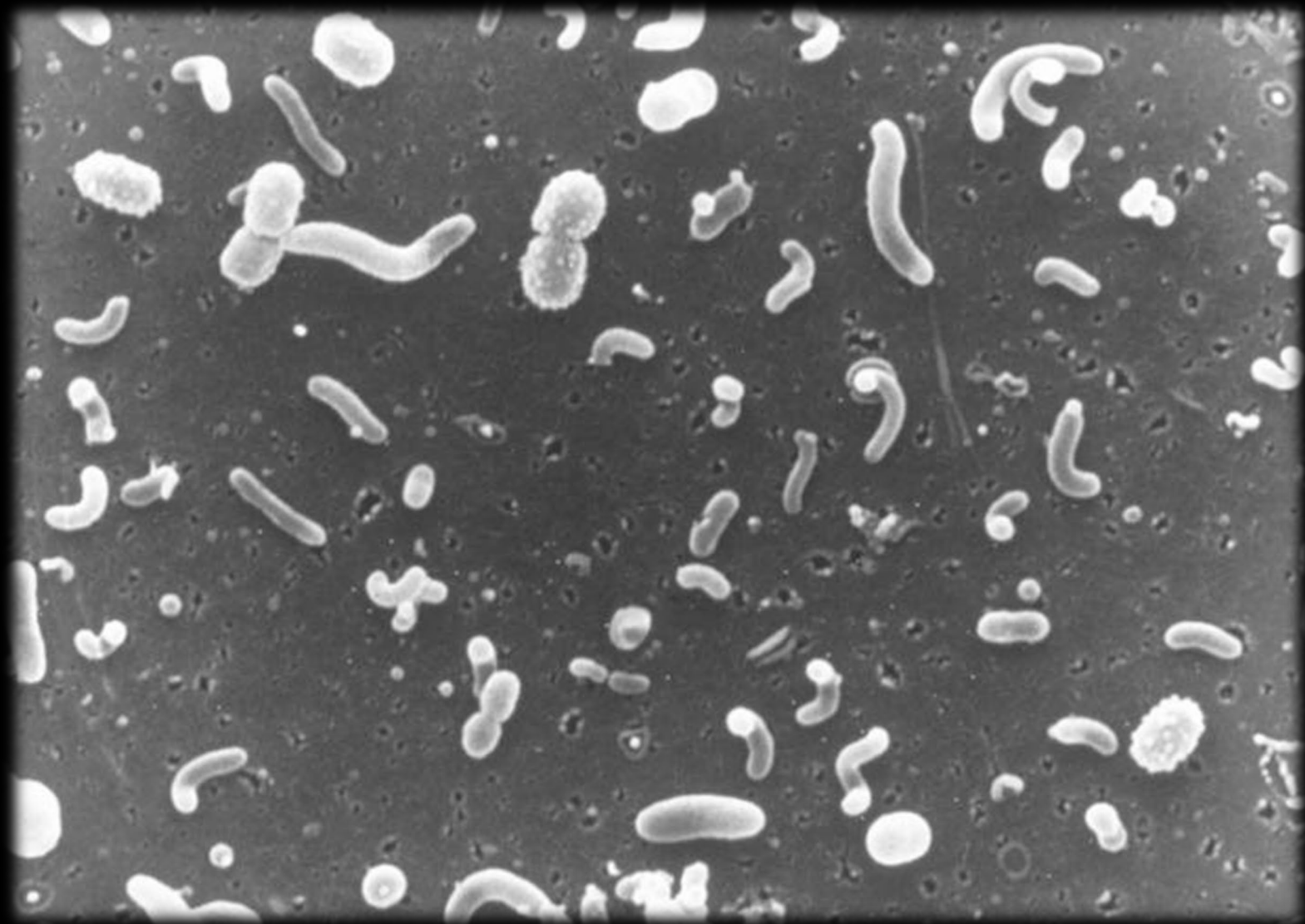


KLIMATEFFEKTER PÅ SJÖARNAS MIKROORGANISMER (MED FOKUS PÅ PATOGENER)



Stefan Bertilsson

INSTITUTIONEN FÖR VATTEN OCH MILJÖ, SLU







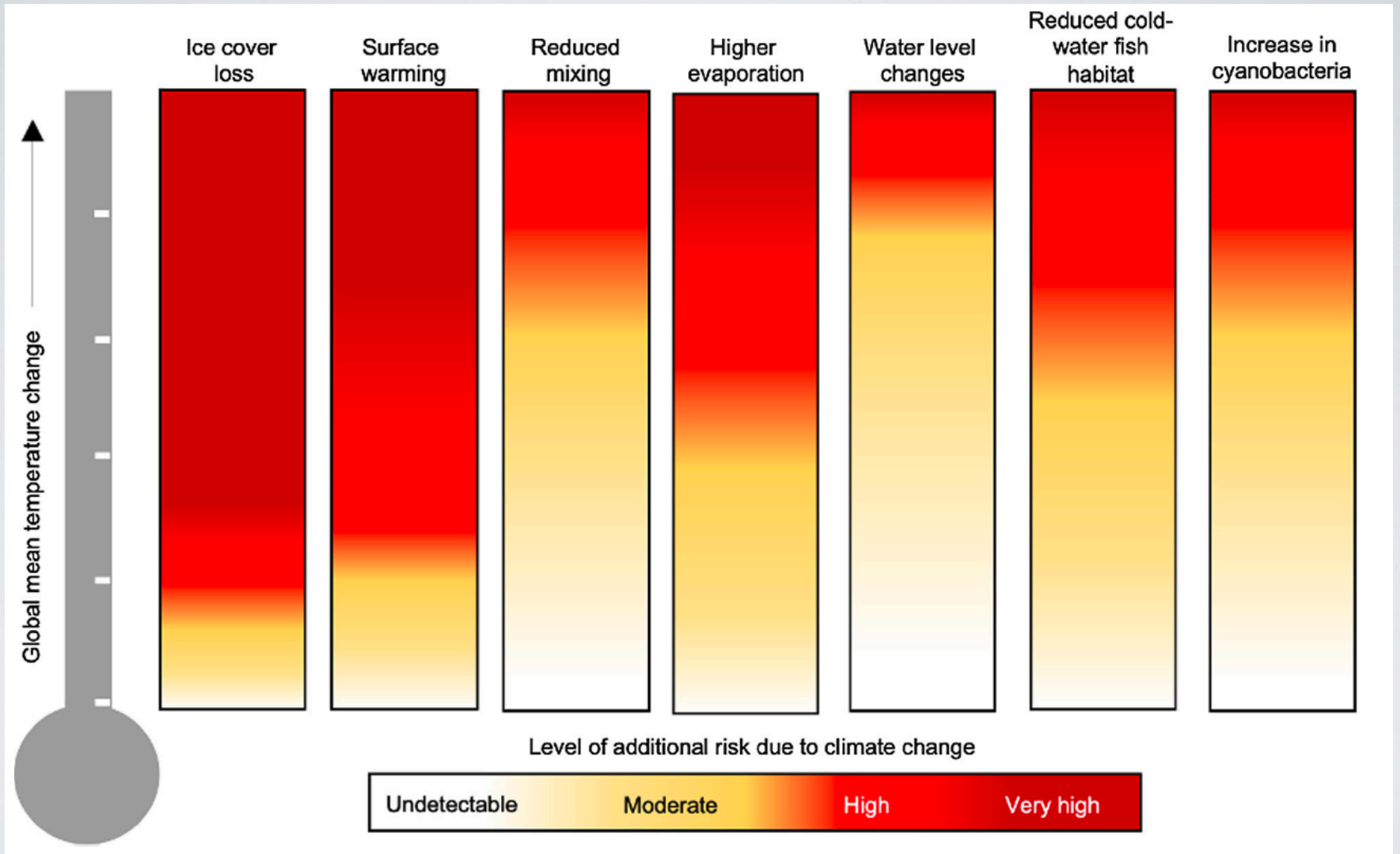




Foto: J. Edberg

UPPSALA CENTRALSTATION 2021



Avloppsvatten släpptes ut i Mälaren: "Ohälsosamma bakterier"

Publicerad 2024-07-01



Saltsjön i Stockholm. Foto: Henrik Montgomery/TT

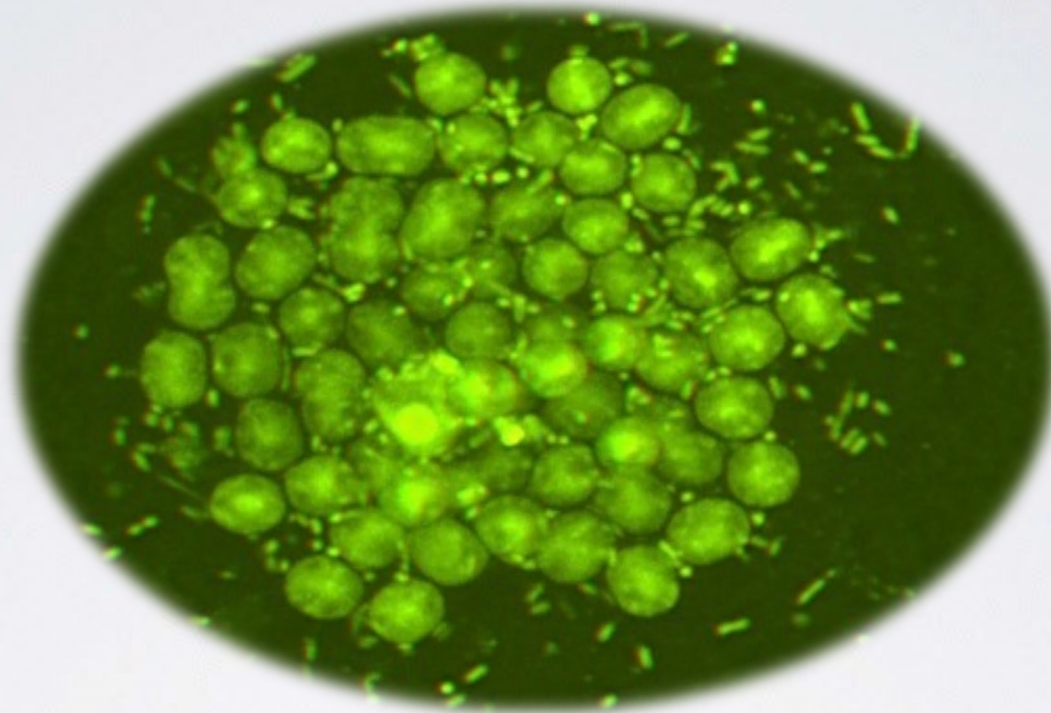
100 miljoner liter orenat avloppsvatten släpptes ut i sjöar och vattendrag i Stockholm.

– Det kan föra med sig ohälsosamma bakterier i vattnet, säger Linda Evjen, utredningsingenjör vid Stockholm vatten och avfall.





Cyanobacterier gynnas (generellt) av klimatförändringar
Toxin-producerande stammar ökar
Men: Mängden toxin per cell minskar



“Higher temperatures consistently increase the likelihood of microcystin occurrence but that the probability of microcystin concentrations above water quality thresholds is highest for water temperatures between 20 and 25 degrees C. **Regions with temperatures that promote microcystin will shift to higher latitudes in the coming decades**”

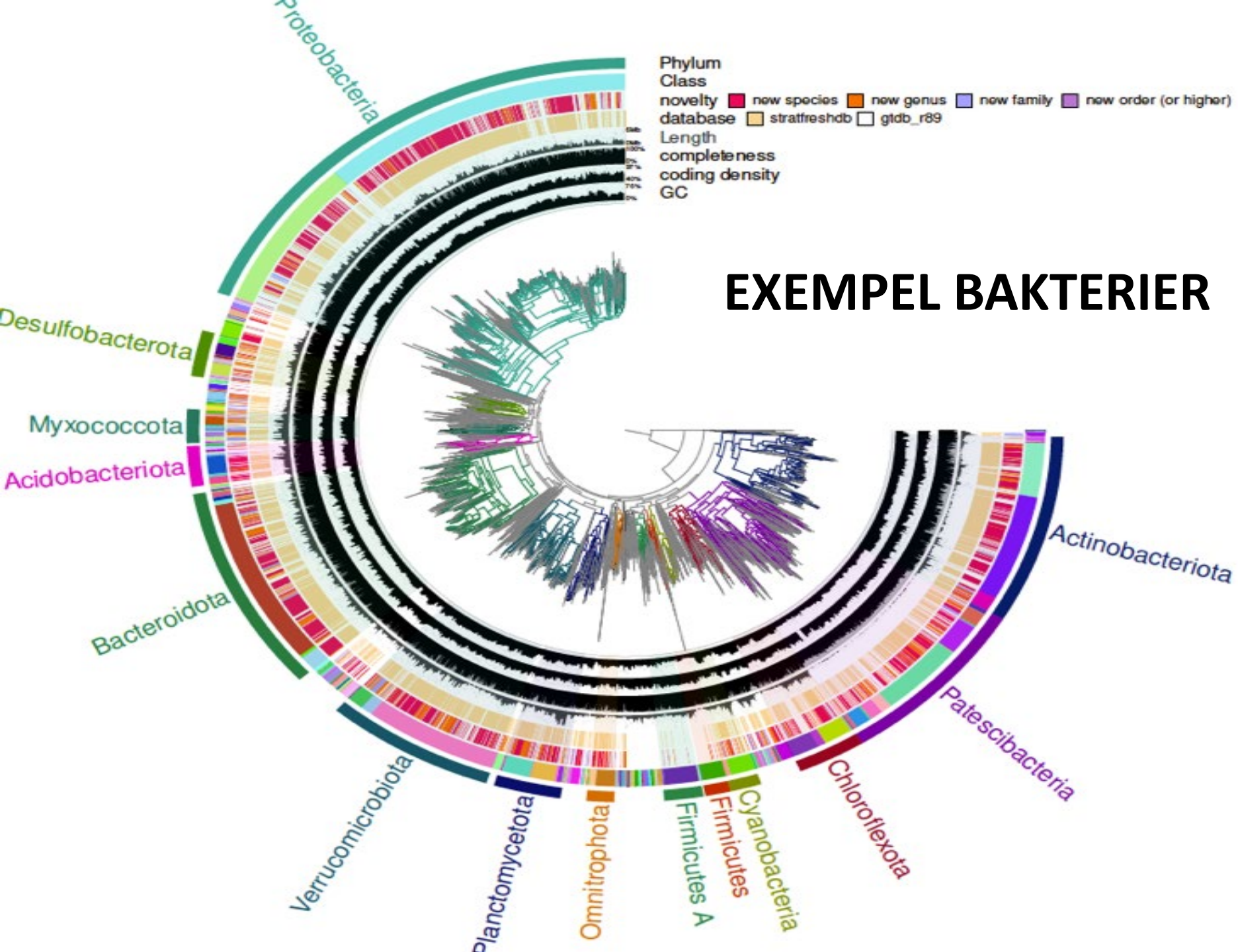
**FÖRHÖJDA TEMPERATURER OCH ORGANISKT KOL FRÅN
VÄXTPLANKTON GYNNAR E.G. VIBRIO CHOLERAЕ**



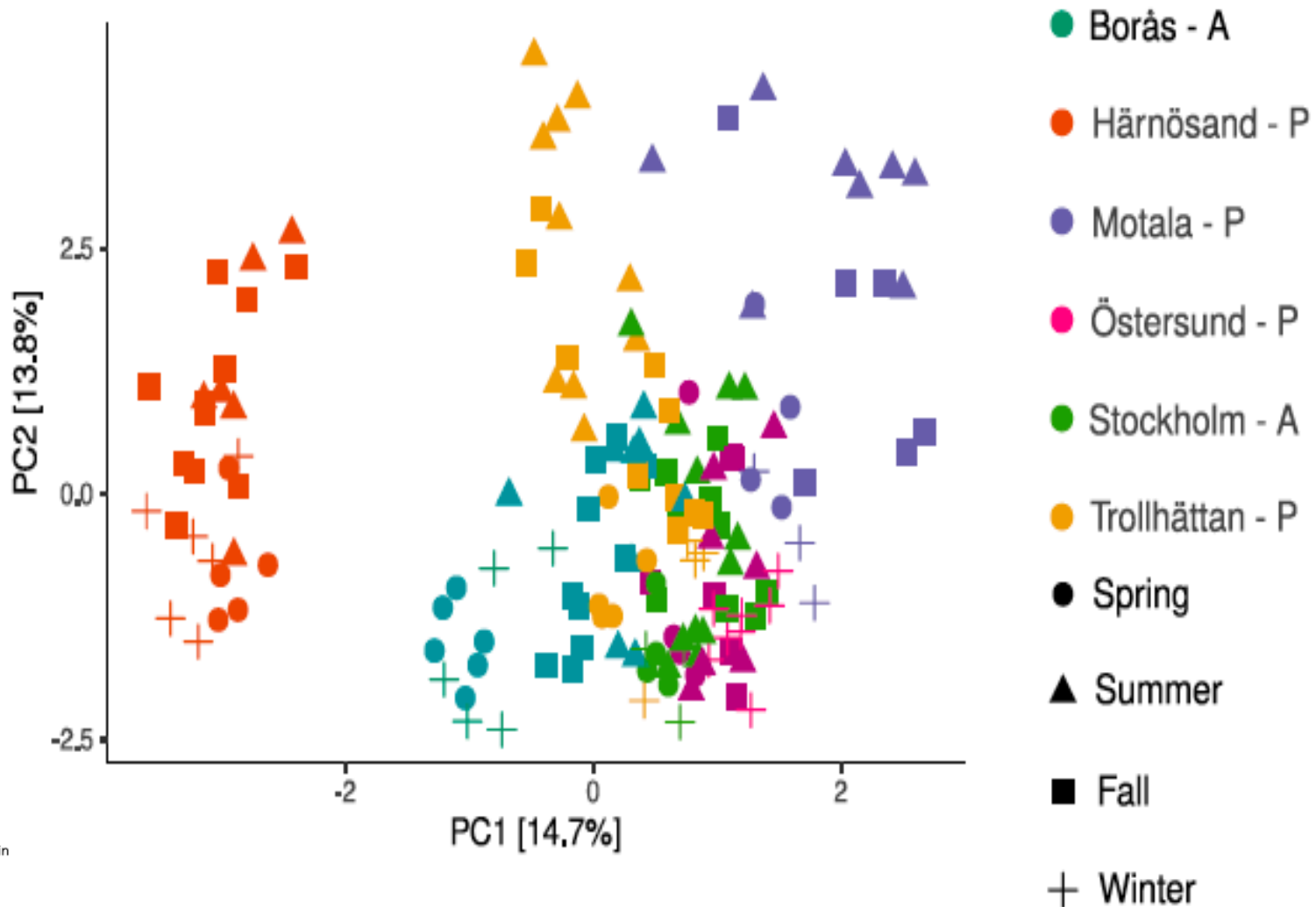
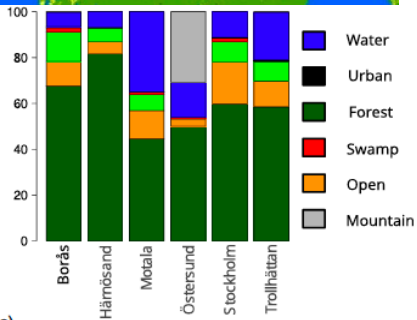


ARTRIKA MIKROBIELLA SAMHÄLLEN I VÅRA SJÖAR

BAKTERIER, VÄXTPLANKTON, VIRUS, PROTOZOER, SVAMPAR



MILJÖFAKTORER AVGÖRANDE



VATTENBURNA MIKROBIELLA PATOGENER

pathogen	source		
	human	animal	environmental
<i>Acanthamoeba</i>	-	-	+
<i>Adenovirus</i>	+	+	-
<i>Aeromonas</i>	+	+	+
<i>Cryptosporidium</i>	+	+	-
Cyanobacteria	-	-	+
<i>E. coli</i> O157	+	+	-
Enterovirus	+	+	-
<i>Trichophyton mentagrophytes</i> var. <i>interdigitale</i>	+	-	-
<i>Trichophyton rubrum</i>	+	-	-
<i>Giardia</i>	+	+	-
Hepatitis A virus	+	-	-
<i>Legionella</i>	-	-	+
<i>Leptospira</i>	-	+	-
<i>Molluscipoxvirus</i>	+	-	-
<i>Mycobacterium</i> (nontuberculous mycobacteria)	-	-	+
<i>Naegleria fowleri</i>	-	-	+
Norovirus	+	-	-
Papillomavirus	+	-	-
<i>Pseudomonas aeruginosa</i>	-	-	+
Rotavirus	+	-	-
<i>Shigella</i>	+	+	-
<i>Staphylococcus aureus</i>	+	-	-
<i>Trichobilharzia</i>	-	+	-
<i>Vibrio</i>	+	+	+

RELEVANTA I SVERIGE?

Organism	Survival and growth in raw water ^a	Infection dose ^b	Confirmed agent in illness outbreaks via drinking water in Sweden after 1980
Bacteria			
Burkholderia pseudomallei	Long, can grow	High	No
Campylobacter spp.	Moderate	Low	Yes
Pathogenic E. coli	Moderate	Low	Yes
Francisella tularensis	Long	Low	No
Legionella	Long, can grow	Moderate	No
Mycobacteria (not tuberculous)	Long, can grow	?	No
Salmonella spp.	Long, can grow	High	Yes
Shigella spp.	Card	Low	Yes
Vibrio cholerae	Long	High	No
Virus			
Adenovirus	Long	Low	No
Astroviruses	Long	Low	No
Enterovirus	Long	Low	No
SEA	Long	Low	No
HEV	Long	Low	No
Calicivirus			
Norovirus	Long	Low	Yes
Sapovirus	Long	Low	No
Rotavirus	Long	Low	No
Protozoa			
Acanthamoeba	Long, can grow	Low	No
Cryptosporidium spp.	Long	Low	Yes
Cyclospora cayatanensis	Long	Low	No
Entamoeba histolytica	Moderate	Low	Yes
Giardia spp.	Moderate	Low	Yes
Naegleria fowleri	Long, can grow	Moderate	No

Impact of climate change on microbiological hazards in food and drinking water in Sweden

Risk profile

- Bacteria: *Campylobacter* spp., different groups of pathogenic *E. coli*, *Francisella tularensis*, *Salmonella* spp., *Shigella* spp., *Vibrio cholerae*
- Virus: calicivirus (noro- and sapovirus), HAV, adenovirus, astrovirus, rotavirus
- Protozoa/parasites: *Cryptosporidium* spp., *Entamoeba histolytica*, *Giardia* spp., *Cyclospora cayentanensis*



VARIERANDE EFFEKT AV KLIMATFÖRÄNDRINGAR

Tillväxer: *Aeromonas*, *Vibrio*, *Mycobacteria*, *Pseudomonas aeruginosa*, *Naegleria fowleri*

Vektor-drivna: *Legionella*, *trichobilharzia*,

Fekala: *E. coli O157*, *Shigella*, *Cryptosporidium*, *Giardia*, *adenovirus*, *enterovirus*, *Leptospira*,

- Förhöjd vattentemperatur (direkta och indirekta effekter):

- Hydrologiskt flöde

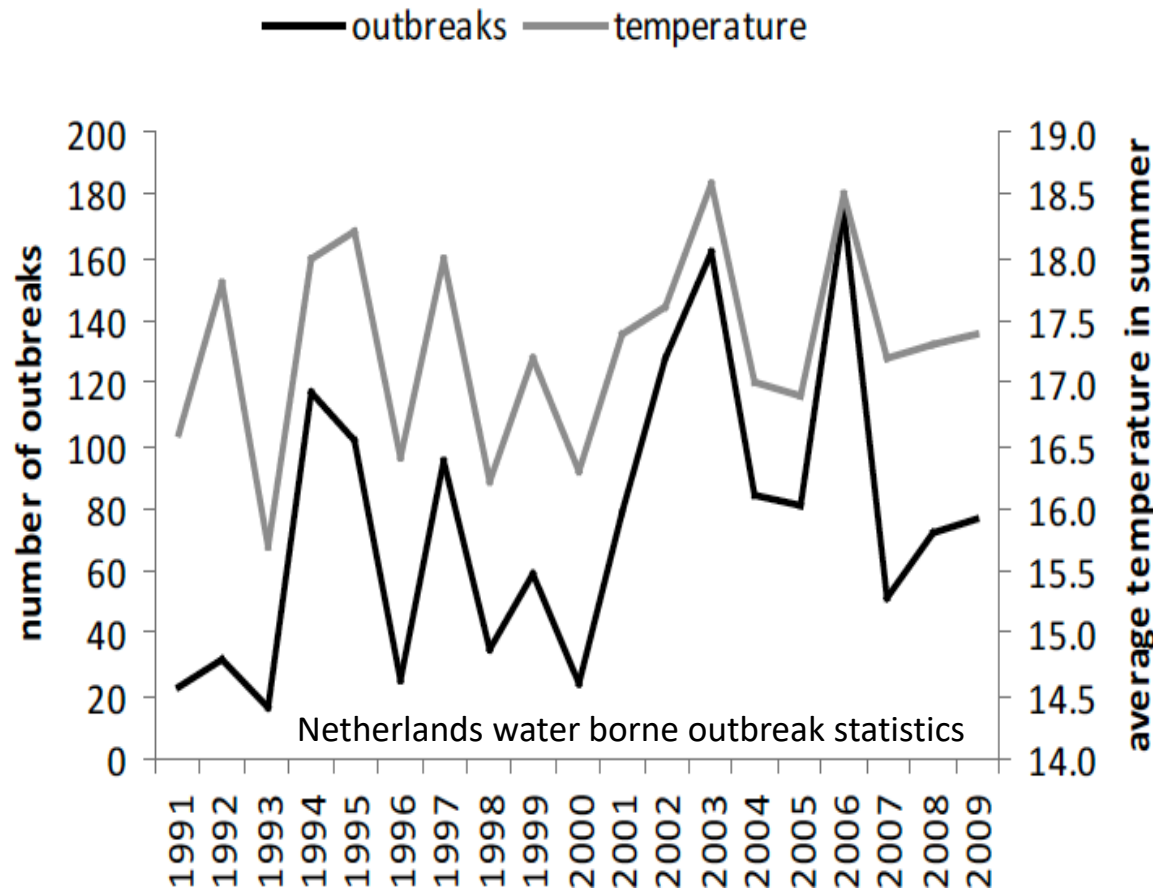
-översvämningar

-ytavrinning

-breddande avlopp/WWTP

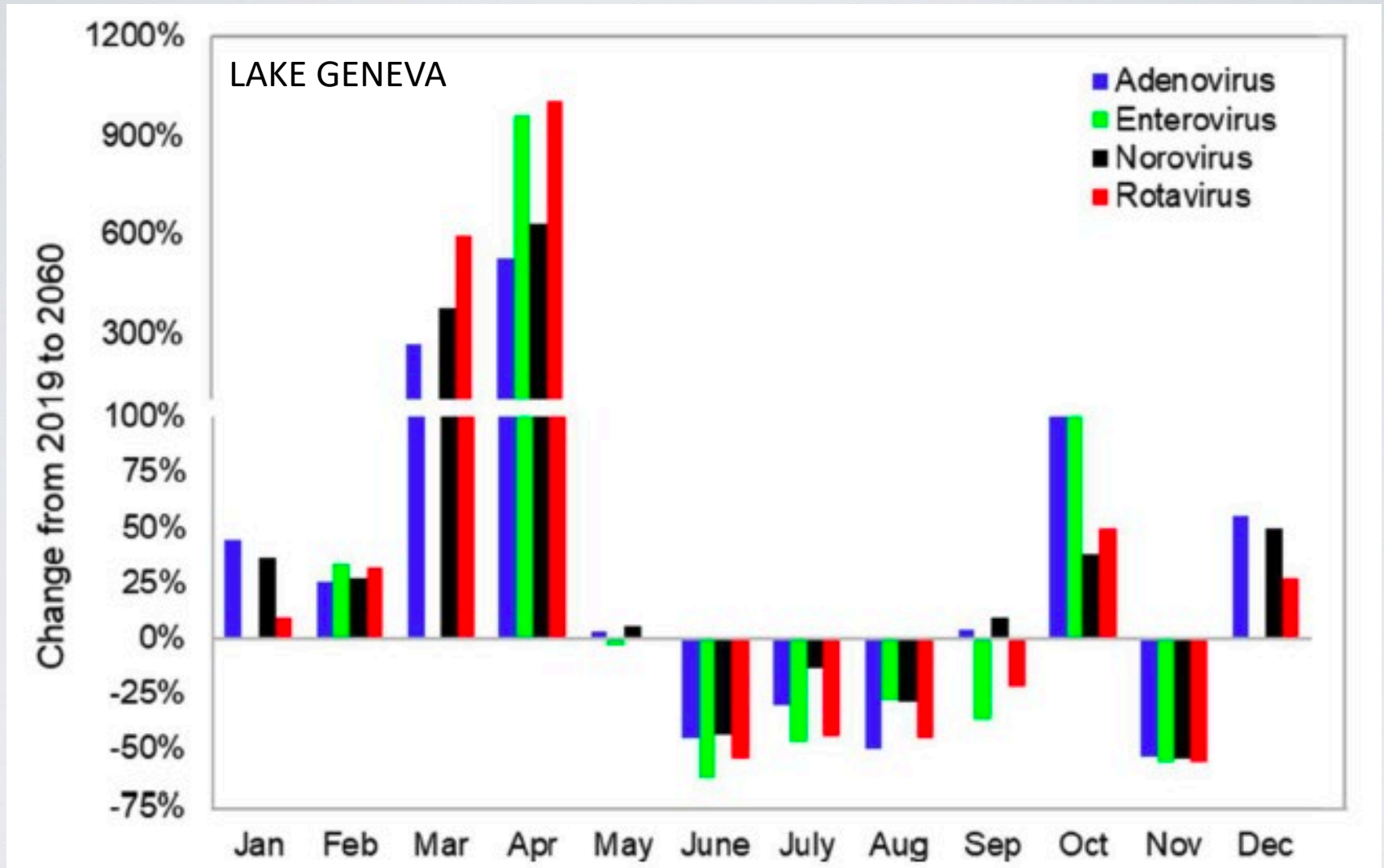
- Resuspenderade sediment

- Säsongsvariation



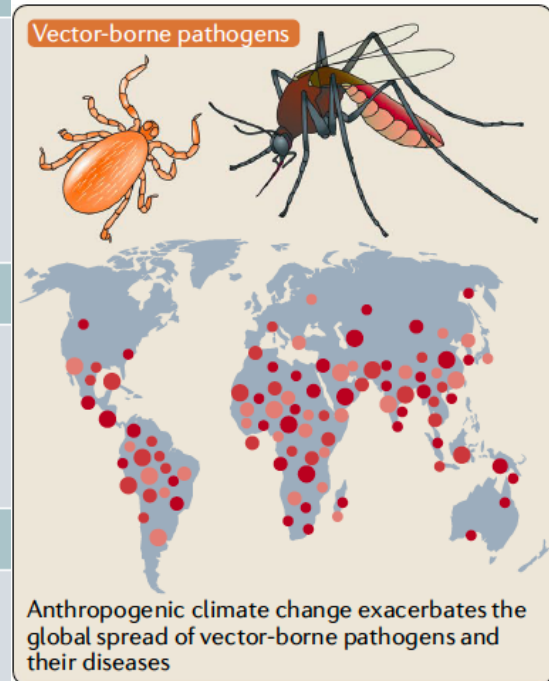
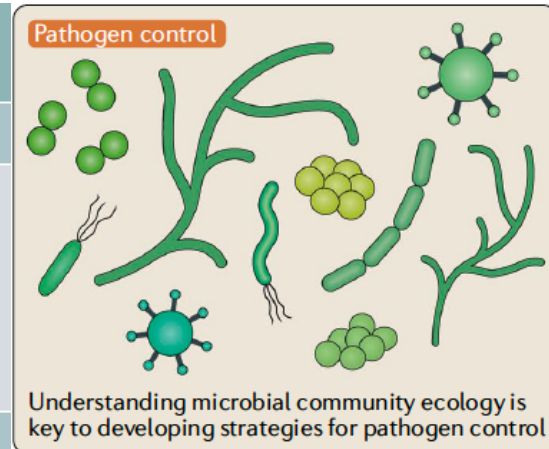
Climate change	Environmental effect	Recreational water-transmitted pathogen fate and behaviour	Recreational water-transmitted pathogens, examples	Recreational water types affected
Temperature increase	Water temperature increase	Growth of pathogens	<i>Acanthamoeba</i> , <i>Aeromonas</i> , Cyanobacteria, <i>Naegleria fowleri</i> , <i>Pseudomonas aeruginosa</i> , <i>Trichobilharzia</i> , <i>Vibrio</i>	Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features
		Inactivation/die-off of pathogens	Adenovirus, <i>Cryptosporidium</i> , <i>E. coli</i> O157, enterovirus, <i>Giardia</i> , hepatitis A virus, <i>Leptospira</i> , norovirus, rotavirus, <i>Shigella</i> , <i>Staphylococcus aureus</i> ,	Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features
	Elevated water temperature and water flow	Elevated concentrations of pathogens in surface water	Adenovirus, <i>Cryptosporidium</i> , <i>E. coli</i> O157, enterovirus, <i>Giardia</i> , hepatitis A virus, norovirus, rotavirus, <i>Shigella</i>	Surface water (fresh and marine)
Rainfall intensity and frequency	Run-off, sewage overflows and flooding	Intensity and frequency of peak concentrations of pathogens in surface water	Adenovirus, <i>Cryptosporidium</i> , <i>E. coli</i> O157, enterovirus, <i>Giardia</i> , hepatitis A virus, norovirus, rotavirus, <i>Shigella</i>	Surface water (fresh and marine)
	Resuspension of river sediments			
Water availability	Decrease in water volume	Pathogen concentrations	<i>Acanthamoeba</i> , <i>Aeromonas</i> , Adenovirus, <i>Cryptosporidium</i> , Cyanobacteria, <i>E. coli</i> O157, enterovirus, <i>Giardia</i> , hepatitis A virus, <i>Leptospira</i> , norovirus, rotavirus, <i>Shigella</i> , <i>Staphylococcus aureus</i> , <i>Trichobilharzia</i> , <i>Vibrio</i>	Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features
	Changes in physiochemical composition of water e.g. salinity	Inactivation/die-off of pathogens	<i>Acanthamoeba</i> , <i>Aeromonas</i> , Adenovirus, <i>Cryptosporidium</i> , Cyanobacteria, <i>E. coli</i> O157, enterovirus, <i>Giardia</i> , hepatitis A virus, <i>Leptospira</i> , norovirus, rotavirus, <i>Shigella</i> , <i>Staphylococcus aureus</i> , <i>Trichobilharzia</i>	
		Growth of pathogens	<i>Vibrio</i>	
	Decrease in availability of recreational water sites			Surface water (fresh and marine), natural or green pools, paddling pools, interactive water features

VIRUS-HALTER NU OCH FRAMÖVER: VAD KAN VI FÖRVÄNTA OSS?



BREDDAT PERSPEKTIV

Example pathogens or diseases	Climatic and environmental factors	Transmission parameters
Vector-borne		
West Nile virus	Precipitation, relative humidity, temperature, El Niño Southern Oscillation	Vector abundance, longevity and biting rate, pathogen replication rate in vector ²⁷³⁻²⁷⁶
Malaria		
Dengue fever		
Lyme disease		
Waterborne		
Cholera	Temperature, precipitation variability, salinity, El Niño Southern Oscillation	Pathogen survival, pathogen replication in environment, pathogen transport ^{244,277-279}
Non-cholera <i>Vibrio</i> spp.		
<i>Cryptosporidium</i> spp.		
Rotavirus		
Airborne		
Influenza	Relative humidity, temperature, wind	Pathogen survival, pathogen and/or host dispersal ²⁸⁰⁻²⁸⁴
Hantavirus		
Coccidioidomycosis		
Foodborne		
<i>Salmonella</i> spp.	Temperature, precipitation	Pathogen replication, human behaviour ^{239,240}
<i>Campylobacter</i> spp.		



CONSENSUS STATEMENT

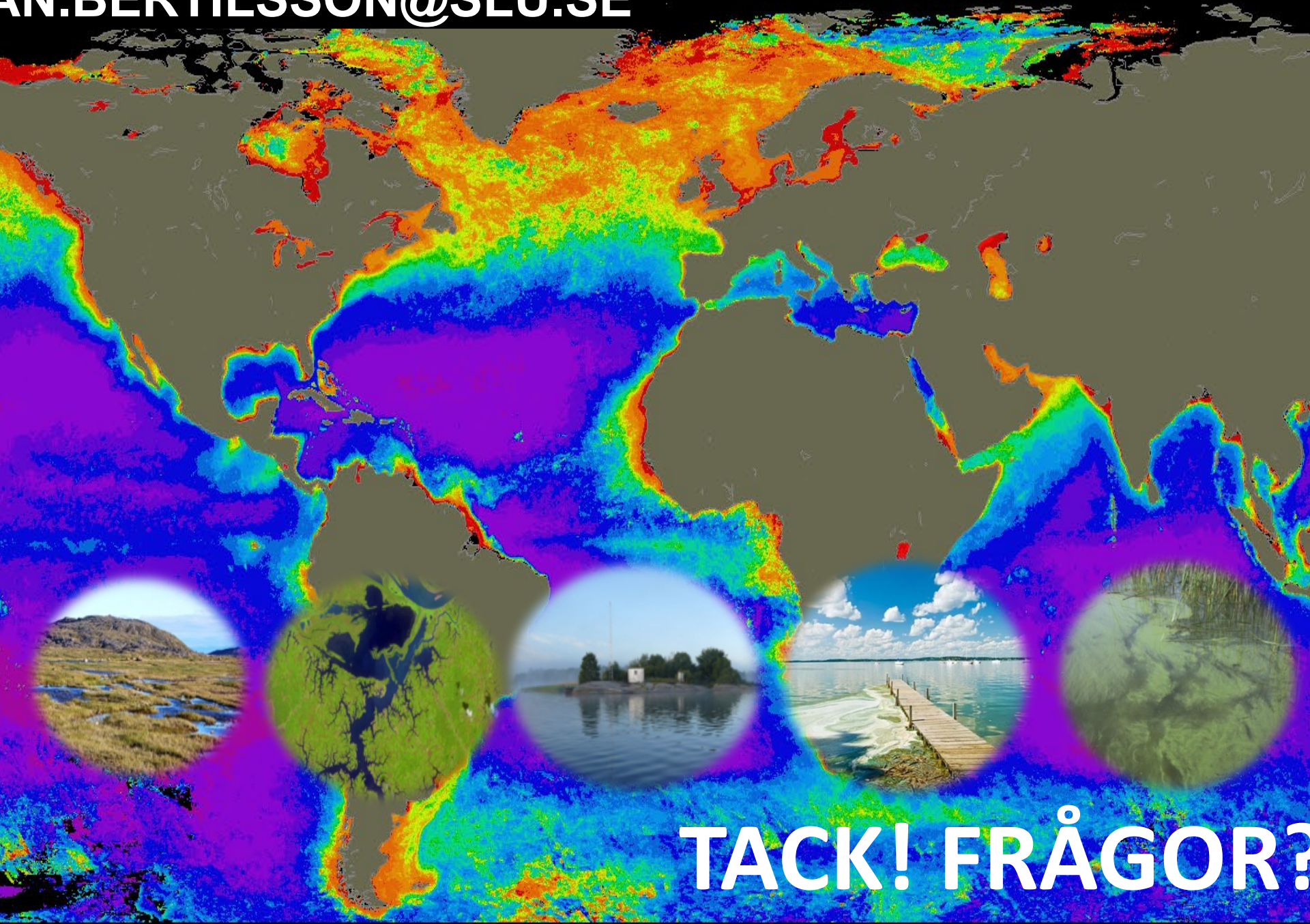
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Scientists' warning to humanity: microorganisms and climate change

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- **BEHOV AV MILJÖMIKROBIOLOGISK BASKUNSKAP FÖR MÄLAREN (OCH ANDRA DRICKSVATTENTÄKTER)**
- **ÄMNESÖVERSKRIDANDE FORSKNING OM MIKROBIELLA RISKER I FRAMTIDA KLIMATSCENARIER**
- **HUR BYGGER VI “KLIMATSÄKRADE” VATTENVERK**
- **MIKROBIELLT MEDVETEN SAMHÄLLSPLANERING**

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TACK! FRÅGOR?