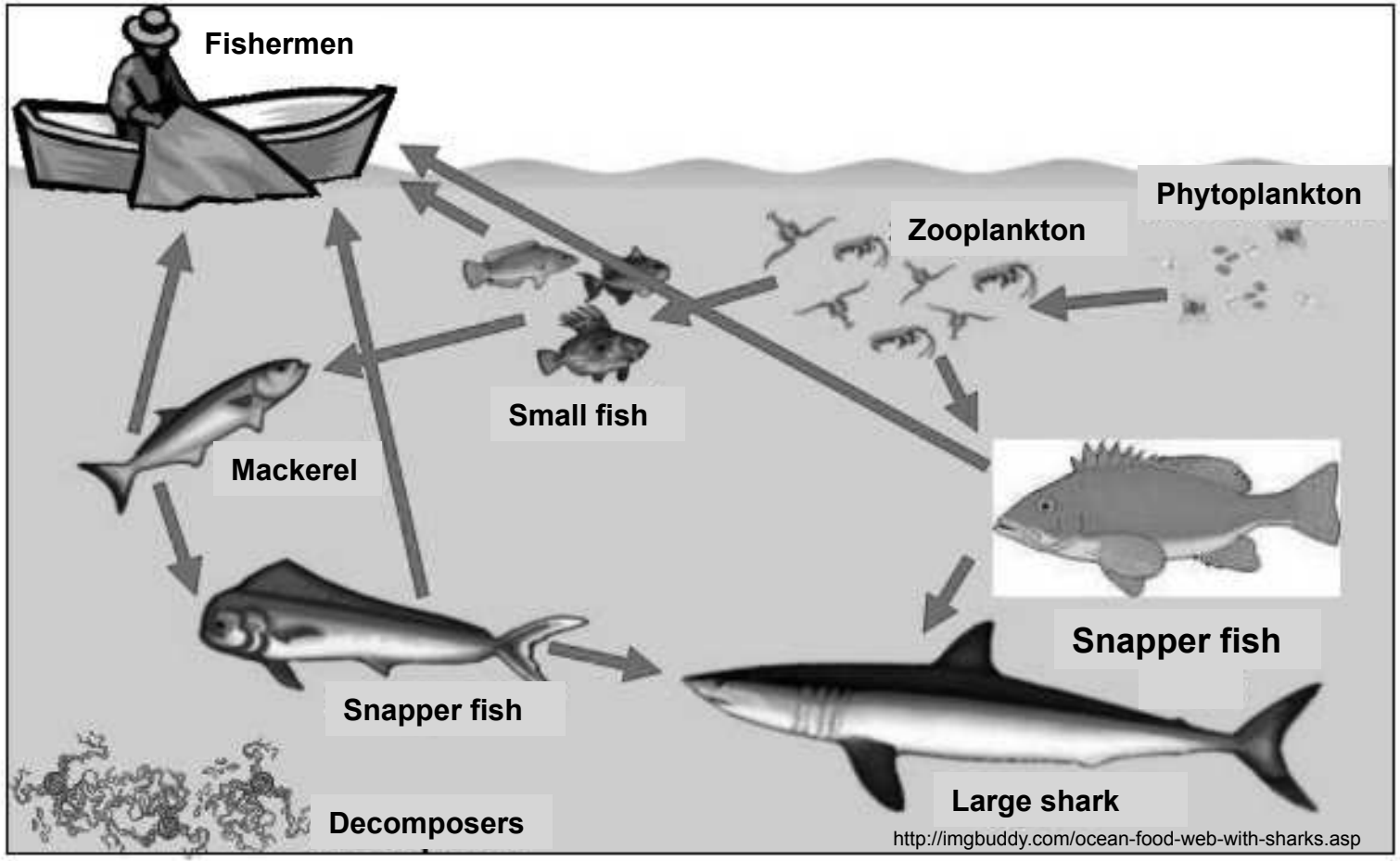
- Introduction on phytoplankton and harmful algal blooms (HABs)
- HABs in Singapore waters
- Current and past projects
- Future plans
- Acknowledgements

Research Background

Phytoplankton species play important roles in:

i. Primary production

ii. Biogeochemical cycles



Algal Blooms

- Refer to a situation when there is an increase in algal cell density to thousands of cells per ml e.g. ~ >500,000 cells/ml, usually dominated by one species or a few species

- Discoloration of the ocean

HABs may affect many living organisms of the coastal ecosystem, from small organisms to fish to people.

Two types of HABs

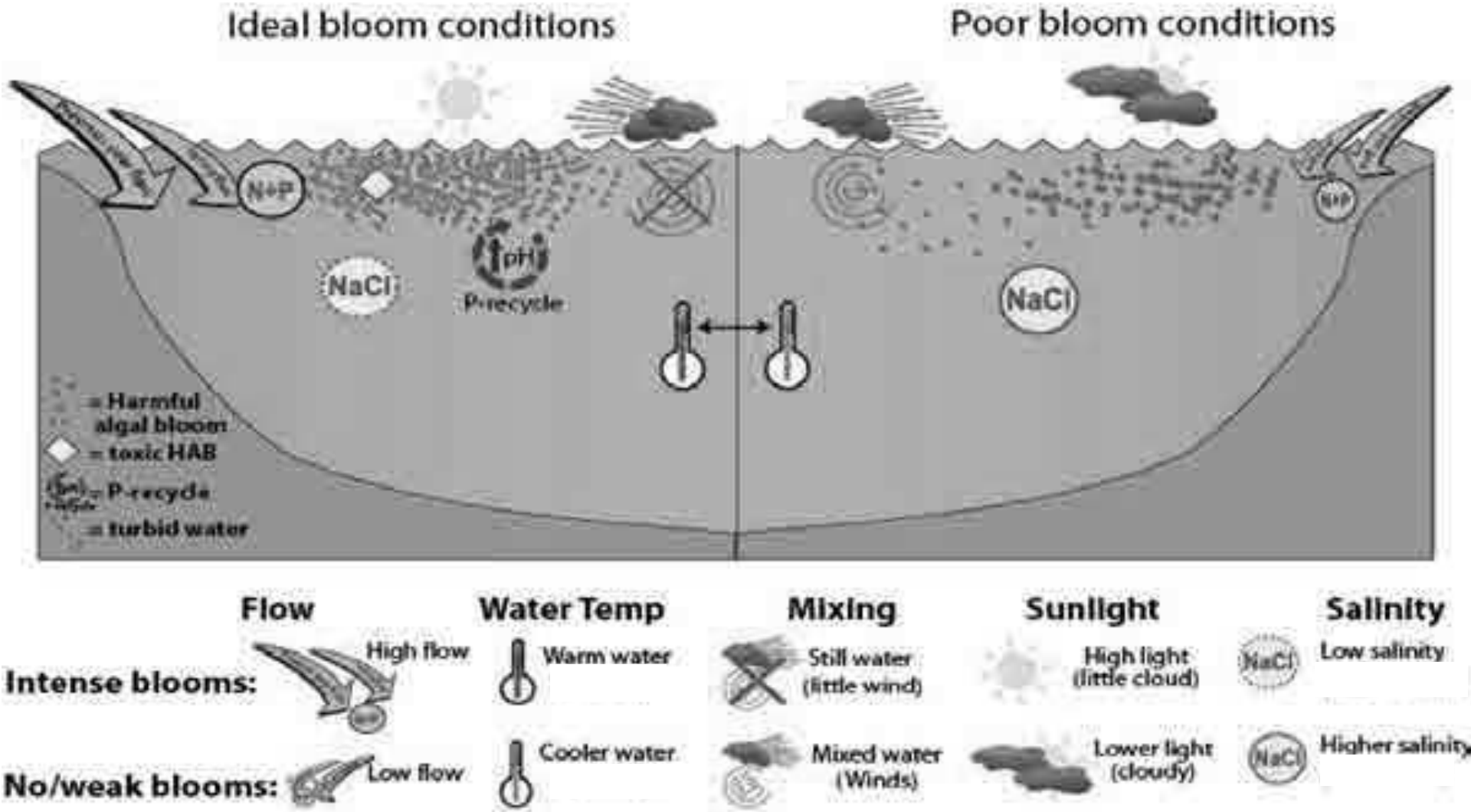
Toxin Producer (toxic plankton)

- Able to produce toxin and cause toxin contamination in shellfish/fish
- Shellfish/Fish poisoning

Algal Bloom (high biomass plankton)

- Able to increase the cell density in a short time and cause massive kill of shellfish/fish
- Cause anoxia and fish damage

What trigger an algal bloom?

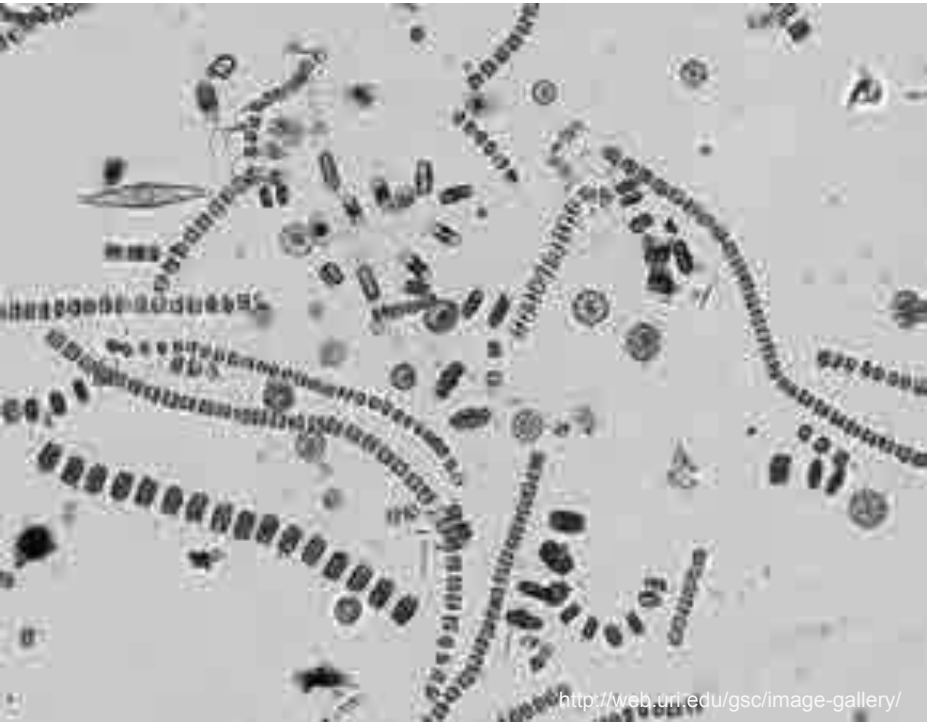


Conceptual diagram detailing the main factors that determine HAB occurrence and characteristics in the Potomac River

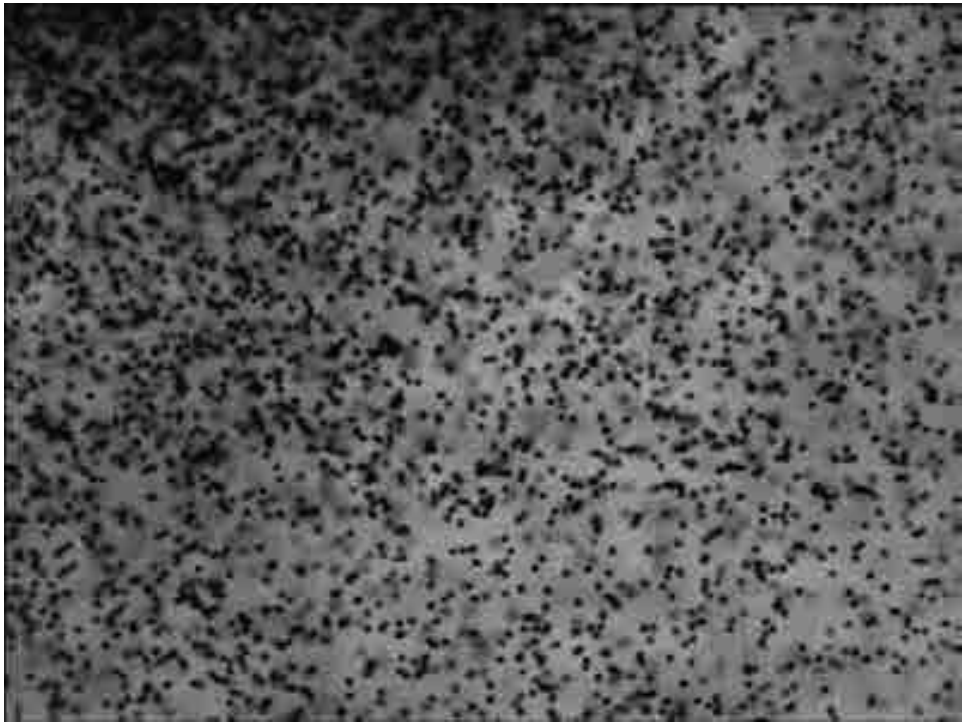
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Ecocheck

Non-bloom VS bloom

Non-bloom period



Bloom period



Harmful Algal Bloom in Singapore – Dec 2009

200,000 fish in farms off Pasir Ris dead

Plankton Bloom Hits Pulau Ubin Fish Farm (The Straits Times, 2 Jan 2010)

Massive fish kill was observed for the first time in Singapore waters during late December 2009, killing 200,000 farm fish.

Harmful Algal Bloom in Singapore – Feb 2014

Massive fish kill was observed in Singapore waters during early Feb 2014, killing both farm fish and wild fish. Loss of million of dollars.

Harmful Algal Bloom in Singapore – Feb 2015


新加坡

养鱼场死鱼情况严重
业者损失今年最惨重

Recent massive fish kill was observed in Singapore waters during early Feb 2015, killing both farm fish (around 600 tonnes) and wild fish.

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http://www.channelnewsasia.com/image/1687032/1425185309000/large16x9/768/432/red-tide-at-pasir-ris.jpg

Current Issues

- Impact of algal blooms on marine ecosystems and the affected area has been expanded

- Food safety (seafood production)

- Bloom forming species are poorly studied

Food Safety!!!

Current and Past Research

- Investigating the response of phytoplankton to environmental changes in Singapore waters
- Physiology of bloom-forming species
- Bloom-forming phytoplankton in Singapore water:
  - Identification of species using microscopic and molecular techniques
- Toxin analysis of bloom-forming species (freshwater and marine species)

Current and Past Research

Investigating the response of phytoplankton to environmental changes in Singapore coastal waters

Navigation:
Computer hardware/software;
GPS system

Sensors:
Salinity; Temperature; Chl-*a*;
Dissolved Oxygen and etc

- Develop mobile sensor networks for monitoring environmental changes at multi-scale
- Network consists of ships, fixed instruments, and autonomous vehicles (Kayaks)

Current and Past Research

Tracking of bloom

Dec 2012 Sea Trial
Diatoms Bloom was observed.

During the Dec 2012 sea trial, environmental parameter variations were observed.

Current and Past Research

Physiology of bloom-forming species

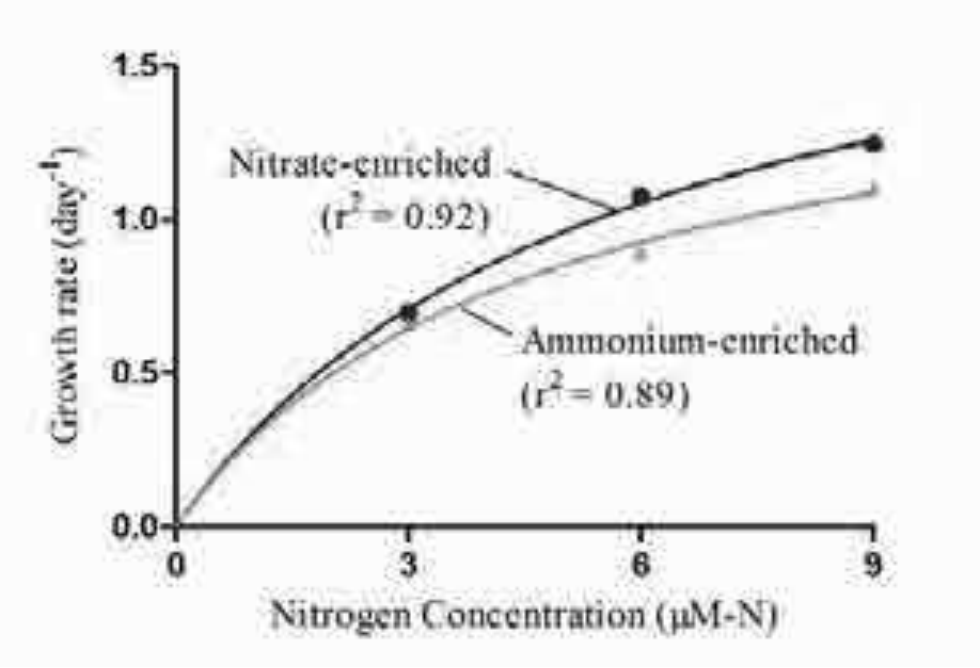


Fig 4: Growth rates of Heterosigma in relation to increasing nitrate (blue closed circle) and ammonium (orange closed triangles) concentration levels.

Ref: Kok and Leong 2012

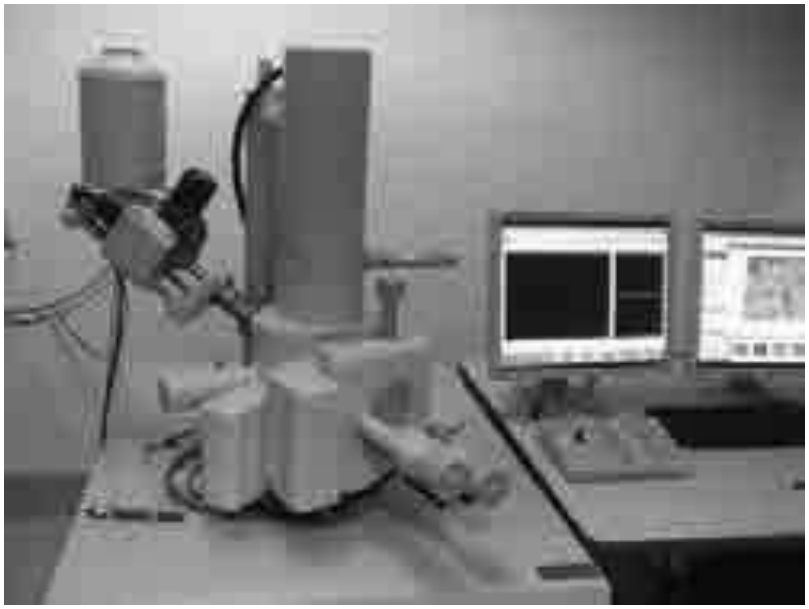
Heterosigma akashiwo
Well known fish killer species around global coastal waters.

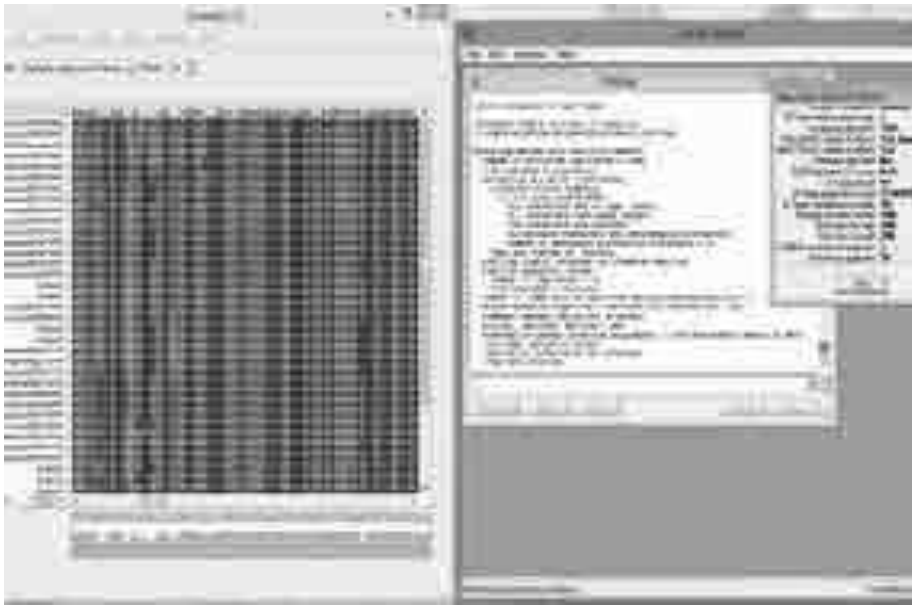
Current and Past Research

Identification of species

Morphological observation

Molecular analysis





Current and Past Research

Potential Harmful Phytoplanktons

Dinoflagellates

i. Karlodinium

ii. Karlodinium

iii. Karenia mikimotoi

iv. Takayama

v. Scrippsiella

vi. Alexandrium

Benthic Dinoflagellates

vii. Gambierdiscus sp.

viii. Ostreopsis sp.

ix. Prorocentrum

x. Coolia sp.

They are known to be associated with fish kills worldwide

Current and Past Research

Potential Harmful Phytoplanktons

Raphidophytes
i. Heterosigma
ii. Chattonella

Diatoms
iii. Cerataulina
iv. ***Pseudo-nitzschia* sp.**

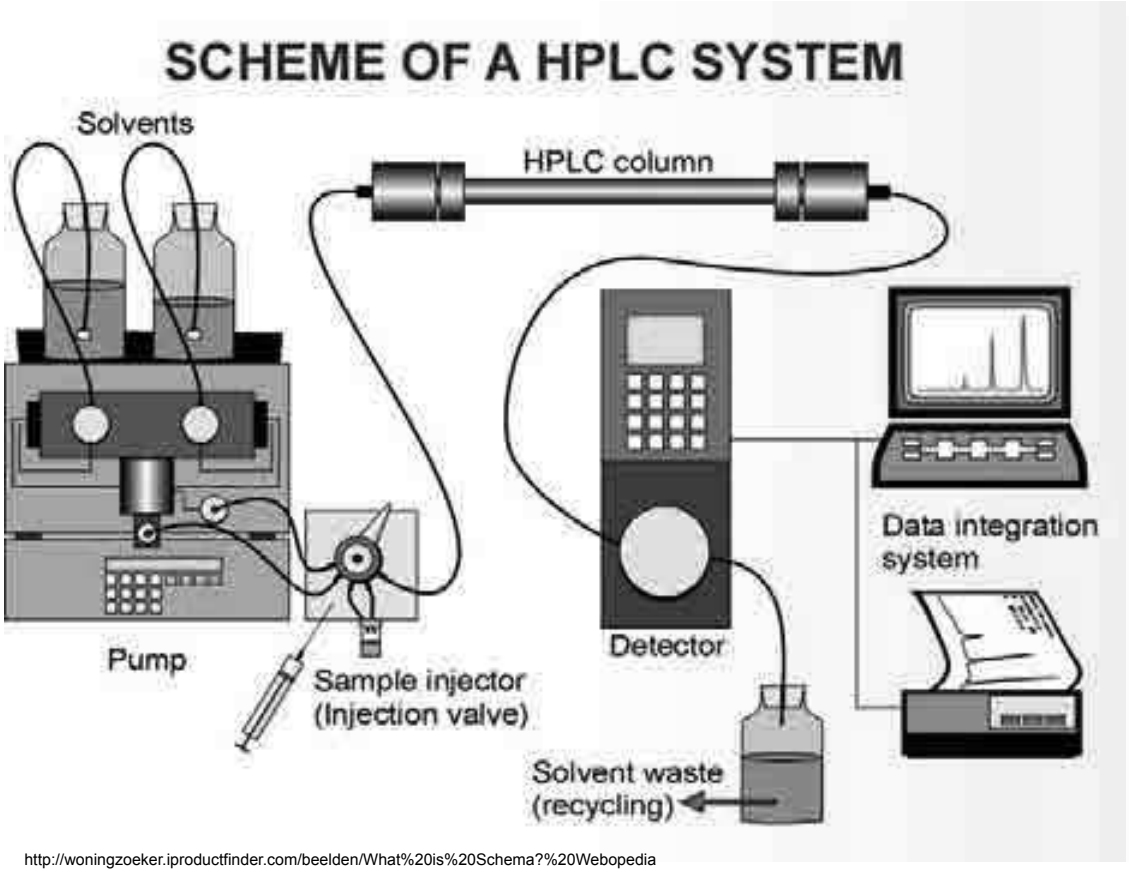
Current and Past Research

Pseudo-nitzschia species in Singapore

Phylogenetic tree from Maximum Likelihood analysis based on large subunit (LSU) rDNA region.

Current and Past Research

- Toxin analysis of bloom-forming species (freshwater and marine water).



http://woningzoeker.iproductfinder.com/beelden/What%20is%20Schema?%20Webopedia

Future plans

Future plans

2. Rapid detection and identification of causative species

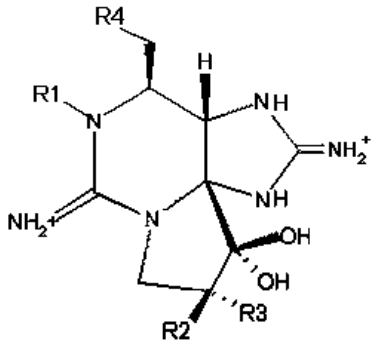
- Different species could harm fishes in different ways

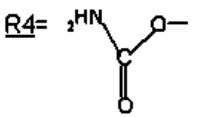
- Identify the species correctly so that appropriate mitigation can be taken

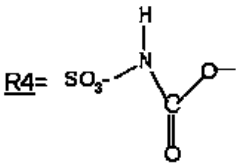
Future plans

3. Toxin measurement

- Analysis of algal toxins
- Preliminary work is in progress:
  - protocol setup



R4= 

R4= 

R4= OH

R4=H

R_1	R_2	R_3	carbamate toxins	N-sulfo-carbamoyl toxins	decarbamoyl toxins	deoxy-decarbamoyl toxins
H	H	H	STX	GNTX5(B1)	dcSTX	doSTX
H	H	OSO_3^-	GNTX2	C1	dcGNTX2	
H	OSO_3^-	H	GNTX3	C2	dcGNTX3	
OH	H	H	neoSTX	GNTX6(B2)	dcneoSTX	doneoSTX
OH	H	OSO_3^-	GNTX1	C3	dcGNTX1	doGNTX1
OH	OSO_3^-	H	GNTX4	C4	dcGNTX4	

http://www.fao.org/docrep/007/y5486e/y5486e06.htm

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Thank You

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