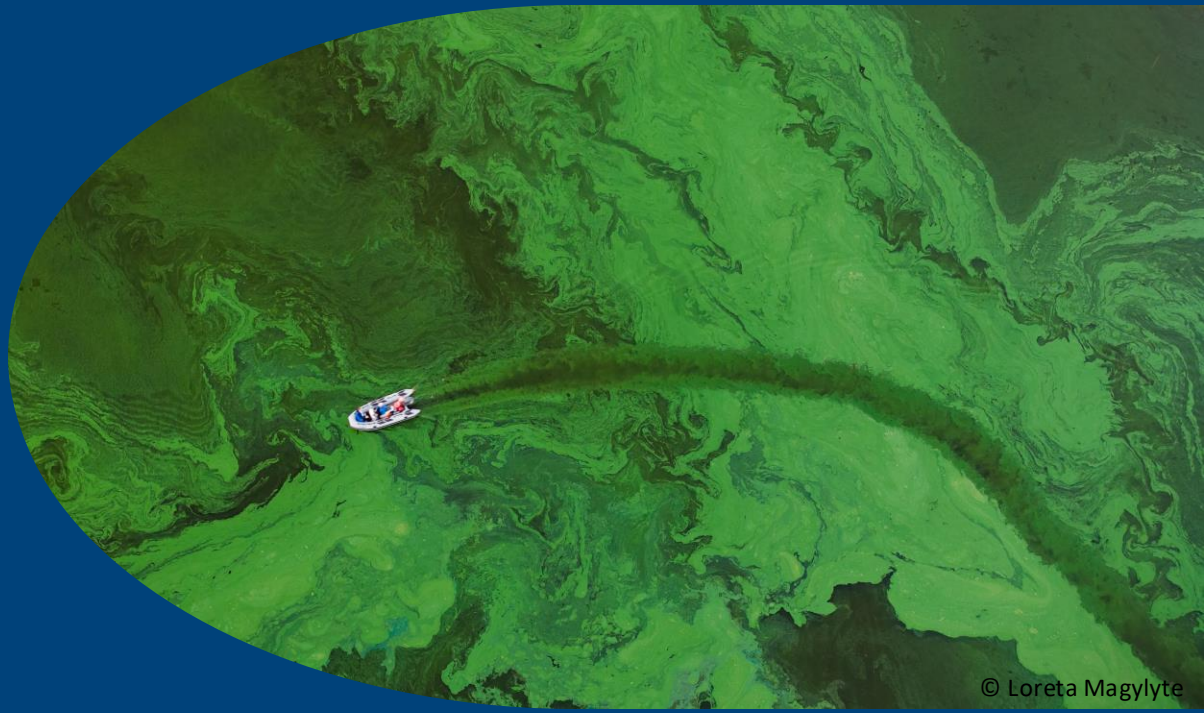
Global HAB Mitigation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Dr. Patrick Burke

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Australian Government

Why is HAB control difficult?

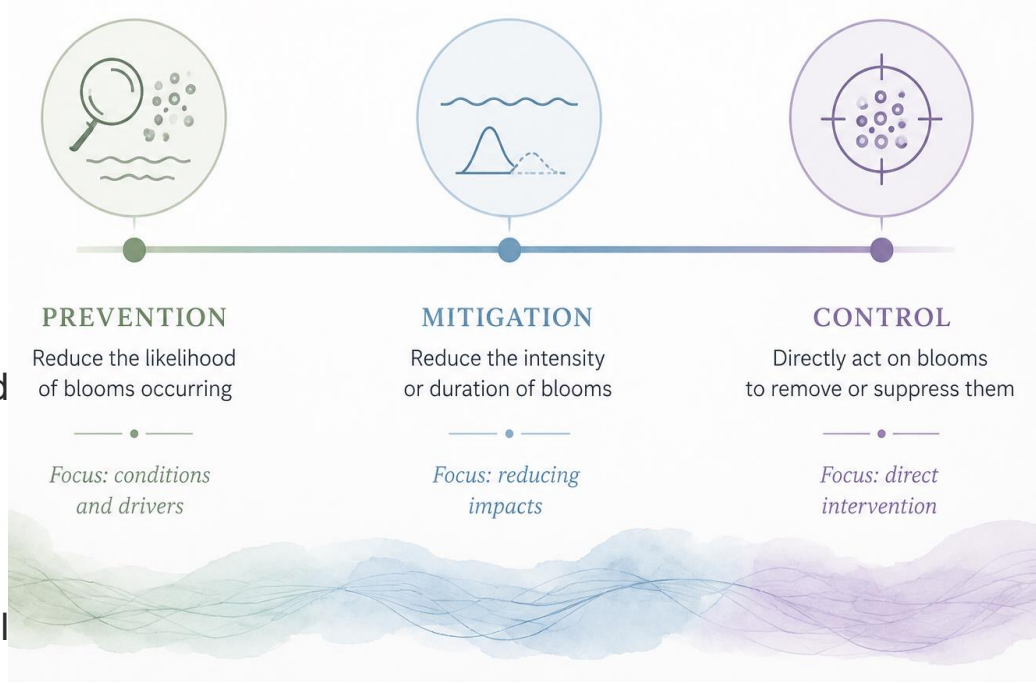
- HAB species are biologically diverse and respond differently to treatments
- Many mitigation strategies perform well in laboratories but fail at field scale
- Marine systems are highly dynamic

Global distribution of HAB events from 1980 to 2024. Map showing location of reported HAB events generated from IOC-UNESCO Harmful Algae Information System. Sourced from Manic et al., 2024.

Prevention Mitigation Control

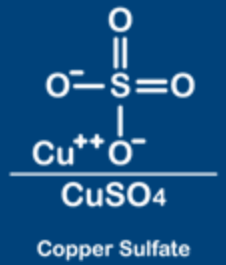
A spectrum of HAB approaches

- HAB interventions target different outcomes
- Approaches vary in timescale, risk and scalability
- No single strategy performs well across all scenarios



Global HAB Mitigation Strategies

Physical



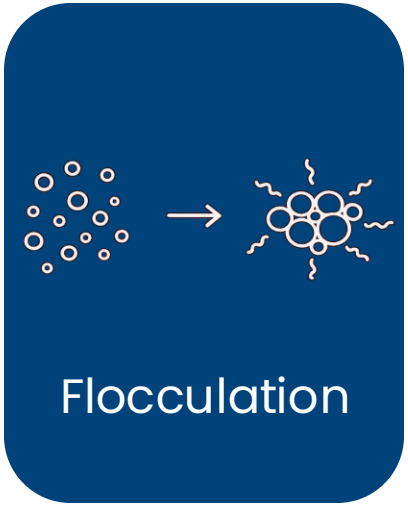
Chemical

Biological

Ecosystem

Physical approaches

Separating, removing or avoiding HAB exposure



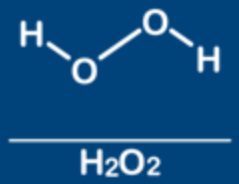
Physical approaches

Deep-water upwelling – Case study: Salmon aquaculture, Canada (Anderson et al., 2025)

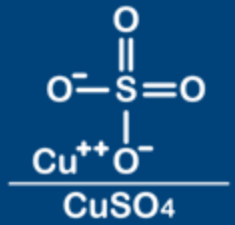
- Draws deeper, cleaner water into fish cages
- Reduces fish exposure to HABs
- Protects assets without removing blooms
- Expensive/ecosystem dependent

Chemical approaches

Rapid suppression through chemical intervention

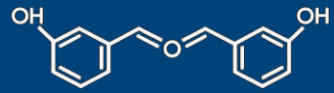


Hydrogen peroxide



Copper sulfate

Ozone



Allelopathics

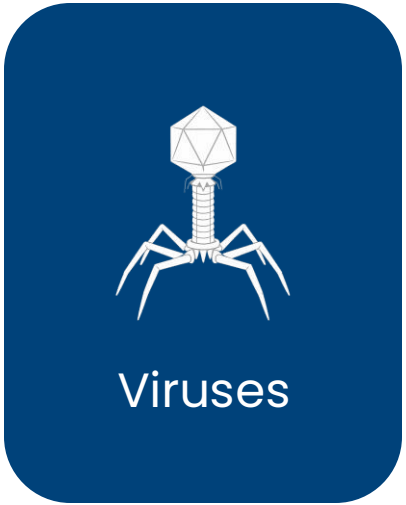
Chemical control

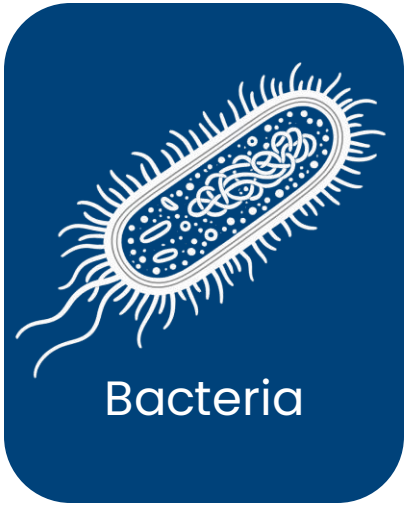
Hydrogen peroxide – Case study: Netherlands (Burson et al., 2014)

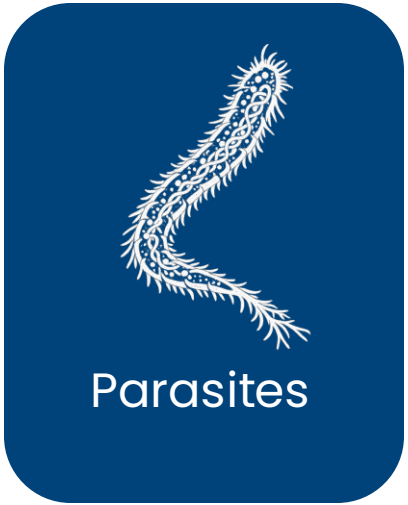
- *Alexandrium ostenfeldii* (2012)
- ~99% Alexandrium reduction within 48 hours
- Rapid toxin suppression
- Collateral zooplankton impacts

Biological approaches

Harnessing ecological interactions to control or manage HABs





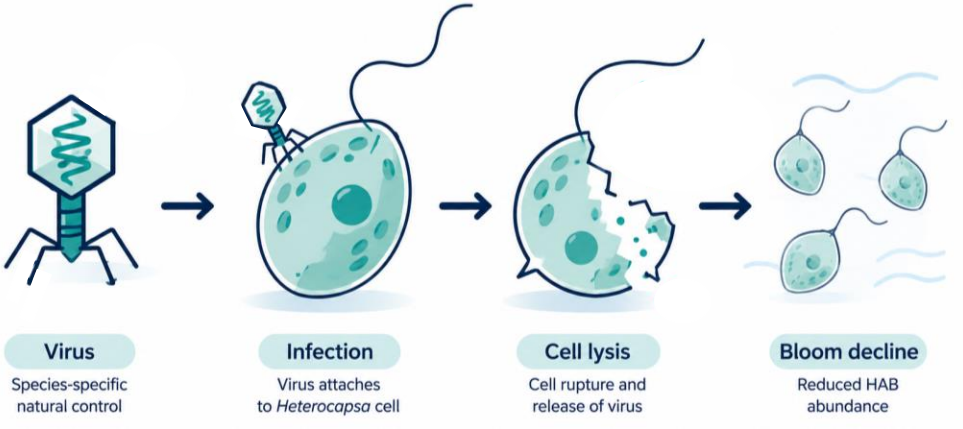


Biological approaches

HcRNAV Virus, Japan – Case study: Lake Kamo (saltwater lake)

(Nakayama et al., 2023)

- *Heterocapsa circularisquama* bloom 2009
- Naturally occurring RNA virus (HcRNAV)
- High species specificity may reduce non-target impacts



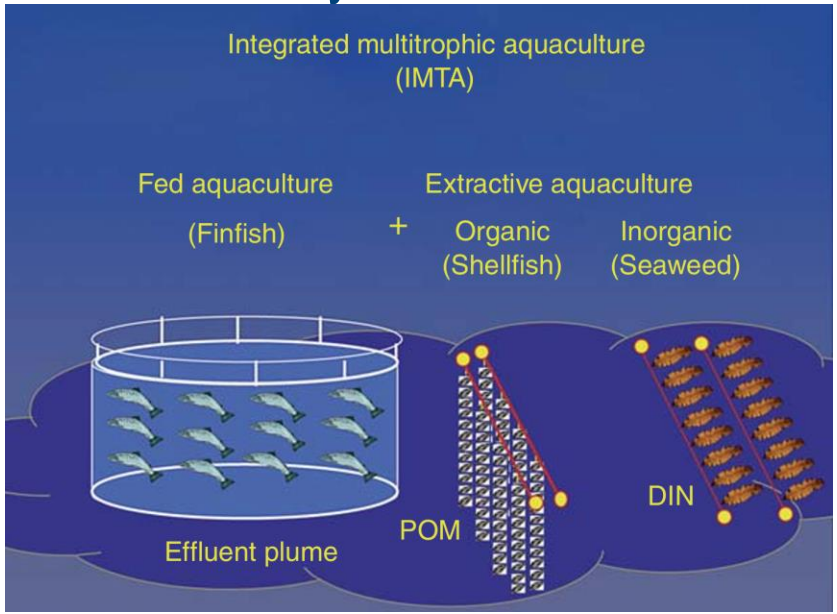
Ecosystem approaches

Managing HAB risk through ecological processes

Ecosystem approaches

IMTA & Cyanobacterial bloom suppression – Case study: China (Tang et al., 2024)

- Compared monoculture vs IMTA systems
- Reduced nutrient accumulation
- Improved recycling of waste nutrients
- IMTA reduced cyanobacterial bloom occurrence



Synthesis

Approach	Spatial Scale	Temporal Scale	Key Strengths	Key Limitations
Physical	Local to regional (metres to kilometres)	Hours to days	Rapid, quick biomass reduction	Expensive (method dependent), often requires repeated application
Chemical	Local (< km)	Hours to days	Fast bloom suppression	Potential non-target impacts & regulatory concerns
Biological	Local to regional	Days to weeks	Potential species-specific and environment compatibility	Slower and difficult to control in open systems. Limited compatibility across HABs
Ecosystem	Regional to ecosystem scale	Months to years	Addresses underlying drivers	Slow response and complex implementation

No single strategy is universally effective.
Monitoring & forecasting!

Thank you

References

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