

# HAB Mitigation for Marine Systems

Kevin Sellner

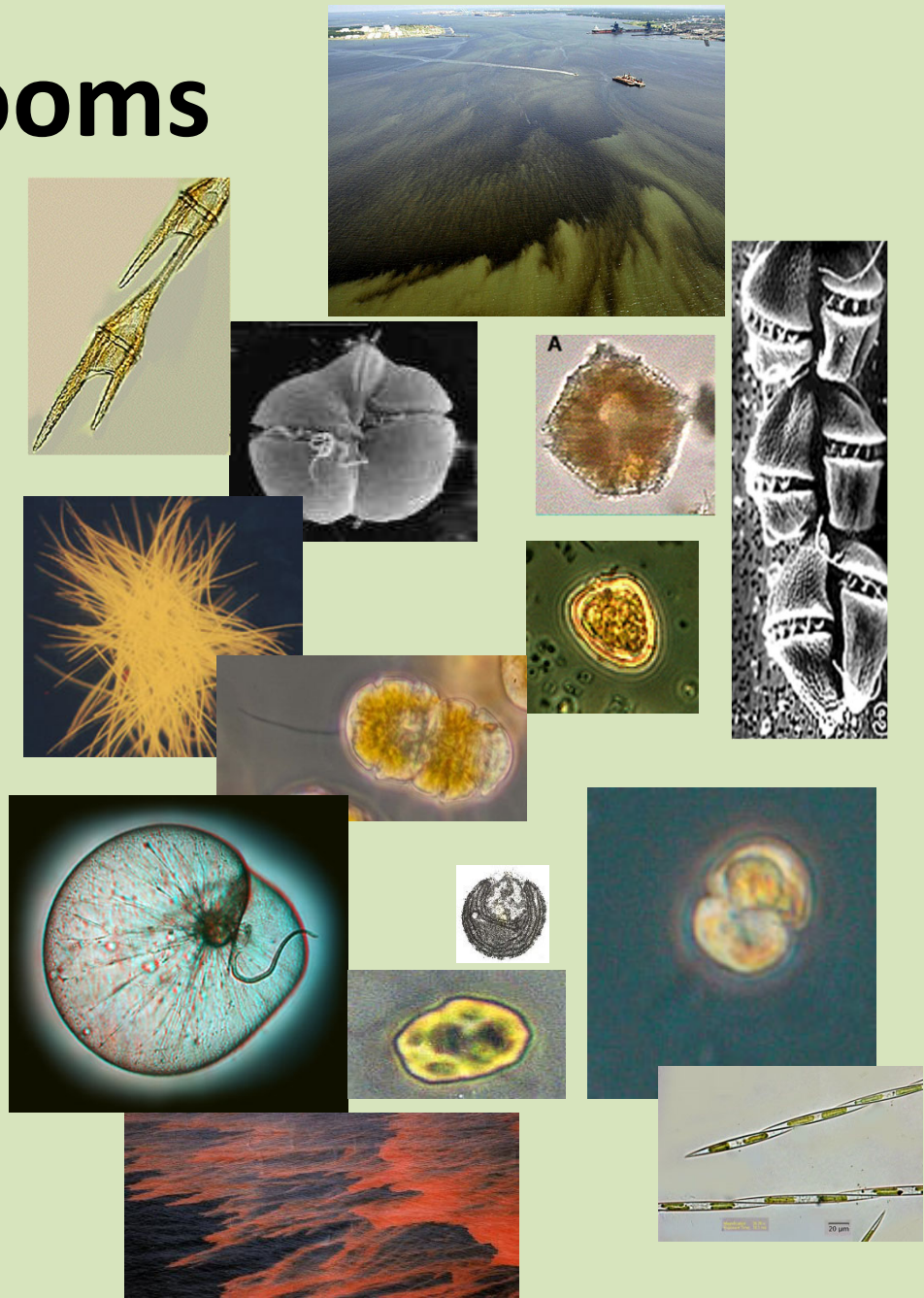
Hood College Center for Coastal & Watershed Studies

US EPA Webinar

May 23, 2019

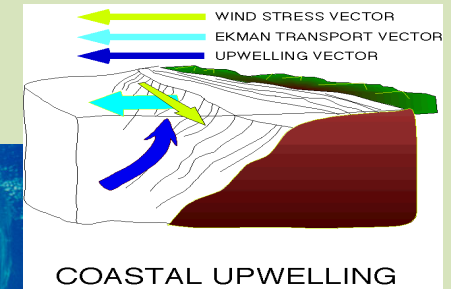
# Harmful Algal Blooms

- Accumulation of one to several taxa leading to elevated biomass or toxins
- Threats to mariculture, consumers, & food web

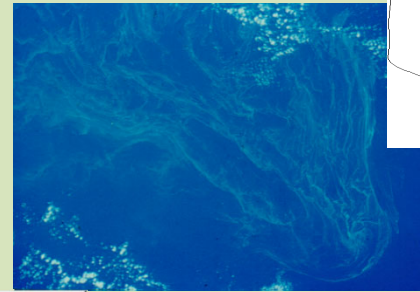


# Coastal Water HABs

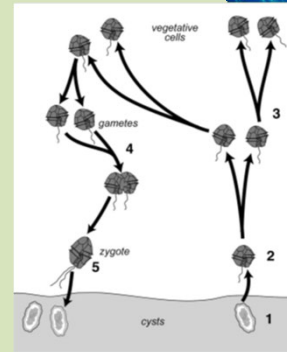
- Natural vs. human-induced
- Natural = physically transported or derived from cyst beds
- Human-induced = function of human land activities for nutrient delivery and stratification



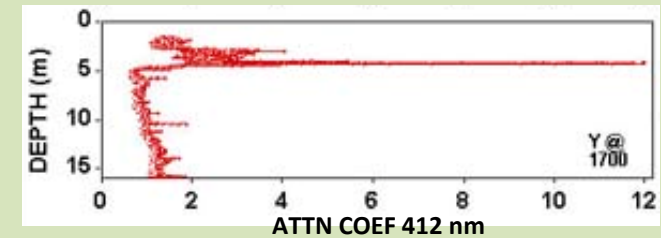
NOAA Pacific Fisheries  
Environmental Laboratory



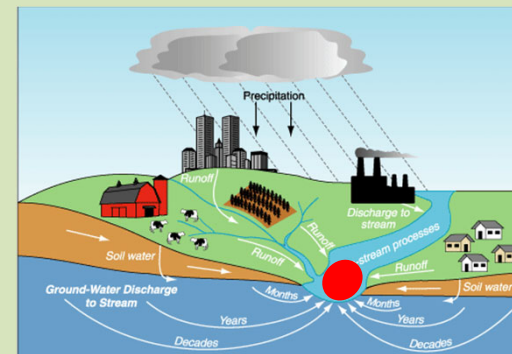
Subramaniam et al. 2001



D. Anderson, pers.comm.



P. Donghay, pers. comm.



● = HAB

USGS

# Brackish-Oceanic Systems

- Fish pen areas:  
Aerators/screens/relocation
- Polyculture?
- Mixing of upper sediment  
cysts
- Resuspension of diatoms
- Locally applied oxidants or  
flocculants

Courte



td.

Fig 1

[http://www.whoi.edu/cms/images/lstokey/2005/1/v43n1-sengco3en\\_5573.jpg](http://www.whoi.edu/cms/images/lstokey/2005/1/v43n1-sengco3en_5573.jpg)



Courtesy of R. Kudela

# Flocculant Use in the Field

Organism	Additive(s)
<i>Prymnesium parvum</i> , brackish-polyhaline	30 kg Phoslock® kgPO <sub>4</sub> <sup>-1</sup>
<i>Chattonella antiqua</i>	360 t modified clay 86 km <sup>-2</sup>
<i>Cochlodinium</i> sp.	200 g montmorillonite and/or kaolinite m <sup>-2</sup> and 110-400 t km <sup>-2</sup>
<i>Cochlodinium</i> sp.	0.11–0.4 g Iriki montmorillonite L <sup>-1</sup>
<i>C. polykrikoides</i>	10 g yellow loess L <sup>-1</sup>
<i>C. polykrikoides</i>	400 g yellow loess (kaolinite) m <sup>-2</sup>
<i>C. polykrikoides</i>	0.005 g sophorolipid L <sup>-1</sup> + 1 g yellow clay L <sup>-1</sup>
<i>C. polykrikoides</i>	24 and 42 g dredged coastal sediment (52% clay) m <sup>-2</sup> + 2–10% slaked lime, quicklime, aluminum sludge, bentonite, zeolite
<i>K. brevis</i>	0.25–0.5 g phosphatic (montmorillonite) clay L <sup>-1</sup>
<i>Heterocapsa triquetra</i>	0.25 g phosphatic (montmorillonite) clay L <sup>-1</sup>
Multiple marine HA spp.	4-10 t modified clay km <sup>-2</sup>
<i>Noctiluca scintillans</i>	Unknown concentration of Iriki montmorillonite
<i>N. scintillans</i>	100 t modified clay (several 100 km) <sup>-2</sup>
<i>Mesodinium rubrum</i>	7.5 g Iriki montmorillonite L <sup>-1</sup>
<i>Phaeocystis globosa</i>	210 t modified clay (nuclear plant intake) <sup>-1</sup>
<i>Prorocentrum sigmoides</i>	2 g Iriki montmorillonite L <sup>-1</sup>
<i>Prorocentrum</i> sp. and <i>Gymnodinium</i> sp.	15 or 30 g coal ash derivative L <sup>-1</sup>

# Flocculants

- Additions of kaolin and PAC at 4-10 g m<sup>-2</sup> (10-25x lower than reported most effective clay flocculation in lakes) removes ~80% of dinoflagellate biomass (Yu et al. 2017)
- Complementary lab studies indicate
  - accumulation of intracellular ROS (Liu et al. 2017)
  - slow mortality of remaining cells (Zhu et al. in press)
  - cyst decline & germination reduction (Zhang et al. 2018)

# Other Mitigants for Marine Waters

- Peroxide in Natural Waters
  - At 50 mg L<sup>-1</sup>, reduction of cells, pellicle cysts, & PSP toxins of *Alexandrium ostenfeldii* in brackish Netherlands waters; returned at lower levels the next year (Matthijs et al. 2011)
  - At 30 mg L<sup>-1</sup>, removal of *Cochlodinium* sp. in Kaogoshima Bay, Japan (Ichikawa et al. 1992)
- CuSO<sub>4</sub> in FL *Karenia* bloom (Rousenfell & Evans 1958)-rapid cell declines but return in 10-14 d

# Lab Approaches

- Peroxide for *Polykrikos*, *Alexandrium* cysts; *Chattonella*
- Garlic extract (0.04%) for *Alexandrium* cultures
- Bacteria extracts-*Cochlodinium*, *Alexandrium*, *Karenia*, *Pseudo-nitzschia*, *Karlodinium*, *Gyrodinium*, *Prorocentrum*
- Sophorolipids-*Alexandrium*, *Heterosigma*, *Cochlodinium*
- Herbicides & fungicides-*Prymnesium*, *Chattonella*, *Heterocapsa*
- Parasites-*Amoebophyra* spp.
- Nanosilica particles

**Issues: Dosage/dilution, costs, ancillary impacts for natural systems**



Thank you!  
sellner@hood.edu

From Sellner & Rensel 2018, pp. 435-492 in HABs A Compendium Desk Reference. Wiley Blackwell