

## Harmful algal blooms and climate change: Learning from the past and present to forecast the future

HAB types	Species	Justification
1. Paralytic shellfish poisoning	<i>Alexandrium fundyense</i>	Subject of extensive field and laboratory studies, northern expansion is expected
2. Diatom (domoic acid poisoning)	<i>Pseudo-nitzschia multiseriata</i>	Wide distribution, toxic, and the genome has been mapped, quantitative genomic studies are underway
3. Fish killing	<i>Heterosigma akashiwo</i> (toxic Pacific strain)	Historical harmful impact, growth-temperature relationships known, northern expansion is expected
	<i>Cochlodinium polykrikoides</i> (toxic Pacific strain)	Widespread impacts in Asian waters, long subject of field and laboratory studies
	<i>Karenia brevis</i> (Atlantic strain)	Large spatial scale blooms, broad field studies, direct human health impacts (aerosols)
4. Diarrhetic shellfish poisoning	<i>Dinophysis</i> spp.	Limited data makes a species selection difficult, but this genus serves a useful role as both toxic and mixotrophic model organism
5. High biomass	<i>Aureococcus anophagefferens</i> (Long Island, NY)	Large scale blooms with long lasting ecological and aesthetic consequences. Already subject to increasing genomic study
6. Cyanobacteria	<i>Nodularia spumigena</i> (Baltic strain)	Persistent high biomass over large salinity ranges, stimulated by eutrophication
7. Ciguatera fish poisoning	<i>Gambierdiscus</i> spp.	Large species complex with highly variable toxicity and temperature tolerances

## Review

**Euromediterranean Biomedical Journal**  
for young doctors  
(formerly: Capsula Eburnea)

### HARMFUL ALGAL BLOOMS IN THE MEDITERRANEAN SEA: EFFECTS ON HUMAN HEALTH.

Margherita Ferrante<sup>1</sup>, Gea Oliveri Conti<sup>1</sup>, Maria Fiore<sup>1</sup>, Venerando Rapisarda<sup>2</sup>,  
Caterina Ledda<sup>1</sup>

	Paralytic shellfish poisoning (PSP)	Neurotoxic shellfish poisoning (NSP)	Amnesic shellfish poisoning (ASP)	Diarrhetic shellfish poisoning (DSP)	Ciguatera fish poisoning (CFP)
<b>Causative organism</b>	<i>Alexandrium andersoni</i> , <i>A. acatenella</i> , <i>A. catenella</i> , <i>A. cohorticula</i> , <i>A. minutum</i> , <i>A. tamarense</i> , <i>A. tamiyavanichi</i> , <i>Gymnodinium catenatum</i> , <i>Pyrodinium bahamense</i>	<i>Karenia brevis</i> (= <i>Gymnodinium breve</i> ); <i>Pfiesteria piscicida</i> (neurotoxic), <i>P. shumwayae</i>	<i>Pseudonitzschia australis</i> , <i>P. delicatissima</i> , <i>P. pseudodelicatissima</i> , <i>P. Multiseriata</i> , <i>P. fraudulenta</i> , <i>P. multistriata</i> , <i>P. pungens</i> , <i>P. seriata</i> , <i>Nitzschia navis-varingica</i>	<i>Dinophysis acuminata</i> , <i>D. acuta</i> , <i>D. caudata</i> , <i>D. fortii</i> , <i>D. mitra</i> , <i>D. norvergica</i> , <i>D. rapa</i> , <i>D. sacculus</i> , <i>D. tripos</i> , <i>Prorocentrum lima</i> , <i>P. arenarium</i> , <i>P. belizeanum</i> , <i>P. cassubicum</i> , <i>P. concavum</i> , <i>P. emarginatum</i> .	<i>Gambierdiscus australes</i> , <i>G. pacificus</i> , <i>G. polynesiensis</i> , <i>G. toxicus</i> , <i>G. yasumotoi</i> <i>Ostreopsis heptagona</i> , <i>Prorocentrum lima</i>
<b>Symptoms in mild case</b>	Within 30 min: tingling sensation or numbness around lips, gradually spreading to face and neck; prickly sensation in fingertips and toes; headache, dizziness, nausea, vomiting, diarrhoea.	After 3–6 h: chills, headache, diarrhoea; muscle weakness, muscle and joint pain; nausea and vomiting, paraesthesia; altered perception of hot and cold, difficulty in breathing, double vision, trouble in talking and swallowing.	After 3–5 h: nausea, vomiting, diarrhoea, abdominal cramps.	After 30 min to a few hours (seldom more than 12 h): diarrhoea, nausea, vomiting, abdominal pain.	Symptoms develop within 12–24 h of eating fish. Gastrointestinal symptoms: diarrhoea, abdominal pain, nausea, vomiting.
<b>Symptoms in extreme case</b>	Muscular paralysis; pronounced respiratory difficulty; choking sensation; death through respiratory paralysis may occur within 2–24 h after ingestion.		Decreased reaction to deep pain; dizziness, hallucinations, confusion; short-term memory loss; seizures.	Chronic exposure may promote tumour formation in the digestive system.	Neurological symptoms: numbness and tingling of hands and feet; cold objects feel hot to touch; difficulty in balance; low heart rate and blood pressure; rashes. In extreme cases, death through respiratory failure.
<b>Treatment</b>	Gastric lavage and artificial respiration. No lasting effects.		At this point, the treatment of ASP is symptomatic.	Recovery after 3 days, irrespective of medical treatment.	No antitoxin or specific treatment is available. Neurological symptoms may last for months or years. Calcium and mannitol may help relieve symptoms.

Table 1: A summary of syndromes, producer species, symptoms and treatment.

# Harmful algal bloom species representative of major taxonomic algal groups along the freshwater-to-marine continuum

## Mitigating the Expansion of Harmful Algal Blooms Across the Freshwater-to-Marine Continuum

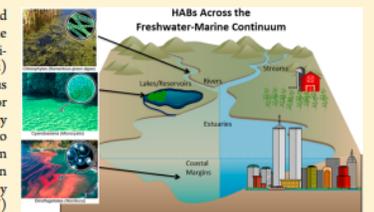
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**ABSTRACT:** Anthropogenic nutrient overenrichment, coupled with rising temperatures, and an increasing frequency of extreme hydrologic events (storms and droughts) are accelerating eutrophication and promoting the expansion of harmful algal blooms (HABs) across the freshwater-to-marine continuum. All HABs—with a focus here on cyanobacterial blooms—pose serious consequences for water supplies, fisheries, recreational uses, tourism, and property values. As nutrient loads grow in watersheds, they begin to compound the effects of legacy stores. This has led to a paradigm shift in our understanding of how nutrients control eutrophication and blooms. Phosphorus (P) reductions have been traditionally prescribed exclusively for freshwater systems, while nitrogen (N) reductions were mainly stressed for brackish and coastal waters. However, because most systems are hydrologically interconnected, single nutrient (e.g., P only) reductions upstream may not necessarily reduce HAB impacts downstream. Reducing both N and P inputs is the only viable nutrient management solution for long-term control of HABs along the continuum. This article highlights where paired physical, chemical, or biological controls may improve beneficial uses in the short term, and offers management strategies that should be enacted across watershed scales to combat the global expansion of HABs across geographically broad freshwater-to-marine continua.



### INTRODUCTION

Phytoplankton are key primary producers (photoautotrophs) that support biogeochemical cycling, food web structure, and the sustainability of aquatic ecosystems spanning the continuum from upstream headwaters to the coastal ocean. Human population growth, along with its associated agricultural, urban and industrial development, have led to nutrient inputs exceeding levels needed to sustain adequate primary productivity along this continuum. The resulting nutrient overenrichment and excessive production of organic matter at the base of the food web, termed “cultural eutrophication”, has led to a suite of undesirable biogeochemical and ecological consequences—the most obvious and troublesome being the overgrowth of noxious phytoplankton (i.e., “blooms”) (Figures 1 and 2).

The connection between excess nutrient inputs and HABs has been broadly recognized in European and North American waters impacted by large-scale agriculture, industrialization, and urbanization. This troubling trend is now rapidly expanding in developing regions of Asia, Central and South America, Africa, Australia–New Zealand, and the Pacific Basin.<sup>1–4</sup> Impacts vary depending on the relationship of drainage basin and airshed areas to the size and volume of receiving waters.<sup>5</sup> Most obvious are relatively small water bodies in urban, industrial, and

agricultural watersheds. However, large lakes, estuaries, and coastal waters are also impacted by accelerating eutrophication, expanding HABs and their toxins. Human hydrologic modifications, including water withdrawals, diversions and dams, have additionally altered the flow paths of water and nutrients entering aquatic ecosystems.

Climate change poses an additional challenge in predicting changes in HAB frequency, intensity, and proliferation.<sup>6–9</sup> Global warming, altered precipitation patterns, and sea level rise, accompanied by changes in ocean and lake circulation, stratification, and upwelling, wind speed, and cyclone frequency and intensity, play increasingly important roles in modulating HAB dynamics.<sup>10</sup> Hydrologic modifications and climate change enable HABs to reach larger magnitudes and persist longer when accompanied by excessive nutrient loading.<sup>3,11</sup>

Contemporary HAB problems must be addressed on land–water–air interactive scales that link watersheds to the coastal ocean, since it is increasingly recognized that in order to combat these threats, we need to treat the freshwater-to-marine continuum as one interconnected system rather than a series of individual water bodies and management districts.

Published: April 16, 2018

### Environmental Science & Technology

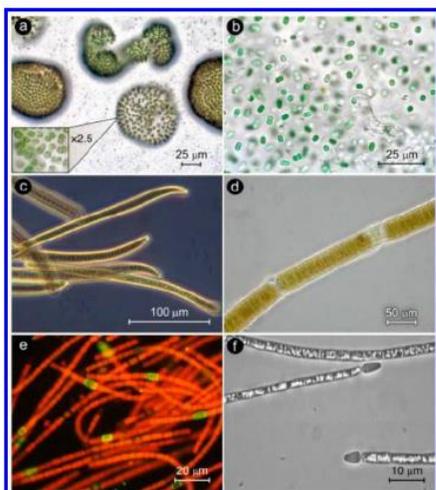
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**Table 1. Common Harmful Bloom-Forming Phytoplankton Genera Observed Across the Freshwater-Marine Continuum and Their Known Toxins<sup>a</sup>**

genus	group	potential toxin(s)	characteristics	salinity range		
				low (0–4)	mod. (4–16)	high (16+)
<i>Anabaena</i>	cyanobacteria	ATX, CYN, MC, STX	B,D,F	×	×	
<i>Anabaenopsis</i>	cyanobacteria	MC	P,D,F	×	×	×
<i>Aphanizomenon</i>	cyanobacteria	ATX, CYN, STX	P,D,F	×	×	
<i>Cylindrospermopsis</i>	cyanobacteria	ATX, CYN, STX	P,D,F	×		
<i>Cylindrospermum</i>	cyanobacteria	ATX, MC	B,D,F	×		
<i>Dolichospermum</i>	cyanobacteria	ATX, CYN, MC, STX	P,D,F	×	×	
<i>Fischerella</i>	cyanobacteria	MC	B,D,F	×		×
<i>Haploisiphon</i>	cyanobacteria	MC	B,D,F	×		
<i>Lyngbya</i>	cyanobacteria	CYN, LYN, STX	B,F	×	×	×
<i>Microcystis</i>	cyanobacteria	MC	P,C	×		
<i>Nodularia</i>	cyanobacteria	NOD	B/P,D,F	×	×	×
<i>Nostoc</i>	cyanobacteria	ATX, MC	B,D,F	×	×	
<i>Oscillatoria</i>	cyanobacteria	ATX, CYN, MC, STX	B/P,D,F	×	×	×
<i>Phormidium</i>	cyanobacteria	ATX, MC	B,F	×	×	×
<i>Planktothrix</i>	cyanobacteria	ATX, MC	P,F	×	×	
<i>Raphidiopsis</i>	cyanobacteria	ATX, CYN, MC	P,F	×	×	
<i>Scytonema</i>	cyanobacteria	MC, STX	B,D,F	×	×	×
<i>Umezakia</i>	cyanobacteria	CYN, MC	P,D,F	×		
<i>Pseudonitzschia</i>	diatom	DA	P		×	×
<i>Alexandrium</i>	dinoflagellate	STX	P		×	×
<i>Gymnodinium</i>	dinoflagellate	STX	P		×	×
<i>Karenia</i>	dinoflagellate	BRV	P		×	×
<i>Karlenidium</i>	dinoflagellate	ICX	P	×	×	×
<i>Pyrodinium</i>	dinoflagellate	STX	P		×	×
<i>Prymnesium</i>	haptophyte	ICX	P	×	×	×

<sup>a</sup>Toxin abbreviations: ATX = anatoxin-a; BRV = brevetoxin; CYN = cylindrospermopsin; DA = domoic acid; ICX = ichthyotoxins; LYN = lyngbyatoxin; MC = microcystin; NOD = nodularin; STX = saxitoxin. Characteristics abbreviations: B = benthic; C = coccoid; D = diazotrophic; F = filamentous; P = planktonic.

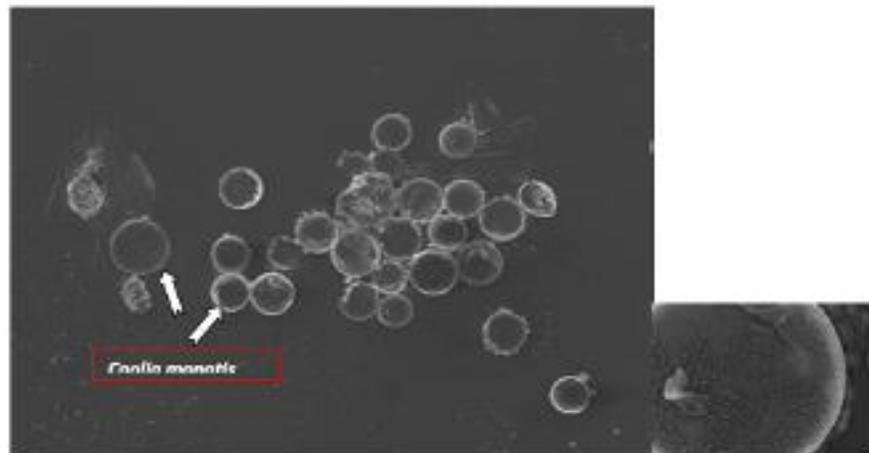
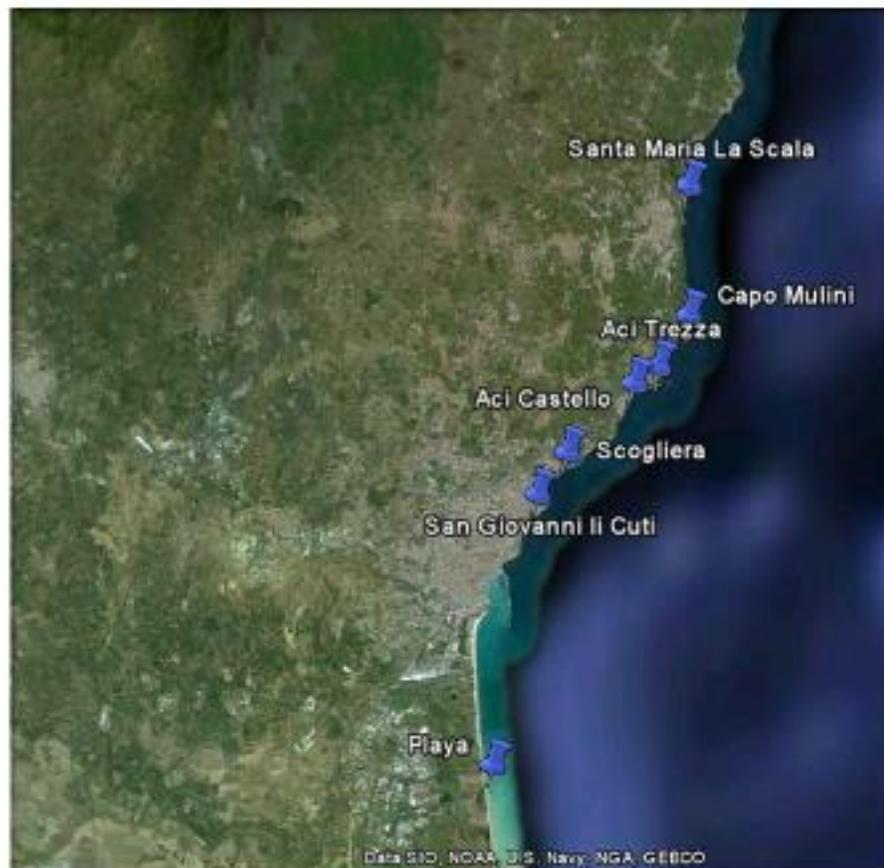
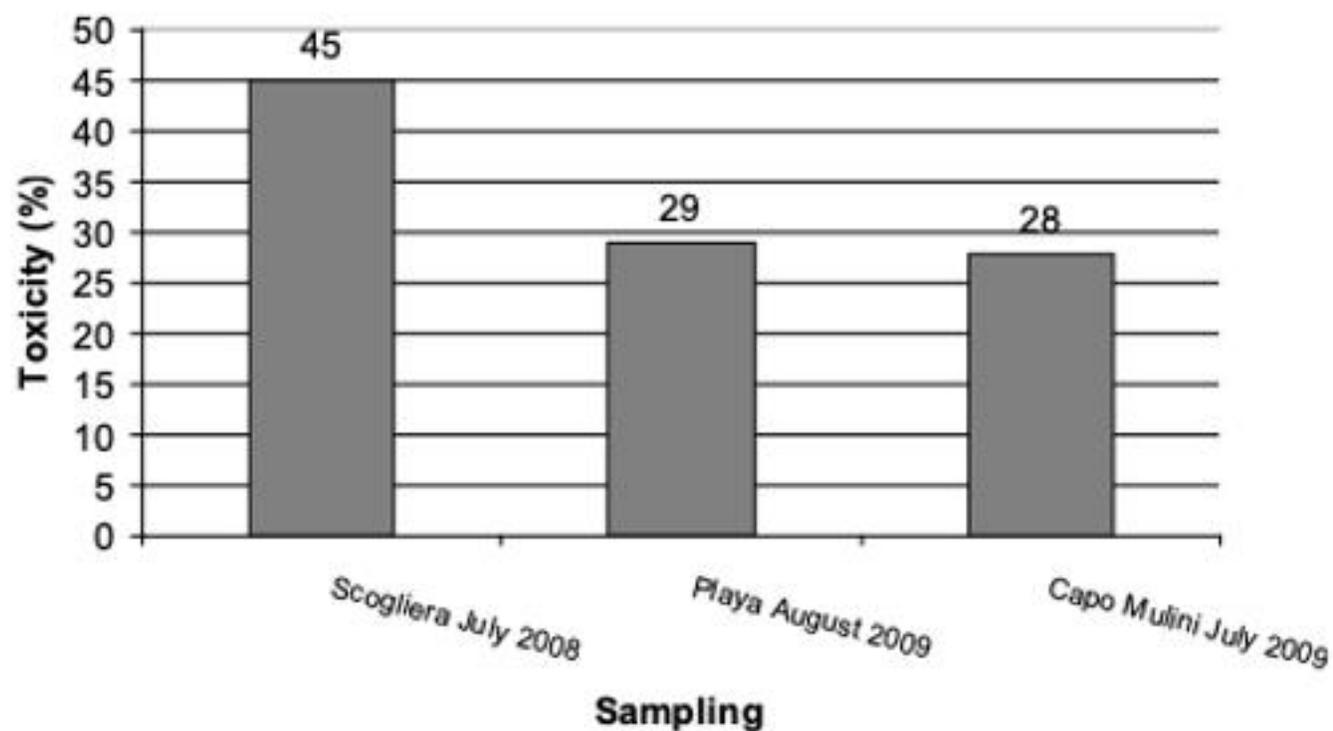
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## Detection of *Ostreopsis ovata* from Eastern Sicily Coast Using SEM Microscopy Coupled to the *Vibrio fischeri* Test

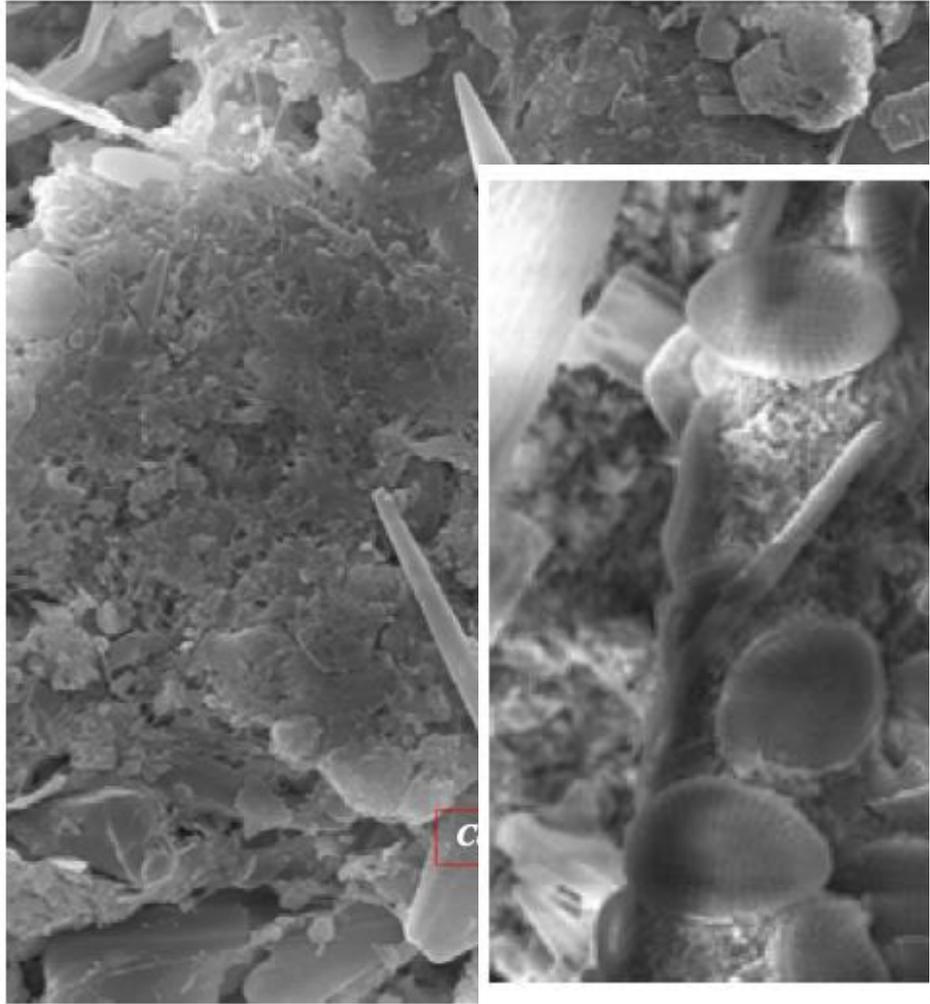
Oliveri Conti G, Ledda C, Zuccarello M, Fiore M, Fallico R, Sciacca S and Ferrante M\*

### *Vibrio fischeri* Toxicity (%)



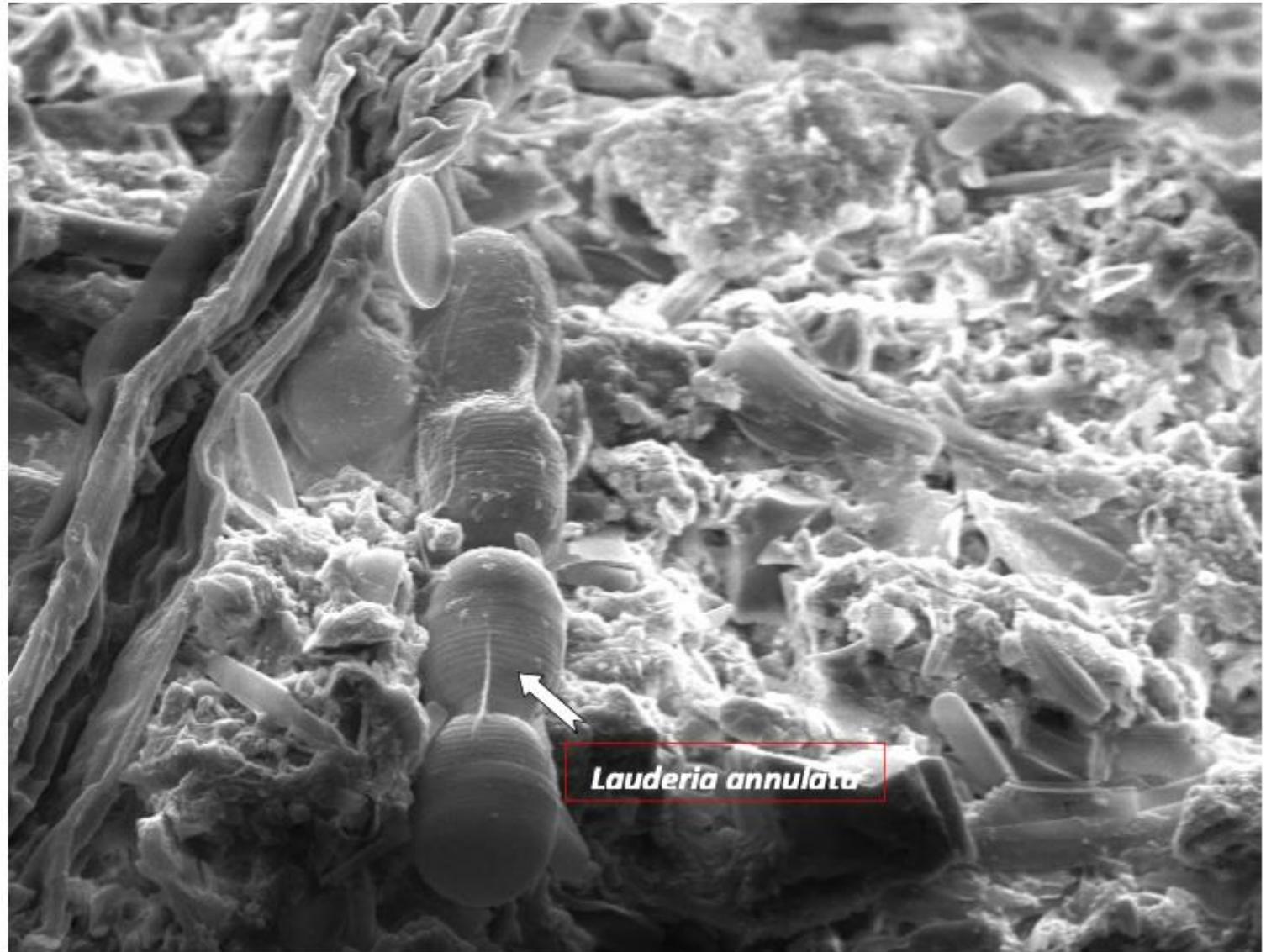
**Figure 4:** Specimens of *Coolia monotis* and structure of its frustule (see zoom) related to cooliatoxin a neurotoxic analog to yessotoxin.

**Citation:** Oliveri Conti G, Ledda C, Zuccarello M, Fiore M, Phallic R, et al. (2011) Detection of *Ostreopsis ovata* from Eastern Sicily Coast Using SEM microscopy coupled to the *Vibrio fischeri* Test Development J Aquac Res S4: 001. doi:[10.4172/2155-9546.S4-001](https://doi.org/10.4172/2155-9546.S4-001)



**Figure 7:** Pseudo-nitzschia (Amnesic Shellfish Poisoning)

**Figure 9:** Cocconeis structure of its Frustrum



**Figure 10:** *Lauderia annulata* in magroalgae sampled in Acicastello 2010, no toxicity reported.

## Living near waterbodies as a proxy of cyanobacteria exposure and risk of amyotrophic lateral sclerosis: a population based case-control study

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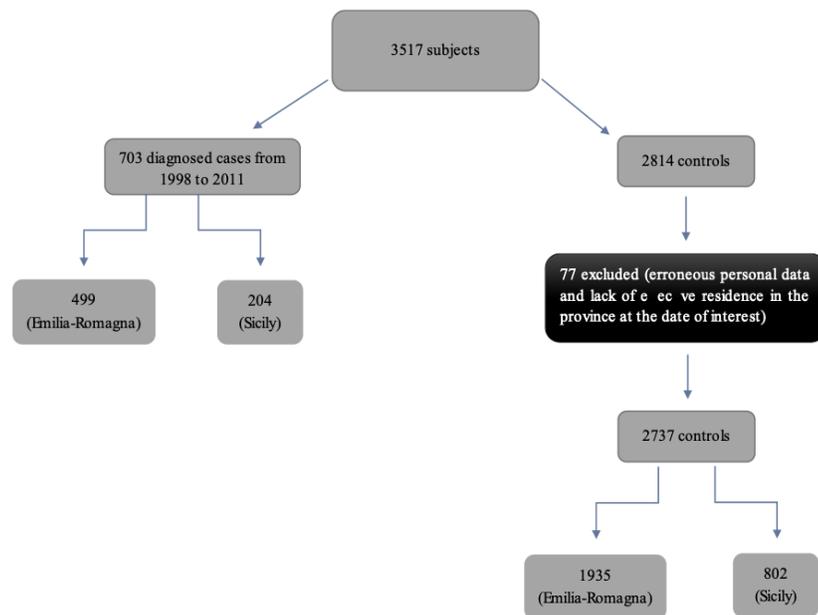


Fig. 1. Flowchart of the study participants.

Lo scopo di questo studio era di indagare l'associazione tra esposizione a cianotossine e rischio di SLA in due popolazioni italiane

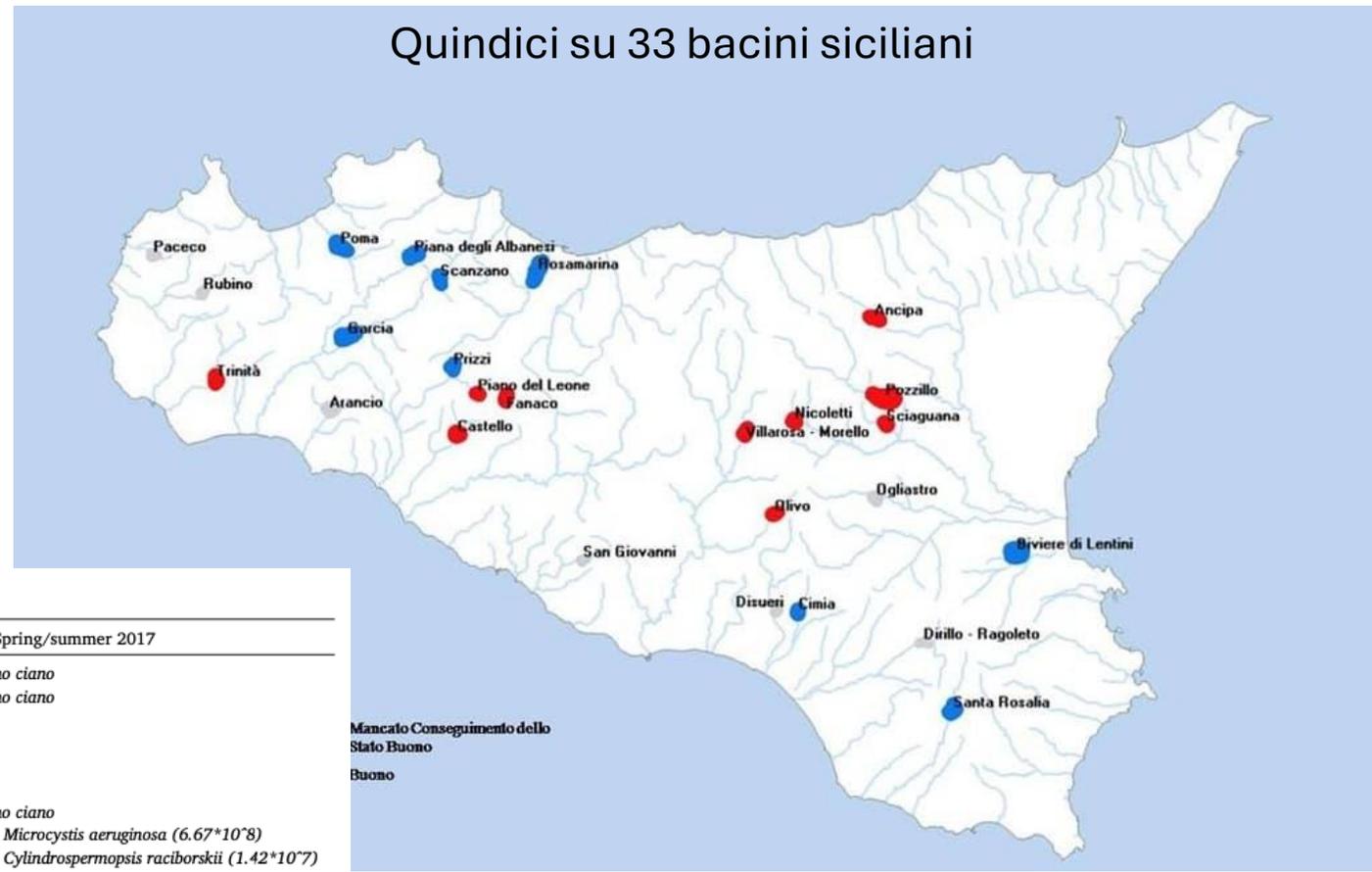
Vicinanza residenziale ai corpi idrici come misura della possibile esposizione alle cianotossine

**I risultati sembrano supportare l'ipotesi che l'esposizione alle cianotossine possa aumentare il rischio di SLA.**

- ✓ Residenza attuale in prossimità di corpi idrici (OR) di SLA di 1,41 (IC 95%: 0,72-2,74)
- ✓ Residenza storica (OR: 1,31; IC 95%: 0,57-2,99).
- ✓ I soggetti <65 anni e le persone che risiedono nella provincia di Modena del Nord Italia avevano OR più elevati, soprattutto se si considerava la residenza storica
- ✓ eccesso di rischio di SLA, sebbene generalmente limitato ai soggetti più giovani e più forte nelle femmine.

# Water quality and human health: A simple monitoring model of toxic cyanobacteria growth in highly variable Mediterranean hot dry environments

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**Table 5**  
Cyanobacteria species and density (cell/l).

Water bodies	Summer 2016	Autumn 2016	Winter 2016/17	Spring/summer 2017
1	- <i>Pseudoanabaena</i> sp	no ciano	no ciano	no ciano
2	- <i>Limnothrix redekei</i> - <i>Borzia</i> sp. - <i>Merismopedia</i> sp - <i>Pseudoanabaena</i> sp - <i>Planktothrix rubescens</i>	- <i>Borzia</i> sp. ( $3 \times 10^2$ ) - <i>Pseudoanabaena</i> sp. ( $2.0 \times 10^3$ ) - <i>Limnothrix redekei</i> ( $6.0 \times 10^2$ )	<i>picocianobatteri</i>	no ciano
3	- <i>Planktothrix agardhii</i>	-	no ciano	no ciano
4	- <i>Anabaenopsis</i> sp - <i>Pseudoanabaena</i>	-	no ciano	- <i>Microcystis aeruginosa</i> ( $6.67 \times 10^8$ ) - <i>Cylindrospermopsis raciborskii</i> ( $1.42 \times 10^7$ ) - <i>Pseudoanabaena</i> sp. ( $2.15 \times 10^6$ ) <i>picocianobatteri</i>
5	- <i>Pseudoanabaena</i> sp. - <i>Chroococcus</i> sp.	-	<i>picocianobatteri</i>	
6	- <i>Oscillatoriales</i> - <i>Dolichospermum</i> sp. - <i>Picocianobatteri</i>	-	<i>picocianobatteri</i>	-
7	- <i>P. rubescens</i> - <i>P. agardhii</i> - <i>Oscillatoriales</i> - <i>Planktolyngbya</i> - <i>picocianobatteri</i>	<i>Planktolyngbya</i> sp. ( $4.2 \times 10^3$ )	<i>picocianobatteri</i>	<i>picocianobatteri</i>
8	<i>Oscillatoria</i> sp.	-	no ciano	no ciano
9	no ciano-	no ciano-	-	-
10	-	-	<i>P. rubescens</i> ( $6.6 \times 10^4$ )	- <i>Planktolyngbya</i> sp. ( $1.2 \times 10^3$ ) - <i>Limnothrix redekei</i> ( $6.0 \times 10^2$ ) - <i>Oscillatoria</i> sp. ( $1.0 \times 10^3$ )
11	-	-	<i>Pseudoanabaena</i> sp. ( $5.0 \times 10^2$ ) <i>picocianobatteri</i>	no ciano
12	-	-	<i>picocianobatteri</i>	<i>picocianobatteri</i>
13	no ciano	-	no ciano	no ciano
14	-	-	no ciano	<i>picocianobatteri</i>
15	-	-	no ciano	no ciano

Probability / Consequence	Unlikely (0-1)	Possible (2)	Likely (3)	Probable (4)
Mild (1)	No action	No action	Low priority	Low priority
Modest (2)	No action	Low priority	Recommended	Recommended
Significant (3)	Low priority	Recommended	Recommended	Highly recommended
Serious (4)	Low priority	Recommended	Highly recommended	Highly recommended

Fig. 1. Matrix identifying the degree of 'need for monitoring' associated to MC and CB occurrence.



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### RESEARCH ARTICLE

## The Relevance of Microcystin Monitoring in Dialysis Centers of Sicilians Cities: An Environmental Study

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#### Abstract:

#### Background:

Sicilian surface basins are among the most important water supply resources available on the island. They are often affected by harmful cyanobacteria blooms as *Planktothrix rubescens* and *Microcystis aeruginosa*. Since dialysates are produced using network water, they could contain cyanotoxins. No study has been conducted yet to evaluate the removal efficiency of osmotic systems for cyanotoxins in abnormal conditions at room temperatures of about 40°C. The aim of this study was to monitor the presence of microcystins in Sicilian dialysis center, network waters and, finally, dialysates produced from these waters in an Agrigento dialysis unit where environmental conditions are favorable for algal bloom.

#### Methods:

This clinic normally receives surface water from artificial basins, where several times, traces of cyanobacteria have been detected. Moreover, dialysates and underground supply waters of a clinic in Catania were also sampled as control. Samplings were performed in summer 2018, when room temperatures were above 38 °C. A total of 40 samples were analyzed by ELISA assay.

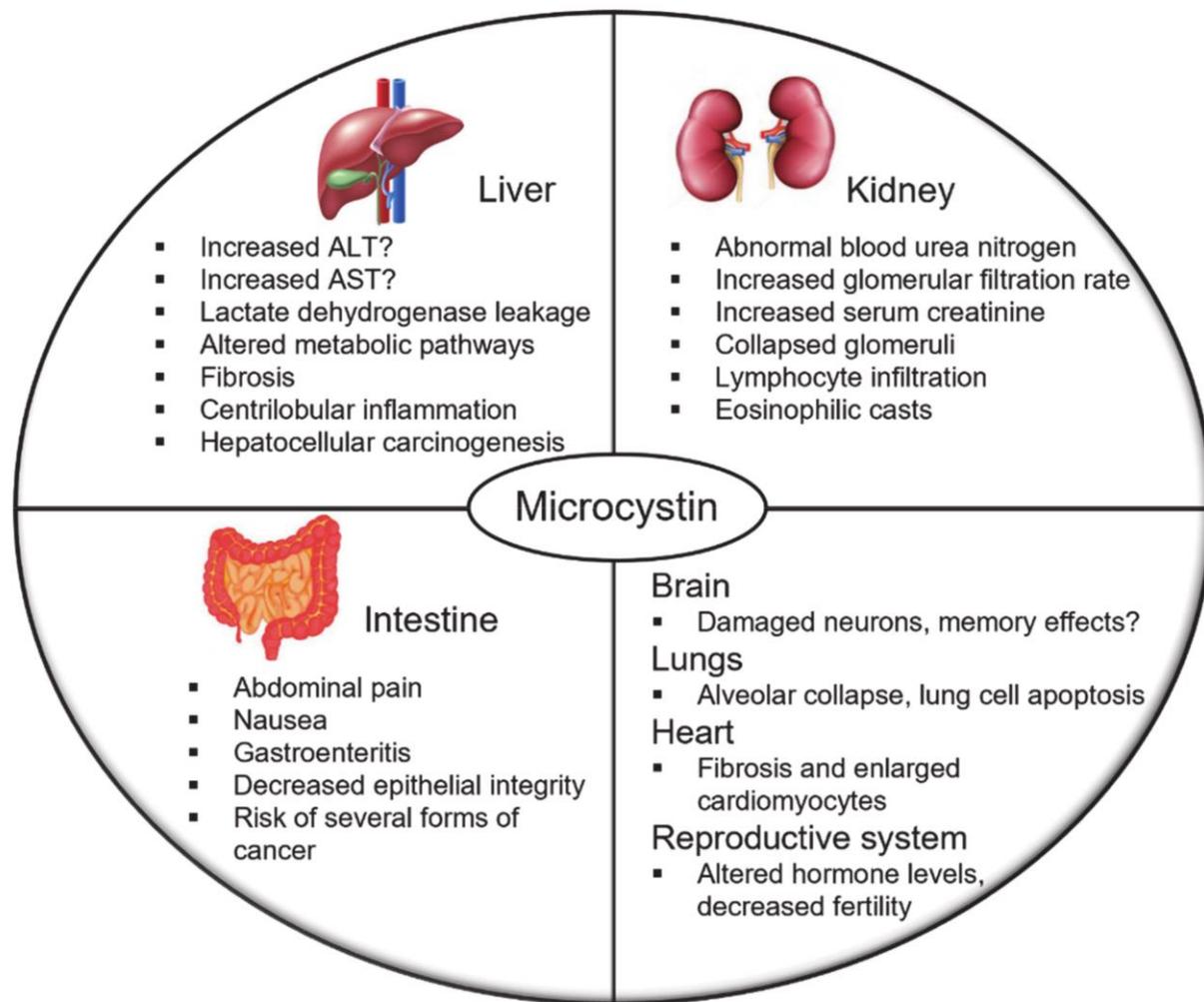
#### Results:

Results of our monitoring highlighted concentrations of MCs in waters of several basins among LOD - 155 ng/L, lower than WHO reference value for drinking waters (1,0 µg/L), that decrease up to undetectable levels whereas no MC contamination was detected both in supply waters and dialysates.

#### Conclusion:

Although our first set of data outcomes seem to be quite comforting, an improvement of law and a complete census of the water supplies of dialysate centers would be ideal.

**Keywords:** Dialysis, *Microcystis aeruginosa*, *Planktothrix rubescens*, Health Risk Management, Sicily (Italy), Microcystins.



# Survey

Valutazione degli impatti di interventi di miglioramento con azione sulle aree blu



Poiché non riusciamo a valutare direttamente gli impatti durante il progetto, svilupperemo proiezioni e modelli di simulazione per valutare l'efficacia di interventi di mitigazione urbani (implementazione di aree blu e mobilità sostenibile), analizzati in termini di co-benefici di salute verificando l'equità della distribuzione di questi benefici tra le diverse fasce della popolazione e considerando l'accessibilità agli interventi proposti.

Le valutazioni saranno fatte anche in comparazione sulle tre principali città siciliane: Palermo, Catania e Messina.

# Review

## PRISMA SYSTEMATIC REVIEW - PROSPERO registration.

### Search databases:

Pubmed

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### Publication date:

The last 10 years

### Language:

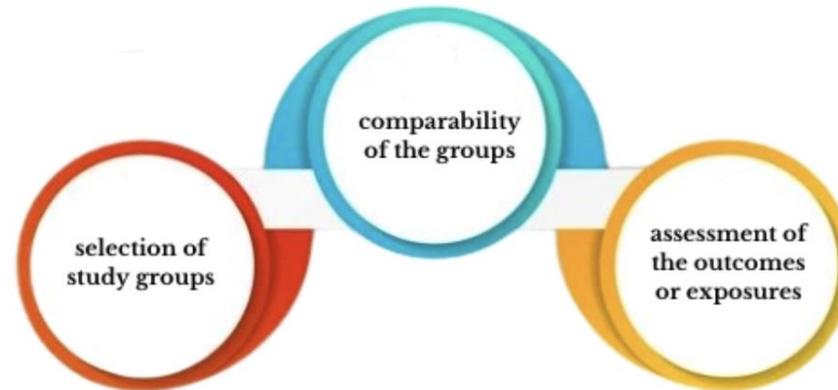
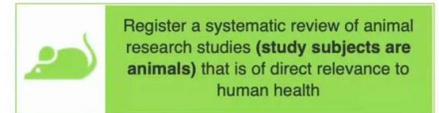
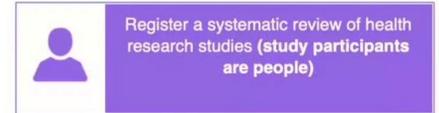
English

### Article type:

Only original articles (no reviews, reports, editorials, PhD theses, commentaries, conference abstracts, meta-analyses, and grey literature).

**Risk of Bias analysis:** New Castle Ottawa Scale (studi vari); o HAMSTAR 2.

## 2. Register the protocol



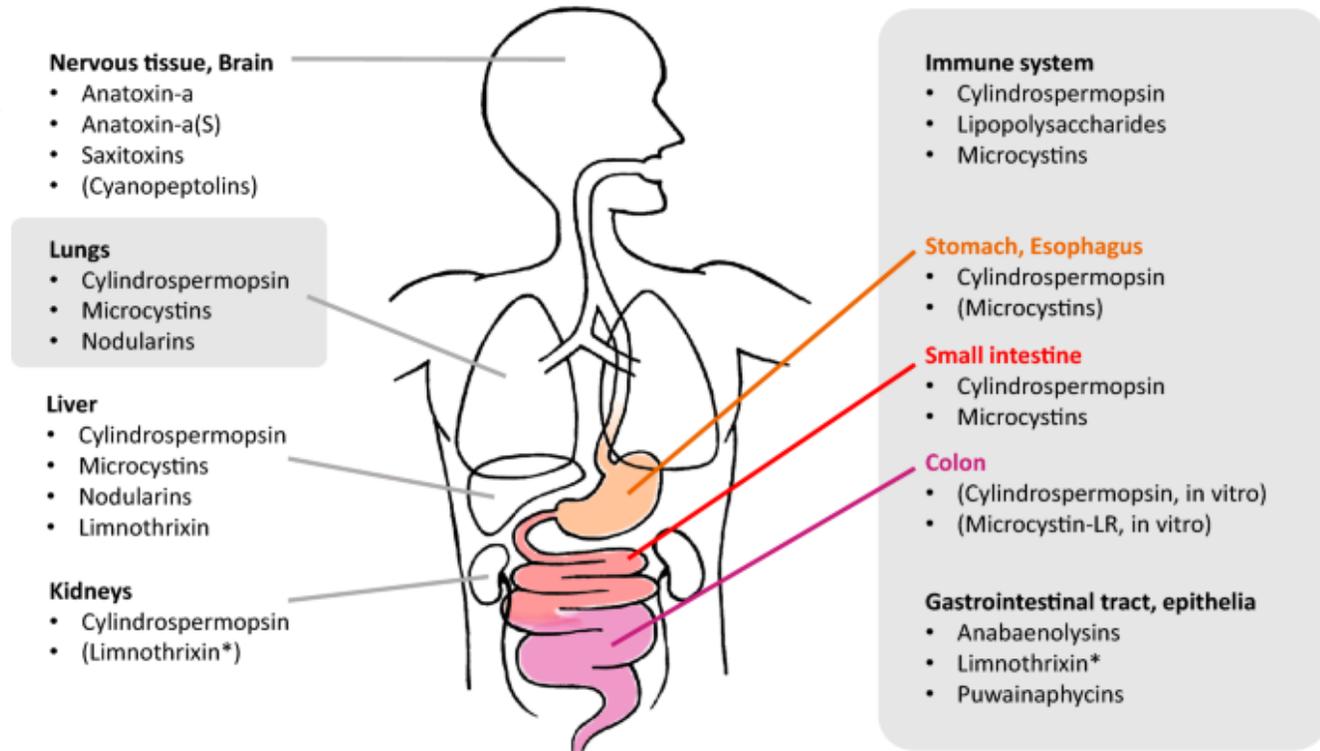
# PRISMA Systematic review proposta1.

## FIORITURE ALGALI E SALUTE UMANA

Le fioriture algali sono indicatori chiari dell'aumento delle temperature marine e della presenza di nutrienti in eccesso. La loro proliferazione non solo minaccia la salute degli ecosistemi marini, ma rappresenta anche un rischio significativo per la salute umana e l'economia. È fondamentale monitorare questi fenomeni e implementare strategie di mitigazione per proteggere sia l'ambiente che le comunità umane.

### KEYWORDS:

Climate change- increasing temperature-Marine water bodies-Algal blooms-Dinoflagellates-Diatoms-Cyanobacteria-Eutrophication-Biotoxins-Bioaerosol inhalation – Dermatitis - Eye irritation - Ecological impact-Environmental monitoring, Harmful Algal Blooms - Algal Biotoxins - Human Health - Human Exposure



# PRISMA Systematic review proposta 2.

## BLUE SPACES E MITIGAZIONE DEGLI EFFETTI SANITARI DEL CAMBIAMENTO CLIMATICO

valorizzare e preservare i «blue spaces» non solo migliora la qualità della vita urbana attraverso benefici diretti sulla salute umana, ma può anche svolgere un ruolo cruciale nella lotta al cambiamento climatico, fornendo soluzioni naturali e sostenibili per affrontare sfide ambientali globali.

### KEYWORDS:

Climate Change - Blue spaces – Marine Environments - Water bodies- Urban health – Human health- Mental health – Neurological Diseases – Health - Air quality - Urban planning - Public Health - Environmental impact - Urban resilience - Ecological restoration - Water management - Policy interventions.

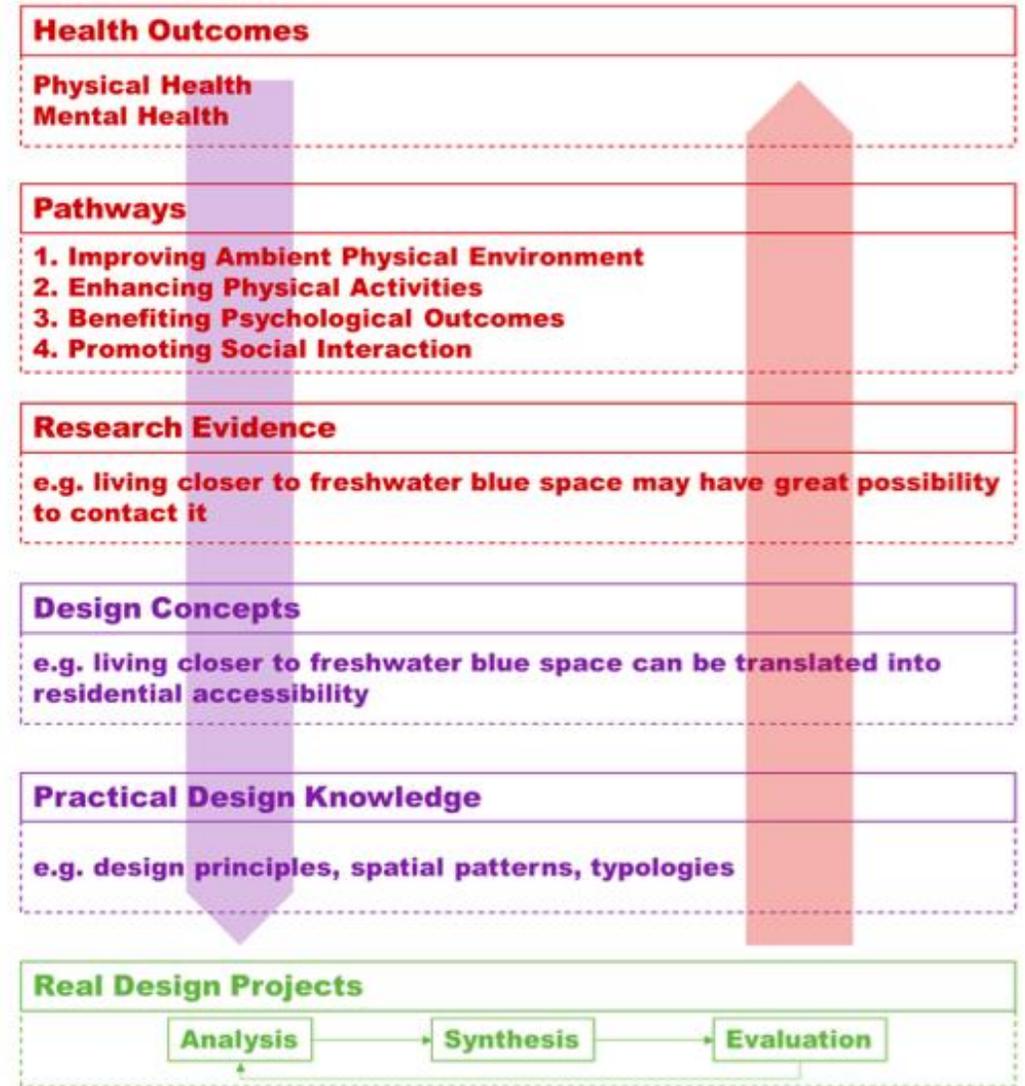


Fig. 1. A framework linking freshwater blue space design and human health.

# PRISMA Systematic review proposta 3.

## Urban greenness and QI in children.



### **KEYWORDS:**

Urban greenness - green spaces – Urban Environments - Urban health – Children health – QI – Child intelligence, mental development.