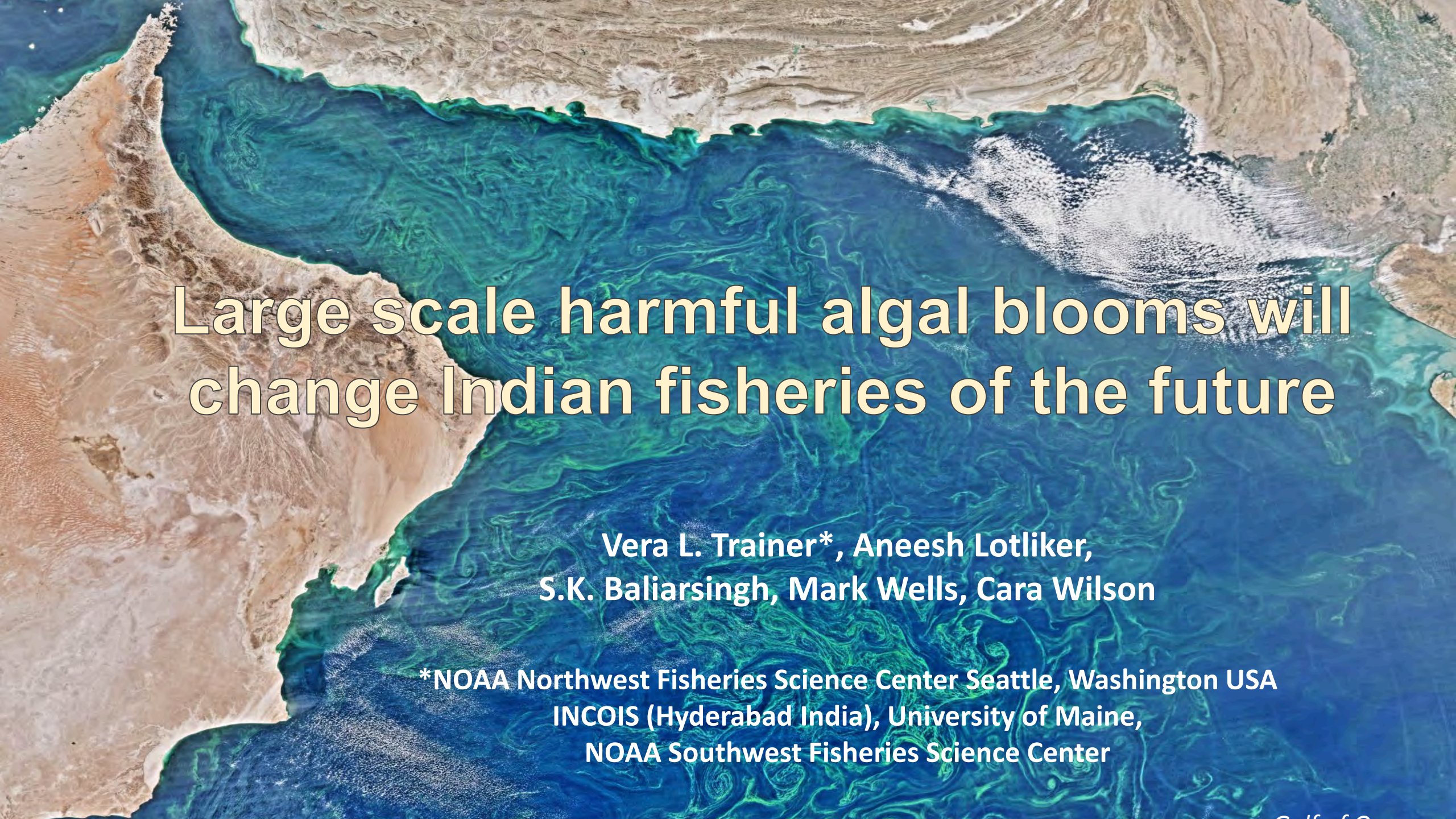

Large scale harmful algal blooms will change Indian fisheries of the future

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INCOIS (Hyderabad India), University of Maine,
NOAA Southwest Fisheries Science Center

Green *Noctiluca scintillans*

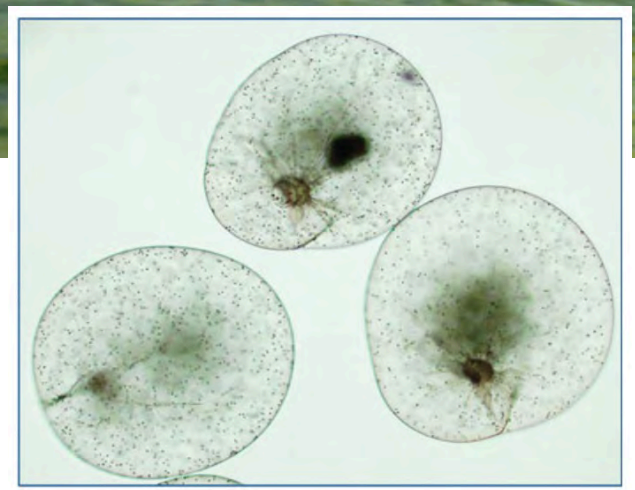
natashavizcarra.com

Contains the photosynthetic symbiont *Pedinomonas noctilucae* (a prasinophyte)

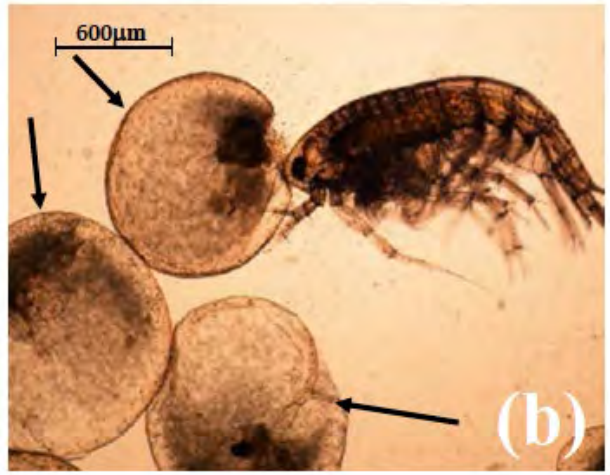
Heterotrophic through phagotrophy + autotrophic

Survives on photosynthesis under food limited conditions

Bloom formation requires feeding on other phytoplankton (diatoms)



K. Furuya



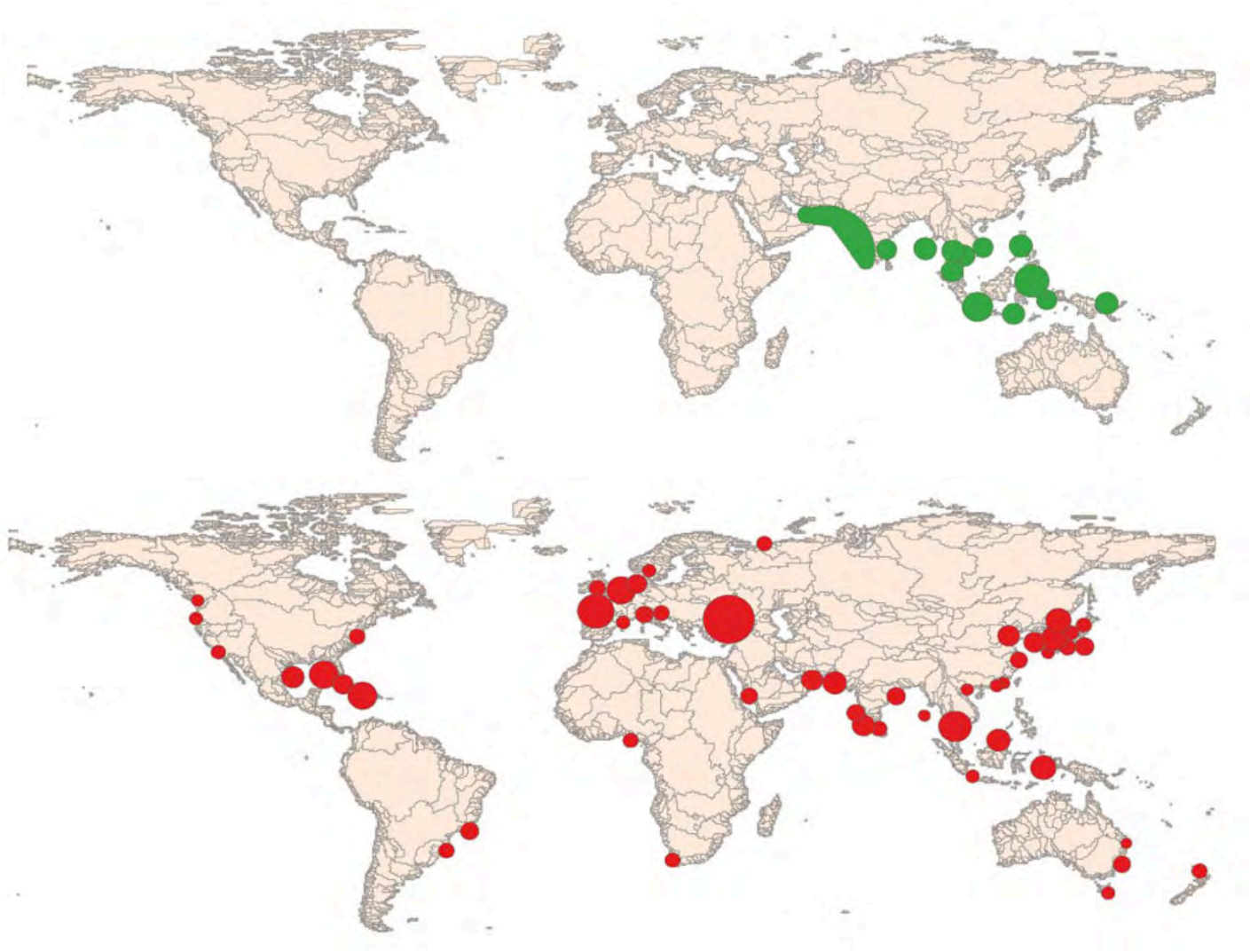
Gomes et al., 2014

Noctiluca scintillans — Distribution

Green *Noctiluca* has been recorded for > 60 y in India

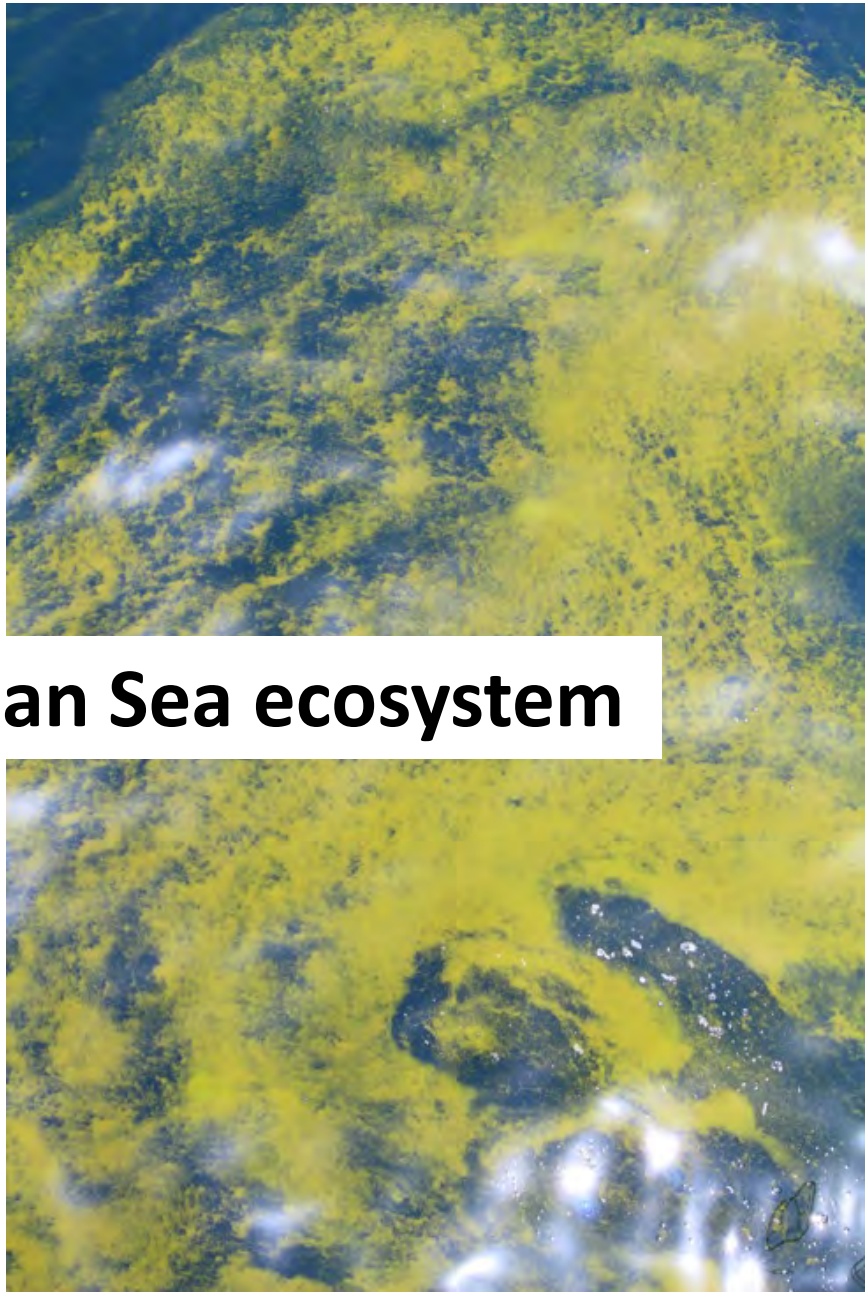
Bloom intensities have been increasing over the last 2 decades

In some cases — correlate with increasing cultural eutrophication, but not always



Harrison et al., 2011

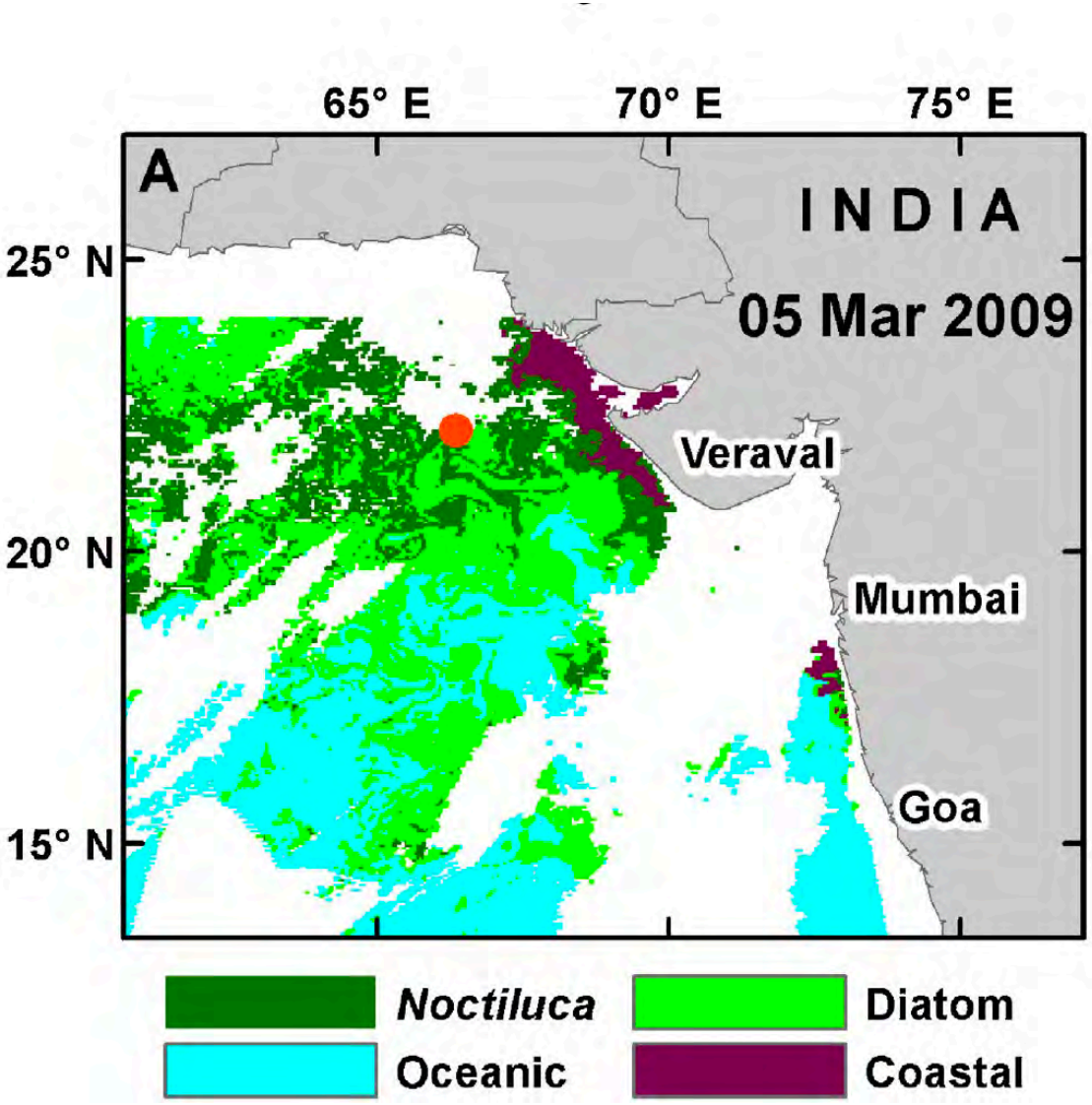




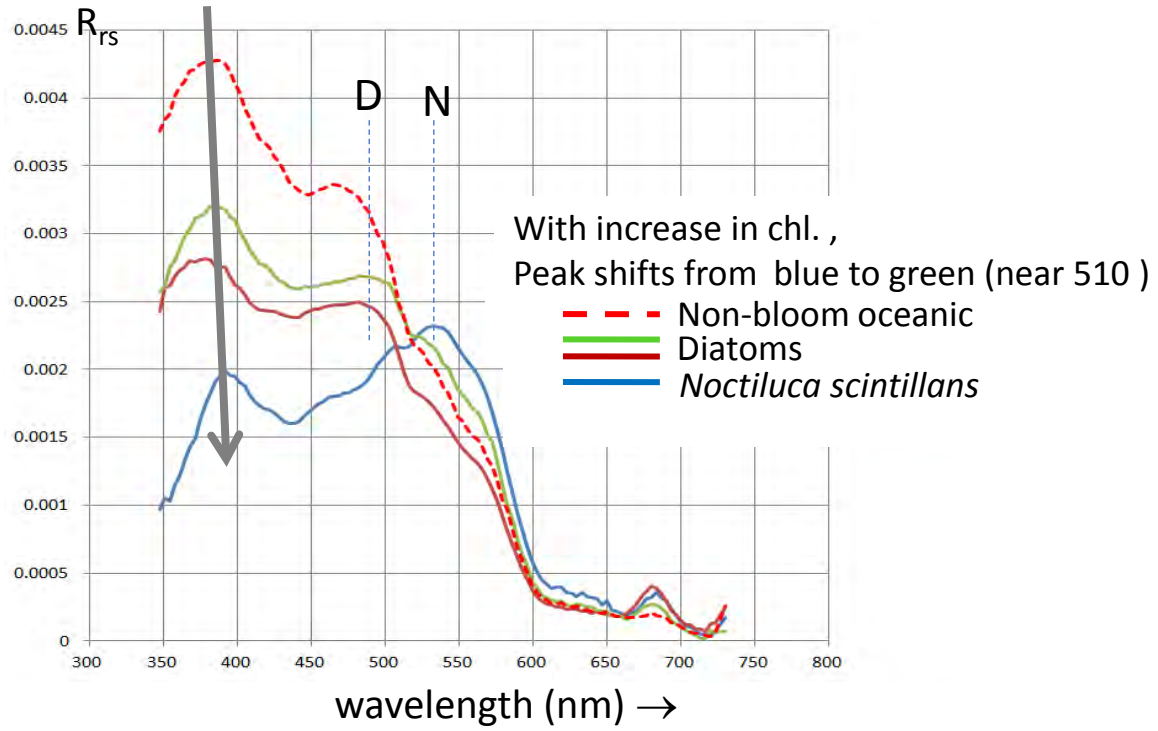
Green *Noctiluca* is changing the Arabian Sea ecosystem

Photos: Aneesh Lotliker (INCOIS)

Satellite algorithm



Satellite algorithm distinguishes diatom and *Noctiluca*



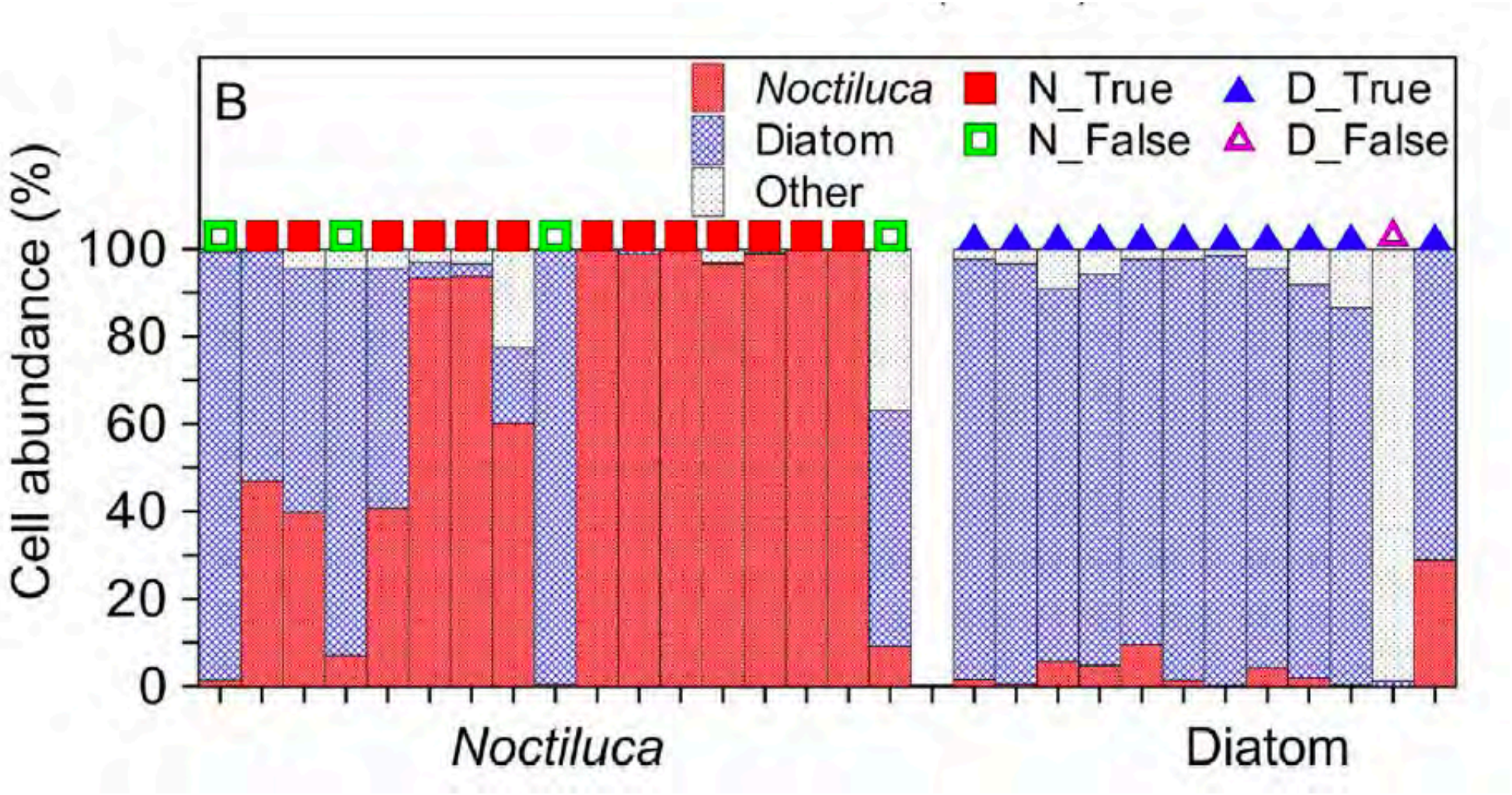
Lotliker et al. 2018. Harmful Algae

Image courtesy : R. Dwivedi, CMLRE
Dwivedi et al. 2016 Environ. Monit. Assess.

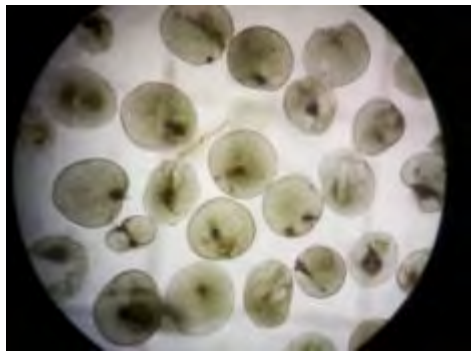
In situ abundance vs. satellite pixel assignment

Noctiluca:
76% accurate

Diatom:
92% accurate

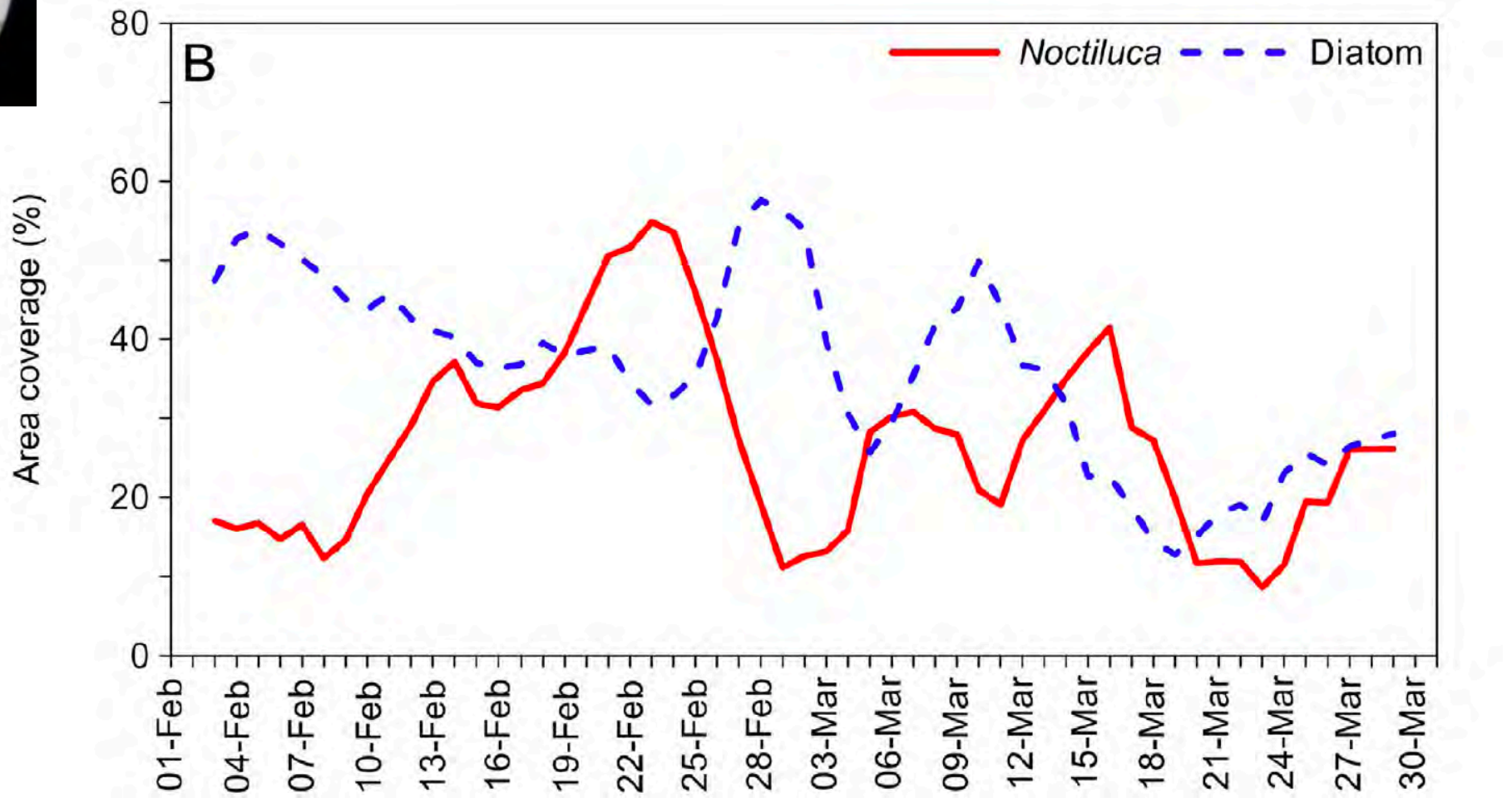


Lotliker et al. 2018



Satellite algorithm

Area coverage of *Noctiluca* vs. diatom

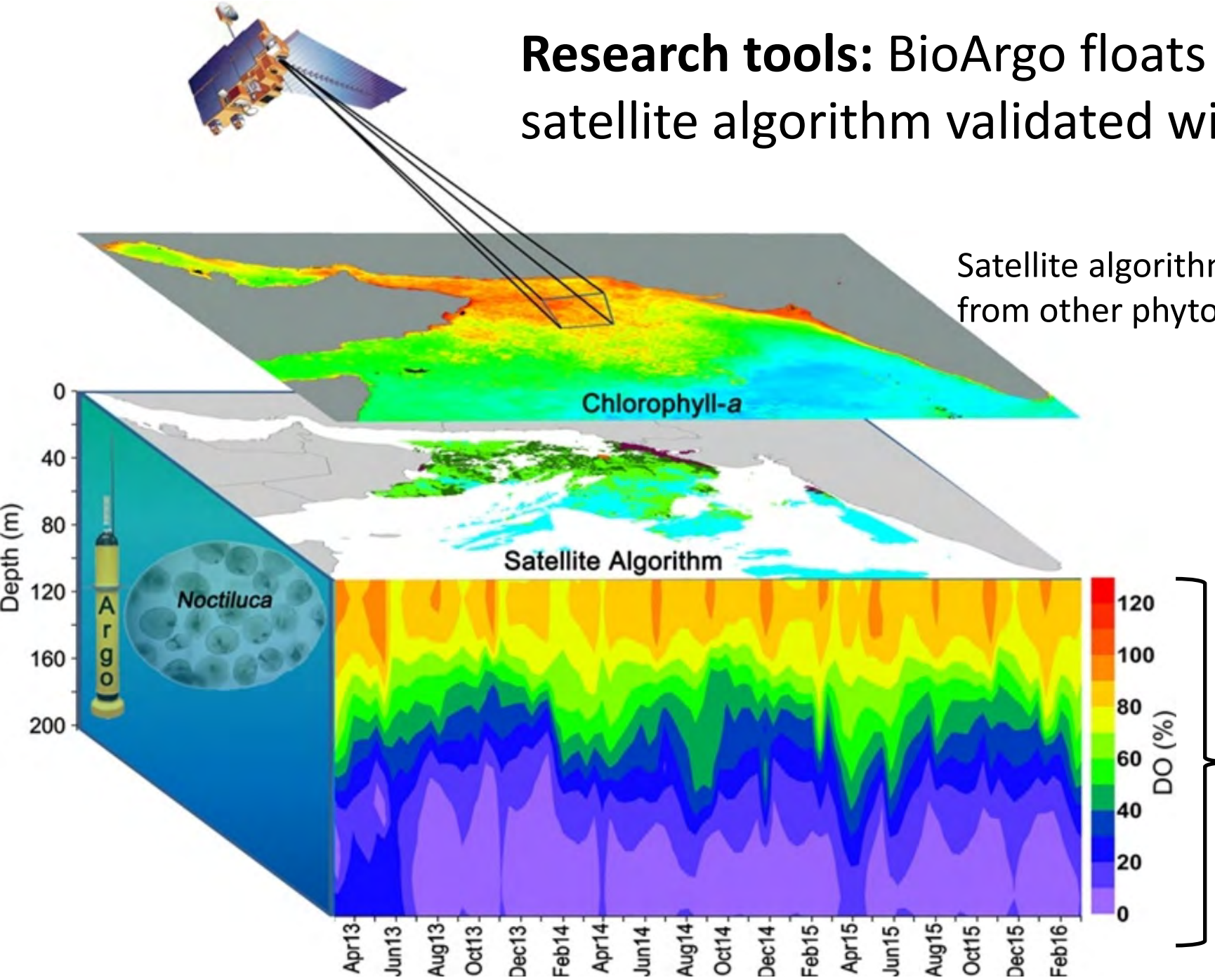


“All fish is diatom” ……Bostwick Ketchum

How will *Noctiluca* blooms impact fisheries? What are the causes?

Lotliker et al. 2018

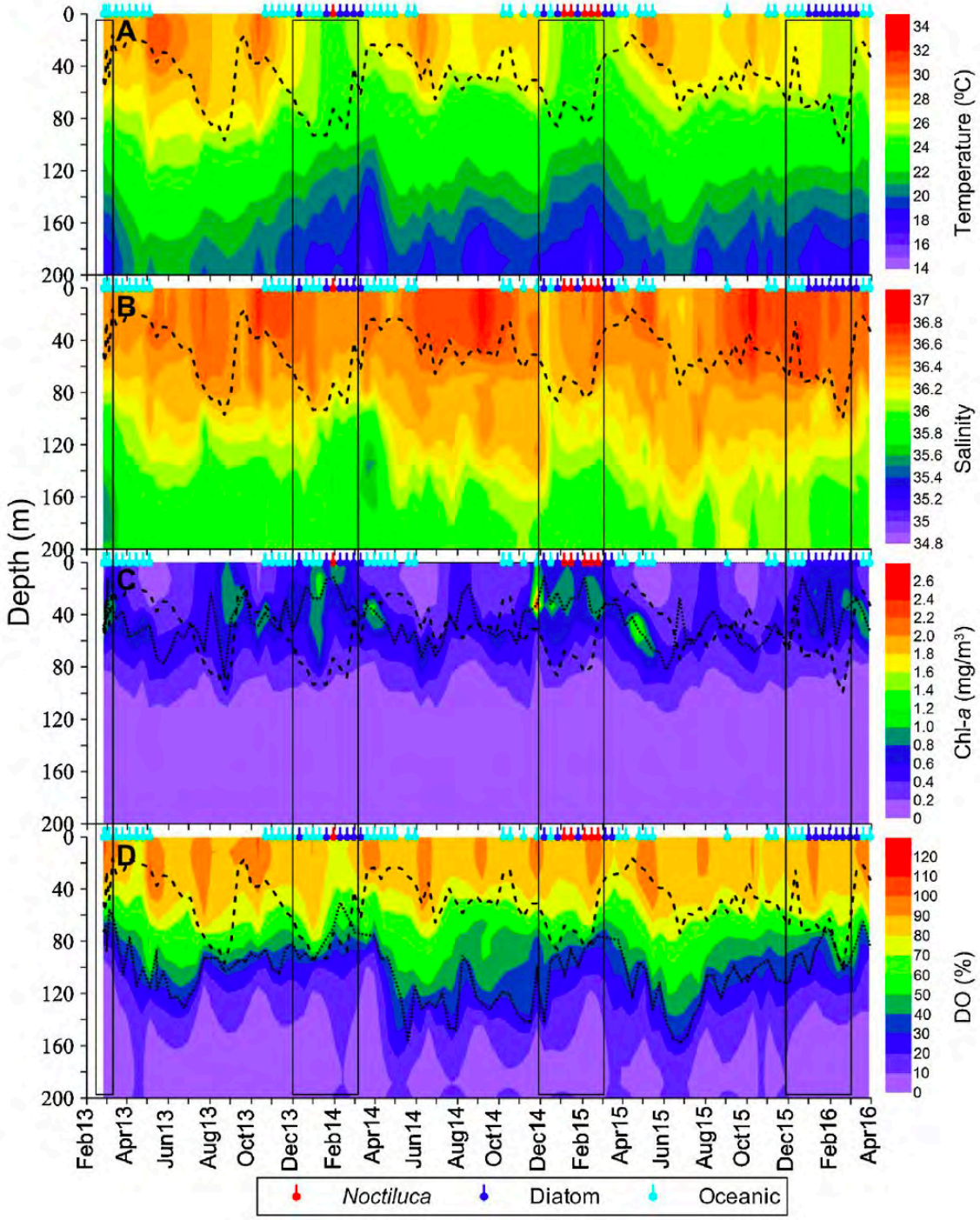
Research tools: BioArgo floats combined with satellite algorithm validated with cruise data



Satellite algorithm distinguishes *Noctiluca* from other phytoplankton

Profiling BioArgo float
Resides at 200-400m
Reports to satellite every 5d

Lotliker et al., 2018



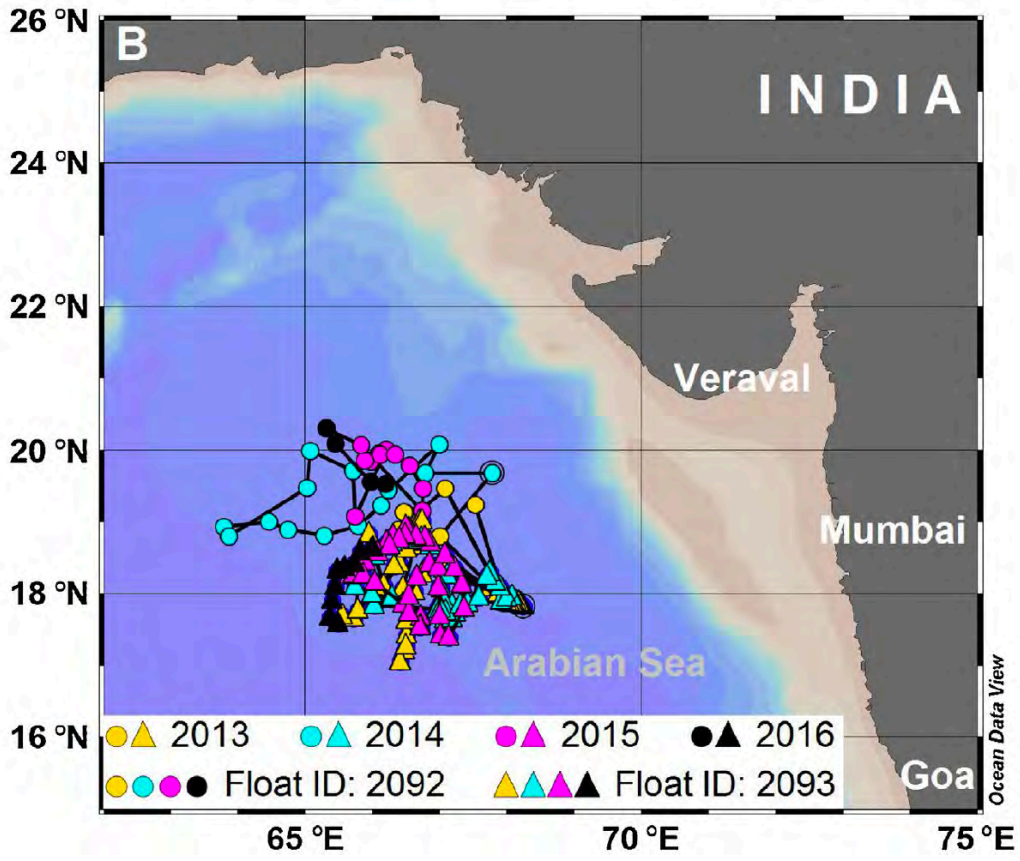
Red dot = *Noctiluca* bloom (satellite algorithm)

MLD

DCM

60-65 µM DO

BioArgo float position



Lotliker et al. 2018

Data acquired & visualized using:

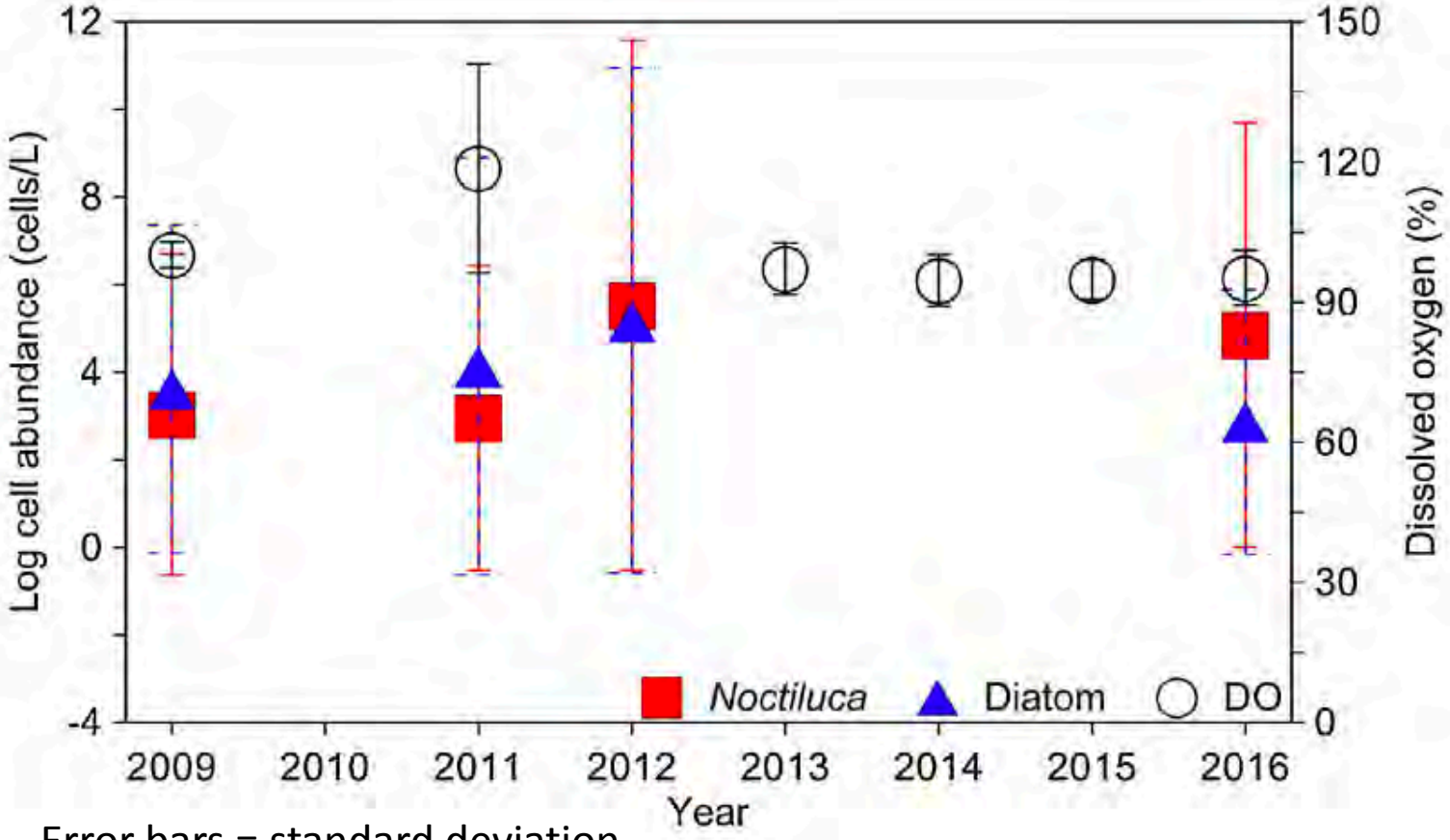
- ERDDAP is a data server that gives you a simple, consistent way to download subsets of scientific datasets in common file formats and make graphs and maps.

- Search “ERDDAP” or

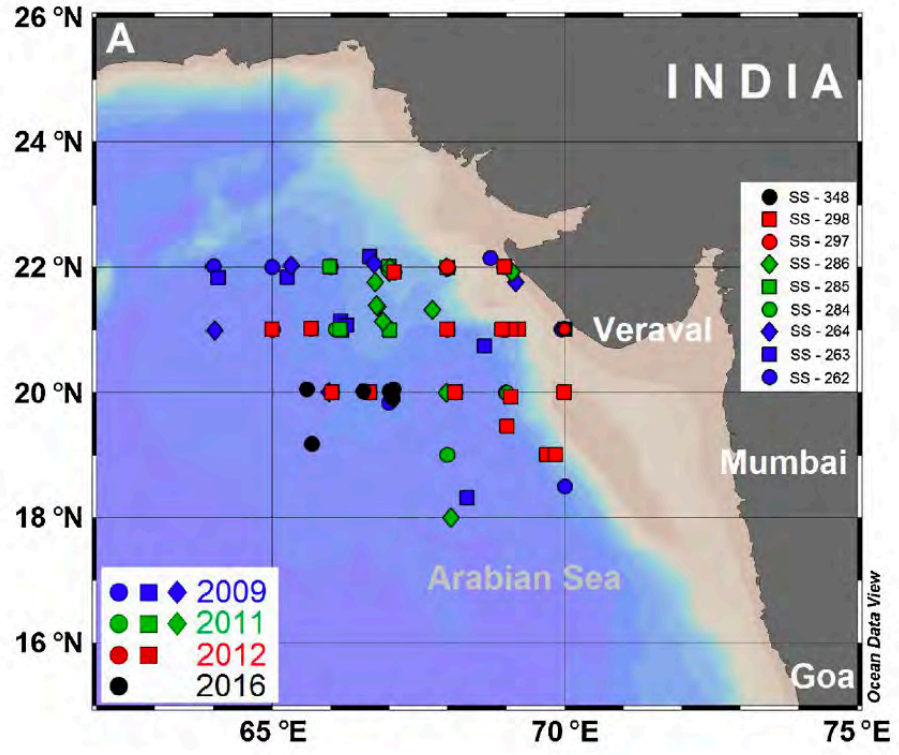
https://upwell.pfeg.noaa.gov/erddap/index.html

ERDDAP = Environmental Research Division's Data Access Program (NOAA)

Mean annual in situ abundance of *Noctiluca* and diatoms & DO saturation upper 40m



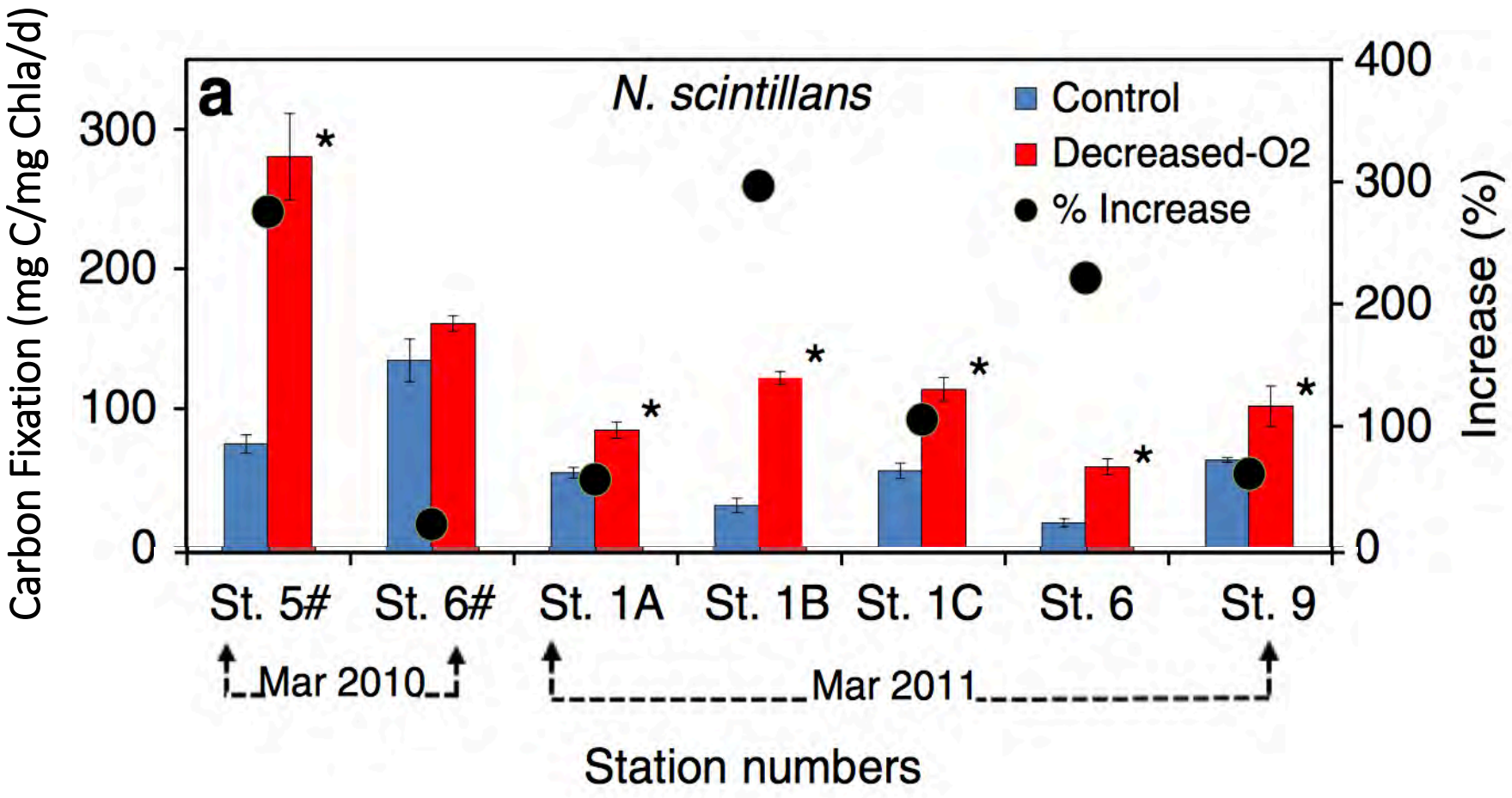
Error bars = standard deviation



Cruises 2009-2016

What are the environmental regulators of oceanic and coastal *Noctiluca* blooms?

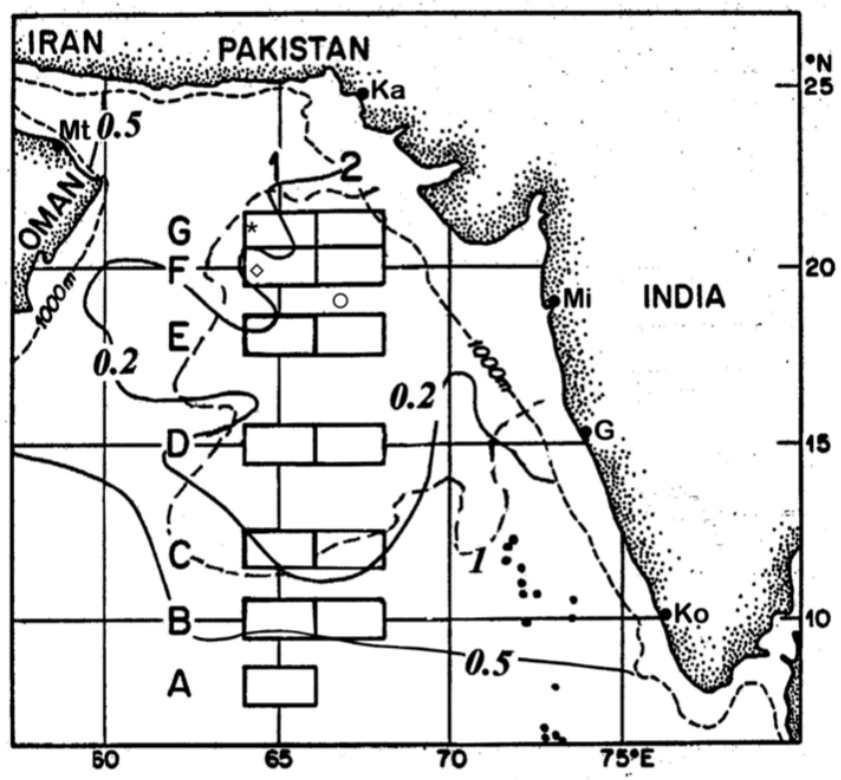
Hypoxia Stimulation of green *Noctiluca*

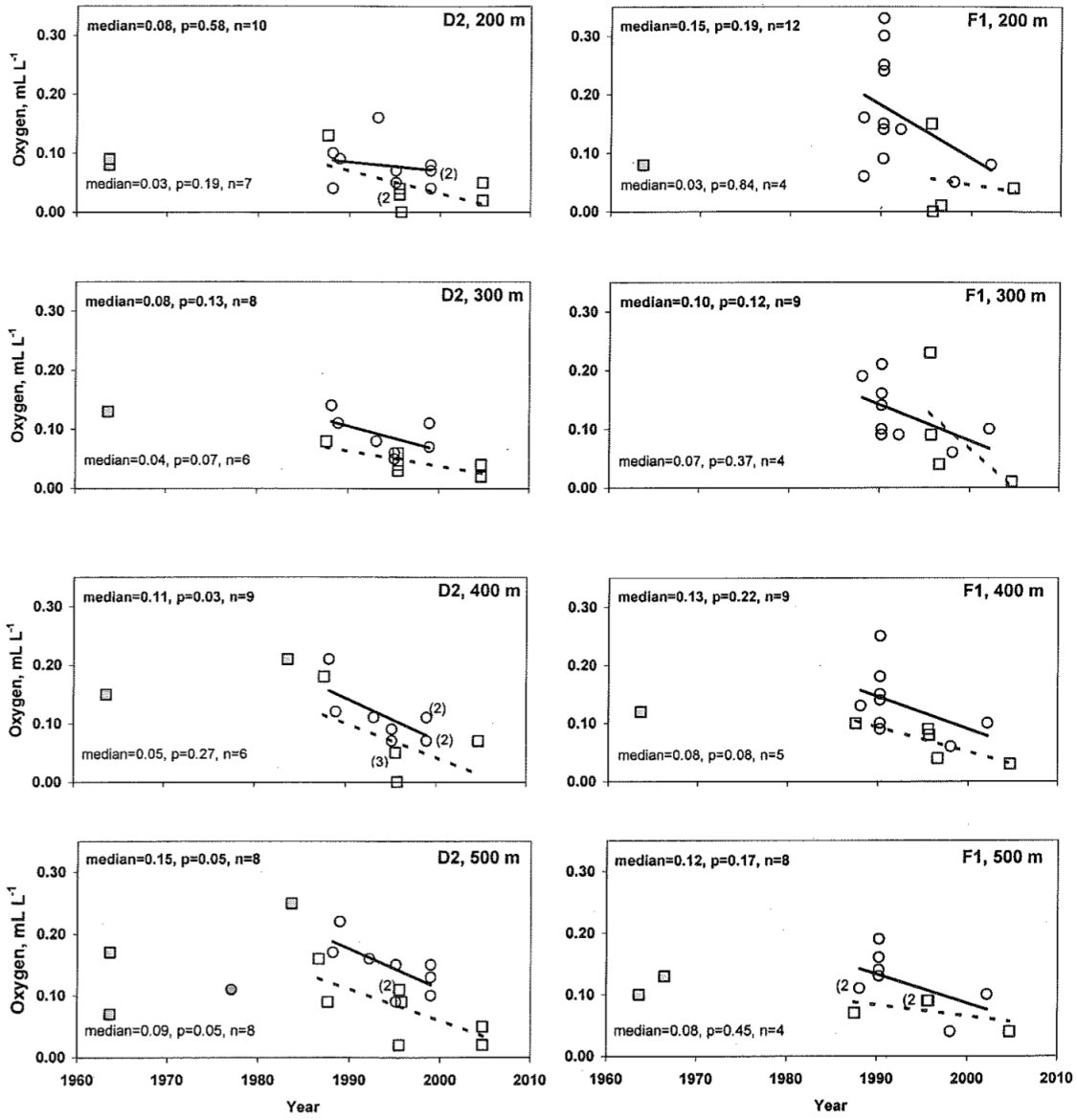


Decreasing O_2 to ~60% saturation stimulates growth of *Noctiluca*

Gomes et al., 2014

Increasing Intensity of OMZ



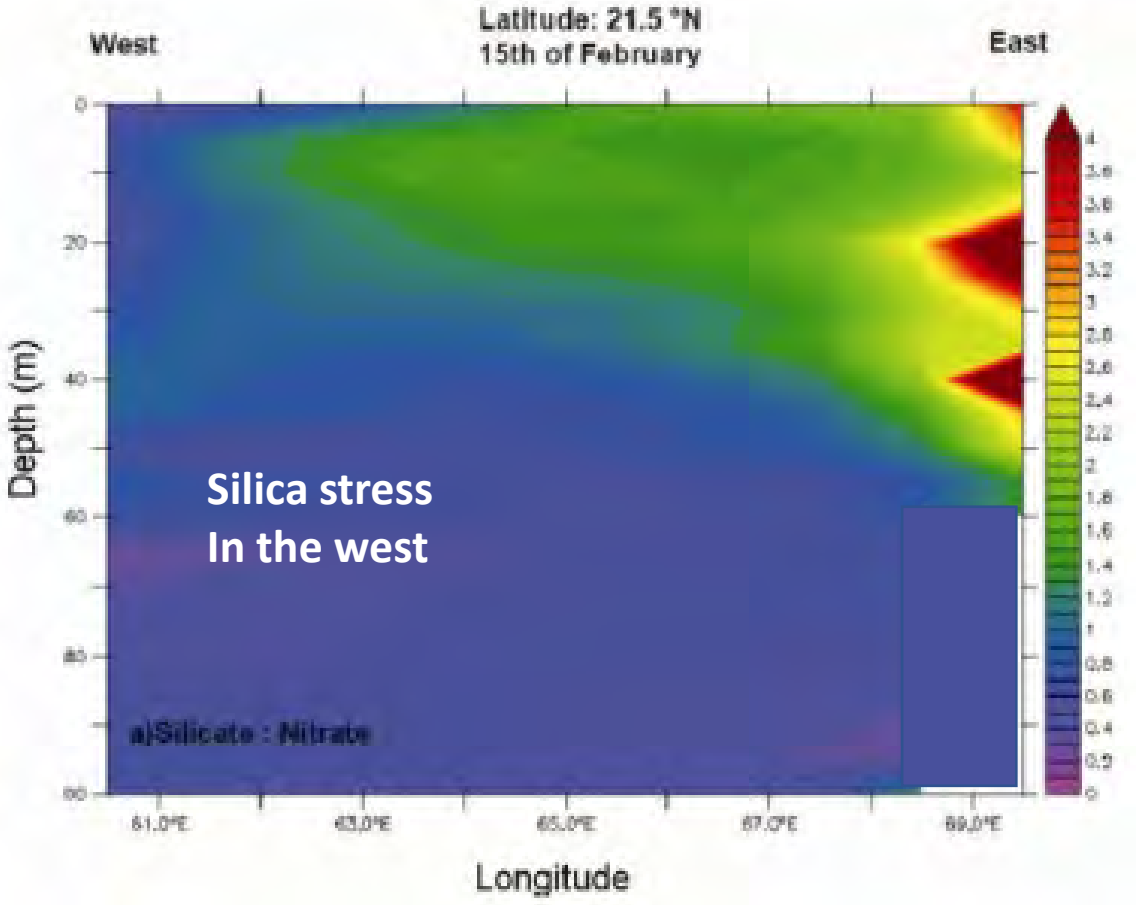


Banse, et al., 2014

Global warming = greater window for *Noctiluca* blooms…

- Strong latitudinal variability in February of Si:N

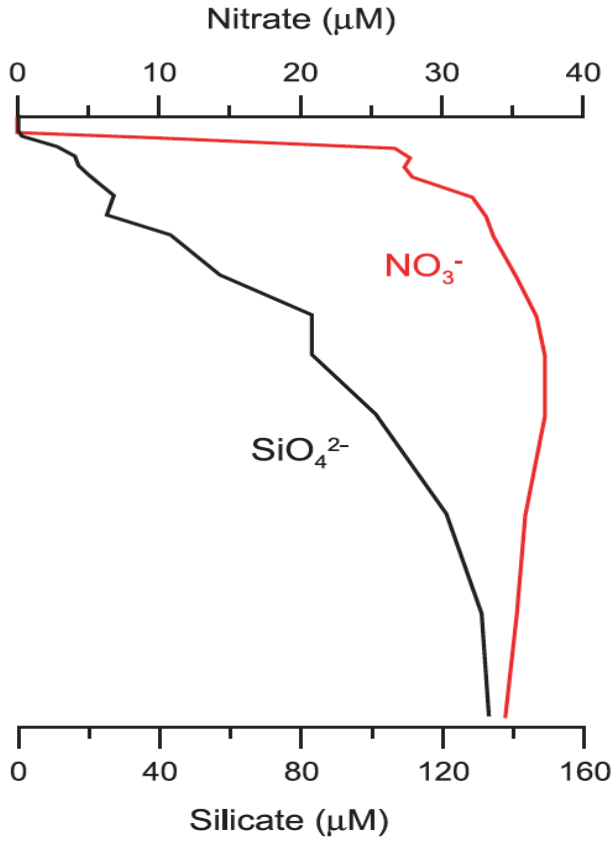
- Western Arabian Sea becomes “silicate stressed” during the latter part of the winter monsoon, possibly triggering the initiation of green *Noctiluca* blooms that later spread toward the east.



Prakash et al. 2017

- Typical vertical profile of Si and N in the northern Arabian Sea

- Increased surface warming — Shallowing of the thermocline



Kumar, M.D. 2006

Future Questions

1. Do low oxygen or changing Si:N ratios contribute to increased competitive advantages for *Noctiluca*?
2. Do fish avoid waters with *Noctiluca* blooms?
3. What effect does OMZ intensification in the Arabian Sea have on intrusion of hypoxic waters onto the shelf along the Western Indian coast?
3. Are there subregions along the coast that will experience more intense hypoxia or Si depletion in the future ("hot spots"), and what is the potential that these changes will enhance *Noctiluca* blooms in the future?

Acknowledgments

NMFS Office of Science and Technology Funding for the project “**Development of Predictive Capabilities for Marine Fisheries and Harmful Algal Blooms in Indian Seas”**

Special thanks
Drs. Usha Varanasi, Satheesh Shenoi, M. Sudhakar, N. Saravanane, Ned Cyr

And to all our colleagues in India